AFRICA ENVIRONMENT OUTLOOK 2

Our Environment, Our Wealth

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FOREWORD

Economic development in Africa is underpinned by the quality and integrity of the natural resource base. The region's environmental assets provide opportunities for Africa to achieve the objectives of the New Partnership for Africa's Development (NEPAD) and make good progress towards meeting the targets of the Millennium Development Goals (MDGs). Africa cannot, therefore, afford to lose its environmental assets through degradation. Hundreds of millions of people depend directly or indirectly on these resources. African governments acknowledge this fact and have put in place measures to safeguard this valuable asset, including the adoption of the landmark Lagos Plan of Action in 1980. The Plan proposed concrete measures to address the interface between environment and development, and stipulated, among others, the need for African governments to define realistic policy options, strategies and programmes for incorporating environmental considerations in development planning.

African leaders established the African Ministerial Conference on the Environment (AMCEN) in 1985 to enhance regional cooperation in environmental policy responses and on technical and scientific activities to minimize degradation and to place a premium on the environmental goods-and-services which are essential to achieve sustainable development. AMCEN is the apex body on environment in Africa and has, despite various resource and capacity challenges, successfully provided regional leadership and environmental policy direction for more than 20 years. To continue doing this in a rapidly globalizing world, there is a need for a dynamic and strategic vision supported by a strong information base. Therefore, AMCEN continues to strengthen the *Africa Environment Outlook* (AEO) reporting initiative since its inception in 2000 during the 8th session in Abuja. The AEO is a flagship report which tracks regional environmental state-and-trends as well as emerging issues.

Since the publication and launch of the first report in July 2002, strategic planning within the environment landscape in Africa has changed. The environmental reporting framework at the national and sub-regional levels has been significantly strengthened and some 22 countries and five sub-regions have produced their environment outlook reports using the AEO methodology. The report had a major influence on Africa's position during the World Summit on Sustainable Development (WSSD), which was held in Johannesburg in August 2002. It was also used in the development of the Environmental Initiative of NEPAD which was adopted in 2003 by the African Union as the framework plan for environmental programmes in the region. This is a clear link between environmental assessment and policy making of which we are proud.

Building on the momentum generated by the first report, AMCEN, with the support of the United Nations Environment Programme (UNEP), has over the past four years produced the second *Africa Environment Outlook – Our Environment, Our Wealth* (AEO-2) report. We are proud of this report, which highlights the central position Africa's environment continues to play in sustainable development, enhancing human well-being. It also flags the many opportunities the environment in Africa provides to eradicate extreme poverty and hunger, greatly enhance accessibility by the majority to safe drinking water and improved sanitation as well as achieve tremendous progress in the implementation of the MDGs.

The AEO-2 report is the achievement of Africa's institutions and experts, and is a further demonstration that Africa has the human resources and skills to chart its own destiny and realize the dream of an African renaissance. All that is needed is the political will and commitment to translate the scientific findings into action on the ground. I would like to commend all the experts, AEO collaborating centres and other stakeholders who, through their expertise and voluntary contribution to the process, have made this report possible and a worthy contribution to the body of knowledge on the African environment.

It is my hope that this report will inspire decision-makers, at all levels in the region, as we pursue our goals of sustainable development in Africa. I wish you all good reading.

Dr. Abdul-Hakim Rajab Elwaer

Secretary of the Peoples' Committee of Environment General Authority, Libyan-Jamahiriya and President of the African Ministerial Conference on the Environment (AMCEN)

PREFACE

If we are to take measures that will make a genuine difference to the lives of the 800 million people in Africa, to future generations and the environment upon which so many depend we need sound-and-solid science.

The second *Africa Environment Outlook – Our Environment, Our Wealth* (AEO-2), is a key contribution to this sound-and-solid science urgently needed for equally sound-and-solid policy making in this rich and extraordinary region.

It highlights the past, it assesses the present and also looks to the future using various plausible scenarios to highlight how a range of inter-related measures may enhance or undermine Africa's environmental wealth.

Wealth based on the land, lakes, rivers and forests, on the wildlife and landscapes and on the beautiful and bountiful marine areas. Wealth based on Africa's human resources. These and other equally important resources represent immense opportunities for Africa and for the rest of the world through cooperation and trade.

I hope these thoughtful and thought-provoking analyses will help those responsible to balance social and economic concerns with environmental ones. This is needed if Africa is to succeed in achieving the Millennium Development Goals on water and sanitation, extreme poverty and hunger, as well as curbing infectious diseases and addressing gender issues.

It is clear from this excellent report – produced by UNEP for the African Ministerial Conference on the Environment (AMCEN) – and others such as the recent Millennium Ecosystem Assessment that the environment is critical for overcoming poverty.

It is also clear that the environment has its role to play in building cooperation and in defusing tensions – it is the peace policy of the 21st century. The level of damaging conflicts witnessed during the later half of the 20th century is mercifully waning.

The AEO-2 report comes at an important time for the region. Positive changes are occurring in no small part due to the efforts of the African Union and the New Partnership for Africa's Development (NEPAD).

A number of Africa's governments are also putting significant efforts into mainstreaming the environment in Poverty Reduction Strategy Papers (PRSPs), proving that the environment is not a luxury but essential to lives and livelihoods.

The AEO-2 focuses on Africa's abundant natural resources, including mineral holdings. These have huge potential. For example, seven per cent of the known global oil reserves and important quantities of the metal coltan used in mobile phones are found here.

Sustainably used and managed, with benefits equitably shared, Africa's abundant natural resources could lift millions of people out of poverty.

The report looks at emerging challenges facing Africa. These include genetically modified crops, chemicals, including the shift of manufacturing from developed to developing countries, and the huge costs linked with the spread of invasive alien species.

UNEP, in cooperation with African countries, regional bodies, multilateral environmental agreements, United Nations agencies, bilateral donors and civil society, is actively addressing such challenges. We hope the recently agreed Bali Strategic Plan on Technology Support and Capacity-Building will help further in strengthening individual African countries' ability to address these challenges.

In many ways the AEO-2 is Bali in action. The Africa Environment Information Network (AEIN) has played a crucial role in ensuring the quality of the report and capacity-building. This will be further strengthened by UNEP's new initiative to watch the environment. I would also like to acknowledge the important role of the NEPAD Secretariat, the African Union, the Economic Commission for Africa and other groupings as well as UNEP Collaborating Centres, in the AEO process, including peer review.

It is not a cliché to say that the Africa of the early 21st century is at a crossroads. Countries are confronted with many remaining and emerging problems. But there is a new spirit, a new optimism that a healthy, just and equitable, and prosperous future is possible.

UNEP, with its headquarters in Africa, is fully aware of its responsibilities in realizing this bright future. Like our African partners, we are fully aware that the environment is vital for development and crucial for this success.

Achim Steiner

United Nations Under-Secretary General and Executive Director, United Nations Environment Programme

INTRODUCTION

"Human development is about freedom. It is about building human capabilities – the range of things people can do, and what they can be. Individual freedoms and rights matter a great deal, but people are restricted in what they can do with that freedom if they are poor, ill, illiterate, discriminated against, threatened by violent conflict or denied a political voice."

HUMAN DEVELOPMENT REPORT 2005 (UNDP 2005)

BACKGROUND

The theme of the *Africa Environment Outlook 2 – Our Environment, Our Wealth* is Environment for Development. This is inspired by two landmark documents of the United Nations (UN) – the Brundtland Commission's report, Our Common Future, and Agenda 21 – and Africa's own vision of renaissance.

In 1987, the Brundtland Commission advised that:

> "The downward spiral of poverty and environmental degradation is a waste of opportunities and of resources. What is needed now is a new era of economic growth – growth that is forceful and at the same time socially and environmentally sustainable" (WCED1987).

Echoing this approach the United Nations Conference on Environment and Development (UNCED), in its environmental programme of action, Agenda 21 reaffirmed the links between environment and development, drawing attention to the fundamental connection between environmental goods-and-services and human well-being:

> "Integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future" (UN 1992).

Building on this vision, *Africa Environment Outlook 2 – Our Environment, Our Wealth* (AEO-2) profiles Africa's environmental resources as an asset for the region's development. The assessment highlights the opportunities presented by the natural resource base to support development and the objectives of the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The report reaffirms the need for sustainable livelihoods, and the importance of environmental initiatives in supporting them. The emphasis is put on *what should and can be done with existing (remaining) environmental assets*, in the context of identified constraints (issues), rather than focusing on what has been (already) lost.

The following are particularly illustrated:

- *adding value* to the resource that still exists (or remains);
- *using natural resources efficiently* (and sustainably) to derive maximum benefit ;
- *mitigating* the constraints and negative effects;
- *maximizing the total value of Africa's natural assets*;
- making a case for *safeguarding and improving* the remaining assets; and
- converting the current environmental challenges into *opportunities for development*.

THE AEO-2 PROCESS

The Africa Environment Outlook (AEO) reporting process was initiated in 2000 by the African Ministerial Conference on the Environment (AMCEN). The first report, AEO-1, was launched during AMCEN's 9th session in Kampala in July 2002, where it was acknowledged as a flagship publication. This report has continued to inspire dialogue in the region and has been used as the primary background document in the preparation of the NEPAD Environment Action Plan (NEPAD-EAP) – showing strong links between environmental assessment and policy making. The 10th

AMCEN session, in June 2004, reaffirmed its endorsement of the AEO process as a valuable monitoring and reporting tool for sustainable environmental management and to provide a framework for national, sub-regional and regional integrated environmental assessment and reporting in Africa.

During the 22nd session of the UNEP Governing Council/Global Ministerial Environment Forum, held in February 2003 in Nairobi, the AMCEN decision on the AEO process was endorsed under decision GC 22/9, which recommended that UNEP continue to support the process. In May 2003, UNEP's Division of Early Warning and Assessment (DEWA) launched the process of preparing the second report, *Africa Environment Outlook 2 – Our Environment, Our Wealth* (AEO-2).

The AEO-2 process has been participatory, with inputs by scientists and other experts from national and sub-regional institutions in Africa. The Collaborating Centres (see Figure 2), using their national networks and capacities built through the Global Environment Outlook (GEO) process, coordinated inputs and the peer reviews in their sub-regions. Capacity-building is an integral part of the AEO process. Through collaboration with experts and stakeholders at multiple levels, the process has enhanced ability at the national level to undertake effective state of the environment assessments, in a way that is policy relevant.

Throughout the process, the AMCEN Inter-Agency Technical Committee (IATC) provided policy guidance. The committee reviewed and approved the proposed structure of the report in March 2004. In February 2005, IATC endorsed the draft recommendations of the report for approval by the AMCEN special session which met in Dakar in March 2005. The final draft report was presented to IATC for a final review and approval for publication in November 2005.

STRUCTURE

AEO-2 provides a comprehensive assessment of environmental state-and-trends, and the implications of this for human well-being and development. The assessment includes an analysis of policy responses and the opportunities available to policymakers to maximize the benefits offered by the environment. It addresses five consecutive and inter-related questions:

- How and why is the environment important from a human perspective?
- How is the environment changing, and why, and what opportunities does it hold?
- Are there special issues, which affect the environment and development, that require immediate attention and new approaches?
- How will different policy choices affect the future?
- What can be done to ensure that environmental value is retained and the lives of people are improved?

To answer these questions the report is divided into five sections:

- Section 1: *Environment for Development* sets the overall context for the analysis, in particular highlighting the human dimension in the environment-human nexus.
- Section 2: *Environmetal State-and-Trends: 20-Year Retrospective* provides an integrated assessment of environmental change, and its relationship to development opportunities.
- Section 3: *Emerging Challenges* analyses four important issues, that emerge from Section 2 as policy challenges, with wide-reaching implications for human well-being, development and the state of the environment.
- Section 4: *Outlook* considers, through scenario analysis, how different policy choices can shape future outcomes.
- Section 5: *Policy Opportunities* identifies policy options, directly related to sections 2 and 3, which might be adopted in order to achieve Africa's environmental and development objectives.

Section 1: *Environment for Development* provides the setting for the assessment and analysis in AEO-2. Chapter 1: *The Human Dimension* explores the linkages between environmental goods-and-services, development and human well-being. The departure point for the chapter is that people and livelihoods are at the centre of the concern for sustainable development and that, consistent with Africa's policy and environmental law, people are entitled to a healthy and productive life in harmony with nature. The chapter's main message is that the environment offers a multitude of opportunities for fundamentally reshaping well-being and development, in a way that is consistent with Africa's priorities.

In demonstrating this, the chapter has three distinct focuses. First, it considers the relationship between human well-being and development, and environmental change. Second, the success of policy in supporting sustainable livelihoods and development is evaluated. And third, the opportunities for enlarging and enhancing the range of available and sustainable development options are discussed.

In examining the relationship between sustainable development and human opportunities, a broad view of the livelihoods concept is taken. Livelihoods are considered to extend from those in which people are wholly dependent on natural resource systems, for subsistence, to those based entirely on wage earning or trade. The chapter begins by discussing the main human drivers of environmental change and considers how these impact on human well-being and development. It looks specifically at demographic change; social change including gender and the division of labour, health, education, knowledge and information, and poverty; economic change including production and consumption patterns; and technological change. This analysis of the environment-human nexus is brought together in a discussion about the concept of livelihoods, and the multiple values associated with environmental goods-and-services and their role in the achievement of sustainable livelihoods. These values may be broadly divided into use and non-use values. Use values include direct use of environmental goods, such as their use as food, energy and economic goods, and indirect uses including the many services the environment provides, such as flood regulation. Non-use values are often not as clearly acknowledged or accounted for. These values may be closely associated with cultural values or securing future options. In some societies in Africa, not only are natural resources important, as economic assets, but they often are an important part of social identity. The integrated and multidimensional discussion of livelihoods and environmental value sets the basis for evaluating and determining policy.

In discussing the different policy initiatives, which have been adopted in response, focus is placed on how these have influenced the environment-human nexus at regional, sub-regional, national and local levels. The Brundtland Commission Report, UNCED, the World Summit on Sustainable Development (WSSD), the NEPAD-EAP, and the AU's Africa Convention on Nature and Natural Resources (ACCNNR) are used to identify the policy priorities of Africa and to evaluate the progress made, or lack of it, and the lessons learnt. Key focal points in the analysis include approaches to participation and the changing role of civil society, environment for development, poverty and inequity, and achieving development targets.

Finally, consideration is given to how the opportunities for improving livelihoods and development, while ensuring environmental sustainability, may be more effectively harnessed. Issues of integrated management, equity, improved governance, technology and research, and infrastructure are given prominence.

Section 2: *Environmental State-and-Trends: 20-Year Retrospective* reviews the state of the environment, and identifies opportunities for development.

A brief synthesis of the state of the environment is given using the main themes in AEO-1 as the baseline, but discussing this within the context of the Brundtland report and the programme areas of NEPAD-EAP. Where appropriate, the general regional situation has been placed in the global context. Six thematic areas, forming the basis of the chapters, have been used in the analysis – Atmosphere, Land, Freshwater, Forests and Woodlands, Coastal and Marine Environments, and Biodiversity. For all these areas, human settlements are closely related to patterns of environmental change, and thus in each chapter human settlements are discussed briefly as they relate to specific aspects of environmental change. Chapter 12: *Environment for Peace and Regional Cooperation* (in Section 3) also examines some of the challenges related to human settlements. In addition, a technical paper has been published on this subject as a complementary report of AEO-2. The state of the resource endowment has been looked at in the context of opportunities for development, and how to move towards looking at "*Our Environment*" as "*Our Wealth*."

Under each theme, the focus has been on identifying opportunities for sustainably deriving benefits from the available resources and for improving environmental management. The chapters focus on adding value to what exists (or remains) to derive maximum benefit to eradicate poverty and promote development. Diversifying the range of activities and improving efficiency are two important aspects of this. The multiple values of the resources are identified and this serves as an important motivation for safeguarding and improving the remaining assets, not only in terms of their environmental quality but also as important economic and social goods.

The concluding Chapter 8: *Interlinkages: The Environment and Policy Web* demonstrates the complex relationships that exist not only between the different environmental sectors but also between the different development objectives, and between environment and development. By taking both a horizontal (linking the different resources) and a vertical (linking the different policy responses as well as socioeconomic factors) approach to interlinkages, a comprehensive picture of the complex environment-policy web is presented. Specific cases are used to demonstrate the interlinkages between major environmental and development challenges and the implications of these for policy and technological responses. Best practice examples highlight some opportunities. Finally, the chapter looks

specifically at environment and development approaches that can be used to more effectively implement an interlinkages approach that supports win-win solutions at multiple levels.

Section 3: *Emerging Challenges* examines four important environmental challenges that the region faces. This is an essential part of the environmental assessment process. One of the functions of AEO, as a monitoring tool, is to keep track of environmental problems (or solutions) that may affect key objectives and targets, and to bring these to the attention of policymakers. Emerging issues are not necessarily new issues; they may be old issues which because of changing circumstances present new challenges or new opportunities. For example, changes in knowledge or changes in the state of the environment may fundamentally reshape opportunities. The section focuses on four emerging issues of regional significance: *Genetically Modified Crops*, *Invasive Alien Species* (IAS), *Chemicals*, and *Environment for Peace and Regional Cooperation* – each discussed in a separate chapter. All four chapters are concerned with ensuring an enabling context for sustainable development which contributes to improving human well-being, economic performance and environmental sustainability. The opportunities for achieving this vary in the four areas under consideration, but to a large extent all chapters speak to two key policy areas: improving sound environmental management and enlarging the opportunities for development through, among other things, promoting peace and stability. These policy concerns lie at the heart of the NEPAD and the UN agendas.

Three chapters – Genetically Modified (GM) Crops, Invasive Alien Species (IAS) and Chemicals – focus on how to deal with problems of uncertainty about impacts of new scientific and technological advances or new economic uses on the environment and on people. These chapters highlight the opportunities that arise from new approaches to policy making and environmental management. The chapters explicitly consider the opportunities that integrated policy processes – bringing together policymakers, the scientific community and the public – offer for more informed choices. In all these areas, the importance of strong links between science and management for ensuring sound environmental management is critical. The need to go beyond policy statements and to adopt measures for effectively implementing policy, through improved institutions including laws and management tools, is emphasized.

In the three chapters (GM crops, IAS and chemicals), an overview of the state-and-trends is given in the context of Africa's development, highlighting, with specific examples, the potential benefits and negative impacts on the environment. An assessment is also made of policy responses at the national and regional levels in the specific areas. This includes the mitigation of environmental impacts. Best practice examples and lessons learned are presented.

Chapter 12: *Environment for Peace and Regional Cooperation* looks at how existing trends of cooperation can be enhanced to improve opportunities for human well-being and development while ensuring sustainable environmental management. The thrust of the chapter – which contains both regional and sub-regional perspectives – is to promote peace and cooperation, and consequently to enhance human security and widen the scope for development. It focuses on the opportunities presented by regional cooperation rather than the losses of armed conflict. It also highlights the impact of conflicts on human settlements, giving examples of urban and other settlements.

The legal and institutional context, including good governance and democracy, is explicitly considered. Attention is drawn to the positive role of institutions at the:

- Sub-regional level, including, for example the Intergovernmental Authority for Development (IGAD), Economic Commission of West African States (ECOWAS), and Southern African Development Community (SADC) Organ on Peace and Security;
- Regional level, including the AU Constitutive Act and the NEPAD African Peer Review Mechanism (APRM); and
- International level, including the UN Charter and the important role of the UN Security Council.

The value of collaborative approaches for environmental management and development, such as river basin commissions (RBC) and transboundary natural resource management (TBNRM) areas, has also been factored in the analysis. The chapter highlights that the environment in Africa presents many opportunities for transboundary and regional cooperation and specifically how this has contributed to new innovative institutional and management approaches, and win-win situations for development and the environment.

Section 4: *Outlook* gives four visions for the future. Its one chapter, Chapter 13: *The Future Today*, looks at the future through the lens of four scenarios: *Market Forces*, *Policy Reform*, *Fortress World*, and *Great Transitions*. For continuity and assessment purposes these scenarios are the same as those used in AEO-1. The scenario analysis

takes place in the context of the overall theme of AEO-2 – Environment for Development.

The chapter reviews how the scenarios in AEO-1 have played out since its launch in July 2002 and uses this to reformulate the assumptions. The objectives of the Environment Initiative of NEPAD and the MDG goals, and the environmental thematic areas discussed in Section 2 have been used to frame the discussions. The region and sub-regions constitute the spatial boundaries for the analysis. The temporal dimension is 2005 to 2025 – ten years prior to the MDG target date and ten years after it. In developing the narratives the following driving forces are seen as central: demographics, health, economics, social issues, culture, technology, institutions and governance, peace and conflict, and natural disasters and climate change.

The scenario analysis provides a coherent framework for understanding how various issues or sectors impinge on one another and interact. Additionally, it can play a valuable role in fostering creativity, stimulating discussion, focusing attention on specific points of interest for policy on environment and development, and for analysing future problems. At the end of each thematic focal point there is a brief presentation of the policy implications of the scenarios.

Section 5: *Policy Opportunities* has one chapter – Chapter 14: *Back to Our Common Future: A Renaissance for the Environment* – which identifies actions Africa's leaders may take to ensure that the African environment contributes more effectively to the realization of the MDGs and the NEPAD objectives. Options for action related to the themes in Section 2: *Environmental State-and-Trends: A 20-Year Retrospective* and Section 3: *Emerging Challenges* are specifically identified. In addition, issues identified by policymakers in the region as being of priority policy focus are highlighted, including the special position of Africa's Small Island Developing States (SIDS).

Medium-term outlooks on the issues are presented as a basis for specifying the policy actions that could be taken. The chapter presents a policy menu, covering a range of policy responses to the policy gaps, and promising strategies for further progress. It also covers some aspects of implementation, including the roles of various stakeholders and target dates.

The actions proposed focus on curbing ongoing environmental degradation and seizing the development opportunities offered by Africa's environmental wealth. This involves going beyond traditional poverty eradication approaches and enhancing the capacity of people and institutions to more effectively use the available opportunities. The actions identified emphasize the need for investment in human, social, economic and environmental capital if Africa is to prosper – and the political will to make Africa's dream a reality.

ANALYTICAL APPROACH

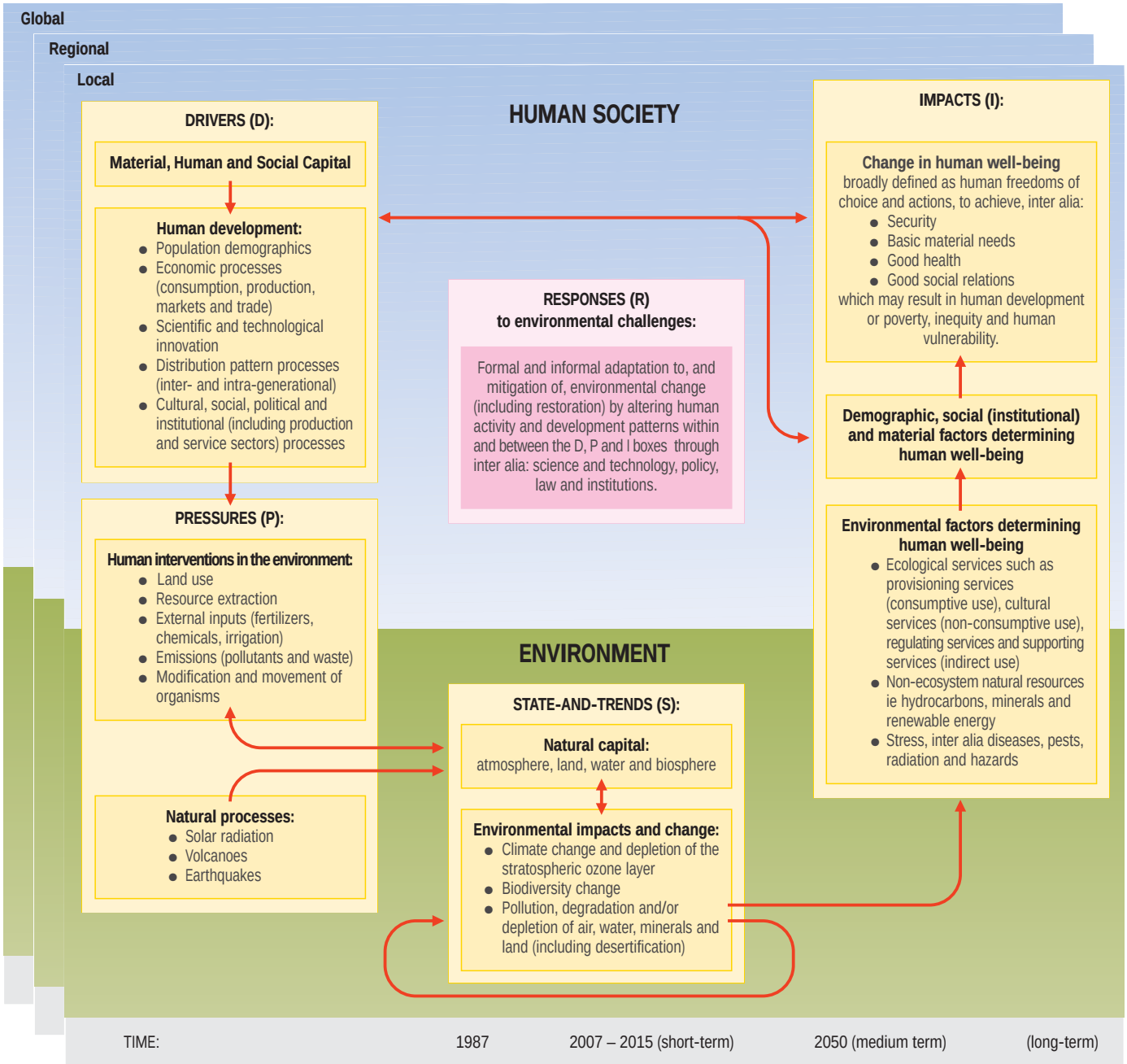
The AEO-2 report uses the **Opportunities Framework** for analysis – this is adapted from the drivers-pressures-state-impact-response (DPSIR) conceptual framework (Figure 1) – focusing the assessment on the available resource base, which provides opportunities for sustainable development and enhanced human well-being. The environmental resources, including goods-and-services, are taken as the asset base available to help reduce human vulnerability to environmental change. The AEO-2 analysis highlights the **opportunities** and **potential** (current and future) of the resources to address sustainable development, alleviate extreme poverty and reduce vulnerability, and enhance environmental sustainability. The pressure dimension is used for trend analysis to show the demands or pressures placed upon the resources and their impacts.

The **opportunities framework** methodology addresses the following questions:

- What resources are available at the regional and sub-regional levels (**resources**)?
- What is the value of these resources ecologically, socially and economically (**value/opportunities and potential**)?
- What are the demands/pressures (human and natural) to the sustainable management of these resources (**demands/pressures**)?
- What will happen if we don't act now (**outlook**)?
- What are we doing to enhance opportunities and what should we do to reduce such pressures and sustainably maximize on the potential, including rehabilitation (**policy actions** which highlight both institutions (law and policy) and governance)?

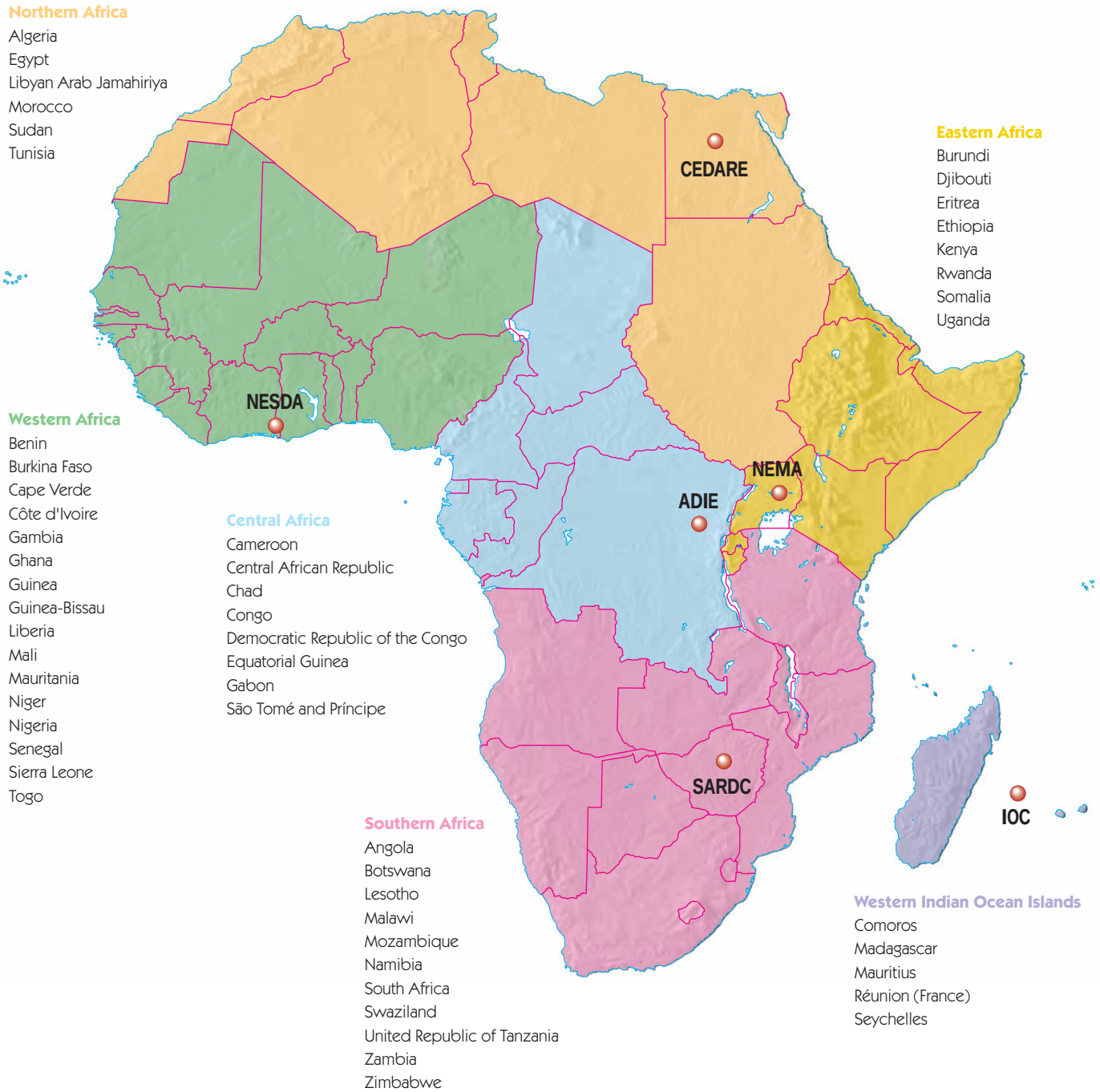
The framework emphasizes the more positive indicators, highlighting among others, services delivery, increased livelihood options, adaptability and reduced vulnerability. The *Opportunities Framework* emphasizes hope over despair, resolution over regret, and strategic response over reaction.

Figure 1: DPSIR framework



AEO-2 SUB-REGIONs

Figure 2: AEO sub-regions and collaborating centres



SECTION 1

ENVIRONMENT FOR DEVELOPMENT

CHAPTER 1
THE HUMAN DIMENSION

Lead Authors: Kassim Kulindwa, Patricia Kameri-Mbote, Jennifer Mohamed-Katerere, Munyaradzi Chenje

Contributing Author: Charles Sebukeera

"However improbable it may sound to the sceptics, Africa will prosper! Whoever we may be, whatever our immediate interest, however much we carry baggage from our past, however much we have been caught by the fashion of cynicism and loss of faith in the capacity of the people, let us err today and say – nothing can stop us now!"

THABO MBEKI, THEN DEPUTY PRESIDENT OF SOUTH AFRICA (MBEKI 1996)

INTRODUCTION

The productivity and sustainability of Africa's environment is heavily dependent on how this asset is managed. This, in turn, can affect the availability, stocks and functioning of the remaining assets, either enhancing opportunities or putting livelihoods at risk. The range of livelihoods, with its opportunities for human development and alleviating extreme poverty and hunger, extends from total dependence on natural resource systems either for subsistence or as part of business, to total dependence on wage earnings, from trade or industry.

National and local aspirations for sustainable development are linked to the integrity of natural resources and the environment. It is, therefore, critical to conserve and sustainably use the region's environmental assets, not only from an environmental perspective but also as a sustainable resource to support human well-being and development and as a sink for wastes from production processes. Over 70 per cent of Africa's population is rural and depends directly on the land and the natural environment for its livelihoods and well-being (IFAD 2001). Thus, how environmental goods-and-services are used will have practical consequences for alleviating poverty, improving human well-being, and ensuring sustained economic development.

The environment and human development are the principal focuses of sustainable development. The challenges faced by African governments are many and complex. Governments must reduce human vulnerability to environmental change and hazards, improve standards of living and generally enhance human well-being. They have to provide social services and security, ensure adequate functioning of infrastructure, provide a climate conducive to investment, economic growth and employment generation, as well as pay their debts while at the same time ensuring that the environment which supports much of its economy and livelihoods is used sustainably. The challenges of meeting the needs of the present generation must be realized without compromising those of future generations. Successfully delivering on all these fronts requires not only good national and regional policies but also supportive global policies and practices. How Africa positions itself globally is critical: it must capture the benefits associated with globalization while at the same time trying to minimize the negative impacts of inequitable relations. Globalization is bringing with it both new opportunities and risks. In the health sector, diseases, such as SARS and avian flu, have the potential through the increased movement of people and goods to impact on already stretched health services. Africa will need to increase its preparedness to respond to such risks. The

complex relationship between different sectors – including health, transportation, human resources, technology, water, forests – and their multiple implications for poverty, well-being and development will need to be faced head-on.

Over the past two decades, African countries have sought to consolidate their efforts towards sustainable development despite the economic difficulties the region has experienced. Many countries have embraced access to a clean and productive environment as a fundamental human right for their citizens. At the regional and sub-regional level, Africa has also adopted forward-looking responses. A healthy environment is seen as critical to the success of Africa's development agenda, and to achieving the various goals and targets of the Millennium Development Goals (MDGs), the World Summit on Sustainable Development (WSSD) Johannesburg Plan of Implementation, the New Partnership for Africa's Development (NEPAD) and its Environmental Action Plan (NEPAD-EAP). The MDG targets are listed in Annex 1.

New efforts have been made to reconcile economic development and environmental sustainability. The Brundtland Commission in 1987 noted that, "The downward spiral of poverty and environmental degradation is a waste of opportunities and of resources. What is needed is a new era of economic growth – growth that is forceful and at the same time socially and environmentally sustainable." (WCED 1987). Five years later, the Earth Summit reinforced the Brundtland Commission's measure of the interdependence of environment and development, stating in Agenda 21: "Integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future." (UN 1992). This message remains important and its challenges are being confronted head-on by Africa.

Through the African Union (AU) and NEPAD – the region's response to tackle poverty and hunger, underdevelopment, governance problems and environmental degradation – African leaders have recognized that a healthy and productive environment is a prerequisite for the successful implementation of its programmes. The environment is considered as one of the central building blocks of the NEPAD agenda from two important perspectives. First, African leaders recognize that underdevelopment itself constitutes a serious threat to the conservation of the environment. Second, and perhaps more importantly in the context of a development agenda, African leaders recognize the inherent challenge to nurture environmental assets and to use them for the development of the region while, at the same time, preserving them for future generations. The core objectives of the NEPAD-EAP are to combat poverty and to contribute to socioeconomic development. New developments in science and technology, including in information and communication technology (ICT), have been recognized as potentially beneficial. The challenge lies in being able to apply these new developments to Africa's social and economic reality, to avoid risks to the environment and to seize the opportunities for human development.

Against the backdrop of today's information-driven and increasingly globalized economy, the contribution of the environment to the realization of Africa's development goals, as reflected in initiatives such as NEPAD, will not only be from the use of the resource base but also from the ability to leverage the total value of these environmental assets. The opportunities for development presented by the different environmental resources are considered in full in Chapters 2-7 of Section 2: *Environmental State-and-Trends: 20-Year Retrospective*. In natural resource valuation, value is not necessarily derived only from the use of the resources or commoditization, but also takes into account

Integration of environment and development concerns and greater attention to them will lead to the fulfilment of basic needs, improved living standards for all, better protected and managed ecosystems and a safer, more prosperous future.

Agenda 21 (UN 1992)

Waterfalls in Bwindi Impenetrable National Park, Uganda.

Source: C.Lambrechts/UNEP

intrinsic and non-use values. Figure 6 shows use and non-use values. Non-use values include existence values (the value derived from the knowledge of the continued existence of the resource or service), bequest values (the value of leaving use and non-use options available for future generations) and option values (the value derived from having available future direct and indirect use values). Use values include consumptive use as well as indirect use derived from the environmental services, such as carbon sequestration.

ENVIRONMENTAL CHANGE AND SOCIOECONOMIC FACTORS

Various human factors drive, influence and affect environmental change at the global, regional, national and local levels.

Drivers of environmental change vary in nature and scope but can be broadly grouped together as demographic, economic and social, science and technology, conflict and governance. Critical social dimensions include poverty and health. Policy and institutions, although most often thought of as the response to mitigate such change, may also drive environment change and impact directly on human vulnerability. Although each driver is discussed individually, there are links between the different drivers – sometimes acting in concert to maximize negative impacts and sometimes producing positive change.

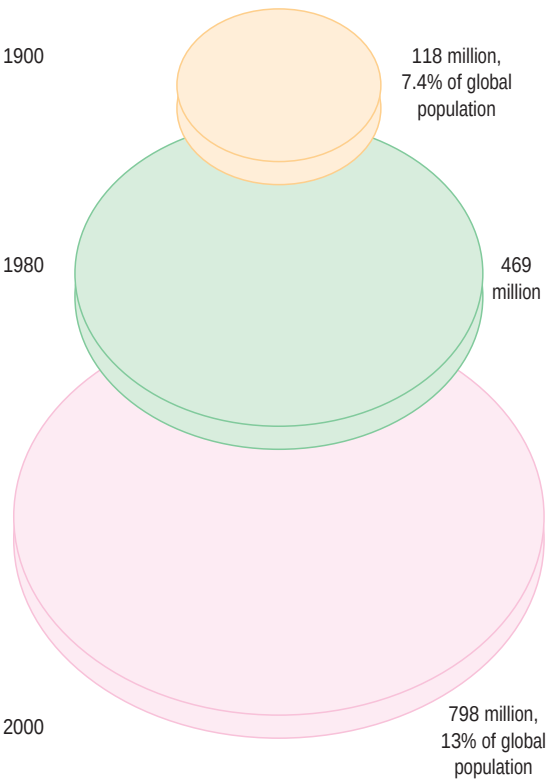
DEMOGRAPHIC CHANGE

People in Africa are at the centre of sustainable development – in rural and urban areas. Although still largely rural, the region has been experiencing major transformation in terms of population composition and distribution, with positive and negative implications for the environment and development. The challenge is not to arrest development but to use the available resources in a more productive and efficient manner, ensuring better and more equitable returns to people while at the same time lessening pressure on the environment.

Changing demography, and particularly the changing age structure of the population, a high rate of urbanization, and a faster rate of population growth in relation to economic growth are major drivers of environmental change in Africa, with significant impacts on the natural resource base. Due to this, it is imperative that population growth and its structural changes are addressed to reduce environmental degradation. Each year, the number of people increases, but the amount of natural resources with which to sustain this population, to improve the quality of lives and to eliminate poverty remain finite (WCED 1987), increasing the challenge of sustainable development. Demographic change is the major driver of land cover change: its primary and most direct impact is through opening new land for agricultural, settlement and infrastructural development (UN Millennium Project 2005a), although other extractive activities such as logging and mining are also significant. Section 2: *Environmental State-and-Trends: 20-Year Retrospective* assesses the state of Africa's environmental assets and some of its chapters also consider the relationship between human settlement and environmental change.

At the beginning of the 20th century, the total population of Africa was about 118 million, accounting for 7.4 per cent of the global population (United Nations Population Division 1996). From 1980 to 2000, it grew from 469 million to 798 million, representing 13 per cent of the world population in 2000 (FAO 2003). By 2020, the urban population is expected to be 646 million up from 302 million in 2000 (FAO 2003). While insufficient data exists to accurately ascertain the magnitude of urbanization, available statistics indicate a current rate of urbanization in Africa of around 3.5 per cent per year (UNCHS 2001). This

Figure 1: Population growth in twentieth-century Africa



Source: Data from FAO 2003

By 2030, the proportion of Africa's urbanized population is expected to reach 53.5 per cent, compared to 39 per cent in 2005.

compiled from WRI 2005

rate is the highest in the world, and is resulting in the rapid growth of urban agglomerations throughout the region. By 2030, the proportion of Africa's urbanized population is expected to reach 53.5 per cent, compared to 39 per cent in 2005 (compiled from WRI 2005). This fast rate of urbanization places strain on infrastructure and other services. Many of the newly urbanized live in slums. There is a growing and urgent need for integrated approaches to environmental planning and management.

In the absence of alternative livelihood opportunities and strategic management of the environment, this rapid population growth and urbanization has resulted in environmental degradation and resource depletion. Between 1990 and 2000, Africa lost 52 million hectares of forests: this amounts to a decrease of 0.8 per cent per year and 56 per cent of the global total (FAO 2003). It is estimated that 60 per cent of the tropical forest areas cleared in Africa as a whole between 1990 and 2000 were converted to permanent agricultural smallholdings (UNEP 2003). However, migration to urban areas is not inevitably destructive, nor does it necessarily lead to the formation or growth of dangerous and unhealthy slum areas (IOM 2005a). It is important to recognize the valuable role urbanization can play in stimulating the economy. The challenge lies in reversing the current pattern, and enhancing the efficiency of and the value derived from natural resource use.

Over the last 20 years, Africa's population has got younger, primarily as a result of the impact of HIV/AIDS, but also due to other setbacks. In 2003, more than 40 per cent of the region's population was below the age of 15 years (FAO 2003). Given this, the youth are becoming increasingly important in natural resource management. The lack of employment and other livelihood opportunities, as well as setbacks in education, health and other capabilities, may mean that this generation will have increased natural resource dependence and pose new threats to the sustainability of marine and terrestrial ecosystems. Degraded environments may spur further social and economic conflicts and hardships.

Population growth presents a major challenge because of the patterns of production and consumption that shape the world, as well as the problems of pervasive poverty (Ness and Golay 1997). Population growth affects the natural resource base in many ways. First, it causes increased demand for food, water, arable land and other essential materials, such as firewood, in all areas. Second, expanded agricultural activities encourage encroachment into forest and woodlands. These consequences are more pronounced in the context of high levels of poverty. Third, the degradation of the natural resource base in turn impinges on the livelihoods of all, but particularly rural, communities. More small farmers are forced to work harder, often on shrinking farms on marginal land, to maintain household incomes (WCED 1987). The option of migration to new lands is virtually closed. In most cases, the impacts vary for men and women depending on the gender relations within the social unit (household, community, livelihood system) that regulates access to and control over resources and management responsibilities. Fourth, global population growth and the increasing demand for fossil fuels and other resources, also places new stress on Africa's environment.

HIV/AIDS has had a significant impact on human capacity with severe economic, social and environmental consequences. Of the 45 most affected countries globally, 35 are in Africa. More than 25.8 million Africans are living with HIV/AIDS (UNAIDS and WHO 2005). Sub-Saharan Africa (SSA) is home to just 10 per cent of the global population but has more than 60 per cent of all people living with HIV (UNAIDS and WHO 2005). In SSA, the adult prevalence rate has

Table 1: Population changes in Africa (million)

Sub-Region	1980	1990	2000	2010	2020
North Africa	109	140	170	209	239
East Africa	104	141	182	230	269
Southern Africa	70	90	113	129	150
Central Africa	54	74	98	127	164
West Africa	132	178	234	278	344
Total Africa	469	623	797	973	1 166

Source: FAO 2003. [Data from World Bank 2002; Africa Development Bank, 2000]

Expanding settlement in the Atlas Mountains, Morocco.

Source: J.C. Mohamed-Katerere

gone down marginally from 7.3 per cent in 2003 to 7.2 per cent in 2005. There is considerable variation between countries. In Zimbabwe, the epidemic is declining (from 26 per cent prevalence among pregnant women in 2002 to 21 per cent in 2004) and there is some suggestion of a similar trend in Kenya, Uganda and Burkina Faso (UNAIDS and WHO 2005). For other countries the threat continues to grow and is particularly severe in South Africa, Nigeria and Mozambique. In Northern Africa, several countries are experiencing an increase in the prevalence of HIV/AIDS, including Algeria, Libya and Morocco (UNAIDS and WHO 2005). Life expectancy at birth in SSA has been reduced from 50 in 1990 to 46 in 2002 (World Bank 2005a) as shown in Annex 2, Table 1a: *Sub-Saharan Africa Region Socioeconomic Indicators*. The productive labour sector has been particularly hard hit by the high mortality in the 20-50 age bracket (FAO 2003). The loss of productive capacity is monumental (UNAIDS 2005, FAO 2003) and results in a decrease in disposable income, increased food insecurity and an increased dependency on the natural resource sector. At the same time, the loss of the most knowledgeable and productive age groups impacts on environmental managerial capacity. There is a significantly higher prevalence among women, due to unequal education and inequitable gender relations (UNAIDS and WHO 2005). The disproportionate impact of HIV/AIDS on women is particularly significant from an environmental perspective, as women in many parts of Africa assume major responsibility for natural resource stewardship (Oglethorpe and Gelman 2004).This demonstrates the importance of meeting MDG 3, to promote gender equity and empower women, not only from a rights perspective but also because of its environmental significance. The realization of this goal is closely related to MDG 2 on achieving universal primary education. Health, food security and environmental degradation are closely linked, and a negative change at any of these levels may have implications for the others.

Conflict affects population distribution and is a leading cause of internal migration. Africa now has more than 7.3 million refugees, 3 million more than in 1990 (FAO 2003). This places new pressures on environmental resources. In crisis situations, a large number of people may be displaced in a short period of time, causing a high level of environmental stress in the place where they are relocated due to increased demand and lack of preparedness. The depletion and deterioration of the areas in which camps are located are often related to the high demand for wood for shelters and energy. The inherent competition between local groups and forced migrants over access to natural resources may polarize social relations in refugee settlement areas and undermine opportunities for collaborative environmental management (Ertegun 2002). State-initiated resettlement initiatives to make way for development and conservation, such as dams and national parks, may also result in large-scale displacements that impact negatively on environmental resources and well-being more generally. Chapter 12: *Environment for Peace and Regional Cooperation* discusses the complex relationship between conflict

and environmental change, and how the environment can be used as a vehicle to improve cooperation.

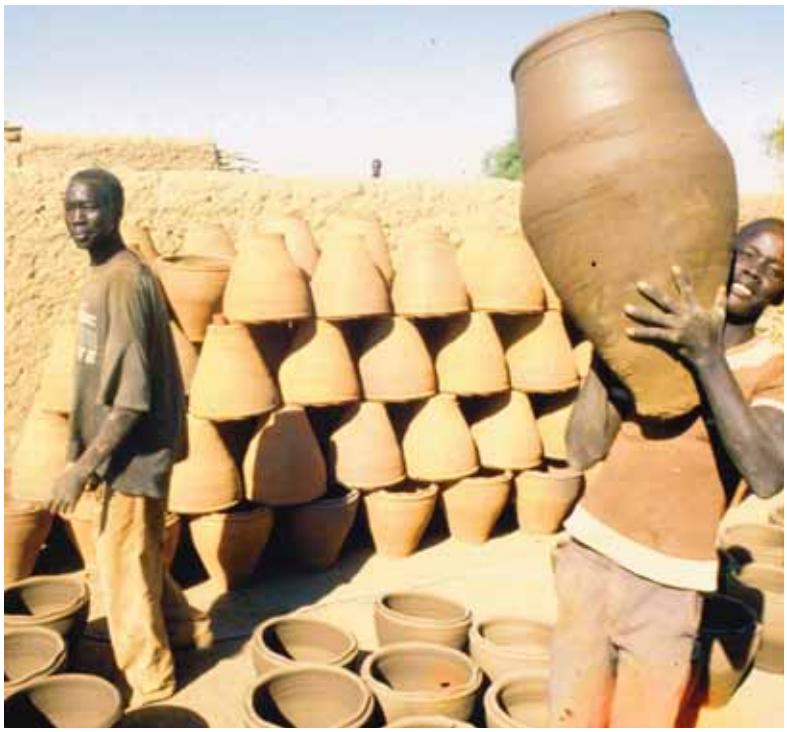
Migration has important implications for development, both positive and negative. Although it contributes to the transmission of disease, the introduction of alien species and the loss of skilled personnel, it may also bring new economic opportunities. The United Nations Economic Commission for Africa (UNECA) and the International Organization for Migration (IOM) estimate that between 1960 and 1975 more than 27 000 highly skilled Africans left the region for industrialized countries. This rose to 40 000 between 1975 and 1984 and then almost doubled by 1987, representing 30 per cent of the highly skilled labour stock (IOM 2005a). It is estimated that since 1990, at least 20 000 highly skilled and qualified persons leave the region annually (IOM 2005b). Although the loss of skilled people has negative impacts on the economy and other sectors, it also contributes to development through significant remittances and the enhancement of capacity of those that have left, in terms of skills and experience, potentially building an important human resource for Africa. Internal transnational migration in Africa is significant – the profile of such migration has changed from being unidirectional and permanent to being increasingly temporary, seasonal and circular. Africa has the most mobile populations in the world: there are many reasons for migration – one important motivation is to cope with ecological and economic problems (IOM 2005b).

Social change

Improved human well-being is a crucial objective of sustainable development and is closely linked to environment goods-and-services.

Human well-being is multidimensional and requires access to resources to live a good life in good health, such as income, food, clean water and energy; personal security through the absence of conflict, the ability to mitigate environmental disasters and good governance; good social relations which include all people and promote fairness and equity; and the opportunity to make choices (MA 2005a). This implies a condition in which people are not just physically well, but have choices and live in dignity. The extent of well-being, as reflected in income, health, education and inequity, is an indication of how successful or unsuccessful development policies have been. In turn, the well-being of people affects their ability to effectively and sustainably manage resources. How these social factors impact on the environment is a product of a complex cultural milieu.

The Human Development Index (HDI) measures the state of human development at the global, regional and national levels and offers an opportunity to make comparisons over time. It looks specifically at the state of development in terms of the goal of increasing people's choices and their ability to live a long and healthy life, to acquire knowledge and to have access to resources needed for a decent standard of living (UNDP 2005). Other human development indicators look at the extent of inequality between rich and poor as well as between men and women; the consumption of environmental resources such as energy; the level of personal security through measures related to refugees, armaments, violence and crime; and the existence of good social relations through the enjoyment of human and labour rights. Between 1990 and 2003, globally, 18 countries, 12 of which are in Africa, experienced reversals in human development, affecting some 240 million people (UNDP 2005). There has also been an increase in the number of African countries identified as having low human development, from 17 countries in 1990 to 30 countries in 2005 (UNDP 2005). Extending human development achievements requires not only reducing income poverty but also making improvements across a broad range of areas. Progress towards achieving the MDGs is presented in Annex 1, Table 2: *Progress to meeting the MDGs*.



Clay pots drying in the open air at an artisanal pottery enterprise, Khartoum, Sudan.

Source: J. Maillard/ILO

Masai women, who support themselves by selling beaded artwork and jewellery, welcome WAVE participants to the Ngong Hills, Kenya.

Source: UNEP

Gender and divisions of labour

Gender relations and the divisions of labour are important factors in the economic development, human well-being and environmental stewardship in Africa and therefore need to be part of an integrated environmental management approach.

Gender inequity, and its impact on resource management, is shaped by many factors including unequal access to basic facilities, such as education and health care, differences in income, the extent of social and political inclusion, as well as social and cultural factors. All these impact upon the choices and opportunities women have, and ultimately on how they use and manage natural resources. African countries generally rank very low on the Gender-related Development Index (GDI): they constitute 35 out of the 40 countries with the lowest GDI ranking (UNDP 2005). However, African countries perform much better in the Gender Empowerment Measure (GEM) with, for example, several African countries having higher rates than the global average for participation of women in parliament (UNDP 2005).

The differential access and control of natural resources by men and women determine how much influence they have on environmental management. In many African societies, productive and parenting roles are clearly divided along gender lines. Gender roles, however, are complex and shaped by other factors, such as age and position in the family. For example, rural women in many parts of Africa are responsible for child rearing, the nutritional and health needs of the family, food production and weeding of crops, while men open up the land. In many places, women are the primary custodians of environmental resources by virtue of their position in the household, giving them responsibility for managing energy, water and farming among other things. They are often the repositories of indigenous knowledge and the promoters of biodiversity conservation and environmentally-friendly management (UNEP 2005).

Labour divisions may also be gendered. In rural Africa, for example, women and girls are almost always the exclusive suppliers of water for household use (Dankelman 2004). They play a lead role in the provision of water for animals, crop growing, and food processing. It is often women who decide where to collect water, how to draw, transport and store it, what water sources should be used for which purposes, and how to purify drinking water. Women make a disproportionately high contribution to the provision of water for family consumption in comparison to men. In many countries, women and children spend much time on water collection, effectively reducing the time for other valued activities (Gordon and others 2004). Gathering non-timber forest products (NTFPs), such as edible foods, is predominantly children and women's responsibility. For example, in the mountain areas of east Africa, women expend close to a third of their daily calories in collecting and supplying water to their homes and communities (UNEP 2005). Degradation, deforestation or the extension of prohibitions on resource extraction may further penalize women in rural areas who already have to travel long distances to collect water or fuelwood. Collection activities compete for time spent in food preparation, child care and providing for the household's nutrition (Picard 1996) and reduce free time and thus limit the opportunity for women to pursue other interests. Technological developments are changing the gender landscape of labour. Where water collection involves long distances,

men may now use bicycles or carts for water transportation, freeing women from this task.

In some instances, however, the division of labour and respective roles give men the opportunity to be custodians of some environmental knowledge. Among nomadic pastoralists, it is the men who take the cattle out on two-day watering regimes and to far-off grazing lands, and deal with predators and raiding.

In urban areas, many women are involved in urban agriculture to supplement household food security and income. Many also participate in markets, selling produce and other wares derived from natural resources.

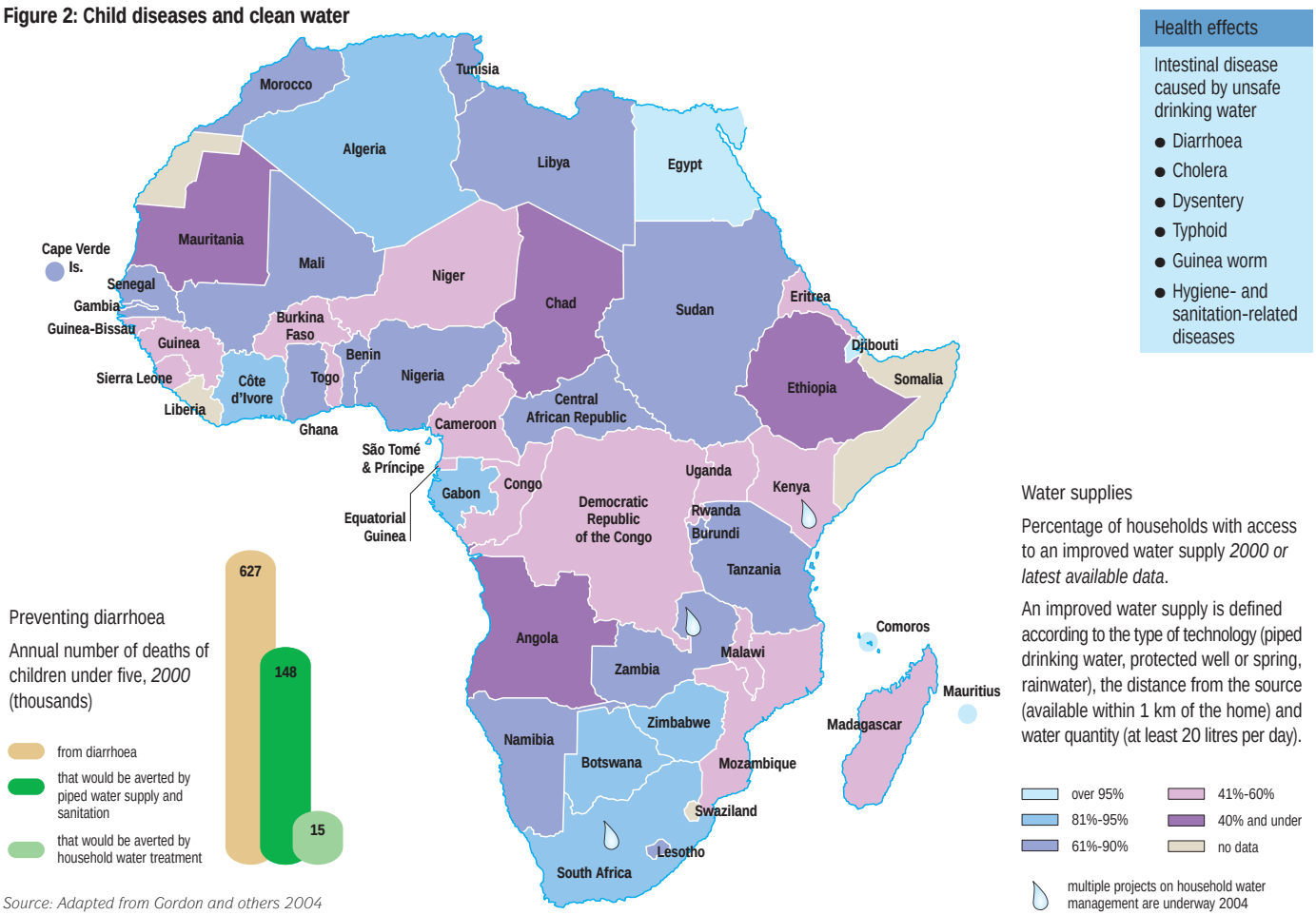
Given the multiple ways environmental management is gendered, policies and technologies must be gender sensitive. Women need to be empowered to be able to participate more effectively in policy processes and environmental decision making.

Health

Good health is essential for people to maximize the opportunities available and is closely linked to the state of the environment. Poor environmental management exacerbates the incidence and negative health impacts of many "natural occurrences" such as floods, droughts and cyclones. Degraded environments also place strain on the ability to meet needs for medicines, food and energy – all central to health. Certain development activities, including agriculture and industry, may strain environmental systems through pollution and environmental degradation, which in turn affect human health.

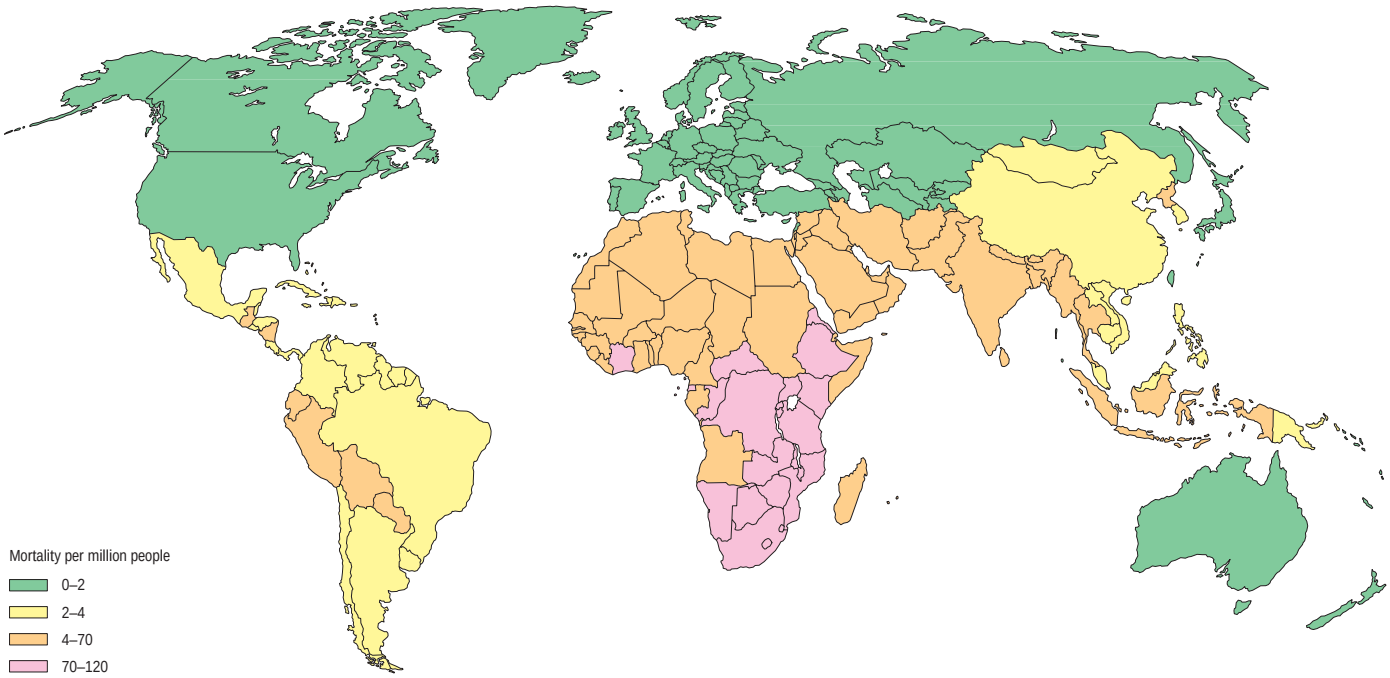
Environmental hazards comprise a significant portion of the health risks facing the poor, and children bear the brunt of this. Although children constitute only 10 per cent of the world's population, they suffer 40 per cent of the environment-related burden of disease (WRI and others 2005). This disease burden is closely associated with environmental management practices and the opportunities available to poor people. Malnutrition is a crucial contributing factor to the impact of disease and is linked to land management and productivity, which in turn are related to environmental changes such as salinization and climate change. In SSA, infant mortality showed a decline from 143 per 1 000 in 1970 to 105 per 1 000 in 2003 (UNDP 2005). However, in parts of SSA, child mortality is still increasing. The overall reduction is largely due to a decrease in deaths from diarrhoeal diseases and the increased use of vaccines. Acute respiratory infection

Figure 2: Child diseases and clean water



Source: Adapted from Gordon and others 2004

Figure 3: World Health Organization estimated mortality attributable to climate change by the year 2000



Source: Patz and others 2005

and malaria, alongside neonatal mortality, remain primary causes of death for children under five. Inadequate sanitation and unclean water are still major threats, causing the deaths of an estimated 1.8 million people worldwide each year, of which 1.6 million are children (Gordon and others 2004). Improving water quality can have major improvements on child mortality as shown in Figure 2. In most of Africa, more than 75 per cent of households depend on biomass for energy for cooking (Gordon and others 2004); in some countries this rises to as much as 90 per cent of households (Warwick and Doig 2004). Indoor air pollution presents a major health risk for poor people dependent on fuelwood for energy, and children under five account for more than half of the 1.6 million deaths per year (Warwick and Doig 2004).

Although Africa has some of the lowest per capita emissions of greenhouse gases that cause global warming, it carries the greatest burden of climate-sensitive diseases (Patz and others 2005). Vector-borne diseases, such as malaria, dengue fever, schistosomiasis, and chagas disease, could expand their ranges as temperature and rainfall patterns change (WRI and others 2005). Malaria is a major cause of death in Africa. Mosquitoes are among the first organisms to expand their range when climate conditions become favourable, so cases of malaria and dengue fever may increase their already heavy toll among the poor (WRI and others 1998). Higher temperatures and humidity may promote the growth of diarrhoeal organisms increasing health risks (WRI and others 2005) and reducing human well-being. This high disease burden is in part due to Africa's low capacity to adapt to the new risks and the challenges associated with a high incidence of poverty. Global climate change not only presents new region-specific health risks, but also a global ethical challenge (Patz and others 2005).

Many African countries prioritized the development of health services from as early as independence. Efforts included the expansion of access to primary health-care facilities, increased spending in the health sector and investment in human capacity. This prominence has continued with the implementation of health sector strategies and, since 2000, programmes to meet the MDG health targets. In many countries, significant improvements have been made in selected health-care indicators, like infant mortality rates and life expectancy. However, cutbacks in health budgets, privatization of health services, and structural adjustment programmes which diverted public spending away from social sectors have reversed the gains made over the past two decades in many countries. In addition, many African countries have lost health professionals to the developed countries where they are able to obtain better benefits. It is estimated that 23 000 health-care professionals emigrate annually from Africa (IOM 2005b). For example, between 1993 and 2002, Ghana lost 630 medical doctors, 410 pharmacists, 87 laboratory

technicians and 11 325 nurses; in 2002 alone, 70 doctors, 77 pharmacists and 214 nurses left Ghana (IOM 2005b). Zimbabwe, South Africa and Nigeria have all suffered significant losses of health personnel (IOM 2005b). The 27 most powerful countries – also members of the Organization for Economic Cooperation and Development (OECD) – saved a "staggering" US$552 000 million by employing professionals trained in developing countries (IRIN 2005).

Unless there are significant inflows of external financial support to complement national health budgets, the situation is likely to worsen considerably, especially given the unabated threats from malaria and HIV/AIDS. Health challenges are monumental given pervasive poverty, the high rates of fertility, maternal and childhood mortality and malnutrition. Africa has two-thirds of the world's known HIV/AIDS cases, 90 per cent of the world's yearly malaria fatalities, and half of its female population is illiterate (UNECA 1999). The ability of African governments to meet the demands for providing basic services and utilities has decreased tremendously, aggravating social conditions as reflected in the low HDI status of many countries (UNDP 2005).

Education, knowledge and information

Knowledge and access to information are essential for effective environmental management and have significant impacts on the economy and the livelihood choices people make.

Indigenous knowledge systems based on centuries of observation and continually developed in response to changing social and environmental conditions are an important resource for many rural people. This knowledge base offers opportunities not only for conservation but also for the commercialization of wild resources, as demonstrated, for example, by the increasing markets for NTFPs, such as *Prunus africana*, *Harpagophytum procumbens* (devil's claw) and *Kigelia africana* (African sausage tree). Trade in devil's claw, a traditional medicinal plant, supports a US$100 million industry, but most benefits go to processing and transformation actors along the marketing chain, and only a very low proportion goes to domestic producers. This pattern will continue as long as there is low investment in improving community skills and access to relevant information (Katerere and Mohamed-Katerere 2005). The opportunities presented by NTFPs are considered in Chapter 6: *Forests and Woodlands*. Literacy and the level of formal education is also an important factor affecting the kind of information people have access to, and thus the range of opportunities at their disposal.

The adult literacy rate is 67 per cent for people above 15 years of age (WRI 2005), with women having a higher illiteracy rate compared to men (WRI 2005). There is considerable variation between literacy rates in African countries, with Zimbabwe having 90 per cent adult literacy, Morocco 50.7 per cent and Burkina Faso 12.8 per cent (UNDP 2005). Improved literacy increases the capacity of people to communicate and to be reached through the electronic and print media, the capability to effectively participate in their communities and in broader governance issues, and provides new opportunities to engage effectively in the productive sector and the market.

In the absence of improved access to formal education, a considerable reduction in illiteracy rates, and accessible environment-related and functional education, opportunities available to most people will continue to be limited, with possible negative influence on the environment. Choices made in one sector may have a direct bearing on the environment. UNAIDS suggests that gender inequality in knowledge about HIV transmission is a key factor in the high levels of infection among African women (UNAIDS and WHO 2005). Given the important role women play as managers and as custodians of indigenous knowledge, this has ramifications for environmental management (Oglethorpe and Gelman 2004).

A wide variety of NTFPs for sale in Mfoundi Market, Yaoundé, Cameroon.

Source: Y. Katerere

Environmental degradation can affect access to education as children, especially the girl child, will spend more time collecting firewood and fetching water instead of attending school. In Malawi, for example, where more than 90 per cent of households use firewood as their main source of energy, children in fuelwood-scarce districts are 10 to 15 per cent less likely to attend secondary school (Nankhuni and Findeis 2003 in WRI and others 2005). The restoration of traditional forests in some areas has been shown to reduce collection times for fuelwood by on average several hours per day – a direct benefit to poor families (WRI and others 2005).

Poverty

Pervasive poverty and social inequities remain major constraints to sustainable development. Poverty is a cause and an effect of environmental degradation. The equitable, efficient and productive use of natural resources offers important opportunities for sustainable livelihoods which can contribute to reducing poverty.

Poverty is multidimensional: it is more than just the lack of access to financial resources – even though income is the most commonly used indicator of poverty – and material resources. It includes the lack of capabilities that enable a person to make choices to live a life that she or he values (Sen 1999). This includes access to income, health, education, empowerment and social inclusion, and human rights. Poverty may be synonymous with powerlessness, with a lack of access to information, institutions and voice (WRI and others 2005).There is considerable variation among poor people and the extent to which they are disempowered. This is affected by various factors including gender, location (urban or rural), culture and ethnicity. Global inequity, particularly in trade, continues to be a major contributor to continued poverty in Africa. These relationships are discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*.

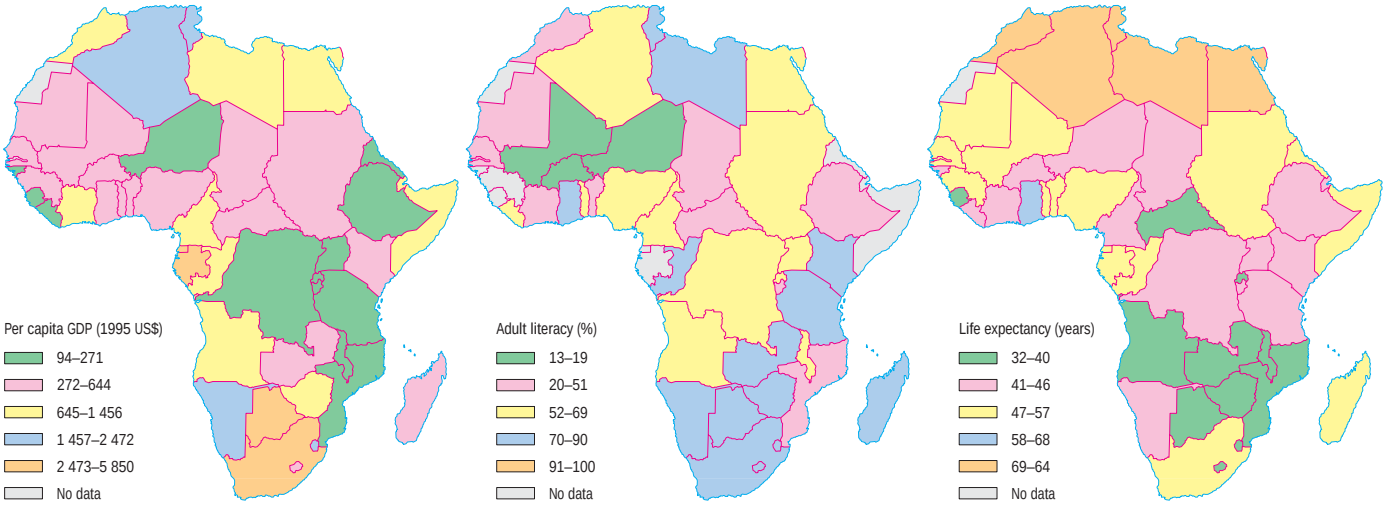
In much of Africa, income poverty is particularly severe. There is, however, considerable variation between income poverty levels: less than 15 per cent of Morocco's population live on less than US$2 a day, compared to Mali where about 91 per cent of people live on less than US$2 a day (UNDP 2005). Between 1981 and 2001, the number of people living on less than US$1 per day in SSA nearly doubled from 164 million to 313 million (Chen and Ravallion 2004). Seventy-eight per cent of SSA's population live on less than US$2 a day. The proportion of people living below the US$1 poverty line has declined in north Africa from 2.0 per cent in 1999 to 1.9 in 2001, while it has increased in SSA from 42.7 per cent in 1999 to 46.4 in 2001 (UN Statistics Division 2005).

The Millennium Project identified the improvement of small-scale agricultural production, through the use of techniques which preserve natural assets, the restoration and improved management of desertified lands, and the protection of surrounding natural habitats, as an important strategy for addressing the MDG target 1 of halving the proportion of people living on less than US$1 a day (UN Millennium Project 2005a). It also recommended actions in forest management, freshwater resources, fisheries and marine ecosystems, and climate change that could make a contribution to addressing this target (UN Millennium Project 2005a).

Woman using an improved energy cooking stove introduced by the Department of Women in Agricultural Development in Ghana.

Source: P.Cenini/FAO

Figure 4: The many measures of poverty



Well-being can be measured using indicators other than income poverty. Three maps of Africa show country-by-country variations in the indicators used by UNDP to annually measure human development: adult literacy, life expectancy at birth, and gross domestic product per capita. [Data sources World Bank 2004a and UNPD 2003, UNESCO 2004].

Source: WRI and others 2005

Across Africa, poverty is more prevalent in rural than in urban areas. The link between environmental resources and the livelihoods of rural people is widely acknowledged. Rural people rely on the environment for a range of goods-and-services. These services include provisioning (food, medicines and energy) and regulating services (such as water purification). Environmental goods may have important cultural and aesthetic values. Natural resources may serve as important safety nets during periods of stress. However, poor people are also more vulnerable to environmental disasters and risks, such as insect-borne diseases, including malaria, and unsafe water. Social and economic shocks from conflict, ill health, falling market prices and so on, exacerbate overall vulnerability.

Poverty may contribute to unsustainable resource use. Policies and institutions are major factors which limit the value poor people can obtain from a resource, effectively forcing them to harvest or use more in order to meet basic needs. Policies and laws that restrict use to subsistence, deny poor people access to value-adding activities which could generate significantly more income. Bureaucratic measures and inefficient economies may limit access to markets, financial resources and other support. Moving towards a regime which acknowledges natural resources as assets of poor people and which empowers people to use these resources efficiently and productively can have positive impacts on equitable growth and for sustainable development.

Economic change

Equitable and environmentally sustainable growth can improve human well-being and increase the range of opportunities available to people, including those who are most disadvantaged.

Africa has experienced its best economic performance in many years. In 2004 Africa grew at 5.1 per cent (OECD Development Centre and AfDB 2005), up from 3.7 per cent in 2003 (AfDB 2004). Between 1990 and 2003, Africa's economies grew at an average of 2.6 per cent annually. This improved growth has had a mixed bag of consequences, increasing opportunities to meet key MDG targets and improving human well-being, which can have positive spin-offs for the environment as options increase. However, SSA must grow on average at 7 per cent per year to reduce income poverty by half by 2015 (AfDB 2004). Only six African countries, mostly in north Africa, are likely to meet the MDG goal of halving the number of people living on less than a dollar a day. The MDGs remain underfinanced – by more than US$40 000 million overall (OECD Development Centre and AfDB 2005). See Annex 1, Table 2: *Progress to meeting the MDGs*.

There is considerable variation between the economic achievements of countries in the region – with prices of oil and metals, low cotton and cocoa prices, dollar depreciation and euro appreciation, the locust plague in the Sahel region, rainfall, corruption, and political conflict and instability being important contributing factors (OECD Development Centre and

Africa has experienced its best economic performance in many years – in 2004 it grew at 5.1 per cent.

OECD Development Centre and AfDB 2005

AfDB 2005). Solid growth is expected to continue between 2005 and 2007 at an average rate of 4.7 per cent as the effect of new oilfields in Central Africa wears off. The high level of vulnerability to external shocks (such as prices and the loss of preferential treatment), environmental factors such as weather conditions, and conflict make these key areas for policy focus and collaborative initiatives (OECD Development Centre and AfDB 2005). This close relationship to the environment is indicative of the need for better environmental monitoring and, in particular, risk and disaster warning systems to support greater preparedness and more effective responses.

Production and consumption

Changing production and consumption patterns, globally and in Africa, and the way in which growth is achieved have direct implications for African livelihoods and their sustainability.

Global economic policy dealing with tariffs, import quotas and crop subsidies has direct impacts on the livelihoods and opportunities of people in Africa (WRI and others 2005). The relationship between global economic policy and practice and economies, livelihoods, human well-being and the environment in Africa is discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*.

Fishermen pulling their nets in Cape Verde.

Source: M.Marzot/FAO

At the national level, growth of the economy can result in both positive and negative effects on well-being and environmental resources. For example, economic expansion may provide new livelihood opportunities to more people through job creation as well as through diversifying livelihood options. Growth must be equitable and specifically focus on delivering benefits to poor people. However, growth may endanger the sustainability of livelihoods depending on how it is carried out with respect to environmental integrity. For instance, when fishing is done in an unsustainable manner, short-run benefits will be accrued, but at the same time sustainability of catch will be impaired through depletion and, therefore, affect long-term benefits.

Although in 2000 Africa accounted for 13.6 per cent of the world population, its gross domestic product (GDP) was just under 1.7 per cent of the world's GDP (UNDP 2005). For SSA, GDP per capita, using purchasing power parity (PPP), amounted to US$1 856 compared to the average for countries with high human development of US$25 665 (UNDP 2005) This is significant for purchasing power, savings and investment growth rates as well as resources available to governments and individuals, making them more reliant on the natural resource base for their basic needs. The GDP per capita (PPP) across the region varies considerably, with Equatorial Guinea having an average GDP per capita of US$19 780, South Africa US$10 346 and Sudan US$1 910 (UNDP 2005). Inequity within a particular country is clearly important for how this benefit is actually spread. Unequal growth remains a major challenge for Africa – income distribution is highly skewed, with 40 per cent of the population receiving only 11 per cent of income, while the richest 20 per cent gets 58 per cent of income (FAO 2003). Income inequality is particularly evident across the urban-rural divide (World Bank 2005b).

Export of natural resources remains a major factor in the economies of many countries. Instability and adverse price trends drive countries to exploit more resources to meet their domestic and foreign obligations, including debt servicing, at the expense of long-term sustainability of the resources.

Africa's economies are more reliant on agriculture than those of any other region, with around 70 per cent of Africans working in the agricultural sector (FAO 2003). About three-fifths of African farmers are subsistence farmers tilling small plots of land to feed their families, with only a minimal surplus that can be sold. Although agriculture is a major employer, employing 56.5 per cent of Africa's total labour force (FAO 2004), it contributes only 14 per cent of GDP,

The use of mobile sawmills give SMEs the opportunity to add value to timber logs and to increase their earning potential.

Source: P.Reidar/CIFOR

while industry and services contributed 29 per cent and 57 per cent respectively (see World Bank, Annex 2, Table 1b: *Sub-Saharan Africa Region Socioeconomic Indicators*). This table also shows that agricultural productivity, in terms of value-added per agricultural worker in 1995 dollars, declined between 1988-90 and 2000-2002 periods from US$382 to US$360. This means that, with high dependency on agriculture and falling productivity at the same time, poverty is increasingly entrenched in rural Africa. The contribution of natural resources to GDP is often undervalued.

In terms of mining and drilling, Africa's most valuable exports are its minerals and petroleum. These activities are concentrated in only a few countries. South Africa, Namibia, Botswana and the Democratic Republic of the Congo have substantial reserves of gold, diamond and copper. Nigeria, Angola, Gabon, Libya, Algeria and others export significant amounts of petroleum. These areas make up the vast majority of mineral and petroleum exports from Africa (OECD Development Centre and AfDB 2003). This has been the focal point for foreign direct investment (FDI) which has been driven primarily by developed countries' needs.

With respect to manufacturing, Africa is the world's least industrialized region. Despite large local supplies of cheap labour, almost all of the region's natural resources are exported elsewhere for secondary processing. The lack of value-adding activities means that the full potential from natural resources is not being earned within African countries. Only about 15 per cent of employment is generated by the manufacturing sector. Industrial sector restructuring and reform measures have led to a collapse of industries in some countries and hence the declining share of manufacturing to total economy. While industrial development offers important opportunities, it also creates certain risks, particularly in the management of pollution and human health. There is evidence that developed countries are relocating their chemical industry to developing countries.

The 1980s and early 1990s witnessed serious economic decline or stagnation in most African countries. Agricultural productivity failed to keep pace with the growth of population and suffered particularly from falling productivity in the export sector and from declining markets and prices. Population growth rates in the period 1990-2003 were higher than the growth of GDP per capita in 2003 at 2.5 per cent and 1.3 per cent respectively (World Bank 2005b). Food imports were and still are essential in most countries to maintain an adequate total food supply and, in certain cases, to keep food costs down. Debt has mounted and pressures on resource use have increased.

In response to the economic hardships of the 1980s, many African countries undertook programmes of economic reform with guidance from the International Monetary Fund (IMF) and the World Bank. These reforms, spearheaded by the Structural Adjustment Programmes (SAPs), aimed at stabilizing the economies, liberalizing exchange rates, freeing the productive energies of the private sector and opening up to trade and investment. As the negative impacts of these policies were realized, new approaches to economic planning and development have been adopted, including the now widely used Poverty Reduction Strategies (PRS).

Impacts of economic change on livelihoods and the environment

Macroeconomic reforms in Africa, epitomized by the SAPs, have had mixed impacts on the environment, mainly through the processes of livelihood diversification and increased human mobility.

A key response to the poor performance of the formal sector has been the diversification into and intensification of informal sector activities as people try to make ends meet. Many of these activities are based on natural resources and include carpentry and craft production, charcoal manufacturing, collection and trade of NTFPs, artisan mining and metal works. Although entry into many such activities is easy, their profitability and efficiency is undercut by bureaucratic controls, lack of investment and inadequate support for market engagement. There is little incentive for users to invest in technologies and to manage resources sustainably (FAO 2003). Since the 1990s, there has been a growing focus on other livelihood activities that could more effectively combine conservation and development interests, such as ecotourism and community-based conservation initiatives.

Livelihood diversification has always played some part in providing a "pathway" out of poverty for poorer groups of people (Barrett and others 2001). Since the mid-1980s, it has become evident that livelihood diversification has increased as a response to economic and social changes. These changes have led to a saturated agricultural labour market, reduced access to common property and increased mobility. In general, these programmes resulted in an increase in the number of people living in poverty and decreased access to social services, such as health and education.

Within the agricultural sector, many rural dwellers have sought to intensify their agricultural activities. Pastoralists in Tanzania, for instance, have adopted crop cultivation to supplement livestock keeping. Other activities include trading in a range of products including milk, firewood, animals and honey; wage employment, both local and outside the area, including working as a hired herder, farm worker and migrant labourer; renting property; and gathering and selling wild products, such as gum arabic, firewood, game trophies, bushmeat, live animals or medicinal plants. Market failures and the need for consumer items have become an important force pushing pastoralists into diversification using wildlife, ecotourism and consumptive utilization.

Agriculture is an important economic activity for many urban dwellers. Urban farmers in Nairobi, Kenya.

Source: Urban Harvest CIP SSA

Good as these activities are in sustaining household livelihoods in the short run, if poorly managed they may have detrimental impacts on environmental resources. The indiscriminate felling of trees for agricultural expansion and timber products has laid watersheds bare, threatening the water catchment functions of forested watersheds. Pressure on water resources for various uses including domestic, livestock and industrial use, among others, has increased due to more extensive economic activities and population congestion in river basins, causing water allocation and use conflicts.

Other alternative income activities, such as artisan mining, have also been affected by economic changes. Artisan mining in Africa has been in existence for centuries, but its magnitude has increased since the mid-1980s as a result of livelihood diversification strategies and opportunities created by trade liberalization. An estimated 20 million people depend on artisan mining in Africa (Henriot 1998). In a number of countries, including Mali, Tanzania, Ghana, South Africa, Zambia and Mozambique, the role of artisan mining in improving livelihood for rural poor communities has been recognized and has accordingly been factored into national planning strategies. Artisan mining has been a major source of income, increasing the wealth of rural populations. This new income supports investments in agriculture and non-agricultural pursuits, and thus increases the options available to rural communities. Inadequate regulation and enforcement in the artisan mining sector has, however, led to serious environmental problems and risk to humans. Toxic chemicals are sometimes used in the extraction of minerals, such as gold, which end up in the rivers. Toxins bioaccumulate in fish and wildlife, which are sources of food for the same communities. Other environmental problems include deforestation, soil erosion, silting of rivers, landslides and mining accidents. It is estimated that the rate of occurrence of fatal accidents in small mining activities is six times higher than it is in larger operations (Gilman 1999).

Migration as a livelihood diversification strategy is important in providing much needed resources for investment in rural production through remittances

Box 1: Impact of mining on the environment and human health

Gold panners use an estimated six tonnes of mercury annually, of which half is lost during the amalgamation process. The extent of its impact is further spread since the panners dilute the mercury with water to increase quantities. When mixed with water, mercury is lethal to human beings and plants. The problem is that mercury has a long life – up to 30 years from the time of immersion. It is therefore active in water bodies for a long time, compounding the pollution and human health problems. A study of panners in Insiza District in Zimbabwe identified symptoms characteristic of occupational mercury poisoning: of those sampled, 60 per cent had general body weaknesses, 55 per cent had nausea symptoms, 50 per cent had lost teeth and 45 per cent had a history of respiratory diseases.

Source: Milne and Marongwe 1995

(Griffin 1976, IOM 2005a, IOM 2005b). In Ethiopia and Mali, for example, migration is widespread and in both countries it is linked to income generation strategies (McDowell and de Haan 1997). This is also the case for many countries in Southern Africa. Migration may represent a rational allocation of total household labour to maximize household utility (Bigsten 1996). In some communities, an increasing scarcity of traditional male labour, due to migration, has also promoted new roles for the women left behind. These women become the main decision-makers, particularly within the agricultural sector. The gendered division of family labour has in some instances changed as a result of the loss of male employment through urban job retrenchment, forcing women to seek additional income-generating activities to support the family (Adepoju 2004). The consequence has been that problems induced by environmental degradation, such as deforestation or decline in water quality, have far-reaching consequences on entire families as time spent on looking for wood or water directly affects the household incomes. Various policy responses seek to address these problems. Currently, several African countries are involved in the World Bank-initiated PRS, whose second phase includes the environment as an important aspect of poverty reduction. The PRS are discussed more fully in Chapter 8: *Interlinkages: The Environment and Policy Web*.

Technological change

Research and the development of new technologies can drive environmental change in positive and negative ways. They may increase the demand for natural resources, their application may impact on the integrity of ecosystems and they may offer an opportunity for more efficient use of natural resources, cleaner production techniques and improved environmental management. However, new technologies may also pose new risks to human and environmental health.

In the last 20 years, the advances in technology have been monumental. Key areas of development include more effective monitoring and assessment techniques, such as remote sensing, the transformation of ICT, biomaterial engineering, rapid advances in biotechnology and genetic modification, and more efficient and faster transportation. Technological innovation can offer important opportunities for responding more effectively to challenges in areas such as economic productivity, agriculture, education, gender inequity, health, water, sanitation, energy and participation in the global economy (UN Millennium Project 2005b).

The pace of technological change in Africa has been slow and is mostly linked to FDI; it has not contributed significantly to enhancing the availability of products and services required by Africa to promote development (FAO 2003). The Johannesburg Plan of Implementation commits the global community to making technological investments in Africa, particularly with a view to increasing the pace of industrialization, but also for

Mobile phones offer new opportunities for communications in remote areas.

Source: Y. Arsian/Still Pictures

improved management of resources, such as water and energy, and the improvement of service provision in these areas. Industrial growth without complementary investment in monitoring systems and health services is likely to create new levels of vulnerability for poor people.

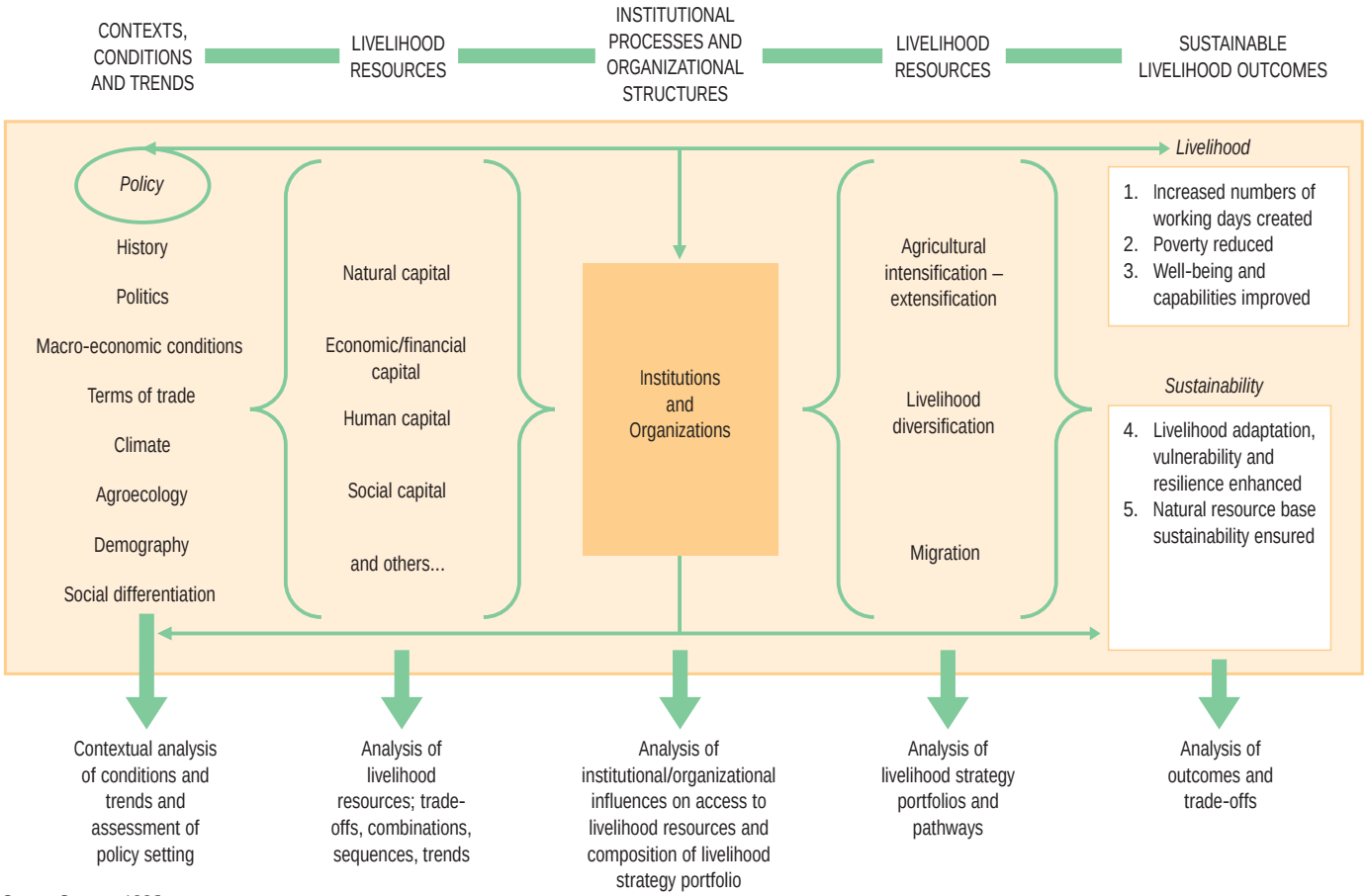
Expenditure on research and development activities, as a percentage of GDP, is very low for African countries. However, there are inadequate statistics available for proper analysis. Developing country investment in research averages 0.9 per cent of GDP, compared to 2.5 per cent for OECD countries.

Information and communication technology at the global level have been significant drivers of economic change, but access to communication technology remains very low despite significant growth in this sector between 1990 and 2003, which increased economic opportunities and participation in global markets. In Burkina Faso, for example, in 1990 there were only two telephone main lines per 1 000 people, but by 2003 this had more than doubled to five lines per 1 000 people, compared to Equatorial Guinea where there was a 450 per cent increase over the same period from four lines per 1 000 people to 18 lines per 1 000 people (UNDP 2005). Other countries, such as Zambia and Uganda, show no growth and Angola has experienced a decline (UNDP 2005). Levels of availability of main lines in 2003 varied significantly across the region, with 285 lines per 1 000 people in Mauritius, 156 lines per 1 000 people in Cape Verde and two lines per 1 000 people in the Congo (UNDP 2005). Access to cellular phones has increased dramatically, with an average of 54 subscribers per 1 000 people in SSA. Several countries, including Gabon, Morocco, Botswana, Tunisia and South Africa, have in the range of 200-400 subscribers per 1 000 people (UNDP 2005). The percentage of internet users is also very low (UNDP 2005).

HUMAN WELL-BEING AND LIVELIHOODS

Improving human well-being is at the core of sustainable development efforts in Africa. Environmental goods-and-services, including supporting services such as soil formation, provisioning services such as wood, regulating services such as water purification, and

Figure 5: Sustainable livelihoods framework



Source: Scoones 1998

cultural services provide important opportunities for meeting human development goals (MA 2005a).

Human well-being is multidimensional. It is the ability of all people to determine and meet their needs and to have a range of choices and opportunities to fulfil their potential (Prescott-Allen 2001). It includes tackling a diverse range of challenges – environmental, social and economic – and widening the options available to people to make a living and to participate actively in society. Sustainable livelihoods that guarantee access and entitlement to a range of assets and opportunities are essential to achieving human well-being. Such livelihoods are not limited to, for example, a particular level of income, paid labour or ability to meet household food security, but must include opportunities for investment and business, national economic stability and reliable and accountable governance systems.

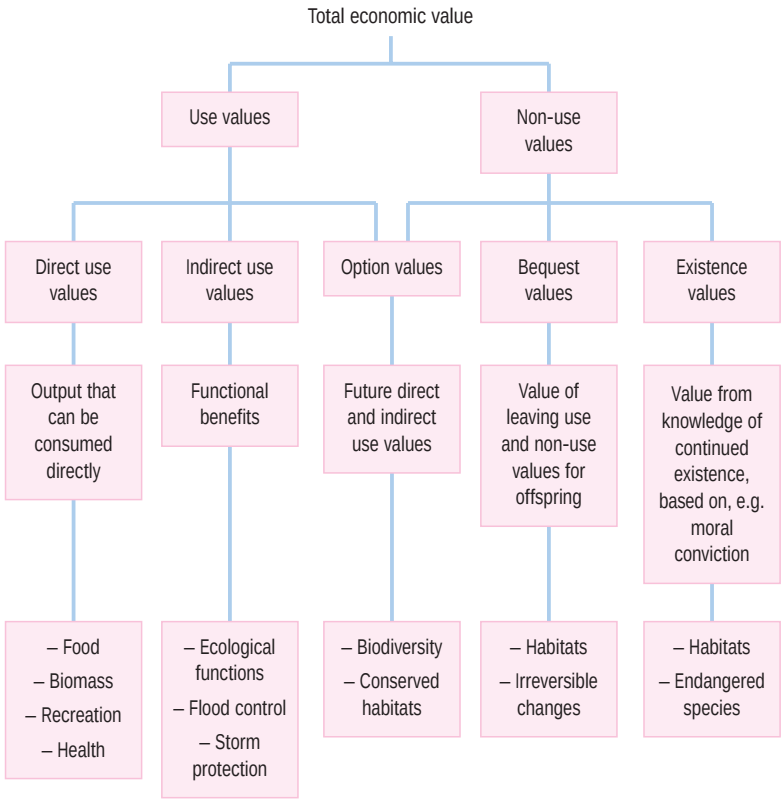
A livelihood comprises the capabilities, assets (including natural, social, human, physical and financial) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base (Scoones 1998). Figure 5 depicts the livelihood framework, illustrating the linkages between the various livelihood aspects.

Environmental and economic changes can introduce vulnerabilities to human well-being and undercut opportunities for development. Improved human well-being is critical to increasing the range of options, choices and responses people are able to make to mitigate and adapt to such changes.

Coping mechanisms, in poor communities, often include intensification of existing productive activity, diversification by adopting additional productive activities and migration to develop productive activity elsewhere.

Income and services derived from environmental resources, including land, forests and woodlands, freshwater and wetlands, coastal and marine resources, and wildlife (flora and fauna) are central to the livelihoods of many rural people and to Africa's economy as a whole. People derive multiple values from natural resources, including use and non-use values. Option values may include use and non-use aspects, and refer to the value placed on the resource as an option for further use. Existence value refers to the benefits derived from knowing the resource exists, such values often being associated with religious and cultural meaning. Bequest value is the value placed on being able to pass natural resource assets onto future generations. These values are reflected in Figure 6.

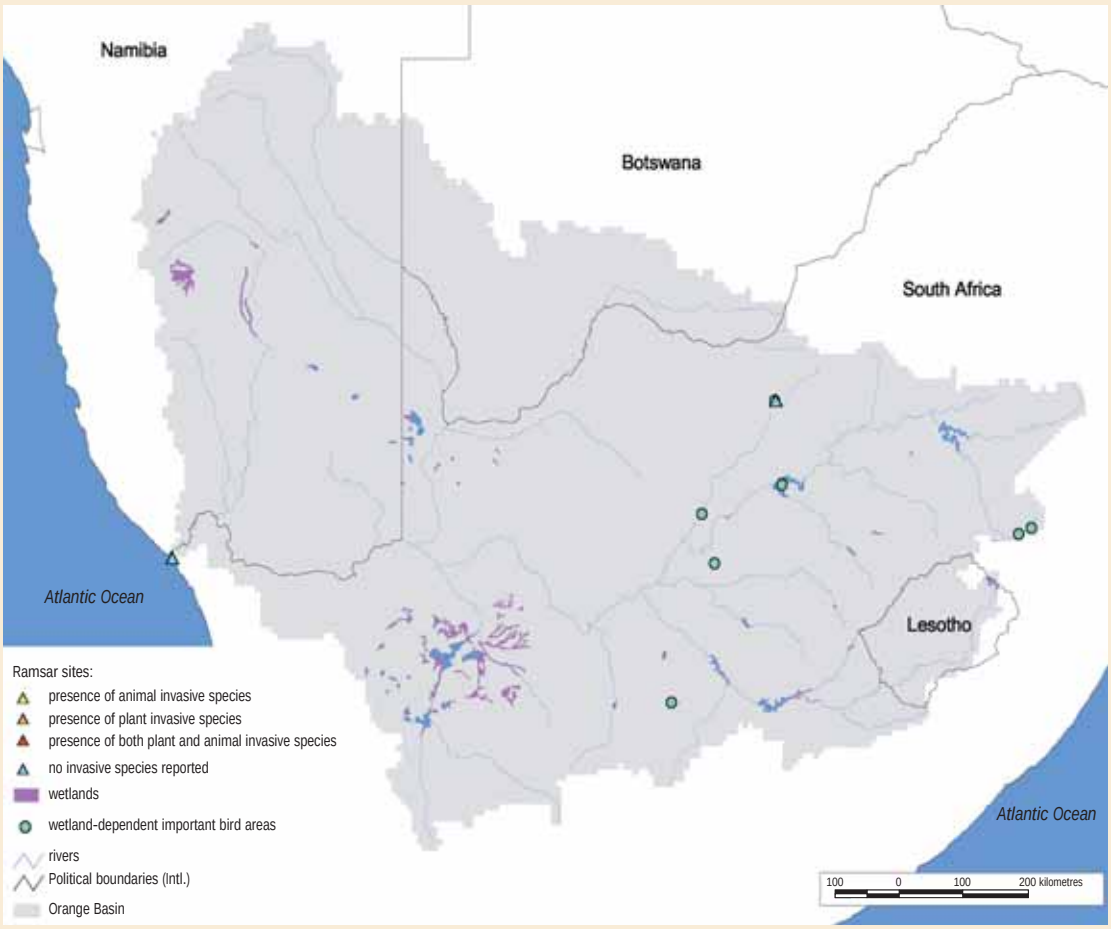
Figure 6: Total economic value



Source: Landell-Mills and Porras 2002. Derived from Munashinghe 1993

Poor people have not been able to effectively capture the full benefits associated with the use of natural resources. This is partly because resources are used primarily for subsistence and value-adding and marketing is neglected. Maximizing the opportunities requires moving beyond a subsistence framework which focuses on minimum or basic needs, to using the available resource in an efficient, equitable, productive and sustainable manner. Increasingly, livelihood approaches have focused on how this resource can be used as an asset for improved human well-being and promoting development. Options for increased investment, employment creation in processing, trade and related services, and small and micronatural resources-based entrepreneurship are increasingly considered. The commercialization of wild resources offers important opportunities for improving income and other aspects of well-being. Widening the options for poor people requires promoting opportunities for them to capture a greater share of the value generated through, among other things, better market access, less bureaucratic restraints on trade and better access to capital and other resources. Achieving better opportunities requires complementary policy development in other areas including good governance, tenure regimes and global trade.

Box 2: Natural resources as key assets



Arable land is an important asset, as most people in Africa rely on agriculture directly and indirectly for their well-being. Agriculture contributes more than 50 per cent to most African countries' economies, and in most countries is the basis for at least 70 per cent of livelihoods, whether through employment, income generation or subsistence food production (WRI and others 2005).

Forests provide a wide variety of highly valuable ecological, economic and social services, including: the conservation of biological diversity; carbon storage; soil and water conservation; and provision of employment, enhanced livelihoods and agricultural production systems (FAO 1999). Important non-timber forest products include edible products (such as mushrooms, wild fruits, wild vegetables, bushmeat and bee products) and livestock fodder, as well as goods-and-services (FAO 2005). Medicinal plants used in traditional medicine may be collected directly by the user or the traditional healers, while some are obtained through local markets. There is a growing export market for NTFPs as ingredients for other products, as unprocessed or processed materials.

http://pdf.wri.org/watersheds_2003/af20.pdf

Number of fish species:	24
Number of fish endemics:	7
Number of amphibian species:	42
Number of Ramsar sites:	2
Number of wetland-dependent IBAs:	7
Number of endemic bird areas:	2
Per cent protected area:	4.7

Wetlands have a multiplicity of benefits for people living in and outside their proximity. They are most important for dry season farming and grazing, inland fisheries, and regulation of stream flows and floods and in treating effluents. These uses of wetlands provide an effective strategy for risk diversification. Other values include fishing, crop cultivation, livestock grazing, grass for domestic use, natural products and medicine, water treatment and purification.

Sources: WRI and others 2005, FAO 1999, FAO 2005

Table 2: Wetland economic values in selected African countries

The Zambezi basin is one of Africa's most productive freshwater resources.

Source: IUCN ROSA

Wetland Goods or Service	Economic Values per Wetland (2002 US$/yr* 1 000)	Wetland
1 Crop cultivation/Agriculture	59.8	Nakivubo
	10 652.6	Hadejia-Jama
	1 293.8	Lake Chilwa
	49 655.2	Zambezi Basin
2 Papyrus harvesting	9.5	Nakivubo
3 Fuelwood	1 601.7	Hadejia-Jama
4 Doum Palm	130.2	Hadejia-Jama
5 Potash	0.89	Hadejia-Jama
6 Vegetation (reeds, bamboo, grass)	13.5	Lake Chilwa
7 Brick-making	17.4	Nakivubo
8 Fishing	3 465.1	Hadejia-Jama
	18 675.5	Lake Chilwa
	78 620.7	Zambezi Basin
9 Fish farming	3.3	Nakivubo
10 Grassland/Livestock farming	638.0	Lake Chilwa
	70 620.7	Zambezi Basin
11 Water treatment and purification	968.9	Nakivubo
12 Water transport	435.7	Lake Chilwa
13 Wildlife services and goods	–1 144.8	Zambezi Basin
14 Ecotourism	813.8	Zambezi Basin
15 Biodiversity	67.6	Zambezi Basin
16 Natural products and medicine	2 620.7	Zambezi Basin

Source: Schuijt 2002

POLICY AND LEGAL RESPONSES FOR SUSTAINABLE DEVELOPMENT

Africa has responded to the challenges posed to sustainable development by committing to and establishing policies for creating an enabling environment at the regional, sub-regional, national and local levels that support sustained economic growth, environmental integrity, efforts for peace, stability and security, democracy and good governance, respect for human rights and fundamental freedoms, including the right to development and gender equality. Although much remains to be done to make this policy objective a reality, Africa (both governments and its people) are committed to and share the Brundtland Commission's vision for a future that is more prosperous, more just and more secure (WCED 1987).

The relationship between human society and the environment is complex and multidimensional, with changes in one domain affecting the other. Although the world has more resources and capacity than ever before, it has not managed to use these in a way that maximizes human opportunity and simultaneously protects the resources that sustain humanity. It is increasingly evident that many of the environmental changes people are setting into motion have fundamental consequences for human well-being and the range of sustainable development options available. A critical message from the Millennium Ecosystem Assessment (MA) is that nearly two-thirds of the services provided by nature are declining worldwide (MA 2005b). Resolving this and moving towards a more sustainable and just future requires not only better management systems but also a need to address the key issues that undermine sustainable development.

Across Africa, there has been a rich and varied response to these challenges at multiple levels, from the regional to the community level. Governments, non-governmental organizations, community groups, scientists and other experts have all been important

contributors to developing policy and defining practical responses to implement such policies. Since the Brundtland Commission put forward its vision for sustainable development in 1987, there have been other key policy responses which reinforce its messages and which seek to make sustainable development a reality. Landmarks on this trajectory of responses include:

- The United Nations Conference on Environment and Development (UNCED) in 1992 with its broad policy consensus reflected in the Rio Declaration and a defined programme of action in Agenda 21;
- The WSSD and its Johannesburg Plan of Implementation;
- The globally agreed time-bound development goals and targets in the MDGs;
- The creation of the AU to succeed the Organization of African Unity (OAU);
- The NEPAD-EAP; and
- The AU's Africa Convention on the Conservation of Nature and Natural Resources (ACCNNR).

Through these policy initiatives, African governments have taken a comprehensive approach to the issue of sustainable development. They have emphasized the following, as well as the links between these aspects:

- An explicit recognition that the environment is integral to sustainable development. In particular there is an increasing shift to seeing the environment as an opportunity for development rather than a constraint;
- A renewed determination to harness the opportunities the environment provides for economic growth and human well-being;
- A commitment to building a more just future based on the recognition that inequity (at multiple levels, including global trade relations and gender) and poverty are important drivers in unsustainable environmental management and are at the core of the growing vulnerability of Africa's people;
- An acceptance that an integrated approach to environmental management is the basis for sustainable development. Such an approach requires understanding the relationship between different aspects of the environment and developing a holistic approach to management, as well as acknowledging the linkages between environment and other areas of human activity, such as trade, science and technology;
- A resolve to build partnerships and promote collaboration, at multiple levels, to address and find solutions to the challenges of sustainable development. This includes not only political collaboration, but also building partnerships in science and technology, capacity-building, trade, human and financial resources;
- An acknowledgement that strengthening national institutions and empowering people is key to effective and sustainable resource management, human development, eradicating poverty, and creating a more equitable society and in addition is consistent with human rights;
- A commitment to enhance human capacity, including scientific and technological capability, so as to be more able to respond to the environmental and development challenges effectively;

Box 3: The African Ministerial Conference on the Environment (AMCEN)

The African Ministerial Conference on the Environment was established in 1985 to strengthen cooperation between African governments on economic, technical and scientific activities to halt the degradation of Africa's environment and satisfy the food and energy needs of its people. It is mandated to:

- Provide information and advocacy for environmental protection in Africa.
- Ensure that the basic (material) human needs are met adequately and in a sustainable manner.
- Ensure socioeconomic development is realized at all levels.
- Ensure that agricultural activities and practices meet the food security needs of the region.

The African Ministerial Conference on the Environment:

- Provides continent-wide leadership on environmental issues.
- Promotes awareness and consensus on global and regional environmental issues, especially those relating to international conventions on biodiversity, desertification and climate change.
- Develops common positions to guide African representatives in negotiations for legally binding international environmental agreements.
- Promotes African participation in international dialogue on global issues of crucial importance to Africa.
- Reviews and monitors environmental programmes at the regional, sub-regional and national levels.
- Promotes the ratification by African countries of multilateral environmental agreements relevant to the region.
- Builds African capacity in the field of environmental management.
- Gives strategic guidance in the implementation of Multilateral Environment Agreements.

Since 2000, AMCEN has also initiated environmental assessment and reporting to keep the regional environment under review in order to provide early warning on emerging environmental issues.

Source: UNEP, undated

Conference circle.

Source: M. Chenje

- An appreciation of the importance of linking policy objectives to clear implementation plans and objectives and a growing commitment to do this; and
- A desire to build and sustain societies based on peace and cooperation, to rid the region of conflict.

Multilateral environmental agreements (MEAs), at the global, regional and sub-regional levels, are an important response to these broad policy positions. They seek to take the challenges identified in policies on board and provide for practical responses. Multilateral environmental agreements may establish clear rules or suggest managerial frameworks to resolve problems. African countries are party to at least 30 conventions at the global level, dealing with various aspects of environmental management, and related areas, such as trade, that impact directly on environmental sustainability.

Most African countries have signed the three international conventions adopted at the UNCED in 1992 – the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC) and the United Nations Convention to Combat Desertification (UNCCD) – as well as the United Nations Convention on the Law of the Sea (UNCLOS). Other MEAs to which African countries are party include those dealing with international trade in endangered species, the management of migratory species, hazardous waste management, cultural heritage, ozone depletion, biosafety, invasive alien species and forest management. Also of critical importance are agreements reached in the trade area, especially the World Trade Organization (WTO) and related agreements on Trade-Related Aspects of Intellectual Property Rights (TRIPS), and sanitary and phytosanitary provisions. Several agreements in agriculture, such as the International Convention for Protection of Plants, have important implications for biodiversity and the sharing of benefits arising from its use. Human rights and development agreements adhered to set the framework for addressing these environmental issues. Additionally, Africa has a growing number of regional and sub-regional MEAs which promote collaboration by establishing an agreed approach to a given issue, which in turn sets the basis for harmonized and coordinated national law. Foremost among these is the ACCNNR adopted by the AU in 2003. This policy and legal approach is reinforced through the establishment of regional and sub-regional organizations. Many sub-regional organizations have spearheaded the development of environmental management policy and law at the sub-region level. In critical areas of sub-regional concern, there have been important multilateral agreements; these include cooperation in the management of shared river basins, wildlife and forests.

These policy and legal initiatives have been complemented by the development of institutions at the regional and sub-regional levels. The African Ministerial Conference on the Environment (AMCEN) is one such initiative which increases opportunities for the development of collaborative approaches to environmental management. Box 3 provides more information about AMCEN. Crucial too is the

strengthening and reorganization of the African Union. Its Constitutive Act provided for the establishment of a specialized technical committee on natural resources and the environment. The Pan-African Parliament, established in 2004, has a permanent standing Committee on Rural Economy, Agriculture, Natural Resources and Environment. In 2005, the AU launched the Economic, Social and Cultural Council of the AU (ECOSOCC) to facilitate and promote civil society participation in the affairs of the AU. See Box 7.

Increased role of civil society

In the last 20 years, the role of civil society in environmental policy development has changed significantly. Today, African governments recognize that civil society must be consulted in environment and development initiatives. Increasingly, civil society organizations are demanding to be more actively included in policy-making processes, including those at a national, sub-regional and regional level.

Civil society is often thought of as a third sector in a tripartite relationship with the state and business. This is the arena in which citizens collectively exercise social and political values to promote various aspects of community well-being. Civil society organizations (CSOs) include religious, traditional, farmers', women's, academic and professional, civic, microfinancing, rights claiming, and non-governmental organizations (NGOs) as well as trade unions. CSOs do not equate with civil society as a whole and they may have diverse or even contradictory interests (Chaplowe 2002). The number of CSOs participating in environment and development issues has grown considerably since the beginning of the 1980s and these organizations vary in scope and scale. There are those that operate primarily at a local level, including community-based organizations (CBOs) and those with national, sub-regional, regional and global mandates. Although the number of CSOs has grown across Africa, there is considerable variation between countries and between urban and rural settings.

In the 1980s, CSOs began to engage more actively in development issues as illustrated by their roles in fighting apartheid, advocating an international code of conduct for the marketing of breast-milk substitutes, improving and increasing official aid (including food aid) following the African famine of the mid-1980s, and working with UNICEF and others to reform SAPs given the negative social impact of these programmes (UN 2003). The activities of African NGOs concentrated on development tasks in the economic, social, cultural and environmental sector. Most African NGOs were not actively engaged in defining policy but had a strong programmatic focus that sought to improve human well-being through improved agriculture, more efficient energy management, water purification and the development of microenterprises among other things. During this period, science and particularly government science-based institutions played a central role in explaining problems and defining solutions and, because the environment was seen as a public good, a government lead was believed to be warranted (Berkhout and others 2003). There was a proliferation of laws and policies that sought to increase controls over environmental use. At the regional as well as the national level, NGOs worked to complement the activities of governments and international agencies in humanitarian areas, such as food crises, but also in environmental management areas including water, wildlife, forest and energy management. The increasing role of community-based organizations, and in particular NGOs, during the 1980s, was linked to a reassessment by donor agencies on the states' ability to act as vehicles for development (Chaplowe 2002). Structural Adjustment Programmes introduced in the 1980s forced many African governments to withdraw or reduce many development and public services, which created a space for the growth of CBOs.

By the 1990s, the role of CBOs began to widen, particularly in the environment and development sector. In 1990, the Arusha Charter on Popular Participation recognized the need to fully integrate African civil society in various governance structures of

Women teaching and learning about food groups in a nutrition education class in Madagascar.

Source: FAO

key institutions in order for them to fully participate in defining the long-term development policies of Africa (UN 2003). CSOs began to actively carve out a role that went beyond being service providers to being more active participants in policy making. Success in this has varied from country to country and institution to institution; in many places this role has remained superficial. At the same time there were important shifts taking place in how the environment was perceived. A more complex understanding of the environment that acknowledged its role in local livelihoods and human well-being was beginning to emerge. Although the framing of solutions to environmental problems still tended to be externally focused or driven, concentrating for example on the role of international environmental law, markets and incentives, the role of local users was becoming more prominent. NGOs took on active advocacy roles, often focusing on the subsistence needs of poor people. Increasingly, NGOs were present at hearings, panels and briefings and in dialogues with governments (UN 2003). In global policy processes, there was a gradual increase in the prominence of Southern NGOs (UN 2003).

At the global level, various initiatives to increase opportunities for participation in environmental policy development were also adopted. The United Nations made direct provision for CBO participation at the 1992 UNCED. Since then, CSOs have played an active role in UN conferences concerned with development issues and which have a bearing on the environment, including ones on Small Island Developing States (SIDS), human rights, women, social development, racism, least developed countries, food aid, and communication and information, as well as the Millennium Summit. Although such approaches were adopted, they fall short of a concerted and formalized approach to bring all sectors together (Reinicke and others 2000). The UN conferences and other processes seek to deal with issues that cannot be treated purely from a national perspective – environmental issues, for example, traverse national or regional boundaries (Tabbush 2005). Participation has given CSOs the opportunity to engage with CSOs from other countries and regions, as well as with governments other than their own. More recently, initiatives by various UN agencies have been adopted to increase CSO participation in UN-led development activities. For example, UNEP's Global Civil Society Forum and Global Women's Assembly on Environment provide new opportunities for civil society participation in its programmes. These initiatives have played a key role in widening the influence of CSOs, including those from Africa.

Box 4: Women negotiating for peace

Although women are often better equipped than men to prevent or resolve conflict, they face formidable obstacles to participating in peace negotiations.

The contribution from Femmes Africa Solidarité (FAS) demonstrates how effective organizing and collaborating with other CSOs can enhance women's advocacy and role in peace negotiations. Femmes Africa Solidarité has successfully employed a multidimensional approach to advocacy. First, the women made their voices heard through international conferences, such as the Pan-African Women's Conference on a Culture for Peace in 1999. Second, the women successfully mobilized for the women of Burundi to attend the third round of inter-Burundi peace negotiations in Arusha. Third, the women built a common platform – the Mano River Women's Network (MARWOPNET) – to resolve the crisis between Guinea and Liberia. Subsequently, MARWOPNET received international acclaim for its key role in rebuilding diplomatic relations between Liberia, Guinea and Sierra Leone. Fourth, the women built partnerships across national boundaries – MARWOPNET was the result of collaboration between women from three countries. Fifth, the negotiation strategies included unified voice, persistence and image-making via the media. Through these approaches, FAS helped women develop more comprehensive, gender-specific policies and practices for addressing conflict that were incorporated in the conflict resolution process.

Source: Tabbush 2005

Although there were many successes after UNCED, the following decade revealed the need for users and managers of natural resources to be more actively involved in shaping their own futures. It has also drawn attention to the complex links between human-driven change and the environment (Berkhout and others 2003). From this emerged a new understanding of the need for integrated approaches focusing on multiple and cross-dimensional linkages. Increasingly, there is a shift to policy processes that bring together not only the different environmental sectors but also other sectors which impact on the environment, such as health, technology and finance, with intellectuals from different disciplines, including the biophysical and social sciences, in partnership with civil society in formulating responses. These approaches are discussed in depth in Chapter 8: *Interlinkages: The Environment and Policy*

Women collecting *Piliostigma reticulatum* pods, Burkina Faso. They will sell these as high quality animal feed.

Source: D.Tiveau/ CIFOR

Web. Rights claiming and advocacy by civil society have been important in bringing about this shift. NGOs became key players in putting forward public concerns, interests and priorities.

By the end of the 1990s, CSOs had come to engage more actively in analysing problems, defining solutions and framing policies. There has been a notable growth in civil society organizations across the board and the kinds of roles they have taken on. They have successfully negotiated a place in regional and sub-regional intergovernmental organizations, including the AU and NEPAD, as discussed later in this chapter. Civil society organizations have played an important role in the development of AU protocols in critical issues of environment and development concern, including biosafety, genetic resources and the rights of women. Partnerships with governments and the business sector have also become increasingly important. This includes partnerships establishing transboundary natural resource management areas, protected areas management and implementing environmental impact assessments. They have also become more critical development partners, raising concerns and drawing attention to some of the potential difficulties associated with new state initiatives. For example, in January 2001, some 200 CBOs from 45 African countries met at the African Social Forum and rejected a neo-liberal approach to globalization (Chaplowe 2002). New kinds of CSOs have begun to emerge: of particular importance has been the development of networks, bringing together different types of CSOs for a common purpose, sometimes in partnership with business, governments and multilateral organizations. Some of these have been local or national in focus, addressing for example HIV/AIDS, land claims, and participation in PRS. Others have taken regional or sub-regional approaches, focusing on a growing range of issues that require cooperation including water resource management, malaria, chemical management, peace-building and food security. These include networks such as the Global Water Partnership (GWP) and the African Stockpile Programme.

The New Partnership for Africa's Development commits Africa's leaders to place their countries, individually and collectively, on a path of sustainable growth and development, and at the same time to participate actively in the world economy, enlarging Africa's economic prospects.

Environment for development

Africa has come to approach the environment in a fundamentally new way – it has moved from seeing environmental issues as a constraint to development to seeing the environment, if properly managed, as an opportunity for development. Chapters 2-7, of Section 2: *Environmental State-and-Trends: 20-Year Retrospective*, discuss the opportunities for development from different environmental goods-and-services.

African governments have adopted new, more encompassing and forward-looking environmental policy and legislation. Beginning in the 1980's, following the Stockholm Human Environment Conference of 1972 and the Lagos Plan of Action of 1980, African countries began to refocus on how to manage the environment and why it was important from a development perspective. By the 1990s, the Brundtland Commission, the UNCED conventions, and Agenda 21, as well as advocacy and actions of civil society, motivated African countries to make a fundamental break with the environmental approaches that had developed during the colonial era and had persisted since then.

In 2002, with the launch of the African Union, a fundamental shift was made from predominantly political cooperation to a joint Africa-wide commitment to promote socioeconomic development. Environmental resources were, and are, seen as a key part of this. The AU's Constitutive Act provides for coordinated policy development in the important environmental areas of energy, mineral resources, food, agriculture and animal resources, forestry, water and environmental protection. The ACCNR, adopted by the AU in July 2003, revised the original convention adopted in Algiers in 1968. The Convention commits Africa to development that is based on the achievement of ecologically rational, economically sound, and socially acceptable policies and programmes which recognize the human right to a satisfactory environment as well as the right to development.

The New Partnership for Africa's Development commits Africa's leaders to place their countries, individually and collectively, on a path of sustainable growth and development, and at the same time to participate actively in the world economy, enlarging Africa's economic prospects. It seeks to address environmental challenges while reducing poverty, and recognizes that the range of issues necessary to nurture the region's environmental base and promote the sustainable use of natural resources is vast and complex, and thus that a systematic combination of initiatives is necessary to develop a coherent environmental programme.

Poverty and inequity

Eradicating poverty is the greatest challenge facing Africa and the world today, and an indispensable requirement for sustainable development.

Since the Brundtland Commission, there has been growing recognition of the close relationship between poverty and environmental problems, as both cause and effect, and thus the futility of approaches that do not take a broad perspective and address the factors underlying world poverty. The WSSD refocused attention on this relationship and the need to improve opportunities through increased investment in human capacity, technology and industrial development, as well as the need for equitable and adequate access to water and energy (UN 2002).

Many policies now deal directly with the relationship between environmental use and equity at the global and national level. UNCED, for example in the CBD, links the issues of sustainable use and conservation closely to the fair and equitable sharing of benefits. Agenda 21 focuses on the need to combat poverty, with the long-term objective of enabling all people to achieve sustainable livelihoods. This requires policies to address issues of development, sustainable resource management and poverty eradication simultaneously (UN 1992). The 2005 World Summit in New York emphasized the importance of peace and security, development and human rights as the basis for human well-being.

It is widely acknowledged that better environmental management systems which promote human well-being

Loading timber logs onto a train in Gabon.

Source: J. Maillard/ILO

can be an important tool for eradicating poverty. Poverty has many facets and is not restricted to income levels and includes, among other factors, health and education dimensions. Addressing poverty requires actions in multiple areas as identified in the MDGs. Inequity at multiple levels, including in gender, has implications for successfully addressing poverty.

Global inequity has important ramifications for the economies of Africa and the opportunities available to it, and thus its ability to eradicate poverty. Trade and increased local entrepreneurship are widely seen as essential to stimulate Africa's economy, and it is acknowledged that natural resources can be used to extend trade opportunities internationally and domestically (Katerere and Mohamed-Katerere 2005). However, as the Brundtland Commission stressed nearly 20 years ago, the international economy will only promote growth if the sustainability of the resource basis is guaranteed and if trade is equitable. Growth was then, and continues to be, stifled by depressed commodity prices, protectionism, intolerable debt burdens and a declining flow of investments (WCED 1987). For example, the European Union's (EU) and United States' agricultural subsidies make it difficult for farmers in developing countries to compete effectively. The EU, while demanding African countries liberalize 90 per cent of their markets over ten years, refuses to reform its highly protectionist Common Agricultural Policy (Griffith and Stuart 2004).

At the regional and sub-regional level, policy and programmes have also been developed to take these concerns on board. The Southern African Development Community's (SADC) policy for environment and natural resource management, for example, linked the need for growth with equitable sustainable development within the sub-region. The empowerment of the poor, including women, through increased access to resources fosters social inclusion and promotes growth. This cannot be achieved without taking on board the environment dimension, especially in Africa where most countries' economic mainstay is the natural resource base.

Box 5: Aquaculture in Zanzibar, Tanzania

Diversifying livelihood options and increasing values of natural resources may improve the socioeconomic status of small-scale fisheries and reduce pressure on fish resources. In Tanzania, various initiatives are geared towards doing this, including coastal aquaculture development. Seaweed has a high carrageenan content which is extracted for use in cosmetics and in the pharmaceutical industry.

Wild seaweed, of the red algal species of *Eucheuma denticulatum* and *Kappaphycus alvarezii*, used to be collected from the intertidal zone of coral reefs around Zanzibar and dried for export to France and Denmark. This practice was replaced in 1989 with seaweed farming, mainly carried out by women. This form of aquaculture is relatively harmless to the environment as it does not pollute the environment with feeds, wastes or other chemicals. Although there are some negative interactions causing inhibition of surrounding biota, these appear to be relatively mild.

The socioeconomic impacts of seaweed farming were initially overwhelmingly positive. Annual production reached 7 000 tonnes, providing income to the women involved and constituting an important earning of foreign exchange. However, over time, monopoly control by a few international corporations has led to reduced prices being paid to producers, despite recent trends showing that the demand and market price for carrageenan is increasing.

Seaweed farming represents an opportunity for prosperity and increased food security for coastal communities, and especially women, to improve their incomes and is thus important for poverty eradication. If production is planned and managed to a greater degree, and policies implemented to ensure equitable access to markets, training and capacity-building, it has the potential to provide a sustainable livelihood for the people involved.

Source: Bryceson 2002

Harnessing opportunities for development

To meet economic growth targets and the MDG targets, to realize regional and national environmental goals, to decrease poverty and to improve overall well-being requires that Africa maximize the opportunities available to it.

The New Economic Partnership for African Development seeks to position Africa to take advantage of the opportunities presented by changing global trade by promoting good governance, allocating resources efficiently and exploring partnerships with the private sector and within key political fora (Katerere and Mohamed-Katerere 2005). It seeks to balance the neo-liberal economic reforms it is promoting with support for social services, particularly health and education.

At the sub-regional level, economic communities have been developed, including the Southern African Development Community (SADC), the Economic Commission of West African States (ECOWAS), the East African Community (EAC), the Economic Community of Central African States (ECCAS), the Intergovernmental Authority on Development (IGAD) and the Arab Maghreb Union (AMU). Many of these initiatives focus on increasing opportunities the natural resource basis offers and stimulating inter-African trade by reducing restrictions on the movement of people, goods-and-services. Some initiatives, such as the Spatial Development Initiatives (SDI) in Southern Africa, provide for joint development and planning in contiguous regions, some of which straddle

Producers load a boat with *Gnetum spp.* for export from Idanao to Orion, Nigeria.

Source: R.Perezim/CIFOR

international borders. Several SDIs seek to harness the under-utilized potential for economic growth by promoting tourism, and other natural resource-based activities, thus increasing investment and lending, infrastructural development and opportunities for local livelihoods, particularly the development of local small and microenterprises (Mohamed-Katerere 2001).

In addition, policies have clearly identified the need to look at the opportunities industry and technological development can bring. The WSSD focuses specifically on the need to strengthen the contribution of industrial development to poverty eradication and sustainable natural resource management. This includes actions, at all levels, to mobilize resources to enhance productivity, increase income-generating employment activities, financial and technical support to rural communities, the development of small and microenterprises, and the support for natural resource management to create sustainable rural livelihoods. The commercialization of wild resources, such as medicinal plants, fruits and resins, can offer important livelihood opportunities. Box 5 looks at the benefits the commercialization of seaweed has brought to poor people in Tanzania. Intellectual property rights of those engaged in product development and poor control of genetic resources potentially undercut the extent of benefits that can be earned.

Integrated approach

Sustainable environmental management requires recognizing the interlinkages between different aspects of the environment, as well as the complex interactions between factors in human society causing change to the environment. Given this, there is a need to deal with environment and development issues in a holistic, comprehensive and integrated manner.

The need for integrated approaches has been recognized in the Stockholm Convention, and in 1987 the Brundtland Commission identified it as the basis of sustainable development strategies. This approach was further developed in the Rio Declaration, Agenda 21 and the UNCED conventions. The WSSD Johannesburg Plan of Implementation draws attention to the ways in which such an approach may create better opportunities for water resource and energy management as well as for the identification and development of alternative technologies.

In the 1990s, many African countries broke with the narrow sectoral approach that had been inherited from the colonial era and which was founded on command-and-control rule-based systems and were the forte of their environmental management systems, to develop more integrated approaches. In this period, most countries adopted national environmental action plans; many also began to reform the natural resource management legislation, giving it a stronger rights and opportunities content. Most African countries also adopted environmental provisions in their constitutions, in many cases echoing the commitment in the African Charter on Human Rights and Peoples Rights recognizing environmental rights.

The NEPAD-EAP, adopted in 2003, takes an integrated approach to the environment and development with full consideration of economic growth, income distribution, poverty eradication, social equity and better governance as part and parcel of Africa's environmental sustainability agenda (NEPAD 2003). The ACCNR also commits to such an approach and calls on parties to integrate development and environmental concerns by treating both as an integral part of national and local development plans, and to give full consideration to ecological, social, economic and cultural factors in their development.

Cooperation at multiple levels

A striking feature of recent policy initiatives is the priority given to improving opportunities for cooperation at the global, regional, sub-regional and national levels.

Regional initiatives which create new levels of cooperation have taken place: many of these emphasize the commonness of Africa's problems and the opportunity collaboration brings to solving these problems. The NEPAD-EAP is one such initiative. It was prepared through a consultative and participatory process under the leadership of AMCEN. It sought to identify the root causes of environmental degradation and the most effective projects from an environmental, institutional and financial perspective. The plan takes a long-term perspective and identifies eight programme areas and actions that African countries should adopt to maintain the integrity of the environment and ensure the sustainable use of their natural resources. It responds to some of the challenges of the MDGs – particularly goals Number 1 on eradicating poverty, Number 7 on environmental sustainability and Number 8 on developing a partnership for development, as well as to the general principles of Agenda 21.

At the sub-regional level, collaboration has also been an important policy focus. In some instances this is between countries, whereas in others it focuses on cooperation within a given country. Sub-regional cooperation is evident in a range of areas, from transboundary natural resource management to disaster responsiveness and early warning systems. The EAC Development Strategy emphasizes economic cooperation and development with a strong focus on the social dimension, and the role of the private sector and civil society is considered as central and crucial to regional development (EAC 2001).

There are several sub-regional initiatives that deal with monitoring and early warning. In the EAC the Regional Environment Assessment Guidelines for Shared Ecosystems of East Africa has been initiated. This builds on an earlier initiative by the then East African Cooperation, where the Committee on Environment and Natural Resources made specific recommendations on shared ecosystems, including developing regional environmental assessment

Ruhakana Rugunda, Minister of Water, Lands and Environment of Uganda, at the 8th RAMSAR Conference of the Contracting Parties. Uganda has long been a pioneer in putting Ramsar principles into practice, policy and law.

Source: RAMSAR

Box 6: Western Indian Ocean (WIO) islands: vulnerability to sudden disaster

The Western Indian Ocean islands have a high level of vulnerability to sudden disaster. Such disasters include tropical cyclones (Comoros, Madagascar, Mauritius and Réunion); land-based volcanoes (Comoros and Réunion); flooding from torrential rain (Comoros, Madagascar, Mauritius); droughts (Madagascar, Mauritius); plagues of locusts (Madagascar); epidemic disease (Comoros and Madagascar), coral bleaching (Seychelles), and throughout the region, transport accidents and marine oil spills. The principal impact of the tsunami of December 2004 in the Western Indian Ocean fell upon the Maldives and the Seychelles, with some damage occurring in the outer islands of Mauritius.

While the Western Indian Ocean countries have well-developed and effective early warning and response systems for the more common tropical cyclones experienced every year, the tsunami of December 2004 demonstrated the weaknesses of certain aspects of the existing systems of disaster management and the need for reassessment and development. Review is now being made of the future risks arising from tsunamis, the cost of protective measures and the value of investing in improvements that need to be made for better protection against the more common disaster risks in the region.

While sometimes the impact of a disaster is irremediable and the event often inescapable, intervention to reduce the risk of the events and damage has been the focus of long-standing national and regional review and action. Reports available since 1951 show that the top ten disasters in the islands of Comoros, Madagascar and Mauritius, covering 96 per cent of the population of the region, resulted in 2 632 deaths and affected the lives of 10.5 million people. These disasters were principally from tropical cyclones, flooding from torrential rain, famine, disease epidemics and transport accidents.

At both the national and international level, the follow-up to the event of the tsunami of 26 December 2004 is still unfolding. Plans for improving the early warning systems are being integrated with building the capacity for emergency relief in the region which can be turned to respond to risks of the wide variety of natural and other disasters to which the island countries may be subjected. These have a grave impact on Madagascar with its population of 17 million (over 90 per cent of the population of the sub-region) where most people live in poverty, where one-third of the children suffer from malnutrition and widespread famine is not uncommon in years of poor harvests.

Long-term plans for monitoring sea level rise and sea surges are at the stage of pilot projects and isolated research exercises. The priority given to these, supported by the Indian Ocean Commission, is likely to be increased, but the need for routine monitoring of tsunami risks has to be considered in the light of other relative risks of disaster and the capacity of each country to respond to them, within the context of comprehensive hazard and risk management.

Source: IOC 2005

procedures and guidelines for shared ecosystems. These assessment guidelines will form a basis for valuating activities in or near shared ecosystems that are likely to cause significant ecological, environmental, health and social impacts. Collaborative initiatives around food security and drought warning have been other areas of sub-regional collaboration, particularly in the SADC region. Box 6 looks at the importance of cooperation in developing early warning for the WIO Islands.

Partnerships with the global community

Although sustainable development is primarily a national responsibility, many of the major challenges facing African countries have a global dimension. Thus, developed countries have some responsibility in the international pursuit of sustainable development, particularly in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

The WSSD noted that Africa's efforts to achieve sustainable development have been hindered by conflicts, insufficient investment, limited market access opportunities and supply side constraints, unsustainable debt burdens, historically declining levels of official development assistance and the impact of HIV/AIDS. The developed world has, through private enterprise, benefited from the use of natural resources, particularly diamonds and forest resources, in conflict areas. For example, in the Democratic Republic of the Congo, the United Nations Security Council found that over 100 private companies, foreign and multinational, were involved in illegal extraction (UN Security Council 2002). Such conflicts have displaced hundreds of thousands of people and had a negative impact on forest resources as a result of settlement, uncontrolled logging and fire. At the WSSD, developing countries reiterated their acknowledgement of the responsibility they bear in the international pursuit of sustainable development.

However, Africa must be the driver of its own future. Africa recognizes, as the WSSD did, that effective global cooperation requires the creation of an enabling environment at the regional, sub-regional, national and local levels which supports sustained economic growth and sustainable development, promotes peace,

EPZs offer new opportunities for business. Here fishnet production in an Indian enterprise operates from Dar es Salaam.

Source: M. Crozet/ILO

stability and security, and establishes good governance, respect for human rights and fundamental freedoms. The New Partnership for Africa's Development seeks to create such an environment and sets the basis for global collaboration. Among other things, it has developed a peer review process. A meeting of the AMCEN Inter-Agency Technical Committee (IATC) in 2004 called for the peer review mechanism process to be expanded to include environmental criteria.

There are a number of areas in which global collaboration is seen as important. Numerous policy agreements have acknowledged the vital role developed countries can play in creating access to new technologies, enhancing technological and other capacities, securing access to new financial resources and creating a fairer global trade system. The WSSD commits parties to implement the outcomes of the Doha Ministerial Conference of the World Trade Organization, further strengthen trade-related technical assistance and capacity-building and ensure the meaningful, effective and full participation of developing countries in multilateral trade negotiations by placing their needs and interests at the heart of the WTO work programme. At the WSSD, the developed countries specifically committed to supporting Africa in a number of areas including industrial development and opportunity, water and energy management, health and technology.

In various fora the global community has agreed to development goals, including those in Agenda 21, WSSD and the MDGs. These global policy processes have also acknowledged that realizing these goals will require access to new and additional financial resources, improved trade opportunities, access to and transfer of environmentally-sound technologies, education and awareness-raising, capacity-building, information for decision making and improved scientific capabilities. In the case of the MDGs, defined targets in these areas need to be met within the agreed time frame. Eradicating the debt burden, as well as improving flows of FDI and development aid, will create new opportunities for developing countries.

Peace, development and environmental cooperation

Conflict situations have negative impacts on the environment and consequently on human well-being. The 2005 World Summit drew attention to the need for peace as the foundation for human well-being.

Over 30 African countries have been involved in wars in the last five years, and many more experience local resource conflicts. Despite this, Africa has an impressive record on the collaborative management of environmental resources. This cooperation has promoted peace and stability in most parts of the region. Important areas of collaboration include the management of water resources and shared river basins as well as more general transboundary natural resource management. Chapter 12: *Environment for Peace and Regional Cooperation* provides a more comprehensive analysis of these issues.

In many parts of Africa, river basin organizations have been established to regulate the rights and responsibilities of the different riparian states (Turton 2003). The SADC region has adopted a Protocol on Shared Watercourse Systems which creates a regional approach to management based on river basins. In the Northern and Eastern Africa sub-regions, the Nile Basin Initiative (NBI) seeks to enhance management and to take concrete steps to realize the development potential of the Nile. Launched in February 1999, the NBI provides a basin-wide framework to fight poverty and promote socioeconomic development through the equitable utilization of and benefit sharing from the Nile Basin water resources (Uganda 2002). Over the past 30 years, various groupings of countries in the Nile Basin have engaged in cooperative activities. However, the inclusion of all countries in a joint dialogue opens up

new opportunities for realizing win-win solutions. It also holds the promise for potential greater regional integration, economically and politically, with benefits far exceeding those derived from the river itself.

The ECOWAS action plan seeks to promote a regional cooperation framework for integrated water resource management, including harmonizing policies and legislation on water resources, facilitating the exchange of experiences, reviving consultation between riparian countries on coordinated management of shared or transborder water basins, and strengthening partnership with all stakeholders. Similarly, the EAC has cooperative water management initiatives, including the revitalized Lake Victoria Development Programme (LVDP), which has developed a common vision for the Lake Victoria Basin development, agriculture, food security, energy, tourism, civil aviation safety, lake resource conflict management, telecommunications and meteorological and inter-university cooperation.

Policies and laws have been developed in several sub-regions to support sustainable transboundary natural resource management including for wildlife, forests, marine resources and mountainous environments. The EAC has transboundary ecosystem management on Mount Kilimanjaro and Mount Elgon. The East Africa Cross Border Biodiversity Project, funded by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP) and executed by the three governments in the Eastern African sub-region, sought to identify and promote systemic national and regional policies and administrative measures to ensure sustainable management of cross-border biological diversity (ecosystems) and to reduce biodiversity loss at cross-border sites in east Africa. The project has generated information on the status of the cross-border sites and detailed policy analyses of forest policies in the three countries, identifying convergences and divergences, which can be used to inform interventions within the EAC strategy.

Social conflict and wars have had a high human and environmental cost. Large numbers of people have been displaced as a result of war, placing new burdens on the natural resource base. In conflict situations, effective management, monitoring and enforcement are not always possible. Such conflict also has adverse consequences for natural resources management, as the collapse of effective government results in indiscriminate harvesting and utilization of natural resources. The revival of ECCAS will hopefully help strengthen environmental governance in Central Africa. This underscores the linkage between environmental resource management and conflict. As long as there is conflict, environmental resource management initiatives, such as those anticipated in the treaty establishing ECCAS, will remain unimplemented as the member states concentrate on the more immediate issues relating to the conflict.

Conflict Logs: abandoned roundwood logs as a result of the imposition of a timber exporting embargo on Liberia, May 2005.

Source: Y. Katerere

Strengthening institutions and empowering people

The lack of capacity, in terms of skills and opportunity, to manage environmental resources undermines the potential for sustainable development – consequently, strengthening institutions and empowering people are important strategies.

The UNCED conventions recognized this and these, along with the ACCNNR, have focused on the value of procedural rights, research, education and information, as well as respect for local knowledge and value systems to achieve this. The WSSD has also drawn attention to the close relationship between well-being and empowerment. It is increasingly recognized that in enhancing capabilities and opportunities for people to participate in decisions that affect their well-being and livelihoods, health services and education must be improved, and sufficient and potable water, shelter, and adequate and nutritious food ensured. WSSD looks specifically at how these aspects of human well-being can be improved, and the MDGs set out targets related to these aspects, to be achieved by 2015.

Most policy initiatives recognize that rights of access to environmental information, participation, recourse to a court of law as well as fair, transparent and accountable processes are important procedural rights needed to support people as effective players in environmental policy and decision making. The United Nations Conference on Environment and Development recognized the potential of users to be effective resource managers – by giving users a direct stake in the resource, the incentive to manage efficiently is increased. Achieving this includes strengthening tenure rights and promoting civil participation in policy development, decision making and environmental management. In addition, the WSSD's Johannesburg Plan of Implementation identified the need to specifically promote women's equal access to and full participation in decision making, on the basis of equality with men (UN 2002). It recognized that this needs to be complemented by mainstreaming gender perspectives in all policies and strategies, eliminating all forms of violence and discrimination against women and improving the status, health and economic welfare of women and girls through full and equal access to economic opportunity, land, credit, education and health-care services (UN 2002).

At the regional and sub-regional levels, empowerment has also been identified as key for sustainable development, although in many countries the development of laws and programmes to make this a reality are still lacking. The AU has, through the creation of the ECOSOCC, sought to increase opportunities for meaningful dialogue with civil society, as discussed in Box 7. At the sub-regional level, economic and development communities are also trying to empower the public. In 2001, the EAC launched the EAC Court of Justice and the EAC Legislative Assembly. The Legislative Assembly has seven standing committees, which include one on Agriculture, Tourism and Natural Resources.

In most policy initiatives, developing skills and capacity of resource users, as well as of national institutions, is seen as essential. This issue is an important focus in the Rio Declaration, Agenda 21, several MEAs including the CBD and WSSD, and the NEPAD-EAP. The NEPAD-EAP focuses on building Africa's capacity to implement global and regional MEAs. In order to achieve this, eight activities are identified, including human resource development, public education and awareness, strengthening institutions and improving coordination, supporting the

Box 7: African Union initiative to promote public participation

Several regional and sub-regional organizations create opportunities for public participation in policymaking processes. One of the most encompassing is the AU's initiative.

The AU's ECOSOCC seeks to promote dialogue between all sections of African society on issues concerning the continent and its future. To this end, it aims to:

- Forge strong partnerships between governments and all segments of civil society, in particular, women, the youth, children, the diaspora, organized labour, the private sector and professional groups.
- Promote the participation of African civil society in the implementation of the policies and programmes of the Union.
- Support policies and programmes that promote peace, security and stability and foster continental development and integration.
- Promote and defend a culture of good governance, democratic principles and institutions, popular participation, human rights and social justice.
- Promote, advocate and defend gender equality.
- Promote and strengthen the institutional, human and operational capacities of the African civil society.

Source: AU, undated

development of information systems, mobilizing and strengthening the role of scientific and technical communities, and promoting south-south cooperation and sharing of expertise (NEPAD 2003).

HARNESSING THE OPPORTUNITIES FOR ENVIRONMENT AND DEVELOPMENT

Sustainable economic growth is essential for improving human well-being. However, the tendency to push production and consumption beyond the Earth's ability to support them makes such an achievement impossible and, if this trend is not stopped, it could herald a disastrous tomorrow for Africa. Sustainable development is only possible where economic growth, social justice and equity, and environmental integrity are achieved.

These three pillars of sustainable development need to be addressed in an integrated manner in order to achieve the desired outcome. Peace and stability are necessary for development, and the environment can create important opportunities for collaboration. An equitable society in which people are empowered to participate effectively in policy making and decisions that affect their well-being is essential. Fairness and equitable distribution of natural resources, as well as other local, national, regional and global wealth and benefits, the rule of law, and respect and tolerance of differences in culture, religious beliefs and traditions are essential for harmonious and sustainable development.

Most economic activities in Africa are based on the natural resource endowment; the depletion of natural resources beyond their regeneration rate, their pollution and reduction of their waste assimilation capacity will impede growth. The social and cultural aspects of use need to be considered as well, and in particular the issue of equity needs to be more effectively addressed. Africa can create new opportunities for growth and well-being through the effective implementation of policies by developing appropriate strategies, project planning and sustainable practices. Incorporation and operationalization of sustainable development principles, including intergenerational and intra-generational equity, the polluter pays principle, the precautionary approach, community participation and the mainstreaming of environment and gender into development planning and decision making will go a long way to achieve sustainable development.

Growth in Africa in the 1990s became associated with income inequality and this trend has continued since then. It is now widely accepted that inequality in access to assets, and especially productive assets, such as land, are critical factors driving inequitable growth and poverty (World Bank 2005b). The Gini index measures the extent to which the distribution of income (or consumption) among individuals or households within a country deviates from a perfectly equal distribution: a value of 0 represents perfect equality, a value of 100 perfect inequality. Many countries in Southern Africa have high values due to the unequal land and natural resource distribution that forms the basis of their economies. Zimbabwe, for example has a value of 56.8 (UNDP 2005). A similarly pattern is evident in Nigeria, with a value of 50.6 as a result of an economy based largely on mineral and oil exports and poor local benefit distribution. A reduction in inequality can add a "redistribution component" to growth, leading to faster overall poverty reduction (World Bank 2005b).

Farmers spreading cattle manure to improve soil fertility, northern Namibia.

Source: T. Cunningham/CIFOR

The World Development Report 2003 points out that, with the global economy growing at a projected rate of 3 per cent per year over the next 50 years, there will be a fourfold increase in world gross domestic product (GDP) (World Bank 2002). This growth will require major investments in new human-made capital to expand capacity and to replace existing capacity as it ages. It is projected to generate more environmental and social stress. Increased income can facilitate better social and environmental outcomes if countries adopt more equitable and pro-poor strategies (WRI and others 2005). Countries should take pre-emptive action

to deal with impending social, economic and environmental catastrophes, such as energy and water crises among others. Adopting an approach to investment and development that incorporates sustainability criteria is critical in avoiding adverse impacts (World Bank 2002). Development paths in Africa can be shifted, provided institutions for implementing the constructive policies are developed.

In order to achieve sustainable development in Africa, financial and other resources, both local and global, have to be mobilized as pledged in many world fora including UNCED in 1992. Investment strategies need to focus more directly on creating opportunities for growth that favours poor people. The downward trend in FDI and development aid needs to be reversed. Technology is potentially an important tool for achieving sustainable development, therefore its transfer and accessibility should be improved. Technologies may be useful in promoting more efficient utilization of resources as well as cleaner production and consumption. The developed world, through the WTO, needs to facilitate the achievement of fairer international trade. This will give developing countries better access to international markets and thus boost their production and economic growth. Poverty Reduction Strategy (PRS) can also provide an opportunity to tackle poverty through improved health and education, and also through mainstreaming the natural environment into everyday decision-making processes for management and utilization of environmental resources. The potential value of PRS is discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*.

Opportunities from the endowment value of natural resources

To enhance the opportunities available from Africa's natural resource endowments, current patterns of unsustainable resource management must be changed. Development now, environment later is not a sustainable option for Africa.

Harvesting of natural resources that has limited regard for regeneration capabilities and focuses primarily on meeting growing demand and ensuring continued supply will have long-term implications for economic growth and the ability to reduce poverty. Agricultural land is being degraded due to overutilization and hence productivity is generally going

Niger: tree planting along crevices caused by floods in seasonal waterways, known locally as *koris*.

Source: F. Paladini/FAO

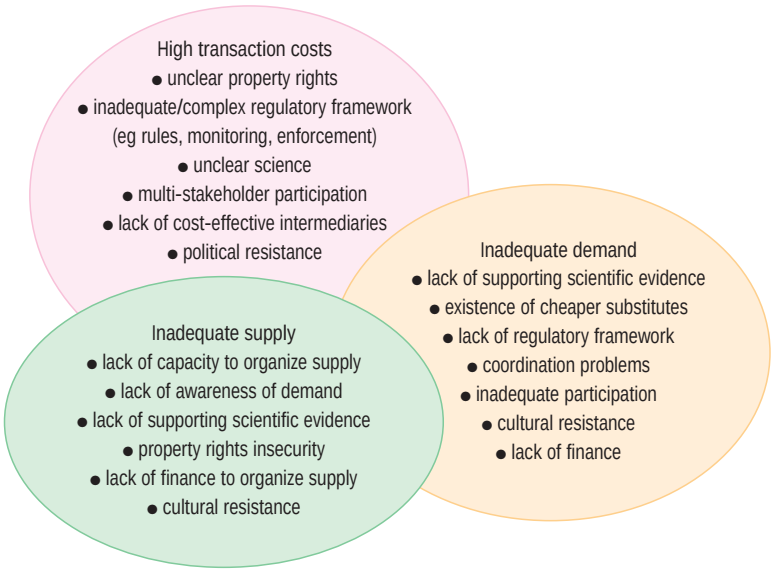
down, demanding more use of inorganic fertilizers and pesticides which pollute the environment. Chapter 3: *Land* discusses the state-and-trends related to land and its management.

Many extractive activities of non-renewable natural resources, such as mining, are done in an environmentally damaging manner through, for example, the clearing of vegetative cover in sensitive water catchment areas and forests. These activities can be undertaken in a more environmentally responsive way, through the use of environmental impact assessment (EIA) systems which give greater attention to restoration and rehabilitation. Chapter 8: *Interlinkages: The Environment and Policy Web* discusses the value of EIAs. Many human activities are also polluting the environment through the use of hazardous chemicals, such as mercury and cyanide in the case of gold mining. These heavy metals and chemicals respectively go on to contaminate the water, which is a habitat for aquatic life and enters the human food chain with deadly effect. Chapter 11: *Chemicals* discusses the challenges related to the increased use of chemicals. Forest clearing for either farm expansion or other development also harms the environment through habitat destruction, which in turn contributes to biodiversity loss. The conflicting objectives and uncoordinated strategies by different sectors contribute to the degradation of natural resources. Revising management and utilization strategies and practices, and bringing them in line with sustainable development objectives, is a good starting point for realizing Africa's development objectives.

The equitable sharing and use of water resources and its efficient and sustainable management present numerous challenges as Africa tries to meet growing demand from industry, agriculture and human use in managing the available water resource, issues of its efficient allocation and use must be considered. The existing situation is that in some quarters water is inefficiently allocated and utilized, potentially leading to increasing water-use conflicts across the region. Chapter 4: *Freshwater* discusses Africa's freshwater resource. Environmental impact assessment is one tool that can be used to effectively include the environment in this and other spheres of and planning.

The valuation of environmental goods-and-services is another opportunity to understand the value of the natural environment outside the conversional markets, which may not fully be able to access the rate of and consequences of degradation. Creating markets for environmental services could create new opportunities for enhancing the value attributed to such resources. In the forest sector, markets could also be used for biodiversity conservation, watershed protection, and landscape beauty. The Kyoto Protocol, which introduced carbon markets and trading, creates opportunities for countries and their inhabitants to engage in forest conservation and/or reforestation, providing a carbon sink function of forests.

Figure 7: Constraints to market development



Source: Landell-Mills and Porras 2002

Although entry into the market can create new opportunities, the high levels of inequity in global markets potentially undercut the opportunities available to poor people. Markets may also place new threats on assets and the range of values available at the local level. A major challenge in developing environmental markets is how to ensure that such development is pro-poor and contributes to growth with equity objectives. Markets transform environmental services into private commodities, creating new sources of income for sellers, improved service delivery for buyers, improved efficiency of resource use and allocation and new investment (Landell-Mills and Porras 2002). To ensure poor people benefit from market access is essential, and support may be necessary to help poor people participate effectively. This can be supported through secure tenure, skills development and education, access to finance and market information, better commodity design (Landell-Mills and Porras 2002), and improved transportation and communications infrastructure. Since markets are multi-stakeholder – incorporating the public and private sectors, communities, non-governmental and local organizations, donors and individual entrepreneurs – it is important for there to be clear governance systems.

Table 3: Impacts of markets on environmental services

Economic benefits

- Income/profits from sale of environmental service
- Diversified production base – lower risks of shocks
- Employment gains – new jobs associated with emerging markets
- Efficiency gains associated with removal of market failure
- Improved infrastructure associated with market development eg research facilities, transport, communications
- Technological transfer
- Achievement of environmental target at least cost – cost savings vis-à-vis command-and-control approaches

Economic costs

- Costs of supply – forest protection, certification
- Transaction costs – searching for buyers, negotiations, contracting, establishing new intermediaries, monitoring and enforcement
- Opportunity costs – eg markets replace existing payments, lost agricultural output when forests planted in agricultural land, lost values when protected, eg timber and NTFPs

Social benefits

- Increased land/resources tenure security – where deals result in the formalization of land tenure to minimize risks to buyers
- Improved health – investments in medical facilities, environmental improvements (eg reduced water and air pollution), more diverse diets, etc.
- Social institution strengthening – eg local cooperative arrangements to support evolving markets may provide a basis for cooperation in other areas
- Knowledge and research – environmental research and education through support for local schools, universities and research bodies
- Skill development – in related fields, eg sustainable forestry, forest-based industries, ecotourism, carbon monitoring, certification, global warming, project management
- Improved recreational and cultural opportunities – more pleasant environment for recreational activities and protection of cultural heritage and religious sites

Social costs

- Loss of rights to forest resources, especially for poor people – where projects involve forest protection or lead to privatization of rights to common lands
- Reduced health – where loss of access to forest-based foods that provide variety in local diets. Also where projects involve fast-growing plantations and reductions in water supplies
- Risks of domination by the wealthy since they have highest weight in a system based on ability to pay
- Land acquisition schemes may push up local land prices and undermine local communities
- Negative cultural impacts associated with monetizing environmental services

Environmental benefits

- Improved supply of marketed services: biodiversity conservation, carbon sequestration, watershed protection services and landscape beauty
- Positive spin-offs for the non-marketed services

Environmental costs

- Negative spin-offs for non-market services – eg reduced biodiversity or water supplies where monoculture plantations for carbon sequestration

Source: Landell-Mills and Porras 2002

Peace, good governance and democracy, and cooperation as an opportunity

More equitable distribution of Africa's wealth will promote harmonious coexistence among people, while polarized benefit sharing brings with it deprivation, insecurity and unrest. Peace and cooperation are crucial for any kind of economic activity leading to economic growth to prevail, and for equitable benefit sharing. Addressing these issues requires multidimensional responses.

Even with good knowledge and understanding of the environmental processes, there can be unsustainable use of the natural resource and a high rate of degradation of the natural environment. Deficiencies in governance are key contributory factors. Corruption, which is a growing scourge in Africa, undermines people's rights and fair distribution and access to resources and national wealth.

In countries with weak governance systems, the values and aspirations of important but not powerful sections of society may be under-represented. In such instances, a small group of interests become dominant, resulting in benefits accruing to a few. In "effective"

democratic processes, the participation of communities in decisions which affect their well-being and livelihoods creates an opportunity for multiple interests, views and knowledge (including indigenous knowledge) to be incorporated in planning and in the decision-making processes. This ensures ownership of the processes, costs and benefit sharing, and inculcates a sense of responsibility in all involved and is thus preferable to a top-down process.

Furthermore, in order to facilitate changing the current situation, environmental management, and legal and institutional reforms should take on board new initiatives, including market economic instruments for allocation and demand management of environmental resources. The operationalization of the polluter pays principle and precautionary approach requires the backing of enforceable legal provisions, which are still largely non-existent. In Africa, these processes are beginning to take root in many countries and therefore there is an opportunity to strengthen these efforts. It should, however, be noted that change dynamics are not linear or evolutionary. This means they differ from area to area and therefore require specific policies and solutions (Scoones and Wolmer 2003) which take account of sub-regional, national and local specificities.

Weak and inappropriate institutions and practices undermine sustainable development. This is the case particularly when institutions lack capacity or are highly bureaucratic. In Malawi, Tanzania and Uganda, public sector institutions are often seen to be constraining rather than enabling people to construct their own livelihood paths out of poverty. In Tanzania, it was found that a combination of poorly functioning markets and disabling institutional set-up procedures, including high taxation and rent-seeking behaviour, made it difficult for people to sustain their livelihoods. In Malawi, access to natural resources was difficult for most due to non-supportive property rights regimes for land, forest and aquatic resources. Local government decentralization was found to create new business opportunities, although licences and imposition of taxes act as barriers to trade and enterprise development. In Uganda, as in Tanzania and Malawi, rural taxation was found to be a barrier to poverty reduction goals (Ellis and Bahiigwa 2003, Ellis and Mdoe 2003, Ellis and others 2003).

Technological changes and research

Technology is a key factor in improving productivity and efficiency in the utilization of natural resources and for improving human well-being.

Technology affects human development in two important ways (UN Millennium Project 2005b). First, innovation can directly increase the ability of existing science, technology and innovation programmes to reduce poverty and expand human capabilities, as is evident through technological innovations in public health, agriculture, energy use, and ICT. Second, technology can indirectly affect human well-being by enhancing productivity and increasing economic growth and incomes through, among other things, promoting economic growth.

The adoption of technologies for more efficient and cleaner production activities, as well as for value-adding activities by small entrepreneurs, is severely constrained by the lack of adequate income as well as inadequate information. Ensuring the uptake of technologies will thus need multidimensional responses that improve the overall capabilities of people.

Unfortunately, local development of technology in Africa related to natural resources has been very slow, leading to over-reliance on technology developed elsewhere (FAO 2003). In most cases, this technology is linked to FDI, with a principal focus on maximizing profits. The development of appropriate technologies that address African priorities and that are responsive to local conditions has not been a focus of research. Nevertheless, new technologies, developed globally, particularly in the areas of ICT, biotechnology (or genomics), nanotechnology, materials science, and spatial information technology potentially offer important opportunities for development, improving human well-being and sustainable environmental management (UN Millennium Project 2005b).

Increasingly, African countries are exploring the opportunities and risks posed by these new

Sudan. Solar power provides electricity for a field hospital in the rebel-held Nuba Mountains (quickly covered when government bombers appear). February 2000.

Source: D. Connell/The Image Works TopFoto

Box 8: Using traditional knowledge for diet drug development

Hoodia gordonii (hoodia) is a cactus plant found in Southern Africa. The San people of the Kalahari, one of the world's oldest indigenous peoples, are reputed to have been eating the hoodia plant for thousands of years, to stave off hunger during long hunting trips. The South African Council on Scientific and Industrial Research (CSIR) identified the P57 substance in the plant, a group of steroidal glycosides, which is an active appetite suppressant. Given high levels of obesity, particularly in developed countries, there has been considerable interest in the potential economic value of this plant.

In 1995, a patent application was filed in Europe, and on 27 January 2005 the patent was granted in an appeal of the European court. In 1997, the CSIR licensed the UK-based Phytopharm, which in turn licensed drug giant Pfizer the following year, for P57 development and global marketing. Unilever has since acquired the rights to develop and market hoodia as an ingredient in its weight-loss products,

The South African San Council, set up in November 2001 and representing the Khomani, the Xun and the Khwe, demanded recognition of their knowledge and a share of benefits arising from product development. After protracted negotiations – spanning three years – a benefit sharing agreement was reached in 2004 between the South African San Council and CSIR. The CSIR will pay the San 8 per cent of milestone payments made by its licensee, Phytopharm, during the drug's clinical development over the next three to four years. The San could earn 6 per cent of all royalties if and when the drug is marketed, possibly in 2008.

Establishing this agreement faced various challenges:

- Traditional knowledge, being community-owned and handed down through generations, clashes with international property rights, which view knowledge as owned by an individual or a company.
- Indigenous knowledge is often held by communities who live in different countries. In this case, the San Councils of Namibia, Botswana, Zambia and Angola will share the monies in percentages to be decided at their next general meeting.

Hoodia gordonii (hoodia).

Source: E. Powell

Income will go into a San Hoodia Benefit Trust set up by the CSIR and the San. The Trust includes representatives of the CSIR, the regional San Councils, the Working Group of Indigenous Minorities in Southern Africa (WIMSA), and an observer from the South African Department of Science and Technology.

Source: Wynberg 2004

technologies. Chapter 9: *Genetically Modified Crops*, for example, considers the diverse claims made about opportunities for development of biotechnology. Many African countries recognize the value of ICT, not only for stimulating the economy, but also for environmental management. Some African countries are investing in the application of ICT for planning, management and monitoring of environmental resources. Ghana, for instance, is using ICT to facilitate the mainstreaming of environment in its Poverty Reduction Strategy Paper (PRSP) and development plans in its district assemblies. A novel aspect of this ICT application is the intricate networking that involves the presidency, the national parliament, the ministry of finance, ministry of local government, and the national development and planning commission: this enhances access and utilization of a common pool of information for decision making (Opio-Odongo and Woodsworth 2004).

In most African countries there is relatively low investment in research activities as a percentage of GDP. However, research is important for improving responses and enhancing capabilities and thus this needs to be urgently addressed through the development of partnerships, stable investment environments, and legal and policy frameworks that provide for fair and equitable intellectual property rights. Research into various environmental goods-and-services, such as wetlands and forest lands, can make a

difference in how they are used and the extent to which value is added to them. Apart from research based on modern knowledge, the value of traditional or indigenous knowledge needs to be acknowledged within Africa. There are various initiatives, particularly in the NGO sector, which seek to apply this knowledge to product development. In the pharmaceutical and cosmetic sector, industry has had a keen interest in how to use this knowledge, as shown in Box 8. The existing genetic and intellectual property regimes do not offer sufficient protection of these assets, thus allowing the benefits associated with their use to be externalized.

Increased investment in research by Africa will need to be complemented by a greater global commitment to the transfer of technology and the more equitable sharing of the benefits associated with this.

Traditional knowledge and cultural practice in natural resources management

Traditional natural resource governance systems are important in environmental management, often informing or complementing contemporary management regimes.

Communities in Africa have relied on traditional knowledge to manage natural resources since time immemorial. Traditional knowledge transcends all aspects of life (such as food, health, housing, communication) and the environment (relations between biodiversity and ecological factors, identification criteria of biodiversity elements).

Traditional cultural practices can make a significant contribution to sustainable development. Most indigenous and local communities are situated in areas where the vast majority of the world's plant genetic resources are found. Many of them have cultivated and used biological diversity in a sustainable way for thousands of years. The abundance of wildlife species, especially in the savannahs of east Africa, is due in great part to the grassland management strategies of pastoralists.

Observations and experimentations in the environment lead to the selection of plant varieties as crops, medicines and timbers for various uses (Andriantsiferana 2003). The role of trees in nutrient recycling, soil organic matter build-up and erosion control has been recognized by traditional farmers, who have identified and have been encouraging the most effective tree species in the fallow. For example, in south-western Nigeria, especially around the city of Ibadan, farmers claim *Gliricidia septum* to be an effective fallow species which restores land productivity for food crops after a fallow of only two years (Getahun and others 1982). When land is abundant, the bush fallow system provides the traditional farmers with an efficient, balanced and stable system for maintaining soil productivity. Problems only arise when land becomes limited due to increasing population and land alienation.

The Barbaig of Tanzania used their land communally by moving their livestock in a seasonal grazing rotation. Although access to land was free to everybody, control was exercised and maintained through customary rules and traditional institutional procedures. Mobility and knowledge of different kinds of fodder is a strategy that

Cameroon's forests provide valuable grazing land.

Source: E. Dounias/CIFOR

can increase productivity of rangelands. Using milk as the main product also increases the number of people who can be supported on livestock. Also, Barbaigs, Maasai and Kurya split herds of cattle during shortage of grazing pastures taking account of the environment's diminished carrying capacity.

Traditional knowledge has been overlooked in the recent past and, in some cases, is being lost.

Infrastructure development

Infrastructure development, including transportation, telecommunications and energy networks, is essential for improving economic opportunity as well as human well-being.

Infrastructure development may generate substantial positive and negative externalities. Infrastructural development creates opportunities to reduce the isolation, and lack of access to essential services, that many rural people experience. It is essential for enhancing the creation and application of science, technology and innovation in development (UN Millennium Project 2005b). It may also exacerbate resource extraction, especially where weak governance regimes exist.

Many African countries inherited transport and communication systems that were designed to serve the interests of former colonial masters, focusing on the movement of goods to ports without facilitating cross-border trade and regional integration (Katerere and Mohamed-Katerere 2005). One consequence of this is high transport costs. In SSA, freight costs are about 20 per cent higher than those of their competitors (AfDB 2004).

Infrastructure affects patterns of production and consumption by firms and individuals (UN Millennium Project 2005b). High transport costs, long distances from the point of sale and the lack of transport infrastructure undermine the market opportunities for natural resources. These factors coalesce to undermine the incentive to engage in value-adding activities that could result in the more efficient and productive uses of resources which may counter tendencies towards overexploitation. Access to electric power is crucial in terms of productive options, and telecommunications are essential for the flow of information.

African countries need to adopt strategies to improve their infrastructure in ways that address these challenges. Infrastructure is one of the eight priorities of NEPAD. Policymakers need to recognize the dynamic role that infrastructure development can play in economic growth, development and conservation. For infrastructure to become more effective, developing countries need to adopt and enforce infrastructure standards (UN Millennium Project 2005a). From the early design stages, they need to promote the interoperability of infrastructure systems, not only nationally, but also regionally and internationally. Standards should be drawn up and implemented so that they do not create barriers to innovation.

CONCLUSION

The future of Africa's development is closely tied to the integrity of its natural resources base. How the region benefits from its stock of natural resources will depend on how strategically it places itself at the global negotiating tables, how it markets these assets and the extent to which it is able to maximize benefits and opportunities for its people.

There are improved opportunities on all these levels. Viable fora for meeting these challenges have been created through NEPAD and AU. The different

Liberia: the road to Greenville from Monrovia. In the absence of financial resources and infrastructural development, the natural environment poses many transport and communications challenges for people trying to develop sustainable livelihoods, May 2005.

Source: Y. Katerere

initiatives being pursued by Africa underscore the interconnectedness of the development process and the need for holistic development planning. Indeed a sector by sector approach to environmental resources management is being replaced by integrated management policies. Similarly, territorial boundaries no longer bar sustainable management of resources, and transboundary cooperation is becoming more common. On another level, there is also growing recognition that human well-being depends on ecosystem services. Governments and development partners are increasingly involving civil society and the private sector in the fashioning and implementation of the different initiatives. What now needs to be urgently addressed is the commitment of adequate resources for the institutions mandated to implement the initiatives to carry out the tasks effectively.

It is important for Africa to comprehensively take stock and value of what it has in terms of natural resources and use them optimally to sustain decent livelihoods. This is the focus of Section 2: *Environmental State-and-Trends: 20-Year Retrospective*.

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SECTION 2

ENVIRONMENT STATE-AND-TRENDS: 20-YEAR RETROSPECTIVE

CHAPTER 2
ATMOSPHERE

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REGIONAL SYNTHESIS

Africa is endowed with diverse and abundant atmospheric resources. These resources include rainfall, air, solar radiation or insolation, and wind. Unlike land and marine resources, atmospheric resources are found in all African countries, although at varying levels, distribution and frequency.

Atmospheric resources provide life-supporting goods-and-services. The air contains oxygen, carbon dioxide and nitrogen that are essential for life and livelihoods. The clouds, with their accompanying lightning phenomenon and rainfall, play a critical role in supporting life on Earth. Rainfall is a source of water for people, animals and plants, and for rain-fed agriculture. The ozone layer, found in the stratosphere, protects human beings from ultraviolet radiation that is likely to cause cancer. Solar insolation provides light and energy. The sun, wind and rivers are sources of energy for direct use or electricity generation.

The northern and southern countries in Africa receive little rainfall, below 1 000 mm per year. The equatorial countries receive over 1 000 mm of rainfall on average. Higher speed winds are generally found in the southern and northern parts of the continent. Virtually all countries in Africa receive over ten hours of sunshine a day, providing good potential for solar energy generation. The air in Africa, except in major industrial cities, is relatively clean.

Atmospheric resources offer a variety of opportunities for sustainable development. Air pollutants including soot and dust, greenhouse gases (GHG), chlorofluorocarbons (CFCs), and heavy metals affect the quality of air and threaten the goods-and-services provided by the atmosphere. These pollutants contribute to climate change, climate variability, depletion of the ozone layer, and low air quality. Climate variability and climate change manifest themselves in global warming, and extreme weather events including floods, droughts, heat waves and typhoons. These phenomena affect human well-being through increasing the incidence of diseases, affect land and marine productive systems from which livelihoods are derived, and destroy infrastructure.

Thus, threats to atmospheric resources undercut development opportunities. Mitigating the causes and impacts of potential threats is important: Africa needs to develop appropriate policy and action. Investing in programmes and businesses that mitigate the effects of climate variability, climate change and air pollution presents opportunities for sustainable development. There are also benefits that can be derived in reversing degradation of atmospheric resources.

INVENTORY OF RESOURCES

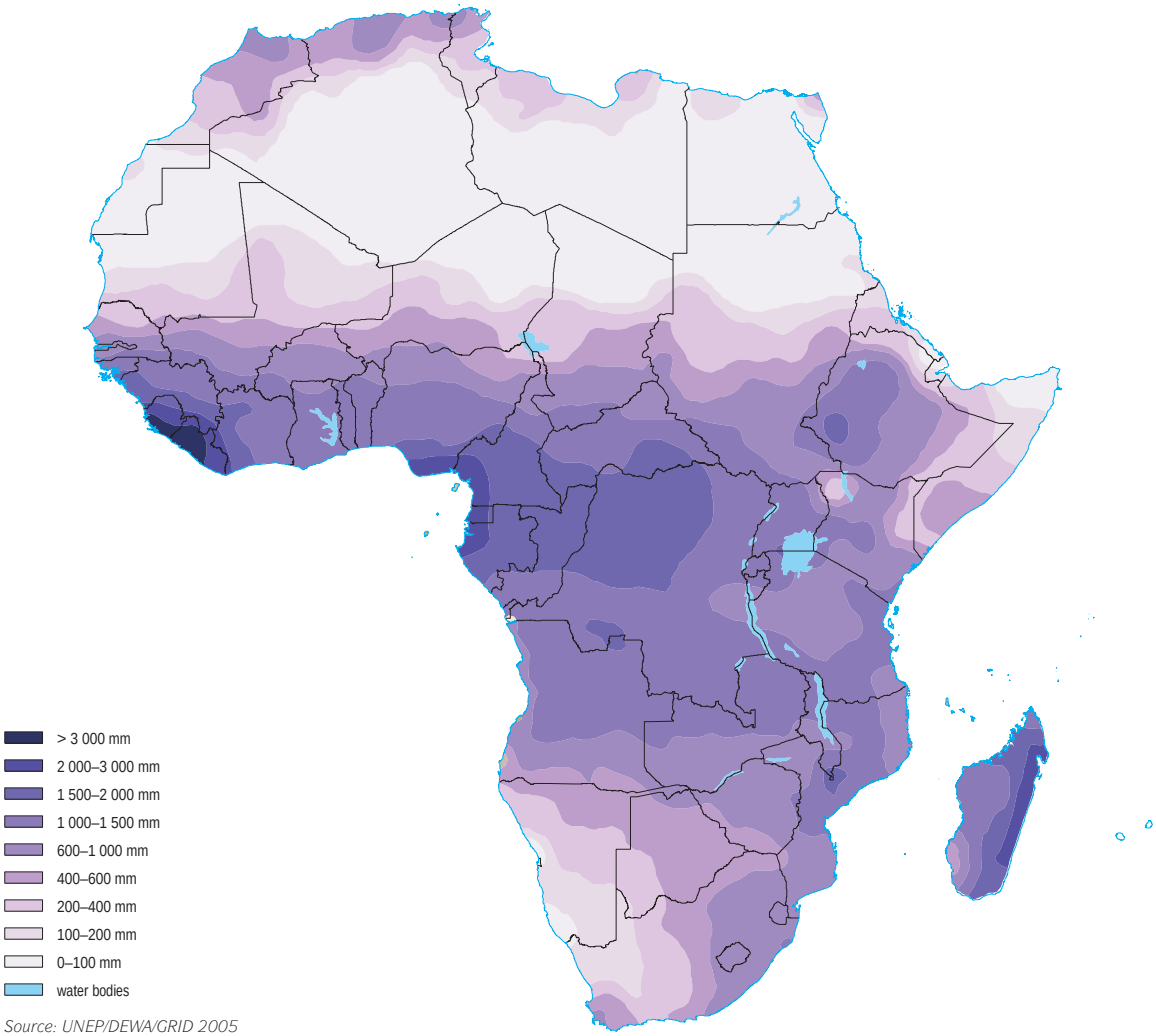
Rainfall and rivers

Africa has virtually the same climatic zones in the northern and southern hemisphere, and these zones are arranged symmetrically on either side of the equator. The zones are determined mainly by latitude, except in the east where highlands greatly modify the climate.

Africa is predominantly a tropical region: only its northern and southern extremes, which are directly influenced by mid-latitude westerly winds, are considered to have temperate climates. Nevertheless, it is, after Australia, the driest region in the world (ECA 2000). The amount, duration and seasonal distribution of rainfall are the most important factors differentiating its climates. Africa has six climatic zones. These are equatorial, savannah, semi-arid, arid, highland and Mediterranean:

- Equatorial climates occur close to the equator in the west and the central parts of Africa, and in eastern Madagascar. Rainfall is high, typically exceeding

Figure 1: Map of rainfall zones



Source: UNEP/DEWA/GRID 2005

1 500 mm per year and as much as 3 200 mm in some places. Rainfall occurs in every month, and many areas experience two rainy seasons per year.

- Tropical savannah climates occur north and south of the tropical wet zone, in much of west and southern Africa, and in most of Madagascar. This climatic zone is marked by a well-defined dry season of three to eight months. Annual rainfall is usually between 500 and 1 500 mm, although limited areas have considerably more: for example, Freetown in Sierra Leone averages 3 800 mm per year. The tropical savannah zone is a transitional zone between tropical wet and semi-arid zones, so there is a progressive decline, moving towards the poles, in total rainfall and the duration of the rainy season. Areas with a longer rainy season tend to have two rainy periods separated by a short dry spell, while areas with a shorter rainy season have a single rainy period.
- Surrounding the tropical savannah climate zone are areas of semi-arid, and then arid climates in the west, north-central, east-central and southern parts of Africa. The semi-arid zone has a short rainy season of up to three months, with about 250-500 mm of rainfall per year. Precipitation is unreliable and scarce.
- Tropical highland climates are common in much of east Africa. In most parts of the world, higher elevations receive higher levels of precipitation, but the highlands of east Africa are an exception, experiencing rather low levels of rainfall. However, the highest mountains and the south-eastern flank of the Ethiopian plateau receive greater precipitation on their windward slopes.
- The coastlands of the Cape in South Africa and the north African coast, from Morocco to Tunisia, have Mediterranean climates. These areas have mild, rainy winters followed by a prolonged summer when conditions are warm and dry. They receive between 250 and 1 000 mm of rainfall per year.

Most of the African continent receives moisture from air originating over the Atlantic Ocean. In the eastern part,

however, rainfall south of the equator comes from large tropical cyclones originating over the Indian Ocean during the southern hemisphere summer. Rainfall from these cyclones is particularly high in eastern Madagascar and the coastal mainland between South Africa and southern Tanzania.

Average rainfall has decreased since 1968, and has been fluctuating around a notably lower mean (UNEP 1999). In Africa, some 3 988 km^3 of renewable water is available annually (ECA 2000). In recent years, the pattern of rainfall has tended to extremes, with the severity and frequency of droughts and floods increasing.

Africa has many rivers, but some, particularly in the mountainous areas, are seasonal and the water flow rates are gradually declining over the years.

The major rivers include the Senqu or Orange, Niger, Zambezi, Limpopo, Senegal, Congo and the Nile. The Nile is the longest river in the world, at about 6 679 km (Pickett 2000). The Nile starts from Lake Victoria and passes through Uganda, Sudan and Egypt to the Mediterranean Sea. The main headstreams, the Blue Nile and the White Nile, join at Khartoum in Sudan to form the Nile proper. The Senqu/Orange River is 2 092 km long and passes through Lesotho, South Africa and Namibia, flowing south-west, north-west, and west to the Atlantic Ocean (Pickett 2000). The Niger River is found in Western Africa, rising in Guinea and flowing about 4 183 km in a wide arc through Mali, Niger and Nigeria to the Gulf of Guinea (Pickett 2000). The Zambezi River is about 2 735 km long, rising in northwest Zambia and flowing south and west to the Mozambique Channel (Pickett 2000). The Limpopo River runs through South Africa, flowing about 1 770 km in a north-east-south-east arc to the Indian Ocean in southern Mozambique (Pickett 2000). The Congo River is 4 666 km long and flows through Congo and the Democratic Republic of the Congo to the Atlantic Ocean (Pickett 2000). The Congo, which alone accounts for some 38 per cent of the continent's discharge into the ocean, drains an area of more than 4.1 million km^2, ranking second only to South America's Amazon River in terms of discharge and size of drainage basin (Microsoft Encarta Online Encyclopaedia 2005). The Congo River basin alone holds almost 30 per cent of Africa's total fresh surface water reserves and the world's largest hydropower potential in any one single river basin (ECA 2000). Africa's rivers provide extensive hydropower potential including for large (> 500 MW), medium (> 10 MW, < 500MW) and small (< 10 MW) plants. The opportunities and challenges associated with Africa's rivers and freshwater systems are discussed more fully in Chapter 4: *Freshwater*.

Wind and solar resources

Africa has traditionally relied on woody biomass for energy. Declining forest and woodland resources creates new challenges for meeting energy needs. Africa's rate of deforestation, at 0.8 per cent per year, is the highest in the world: between 1990 and 2000 an average annual loss of 5 262 000 ha per year was incurred (FAO 2005). Chapter 6: *Forests and Woodlands* considers the challenges and opportunities associated with forest resources and energy more fully. There are no reliable statistics on the extent to which other biomass, such as farm and urban waste, is available for energy. In this context, wind and solar energy are particularly important.

Low wind speeds prevail in many African countries, particularly in those that are landlocked. South Africa has some of the highest wind potential in the region. For example, wind speeds of 7.2 to 9.7 metres per second have been recorded around Cape Town and Cape Agulhas (Karekezi 2001). Northern Africa's coast also experiences optimal wind speed, especially Morocco. Other countries in Africa have relatively low speeds, as shown in Table 1 (Karekezi 2001).

Table 1: Wind energy potential for selected countries

Country	Potential (metre per second)
Botswana	3
Burundi	>6
Djibouti	4
Kenya	3
Morocco	>10
Mozambique	0.7-2.6
Seychelles	3.62-6.34*
South Africa	7.29-9.7**
Sudan	3
Tanzania	3
Uganda	2
Zambia	3.5
Zimbabwe	2.9

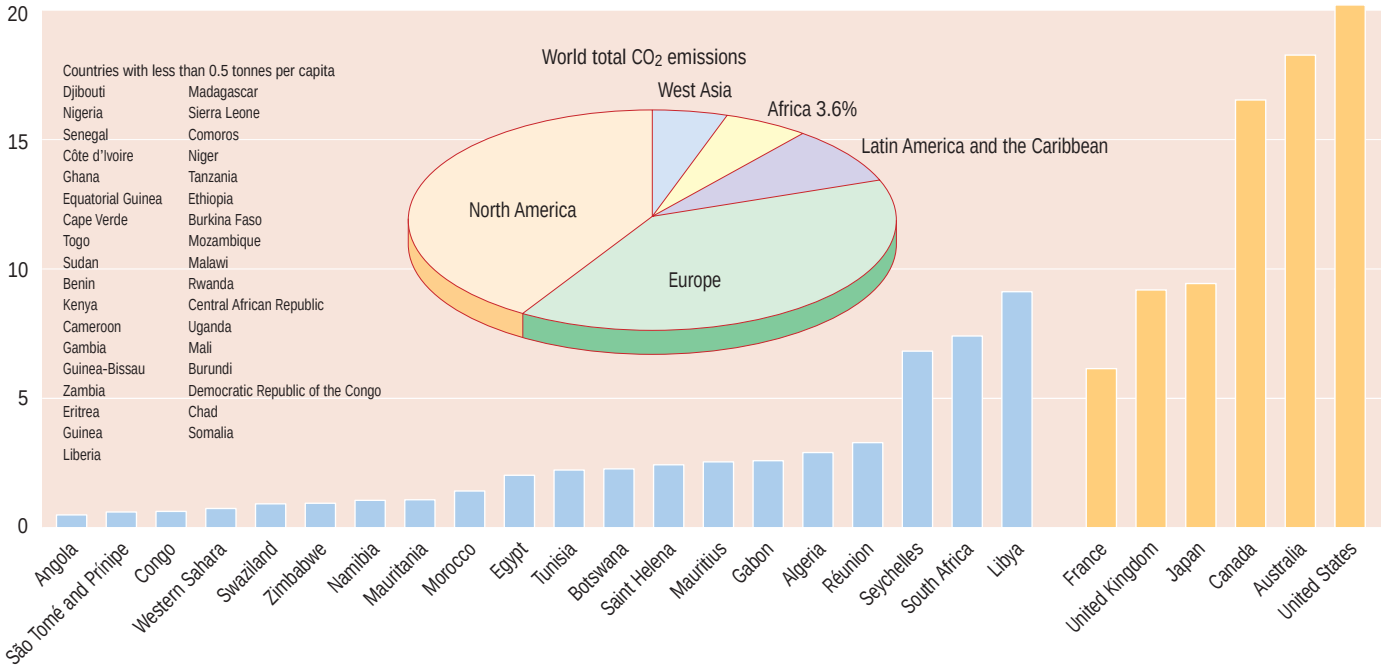
** average wind speed for two seasons,*

*** highest wind speed recorded*

Source: adapted from Karekezi 2001

Figure 2: World CO_2 emissions per capita

tonnes of CO_2 per capita (2002)



Source: UNSTATS/CDIAC 2006

Africa is endowed with enormous potential for solar energy generation; the actual potential depends on how its primary solar energy is converted into a useable resource such as through photovoltaic cells or power-concentrating technologies. Concentrating solar power technologies use reflective materials, such as mirrors, to concentrate the sun's energy and direct it into a thermal receiver, and can be used to provide heating and lighting. Photovoltaic technologies use light to produce electricity. Estimates of the globally available solar energy is more than adequate to meet current and projected energy needs up to 2020 (Rogner 2000). For sub-Saharan Africa (SSA), the minimum estimated solar energy is 371.9 exajoules and the maximum is 9 528 exajoules (Rogner 2000).

Air

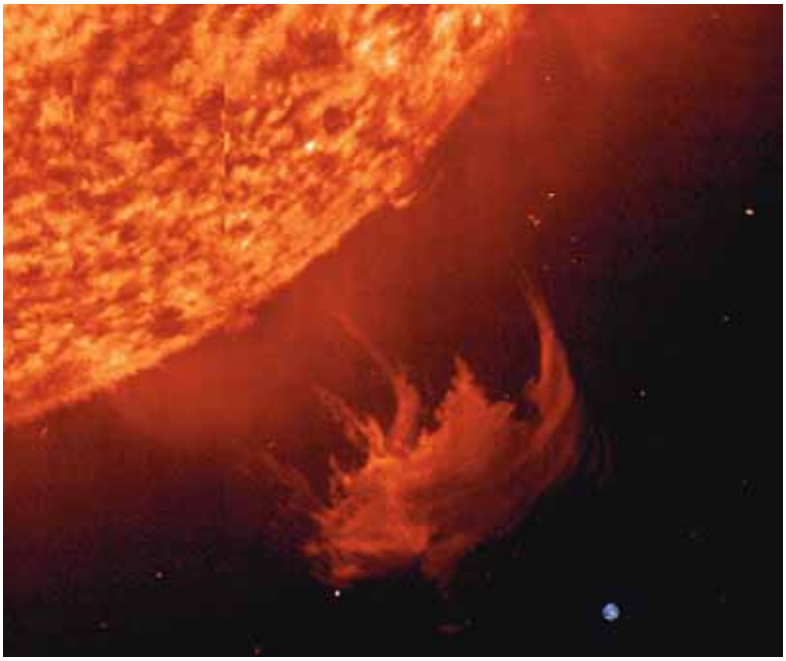
Africa's air is relatively clean. However, pollution is an emerging issue in urban centres and is already a problem in major industrial cities, like Cairo. The air is polluted by emissions from industry, motor vehicles and households, including oxides of sulphur, carbon, nitrogen, particulates, lead and organic compounds. Because of the reliance of many households on woody biomass for energy, indoor pollution is a concern. This has a disproportionately high impact on women and children (Gordon and others 2004).

Industrialization is taking root in many countries, and this, along with the increasing number of households, is putting pressure on the quality of air. In the transport sector, the excessive use of second-hand vehicles and poor maintenance of vehicles are major contributors to air pollution. The use of leaded fuel is also a contributor. However, Africa contributes only 3.6 per cent of global emissions of carbon dioxide, the principal gas linked with global warming.

Endowment opportunities

Atmospheric resources offer important opportunities for sustainable development and improving human well-being. Their sustainable management can contribute towards the realization of the Millennium Development Goals (MDGs) and meeting the MDG targets, as well as regional and national targets:

- Rainwater harvesting can increase access to safe and clean water;
- Effective rain-fed agriculture can improve food security and thus reduce extreme hunger;
- Harnessing renewable energy resources can power small-scale rural industries and improve income;
- Developing national renewable energy resources can enhance reliability and lower costs of electricity to the productive sectors;
- Harnessing solar energy can improve access to household lighting and power, and increase livelihood and educational opportunities;
- Increasing participation in global businesses and the market sector can lead to improved income and enhance opportunity; and



Solar flares from the sun
This image shows how tiny the Earth (blue dot on the right) is compared to the size of the flare.

Source: SOHO (ESA & NASA)

- Reducing air pollution can result in improved health and reduce child and maternal mortality levels.

Improving scientific and technological capacity, including through partnerships with the global community, is an important strategy for harnessing the full potential of atmospheric resources. Information and knowledge are increasingly driving societies and economies. The success of future societies, businesses and economies will be determined by their abilities to generate, process and make use of knowledge. Thus, harnessing atmospheric resources for sustainable development demands that Africa invest in broadening and strengthening science and technology capacity. Adding value to natural resources requires the development of new materials, processes and products. Advances in materials and biotechnology are crucial for most renewable energy technologies (IEA 2004). In the short term, Africa will have to rely heavily on technology transfer, although in the medium to long term, developing indigenous technology will be essential.

Africa can promote innovations through the establishment of science parks. These will serve as seed-beds for new technology-based firms (NTBFs), which could contribute to poverty reduction in the medium to long term. In the short term, African governments could enter into partnerships with scientists in the African diaspora to support research and development in Africa. This strategy will repatriate knowledge and skills to Africa and assist in mitigating the "brain drain".

Investment in basic research is important for maximizing opportunities. International cooperation, including through establishing partnerships between developing countries, could offer crucial support and access to resources. Cooperation between South Africa, India and Brazil in nanotechnology development is one example for an effective research partnership. Investing in basic research is important, as noted by the IEA:

> "Developing advanced technologies requires not only applied research and technology refinement, but also the innovation that stems from advances in basic science. Knowledge flowing from basic research is what will feed the development of new materials, bioprocesses, nanotechnologies, and other approaches that could reduce clean technology costs. It could also lead to new unforeseen technologies and novel approaches to providing energy services. Effective linkage between basic science and applied technology development will be important to ensure that these opportunities are opened up" (IEA 2003a).

The availability of fossil energy reserves underpins the wealth of African countries and their ability to invest in the development of renewable energy resources, such as hydropower and solar energy. Oil reserves are found mainly in Algeria, Angola, Chad, Gabon, Mauritania, Equatorial Guinea, Egypt, Nigeria, Libya and Sudan and have been an important factor in improved economic growth (ECA 2005b). Africa has just 5 per cent of the world's coal resources, and over 97 per cent of this is found in South Africa, Mozambique, Zimbabwe and Botswana (EIA 2003). Most of the natural gas reserves are found in Western Africa (Nigeria 30.8 per cent) and Northern Africa (Egypt 10.7 per cent, Algeria 39.6 per cent, and Libya 11.5 per cent) (WEC 2001). Countries not endowed with fossil fuel reserves require substantial financial support to develop their atmospheric resources.

Wind

Where good sites are available, wind energy is an option that should be given a chance. Although generation costs vary from site to site, these have come down considerably over the last 15 years and it is estimated that generation costs are equivalent to more traditional energy generation, making wind energy a competitive

option (Morthorst and Jacobsen 2003, ISES 2006). The world potential for wind development is enormous. It is projected that 130 GW will have been installed globally by the year 2010 (IEA 2004).

Wind speed and frequency determine how much energy can be produced by wind turbines (Rogner 2000). Low wind speeds prevail in most of Africa, with average wind speeds of between 3 to 6 metre per second (Karekezi 2001). Despite the average low wind speeds, there are some localized sites with good wind speeds that could be tapped for water pumping and electricity generation. There is potential to generate wind power from 24 per cent of Africa's land – with an estimated gross electrical potential of 106 000 TWh (Rogner 2000) Africa can utilize this potential through the development of community-level systems. Hybrid energy systems, coupling wind turbines with conventional generators, may be used to mitigate the intermittent nature of wind and energy constant energy supply.

African governments should invest in local capacity to plan, design and construct wind plants. Wind towers are site-specific and are best suited for local design and construction. Electrical and electronic components may

Box 1: Wind power generation in South Africa

The South African government has strongly embraced wind power generation and has committed itself to producing 4 per cent of its requirements as renewable energy by 2012.

The South African electricity supply authority, ESKOM's wind power generation project, the South African Bulk Renewable Energy – Generation (SABRE-Gen) (of ESKOM) is investigating the potential of using wind energy for bulk electricity generation in Southern Africa (using turbines of 600 KW or higher capacity). This project focuses on:

- Understanding the implications of using wind energy on a large scale in a Southern African environment;
- Determining the most suitable applications for wind energy;
- Determining the most appropriate scale of implementations.
- Information sourcing and documentation for the effective implementation of wind energy;
- Preparing the market and industry for implementation; and
- Investigating the sustainability of wind energy in a Southern African environment.

This study has five components, namely: scanning/pre-feasibility; wind resource assessment; feasibility; research and demonstration facility; and business case development. The research and demonstration facility has been established and the last component, business case development, is ongoing (2003-2005) (SABRE-Gen 2004).

South Africa's first commercially available, wind-generated electricity could be lighting homes in the Western Cape soon. The US$11 million project has come closer to reality with the approval by the Department of Environment Affairs and Tourism of a plan to erect four wind turbines on a farm near Darling, 70 km outside Cape Town. The wind farm project, supported by the Danish International Development Agency (DANIDA), the United Nations Development Programme (UNDP), and the Global Environment Facility (GEF) will produce 5.2 MW, enough to light a town like Darling. The Danish government is backing the project with US$3 million. The South African Wind Energy Programme, through GEF, will mobilize about US$65 million to be spent on wind energy to the tune of 50 MW capacity. The British government has promised US$3 million for a training centre on the farm once the Western Cape Department of Nature Conservation gives the go-ahead (SABCnews 2005).

Wind turbine, Germany.

Source: M. Schroeder/Still Pictures

During the predicted lifetime (20 years) of the Darling National Demonstration Project, the main environmental benefits will be the reduction of pollutants from conventional electricity generation, including of carbon dioxide, sulphur dioxide, nitric oxide, particulates, and slag and fly ash (DME 2005). The Project will also result in the saving of 100 000 t of coal and 60 million l of water.

Source: SABRE-Gen 2004, SABCnews 2005 and DME-Danida 2005

be sourced from global markets. However, there is a need to standardize these components. Wind power plants are capable of powering small industries in off-grid locations. Governments should harmonize their policies on energy and industry. Partnerships with the private sector as well as with the global community, as envisaged under the World Summit on Sustainable Development (WSSD) Johannesburg Plan of Implementation, are important.

Powering small-scale industries in rural and off-grid areas

Where suitable sites exist, wind presents opportunities for powering small-scale industries, including water pumping. However, investment in local capacity to plan, design and construct wind, biomass and hydro turbine-generator sets is essential to take advantage of this opportunity. Wind towers and hydropower plant civil works are site-specific. Planning, engineering and design costs would be drastically reduced if local personnel undertook these tasks. This is the strategy used by China and India (Lew and Logan 2005), who are among the world leaders in wind and small hydropower plants.

Development of rural power plants should be encouraged to supply power to communities and homes and thus improve livelihood opportunities and human well-being. Investments could target the following:

- Invest in planning and design of plants;
- Standardize key components of plants and produce most of these components in Africa;
- Invest in a large number of small plants to achieve economies of scale;
- Develop computer-based tools and instruments and standardize design of plants; and
- Invest in technology for modern computer-based survey and mapping techniques as a means of lowering design and engineering costs.

Access to electricity in rural areas, transmitted or generated, will contribute to the improvement of the lives of the rural women and children who are forced to spend lots of time in search of firewood and often trek long distances for water and firewood.

Solar radiation

The availability of solar resources is not a factor undermining its potential use; instead, there are three factors determining uptake: the availability of efficient and low-cost technologies to convert solar energy into electricity and hydrogen, effective energy storage technologies, and high efficiency end-use technologies (Rogner 2000).

Concentrating solar power

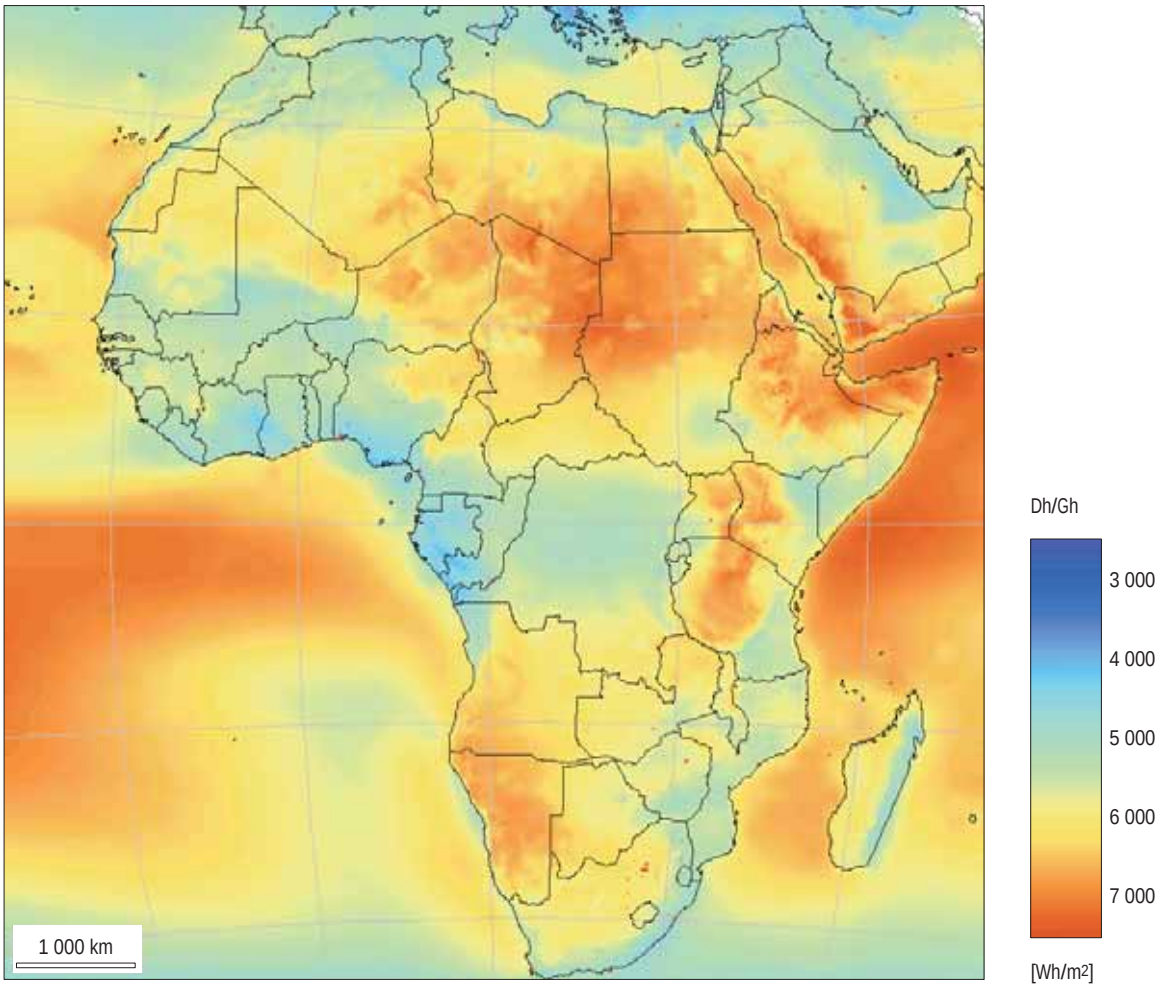
Concentrating solar power systems – or solar thermal energy – provide both heat, such as warming water, and electricity through the use of reflective techniques. These systems are particularly suitable where there is plenty of direct solar irradiation. Concentrating solar power systems have high potential in the arid and semi-arid lands (ASAL) of the northern and southern parts of Africa. Concentrating solar power systems are suitable for provision of industrial and commercial power. These systems may replace conventional fossil fuel plants and contribute significantly to environmental conservation. Although they have not been extensively used, these systems are not new to Africa. Egypt has an early and continued interest in this sector. Egypt is one of the few countries in the world that has a government department dedicated to the development of renewable energy sources. Under the direction of the New and Renewable Energy Authority (part of the Ministry of Energy), one of the first solar thermal power plants built since the 1980s will come on line in 2007 at El Koraimat near Cairo (Greenpeace International 2005).

The costs of investing in concentrating solar power systems are relatively high. Investment costs range from US$3 600 to $15 400 per KW in places with insolation levels of 1 700 KWh per m^2 (IEA 2003b). Generation costs are in the order of US$0.1 to US$0.15 per KWh (IEA 2003b). Where insolation levels are over 1 700 KWh per m^2 , as is common in Africa, optimal cost-competitiveness is achievable.

A concentrating solar power plant located at Kramer Junction in the Mojave Desert, California, USA.

Source: M. Bond/Still Pictures

Figure 3: Solar radiation



Source: EC 2005

Compared to other renewable energy systems, concentrating solar power systems currently have a low market potential. Global capacity was estimated at 825 MW in 2005, and was predicted to increase to 2 225 MW by 2010 and to 20 150 MW by 2020 (IEA 2003b). The global energy contribution from these systems stands at over 1 TWh, and growth rates of about 20 per cent are foreseen (IEA 2003b). Africa stands to benefit by investing in concentrating solar power systems. Morocco and Egypt have ongoing projects in this area. Morocco is setting up a 30-50 MW plant (IEA 2003b), while Egypt is working on a 35 MW plant (El-Sayed 2005).

Africa needs to build its research and development (R&D) capacity to participate effectively in the fast-growing concentrating solar power market. The projects in Egypt and Morocco will help accumulate knowledge and experience, and in turn lower engineering and development costs. The Egyptian government has increased interest and incentives for development of electricity supply utilizing renewable energy such as solar power. Two 130 MW solar-supported steam generation power plants are being constructed at Kuraymat in Egypt (El-Sayed 2005). One option is to develop capacity and capability to manufacture plant and machinery necessary for power generation. In the short term, one strategy may be to acquire disembodied technologies from developed countries.

Solar photovoltaic power

Solar photovoltaic (PV) power has the potential to meet the small energy services needs of isolated off-grid communities as it is ideal for lighting, powering electronic equipment and charging of telecommunication equipment. Lighting and small power needs of schools and community health centres may also be met from solar PV. Photovoltaic systems tend to penetrate the market faster when marketed as complete energy service packages like solar lanterns.

The high prices of solar PV equipment have contributed significantly to the low sales and poor adoption. The cost of a PV panel at US$4.7 per Watt

(based on retail prices in Nairobi for 40 Watt panels) is prohibitive in comparison to competing fuels like wood, kerosene and gas. These prices will have to come down for this technology to be widely adopted and the benefits of solar energy to be utilized.

Apart from deriving energy services from PV solar generators, there are also business opportunities associated with this sector. This market is growing at 30 per cent per year (500 MW per year) and is set to continue growing at this high rate beyond 2010 (IEA 2004). The capital cost of the PV system has been halving every decade. This trend is expected to continue. This should serve as an incentive for Africa to invest in PV systems.

Solar home systems (SHS) and solar lanterns are ideal for lighting and powering most domestic electrical and electronic equipment. Concerted efforts to achieve widespread adoption of these technologies continue to be hampered by high initial investment costs. For example in 2005, an SHS of 40W, capable of powering an average rural home, costs US$500 in Kenya. The cheapest solar lantern of 11W retails for US$100 in Kenya. These prices are well beyond the reach of the average income in Africa. The cost challenge presents an opportunity for Africa to invest in projects that will reduce the current prices by at least half in the short term. Opportunities for investment in solar PV production, construction and use include:

- Cell assembly into panel modules; cell manufacture requires huge expertise and costly infrastructure and is not a priority for Africa at the moment;
- Research and development to improve on and manufacture batteries in Africa. Some countries like Egypt have already achieved this and others may learn from them;
- Invest in manufacture of inverters and controllers;
- Grid-connected SHS should be encouraged. These systems use the grid for energy storage and eliminate the battery and are ideal for urban homes.

Solar dryers and heaters

Natural solar drying of raw foodstuffs and linen is common in Africa. Direct drying of grains and tubers preserves and prepares food for milling. Solar heat is also used for heating water and space. However, practices and methodologies currently in use do not make maximum use of the available solar heat. Developing indigenous drying and heating solar systems through increasing investment in technology development will create new business opportunities in the manufacturing and marketing sectors.

The potential for solar drying and heating is enormous, particularly in ASAL. Drying food is an important part of the food security strategies of poor communities. There is potential to develop and widely use solar drying systems for the preservation of food. This could contribute to meeting the MDG target of reducing the number of people experiencing chronic hunger by 2015. The commercialization of the drying of fish and agricultural products may also increase and diversify income-generating opportunities (UNEP and

Fish drying in KwaZulu-Natal, South Africa.

Source: A. Mohamed

AREED undated). This technology may also be used to dry timber and tobacco.

Botswana has implemented several solar heating projects and accumulated experience which other countries can benefit from. The government of Botswana, in partnership with the housing corporation and the mining companies, has installed over 10 000 solar water-heating units. The full potential was not realized because the first generation units did not supply adequate hot water and thus were abandoned by users (Bakaya-Kyahurwa and Oladiran 2000) illustrating the need for a better match between technology and demand. Box 2 illustrates the success of solar power in rural electrification.

Enhanced use of natural lighting

Sunlight is a natural resource that offers opportunities for sustainable development. Daylight can reduce reliance on artificial lighting during the day and improve indoor ambience where innovative architectural designs are adopted. Investment in architectural technologies and training is critical to harvest these benefits. This would include education and information on available technologies; improving capacity to use computer-aided design in architectural and engineering consultancy; developing and enforcing standards for incorporating environmental concerns in building design; and constructing government demonstration projects.

There are an increasing number of examples globally of how buildings can be designed to benefit from natural light and air flows and reduce energy consumption. In the US, the Leadership Energy and Environment Design (LEED) has developed green building standards and these have become widely accepted, with developers of 1 700 buildings seeking certification. All new federal buildings are required to meet minimum LEED standards (Gunther 2005).

Rainwater

Relatively few African countries have an average annual rainfall exceeding 1 000 mm. More countries receive an average annual rainfall below 500 mm, and are thus considered to be dry lands. However, despite a history of drought and floods, rainwater has the potential to supply safe water and enhance food security through effective rain-fed agriculture.

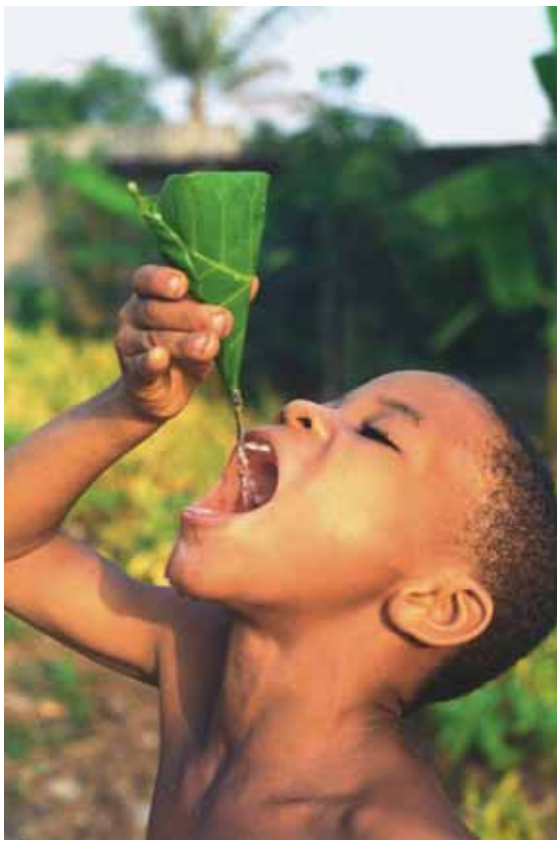
Box 2: Solar rural electrification

The government of Botswana recognizes the need for electricity in rural areas and has initiated a rural electrification programme in Manyana based on home lighting systems.

In 1992, as the first phase of this programme, the government implemented a solar pilot project in the village of Manyana. The pilot project consists of 42 PV lighting systems, 6 PV powered streetlights, PV lighting and refrigeration systems for the village clinic, and 6 solar water-heating systems. The 42 participating households in Manyana are using the systems on a long-term (15 year) lease-purchase arrangement where monthly payments are roughly equivalent to their former expenditures on kerosene and candles.

The Renewable Energy for African Development (REFAD) Programme evaluated the project and provided additional input for establishing a widespread, commercially-driven rural electrification programme. The REFAD team's research indicated that the project had overwhelmingly positive effects on the lifestyles and economy of the rural community. Nearly all the households in the area, without electricity service, expressed interest in purchasing the PV systems.

Source: Solar Industry Journal 1994



Boy drinking water from a banana leaf, Nigeria.

Source: I. Uwanaka/UNEP/Still Pictures

Rainwater harvesting for enhanced access to safe and clean water

Collecting rainwater for drinking, livestock and domestic use is an established practice in Africa. However, traditional collection techniques have become inadequate due to population growth and reduced rainfall. New methods of rainwater harvesting are taking root in Africa; for example, roof catchment and collection in tanks are particularly popular. Plastic or concrete tanks are preferred over metal tanks, as the latter corrode. Box 3 demonstrates the success of rainwater harvesting in Kenya.

Improving the effectiveness of rain-fed agriculture

With the use of appropriate technologies, rainwater could play a bigger role in irrigation and combating the effects of drought. However, appropriate technologies will need to be developed and or acquired, and widely disseminated.

There is growing acknowledgement of the value of rainwater harvesting in rural areas. In Kenya, for example, road run-off catchment, water and farm ponds, sand and sub-surface dams, and conservation tillage have been adopted to increase agricultural production (rainwaterharvesting.org 2003). A non-governmental organization, Practical Action's (ITDG) work in Darfur, western Sudan, is a further example of effective use of rain-fed agriculture. In Darfur, ITDG is supporting the construction of dams across gullies, crescent terraces, shallow wells and channels as appropriate technologies for rainwater harvesting.

Investment in research and development to produce new irrigation systems that use water effectively, particularly in ASAL, should be encouraged. Widespread adoption of low-cost tube irrigation can contribute to poverty alleviation and improve food security and protect against famine. It has, for example, been successfully used in eastern India (Barker and others 2000).

Box 3: Rainwater harvesting in Kenya

The National Museum of Kenya has introduced the concept of large-scale rainwater harvesting in Nairobi city by executing rainwater harvesting in the museum campus. With the support of the Regional Land and Water Management Unit (RELMA), a rainwater harvesting plan for the botanical garden was designed and initial funding for the construction of three underground tanks, all of 105 000 litre capacity, was provided. The tanks receive water from the roof catchment. Following this initial success, RELMA, upon the request of the museum, further facilitated the design and installation of a plastic-lined tank of 30 000 litre capacity for re-use of water from the snake park which houses tropical snakes and crocodiles.

The Elementaita Rotary Community Corps implemented a rainwater harvesting project for Elementaita village in the Nakuru district of Kenya. The women of this village initially fetched water from a seasonal river 10 km away from the village. The project entailed construction of rainwater storage tanks of 10 000 litres with the help of community participation. The total cost of the storage tank was US$600. The community and Rotary International shared the costs. By 2005, 116 such tanks had been constructed. Rotary International has a target of constructing 100 storage tanks every year in the region.

Source: rainwaterharvesting.org 2003

THREATS TO ATMOSPHERIC RESOURCES

Climate variability and change

Climate change is a major threat to atmospheric resources and is resulting in climatic variations that have effects at multiple scales – temporal and spatial. It is closely linked to global patterns of energy consumption and production. Its impacts are increased by poor natural resource management.

Climate change has multiple impacts, at diverse scales and in particular affects ecosystems, which in turn affect livelihoods and human well-being. Even a temperature rise of as little as 1 °C will affect land, coastal and marine, freshwater, and forests and woodland resources. Biodiversity will also be affected, as will human settlements. New health challenges are expected as vector-borne diseases, such as malaria, are predicted to increase. Environmental change affects food production systems, contributing to malnutrition, famine and starvation, and insect ranges and numbers, increasing the incidence of diseases such as malaria. Climate change contributes to population displacement, undermining social cohesion and cultures. The impacts of climate change are also considered in Chapter 3: *Land* and Chapter 5: *Coastal and Marine Environments*.

Several factors, including an over-dependence on rain-fed agriculture and the high incidence of poverty, make Africa's people particularly vulnerable to climate variability. Poor people have little protection against extreme climatic events: they have few resource reserves, poor building structures, and depend directly on natural resources for their livelihoods. Extreme weather events have serious economic and business implications. Floods and droughts cause damage to property and loss of life that affect the opportunities available and that increase the cost of business through higher insurance premiums and claims.

Climatic variations manifest themselves as extreme weather variations, such as floods and droughts. These events are increasing in magnitude and frequency over the years. The mean annual

El Niño floods in Rhoka Village, Tana River Valley, Kenya.

Source: G. Griffiths/CHRISTIAN AID/Still Pictures

rainfall has been decreasing over the decades. Many countries, including Botswana, Burkina Faso, Chad, Ethiopia, Kenya, Mauritania and Mozambique, experience drought at regular intervals. The 1997-98 El Niño floods caused heavy damage to roads, buildings, bridges, railway lines and other property including schools. Incidences of epidemic diseases such as malaria increased during this period. This is related to improved conditions for mosquito breeding; mosquitoes transmit many viruses, over 100 of which are known to infect humans, including malaria, dengue, yellow fever and severe and sometimes fatal encephalitis and dengue haemorrhagic fever (Akhtar and others 2001). Cholera, which is transmitted by water or food, could aggravate health problems in many parts of the world including Africa. During the 1997-98 El Niño event, excessive flooding is reported to have caused epidemics in Djibouti, Somalia, Kenya, Tanzania and Mozambique (Hassan and others 2005).

Mean global temperatures are rising, slowly but surely (Christy and others 2001). This rise in global temperature is attributed to anthropogenic emission of GHG, particularly carbon dioxide. Greenhouse gas emissions result from the burning of fossil fuels in industry, transport vehicles, waste disposal and in households. Africa contributed 341 836 m^3 of CO_2 in 1970, or 2.2 per cent of global emissions (WRI 2005); by 2000 this had risen to nearly 3.6 per cent of global emissions (UNSTATS/CDIAC 2006). Although African emission levels are low, their steady increase demands increased investment in clean production processes and the fulfilment of the commitment made by industrialized countries at WSSD to support Africa in this through partnership and investment.

Climate change is causing the rapid melting of snow caps and a concomitant rise in sea level. For example, the glaciers on Kilimanjaro have shrunk by 73 per cent over the century (Mastny 2000). This process may result in the displacement of people, loss of lowland areas, reduced agricultural production, health problems and enhanced climate variability. The challenges associated with climate change are discussed in relation to land resources in Chapter 3: *Land*.

Atmospheric pollution

In comparison to developed countries, Africa's air pollution levels are still relatively low. However, air pollution is increasing fairly fast as a result of increasing

population, urbanization and industrial production. Major pollutants include sulphur dioxide, carbon monoxide, soot, dust and lead. For large industrial cities, like Cairo, air pollution is of immediate concern. Indoor pollution emanating from the burning of fuelwood is another area of concern.

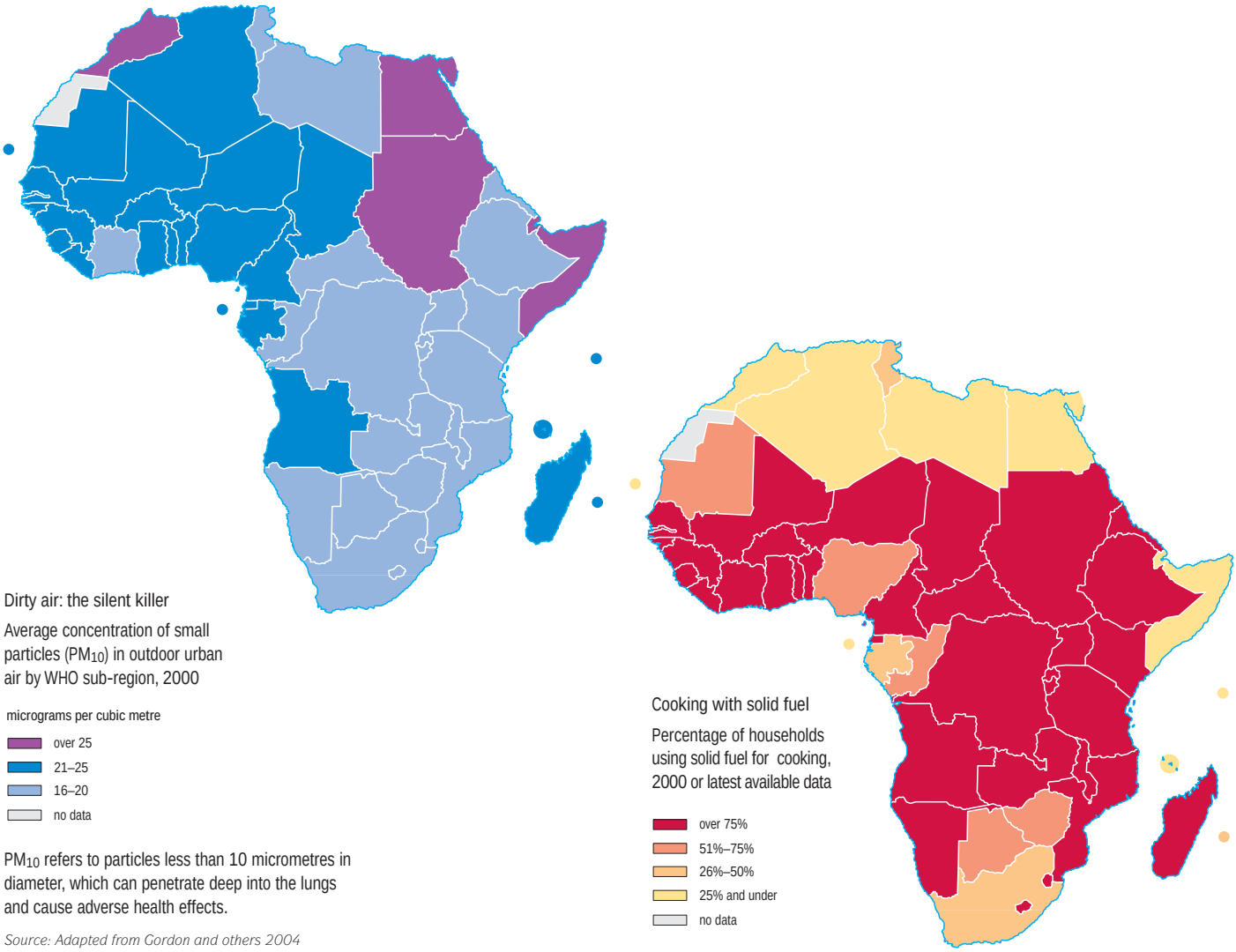
Many factors contribute to increasing air degradation. Inefficient industrial technologies and vehicle emissions are important contributors in urban areas. High dependency on old vehicles is a result of the high taxes many governments place on new vehicles and the lack of financial resources available to consumers. The lack of emission controls on vehicles, and poor monitoring and enforcement systems, exacerbate pollution problems. The transportation system, with its use of trucks for long-distance transportation of goods and poor railway systems, contributes to pollution problems. Open burning of waste also contributes to air degradation. In rural areas, burning of biomass for energy services in small-scale industries like brick firing contributes to air pollution. The use of biomass fuel for cooking and heating in households also lowers the quality of air. Indoor pollution disproportionately affects women and children (Gordon and others 2004) as women bear the burden of cooking and are thus more vulnerable. Improving air quality is essential for improving health, and in particular for reducing the maternal and child mortality rates as envisaged in MDGs.

Ozone layer depletion

The ozone layer shields people and plants from harm from ultraviolet radiation, which causes skin cancer and cataracts in people, stunts growth in plants, including food crops, and kills the tiny organisms which form the base of the marine food chain.

The ozone layer is threatened by the production of industrial chemical emissions, particularly the CFCs.

Figure 4: Air pollution in cities and indoor air pollution



PM_{10} refers to particles less than 10 micrometres in diameter, which can penetrate deep into the lungs and cause adverse health effects.

Source: Adapted from Gordon and others 2004

These chemicals are stable and stay long enough in the atmosphere to reach the ozone layer where they decompose due to strong radiation and eventually react with and destroy the ozone layer, causing "holes" that let the ultra violet (UV) radiation through. The rapidly rising level of UV-radiation in some parts of the world is alarming: in the Arctic, their intensities are 130 per cent higher than 1970s levels.

Measures to reduce the release of CFCs into the atmosphere have now been stipulated in the Montreal Protocol. Parties to the Montreal Protocol agreed to phase out CFCs, halons and carbon tetrachloride by 2000, and methyl chloroforms by 2005. A global fund to help developing countries adopt environmentally friendly technology was established. Most African countries have taken the opportunity to eliminate ozone depleting substances (ODS) through national action plans. Chapter 11: *Chemicals* considers the opportunities and challenges faced by the use of chemicals and Africa's policy response.

Challenges faced in realizing opportunities for development

Mitigating causes and impacts of climate variability and air pollution

Policy interventions are necessary:

- In the short term, to reduce the effect and impact of extreme climate changes on lives, livelihoods and infrastructure.
- In the medium term, to reduce emissions and pollutant concentration in the atmosphere, whilst at the same time limiting the release of more emissions and pollutants into the air.
- In the long term, to adapt to climate variability and change.

Globally, mitigation measures have primarily targeted reducing pollutants and ozone depleting substances as well as stabilizing GHG concentrations in the atmosphere through increased sinks and reduced emissions. Programme Area 5 of the New Partnership for Africa's Development Environment Action Plan (NEPAD-EAP) specifically focuses on combating climate change in Africa. These global and regional responses may help reduce the frequency and severity of floods, drought and heat waves; the loss of snowcaps; and sea-level rise. This will have positive implications for livelihoods and human well-being. Additionally, mitigating climate change and air pollution interventions offer business opportunities that contribute to job creation, poverty reduction and other NEPAD objectives.

Energy production from coal is one of the largest contributors to CO_2 emissions. Power generation, South Africa.

Source: A. Mohamed

Early warning systems

Given the failure to reduce emissions significantly, extreme weather events are predicted to occur with increasing frequency and severity. Investing in capacity for early warning systems will reduce both direct and secondary impacts of such events. Forewarned is forearmed: people will be able to accumulate food reserves, reinforce shelter or move to safer ground. Information and capacity-building lie at the heart of developing effective response systems. The ability to respond effectively is also affected by available resources, such as transport, to leave a threatened area. Poverty may prevent many communities from taking proactive measures, even if they are forewarned. Public support and international partnerships are critical for effective response systems.

Africa should invest in research to be able to develop, construct, deploy and use early warning systems. Community-based traditional warning systems should be researched and, where viable, developed and deployed. Early warning requires regionally and internationally linked systems, where spatial and temporal data from numerous observation points are brought together for analysis. International cooperation is therefore essential in developing effective early warning systems. Investing in the production of early warning systems will contribute to wealth creation and achievement of NEPAD objectives.

Investing in drug availability

In the short term, diseases and epidemics linked to climate change and climate variability will continue to occur. African governments should encourage the private sector to invest in the pharmaceutical sector and manufacture drugs to combat malaria, typhoid, diarrhoea and other diseases. Manufacture of other disease-preventing products, like mosquito nets and repellents, will help reduce the incidence of diseases. These measures are essential to meeting regional and global development targets.

Building buffers

Floods, when left uncontrolled, cause severe damage to livelihoods and result in the loss of life. Building buffers along coastlines and rivers prone to flooding will help reduce damage. Investing in capacity to design and construct such buffers creates jobs which contribute to reducing poverty. This is particularly effective when the affected communities are actively involved in the process. Building buffers will also boost the construction sector. Preventing damage to infrastructure will directly contribute to a NEPAD objective of ensuring good infrastructure in Africa.

Investing in food production and storage systems

Given agricultural production systems and the high levels of subsistence production, rural people are particularly vulnerable to extreme weather events.

In the face of climate change and possibly increasing aridity, developing crops that will grow with minimal rain is a good investment. Agricultural research institutes in a number of African countries, including Kenya Agricultural Research Institute (KARI) in Kenya, are already working on developing drought-resilient food and cash crops (Odame and others 2003). The success of this research could contribute to poverty alleviation in some of the most disadvantaged and marginalized communities. Women in ASAL areas will particularly benefit from drought-resilient crops. Men will be most likely to continue with livestock husbandry. Chapter 10: *Genetically Modified Crops* considers the opportunities and challenges associated with the adoption of genetically modified (GM) crops.

Investing in food reserves and storage improves food security. Besides storage, there are benefits in investing in post-harvest food processing and distribution networks. A large network of retailers can serve as a food reserve. South Africa has an elaborate post-harvest food processing and packaging industry that should serve as an example to other countries.

Establishing an extreme weather fund

Extreme weather events create a series of problems that can lead to severe loss of production and the collapse of an entire economy. For example, Kenya experienced a severe drought in 1999-2001, which

Rain clouds gather over The Amphitheatre in the Drakensberg Mountains, South Africa.

Source: A. Mohamed

caused a shortage of water in a dam, leading to closure of power plants and subsequent blackouts and power rationing. This has forced many industries to reduce production or even to shut down. The Kenya economy lost so much that the government was forced to invest in emergency generators at a cost of US$120 million. Raising such large amounts of money at short notice can prove to be a major challenge to most African governments, and such unplanned investments divert funds from other sectors and interrupt planned programmes. Establishing a financial mechanism to ensure an extreme weather reserve fund will reduce the impact on the economy and reduce loss of lives and property.

Conservation of wetlands and woodlands

Draining wetlands and destroying woodlands is a major cause of environmental degradation. Investing in the conservation of these zones will reduce the impacts of climate variability. In addition, woodlands and wetlands provide opportunities for ecotourism thereby contributing directly to job creation, poverty reduction and other NEPAD objectives.

Investing in energy efficiency

The efficient use of energy is an opportunity for reducing GHG emissions which also contributes directly to achieving social and economic development. Efficient burning of fuels in industry, transport and household sectors is a win-win process. Saving energy saves fuel and money. Investing in energy-efficient technologies will contribute to an improvement of a firm's bottom line. For example, Kenya is currently implementing a GEF- and UNDP-funded, energy-efficient project for small and medium enterprises (SMEs); this US$5 million project has contributed to awareness creation and capacity-building for energy-efficient adoption in SMEs.

Investing in cleaner production saves materials and energy and also reduces GHG emissions. Africa should continue with the ongoing establishment of national cleaner production centres. These centres will assist industries switch to "cleaner" production and products. The Clean Development Mechanism (CDM) adopted under the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) is a project-based tool designed to make it easier for industrialized countries to reduce GHG emissions. It relies predominantly on market-based tools. Through carbon trading, developing countries can use this mechanism to support sustainable development initiatives. Africa's participation in carbon trading is still relatively small.

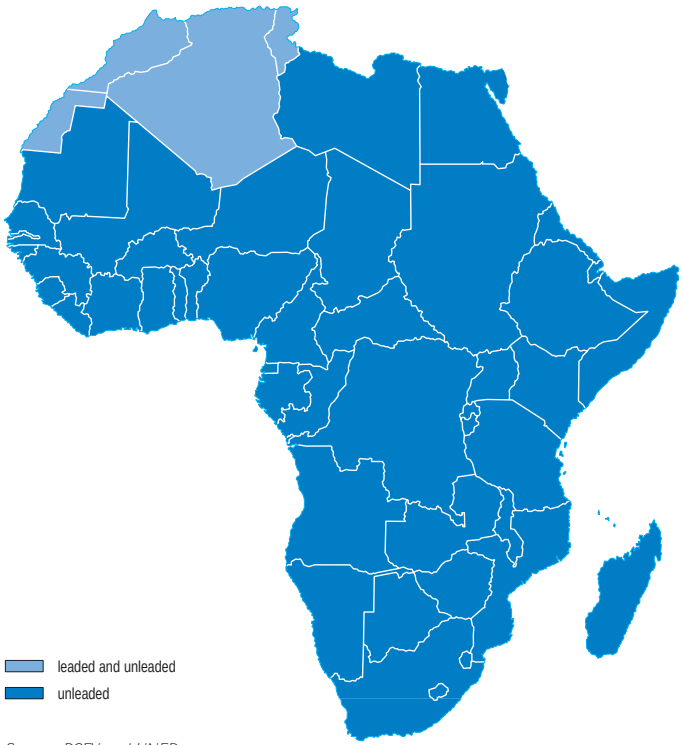
Fuel switch

Switching from fossil fuels to renewable energy resources contributes to GHG emission reduction. Moving away from traditional to modern energy forms entails changing fuels from solid to liquid, liquid to gas, and gas to electricity as end-use energy forms. African rural and urban poor will particularly benefit from fuel switch.

Phasing out leaded fuels will reduce pollution and lead-induced sicknesses. In the Dakar Declaration of 2001, SSA agreed to phase out leaded petrol. The Partnership for Clean Fuels and Vehicles (PCFV), formed at WSSD in 2002, was developed to support this phasing out. At that time, only one country in SSA, Sudan, was completely lead free. However, as of January 2006, with South Africa going unleaded, all of SSA has now switched (UNEP 2005c).

There are several projects across Africa implementing fuel switch programmes. The Servant Flood of Light Development Foundation and Community Uplift Ministries of the USA is promoting a fuel switch project in Kenya. The project involves replacing firewood with gas for cooking, and kerosene with battery-powered electric lamps for lighting. The project relies on a gas-powered electricity generator for charging batteries at community levels. Two projects, recently launched in Kitale and Vihiga districts, are so far giving the expected results. However, it is still too early to make concrete conclusions on the future of these projects.

Figure 5: Status of leaded gasoline phase out



Source: PCFV and UNEP

Local vehicle manufacture and traffic management

The manufacture of motor vehicles in Africa is an opportunity for job creation and poverty reduction, which could contribute to GHG emission reduction by making new vehicles more easily available to consumers. Many countries in SSA rely on imported used vehicles. Not only is this practice paramount to exporting jobs, but it contributes to pollution problems. By building capacity for new vehicle production, Africa will create jobs, reduce poverty and help conserve the environment. Investing in efficient combustion and engine tuning will provide new business opportunities whilst reducing GHG emissions.

The development of efficient public transport systems in developing countries can provide badly needed mobility, reduce the rate of growth of private vehicle use, and offer an opportunity to reduce pollution (IEA 2003c).

SUB-REGIONAL OVERVIEWS

EASTERN AFRICA

Eastern Africa has a large variety of complex topographical features that play an important role in modulating the global climate; these include variations in its surface terrain and a large inland moisture source in the Congo basin and inland lakes (Atheru and Mutai 2002). The processes that influence climate over Eastern Africa include the ITCZ, Intra-Seasonal Oscillations (MJO), Quasi-Biennial Oscillations (QBO), tropical cyclones, jet streams, subtropical anticyclones, and other anomalies over the Atlantic and Indian Oceans. Others factors include disturbances from the mid-latitudes, El Niño/Southern Oscillation (ENSO), easterly waves, equatorial westerlies, mesoscale circulations and monsoon circulation (Atheru and Mutai 2002).

Drought and floods are frequent in Eastern Africa, particularly affecting areas of southern Ethiopia, southern Somalia and eastern Kenya. Rainfall is the most important climatic factor for many African countries and its inter-annual variability has a major impact on national economies. Climatic variability over the past millennium has resulted in extended periods of drought followed by periods of heavy rainfall (Atheru and Mutai 2002). This has resulted in major disasters: alternating flooding and droughts are an important reason for food insecurity. In 2003, Ethiopia's food aid requirements of 1.34 million tonnes amounted to over half of that for Eastern Africa's requirements.

Sources of GHG emissions include fuel combustion in transport, household biomass use, animal waste and rice cultivation There are other minor sources such as industrial fuel combustion. The National Communications to the UNFCCC are the most authoritative statements by Eastern African governments on climate change and related impacts on their economies. The contribution by the sub-region to the global GHG concentrations still remains unquantified. The National Communications to UNFCCC, however, serve to provide a baseline for future studies.

Increasingly, there are reports pointing to the emerging importance of dust as a key factor in the sub-region's climate variability and change. Dust storms over the eastern plains of Somalia, northeast Kenya, northern Sudan and Ethiopia are common phenomena through most of the year. Dust is one of the least understood components of the Earth's atmosphere and it may have a greater importance for climate change than has been realized up until now (RGS 2004). As dust deposits increase, levels of carbon dioxide in the atmosphere could change, which in turn would affect temperatures and rainfall.

Progress has been made in assessing the vulnerability of local communities and ecosystems to climate change. For instance, the Assessment of Impacts and Adaptations to Climate Change (AIACC) study shows that climate change has altered the microclimates in the highlands. Analysis of time-series data from 1978 to 1999 reveals that the maximum and minimum temperatures have changed, with significant increases generally recorded at all sites.

Vehicles – both land and water – are an essential part of modern life but they are also major polluters.

Source: M. Chenje

Analysis of data over the period 1961-2001 also reveals decreasing rainfall. The temperature changes have been more pronounced at the higher altitudes than in the lowlands with, for example, temperatures in the Kabale district of Uganda increasing dramatically by 2°C in the last three decades (Wandiga and others, forthcoming).

The temperature increases in the eastern highlands have resulted in an increased range for malaria-carrying mosquitoes. There have been increasing malaria epidemics in the highland communities. Communities living at altitudes above 1 100 m are more vulnerable to malaria epidemics due to lack of immunity (ECA 2005a).

The Intergovernmental Panel on Climate Change (IPCC) warns of potentially disastrous global warming effects on agriculture and water supplies in tropical and sub-tropical Africa. Even a small increase in temperature will mean a decrease in agricultural production (Wandiga and others forthcoming, CGIAR 2000). There is gradual yet dramatic disappearance of glaciers on the Ruwenzoris in Uganda and Mt Kenya. The ice cap on Mt Kenya has shrunk by 40 per cent since 1963, and a number of seasonal rivers that used to flow from atop the mountain to the surrounding areas have since dried up (ECA 2005b). The snow and glaciers act as water towers and thus towns and farming communities around the mountains will be affected.

Eastern Africa has a very high rate of urbanization. In 1980, the urban population was just over 10 million people and by 2005 it had reached 37.14 million (WRI 2005). Increased activities in key economic sectors are contributing significantly to air pollution. Although the manufacturing sector is responsible for part of the pollution, the transportation sector is increasingly being recognized as the highest polluter, emitting atmospheric reactive gases and other toxic chemicals. These gases, including sulphur, are products of combustion of diesel and gasoline.

There are also concerns on the contribution of household emissions to the GHG load. In Kenya, for example, charcoal production and consumption are believed to be emitting more GHGs (mainly CO_2, CH_4 and NO_x) than the industry and transport sectors combined (Republic of Kenya 2002). The use of traditional kilns in the charcoal production process, characterized by low efficiencies in the range 8-15 per cent, has been found to be responsible for about 4 per cent of the global biomass burning-derived CH_4 emissions and 0.12 per cent of all known sources (Kituyi 2000). Besides emission of GHGs, biofuel production and consumption has other important impacts. They contribute to acute respiratory infections (ARI) in children under 5 through emissions of particulate matter (PM), polycyclic aromatc hydrocarbons (PAHs) and CO_2.

Though not to the same level, governments have demonstrated commitment to conserving the atmosphere through regional and international initiatives. They have all ratified the UNFCCC and the UN Convention to Combat Desertification (UNCCD) – this being a key indicator of commitment in its own right. Some have also ratified the Kyoto Protocol, which came into force in February 2005.

There are a number of initiatives focused on sustaining atmospheric resources, including the NEPAD-EAP Programme 5: combating climate change; the CDM defined under Article 12 of the Kyoto Protocol which provides opportunities for mitigating climate change through energy conservation and emission reduction initiatives; the NAPA driven by the UNFCCC process which provides opportunities for LDCs to develop their agenda for adaptation to climate change (see Box 4); and the World Bank's Clean Air Initiative in SSA which was launched in 1998 as a response to

Box 4: National Adaptation Programme of Action (NAPA)

The National Adaptation Programme of Action (NAPA) has been established to address the urgent and immediate national needs of Least Developed Countries (LDCs) for adapting to the adverse impacts of climate change and for preparation of national communications to the UNFCCC. It is funded through the GEF from a special LDC fund established at the Seventh Conference of the Parties (COP-7). An LDC expert group was established at COP-7 to advise on the preparation of NAPAs.

National Adaptation Programmes of Action will serve as simplified and direct channels of communication for information relating to the urgent and immediate adaptation needs of the LDCs as they prepare for the predicted impacts of climate change.

While the NAPA identifies urgent and immediate action, it still needs to fit within development goals, plans and frameworks, especially in relation to rural citizens and economic development plans for the country. NAPAs will not attempt to implement broad national development goals but will build upon national goals and integrate into national plans. They should also promote synergies with other plans of action, and action in the context of other Multilateral Environmental Agreements (MEAs). Most, if not all, countries have elaborated their development goals, and have systems in place to implement the associated plans through economic planning, among other things. It is important that the NAPA team be aware of these, because NAPAs may be expected to safeguard important systems, including infrastructure, that would be critical in achieving economic goals for the country. For example, a NAPA may wish to flood-proof a single bridge that connects a major cash crop producing area of a region.

Source: UNFCCC 2002

deteriorating air quality attributed mainly to increased traffic and the changing landscape of African cities as a result of rapid urbanization.

With respect to capacity-building for monitoring, prediction and early warning, a WMO-supported Drought Monitoring Centre (WMO-DMC) has been established in Nairobi, Kenya, but unfortunately this is under-utilized. Climatic monitoring and skilful seasonal climate prediction is crucial for proper planning and management of all climate-sensitive activities including agriculture, water resources and hydroelectric power generation among others. A few universities also offer meteorology studies leading to both graduate and post-graduate degrees. These need to be revised to take into consideration the identified concerns. The Inter-University Council for East Africa (IUCEA) could play a key role in ensuring cross-border learning and information exchange at the universities.

The greatest threat to the success of interventions to protect the atmosphere is low funding for government programmes and projects. This is mainly due to low budgetary allocations by governments in the sub-regions and low interest by donors on the subject, who instead are interested in HIV/AIDS etc. Most national policies remain weak mainly on elements of regional cooperation, technology transfer, and cross-border training to optimize sub-regional opportunities. Most countries lack appropriate mechanisms for domesticating key multilateral environmental agreements such as the Kyoto Protocol, among others. This is also attributed to weak national and regional institutions – weak in terms of programmatic focus, funding levels and overall organizational structures. Lastly, atmosphere-related issues rarely rank high on any country's political agenda compared to health or food security issues. The natural links between drought and poverty or food insecurity, and air pollution and human health, for instance, have not been made clear to politicians and other critical decision-makers. They therefore remain of low priority on the political agenda.

NORTHERN AFRICA

Industrial development and high levels of urbanization contribute towards the present situation in large urban centres in Northern Africa. There are two main sources of air pollution:

- Natural, such as dust and sandstorms; and
- Anthropogenic activities including stationary sources, such as thermal power generating plants and industrial parks, and mobile sources including vehicles.

Libya has the highest per capita share of CO_2 emissions compared to its neighbours. All countries have experienced significant growth in CO_2 emissions, which is often related to economic growth.

Cairo, the capital of Egypt, has poor air quality. The average inhabitant ingests more than 20 times the level of accepted air pollution. When this is manifested as smog – known to Egyptians as the Black Cloud – health problems ensue (Evans 2004).

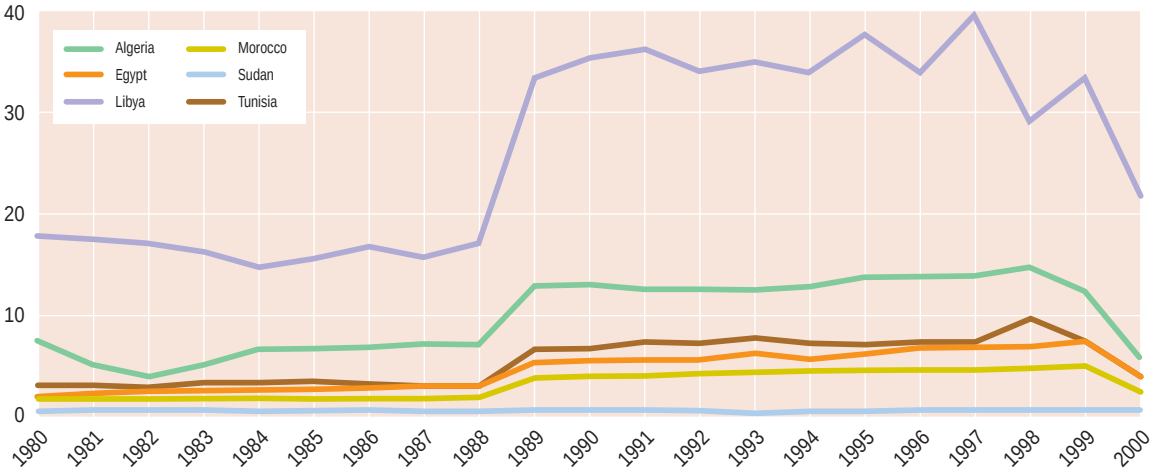
In Tunisia, energy generation and the transport sector are among the major contributors to air

Pollution hangs over Cairo.

Source: M.Chenje

Figure 6: Per capita carbon dioxide emissions in Northern Africa

metric tonnes of CO_2 per person



Source: UNEP 2005a

pollution, at 31 per cent and 30 per cent respectively. The transport sector is the top contributor of CO_2 and lead emissions (Tunisia 2002). CO_2 emissions account for 92 per cent of the total GHG emissions, while methane emissions account for 7 per cent, and nitrogen oxide for 1 per cent. GHG emissions of CO_2 from the transport sector rose from 3.4 million tonnes to 5.8 million tonnes between 1994 and 2002, with an annual increase rate of 9 per cent. They also accounted for about 29 per cent of the total emissions generated by the energy sector in the year 2002, rising from 23 per cent in 1994 (Tunisia 2002).

The national plan to survey air quality in Tunisia is based on the installation of a network of fixed stations and the acquisition of mobile laboratories to monitor air quality and control the sources of pollution. By 2002, five stations had been set up. The stations revealed that, except at peak hours during which time higher elevations in the concentrations of CO_2 and SO_2 were recorded, the air quality in Tunisia conforms to standard. A national commission for the protection of the ozone layer was established in which all relevant ministries are represented (Soussi 2004).

In Libya, the main sources of air pollution are related to the use of petroleum derivatives as fuel in many industrial, artisan and transport fields. Oil refineries are the main sources of atmospheric pollution due to the harmful gas emissions, mainly hydrocarbons, carbons, nitrogen oxides and sulphur from burning fuel in oilfields and refineries. Most of the plants were not subjected to environmental evaluation prior to their establishment, and they have adverse effects on the surrounding residential and maritime areas. The plants do not have the necessary pollution control, monitoring and measurement systems, nor the necessary equipment and devices for limiting or decreasing the volume and concentration of the pollutants.

In Morocco, the emissions of GHG and the use of ODS contributes little to the pressures on the environment. Air pollution is mainly due to road traffic and industry, particularly along the Mohammedia-Safi road axis. The effect of the deterioration of air quality on the economy, in terms of the decrease of productivity due, in part, to respiratory diseases, is estimated at 1.9 per cent of the Gross Domestic Product (GDP) (Firadi 2004).

All countries experienced significant growth in CO_2 emissions, which is often correlated with economic growth. For example, there was a 14.28 per cent increase in per capita CO_2 emissions between 1990 and 2001 in Libya (WRI 2005).

There has recently been increasing awareness of the diverse and complex results of air pollution. Public and private sector establishments are becoming more interested in undertaking preventive measures to control air pollution, and there is a detectable shift from end-of-pipe treatments to a more proactive approach. including cleaner production and waste minimization at source. National Cleaner Production Centres have been established in some countries, such as Morocco and Tunisia, and will soon be set up in Egypt, to raise awareness, build the capacities of development partners, and support stakeholders.

There are many instances of how industries are integrating environmental considerations into industrial development and implementation. For example, some

SMEs have been keen to incorporate the components of environmental management systems (EMS) into their day-to-day operations. For example, the Coptic Evangelical Organization for Social Services (CEOSS), an Egyptian non-governmental organization (NGO), has mobilized approximately US$1 million to institutionalize EMS in SMEs of western Minya in Upper Egypt.

In both Egypt and Morocco there has been some investment in the development of renewable energy. The Egyptian government has been working with USAID to plan a combined natural gas/solar power plant in Egypt. Feasibility studies have been completed on the 127-MW plant, which will use solar energy during the day and natural gas at night. The plant, which has received funding from USAID and the Global Environmental Facility, is expected to cost $120 million and come online in 2006 (EIA 2005).

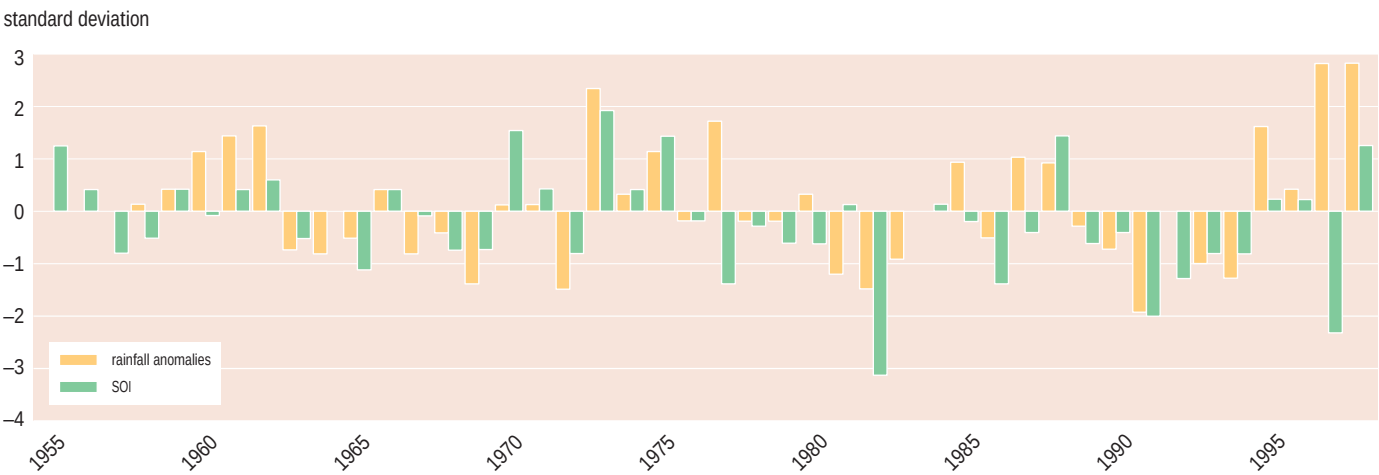
SOUTHERN AFRICA

The atmosphere provides the supporting medium for human well-being and environmental goods-and-services. Its dynamism is characterized by seasonal and daily changes in temperature, rainfall and wind systems which shape human cultures, food production and the location of settlements, as well as the general state of the environment. Climate is the most important aspect of atmospheric phenomena. However, changes and variability in climate patterns in Southern Africa in the form of changes in rainfall patterns, rising temperatures and the increased frequency of extreme weather events such as droughts, floods and tropical cyclones, have far-reaching impacts on socioeconomic development and human well-being.

The monthly variation in temperature is gradual, with the peak of the rainy season occurring between December and March. During this period, surface temperatures are warmest over the desert areas of Botswana and Namibia and exceed 26°C; relatively cooler conditions prevail over the central parts and also to the southeast where temperatures may be less than 20°C as a result of the cloudiness associated with summer rains (DMC undated). In the dry winter, the temperatures are cooler; the coldest areas, stretching from Lesotho through South Africa and to the southern tip of Namibia, experience temperatures averaging less than 14°C (Chenje and Johnson 1996).

Rainfall is the most critical factor for livestock and crop production in the ASAL. Generally, rainfall increases towards the equator, resulting in more rain in Tanzania, northern Mozambique and Angola, and less in South Africa, Botswana and Namibia. Rainfall is generally seasonal. Some important determinants of rainfall patterns include the Inter-Tropical Convergence Zone (ITCZ), the Botswana Upper High and the El Niño phenomenon. The ITCZ migrates seasonally over Africa, in response to the position of the sun, and its arrival leads to substantial rainfall amounts; it is responsible for most of the rainfall in the sub-region. A middle-level atmospheric condition, known as the Botswana Upper High, occurs from time to time and is inimical to rainfall activity in its vicinity. The persistent occurrence of the Botswana Upper High results in drought. The El Niño phenomenon is thought to decrease Southern Africa's rainfall. During most El Niño episodes, the bulk of Southern Africa is likely to experience drought conditions while during a La Niña, there are chances of higher than normal rainfall. However, as shown in Figure 7, the relationship between the El Niño and rainfall anomalies sometimes breaks down, as happened in the 1986/87 and 1997/98 seasons.

Figure 7: Standardized mean rainfall anomalies and El Niño Southern Oscillation Index (SOI)



Source: Hirji and others 2002

Table 2: Rainfall trends in Southern Africa 1986-2003

1986-87	Drought conditions returned to the region.
1988-90	Near normal seasons.
1991-92	Severe drought in southern Africa, excluding Namibia.
1993-94	Conditions improved.
1994-95	Many SADC countries were hit by the worst drought in memory, surpassing effects of the 1991-92 drought in some parts of the region.
1996-97	Normal rainfall for most of the region.
1997-98	Normal rainfall throughout the region, including the northeast, although impacts of El Niño were significant.
1999-2000	Cyclone Eline hit the region and widespread floods devastated large parts of the Limpopo basin (southern and central Mozambique, southeastern Zimbabwe, parts of South Africa and Botswana).
2001-03	Another severe drought in the SADC region, particularly from Zimbabwe northwards.

Source: adapted from Chenje 2000

The most common indicator of climate variability is the amount of rainfall received over the years, and year-to-year rainfall variability is high. The most critical variations are manifested as droughts, floods and tropical cyclones. Droughts have occurred periodically in Southern Africa throughout recorded history. As shown in Table 2, serious droughts have afflicted the sub-region in 1986-87, 1991-92, 1994-95 and 2001-2003 (Chenje 2000). The droughts of the 1980s and 1990s have had a marked negative impact. For instance, the water level of the Kariba Dam on the Zambezi River dropped by 11.6 metres between 1981 and 1992, resulting in a reduction of the dam's capacity to generate hydropower.

In addition to droughts, Southern Africa experiences exceptionally wet seasons resulting in extensive flooding. Most flooding is associated with active cyclones that develop in the Indian Ocean. The 1999-2001 rainfall seasons were dominated by active tropical cyclonic activity, which caused considerable human suffering. Tropical cyclone Eline had the most devastating effects during this period. As a result of cyclone Eline, heavy rains were experienced over southern Mozambique, parts of South Africa's Limpopo Province and southeastern Zimbabwe, with over 200 mm of rain recorded over periods of less than 48 hours at many weather stations.

Apart from these vagaries of nature, climate change poses a serious threat: records have revealed temperatures to rise by over 0.5°C over the past 100 years (Zöckler and Lysenko 2000) and the 1990s were the warmest ever (WWF-Nepal 2005). There are also concerns about the possible negative impacts of sea-level rise. Climate models project an increase in global mean surface temperature of about 1-3.5°C by 2100 and an associated increase in sea level of about 15-95 cm (UN 2003). Crop yields are expected to be affected, dropping by as much as 10-20 per cent in some parts of the sub-region (Hoffman 2001). It is also predicted that the malaria-carrying anopheles female mosquito will spread to parts of Namibia and South Africa where it has not been found before (Watson and others 1998).

Addressing the threats associated with climate change demands new levels of research. Technological investment is an important aspect of responses, and partnerships with the international community can support this. The opportunity offered by carbon trading, by forestation and reforestation should be captured.

The Southern African Development Community Drought Monitoring Centre (SADC-DMC) was established in 1991 with the main objective of minimizing the negative impacts of climatic extremes on socioeconomic development in the sub-region. This is achieved through the monitoring of near real-time climatic trends and generating long-range climate outlook products on monthly and seasonal (up to six months) time scales. These outlook projections are disseminated to the sub-regional community to afford greater opportunity to decision-makers for the development of strategic plans.

The SADC Regional Early Warning System, in conjunction with the Famine Early Warning System and SADC-DMC, is providing advisory services regarding the status of the food security situation. Such systems have been useful in informing national and regional policies, forming the basis for food aid requests, as well as laying the foundation for land and agrarian reforms. Recently, there have been further efforts in Southern Africa to develop long-lead climate forecasting based on tropical sea surface temperature

conditions. In order to maximize the benefits of advances in climate prediction, Southern Africa has demonstrated a need for a sub-regional climate network, which would meet regularly, interpret global and regional climate signals, and provide seasonal rainfall forecasts. This is currently done through the Southern Africa Regional Climate Outlook Forum (SARCOF) process, which advises on the likely status of the rainfall season before its onset.

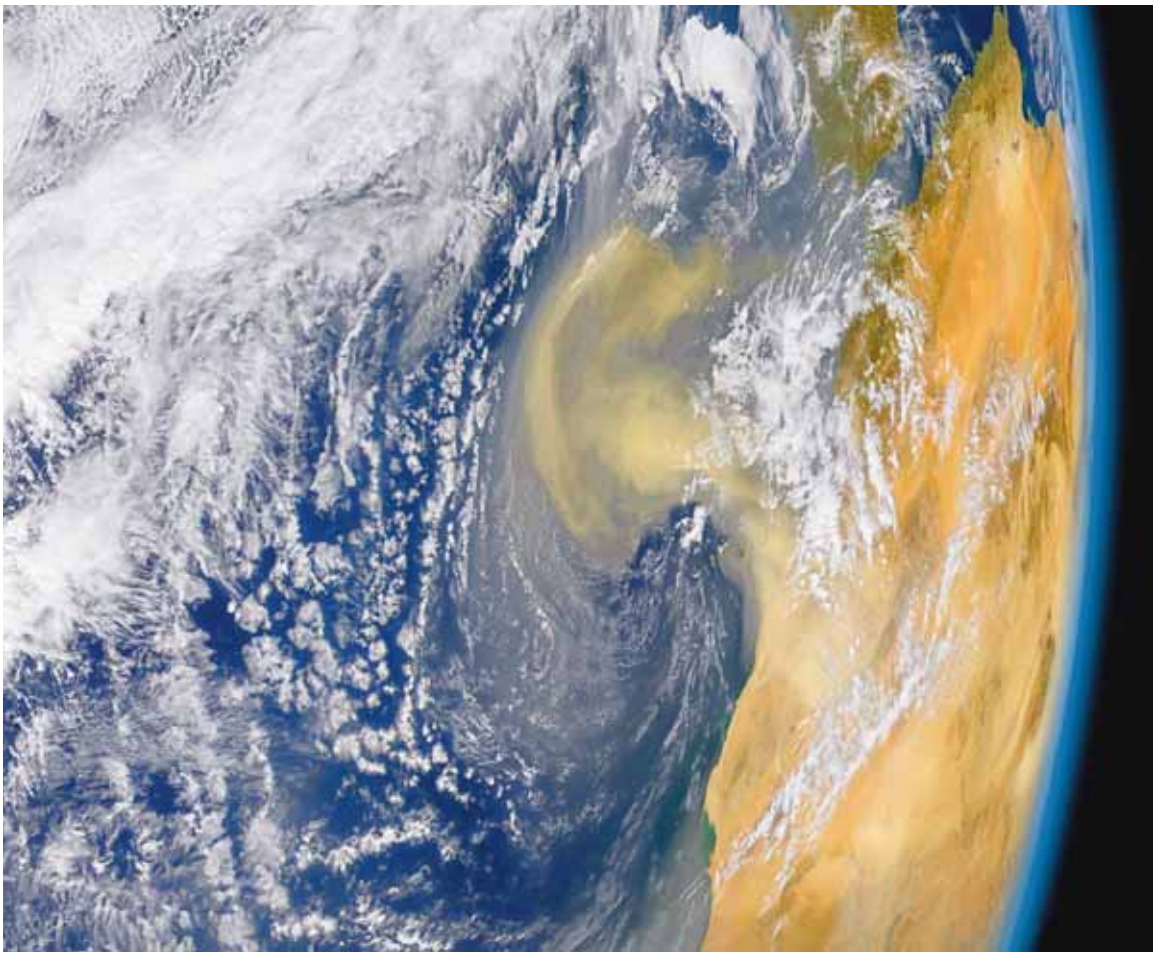
Climate change and variability are global issues, requiring concerted international efforts. The global nature of these atmospheric phenomena presents a great challenge as it is difficult to reach international consensus on appropriate solutions and levels of responsibility. Some countries may find no direct value in addressing climate change and variability issues since their contribution to the phenomena is minimal. There is, therefore, a need to increase awareness on the affects of climate change.

The reliability of sub-regional predictions is still low, and the degree to which climate variability may change is uncertain. Given this, policymakers need to consider the value of taking precautionary measures by, for example, reducing GHG emissions and enhancing the resilience of vulnerable systems.

WESTERN AFRICA

There are four climatic zones in Western Africa: Sahelian (rainy season does not exceed three months; irregular rainfall not exceeding 500 mm); Sudanian (precipitations between less than 88 mm in the north of Nigeria and 1 000 mm in the north of Mali); tropical humid (annual mean rainfall approximately 1 500 mm); and equatorial (essentially localized along the Gulf of Guinea, with annual rainfall above 2 000 mm).

The temperature in Western Africa is influenced by two air masses: the Harmattan, a dry and hot northeast wind blowing through the Sahara, and the monsoon, a



Dust is a poorly understood factor in climate change
A massive sandstorm blowing off the northwest African coast, blanketing hundreds of thousands of square kilometres of the eastern Atlantic Ocean with a dense cloud of Sahara Desert sand.

Source: SeaWiFS Project, NASA/GSFC and ORBIMAGE

humid southwest wind blowing through the Atlantic Ocean. These two air masses are controlled by the seasonal movement of the inter-tropical convergence zone and move from the north to the south. Rainfall patterns are unequally distributed through the sub-region and influenced by this airflow.

GHG emissions affect climate variability by generating, for example, a deficit in rainfall. Greenhouse gas emissions in the region are low. However climate patterns are affected by global emissions, these variations have an effect on ecosystems and the economy. The immediate effect of climate variability is food insecurity: for example, groundnut production has virtually disappeared in Niger and a similar trend is evident in Senegal. The Sahel region – including Senegal, Mauritania, Mali, Burkina Faso, Niger, Nigeria and Chad – has experienced three decades of drought and patchy rain (IRIN 2005). The quality of rain is as important as the amount of rain, with heavy downpours and wind causing flooding, erosion and deterioration of the soil (IRIN 2005).

In addition to food insecurity. there is deterioration in air quality, especially in urban areas. The resulting pollution affects the quality of life of people in these areas. It also generates environmental costs and impacts on public health. Drought has resulted in increased dust generation in Western Africa and this affects not only the countries of the region but is believed to impact on climatic systems in the Carribean and may affect coral reef health.

These challenges compel the sub-region to implement strategies to reduce the risks and place value on the available potentialities.

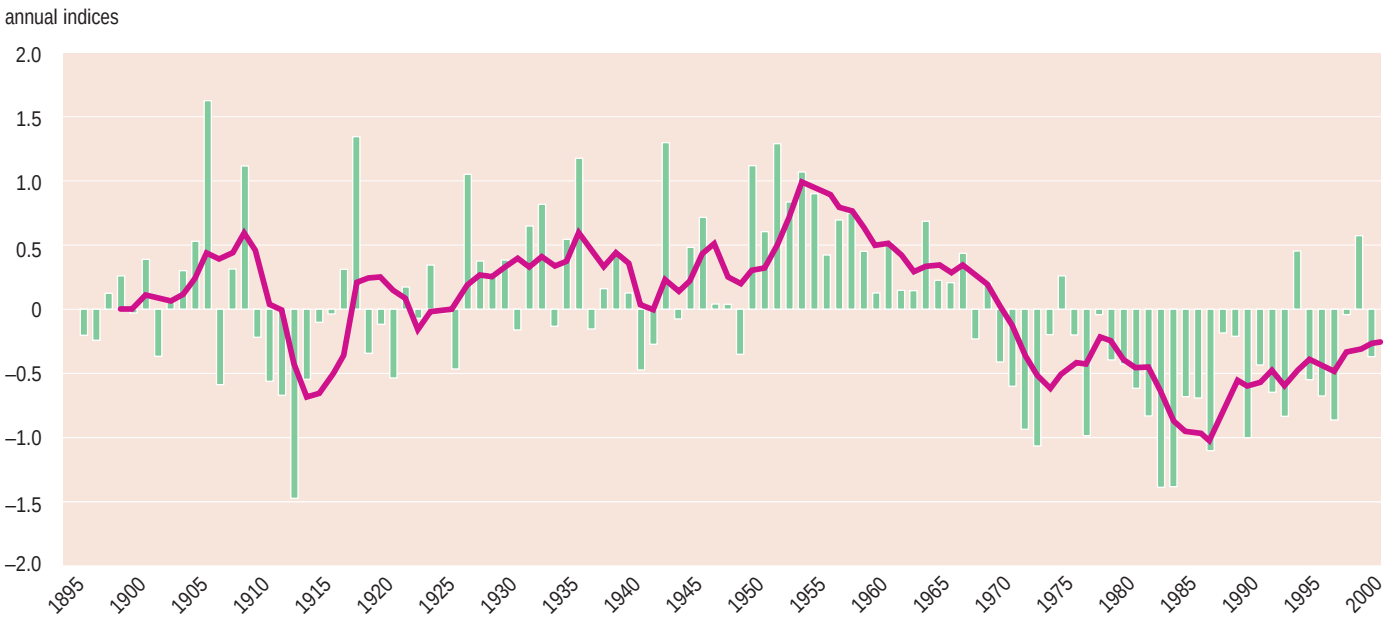
The utilization of renewable energy is still weak, but with effective policy interventions can increase in the short term. Wind and solar energy is still underexploited.

Greenhouse gas emissions affect climate variability and contribute to climate change in the long term. Climate variability is a major threat to the utilization of biomass energy. Climate is an important element of the capacity of land to produce in quantity and quality, and extreme climatic events (drought, floods, sand wind, etc) have important environmental and socioeconomic costs. Furthermore, global warming associated with GHG emissions has adverse effects on the climate. This can result in, for example, a reduction in the duration of the rainfall season.

Some adaptive measures to mitigate vulnerability to climate variability have been developed and are being implemented. These include measures to improve agricultural productivity through, for example, the setting up of integrated water resources management programmes and the selection of species that are not prone to drought.

Facing climate modification requires the strengthening of climatic forecast and early warning systems, especially given the probability of further deterioration of rainfall patterns. To avoid water unavailability that may result from this, water collection and management systems are set up for irrigation and for domestic use.

Figure 8: Annual index of rainfall in the Sahel region



Source: L'Hôte and others 2002

Addressing the challenges of climate change requires better implementation of the NEPAD climate change strategy, and specifically of projects dealing with:

- The elaboration of decision-making tools for assessing the vulnerability to climate;
- The promotion of initiatives and strategies to capitalize renewable energies; and
- The assessment of the synergetic effects of adaptation and mitigation activities through agroforestry pilot projects.

WESTERN INDIAN OCEAN ISLANDS

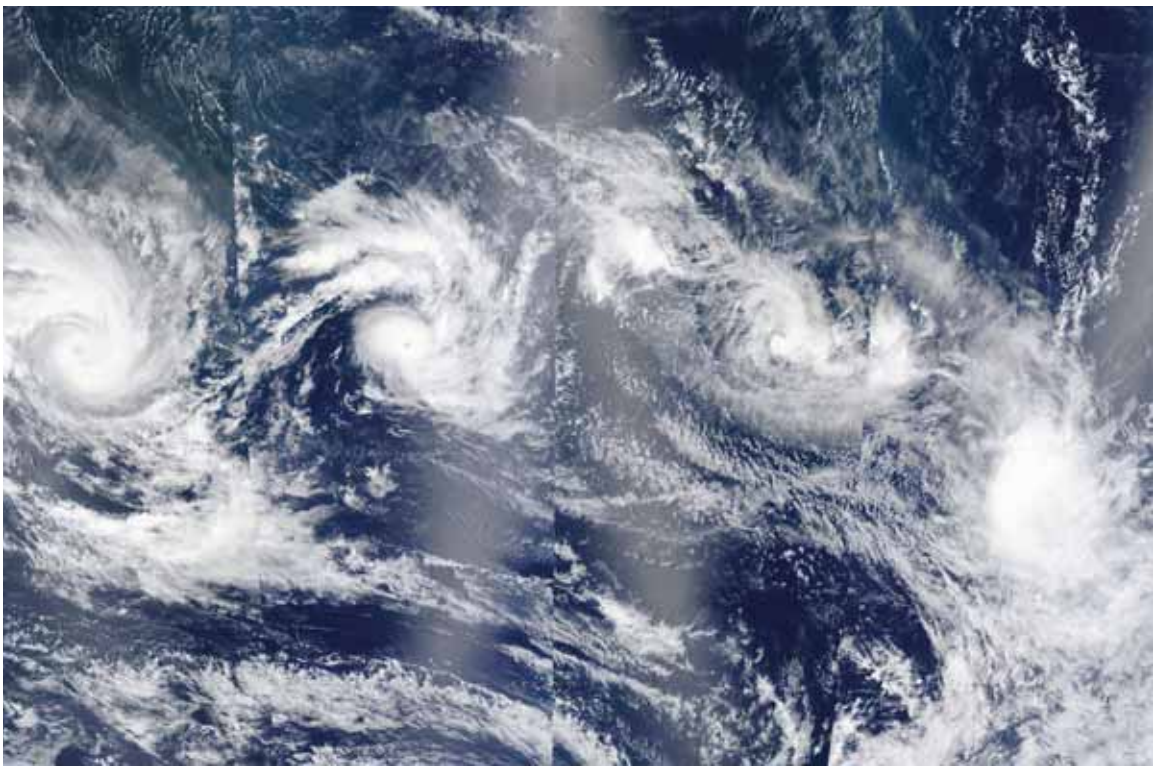
One of the most important assets for the Western Indian Ocean (WIO) states is its climate, which supports the evolution of a wide diversity of ecosystems and helps to promote socioeconomic activities such as agriculture, fisheries and tourism. This favourable climate is at risk, however, from external and internal stresses. The sub-region is already experiencing the negative impacts of global warming. Although the emission of GHG is small, industrialization and urbanization are contributing to deterioration of the state of the atmosphere. Many of these effects are long-term, and possibly irreversible, with adverse social and economic consequences. Climate variation affects the potential to attract tourists, the capacity for agriculture and the propensity for disease.

Madagascar experiences serious periods of both drought and torrential rain. The high humidity, coupled with large areas of stagnant floodwater in the summer months, can promote malaria. Malaria, once endemic in Mauritius, has now been eradicated by a sustained, integrated programme of prevention, early detection and effective treatment.

All WIO countries suffer from water scarcity and this is exacerbated by the increasing demand from agriculture and tourism, particularly in Mauritius and the Seychelles.

The high percentage of warm and wet days in Mauritius has proved well-suited to the production of sugar cane. September, October and November have the lowest rainfall, fewest wet days and a temperature range more comfortable for the European tourists.

Two important climate systems affecting the WIO islands are the ITCZ and the Indian Ocean Dipole. The ITCZ, which is the breeding ground for tropical cyclones,



Cyclones are an important feature of weather patterns for the WIO islands
Multiple cyclones in the Indian Ocean, 12 February 2003. The cyclones pictured are (west to east) Gerry, Hape, 18S (later named Isha) and Fiona.

Source: Earth Observatory/NASA

Table 3: Passenger motor vehicles per thousand population, Western Indian Ocean countries, Africa and North America 1990 and 2001

	Passenger motor vehicles per thousand population	
Countries/regions	**1990**	**2001***
Madagascar	4	4
Mauritius	43	77
Seychelles	95	104
Africa	15	17
North America	692	749

** or latest year*

Source: UNEP 2005b

also gives rise to heavy rainfall over the Seychelles during the summer months (November to April) when it oscillates around the latitude of 8°S. In March 2005, the Mascarene Islands experienced record rainfall as the ITCZ oscillated much further south for days, causing widespread flooding and accumulation of water with increased mosquito breeding and sanitation problems. When the Indian Ocean Dipole occurs at the same time as the ENSO event, changes are produced in the patterns of circulation of the air and sea across the Indian Ocean, affecting temperature and rainfall across the sub-region. However, further studies are necessary to confirm the nature and extent of the impact of these phenomena on cyclone formation and climate generally. The ENSO is predicted to become more frequent with global climate change, and expected to cause important disruption in coastal processes. Coral bleaching events may become more frequent and severe, as the climate continues to warm, exposing coral reefs to an increasingly hostile environment. In the 1997-98 El Niño event, coral reefs in the Indian Ocean suffered extensive and severe bleaching.

There are widespread socioeconomic impacts of abnormal weather. Records show that in the period 1951-2004, windstorms accounted for 80 per cent of the deaths from natural disasters. Although the Seychelles lie outside the cyclone belt, these islands are experiencing an increasing frequency and intensity of storms. In August 1997, extreme rainfall conditions led to floods and landslides causing damage to more than 500 houses and almost 40 per cent of public roads. A similar event in September 2002 hit the island of Praslin, the second largest island in the Seychelles, destroying over 25 000 trees, and causing damage to housing and infrastructure with a total estimated loss of US$87 million.

The future likely impacts of climate change and sea-level rise in the WIO countries include coastal erosion, droughts, coral bleaching, more mosquito-borne disease, saline intrusion into water sources, flooding, storm surges, and greater water scarcity in the face of increasing demand. October 2004 was the warmest month of the year recorded in the WIO countries since the industrial revolution. This followed October 2003 which was the warmest October ever recorded in Mauritius. Building resilience against climate change requires establishing special funds and making new investments.

The prevalence of passenger motor vehicles and CO_2 emissions are rising steadily in the more developed of the WIO countries, and at much higher rates than for Africa as a whole. Whilst these levels remain substantially below those reported for North America, the trend presents a growing threat to both livelihoods and to health, in terms of road congestion, increasing travel times, higher transport costs and air pollution.

The WIO countries have established environmental programmes and developed policies to integrate climate-related concerns in their political agendas. All WIO countries have submitted their first National Communication within the framework of the UNFCCC, and some are in the process of preparing their second National Communication.

Initiatives to reduce air pollution and promote greater efficiency in energy generation and use require a variety of educational and other measures in the public and the private sector. These include the

Table 4: CO_2 total emissions WIO countries, Africa and North America per head per year (metric tonnes) 1982[1] and 2001[2]

Countries/regions	1982	2001
Comoros	0.1	0.12
Madagascar	0.18	0.14
Seychelles	0.61	2.44
WIO countries	0.22	0.31
Africa	1.11	1.04
North America	19.32	19.94

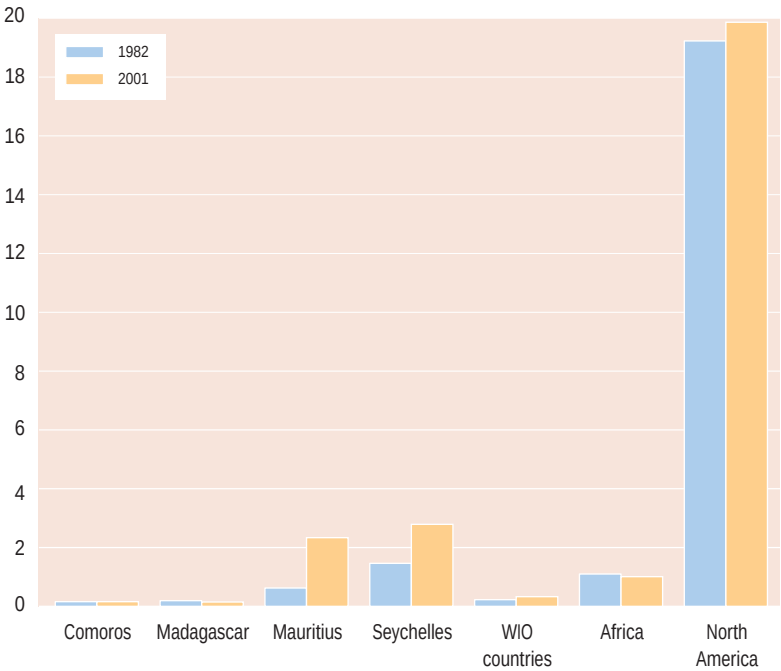
[1] or earliest reported later year

[2] or latest year

Source: UNEP 2005b

Figure 9: Comparison of emission levels

metric tonnes per head per year



Source: UNEP 2005b

promotion of low energy lighting, photovoltaic systems, solar water heating and solar wood drying kilns for timber treatment for construction, liquid propane gas (LPG) cookers for domestic cooking, solar street lighting, methane gas for energy production, ethanol as a partial fuel substitute, sugar cane bagasse for energy production, and wind-generated energy in, for example, Mauritius' outer island of Rodrigues. But these initiatives, with the exception of the use of bagasse, have yet to be developed as major programmes which benefit from standardization and economies of scale, in any of the countries. Both wind and solar equipment have to be made more robust against cyclone damage. Moreover, the public sector has yet to show a coherent, environmentally friendly approach to energy efficiency in the provision of its own services and in public contracts in building designs and materials for schools, hospitals and public sector housing.

CONCLUSION

Atmospheric resources are essential for the maintenance of life and human well-being, and they provide multiple opportunities for development. Atmospheric resources are transboundary resources and are affected by global, regional and national practices. The unsustainable management of these resources – at the global, regional, sub-regional and national levels – have implications for development and livelihoods in Africa. This is most acutely felt in activities directly dependent on natural resources and processes such as agriculture. Thus partnerships at multiple scales are critical to addressing the challenges and maximizing opportunities.

Policy interventions are necessary to remove barriers to investments in renewable energy resources and mitigation of impacts of climate change, extreme weather events and air pollution. Policy objectives should promote investments in businesses and projects which contribute to sustainable development whilst conserving the value and quality of atmospheric resources. African governments are called upon to bridge the gap between the existing information and policy actions. Policies should be translated into laws and regulations as a strategy to ensure implementation and smooth governance of the use of atmospheric assets.

Poor access to modern environmentally sound technologies, lack of capacity to develop or acquire technology, and restrictions imposed by developed countries, contribute significantly to denying African people the opportunity to use atmospheric resources. Barriers that contribute to low use of modern technologies in exploiting renewable energy resources include lack of information, high capital cost of renewable energy supply systems, the intermittent nature of renewable energy resources, site-specific constraints, and poor access to modern technologies.

Harmonizing policy interventions across sectors is critical given the close relationship between energy, consumption and production patterns, environmental management and climate change. This involves building cooperation between different stakeholders. The value of such an approach is discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*. Planning and setting clear targets is important, especially regarding a shift to renewable energy. Formulating and enforcing standards in relation to equipment as well as pollution is crucial. The implementation of MEAs through policies and programmes designed to meet their objectives and targets can be an important complement to national activities. These MEAs include UNFCCC and its Kyoto Protocol, as well as the Montreal Convention.

Developing capacity for early warning systems is crucial given the wide-ranging impacts of climate variability. This must be coupled with effective response systems.

The key to successful policy interventions is political will, as expressed in the following quote:

> "The reductions in poverty in both countries [India and China] are primarily the result not of the policies of the global great and good, or of the charity of rich countries, but of better domestic government – including the provision of basic education and health care and, crucially, the freeing up of markets. In both countries, even better government would reduce poverty further. For instance, corruption remains rife in both countries, and has a particularly severe impact on the poor by depriving them of needed services and raising their cost of access to markets and to finance" (Economist 2004).

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CHAPTER 3
LAND

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REGIONAL SYNTHESIS

Africa is the second largest continent in the world after Asia, and with a total land area of more than 3 025.8 million ha, its landmass is more than three times that of the United States of America. Of Africa's 53 countries, Sudan is the largest, covering 250.39 million ha and Seychelles the smallest, covering only 45 600 ha (Global Geografia undated). In terms of population density, Mauritius was in 2001 the most densely populated with 583 people/100 ha, compared to Namibia, the least densely populated at 2 people/100 ha (Global Geografia undated).

OVERVIEW OF RESOURCES

The African landscape is a rich and dynamic mosaic of resources, which includes forests and woodlands, arable land, mountains, deserts, coastal lands and freshwater systems, that holds vast opportunities for development and improving human well-being if managed sustainably.

Forests and woodlands

Forests and woodlands cover about 650 million ha or 21.8 per cent of the land area (FAO 2003). About 16.8 per cent of global forest cover is found in Africa, with the Congo basin home to the second largest contiguous block of tropical rainforest in the world (FAO 2003). Chapter 6: *Forests and Woodlands*, provides a more comprehensive analysis of the resources and opportunities they provide for sustainable development in Africa.

Arable land

About 630 million ha of land in Africa is suitable for cultivation, supporting the majority of the people through subsistence and commercial agriculture. Agricultural productivity is closely linked to environmental factors, including soil quality and water availability.

Agriculture makes an important contribution to earnings. In Morocco, for example, the agricultural sector was worth US$7 000 million in 2002, of which US$1 000 million was export earnings (FAO 2004b).

Africa's soils are classified into six different categories, with the first four being of good quality which unfortunately cover only 10.6 per cent of the land area or 3 100 million ha and support about 400 million people (Reich and others 2001). Classes I-IV do not have major constraints and rainfall is usually stable and adequate for at least one major crop per season. However, Classes V-VI of the soils in Africa are of poor quality and have limitations which make low-input agriculture on which many people depend a challenge. Classes V-VI soils are highly acidic, impermeable, frequently waterlogged, easily accumulate salts, and require major investments to manage. They cover 11 200 million ha and support about 200 million people, that is about 23 per cent of the population (Reich and others 2001).

Wetlands

Wetlands cover about 1 per cent of the region's total surface area, and are found in virtually all countries. Some of the more prominent wetlands include the Congo Swamps, the Chad Basin, the Okavango Delta, the Bangweulu swamps, the floodplains and deltas of the Niger and Zambezi Rivers, and the Greater St Lucia Park wetlands in South Africa. In 1999 the Okavango Delta, which covers 6.864 million ha of Botswana's land area, constituted nearly 10 per cent of the total area of the world's wetlands protected under the Ramsar Convention and almost 50 per cent of the area designated in Africa (Frazier 1999).

Wetlands are not only critical in terms of biodiversity but also support many communities, providing a diversity of livelihood activities. For example, in

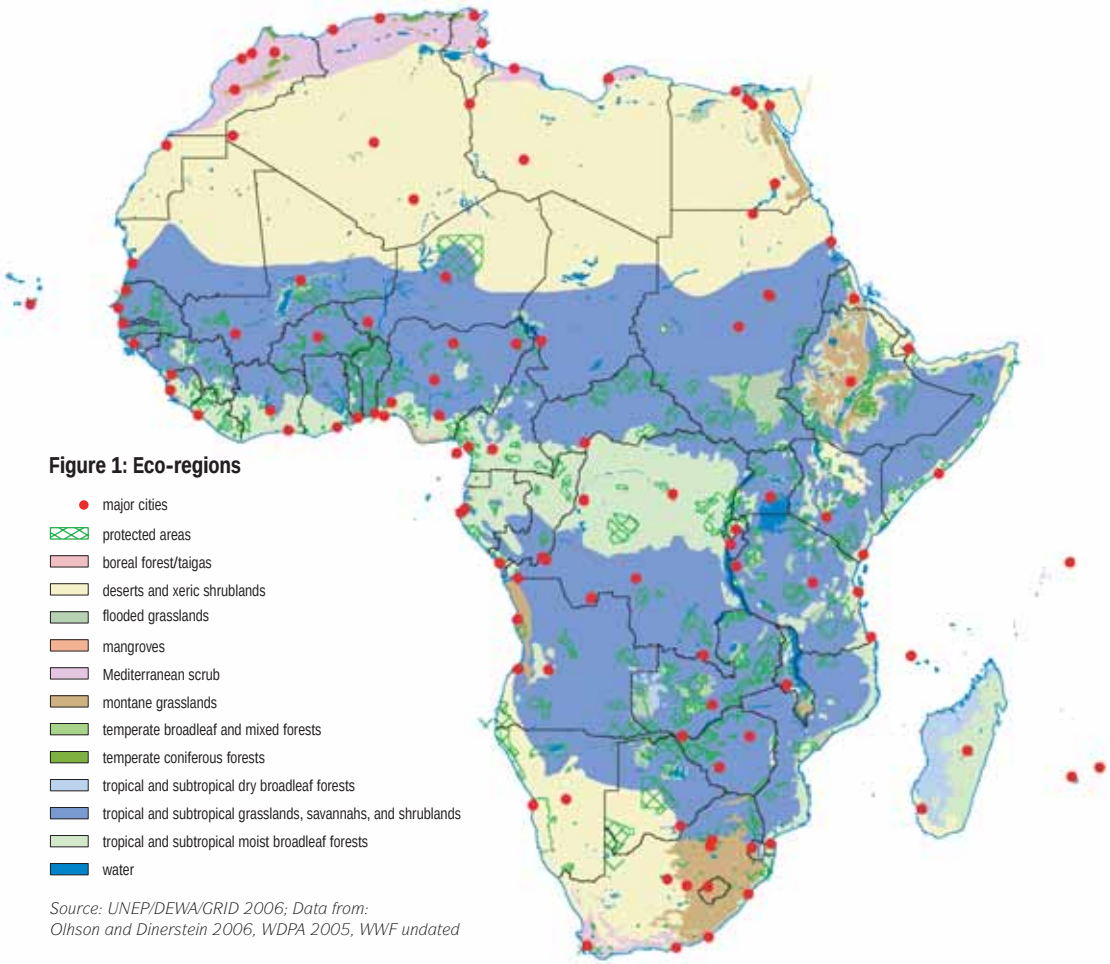


Figure 1: Eco-regions

Source: UNEP/DEWA/GRID 2006; Data from: Olhson and Dinerstein 2006, WDPA 2005, WWF undated

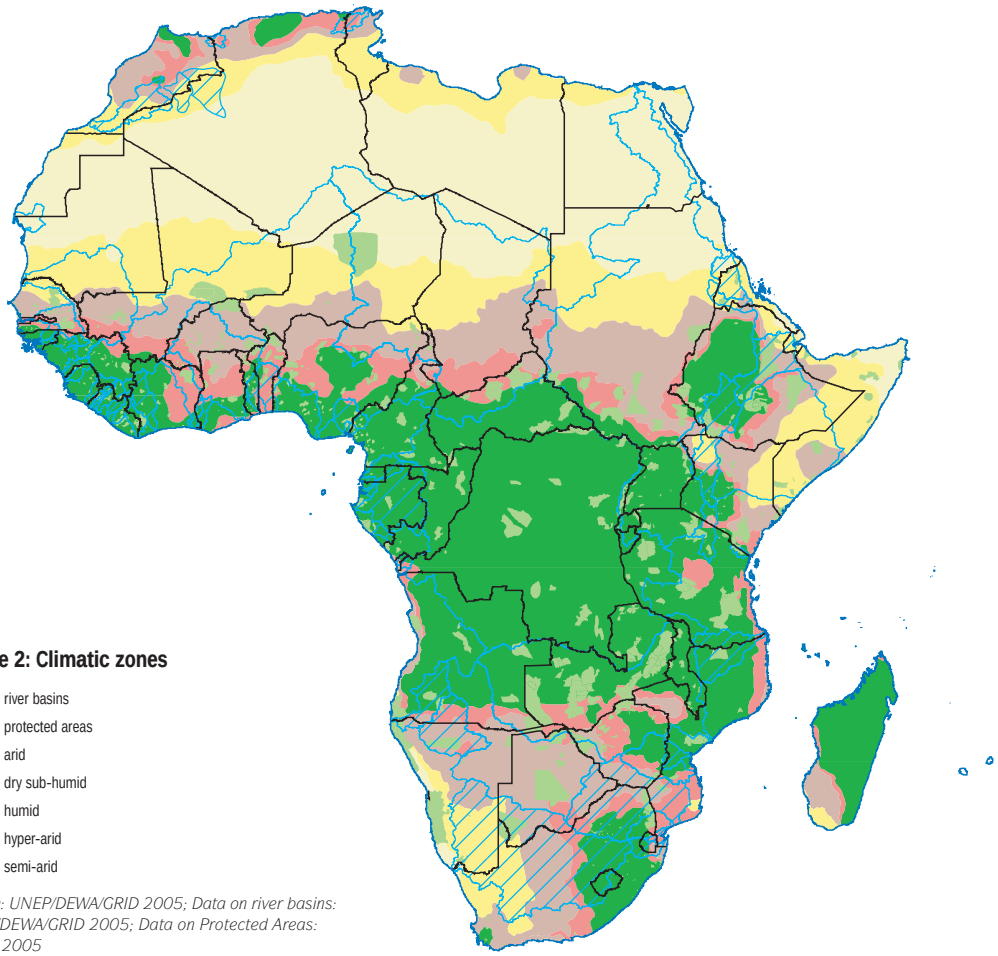


Figure 2: Climatic zones

Source: UNEP/DEWA/GRID 2005; Data on river basins: UNEP/DEWA/GRID 2005; Data on Protected Areas: WDPA 2005

Aerial view of islands and waterways of the Central Okavango Wilderness Area in the Okavango Delta, Botswana.

Source: M. Harvey/ Still Pictures

Tanzania's Rufiji Delta, a study covering 720 000 ha found that crop production has a gross market value of US$3.8 million annually, and natural resources have an economic direct use value of US$10.3 million annually (Turpie 2000). Most coastal wetlands in Africa support mangrove forests, which extend from Senegal to Angola on the west coast and from Somalia to South Africa on the east coast. Fisheries in estuaries and lagoons, for example, contribute to national economies, accounting for more than three-quarters of fishery landings in Africa (UNEP 2003). Wetlands issues are analysed in more detail in Chapter 4: *Freshwater* and Chapter 5: *Coastal and Marine Environments*.

Mountains

Some of the physically smallest countries in Africa also have the highest percentage of mountainous areas. These include Lesotho, Rwanda and Swaziland. The three countries are in the top 20 countries in the world with the highest percentage of mountainous areas (Mountain Partnership 2001). African mountain ranges are the headwaters of most of the large African rivers such as the Nile and Tana Rivers. According to the Food and Agriculture Organization of the United Nations (FAO), one out of every two people worldwide drinks water that originates in mountains (FAO 2002a).

In terms of economic activity, mountains support forestry and tourism, as they support birdwatching, hiking and climbing, among other recreational activities. They are, therefore, key in both local and national economies. Mountain water generates hydroelectricity, facilitates industrial processes, and is critical in irrigated agriculture. Table 1 lists some of the highest mountain ranges in Africa.

Mountains in Africa have been described as "islands of high productivity in a continent where dryness and aridity are increasing at an alarming rate" (Njiro 1998). People also settle in mountain areas as the lowlands are difficult to manage due to poor soils and erratic rainfall patterns, and are usually home to pests such as mosquitoes and tsetse flies.

Mountains are also important biodiversity areas. Stretching across Tanzania and into Kenya, the Eastern Arc Mountains and coastal forests are recognized as one of 32 globally important "hotspots" for biodiversity. The Uluguru Mountains, for example, are renowned for biodiversity conservation and supply water to the capital, Dar es Salaam, whose population is between 3-4 million people (ACF 2004). More than 100 000 of the Luguru people live on the mountains and grow crops through much of the year, including fruits and temperate vegetables. Their produce is sold to urban residents in the lowlands (ACF 2004).

Table 1: Some selected mountain ranges in Africa

Mountain	Mountainous chain	Height (m)	Countries
Kilimanjaro	Rift Valley	5 895	Tanzania
Mount Kenya	Rift Valley	5 199	Kenya
Ruwenzori	Mitumba Mountains	5 119	Uganda/ Dem. Rep. of the Congo
Ras Dascian	Simen Mountains	4 620	Ethiopia
Karisimbi	Mitumba Mountains	4 507	Rwanda
Jebel Toubkal	Haut Atlas	4 167	Morocco
Mont Cameroun	Adamoua	4 070	Cameroon
Thabana Ntlenyana	Drakensberg	3 482	Lesotho
Injasuti	Drakensberg	3 446	South Africa
Emi Koussi	Tibesti	3 415	Chad
Kinyeti	Al Istiwa'iyah	3 187	Sudan
Jabal Marrah	Jabal Marrah	3 088	Sudan
Piton des Neiges	Réunion Island	3 069	Réunion (France)
Pico de Santa Isabel	Bioko Island	3 008	Equatorial Guinea
Satipwa Peak	Mulanje Mountains	3 002	Malawi
Tahat	Ahaggar	2 918	Algeria
Maromokotro	Tsaratanana	2 876	Madagascar
Pico de Fogo	Fogo Island	2 829	Cape Verde
Jabal Hamoyet	Red Sea Hills	2 780	Eritrea
Serra Môco	Planalto do Bié	2 620	Angola
Mount Brandberg	Namib Desert	2 606	Namibia
Nyangani	Manicaland Mountains	2 593	Zimbabwe
Surud Ad	Cal Madow	2 408	Somalia
Kartala	Grande Comore Island	2 361	Comoros
Mount Gréboun	Aïr Azbine	2 310	Niger
Makutu Mountains	Makutu Mountains	2 164	Zambia
Musa Ali	Danakil Mountains	2 063	Djibouti/Eritrea/Ethiopia
Vogel Peak	Shebshi Mountains	2 042	Nigeria
Pico de São Tomé	São Tomé Island	2 024	São Tomé and Príncipe
Bintimani	Loma Mountains	1 948	Sierra Leone
Emlembe	Lebonboberge	1 862	Swaziland
Nimba Mountains	Nimba Mountains	1 752	Côte d'Ivoire/Guinea
Mont Iboundji	Massif du Chaillu	1 575	Gabon

Source: Global Geografia undated

Deserts

A total of 1 274 million ha in Africa are extreme deserts, exemplified by the Sahara Desert in Northern Africa – the largest desert in the world – and the Kgalagadi Desert and the Namib Desert in Southern Africa. The Sahara covers 906.5 million ha and is home to about 2 million people excluding those in the Nile valley (The Columbia Encyclopaedia Sixth Edition 2003). At about 26 million ha, the Kgalagadi Desert is about the size of France, and together with Namibia's Skeleton Coast, is the world's largest body of sand (Linacre and Geerts 1998). Along Namibia's coastal areas, the desert is commonly referred to as the Namib Desert (GraphicMaps.com undated).

Desert ecosystems support distinctive plants and animals specially adapted to the harsh environment. Even though the Sahara has one of the harshest climates in the world, the inhabitants produce date palms, fruits, vegetables, grains and other crops. Huge oil and gas deposits also exist in Algeria and Libya (The Columbia Encyclopaedia Sixth Edition 2003).

Endowment and opportunities

Africa has priceless land resources which provide environmental goods-and-services from local to global levels. Land resources are terrestrial features that exist above the mean sea level. They include landforms such as plains, valleys, plateaux, mountains, deltas and peninsulas, islands and basins; soils; and plants and animals. In terms of economics, land resources also include mineral and fossil fuel deposits, natural and farmed timber, crops, animals and fish (Hamblin 1998).

Land is a critical factor in natural and human-managed production systems, influencing the level of natural capital, and social and economic development. These resources are just as important at the household level as they are at national and global levels. In Uganda, for example, land constitutes between 50-60 per cent of the asset endowment of the poorest households (World Bank 2003a).

Land in Africa is used for many activities: agriculture and forestry; urban expansion and infrastructural development including transportation; mining and oil extraction; tourism and recreation; and also as a sink for domestic and industrial waste. It is critical in the cradle-to-grave cycle of both living and non-living things, providing habitats and other ecological goods-and-services, sustaining investment and human livelihoods, and absorbing solid and liquid waste, pollutants and pesticides.

Land is critical to all aspects of human well-being. It provides material resources for livelihoods, food and health, provides security against environmental shocks and future uncertainties, and underlies many social and cultural systems. Access to land and the resources it offers is at the core of enhancing opportunities and choices, particularly for those who depend more directly on it.

Africa's significant land resources can contribute to sustainable development, and to achieving the targets under all the eight Millennium Development Goals (MDGs). (The MDGs and their targets are set out in Annex 1). Whether in pristine condition or degraded, land resources provide vast opportunities for investment for internal and external investors. The degraded lands can be restored in some cases or converted to other land uses, and thus still contribute to development. Through careful planning, degraded lands can be used and thus avoid the need for conversion of well-conserved land to other uses, such as settlement.

Land-use decisions from the household to the national level, in rural and urban areas, have a major role to play in sustainable development, influencing environmental governance and thus resource sustainability. Tenure regimes, access and equity issues, poverty alleviation and gender dimensions all shape governance and the opportunities available at different levels. Governance today will have important implications for the opportunities of future generations, either enhancing or foreclosing choices.

Land and its value are closely related to the environment, with the sustainability of one being a product of the other. The value of land resources is not only monetary but also includes values such as ecosystems function and non-use values. Such non-use values, as shown in Table 2, include intrinsic significance in terms of culture, aesthetic, heritage and bequest. Some of these values are shown in Table 2. A broad methodology for the valuation of environmental goods-and-services is described in Chapter 1: *The Human Dimension*.

Land resources are terrestrial features that exist above the mean sea level. They include landforms such as plains, valleys, plateaux, mountains, deltas and peninsulas, islands and basins; soils; and plants and animals. In terms of economics, land resources also include mineral and fossil fuel deposits, natural and farmed timber, crops, animals and fish.

Hamblin 1998

Agriculture

Agriculture is a crucial economic activity, providing employment and livelihoods for many and serving as the basis for many industries. About 203 million people or 56.6 per cent of the total labour force engaged in agricultural labour in 2002 (FAOSTAT 2004). In most African countries, agriculture supports the survival and well-being of up to 70 per cent of the population (ECA 2004c). Thus, for many, their livelihoods are directly affected by environmental changes, both sudden and gradual, which impact on agricultural productivity.

Livestock and environmental goods offer some security from such shocks. About 70 per cent of the rural poor in Africa own livestock (ILRI 2004) contributing significantly to household and community resilience to disasters, particularly in arid and semi-arid zones. More than 200 million people rely on their livestock for income (sales of milk, meat, skins) and draught power. Overall, livestock contributes about 30 per cent of the gross value of agricultural production in Africa (ILRI 2004). According to the International Livestock Research Centre (ILRI) (2004), opportunities

Box 1: Land use issues key to sustainable development

Land lies at the heart of achieving sustainable development:

- It is a multidimensional store of value capable of yielding a stream of economic, social, environmental and cultural benefits indefinitely into the future.
- People are central, including those who "own" the land or property rights.

Source: IIED and WBCSD 2002

Table 2: Land and land-based ecosystems

Direct values Consumptive and non-consumptive use of resources:	Indirect values Ecosystem functions and services such as:	Option values Premium placed on possible future uses, including:	Non-use values Intrinsic significance in terms of:
Domestic use	Land quality	Pharmaceutical	Culture
Industrial input	Soils	Agricultural	Aesthetic
Commercial use	Micro-organisms	Industrial	Heritage
Mining	Water flow	Mining	Bequest etc.
Oil extraction	Water storage	Tourism	
Growing crops	Water recharge	Forestry	
Human settlements	Flood control	Human settlements	
Wood fuel	Storm protection	Leisure etc.	
Wild plants	Nutrient retention		
Wild animals	Moisture retention		
Tourism	Microclimate		
Waste disposal etc.	Natural sink etc.		

Source: Adapted from Hirji and others 2002

exist to commercialize livestock production to target regional deficits in livestock products where they can be produced competitively.

The irony is that, despite the majority of the total labour force working in agriculture, the region is still unable to feed its growing population. For example, between 20 and 75 per cent of the population in 29 countries in Central, Western, Eastern and Southern Africa were reported in 2004 to be undernourished (WFP 2003). In the Democratic Republic of the Congo (DRC), where 75 per cent of the total population of 51 million people were reported to be undernourished, 50 per cent of infant mortality is related to malnutrition (WFP 2003). Poor nutrition impacts on health, education and the opportunity to participate fully in community and public affairs. Most often women and children carry a disproportionate burden from food insecurity.

Africa spends between US$15 and 20 000 million on food imports annually, in addition to the US$2 000 million it receives in food aid annually (ECA 2004a). These are vast amounts of money that the region can ill afford to externalize, and which could be used to revitalize agriculture, particularly the low-input agriculture whose yields are limited, and thus increase productivity. About 70 per cent of Africa's poor, and at least two-thirds of its population, live in rural areas (ECA 2004a) depending mainly on agriculture and natural resources for their livelihoods.

Agriculture provides the opportunities to address extreme poverty in Africa, where the proportion of people living below the poverty line, of less than US$1 a day, increased from 47.6 per cent in 1985 to 59 per cent in 2000 (ECA 2004a). As a result, more and more people in Africa have limited access to food and other basic amenities such as potable water, minimum health care and education, effectively limiting the opportunities available to them. Poverty and nutritional status are closely linked. About 26 per cent of the people in Africa – more than 200 million people, particularly women and children – are undernourished (ECA 2004a); this is a reflection of poverty (FAO 2002c). It deepens other

Clear-felling of forests for agriculture, post-conflict Liberia, May 2005.

Source: Y. Katerere

Box 2: Food for thought

- Agriculture in Africa accounts for about 60 per cent of the total labour force, 20 per cent of total merchandise exports and 17 per cent of GDP.
- Between 1997 and 1999, about 200 million people – or 28 per cent of Africa's population – were chronically hungry, compared to 173 million in 1990-92.
- Only 10 countries reduced the number of the hungry during the 1990s. At the end of the 1990s, 30 countries had over 20 per cent of their population undernourished, and in 18 of them, more than 35 per cent of the population were chronically hungry.
- As of 2001, about 28 million people in Africa were facing food emergencies due to droughts, floods and strife, of which some 25 million needed emergency food and agricultural assistance.
- The World Food Programme – which accounts for two-fifths of international food aid – has spent US$12 500 million (45 per cent of its total investment since its establishment) in Africa and 50 per cent in 2001. In 2000, Africa received 2.8 million tonnes of food aid, which is 25 per cent of the world total.
- Africa spent an estimated US$18 700 million on food imports in 2000 alone. Imports of agricultural products have been rising faster than exports since the 1960s, and Africa as a whole has been a net agricultural importing region since 1980.
- Agriculture-led development is fundamental to cutting hunger, reducing poverty (70 per cent of which is in rural areas), generating economic growth, reducing the burden of food imports and opening the way to an expansion of exports.
- A mere 7 per cent (barely 3.7 per cent in sub-Saharan Africa) of Africa's arable land is irrigated, compared to 10 per cent, 29 per cent and 41 per cent for South America, East and Southeast Asia and South Asia respectively.
- Soils covering 38 per cent of the region are classified as having low nutrient reserves.

Source: NEPAD 2002

aspects of poverty such as incapacity to work and resistance to disease. It also affects children's mental development and educational achievements.

Agriculture is not limited to subsistence food crops and livestock production but includes crops grown for sale, such as tobacco, cotton and flowers. Most agricultural households rely to some extent on sale of agricultural products. Thus, access to markets, finance and supporting infrastructure are crucial.

Horticulture, which includes vegetables, fruits and cut flowers, has become a major activity. It has grown to be the single largest category in world agricultural trade, accounting for over 20 per cent of such trade in recent years (World Bank undated). While in sub-Saharan Africa (SSA), horticultural exports now exceed US$2 000 million, this is only 4 per cent of the global total (World Bank undated). Significant opportunities for expansion, therefore, exist in Africa to boost employment as well as foreign currency earnings. The challenges would be to adequately deal with environmental problems, which include pollution from chemicals.

An opportunity which is yet to be fully exploited is irrigated agriculture. Only 6 per cent of the total cultivated land is under irrigation in Africa, compared to 33 per cent in Asia (FAO 2002a). In a region where droughts are prevalent, often destroying crops and exacerbating food insecurity, irrigation could be a key factor in enhancing food security. Irrigation increases yields of most crops by between 100 and 400 per cent, and it has been projected that in the next three decades, 70 per cent of gains in cereal production globally would be from irrigated land (FAO 2002a). According to the Economic Commission for Africa (ECA) (2004), little progress towards sustainable development can be achieved until Africa reaches a minimum level of developing and managing water resources for secure food and agricultural production. The potential for and the challenges related to irrigation are more fully discussed in Chapter 4: *Freshwater*.

In order to maximize the potential of the agricultural sector, institutional and governance reforms which increase opportunities for rural people, such as better access to finance, and support the development of small and microenterprises is essential. Agricultural opportunities are closely linked to global trade policies and practices. These are discussed in Chapter 1: *The Human Dimension* and opportunities to respond effectively to these are considered in Chapter 8: *Interlinkages: The Environment and Policy Web*.

Taking action in the agricultural sector

Various policy responses have been proposed to reverse the slide in agriculture and help boost production and enhance food security. One of the major responses is the Comprehensive Africa Agriculture Development Programme (CAADP), which was endorsed by African governments in late 2002 in the context of the New Partnership for Africa's Development (NEPAD). The CAADP has three immediate "pillars" and a long-term one which together can help tackle Africa's agricultural crisis (NEPAD 2002). The mutually reinforcing pillars on which to base the immediate improvement of agriculture, food security and trade balance are:

- **Extending the area under sustainable land management and reliable water control systems.** Building up soil fertility and the moisture-holding capacity of agricultural soils, and rapidly increasing the area under irrigation, especially small-scale irrigation, will not only provide farmers with

Irrigation can increase crop yields and food security.

Irrigation. Large-scale farming in south-western Burkina Faso.

Source: D.Tiveau/CIFOR

Smallholder farming using furrow irrigation, Burkina Faso.

Source: Y. Katerere

opportunities to raise output on a sustainable basis, but will also contribute to the reliability of food supplies.

- Improving rural infrastructure and trade-related capacities for market access. Roads, storage, markets, packaging and handling systems, and input supply networks should be improved to raise the competitiveness of local production vis-à-vis imports and export markets.
- Increasing food supply and reducing hunger. Several factors including the limited use of irrigation and other inputs undercut crop and livestock yields. There is a need to improve access to technology by small farmers. These can play a major role in increasing food availability close to where it is most needed, raising rural incomes, and expanding employment opportunities and contributing to growth in exports. Food storage and its protection from mildew and pests are of critical importance. It is also important to respond to the growing frequency and severity of disasters and emergencies which impact on food security. In addition, conflict and war also disrupt food production. As a result, more aid is being diverted to emergency relief than to necessary long-term development.
- Agricultural research, technology dissemination and adoption, is the long-term pillar to achieve accelerated gains in productivity and requires:
  a) enhanced rate of adoption of the most promising available technologies by linking, more efficiently, research and extension systems to producers;
  b) technology delivery systems that quickly bring innovations to farmers and agribusinesses through appropriate use of new information and communication technologies;
  c) renewing the ability of agricultural research systems to efficiently and effectively generate and adapt to Africa's new knowledge and technologies, including biotechnology; and
  d) mechanisms that reduce the costs and risks of adopting new technologies.

It was estimated that a budget of US$251 000 million for the period 2002-2015 was needed to successfully implement these four pillars. If Africa were to invest in agriculture the total of about US$22 000 million (ECA 2004a) it spends annually on food imports and food aid, it would take the region less than a decade to implement the four proposed agricultural pillars highlighted in the CAADP.

The CAADP budget is slightly less than Africa's total debt of over US$292 000 million for the period 2000-2002 (UNCTAD 2004). Africa's debt burden has been described as a major obstacle to the region's economic growth and poverty reduction, threatening efforts to meet the MDGs, particularly that of halving poverty by 2015 (UNCTAD 2004).

Settlement, urban expansion and infrastructural development

African society is rapidly changing from rural to urban, with cities and towns expanding, not only in terms of population growth, but also spatially. They are taking up more space and encroaching on rural and agriculturally productive land. Globally, urban and built-up areas occupied in 1999 more than 471 million ha – about 4 per cent of the total land area (WRI and others 2000). Abidjan, for example, covered in 1999 more than 57 735 ha of which 36 003 ha, or 62 per cent of the area of the metropolis, was for natural spaces,

3 396 ha or 5.88 per cent was classified as urban land, 1 778 ha or 4.9 per cent of the city area was set aside for human activities and 2 825 ha for installations, excluding road networks (Attahi 1999).

One of the major impacts of urbanization in Africa is the increased generation of solid waste, which contributes to land conversion for landfills. For example, in the African Small Island Developing States (SIDS) of the Indian Ocean, at least 2.8 million tonnes of solid wastes are generated annually, of which only 30 per cent are collected routinely. Beach deposited rubbish is estimated to be about 40 640 tonnes per year (Payet and others 2004), threatening coastal ecosystems and undermining economic activities such as fisheries and tourism. The dumping of solid wastes in rivers, on beaches and in the sea has become common practice, particularly in the Comoros and Madagascar. However, such practices have been discontinued in Seychelles and Mauritius, both of which have adopted a national solid waste management plan. They have also invested in infrastructural development, with Seychelles spending between US$6-8 million in solid waste management over the last ten years (Payet and others 2004).

Urban settlements can offer important opportunities for trade, culture, education and development.

Market street in Essaouira, Morocco.

Source: J.C. Mohamed-Katerere

Downtown Antananarivo, Madagascar.

Source: V. Rabesahala

Despite the negative attributes of urbanization, these new and growing areas, which are located in coastal areas and the hinterland, have also become vibrant centres of education, culture, commerce and industry and technological innovation, providing opportunities for various manufacturing and service industries (WRI and others 2000).

Mining and oil extraction

Globally, mining has played a key role in driving the economic development of many countries in the world, including South Africa, Australia, Canada, Sweden and the United States. Many of the world's richest countries have extensive minerals industries, which they have used as a platform for broad-based industrial development (IIED and WBCSD 2002).

For a region rich in minerals, mining provides many opportunities to support sustainable development. The region contains about 30 per cent of the Earth's mineral reserves, including 40 per cent of gold, 60 per cent of cobalt and 90 per cent of platinum (UN 2002a). In the Southern African Development Community (SADC), for example, the mining industry contributes about 60 per cent of foreign exchange earnings, 10 per cent of Gross Domestic Product (GDP) and 5 per cent of employment (SADC 2004a). The economies of Angola, Botswana, the DRC, Namibia, South Africa, Tanzania, Zambia and Zimbabwe get between 22 per cent and 90 per cent of their foreign exchange directly from mining and mineral exploitation (Hounsome and Ashton 2001).

However, the environmental costs of mining can be massive in terms of land conversion and degradation, habitat conversion and groundwater pollution. A major by-product of large-scale mining is large volumes of waste and chemical pollution, which may have devastating impacts on ecosystems. Acid drainage has been described as the most pervasive problem associated with waste dumps (IIED and WBCSD 2002). The effects of mining and smelting that occurred over past decades, centuries, or even millennia prove that some impacts can be long-term, forcing society to continue to pay for natural capital stocks that have been drawn down by past generations. Due to the long-lasting impact of mining, many governments have, since the 1990s, enacted environmental impact assessment

Gold panning in Kalsaka Village, Yatenga Province, Burkina Faso.

Source: M. Edwards/Still Pictures

(EIA) policies and laws. This has helped countries to make a better evaluation of the benefits and costs associated with mining and to adopt measures to avoid and mitigate harmful impacts. (Chapter 8: *Interlinkages: The Environment and Policy Web*, examines the opportunities value of EIA in more depth). South Africa, for example, undertook an EIA of a proposed mining venture of titanium along the eastern shores of St Lucia, an area renowned as a valuable source of biological diversity. A review panel, which was charged to determine whether mining would be compatible with nature conservation and tourism, concluded that there was no compatibility. As a result, mining permission was refused and in 1999 the area was declared a World Heritage Site (IIED and WBCSD 2002).

Africa is a significant player in oil production. All sub-regions of Africa are crude oil exporters, except Eastern Africa, but this could change given the recent discovery of crude oil reserves in Sudan.

In 2003, Africa produced 8.7 million barrels per day (bbl/d) of oil with the top producers being Nigeria, Algeria, Libya, Angola and Egypt (Energy Information Administration 2005c). Total African oil consumption in 2003 was 2.7 million bbl/d and the top oil consumers were Egypt, South Africa, Nigeria, Libya and Algeria (Energy Information Administration 2005d). In 2002, South Africa was the largest net crude oil importer in Africa, followed by Morocco (Energy Information Administration 2005e).

In the Great Lakes countries of Burundi, Kenya, Rwanda, Tanzania and Uganda, oil consumption averaged about 91 000 bbl/d in 2001, virtually all imported. Kerosene is used extensively in rural areas for lighting and, in urban areas, for cooking and lighting (Energy Information Administration 2004).

Oil has been a key factor in the positive economic growth Africa has experienced, with key oil producers showing impressive growth: Chad grew at 39.4 per cent and Equatorial Guinea at 18.3 per cent (ECA 2005a). Similarly, the overall impressive growth rates in Central Africa and Northern Africa are directly linked to oil (ECA 2005a). The full potential of the oil resources, which fuelled economic development in these countries and the rest of the region, however, is yet to be realized. The irony is that in many cases, these resources have often contributed to environmental degradation and civil conflict. The challenges associated with managing natural resource abundance are discussed fully in Chapter 12: *Environment for Peace and Regional Cooperation*. An increasing number of countries are establishing governance and institutional systems that promote social investment. In Chad, for example, the government, in collaboration with the World Bank and non-profit organizations, agreed to ensure that oil

Box 3: Chad charts a new path in oil revenue management

The World Bank approved funding for the project in 2000 (see attached figure), and the government received its first US$38 million in oil revenues in 2004. Over the next two decades, the country expects to receive at least US$2 000 million, boosting national revenues by 50 per cent, according to the World Bank. About 80 per cent of oil revenues would be spent on schools, clinics, roads and other basic needs. Five per cent would be ploughed into a fund for future generations, and another 5 per cent would be used to develop the southern oil region, near the border with Cameroon. The remaining 10 per cent would be invested to absorb possible oil prices falls.

The World Bank has most of the revenue in a London account to avoid "leakage." A citizens' committee, with four members from non-profit groups and five from government, must approve all oil revenue expenditures. The World Bank has commended the establishment of the Committee of Control and Monitoring of the Oil Revenues. However, the project has not been without its critics. Damage to the environment has been a major concern.

Sources: MacLaughlin 2004, Tcheyan 2003

New oil venture in Chad provides opportunities.

revenues benefit poor people. This project faces various challenges regarding agreement on exactly which sectors should benefit from the profits.

Tourism and recreation

Land-based tourism is a major economic activity in Africa, drawing millions of visitors to different sites across the region every year and generating millions of dollars in foreign exchange earnings. Sites such as the pyramids of Egypt, the Great Rift Valley of Eastern and Southern Africa, Great Zimbabwe, Table Mountain in South Africa, Mount Kenya in Kenya and Mount Kilimanjaro in Tanzania are some of the major attractions. Mountains, wildlife, wetlands and coastal areas are also major tourist attractions. These and other attractions contributed to the arrival of a total of about 124 million international tourists in the five years of 1990, 1995, 2000, 2002 and 2003 (World Tourism Organization 2005). The visitors spent a total of US$52 891 million in those five years (World Tourism Organization 2005). In 2003 and 2004 the region attracted 78.1 million international tourists.

In 2004, international tourist arrivals grew at 10 per cent worldwide and 14 per cent in Africa – to 41.6 million, up from 36.5 million in 2003. However, the region shared only 7.4 per cent of the global increase of 69 million tourists, and almost all the increase was concentrated in Northern Africa (ECA 2005).

Ecotourism accounted for 20 per cent of total international tourism. In recognition of ecotourism's growth potential, particularly for developing countries, the UN Economic and Social Council (ECOSOC) declared 2002 the International Year of Ecotourism. Many countries in Africa, such as Kenya and South Africa, have invested heavily in ecotourism.

Tourism in Africa varies widely, from viewing gorillas in the Great Lakes Region to lemurs in Madagascar, from trekking in Ethiopia to birdwatching in Botswana, from looking at rock paintings in South Africa to visiting rainforests in Ghana, from mountain-climbing in Eastern Africa (Mt Kilimanjaro and Mt Kenya, for example) to scuba-diving in the Seychelles and to photographic safaris in Eastern and Southern Africa (Vieta 1999). In the Great Lakes Region, for example, revenue from tourism based on gorilla viewing and other activities brings in about US$20 million to the region annually (Pickrell 2004). Tourism in the area is certain to be boosted with the news in 2004 that the first census since 1989 revealed that the population of the apes in the Virunga mountains has grown by 17 per cent, increasing from 324 in 1989 to 380 by the end of 2003 (Pickrell 2004).

Tourism can serve as a powerful incentive to protect natural resources. In Madagascar, where tourism is the country's second largest foreign exchange earner, the country had by 1998 established 40 new protected areas, covering roughly 2 per cent of the country's land

Cultural heritage offers important opportunities for tourism.

Great Zimbabwe, Masvingo. Great Zimbabwe, one of the oldest preserved architectural monuments in Africa, are the ruins of an 11th -15th century kingdom, and a UNESCO World Heritage site.

Source: R. Giling/Still Pictures

area (Vieta 1999). In Southern and Eastern Africa, privately-owned protected areas that support tourism and hunting enterprises are also growing.

Tourism not only generates revenue to support conservation and management of natural environments but also generates many jobs. For example, hundreds of people live off the Bwindi Impenetrable Forest in Uganda, where foreign tourists trek to view gorillas. It has been argued that tourism has larger multiplier effects, with revenue spreading from hotel accommodation, food and beverages, shopping, entertainment and transport to income of hotel staff, taxi operators, shopkeepers and suppliers of goods-and-services (UN undated).

Despite the growth of tourism, the region still only accounts for less than 4 per cent of world tourism,

The Great Pyramids, Egypt, considered one of the Seven Wonders of the Ancient World, is a UNESCO World Heritage site.

Source: M. Chenje

with its revenue share at only 2.5 per cent – about US$16 000 million in 2002 of the annual sales of about US$4.5 million million (Saunders undated). Therefore, opportunities for further investment and development are vast in the region. In Kenya, for example, new regulations that will allow sport bird shooting are expected to attract up to 2 000 sport hunters annually, boosting revenues by US$5 million each year. New Kenya Wildlife Service (KWS) rules provide for

Table 3: International tourist arrivals and receipts

Year	1990	1995	2000	2002	2003
Arrivals (thousand)	15 160	20 438	28 154	29 492	30 763
Receipts (US$ million)	6 402	8 544	10 608	11 843	15 494

Source: World Tourism Organization 2005

Tourists at Bemaraha Tsingy, a UNESCO World Heritage site, Madagascar.

Source: R. Butler/ WildMadagascar

private landowners to obtain special authorization to manage their own game bird populations, including breeding, as well as determine open and closed seasons (African Environmental News Services 2003).

Several African countries including Ethiopia, South Africa, Kenya and Benin have significant palaeontology sites. In Ethiopia, the government is using these sites to promote "palaeo-tourism," and to generate revenue (IRIN 2004a). Ethiopia is home to some of the most famous prehistoric remains ever found, including some of the world's oldest human remains: Ethiopia's discoveries chart man's prehistory from more than 6 million years ago to modern ancestors (IRIN 2004a). Tourism officials in Afar believe that "palaeo-tourism" could generate an additional US$2 million in revenue annually for this region alone (IRIN 2004a). The Ethiopian Tourism Commission has reported that the sector generated more than US$77 million in 2003 (IRIN 2004a). This revenue is important in the fight against poverty and plays a key role in the government's poverty reduction strategy paper (PRSP). South Africa has also made palaeontology and other cultural heritage sites a focus of their tourism industry.

The tourism industry in Africa also has human and environmental costs, contributing to the displacement of communities and thus undermining rights and livelihoods, the generation of waste and pollution, and the unsustainable use of water. In Africa, for example, tourism's effects on indigenous peoples have been profound, with the eviction of communities from their lands, in addition to economic dislocation, breakdown of traditional values, and environmental degradation. Pastoralism has been attacked as primitive and destructive (Chavez 1999). The massive influx of tourists and their vehicles in the Masai Mara National Park in Kenya and in the Ngorongoro Conservation Area in Tanzania has destroyed grass cover, affecting plant and animal species in the area. Hotels have dumped their sewage in Masai settlement areas while campsites have polluted adjacent rivers (Chavez 1999). One emerging approach is to focus on promoting community conservation areas and also collaborative tourism initiatives in order to ensure greater benefits to communities. There are different levels of community participation, varying from passive participation to interactive decision making to community empowerment initiatives.

The challenge facing policymakers in this industry and other land-based activities is to critically assess the costs and benefits to ensure that all options are fully weighed and that the policy responses contribute to sustainable development and minimize overexploitation. Additionally, measures need to be adopted to ensure that the benefits associated with tourism are spread across society, and that those who are directly involved in conservation are rewarded for this.

Challenges faced in realizing opportunities for development

As already indicated, Africa is endowed with enough land to undertake small- and large-scale activities to strengthen household security, national development, transboundary cooperation and regional integration to transform trade, and create new opportunities for sustainable development which is sensitive to the environment and social and economic issues. There are, however, many threats and challenges which continue to undermine such progress, limiting its potential. These include pandemics such as HIV/AIDS, climate variability and change, extreme weather events such as drought and floods, ineffective land-use planning, land degradation and desertification, invasive alien species (IAS), limited or weak governance systems, corruption and greed, armed conflict and the attendant overexploitation of natural resources, and limited foreign direct investment (FDI). Limited domestic investment and wasted opportunities and loss of revenue due to leakage in sectors such as tourism are also important factors.

HIV/AIDS pandemic

One of the biggest threats to Africa's capacity to implement the necessary response measures to derive the most benefits from the opportunities available in terms of land is the HIV/AIDS pandemic.

About 70 per cent of the world's 42 million people with HIV/AIDS are in Africa, the worst region impacted by the pandemic. More than 25 million Africans have so far succumbed to the pandemic and more than 12 million children have been orphaned. The tragedy is that the very human resources upon whom Africa should depend to convert its land resources into opportunities for sustainable development are being buried in millions every year. About 2.3 million Africans – men and women, and most of them in the prime of their lives as parents and workers – die each year (World Bank undated).

No economic sector in Africa is spared, and this is Africa's greatest tragedy of the 21st century which threatens sustainable development in the region. Box 4 illustrates some impacts of HIV/AIDS in the agricultural sector in Africa:

Other diseases

Malaria, water-borne diseases, tuberculosis, childhood diseases, tropical diseases, respiratory and nutrition-related diseases are also significant contributors to death (WHO 2004). All diseases affect well-being and labour productivity – some fundamentally undercut production systems. The environment-health connection and its implications for well-being and livelihoods are discussed in Chapter 1: *The Human Dimension*.

The tsetse fly is a major threat to people and livestock. About 60 million people in the region are at risk from Human African Trypanosomiasis (HAT), or sleeping sickness, which is spread by the tsetse. Sleeping sickness is found in 36 countries in sub-Saharan Africa. Between 300 000-500 000 cases are reported annually, and it kills about 66 000 people annually (WHO/TDR 2002). The WHO/Special Programme for Research and Training in Tropical Diseases (TDR) reports that although 55 million people are exposed to the risk of infection, only 4 million are under regular surveillance (WHO/TDR and Trends in Parasitology 2002), and the disease has re-emerged since the 1970s (WHO/TDR 2002). In 2002, there were 24 000 deaths from trypanosomiasis (WHO 2004). Authorities often lack, or do not have, adequate economic resources to fund programmes to control sleeping sickness due to competing health priorities. Governments often accord sleeping sickness a low priority, until it assumes the level of an epidemic (TDR/Scientific Working Group 2003). In some countries, sleeping sickness is a major cause of death. In some areas of Angola, the DRC and southern Sudan, its

Box 4: HIV/AIDS and agriculture in Africa

- HIV/AIDS has killed about 7 million agricultural workers since 1985 in the 25 hardest-hit countries in Africa. About 16 million more could be killed before 2020.
- The most badly affected African countries could lose up to 26 per cent of their agricultural labour force in two decades.
- Food consumption has dropped by 40 per cent in homes afflicted by HIV/AIDS.
- A meagre US$150 million is spent every year in Africa on HIV/AIDS, largely for prevention.
- In 2000, about 3 million people died of HIV/AIDS and 5.3 million people became infected around the world.
- By 1999, there were 13.2 million HIV/AIDS orphans, 95 per cent of them in sub-Saharan Africa.
- HIV infection rates are three to five times higher in young women than in young men.

Source: FAO 2002b

prevalence is between 20 and 50 per cent (WHO 2001), surpassing that of HIV/AIDS.

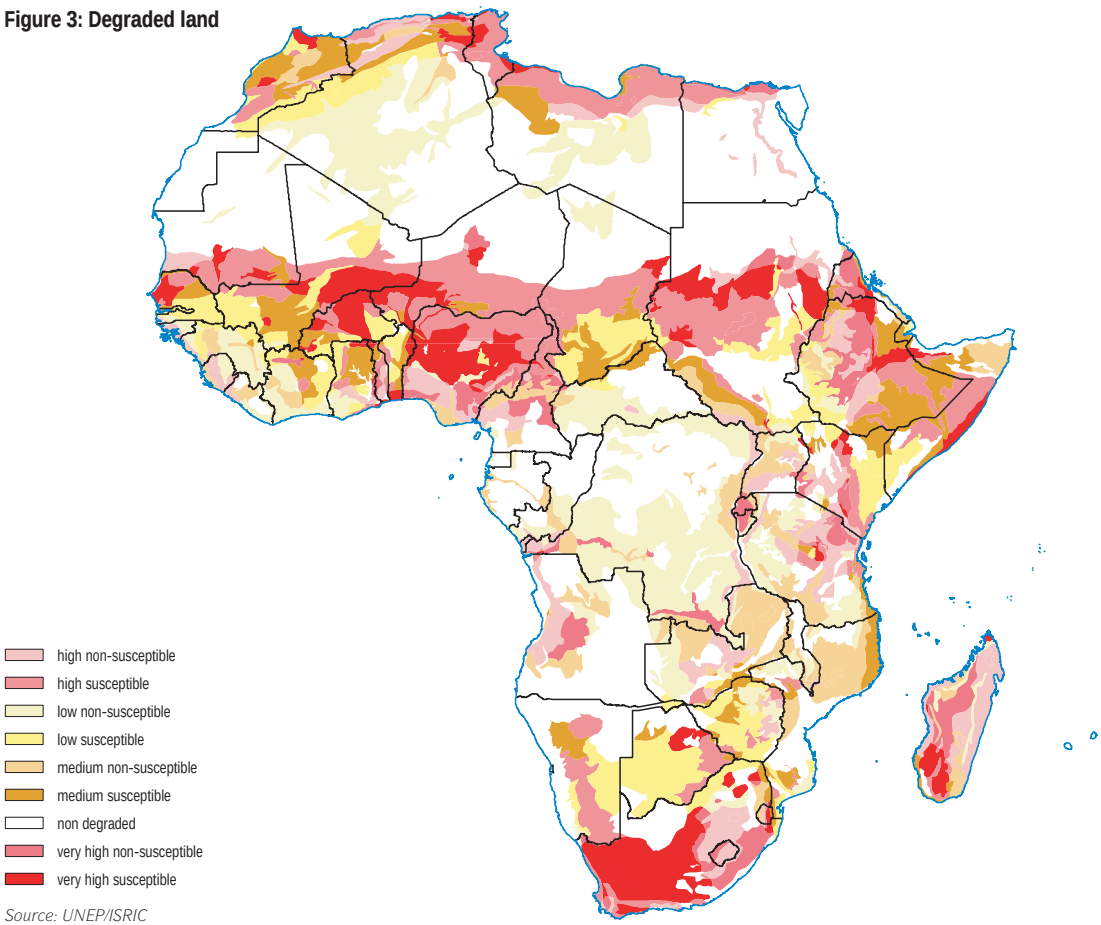
About 46 million cattle are at risk of contracting tsetse-transmitted trypanosomiasis in Africa. About 3 million cattle die of Animal African Trypanosomiasis (AAT) annually (FAO undated). In the tsetse-infested areas, trypanosomiasis reduces meat and milk production by at least 50 per cent. It also limits opportunities for farmers in terms of crop and livestock production: there is less efficient nutrient cycling, less access to animal traction, lower income from milk and meat sales and less access to liquid capital (Swallow 1999). The economic losses in cattle production alone are between US$1 000 and 1 200 million annually, while total losses, in terms of agricultural GDP in Africa, amount to about US$4 750 000 million per year (FAO undated).

Land degradation and desertification

While irrigation could enhance food production, its inefficient application could also be a risk, particularly in terms of salinization. For example, about 10 per cent of the world's irrigated land has been damaged by salt, increasing the threats to food security (FAO 2002a). The build-up of salts in the soil lowers yields and can damage the land beyond economic repair. Salinization is reducing the world's irrigated area by 1 to 2 per cent every year (FAO 2002a), hitting hardest in the arid and semi-arid regions such as those common in Africa. In Senegal, for example, land has been cultivated and farmed without appropriate management of organic and mineral fertilizers, enhancing mineralization and soil organic matter loss (Tieszen and others 2004).

A further threat to Africa realizing the full potential of its land resources is desertification. UN Secretary-General, Kofi Annan, has said that desertification undermines the fertility of the world's land, with productivity losses reaching 50 per cent in some areas (UN 2004). Today, a third of the Earth's surface is threatened by desertification, which adds up to an area of over 4 000 million ha of the planet (UNCCD 2004). It not only contributes to food insecurity, famine and poverty, but may also fuel social, economic and political tensions that can cause migration, conflicts, further poverty and land degradation. It is estimated that the livelihoods of more than 1 000 million people globally are at risk from desertification, which may eventually force 135 million people off their land. The problem appears to be most severe in SSA and the Horn of Africa.

Figure 3: Degraded land



Source: UNEP/ISRIC

Climate variability and change

Climate variability and change are major threats limiting opportunities for sustainable development. For example, crop yields in SSA are projected to fall by 20 per cent due to global warming and climate change (Simms and others 2004). It has been projected that as climate change pushes the world towards more extreme weather, more and more people would be exposed to recurrent disasters.

Droughts and floods are common problems impacting on different parts of the region with devastating results on people and the environment. Millions of people face famine with relentless regularity, increasing their vulnerability to disease and other hardships. For example, at the beginning of 2003, about 25 million people faced famine, and by April 2003, this figure had jumped to 40 million (Harsch 2003a). In Southern Africa, for example, much of the famine in 2003 was attributed to the severe drought of 2002-2003. In the Horn of Africa (Sudan, Eritrea and Ethiopia), famine is mainly a result of drought, although in Ethiopia and Eritrea, war was also a contributory factor (Harsch 2003b). A total of 13.6 million people in the two countries faced immediate food shortages in early 2003 (UN 2003). In Mozambique, the floods in 2000 – the worst in 150 years – left the country's lowlands in the Limpopo River basin inundated for up to three months, affecting the plant resources upon which people relied (IRIN 2004b).

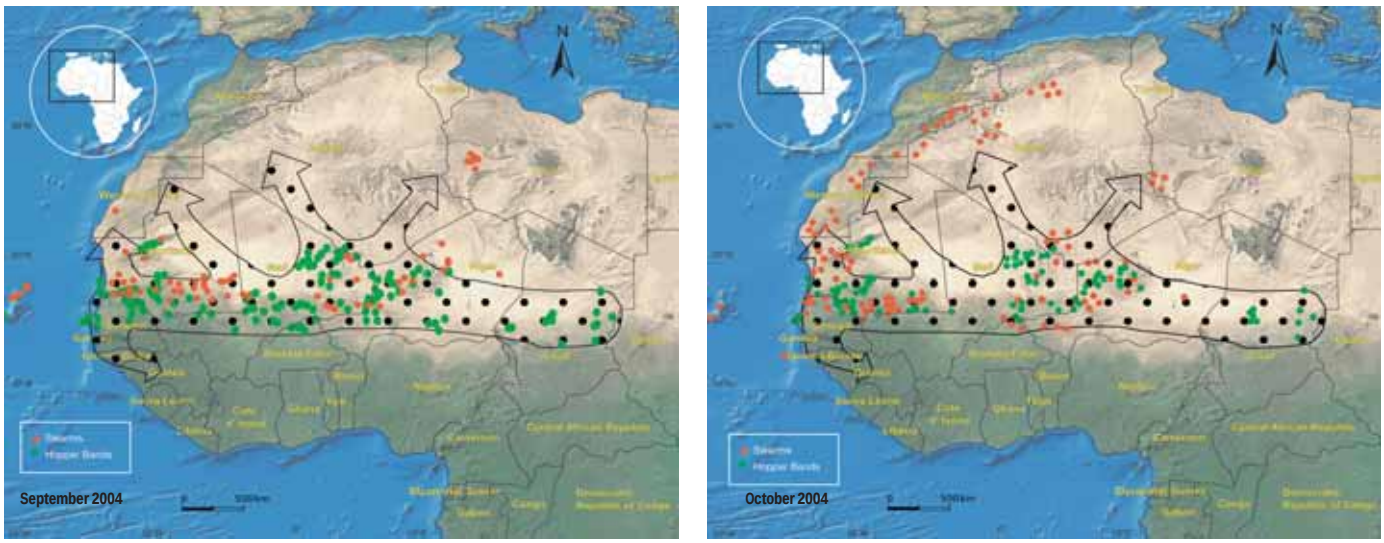
Global warming is also a threat to mountain glaciers, many of which are melting at unprecedented rates. For example, an ice cap on Mount Kenya has shrunk by 40 per cent since 1963 (FAO 2004b).

Pests

In addition to extreme weather events, such as drought and floods, pests pose a serious threat to food security. For example, in 2004, more than ten countries in Western and Northern Africa were invaded by swarms of locusts, destroying vegetation and crops.

Desert locusts periodically invade Northern Africa and the Sahel – the 1986-1989 plague cost more than US$300 million to control (USAID 2004). In 2004, locusts started invading the Sahel from the end of June, with Mauritania, Mali, Senegal and Niger the worst affected. More than 2.5 million rural households were at risk of food shortages as over four million ha of crops and farmland were invaded by the swarms. In Mauritania, about 1.6 million ha were invaded and an estimated 80 per cent of crops were destroyed (FAO 2004b). The invasion also affected national economies. For example, Morocco spent about US$30 million in defence of an agricultural sector worth US$7 000 million in 2002, of which US$1 000 million were in export earnings (FAO 2004a).

Ironically, good rains, which would normally boost agricultural production, also provided ideal weather conditions for the locusts to multiply. The desert locust has been described as a pest of unusually destructive powers (FAO 2004a). A tonne of locusts – just a small part of an average swarm – eats the same amount of food in a day as 2 500 people. Each swarm is composed of millions of insects, sometimes covering several hectares. Adult locusts can fly over 200 km per day, easily crossing borders (FAO 2004b).



Locust invasions, 2004
More than ten countries were affected by the locust invasion in 2004 – the worst since 1986-89.

Source: FAO-Desert Locust Information Service 2004

Control involves spraying, and FAO has promoted the sound use of pesticides to reduce risks to human health and the environment. The pesticides used usually degrade in a week. The Food and Agriculture Organization of the United Nations and governments in the region are seeking a safer replacement for conventional pesticides by testing a fungus that attacks locusts in the field, and a natural hormone that disrupts the insects' normal behaviour (FAO 2004b).

In Western Africa, the Centre for Eco-toxicological Research in the Sahel, which was established in 1991 in Senegal with FAO assistance, helps governments to monitor the risk of environmental and human health from pesticides. It helps governments establish safety measures, check the health of people, and ensure the safe handling of leftover pesticides. The centre also trains national environmental monitoring teams and collaborates with national chemical laboratories and other institutions such as universities (FAO 2004c). Chapter 11: *Chemicals* considers the challenges and opportunities the use of chemicals pose for Africa.

Invasive alien species

Invasive alien species (IAS) are a major factor in environmental change in Africa, contributing to or exacerbating human vulnerability and foreclosing some livelihood and development options. Invasive species impact on economic sectors such as agriculture, forestry, fisheries, tourism, water management and hydropower production (UNEP 2004).

The region is now home to hundreds of IAS – both plant and animal – but the magnitude of the problem varies from country to country, with some such as South Africa facing serious challenges to control different types of IAS. On Marion Island, for example, the numbers of the island's only land bird – the lesser sheathbill – have dropped, and the introduced house mouse is suspected of out-competing the bird species for food (Joubert 2005).

Plant and animal invasive alien species cost millions of US dollars annually in terms of lost revenue and expenditure on control measures. The World Conservation Union (IUCN) estimates that worldwide the economic costs of invasive alien species are about US$400 000 million annually (Howard and Matindi 2003). If control measures can be used as an indicator of the magnitude of the problem, the proposals by the African Ministerial Conference on the Environment (AMCEN) to raise more than US$265 million to fund various projects in Africa over 3-5 years (NEPAD 2003) show that IAS are as significant an environmental issue in the region as land degradation, drought and biodiversity loss. The IAS problem has been identified as an emerging issue and is analysed in greater detail in Chapter 10: *Invasive Alien Species*.

Armed conflict

Armed conflict has affected most parts of the region at one time or another. Millions of lives have been lost and tens of millions of people have been displaced, either internally or as refugees, throwing this critical human resource into a virtually unproductive existence for long periods. Displaced people end up unable to contribute to the economic development of their countries and being dependent on humanitarian assistance. The displacement of people, for example, in the Great Lakes Region, has contributed to the overexploitation of resources in national parks. In Rwanda's Kagera

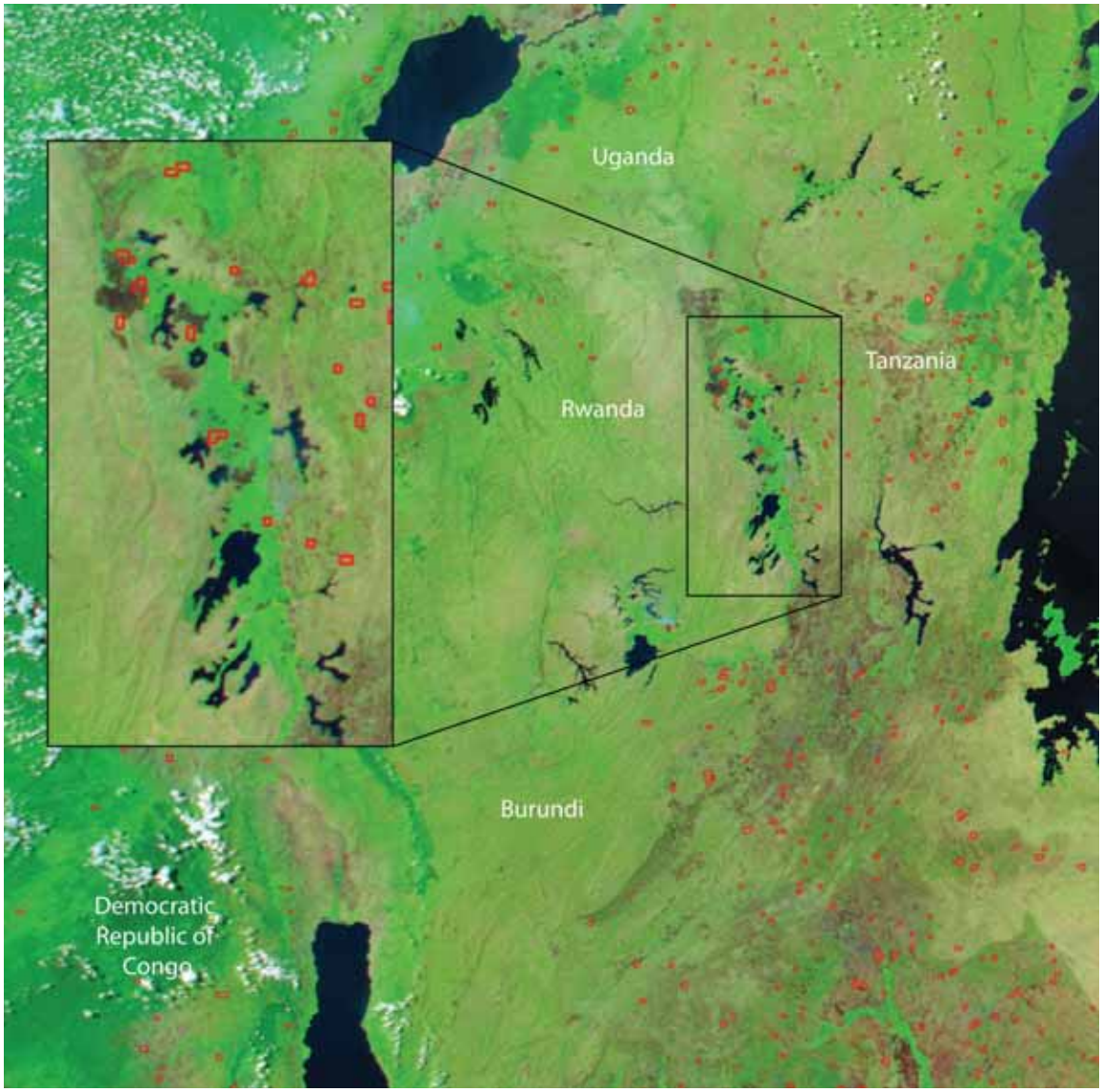
Box 5: WSSD decisions on land

The World Summit on Sustainable Development (WSSD) Johannesburg Plan of Implementation chapter on Africa highlights a number of activities related to land. It emphasizes, among other priorities, the need to achieve significantly improved sustainable agricultural productivity and food security to meet the agreed MDGs, particularly to halve by 2015 the proportion of people who suffer from hunger.

This would be undertaken through initiatives at all levels which:

- Support the development and implementation of national policies and programmes to regenerate the agricultural sector. African countries were expected to have developed and implemented food security strategies in their national poverty eradication programmes by 2005.
- Promote and support efforts and initiatives to secure equitable access to land tenure and clarify resource rights and responsibilities. This was to be done through land and tenure reform which respects the rule of law.
- Provide access to credit to all, especially to women, and enable economic and social empowerment and poverty eradication as well as efficient and ecologically sound utilization of land.
- Enable women producers to become decision-makers and owners in the sector, including the right to inherit land.

Source: UN 2002b



Fires along the boundary of Rwanda's Kagera National Park
Numerous fires (marked in yellow) are believed to have been started by poachers who may have burned as much as one-third of the protected land in the park. The park is a last refuge for elephants, lions, hyenas, leopards, buffalo, antelopes, zebra and other wildlife in the country.

Source: Earth Observatory 2004

National Park, for example, fires captured by satellite imagery in July 2004 are reported to have been started by poachers and as much as one-third of the protected land has been damaged (Earth Observatory 2004). The park's landscapes have been almost completely deforested or otherwise transformed.

Insecurity due to armed conflict has major impacts on tourism, forcing visitors to stay away. The 1998-2000 Ethiopia-Eritrea war, for example, severely dented tourism, with thousands of potential visitors deciding to stay away from Ethiopia. The country had only 109 000 visitors in 2000, but the industry has since recorded an increase of more than 30 per cent in the number of foreign visitors (IRIN 2004a).

Chapter 12: *Environment for Peace and Regional Cooperation* discusses the opportunities the environment offers for improving cooperation and thus promoting a climate conducive to sustainable development.

Governance and land policies

The governance of land has social, economic and environmental dimensions which are interlinked and, therefore, require careful considerations of all available options to minimize potential conflict among people and across economic activities. Given that Africa's land is critical to agriculture, mining, wildlife conservation, urbanization and infrastructural development, governance issues and policies are complex,

Women played an active role in the "citizens' jury" on the use of GM crops in Mali and its implications for food security, January 2006.

Source: M.Pimbert

often requiring juggling acts to balance and satisfy competing interests. Land-use management, therefore, has implications at disparate levels from household to community, from community to national, from sub-regional to regional, and finally to international.

Governance has social and economic dimensions, and inequitable gender relations often place women at a disadvantage. Poverty in Africa has strong gender dimensions. Women often have weaker land and natural resources rights than men, which, coupled with inequitable education, lessens the opportunities available to women. In Cameroon, for example, women have only user rights and not ownership rights to the land (Baye 2002).

Property rights are often at the core of available opportunities. Existing property regimes often favour the rich and other established sectors. This has been particularly evident in land and natural resource tenure. The enforcement of property rights, without due consideration of equity and justice issues, may exacerbate conflict among users at different levels including the local and national, and possibly beyond this. It has been argued that land ownership makes poor people less reliant on wage labour and increases opportunities available to them, thus reducing their vulnerability to shocks. Providing poor people with access to land, together with building their capacity to effectively use the land, is central to reducing poverty. It also empowers the poor and communities (World Bank 2003a). Improving land productivity needs to be part of a multi-pronged economic strategy that amongst other things promotes industrial development and diversifies options.

Land-use management

Effective land-use management, which takes into account equity and access issues and tenure rights, is critical to sustainable development in Africa. Ineffective land-use planning and management can only lead to overexploitation of the resource, contributing to increased land degradation, salinization, pollution, soil erosion and conversion of fragile lands.

Legal and institutional frameworks

A disparate body of legal and institutional frameworks exist at national, sub-regional, regional and international levels to deal with the different dimensions of land.

Many resource-rich countries in Africa face special governance challenges related to weak and poorly enforced law and policy. Countries dependent on oil, gas and mining and that have weak political institutions often have higher levels of inequality and poverty than non-oil and -mineral economies at similar income levels. Such countries often lag behind in overall development, with higher levels of child malnutrition, lower educational outcomes, and even shorter life expectancy (Nankani 2004). To maximize the benefits of increased economic growth, countries must build stronger governance structures and strengthen accountability and transparency as well as eliminating graft.

In terms of agriculture, ministries or departments of agriculture administer different laws and policies aimed at enhancing food production for national consumption as well as for export. The fact that food production in Africa has been declining over the past few decades is arguably an indicator of inefficiency, although there are other root causes. An opportunity which policymakers should pursue in terms of food production is the expansion of irrigation, particularly in sub-regions and countries with the most potential. The adoption by Africa of CAADP is also an opportunity to turn around agriculture and livestock production in the region.

Africa has played a significant role in various international conferences of the past two decades, including the 1992 Earth Summit and the 1996 World Food Summit. These conferences, as well as the follow-up international conferences such as the World Food Summit +5 and the WSSD, have given Africa the opportunity to put forward its concerns and to have the global community take them on board.

The region has also ratified various multilateral environmental agreements, whose objectives vary from biodiversity and biotechnology, climate change and desertification to persistent organic pollutants and other chemicals initiatives. Several of these are directly relevant to the challenges of land.

At the regional level, NEPAD's Environmental Action Plan (NEPAD-EAP) adopted in 2002 and endorsed by the African Union (AU) in July 2003, has become the blueprint to help address, among others, land issues in Africa. The opportunities and challenges of addressing these through an interlinkages approach are considered in Chapter 8: *Interlinkages: The Environment and Policy Web*.

UN Convention to Combat Desertification

One of the main challenges facing Africa is desertification. Both the global community and Africa have specifically recognized the need to address this issue. The United Nations Convention to Combat Desertification (UNCCD) is the key global instrument addressing this. The UN General Assembly has declared 2006 the International Year of Deserts and Desertification (UN 2004). Regarding land degradation and desertification, Africa collectively as a region and individually as countries has been in the forefront of implementing the UNCCD. All the 53 African countries have ratified the Convention and are in various stages of implementing its provisions. In 2005, the Committee for the Review of the Implementation of the Convention (CRIC) reviewed the status of implementation in Africa, and concluded that countries are moving from planning to action.

The AU, and its predecessor the Organization of African Unity (OAU), have played a key role in the implementation of the UNCCD, which the OAU described in 2002 as "an umbrella Convention for Africa for environment and natural resources management" (OAU 2002).

The AU – the region's highest policy-making body – has been involved in the preparatory activities for national, sub-regional and regional action programmes and in desertification and land degradation control activities in many parts of Africa. In 1998, for example, the OAU granted US$300 000 from its Special Emergency Assistance Fund for Drought and Famine in Africa (OAU/SEAF) to the UNCCD Secretariat to implement transboundary projects to combat desertification and land degradation, and to fight hunger in the Sahel and Maghreb border regions.

Between 1998 and 2001, the OAU/SEAF provided grants totalling about US$4 million to Sudan, Chad, Tanzania, Cameroon and Niger to fund activities to combat both the causes and impacts of desertification and land degradation. Funding was also made available for transboundary projects on desertification, land degradation and food security in the Sahel and Maghreb border regions (OAU 2002).

Sub-regional organizations and economic groupings have been involved in implementing sub-regional action programmes as well as supporting the implementation of national action programmes (NAP) in various sub-regions (UNCCD 2005). A total of 32 African countries had by November 2005 finalized (see Table 4), validated and adopted their NAP and two others had working drafts (UNCCD 2005). The United Nations (UN)

Table 4: National Action Programmes (NAP)

Country	Year of submission
Algeria	2004
Benin	2000
Botswana*	2001
Burkina Faso	2000
Burundi	2005
Cape Verde	2000
Chad	2000
Democratic Republic of the Congo*	2004
Djibouti	2000
Egypt	2005
Eritrea	2002
Ethiopia	2000
Gambia	2000
Ghana	2002
Kenya	2002
Lesotho	2000
Madagascar	2001
Malawi	2001
Mali	2000
Mauritania	2002
Morocco	2002
Mozambique	2002
Niger	2000
Nigeria	2001
Senegal	2000
South Africa	2004
Sudan	2002
Swaziland	2000
Tanzania	2000
Togo	2002
Tunisia	2000
Uganda	2000
Zambia	2002
Zimbabwe	2000

** working draft of NAP document*

Source: UNCCD 2005

Box 6: Thematic Programme Networks

The UNCCD has facilitated the establishment of Thematic Programme Networks (TPNs) in the context of the Regional Action Programme (RAP) to combat desertification in Africa. The TPNs are networks of institutions and agencies linked together via an institutional focal point. Regional, sub-regional and national focal institutions will involve key actors at regional, sub-regional and national levels in the affected countries.

The following are the themes of the TPNs:

- Integrated management of international river, lake and hydrogeological basins;
- Promotion of agroforestry and soil conservation;
- Rational use of rangelands and promotion of fodder crops development;
- Ecological monitoring, natural resources mapping, remote sensing and early warning systems;
- Promotion of new and renewable energy sources and technologies; and
- Promotion of sustainable agricultural farming systems.

Source: UNCCD 2005

system has played a critical role in the implementation of the Convention in different regions. For example, the UN Development Programme has, through its Drylands Development Centre (formerly the Office to Combat Desertification and Drought (UNSO)), made considerable investment, financial and otherwise, and spent since 1995 a total of US$18 million to support 29 countries in Africa, 22 in Asia and 19 in Latin America and the Caribbean to develop national action plans to combat desertification and drought (UNDP 2002). The United Nations Environment Programme (UNEP) and United Nations Development Programme (UNDP) Joint Venture with UNSO also provided funding to desertification control projects in the Sudano-Sahelian region over the years from 1979 up to the mid-1990s. The Joint Venture also provided extensive support to governments to develop National Action Plans to Combat Desertification (NPACDs) of which many seem to have been converted into NAPs, for example, the Tunisia NPACD which was already in its second phase of implementation in the mid-late 1990s.

Programmes and projects by UNEP and its Division of Global Environment Facility Coordination (DGEF) on land and land degradation, such as the Desert Margins programme in nine SSA countries, People, Land Management and Environmental Change (PLEC) in Kenya, Tanzania, Uganda, Ghana, and Guinea, Land Degradation Assessment in Drylands (LADA) in Fouta Djallon, Senegal-Mauritania and Niger-Nigeria, and the Kalahari-Namib Action Plan, have been key policy interventions.

The implementation of the UNCCD has also facilitated strategic coordination at different levels including at the national, regional and international levels. For example, at the regional level, governments adopt common positions through various fora. At a preparatory African Ministerial Conference in mid-2003 to the sixth session of the UNCCD Conference of the Parties (COP.6), the ministers urged the parties to take appropriate measures to strengthen access to the world market for agricultural products from arid, semi-arid and dry sub-humid areas of Africa (UNCCD Secretariat 2003). The linkage between African agricultural trade and desertification is obvious because in many African countries, combating desertification and promoting development are "virtually one and the same due to the social and economic importance of natural resources and agriculture" (UNCCD Secretariat undated).

Networks such as the FAO-UNEP Global Land Cover Network (GLCN), which has already implemented Africover in ten Eastern African countries, and the present expansion of GLCN to Western, Southern and Northern Africa are major efforts to harmonize land cover classification, and data and information in Africa. They will help to create a comparable land cover database which is usable across scales and users/operators in different sectors of society.

In terms of climate change, which has been projected to have a major impact on Africa, a total of 52 countries have ratified the UN Framework Convention on Climate Change (UNFCCC), and nearly all of the countries have ratified the Kyoto Protocol, which came into effect in late 2004.

SUB-REGIONAL SECTIONS

CENTRAL AFRICA

OVERVIEW OF LAND RESOURCES

Nearly 19 per cent of Central Africa's total area of about 536.6 million ha is used for agriculture, although, as Table 5 shows, there are variations between the countries (FAOSTAT 2005). Irrigated agriculture is limited due to high, reliable rainfall in the humid zone which is conducive to rain-fed agriculture. Only about 88 000 ha are irrigated (FAOSTAT 2005).

As shown in Table 5 São Tomé and Príncipe has the smallest land area, covering 96 000 ha, while total land cover in the DRC is nearly 234.5 million ha. The sub-region has extensive forest and woodland resources; about 240.33 million ha is forested (FAO 2005).

Table 5: Status of land in Central Africa

Country	Total area (1 000 ha)	Land area (1 000 ha)	Agricultural area (1 000 ha)	Agricultural as % of total area*	Total forest area ('000 ha)
Cameroon	47 544	46 540	9 160	19.27	23 858
Central African Republic	62 298	62 298	5 149	8.27	22 907
Chad	128 400	125 920	48 630	37.87	12 692
Congo, Dem. Republic of the	234 486	226 705	22 800	9.72	135 207
Congo, Republic of the	34 200	34 150	10 547	30.84	22 060
Equatorial Guinea	2 805	2 805	334	11.91	1 752
Gabon	26 767	25 767	5 160	19.28	21 826
São Tomé and Príncipe	96	96	56	58.33	27
Total*	536 596	524 281	101 836	18.98	240 329

** aggregated data*

Source: FAO 2005 and FAOSTAT 2005

Endowments and opportunities

In 2004, Central Africa led economic growth in Africa with 7.3 per cent. This was fuelled by high oil prices supported by higher oil production in all oil-producing countries of the sub-region except Gabon (ECA 2005). Chad and Equatorial Guinea recorded the fastest growth in the continent in 2004: although oil was the principal factor in Chad, cattle and cotton production also contributed to the impressive growth (ECA 2005).

Agriculture contributes significantly to the Gross Domestic Product of the sub-region, with Cameroon, Central African Republic and Chad registering 44, 55 and 39 per cent respectively during the year 2000 (WRI and others 2003). Agropastoralism is the main agricultural activity, while major crops in the sub-region include cassava, cocoa, coffee, cotton, groundnuts, maize, millet, palm oil, rubber and sorghum. In 2000, Cameroon was the main exporter of cereals and pulses, which accounted for US$141 million and US$860 000 respectively (WRI and others 2003). However, Central Africa is a net importer of food.Due to the vast resources available, there is a glaring opportunity for the countries to diversify agricultural production so that they fully achieve their potential to become net food exporters. The sub-region has made great strides in improving its cereal yields, with as much as 56 and 30 per cent improvement having been realized in Cameroon and the Central African Republic, respectively, since 1989 (WRI and others 2003).

Central Africa is also endowed with considerable oil reserves, particularly in Cameroon, Chad and São Tomé and Principe. São Tomé has untapped off-shore oil reserves estimated at 6 000 million barrels (Infoplease 2005). Cameroon is SSA's sixth-largest oil producer, with reserves estimated at 400 million barrels, while Chad has 900 million barrels (Energy Information Administration 2005a).

Cocoa farmers collecting cocoa pods, São Tomé and Príncipe. National Smallholders Support Programme.

Source: G.Planchenault/IFAD

Challenges faced in realizing opportunities for development

Land degradation, which includes erosion and soil compaction, is the main threat to the sustainable use of land resources. The main causes of land degradation are vegetation removal through commercial logging and tree cutting to provide domestic fuel, as well as clearance of forests for commercial or subsistence cultivation. During the period 1990-2000, the sub-

region experienced extensive forest loss, ranging from 0.1 per cent in the Republic of Congo to 0.9 per cent in Cameroon (WRI and others 2003). Its soils are exposed to salinization, through inundation and saltwater intrusionto in irrigated land (WRI 2001).

Declining productivity and soil structure in the Sahelian zones of Chad and Cameroon are exacerbated by unpredictable rainfall and drought, resulting in extreme degradation and desertification. Chad is highly vulnerable to desertification, with 58 per cent of the area already classified as desert, and 30 per cent classified as extremely vulnerable (Reich and others 2001).

Armed conflict is also a threat to the sustainable management and use of land resources. The sub-region has experienced considerable conflict over the past two decades, displacing people and causing land degradation through deforestation.

As part of efforts to address the various threats to the land resources, a number of institutions and policies are in place, and they include the Economic and Monetary Community of Central Africa (CEMAC); the Economic Community of Central African States (ECCAS); the Lake Chad Basin Commission (LCBC); and the African Timber Organization (ATO). The primary aim of these organizations is to promote economic cooperation and sound environmental management in the sub-region.

Central Africa is challenged to improve food production and cut down on food imports. A comprehensive, integrated approach to improving food security and land quality is an environmental and developmental priority.

Land tenure and access to land resources are two important factors influencing land and natural resources management. An improvement in tenure arrangements has a direct effect on people's security and on their investment in land resources management. In particular, there is a need to harmonize customary and statutory laws in order to avoid conflicting situations that can lead to disputes over access to land resources.

EASTERN AFRICA

OVERVIEW OF LAND RESOURCES

Land is a primary asset for survival and development in Eastern Africa. Land supports the livelihoods of most rural people. Rural population is high: in Rwanda, Ethiopia, Burundi, Eritrea and Uganda more than 80 per cent of the people live in rural areas; in Kenya and Somalia more than 60 per cent live in rural areas; and, in contrast, in Djibouti only 16.3 per cent live in rural areas (FAO 2005). Land also provides diverse functions in support of ecosystem processes.

As shown in Table 6 below, Uganda has the highest proportion of potentially arable land, whereas in Rwanda, all arable land is in use (FAO/AGL 2003) and land pressure is pushing cultivation into marginal areas. In Eritrea, 88 per cent is under cultivation. Countries such as Rwanda and Burundi face enormous challenges as they are physically small with high population densities. Burundi's population density is 265.8 per km^2 and Rwanda's 340.1 per km^2 (FAO 2005). Burundi has the highest rate of deforestation in Africa, and one of the highest globally, with a 9 per cent change per year (FAO 2005). Potential arable land is negligible in Djibouti because of the extremely arid conditions in the country.

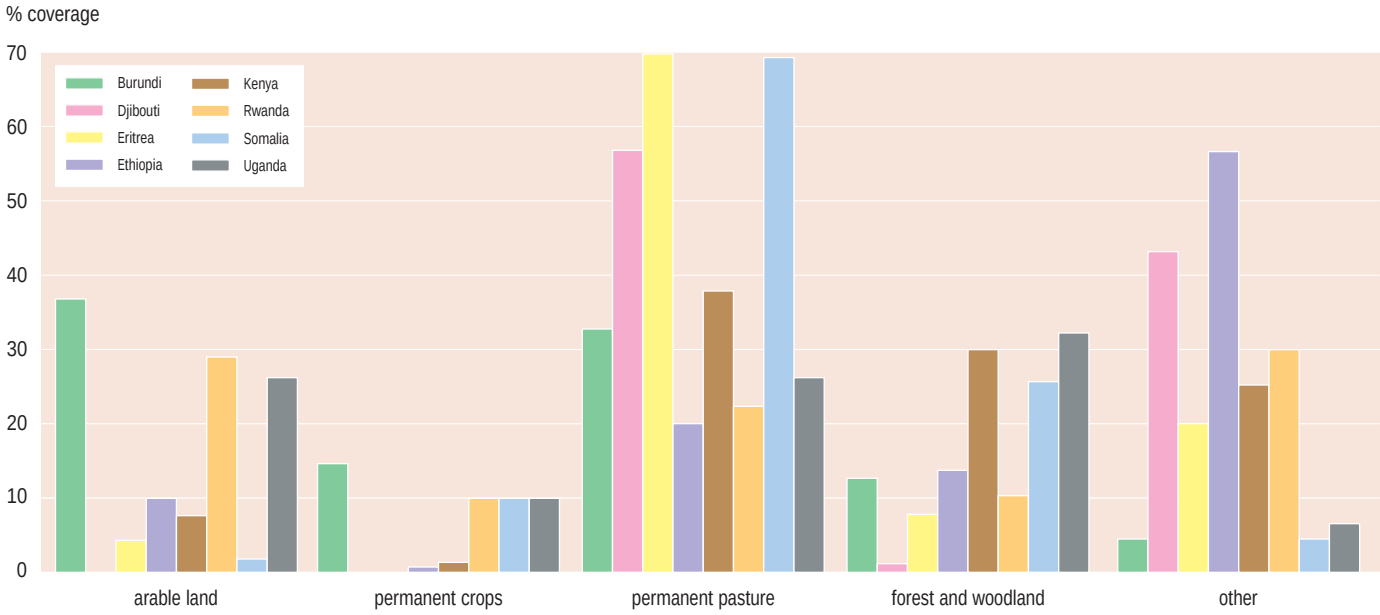
More than one-third of the land area is covered by permanent pasture as the dominant land use is

Table 6: Actual and potential arable land in countries of Eastern Africa

	Total area	Potential arable land		Actual arable land in 1994	
Country	'000 km^2	'000 ha	% of total area	'000 ha	% of potential
Burundi	26	1 414	54.4	1 180	83.5
Djibouti	23	0	0	0	0.0
Ethiopia	1 101	42 945	39	11 012	25.6
Eritrea	94	590	6.3	519	88.0
Kenya	569	15 845	27.8	4 520	28.5
Rwanda	25	746	29.8	1 170	156.8
Somalia	627	2 381	3.8	1 020	42.8
Uganda	200	14 169	70.8	6 800	48.0
Total	2 665	78 090	29.3	26 221	33.6

Source: Compiled from FAO/AGL 2003

Figure 4: Land use and land cover for Eastern African countries (1994)



Source: Compiled from FAOSTAT 2004

livestock grazing as shown in Figure 4 (FAOSTAT 2004). About 73 per cent of the total area is characterized by desert and dryland conditions, of which significant proportions fall in Djibouti, Eritrea and Somalia.

Though immense, the potential of irrigation is under-utilized. The current extent of irrigated land is largest in Somalia. followed by Ethiopia, Kenya and Burundi. In the Horn of Africa, less than 1 per cent of the cultivable area is irrigated (IATFUN 2000). In Ethiopia, about 214 720 ha is irrigated, while the potentially irrigable land is estimated to be 3 328 910 ha (MoWRD 2001), implying that only 6.5 per cent of the potentially irrigable land is currently under irrigation. The area currently under irrigation accounts for about 3 per cent of the country's total food production (FDRE 2003). In Kenya, potentially irrigable land is estimated to be 540 000 ha, of which 52 000 ha or 9.6 per cent of the potential has been developed.

Endowments and opportunities

Agriculture and tourism are the main drivers of growth in Eastern Africa. Improved agriculture was a key factor in Tanzania's growth of 6.1 per cent and Ethiopia's growth of 11.6 per cent per year (ECA 2005).

Land is primarily utilized for agriculture (crop and livestock production), nature-based tourism and extraction of other land-based natural resources such as metal ores and oils. By putting in place appropriate institutional and policy frameworks, and conservation-based agricultural development technologies, the breadth of opportunities to be derived from land can be immense and thus hold great potential for breaking the circle of poverty. Though variable between countries, agriculture accounts for the highest share of GDP, contributing 51.5 per cent in Burundi, 49.9 per cent in Ethiopia, 43.1 per cent in Uganda and 38.9 per cent in Rwanda. For Djibouti, Eritrea and Kenya, the GDP is derived from diverse service sectors.

Integrated land-use planning is an essential tool and defines an approach to land resources management. It introduces mechanisms and incentives for bringing about change in land allocation as well as for identifying suitable biophysical and economic uses, and it prescribes appropriate management practices and options to ensure that land resources are conserved (FAO/UNEP 1999). In Ethiopia, attempts have been made to formulate and implement integrated land-use plans at village, district, regional and national levels. The national land-use plan was based on a nationwide socioeconomic and physical land resources database (Henricksen 1988). There are attempts to implement local or village level integrated land-use planning using watershed or farmer's service cooperative boundaries as planning units (Gittins and Henricksen 1986, LUPRD 1989, MoARD 2005). In Kenya, the watershed management approach has been used extensively to conserve and develop resources at a microlevel.

There are opportunities from agricultural research and technologies which can contribute to development, such as the use of improved seed varieties, agrochemicals and other improved agronomic practices (appropriate planting date, seeding rate, etc). This could

result in substantive yield increases, as current production is often characterized by low input and management levels.

The sustainable use of land resources requires, among other things, a strong institutional framework at all levels. The mushrooming of multiple sub-regional institutions to manage resources, which are of an inter-country nature, is a key element in fostering economic growth. The Intergovernmental Authority on Development (IGAD) was put in place in 1986 with seven member counties including Djibouti, Sudan, Uganda, Kenya, Ethiopia, Eritrea and Somalia, with the aim of strengthening regional cooperation and efforts in areas of food security and environmental protection, maintenance of peace and security and humanitarian affairs, and enhancing economic cooperation and integration of member countries.

Recurrent drought, limited alternative sources of income, population pressure, limited technology, lack of product diversification and market integration, lack of institutional capacity, environmental degradation and poor access to credit all undermine efficient and sustainable land use. In some countries, including Ethiopia, many interlocking and reinforcing factors including poverty, misguided policies, technological stagnation, population pressure, insecurity of land rights, weak institutional support (credit, extension, etc), drought and political instability contributed to the stagnation of agriculture, food insecurity and the degradation of natural resources (Shiferaw 1994, FDRE 2003). These factors may make efficient planning and management difficult: in Ethiopia, for example, the effectiveness of the recently launched nationwide agricultural extension programme, which embraces about 40 per cent of the farming population, has been constrained by high agricultural input prices, shortage of complementary inputs and inadequate extension services (Bonger and others 2004). Access to improved technology in Ethiopia is minimal where the average rate of fertilizer (nutrient) application per hectare of cultivated land is 17.5 kg (CSA 1996). In Uganda, increased crop and livestock disease, soil degradation, lack of access to improved agricultural inputs, weak agricultural extension systems, inefficient markets, increasing land fragmentation and unreliable weather have been cited as contributing to the declining crop yield of smallholder farmers (McDonagh and Bahiigwa 2002). On the high and medium potential lands of Kenya, land productivity potential is adversely affected by soil erosion, decline in soil fertility, soil salinization, crop and livestock diseases and fragmentation of landholdings. In the lowlands, where pastoralism is the predominant farming system, a combination of physical, environmental and socioeconomic factors constrain production efficiency. Gradual resource shrinkage, tenure insecurity and inadequate livestock watering may also be major problems in pastoral areas, as they are in Ethiopia (Arsano 1999, Sisay 1999).

Land degradation is a serious problem as shown in Table 7. The total area suffering from severe to very severe degradation is about 14 per cent (FAOSTAT 2005). In particular, Burundi and Rwanda face a serious

Green tea plantations, Gokeke, Rwanda.

Source: D. Balducci/Still Pictures

Table 7: Land degradation in Eastern Africa

	Total area	Severe		Very severe	
Country	**'000 km²**	**area (%)**	**'000 km²***	**area (%)**	**'000 km²***
Burundi	26	0	0	76	0
Djibouti	23	0	0	0	0
Eritrea	94	55	51.7	8	4.136
Ethiopia	1 101	8	88.08	20	17.616
Kenya	569	19	108.11	11	11.8921
Rwanda	25	0	0	71	0
Somalia	627	0	0	15	0
Uganda	200	41	82	12	9.84
Total	2 665		329.89		43.4841
Total (severe - v. severe)*	373.3741	14.01			

** aggregated data*

Source: FAOSTAT 2005

threat of land degradation, where about 76 and 71 per cent of the respective country's total area encounters very severe degradation problems (FAOSTAT 2005). They are followed by Eritrea, Uganda, Kenya and Ethiopia, where areas with severe to very severe degradation constitute about 63, 53, 30 and 26 per cent respectively of total land area (FAOSTAT 2005). In Djibouti, wind erosion is the principal form of erosion but is mainly viewed as "natural" due to the absence of agricultural land (FAO/AGL 2003).

The pressures and driving forces that are attributable to land degradation are similar across the countries of the sub-region. Typical proximate causes include overcultivation, overgrazing and deforestation. The process of soil degradation is affected by poverty, population dynamics, insecure tenure, weak institutional support (eg extension, credit, etc), political instability and factors related to physical land attributes such as topography, soil and rainfall conditions. Topography is an important consideration, as many countries are mountainous. In order of magnitude, Rwanda, Burundi and Ethiopia encounter the highest potential erosion risk due to steep topography.

The areas with the most severe land degradation are also those with the highest population density. The high population density, in the central and northern highlands of Eritrea, Rwanda and Burundi, is an important consideration. Rwanda has the highest population in Africa, with 340 people per km^2; its population is growing at 2.1 per cent per year (FAO 2005). Burundi, with a population density of 265.8, is growing at 3.1 per cent per year (FAO 2005).

Land tenure is profoundly political, and it continues to be a critical factor in the development of African politics and economies (Bruce and others 1996). Land tenure, and in particular ownership and access rights, has been widely recognized to have important bearings on effective, efficient and sustainable management and production regimes. The topography of land tenure varies from country to country and includes freehold tenure, state leasehold and community-based tenure (legally recognized indigenous tenure and community-based). A combination of freehold, state leasehold and community-based tenure prevail in Kenya, Uganda and Rwanda (Bruce and others 1996). In Burundi and Djibouti, freehold and community-based tenure, including pastoral systems, occur extensively (Bruce and others 1996). In Ethiopia and Eritrea, state leasehold and community-based tenure, including pastoral regimes, dominate. Overall, the tenure situation assessment in most of the sub-region's countries (Uganda, Somalia, Kenya and Rwanda) reveals that compulsory and systematic tenure conversion to individual ownership offered little benefit to smallholder farmers (Bruce and others 1996). In Ethiopia, tenure insecurity is described as being one of the major problems associated with the existing land system (Rahmato 2004, EEA/EEPRI 2002). In Kenya, where formal titles to land are held by many farmers, the lack of any significant relationship between land title and crop yield is perhaps explained by the limited use of land titles in obtaining formal credits (Migot-Adholla and others 1994).

NORTHERN AFRICA

Northern Africa is characterized by mostly arid areas, yet land resources play a pivotal role in its development and the well-being of its people.

OVERVIEW OF LAND RESOURCES

The main three land-use categories are cultivated land, forests and rangelands. Agricultural land constitutes 233 590 ha, which is nearly 28.8 per cent of the total land area (FAOSTAT 2005).

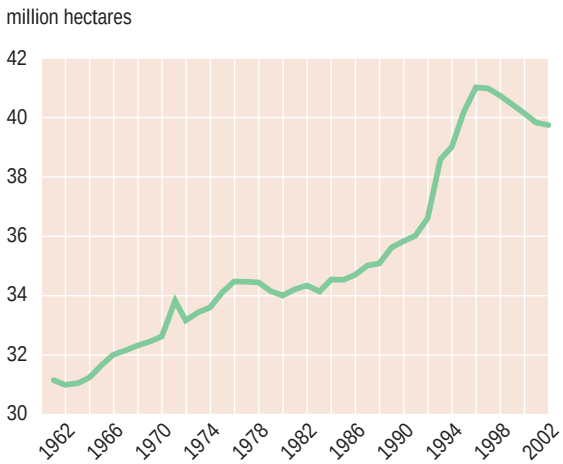
Arable land in Northern Africa is of varied soil characteristics, which belong to the Aridisol group. Aside from the alluvial soils of the river basins, the desert soils are of inferior chemical, physical and nutritional properties. In general, soil resilience is rather weak with rapid responses to development and degradation.

The extent of use of arable land varies considerably among the countries. Some countries have already fully utilized the land resources available to them, while others are still to fully utilize them. In Sudan, for example, there are vast areas of potential arable land yet to be developed. The extent to which irrigation is used varies dramatically, with 99.94 per cent of all agricultural land in Egypt being under irrigation, compared with less than 1.5 per cent in Algeria and Sudan (FAOSTAT 2005).

Over the past 50 years, the traditional systems of cultivation and conservation have broken down. Productivity has declined as soil erosion from overcultivation and overgrazed lands has reduced soil fertility. Coupled with naturally inadequate drainage, this has led to the accumulation of high levels of soluble salts, especially in Egypt and Sudan. In Egypt 3.4 million ha of all agricultural land is irrigated (FAOSTAT 2005). About one million hectares are suffering from primary or secondary salinization (Goossens and others 1994). This is in part due to the use of saline drainage water and brackish water in irrigation.

More than 57 per cent of the total land of Northern Africa is threatened by desertification (CAMRE and others 1996).

Figure 5: Northern Africa: arable land



Source: UNEP 2005

A farmer using an irrigation pump near the village of Talla in the El Minya district. Egypt-Minya Agricultural Development Project.

Source: G. Bizzarri/IFAD

Endowments and opportunities

The continued expansion of the oil sector contributed to an overall growth rate of 4.8 per cent in 2004, close to that in 2003 (ECA 2005). Gross Domestic Product was projected to be 5.2 per cent for 2005, led by growth in the agricultural sector, assuming good weather conditions and continued gains from oil through foreign investment inflows to oil-related activities in Libya, Mauritania and Sudan (ECA 2005).

Growth in tourism in Morocco and Tunisia offers opportunities for development. In Egypt, tourism continues to be an important industry and a key factor in its sustained growth of 3.2 per cent in 2004 (ECA 2005).

Land cultivation is becoming increasingly dualistic in nature. A high technology agribusiness sector is developing alongside traditional smallholder agriculture. The cultivable land covers between 22 and 25 per cent of the total land area. The percentage of agricultural land (including arable, forests and rangeland) to the total land area ranges from 2.6 per cent in Egypt to 77.4 per cent in Morocco. The percentage of irrigated land as a percentage of arable land varies between nearly 100 per cent in Egypt, where rain-fed agriculture is almost negligible, to around 15 per cent in Morocco and Sudan, where arable rain-fed areas amount to 16.1 per cent and 3.32 per cent respectively. The expansion and intensification of land use in marginal dry areas has greatly exacerbated the risk of land degradation.

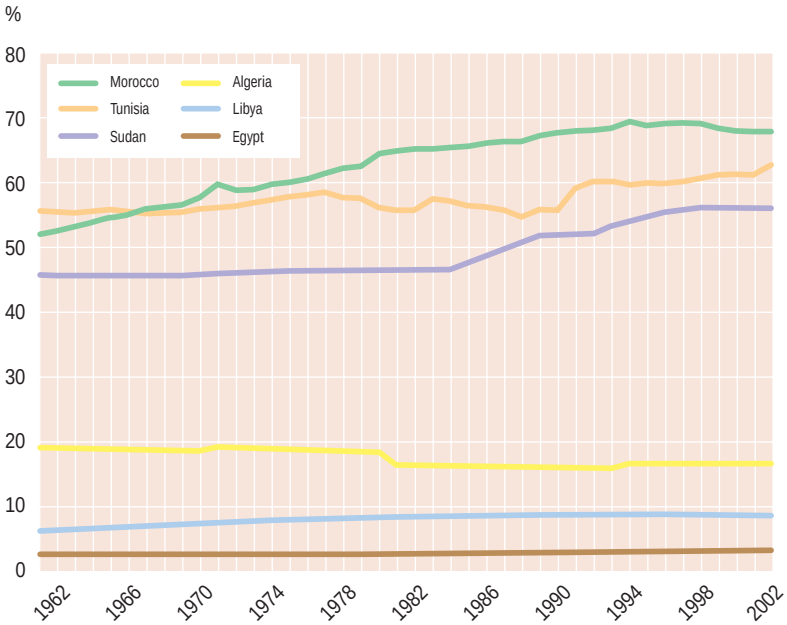
Challenges faced in realizing opportunities for development

Land resources are affected by population dynamics. Since 1970, the population size has doubled and is continuing to grow at an average of 2 per cent per year. Population growth, coupled with the resulting higher consumption of food commodities, places new pressures on resources (Miladi 1999).

Despite the increase in agricultural land resources, the rapid population increase has caused a decline of the per capita share of cultivated land. High population in coastal towns, such as Alexandria in Egypt, is resulting in pollution-related degradation and thus threatens the tourism industry as well as local livelihoods.

Degradation processes of the available land resources are varied and widespread. The main pressures include rapid population growth, climatic stresses, drought and overgrazing. The resulting impacts include serious losses of soil through wind and water erosion, loss of soil fertility, loss of biodiversity through degradation of natural plant cover and deforestation, pollution of land and water resources, increased soil salinity and waterlogging, and social impacts including increased poverty and rural-urban migration.

Figure 6: Northern Africa countries: agricultural area (as per cent of land area)



Source: UNEP 2005

Combating such degradation processes is of paramount importance for the sustainable development of the land resources, improving agricultural productivity and food security, securing a safe environment and enhancing socioeconomic benefits. In response to the various adverse impacts of degradation processes, the countries of Northern Africa are carrying out various activities to assess and monitor the degradation processes.

Lack of secure land tenure has been reported as a major constraint to land development (FAO 1993). Lack of secure property rights is a hindrance to land development and improvement, and does not support the development of trade. It may be a factor in environmental degradation.

Earthquakes are one of the natural disasters faced by Northern African countries. Establishing a regional network of seismic stations is necessary if the Earthquake Prognostics Strategy is to be implemented. Other tasks of high priority are:

- Studying the relation between the modern tectonic movements and the seismic activity to make micro-zonation maps which may be applied to better designed buildings, dams and power plants;
- Increasing public awareness and preparedness for earthquakes in threatened areas; and
- Facilitating insurance and the development of technologies which provide physical defence against the negative impacts of earthquakes.

Goats feeding in a tree, Morocco.

Source: Y. Katerere

SOUTHERN AFRICA

OVERVIEW OF LAND RESOURCES

Southern Africa covers a total land area of 693 000 million ha, of which approximately 20 per cent is arable as shown in Table 8 (SADC 2000). Arable and domesticated land is used for agriculture, forestry, wetlands and wildlife conservation, and human settlements.

Cattle grazing in Miombo woodland, north-western Zimbabwe.

Source: Y. Katerere

ENDOWMENTS AND OPPORTUNITIES

Economic growth in the sub-region is closely linked to land resources. The strongest growth was in Angola which grew at 11.5 per cent in 2004 (linked to oil and diamonds) and 8.3 per cent in Mozambique (strong agricultural performance and donor support). South Africa, which accounts for one-fifth of Africa's total GDP, grew at 2.8 per cent in 2004. Increased mining activities was the key growth factor in Botswana, Mozambique, Namibia and Zambia; agricultural expansion was an important factor in Mozambique and Zambia, and increased tourist activity in South Africa and Zambia

Crop production is the dominant land use, contributing about 34 per cent to GDP (Chenje 2000). For this reason, the performance of crop production has a strong influence on food security, economic growth and stability. As most economies in Southern Africa are based on agriculture, there is a big demand for arable land, mainly in the rural areas. Up to 62 per cent of the population lives in rural areas, depending on agriculture for their livelihood (UNEP 2002a). There is a growing trend towards export agriculture, influencing an increase in the production of cash crops including cotton, tobacco, tea, coffee, sugar and wheat. However, maize, a staple food for the majority of the region's population, is still an important crop and is widely grown. Increased commercial agriculture offers important employment opportunities. However, where labour is gendered, as it is in much of Africa, with cash crops identified as men's crops and

Table 8: Total land in Southern Africa

Country	Total area (in million ha)	Arable land (in million ha)
Angola	124.7	3.0
Botswana	58.2	0.3
Lesotho	3.0	0.3
Malawi	11.8	2.1
Mozambique	80.2	3.9
Namibia	82.4	0.8
South Africa	122.1	114.7
Swaziland	1.7	0.1
Tanzania	94.5	4.0
Zambia	75.3	5.3
Zimbabwe	39.1	5.2
Total	693.0	139.7

Source: SADC 2000

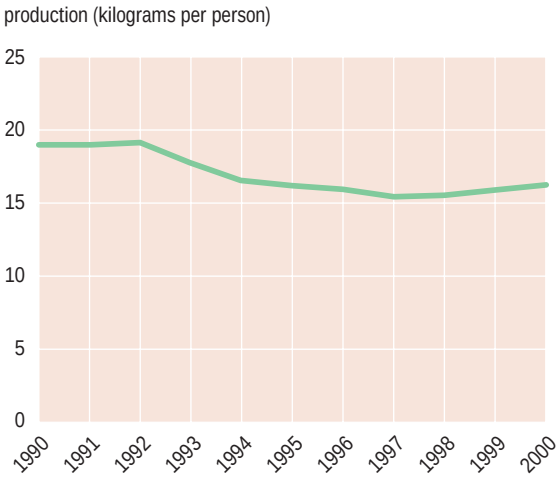
subsistence food crops as women's crops, women may not derive the same benefit (ECA 2005). Disproportional income levels are also a factor in the gendered nature of poverty.

Livestock farming is another common form of land use, although livestock production has fluctuated over the last three decades due to drought and diseases such as foot-and-mouth, cattle-lung disease and anthrax. Meat production per capita has generally been declining as shown in Figure 7.

Challenges faced in realizing opportunities for development

Land tenure arrangements and associated equity issues are a major threat to the sustainable use of land resources. The communal land tenure system is the most widespread, in which individual property rights are weak. In some countries, particularly Namibia, South Africa and Zimbabwe, colonial dispossession and weak land tenure rights are key factors in the high levels of unemployment and poverty (ECA 2005). Unemployment rates are particularly high in Namibia (34 per cent) and South Africa (30 per cent) (ECA 2005). The land tenure system is closely associated with social inequity, including high levels of income inequality. The Gini index, which is a measure of the extent of inequality in a country, is 50 in Zimbabwe, 59 in South Africa and 74 in Namibia, while the SSA average is 42.8 and the global average is 40.0 (UNDP 2004).

Figure 7: Per capita meat production in Southern Africa



Source: UNEP 2002b

Table 9 shows the land tenure system in 1999. The situation has changed quite a lot, especially in Zimbabwe, where the government has made efforts to decongest rural areas, settle landless people and deracialize commercial agriculture by acquiring 10 million ha of prime large-scale farms for resettlement (SLSA 2001).

The major cause of tenure insecurity in the communal lands is the lack of devolution of planning and decision making, poor resource-mobilization, inadequate enforcement and inadequate administration of matters relating to the affairs of local communities (Katerere and Guveya 1998).

Table 9: Land tenure in Southern Africa in 1999

Country	Private/Freehold and Leasehold (%)	Communal/Tribal/ Customary (%)	Conservation/Minerals/ Water Catchment/ Reserves/etc (%)
Angola	5.4	88.0	6.6
Botswana	5.0	70.0	25.0
Lesotho	5.0***	90.0	5.0
Malawi	4.3	78.7	17.0
Mozambique	2.9	93.0	4.1
Namibia	44.0	41.0	15.0
South Africa	72.0	14.0	14.0
Swaziland	40.0	60.0**	-
Tanzania	1.5	84.0	14.5
Zambia	3.1	89.0	7.9
Zimbabwe	41.0*	42.0	16.0

** includes small-scale farm leases and resettlements.*

***includes Swazi Nation Land held under customary tenure and leased to companies.*

****leases in urban areas.*

Source: Cumming 1999

Trade liberalization and globalization are putting severe pressure on the livelihoods of the people, resulting in many having to depend further on land and other natural resources. Notable among these factors are a fall in formal sector employment, privatization of key resources and enterprises, reduced levels of state support to agriculture, and the continuing marginalization of the non-commercial or peasant sectors. Chapter 1: *The Human Dimension* considers how economic change impacts on the environment and livelihoods and specifically looks at some of the challenges associated with structural adjustment programmes (SAPs). Chapter 8: *Interlinkages: The Environment and Policy Web* discusses the link between economic policy and environmental change, and considers the need for interlinked responses.

Declining per capita landholdings and the general skewed land ownership pattern in Southern Africa have been accompanied by a fall in human well-being indicators, such as per capita food production. The production of cereals, root crops and livestock, which form the primary staple food in Southern Africa, has been increasing since 1970, but has not kept pace with population growth, resulting in overall per capita food production falling by 25 per cent since 1980 (Cumming 1999). While the declining trends in per capita food production are largely attributable to declining landholding sizes as shown in Table 10, other factors have also shaped the trends over the past two decades. Drought is one factor that caused a significant decline in the per capita food production index for Southern Africa following the poor seasons experienced in 1991-92, 1994-95, 2001-03 and 2004-05.

Soil erosion is the most widespread form of land degradation, and one of the biggest threats to agricultural productivity in Southern Africa. It is estimated that about 15 per cent of the land is degraded through erosion (UNEP 2002a).

Land policy debates are characterized by a range of challenges:

- The privatization of resources, including both communal and state resources;
- The retreat by the state from key areas of the economy, including both productive activities and services;
- The pursuit of FDI;
- The sweeping deregulation of markets;
- Dealing with the emerging issue of genetically modified organisms (GMOs); and
- Effectively reforming the land sector.

As a result there is convergence of policy in key areas that can be attributed to the growing exposure of the sub-region to globalization, which has seen an accelerated phase of regional integration and intergovernmental programmes such as the Regional Indicative Strategic Development Plan (RISDP). Box 7 shows the food security objectives of the RISDP.

Table 10: Per capita access to land and food production trends 1980-2000

	Per capita arable land area (ha)			Food production per capita (index trends)			
Country	**1980**	**1990**	**2000**	**1980**	**1990**	**1995**	**1999**
Angola	0.5	0.36	0.28	120	98	104	105
Botswana	1.5	1.06	0.70	103	100	92	79
DRC	*	*	*	101	101	90	68
Lesotho	0.2	0.18	0.12	112	111	80	83
Malawi	0.4	0.28	0.36	137	97	100	140
Mauritius	*	*	*	86	101	100	77
Mozambique	0.3	0.20	0.21	119	107	89	104
Namibia	*	*	*	142	96	96	77
South Africa	*	*	*	112	98	79	888
Swaziland	0.3	0.21	0.14	110	97	76	69
Tanzania	0.3	0.19	0.18	102	100	86	83
Zambia	0.9	0.62	0.21	94	94	82	83
Zimbabwe	0.4	0.29	*	105	104	68	92

** data unavailable*

Source: Cleaver 1993

Box 7: Food security objectives of the Regional Indicative Strategic Development Plan

- **Improving food availability.** Member states are required to promote agricultural production and productivity, take measures that increase competitiveness and promote trade and also promote the sustainable use of natural resources.
- **Improving access to food through rural non-farm income generation.** Member states are encouraged to adopt policies which will generate the maximum employment gains and incomes, introduce measures that improve income stability and equity, and develop safety nets (such as food for work, cash for work and targeted distribution of inputs or food) for vulnerable groups. Most of these measures require public, private and non-governmental organization (NGO) partnerships.
- **Improving nutrition.** Member states are urged to adopt strategies that improve the nutritional value of food, minimise food losses, particularly for the resource-poor, and address food safety.
- **Disaster-induced emergencies.** The objective is to improve forecasting, prevention, mitigation and recovery from the adverse effects of natural disasters.
- **Enhance institutional frameworks.** The objective is to strengthen the institutional framework of the relevant institutions and expertise, as well as build capacity for implementing food security programmes in the SADC region.

Source: SADC 2004b

The Southern African Development Community member states have demonstrated strong commitment to implement the UNCCD by ratifying it and by developing national and sub-regional programmes to combat desertification. The SADC Sub-Regional Action Programme (SRAP), which was approved by the SADC Council of Ministers in 1997, provides a collective response to problems of land degradation, drought and desertification, especially those of a transboundary nature.

WESTERN AFRICA

As shown in Figure 8, about 70 per cent of Western Africa, covering mainly the Sahelian zone, is semi-arid to desert (CILSS 2005). The sub-region is experiencing an increase in land degradation caused by salinity, erosion and the loss of soil fertility.

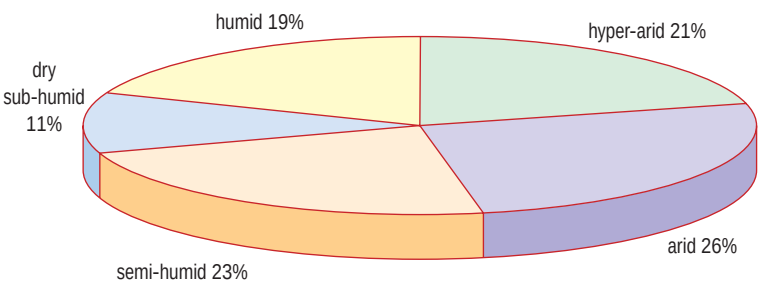
OVERVIEW OF LAND RESOURCES

The total land area of the sub-region is 607.84 million ha (FAO 2005). Arable land, permanent pasture and protected areas are shown in Table 11.

ENDOWMENTS AND OPPORTUNITIES

West Africa is projected to grow 4.5 per cent in 2005, with 8 of the 15 countries expected to record improvements over those achieved in 2004. These are Benin, Burkina Faso, Cape Verde, Côte d'Ivoire, Guinea, Guinea-Bissau, Mali and Senegal (ECA 2005). Land resources are the primary driver of this growth. Factors behind this growth include agricultural growth in Benin, Gambia, Guinea, Mali, Senegal, Sierra Leone and Togo; donor support for Guinea-Bissau, Liberia and Sierra Leone; expansion in mining in Burkina Faso, Guinea, Ghana, Mali and Sierra Leone; foreign investment inflows to Cape Verde and Liberia (in response to anticipated improvement in political stability); and growth in tourism in Cape Verde and Gambia (ECA 2005).

Figure 8: State of aridity in Western Africa



Source: CILSS 2005

Agriculture is the main source of revenue of almost 60 per cent of the population. The main subsistence and cash crops are maize, rice, coffee, cotton, cocoa, palm oil and fruits. Agricultural income represents an important part of GDP.

In the Sahelian zone, semi-nomadic and domestic livestock production are important activities. However, the long duration of the dry season compels breeders to move their cattle towards the south. This happens in Senegal, Niger, Gambia, Guinea-Bissau, Mali, Mauritania and Burkina Faso.

Regionally, oil has been an important stimulant of growth. The full potential of this for Western Africa is not known. Benin, Ghana, Gambia, Guinea-Bissau, Mali, Niger, Senegal and Togo are all believed to have some oil deposits. Nigeria is the largest oil producer in Africa and the eleventh largest in the world, In 2004, Nigeria's

Table 11: Arable land and permanent pasture

Country	Land area (1 000 ha)		Arable land (1 000 ha)		Permanent pasture (1 000 ha)	
	1990	2003	1990	2003	1990	2003
Benin	11 062	11 062	1 615	2 650	550	550
Burkina Faso	27 360	27 360	3 520	4 840	6 000	6 000
Cape Verde	403	403	41	46	25	25
Côte d'Ivoire	31 800	31 800	2 430	3 300	13 000	13 000
Gambia	1 000	1 000	182	315	450	459
Ghana	22 754	22 754	2 700	4 185	8 405	8 350
Guinea	24 572	24 572	728	1 100	10 788	10 700
Guinea-Bissau	2 812	2 812	300	300	1 080	1 080
Liberia	9 632	9 632	400	382	1 993	2 000
Mali	122 019	122 019	2 053	4 660	30 000	30 000
Mauritania	102 522	102 522	400	488	39 250	39 250
Niger	126 670	126 670	11 036	14 483	22 000	24 000
Nigeria	91 077	91 077	29 539	30 500	40 000	39 200
Senegal	19 253	19 253	2 325	2 460	5 744	5 650
Sierra Leone	7 162	7 162	486	570	2 204	2 200
Togo	5 439	5 439	2 100	2 510	1 000	1 000
Total	605 537	605 537	59 855	72 789	182 489	183 464

Source: FAOSTAT 2005

production averaged 2.5 million barrels per day (bbl/d) and it plans to increase this to 3 million bbl/d in 2006 and to 4 million bbl/d by 2010 (Energy Information Administration 2005b).

Mining, including for gold, phosphates, iron, uranium and diamonds, offers opportunities for development.

Challenges faced in realizing opportunities for development

Land degradation is the main threat to the opportunities of land for sustainable development. There are several reasons for land degradation in Western Africa: overexploitation, bush fires, and population pressure associated with high population growth rates, to name but few. Land degradation can also be attributed to repeated periods of drought. The immediate effects of the degradation process are erosion, loss in soil fertility, reduction of biodiversity and biomass productivity, and impoverishment of the population.

In the Sahel, overgrazing is another threat to opportunities as it emphasizes land degradation.

Western Indian Ocean Islands

Overview of land resources

The four island countries of the Western Indian Ocean (WIO) sub-region have a total land area of 59.2 million ha, 99 per cent of which is Madagascar, the fourth largest island country in the world (UNDP 2004). Large parts of the sub-region are mountainous, rugged and dry.

Endowments and opportunities

The main use of land is agriculture, although this has been steadily declining due to pressures from population growth and industrial development. As shown in Figure 9, only in Madagascar and the Seychelles is the majority of land still used for agriculture. Agriculture contributes 3 per cent and 6 per cent of the GDP for the Seychelles and Mauritius, respectively, and 35 per cent and 41 per cent of the GDP for the Comoros and Madagascar, respectively (FAO 2003).

The pattern of agriculture varies between the islands depending on climatic conditions for producing particular crops. The islands, however, remain net importers of cereals and staples such as rice and potatoes.

Agricultural expansion and tourism were the main growth factors for Madagascar, Mauritius and the Seychelles.

Challenges faced in realizing opportunities for development

Population growth in WIO countries puts pressure on land, as demonstrated in Box 8. Population growth in

Table 12: The extent of land area in the Western Indian Ocean island countries and the population

Countries	Population Millions	Land area km²	Population density Pop/km²	Population growth % per year	Population growth '000 per year	Land use Agriculture as % of total land	Coastline km
Comoros	0.7	2 171	315	2.6	18.2	34	469
Madagascar	16.4	587 041	27	2.7	442.8	53	9 935
Mauritius	1.2	2 045	581	0.8	9.6	44	496
Seychelles	0.1	455	173	0.8	0.0	84	746
Total	18.4	591 712	31.09	2. 56	470.6	53	11 646

Sources: FAOSTAT 2005, UNDP 2004; WRI 2005

Madagascar is predicted to be 2.5 per cent per annum for the period 2003-2015: with the current population at 17.6 million this will give an increase to 23.8 million by 2015 (UNDP 2005). In 2003, population density in Madagascar was 29.9 people per km² (FAO 2005). In contrast, population density in Mauritius was 604.5 people per km² – the highest in Africa (FAO 2005), with the population expected to grow at 0.8 per cent per annum (UNDP 2005).

In Madagascar, frequent drought conditions and seasonal floods from cyclones create food emergencies. Climate change will also increase the pressure on land resources, through less predictable weather conditions and the impact of sea-level rise on the coastal regions, especially in the smaller islands.

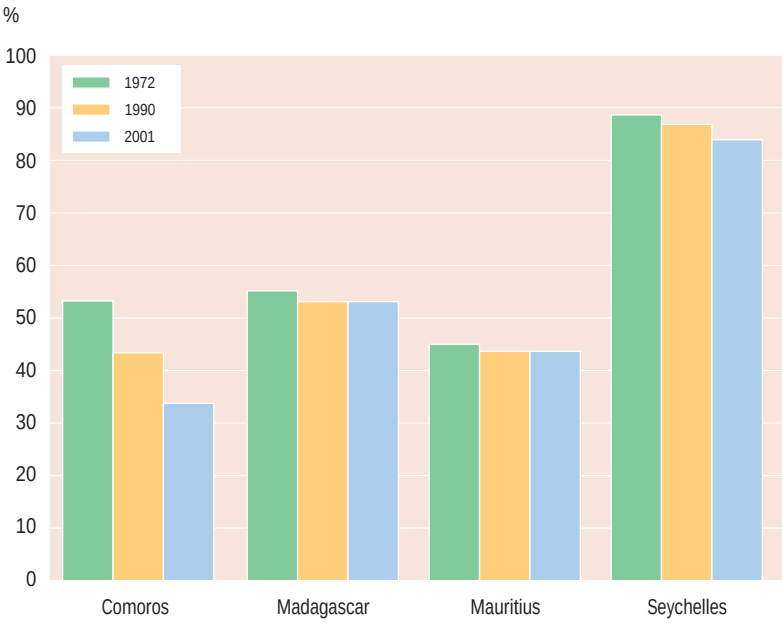
The WIO islands are challenged to respond to the NEPAD policy to combat land degradation. This is being done through the Indian Ocean Commission's (IOC) Environment Programme which calls upon each of the four countries to develop and implement action plans to promote sustained livelihoods and mitigate the past impact of land degradation on other resources. In Madagascar, an environmental awareness programme supports the national conservation strategy, focusing on habitat and biodiversity protection, the creation of a national environmental fund with research projects on land mapping and management, environmental education, training and institutional support.

The sub-region should also develop irrigation; over one million hectares of land has potential for irrigation. In a sub-region where droughts are prevalent, often destroying crops and exacerbating food insecurity, irrigation could be a key factor in enhancing food security.

Enhancing and extending property rights are key challenges for promoting development and conservation. Mauritius and the Seychelles have established more equitable mechanisms for distribution of land with effective protection of land rights. In Mauritius, 90 per cent of the land is privately-owned and more than 85 per cent of people live in owner-occupied property with government-registered deeds. By contrast, in Madagascar, landownership has been without enforceable land registration, creating difficulties in its use as collateral for investment. This is now changing and land registration is being introduced as part of a general policy to improve land use, to reduce land degradation and short-term exploitation, and to promote the development of investment.

Controlling and managing pollution is important for the tourism sector which is an important part of the economy.

Figure 9: Western Indian Ocean countries: agricultural areas (as a percentage of total land area)



Source: FAO 2003

Sugar cane fields, Mauritius.

Source: A. Mohamed

CONCLUSION

Land is a key factor in sustainably managing the environment for development in Africa, but there are many challenges to be overcome. The region has sufficient land resources to produce enough food to feed its people and yet one in three people in the region is presently undernourished (USAID 2003). Increasing agricultural production in Africa – the dominant economic activity in most parts of the region – is the key to addressing extreme poverty and hunger (USAID 2003).

Although mainly arid and semi-arid, Africa has significant freshwater resources to harness and expand irrigated agriculture and enhance food production, and yet governments often depend on food imports and/or humanitarian aid. The challenges of physically accessing the water resources, as well as inadequate investment in appropriate technology, limit irrigation

Box 8: Pressures on land use in Mauritius

The demand for housing in Mauritius is the single largest pressure on the future use of land and could involve conversion of 5 000 ha by 2020. About 800 ha of land could be needed for new business parks and industry, including small- to medium-scale enterprises, while 400 ha may be needed for new schools, colleges and universities and other institutions. To this should be added demand for integrated resorts, leisure complexes, public transport, highways and utilities including the proposed Light Railway system and new water storage dams.

Because of land scarcity, residential estates have been built on hillsides and there is increasing pressure to develop housing on mountain slopes. Some 66 per cent of industry in Mauritius is located in the central urban zone. In many coastal areas, rapid development of housing and commerce has outstripped the rate of provision of environmental services and community facilities, especially waste management and sewage. Many coastal settlements do not conform to the planning guidelines for set-back, sea defences, access to the beach and height of buildings. The effects include a reduction in scenic attractiveness, restricted public access to the beaches, pollution of coastal waters with sewage and solid wastes, and beach erosion. The Tourism Development Plan for Mauritius (2002) predicts that provision for tourists will expand from around 9 000 rooms at present to 20 000 by 2020.

Some 20 per cent of wetlands in Mauritius have been filled in the northern tourist zone, 50 per cent in the western area, and 50 per cent of the remainder are under pressure. Building has increased pollution of the lagoon by affecting the important functions of the wetlands in reducing nutrient loads and retaining sediment.

The concentration of business, industry and residences in the Port Louis and central area of Plaines Wilhems has put acute stress on infrastructure and resources. These heavily built-up areas, coupled with a lack of adequate planning, give rise to serious problems of traffic congestion. The impact includes localized episodes of poor air quality, its effects on the health of the urban population and delays in travelling around the island and consequent higher transport and operating costs for business. The main challenge facing land resources in Mauritius is to ensure that land is readily available for the economic development objectives of the nation, while taking into account environmental concerns and social needs. One solution is to concentrate future major development in strategic growth clusters in the conurbations, promoting an urban renaissance, particularly in key town centres, thus enabling rural regeneration and tourism development in other settlements in the countryside and on the coast. Development should be planned so that, wherever possible, it minimizes the need to travel and facilitates safe and convenient movement on foot, by bicycle and by public transport. There should also be proper planning in order to make the best use of existing transportation networks whilst also having regard to strategic priorities. This will all require more attention from professionals, skilled in land development and urban planning, which the country lacks at present. The aim would be to manage development in ways which enhance and protect the environment and provide a better quality of life for the people.

Source: SADC 2004b

expansion. The funds available to import food could, over the next decade, be invested, for example, in strategic areas to incrementally build food security at different levels.

The region is a mining giant: Africa produces 77 per cent of platinum in the world; 62 per cent of aluminium silicate; more than 50 per cent of vanadium and vermiculite; more than 40 per cent of diamonds, palladium and chromium; and more than 20 per cent of gold, cobalt, uranium, manganese and phosphate rock (ECA 2004b). And yet its industrial base is insignificant on the global market, and the majority of its people live in growing poverty. There is a need for Africa to move from being a major exporter of primary resources to strengthening its industrial and manufacturing base.

Africa has numerous tourist attractions, ranging from wildlife to cultural heritage, and yet it contributes only 4 per cent annually to the multi-million dollar global tourism industry. Issues of poor infrastructure, lingering perceptions of instability and other external factors such as adverse travel advisories conspire to retard any significant development in this sector.

The region has the human resource base to tackle these and other challenges, but many who have acquired the necessary skills and experience or are in the process of doing so, are faced with the threat of HIV/AIDS. This is the greatest threat to the security and development of the region, and to individual countries. In some countries, life expectancy has been cut by about 50 per cent in the past two decades. Women are the most vulnerable to HIV/AIDS and are at least 20 per cent more likely to be infected than men as a result of inadequate education and poor gender relations. Malaria is another serious threat to the realization of the MDGs, contributing to the decrease of the region's GDP by about US$12 000 million annually (USAID 2003). Malaria kills 2.5 million people every year – 90 per cent of them in Africa (USAID 2004).

Environmental governance in terms of land is well entrenched with so many laws and policies, institutions and stakeholders but yet effectiveness remains a mirage due to various factors, including policy failures.

Some governments have made great strides in opening up the democratic space, with more one-party states being abandoned, and general and presidential elections being held. Since the end of 2002, presidential or parliamentary elections have taken place in countries such as Nigeria, Togo, Rwanda, Guinea, Algeria, South Africa, Ghana, Namibia, Mozambique and Zimbabwe. Opposition politics has flourished since the 1990s and has become entrenched in governance systems across Africa. Even though many stakeholders are now involved in governance, inequalities still persist, particularly in terms of access

Landscapes of northern Shoa, Ethiopia.

Source: S. Sprague/Still Pictures

to land resources, especially for women. Human Rights Watch (Ganesan and Vines 2004), for example, reported that governments in many resource-rich countries are abusive, unaccountable and corrupt: "Rather than representing the citizenry, the government becomes predatory, committing abuses to maintain power and controlling the resources of the state for the benefit of a few."

Managing Africa's land resources is complex, requiring the input and participation of different stakeholders and interests as well as transparent and effective governance structures. Governance systems should be able to balance the needs of small and large investors, community and national interests as well as sectoral demands and conflicts. It is evident from different economic data provided in previous sections that land is the foundation upon which the eight MDGs – from eradicating extreme poverty and improving gender equality to ensuring environmental sustainability and developing a global partnership for development – can be realized in Africa. Land in Africa is a social, economic and environmental good, and as long as all the ingredients critical to achieving the MDGs through the available land resources are rationed, the goals will remain a chimera.

The importance of stronger tenure rights, with related improved governance system as the basis for improving sustainable management and enhancing opportunities can not be overemphasized. Long before the MDGs were adopted by world leaders in 2000, the World Commission on Environment and Development (WCED) was visionary in its analysis of the role of land in sustainable development, saying in its 1987 report:

> "In many countries where land is very unequally distributed land reform is a basic requirement. Without it, institutional and policy changes meant to protect the resource base can actually promote inequalities by shutting the poor off from the resources and by favouring those with large farms, who are better able to obtain the limited credit and services available."

> "By leaving hundreds of millions without options, such changes can have the opposite of their intended effect, ensuring the continued violation of ecological imperatives."

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CHAPTER 4
FRESHWATER

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REGIONAL SYNTHESIS

The availability of and access to freshwater is an important determinant of patterns of economic growth and social development. This is particularly the case in Africa where most people live in rural areas and are still heavily dependent on agriculture for their livelihoods. Water is an essential resource for sustaining economic development in all sectors. Freshwater is a necessary input for industry and mining, hydropower generation, tourism, subsistence and commercial agriculture, fisheries and livestock production, and tourism. These activities are central to livelihoods and human well-being; they provide employment and contribute to national economies through, among other things, export earnings.

Water is not only an economic good but also a social good. Safe water supply and appropriate sanitation are the most essential components for a healthy and prosperous life. The provision of safe drinking water and adequate sanitation facilities, to the rural and rapidly expanding urban populations, can reduce mortality rates related to water-borne and water-related diseases, such as cholera, diarrhoea and malaria.

Economic security and human well-being are dependent on the protection of this resource. This demands that water be managed as part of a healthy functional ecosystem, in order to ensure it continues to deliver essential environmental goods-and-services. The hydrological cycle links the different components of the environment (atmospheric, marine, aquatic, terrestrial and subterranean), and this means that water resources are linked, via the water itself, to all the other components of the broader environment (MacKay and others 2004). This has important implications for management choices: integrated water resource management (IWRM) approaches ensure that water resources are managed as ecosystems. Further, the transboundary nature of water means that regional and sub-regional cooperation are essential to ensure the beneficial and sustainable use of this resource.

Africa is endowed with immense renewable natural resources including freshwater resources. Yet, natural phenomena, such as rainfall patterns and climate change and variability, and human factors, such as population growth, competition over water, and pollution, increasingly threaten the sustainability of resources, and hence the livelihoods of many, particularly poor, people. It is widely recognized that a radical change in approach is required in order to adequately address these threats and so that the available water resources do not become a constraint, but serve as an instrument for accomplishing New Partnership for Africa's Development (NEPAD) development goals. These goals include poverty alleviation, economic recovery and securing a sustainable environment. It is in this light that a shared Africa Water Vision and water supply and sanitation targets were defined at the World Water Forum in The Hague in 2000. The Vision calls for a new way of thinking about water and a new form of regional cooperation. It aspires to "An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socioeconomic development, regional cooperation, and the environment" and specific targets have, as shown in Box 1 been set to achieve this (ECA and others 2000). Achieving this Vision requires new approaches to governance and institutions, including, among other things, the adoption of integrated and participatory approaches, management at the lowest possible level and the mainstreaming of gender issues.

> An Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socioeconomic development, regional cooperation, and the environment.
>
> Africa Water Vision for 2025 (ECA and others 2000)

Box 1: The Africa Water Vision for 2025: targets for urgent water needs

By 2015:

- Reduce by 75 per cent the proportion of people without access to safe and adequate water supply.
- Reduce by 70 per cent the proportion of people without access to safe and adequate sanitation.
- Increase by 10 per cent water productivity of rain-fed agriculture and irrigation.
- Increase the area of irrigated land by 25 per cent.
- Realized 10 per cent of the development potential for agriculture, hydropower, industry, tourism and transportation.
- Implement measures in all countries to ensure the allocation of sufficient water for environmental sustainability.
- Implement measures in all countries to conserve and restore watershed ecosystems.

By 2025:

- Reduce by 95 per cent the proportion of people without access to safe and adequate water supply.
- Reduce by 95 per cent the proportion of people without access to safe and adequate sanitation.
- Increase by 60 per cent water productivity of rain-fed agriculture and irrigation.
- Increase the area of irrigated land by 100 per cent.
- Realized 25 per cent of the development potential for agriculture, hydropower, industry, tourism and transportation.
- Implement measures in all river basins to ensure the allocation of sufficient water for environmental sustainability.
- Implement measures in all river basins to conserve and restore watershed ecosystems.

Source: ECA and others 2000

Overview of resources

Africa's extreme variability of rainfall – in time and space – is reflected in an uneven distribution of surface and groundwater resources, from areas of severe aridity with limited freshwater resources like the Sahara and Kalahari deserts in the northern and southern parts, to the tropical belt of mid-Africa with abundant freshwater resources.

Internal renewable freshwater resources average about 3 950 km^3 per year, as shown in Table 1. This amounts to about 10 per cent of the freshwater resources available globally and closely resembles Africa's share of the world population at 12 per cent (Donkor 2003).

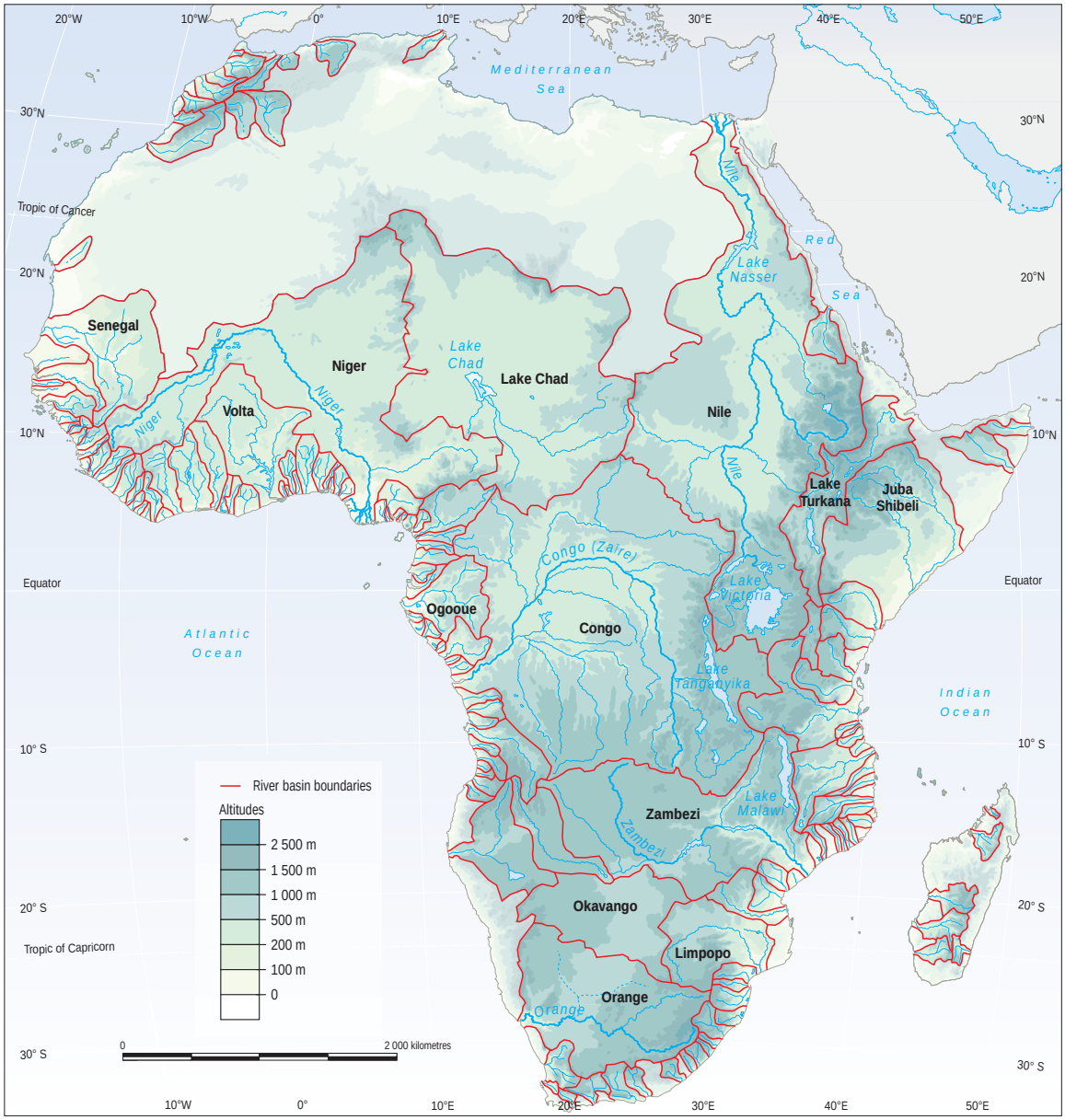
There are over 50 internationally shared river and lake basins in Africa. Figure 1 shows the major river basins. These are the Niger, Lake Chad, Nile, Zambezi and Orange river basins. Most of the surface water resources are concentrated in the Congo, Niger, Ogooue, Zambezi and Nile. Less than 10 per cent of Africa's river and lake basins are covered by wetlands (IUCN and others 2003). Nevertheless, wetlands are an essential part of freshwater systems as they provide an array of environmental goods-and-services, such as flood and erosion control, water storage and filtering, a range of food and material products, as well as opportunities for recreation. Some basins, such as the

Table 1: Renewable water resources

Sub-region	Population (million)	Area (1 000 km^2)	Average precipitation (mm/yr)	Average precipitation (km^3/yr)	Internal renewable resources (km^3/yr)	Internal renewable resources Percentage
Northern Africa	174	8 259	195	1 611	79	>1
Western Africa	224	6 138	629	3 860	1 058	27
Central Africa	82	5 366	1 257	6 746	1 743	44
Eastern Africa	144	2 758	696	1919	187	5
Southern Africa	150	6 930	778	5395	537	14
Western Indian Ocean islands	19	594	1 518	2 821	345	9
Total	793	30 045	744	22 352	3 949	

Source: AQUASTAT 2003

Figure 1: Africa's water resources



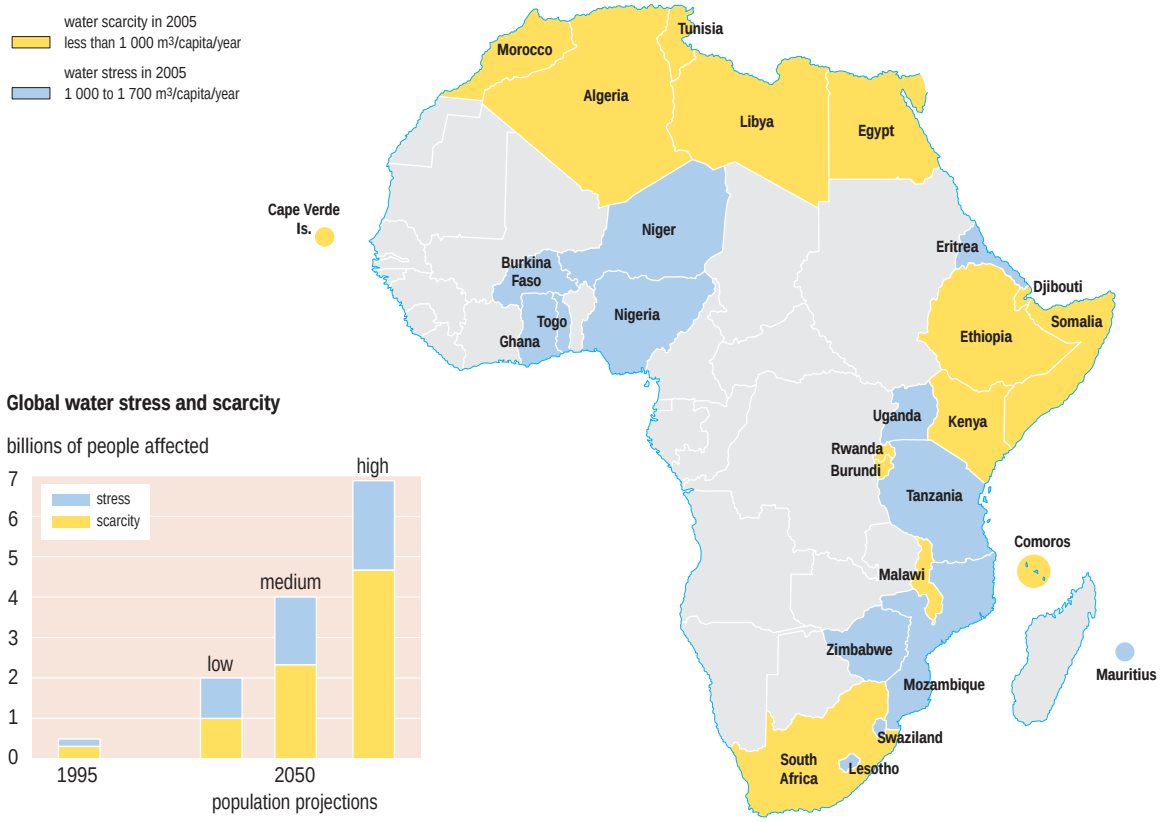
Source UNEP 2002c; Data from Revenga and others 1998, Rekacewicz 1996, Wolf and others 1999

Nile, Volta and Zambezi, have large dams (> 60 metres high) for water supply and power generation. New dams are currently under construction in the Niger and Orange river basins. Compared with the last few decades, the rate of construction of new dams has greatly slowed down (IUCN and others 2003).

The urban population of sub-Saharan Africa (SSA) is expanding at a rapid rate, and as a result there is a rise in demand for potable water supply. Changing population patterns and growth are discussed in Chapter 1: *The Human Dimension*. Groundwater can be a viable resource to meet growing demand provided the necessary protective and institutional measures are in place and enforced. Annual groundwater recharge per capita is lowest for Northern Africa: 144 m^3 per capita for the Atlas Mountains and 350 m^3 per capita for the North African basins; the extent of groundwater development in these parts is 49 per cent and 22 per cent of mean annual groundwater recharge respectively (IGRAC 2004). In other sub-regions, annual groundwater recharge ranges from 2 400 to 9 900 m^3 per capita (IGRAC 2004).

Climate change and variability, population growth and increasing water demand, overexploitation and environmental degradation have significantly contributed to the worsening of the state of freshwater resources, leading to an increasing number of African countries where water demand outstrips available resources. Fourteen African countries experience water stress (less than 1 700 m^3 per capita/year) or water scarcity (less than 1 000 m^3 per capita/year; WRI and others 2000).

Figure 2: Freshwater stress and scarcity by 2025



Source: UNEP 2002

Endowment and opportunities

Africa's freshwater system holds a vast array of opportunities. In 2005, only about 5 per cent of the development potential of these resources – irrigation, industry, tourism and hydropower – was expected to be utilized (ECA and others 2000). Freshwater resources can potentially be used to improve human well-being through meeting urgent water needs in the areas of health and food security.

Wetlands

Freshwater is an integral part of the environment and its temporal and spatial availability is indispensable to the efficient functioning of wetlands and lakes, including coastal beneficiaries such as mangrove forests and other coastal wetlands.

The largest inland wetlands include: the Congo River swamps, the Sudd in the upper Nile, the Lake Victoria basin, the Chad basin, the Okavango Delta, the Bangweulu swamps, the Lake Tanganyika basin, the Lake Malawi/Nyasa/Niassa basin, and the floodplains and deltas of the Niger and Zambezi rivers (NEPAD 2003).

These wetlands provide a number of environmental goods-and-services including flood control, erosion control, and toxicant removal and/or retention. (see Box 2). The lakes are a habitat for major sources of nutritional supplies of fish, which are mostly treated as open access resources for subsistence and commercial use. Wetlands and freshwater bodies are associated with rare varieties of plant and animal species. In addition to this rich biodiversity they are also an important source of food. Further, they may

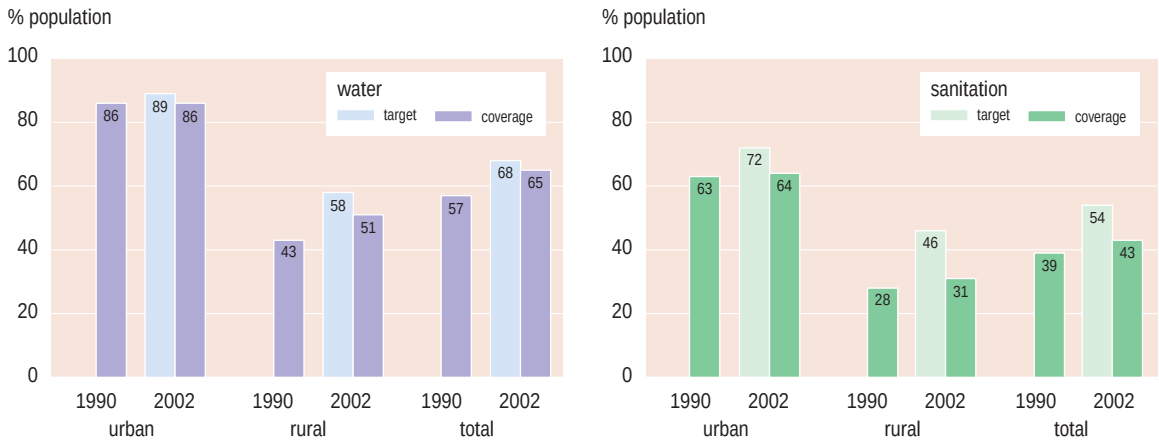
Box 2: Understanding how a wetland functions

Wetlands tend to be found where water is spread out and the speed of water flow is reduced. Slow water-flow increases the entrapment of sediment in the wetland and also leads to saturation of the soils for extended periods, creating anoxic conditions below the surface (the "bad egg" smell in some wetland sediments). The saturated conditions create a favourable environment for certain plants and micro-organisms to grow. The waterlogged state of the soil slows down the decomposition of the soil's organic matter and provides a suitable environment for many chemical processes that help to trap pollutants like heavy metals.

The special way in which wetlands function provides several benefits to people. One important ecosystem service is the removal of nutrients and other pollutants. Wetlands purify water by slowing down water flow, supporting abundant plant growth, and creating waterlogged soils which support the activity of soil micro-organisms, especially those occurring in the root zone of plants.

Source: Dickens and others 2003

Figure 3: Water supply and sanitation coverage in rural and urban settings between 1990 and 2002 for Africa



Source: WHO and UNICEF 2004

serve as important transport waterways and are important areas for tourism, such as the St Lucia Wetlands on South Africa's east coast which have been declared a World Heritage Site.

Health and well-being

In 2002, the United Nations Economic and Social Council (ECOSOC) recognized water as a human right. Clean and safe drinking water for domestic use is widely considered as one of the most urgent water needs. As shown in Figure 3, 51 per cent of rural areas had access to water supply in 2002, compared with 86 per cent in urban areas (WHO and UNICEF 2004).

Access to safe water is a precondition for health and for success in the fight against poverty and hunger. It is crucial for meeting several of the Millennium Development Goals' (MDGs) targets (Annex 1 lists and shows progress made towards meeting these targets) including:

- Target 1: Reduce by half the proportion of people living on less than a dollar a day;
- Target 2: Reduce by half the proportion of people who suffer from hunger;
- Target 5: Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate; and
- Target 10: Halve, by 2015, the proportion of people without access to safe drinking water and basic sanitation.

Recreation and rest are also important aspects of human well-being. For many rural people, especially children, rivers provide one of the few opportunities for recreation.

Irrigation

Meeting irrigation water needs, for food security and economic development, is another important area. Several basins are used for irrigated agriculture. These

Children playing in a stream on the outskirts of Brazzaville, Congo.

Source: M. Marzot/FAO

include the Limpopo basin which provides 82 per cent of the potential irrigation area of approximately 0.3 million ha, and the Nile basin which provides over 50 per cent of the potential 10 million ha (AQUASTAT 2003). Egypt and Sudan utilize 70 per cent of their respective shares of the basin land of 4.4 million ha and 2.8 million ha (AQUASTAT 2003). Utilization of potential irrigation areas of other basins is less (eg Congo: only 0.4 per cent; Zambezi: only 5 per cent; and Niger: 33 per cent). With its 30.3 million km^2 of irrigation potential, Africa provides considerable opportunities for further expansion of irrigated agriculture. Irrigation, along with other opportunities and challenges faced in the agricultural sector, are considered more fully in Chapter 3: *Land*.

In meeting urgent water needs, there is scope for alternative technologies, such as rainwater harvesting, wastewater recycling and desalination. Wastewater recycling is practised in particular in Southern Africa. As early as 1994, Windhoek, Namibia, was recycling 13 per cent of its wastewater for domestic consumption, while Harare, Zimbabwe, was recycling 10 per cent (Mohammed and Francis 2002). Gaborone, Botswana, plans to recycle 60 per cent of its urban flow by the year 2020 (Mohammed and Francis 2002). Artificial groundwater recharge may be applied to enhance the sustainability and yield of aquifers (see eg Murray 2004). In Egypt, for example, at present 40 million m^3 per annum of drainage water is re-used for irrigation. An extra 30 million m^3 per annum in Egypt could be considered for re-use in the future. Another way of recycling is re-use of treated wastewater which could be increased from the present 5 million m^3 per annum to 25 million m^3 per annum by the year 2010.

• Dams fundamentally alter rivers and the use of a natural resource, frequently entailing a relocation of benefits from local riparian users to new groups of beneficiaries at a regional or national level. •

WCD 2000

Hydropower

Per capita electricity consumption in Africa is still low (515 kWh/cap) compared to the world's average (2326 kWh/cap) (Lokolo 2004). At the household level, only 20 per cent have access to electricity: However, in Northern Africa household access is significant, averaging 86 per cent, with some countries including Algeria, Egypt, Libya and Tunisia reaching 95 per cent. In contrast, the rest of Africa averages 15 per cent, with Central Africa having the lowest rate at only 9 per cent (Ogunlade and Youba 2002).

Although many of Africa's rivers could be utilized for electricity generation, less than 5 per cent (ECA 2000) of the economically feasible hydropower potential, of one million GWh per year, is being utilized. Hydropower contributes about 20 per cent to overall electricity generation (Lokolo 2004).

The Congo River accounts for nearly 30 per cent of Africa's surface water reserves and has the largest hydropower potential in the world (ECA 2000). Current usage is discussed in the Central African section of this chapter. It has vast untapped potential. It is estimated that it could generate, 40 000 megawatts, sufficient power supply for the whole of Africa and to have sufficient over to export (ECA 2000). South Africa's power generating company, ESKOM, plans to develop a hydropower dam at Inga on the Congo River. It will have a series of 52 750 mw turbine installations at the Inga Rapids, and its installed capacity would be more than twice that of the huge Three Gorges Dam in China. Its estimated cost is US$50 000 million (Hathaway 2005).

Small-scale generation also holds important opportunities with, perhaps, fewer of the environmental

Hydroelectric dam, Tanzania.

Source: M. Edwards/Still Pictures

costs. Small power plants have the potential to meet the energy needs of rural and off-grid communities. These plants are classified into three types: small (1 – 10 MW), mini (100 KW – 1 MW) and micro (< 100 KW). Hydropower has the potential to supply low-cost electricity in several countries. However, droughts are increasing in severity and frequency, posing a major threat to a reliance on hydropower.

Hydropower development faces several barriers. These include lack of investment, low technical capacity, and a weak regulatory and policy environment. Several factors contribute to the high cost of hydropower plants. These include the employment of foreign experts in planning and design; lack of local investment capital; long lead times; lack of local production capacity; and comparatively low demand or poor economies of scale. The environmental and social costs associated with large dams are making this a less attractive option for harnessing hydropower potential. The World Commission on Dams (WCD), for example, noted that, "The global debate about large dams is at once overwhelmingly complex and fundamentally simple. It is complex because the issues are not confined to the design, construction and operation of dams themselves but embrace the range of social issues, environmental and political choices on which the human aspiration to development and improved well-being depend. Dams fundamentally alter rivers and the use of a natural resource, frequently entailing a relocation of benefits from local riparian users to new groups of beneficiaries at a regional or national level. At the heart of the dams debate are issues of equity, governance, justice and power – issues that underlie the many intractable problems faced by humanity" (WCD 2000). With careful planning, however, hydropower potential can be developed and utilized while minimizing the negative environmental and social impacts.

The feasibility of large dams and the implications for environment and social systems are contested.

Tourism

Water-based tourism is important in several localities and in such places it is often an integral part of livelihoods systems, providing a range of income and business opportunities. Zimbabwe's Lake Kariba and Malawi's Lake Malawi are examples of this, and support photographic and sports-based tourism. Lake Malawi hosts a rich diversity of tropical freshwater fish – it has more species of fish than any other lake in the world (S & E Bulletin 1999). The value of tourism and the opportunities it presents are discussed more fully in Chapter 3: *Land*.

Challenges faced in realizing opportunities for development

Climate change and variability, population growth and increasing water demand, overexploitation and environmental degradation will continue to contribute to a worsening of the state of freshwater systems. In 2000, the United Nations noted that, "Global freshwater consumption rose sixfold between 1900 and 1995 – more than twice the rate of population growth. About one-third of the world's population already lives in countries considered to be water stressed – that is where consumption exceeds 10 per cent of supply. If present trends continue, two out of every three people on Earth will live in that condition by 2025" (Annan 2000).

The overexploitation and regulation of water resources have caused significant changes in the flow regimes of rivers, resulting in negative impacts on the environment and loss of ecosystem functioning. Poor land-use practices have resulted in pollution and sedimentation of river channels, lakes and reservoirs, and changes in hydrological processes. Dams, in particular large dams, threaten freshwater resources by fragmenting and transforming aquatic systems. The region is marked by a recurrence of climatic extremes in the form of flooding and drought. Global change scenarios predict a continuing global warming for this century of between 1° and 6°C, a sea-level rise of between 0.1 and 0.9 m (IPCC 2001), and an increasing frequency of climatic extremes that may further aggravate the state of available freshwater resources.

Not only is the quantity of freshwater fundamental for the development of all sub-regions, but the quality of the resource is equally important. Deterioration of the quality of water resources resulting from further increases in salinity and nutrient loads from irrigation (irrigated agriculture) and the domestic, industrial and

Global freshwater consumption rose sixfold between 1900 and 1995 – more than twice the rate of population growth. About one-third of the world's population already lives in countries considered to be water stressed – that is where consumption exceeds 10 per cent of supply. If present trends continue, two out of every three people on Earth will live in that condition by 2025.

Kofi Annan, Secretary General of the United Nations. 2000

Pollution of rivers from industry is a growing problem in many parts of Africa.

Source: M. Chenje

mining sectors will significantly deplete available resources and increase water scarcity. Increased human activities lead to the exposure of the water environment to a range of chemical, microbial and biological pollutants as well as to micro-pollutants. The mining and industrial sectors, in particular, produce high concentrations of wastes and effluents that act as non-point sources of water quality degradation and acid mine drainage. Increased groundwater pollution is a particular concern for the more arid countries.

Governance of water resources

Governance is the central issue for water resources, especially in the light of water scarcity and environmental change, and is critical for maximizing available opportunities. Threats to good management and regional cooperation include climate variability (with droughts over the past 30 years) because it results in a decrease in water availability and an increase in competition over water, political instability, and low priority given to water and sanitation in terms of investment in infrastructure and maintenance. The high rates of population growth and subsequent increased demand from the agricultural and domestic sectors for freshwater resources, have increased the pressure on the resources, even in areas like Central Africa with its relative abundance of water resources. There is the possibility that increasing water scarcity may lead to water-related conflicts.

Implementation and enforcement

The lack of, or weak, regulatory instruments, institutional frameworks and human capacity make realizing policy objectives a challenge. For example, in Central Africa, legislation for water management is not only weak but also difficult to enforce. In several countries, the implementation and enforcement of law and policy is a problem. In Cameroon, for example, the Environmental and Water Management Law (1996), which aims at protecting continental and maritime waters, is still awaiting its implementation.

IWRM demands that multiple uses of freshwater are taken into account in management, including its ecosystem functions. Here, a fish eagle (*Haliaeetus vocifer*) fishes in Lake Malawi.

Source: M. Chenje

Water resource management

Water-sector reforms have been constrained by various factors, including internal resistance from executives of institutions, the lack of political will, frequent changes in government, and dependence on development partners to find the resources for the reforms. Other common obstacles for effective water resource management are the fragmentation of water management administration among various institutions, the absence of mechanisms for coordination, inadequate institutional capacity and resources, and the lack of an integrated approach towards water management.

Some countries lack adequate organizational frameworks to achieve sustainable water management. Burundi, for example, has no water authority to coordinate water-related activities; management and conservation are shared among nine ministries, which tend to compete with rather than complement each other (GWP 2006). The extended civil war – over 12 years – affected donor funding, financing and organizational and institutional development. This has resulted in a decline in water quality, delivery services and management capacity in the country (GWP 2006).

One of the biggest challenges, that must be addressed if the targets of the Africa Water Vision and the MDGs are to be met, is the lack of adequate human (technical and managerial), financial and material resources water authorities face, in particular as this relates to planning and implementing water and sanitation policies and programmes. There is generally a lack of know-how and institutional "strength", particularly in the area of IWRM, and this has limited the success of water resource management initiatives. Africa is also faced with the problem of retaining trained and highly skilled personnel, as many leave to work in countries where financial rewards and research opportunities are offered, The cost and implications of this are considered in Chapter 1: *The Human Dimension*.

Information generation and management

A key limitation at national, sub-regional and regional levels that is linked to inadequate financial and human capacity is the lack of adequate and good quality data on water resources. Good quality data is a prerequisite for effective and sustainable water resource management. Water-related data and information are often too general or of poor quality, due to inconsistencies or the period

over which the records were compiled. Data gaps may also result from disruptions to management from conflict or lack of funds. In Uganda, for example, there is a paucity of data on the quality of the country's surface and groundwater. In Ethiopia, there is a clear need for more detailed groundwater data, and in Central Africa hydrometric monitoring networks need to be revitalized. Another obstacle is the shortage of facilities and of skilled people at various levels to collect and analyse the information and data for longer-term water management.

Knowledge gaps

There is generally an information bias towards water quantity against quality. Information on groundwater resources is also less detailed and accurate in comparison with surface water resources. More information is needed in the areas of climate variability and change, water pollution and environmental flow. More and longer-term time-series of data and analyses are also needed, and what still needs to be resolved is the often restricted access to databases and the limited sharing of transboundary information. Better governance systems which increase opportunities for participation, accountability and transparency may help correct this information bias.

Another area in which there is a lack of knowledge is in early warning and disaster management. Fluctuations in rainfall, pollution of water sources and so on, have implications for food security, human and livestock health, and general economic opportunity, and thus need to be carefully monitored. Early warning gives users the opportunity to avoid harm and find alternatives.

Safe drinking water and sanitation

Despite improvement in the coverage for drinking water supply between 1990 and 2002 (Figure 3, WHO/UNICEF 2004), the coverage still falls short of the progress needed to achieve the MDG target of 75 per cent coverage by 2015. Regarding the MDG sanitation target, the situation is critical, though Northern Africa is almost on track in meeting both targets.

Poor sanitation, unsafe water and unhygienic environments are a leading cause of illness and death among children in Africa (WRI and others 2005, Gordon and others 2004) and cause millions of children in the developing world to suffer needlessly from disease. Chapter 1: *The Human Dimension* considers this more fully.

Obstacles to accelerating the rate of progress towards the MDG targets in all sub-regions, with the exception of Northern Africa, include, as stated above, political instability, high rates of population growth and the subsequent increased demand from the agricultural and domestic sectors, and the low priority given to water and sanitation in terms of investment in infrastructure and maintenance.

Many people do not have easy access to potable water. Here, women collect water in a forest in Cameroon.

Source: J. Nguiebouri/ CIFOR

Food security

Currently, huge losses due to crop failures, arising from droughts and flooding, are being experienced more frequently than ever before in Africa, causing famines and economic hardships. Insufficient investment and operational funds for irrigation infrastructure is a major constraint. In Eastern Africa, as elsewhere, there is a pressing need for development strategies that ensure food security. There is a growing pressure also on Southern Africa's water from the growing population and the major sectors of the different economies. In Western Africa, agricultural production will have to rise rapidly in the coming years to secure food and nutrition for the population. Meeting water needs for food security is therefore an important challenge.

Public health

Africa has relatively high morbidity and mortality rates concerning water-borne and water-related diseases, such as malaria, cholera and diarrhoea. It also has the highest incidence of HIV/Aids in the world (up to 36 per cent in Southern Africa; Ashton and Ramasar 2002). The implications of these diseases are enormous and affect the water sector in terms of water demand and supply, sanitation and human resource capacity

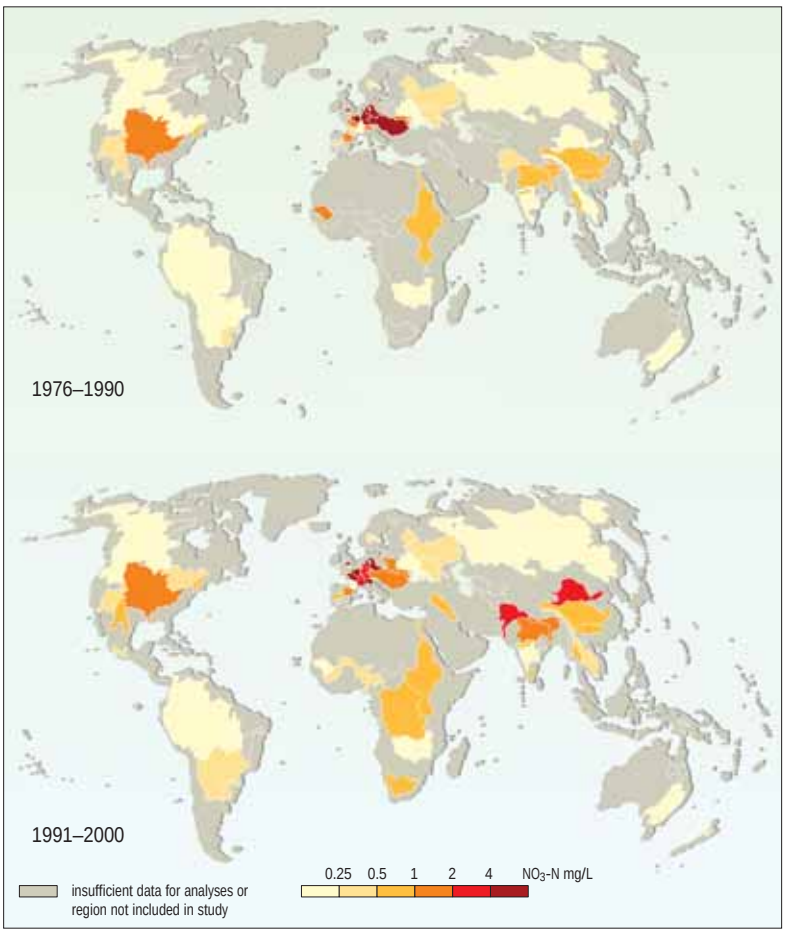
(including service provision). Any decline in drinking water quality and inadequate sanitation facilities will lead to increased health risks, particularly for those people with compromised immune systems.

Environmental degradation

Environmental degradation in surrounding ecosystems and of freshwater bodies threatens water quality and the opportunities derived from them.

For countries relying on hydropower generation for their electricity supply, environmental degradation is a serious concern. Hydropower generation requires the reliable flow of water for most of the time (wet and dry seasons). Among the many factors leading to the degradation of watershed ecosystems, dams are the main physical threat. They fragment and transform aquatic and terrestrial ecosystems with a range of effects that vary in duration, scale and degree of reversibility (WCD 2000). Degradation of the catchment area's environment results in the decline of springs, streams and rivers, with catastrophic consequences for human welfare and environmental integrity.

Figure 4: Global average nitrate levels. Concentrations at major river mouths



Source: UNEP GEMS/Water Programme 2005

Pollution of water resources is also a great concern as it is a threat to both the environment and the availability of freshwater. Agricultural chemical use contributes to pollution of rivers and lakes, including eutrophication which threatens aquatic life. The burning of biomass contributes to the atmospheric deposition of nutrients into freshwater systems. This can promote the formation of blue-green algae, which is toxic and potentially poses a health hazard to domestic animals, aquatic life and people (S & E 1999). Chapter 11: *Chemicals* discusses the opportunities and challenges faced by increasing chemical use.

Invasive alien species threaten freshwater resources, undermining their sustainability and contribution to livelihoods. The threats faced in this regard are considered in Chapter 10: *Invasive Alien Species*.

Financial resources

The World Panel on Financing Water Infrastructure noted that the flow of financial resources for water and sanitation has fallen over the last years (WWC 2003). Governments have not been giving enough priority or resources to their water sector, international loans and equity investment in water have been low and falling, and official aid for the water sector has also fallen. This trend constitutes a huge challenge, and must be reversed if water resource development goals are to be achieved.

A further challenge is that many water sector agencies are not adequately prepared for absorbing increased funding. A major effort of capacity-building is thus required to strengthen the public sector in the preparation and implementation of projects and programmes, including those involving private participation (WWC 2003).

The absence of economic incentives and appropriate price regulation may not encourage resource users and polluters to take conservation or other measures. In Northern Africa, for instance, irrigation water has been provided free of charge to farmers and consequently no conservation measures are taken by them. Another issue is the effective allocation and use of governments' budgets. Due to capital shortage, only part of the potential for irrigation in Africa could possibly be reached.

One major problem that water authorities are faced with is the low collection of water revenues and the use of flat-rate charging for water services. Regarding the latter, water meters may be used to encourage efficient use of the scarce resource and to reduce wastage.

Small water-supply and sanitation providers, such as community-based organizations (CBOs) and private-sector suppliers, play an important role in the water and sanitation sector. However, these providers are faced with problems related to finance and access to credit facilities.

Fika Phatso Dam in the eastern Free State, South Africa. In recent years there has been a dramatic fall in water levels due to, among other factors, overutilization.

Source: A. Mohamed

Strategies for enhancing opportunities for development

Improved governance

An improved legal and institutional context with enhanced transparency and accountability could contribute to more effective resource management, and at the same time maximize available opportunities and ensure the fair and equitable distribution of benefits. This would have positive spin-offs at multiple levels, including for human well-being and in particular health and nutrition, livelihoods and economic development.

An improved governance framework will need to address:

- Basic principles, such as equity and efficiency in water allocation and distribution, the need for integrated management approaches using the catchment and basin as basic units, and the need to balance the different water uses (eg for socioeconomic development versus maintenance of ecosystem integrity);
- The roles of government, civil society and the private sector and their responsibilities regarding management and administration of water resources;
- Regulatory regimes (eg water tariffs and subsidies to resource users and polluters) and;
- Risk management of water-related disasters, and climate variability and change.

An increasing number of countries are developing new policies, strategies and laws for water resource development and management based on the principles of IWRM that aim at decentralization, integration and cost-recovery. The Global Water Programme (GWP), for example, seeks to encourage dialogue among financiers, water professionals, decision-makers and water users at regional and country level. For example, in Ethiopia a process has been initiated to develop an IWRM plan to be implemented in connection with the process of decentralization in the country, and to this end has developed various laws, policies and strategies (GWP 2006). Countries which are undergoing water-sector reform have often restructured their institutional and legal frameworks. This may include setting up river and lake catchment and basin organizations.

The multiplicity of transboundary water basins in Africa has led to international cooperation and action plans, such as the establishment of the Africa Ministerial Council on Water (AMCOW) and the Africa Water Task Force to steer the processes. Through the New Partnership for Africa's Development (NEPAD), a short-term action plan (STAP) was prepared, with the aim of strengthening the enabling environment for effective cooperative management and development of transboundary water resources, and of initiating the implementation of prioritized programmes (see Box 3). Also, the Southern African Development Community (SADC) Protocol on

Box 3: Short-term action plan (STAP) for Transboundary Water Resources (TWR)

The NEPAD STAP on transboundary water resource management has five strategic areas:

- Facilitating political will and action.
- Facilitating resource mobilization.
- Fostering partnerships.
- Developing strategic frameworks, including the medium- to long-term strategic framework (plans that require more time for preparation and development).
- Facilitating capacity-building.

At a consultation meeting in June 2003, the African Development Bank (AfDB) and its development partners (including the World Bank), agreed to provide support to NEPAD for the implementation of STAP-TWR. It was also agreed that NEPAD's involvement in transboundary water resource management would initially focus on the following river basins: Niger and Senegal in Western Africa, Nile in Eastern Africa, Congo and Lake Chad in Central Africa, and Zambezi and Okavango in Southern Africa.

Source: AfDB 2004

Shared Watercourses, and the Nile Basin Initiative (NBI) are examples of transboundary cooperation that unlock development potentials and seek win-win benefits.

Though it is necessary to manage water resources at national and sub-regional levels, the management of water resources is best done at local level. Community-based natural resource management — especially water management — plays a critical part within holistic and integrated approaches for solving water scarcity problems. Key components of successful local water management are decentralizing decision making, accountability, and fostering ownership.

Capacity-building needs to be systematically included in IWRM plans. The capacity should be developed at all levels. Tailor-made capacity-building programmes for Africa can be developed and sustained that include institutional, human (technical and managerial), material and technological as well as financial aspects. Creative approaches (these are described more fully in Box 4) can be applied, in particular:

- Networking of education and training institutions, nationally and internationally (eg Capacity Building for Integrated Water Resources Management (Cap-Net and GWP);
- Establishing and sustaining national and international centres of excellence for critical issues;
- Enhancing distance education (eg the United Nations University (UNU) Water Virtual Learning Centre); and
- Strengthening partnerships with international training institutions (the United Nations Educational, Scientific and Cultural Organization's (UNESCO) Institute for Water Education (UNESCO-IHE).

Opportunities can be increased through establishing partnerships between the public sector and civil society and the private sector. This may improve the implementation of community projects, particularly targeting the poor (see for example, Box 14: Private Sector Participation in the Zambian water supply and sanitation sector).

Political will and a strategic approach to address this issue of capacity strengthening and retention, are essential. At the Pan-African Conference on Implementation and Partnership on Water (PANAFCON 2003), African water ministers recognized that one of the biggest challenges that must be addressed immediately to reach the African Water Vision and the MDGs is human and institutional capacity-building (AMCOW 2003).

For establishing adequate monitoring and assessment programmes that can answer today's questions and prepare for tomorrow, new and emerging monitoring technologies (eg the European Space Agency (ESA) and the UNESCO Earth Observation for Integrated Water Resources Management in Africa (TIGER-SHIP)) exist that can be exploited (PANAFCON 2003 recommendations). Institutions have been established (eg International Institutions for Geo-Information Science and Earth Observations (ITC)) that can underpin such advances and can provide on-the-ground monitoring, assessment and associated capacity development.

Mainstreaming gender

Central to integrated water management at basin level are the interests of the people who carry buckets of water to their homes or fields to ensure a minimum level of welfare. Women are usually the ones who are most directly concerned with the family's water supply. Women also play a pivotal role in agriculture by providing labour to family fields or their own fields. Although the pivotal role of African women in the provision and safeguarding of water for domestic and agricultural use is widely recognized, they have a much less influential role in the management and decision-making processes related to water resources than men (Box 5).

Sustainable water resources management requires that the role of women is reflected in institutional arrangements, and that men and women alike are given influential roles at all levels in water resources

Box 4: Water sector capacity-building initiatives

Capacity constraints are a severe limitation to realizing the opportunities for development associated with freshwater. Capacity-building is an essential and continual response reflecting society's need to engage with new ideas and technologies, and to change social and political realities (Cap-Net 2002). Water-sector capacity-building supports the process of transformation for the implementation of integrated water resources management, including water policies and legislation, institutional development and human resources development. The complexity of the IWRM demands a capacity-building approach that addresses a wide range of issues, problems and opportunities across sectors. There is no one correct solution, and thus it is essential to emphasize the importance of local control and local solutions backed by local adaptation of internationally- accepted knowledge and principles.

The Cap-Net capacity-building initiative led by the United Nations Development Programme (UNDP) is guided by three principles: local ownership, partnership and motivation from demand. Its African initiatives focus on education and training, institutional capacity and research. Sub-regional cooperation is an important aspect of its activities. It has three Africa initiatives:

- West Africa Capacity Building Network (WA-Net).
- WaterNet (a Southern Africa network for capacity-building in IWRM).
- Nile Basin Capacity Building Network for River Engineering (NBCBN-RE).

The GWP is a working partnership among all those involved in water management including government agencies, public institutions, private companies, professional organizations, multilateral development agencies and others committed to the Dublin-Rio principles. Its mission is to support countries in the sustainable management of their water resources. Specifically, its objectives include identifying gaps and stimulating partners to meet critical needs within their human and financial resources and supporting action at the local, national, regional or river basin level that follows principles of sustainable water resources management.

The Internet-based "Virtual Learning Center for Water" provides distance learning opportunities and information on best water management practices for developing countries. It is a new United Nations (UN) project in which the UNU's Canadian-based International Network on Water, Environment and Health (UNU-INWEH) will play a leading role.

Sources: Cap-Net 2002, GWP 2005 and UNU/INWEH 2001

programmes, including in decision making and implementation. Mainstreaming gender concerns along these lines can speed up the achievement of sustainable water management by improving the access of women and men to water and water-related services to meet their essential needs. Nevertheless, in realizing the active and effective participation of women in IWRM, consideration has to be given to the way in which societies assign certain social, economic and cultural roles to men and women. These social and cultural differences require tailor-made approaches, mechanisms and activities for women to participate in IWRM.

Finances

The World Panel on Financing Water Infrastructure (WWC 2003) proposed several measures for solving the problem of financing water projects in developing countries. One such measure was to urge donors (multilateral financial institutions like the World Bank Group, the regional development banks and the European Investment Bank (EIB)) to honour their commitments to increase aid to the water sector. Others included the encouragement of international commercial lending, the promotion of private investment and operations, and the recognition and support of community initiatives and non-governmental organizations (NGOs) by providing them with the resources necessary to perform their important role.

In the light of the MDGs, urgent water needs of poor households take centre stage. The Water and Sanitation Program (WSP) acknowledges the important role played by small water supply and sanitation providers, such as CBOs and the private sector. However, these providers are faced with problems related to finance and access to

Box 5: How is gender policy working on the ground?

A study conducted in the Peddie region of South Africa looked at four villages, Cisira, Ncala, Nqwenerana and Mgwangqa, to determine the effects of gender policies on the involvement of rural women in water supply and sanitation schemes. The Peddie water scheme is a Build, Operate, Train and Transfer (BOTT) scheme, which means that the community was involved in the sustainability of the scheme, and to a certain extent the maintenance. The study found that cultural norms restricted women from asserting themselves in the presence of men. Culture practices did not allow women to interact with outsiders such as project implementing agents. As a result, the needs and concern of the most vulnerable members of the communities were not properly addressed.

Source: Berold 2004

credit facilities. Microfinance is proposed as an option to financing small water and sanitation services in SSA (Mehta and Virjee 2003). Opportunities exist for microfinance in Africa due to two main factors: the market size is quite significant and market penetration to date has been very low due to inappropriate financing products. It has been estimated that there are over 1 000 providers or initiatives in SSA, of which perhaps only 20 are on their way to sustainability, while market penetration is only 7 per cent of all poor households in Western Africa and even lower in Eastern and Southern Africa (Mehta and Virjee 2003).

Many countries have embarked on cost-recovery approaches in providing water to urban and rural areas at various degrees of recovery rates. In most cases, operations and maintenance (O&M) charges are being covered in cost-recovery schemes. In Madagascar for instance, cost-recovery of O&M for irrigation amounts to 75 per cent (Dinar and Subramanian 1997). Available evidence indicates that only a few countries attempt to recover capital costs from users. One major problem facing water authorities is the poor water revenue and the use of flat-rate charging of water services which is not feasible from either an environmental or financial viewpoint. It does not penalize irrational consumption nor reward rational use of water resources. Furthermore, cost-recovery requires proper functioning meters and monitoring real consumption, in addition to realistic pricing for water production and delivery, and for collecting and treating wastewater. Water management agencies should consider the opportunities for privatizing certain services, such as water treatment. Water meters should be promoted to encourage efficient use of the scarce resource and to reduce wastage.

New financial mechanisms can be developed and delivery systems improved to reach greater numbers of clients. There is a need to find non-conventional financial and economic instruments. Through market research, financial services can be further strengthened.

SUB-REGIONAL OVERVIEWS

CENTRAL AFRICA

Overview of resources

Central Africa is generally well endowed with freshwater resources for its growing population. In 2003, there were 98 million people and by 2020 this is expected to reach 164 million (AQUASTAT 2003) although there are large differences from country to country.

Men on a barge used for transportation of goods along the Congo River.

Source: A. Mohamed

Of the eight countries of the sub-region, six open up to the Atlantic Ocean and two are landlocked – Chad and the Central African Republic (CAR). The largest transboundary basins are the Congo (Africa's largest river basin) and Ogooue river basins, and the internally-draining Lake Chad basin. Rainfall and freshwater resources are unevenly distributed. The average rainfall in the Congo River basin ranges from 1 200 mm per annum in the north and south to more than 2 000 mm in the centre (ECA 2000).

Endowment and opportunities

There are abundant inland wetland resources and lakes that render many socioeconomic benefits to communities. These include, among others, water supply, irrigation, fish rearing, hydropower and transport.

The Congo basin, which straddles Central, Eastern and Southern Africa, contains a wide diversity of freshwater habitats, including swamps, lakes and floodplains, that support diverse ecosystems, and are thus an important livelihood resource. The Lake Chad basin supports more than 20 million people (ECA 2000) and is among the most productive freshwater systems in Africa. Approximately 100 000 tonnes of fish are landed there every year (SFLP 2002). As Box 6 and Figure 5 show, this resource is under threat from a combination of factors, including decreasing rainfall, desertification and increasing agriculture.

Box 6: Opportunities for strengthening the governance of Lake Chad

Lake Chad, once one of Africa's largest freshwater bodies, used to be an important source of water and economic activities, including irrigation projects and fisheries, in the four countries sharing the lake: Chad, Nigeria, Niger and Cameroon. However, the lake has dramatically decreased in size since the early 1960s, from approximately 25 000 km^2 to around 1 350 km^2 in 2001.

Fifty per cent of the decrease in the lake's size is attributed to human water use. The lake has been the source of water for large and unsustainable irrigation projects in Niger, Nigeria, Cameroon and Chad, especially over the period 1983 to 1994, when irrigation water use increased dramatically (four-fold). Another human factor causing the lake to shrink was overgrazing which resulted in the loss of vegetation and deforestation.

The remaining 50 per cent of the decrease in the lake's size is attributed to shifting climate patterns. Since the 1960s, the region has suffered from a significant decline in rainfall, and IPCC (2001) predicts reduced rainfall and run-off, and increased desertification. This could mean that Lake Chad will continue to shrink.

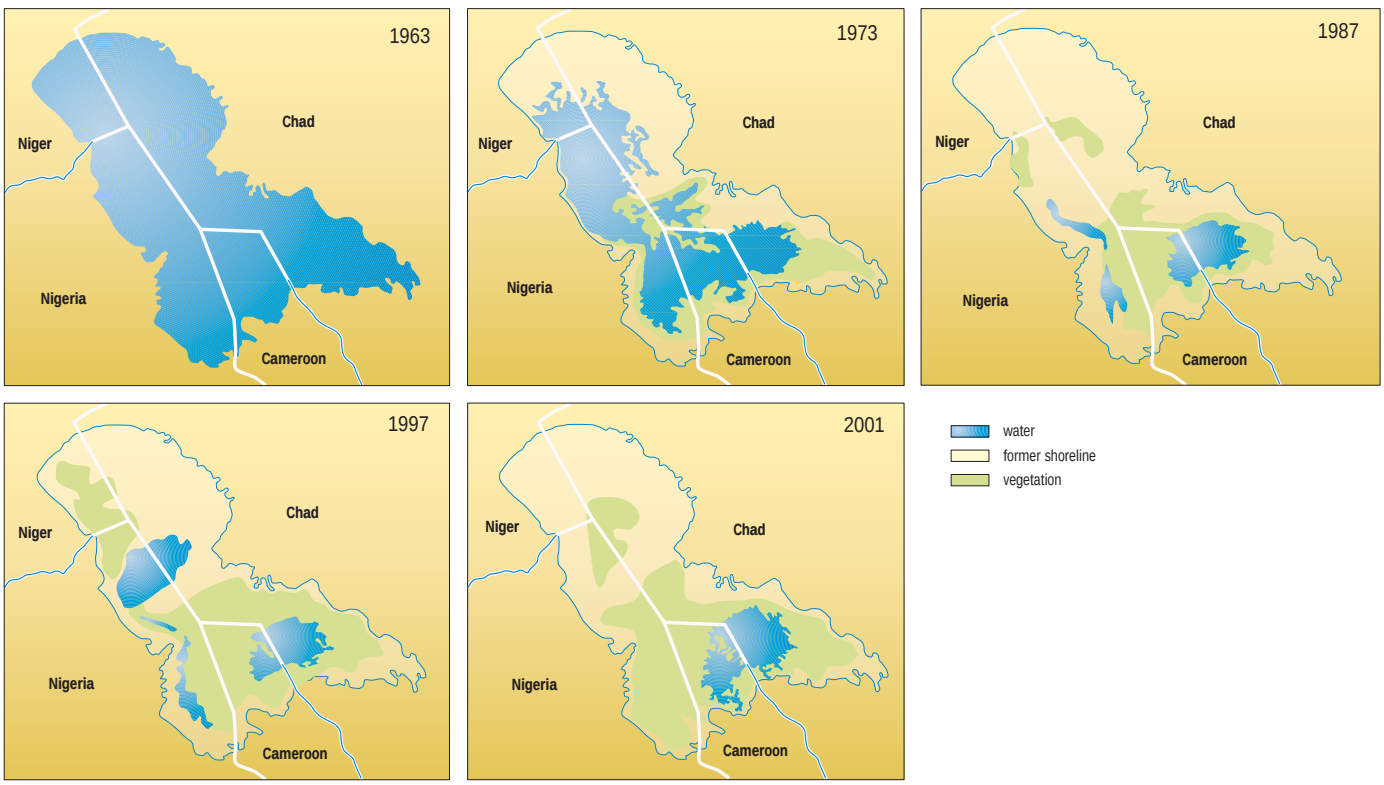
A holistic and integrated management approach by the lake basin states is becoming increasingly important to stop Lake Chad from drying up and to ensure the sustainable use of the resource. Clearly, this is a major challenge for the Lake Chad Basin Commission.

Source: GSFC 2001, UNEP 2002

Despite the relative abundance of water resources in most countries, rapid population growth and climate variability (with an increasing incidence of droughts over the past 30 years) have increased the pressure on the resources. An appropriate governance of water resources in the long term is needed to ensure its sustainable use. This has become especially urgent for the drought-stricken parts of the sub-region (see Box 6).

Improved regional cooperation is enhancing the opportunities for improved resource management. The Economic and Monetary Community of Central Africa (CEMAC) is an organization of Central African states, including Cameroon, CAR, Chad, the Democratic Republic of the Congo (DRC), Equatorial Guinea and Gabon, established to promote economic integration. The Organisation d'Harmonisation du Droit des Affaires

Figure 5: A chronology of change: natural and anthropogenic factors affecting Lake Chad



Source: UNEP 2002, data from GSFC 2001

en Afrique (OHADA) is also concerned with regional integration and economic growth. Such collaborative initiatives create opportunities for strengthening governance of transboundary water resources.

Information and data remain a challenge. Several network projects, such as the Waza Logone Project of IUCN-The World Conservation Union (IUCN), the Western and Central Africa Flow Regimes from International Experimental and Network Data (FRIEND) Project of UNESCO and the African Multidisciplinary Monsoon Analysis (AMMA) support data collection and analysis.

There is great opportunity for the expansion of irrigated agriculture. The Congo River is the largest river in Africa; its catchment area amounts to 3.7 million km^2 (ECA 2000), and total annual discharge is 1 269 km^3. The DRC, CAR, and the Congo fall within it (FAO 1997). For the DRC, 98.7 per cent of its land area falls within the basin; for Congo this is 72.2 per cent; for the CAR 64.8 per cent; and in Cameroon only 20.3 per cent (FAO 1997). In 1997, the irrigation potential was for these four countries was 8 685 000 ha. This requires about 137.4 km^3 of water per year (FAO 1997).

There is huge potential for hydroelectric power generation on the Congo River. The Inga Hydroelectric Facility on the Congo River could play an important role in providing power to Central, Northern and Southern Africa, and even to southern Europe (see Box 7).

Box 7: The Inga Hydroelectric Facility

The DRC currently has 1 775 megawatts (MW) of electricity generating capacity at its Inga Hydroelectric Facility. Inga, operated by the DRC's Société Nationale d'Electricité (SNEL), domestically provides power to Kinshasa and other parts of western DRC. Inga also provides power to the neighbouring Congo power grid along a 220 KV connection. The interconnection supplies nearly one-third of the electricity consumed in Congo. Inga also exports power to Southern African countries including Zambia, Zimbabwe and South Africa

An expansion of the existing facility, Grand Inga, is proposed. With 39 000 MW, this would be nearly as large as South Africa's existing capacity (43 110 MW) and provides the possibility for exporting electricity. Feasibility studies indicated that the Grand Inga project and a connection to Egypt are viable, with a Northern Energy Highway (NEH) passing through Congo, Central African Republic and Sudan. A high voltage DC connection from Inga to Nalubale, Uganda, is also being proposed. It is expected that Grand Inga will be implemented in four phases at a cost of approximately US$4 000 million, while the NEH and related infrastructure would cost approximately US$5 billion.

Source: EIA 2002

Challenges faced in realizing opportunities

Central Africa is characterized by an abundance of freshwater resources, except for the northern parts (Chad, northern Cameroon and CAR) where in the past three decades there was a decline in rainfall (shrinkage of Lake Chad; see Box 6 and Figure 5). The demand for water is rising but it is unlikely that freshwater availability, which is currently well above the water-stress threshold of 1 700 m^3 per person per year, will be affected much in the short to medium term.

In parts of Central Africa the quality of water resources is declining due to pollution from industrial effluents and sewage outflows, agricultural run-off and, in coastal areas, from seawater intrusion. Further threats include logging operations (that impair water quality through sedimentation) and mining operations. Drought poses a significant risk to the wetland systems in northern Cameroon and Chad. The impacts include loss of vegetation with conversion to bare soils and eventual erosion and loss of fertility.

Improving freshwater management by evolving strategy planning, developing a legal and policy framework for natural resources, developing and facilitating access to the freshwater, and heightening public awareness of water use are challenges Central African governments face in the next decade.

EASTERN AFRICA

Overview of resources

Eastern Africa's renewable freshwater resources amount to 187 km^3 per year (AQUASTAT 2003). These surface and ground freshwater resources present opportunities for multiple uses in the domestic water supply, agriculture, fisheries, industry, aquatic, biodiversity and energy sectors. However, the availability of freshwater is highly variable both in space and time, and flooding and drought occur frequently. There is also competition for access to water resources between different user groups and between countries. Water availability and access are therefore priority issues.

The sub-region has extensive wetlands which are a buffer against pollution, flooding and siltation. They also provide critical ecological services, such as habitat for migratory birds, and fish breeding grounds. Wetlands also provide seasonal pasture as the water table recedes during the dry seasons. Many wetlands

are hence undergoing rapid conversion to other land uses. There is also excessive sedimentation, dumping of solid wastes and discharge of huge amounts of sewage in some of the wetlands.

Eastern Africa's freshwater resources account for only 4.7 per cent of Africa's total, yet the sub-region is home to 19 per cent of the region's population (UNDP 2003). This imbalance is set to worsen in the next two decades following unprecedented human and animal population increase.

Endowment and opportunities

This sub-region drains in substantial part the Nile, the whole Lake Victoria basin, Lake Turkana and Lake Natron, as well as well-known deltas and swamps, such as the Sudd in Sudan (NEPAD 2003). The lakes of Eastern Africa have abundant fish stocks and are rich with floodplains and wetlands that support diverse ecosystems. Lake Victoria is the second largest lake in the world and has a surface area of between 67 000 and 69 000 km^2 (ECA 2000); its surrounding wetlands contain 430 fish species, 350 of which may be endemic (NBI and others 2001).

Eastern Africa is yet to fully maximize the use of its water resources. Fifty-eight per cent of the population still lack access to clean and safe water (WHO/UNICEF 2004).

There is also vast unutilized irrigation potential. The irrigation potential of the Shebelli-Juba basin for Kenya, Somalia and Ethiopia is estimated at 323 000 ha (this is less than half the potential irrigable land in the basin). However, currently less than 200 000 ha is under irrigation (ECA 2000). The Nile basin has considerable irrigation potential (ECA 2000):

- In Burundi and Rwanda, given their topography, a well designed irrigation system could support all-year cultivation of 105 000 ha and 150 000 ha respectively;
- In Uganda, at least 200 000 ha of land could be brought under irrigation;
- In Ethiopia, potential irrigated land is estimated at 2.2 million ha; and
- In Eritrea, the Nile basin could support 60 000-300 000 ha of irrigated land.

Meeting urgent water needs can be achieved by maintaining and improving existing water management systems using intermediate technology. Examples are water harvesting, water recycling and leak detection for both drinking water-supply and irrigation practices. Small-scale and traditional water supply and irrigation systems can satisfy pressing needs for safe drinking water and food security. These systems are often more carefully managed than larger systems because communities feel "ownership" and take responsibility for them.

Eastern Africa is currently experiencing an energy crisis yet it has considerable hydropower potential, which is currently in excess of energy needs. It has developed only a fraction of its hydropower potential.

Furrow irrigation, drawing on the Nego River waters, Boku, Ethiopia.

Source: A. Conti/IFAD

Aside from the traditional uses of freshwater discussed above, it has come to be recognized that adequate and reliable water resources are key to security. Eastern Africa is the "water tower" of the African continent. For example, 11 out of 12 Ethiopian rivers flow into neighbouring countries. The amount of discharge that remains within Ethiopia is not more than 9 per cent of the annual total (EPA 2003). Ethiopia contributes more than 78 per cent of the Nile waters that eventually reach Egypt. On the other hand, Uganda is both an upper and lower riparian state with dependency of 41 per cent on waters originating from outside its borders. Eastern Africa therefore has a duty to ensure that it shares its transboundary waters effectively amongst individuals, economic sectors, intra-state jurisdictions and sovereign nations, while respecting the need for environmental sustainability.

Challenges faced in realizing opportunities for development

As shown in Figure 2, water stress is likely to increase. Eritrea and Uganda are expected to experience water stress by 2025, whereas the other countries are expected to experience water scarcity (WRI 2000). General circulation models predict an increase in rainfall of up to 20 per cent, a change in seasonal distribution of rainfall and an increase in air temperature of up to 5°C for this century (IPCC 2001), but there are also indications of increasing frequency and intensity of drought.

Eastern Africa's population is growing rapidly. In 2000 it was 182 million people, by 2010 it is predicted to rise to 230 million and by 2020 to 269 million. The burgeoning population will impact on available freshwater resources and wetlands in several ways. It will lead to increased pressure on the land, destruction of catchment, devegetation of wetlands, and devastation of forests. This will lead to secondary effects of soil erosion, overall loss of fertility of the soils and poor soil moisture retention, further destabilizing the equilibrium of the natural hydrological cycle.

Overexploitation of water resources in some parts of Eastern Africa has led to undesirable effects, such as lowering of the water table and saline seawater intrusion. The current population pressure on forests, wetlands, rangelands and marginal agricultural lands, as well as inappropriate cultivation practices, forest removal and high grazing intensities, have led to unwanted sediment and stream flow changes that impact the downstream communities (UNEP 2004). This has led to unprecedented levels of soil erosion and siltation.

In the last two decades, freshwater resources have been exposed to increased industrial pollution and invasive alien species (IAS). These problems are considered in Chapter 10: *Invasive Alien Species* and Chapter 11: *Chemicals*. The rapidly growing population

The Nile waters offer Eastern Africa opportunities for hydropower, irrigation and recreation – provided they are managed sustainably. Uganda.

Source: IRN

and the attendant agricultural development (which demands more clearing of forests, irrigation, fertilizers and pesticides) and industrialization are the main causes of water quality deterioration. Lack of domestic and industrial waste treatment facilities continue to threaten the quality of Eastern Africa freshwater.

Lake Victoria is of great economic worth to the sub-region and of great scientific and cultural significance to the global community, mainly with respect to its unique water-borne biodiversity. It is suffering severely from: degradation of water quality because of pollution from land-based activities; the introduction of invasive alien species (both fish and plants); and excessive exploitation of living resources. It is also facing the typical consequences of these problems: potentially irreversible environmental damage, hardships among the poor, and serious health concerns. The lake is facing heavy pollution by domestic and industrial wastes, and agricultural run-off that has high nitrogen and phosphorous content. Invasive weeds, such as *Eichhornia crassipes* (water hyacinth), thrive well in such polluted waters. There is therefore a danger that the continued organic pollution of the lake may reverse the success achieved so far using biocontrol methods to control the water hyacinth.

Human and ecological health problems are a concern in some lake basins, such as Lake Victoria. Water-borne and water-dependent diseases, such as dysentery, malaria, bilharzia, typhoid, cholera etc, are common, erupting violently from time to time during the El Niño rains that often cause widespread flooding. Social habits, lack of education, and ready cash due to the expansion of the fishery have contributed synergistically to the HIV/AIDS epidemic. Whilst high protein foods like fish are available, they are often sold rather than consumed by fishers (UNEP 2004).

Overexploitation of the fisheries sector continues to be a threat to the freshwater ecosystem. The introduction of the Nile perch in Lake Victoria, overfishing, unregulated gill net mesh sizes and exploitative fishing techniques have led to the decline of nearly all the endemic species in the lake (UNEP 2004). It has been observed that there has been an increase in fish mortality, a marked reduction in age attained, and length at maturity of the Nile perch, a reduction in catch per unit effort, as well as an increased proportion of immature fish in the catches (UNEP 2004).

There is high potential for irrigation in Eastern Africa, yet, only half of this potential could possibly be reached due to capital shortage. Redirecting governments' budgets could be an option and may prove to be more cost-effective and efficient.

Strategies to improve opportunities

Improved governance and management set the basis for realizing available opportunities. At the national level, responses regarding increased competition over freshwater resources include revision of water resource development policies and greater involvement of stakeholders in water resource management and water supply.

Many countries face implementation challenges. Ethiopia's Water Resource Policy (1999) focuses on improving clean and safe water supply, but there are no appropriate directives and regulatory instruments to enforce the legislation. In 2001, Ethiopia engaged stakeholders to provide input in the development of a sectoral strategic action plan to realize the objectives of the national water policy. The General Water Resource Development Programme (2002-2016) was initiated to address water quality management as part of integrated water resource management within the river basin. Under this programme, institutional set-ups are to be strengthened and new ones established for effective water quality management and monitoring, such as laboratories at national and regional levels, River Basin Commissions/Authorities and a National Water Resource Council.

Kenya has made progress in reforming the water sector, especially in supply and sanitation. Goals as stated in the 2002 Water Act include enhancing the provision, conservation, control, apportionment and use of water. As a result of these reforms, the Water Resource Management Authority was established, and the first National Water Resource Management Strategy was drafted in 2004 to provide a clear road map for

Hippos are one of the main attractions at the Mara River, Kenya.

Source: C. Lambrechts/UNEP

Box 8: Lake Victoria Environmental Management Programme

Lake Victoria is the world's second largest body of freshwater. The lake and its catchment support 30 million people, and fisheries and agriculture are the main economic activities. In 1995, the three riparian countries, Kenya, Uganda and Tanzania, established LVEMP, a long-term programme which aims at improving the sustainable use of the basin's natural resources.

Results of the first phase include:

- A water quality model for Lake Victoria for various uses, the establishment of 56 water quality monitoring stations and standardized monitoring procedures; and
- Reduction in the infestation of water hyacinth by 80 per cent from 1998-2002 and establishment of a Regional Water Hyacinth Surveillance System.

Two major transboundary issues associated with the two upstream countries Rwanda and Burundi were identified during LVEMP-1. These are the influx of water hyacinth and siltation associated with deforestation. Both countries will therefore be included in the second phase of the project. Some of the other issues to be considered in LVEMP-2 are:

- Establishment of national steering mechanisms;
- A focus on investment for high priority environmental issues (eg effluent treatment); and
- Development of a management information system.

Source: LVEMP 2005, Nyirabu 2002

assessing, developing and managing the limited available freshwater resources in an integrated and sustainable manner. Devolution of responsibilities to the lowest appropriate levels is gradually taking place. Kenya is also preparing a national IWRM and water efficiency plan.

Uganda's water policy (Ntambirweki and Dribidu 1998) is geared towards privatization and decentralization. Its goal is managing and developing water resources in a sustainable manner through community participation, capacity-building and a demand-driven approach. The major areas of concern pertaining to water resources management are poor watershed management, inadequate water accessibility and quantity, poor water quality, inadequate institutional capacity, and international water rights.

Major international programmes for water resource management include the Lake Victoria Environmental Management Programme (LVEMP) and the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP). The LVEMP was established in 1995 by Kenya, Uganda and Tanzania to improve sustainable use of the basin's natural resources. It focused primarily on fisheries management, pollution control, control of invasive alien species and land use management. A more detailed account of the LVEMP is given in Box 8.

The Nile Equatorial Lakes Subsidiary Action Programme (NELSAP), the Nile Basin Initiative's (see Northern Africa section) investment programme, currently focuses on the identification of major sub-regional development options and appropriate projects; three River Basin Management and Development Projects in the Sio-Malaba/Malakisi, the Mara and the Kagera Basins; and capacity-building through NBI's training project aimed at developing IWRM skills in all NBI countries.

Both LVEMP and NELSAP are expected to foster dialogue and cooperation, and contribute to the improvement of food security and the alleviation of poverty.

Capacity-building is critically needed. Ethiopia, for example, recently designed a project called Ethiopian Groundwater Resources Assessment Programme

Box 9: Ethiopian Groundwater Resources Assessment Programme

A multilateral project was recently designed to carry out detailed hydro(geo)logical studies in the entire country over a period of fifteen years. This project is called EGRAP. The Ethiopian Groundwater Resources Assessment Programme will focus on "type areas" for complete hydrogeologic analysis. They are selected on the basis of hydrogeologic setting, data availability and socioeconomic requirements. The knowledge gained through the "type area" studies will be transferred to similar areas of the country, providing for an efficient and cost-effective approach to assess the groundwater resources of the entire country. EGRAP is incorporated in the Water Sector Strategic Development Programme.

A start was also made with the development of the Ethiopian National Groundwater Database (ENGDA). The Ethiopian National Groundwater Database will be used for storing, processing and analysing groundwater data, and is critical to the long-term programme of EGRAP. At this stage, several standardized field forms have been developed and a data dictionary is being prepared. Obviously, there is still a long way to go to develop the national database.

Three national counterparts (Ministry of Water Resources, Geological Survey of Ethiopia and the Department of Geology and Geophysics of Addis Ababa University), the US Geological Survey and the International Atomic Energy Agency (IAEA) are currently involved in EGRAP.

Source: Amha and others 2001

(EGRAP) with the aim to assess the groundwater resources of the entire country. The country has also started developing a national groundwater database (see Box 9).

NORTHERN AFRICA

OVERVIEW OF RESOURCES

Northern Africa has a number of large water basins that are shared among several countries. These include surface and groundwater bodies. The Nile basin is its most important transboundary water basin. Groundwater aquifers, such as the Nubian Sandstone Aquifer, which are mostly non-renewable and transboundary in nature, play a vital role in meeting basic water needs.

Northern Africa is Africa's driest sub-region and is characterized by limited water resources. The harsh conditions in the Sahara Desert have forced the majority of the people to live along the Mediterranean coast and the Nile. The region lies in the arid or semi-arid climate zones, where dry conditions prevail all over, except for a narrow strip along the northern coast of the Mediterranean. Annual rainfall is highest along the north coast, and decreases southwards. It ranges from less than 50 mm in the southern parts (deserts) to 1 000 mm in few parts of the extreme north-western parts (Figure 6).

ENDOWMENT AND OPPORTUNITIES

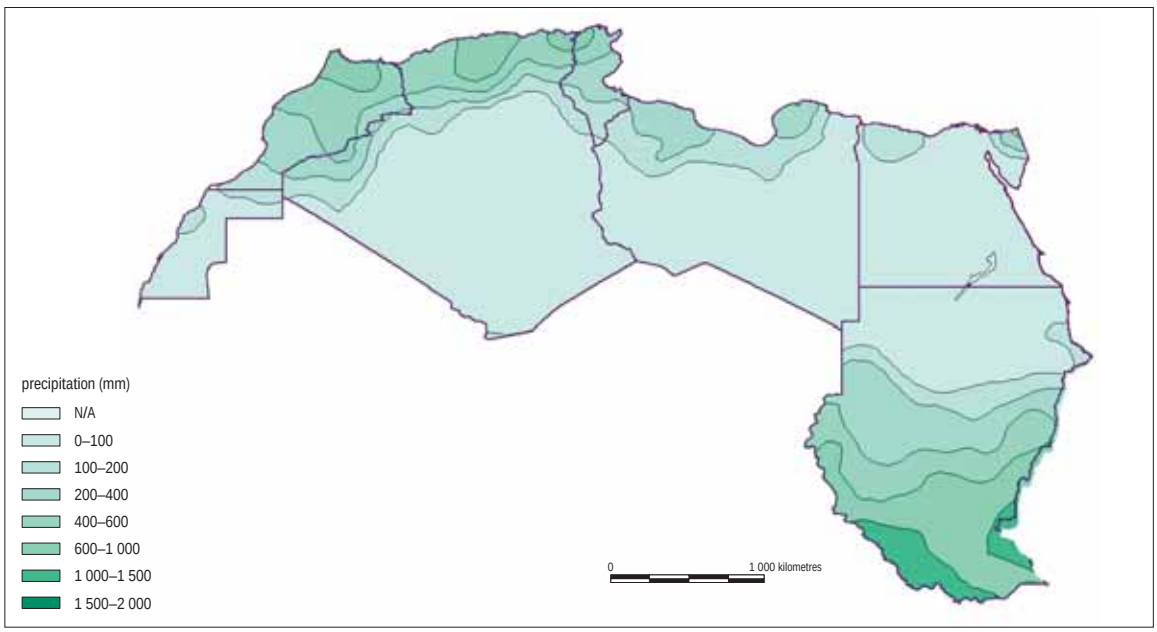
The Nile supports a range of ecosystems, such as the highly productive Sudd wetlands in southern Sudan. These wetlands and the Nile delta sustain important fish, mammal and bird species. The 20 000 km^2 Nile delta in Egypt includes lakes, freshwater and saline wetlands, and intertidal areas, as well as large agricultural areas and towns (NBI and others 2001). The wetlands play an important role in flood retention and release, maintaining flows in the Nile system and thereby supporting vulnerable communities long after the rains have passed.

Inland waters, not associated with the Nile, depend mainly upon drainage from the Atlas Mountains. These rivers are intermittent, with a discharge either to the coast or to the interior into salt pans or sand dunes (NEPAD 2003). In the desert areas, the inland waters manifest as oases, which are crucial life-support systems to nomadic peoples.

Various options for transboundary water sharing have been studied to achieve a more balanced distribution of the available water resources in the region. From a technical point of view, Congo River water could be transferred via its tributary (the Ubangui River) to the north to supply Lake Chad and the northern African countries via the Al-Kufra basin.

Being primarily agricultural economies, the agricultural sector requires the most water. The gap between water needs and available resources is narrowed in several ways. In Egypt, for example, where demand is met through the re-use of irrigation and treated water, two non-conventional options that are being implemented are water harvesting for agriculture in the Sinai and desalination of seawater in coastal areas.

Figure 6: Mean annual precipitation in Northern Africa



Source: CEDARE (2005); data from UNEP- GRID

Box 10: The Nile Basin Initiative

The Nile is the world's longest river and traverses almost 6 700 km through ten countries, from the Kagera River in Burundi and Rwanda to the delta in Egypt. The Nile basin is home to 160 million people, but despite the basin's extraordinary natural endowments, these people face considerable challenges: poverty, political instability, rapid population growth and frequent natural disasters, all placing additional strain on the resources.

Over the past four decades, various Nile countries have engaged in cooperative activities but in 1999, all riparian countries united in common pursuit of the long-term development and management of the Nile waters and established the NBI. The NBI provides a basin-wide framework guided by a shared vision: "To achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile basin water resources."

To translate the NBI's vision into action, a Strategic Action Programme has been formulated to identify and prepare cooperative projects in the basin. Among them are projects addressing issues related to efficient use of water for agriculture, water resource planning and management, stakeholder involvement, environmental management and power trade. Some projects, including those aimed at harnessing energy, are nearing their implementation stage.

The inclusion of all countries in a joint dialogue opens up new opportunities for realizing win-win solutions. It also holds the promise for potential greater economic and political integration of the region, with benefits exceeding those derived from the river itself.

Source: NB1 2001

Libya has adopted a different approach and aims at meeting urgent water needs through its Great Man-Made River (GMMR) project by tapping non-renewable resources (Box 11).

Water use is expected to increase with expansion in previously uninhabited land. The area of the Nile valley and its delta represents about 4 per cent of the area of Egypt. With the increase in population, at a somewhat decreasing rate of growth of 2.6 per cent, the Egyptian government has realized the necessity of accelerating its horizontal expansion plans into the deserted and uninhabited regions of Egypt. As part of this expansion plan, agricultural land will expand by an area of just over 1.4 million ha in several regions of Egypt, by the year 2017 (Zalla and others 2000). The Southern Egypt Development Project (Toshka Project) represents 226 800 ha of the total planned agricultural expansion (Box 12).

The gap between water needs and available resources is narrowed in several ways. Water recycling

Box 11: Libya's Great Man-Made River project

The impending water stress in Libya was recognized by the government at an early stage and its answer to the crisis was the Great Man-Made River (GMMR) project, which commenced in 1984. The decisions for the implementation and funding of the project were made at grassroots level by the Basic Peoples Congresses.

The project intends to draw water from aquifers beneath the Sahara Desert and convey it along a network of huge underground pipes to the more populous northern region to meet the country's present (47 million m^3 per year) and future water demands. The project will also bring a halt to the overexploitation of groundwater in coastal areas, which has resulted in seawater intrusion and increased salinity of the wells.

The GMMR project is massive in many ways. Within a timeframe of around 50 years, a 3 380 km-long network of pipelines will provide for the country's 5.6 million inhabitants and for 130 000 ha of agricultural land to be developed. Non-renewable (fossil) groundwater, originating from 38 000 to 7 000 years ago, will be drawn from four major groundwater basins, each containing 2 500-3 000 km^3 of economically extractable water.

At a total investment cost of US$33 700 million over 50 years, feasibility studies have shown that the cost of each litre of groundwater abstracted and transported in this way is about ten times cheaper in comparison with water from a pipeline connected to southern Europe, desalination or transportation by ship. The main part of the project is funded by the Libyan people in the form of levies on, for example, fuel, tobacco and international travel.

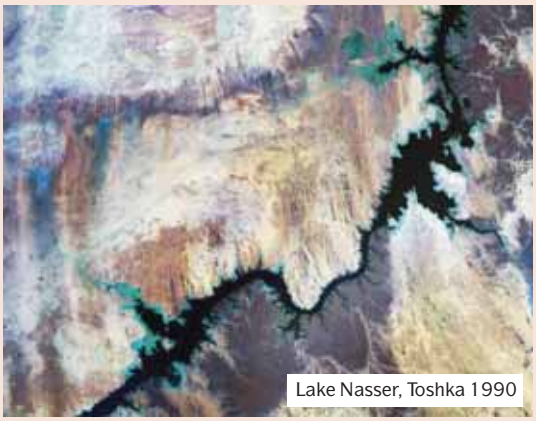
Source: NB1 2001

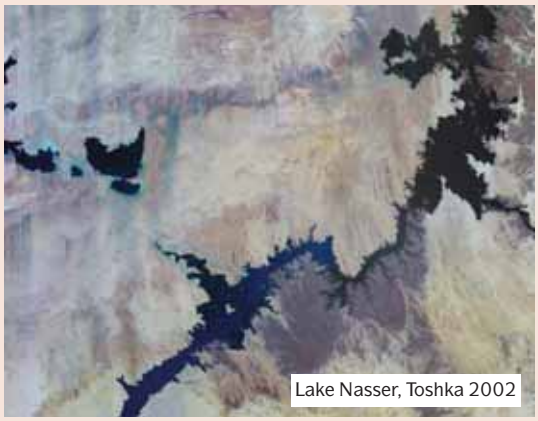
Box 12: Toshka Project – increasing habitable land

In one of the world's most ancient civilizations, new and substantial communities are being created. Toshka is the new delta; a new civilization in the making. It is located to the west of Lake Nasser, and 220 km southwest of Aswan, in an area that once supported a thriving agrarian society. A land rich in promise, with great mineral wealth, cultural distinction and biodiversity, Toshka is poised for a reawakening.

Although Egypt is a huge country, nearly as large as France and Spain combined, less than 5 per cent of its area is inhabited. Yet, thanks to subtle contours of topography, state-of-the-art technology, and the vision of a people whose proud history dates to the very beginning of civilization, Egypt has ambitiously set out to completely shift its own demographic map through the creation of a new valley.

Specifically, the mega-projects call for an increase of habitable land from 5 to 25 per cent of the country's area by 2017, development of agricultural production, and the creation of new jobs and long-term investment opportunities. Strategies to accomplish these goals include incentives to encourage farming, industrialization, tourism, community building, and infrastructure development. The targeted area for reclamation comprises 3.4 million acres in southern Egypt and the new valley, Sinai, and both sides of the Nile valley and Delta.


Lake Nasser, Toshka 1990


Lake Nasser, Toshka 2002

Source: MWRI undated a, MWRI undated b

and water harvesting are options that could be built upon for increasing water availability. In the agricultural sector, modifying cropping patterns and selecting crops using less water will reduce water use.

Challenges faced in realizing opportunities

Northern Africa is the most water-stressed sub-region and freshwater availability will become an even more important issue in the coming decades. Increasing water scarcity may lead to water-related conflicts. For the western Maghreb countries (Morocco, Algeria and Tunisia), climate change scenarios predict a rise in temperature of between 2° and 4°C this century, accompanied by a reduction in rainfall of up to 20 per cent and increased evapotranspiration (IPCC 2001). This would result in decreased soil moisture and reduced surface and groundwater resources.

Salinization of soils, which threatens food production, is already a concern in irrigated areas, especially along the Nile, and may worsen. Similarly, as a result of land degradation due to agriculture and livestock grazing, soil erosion is causing sedimentation impacts downstream. Erosion in the Nile delta has increased since the 1960s when completion of the Aswan High Dam stopped the annual flood with its replenishing sediment (NBI and others 2001). Another concern is seawater intrusion resulting from overexploitation of groundwater resources in coastal areas, where the main urban centres are located. The Nile basin's most polluted wetlands are in the Nile delta, where irrigation drainage water, untreated or partially-treated urban wastes and industrial effluents have destroyed several forms of aquatic life, reduced the productivity of the fisheries and contaminated the fish catch (NBI and others 2001). Throughout North Africa, pollution due to urban wastes and agriculture are causing water quality degradation.

Strategies to improve opportunities

Improved institutional and governance frameworks may increase the potential to improve opportunities.

Egypt and Sudan have reformed their legal systems to protect water resources from pollution and misuse. At institutional level, both countries have decentralized

The Egypt-West Beheira underground irrigation system construction site.

Source: U. Wieland/IFAD

water resource management and established institutions to support the participation of stakeholders in decision-making processes. Transboundary cooperation on water matters takes place within the framework of the Nile Basin Initiative (Box 10).

For all sectors, water demand can be reduced by introducing participatory management approaches and applying key principles, such as the polluter pays principle. Measures are also taken for the protection of water resources and these include the establishment of monitoring networks with water quality indicators and the enforcement of laws

Across the Maghreb in the northwest, awareness has been raised about the consequences of climate change for agriculture and coastal zones, and the communities who are dependent on them for their livelihoods. This has resulted in the political will to address the issues at regional level and in the development of a three-year vulnerability and adaptation project for the region (the *Projet Maghrébin sur les Changements Climatiques*). The project aims to achieve:

- A regionally integrated adaptation network, capable of continuing policy development, information exchange, vulnerability monitoring and project identification;
- Strengthened national capacities to respond to climate change;
- Development of national adaptation plans; and
- Deepened public awareness of the risks of climate change and the opportunities of carefully considered options.

Capacity-building is recognized as a basic requirement for water resource development. For this reason, training centres for water professionals have been set up in Egypt and Sudan. Professionals from other African countries are also being trained here. In the Maghreb, capacity exists within "Centres of Excellence" that, if suitably strengthened, would be capable of assuming leadership in the development of a planning framework to identify, assess and implement adaptation strategies in the near future.

Over the past few years, data collection systems have been improved. In Egypt, for example, a countrywide telemetry system was established for measuring water levels in canals. Databases were also built and data formats standardized to facilitate exchange of information.

Egypt and Sudan have embarked on cost-recovery approaches for the industrial and domestic sectors. Irrigation water, however, has been provided free of charge to farmers and, consequently, no conservation measures were taken.

Among the strategic options is private sector participation. Investors have been encouraged to own

and cultivate new land using modern irrigation systems, such as sprinklers and drip irrigation. In addition, donors financially and technically assist in improving the legal and institutional arrangements in the water sector, developing water resource plans and transferring knowledge and technology.

SOUTHERN AFRICA

Overview of resources

Southern Africa is vulnerable to environmental change due to its limited water resources. Poverty is widespread, with large numbers of its people living on less than a dollar a day, HIV/AIDs is a growing problem in many of the countries and its population is largely rural and heavily dependent on agriculture. Chapter 1: *The Human Dimension* gives an overview of these issues and their significance for environmental management and economic opportunity.

This sub-region has 12 major internationally shared river basins, of which the four largest basins are the Zambezi, Orange, Okavango and Limpopo river basins. Surface run-off in the northern and eastern parts is available in sufficient quantities throughout the year. In the south-western part it only occurs with extreme episodic rainfall events. Under such conditions, people rely largely on dams and groundwater resources. Major groundwater resources are found in the Kalahari-Etosha, Karoo, Cape Fold Belt, East Kalahari Precambrian Belt and the coastal basins of Mozambique and Tanzania. The region has experienced floods in the northeast and episodes of severe and prolonged droughts in other places.

Endowment and opportunities

Southern Africa's freshwater resources are critical aspects of local livelihoods and a central component of many economic activities. Several are also recognized as globally significant from a biological diversity perspective. These include the Okavango Delta, the St Lucia Wetlands and Lake Malawi.

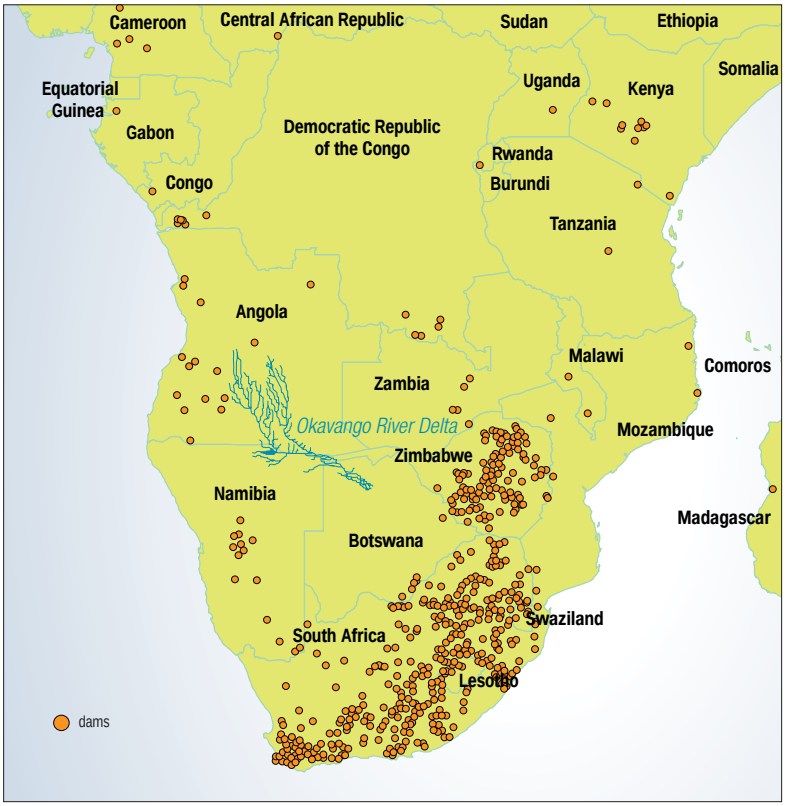
Lake Malawi is the third largest lake in Africa. It is 560 km long, 75 km wide (at maximum width), has a maximum depth of 700 m at its western shore and a mean depth of about 290 m, with lake capacity (volume) estimated at 8 400 km^3 (ECA 2000). It is an important resource for people in Tanzania, Malawi and Mozambique, who rely on it for potable water, food, irrigation and hydropower (S & E 1999). It is also important for navigation, transportation and tourism, and supports both subsistence and commercial fisheries (ECA 2000). It has the largest number of fish species of any lake in the world, estimated at more than 600, of which half have been identified. Many of these are endemic (S & E 1999).

To meet the demand of the growing population, solutions in the past mainly focused on the supply side of resource management. As a result, as shown in Figure 7, Southern Africa has a high concentration of dams and inter-basin transfer schemes. Yet, cheaper and readily accessible solutions have proven to be

Blyde River Canyon, Mpumalanga, South Africa.

Source: P. Sander

Figure 7: Dams in Southern Africa



Source: adapted from Benoit 2002

possible and significant strides have been made towards the development of infrastructure for water supply and sanitation services. Among the adopted measures are improved maintenance and efficiency of urban water distribution networks, and improvement of sewage treatment and disposal facilities. Various tools are deployed to control the impacts of discharges on water quality, such as subsidies per unit of pollution emission abatement, waste charges, and penalties for pollution, following "the polluter-pays" principle.

Irrigated agriculture places the highest demand on water and many countries are introducing more efficient, cost-effective and sustainable water demand management (WDM) measures aimed at controlling demand to conserve water. Namibia, for instance, has been successful in implementing a wide range of WDM measures including plastic covers over the soil to reduce evaporation, block-tariff systems in the urban sector to curb excessive water use, leak detection programmes and public campaigns to educate people about the role of water (Chiuta and others 2002).

Challenges faced in realizing development opportunities

Future projections for Southern Africa for 2025 (Chiuta and others 2002) suggest that water availability per person will sharply decrease for most countries (see Figure 2). Southern Africa is among the few regions in the world for which most global climate models agree upon an increase in aridity in the future and hence a further lowering of water availability for livelihoods (DWC 2003, IPCC 2001). In particular, the projection looks bleak for Malawi and South Africa. In addition, Lesotho, Tanzania and Zimbabwe are expected to experience water stress by 2025, while Swaziland is likely to experience water quality and availability problems in the dry season.

The sub-region has experienced floods in the northeast and episodes of severe and prolonged droughts in other places. Repeated droughts affect freshwater availability and make the sub-region prone to soil erosion, which in turn affects water quality through siltation. The extreme amounts of soils transported to the coast especially impact the mangrove forests, causing asphyxiation of the buried roots.

Overabstraction of surface water resources has caused significant changes in the flow regimes and water quality of many rivers, leading to negative impacts on aquatic biota and subsequent loss of ecological function and health (Hirji and others 2002). For example, the building of the Kariba Dam altered the hydrological regime of the Zambezi River and changed the Marrameu floodplain to a dry, bushy area prone to fire. Additional threats to the remaining Zambezi basin wetlands include reduced flows caused by droughts and water abstractions, aquatic weed infestation, pesticides (especially DDT), infrastructure development like dams, overuse of resources due to human pressures, uncontrolled fires, pollution and deforestation (Schuijt 2002).

Pollution, especially from agricultural drainage and wash-off, urban wash-off and effluent return flows, industries, mining, and areas with insufficient sanitation services, is increasing. Pollution of groundwater resources is of particular concern because it is costly and time-consuming to rehabilitate. Water quality management should therefore form an integral part of a strategy for water resource management (DWAF 2004).

Invasive alien species, and in particular *Eichhornia crassipes* (water hyacinth), threatens many freshwater bodies (Chenje 2000).

Strategies to improve development opportunities

There has been good progress in water sector reforms since the late 1990s, with an increasingly integrated approach to water resource management (surface water, groundwater, socioeconomic and other issues dealt with in an integrated manner). The reforms, which

include the setting up of new institutions with new functions, responsibilities, legislation and guidelines for water resource development and management, take place at different paces and at different scales. Box 13 lists some of the main lessons learnt from the reforms providing opportunities for further improvements in the area of good management.

Most countries have established catchment management institutions with specified powers and responsibilities. Transboundary cooperation on water matters takes place within the framework of the Protocol on Shared Watercourses (SADC 1995, SADC 2000). River Basin Commissions have been established in all of the four largest river basins, with the most recent developments being the establishment of the Zambezi Watercourse Commission in 2004 and the Limpopo Watercourse Commission in 2003.

Box 13: Lessons learnt from water sector reforms in Southern Africa

- There should be proper stakeholder participation and engagement to ensure the development of comprehensive legislation and institutional frameworks that adequately address water-related societal needs and concerns;
- Water legislation, guidelines and institutional set-up should be kept as simple as possible to avoid ineffectiveness and delayed implementation as a result of over-sophisticated documentation (the challenge is the implementation);
- Capacity-building forms an integral part of water sector reform. It is the backbone of successful implementation of IWRM programmes; and
- A systematic approach should be followed within a realistic timeframe for the development of water-related legislation and guidelines, taking into account the above and the availability of financial resources and sound hydro(geo)logical data. The process of water policy development in South Africa, for example, took well over ten years, with the following milestones:

  1994: Initiation of water policy development
  1996: Development of fundamental principles and objectives for a new water law
  1997: Development of national water policy
  1998: National Water Act
  2004: National Water Resource Strategy

Source: Sub-regional expert consultations for AEO-2

Capacity enhancement programmes at various academic and institutional levels, such as WaterNet and the GWP, support and facilitate the adoption of IWRM approaches. Water-related data and information are increasingly compiled according to hydrologic boundaries. Opportunities for further work are in the areas of climate variability and change, water pollution, groundwater recharge and environmental flow.

Many Southern African countries have embarked on cost-recovery approaches or on enhancing private sector participation in providing water to urban and rural areas at various degrees of recovery rates. Box 14 describes an initiative that was undertaken to improve water and sanitation service provision to poor urban and rural communities.

Other measures that are possible for solving the problem of financing water projects in developing countries, besides donor support, include the encouragement of international commercial lending, the promotion of private investment and operations, and the recognition and support of community initiatives and non-governmental organizations by providing them with the resources necessary to perform their important role.

Box 14: Private sector participation in the Zambian water supply and sanitation sector

About 45 per cent of Zambia's population of approximately ten million live in urban areas, of which 50 to 70 per cent live in peri-urban areas. One of the major aims of water sector reforms that the Zambian government has been implementing since 1994, was to alleviate the pressure on the water supply and sanitation situation. Presently, the majority of the water supply and sanitation service provision schemes in low-income peri-urban areas have been commercialized and responsibilities have been devolved to local authorities and the private sector.

A Devolution Trust Fund (DTF) was established in 2001 by Zambia's National Water Supply and Sanitation Council under a provision in the Water Supply and Sanitation Act of 1997 to improve the service provision in the low-income peri-urban areas. The DTF assists Commercial Water Utilities in expanding their services in these areas and also the establishment of water kiosks. These are low-cost public outlets run by private water vendors who are linked by contract to professional operators of the entire system. The kiosks can achieve an acceptable service standard and have other advantages, such as improving quality of available water, if they are linked to the main water network.

The DTF is perceived by all stakeholders as an appropriate instrument to alleviate the pressure on the water supply and sanitation situation in peri-urban areas. It can contribute to realizing the target of halving the proportion of people with no access to clean water and proper sanitation by 2015.

Source: GTZ 2004

WESTERN AFRICA

OVERVIEW OF RESOURCES

Western Africa's water resources are characterized by extreme variability over both space and time. It is highly vulnerable to climate variability, as illustrated by the disastrous impact of drought over the past 30 years. The impact of drought is considered in Chapter 3: *Land*. In some areas, there is a looming water crisis.

The sub-region has six major internationally shared river basins. The three largest basins are those of the Niger, Volta and Senegal rivers. These freshwater resources are unevenly distributed between countries. Temporal variation in rainfall is common, but only the countries in the northern Sahelian zone regularly experience drought, whilst floods periodically affect countries in the wetter coastal belt. Groundwater mainly occurs in basement, coastal and Sahelian sedimentary aquifers. The availability of groundwater varies considerably from one type of hydrogeological domain to another, depending on the local levels of precipitation and infiltration, which determine the actual recharge. In Mauritania, for example, internal renewable groundwater resources are estimated at 0.3 km^3 per year and these are important sources of water for domestic use, irrigation and livestock watering (FAOSTAT 1997).

ENDOWMENT AND OPPORTUNITIES

Wetland ecosystems and their resources are diverse, including inland water resources with abundant fisheries (NEPAD 2003). These resources provide food supply and income to many communities. For example, the Niger River system sustains biological communities which include 250 species of freshwater fish, of which 20 are not found anywhere else (WWF 2002). Specialized flora have developed in the floodplains and delta to cope with extreme fluctuations in water level.

There is great opportunity for the expansion of irrigated agriculture. The Senegal River has a maximum irrigation potential of 420 000 ha, of which only 118 000 ha is under irrigation (ECA 2000). The Diama Dam offers irrigation opportunities of 240 000 ha (see Box 15). The Niger River is Africa's second longest river at 4 100 km, and the basin covers 1 471 000 km^2; this amounts to 7.25 per cent of the total area of the African continent (ECA 2000). The irrigation potential of the Niger River is vast (FAO 1997):

- In Guinea it could support 185 000 ha (only 6 000 is under irrigation);
- In Côte d'Ivoire it could support 50 000 ha;
- In Mali it could support 556 000 ha (only 130 000 is under irrigation);
- In Burkina Faso it could support 5000 ha (only 850 is under irrigation);
- In Benin it could support 100 000 ha; and
- In Niger it could support 140 000 ha.

Due to insufficient investment and operational funds for water supply systems and irrigation infrastructure, unaccounted-for water for Africa as a whole is often between 40 and 60 per cent (AfDB and ADF 2000). Exceptions are Abidjan in Côte d'Ivoire and Conakry in Guinea, where unaccounted-for water has been reduced to about 25 per cent. In Lomé (Togo), the public water utility has made major improvements, with losses now down to only 20 per cent, most water bills paid and water subsidies no longer required (Briscoe 2000). Another challenge is to protect the environment. Progress has been made in this regard through public education and awareness.

Box 15: The Diama Dam

Located at 26 km from Saint Louis (Senegal), the Diama Dam was brought into service in November 1985.

The Diama Dam uses a mobile stopping mechanism composed of 7 valves, 20 m wide and 11.5 m high, which is opened in periods of up-rising to ensure the normal flow of the river and is closed in periods of low water level to prevent the increase of salted water in the river. This allows the dam to constitute a freshwater reserve in the Senegal River. It contributes to the filling of the Guiers Lake (in Senegal), Rkîz Lake (in Mauritania) and the depression of the Aftout-es-Sahel (Mauritania). It also supports irrigation.

Source: Euroconsult/RIN 1990

CHALLENGES FACED IN REALIZING DEVELOPMENT OPPORTUNITIES

Of the 16 Western African countries, two, Burkina Faso and Nigeria, currently experience water stress (WRI 2000) and by 2025 this is expected to rise to five (see Figure 2).

Climate change is expected to bring about reduced rainfall and increased evaporation in the areas to the north, thus advancing the rate of desertification in the Sahel (IPCC 2001). Combined with existing high rates of deforestation and degradation of vegetation cover, this could have serious consequences for soil erosion and agricultural activity (NEPAD 2003).

There is growing concern about pollution of water resources. This is particularly the case in the Niger delta

in Nigeria, with the frequent spillage from oil production and distribution. Population growth and development are further threatening the Niger River's ability to supply crucially needed natural resources to the people of West Africa. River flows in the basin are decreasing at the same time that fishing pressure is increasing, leading to drastic declines in the productivity of the Niger's fisheries (WWF undated).

Strategies to improve development opportunities

In the light of the major issues identified, the countries have responded by initiating water sector strategies and reforms at national and transboundary levels. At national level, water sector reforms include:

- Establishing new institutions to improve the coordination of water resources development and management. Water departments were upgraded or converted into public agencies to operate along commercial lines;
- Reorganizing institutions in the water supply, sanitation and irrigation sectors to improve their efficiency; and
- Revisiting the legal framework to create a common approach for water laws as well as to break the state monopoly on water supply and promote competition.

Major challenges for water resource management are to decentralize and devolve responsibilities to the lowest appropriate level, increase investment in the water sector infrastructure, attain cost-recovery, and to provide adequate institutional and legal capacity. Reforms are currently being implemented in Nigeria's River Basin Development Authorities (RBDA) to address the involvement of marginalized communities in the these structures (Box 16).

At transboundary level, water sector reforms of basin organizations (Niger Basin Authority, Senegal River Basin Organization and Lake Chad Basin Commission) included the review of their focus, functions, financing, structure, leadership and secretariat. Efforts are being made to revive the war-torn Mano River Union and to promote the set-up of new river basin organizations, such as for the Volta River basin. The water sector reforms, however, have been constrained in many countries by various factors, among which are internal resistance from executives of institutions, the lack of political will, political instability or frequent changes in government, and dependence on development partners to find the resources for reforms. Despite these constraints, the Senegal River Basin Organization has been successful in achieving tangible development goals, particularly in the hydropower subsector.

Opportunities have been created to face the challenges, such as the Regional Action Plan for IWRM (2000-2004) and a project for the creation of a permanent structure for the coordination and monitoring of IWRM. In 2002, the African Network of Basin Organizations (ANBO) was established which constitutes an opportunity for basin organizations and authorities to cooperate with international partners in the implementation of their programmes. As such, ANBO could mobilize solidarity for the achievement of the MDGs.

Opportunities for capacity-building exist, for example through WA-Net at the University of Cape Coast (Ghana) and the Water Resources Institute in Kaduna (Nigeria). To date, WA-Net has significantly contributed to the Western African capacity-building endeavour in the water sector.

Box 16: Reforms in Nigeria's River Basin Development Authorities in favour of the rural communities

Previously, most of Nigeria's river basin development agencies concentrated on developing water distribution infrastructure in a non-participatory manner. This was an important challenge for the government to transform them into participatory management agencies. The government is aware that this is a long-term task and that the sequencing issue is vital. There is broad agreement that it would be best to start with one or two of the twelve RBDAs, and to start where there are major users who are demanding greater participation and clarity about rights, allocation procedures and financing. Here there is an obvious (and potentially productive) spin-off from a concession agreement in Lagos, which would make a good pilot case. A private operator cannot depend on the current vague "license agreement" between the Ogun-Oshun RBDA and users, but will require much greater clarity on water rights, operating procedures and financing. A second pilot basin which might prove productive is the Hadeija-Jamaare, where stakeholders include the city of Kano, irrigators of 20 000 ha, the Hadeija Wetlands (a RAMSAR site whose interests are represented by articulate NGOs) and ultimately Lake Chad (World Bank 2000).

Source: World Bank 2000

Box 17: Moving from a vicious to a virtuous cycle – Conakry (Guinea) water supply

A common problem for the development of water utilities is how to escape from a "low-level equilibrium trap." Such a low-level trap starts with the poor quality of services, causing people to be unwilling to pay, resulting in low revenues, which in turn result in poor services, and so on.

An innovative approach in the city of Conakry shows how creative financing can assist in breaking out of this vicious cycle. In 1987, the government water utility functioned poorly, and the quality of services in Conakry was abysmal. The government of Guinea decided to involve the private sector. No private company, however, would be interested in a contract when revenues are only a fraction of the costs. The private operator was assured of sufficient revenues by a combination of (initially low, but rising) revenues from users and (initially high, but declining) subsidies from the government (largely paid out of a World Bank credit). The "trick" was to use a time-bound, transparent "transition subsidy" to improve services, and then to raise tariffs for the improved services. The vicious cycle was replaced by a virtuous cycle of good services and reliable revenues.

Source: Briscoe 2000

Governments' recognition that water is not only a social but also an economic and environmental good is reflected in economic and environmental reforms. These reforms have seen the removal of government subsidies on prices of commodities and services, and the encouragement of private sector participation.

There has been improvement in funding the water supply subsector by establishing modalities for mobilizing investment funds from governments, beneficiaries and donors. Mechanisms have also been established for cost-recovery through water tariffs that take into account the costs of investment, operation, maintenance, system expansion and renewal. Box 17 describes an innovative approach adopted by the city of Conakry, Guinea, to involve the private sector in urban water supply with the aim to improve services.

More opportunities exist for small water supply and sanitation service provision because of the significant market size and very low market penetration. It is estimated that market penetration is only 7 per cent of all poor households in Western Africa (Mehta and Virjee 2003).

WESTERN INDIAN OCEAN ISLANDS

Overview of resources

The Western Indian Ocean (WIO) islands are separated by large expanses of ocean and do not share any freshwater resources. Freshwater resources vary considerably across the islands.

Madagascar can be divided into two major basins - one draining to the west into the Mozambique Channel and the other draining to the east into the Indian Ocean. Water in Madagascar, Mauritius and the Seychelles is primarily extracted from rivers on the main inhabited islands through the construction of dams and reservoirs, while the islands of Comoros are heavily dependent on groundwater resources. The islands are subject to tropical storms or cyclones with heavy rainfall from November to May giving rise to periodic flooding. Despite the relative abundance of rainfall, the islands also experience periods of water shortage.

There are large variations in rainfall across the countries and this has implications for available freshwater resources. All the countries experience extended dry seasons with periods of heavy rain, torrential at times, which present technical problems for storage, treatment and distribution. Climatic patterns are discussed in Chapter 2: *Atmosphere*.

Endowment and opportunities

Wetlands occur throughout the island states. These wetlands are important habitats that provide breeding grounds for large numbers of waterfowl. These natural assets make the island states ideal tourist destinations.

On the Mauritius island of Agalega, 1 000 km north of Mauritius main island (Government of Mauritius 2005), the use of groundwater is declining for domestic or agricultural purposes, because of saltwater intrusion and land pollution; rainwater harvesting from pitched roofs is proving a problem because of faecal contamination from birds.

In the areas of public awareness and information, and economic measures, such as metering and charging for water use, there are opportunities to further curtail the demand for freshwater.

Challenges faced in realizing opportunities for development

Projections for the WIO islands place Mauritius in the category of water-stressed countries and Comoros in the category of water-scarce countries by 2025 (see Figure 2). Comoros is currently on the threshold, with just 1 700 m^3 available per person per year (UNEP 2005a). Water availability is a problem across the sub-region (UNEP 2005a):

- Precise figures for the Seychelles, where most water comes from rivers, are not available, but water shortages were so severe during 1998, partly as a result of the very extreme El Niño event, that the brewing and fish canning industries were forced to close;
- Mahé, which is part of the Seychelles, is under increasing threat of water shortages as a result of wilt disease that is damaging a tree species, *Pterocarpus indica*, important for watershed management; and
- Water supply in the Comoros on the islands of Grande Comore, Mohéli and Anjouan is threatened by the fragile equilibrium between freshwater and seawater.

In the Comoros, seawater intrusion reaches as far as 2 km inland due to the high water table around the coast (UNEP 2004). There are also problems of contamination of groundwater through seepage from septic tanks, substandard equipment and an insufficient number of water pumps.

The Intergovernmental Panel on Climate Change's (IPCC) projected worst-case scenario of a 1 m sea-level rise by 2100 would result in loss of coastal land, agricultural opportunities, groundwater resources (due to salinization), biodiversity critical to community support, and in loss of livelihoods (IPCC 2001). The social impacts of a sea-level rise will cause migration and displacement of people, water-related diseases and water supply problems.

In the Seychelles, high fertilizer use means that rivers have fertilizer loads of up to 25 kg per day (UNEP 2005b). Wells in Mauritius have high nitrate levels reaching 50 microgrammes per litre, which is up to the World Health Organization defined safety limits (UNEP 2005b). Mauritius uses, on average, 57 500 tonnes of fertilizer annually, representing 600 kg per hectare, or three times the rate in western Europe (UNEP 2005b).

For many people in many of the WIO islands, water-borne and tropical communicable diseases are widespread, as a result of contamination of water supplies by human waste. The Comoros, for example, suffered cholera epidemics in 1975, 1998 and 2001. Two recent outbreaks were associated with poor sanitation and pollution of freshwater. Poor disposal of waste, particularly containers, is also generating increased risk of malarial infections, especially in Madagascar and the Comoros. The containers, ranging from old plastic bags to paint tins, accumulate rainwater, which is an ideal breeding ground for disease-carrying insects. Both Mauritius and the Seychelles have developed organized waste management schemes. In the Comoros, collection and disposal of waste is poorly managed.

In the Comoros, malaria is one of the principal causes of morbidity and mortality, being associated with 25 per cent of hospital admissions and 10-25 per cent of deaths in children under five years old (WHO/UNICEF 2003). Diarrhoea is a significant cause of morbidity in children in the Comoros and is associated with poor water quality.

Madagascar has health problems associated with stagnant water in irrigation canals in rice fields which promote mosquito breeding and are host to the spread of the parasites producing bilharzia. Mauritius and the Seychelles are relatively free from diseases affected by poor quality of water. Malaria has been successfully eradicated in Mauritius, although in the past it was responsible for over 2 000 deaths per year. Tourist areas throughout the sub-region have yet to introduce quality controls on water in bathing areas, although the adoption of the Blue Flag schemes of western Europe is being considered.

Well-maintained marshes and rivers at the ornithological park, Bois d'Oiseaux, Mauritius.

Source: F. Silvio/TopFoto

Strategies for improving development opportunities

The role of the private sector in financing water projects and infrastructure is increasing, although more so in Mauritius and the Seychelles than in Madagascar and Comoros (UNEP 2004). In the Seychelles, the role and importance of NGOs in sustainable development has increased since 1996.

In January 2005, the Mauritius Strategy was adopted, by the Small Island Developing States (SIDS) and the international community, to ensure the successful implementation of the 1994 Barbados Programme of Action (BPoA). The BPoA focuses on problems SIDS face related to climate change and sea-level rise, natural and environmental disasters, freshwater resources, and capacity-building. Selected challenges and actions related to freshwater resources are listed in Box 18. The next step is to outline a road map for the implementation of the strategy.

Box 19 illustrates the progress made with disaster management in one of the island states, the Seychelles.

Box 18: Mauritius Strategy – freshwater challenges and actions

- Small Island Developing States continue to face water management and water access challenges, caused in part by deficiencies in water availability, water catchment and storage, pollution of water resources, saline intrusion and leakage in the delivery system. Sustained urban water supply and sanitation systems are constrained by a lack of human, institutional and financial resources;
- Further action is required, with the necessary support from the international community, to meet the MDGs and the World Summit on Sustainable Development (WSSD) 2015 targets on sustainable access to safe drinking water and sanitation, hygiene, and the production of IWRM and water efficiency plans;
- Seek international support to build self-reliance and implement agreed priority actions, namely: IWRM, water demand management, water governance, capacity-building; and regional and inter-small island developing states water partnerships.

Source: UN 2005

CONCLUSION

Developing appropriate policy and management systems is essential to enhance the value obtained from freshwater resources and to ensure its sustainability. This includes interventions to strengthen governance, improve knowledge and information systems including data collection and monitoring and evaluation, enhance human and institutional capacity, develop IWRM systems which focus on catchment and basins as the management unit, and mainstream gender. Cooperation and partnership, between multiple stakeholders and at multiple levels, from the local to the sub-regional to the regional, are at the core of successful interventions. These responses should improve the opportunities to meet urgent needs for potable water, sanitation, irrigation and hydropower, among others. A critical issue that will need to be addressed systematically is financing. The approach of the Africa Water Vision is set out in Box 20.

Box 19: Disaster management in the Seychelles

For about twenty years after independence, the Seychelles were fortunate in escaping major environmental and natural hazards. That situation changed when the 1997 El Niño floods struck the Seychelles, raising public and government awareness about the necessity of strategic disaster management. In 2004, a National Strategy for Risk and Disaster Management was drafted. In October of the same year, Seychelles created a National Disaster Secretariat. The Secretariat acts as the operational arm of a National Disaster Committee.

Mahé, the largest island of the Seychelles, took the full force of the tsunami on 26 December 2004. The seawater was driven hundreds of metres up into the city drainage system, blocking pipes with silt and flooding roads, shops and houses.

Source: UNEP 2005a

Box 20: Thematic areas towards achieving the Africa Water Vision for the year 2025

Strengthening governance of water resources

- Developing and implementing institutional reform and capacity-building at local, national and transboundary water basin levels;
- Using the water basin as the unit for water resource management;
- Strengthening river basin and aquifer basin management;
- Creating an enabling environment for cooperation between countries
  sharing international water basins;
- Mainstreaming management at the lowest appropriate level and creating institutional arrangements for full stakeholder participation; and
- Liberalizing water markets while meeting the basic needs of the poor.

Improving capacity and information

- Establishing a sustainable system for data collection, management, and dissemination, including standardization and harmonization of data;
- Building institutional and human capacity for effective water management;
- Facilitating access to Internet services at local levels; and
- Mainstreaming gender and youth concerns in all activities.

Meeting urgent water needs

- Expanding safe water supply and sanitation services to meet basic human needs;
- Ensuring adequate water for sustainable food security;
- Ensuring that water for the environment is adequate in quantity and quality;
- Ensuring adequate water for economic development in the areas of agricultural production, energy and hydropower production, industry,
  tourism and transportation;
- Managing drought and desertification;
- Conserving and restoring ecosystems;
- Protecting water sheds and controlling siltation of hydraulic structures;
- Meeting the needs of rural energy supply; and
- Developing non-conventional water resources such as desalination and re-use of water.

Strengthening the financial base for the desired future

- Mainstreaming cost-recovery and service differentiation, allowing for a range of service options, each with its own price tag;
- Securing sustainable financing and initial donor assistance for tackling urgent water needs;
- Securing sustainable financing for institutional reform;
- Securing sustainable financing for information generation and management;
- Shifting from government to private sector financing in the water sector; and
- Establishing mechanisms for sustainable financing of water resources management.

Source: Donkor 2003

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CHAPTER 5
COASTAL AND MARINE ENVIRONMENTS

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REGIONAL SYNTHESIS

As coastal populations in Africa continue to grow, and pressures on the environment from land-based and marine human activities increase, coastal and marine living resources and their habitats are being lost or damaged in ways that are diminishing biodiversity and thus decreasing livelihood opportunities and aggravating poverty. Degradation has become increasingly acute within the last 50 years (Crossland and others 2005). Arresting further losses of coastal and marine resources, and building on opportunities to manage the resources that remain in a sustainable way, are urgent objectives.

The main causes of this degradation, apart from natural disasters, are poverty and the pressures of economic development at local to global scales. Economic gains, many bringing only short-term benefits, are being made at the expense of the integrity of ecosystems and the vulnerable communities that they support. The overexploitation of offshore fisheries impacts on the food security of coastal populations. Another key concern is the modification of river flows to the coast by damming and irrigation, and pollution from land, marine and atmospheric sources (Crossland and others 2005).

Africa's coastal and marine areas also have important non-living resources. There are offshore commercial oil and natural gas reserves in some 20 countries and many of these are being developed to supply the global energy market as well as domestic needs (EIA 2005). Many countries in Western Africa, for example, are oil producers, with Cameroon, Gabon and Nigeria being net exporters. Alluvial diamond- and heavy mineral-bearing sands have long been worked from the coastal sediments of Southern Africa. Exploitation of these non-living resources has damaged the coastal environment and, in the case of oil production in the Niger delta, caused civil conflict.

Africa's coastal environment is becoming an increasingly attractive destination for global tourism. In some countries, especially the small island developing states (SIDS), tourism, and its related services, is a main contributor to national economies (WTTC 2005).

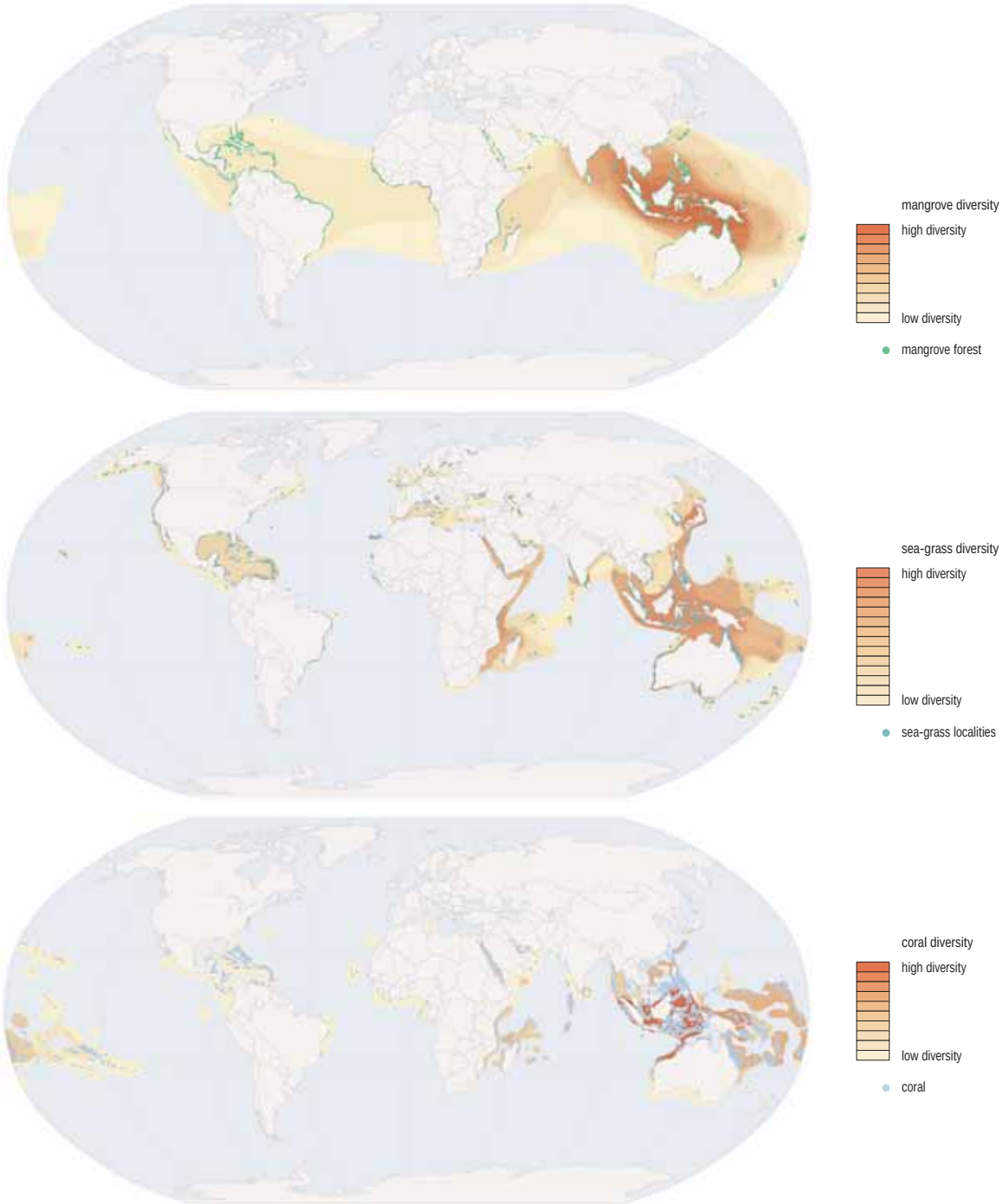
Most countries recognize the value of their coastal and marine biodiversity and have gazetted marine and wetland protected areas to ensure their sustainability (UNEP-WCMC 2000). The protection and restoration of Africa's coastal and marine ecosystems and their services are long-term objectives for local to global communities. These objectives must be achieved in the face of the pressures from land-use change, including urbanization, and climate change, including the rising sea level, coastal erosion and lowland flooding (IPCC 2001). This demands policy approaches that are multisectoral and occur at multiple levels; such approaches are discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*.

OVERVIEW OF RESOURCES

Africa's mainland and island states have rich and varied coastal and marine resources, both living and non-living. The coasts range from deserts to fertile plains to rain forest, from coral reefs to lagoons, and from high-relief, rocky shores to deeply indented estuaries and deltas. Their marine environments include the open Atlantic and Indian oceans and the almost landlocked Mediterranean and Red seas. Continental shelves, where waters are less than 200 m deep, in some places extend more than 200 km offshore, while elsewhere they are almost absent.

The biodiversity of the coastal zone is an important resource and there are many designated protected areas, both wetland and marine. The coral reefs, sea-

Figure 1: Global distribution of mangrove, sea-grass and coral diversity

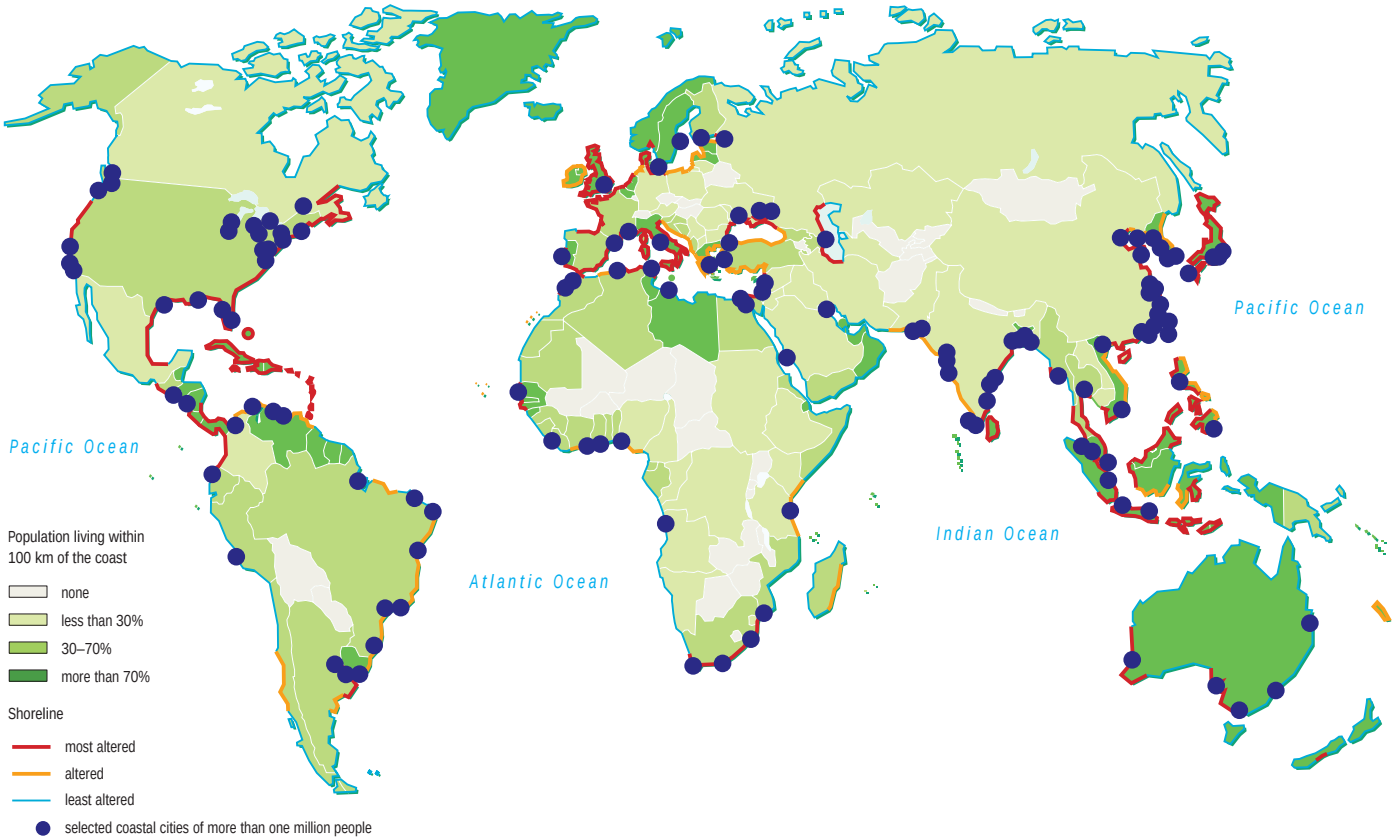


Source: Groombridge and Jenkins 2002; Maps prepared by UNEP WCMC

grass beds, sand dunes, estuaries, mangrove forests and other wetlands that occur around many shores provide valuable services for humanity, as well as crucial nursery habitats for marine animals and sanctuaries for endangered species. The coral reefs, sea-grass beds, sand dunes, estuaries, mangrove forests and other wetlands that occur around many shores provide valuable services for humanity, as well as crucial nursery habitats for marine animals and sanctuaries for endangered species (Figure 1). LMEs are relatively large regions, in the order of 200 000 km^2 or greater, characterized by distinct bathymetry, hydrography, productivity, and trophically dependent populations (Sherman and Alexander 1986). Many of these LMEs are characterized by seasonal or permanent coastal upwellings of cold, nutrient-rich oceanic water (where water is forced upwards from the ocean depths to the surface) supporting important fisheries.

During the last decade or so, substantial oil and natural gas resources have been discovered offshore,

Figure 2: Coastal populations and shoreline degradation



Source: UNEP 2002c; data from Burke and others 2001, and Harrison and Pearce 2001

some of them in deep or ultra-deep water on the continental slope, as in Western Africa (EIA 2005) (Figure 2). Many offshore areas remain unexplored. The largest of the new oil reserves are those off the Niger delta, itself a globally important, established production area. Other major oil reserves have been discovered and are being developed within the Exclusive Economic Zones (EEZs) of Cameroon, Equatorial Guinea and Angola. Many oil reserves are associated with natural gas. Large reserves of non-associated gas have been discovered offshore around the Gulf of Guinea – notably in Nigeria – and off Namibia and South Africa; also in the Mediterranean in the Gulf of Gabès and off the Nile delta. Natural gas is in production off the Tanzanian mainland.

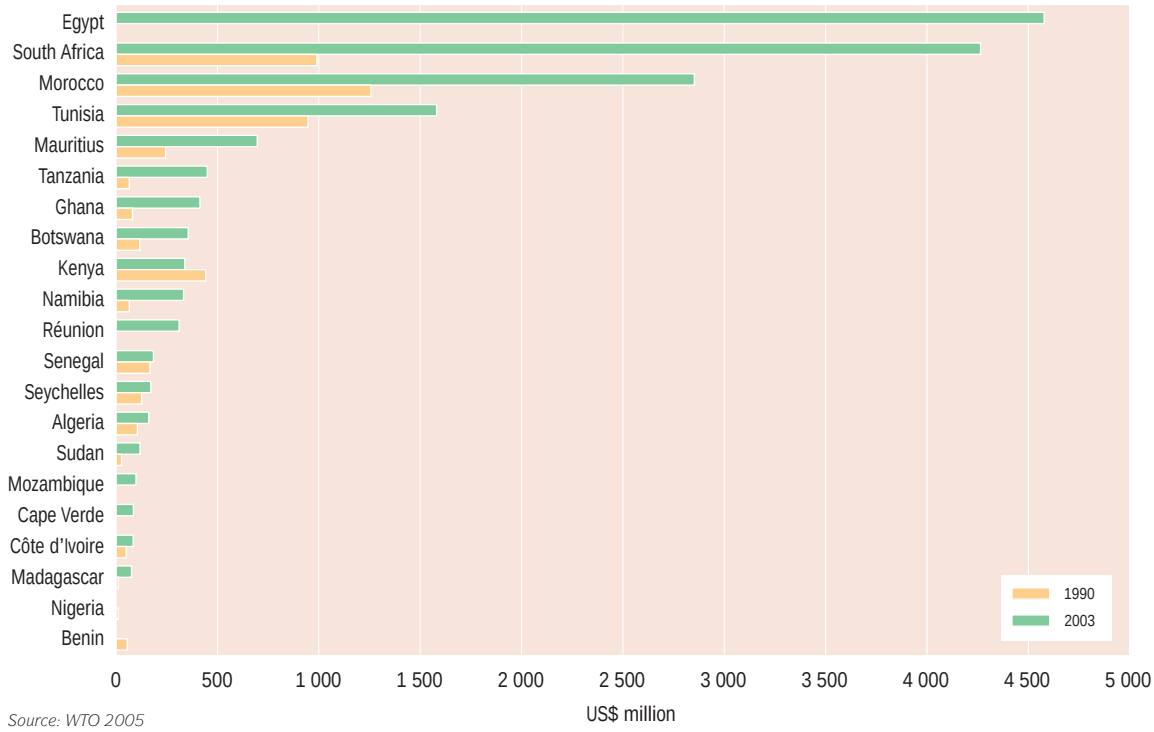
Many of the coastal sediments of Southern and Eastern Africa yield mineral resources. The coastal sand dunes and seabed sediments along the Atlantic shores of South Africa and Namibia contain commercially valuable alluvial diamonds, while coastal sediments on South Africa's Indian Ocean shores and in Mozambique contain commercial titanium and zirconium minerals. Coastal sands in Kenya are also a source of titanium.

Endowments and opportunities

Africa's marine and coastal resources have traditionally supported livelihoods through subsistence fisheries, agriculture and trading. Nowadays, the coastal areas are the locus of rapid urban and industrial growth, oil and gas development, industrial-scale fisheries and tourism (Figure 2). While there is a general trend of population increase in the coastal areas, the coastal cities are the principal growth nodes. It has been estimated that by 2025 the coastal zone from Accra to the Niger delta could be an unbroken chain of cities, with a total population of 50 million along 500 km of coastline (Hatziolos and others 1996, Figure 2). Much of the region's heavy industry, including most refineries and gas liquefaction plants, is sited at coastal locations, along with terminal facilities for tankers and undersea pipelines, and bases for offshore engineering services.

The natural coastal assets have supported a growth in tourism, with substantial economic benefits including the creation of many jobs for men and women. Tourism has become a big employer and source of income, notably in Morocco, Tunisia, Egypt, Mauritius and South Africa (Figure 3). Many countries are set to further develop their coastal tourism, with an increasing market for eco- and

Figure 3: International tourism receipts in African coastal countries, 1990 and 2003



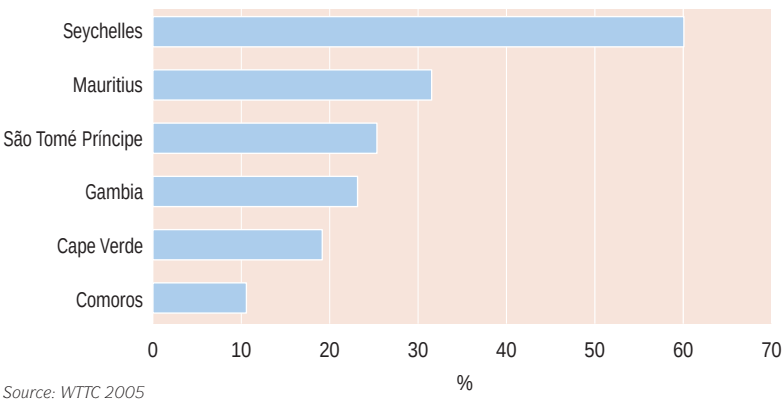
Source: WTO 2005

cultural tourism. Tourism revenues were expected to grow by 5 to 10 per cent in 2005, and annually, in real terms, by about 5 per cent between 2006 and 2015 (WTTC 2005). Much of this growth is likely to be coastal. Coral reefs are a major ecotourism attraction. There are opportunities for involving indigenous coastal communities in ecotourism, improving their well-being as well as contributing to national economies. In some countries – particularly some SIDS – tourism with its related services is already the largest employer and the tourism economy makes the largest contribution to Gross National Product (GNP) (Figure 4).

Artisanal fisheries are the mainstay of coastal communities' livelihoods around much of Africa's coastline, employing mostly men operating in small, undecked boats. Some countries, such as Morocco, Egypt, South Africa, Ghana and Senegal, have offshore industrial fishing fleets which employ mostly men, while men and women are engaged in the preparation of fish products onshore, as in the tuna canneries of Ghana, Seychelles and Mauritius. Intertidal harvesting for shellfish or maricultured seaweed, as in Tanzania, is carried out by women.

The extent to which coastal communities, and their countries, benefit from fisheries resources varies greatly, as shown in Figure 5. The resources are exploited by industrial as well as artisanal fleets, the former comprising local and foreign-flag vessels. Where the artisanal sector is strong, as on the Atlantic coast, all vessels operate in about the same areas, targeting similar species, and this often leads to conflict between artisanal and industrial fleets. Cases of poaching and illegal, unregulated and unreported (IUU) fishing by vessels from outside the region are common, the latter jeopardizing the catches of local, small-scale fishers with serious consequences for food security and income. Increases in industrial-scale fishing over the last decade or so have impacted adversely on artisanal fisheries, already stressed through population pressure by overharvesting and the use of unsustainable fishing methods. Generally, artisanal fisheries are showing decreasing returns per fishing effort and reductions in the sizes of fish caught.

Figure 4: Travel and tourism economies as percentages of Gross Domestic Product 2005 for selected SIDS and Gambia



Source: WTTC 2005

Countries whose EEZs extend into the areas of oceanic upwelling in the Atlantic LMEs tend to be major, industrial producers of marine fish, much of it taken by foreign fleets under access agreements. In Eastern Africa, Somalia could benefit from the rich fisheries of the Somali Current upwelling, but much of its production is captured illegally (Coffen-Smout 1988). In the Western Indian Ocean, fisheries contribute significantly to all national economies, with stocks including tuna exploited under licence by foreign fleets. Fish processing and transhipment provides additional employment and revenue (UNEP 2004). In Mozambique and Tanzania, estuarine prawn fisheries make an important economic contribution (UNEP 2001). In the Mediterranean, where foreign industrial fleets are becoming prevalent, there may still be some scope for increased production, but at the expense of the size of fish caught (Alm 2002). Total reported marine fish capture continues to increase, with nearly 5 million t recorded in 2003 (Figure 5, FAO 2005). In the last three decades, imports of fish and fishery products by African countries exceeded the exports of the same in quantity, although the gap is gradually decreasing. Conversely, export values were far in excess of import values. This is because many African countries import large quantities of low-grade species, like mackerel and sardinellas, and export high-grade species like shrimps and snappers, and other demersal species.

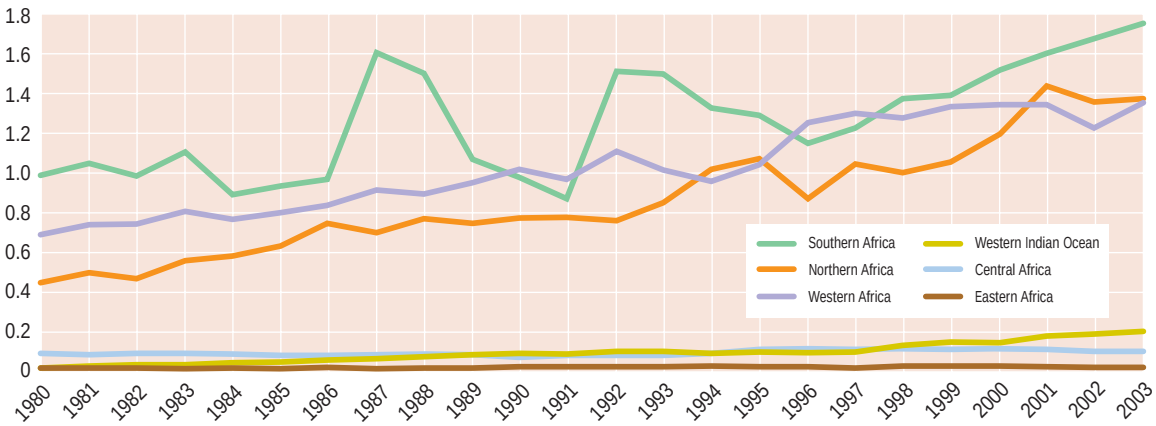
Aquaculture makes important contributions to the livelihoods of coastal dwellers in Egypt, particularly fish from the brackish water lagoons of the Nile delta. In Zanzibar, Tanzania, seaweed farming has become important, improving livelihoods particularly of women. Few countries have seized the opportunities of aquaculture, although considerable potential exists across the region (MA 2005). For sub-Saharan Africa (SSA), it is estimated that less than 5 per cent of the potential has been utilized, contributing less than 0.2 per cent to world aquaculture production.

In addition to fishery resources, coastal and marine ecosystems provide important services. Coral reefs and their associated sea-grass meadows and mangrove forests,

Essaouira is a bustling coastal city in Morocco supporting the film industry, the arts, tourism and thriving fisheries. Here, a view of Essaouira through an old city gate.

Source: J.C. Mohamed-Katerere

Figure 5: Reported marine fish capture in African sub-regions since 1980



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

and other coastal wetlands, provide nursery areas and shelter for a host of animals, both marine and terrestrial, as well as protection against inundation and erosion by marine storm surges and extreme waves (Figure 1). Mangrove forests act as chemical cleansing buffers, absorbing land-sourced pollutants, and they also have cultural and medicinal values. Beaches and dune systems provide coast protection as well as sites for nesting and breeding.

Offshore oil and gas development is making substantial contributions to national economies, providing jobs for men, though many of these are short-term. With the engagement of industry and effective national governance, the benefits to coastal communities and the protection of coastal and marine ecosystems could be substantially improved. In many countries, hydrocarbon development is supplying growing domestic and transnational energy markets. The value of the resources to national economies is difficult to estimate because of the volatile nature of the global energy market and the nature of specific licensing arrangements. The sums involved are potentially huge. But these resources are finite and the income generated from their production cannot be sustainable over the long term. The alluvial mineral resources of Southern Africa are similarly finite, and these too make substantial economic contributions.

Challenges faced in realizing opportunities for development

The capacity of most coastal nations to utilize their coastal and marine assets, while simultaneously protecting them from degradation, is lacking.

Although the success of coastal tourism is subject to local security issues as well as global economic pressures, its sustainability depends, above all, on the protection and beneficial management of those assets. The region's fisheries have scope for restoration and continuing to be major contributors to coastal livelihoods, and the national economy, but only if the pressures leading to overexploitation and pollution can be controlled. Oil and natural gas development and mineral extraction have a potential for increasing the general levels of economic security and human well-being in the short to medium term, but these resources are finite and there is a need to diversify into sustainable ventures.

The overexploitation of fisheries at artisanal and industrial scales using unsustainable fishing methods, and the introduction to coastal ecosystems of invasive alien species from marine sources, are further concerns. Coastal ecosystems, especially estuaries and lagoonal wetlands, are becoming increasingly impacted by activities within river catchment, with deforestation, intensive agriculture, damming and irrigation all changing the nature of material fluxes (water, sediment, nutrients and pesticides) (Arthurton and others 2002, Crossland and others 2005). At the global scale, human-induced atmospheric warming has been contributing to a slow but persistent eustatic sea-level rise and significant climatic changes in the region (IPCC 2001). In the last decade, episodes of unusually high sea temperatures have caused widespread mortality of reef coral.

A summary of the principal issues faced in realizing development opportunities is given in Table 1.

Fishermen preparing their nets, Cape Town, South Africa.

Source: A. Mohamed

Table 1: Issues, threats and constraints related to regional development opportunities and goals

Opportunities for development	Issues, threats and constraints related to development NEPAD *issues in italics*
Oil and gas production	*Resource sustainability*
	Marine and coastal pollution, water- and airborne
	Coastal habitat loss
	Invasive species from tanker ballast waters
Coastal mineral extraction	*Habitat loss through excavation, siltation, pan construction*
	Restoration of industrial mining sites
	Coastal erosion from beach sand mining
Urban, industrial and port development	*Urban sprawl and habitat loss through construction, siltation*
	Solid waste, sewage discharge and industrial effluents; hazardous waste
	Pollution of coastal wetlands and seas
	Invasive species especially from shipping ballast waters
	Coastal erosion
	Inundation due to sea-level rise; extreme wave events
Tourism growth	*Urban sprawl and habitat loss from construction and tourist pressures*
	Solid waste and sewage discharge; chemical effluents
	Loss of amenity value
	Coral bleaching
	Coastal erosion, beach loss
	Sea-level rise; extreme wave events
Marine fisheries growth and sustainability	*Overharvesting and use of destructive methods*
	By-catch and endangered species
	Regulation and enforcement; illegal fishing
	Protection of nursery areas
	Land-sourced pollution of coastal waters
	Reduced freshwater discharge from rivers (prawn fisheries)
Coastal aquaculture growth	*Wetland drainage and reclamation for agriculture and urban growth*
	Habitat and biodiversity loss, especially from pond construction
	Urban, industrial and agricultural pollution; pollution from aquaculture
	Lack of freshwater input
	Institutional constraints
	Coastal erosion; sea-level rise
Coastal agriculture sustainability	*Habitat and biodiversity loss*
	Coastal siltation from increased run-off
	Reduced freshwater discharge from rivers through irrigation
	Reduced flooding and sedimentation through damming
	Salinization of groundwater
	Control of fertilizers and pesticides
	Impact of urban sprawl
	Coastal erosion; sea-level rise

Empowerment and capacity

The will and capacity of countries to manage their coastal and marine resources in ways that promote human well-being, for present populations and for future generations, are important issues. Effective governance at community to global levels is a prerequisite for environmental stewardship, while the development and maintenance of that stewardship depends on a sustained commitment to human and technical capacity-building. Such capacity-building encompasses scientific data collection and monitoring, the construction of appropriate legal frameworks, and improving capabilities in surveillance and the enforcement of legislation. Capacity-building in monitoring and enforcement at community level offers

Table 2: Priority areas for promoting best practice in governance and management

Priority areas	Means
Fisheries: regulation and practice	Laws, licensing, surveillance, health and safety, education and training
Coastal and marine conservation (including Marine Protected Areas (MPAs) and wetlands) programme, public awareness	Management, community benefits
ICZM	Establish and improve planning and management institutions (especially urban, industrial and tourism-related)
Waste management and pollution control	Improve local waste services, sewage systems, industrial and agricultural effluent control; international action on marine waste, litter and illegal dumping; oil spill management; protection against invasive species
Coastal protection	Vulnerability assessment, adaptive land-use planning, shoreline maintenance; participatory 'Blue Flag' schemes
Inter-sector cooperation	Consultation and engagement between stakeholders, locally, at the catchment scale, nationally and internationally
Information systems, monitoring, R & D	Ground-truthing and remote sensing techniques, standards for monitoring, establishing performance indicators, improving evidence base including community reporting, costing
Human and operational capacity	Develop professional, technical and managerial resources; equipment and physical infrastructure investment and maintenance

Sources: Alm 2002, Francis and Torell 2004, Hatziolos and others 1996, UNEP and EEA 1999, UNEP 2002a, UNEP 2004

important opportunities. Community-based or participatory monitoring has been very effective in increasing the manpower available for monitoring (thus cost-effective) and at the same time enhancing environmental awareness and ownership among community members. This has been effective in mangrove and coral reef monitoring in Tanzania (Wagner 2004).

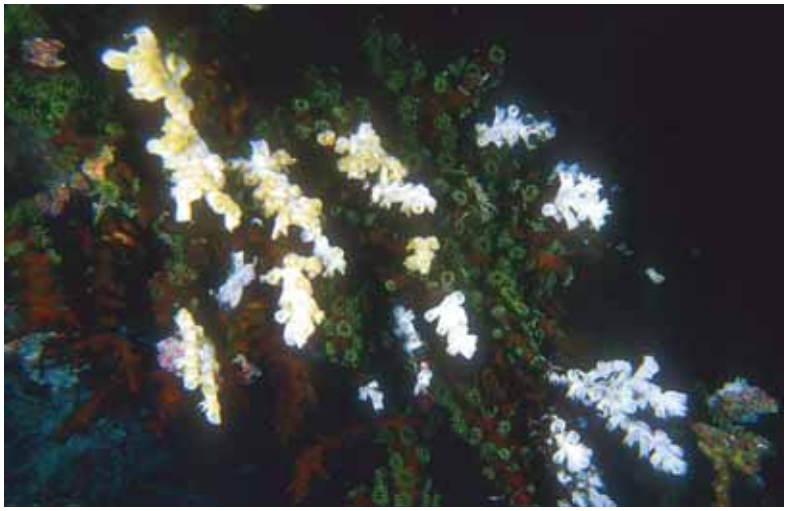
In order to develop and maintain environmental stewardship, there must be sustained commitment to finance, human and operational capacity-building, as well as to the promotion of public awareness. Capacity-building should include the development of appropriate institutions and legal frameworks, scientific data collection and monitoring, and capabilities in surveillance, as well as the monitoring and enforcement of legislation. There is a clear need for the development of professional, technical and managerial staff in each of the priority areas and activities identified in Table 2.

Collaboration and cooperation

Most coastal countries are signatories to one or more multilateral environmental agreement (MEA) that deals with marine and coastal management issues. These MEAs include the Barcelona Convention, the Jeddah Convention, the Nairobi Convention and the Abidjan Convention, as well as the International Convention for the Prevention of Pollution from Ships (MARPOL) relating to the control of pollution from ships, and the United Nations Convention on the Law of the Sea (UNCLOS). These conventions lay the foundations for coastal states to develop legislation and management plans relating to their coastal and marine environments, integrating the various sectoral policies and, increasingly, taking account of river catchment that discharge to those environments (UNEP/MAP/PAP 1999). Under Article 76 of UNCLOS, a state may submit proposals to extend its defined continental shelf beyond the 200-nautical mile limit of its EEZ for the purposes of mineral extraction and harvesting benthic organisms (UNEP/GRID-Arendal, 2004). Some countries have introduced legislation for coastal management.

Recognizing the transnational issues involved in an ecosystem-wide approach to catchment, coastal and marine resource management, national legislation and management plans should place a priority on the coordination of sector interests, with the involvement of all resource users. Policies should reflect the marked increase in environmental degradation over the last 50 years or so, as well as acknowledge the priorities for taking action.

Partnerships with global actors are increasingly important in addressing coastal and marine management issues. Initiatives for improving resource management and related capacity-building are in place through organizations such as the Intergovernmental Oceanographic Commission of UNESCO (IOC), the World Bank, The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA), LOICZ (Land-Ocean Interactions in the Coastal Zone), WWF – the World Wide Fund For Nature (WWF), IUCN- the World Conservation Union (IUCN) and UNEP. These initiatives, along with many bilateral agreements, commonly have overlapping objectives and there would be merit in improved coordination and cooperation amongst the various organizations and donors.



Bleached coral caused by ocean warming, Maldives.

Source: P. Kobeh/Still Pictures

Destruction and pollution

Key issues in the management of the coastal zone and offshore waters include the loss of biodiversity and habitats through human-related pressures, the impacts of which have become increasingly acute within the last 50 years or so. Physical destruction and pollution of habitats from land-based and marine sources as a consequence of economic development is rife. For example, the clearance of mangroves for local consumption and export, as well as land clearance for agriculture and fuelwood leading to siltation, threaten marine life (UNEP 2004).

Competition for space is intense around developing cities, where urban sprawl is making inroads into coastal wetlands and disturbing them through land-filling, pollution and eutrophication. Elsewhere, agriculture is impinging on wetlands, with drainage schemes and pollution from fertilizers and pesticides. Mangrove forests, which provide an invaluable range of ecological services and products, including pollution filtering and coastal defence, are especially vulnerable to development pressure from overharvesting (eg for construction poles) and clearance for agriculture, prawn ponds and salt pans. They are also being stressed by reduced freshwater supply due to damming. Protected area status provides little assurance from the impacts of these competing economic activities. One challenge is how to deal with oil and gas exploration in or adjacent to marine protected areas (MPAs).

Unsustainable fisheries

Overexploitation of fisheries has two main drivers – at the artisanal scale, poverty and population growth (including the inward migration of fishers) amongst coastal communities (an added difficulty is that many fishers will not easily accept alternative means of livelihood) and, at the industrial scale, commercial incentives and subsidies available to foreign fleets operating under licence, or in some cases illegally, in EEZs.

Economic and social benefits accruing to western coastal countries, in particular those arising from access agreements with distant water fleets, have generally not been realized (though the case of Namibia is an exception) and few coastal people benefit directly from access fees in terms of direct or indirect employment or in improved standards of living (Alder and Sumaila 2004). There will be serious consequences for rural coastal populations if the degradation of fisheries, through overharvesting (inshore and offshore) and the use of damaging methods, continues unchecked. Fishing access agreements in the coastal states are signed by various ministries, each with their own development agenda and no common goal. Although the extent of stocks may be poorly known, countries continue to sign agreements with foreign fleets who may take advantage of the lack of surveillance and fish beyond their agreed quotas (Alder and Sumaila 2004).

The fish stocks in most of the LMEs around Africa, as in the rest of the world's oceans, are overexploited (Pauly and others 2002), and where catch tonnages are increasing, as in the Mediterranean, there are reductions in the sizes of fish caught (Alm 2002). The resulting by-catch (non-target species) also poses a threat to biodiversity. Effective enforcement of regulations concerning fishing methods, such as the minimum allowable net mesh sizes, is needed if stocks are to attain maturity. Without the recognition by the international community of the precarious state of most

of the offshore fisheries, there is a real danger that stocks will collapse. There is an urgent need for international agreement on fisheries regulation, as well as for financial support for monitoring, control and surveillance, and for enforcement of regulation. Most countries do not yet have the management and operational capacity to fully develop their EEZs to their own long-term economic advantage, although those of the Western Indian Ocean have recently come together (with the help of WWF) to set up minimum terms and conditions for fishing access. With this capacity in place, there should be opportunities to restore the fisheries resources to a sustainable level. There is also a great need for capacity-building in the area of negotiations.

Data collection and the development of inventories remain a challenge. In the region as a whole, the quality of reported statistics for fisheries, especially for fish catches, numbers of fishers and fishing boats, is varied and in some cases unreliable.

Tourism

Coastal tourism development has the potential for long-term benefits to coastal communities and national economies, but it also raises important issues of sustainability. For sites of mass tourism, the construction of hotels and transport infrastructure involves habitat loss, while the pressures of tourist numbers – through physical disturbance, high demand for freshwater, pollution and eutrophication – impact adversely on the living resources, especially those of coral reef ecosystems. The short-term aspirations of developers must be appraised in the longer-term contexts of the sustainability of the amenity that has attracted those developers in the first place and of the implications of climate change. In particular, tourism development should aim to avoid the sidelining and alienation of indigenous communities by involving them in ecotourism.

Coastal tourism threatens coral reefs and coastal ecosystems
Tourism development at Hurghada on Egypt's Red Sea coast.

Source: Google Earth

Coastal accretion and erosion

Much of Africa's coastal zone is vulnerable to physical shoreline change, in some places from accretion, but mostly from erosion. Most of the change is due to, or exacerbated by, human activities. Locally, it is caused by coastal engineering, such as port development interrupting the longshore transport of protective beach sediment. More widely, it is due to the retention (by damming) of river-borne sediments formerly discharged at the coast (WCD 2000, Crossland and others 2005), as in the case of the Nile delta. Short of dismantling existing dams, there is little that can be done in mitigation other than installing expensive coastal defences. Coastal erosion and the progressive flooding of coastal lowlands are likely to increase, largely as a consequence of the rise in sea level produced by global warming (IPCC 2001). Apart from catastrophic temporary inundations caused by tsunamis or climate-driven marine surges, physical shoreline change is usually a slow process, and the most cost-effective solutions for threatened communities will be those involving adaptation by planned relocation. The long-term impact of sea-temperature rise (resulting from climate change) on the integrity of the region's coral reefs is likely to be profound (Lindeboom 2002).

Incentives and empowerment for coastal communities to sustainably manage and develop the resources upon which they depend should be considered at the national level. Payments for the use of ecosystem services by developers and harvesters of all sorts may provide a pathway for this. The valuation of ecological services is not simple, but global knowledge in this field is fast developing. "Cap and trade" schemes, similar to those being applied to the production of gases such as carbon dioxide, can be applied to fisheries, for example, with quotas being tradable between countries or smaller stakeholders. With or without such incentives, the promotion of public awareness is important if Africa and its coastal communities are going to benefit from their coastal and marine resources over the long term.

Two children playing in the sea, Cameroon. Offshore is a big tanker.

Source: A. Buck/Still Pictures

SUB-REGIONAL OVERVIEWS

CENTRAL AFRICA

The principal concerns are the loss and degradation of coastal habitats and the modification of marine ecosystems due to pollution from land-based urban and industrial sources (including oil and natural gas development) and from the overharvesting of marine fish stocks. Pressures from continuing population growth, notably in the coastal cities, such as Douala in Cameroon and Libreville in Gabon, are having increasing impacts on the coastal environment. These impacts may be exacerbated by global climate change and sea-level rise, particularly with regard to coastal erosion – already a serious problem locally – and the inundation of low-lying coasts such as those of Cameroon and Gabon (IPCC 2001, UNEP 2002a).

OVERVIEW OF RESOURCES

Except for Chad and the Central African Republic, all the countries of Central Africa – Cameroon, Congo, the Democratic Republic of the Congo, Gabon, Equatorial Guinea and São Tomé and Príncipe – border the Atlantic Ocean. The mainland shores are mostly low-lying, with estuaries and mangrove swamps, especially in Cameroon and Gabon, and lagoons protected by sandy beaches. Rivers, including the Kouilou, Ogooué, Sanaga and, notably, the Congo, drain a hinterland of rainforest. The EEZs of these countries form part of the Guinea Current LME (NOAA 2003a) and have substantial fisheries resources. Total marine fish production in 2001 for all Central African countries was 113 000 t, with Cameroon being the main producer (Figure 8, FAO 2005). Abundant oil and natural gas resources occur offshore, notably off Cameroon and Equatorial Guinea.

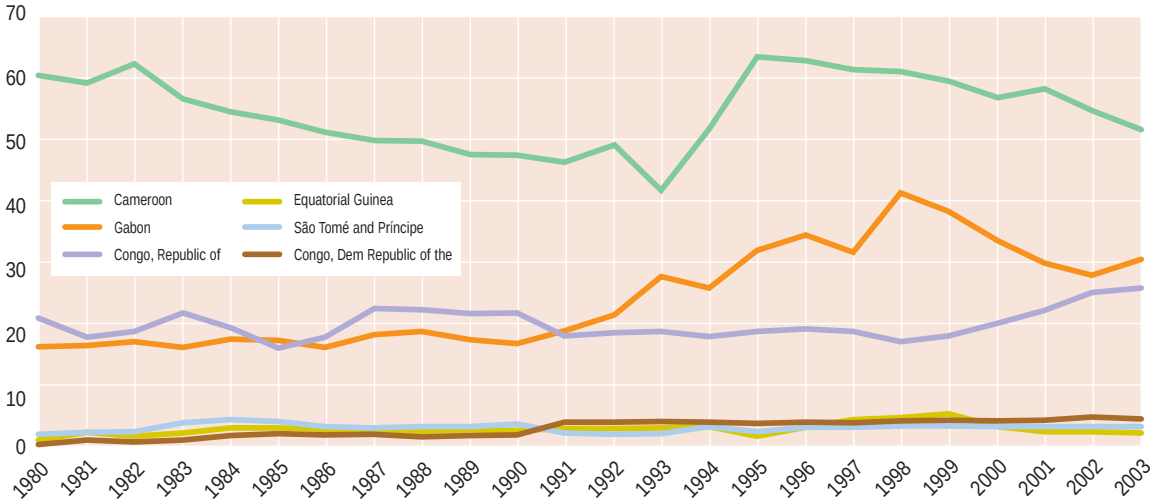
The Guinea Current LME is characterized by its tropical climate. It is considered to be highly productive, with climate being the primary driving force and intensive fishing the secondary force. The living marine resources include commercially valuable fish which are exploited at artisanal and industrial scales. The major pelagic species on the Gabon shelf is the sardinella. The demersal communities include croakers and the threadfin in nearshore waters, and sea bream and driftfish in deeper waters (NOAA 2003a).

Estuaries and coastal lagoons make a major contribution to fish diversity. Mangrove forests are extensive on the sheltered coasts of Cameroon (3 060 km^2) and Gabon (2 500 km^2) (UNEP-WCMC 2000, Figure 1). While some coral species are recorded, there are no coral reefs. Gabon has a number of coastal protected areas, including three sites protected under the Ramsar Convention on Wetlands (Ramsar) with rare and endangered mammals and birds.

The coastal areas of Central Africa have substantial hydrocarbon resources (EIA 2005). Gabon, Equatorial Guinea and Cameroon are all significant producers and exporters of crude oil. Much of the production now comes from offshore wells. In Equatorial Guinea, production has increased from 17 000 barrels per day (bbl/d) in 1996 to an average of 350 000 bbl/d for the first half of 2004 (EIA 2005). The Democratic Republic of the Congo is now a minor producer from a well on its continental shelf. While there is concern

Figure 6: Reported marine fish catches in Central African countries since 1950

thousand metric tonnes



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

over the longevity of the reserves in Gabon, a country almost wholly dependent on oil revenues to fund its economy, Cameroon and Equatorial Guinea are thought to have major reserves. Equatorial Guinea also has huge natural gas reserves, located off Bioko Island. Natural gas and condensate production in Equatorial Guinea has expanded rapidly in the last five years. Alba, the country's largest natural gas field, contains 1.3 x 10^{12} cubic feet of discovered reserves, with probable reserves estimated to be at least at 4.4 x 10^{12} cubic feet.

Endowments and opportunities

Hydrocarbon resources are making an increasingly strong contribution to the economies of Central African countries (EIA 2005) and have been a key factor in improved economic growth, as discussed in Chapter 1: *The Human Dimension*. Over the last decade or so, the focus of exploration has shifted from onshore to the coastal waters, where there are now many successful production ventures. The offshore Joint Development Zone, shared by São Tomé and neighbouring Nigeria, is reported to hold reserves of 11 000 million barrels and could potentially yield up to 3 million bbl/d when fully operational (EIA 2005). If successful, this development could have an immense impact on the economy of this otherwise impoverished SIDS. Hydrocarbon resources development and production present considerable local employment opportunities.

The natural beauty, biodiversity and socio-cultural aspects of the coastal areas provide strong potential for fishery and tourism, and in particular ecotourism. Total marine fish production in 2001 for all Central African countries was 113 000 t, with Cameroon being the main producer (Figure 6, FAO 2005). However, the LME shows evidence of ecosystem stress and there are major fluctuations of commercially valuable species (NOAA 2003a).

Challenges faced in realizing development

Marine pollution and coastal erosion continue to disturb and destroy habitats, disrupt ecosystem functioning, cause loss of biodiversity, and affect human health and well-being. The main pollution problems are the discharge of industrial effluents and sewage, solid waste including marine-transported debris, and beach pollution. Coastal erosion has a serious impact on the low-lying coasts. Contributing causes include mangrove clearance and the reduction in sediment discharge through the damming of rivers draining the hinterland. Further entrapment of sediment in the Sanaga River basin, where Cameroon is set to construct another dam, may exacerbate erosion. Erosion can be expected to increase with sea-level rise associated with global climate change (IPCC 2001). In São Tomé, coastal erosion, exacerbated by beach sand mining (now largely banned), has been reported to be threatening infrastructure in the southern part of the main island (UNEP 1999).

The risk of offshore oil spills from wells, terminals and tankers is a serious threat (UNEP 1999, UNEP 2002a). These problems affect the islands of São Tomé and Príncipe as well as the mainland shores and their coastal waters. This risk of oil pollution comes not only from Central Africa's offshore development but also from the huge hydrocarbon developments off neighbouring Nigeria and, to a lesser extent, Angola. As well as water-borne oil pollution, air quality is affected by the flaring of natural gas associated with oil production.

Population growth and poverty are the major factors in coastal degradation. The coastal population continues to expand, in part by inward migration. Much of this expansion is in the coastal cities of Douala in Cameroon and Libreville in Gabon, accompanied by urban sprawl and the consequent loss of formerly rich habitats (Figure 2).

There is strong evidence of serious degradation in the Guinea Current coastal environment (NOAA 2003a). Primary productivity surveys in coastal waters have revealed an increasing occurrence of harmful algal blooms, indicating intense eutrophication and therefore excessive nutrient loading from anthropogenic sources. Agricultural run-off contributes to increased eutrophication in the estuaries and coastal environments. The restoration of lagoons, mangroves, estuaries, deltas and tidal wetlands will benefit local communities. Not only are these habitats rich in natural resources but they are also effective filters for pollution.

The overfishing and overexploitation of transboundary and migratory fish by industrialized foreign fleets is having a detrimental effect on artisanal fishermen, and in particular on coastal communities that depend on the nearshore fisheries resource for food (NOAA 2003a). This becomes particularly serious in a context of exploding demographics in the coastal areas.

EASTERN AFRICA

The main concerns are the loss of biodiversity, habitat degradation and the modification of mangrove and coral reef ecosystems. Human-related pressures come from overfishing and fishing-related damage, from urbanization and tourism development, from agriculture and industry, and from damming for hydropower. Other important concerns are the reported dumping of hazardous wastes on Somalia's shores and coastal waters (UNEP 2005a) and climate change, contributing to coral bleaching and sea-level rise, which in turn leads to coastal erosion and inundation of coastal lowlands. Another issue is the sporadic infestation of coral reefs by the invasive crown-of-thorns starfish (COTS). The shores facing the Indian Ocean were impacted by the catastrophic tsunami of 26 December 2004, and in Somalia, some 300 people are reported to have died (UNEP 2005a).

OVERVIEW OF RESOURCES

The sub-region's long coastline stretches from the Red Sea, which flanks Eritrea, through the Gulf of Aden, off Djibouti, to the Indian Ocean, off Somalia and Kenya. Most of the coastal zone is arid and, outside the few coastal cities, sparsely populated, except in Kenya where the coast has a monsoonal climate and supports a large and growing population.

Most countries have important marine fisheries resources, as well as the inshore and reef fisheries which are traditionally exploited by artisanal fishers. There are prolific fisheries associated with the upwelling of the Somali Current off the north-eastern coast of Somalia, and seasonally rich resources off Djibouti and Eritrea.

Coral reefs occur extensively, except where there is upwelling or sediment is discharged. Surveys of reefs in the late 1990s, here, and on the shores of the Gulf of Aden, reported reef health to be generally good, and the diversity of coral and reef-associated fauna to be globally significant, with a high level of endemism and species diversity (PERSGA/GEF 2003, Kotb and others 2004). Reefs occur as an interrupted barrier on Somalia's southern coast (UNEP-WCMC 2000), and in Kenya they fringe a cliff-bounded, intertidal platform extending over some 150 km of the Mombasa shore. Kenya's coral reefs suffered severe mortality in the 1998 bleaching event, but recovery of coral cover is now at 50-100 per cent levels (Obura and others 2004).

Coral reefs occur extensively along Africa's east coast
In southern Somalia coral reefs form a barrier along the coast.

Source: NASA 2001

Mangroves colonize some sheltered inlets on the Red Sea and in southern Somalia, and in Kenya exist as extensive, lush forests, in the Lamu district, and as linings to tidal creeks, further south; they have a total estimated area of 610 km^2 (Taylor and others 2003). The coral reefs, sea-grass beds and mangroves of the Somali Current LME (NOAA 2000) form a productive and diverse ecosystem of great ecological and socioeconomic importance; the mangroves also providing sanctuary to a wide variety of terrestrial fauna (UNEP/GPA and WIOMSA 2004). For the Red Sea, several MPAs have been declared or proposed – notably the Dahlak Archipelago marine park (2 000 km^2) in Eritrea – but these are mostly lacking effective management plans and enforcement (Kotb and others 2004). In Kenya, MPAs, such as the Watamu and Kisite marine national parks, are well established and generally well managed (IUCN and others 2004, Obura and others 2004). No effective protection exists on the Somali coast.

Oil and gas exploration is continuing along the Eritrean and Kenyan coasts (EIA 2005). The Pleistocene reef limestones provide raw materials for an established cement industry near Mombasa, and in Somalia similar limestones are quarried for aggregate and building stone. In a new coastal development venture in Kenya, mineral sands have been identified as a source of titanium ore.

The coastal zone has a rich archaeological and cultural heritage which includes the UNESCO World Heritage site of Lamu Old Town in Kenya, the oldest and best-preserved Swahili settlement in East Africa (UNESCO 2005). Other significant heritage sites in Kenya include Mombasa's Old Town and Fort Jesus. The Gedi ruins near Malindi, gazetted as a monument in 1927 and now a National Museum, mark an Islamic civilization city (National Museums of Kenya undated).

Endowments and opportunities

Inshore and reef-related fisheries have been a mainstay of the coastal populations and continue to be an essential resource for their livelihoods (FAO 2004b, FAO 2002a, PERSGA/GEF 2003, UNEP 1998). The Red Sea coasts of Eritrea and Djibouti support extensive reef-based artisanal fisheries; there are also productive offshore fisheries due to the seasonal upwelling in the Gulf of Aden.

Fisheries are dominated by foreign fleets, with production far outstripping that of artisanal fishers (FAO 2002a). Most commercial operations in the prolific fisheries of the Somali Current upwelling are carried out by foreign vessels, many of them illegally (UNEP 2002a). In Kenya, most fishing activity takes place along the reef, with mainly reef- and sea-grass-associated fish species being exploited; a few freezer trawlers fish for shrimp in the shallow waters of

Lamu – a UNESCO World Heritage site on the Kenyan coast, is a highly acclaimed tourist destination.

Source: S. Köppel

Ungwana Bay (FAO 2001a). Little is known of the potential of the offshore fisheries resource in southern Somali and Kenyan waters.

While artisanal and inshore fisheries are generally overharvested, some countries have not yet developed the capacity to fully exploit, or enforce regulation of, their offshore fisheries. But this is changing. Eritrea now places a high priority on the development of commercial fisheries (Kotb and others 2004), aiming to increase production three- to four-fold, up to between 50 000 and 60 000 t per year. Some 80 to 85 per cent of this production is expected to be generated by the foreign industrial fleet, especially trawlers, but the contribution from artisanal fisheries may also be increased (FAO 2002a). In Djibouti, pelagic and small tuna species are considered to be significantly underexploited (FAO 2004b). Djibouti is aiming for an annual maximum sustainable yield (MSY) of 5 000 t, compared with a 2001 level of 350 t.

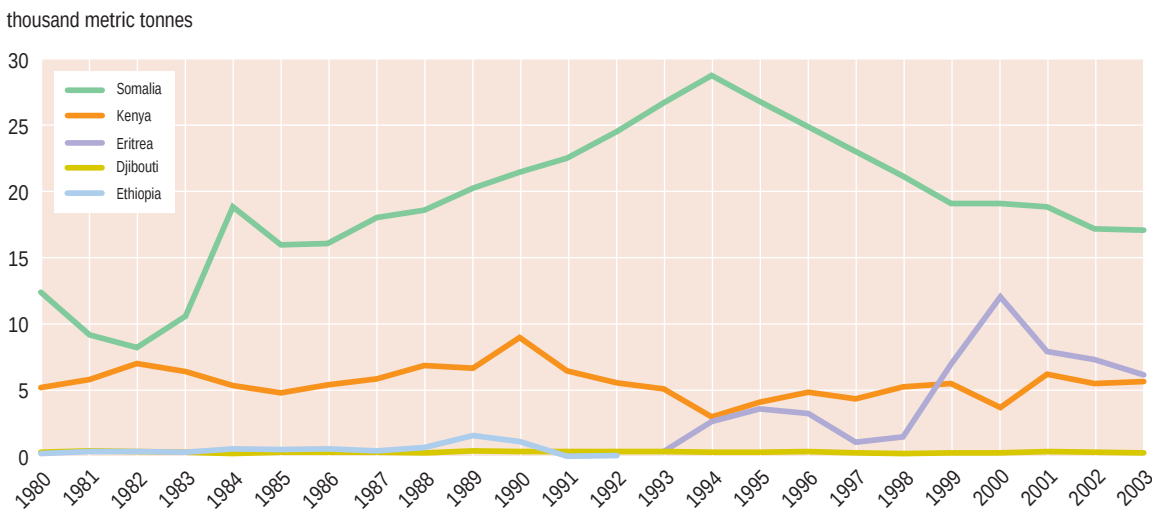
In Kenya, coastal tourism is a major foreign exchange earner, with its beach and coral reef resources, coastal heritage sites and forest reserves being major assets. Coastal tourism is starting to develop in Djibouti and has shown a moderate growth in Eritrea (Kotb and others 2004). In Somalia, ecotourism offers promise, but promise that cannot be realized until stability and effective governance is re-established (Coffen-Smout 1998).

Challenges faced in realizing development opportunities

Adopting transboundary approaches to manage marine and coastal resources is essential if their sustainability is to be ensured. The main transboundary cooperation is within the framework of the Nairobi (involving Kenya and Somalia) and Jeddah (involving Djibouti and Somalia) conventions. For the Red Sea and Gulf of Aden, PERSGA implements the Jeddah Convention. Priority actions have been identified in the Regional Action Plan coordinated by PERSGA in 2003. The Nairobi Convention is administered by UNEP. Land-based activities impacting the coastal and marine resources in Kenya are addressed through UNEP as part of the GEF-funded WIO-LaB project (WIO-LaB 2005).

The loss of biodiversity, degradation of habitats, and the modification of mangrove and coral reef ecosystems have widespread consequences. Direct human pressures on the coastal and marine environment come from increasing coastal populations, pollution and the growth of tourism. Indirect pressures come from the consequences of climate change – rising sea level and high sea temperatures leading to coral bleaching. Urbanization and industrial growth, and the development of mass tourism are contributing to the loss of habitats and the degradation of living resources. Tourism development tends to be poorly controlled and is contributing to reef deterioration, pollution, inappropriate construction of sea defences, and the loss of the natural tourism value

Figure 7: Reported marine fish catches in Eastern African countries since 1980



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

Box 1: The socioeconomic context of small-scale marine fisheries in Kenya

Small-scale marine fisheries in Kenya are multispecies and use multigear. These are economically valuable, generating in excess of US$3.2 million per year for local fishers, which would represent significantly more for the wider community if the income for traders was known. The small-scale fishers land at least 95 per cent of the marine catch. It is estimated that more than 60 000 coastal people depend on these fisheries. In some coastal communities, over 70 per cent of households depend on fisheries, but an estimated average for the coast as a whole is 45 per cent of households.

Although very few coastal households depend solely on fishing for their livelihood, many depend only on fisheries resources for income. Fishing and trading fish is one activity amongst a range of livelihood activities (both subsistence and income earning) carried out by coastal households. Fish is an important source of animal protein for coastal communities, 70 per cent of fisheries-dependent households and 50 per cent of non-fisheries-dependent households eat fish more than once a week. Fisheries-dependent households in Kenya are poor: this is the perception of fishers and is confirmed by food security and quality of life indicators. The high levels of dependence reflect the paucity of alternative income earning options. This situation makes coastal communities highly vulnerable to mismanagement or loss of fisheries resources. The lack of effective management, by both formal and informal institutions, and the high dependence on these resources have been identified by fisheries stakeholders as important contributors to poverty in coastal communities. The prevalence of destructive fishing gear, primarily small meshed nets, coupled with growing numbers of fishers, are key management issues to tackle.

Source: UN 2005

(UNEP/GPA and WIOMSA 2004). Population increase and migration to coastal areas are putting resources under increasing pressure, and people are resorting to practices to cater for their needs which are increasingly environmentally damaging (Francis and Torell 2004). Other human-related pressures come from overfishing and fishing-related damage, from urbanization and tourism development, pollution from agriculture and industry and, in Kenya, the damming of rivers for hydropower. Another key issue is the reported use of Somali shores and coastal waters as dumping grounds for hazardous wastes (UNEP 2005a).

The principal threats to the continuing health of the coral reefs come from recurrences of bleaching events similar to that of 1998, overfishing and the use of destructive gear (Obura and others 2004). Another issue is the sporadic infestation of coral reefs by the invasive COTS. In the absence of efficient regulatory mechanisms and because it is an open access resource, marine fishery often provides a refuge of last resort for impoverished coastal dwellers (Ochiewo 2004) as shown in Box 1. In Kenya, there are indications that the degradation of reef fisheries and ecosystems has been checked or at least slowed down along those stretches of coast where MPAs have been established (FAO 2001a).

There is a lack of public and government awareness of the issues, poor enforcement of the legal framework relating to reef conservation and, in the case of Somalia, a lack of effective governance (Kotb and others 2004, Obura and others 2004). Mangroves are also under threat. Increasing land-based pollution, decreasing freshwater discharge from rivers and overharvesting are having adverse effects on the health of mangroves – the nursery areas for many marine fish species. In Kenya, there has been overharvesting to meet an increased demand from tourism developments for construction timber, as well as mangrove clearance from the expansion of agriculture and solar salt pans (UNEP/GPA and WIOMSA 2004). Seepage of saline groundwater from the salt pans has killed neighbouring mangroves (Taylor and others 2003).

Damming on the Tana River in Kenya for hydropower (Box 2) has led to a reduction in the frequency and extent of seasonal flooding events, with negative impacts on agriculture and fisheries in the lower floodplains and coastal wetlands (IUCN 2003b, Crossland and others 2005) and on the prawn fishery in the adjoining Ungwana Bay. The introduction of short-term, high flow releases to simulate the natural flooding regime is under consideration in the design of the Mutonga-Grand Falls dam planned for the Upper Tana (Acreman 2005).

Physical shoreline change including coastal erosion is another common issue. It is caused by natural phenomena, such as the Indian Ocean tsunami of December 2004, as well as human pressures (Kairu and Nyandwi 2000, UNEP/GPA 2004, Crossland and others 2005, UNEP 2005a). Shoreline change impacts on

Box 2: Management of the downstream and coastal impacts of damming in the Tana basin, Kenya

Tana and Athi Rivers Development Authority (TARDA) plans to construct a high dam at Mutonga-Grand Falls, downstream of the existing Seven Forks dams. The dam will provide hydroelectricity as well as water storage for irrigation projects and urban/rural water supply schemes. The dam has the potential to exacerbate the changes in downstream flow caused by the present dams. Although the base flow is expected to increase by continuous release, the peak flood flows are expected to reduce considerably both in frequency and severity. Increased base flow is important for sustaining livelihood systems in the lower Tana basin during the dry seasons.

Reduced peak flows due to the existing damming have already impacted on the livelihoods of the riverine communities in the lower Tana basin, downstream of Garissa, who depend on seasonal flooding to cultivate the fertile floodplain soils, and on the maintenance of the rich biodiversity of the extensive delta, with its mangrove forests and productive fisheries. The coastal prawn fishery of Ungwana Bay has become stressed through reduced nutrient discharge from the delta distributaries and there is concern that the intrusion of saline waters into the delta will be enhanced. The delta front is formed of prominent sand dunes, the sand redistributed from the discharged river bedload by tidal and wave currents and wind. The expected reductions in peak flows are likely to further reduce the amount of sand discharged, aggravating the erosion already affecting the delta shore.

The need for integration of downstream values into hydropower planning in the Tana system has been highlighted in a case study (IUCN 2003b), based on research in the early 1990s into the economic valuation of the costs and benefits in the lower Tana resulting from dam construction (Emerton in Nippon Koei 1994). The resource value of the Tana's floodplain and its floods has been recognized by the dam's designers and developers (Acreman 2005). The dam is expected to store enough water to produce short-term, high releases to simulate natural floods, as well as meeting the target for power generation. The possibility of releasing silt together with the floodwater is also being examined. Modelling studies have been undertaken in order to determine the optimum release required to maintain or improve the integrity of the riverine and coastal-marine ecosystems.

The determination of the optimum environmental flow is a challenging scientific assignment, requiring input from ecologists and socioeconomists as well as hydrologists. Integrated management of the Tana River system, taking into consideration the downstream and coastal impacts of damming, is a priority objective, so that development activities upstream are initiated with full awareness of the potential consequences for its floodplain and delta, and its adjoining coastal waters in Ungwana Bay.

Mouth of the Tana River on Kenya's Indian Ocean coast.

Source: Altitude/Still Pictures

Sources: Acreman 2005, Emerton in Nippon Koei 1994, IUCN 2003b

tourism infrastructure and on the attractiveness of the coastal environment upon which coastal tourism largely depends. The loss of beach sands and the erosion of low-lying beach plains, much favoured as sites for hotel development, are particular concerns in Kenya. In many instances, beach erosion has been exacerbated by the installation of inappropriate, hard-engineered sea defences. Beach sand erosion also endangers the nesting sites of the sea turtle, an endangered species. It is anticipated that coastal erosion will increase with sea-level rise associated with global climate change (IPCC 2001). Shoreline accretion can also be a problem. During the last 40 years or so, changes in the regime of sediment discharge from the Sabaki River have led to major siltation and beach progradation in the vicinity of the resort town of Malindi (Kairu and Nyandwi 2000, UNEP/GPA 2004).

NORTHERN AFRICA

Loss of habitats and the modification of ecosystems, due primarily to the pressures of land-based and marine human activities, are the main environmental challenges. The pressures include urbanization and industrialization resulting in pollution and eutrophication, damming and irrigation leading to saline intrusion and coastal erosion, and the overexploitation of marine fisheries (Figure 2). There is concern over the potential impacts of climate change and associated, anticipated sea-level rise, particularly coastal erosion and the inundation of coastal lowlands.

Overview of resources

The bordering seas – the Atlantic Ocean and the almost landlocked Mediterranean and Red seas connected by the Straits of Gibraltar and the Suez Canal – are endowed with biodiverse coastal and marine ecosystems, including wetlands on the Atlantic and Mediterranean coasts, coral reefs and mangroves around the Red Sea, and a wide variety of fisheries (Figure 1). The coastal climate is mostly semi-arid to arid and the few significant rivers, notably the Nile, are now dammed so that there is little freshwater and sediment discharge to the sea. Substantial oil and gas resources occur offshore, mainly in the Mediterranean and Red seas. The coasts have a wealth of cultural heritage sites.

The Mediterranean shores are mainly sandy and host a variety of turtles, as well as cetaceans and the monk seal. Their many protected areas include marine and coastal wetland national parks such as Kouf and Karabolli in Libya, and Ichkeul, a UNESCO World Heritage site in Tunisia, of importance for migratory birds. Another key ornithological site (with Ramsar status) is the intertidal wetland of Moulay Bousselham on Morocco's Atlantic coast. The biodiversity of the Red Sea coasts of Egypt and Sudan is globally significant. Corals occur extensively, primarily on mainland-fringing and barrier reefs, around islands and, in Sudan, on an atoll. Mangroves occur in sheltered mainland inlets. Besides hosting several varieties of sea-grass, these coasts are home to three turtle species, inshore cetaceans and dugongs. Reef health in the late 1990s was considered generally good, and the coral diversity and reef-associated fauna amongst the highest in the Indian Ocean region (PERSGA/GEF 2003). Protected areas in the Red Sea include the marine national parks of Ras Mohammed on the Egyptian Sinai peninsula and the Sanganeb Atoll off the Sudan shore (Abdellatif 1993), where 124 coral species are recorded.

Morocco has a productive, nutrient-rich upwelling area off its Atlantic coast – part of the Canary Current LME. The Mediterranean Sea is considered to be a low productivity ecosystem with intensive fishing its primary driving force (NOAA 2003b). It is relatively poor in marine resources except around the Nile delta, where high nutrient outflows increase productivity (FAO 2003b). The reefs of the Red Sea provide some of the most productive coastal fisheries.

Offshore hydrocarbon resources are especially important (EIA 2005). Huge offshore gas reserves have been discovered in the Gulf of Gabès, where a transboundary field is being developed jointly by Tunisia and Libya. The majority of Egypt's oil reserves are also situated offshore, with the main production in the Gulf of Suez, while some of its largest gas resources have recently been proved off the Nile delta. Morocco has limited resources of natural gas and oil in its coastal Essaouira basin.

The coastal zone has a rich archaeological and cultural heritage, including UNESCO World Heritage sites in Morocco, Algeria, Tunisia and Libya (UNESCO 2005) and the now submerged archaeological heritage of the city of Alexandria in Egypt.

The UNESCO World Heritage site of Leptis Magna in Libya. The city was originally a Phoenician trading port developed by Septimius Severus, emperor of the Roman Empire from AD 193. Such sites may support the growth of tourism.

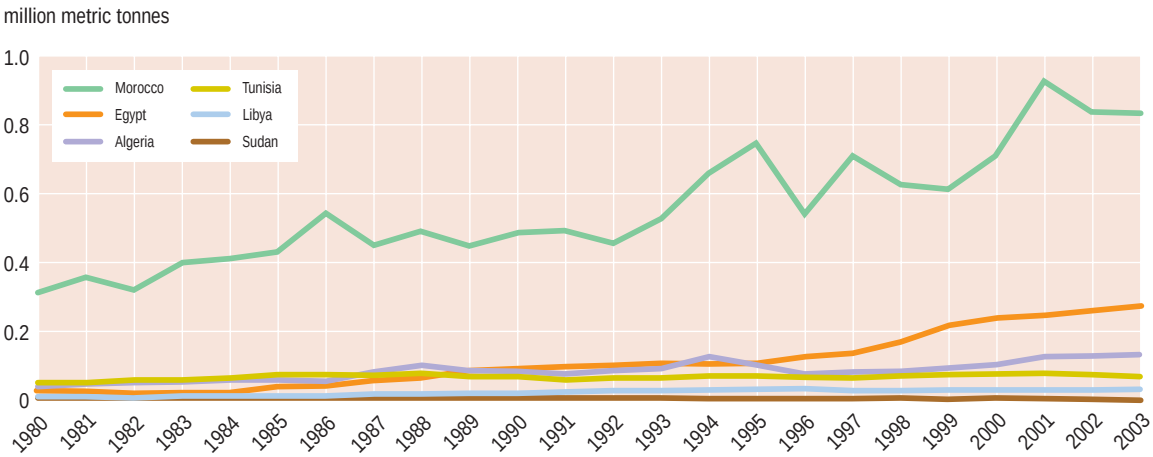
Source: J. Dugast/Still Pictures

Endowments and opportunities

The development of oil and natural gas resources underpins most national economies, with considerable local employment opportunities, though mostly for men. During the last decade or so, much of the development has focused on offshore acreage (EIA 2005) and this is likely to continue. Algeria, Tunisia, Libya and Egypt are all set to substantially increase gas production, feeding growing demand mostly from Europe, as well as satisfying the national and transnational needs of the electricity sector, along with industry and domestic consumers. Natural gas, largely from off the Nile delta, is likely to drive Egypt's energy sector for the foreseeable future.

Reported marine fish production has increased overall during the period 1980-2003, totalling about 1.4 million t in 2001 (Figure 11, FAO 2005). Morocco (Atlantic and Mediterranean) is by far the largest producer. In 2001, its total marine fish production was 933 197 t – a six-fold

Figure 8: Reported marine fish catches in Northern African countries since 1980



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

increase since 1961. Egypt (Mediterranean and Red Sea) is the second largest producer (FAO 2005). Generally in the Mediterranean, total fish landings have increased steadily, not only due to greater fishing pressure, but also to higher nutrient input into a formerly low-nutrient sea (Alm 2002). In the Red Sea, where the total fish landings amount to about 22 800 t per year, 44 per cent of the landings are coral reef-based (PERSGA/GEF 2003). Artisanal fisheries are still important in the Mediterranean and Red seas, but industrial fishing including foreign fleets is becoming prevalent.

Further development of marine fisheries will depend on the success of regulation at national and international levels. The principal fishing grounds on the continental shelf off the Nile delta are fairly heavily exploited (FAO 2003b), but elsewhere there is potential for increased catches. Algeria's five-year fisheries plan aims to increase production to 230 000 t per year, with the creation of 100 000 new jobs (FAO 2003a). Egypt aims to increase Red Sea catches to 70 000 t per year (PERSGA/GEF 2003). Sudan also has potential for increased production, notably of finfish, doubling its present yield of 5 000 t per year (FAO 2002b). Aquaculture in coastal wetlands makes a significant contribution to total fish production, particularly in Egypt, by far the largest producer of farmed fish, with rapid development mostly in semi-intensive, brackish water farms (El Gamal 2001, FAO 2003b). According to Egypt's General Authority of Fish Resources Development (GAFRD), the total production from fish farms in 2003 was 445 200 t (GAFRD 2003).

Tourism is a major foreign exchange earner, much of it generated in coastal areas (Figure 3). The cultural heritage sites are major assets with significant development potential over the long term. Statistics and forecasts indicate steady growth in this sector (WTTC 2005). Demand overall in Northern African countries, excluding Sudan, is expected to grow by 9 per cent in 2005 and by 5.5 per cent per year, in real terms, between 2006 and 2015. It is Egypt's most dynamic industry and the largest earner of foreign

Inshore fishers at the mouth of the Sebou River, Morocco. Moroccan fisheries are among the most productive of all Northern African countries.

Source: R. Arthurton

exchange. Its annual increase of tourist inflows from 1982 to 1999 averaged 9.7 per cent and is expected to account for 15.4 per cent of GDP in 2005. Much of its tourism economy is sustained by its Red Sea coral reef coasts, where activity is locally intense.

Challenges faced in realizing development opportunities

The environmental issues and threats relating to the realization of development opportunities are being addressed locally to globally, within the framework of integrated management of coastal resources. All countries are party to either the Convention for the Protection of the Mediterranean Sea against Pollution (the Barcelona Convention) or the Jeddah Convention (Red Sea and Gulf of Aden) – in Egypt's case, both. These MEAs focus on cooperation for a coordinated approach to protection and enhancement of the marine environment and coastal zones. Tunisia has passed specific coastal zone legislation and has established the Tunisian Agency of Coastal Protection and Management (UNEP/MAP/PAP 2001). Algeria is drafting such legislation and creating an agency. Support for capacity-building for the sustainable management of coastal and marine resources is offered by the World Bank's Mediterranean Environmental Technical Assistance Programme, focused on water quality, municipal and hazardous waste, and policy and legislation tools (METAP 2004). A Strategic Action Programme for land-based sources of marine pollution has been adopted by all 20 Mediterranean countries under the Barcelona Convention. Initiatives exist for strengthening the management of Mediterranean coastal wetlands through MedWet and its programmes such as MedWetCoast and the North African Wetland Network (Box 3).

Population growth in the southern Mediterranean countries will present major challenges in physical planning and policy formation to protect coastal areas (Alm 2002). Urban sprawl is a priority issue. In Algeria, coastal cities have more than tripled their surface area in 30 years. Much prime agricultural land is being lost to urban expansion and coastal wetland lost to both peri-urban landfill and agricultural reclamation. In this competition for space, semi-intensive brackish water fish farms are increasingly vulnerable (El Gamal 2001). As well as suffering population pressures, parts of coastal Morocco and Algeria are prone to damaging earthquakes.

Coastal pollution is a serious concern. In Egypt, the discharge of untreated municipal waste and industrial and agricultural pollutants has been commonplace, leading to eutrophication and related public health risks (UNEP/MAP 1999, EEAA 2002, Crossland and others

Box 3: Environmental degradation of Lake Maryout, Egypt

Lake Maryout covers 60 km^2, the remains of a once much more extensive coastal lake separating Alexandria's Mediterranean shoreline from the Egyptian hinterland. It has high salinity and is fed by agricultural drainage waters (though formerly by a branch of the River Nile). Historically it has provided a rich fisheries resource, but is now identified by Egypt's National Environmental Action Plan as the country's most polluted lake. In the decade 1980-1990, annual fish production there fell from more than 10 000 t to less than 2 000 t.

The current phase of the lake's decline stemmed from the 1950s, when its southern parts were reclaimed for agriculture. In 1986, the lake became the receptacle for Alexandria's sewage, which had earlier been discharged untreated to the sea. Additional contemporary pressures come from urban expansion and industrial development, the discharge of industrial liquid and solid waste, and agricultural effluent, which is heavily polluted with pesticides. In 1994, sewage and industrial waste became subject to treatment, and some of the drainage canals that used to flood the lake with industrial waste were closed.

While some of the environmentally damaging activities have now been curtailed, land reclamation for urban project development continues to threaten the capacity of the lake to function as a fishery. The multiplicity of government bodies controlling the lake is the source of most of the environmental problems. Major factors which have led to the current deterioration in the state of the lake are the conflicts between different stakeholders (urban developers, fishermen and farmers) and the lack of an integrated policy between the many institutional bodies at the national and local scale, who have responsibilities in managing the lake resource. Environmental sustainability of the lake resource is a choice, but it requires a collective understanding to see beyond destructive environmental conflict which is leading to its deterioration.

Source: UN 2005

2005) (Box 3), though the situation is improving with many of the polluting sources now stopped. For example, in Tunisia, 65 per cent of wastewater is now treated (METAP 2004).

Overexploitation of fisheries is another key factor determining the health of the marine ecosystem. Foreign fleets and new technology are contributing to the problem, reflected in a decrease in the mean size of fish caught (Alm 2002). The issues of by-catch and discards, as well as the damage to seabed habitats from trawling, are problems for biodiversity. Another factor affecting biodiversity is the introduction of invasive species, especially from ships' ballast water discharge. In the Mediterranean, more than 240 non-indigenous species have been identified, much of the introduction attributed to migration and transport by shipping through the Suez Canal (Lindeboom 2002).

Oil and gas development is another contributor to habitat disturbance and loss, notably seabed disturbance around platforms and submarine pipelines, and pollution from drilling compounds. Accidental pollution from oil wells and oil transportation remains a risk.

Much of the development of tourism on Egypt's Red Sea coast is poorly controlled, leading to an overall decline in coral cover and the loss of the natural tourism attraction (PERSGA 2005). The construction of hotels and transport infrastructure inevitably involves habitat loss, while the pressures of tourist numbers – physical disturbance, high demand for freshwater, pollution and eutrophication – impact adversely on the living resources, especially those of coral reef ecosystems. The reefs also suffer from destructive fishing methods, including the use of explosives. Considering the importance of coral reefs in the development of tourism on the Red Sea coasts, there is a worrying lack of public and government awareness, as well as poor enforcement of the legal framework relating to reef conservation (Kotb and others 2004). Human-induced global warming is likely to be responsible for the coral bleaching in 1998 which caused the extensive coral mortality in the northern-central Red Sea (Kotb and others 2004).

The discharge of freshwater and sediment from rivers into the Mediterranean has been drastically reduced over the last few decades as a result of damming and agricultural irrigation (UNEP/MAP/PAP 2001), leading to coastal erosion and to the saline intrusion of deltaic wetlands. Freshwater discharge from the River Nile became insignificant with the commissioning in 1968 of the Aswan High Dam. The reductions in sediment discharge, as a consequence of damming, have caused a major retreat of the (formerly prograding) distributary mouths at Damietta and Rosetta (Milliman 1997, NEAP 2002, Crossland and others 2005), where coastal defences have been installed in an attempt to arrest the retreat. Similar impacts of damming have been reported from the delta of the Moulouya River in Morocco (Snoussi and others 2002), as shown in

Box 4: Tourism and water resources in Tunisia

Tunisia is a relatively water-scarce country, especially in the tourism zones along the eastern seaboard and the offshore islands. Water must be transferred to some of the best known tourist resort areas such as Sfax and the island of Kerkenna. Within perhaps ten years, it may also be necessary to do so to Djerba. While in absolute terms tourists in Tunisia consume only 1 per cent of national water resources, per head they consume nine times as much as nationals, partly because the use of water by tourists in hotels and resorts is typically very wasteful. Extensive treatment of this water is required before it can be re-used. In Tunisia, it is predicted that, even without the effects of climate change, water rationing may ultimately be required because of the regional water demand conflicts to which tourism contributes.

Source: WTO 2003

Climate change may threaten coastal development
The city of Alexandria on Egypt's Mediterranean coast is vulnerable to sea-level rise.

Source: TerraServer 2004

Box 5: Multiple uses and conflicts on the Moulouya coastal wetland, Morocco

The Moulouya deltaic zone, with its complex marshes, is a 3 000 ha Moroccan Site of Biological and Ecological Interest. It is a refuge for many birds of worldwide or national interest.

The main human activities in the area are agriculture and grazing. National tourism at the adjoining Saïdia beach provides an important summer income for the local population. In 1992, a 230-ha aquaculture farm was established close to the estuary, but closed in 1996 because it caused accelerated salinization of the aquifer. This had a negative impact on the vegetation and generated conflicts between agriculture, aquaculture and wetland conservation. A multidisciplinary analysis of the state of the Moulouya coastal wetland has been carried out as part of the MedWetCoast Project. This has shown that, in terms of biodiversity, among the 67 globally threatened taxa present on the Mediterranean coast of Morocco, 13 are present on the delta site. This and previous studies have revealed impacts including: erosion of the delta coastline related mainly to water and sediment abstraction by damming (Snoussi, Haida and Imassi 2002, Imassi and Snoussi 2003); water pollution and salinization related to agricultural practices (Benkaddour 1997); wetland reclamation and gradual encroachment of agriculture on wetlands; saltwater intrusion in connection with overpumping of freshwater and aquaculture activities (Sadki 1996); losses of the ecological and economic values of the wetlands (Khattabi 2002); and problems of water management between the different users and wetland conservation (Snoussi, 2004).

The overall initiative of MedWetCoast aims at ensuring the sustainable management of the biological diversity of the coastal areas and wetlands in six Mediterranean countries, through the development of adequate legal and regulatory frameworks, the creation of institutional organizations adapted to the complexity of the issues at stake, capacity-building and the development of an exchange network at the regional level.

Sources: Benkaddour 1997, Khattabi 2002, Sadki 1996, Snoussi, Haida and Imassi 2002, Imassi and Snoussi 2003, Snoussi 2004

Box 5. Coastal erosion and saline intrusion are some of the expected impacts of climate change and its anticipated, associated sea-level rise (IPCC 2001). Coastal erosion is already widely reported, with major beach loss in Algeria and Tunisia necessitating costly renourishment (Alm 2002). Sea-level rise poses particular problems for the Nile delta and the city of Alexandria, much of which would be inundated by a rise in sea level of only a metre or so (El Raey and others 1999).

SOUTHERN AFRICA

The main challenges facing the sustainable use of coastal and marine resources are the loss of natural habitat and biodiversity, and the consequent loss of any opportunity of exploitation of renewable living resources. Other concerns include the long-term effects of climatic change and sea-level rise, and the interruption of coastal processes such as sediment supply, beach dynamics, and degradation of water quality due to human activities in catchment and estuaries. There are difficulties in managing human activities impacting on the environment because of inadequate legislation and compliance, the lack of capacity for detection, and inadequate education and environmental awareness. All these factors are exacerbated by poverty and disease, and, in some countries, conflict and migration.

OVERVIEW OF RESOURCES

The coastal and marine areas, which extend along the 10 000 km of coastline from Angola on the Atlantic Ocean side to Tanzania on the Indian Ocean side and offshore to the limit of the EEZ, encompass diverse living and non-living resources. The west coast is characterized largely by desert conditions and sparse human populations, but with rain forest established towards the mouth of the Congo River. Its seas are influenced by the cold, northward flowing Benguela Current, with highly productive upwellings supporting industrial-scale fisheries. The east coast, under the influence of the East African Coast Current which flows northward along the coast of Tanzania and the warm, southward flowing Mozambique and Agulhas currents, is sub-tropical in South Africa, becoming tropical and wetter northwards. Marine diversity increases towards the warmer zones. Much of the hinterland drains to this coast through rivers including the Rufiji, Zambezi, Limpopo and Incomati. In Mozambique and Tanzania, there are extensive coral reefs and sea-grass beds, and mangrove forests, especially around the Rufiji and Zambezi deltas (Figure 1), which are largely protected by barrier beaches. Parts of

the South African coast are heavily urbanized and have associated industrial development (Figure 2).

There is a rich coastal and marine biodiversity associated with the fringing and patch coral reefs and mangrove forests in Tanzania and Mozambique (Figure 1). Mangrove areas in those countries total 6 483 km^2 (Taylor and others 2003) while, in Tanzania, fringing reef platforms and patch reefs occur on over 80 per cent of the coast (UNEP-WCMC 2000). Coral communities also occur on the Maputoland Reef in KwaZulu Natal, South Africa (Obura and others 2004). Most reefs were severely affected by the coral bleaching event of 1998 and there was further mortality in 2002. Patchy infestation by COTS has also been reported (Obura and others 2004). The Agulhas Current LME has an enhancing effect on biodiversity which extends from Tanzania to well along the South African coast. The estuaries of Tanzania and Mozambique support penaeid prawn fisheries while, on the reef shores, artisanal and subsistence fishing are major activities. In Tanzania, areas of coastal forest with high levels of endemism occur over about 350 km^2 as fragments of a formerly extensive lowland forest (UNEP 2001). The west coast has no significant coral reef development, with only a few coral species reported from Angola (UNEP-WCMC 2000, Figure 1). Mangrove is confined to Angola where 1 100 km^2 are recorded. It is characterized by productive upwelling systems between Cape Agulhas in South Africa and southern Angola – the Benguela Current LME (Box 6). It has relatively low diversity but makes an important contribution to the total African, and global, fish catch, with epipelagic species including the South African pilchard and the Cape anchovy.

There are significant coastal and offshore hydrocarbon resources (EIA 2005). Angola has by far the majority of Southern Africa's estimated crude reserves – 5.4 thousand million barrels, mostly located in deep water. Reserves of natural gas, also largely offshore, make up about 2.5 per cent of Africa's total. Reserves have been discovered in Angola (1.6 x 10^{12} cubic feet); Mozambique (4.5 x 10^{12} cubic feet); Namibia (2.2 x 10^{12} cubic feet); South Africa (780 x 10^9 cubic feet) and Tanzania (800 x 10^9 cubic feet), where there are commercial reserves under production around the island of Songo-Songo (EIA 2005).

Mangrove forests provide valuable ecosystem services
The Zambezi delta, Mozambique, showing the extensive development of mangrove (dark green) between the distributary's channels. The mangrove is subject to overharvesting and clearance.

Source: NASA 2000

Rivers may transport large amounts of sediment to the sea
Plumes of suspended sediment discharged to the Atlantic Ocean from the Gariep (formerly Orange) River at the boundary of Namibia and South Africa. The river has been the conduit for alluvial diamonds that are being dredged and mined in this coastal zone.

Source: NASA 2000

Box 6: The Benguela Current Large Marine Ecosystem (BCLME) Programme: joint cooperative management of shared resources

The Benguela Current LME is one of the world's most productive marine environments. In 2000, the total fish catch of the region was 1 166 000 t. The fishing industry has become an economic mainstay, contributing 10 per cent of GDP in Namibia, 4 per cent in Angola and 0.37 per cent in South Africa. The continental shelf is also rich in oil, natural gas and diamonds. Oil production contributes 70 per cent of Angolan GDP, and the Kudu gas fields in Namibia hold some of the largest reserves in western Africa. The marine diamond mining industry in Namibia and South Africa yields close to a million carats of diamonds each year. The exceptional natural beauty, biodiversity and cultural attributes of the BCLME already attract large numbers of tourists, particularly in South Africa, and tourism has the potential to grow substantially.

The ecosystem faces accelerating threats which, if left unchecked, could threaten vital economic and ecological values. The primary threats include habitat loss and pollution – particularly in areas adjacent to urban centres – and increasing exploitation of straddling fish stocks, concerns exacerbated by the lack of a coordinated regional management framework. There is also the recognition that oil and gas exploration and production, and diamond mining in and around critical marine habitats, will have to be undertaken in an environmentally safe manner to minimize impacts. In addition, the BCLME is characterized by a high degree of environmental variability, manifest in fluctuations in the abundance and distribution of marine living resources. Global climate change has the potential to influence this variability. The transboundary nature of these issues demands regional cooperation for their effective management.

In 1999, Angola, Namibia and South Africa signed a Strategic Action Programme, identifying strategies and priority actions required to protect the BCLME. In 2002, the Benguela Current Large Marine Ecosystem (BCLME) Programme was officially launched. The Programme aims to integrate management, sustain development and protect and conserve the ecosystem. The regional initiative is funded by the Global Environment Facility (GEF), which is contributing US$15.2 million, complementing an investment of approximately US$16 million by the three countries. The initiative aims to lay the foundation for a long-term collaborative management system, overseen by a regional management organization, to be known as the Benguela Current Commission.

From its inception in March 2002 to the end of 2004, the Programme had instituted 60 projects worth US$4.7 million. These were designed to address transboundary environmental problems and contribute to the integrated and sustainable management of the BCLME. The Programme is regarded as a concrete and constructive initiative towards the New Partnership for Africa's Development (NEPAD).

Sources: Benkaddour 1997, Khattabi 2002, Sadki 1996, Snoussi, Haida and Imassi 2002, Imassi and Snoussi 2003, Snoussi 2004

Diamond mining from coastal sand dunes and by dredging inshore seabed sediments is a major industry in Namibia and western South Africa. The minerals have been derived over time from the diamond-bearing volcanic rocks exposed in the catchment of the Gariep (formerly Orange) River. In coastal sediments on the Indian Ocean shores of South Africa and Mozambique, there are commercially viable titanium and zirconium minerals, also derived from the hinterland.

There are three coastal UNESCO World Heritage sites in South Africa (UNESCO 2005). The Greater St Lucia Wetland Park has critical habitats for species from marine, wetland and savannah environments, and has exceptional species diversity.

Endowments and opportunities

The combination of coastal attractions and unique wildlife presents a powerful resource for the long term if utilized with care. Nearly all of the coastline holds some sort of attraction. With careful management, the value of the assets underpinning such attractions can increase. Travel and tourism are already major foreign exchange earners in Southern Africa and much of the income is generated in coastal areas, providing substantial employment opportunities for women as well as men. In South Africa, travel and tourism in 2005 is expected to generate US$30.3 thousand million of economic activity (total demand), in Namibia, US$1 004.4 million and in Tanzania, US$1 858.4 million, accounting for 9.7 per cent of its GDP and 7.7 per cent of total employment (WTTC 2005).

The mangrove forests present opportunities for improving the livelihoods of coastal people and contributing to the alleviation of poverty (Taylor and others 2003). They are a rich source of fuel, building

poles, and materials for boat making, and provide nectar for large populations of bees. With effective conservation and replanting programmes, perhaps supported by ecotourism, these resources could be harvested on a sustainable basis, maintaining supplies while preserving their important ecological functions.

Total marine fisheries production declined from 1 556 000 t in 1988 to 1 289 000 t in 2000, the contribution to the world total declining from 11.0 to 7.2 per cent (FAO 2002c). However, despite this trend some countries have increased their production (Figure 9). The overall declining trend is a continuation of that reported for the period 1972-97 (UNEP 2002a) and is part of the global trend (Pauly and others). Approximately half the finfish catch is taken by South Africa, and more than half the crustacean catch is taken by Mozambique, where catch value is dominated by the shallow-water penaeid prawns. Despite the declining trends in marine fish production, fishery commodity exports over the period 1988-2000 rose in value from US$200 million to US$892 million, while imports declined from US$224 million to US$195 million (FAO 2004b). In South Africa, coastal goods-and-services in 1998 were estimated to be worth about US$29 000 million (Government of South Africa 1998) or 37 per cent of the GDP; this figure incorporated about US$175 million in terms of benefits to subsistence fishermen. The commercial fishery was worth about US$270 million and the recreational fishery US$200 million.

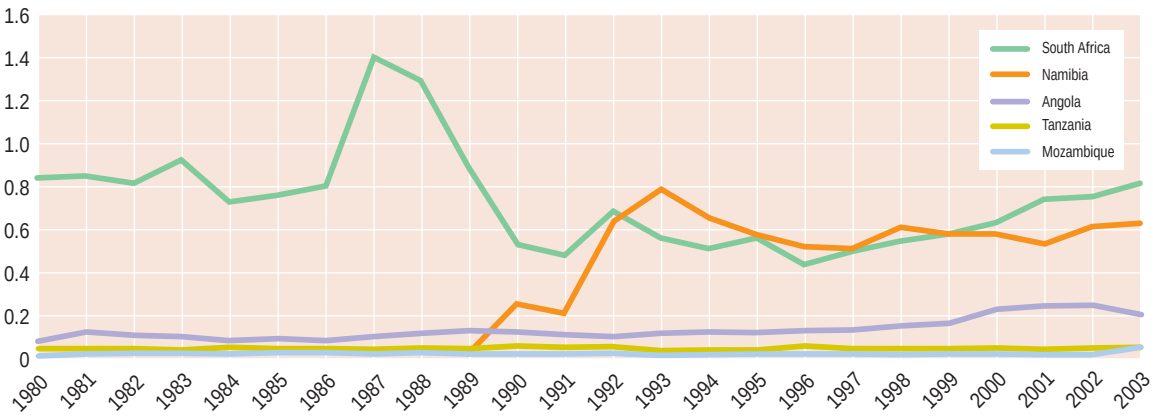
Coastal wetlands maybe important reservoirs of biodiversity
The Greater St Lucia Wetland Park is a United Nations World Heritage site located on the Indian Ocean coast of South Africa. A colony of coelacanth was discovered in the shallow waters of the park in 2000.

Source: Google Earth

Combined freshwater and marine aquaculture production rose from 4 000 t in 1988 to 11 000 t in 2000 (FAO 2002c). The seaweed *Eucheuma* is cultivated, mainly by women, on intertidal platforms mainly in Zanzibar, Tanzania, with a production of 7 000 t in 2002 (Figure 9). Cultivation is slowly spreading to mainland Tanzania and Mozambique. Seaweed farming represents an opportunity for coastal villagers, and especially women, to improve their incomes.

Figure 9: Reported marine fish catches in Southern African countries

million metric tonnes



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

Bundles of seaweed harvested from an intertidal reef platform awaiting shipment on Pemba Island, Tanzania.

Source: R. Arthurton

Hydrocarbon resources are making an increasingly strong contribution to the economy. Over the last decade or so, the focus of oil and gas exploration has shifted offshore to the coastal waters, where there are now many successful production ventures (EIA 2005). Angola is the only significant oil producer. Overall, by early 2004, Angola's production reached nearly 950 000 bbl/d and this is expected to double by early 2008, with new deep-water production sites. South Africa's production is also from offshore fields which, by late 2003, yielded more than 60 000 bbl/d. Much of the gas associated with oil production is currently flared or reinjected. In Tanzania, production on the island of Songo-Songo is gathered from on and around the island and transported via a 225-km pipeline to Dar es Salaam where it provides fuel for electricity generation. Development and production present considerable local employment opportunities, though mostly for men.

The value of the alluvial diamond industry in Namibia and western South Africa was estimated at US$625 million in 1998 (Government of South Africa 1998).

Challenges faced in realizing development

The environmental issues and threats relating to the realization of development opportunities are addressed within the framework of the Nairobi Convention (by Tanzania, Mozambique and South Africa) and the Abidjan Convention (by Angola, Namibia and South

Box 7: Pollution management in South Africa through private-public consensus

The Saldanha Bay Water Quality Forum Trust was set up in 1996 to promote water quality and ecosystems for the benefit of the local community and is funded by the implemention of a management approach based on the polluter pays principle.

Saldanha Bay is a coastal embayment located in the southern Benguela upwelling system, approximately 100 km north of Cape Town, South Africa (Monteiro and Largier, 1999). It provides one of the few naturally sheltered areas for in-water mariculture operations in South Africa (Probyn and others 2001).

The environmental problem: For many decades, the bay has been subject to the discharge of wastewater from land-based fish processing industries (Stenton-Dozey, Jackson and Busy 1999). This pollution poses a continual threat to shellfish culture operations and recreational harvest in the area. Wastewater discharges, mainly from the fish processing industries, introduce nutrients (ammonia) into the system. This condition is favoured by opportunistic species (including harmful algal blooms) and therefore enhances the risk of *in situ* growth of toxic algal blooms. Consequently, the deposition of organic matter and hypoxia (eg those introduced through port operations) creates an environment that favours high rates of build-up of toxic substances.

Management and finance: In the 1990s, individuals with an interest in the area started to create awareness for the need to address these conflicting issues and this led to the establishment of the Trust. The Trust is a voluntary organization comprising officials from local, regional and national authorities, representative of all major industries in the area, and other groups who have a common interest in maintaining water quality and ecosystem functioning in order to keep Saldanha Bay fit for all its designated uses. It also acts as an advisory body to legislative authorities such as the Department of Water Affairs and Forestry and Department of Environmental Affairs and Tourism. The Trust collects funding by applying the polluter pays principle, and financial resources are utilized to commission joint scientific investigations and monitoring programmes to make informed decisions on the management of the area (Taljaard and Monteiro 2002, Monteiro and Kemp 2004).

A quote from *Bay Watch*, the publication of the Saldanha Bay Water Quality Forum Trust (2004) probably explains this best:

> "This is a most unique forum in that, as far as I am aware, it is a the only non-government body (in South Africa) that is totally successful in melting the private sector with their contributions and the government with their overseeing capacity, to form a unit that is ultimately functional and effective."

Sources: Benkaddour 1997, Khattabi 2002, Sadki 1996, Snoussi, Haida and Imassi 2002, Imassi and Snoussi 2003, Snoussi 2004

Africa). These MEAs focus on coordinated protection and enhancement of the marine environment and coastal zones. Land-based activities impacting the coastal and marine resources in the countries flanking the Indian Ocean are being addressed through the Nairobi Convention as part of the GEF-funded WIO-LaB project (WIO-LaB 2005).

The coastal environment is vulnerable and is being degraded by the current levels of development. Critical ecological functions are being undermined, including those provided by mangrove swamps, coral reefs, rivers and estuaries, which protect and stabilize coastlines, and provide sediments for beaches and nursery areas for fish and prawns. These changes, ironically brought about by development activity, are increasing the vulnerability of human populations, particularly those in low-lying coastal areas. Such vulnerability will be exacerbated by sea-level rise, storm surges and tsunamis.

Population growth, combined with migration to large coastal cities, will form one of the major challenges for physical planning and policy formation to protect coastal areas. On the eastern coasts, the population is growing at 5 to 6 per cent annually, due to births and migration from inland rural areas, and coastal poverty levels are high (Obura and others 2004). The traditional cultural and religious beliefs of the indigenous communities relating to the marine environment and its resources are being lost as population densities increase and people move in from other areas, thus diminishing a vital management resource.

In Tanzania and Mozambique, the degradation of the coral reef resources due to increasing population pressures and coral bleaching is one of the most important management issues (Obura 2004, Obura and others 2004). Bleaching has caused the decline of 30 per cent of the reefs, and the threats posed by a growing population are probably slowing their recovery. In Mozambique and southern Tanzania, there have been increased rates of reef erosion, due in part to the bio-erosion of dead coral tables and plates. A patchy but widespread increase in COTS infestation was recorded in 2003 and 2004 in Tanzania. Much of the damage to the reef ecosystems is coming from fisheries exploitation. Specific threats include excess harvesting (in part by migrant fishers), the use of destructive gears such as beach seines and gill nets, and bomb fishing that damages juvenile fish populations and vulnerable species. In Tanzania, by far the most destructive type of fishing is dynamiting, which has been practised since the 1960s (Wagner 2004). In the 1980s and 1990s, dynamite blasts reached epidemic rates. Recent management initiatives there have already had a significant positive impact on the coral reef environment (Wagner 2004). Resource users, particularly fishing communities, have been increasingly involved, enhancing their environmental awareness. Mangrove areas continue to be under threat from pollution and coastal development, notably aquaculture and the construction of salt pans. The overall rate of deforestation in Mozambique is estimated at 18 km^2 per year (Taylor and others 2003).

In South Africa, the once abundant, easily accessible, shallow sub-tidal invertebrate resources, such as the southern rock lobster and the abalone, have been reduced by heavy commercial and in part illegal exploitation. High prices obtainable for abalone in eastern Asia have exacerbated the pressure on this species and increased poaching. The shallow-water prawns of Mozambique have long been the targets of artisanal fisheries and a major tourist attraction in local restaurants (Box 8). With the possible exception of sea cucumbers in Mozambique, there are few, if any, other large invertebrate stocks which remain to be profitably exploited. In contrast to most western African countries, Namibia's policy of fisheries management since independence has generated economic and social benefits to the country (Alder and Sumaila 2004).

Constraints to coastal aquaculture development include the lack of sheltered waters and the environmental degradation of coastal environments, such as mangrove forests. It should also be realized that aquaculture and mariculture are energy-consuming, rather than energy-producing, processes. While there

Box 8: Catchment2Coast Transboundary Ecosystem Programme

One challenge in the sustainable management of the tropical coastal ecosystems of southern and eastern Africa is their dependence on large transboundary river inputs. The magnitude of human needs for water resources in large river basins is decreasing the socioeconomic value of coastal ecosystem services. There is a need to focus on increasing socioeconomic value at the system level, rather than at either the river basin or coastal level, to avoid future conflict. The Catchment2Coast Programme (2002–2005) has been able to show that the success of integrated freshwater and coastal ecosystem management lies in understanding the river-coastal linkages. The programme used the Maputo Bay catchment (shared by South Africa, Swaziland and Mozambique) as a pilot study, and was able to hindcast the ecosystem production for a nine-year period (1996-2004). This study was used to explain variability in CPUE (Catch per Unit Effort) for the prawn fishery in Maputo Bay. The findings can be used to inform environmental management and planning in other river-coastal systems.

Source: Monteiro and Mathews (2003)

Box 9: The Cape Verde Islands and the West African Marine Eco-region

The West African Marine Eco-region spans 3 500 km of coast in Western Africa and includes six countries: Mauritania, Senegal,, Gambia, Cape Verde, Guinea-Bissau and Guinea. This coastline presents a wide variety of habitats, from rocky cliffs and broad sandy beaches, to extensive sea-grass prairies in the north, and dense mangrove forests and well-developed estuaries in the south.

Among its most striking features are the unique coral reefs of Cape Verde and the powerful coastal upwellings of cold water that support one of the most diverse, and economically important, fishing zones in the world. The upwellings are primarily the result of the year-round trade winds that push surface waters away from the coast and draw cold, nutrient-rich waters from deep in the ocean up to the surface. These rich waters meet the tropical sun to provide a perfect environment for plankton – the foundation of a tremendously productive food chain that supports incredible biodiversity.

Over 1 000 species of fish have been identified, as have several species of cetaceans including dolphins and whales, five species of endangered marine turtles, and a colony of 100 monk seals – the largest breeding colony left on Earth. While the continental upwellings support their characteristic floral and faunal diversity, the offshore archipelago of Cape Verde harbours one of the most important coral reefs in the world. Recently published studies have identified Cape Verde as both a centre of endemism, because of its unique and rare species, and as a top 10 global hot spot for coral communities, where conservation action is most needed and could have the greatest benefits.

Source: WWF 2005

might be employment opportunities, the products, whether they be mussels, prawns, abalone or fish, tend to be beyond the means of poor communities.

Mineral extraction from dunes and the seabed is controversial, given the environmental degradation to which it can lead. On the east coast of South Africa, the mitigation of these impacts constitutes a sub-industry. The exploitation of mineral resources is a comparatively short-term operation and one which needs to be carefully managed in order to mitigate any short- or long-term environmental impacts. There is also a need for responsible management in order to maximize the benefits to the people of the country and to allow investment of profits in longer-term sustainable developments. In Tanzania, the extraction of live coral for lime burning is a widespread activity which can have highly destructive effects on reef habitats (see Obura 2004).

Physical shoreline change, including coastal erosion, is another common issue, though its causes include natural forcing as well as human interventions and pressures. In Tanzania, shoreline change – accretion as well as erosion – impacts particularly on tourism infrastructure. Erosion has led to the demolition of beach hotels on low-lying beach plains at Kunduchi, near Dar es Salaam. Attempts have been made to stabilize shorelines by the installation of groynes (Kairu and Nyandwi 2000, UNEP/GPA 2004). It is anticipated that coastal erosion will increase with sea-level rise associated with global climate change (IPCC 2001).

WESTERN AFRICA

The main concerns of the mainland states are the degradation of their coastal habitats and biodiversity through pollution, saline intrusion and erosion, and the overexploitation of their fisheries resources. The coastal degradation has contributing causes in the pressures generated by an expanding coastal population, urbanization and industrial development. This includes the development of coastal and offshore oil and gas resources. In some countries, these pressures have been exacerbated in recent years by human conflict and political instability. The damming of rivers, reducing the amount of freshwater and sandy sediment being discharged at the coast, contributes to the degradation of coastal wetlands and coastal erosion. The potential impacts of climate change and sea-level rise, particularly with regard to coastal erosion and the inundation of coastal lowlands, are important issues in coastal land use and planning.

OVERVIEW OF RESOURCES

Western Africa's varied coastal zone extends for some 4 400 km, from the desert sandy shores of Mauritania in the north, through deeply indented, estuarine and island coasts (eg Guinea-Bissau with its Bijagos archipelago), to the lagoonal coasts with their extensive barrier beaches on the Gulf of Guinea. The huge delta of the Niger and Cross rivers forms its eastern end. Major rivers – Senegal, Volta, Niger –drain the hinterland, each dammed

variously for agricultural irrigation and hydropower, altering the nature of water and sediment discharge to the coast. The volcanic, mountainous SIDS of the Cape Verde Islands lie some 600 km west of Dakar, Senegal.

The seas off Mauritania, Senegal and Gambia form part of the Canary Current LME, sustained by the cold, southward flowing Canary Current, with its nutrient-rich coastal upwellings (URI 2003). Countries from Guinea-Bissau to Nigeria flank the Guinea Current LME which is sustained by the eastward-flowing Guinea Current. Seasonal upwelling of cold, nutrient-rich water occurs off the coasts of Ghana and Côte d'Ivoire. Both LMEs have substantial fisheries resources. Both are driven by climate, with intensive fishing as their secondary force. Commercially valuable fish in the Canary Current LME include cephalopods, tuna and hake. In both LMEs, more than half of the commercial catch comprises small pelagic clupeoids (herring, sardines and anchovies). Many coastal wetlands support important fisheries.

Mangroves are abundant in the Niger delta, covering many thousand square kilometres, and also in Guinea-Bissau (2 366 km^2) and Senegal (1 690 km^2) (UNEP-WCMC 2000). Coral reefs occur only in the Cape Verde Islands (Box 9). The coastal waters are home to endangered species including marine turtles, inshore cetaceans and the West African manatee. There are many designated coastal wetland protected areas, with some twenty Ramsar sites, notably in Mauritania, Senegal, Gambia, Guinea, Côte d'Ivoire, Ghana and Benin (IUCN 2003a, Wetlands International 2005). Banc d'Arguin, in Mauritania, is a UNESCO World Heritage site (UNESCO 2005) where the desert environment is juxtaposed with biodiverse coastal habitats over more than 180 km of shoreline. Many of the coastal wetlands support important fisheries. Cultural World Heritage sites include the island of Gorée off the Senegal coast at Dakar. From the 15th to the 19th century, this was the largest slave-trading centre on the African coast.

Western Africa has important hydrocarbon resources (EIA 2005). Oil and gas have long been developed in the Niger delta, but now there is increasing exploration and development in most countries, mainly in offshore sites in water depths ranging from shallow to ultra-deep, beyond the continental shelf. Organization of Petroleum Exporting Countries (OPEC) statistics list Nigeria's estimated crude reserves at 31 000.5 million barrels. Smaller oil (and significant gas) reserves are located offshore in the Gulf of Guinea in Benin, Ghana and Côte d'Ivoire, also offshore Senegal and Mauritania, where the Chinguetti field, located in deep water near the capital, Nouakchott, was proved in 2001 to be commercial. There are also significant reserves of natural gas, which amount to approximately 32 per cent of Africa's natural gas reserves (EIA 2005). Nigeria's gas reserves are the ninth-largest in the world. The West African Pipeline

Box 10: Diawling National Park, Mauritania – an area of important biodiversity

The wetlands of the Senegal delta are recognized to be among the richest and most extensive in West Africa. They have provided an interface between the freshwater of the Senegal River with its seasonal floods and the marine waters that intrude the estuary. This interface has favoured the development of rich botanical variety. In addition, this zone has served as a fish spawning ground and constitutes important feeding and nesting sites for numerous species of fish-eating birds.

Source: IUCN 2002

Source: IUCN

Mangrove forests (dark green) fringe estuaries and tidal creeks in Guinea-Bissau.

Source: NASA Earth Observatory

project, carrying gas from Nigeria to Benin, Togo and Ghana is set to proceed. While Nigeria is likely to remain by far the largest producer of oil and gas, nearly every country has attracted exploration interest.

Endowments and opportunities

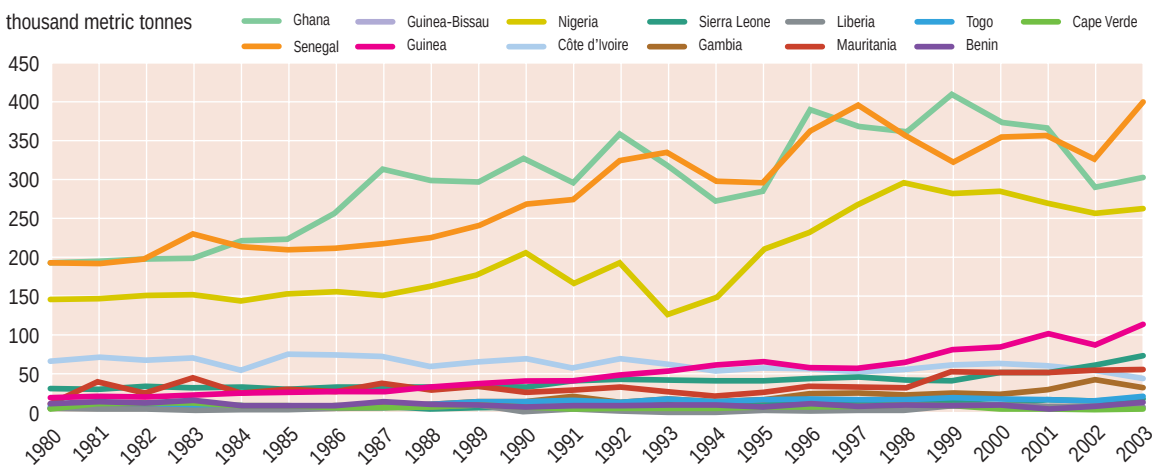
The coastal areas of Western African countries have dense and growing populations and developing commerce. This is where most of the industrial infrastructure is located, historically because of access to port facilities. In Nigeria, about 10 per cent of the total population of over 120 million live in the coastal city of Lagos, which is also the centre for 85 per cent of the country's formal industry. Coastal cities are likely to continue to be nodes of population growth for the foreseeable future, with opportunities over the longer term for people to improve their economic well-being. As well as the intrinsic attractions of coastal areas for growing populations, rich biodiversity and marine fisheries, and the extensive coastal and offshore oil and gas fields, are key assets with potential for boosting economic development and alleviating poverty.

Oil and gas development offers most countries a prospect of economic growth as well as a contribution to their energy needs (EIA 2005). Nigeria is the only significant oil producer, with production exceeding 2 million bbl/d in 2003. It ranks as the sixth-largest oil producer in the world, with exports accounting for 95 per cent of the country's foreign income. Nigeria has the potential to maintain its already substantial crude oil production as recent discoveries in new deep-water projects come on stream. The offshore Joint Development Zone, shared by Nigeria with neighbouring São Tomé (Central Africa), could soon potentially yield up to 3 million bbl/d. Nigeria is developing several projects to utilize its vast reserves of natural gas. Much of the present gas production from oilfields is flared. The projects involve the reinjection of gas into oilfields to maintain pumping pressure, and processing to produce liquefied natural gas (LNG). There are also schemes being planned to distribute gas for domestic and transboundary consumption.

Marine fisheries make an important contribution to food security, employment and national income, with Ghana, Senegal and Nigeria the main producers. In the Cape Verde Islands, fishery products represent 63 per cent of the state's exports (FAO 2005). Significant changes in species composition and fishery patterns have occurred, apparently partly due to overfishing, as shown by a decline in CPUE and the taking of immature fish by artisanal fishers (NOAA 2003a).

Tourism has potential for substantial growth, with the biodiversity and socio-cultural heritage aspects of many coastal areas providing a strong attraction. Ecotourism in particular should thrive with improved management of national parks. Individual countries show wide variations in their overall travel and tourism statistics and forecasts (WTTC 2005). Given trends elsewhere, it is plausible that coastal areas make a significant contribution to tourism. Ghana's travel and tourism economy in 2005 was expected to account for 10.8 per cent of GDP and 11.5 per cent of total employment (WTTC 2005).

Figure 10: Reported marine fish catches in Western African countries since 1980



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

Challenges faced in realizing development opportunities

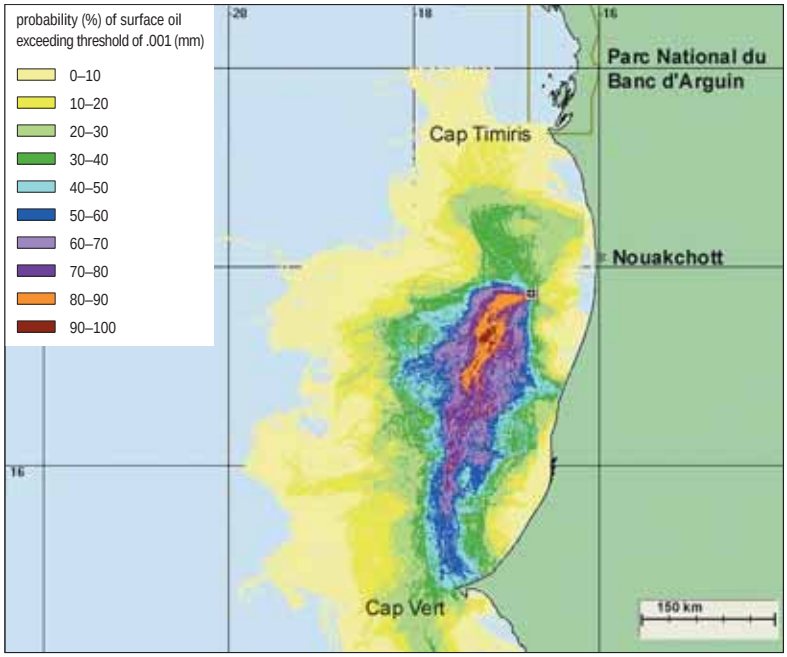
All countries are signatories to the UNEP-administered Abidjan Convention. The environmental issues and challenges faced in the realization of development opportunities are being addressed at local to global levels within this framework. Important initiatives in the control and reduction of pollution are already in progress, with the member countries committed to reducing and controlling land-based sources of pollution.

The continuing growth of coastal populations, and in particular the increasing urbanization along the coast, is placing severe stress on the living resources through physical disruption and pollution, resulting in the degradation or loss of habitats that have crucial value in ecosystem services and biodiversity. One such example is the Diawling National Park (Box 10) on the estuary of the Senegal River, where damming has led to restricted freshwater flow in the dry season (Hamerlynck 1999). Aquatic weeds, such as the *Nypa* palm, infest many estuaries (Crossland and others 2005).

The intensity of industrial-scale marine fishing, notably by foreign fleets operating under licensed agreements, also continues to increase, with serious impacts on fish stocks. Despite increasing catches by foreign fishing fleets, the economic growth and social benefits from marine resources have not been realized in many Western African countries that host these fleets (Alder and Sumaila 2004). Alongside the impacts on living resources, there has been a rapid expansion in seabed and marine engineering for the development of oil and gas resources, with accompanying air pollution and the ever-present risk of extensive oil pollution. The scale of environmental destruction and accompanying civil unrest arising from oil production operations in the Niger delta over the last few decades serves as a shocking indictment of the industry.

Coastal erosion by wave action has long been an important issue on the high-energy coasts of Western Africa (UNEP 1999). Reductions in the discharge of sand, due to damming and the disruption of longshore

Figure 11: Modelling oil spills in Chinguetti field, Mauritania



Conditional probability of exposure from a 140 000 barrels (22 260 m³) sea-floor release of crude oil over 14 days from the Chinguetti field, in winter (assuming no intervention).

Source: APASA 2004

Coastal erosion caused by the interruption of beach sand supply by longshore drift due to nearby port construction at Cotonou, Benin.

Source: R. Arthurton

sand transport by coastal engineering such as port development, have exacerbated this process. Some shorelines, such as the sand spit of Langue de Barbarie at the mouth of the Senegal River, have shown periodic erosion and accretion, mostly without obvious human influence.

The issue of climate change and its anticipated, associated sea-level rise (IPCC 2001) has important implications. As well as the increasing desertification of the Sahel (which may lead to further increases in coastal populations), there is likely to be an increase in coastal erosion and inundation of what are now densely populated low-lying areas, such as the Victoria Island beaches in Lagos, Nigeria, and the Greater Banjul Area in Gambia (Jallow and others 1996, UNEP 1999).

WESTERN INDIAN OCEAN ISLANDS

Pollution and the impacts of climate change, including coastal erosion and coral bleaching, are the main concerns (UNEP 2004). The potential impact of anticipated sea-level rise is also a major issue (IPCC 2001, UNEP 2002a). Southern areas, including Mauritius, Réunion and Madagascar, are subject to frequent tropical cyclones, causing loss of life and widespread devastation and destruction of coastal infrastructure (UNEP 2005b).

OVERVIEW OF RESOURCES

The islands form a heterogeneous group, reflecting their contrasting geological origins – micro-continental (Madagascar and the granitic islands of the Seychelles Bank), volcanic (Mauritius and the Comoros) or low-lying coralline (eg Aldabra in western Seychelles) (UNEP 2004). The Seychelles Bank and Mauritius form the ends of the crescentic Mascarene Plateau where the ocean shoals to less than 200 m. All countries except Madagascar are classified as SIDS, acknowledged to be especially dependent on their coastal and marine resources. All have large EEZs in relation to their land areas. The combined EEZs cover an ocean area of approximately 3.8 million km^2, while the total land cover is only 586 250 km^2, of which Madagascar constitutes about 99 per cent (UNEP 2004).

Coastal reef formations
Coral reefs form the fringes of extensive lagoonal platforms at Tanjon'i Masoala, south-eastern Madagascar.

Source: NASA 2001

The seas are endowed with rich and varied coastal and marine ecosystems, including parts of the Somali Current and Agulhas Current LMEs. There are extensive coral reefs, covering some 5 000 km^2, with 320 species of hard corals (UNEP-WCMC 2000, Ahamada, and others 2004, Figure 1) and, notably on Madagascar, coastal wetlands. The reefs constitute an important resource for fishing, tourism and recreation, as well as providing protection to vulnerable shores against potentially damaging waves. There are many endemic species, as well as endangered species including turtles, dugongs and cetaceans.

Coral reefs collectively cover an area of more than 5 000 km^2, with 320 species of hard corals. They constitute an important resource for fishing, tourism and recreation, as well as providing protection to vulnerable shores against potentially damaging waves (Ahamada, and others 2004). Fringing reef almost completely surrounds the islands of Mauritius (including Rodrigues) and the Comoros islands, while many fringing and patch reefs occur around the granitic islands of the Seychelles. The island of Aldabra, a designated World Heritage site (UNESCO 2005) in the western Seychelles, is a classic atoll. In Madagascar there are extensive coral reefs in the south-western and northern parts of the island (UNEP-WCMC 2000), all affected by the bleaching event of 1998 as a result of unusually high sea-surface temperatures. Live coral cover was reduced to less than 10 per cent around some of the Seychelles' granitic islands, while Mauritius was relatively lightly affected (Linden and Sporrong 1999).

The deep waters surrounding the Comoros are home to the coelacanth, a living representative of a family of fish known to have existed 370 million years ago (UNEP 2002b). Coelacanths have also been reported in the adjoining waters of Southern Africa and are the subject of a regional project, the African Coelacanth Ecosystem Programme (ACEP 2004). Coastal wetlands are extensive in Madagascar where mangroves cover an estimated 340 000 ha. More than 30 km^2 of mangrove stands are present in the Comoros (UNEP 2004). In the

Northern Madagascar
Mangrove forest (dark green) cut by tidal creeks. River discharges into the sea carry a high suspended sediment load.

Source: NASA 2000

Seychelles, remaining mangrove totals only 29 km^2, the largest areas being on the western islands, including Aldabra (Taylor and others 2003). In the sub-region as a whole, there are 15, mostly coastal, MPAs, established for different purposes and with different styles of management (Francis and others 2002, UNEP 2004).

All the countries have important marine fisheries resources. In addition to the inshore and reef fisheries traditionally exploited by artisanal fishers, the fisheries resources include the offshore demersal fishery of the banks of the Mascarene Plateau and the Chagos Archipelago, as well as extensive oceanic tuna fisheries that support commercial industries in Mauritius and the Seychelles.

Offshore geophysical and geological exploration for oil has taken place on the Seychelles Bank since the 1970s, with minor exploration drilling (SNOC 2000). The geochemical analyses and exploration data from its offshore acreage indicate potential for commercial production (MBendi 2005b). In 2005, an agreement was signed for exploration rights around Constant, Topaz, Farquhar and Coetivy islands (EIA 2005). There are no known oil and gas reserves in Mauritius. In Madagascar, the existence of oil and gas reserves has been confirmed; Bemolanga and Tsimiroro are exhumed oil fields, while numerous other wells include oil shows (MBendi 2005a). It has a modest production of crude and gas (MBendi 2005a), with reserves of 70 x 10^9 cubic feet of natural gas (EIA 2005). A field off the west coast containing heavy oil was proved in 2003, but deemed to lie too deep and to be too heavy to be commercially viable. Offshore exploration has continued over the last decade in the Majunga basin, off the west coast (EIA 2005).

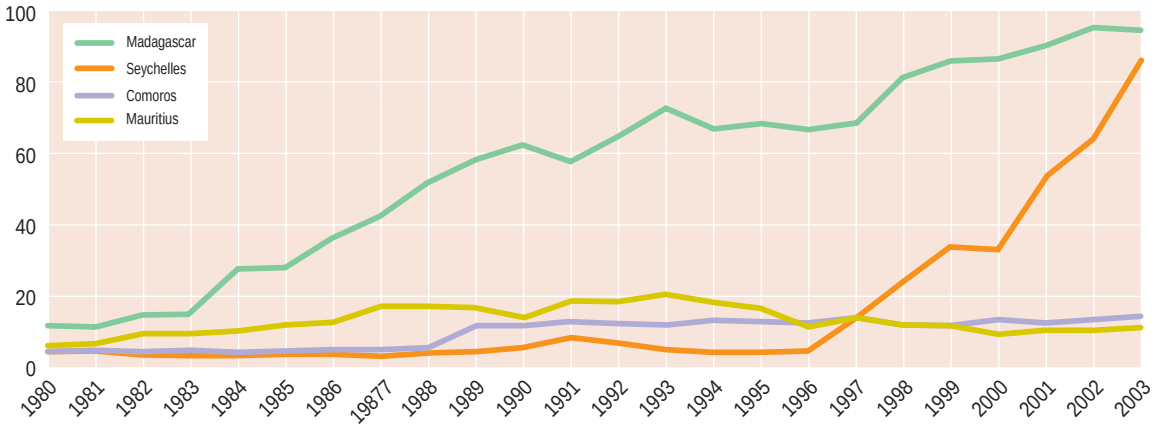
Box 11: Tourism benefits local people and conservation

One way of promoting conservation at community level is to ensure that local people benefit financially from protected areas. In addition, those who may have become poachers or who would have opposed the management of the protected area receive legitimate livelihoods. Cousin, a small island in the Seychelles, is a good example. This sea-and-island reserve was established by law in 1968, and run by an NGO, Nature Seychelles, who developed an ecotourism initiative in 1972. It has grown to become a modern practice run under internationally accepted principles. It has won numerous accolades, including the Condé Nast Ecotourism Award for 1994. A wholly Seychellois team runs the Reserve and only local people are involved in ecotourism there, ranging from small boat operators to larger tour organizations. Other small businesses on the neighbouring island of Praslin, such as shops, cargo service, mechanics, small contractors and boatyards, also benefit from business associated with Cousin. Poaching is virtually zero. Ecotourism brings sufficient revenues to run the Reserve and also for implementation of other conservation and educational programmes including the Local Environment Action Program (LEAP) and the Special Program on Learning and Awareness on Species and Habitats (SPLASH).

Source: Shah 2002

Figure 12: Reported marine fish catches in the Western Indian Ocean Island countries since 1980

thousand metric tonnes



Fishery production relates to catch of aquatic organisms, taken for commercial, industrial, recreational and subsistence purposes from inland, brackish and marine waters. The harvest from mariculture, aquaculture and other kinds of fish farming is also included. Catches of fish, crustaceans and molluscs are expressed in live weight, that is the nominal weight of the aquatic organisms at the time of capture. To assign nationality to catches, the flag of the fishing vessel is used, unless the wording of chartering and joint operation contracts indicates otherwise.

Source: FAO Fisheries Department, Fishery Information, Data and Statistics Units

Endowments and opportunities

The island states are valued for their outstanding natural beauty and tropical biodiversity, but are under pressure from land-based pollution and degradation of coastal wetlands and beaches. Tourism is already a major foreign exchange earner and is becoming increasingly important, particularly in the Seychelles and Mauritius. Directly and indirectly, tourism accounts for much of the employment in the SIDS, for women as well as men. The Seychelles already has a buoyant tourist industry, currently with a maximum of about 130 000 tourists per year. It is planned to increase arrivals to 200 000 by 2010 (UNEP 2004). The Seychelles' tourism economy (direct and indirect impact) in 2005 was expected to account for 60.2 per cent of GDP and 76.7 per cent of total employment (WTTC 2005) and was expected to grow by 14.0 per cent in 2005. Mauritius' tourism in 2005 was expected to account for 31.6 per cent of GDP and 33.9 per cent of total employment. It was expected to grow by 12.7 per cent in 2005. Tourism in Madagascar and the Comoros is less developed, but both countries have a great development potential, with tourism the primary foreign exchange earner in Madagascar (UNEP 2004).

Fisheries contribute significantly to all the national economies. Stocks within EEZs are exploited under licence by foreign fleets and licence fees form a significant proportion of national revenue (FAO 2004a). The fisheries are known to be nearly fully exploited and overfishing may have already occurred in many coastal areas, with most of the largely artisanal coastal fisheries being exploited beyond their MSY (UNEP 2004). Overall catches have increased over the past three decades to a level that has been more or less stable in recent years, but with a decline in Mauritius and the Comoros (Figure 12, FAO 2004b). There is scope for improvement in the quality of fisheries catch data for the purposes of policy making and management. Some marine fisheries may have scope for development, subject to enforcement of regulation at national and international levels. In the Seychelles, where there is now a highly developed tuna industry, including a canning factory employing 1 800 workers (FAO 2001b), fishing has become the largest earner after tourism,

Box 12: Science in support of management

Complex decision-making processes are required for managing coastal and marine environments. In the WIO region these are generally weakened by inadequate information and research inputs. Therefore, it is essential that appropriate scientific information is available for the assessment of impacts, and that a sound scientific base exists which can accommodate the changing needs of management institutions, as well as society at large, and upon which policies and practices of resource management can be built. Consequently, input from the scientific community needs to be developed in collaboration with relevant stakeholders. In addition to the information needs, it is necessary that research capacity-building is continued to meet long-term scientific development and the environmental needs of the region.

Source: WIOMSA 2005

contributing 12-15 per cent to GDP (Seychelles Fishing Authority, unpublished data). Licence fees of US$8 million are collected every year, with income from indirect expenditure (port dues, food supplies, services, etc.) amounting to over US$2 million. The Seychelles particularly, but also Mauritius, have important canning and transhipment facilities for tuna.

Aquaculture is a developing industry in all countries except the Comoros. The islands' coastlines are well suited for several types of aquaculture development (Rönnbäck and others 2002). Such developments present scope for increasing food security, in particular for coastal populations, and provide new sources of income for local economies and export markets. In Madagascar, there has been extensive conversion of coastal wetlands and mangrove areas to pond culture (UNEP 2004). In Mauritius, commercial aquaculture, mostly in freshwater ponds, consists of the production of giant freshwater prawns and red tilapia (FAO 2000).

North-western Madagascar
Suspended sediment run-off discharged to the sea reflects high levels of soil erosion in the hinterland.

Source: NASA 2001

Challenges faced in realizing development opportunities

All countries are signatories to the UNEP-administered Nairobi Convention, which has a cooperative and coordinated approach to protection and enhancement of the marine and coastal environment. Similar resource development objectives are iterated specifically for SIDS in the Mauritius Strategy for the Implementation of the Programme of Action for the Sustainable Development of Small Island Developing States (UNEP 2005b).

Major efforts are needed to regulate the pressures that are now leading to extensive habitat loss and degradation (UNEP/GPA and WIOMSA 2004). The tasks involve sea-use and catchment management as well as the management of coastal resources. The island states have made considerable strides in establishing effective resource management (Ahamada and others 2004). In Mauritius, new MPAs have been proclaimed, with supporting regulations and long-term monitoring of coral and fish communities, and in the Comoros, management of the environment and coastal zone has become a priority. Madagascar has adopted regulations to protect the natural environment, including marine areas, while the Seychelles has a national environmental management plan as well as a national biodiversity action plan that guides marine and terrestrial biodiversity conservation.

Concerns over the impacts of tourism development on the environment in some countries, including Mauritius and the Seychelles, are to be addressed through UNEP in a major GEF-funded project entitled *Reduction of Environmental Impact from Coastal Tourism through Introduction of Policy Changes and Strengthening Public-Private Partnerships*. This initiative recognizes the importance of protecting the attractiveness of the coastal resources in order to sustain the tourism market in the long term. The development of tourism is creating new coastal nodes, as at Grande Baie in Mauritius. However, this type of development is often poorly controlled and is leading to the deterioration of coral reefs and the loss of the natural tourism attraction. Much of the original coastline has been physically altered, and habitats destroyed by dredging and filling operations and the sediment plumes which they generate. Pollution due to the improper disposal of solid waste and euthrophication, due to poor sewage treatment, were identified as severe concerns in the Indian Ocean Islands GIWA assessment (UNEP 2004). In Mauritius, preliminary surveys indicate damaging nutrient levels in many areas, which may have caused the development of six red tides in 1996 in the Trou-aux-Biches area. The coastal impacts of the widespread use of nitrate fertilizers and pesticides in the island's agriculture raise particular concerns. Two major GEF-funded projects relate to pollution in the coastal and marine environment. Land-based activities impacting on coastal and marine resources are being addressed through UNEP under the Western Indian Ocean Land-based Activities Project (WIO-LaB) (WIO-LaB 2005), and the problems of oil spills are being covered by the Western Indian Ocean Islands Oil Spill Contingency Planning project.

Coral reefs continue to suffer pressures from increasing populations, coastal development and marine-transported litter (Ahamada and others 2004, UNEP 2004). Mining of coral and sand for use in construction is also damaging habitats, with most states implementing stricter legislation and licensing. Intensive tourism is thought to be damaging to reef habitats by pollution from boats, hotels and other facilities, and by anchor damage, trampling and removal of coral as souvenirs. Degradation of coral reefs is especially detrimental to the dive tourism industry. Fishing with dynamite, a common practice in the Comoros despite awareness campaigns, threatens coastal ecosytems. Stresses on reefs have been exacerbated by coral bleaching events (Ahamada and others 2004). Since the 1998 event, which reduced live hard coral cover on many reefs to less than 5 per cent, there have been further, though smaller, damaging episodes. Some reefs are showing recovery. Further pressures come from agriculture, where nutrients and sediments are discharged at the coast, particularly during cyclones. In Madagascar, deforestation is exacerbating soil erosion and sediment run-off (UNEP 2004, UNEP 2005a).

Overexploitation of the inshore and reef artisanal fisheries, including the non-selective and destructive practices of dynamite fishing, purse-seining and drag-netting, is a serious issue (UNEP 2004). The offshore fisheries have provided strong growth in production over the last two decades. However, there is an urgent need to develop institutional capacity in the region to address the problems facing fisheries, with an emphasis on regional institutions to deal with transboundary and highly migratory stocks, and to cope with high seas issues. The major challenges to productivity and biodiversity in the region's fisheries stem from a lack of regional cooperation and political will, poor monitoring and scientific capacity, and inadequate compliance structures. Biodiversity issues include concern over the large catches of non-target, endangered species, especially turtles, dolphins and dugongs. In the Seychelles, by-catch in the industrial tuna fishery constitutes 25-30 per cent of the catch. The unregulated development of coastal aquaculture could pose serious environmental threats and cause conflict amongst coastal communities. The practice of mangrove clearance for the construction of prawn ponds is a particular issue in Madagascar (UNEP 2004).

Improving management demands investing in and building local capacity in all sectors of the fishing industry, to reduce the reliance on distant water fleets and to adopt regional approaches to fisheries management. A long-term project due to begin in 2006 – the GEF-World Bank-supported South West Indian Ocean Fisheries Project (SWIOFP), designed to interface with a GEF-UNDP initiative to study the Agulhas Current and Somali Current LMEs – should bring an unprecedented level of scientific and management cooperation. In another project, a framework for regional fisheries management of non-tuna species is being developed, through the establishment of the South West Indian Ocean Fisheries Commission (SWIOFC). A non-binding coastal arrangement is in place within this framework, and negotiations are under way for a binding high seas arrangement.

Coastal erosion due to the impact of large waves is a major issue and has serious implications for tourism development. The extent to which upward reef growth and platform sedimentation might keep pace with sea-level rise is unknown, but it is likely that the protection from large waves offered by reefs will become less effective. In the extreme case of the Indian Ocean tsunami impact of 26 December 2004, damage in the Seychelles was estimated at US$30 million (UNEP 2005a). Even where shores are fringed by extensive reef platforms and lagoons, as around Mauritius, they may be susceptible to erosion. The most critical coasts are those formed by low-lying beach plains, where former beach sands have accreted on rock platforms (the so-called "plateau" sands of the Seychelles islands such as Praslin and La Digue) (Kairu and Nyandwi 2000,

Box 13: Ecological restoration of islands in the Seychelles

The environment of most of the islands of the Western Indian Ocean has been severely degraded. An island restoration programme, initiated in 1999 in the Seychelles, points the way to sustainable mechanisms of island restoration. A collaborative effort between an NGO, Nature Seychelles, private island owners and the Seychelles government, the programme is ongoing. Components include biological assessment of islands, socioeconomic valuation of restored ecosystems and ecotourism, cost analysis of restoration and maintenance, education and awareness, island management plans, removal of alien predators and other invasive alien species, establishment or rehabilitation of native coastal habitats and translocation of globally threatened endemic species. Islands in the programme include Frégate, North and Denis islands, private 5-star hotel resorts. Establishment of new populations of endangered species will not only lead to the downgrading of the threat status of these species on the IUCN Red List, but also to enhancing ecotourism potential, thus inducing hotel owners to contribute to conservation efforts. The programme has been financed by the GEF, the Seychelles government and island owners, and has involved international partners such as BirdLife International.

Sources: Shah 2001, Henri and others 2004

UNEP/GPA 2004). Attempts have been made to stabilize shorelines in the Seychelles by the installation of groynes, and in Mauritius by the use of rock-filled wire gabions. The erosion of beaches and non-rocky beachhead materials is likely to be aggravated by rising eustatic sea level and an increasing frequency of storm surge events arising from global climate change (IPCC 2001). In the Seychelles, a national beach monitoring programme was launched in 2003.

CONCLUSION

The continuing capacity of the region's coastal and marine ecosystems to provide the goods-and-services that are essential to human well-being will depend on the effectiveness of ecosystem management in response to the pressures of global change. Such management requires reliable monitoring information gathered from community to global levels and needs to be supported by nationally and internationally relevant legislation. Robust governance and institutional capacity, and the cooperative integration of sectoral interests at all scales, are essential. Response and compliance mechanisms should involve education as well as local and cultural knowledge. The enforcement of international agreements need to be strengthened, along with the promotion of public awareness and the enhancement of capacity for implementation, surveillance and enforcement, using remote sensing techniques as appropriate. Key research aims are to improve understanding of the causal linkages within, and affecting, the coastal and marine ecosystems, and of the value of the ecosystem's services to humanity in order to appropriately inform policymakers and to provide the information that resource managers need to act effectively within policy frameworks (Crossland and others 2005).

The development and application of integrated coastal management (ICZM or ICAM) plans should be promoted, with strong inter-sectoral and international linkages, including those with catchment management authorities with responsibilities for Integrated Water Resource Management (IWRM). The impacts of reduced freshwater and sediment discharge from rivers on coastal ecosystems and stability are a particular concern.

Action in terms of consultation, cooordination and the implementation of relevant legislation, at various levels, is urgently needed to halt the degradation of coastal and marine fisheries (industrial, subsistence and artisanal) and to restore their sustainability for the benefit of coastal communities and national economies. Effective monitoring and surveillance capacity will be needed to achieve this goal. Remedial measures need to be agreed at the international and ecosystem levels, with a clear understanding of the long-term negative consequences for human well-being of non-compliance. Regional cooperation, such as the BCLME programme (Box 6), in the management of widespread or shared migratory stocks should be seen as essential rather than only an opportunity. Protection of artisanal fisheries in the face of population pressure and industrial-scale fishing is an urgent issue and directly impacts on well-being and the ability of countries to meet the income and nutritional targets of the MDGs. Recognizing the potential for aquaculture development, appropriate regulations are needed to protect coastal ecosystems, and to promote sustainable production practices.

Management of existing protected areas requires increased public awareness, financial support and political will, with stronger enforcement of national and international laws. Coral reefs and coastal wetlands must be rigorously protected within an integrated management framework, involving local fishermen in monitoring where feasible.

Nature protection programme in the Seychelles. Sea turtle nests are registered and hatched turtle young are escorted to the sea.

Source: J. Tack/Still Pictures

Water- and airborne pollution control measures, including coastal and catchment point and diffuse sources, as well as offshore oil and gas fields, should be obligatory, with financial incentives for compliance and penalties for non-compliance. The issues of solid waste management and of marine-transported litter impacting shores need urgent attention, particularly as they affect SIDS. The latter requires international cooperation, with a strengthening of adherence to MARPOL – the Convention for the Prevention of Pollution from Ships.

The management of coastal erosion and marine inundation in the context of global climate change is a particularly difficult challenge, involving cooperation at local to global levels, as well as the adoption of interlinkages approaches as discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*. Long-term planning for adaptation to sea-level rise and increased storminess should be instituted by all coastal managers, especially urban authorities. Coastal development, including tourism infrastructure, should reflect a shoreline's susceptibility to change, with appropriate setback regimes and the relocation of vulnerable communities.

Much of the region's coastline is exposed to extreme tsunami waves and to storm-driven marine surges that generate unusually high sea levels. Learning from the lessons of the Indian Ocean tsunami of December 2004, the development of an early warning system for these extreme marine hazards should be a priority, as well as the promotion of public awareness and emergency procedures.

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CHAPTER 6
FORESTS AND WOODLANDS

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REGIONAL SYNTHESIS

Forests and woodlands occupy an estimated 650 million ha or 21.8 per cent of the land area in Africa (FAO 2005). These account for 16.8 per cent of the global forest cover (FAO 2005). The distribution of forests and woodlands varies from one sub-region to the other, with Northern Africa having the least forest cover while Central Africa has the densest cover. The Congo basin in Central Africa is home to the world's second largest continuous block of tropical rain forest (FAO 2003a).

OVERVIEW OF RESOURCES

Africa's forests and woodlands can be classified into nine general categories including tropical rain forests, tropical moist forests, tropical dry forests, tropical shrubs, tropical mountain forest, subtropical humid forests, subtropical dry forests, subtropical mountain forests and plantations (FAO 2003a). Mangrove forests cover 3 390 107 ha (FAO 2003a). Only 32.5 million ha of forests and woodlands, or 5 per cent of the total forest area, are formally protected (FAO 2003a).

The forest sector in Africa plays an important role in the livelihoods of many communities and in the economic development of many countries. This is particularly so in Western, Central and Eastern Africa where there is considerable forest cover. Africa has a high per capita forest cover at 0.8 ha per person compared to 0.6 ha globally (FAO 2002).

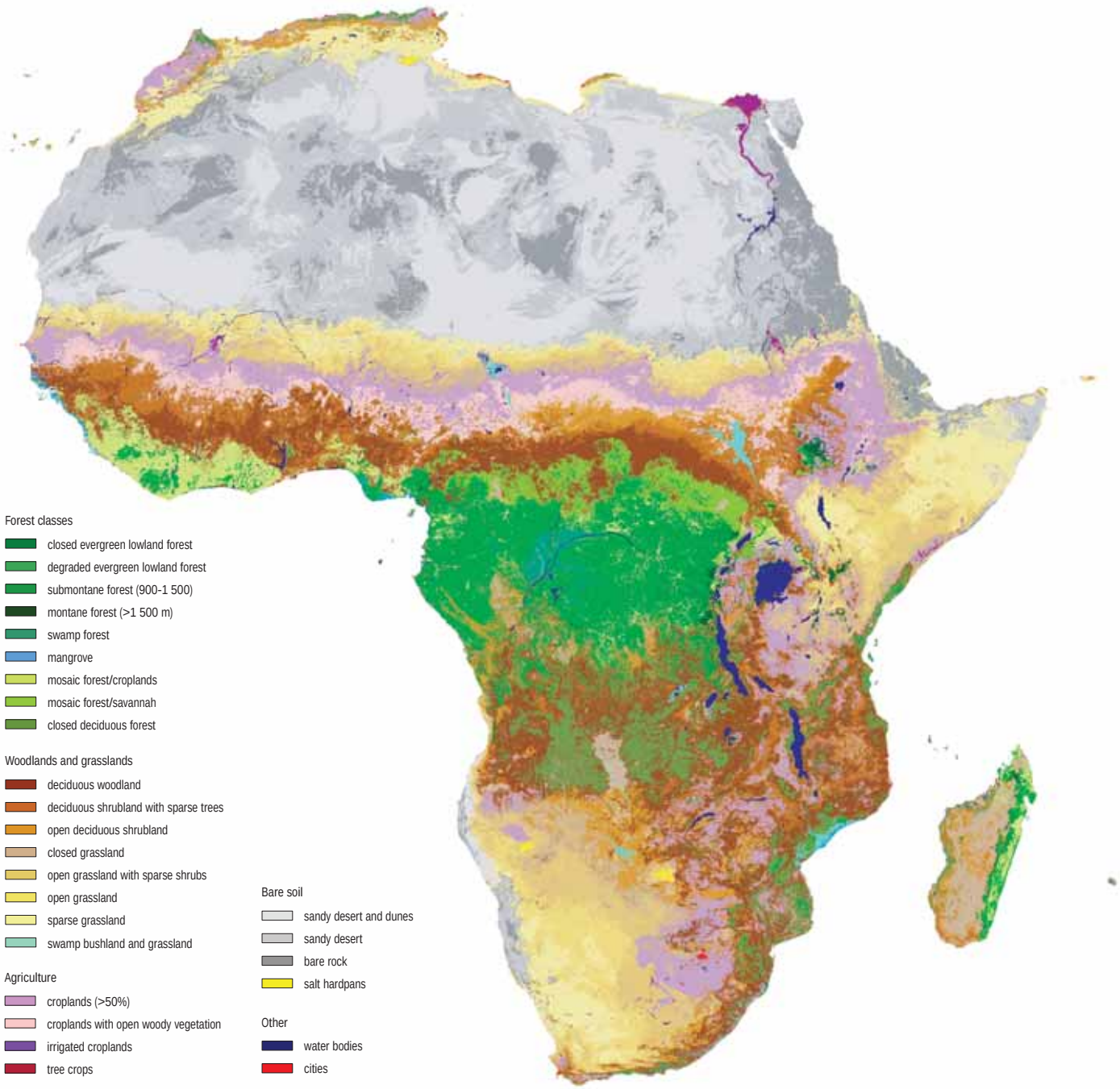
On average, forests account for 6 per cent of Gross Domestic Product (GDP) in the Africa, which is the highest in the world (NEPAD 2003). In Uganda, for example, forests and woodlands are now recognized as an important component of the nation's stock of economic assets and they contribute in excess of US$546.6 million to the economy through forestry, tourism, agriculture and energy (Emerton and Muramira 1999). Forests and woodlands also contribute to the long-term social and economic development goals of New Partnership for Africa's Development (NEPAD) and can play an important role in addressing the Millennium Development Goals (MDGs) and meeting its targets. They provide energy, food, timber and non-timber forest products (NTFPs) and are important contributors to wealth and health at the household, community, national, sub-regional, regional or even global level. The MDGs and their targets, as well as progress towards them, are shown in Annex 1.

Forests and woodlands are also key components of the environment and provide essential services that are critical to combating land degradation and climate change, as well as to conserving wetlands, coastal areas and freshwater systems. In this regard, the NEPAD programme on forests and woodlands is critical to the success of the other NEPAD programmes, including those on combating land degradation and climate change, and on conserving wetlands, coastal and freshwater resources.

ENDOWMENTS AND OPPORTUNITIES

Forests and woodlands provided a wide range of goods-and-services that create opportunities for development and improving human well-being. Some goods, such as wood for fuel and construction, are quite evident while others, such as water sources, are less obvious. The environmental functions of forests and woodlands include protecting catchment, purifying water and regulating river flows, which in turn ensure the supply of water for hydropower generation. Forests and woodlands also help prevent soil erosion (from water and wind) and thus are critical for agriculture and food production. They supply timber, wood for energy, construction materials and NTFPs including food and medicines. Other services include provision of shade,

Figure 1: Forest, woodlands and vegetation cover



Source: UNEP/DEWA/GRID 2005: data from ECJRC 2003

habitat functions, grazing, cultural (sacred groves, shade, peace trees and plants, meeting places, boundaries and training areas) and aesthetic values. The overall value of these goods-and-services is immense: it has been suggested that if the value of carbon sequestration is added to the above values, the local value of forests could easily support flourishing local livelihoods, while allowing forest-adjacent communities to maintain their security.

Manufacturing and value-added activities

In Central and Western Africa, the forest sector contributes more than 60 per cent of GDP through export of timber products (FAO 2003b). Africa's wood production (including roundwood and fuelwood), this increased from 340 million m^3 in 1980 to 699 million m^3 in 2000 (FAO 2003b). However, trade is characterized by unprocessed products, primarily roundwood and sawn planks. This means that the full potential value of forest resources is not captured. A huge opportunity, therefore, exists in investing in value-adding and processing of wood products. The main existing value-added products are paper, furniture and sawn logs produced essentially by the established

private sector, and charcoal production and crafts by the informal sector.

Greater benefits can be realized in those countries with significant hardwood forests, particularly the Democratic Republic of the Congo (DRC), Congo, Gabon, and Cameroon, through more innovative institutional arrangements such as market-based price determination through tendering, improving tax collection through the privatizatization of tax revenue collection, or privatizing commercial functions (FAO 2005). A number of countries have now imposed restrictions on log exports to encourage domestic processing. Domestic processing, however, has to be supported by strict quality control if African processed wood products are to gain secure access to the international market. Additionally, products will require certification to show that they come from sustainably managed forests, given the growing environmental consciousness of global consumers.

Energy

In Eastern, Western and Southern Africa, more than 90 per cent of rural households depend on woodfuel, including fuelwood and charcoal, for their energy requirements. The sustainability of this high dependence is questionable and, increasingly, African countries are looking at the energy opportunities offered by other resources, including solar and wind energy (see Chapter 2: *Atmosphere*) and hydropower (see Chapter 4: *Freshwater*).

Woodfuel supports lucrative local trade. Trade in charcoal is a major source of income for many households. For example, in Zambia, the charcoal industry generated about US$30 million in 1998 alone, and in the same year about 60 000 Zambians directly depended on charcoal production for the bulk of their income (Kalumiana 2000).

As charcoal becomes an important tradable commodity, there is an opportunity for governments to recognize and regularize charcoal production by putting in place long-term plans for sustainable production, while at the same time creating a supportive legal and economic framework for micro- and small and medium enterprises (SMEs) development. Increasing efficiency and ensuring that the development of this sector does not accelerate deforestation requires appropriate policy interventions. There is ongoing research to develop more efficient charcoal production methods

Wood carving provides valuable income for many rural families. Wooden sculpture for sale on the roadside, Kenya.

Source: V. Rabesahala

using improved kilns in a number of countries in Eastern and Southern Africa. There is also research on charcoal briquettes production using wastes such as farm refuse, sawdust and woodchips (Kalumiana 2000). These initiatives can be supported through active private sector involvement.

Urban markets for wood products are already attracting investment from the private sector and this interest is growing in many countries. There are additional opportunities for medium- and long-term investment. Commercial plantations for fuelwood and construction timber are big business in South Africa, Zimbabwe, Ethiopia, Kenya, Zambia and many Sahelian countries like Burkina Faso, Chad and Mali.

Box 1: Making the shea butter trade work for women in Burkina Faso

Vitellaria paradoxa (shea) – known in the local Dioula language as *karate*, meaning life – generally grows wild, and needs little attention. The tree has traditional medicinal value: it is used in childhood ailments and minor scrapes and cuts, and the shell of the nuts can be used to repel mosquitoes. Above all, the fruity part of the nut, when crushed, yields a vegetable oil that can be used in cooking, soap-making and skin and hair care. It is this that makes it a valuable trade commodity. Harvesting the nuts and making the butter have traditionally been women's work and now with new approaches to market it is giving women better opportunities, primarily through improved incomes.

Shea butter trees grow in the semi-arid Sahel region of west Africa, and Burkina Faso has the largest concentration of them. In 2000, the country generated the equivalent of US$7 million out of the export of shea butter and unprocessed shea kernels. Shea products are the third most important export after cotton and livestock.

The Burkinabe rural women producers of the valuable emollient shea butter are making a direct link to global markets using this non-timber forest product. In the third "Shea Trade Fair," which took place in Ouagadougou, Burkina Faso, from 20 to 23 February 2001, producers and traders marketed their shea butter products directly to international companies who use it in high quality skin and hair products as well as in pastries and chocolates. These women have managed to double their earnings by developing ties to companies in Europe and the US, and selling directly on the international market. Because of renewed interest in natural and biological products, shea butter is being progressively introduced into industrial markets traditionally occupied by palm oil, cocoa or coconut oil.

Sources: UNIFEM 2001 and Harsch 2001

Non-timber forest products

In addition to the mainstream timber products, like timber and woodfuel, forests and woodlands support other activities including ecotourism, the crafts industry, the traditional medicine sector, the pharmaceutical industry and bushmeat trade. These too are significant in enhancing household incomes. For example, it was estimated that 2.9 million people (530 000 households), lived within 5 km of closed canopy forest in Kenya in 1995, and depended on forests to provide timber and NTFPs. The woodcarving industry in Kenya, for example, supported over 80 000 people with approximately 400 000 dependants, and was worth US$8.21 million (Waithaka and Mwathe 2003). There is scope for building on the potential of these resources to contribute to livelihoods and development through, for example, increased partnerships and improved opportunities for local people to engage in these activities.

The contribution of forests and woodlands to national economies through production of gums and resins, medicinal plants, honey and beeswax, and bushmeat, though not quantified, is quite considerable. Table 1 shows some of the main NTFPs traded in Africa. Sudan, for instance, is the biggest producer of gums and resins in the world, commanding over 80 per cent of global production (Karamoja Data Centre undated) The potential for increased production of gums and resins in Sudan as well as the neighbouring states of Kenya, Chad, Eritrea, Ethiopia and Central Africa Republic is huge.

Another emerging NTFP export sector is medicinal plants. In 2003, the annual export trade in medicinal plants in South Africa was estimated at about US$60 million, while in Zambia annual exports were valued at about US$4.4 million (FAO 2003a). Medicinal plants are a growing major foreign exchange earner in Egypt, Morocco and Cameroon, with annual earnings of US$12.4, 12.8 and 2.9 million, respectively (FAO 2002). Northern Africa has one of the richest, oldest and most diverse uses of medicinal plants in the region.

Medicinal plants are also an important commodity in local markets as many people still rely on traditional medicine for their primary health care. In Ethiopia, for instance, 600 plant species are documented as being used in traditional medicine (FAO 2002). This important

Table 1: Trade in non-timber forest products

Sub-region	Main NTFP	Selected national statistical data available
Northern Africa	Cork, medicinal plants, aromatic plants, fodder	**Algeria**: Annual *Quercus suber* (cork) production of 6 000 tonnes exploited from 460 000 ha of cork forests **Morocco**: Annual export of 6 850 tonnes of medicinal plants worth US$12.85 million in 1992-1995 **Egypt**: Annual export of 11 250 tonnes of medicinal plants worth US$12.35 million in 1992-1995 **Tunisia**: Annual production of 10 000 tonnes of *Pinus halepensis* seeds
Eastern Africa	Exudates, medicinal plants, bee products	**Eritrea**: Export of 49 tonnes of *Acacia senegal* (gum arabic) and 543 tonnes of *Boswellia papyrifera* (olibanum) in 1997 **Ethiopia**: Annual honey production of 20 000 tonnes in 1976-1983 and annual production of gum arabic of 375 tonnes in 1988-1994 **Tanzania**: Export of 756 tonnes of *Cinchona spp*. bark worth US$258 000 in 1991
Western Indian Ocean islands	Edible plants, medicinal plants, ornamental plants, living animals	**Madagascar**: Export of 300 tonnes of *Prunus africana* bark worth US$1.4 million in 1993
Southern Africa	Edible plants, medicinal plants, bee products, fodder	**Namibia**: Annual export of 600 tonnes of *Harpagophytum procumbens* (devil's claw) worth US$1.5-2 million in 1998 **Zambia**: Honey production of 90 tonnes and beeswax production of 29 tonnes worth US$170 000 and US$74 000, respectively, in 1992
Central Africa	Edible plants, medicinal plants, bushmeat, rattan	**Cameroon**: Annual export of 600 tonnes of *Gnetum spp*. leaves worth US$2.9 million **Rwanda**: Production of 23 000 tonnes of honey in 1998
Western Africa	Edible plants, medicinal plants, bushmeat, fodder	**Burkina Faso**: Annual export of 14 200 tonnes of *Vitellaria paradoxa* (shea butter) worth US$2.4 million in 1984-1990 **Guinea**: Annual use of more than 100 million *Lophira lanceolata* (chewing sticks) **Liberia**: Annual use of 100 000 tonnes of bushmeat for subsistence purposes

Source: FAO 2002

role is underlined by the high ratio of traditional healers to western-trained medical doctors, estimated to be 92:1 in Ghana and 149:1 in Nigeria (FAO 2002).

As research advances, the role of medicinal plants in the pharmaceutical industries is increasing exponentially. Some of the opportunities and challenges associated with this sector are highlighted in Chapter 1: *The Human Dimension*. The natural stock may not be able to sustain the demand, especially if poorly managed. There is an opportunity for investing in the growing of medicinal plants to supply the growing demand. The Swiss Agency for Development and Cooperation (SDC) and IUCN – the World Conservation Union (IUCN) are working with farmers in Northern Africa to promote the conservation of endangered and economically useful medicinal and aromatic plants, indigenous knowledge, and the equitable participation of people in the management and conservation of these plants (IUCN 2005). In Southern Africa, there is also an increase in the use of medicinal plants; this may be related to harsh economic circumstances, high population growth and the prevalence of incurable diseases, such as HIV/AIDS.

Markets for environmental services

Forests provide a wide array of environmental resources, some of which can be successfully commercialized, increasing financial benefits. Environmental services from forests also have non-use values. Chapter 1: *The Human Dimension* provides an overview of the value of environmental goods-and-services and their role in supporting livelihoods.

Forests play an important role in carbon sequestration, and by investing in forest development and conservation countries can benefit from carbon trading. A number of corporate institutions in Europe are already benefiting from carbon trading by investing in tree planting in some parts of Africa. Carbon trading also offers opportunities for indigenous companies and in particular SMEs. The market

Medicinal plants market near Mathare, Nairobi, Kenya.

Source: C. Lambrechts/ UNEP

for environmental services from forests is growing rapidly around the world, often facilitated by national and regional policies as well as international conventions and agreements (Scherr and others 2004). Certain segments of society that are able and willing to pay for these services are creating opportunities for the forest owners. Markets for carbon sequestration have been adopted in Uganda, Tanzania, Malawi and Madagascar (Landell-Mills and Porras 2002).

The increasing demand for nature-based recreation has induced a dynamic private sector involvement in the management of game reserves and parks in Kenya, Namibia, South Africa and Madagascar.

Many nature-based tourism and ecotourism activities revolve around forests, establishing a strong cause-and-effect relationship between ecotourism development and forest use. Ecotourism provides a means by which people can use forests and wildlife, without extracting resources

Box 2: Some of the non-timber values of forests and woodlands in Africa

Africa is a source of internationally traded NTFPs particularly medicinal plants and spices. The most important internationally traded species include *Thymus spp*., *Laurus nobilis*, *Rosmarinus officinalis* (Northern Africa), *Prunus africana* (Eastern, Southern and Central Africa), *Warburgia salutaris* (Eastern and Southern Africa) and *Harpagophytum procumbens* and *Harpagophytum zeyheri* (Southern Africa) (FAO 2000).

Local benefits from NTFPs are also important. They provide important foodstuffs, in particular during the "hungry season" and in marginalized areas. Important edible plants include fruits (eg *Irvingia gabonensis*, *Elaeis guineensis*), nuts (eg *Vitellaria paradoxa*), seeds (eg *Cola acuminata*), vegetables (*Gnetum africanum*), bark (eg *Garcinia sp.*), roots (eg *Dioscorea sp*.) and spices (eg *Piper guineense*). Mushrooms such as *Cantharellus spp*. and *Boletus spp*. are also collected, particularly in Eastern and Southern Africa.

In Uganda the consumption of NTFPs, including medicines, wild foods (such as bamboo shoots and honey), shea butter, resins such as gum arabic, curios, and weaving materials has been estimated to be worth some US$1.4 per capita at the household level and US$0.7 per capita for commercial products (NEMA 1996). At current population levels and at 1998 prices, this equates to a total value of some US$44 million/year.

Source: FAO 2002 and NEMA 1996

The rain forest of Nosy Mangabe, Madagascar, has historically been used for cultural purposes. Here, coffins are sheltered by the roots of ancient trees.

Source: R. Butler/WildMadagascar

or degrading the environment, and draw income from it. This non-extractive aspect presents a strong incentive to protect the resource. However, the capacity of ecotourism to generate income and employment for surrounding communities depends on how well it is managed (FAO 2005), and in particular on the systems set up for planning and benefit sharing.

Strengthening local institutions for forest management and developing information, through research on multiple uses of forests and new products of potential commercial value, creates investment opportunities for both the scientific community and the private sector.

Challenges faced in realizing opportunities for development

The endowment value of forests and woodlands in Africa is enormous, and can be used to promote a wide range of livelihood opportunities, including increased income and enhanced livelihood security. However, as forests and woodlands are declining, primarily as a result of increased woodfuel collection, clearing of forests for agriculture, illegal and poorly regulated timber extraction, conflicts, increasing urbanization and industrialization (FAO 2002), these opportunities are diminishing. Between 1990 and 2000, Africa's forests and woodlands receded faster than the global average; deforestation in Africa took place at an average of 0.8 per cent, as compared to the world average of 0.2 per cent (FAO 2005).

Policy, legal, institutional, technical and economic constraints have undermined wider adoption of sustainable forest management as well as limited opportunities for development.

One major constraint is that Africa has not been able to take advantage of its wealth of raw materials and traditional knowledge to invest in processing (Katerere and Mohamed-Katerere 2005). This continues to undermine opportunities for employment and income generation (FAO 2003a). With increasing private sector involvement, including foreign-based companies, there is a good opportunity for governments to foster viable partnerships with the communities and civil societies in the protection of traditional rights of forest-adjacent communities, and equitable sharing of benefits from forest resources to promote livelihood security and ensure sustainable use of forest and woodland resources. This is consistent with obligations under the Convention on Biological Diversity (CBD). Additionally, it is essential for there to be increased investment in the development of micro- and SMEs if people are to have the opportunity to move away from subsistence-based livelihoods (Katerere and Mohamed-Katerere 2005).

Market development

The opportunities for local people to participate directly in the market are hampered by poor infrastructure, poor access to financial and other support, as well as inadequate opportunity to develop micro- and SMEs. If opportunities for new and existing business are to be increased these factors requires urgent attention, as discussed in Chapter 1: *The Human Dimension*.

One missed opportunity is NTFPs. The full range of benefits available from the commercialization of NTFPs has not been realized. One challenge is that the returns to producer communities are often very low. This is a result of a combination of factors including low product price, high producer dependency on market intermediaries, the lack of technical and financial support, non-supportive legal and regulatory framework, and the poor relationship between final product price and production cost (Katerere and

Processing timber in a sawmill.

Source: P. Reidar/CIFOR

Mohamed-Katerere 2005). This is demonstrated in relation to *Harpagophytum* species, and in particular *Harpagophytum procumbens* (devil's claw), which forms the basis of trade in Southern Africa (Box 3).

The successful marketing of NTFPs remains a challenge and in particular the high cost of product promotion, the high availability of substitutes, the lack of access to market information, the lack of contact with final consumers, the lack of financial instruments, the lack of technical support, inadequate community organization, lack of market value, poor quality control, lack of attractive product presentation, lack of management capacity and poor understanding of consumer demands and needs (Marshall and others 2003). Low investment in production processes undermines efficiency and results in higher product costs, making the final products uncompetitive globally.

Additional constraints to developing pro-poor markets include insecure tenure and the free availability

Box 3: Poor returns to communities in commercialization of some NTFPs

Trade in *Harpagophytum* species, and in particular *Harpagophyyum procumbens* (devil's claw), a traditional medicinal plant, supports a US$100 million industry, but most benefits accrue to processing and transformation actors along the marketing chain and only a very low proportion to domestic producers. Harvesters of devil's claw, in Namibia, that sell to intermediaries who then sell to the exporter, receive only 0.36 per cent of the retail price; those in non-governmental organizations (NGO) facilitated marketing chain receive 0.64 per cent, while those with direct contact with a local exporter receive the most at 0.85 per cent (Wynberg 2004). This pattern is set to continue in the absence of direct investment in community skills and opportunities.

The African Union (AU) has adopted a model law which seeks to control harvesting, ensure fairer distribution of benefits and recognize local intellectual property rights. Building on this and developing supporting national legislation could create new opportunities for improved benefit sharing. International regulatory regimes, such as those imposed by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), often do not make adequate provision for local variation in species numbers, thus potentially placing unfair restrictions on certain communities. Under CITES, devil's claw is listed as endangered. However, there is no local scarcity in Namibia. Global certification also places an added cost on poor communities.

Source: Katerere and Mohamed-Katerere 2005

Moroccan women cleaning argan tree nuts for medicinal oil production.

Source: Y. Katerere

of genetic resources in gene banks. Table 2 sets out some of the impacts of markets on household assets.

Weak management, monitoring and evaluation systems

Weak institutions have paved way for large-scale illegal logging (FAO 2003a) in many countries. Throughout Africa, forestry departments are experiencing acute shortage of staff and equipments. Forestry education has also declined over the past two decades; the situation is made worse by declining donor investments (FAO and others 2005).

Political instability and budget problems have also forced many institutions to close for long periods – one consequence of this is that there is an acute shortage of trained forestry practitioners. A report by the Food and Agriculture Organization of the United Nations (FAO) and IUCN shows a particularly worrying situation in Central Africa, which has the richest forests in the region (FAO, RIFFEAC and UICN 2003). The DRC, for example, has only 100 professional foresters to manage forests covering an area three times the size of France. Congo's faculty of forestry was ransacked in 1997/98 and only reopened in 2002. The Central African Republic's faculty was also pillaged (FAO, RIFFEAC and UICN 2003).

Conflict and war

Another challenge for forest management is conflict and war. In many conflict areas, forest management has been suspended and illegal loggers, even if not directly involved in the conflicts, have at times devastated forest resources. Post-conflict periods do not necessarily lead to more sustainable systems. There may, for example, be an increased demand for wood during post-conflict reconstruction which can worsen the situation. Conflict around forest and other natural resources is discussed in Chapter 12: *Environment for Peace and Regional Cooperation*.

Agricultural pressures

Although 5 per cent of Africa's forests are designated as protected areas, the management accorded to the areas is not commensurate with their conservation status. Encroachment, illegal logging, grazing and poaching of wild animals persist in these areas (FAO 2003a). Agricultural expansion and overgrazing are also an increasing problem and major causes of the loss of woody vegetation cover, especially in Eastern, Southern and Western Africa (FAO 2003a). Given the high dependence on agriculture, there is growing pressure to increase the area under agriculture to meet the food requirements of the growing population at the

Table 2: Impacts of markets for key assets held by poor households

Potential benefits	Potential costs
Natural assets ● Forest conservation due to new market opportunities and better management. ● Increased value of natural assets where markets regularize land tenure. ● Positive spin-offs for other natural assets eg soil fertility, water-flows and quality, air quality due to reduced forest fires and forest loss.	Natural assets ● Lost access and use rights due to increased competition for resources. ● Lost use values (eg Timber and NTFPs) where new harvesting regulations are imposed. ● Negative spin-offs for other natural assets eg worsened water quality due to replacement of natural forests for fast-growing plantations for carbon sequestration.
Physical assets ● Improved infrastructure development including transport, market infrastructure, research, and health care.	Physical assets ● Dismantling of local infrastructure eg roads, to ensure sustained environmental services supply. ● Greater inequality as infrastructural investment is targeted at certain market participants.
Human assets ● Training for enterprise development, marketing, project and environmental management, negotiation skills. ● Improved health through more varied diets, improved water supply (quantity and quality) and air quality, investment in health clinics, increased disposable income for medical treatment.	Human assets ● Inappropriate education diverts spending away from broader skills development. ● Poor people capture few educational and skills development opportunities as offered only menial jobs. ● Reduced health where poor people are excluded from collecting NTFPs for domestic consumption and from lost disposable income.
Social assets ● Increased tenure security where markets promote rights formalization. ● Increased community management and organizational capacity. ● Protection of forest-based cultural heritage.	Social assets ● Reduced tenure security where markets displace people who lack formal property rights. ● Less cooperation between stakeholders due to increased divisions between those who gain and lose. ● Threats to cultural heritage where markets and commercialization undermine local values.
Political assets ● Increased participation due to improved organization capacity and contacts in the private and public sector.	Political assets ● Loss of political representation where markets lead to increased competition for resources and exclusion of poor people from forest areas.
Financial assets ● Income from sales of environmental services. ● Income from secondary employment (eg NTFPs, fuelwood, timber, ecotourism, transport). ● Improved security and stability of income due to diversification.	Financial assets ● High transaction and opportunity costs of bringing services to market exclude poor suppliers. ● Reduced forest-derived income as new restrictions imposed. ● Poor people excluded from new markets through lack of necessary skills and assets. ● Reduced security where contract design is inflexible and unable to respond to changes.

Source: Landell-Mills and Porras 2002

Dry season forest fire, Zimbabwe.

Source: P. Frost/CIFOR

expense of forests. The ongoing land reforms in Southern Africa have seen movement of commercial farmers from Zimbabwe and South Africa to Mozambique and Zambia, and countries outside the Southern African Development Community (SADC) region. This development could potentially reduce forest cover in the recipient countries. Newly-settled farmers also tend to open up new land for crop cultivation. Some of the challenges associated with increased agricultural demand are considered in Chapter 3: *Land*.

Fire

Bush fires are another threat to forests and woodlands, causing enormous destruction to both flora and fauna. The total global area burned annually between 2002 and 2003 was in the range of 300 to 400 million ha, and about half of this was in Africa (FAO 2005).

The combination of the above pressures on forests has resulted in the decline in both the quality and quantity of forest and woodland resources. Between 1990 and 2000, Africa lost about 52 million ha of forest, accounting for about 56 per cent of the global reduction in forest cover (FAO 2003b). Southern Africa accounted for about 31 per cent of the forest loss on the continent. Three countries, namely Sudan, Zambia and the DRC, accounted for almost 44 per cent of Africa's deforestation (FAO 2003b). Deforestation is particularly rampant outside protected areas, especially where regulatory and enforcement frameworks are inadequate. In many rural areas, there has been a breakdown in traditional community arrangements and this has, in the face of no alternative regulatory system, contributed to poor management.

Strategies to improve opportunities

Improved regional collaboration and harmonization of approaches

Africa recognizes the immense value of its forests and has mainstreamed forests in its development agenda, the NEPAD. The NEPAD Environment Action Plan (NEPAD-EAP) locates forests and woodlands in Programme Area 6: Transboundary conservation or management of natural resources, which emphasizes the protection and sustainable management of Africa's forest resources through:

- Strengthening national plans and programmes for forest management, inventory and monitoring. This

includes improving the participation of stakeholders, such as communities and the private sector, in new approaches and initiatives as well as the promotion of the wide range of roles played by forests. Also included here are measures to improve and integrate mapping and knowledge (scientific as well as traditional knowledge) and to strengthen monitoring and assessment.

- Maintaining protected areas by, among other measures, improving capacities, forming collaborative management partnerships with other countries, and restoring ecosystems; and
- Strengthening forest law and governance, by encouraging the sharing of information on trade in illegally harvested forest products, improving participation in international fora and international agreements, and more effective implementation of measures to reduce corruption.

The NEPAD-EAP recognizes that forests and woodlands are an important crosscutting issue critical to the success of the other NEPAD programmes, including combating land degradation and climate change, and conserving wetlands, and coastal and freshwater resources. Special attention, therefore, needs to be given to enhancing the quality of forest resources at the sub-regional and national levels and to maximizing the benefits that can be derived from forests and woodlands.

In the recent past, most countries have developed policies that can support and influence sustainable use of forest and woodland resources, including national environment action plans and national sustainable development strategies. These policies aim at sound sustainable development by reconciling economic development and conservation of resources, and they provide a good basis for the proper management of natural resources. Their effective implementation is among the best opportunities African countries have to conserve their woodland resources and maximize benefits for their citizens.

Other measures to reduce the loss of forests include integrated land-use planning; conservation and sustainable use of natural and planted forests; community involvement in all aspects of forest management; developing markets for a wider range of forest goods-and-services, including carbon sequestration and watershed protection services; and independent third-party certification of products from sustainably managed forests. Chapter 12: *Environment for Peace and Regional Cooperation* considers how improved cooperation in forest management has improved opportunities for conserving forest resources and enhancing peace.

Box 4: Kenya's Green Belt Movement

Kenya's GBM has focused on environmental conservation and community empowerment for at least thirty years. The movement's sustained efforts in these areas have been rewarded by the awarding of the Nobel Prize to its founder, Professor Wangari Maathai, in 2004. Its major achievements include the creation of over 600 community networks across Kenya that care for 6 000 tree nurseries. Over the years, these networks, along with individuals, have participated in planting more than 30 million trees on private and public land, protected reserves, sites with cultural significance, and in urban centres. This has resulted in the transformation of many landscapes (forests, steep slopes and other degraded areas) and in the increased protection and restoration of habitats for local biodiversity.

Professor Wangari Maathai, Nobel Peace Prize winner, 2004.

Source: Associated Press

Additionally, Kenyans' attitudes toward the environment have also been transformed: awareness of the impacts of ecological decline has increased, along with public interest in defending the environment, including forests and public parks and open spaces. Tree planting also provides an entry point for the GBM's other initiatives, including civic and environmental education, capacity-building and advocacy. During the review process for Kenya's new constitution, GBM held civic and environmental education seminars and conducted tree-planting activities to support the process and encourage a peaceful transition. Over 250 000 peace trees were planted.

Source: GBM 2006

Forestation and reforestation

Some countries have adopted aggressive programmes of forestation and reforestation, with demonstrated results in the short run. As a result of these efforts, the annual planting rate in Africa overall is estimated at 194 000 ha or about 4.4 per cent of the global planting rate (FAO 2003a)

In the Western Indian Ocean (WIO) island states, for example, vegetation cover is changing considerably through the development of agroforestry plantations. The Seychelles has extensive coconut plantations as well as a relatively large planted estate of *Casuarina* and *Albizia* species (UNEP 2005a). Both Cape Verde (9.3 per cent) and Gambia (1.0 per cent) show increases in forest cover (FAO 2005). Similarly, there is a positive trend in Northern Africa, with Egypt experiencing a

Young forest plantation on Mount Kilimanjaro, Tanzania.

Source: C. Lambrechts/UNEP

growth of 3.3 per cent, Libya 1.4 per cent and Tunisia 0.2 per cent (FAO 2005).

As natural forest areas shrink, the concern to conserve the remaining areas for environmental services has resulted in many countries setting them aside as protected areas, thus making them largely unavailable for commercial exploitation. This has led to a push to expand the plantation areas, especially in South Africa, Swaziland and Zimbabwe. Swaziland has experienced a growth of 1.2 per cent. There is also increased private planting in Eastern and Western Africa. Some countries, like Uganda, are actively seeking the involvement of the private sector in plantation development, including establishing a loan scheme by the National Forestry Authority for tree farmers and offering leases on its own reserve land to encourage private plantations development. Nevertheless, Uganda's forest cover continues to decline at a rate of 2 per cent per year.

Community empowerment

Improving the opportunities available to local users will have benefits at the local level, with potentially positive spin-offs at the national, sub-regional and regional level. The importance of community and public involvement in the management of forests has been recognized and promoted across Africa, with many countries adopting new laws and policies to support this (Katerere and Mohamed-Katerere 2005). There is increased community involvement in several sectors including forest management, ecotourism, advocacy, public education, and forestation and reforestation. Governments are also increasingly recognizing the value local users bring to resource management as their primary custodians.

Non-governmental organizations, such as the Green Belt Movement (GBM) in Kenya, have played an important role in promoting such approaches, as shown in Box 4.

Human resource capacity

Human resources development, particularly in terms of professional training, has not been sufficient to meet the needs associated with sustainable management and enhancing development opportunities.

Investment in forest-related education is an important challenge. From 1993 to 2002, the number of forestry bachelor degrees awarded has been increasing steadily, but the number of post-graduate degrees has declined significantly (FAO, RIFFEAC and UICN 2003). Certificate-level forestry training has practically disappeared. International partnerships can play a key role in addressing this problem. One option is to increase the opportunity for African students to study in developed countries.

Agroforestry

While forests are valued for their timber, fruits and medicinal values, the opportunity presented by agroforestry to communities in the region is not well known. Agroforestry technologies that can be readily adopted include planting of nitrogen-fixing trees, the domestication of indigenous fruit trees, medicinal trees, live fences, and woodlots for timber and fuelwood. Regional cooperation, including through sharing experiences and lessons on effective resource management, may improve opportunities. The strengthening of the East African Community, for instance, is a good opportunity for improved cooperation between Uganda, Kenya, Tanzania, Rwanda and Burundi.

Economic and development opportunities

The extent and quality of forests and woodland varies from one sub-region to the other as does their socioeconomic significance. The sub-regional analysis discusses the various issues related to sustainable management of the forests and woodlands at this level and the various strategies being put in place to optimize benefits and ensure sustainability. A multilevel strategy for harnessing opportunities, which brings in multiple actors and focuses on improving opportunities for local users, increasing investment in value-adding activities, and utilizing the opportunities for environmental service markets, is essential (Katerere and Mohamed-Katerere 2005).

There are several possible levels of economic activities involving local communities, including in small-scale income-generating, cooperative projects, and large-scale partnership projects with the private sector. Effective local level management of natural resources requires that local people have clear, unambiguous proprietary rights to the resources they manage (UNEP 2005a). For communities to take advantage of emerging opportunities, a policy and legislative framework is required that protects the communities' rights to forest resources, promotes access to markets, ensures proximity to markets, improves local expertise, gives access to information, improves institutional capacity to manage resources, adds value to products and services, increases the negotiation capacity of local people, and promotes partnership (FAO 2005).

The proportion of logs domestically processed in Africa increased slightly from 80 per cent in 2003 to 82 per cent in 2004. This reflects increasing populations, growing economies and the emphasis on producing and exporting value-added products in this region (ITTO 2004). South Africa accounts for about 42 per cent of Africa's share of value-added wood industries. Other African countries' share in processing is considerably lower. According to FAO's Global Forest Resources Assessment 2005, the wood industry's gross added value stems from wood processing rather than wood availability (FAO 2006). Ultimately, it is the improvement of and access to technology that will enhance the value-adding, manufacturing and marketing performance of the wood industry. The World Summit on Sustainable Development (WSSD) in its Johannesburg Plan of Implementation prioritized investment in industry as critical to meeting sustainable development goals.

If the existence of large forest areas is neither an essential nor a sufficient condition for the promotion of dynamic forest industries in Africa, it most certainly is for the expansion of schemes such as the Clean Development Mechanism (CDM) that focus on the carbon sequestration value of forests. This market has been evolving quickly (Landell-Mills and Porras 2002), but Africa has not seized the opportunities available through it (Katerere and Mohamed-Katerere). Forestation and reforestation schemes can be an important component of carbon trade as envisaged under the Kyoto Protocol. In order to maximize the benefits from CDM-related activities, African nations must ensure that more land is available for forestation and reforestation, and that forest conservation and sustainable management activities are pursued. Increasing the availability of forests for carbon sequestration also implies that more carbon market traders will come into play, boost competition, thus motivating countries to sustain management and conservation activities.

SUB-REGIONAL OVERVIEW

CENTRAL AFRICA

OVERVIEW OF RESOURCES

Forests in Central Africa cover an estimated area of 240 million ha; these are mainly dense tropical rain forest (FAO 2005). The sub-region is dominated by the Congo basin forest ecosystem, which is the second largest forest in the world, second only to the Amazon forest. The ecosystem comprises 200 million ha, about 18 per cent of the world's tropical forests, and hosts about 400 mammalian species and more than 10 000 plant species (Maathai 2005).

Table 3: Forest cover as percentage of total land area

Country	Total land area ('000 ha)	Total forest area in 2000 ('000 ha)	% of land area in 2000
Cameroon	46 540	23 858	51.0
Central African Republic	62 297	22 907	36.8
Chad	125 920	12 692	10.0
Congo	34 150	22 060	64.6
DRC	226 705	135 207	59.6
Equatorial Guinea	2 805	1 752	62.5
Gabon	25 767	21 826	84.7
São Tomé and Príncipe	95	27	28.3

Source: FAO 2005

As shown in Table 3, most of the countries have considerable forest cover, with Gabon being most forested with 84.7 per cent of its total land area under forest cover. Chad is the least forested, with only 10 per cent of the land under forest. All the countries, with the exception of São Tomé and Príncipe, are experiencing a gradual decline in the area of their forest cover.

Endowments and opportunities

Forests play a major role in the economies of Cameroon, the Central African Republic, Congo, the Democratic Republic of the Congo, Equatorial Guinea and Gabon, and in the livelihoods of local people.

The forest sector contributes, on average, between 5 and 13 per cent of the GDP of these countries (FAO 2002). Up to 60 per cent of export earnings for Gabon are from timber products, while for the Central African Republic it is about 50 per cent (FAO 2002). Gabon is the biggest exporter of industrial roundwood, exporting nearly 97 per cent of its total production (FAO 2005). Export of medicinal plants is a major foreign exchange earner in Cameroon, with annual earnings of 2.9 million dollars (FAO 2002).

Forests and woodlands also play an important role in climate modification, catchment protection and regulation of hydrological networks, and biodiversity.

For the local communities, forests and woodlands have multiple uses, which vary extensively with the type of forest, and the community. These range from construction materials, foods, energy, medicines, catchment protection, soil protection, shade, habitat for wildlife and bees, grazing as well as cultural values (including sacred groves, shade, peace trees and plants, meeting places and training areas). Forests play a very important role as carbon sinks, and the Congo basin with its dense forest cover can benefit from carbon trading.

Challenges faced in realizing opportunities for development

Forests and woodlands are declining, mainly due to overharvesting and bush fires, agricultural expansion and overgrazing.

User rights in the forests are allocated by governments through administrative or competitive processes (FAO 2005). In Gabon, for example, there are 221 concessions over 11.9 million ha or 56 per cent of the forest area (Global Forest Watch 2000). Cameroon has allocated 81 per cent of its forests to concessions (White and Martin 2002). Although the allocation process takes advantage of market forces, sometimes monitoring and enforcement of regulations in the permit areas by the governments is inadequate, leading to illegal practices such as felling of protected species, wrong classification of logs, felling undersized trees and transportation or removal of more logs than permitted (UNEP 2004).

Central Africa has an estimated population of close to 80 million inhabitants, of which 65 million currently live in or near the forest (FAO 2003a). Local communities use bush fires as a technique for agriculture and hunting. Through monitoring, the Global Fire Monitoring Centre (GFMC) has detected an increasing number of fire events in Central Africa, which indicates fire is systematically being employed in land-use change (FAO 2005). Central Africa has experienced several prolonged conflicts, which has had various implications for the management of forest resources. Some of the challenges associated with conflict and forest management are discussed in Chapter 12: *Environment for Peace and Regional Cooperation*.

Table 4: Production and consumption of industrial roundwood in Central Africa 2002

Country	Production ('000 cubic metres)	Consumption ('000 cubic metres)	Export ('000 cubic metres)
Cameroon	1 270	1 051	219
Central African Republic	1 058	958	100
Chad	761	761	-
Congo	1 251	692	559
DRC	3 653	3 651	2
Equatorial Guinea	364	515	0
Gabon	2 584	84	2 500
São Tomé and Príncipe	9	9	0

Source: FAO 2005

For forest dwellers in Cameroon, timber and non-timber resources are valued as construction materials.

Source: C.Dounias/CIFOR

Strategies to improve opportunities

For sustainable forest harvesting to support livelihoods and human well-being, the Central African countries have put in place measures to ensure sustainability of the resource use. Among these are strengthening forest law and governance by:

- Encouraging sharing of information on trade in illegally harvested forest products;
- Participating in international fora and international agreements; and
- Implementing measures to cut corruption.

Strengthening cooperation to harmonize forest legislation and harvesting are also important. The Central Africa Forestry Commission (COMIFAC) presents a good opportunity for all the countries to share experiences and lessons on effective resource management through:

- Creating projects and programmes to evolve forest and environment management, with demonstrated results in the short run;
- Creating monitoring and enforcement systems;
- Providing support to the local forestry and environment NGO's;
- Sensitizing the local populations in the sustainable use of forest resources and employing them in all forest programmes; and
- Enforcing partnerships at the international level.

EASTERN AFRICA

Forests and woodlands are widespread and include high altitude forest, medium altitude moist evergreen forest and semi-deciduous forests. Most of the larger tracts of forests are gazetted as forest reserves, but there are also extensive patches of forests and woodlands outside the gazetted forest estate that are under the management of local communities or private landowners. Forests, particularly those in the Eastern Arc and the Albertine rift, are rich in biological diversity (UNEP 2002).

Forests and woodlands provide substantive livelihoods for many people. They provide both direct economic benefits (energy, food, timber and non-timber products) and indirect benefits through the provision of ecological services (water catchment, controlling erosion and moderation of local climate). Woodfuel and timber are among the most important forest products, with woodfuel being the main source of energy and timber being extensively used in the construction industry (FAO 2003a). Annually, about 173 million m^3 of woodfuel and about 5.2 million m^3 of industrial roundwood is produced, most of which is consumed within the sub-region (FAO 2005).

As forest-based supplies of timber and NTFPs decline, trees outside forests have become more

Table 5: Forest area and area change in the Eastern Africa countries as of 2000

Country	Total land area ('000 ha)	Total forest area ('000 ha)	% of land area	Annual change '000 ha (1990-2000)	Annual rate of change % (1990-2000)
Burundi	2 568	94	3.7	-15	-9.0
Djibouti	2 317	6	0.3	not available	not available
Eritrea	11 759	1 585	13.5	-5	-0.3
Ethiopia	11 430	4 593	4.2	-40	-0.8
Kenya	56 915	17 096	30	-93	-0.5
Rwanda	2 466	307	12.4	-15	-3.9
Somalia	62 734	7 515	12.0	-77	-1.0
Uganda	19 964	4 190	21.0	-91	-0.2

Source: FAO 2005

important. In fact, increasing demand has led to substantial tree planting of woodlots and, in some countries, including Kenya, Rwanda and Burundi, home gardens and woodlots have become important sources of wood and NTFPs (FAO 2003a).

Overview of resources

Eastern Africa has rather limited forest and woodland cover amounting to approximately 13 per cent (UNEP 2002). Forest and woodland cover varies considerably, as shown in Table 5. Kenya is the most forested country with about 30 per cent of its land area under forest, followed by Uganda with 21 per cent. Djibouti has the least forest cover with about 6 000 ha or only 0.3 per cent of the land area under forests (FAO 2005).

It is estimated that the change in forest cover in Eastern Africa is 0.51 per cent per year. There is, however, considerable variation between countries, with Burundi experiencing a decline of 9 per cent compared with 2 per cent in Uganda (FAO 2005). At the current deforestation rates, and if sustainable forest management practices are not promptly adopted, forests and woodlands may degrade rapidly by 2020 (FAO 2003a). There is, however, no reliable data on the extent of forests and woodlands that are sustainably managed (FAO 2003a). In some countries, such as Eritrea, forests are not protected, which makes them even more vulnerable to degradation (MoLWE Department of Environment 1995, MoLWE Department of Environment 2000).

Forest degradation in the Mau escarpment, Kenya.

Source: C. Lambrechts/UNEP

Endowments and opportunities

Forests and woodlands are a vital resource. Their effective utilization is important and should be based on the equitable sharing of benefits, costs and knowledge. Forests are a source of wealth that can be realized through sustainable harvesting of timber and non-timber products, tourism and ecotourism, and carbon trading. Forests also provide catchment protection, in addition to being reservoirs for biodiversity. The forest watershed catchment value for Uganda, for example, has been calculated to be US$13.2 million per year (Moyini and others 2002). There is potential to enhance community benefits through joint forest management. Joint forest management and forest user groups increase community participation and help achieve economic,

social and environmental goals that governments sometimes have difficulties meeting (FAO 2005).

Valuation studies have been undertaken in various countries (Shechambo 2002, Emerton 2001). Though data is fragmented, the overall picture is that the resource endowment value for forests and woodlands is a big contribution to GDP (NEMA 1998, Moyini and others 2002, EPA 2003). Wood, for example, contributes directly to national economies as a source of energy supply (FAO 2005). Currently woodfuel prices range from US$1 to US$10 per cubic metre in developing countries (Broadhead and others 2001). The market prices of woodfuel can be used as a rough estimate of the value of woodfuel production, and with the total production of 173 million m^3 of woodfuel its value ranges from US$173 million to US$1 700 million per year (FAO 2005). There are other positive externalities associated with wood energy, for example, the employment generated by wood energy production (FAO 2005). The negative externality is the environmental cost of woodfuel harvesting in terms of forest loss and degradation (FAO 2005).

Challenges faced in realizing opportunities for development

Forests and woodlands are the main source of fuel for the majority of the households and while this is an opportunity it is also directly linked to the main threats: deforestation and declining forest quality. Throughout the sub-region, the rate of offtake from the forest is more than the natural regeneration capacity. There is very little investment in forestation and reforestation.

Chronic lack of resources and low public investment remains problematic in the forest sector (FAO 2005). Mismanagement, inadequate or non-existent inventory, and poor monitoring hinder the effective use of the opportunities offered by forests and woodlands. Poor governance, including limited opportunity for community involvement and mismanaged decentralization, along with the undervaluation of the total contribution of forests and woodlands to livelihoods, contribute to unsustainable practices.

NORTHERN AFRICA

Northern Africa is characterized by desert conditions, limited water resources and an arid climate. Forests are not common in most of the six countries, except along the coast of the western Mediterranean Sea and in the tropical zone of southern Sudan.

Overview of resources

The total forest area in Northern Africa is about 67 million ha and constitutes 8.3 per cent of the total land area, which is about 10.4 per cent of the total African forest cover (FAO 2005). Closed forests occur on the coast of the western Mediterranean countries, in the Atlas Mountains and in southern Sudan. Other wooded areas occur as natural desert vegetation in sandy valleys (*wadis*) and depressions. Coastal and inland high mountains also support woody plants. Mangroves or tidal forests occupy small areas of the Red Sea coasts. Wetlands, with their hydrophilous reeds, and cultivated trees are important tree resources and provide various goods-and-services including timber, NTFPs, grazing and desertification control (AOAD 1998, Hegazy 1999). The distribution of forests and the rate of forest cover change are shown in Table 6.

Forests have changed in both nature and extent over the last 30 years: closed forests and open forests used to cover a significant part of total land area. Available statistics indicate that the area of natural forests was reduced by about 53.3 per cent during the period

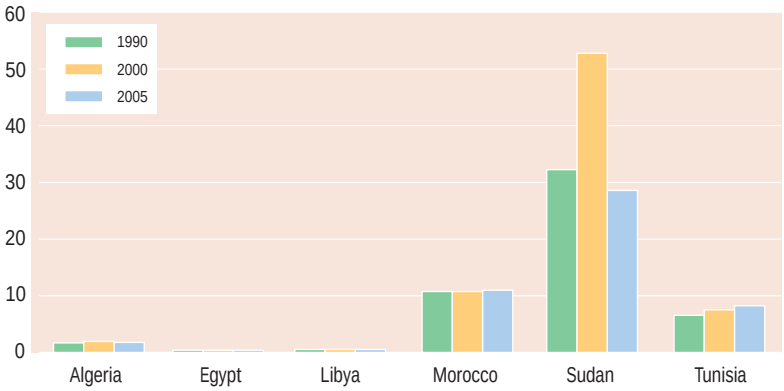
Table 6: Forest cover as percentage of total land area in Northern Africa

	Total land area	Forest area 2000		Forest cover change 1990-2000	
Country	('000 ha)	Total forest ('000 ha)	Percentage of land area ('000 ha)	Annual change	Annual rate of change
Algeria	238 174	2 145	0.9	27	1.3
Egypt	99 545	72	0.1	2	3.3
Libya	175 954	358	0.2	5	1.4
Morocco	44 630	3 025	6.8	-1	not available
Sudan	237 600	61 627	25.9	-959	-1.4
Tunisia	16 362	510	3.1	1	0.2
Total	812 265	67 737	8.3	-925	0.8

Source: Adapted from FAO 2005

Figure 2: Forest as a percentage of land 1990-2005

percentage of total land area



Source: FAO 2006

Box 5: Reasons for planting trees in Northern Africa

In general, forest plantation has been carried out for various purposes: sand dune fixation (eg Morocco and Egypt); rehabilitation of degraded steppe areas (eg Algeria); range rehabilitation and improvement, and watershed management (eg Morocco and Tunisia); and protection of agricultural areas (eg Libya, Egypt and Morocco). However, forest plantation efforts have not been able to keep up with the loss of natural forests.

Sources: FAO 1997

1972-1992 (FAO 1999). However, Northern Africa has begun to increase forest cover over the last decade, primarily through tree planting, with Egypt having the highest increase of 3.3 per cent, followed by Algeria at 1.3 per cent (FAO 2005). From 1990 to 2000, a total of 1 693 000 ha of trees was planted. This amounts to 27 per cent of the total forest cover in the sub-region (FAO 2002 and FAO 2005).

Opportunities provided by forests and woodlands

Natural forests in Northern Africa are important for protecting the environment and in particular in dune stabilization.

Due to their size, however, they have not been able to support any considerable commercial function. The total share of forests to GDP is very low except in Sudan, where it is about 13 per cent (FAO 1999). Where forests exist, fuelwood and charcoal are the major forest products. Production of industrial wood is very limited, implying that most demand for industrial roundwood and processed wood has to be met by imports (FAO 1999).

Challenges faced in realizing opportunities for development

Over the past few decades, forests have been subjected to various pressures including land-clearing for human settlements and agricultural activities (Gilani 1997, Thirgood 1981, AOAD 1998). Livestock overgrazing, overcollection of fuelwood and charcoal production, urban sprawl, illicit felling, and frequent natural and man-made fires in the Mediterranean and tropical areas of the region have exterminated most of the natural forests and have degraded soils.

Tree planting is used to stabilize dunes, N'Takat, Mauritania.

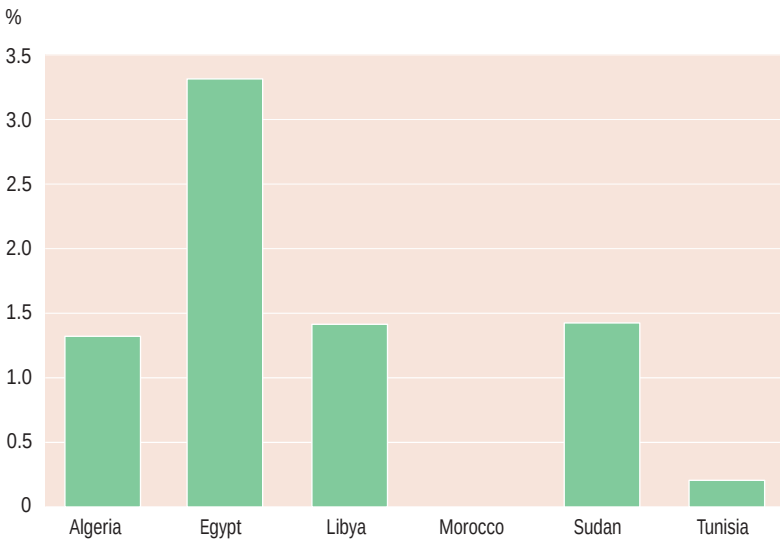
Source: H. Wagner/IFAD

Although the annual average loss of forest is low at slightly less than 1 per cent (FAO 1999), forest loses estimated at 44 000 ha per year have been attributed to fires alone. In some countries, deforestation due to production of charcoal has increased eight to ten times more than the forest's production capacity. Another major pressure on some of the forests is the increasing demand for gum arabic, particularly in Sudan (CAMRE/UNEP/ACSAD 1996, Abuzeid 1995).

In Morocco, Algeria and Tunisia, the reduction of forests has resulted in a reduced influence on regulating water and maintaining soil. As a result, flooding, erosion, desertification and silted dams are on the increase. Forests and other woody vegetative cover in upland and sloping land serve important environmental functions in land stabilization, erosion control and regulation of hydrologic flow (FAO 1997). Recently, road construction, quarrying and mining industries, building dams and construction of irrigation canals have contributed to the deterioration of forest ecosystems by reducing forest areas and destroying habitats, thus affecting forest biodiversity.

Other factors contributing to the decline of the forest resources include ambiguity of ownership, lack of technical personnel and lack of financial resources and appropriate technology, coupled with the underlying market and policy failures of forest resource pricing, and trade policies. Although forest legislation has been in place in most countries since the nineteenth century, its weaknesses and lack of enforcement had limited its effectiveness in protecting forests and wildlife resources (FAO 1999).

Figure 3: Annual change rate in forests 2000



Source: UNEP 2005b, data FAO 2002

Strategies to improve opportunities

The extent of concerns about forest deterioration is reflected in the launch of substantial forestation and reforestation programmes and the various measures taken recently to protect and increase forest areas. Forest lands are being demarcated in all the countries, and new forest reserves have been declared in some countries like Sudan as a result of mounting awareness and interest in conservation. Managing forests on a sustainable basis is being pursued in a regional context. The Egyptian government, for example, through the Ministry of Agriculture and Land Reclamation (MANR),

Plantations are an important source of timber in Northern Africa. *Pinus spp*. plantations in the Atlas Mountains, Morocco.

Source: J.C. Mohamed-Katerere

has successfully developed and implemented a programme for safer use of treated wastewater to plant trees in the Sarabium area, in the Governorate of Ismailia, next to the wastewater plant that treats 90 000 m^3 per day. The planted area is almost 210 ha. This initiative could help reduce Egypt's dependence on timber imports (EEAA 2002).

Forest plantations in the region represent the main way of extending forests and wooded areas. In 2000, Morocco had large eucalyptus (214 000 ha) and coniferous (235 000 ha) plantations. The total plantation area was 534 000 ha, the second largest plantation after Algeria (718 000 ha) (FAO 2002). Tunisia had a total plantation area of 202 000 ha in 2000. Egypt does not have natural forests, but has planted about 34 000 ha of trees (Riad 2000).

SOUTHERN AFRICA

Southern Africa has a range of forest and woodland types that provide key goods-and-services and are a valuable source of export earnings and revenue as well as for local livelihoods.

These forests and woodland types include tropical rain forests found in parts of Angola and the Congo basin; afromontane forests found in pockets in the high altitude and high rainfall areas of Malawi, Mozambique, Tanzania, Zambia and Zimbabwe; mangrove forests found on the coastline of Angola, Mozambique, Tanzania and South Africa; Zambezi teak forests found in the western parts of Zimbabwe and Zambia, extending into northern Botswana, north-eastern Namibia and parts of south-eastern Angola; Miombo woodlands found north of the Limpopo River; Mopane woodlands found in the dry and low-lying parts of Angola, Botswana, Mozambique, South Africa, Zambia and Zimbabwe; and the Cape Floristic Centre forests found along the south-western coastline and located entirely within South Africa (McCullum 2000).

OVERVIEW OF RESOURCES

Forests and woodlands cover about 221.94 million ha or 32.5 per cent of the total land area (FAO 2005). As shown in Table 7 there is considerable variation in vegetation cover across countries. Lesotho, Namibia and South Africa are the least forested countries with less than 30 per cent forest cover. At 56 per cent vegetation cover, Angola is the most densely forested country in the sub-region (UNEP 2002).

Of the total forested area in the region, 2.5 million ha was under forest plantations in 2001 (UNEP 2002). This represents a 9 per cent growth in plantations when compared with the 2.3 million ha of plantations in 1992 (Chenje and Johnson 1994). Lesotho has experienced considerable growth in the extent of its forests, doubling the area under forest plantation from 7 000 ha in 2000 to 14 000 ha in 2003 (FAO 2003a). As Table 7 shows, South Africa has the largest extent of forest plantations followed by Swaziland, Zimbabwe, Angola, Tanzania and Malawi.

However, the total land under forests declined from 1990 to 2000. Over this period, South Africa experienced a deforestation rate of 0.1 per cent per year, Angola, Mozambique and Tanzania 0.2 per cent, Botswana and Namibia 0.9 per cent, Swaziland 1.2 per cent, Zimbabwe 1.5 per cent, and Zambia and Malawi 2.4 per cent (FAO 2005).

Table 7: Forest and woodland cover in Southern Africa 2000

Country	Total land area ('000 ha)	Forest cover in 2000 ('000 ha)	Land area (%)	Total forest plantation ('000 ha)
Angola	124 670	69 756	56.0	141
Botswana	56 673	12 427	21.9	1
Lesotho	3 035	14	0.5	14
Malawi	9 408	2 562	27.2	112
Mozambique	79 409	30 601	39.0	50
Namibia	82 329	8 040	9.8	not available
South Africa	122 704	8 917	7.3	1 554
Swaziland	1 720	522	30.3	161
Tanzania	88 359	38 811	43.9	135
Zambia	74 339	31 246	42.0	75
Zimbabwe	38 667	19 040	49.2	141

Source: FAO 2005

Table 8: Forest timber-based industry in Southern Africa*

Product	Production 2000	Consumption 2000	Share of global production (%)	Lead Southern African producers
Industrial roundwood (million m³)	23.97	23.61	34.9	South Africa, Swaziland and Zimbabwe
Sawn timber (million m³)	2.22	2.47	28.9	South Africa, Swaziland and Zimbabwe
Wood-based panels (million m³)	0.603	0.597	29.3	South Africa, Malawi and
Zambia Plywood (million m³)	0.070	0.071	10.2	South Africa, Mozambique and Angola
Fibreboard (million m³)	0.150	0.154	65.2	South Africa
Wood pulp (tonnes)	2.351	1.464	87.5	South Africa, Swaziland and Zimbabwe
Paper and paperboard (t)	2.125	1.892	72.9	South Africa and Zimbabwe
Newsprint (t)	0.345	0.201	93.8	South Africa and Zimbabwe
Printing and writing paper (t)	0.515	0.672	78.3	South Africa

**excludes Tanzania*

Source: FAO 2003b

Endowments and opportunities

Forests and woodlands provide essential materials for local consumption, trade and export. The significance of the timber industry is shown in Table 8.

Other functions of forests and woodlands include environmental and cultural services. Forests and woodlands are often important sacred and burial sites. With the exception of South Africa, fuelwood is the primary source of energy. Fuelwood consumption continues to increase; in 2000 total fuelwood consumption was estimated at 178 million m³. About 87 per cent of the roundwood production in the region is used as fuelwood (FAO 2003d). The situation is likely to continue since fuelwood remains the most reliable, affordable and accessible source of energy for poor households. However, as discussed in Chapter 2: *Atmosphere*, several countries are investing in the development of renewable solar and wind energy.

In addition to timber, wood-processing and paper production, forests and woodlands provide a wide range of goods-and-services for subsistence and trade including medicinal plants, fruits, exudates, bee products, insects, roots, thatch grass, forage and mushrooms. As a result of expanding international trade

Boys selling wild mushrooms collected in Miombo woodlands, Zimbabwe.

Source: Y. Katerere

Growing vegetables on a patch of cleared forest, Nigeria. The forest will be allowed to regenerate.

Source: M. Edwards/Still Pictures

in medicinal plants and indigenous fruit, it is important to develop a legal regime for intellectual and property rights which recognizes and respects local people's interests, and ensures equitable benefit sharing.

Threats to the opportunities

Some countries in Southern Africa have very fast-growing populations, and face the challenge of needing to increase food supplies to meet demand for food (UNEP 2002). Population change is shown in Table 9. This has necessitated the opening up of large areas of forests and woodlands for agricultural production. Between 1990 and 2000, forest cover fell from 380 to 357 million ha. The increase in urbanization and the pressure on land in peri-urban areas for cultivation also present new challenges.

Fire plays an important role in determining the distribution and composition of some vegetation types. It is responsible for the widespread occurrence of grasslands in Southern Africa. Observations from Mbeya, Tanzania, indicate that burning encourages growth of grass and prevents regeneration of woody plants (Chenje 2000).

Strategies to improve opportunities

Many countries have made major investments in rural forestation programmes with a bias in indigenous species and agroforestry. Further, in attempting to reduce deforestation caused by the overharvesting of commercial indigenous timber, Botswana and Zambia have restricted logging of timber for commercial purposes while Zimbabwe has imposed a ban on the export of unprocessed indigenous timber.

All SADC Member States signed the SADC Forestry Protocol, and three countries had ratified it by 2004 (SADC 2002). The specific objectives of the Protocol include the promotion of the development, conservation, sustainable management and utilization of all types of forests and trees; the promotion of trade in forest products in order to alleviate poverty and generate economic opportunities; and the achievement of the effective protection of the environment and the safeguard of the interests of both present and future generations (SADC 2002).

Table 9: Population density and rate of population change in Southern Africa

Country	Total land area ('000 ha)	Total population '000 (in 2003)	Density per sq. km in 2003	Annual rate of population change 2000-2005 (%)	Rural population 2003 (%)
Angola	124 670	13 625	10.9	3.1	64.3
Botswana	56 673	1 785	3.1	0.8	48.4
Lesotho	3 053	1 802	59.4	0.2	82.1
Malawi	9 409	12 105	128.7	2.0	83.7
Mozambique	78 409	18 863	24.1	1.7	64.4
Namibia	82 329	1 987	2.4	1.4	67.6
South Africa	121 758	45 026	37.0	0.6	43.1
Swaziland	1 721	1 077	62.6	0.8	76.5
Tanzania	88 359	36 977	41.8	1.9	64.6
Zambia	74 339	10 812	14.5	1.2	64.3
Zimbabwe	38 685	12 891	33.3	0.5	65.1

Source: FAO 2005

There is also growing pressure to certify the origin of wood products to show that they are obtained from sustainably managed areas as a response to growing awareness of the negative environmental and social impacts of deforestation. Certification has only been done in some exotic timber plantations where considerable value addition is done to timber products. The entire 974 000 ha of certified plantations in Africa are, however, mostly found in Southern Africa (FAO 2003b), with the highest proportions being in South Africa followed by Swaziland and then Zimbabwe.

Many governments acknowledge the potential value and opportunity that forests and woodlands bring to improving livelihoods, particularly in rural areas, and are increasingly recognizing that secure tenure is an important aspect of this. Several countries have initiated reforms to support local communities, including the empowerment of local bodies and communities to manage communal resources through a process of decentralization and devolution of administrative powers and responsibilities.

Future challenges and recommendations

The people of Southern Africa will continue to be highly dependent on forests and woodlands for the foreseeable future. Despite their aspirations, many people may even become more dependent on natural resources as poverty and population increase. The region is therefore challenged to realize the multiple benefits accruing from forests and woodlands, in addition to crop production which converts forests to cultivable land (Chenje 2000). The multiple uses of forests include commercial timber production. Certification can serve as a check on management practices. However, the process of certification is expensive, and this challenges the region to add value to forest and woodland products and increase their revenue.

The commercialization of NTFPs raises the issue of benefit sharing at the community, national and international levels. Legislation that regulates access to forest resources by outside parties is poorly developed. This deficiency may result in biopiracy, especially of medicinal plants, which are highly profitable on the global market and about which traditional healers have a lot of knowledge.

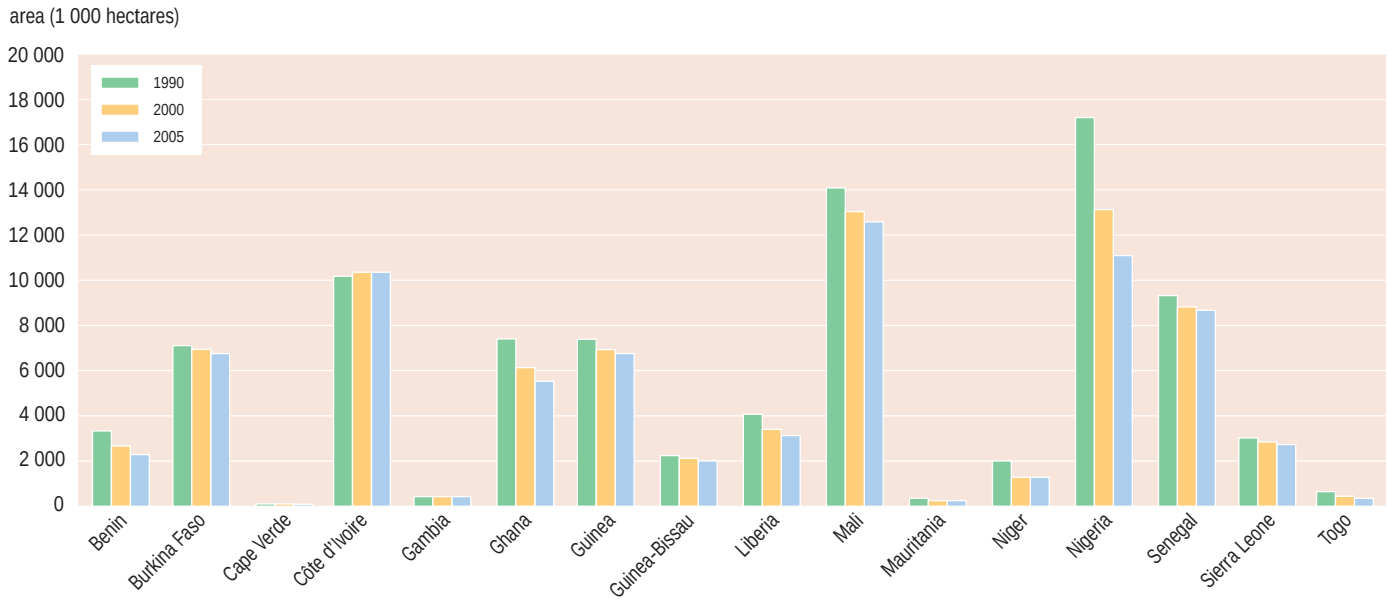
It must be noted that existing information on forests and woodlands is often outdated and incomplete. This is partly because most of it is obtained from secondary sources. For instance, no forestry inventory has been done in Angola since independence in 1975 (Chenje 2000). Therefore, an important challenge is to develop and update its forest and woodlands database, and to develop effective monitoring and evaluation systems.

Western Africa

Inventory of forests resources

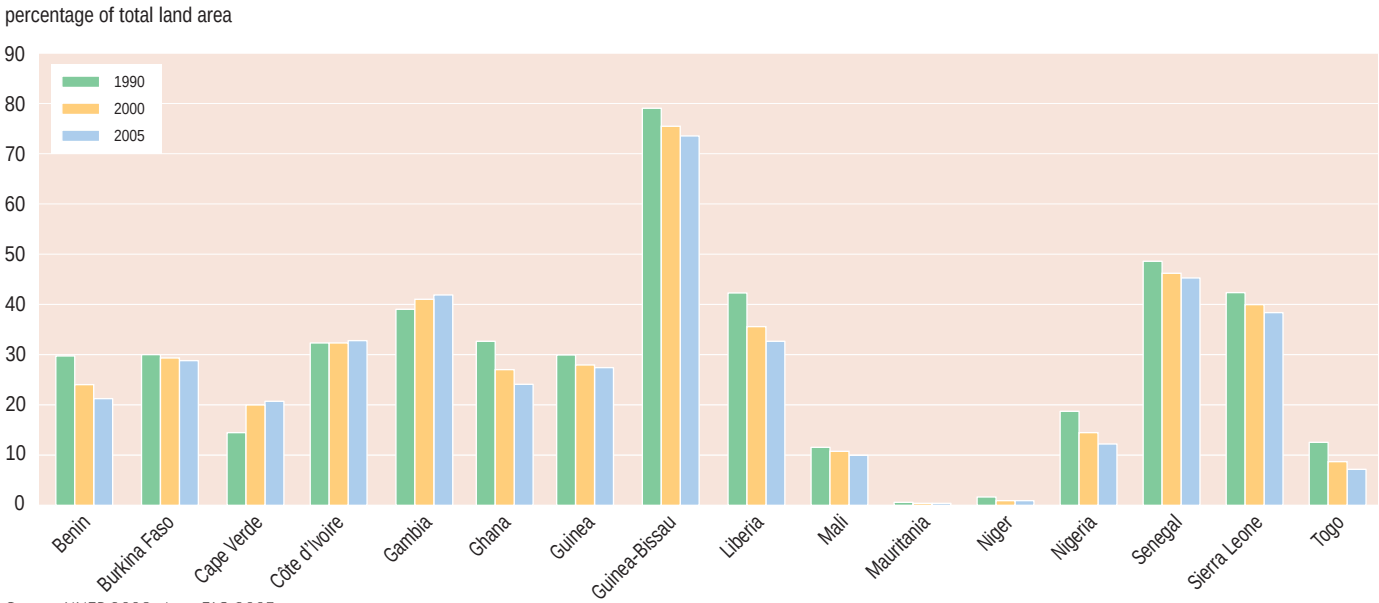
The total forest cover in Western African is about 115 million ha, representing 12 per cent of the total land area (FAO 2005). Forest cover varies considerably from one country to another, as shown in Figure 4. Guinea-Bissau is the most forested with 60.5 per cent forest cover, while Mauritania is the least forested with only 0.3 per cent (FAO 2005)

Figure 4: Forest cover in Western Africa 1990-2000



Source: UNEP 2006, data FAO 2005

Figure 5: Percentage of forest area



Source: UNEP 2006, data FAO 2005

The Guinea Forest of Western Africa, which extends from the coastline of Guinea to the borders of Cameroon, is important from a biodiversity perspective. It is recognized by Conservation International as one of the world's biodiversity hotspots and encompasses part of the UpperGuinea Forest Ecosystem: Guinea, eastern Sierra Leone, Liberia, Côte d'Ivoire, Ghana and western Togo (CEPF 2000). It also encompasses the Lower Guinea Forest Ecosystem, including western Nigeria, south-western Cameroon, the islands of Bioko and Pagalu (Equatorial Guinea), as well as São Tomé and Príncipe (CEPF 2000). The extent of this area is shown in Figure 6. The area is under considerable pressure from logging industries and farming or hunting activities. Only 15 per cent of its original vegetation (approximately 141 000 km^2 of closed canopy forest cover) is left, and is, moreover, highly fragmented (CEPF 2000). The largest remaining portion is in Liberia, where civil conflicts disrupted conservation activities.

Deforestation varies across the region. In terms of land area, Nigeria and Côte d'Ivoire have by far the highest annual rate of forest loss, at nearly 663 000 ha.

Statistical data on forest plantations is unreliable due to lack of inventory and frequent forest fires, lack of maintenance and uncontrolled land clearance for cultivation. However, countries like Côte d'Ivoire, Benin and Nigeria have made some efforts in the establishment of industrial plantations (UNEP/NESDA 2004). In the Sahelian zone, such plantations are not established on an industrial basis and are less important, except in Senegal where plantations are created to stop desertification, which is an important ecological problem (FAO 2002).

Figure 6: Extent of the Guinea forest hotspot

Source: Conservation International undated

Endowments and opportunities

In several countries, especially in the Sahel, more than 90 per cent of wood consumed is used as fuelwood, mostly for domestic energy requirements (UNEP/NESDA 2004). In Mali and Burkina Faso, for example 93 and 96 per cent respectively of wood is used for fuel (UNEP/NESDA 2004). In Gambia, 97.8 per cent of all household energy comes from wood energy (NEA 2002). Nigeria and Côte d'Ivoire are the leading roundwood producers in the sub-region (FAO 2003c). For example, roundwood production in 2000 in Côte d'Ivoire amounted to about 3.4 million m^3 and in Nigeria to 9.4 million m^3. The timber industry represents an important source of GNP.

A 12 year-old ULIMO fighter in the forest, Monrovia.

Source: D.Browne/ILO

Western Africa's forests present a good potential for carbon sequestration. With the CDM, a monetary value can be given to environmental benefits coming from activities aimed at reducing carbon emissions.

Challenges faced in realizing opportunities for development

Forest resources are threatened by a combination of factors, including agricultural expansion, increased collection of fuelwood, overgrazing, fast urbanization, industrialization, drought, civil wars and bush fires, which result in changes in forest cover (UNEP/NESDA 2004). Rapid deforestation is an issue of major concern, given the scope of degradation, which started in the 1970s. According to FAO (2001), close to 12 million ha of forests were lost in Western Africa from 1990 to 2000. The other concern is rapid loss of unique flora and fauna. As the forests disappear, the populations of wild animals and plants also reduce.

Recurrent civil strife has had considerable impact on the forest resources. In Liberia and Sierra Leone, for example, timber was illegally exploited during the civil conflict to finance the war, resulting in the reduction of the two countries' forest cover from 38.1 per cent to 31.3 per cent during the 1990s (UNEP 2004). In addition, after the war, reconstruction efforts further pressured forest resources through the increased demand for construction timber.

In the Sahelian zone, deforestation is spiralling out of control largely as a result of the vagaries of the weather. The challenges associated with climate change are discussed more fully in Chapter 2: *Atmosphere*. The rate of woody biomass offtake outstrips the natural regeneration to the extent that wood is not really considered a renewable resource any more (AGRHYMET 2002). The annual rate of forest loss in Niger, for example, which has the highest rate of deforestation, is about 100 000 ha against 5 000 ha of forest replanting (CNEDD-Niger 2002).

WESTERN INDIAN OCEAN ISLANDS

Most of the WIO islands have humid tropical climates which are conducive to forest growth. However, the extent of closed canopy forest on the islands is limited due to population pressure, frequent cyclones and recurrent droughts, particularly in Madagascar and Mauritius (UNEP 2002).

Overview of resources

The major types of forests and woodlands on the islands include evergreen broadleaf rain forests, upper and lower montane forests, semi-evergreen moist forests,

Table 10: Forest cover in the Western Indian Ocean island countries

		Forest area in 2000		Forest cover change, 1990-2000	
Country	Total land area ('000 ha)	('000 ha) (excluding plantations)	% of total land area	Annual change ('000 ha)	% rate of change (%)
Comoros	186	8	4.3	not available	-4.3
Madagascar	58 154	11 727	20.2	-117	-0.9
Mauritius	202	16	7.9	not available	-0.6
Seychelles	45	30	66.7	not available	not available
Total	58 587	11 781	20.1		

Source: FAO 2005

mangroves and savannah woodlands. Forest cover in the island states ranges from 66.7 per cent in the Seychelles to 4.3 per cent in the Comoros (FAO 2005). Comoros has the highest rate of forest loss among the islands, which is largely attributed to charcoal making (UNEP 2004).

Forest cover ranges from 20 per cent in Madagascar, with 12 per cent woodland, to about 4 per cent in the Comoros, with 13 per cent woodland (UNEP 2002). Charcoal making has been blamed for extensive deforestation in the Comoros (UNEP 2004).

Endowments and opportunities

Most of the forests and woodlands on the Western Indian Ocean islands have a high animal and plant species endemism, making them some of the world's biodiversity hotspots. The Coco-de-Mer palm (*Lodoicea maldivica*) found on Praslin Island in the Seychelles is, for instance, endemic to this environment. The two remaining forest tracts of approximately 10 km^2 on Anjouan island in the Comoros are home to the last surviving population of the Anjouan scops owl (*Otus capnodes*) and the Livingstone's fruit bat (*Pteropus livingstonii*) (UNEP 2004).

The forests and woodlands are also a source of various medicinal and ornamental plants, fruits, honey, essential oils, meat, and animal fodder.

Fuelwood is a vital resource for local communities, especially in countries such as the Comoros. Fruit farming in plantations and orchards is well developed in Madagascar, in terms of the volume and range of produce from fruit trees. This is less so in the other countries in the sub-region, but new developments are taking place in market gardening to open up new domestic and foreign trade across the sub-region. The produce includes fresh and dried fruit, fruit juice and tinned fruit. The intensity of commitment to fruit growing per thousand population varies between the countries, with the Comoros having 16 ha of fruit trees per 1000 people, Madagascar 11 ha, Seychelles 5 ha, and Mauritius 1 ha. While trees bearing fruit have a growing potential for the future, the coconut industry is active in all countries in the region, and Madagascar also has a continuing commitment to coffee growing on a large scale.

There are also plans to establish national parks in the Karthala Mountain (2 361 metres high) on Grande Comore to strengthen the conservation status of the area. This will promote specialist ecotourism, and may help combat soil erosion and desertification of the island. In the above respect, the Comoros has identified, mapped and is promoting 21 nature walks on the islands including 4 forest walks: La Forêt de la Grille, La Forêt Humide de Moheli, La Forêt Humide d'Anjouan, and Les Forêts Humides de Mayotte (Louette and others 2004). The Seychelles has also opened a "green" hotline, for rapid public reporting of environmental contraventions, including the illegal felling of trees.

Although commercial timber production is now limited in most of the islands, Madagascar and Mauritius continue to enjoy a thriving export trade in industrial wood products. This trade is worth US$4 200 million in Madagascar and US$9 500 million in Mauritius. Table 11 shows the significance of trade.

Table 11: Trade in forest products

Countries	Imports US$ m	Exports US$ m	Net trade US$ m
Comoros	249	0	-249
Madagascar	2 436	4 177	+1 741
Mauritius	6 868	2 345	-4 523
Seychelles	12	0	-12
Total	9 565	6 522	-3 043

Source: FAOSTAT 2005

Banana production is a vibrant economic activity in Madagascar.

Source: D. Tsialonina

Challenges faced in realizing opportunities for development

The WIO region experienced considerable deforestation in the 1990s. Forest area reduced from 13 million ha in 1990 to 11.9 million in 2002. The greatest loss in forest cover occurred in Madagascar, which contributed 99 per cent of the total loss. The greatest percentage loss within countries, however,

occurred in the Comoros with a reduction from 12 000 ha to 7 000 ha, a loss of 41 per cent.

Two important causes of deforestation are frequent cyclones and droughts. During droughts, the risk of fire is also high. The major concern regarding forests is the high rate of deforestation and its environmental consequences such as soil erosion, desertification, and loss of ecosystem processes such as regulation of soil and water quality. In some countries, forests and woodlands are subjected to severe stress as a result of agricultural encroachment.

Strategies to improve opportunities

In view of the pressures on forests and woodlands in the WIO islands, a number of measures have been put in place to mitigate deforestation. They include promoting the integrated management of forests and woodlands through the establishment of Conservation Management Areas in Mauritius which are zones that have lately been infested with alien plant species. In pursuance of the desire to implement sustainable management of forests and forest resources, two countries, Mauritius and the Seychelles have joined the Dry Zone Africa process which aims at establishing criteria and indicators for sustainable forest management.

In addition to the above programmes, some countries, including the Comoros, have established programmes for the reforestation of previously logged areas. However, the speed and extent of reforestation has been slow. Through its FAO Plan of Action, the FAO also intends to achieve sustainable management of the forest resources in the Small Island Developing States (SIDS) by establishing a holistic and integrated approach to the use of forest resources; promoting the rehabilitation and conservation of forest lands; enhancing coastal protection; promoting agroforestry systems; strengthening integrated planning; and developing ecotourism (FAO 2004).

CONCLUSION

Forest and woodland resources in Africa continue to play a major role in the livelihoods of many communities, and in development more generally. The role played by forests and woodlands as sources of energy, food products and medicinal plants, as well as for the protection of catchment and water quality, is a major contribution to many national economies. These opportunities are under threat from changes in the state and integrity of the forests.

Low investment in the forest sector, increasing population pressure, weak public sector institutions responsible for forestry resources management, deforestation and declining forest quality are jeopardizing the environmental services and community benefits. Reduced access to forest products has a number of implications, including increased shortages of woodfuel, and it impacts negatively on the nutrition status of many.

Government action will, therefore, need to address a number of key concerns, including actively engaging the private sector and civil society in forestry and woodland resources management, and reviewing the legal and institutional capacities of the public sector institutions responsible for forestry resources. Governments will also need to undertake comprehensive inventory and valuation of forests and woodlands, and to introduce mechanisms which encourage sustainable utilization of forest and woodland resources, including issuing concessions on standing volumes rather than harvested volumes.

Specifically, African governments will need to put in place strong policies and find resources to enforce them. Conservation and sustainable use and management of Africa's forests and woodlands are necessary as the basis for the promotion, development and growth of other sectors. In this regard, it is important that African states implement various aspects of the CBD by developing and implementing national biodiversity strategic action plans, nature reserves and protected areas systems. The accomplishment of set targets on biological diversity are of particular importance to the well-being and livelihood needs of Africa's people.

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CHAPTER 7
BIODIVERSITY

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REGIONAL SYNTHESIS

Biodiversity offers multiple opportunities for development and improving human well-being. It is the basis for essential environmental services upon which life on Earth depends. Thus, its conservation and sustainable use are of critical importance.

The opportunities and challenges associated with biodiversity typically apply over large geographical extents, although one or two issues may be more important at any given location. To avoid repetition, particular issues are highlighted in the sub-regional sections, not because they are restricted to those areas, but because they are best illustrated there. Deforestation is discussed under Central Africa, while relations between protected areas and adjacent populations are dealt with under Eastern Africa. Riparian biodiversity is discussed in Northern Africa, climate change and invasive alien species (IAS) in Southern Africa, desertification in Western Africa, and endemism in the Western Indian Ocean (WIO) islands. Habitat degradation and resource overexploitation are discussed in this regional synthesis, because they are overwhelmingly important as drivers of biodiversity loss throughout Africa.

INVENTORY OF RESOURCES

Africa is well endowed with both variety and abundance of living things, together referred to as biological diversity, or biodiversity. That biodiversity, with some exceptions, is currently in a better condition than in many parts of the world. Biodiversity can be considered at three major levels:

- The genetic variation within populations;
- The number, relative abundance and uniqueness of species; and
- The variety, extent and condition of ecosystems.

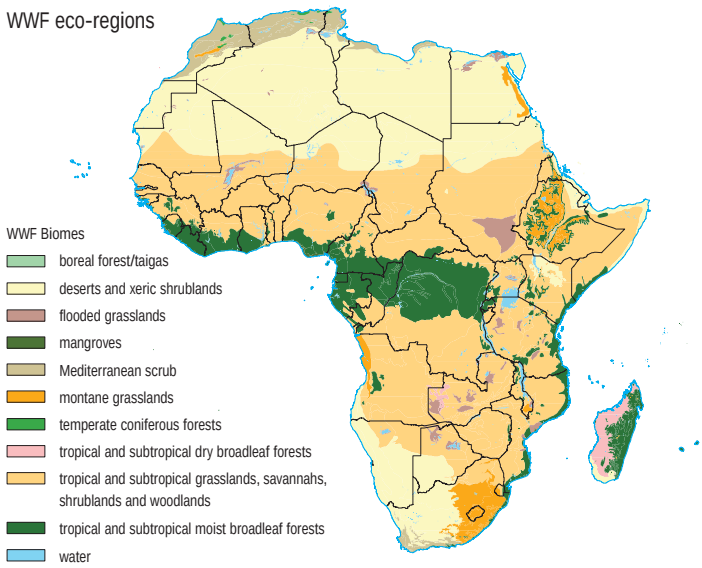
Broad geographical patterns

Ecosystems are broadly arranged in a latitudinal pattern (White 1983), with increasing species richness towards the equator (Mutke and Barthlott 2005). However, plant species richness is also high in the winter-rainfall Mediterranean climate regions of Northern Africa and the southern Cape (Cowling and others 1996). In between are the subtropical deserts, which are generally a zone of lower diversity: for example, a vast part of the Sahara, the Ténéré, is home to only 20 plant species in an area of about 200 000 km^2. Overlaid on these latitudinal patterns are pockets of rich biodiversity with small distribution ranges, particularly in tropical montane areas (Rahbek 1995). From Ethiopia to the Cape, mountains contain several centres of endemism for birds, mammals, and plants (Fjeldsa and Lovett 1997, de Klerk and others 2002). One of the most globally important centres of endemism is the coastal mountain range in the eastern part of Madagascar (Goodman and Benstead 2003).

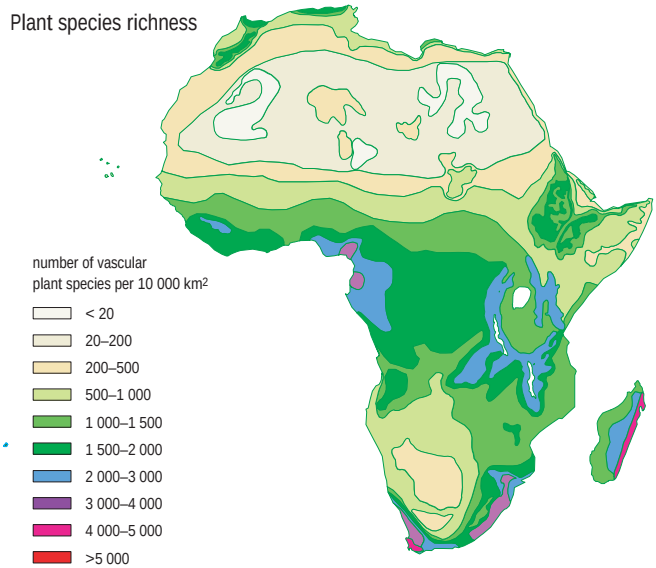
The increasing richness of plants and vertebrates toward the equator is related primarily to climatic factors, such as water availability (Mutke and others 2001), however the diversity of land variations, such as topographic, is also important. There are exceptions to this: some areas with harsh climates including, the Namib Desert and the Karoo in the west of South Africa have an estimated 4 500 plant species, a third to one-half of which are endemic (Davis and others 1994).

Spatial patterns of diversity vary for different species, and the diversity and abundance of different species influence each other. For example, the Cape is a centre of plant diversity of global importance, but not a centre of diversity for mammals, birds, snakes and amphibians (Figure 1). The Central Zambezian Miombo

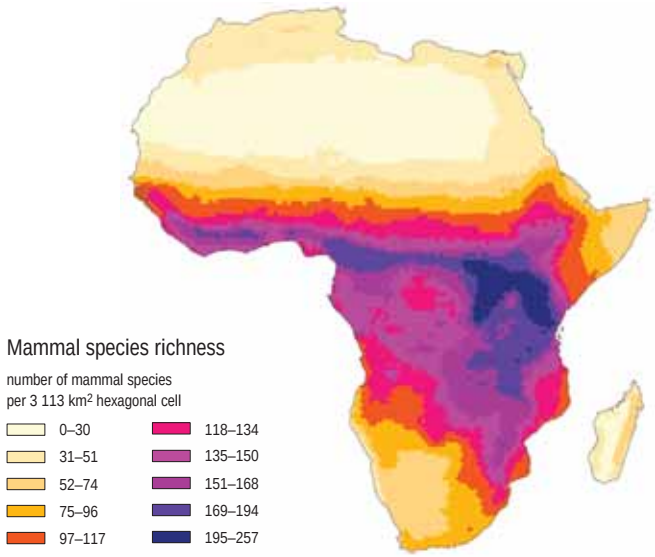
Figure 1: The distribution of biodiversity



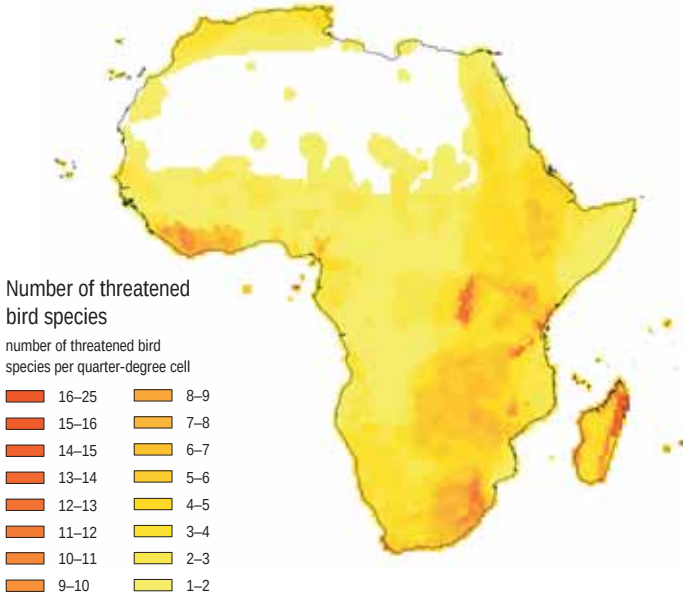
Source: Eco-regions are large units of land or water that contain a distinct assemblage of species, habitats and processes, whose boundaries depict the original extent of natural communities before major land-use change. Olhson and Dinerstein 2006, WWF undated; Map redrawn by UNEP/DEWA/GRID 2006.



Source: Plant species richness per 10 000 km² (Mutke and Barthlott 2005). Colours indicate the major biomes as defined by the WWF. Biomes represent groups of eco-regions with similar vegetation types.



Source: Data from IUCN – The World Conservation Union – Species Survival Commission; University of Virginia, Virginia; Center for Applied Biodiversity and Science at Conservation International (CI – CABS), Instituto di Ecologia Applicata (IEA) Rome; Zoological Society of London; and The African Mammals Databank (AMD).



Source: Number of threatened bird species per quarter-degree grid cell (BirdLife International 2004).

woodlands located in Zambia, the Democratic Republic of the Congo (DRC) and Tanzania is a centre of bird diversity, but not of plant diversity.

Species richness and endemism

About 1 000 vertebrate species occur in just 4 of the 119 eco-regions (covering about 8 per cent of Africa's total area): Northern Acacia-Commiphora bushlands and thickets, Northern Congolian forest-savannah mosaic, Albertine Rift montane forests and Central Zambezian Miombo woodlands (Burgess and others 2004).

A quarter (1 229 species) of the world's approximately 4 700 mammal species occur in Africa (Brooks and others 2001), including about 960 species in sub-Saharan Africa (SSA) and 137 species in Madagascar. The eastern and southern savannahs host large populations of mammals, including at least 79 species of antelope (Klopper and others 2002).

More than 2 000 bird species occur, constituting more than a fifth of the approximately 10 000 bird species in the world, (Burgess and others 2004, BirdLife International undated). About 1 600 bird species are endemic to SSA (Jetz and Rahbek 2001). Bird species richness is highest in Eastern Africa around the Albertine Rift montane forests, the Victoria basin forest-savannah mosaic, East African montane

Box 1: Plant Diversity: Kupe-Bakossi

The area of Kupe-Bakossi, 100 km north of Cameroon's second city of Douala, is a highly diverse region, with two extinct volcanoes (Mwanenguba and Edib), river valleys, grassland and some of the wettest forest in Africa. It is also the top centre for documented plant diversity in mainland tropical Africa, with a total of 2 440 species of which 82 are strictly endemic and 232 are threatened with extinction according to IUCN 2001 criteria. This richly diverse area has been under threat both from illegal logging and encroaching farmland. Among recently documented species is a new Cola species, an orchid species and genus not seen since it was discovered around 30 years ago on a tree that had just been felled in a logging operation, *Ossiculum aurantiacum*, a new mint specific to waterfalls, *Plectranthus cataractarum*, a new shrimp plant, *Justicia leucoxiphus*, as well as three new species of coffee.

Source: RBG 2005

Ossiculum aurantiacum is a highly attractive and critically endangered orchid, endemic to Cameroon.

Source: H. Beentje

forests, Northern Congolian forest-savannah mosaic, and then into the *Acacia-Commiphora* bushlands and thickets and the Central Zambezian Miombo woodlands. The large size of these eco-regions, their high level of habitat heterogeneity, and their presence on a migratory flyway explain this pattern. The next highest band of species richness is found across the remainder of the tropical belt, with the exception of the western portion of the Upper Guinea forests and the centre of the Congo basin. The eco-regions of Madagascar and other offshore islands all have much lower bird species richness than the continental mainland (Burgess and others 2004).

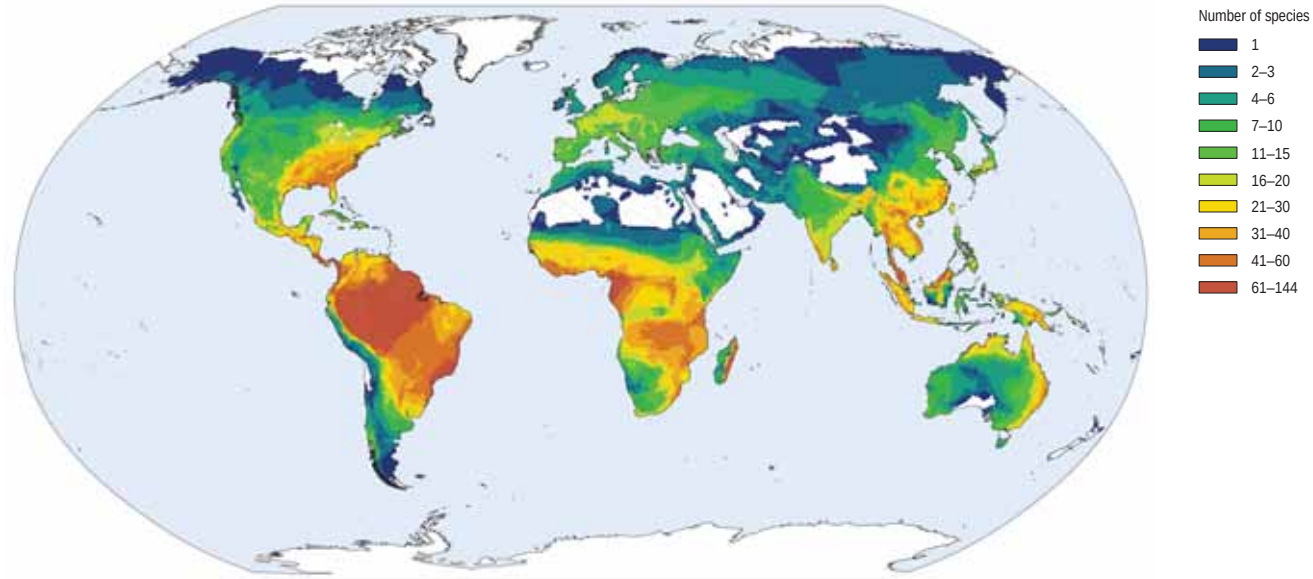
Africa has about 950 amphibian species (GAA 2004); however numerous new species and even genera are described every year. The highest levels of amphibian species richness occur in the DRC (210), Cameroon (189) and Tanzania (157); these countries are also ranked among the 20 countries with the highest level of diversity and endemism (GAA 2004). The fauna of Madagascar are particularly undersampled: from 1990 to 1999 discoveries of new amphibian and reptile species increased the number of known species by 25 per cent and 18 per cent, respectively (Goodman 2004). The Congo basin is also under-represented due to inadequate surveys (GAA 2004).

Overall plant richness at species, genus and family level is lower than that of other tropical areas. The African mainland has between 40 000 and 60 000 plant species (Beentje and others 1994, Beentje 1996), of which approximately 35 000 are endemic. South America, by comparison, has about 90 000 plant species (Frodin 2001) in an area 40 per cent smaller. Parts of the Congo basin have moderate levels of plant species richness, comparable to many parts of Central Europe (Barthlott and others 2005). This is a consequence of major extinction events due to historic climate variations (Hamilton and Taylor 1991, Davis and others 1994) and fewer major tectonic events, which are thought to having triggered the evolution of many species in the South American Andes (Burgess and others 2004). Five of the 20 global centres of plant diversity are located in Africa. More than 3 000 plant species per 10 000 km^2 occur in the Cameroon-Guinea centre, the Capensis centre, the Maputaland-Pondoland centre, the Albertine Rift centre and the Madagascar centre (Barthlott and others 2005).

At least a sixth of the world's estimated 270 000 plant species (Groombridge and Jenkins 2002) are endemic to Africa. The Cape Floral Kingdom, a global centre of plant endemism (Barthlott and others 2005) has about 9 000 vascular plant species occurring in an area of 90 000 km^2 (Goldblatt and Manning 2000) of which about 69 per cent are endemic. More than 12 000 plant species occur in Madagascar, at least 81 per cent of which are endemic (Davis and others 1994), which is an exceptionally high proportion by global standards. More recent studies suggest that these figures for species richness and endemism in Madagascar may be underestimates (Goodman 2004).

Southern Africa has a rich and varied insect and arachnid fauna, with at least 580 families and about

Figure 2: Global diversity of amphibians



Source: GAA 2004

100 000 species recorded (Barnard 1998).There is a high diversity of butterflies in the rainforests of the upper Guinea, the Albertine Rift, and the Congo basin, as well as in the Central Zambezian Miombo woodlands (Burgess and others 2004). Namibia is thought to be one of the global centres of arachnid richness (Barnard 1998) and about one-third of the Southern African insect species are believed to occur in Namibia, although less than a quarter of these species are described.

Africa has several global centres of freshwater biodiversity (Groombridge and Jenkins 2002) and many of these are also centres of intensive fishing activity. Centres of species richness and endemism for freshwater fish, molluscs and crustacea are located in the upper Guinea river region (mainly Guinea and Liberia), Cabinda (DRC), and the eastern part of Madagascar. It is conservatively estimated that Africa has at least 2 000 fish species, which is thought to be the highest species richness in the world (Klopper and others 2002). The explosive diversification of certain types of fish, such as the Cichlidae in the Great Lakes, has contributed to this richness. Fish species richness in the Congo basin is second only to that of the Amazon basin. Data on endemism is inadequate (Groombridge and Jenkins 2002). Fish diversity at the family level is somewhat lower than in southern America and Southeast Asia.

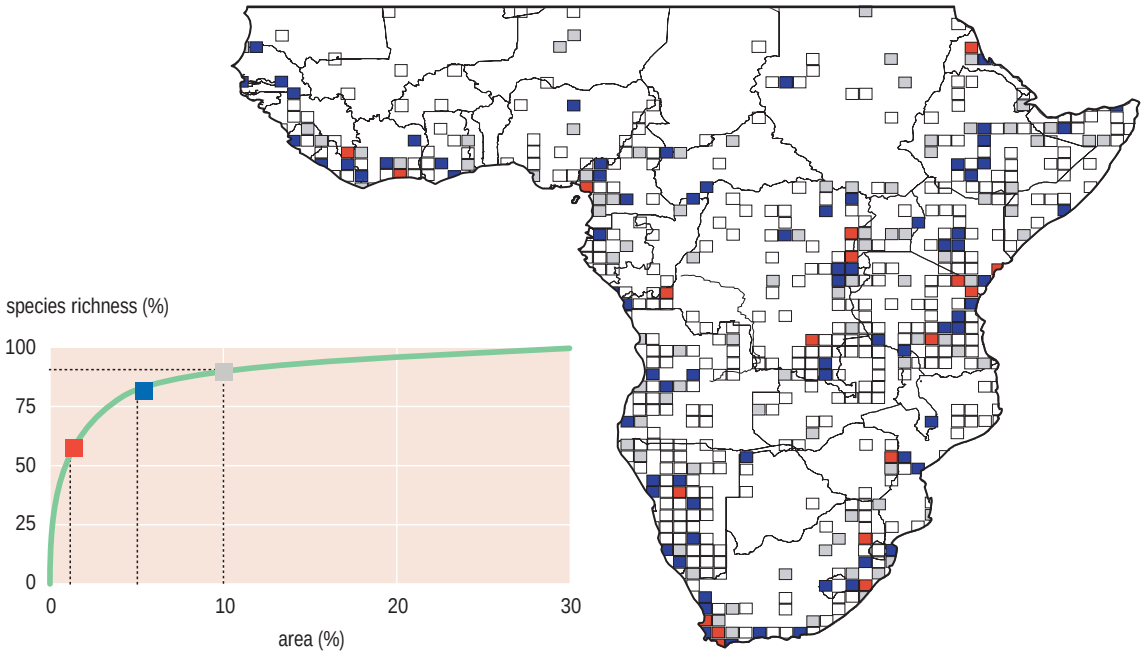
The coastal and marine ecosystems along Africa's 40 000 km coastline contain a high marine biodiversity, with overlapping centres of endemism of, for example, fish, corals, snails and lobsters at the coast of eastern South Africa and in the Red Sea (Roberts and others 2002). See also Chapter 5: *Coastal and Marine Environments*.

Centres of biodiversity

Biodiversity information is patchy for many organisms. Centres of biodiversity are located in the following eco-regions: Mt Cameroon and Bioko montane forests, overlapping with the Cross-Sanaga-Bioko coastal forests; the Cameroon highlands' forests; the Eastern Arc forests and the northern Zanzibar-Inhambane coastal forest mosaic; the Guinea montane forests and the western Guinea forests; the Drakensberg montane grasslands and forests; the Albertine Rift montane forests and the upper Guinea lowland rain forests.

Nearly two-thirds (62 per cent) of SSA species of plants and vertebrates can be represented (though not necessarily adequately protected) in approximately 1 per cent of its land area, as shown in Figure 3. This 1 per cent area includes key taxon-specific centres of diversity (such as the Cape for plants) and a few multi-taxon centres of biodiversity such as, for example, Mt Cameroon, East Usambaras, Mt Nimba, Western Ruwenzori, Mt Elgon and parts of the upper Guinea lowland forests. Many of the represented species are endemic to these areas. To include all vertebrate and plant species occurring in SSA in protected areas, about a third of its total area would need to be included into conservation strategies. Hence, identifying locations of high biodiversity in several major groups, so that a high proportion of biodiversity can be protected in a comparatively small area, is an important research goal.

Figure 3: Plant and vertebrate diversity



The figure shows the proportion of plants, birds, mammals, snakes and frogs species in SSA that can be represented by hypothetical sets of areas of varying size. The solid black curve indicates the proportion of species represented by successively cumulating areas that cover a maximum number of species for each of the groups. The map indicates the location of one-degree grid cells that are part of selected area sets. For example, within 1 per cent of SSA (red one-degree grid cells), 58 per cent of all 9 692 included species can be represented in at least one grid cell. To represent all species, approximately 30 per cent of SSA is needed (represented by all coloured grid cells plus the open cells framed in grey).However, areas which represent many species are not necessarily priority areas for conservation.

Sources: Plant distribution data: Biogeographic Information System on African Plant Diversity (Küper and others 2004). Vertebrate distribution data: Zoological Museum, University of Copenhagen (Fjeldsa and others 2004)

Ecosystem change and conservation

In comparison with most other parts of the world, such as eastern Europe, North America and Southeast Asia, Africa's biodiversity is still in good condition (Hoekstra and others 2005, Scholes and Biggs 2005). Contemporary biodiversity patterns are strongly influenced by land-use patterns of mammalian herbivores and people. However:

- Approximately half of Africa's terrestrial eco-regions have lost more than 50 per cent of their area to cultivation, degradation or urbanization (Burgess and others 2005).
- Eco-regions that have gone through more than a 95 per cent transformation include the Mandara Plateau mosaic, Cross-Niger transition forests, Jos Plateau forest-grassland mosaic, and Nigerian lowland forests.
- Nine other eco-regions have lost more than 80 per cent of their habitat, including the species-rich lowland Fynbos and Renosterveld and the forests and grasslands of the Ethiopian Highlands.
- The Mediterranean woodlands and forests have lost more than 75 per cent of their original habitat, and the few remaining blocks of habitat are highly fragmented (Burgess and others 2005).

• Africa has over 2 million km² of protected areas. •

IUCN-WCPA undated

The challenges and opportunities associated with human activities are also considered in relation to specific themes in the other chapters of this section.

Africa has over 2 million km² of protected areas (an area four times the size of Spain) (IUCN-WCPA undated). The eco-regions under the best protection tend to be the savannah habitats, particularly those of Eastern and Southern Africa (Burgess and others 2005). Charismatic animals, such as large mammals, are much better covered by the current network of protected areas (de Klerk and others 2004, Fjeldsa and others 2004) than, for example, plants (Burgess and others 2005). Many range-restricted species are not adequately included in these areas (Rodrigues and others 2004).

The least protected areas are found in Northern Africa, Madagascar, the drier parts of South Africa, and in the most heavily deforested parts of Western and Eastern Africa (Tables 1-6). Of the 119 ecoregions, 89 have less than the 10 per cent of their area officially protected, which is the guideline suggested by the 2010 biodiversity targets of the Convention on Biological Diversity (CBD). Some of the least well-protected eco-regions are also those with high biodiversity values, including Mt Cameroon and the

Bioko area, the Eastern Arc forests, the Succulent Karoo, the Ethiopian montane forests, the lowland Fynbos and Renosterveld, the western Guinean lowland forests, the east African montane forests, the Albertine Rift montane forests, and the Northern Zanzibar-Inhambane coastal forest mosaic.

Endowments and opportunities

There is a considerable overlap between historic cultural centres and centres of biodiversity. Some factors promoting high biodiversity, such as perennial water availability, environmental heterogeneity and fertile soils have also favoured human settlement (Balmford and others 2001). In general, patterns of biodiversity and language diversity coincide (Moore and others 2002), and show parallel extinction risks (Sutherland 2003), suggesting that cultural cohesion and biodiversity sustainability are closely linked.

The most important centres of vertebrate and plant diversity are inhabited by more than 100 million people (Balmford and others 2001) and are areas of intensive land use. These have been identified as "hotspots" (Myers and others 2000). In Africa, these are the Cape Floristic Region, the Coastal Forests of Eastern Africa, the Eastern Afromontane, the Guinean Forests of West Africa, the Horn of Africa, Madagascar and the Indian Ocean Islands, Maputaland-Pondoland-Albany and the Succulent Karoo (CI 2006). Despite their proximity to metropolitan areas and despite often being completely surrounded by transformed land, many sites of primary vegetation remain within hotspots (for example, the Taï and Banco national parks of Côte d'Ivoire, the Table Mountain National Park of South Africa, and parts of the coastal forests of Eastern Africa); these areas contain irreplaceable habitats for endemic species. For example, the Taï National Park currently represents at least 40 per cent of the total remaining forest area of Côte d'Ivoire (Poorter and others 2004).

There are at least two fundamental reasons for Africa's biodiversity richness:

- First, it has occupied its position astride the equator for hundreds of millions of years. Its life forms have not, during this period, been wiped clean by glaciers or inundated by oceans, and have been able to gradually accumulate new varieties.
- Second, perhaps because Africa has been occupied by humans for longer than any other continent, it has not suffered the mass extinctions that followed the arrival of the human species elsewhere.

In this place where humans evolved, people coexisted with other living things, at least until the modern era. That situation is rapidly changing. Major increases in the human population and rising wealth create pressures on land, and on freshwater and marine ecosystems. Global trade has intensified the demand for animal products, tropical timbers, cash crops and seafood. At the same time, global connectedness has brought new problems, such as global climate change, IAS, the spread of viral diseases, and the introduction of new technologies. The result is that biodiversity, so persistent for millions of years, is now under unprecedented threat. These human drivers and pressures are discussed more fully in Chapter 1: *The Human Dimension*.

Biodiversity underlies the provision of a large variety of benefits that people obtain from ecosystems (MA 2006). These include environmental goods, such as food and wood for energy, and ecosystem functions that depend on particular organisms, for example pollination by bees, or nitrogen fixation by symbiotic bacteria in the roots of legumes. Living organisms are critical in creating the environmental conditions on Earth that make it habitable to humans and many other species by, for instance, regulating the climate and atmospheric composition (Lovelock 1979, Steffen and others 2004, MA 2006).

Women collecting NTFPs in a forest, Cameroon.

Source: J. Nguieburi/CIFOR

Environmental goods

Many important food crops originate in Africa, including several species of millet and sorghum, one species of rice, the grain crop teff, and the oil palm. Globally, about 7 000 of the 270 000 known plant species have been used as food (FAO 1997), but only about 200 have been domesticated, and just 20 of these are of major economic importance (Groombridge and Jenkins 2002). About two-thirds of the overall calorie intake is provided by ten crops (FAOSTAT 2005). Globally, only 30-40 species (0.25 per cent of 15 000 species of mammals and birds) have been used extensively in livestock production, and fewer than 14 account for over 90 per cent of livestock production (FAOSTAT 2005). African biodiversity is closely linked to nutrition and achieving food security. Nearly three-quarters of the recorded protein consumption in Africa is derived from plant sources (FAOSTAT 2005). In rural areas, essential micronutrients are derived from eating a large variety of plant foods. Foods from the wild are particularly important in times of stress – drought, ill-health and economic change – and, as discussed in Chapter 9: *Genetically Modified Crops*, shifts to monoculture may present threats to biodiversity, human health and food security. Much of the animal protein consumed is either directly harvested from wild populations (fisheries and bushmeat), or produced through grazing of natural ecosystems by domestic livestock. Freshwater fish is a key source of protein. For example, in hyper-arid Mali, fish makes up 60 per cent of the total animal protein consumed annually (Quensière 1994, MA 2006). In Central and Western Africa, bushmeat (wild animals and birds) is a major source of animal protein, making up more than 80 per cent of consumption in some areas (Robinson and Bennett 2000). Milk, often in sour form, is also an important protein source (FAOSTAT 2005).

Freshwater fisheries, such as those at lakes Victoria, Tanganyika and Malawi, support subsistence livelihoods and enterprises at multiple levels. Wetland systems, including those of Lake Banguelu, the Kafue floodplain and the Okavango delta, are also important sources of food. Important commercial marine fisheries are located off the west coast of Southern Africa (South Africa, Namibia and Angola), the Horn of Africa, and off the coast of Mauritania in Western Africa; collectively these provide about half of the total catch. These fisheries are centred on commercially important species such as hake, anchovy and pilchard, and the associated industries are an important source of employment. Chapter 5: *Coastal and Marine Environments* considers the importance of fisheries.

Forests and woodlands provide a wide range of environmental goods and an overview of these is given in Chapter 6: *Forests and Woodlands*. Over 80 per cent of people rely on wood or charcoal for domestic cooking and heating (IEA 2002), as processed fossil fuels are too expensive. Charcoal tends to be preferred in most urban areas, as the energy content per unit mass is about double that of wood. Charcoal is also cleaner-burning at the point of consumption than wood, so that the health impacts of charcoal are about four times lower than that of wood (IEA 2002), but the total greenhouse gas (GHG) emissions (including the making of the charcoal using earth kilns which are not efficient) are higher. Forests and woodlands also provide poles,

Box 2: Livestock production, biodiversity and human well-being

Most domestic livestock is grazed in natural or semi-natural ecosystems, rather than on planted pastures. Domestic livestock consists primarily of cattle in areas that receive more than 450 mm mean annual rainfall, and of sheep and goats in drier areas (Scholes and Biggs 2004). The natural grass and tree growth provides feed at almost no direct input cost to the livestock owners and, provided that the stocking rates are within the productive capacity of the land, at relatively low cost to biodiversity (Scholes and Biggs 2005). In contrast, raising livestock on planted pastures, or on grain-based feeds in feedlots, as practised in many western agricultural systems, entails substantial input costs, and has major on- and off-site impacts on biodiversity.

The services provided by livestock extend beyond food. In many rural agricultural societies, cattle are important assets and status symbols. In the absence of a banking system, animals are sold when large expenses need to be met (WRI and others 2005). Oxen, and donkeys in poorer communities, provide transport and draught power for ploughing.

The genetic diversity of indigenous cattle breeds has proven invaluable over the past 50 years in providing disease resistance and climate tolerance to imported European breeds (see for example OSU 1996 and ARC-AII undated), and the conservation of traditional livestock diversity is receiving belated attention through the research of organizations such as the International Livestock Research Institute (ILRI) based in Nairobi, Kenya.

Sources: Scholes and Briggs 2004, WRI and others 2005, OSU 1996, ARC-AII undated.

bark string and thatch for houses and livestock pens. Especially in rural areas with only a partial cash economy, natural ecosystems are the main source of building material, which would be unaffordable if it had to be purchased. Several forest and woodland species are important as commercially traded timber, especially for the furniture industry. These include species such as *Pterocarpus angolensis* and *Melia*. Most of these species are harvested from natural ecosystems, although some are now being established as plantations.

Natural ecosystems provide a wide variety of plants and animals that are important for traditional medicines and modern pharmaceutical products. Up to 80 per cent of people make some use of traditional medicine (WHO 2003), which draws on a wide variety of indigenous plants and animals, and especially on rare or unusual organisms. Important modern pharmaceutical products are derived from certain plants, as discussed in Chapter 1: *The Human Dimension* and Chapter 6: *Forests and Woodlands*. For example, the Namibian devil's claw (*Harpagophytum procumbens*) is used locally for digestive problems, arthritis and low back pain, and supports lucrative trade. The bark of the afromontane tree *Prunus africana* is the source of a commercial prostrate remedy. Pharmaceutical bioprospecting is likely to increase in coming years, especially as new methods that utilize evolutionary and ecological knowledge enhance productivity. The 2004 global market for herbal medicines, including herbal products and raw materials, was estimated to be US$65 000 million (Lambert and others 2005). As a source of income, medicinal plants compare favourably with coffee, oil palm, cocoa and cotton, and they do not appear to be affected by the Organisation for Economic Cooperation and Development's (OECD) market and trade barriers which affect other commodities from developing countries (Lambert and others 2005). Rural communities have a great opportunity to effectively use their local knowledge to become serious players in the global herbal medicine market.

Many plants and animals originating in Africa are important commercial trade products. Coffee (*Coffea arabica* and *Coffea robusta*) originates in Ethiopia and ranks among the five most valuable agricultural exports from developing nations (FAOSTAT 2005), employing about 25 million people worldwide (O'Brien and Kinnaird 2003). *Aspalathus linearis* (*Rooibos* tea), originating from South Africa, is now traded globally in the fast-growing speciality tea industry. The world's ornamental flower market includes a substantial number of species derived from Africa: *Gladiolus*, *Pelargonium*, *Geranium*, *Strelitzia*, *Viola*, *Protea*, *Kniphofia* and *Zantedescia*. The growing international pet trade includes several African species, including many endemic cichlid fish species from Africa's rift valley lakes for aquariums. Key trade-related concerns include: the illegal (and often wasteful) harvesting from wild populations of often rare species; the accrual of benefits to individuals, whereas the costs are borne by society as a whole; and international intellectual property rights and patent agreements which can deprive local people of benefits. Currently, relatively little of the value derived from species originating in Africa accrues to Africa. Ensuring that such benefits are captured in future represents a major opportunity for expanding biodiversity-based development. Some of the problems associated with realizing these opportunities are discussed in Chapter 1: *The Human Dimension*.

Prunus africana is a valuable medicinal plant, Cameroon.

Source: O. Ndoye/CIFOR

Environmental services

Biodiversity has "intrinsic value" – or value for its own sake – but it also has significant value in all cultures for the things that it provides: food, medicine, building and craft materials and spiritual, cultural and aesthetic services. Less obvious, but just as important, are the services that allow natural and human-altered ecosystems (such as agricultural and urban landscapes) to function properly – regulating the climate, soil fertility, and the outbreak of pests and diseases. Some level of biodiversity – the exact amount is at this stage unknown – is a necessary condition for the delivery of ecosystem services, but it is especially important for

maintaining functional ecosystems (MA 2006). The value of ecosystem services can sometimes be expressed in monetary terms (Costanza and others 1997, UNEP 2002) but these estimates are very contentious, and are not the only way of expressing importance. Value can, for instance, be measured in terms of other aspects of human well-being, such as health, security or good social relations. Other aspects related to value and livelihoods are considered in Chapter 1: *The Human Dimension*.

Ecosystem services depend not so much on the absolute number of species present, but on the diversity of the functions performed by different members of the ecological community. The preservation of the natural biodiversity of an area and genetic diversity of crop species can enhance resistance to invasion by pests and diseases thus reducing agricultural losses. Planting a variety of crop species and varieties, and preserving their wild relatives, increases crop resistance to pests and diseases and thus the probability of meeting food needs. Ethiopia and the Upper Nile are recognized as global centres of crop plant genetic diversity (Hawkes and Worede 1991). Agro-biodiversity farming practices can enhance biological control and reduce the dependency and costs associated with biocides in monocropping systems (MA 2006). Similarly, natural and semi-natural ecosystems, both terrestrial and marine, appear to be more resistant to IAS if the number, types and relative abundance of native species are preserved (MA 2006).

Biodiversity can provide pollution detoxification and control. Certain aquatic and marine organisms provide water filtration services that significantly reduce the impacts of pollution on water quality. For example, the hydrological processes in wetlands, and particularly the slowing down of water-flow by vegetation and the creation of anaerobic zones, bring about the deposition of heavy metals from streams and rivers, reduction in nitrogen loading through denitrification, and reduction of pathogens through predation by other micro-organisms. Well-vegetated watersheds significantly reduce the volume of sediment flowing down rivers. Protecting the ecosystems and organisms that provide such services is generally far more cost-effective than the alternative of building and operating water filtration plants. In the context of the oceans, some marine microbes can degrade toxic hydrocarbons such as those released in an oil spill, providing valuable pollution processing services.

Ecosystem biodiversity – both terrestrial and marine – influences climate at local, regional and global scales. The type and distribution of habitats and the functional

• Some level of biodiversity – the exact amount is at this stage unknown – is a necessary condition for the delivery of ecosystem services, but it is especially important for maintaining functional ecosystems. •

MA 2006

Africa's biodiversity is remarkably intact. Miombo woodlands in eastern Zimbabwe.

Source: Y Katerere

diversity of terrestrial plants influence the reflection of incoming radiation from the sun back to space, evapotranspiration, air temperature, fire regime and carbon sequestration, all of which influence climate (MA 2006). It has been suggested that human-induced changes to the vegetation in the semi-arid Sahel has contributed to decreased precipitation since the 1970s and to desertification (Thomas and Middleton 1994). Marine biodiversity plays a major role in climate regulation, particularly through its effects on nitrogen cycling and carbon sequestration. If there were no life in the ocean, transfer of carbon dioxide from the atmosphere to the sea floor would cease, and atmospheric carbon dioxide levels would rise (MA 2006).

Recreational and spiritual values

People of all cultures and income levels value the cultural, spiritual, religious, educational and aesthetic benefits of biodiversity (Biggs and others 2004, MA 2005). Traditional societies express these values in the form of sacred species, ecosystems and landscapes, while urban and developed societies express this in the form of protected areas and heritage sites. Many religions attach spiritual values to ecosystems or components of ecosystems, such as trees, hills, rivers or groves. Loss or damage to ecosystems can therefore harm social relations by, for example, impeding religious and social ceremonies that bind people (MA 2003, MA 2005). Biodiversity also has intrinsic value for many people: it is valued as an end in itself, apart from any use value that it provides to people.

Nature-based tourism

Nature-based tourism is one of the fastest-growing tourism sectors worldwide and in Africa (Scholes and Biggs 2004). It depends on the conservation of natural landscapes and wildlife, so that using ecosystems in this way can jointly promote human well-being and biodiversity conservation if well managed. International tourism represents about 7 per cent of the worldwide export of goods-and-services, ranking fourth after exports of chemicals, automotive products and fuels (Christ and others 2003). Nature-based tourism makes up approximately half of the total tourism market

Box 3: Increasing the opportunities associated with nature-based tourism

Nature-based tourism is sometimes the most profitable use of the land for the individual land-user, particularly in arid areas or areas with poor agricultural soils (Barnes 1995; Barnes and others 2001). Taking costs and benefits as a whole, its net social benefit is often positive, especially when compared to highly-subsidized land uses(Scholes and Biggs 2005). For example, the effective management of a protected-area network in Madagascar would cost approximately US$18 million annually in management, but would generate more than US$20 million annually in net local benefits from nature-based tourism, watershed production and direct payments for biodiversity conservation (Carret and Loyer 2003). Nature-based tourism tends to be labour-intensive, and in the context of the high unemployment rates, this is a significant development advantage.

Several significant challenges remain to increasing Africa's share of the world's tourism market:

- Tourism is highly sensitive to political and economic instability and increasing the opportunities for peace through regional cooperation is important.
- Poor infrastructural development, both in terms of air and road transport, affect markets.
- The threat of diseases, such as malaria, also affects potential markets.

A second set of challenges centres on the distribution of costs and benefits between foreign and local recipients, and between local people and urban elites. In the worst cases, the brunt of the costs, such as denial of access to grazing land and wild food sources, are borne by the local people, while the bulk of the benefits are enjoyed by foreign owners and middlemen in the tourism market chain. In best practice examples, the costs to local people are minimized by negotiated access, and the benefits are spread by joint ownership, profit-sharing, preferential employment, associated enterprises (eg craft industries) or outsourcing schemes (eg vegetable growing, transport services). Africa has a number of successful ventures based on cooperation with communities, including the Campfire programme in Zimbabwe, initiatives with the Himba people in Namibia and the Makuleke and Mier communities in South Africa, and Wilderness Safaris in Botswana.

Sources: Scholes and Briggs 2004, WRI and others 2005, OSU 1996, ARC-AII undated.

(Christ and others 2003). The significance of this sector is discussed more fully in Chapter 3: *Land* and Chapter 5: *Coastal and Marine Environments*.

Adding value to genetic resources

Genetic resources include all chemical and genetic information of substances that could be used as biochemical precursors in the synthesis of pharmaceutical or agricultural products. Selecting substances for investigation often depends on traditional knowledge about which plants or animals are used for specific purposes.

There is a substantial global market for pharmaceutical value-addition to genetic resources. Global sales of pharmaceuticals amounted to US$300 000 million in 1998. Of the 25 per cent best-selling drugs worldwide in 1997, 42 per cent of sales came from biological or natural products, or entities derived from natural products, with a total value of US$17 500 million (Newman and Laird 1999). Despite the technical progress in the development of fully synthetic drugs, 11 per cent of the 252 drugs considered as basic and essential by the World Health Organization (WHO) originate exclusively from flowering plants (Rates 2001). The pharmaceutical industry is highly research-intensive. Of the average expenditure of US$500 million on the development of a new drug, about 37 per cent is spent during the "discovery phase" (Laird 2002). Of the approximately 120 pharmaceutical products derived from plants in 1985, 75 per cent were discovered by studying their traditional medical use (Farnsworth and others 1985). Traditional African cultures have a deep knowledge of their natural environment, sometimes accumulated over thousands of years. Chapter 1: *The Human Dimension* and Chapter 6: *Forests and Woodlands* look at specific examples of the value of commercializing this knowledge.

A second important market for genetic resources is the agro-industry. Responding to global and regional market and financial pressures, farmers now grow a limited number of high-yielding varieties of food crops. This may result in higher income in the short term, but makes production more susceptible to disease or environmental problems, and more dependent on fertilizers and pesticides. Cultivars of many of the world's most important economic plants stem from a very narrow genetic base. For example, plantations of oil palm in Malaysia are based on material from only four specimens of this plant from Western Africa (Groombridge and Jenkins 2002). Considerable efforts are therefore underway to broaden the genetic bases of crops through the introduction of varieties to increase resilience and maximize productivity. Typically, the development and release of a new, modern variety takes 8-15 years and costs in the range of US$1-2.5 million, for a traditionally bred variety, and US$25-75 million to develop a transgene for genetically modified (GM) varieties (Laird 2002). However, the wild relatives of many important food crops are fast disappearing. For example, Ethiopia, which is the geographic origin of coffee and is a centre of

Box 4: The fair and equitable use of genetic resources

Currently, the legal framework for fair and equitable exchange of genetic resources is very complex and made up of a combination of international and national law, contractual agreements, researcher codes of ethics, institutional or corporate policies, and indigenous people's declarations, which are often in conflict.

At a global level, it is now accepted that collecting genetic resources and related knowledge requires the "prior informed consent" of the custodians or owners and the fair and equitable sharing of benefits (UNEP 1992). There is also growing appreciation that what is fair and equitable is likely to differ substantially across industry sectors, and individual research and development programmes, and that successful benefit-sharing arrangements are those tailored to the specific circumstances of an individual case. The CBD envisages the use of genetic information as a source to generate income for providers of genetic material and, therefore, to create incentives to protect biodiversity. Chapter 9: *Genetically Modified Crops* considers, among other things, the approach of the AU to the use of genetic resources.

A major challenge for global legal frameworks is that large parts of the global economic benefits arising from the use of genetic resources currently accrue in regions different from where the respective resources originate. In addition, genetic resources can commonly be supplied by many different, often competing, suppliers at varying scales (communities, regions or nations), and defining the group to whom benefits should accrue can be very contentious.

Sources: Posey and Dutfield 1996, UNEP 1992, Yamin 2003

genetic diversity, is one country whose biodiversity has been least explored, but has only 4 000 km^2 of land containing populations of wild coffee remaining (Groombridge and Jenkins 2002). Many other populations of wild species are increasingly restricted in distribution and fragmented, and nine species for mainland Africa were listed as threatened in 1998.

Challenges faced in realizing opportunities for development

The imperative to improve human well-being can place multiple and often competing demands on ecosystems. Difficult trade-offs may have to be made, for instance between the protection of habitat for biodiversity, and the transformation of ecosystems for human needs. Some ecosystem transformation is inevitable if the Millennium Development Goals (MDGs) are to be met, but the impact on biodiversity will depend on how development activities are carried out. Significant opportunities exist to generate wealth through activities that draw on environmental goods-and-services, and at the same time promote the conservation of these resources. These activities include a range of moderate intensity extractive uses, such as livestock or wildlife ranching, wild plant harvesting, low-impact logging, and sustainable fisheries, as well as non-extractive uses, such as nature-based tourism and the exploitation of genetic resources.

As already discussed, despite significant environmental change, Africa still has a significant store of biodiversity. The key challenge in promoting sustainable natural resource use is to ensure that the rate of extraction (including the incidental damage caused during the harvest process) remains within the limits of sustainability. Strategies to ensure sustainability may rely on a combination of protection strategies including protected areas and conservation measures within "used-and-lived-in" spaces. Important challenges are how to:

- Determine the sustainable extraction rate and practices; and
- Establish and maintain institutions that are able to regulate natural resource use within the limits without placing undue constraints on their legitimate use.

Habitat degradation and loss

Habitat refers to the range of resources that a species needs to maintain a viable population including sufficient territory, necessary food and water, and required physical features such as tree cover, rocky hills or deep pools, as well as the organisms and ecosystem disturbances that must be present for it to complete its life cycle. The major current cause of biodiversity loss in Africa is habitat loss and that is likely to remain true for the first third of the 21st century (Sala and others 2000).

Expanding agriculture is an important cause of habitat loss. Newly planted fields, Morocco.

Source: J.C. Mohamed-Katerere

Habitat is lost when land cover (or its aquatic equivalent) is changed, usually as a result of changing use by humans. Common examples are the conversion of near-natural vegetation to temporary or permanent croplands; the replacement of forest by pastures; the expansion of human settlements; and the alteration of river habitats by dams, pollution and removal of water for human use. Forests and woodland cover is declining at a rate more or less equivalent to the increase in cropland (Scholes and Biggs 2005). The terrestrial ecosystem type where the greatest degree of habitat loss has occurred is grasslands, which have been converted to cereal agriculture (Scholes and Biggs 2005).

Habitat fragmentation – the division of continuous patches into smaller pieces which are partly or fully disconnected from one another by infrastructure, agricultural fields or human settlements – can have similar outcomes for biodiversity as outright habitat losses. First, the "edge effect" disrupts biodiversity for a considerable distance into the remnant patches. Second, the number of species that can be supported in the long term depends on habitat size.

> The major current cause of biodiversity loss in Africa is habitat loss and that is likely to remain true for the first third of the 21st century.
>
> Sala and others 2000

Overexploitation of resources

If renewable resources are harvested at a rate greater than their regeneration rate, the long-term flow of benefits is reduced, and they are said to be overharvested. When natural capital is drawn down too

far, fundamental ecosystem changes can occur which make ecosystem recovery to full service delivery potential very slow or impossible, and degradation is said to have occurred. Degraded ecosystems support half or less of the biodiversity of non-degraded used ecosystems (Scholes and Biggs 2005).

Much overharvesting is the unintended side effect of activities aimed at harvesting just one or a few components of the ecosystem. The discarded "by-catch" in fisheries and the habitat destruction caused by logging are examples of this. Regulatory policies that pay no heed to anything other than the target species encourage this kind of damage.

Overharvesting is a problem in many localities. For example, about 9 per cent of rangelands south of the equator are grazed by domestic livestock at unsustainable rates (Scholes and Biggs 2004). The fish stocks in the Great Lakes (Lake Victoria in particular) show classic symptoms of overfishing, and marine fish stocks in Western and Eastern Africa are at risk of overfishing.

The CBD has three objectives: the conservation of biodiversity, the sustainable use of its components, and the equitable sharing of benefits arising from the use of biodiversity.

Strategies for enhancing opportunities from biodiversity

While significant challenges for researching and managing biodiversity in Africa remain, there is enough information available to give broad but concrete direction to the development of national, sub-regional and regional biodiversity policy.

Multilateral agreements

Many multilateral environmental agreements (MEAs) exist to promote biodiversity protection. Most African countries have ratified the Ramsar Convention (protecting wetlands of international importance), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the Convention Concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention), the United Nations Convention to Combat Desertification (UNCCD), the United Nations Framework Convention on Climate Change (UNFCCC), and the CBD. These global MEAs are complemented by sub-regional and regional agreements, such as the African Convention on the Conservation of Nature and Natural Resources (ACCNNR) and the New Partnership for Africa's Development (NEPAD) Environmental Initiative. The 2002 World Summit on Sustainable Development (WSSD) saw convergence on a shared vision of sustainable development as a way of alleviating poverty, raising human well-being, and simultaneously meeting biodiversity protection objectives. Recognition of the administrative burden that the multiplicity of environmental agreements places on resource-constrained governments has prompted a desire to rationalize their implementation. Among the conclusions of the WSSD was that the link between the

The sustainable use of natural resources is a priority for many African countries. Handicrafts from *Raphia farinifera* provide income opportunities in Madagascar.

Source: V. Rabesahala

Box 5: Collaboration and conservation

Biodiversity gains are best made through the avoidance of ecosystem degradation. This may demand inter-state collaboration or state-community collaboration.

The Central African Forest Treaty is an example of a successful inter-state collaboration. The area of Congo forest that is formally protected has increased by 36 per cent (an addition of 46 000 km^2) since the Yaoundé Declaration of 1999. At the national level, the Declaration triggered re-evaluation of protected area networks. In Gabon, 13 new national parks covering 30 000 km^2 were established in 2003, making up about 10 per cent of the national land area. A similar process is under way in Cameroon. The DRC and Central African Republic (CAR) are planning similar reviews of their protected area networks. In February 2005, at the second Congo Basin Forest Summit, the Central African Forest Treaty, Africa's first region-wide conservation treaty was signed. It creates a single organisation, the Central African Forests Commission (COMIFAC), to oversee forest conservation activities in the Congo basin. Future efforts will focus less on opening new parks and more on implementing sustainable forestry in the areas outside the parks.

Collaboration between the state, representing the needs of society as a whole and those of future generations, and those people and groups that get all or part of their livelihoods from use of the resources, may also be important in protecting biodiversity. Experience in several parts of Africa and elsewhere is that when use rights for biodiversity are devolved to groups of people who have a vested interest in the maintenance of the resource in the long term, the outcome for biodiversity and livelihoods is favourable and reduces the burden on governments (Hulme and Murphree 2001). In Il Ngwesi, Kenya, a community partnership with a private-sector ecotourism operator and a government parastatal, the Kenya Wildlife Service (KWS) saw a reversal in the rate of biodiversity decline and a reduction in the vulnerability of a pastoral community within a period of six years (UNEP 2004a). The community established a conservancy area of 8 700 ha to restore plant biodiversity in order to attract wildlife back to a group ranch for ecotourism. They also formed a group of scouts to control poaching and cattle rustling. Household incomes increased from almost zero to US$800 annually over the same period (UNEP 2004a).

Sources: COMIFAC 2005, Hulme and Murphree 2001, UNEP 2004a

conservation of natural resources and economic development in Africa is particularly close.

The CBD is particularly focussed on biodiversity. It has three objectives:

- The conservation of biodiversity;
- The sustainable use of its components; and
- The equitable sharing of benefits arising from the use of biodiversity.

Realizing any one of these objectives is dependent upon the other. This requires adequate political and legal instruments to appropriately allocate access, benefits and costs and to make linkages between different environmental sectors as well as with development sectors. Such an approach is discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*. Partnerships with non-governmental organizations (NGOs), community-based organizations, and the technical and scientific community play an important role in conservation planning and policy. Such partnerships are also critical to the success of implementation efforts.

Biodiversity policy

A cost-efficient and robust strategy for biodiversity conservation may have two pillars. The first pillar is the classical approach of identifying those parts of the land, waters and sea where the conservation value exceeds any other use value, and requires strict protection. The second pillar recognizes that, even with such a safety net in place, most wild organisms live in places that are used primarily for purposes other than biodiversity conservation. Adjustments to the way in which these ecosystems are used can lead to a high degree of biodiversity preservation, without unacceptable decreases in the output of other services.

The key issues for establishing an effective protected area network are prioritization of levels of protection and use. Identifying protected areas should not be arbitrary. Sufficient knowledge exists to apply more refined techniques to identify locations that are critical for many species, robust to climate change, and have a good chance of being economically viable. In general, consolidated reserves are more viable than the equivalent area of isolated patches. In some instances transboundary parks are important for habitat protection.

There are known priority areas for conservation in every country, but overall, the greatest current urgency relates to multitaxon centres of endemism, such as the Eastern Arc mountains and Mt Cameroon. As shown in Box 5, adopting collaborative approaches at multiple levels can be important for achieving biodiversity conservation objectives.

Improving science

About US$245 million is currently spent annually by the international community for protected area management in SSA (James and others 2001). The efficacy of these investments depends partly on the availability and reliability of information on the spatial distribution and condition of biodiversity (Balmford and Gaston 1999). The currently available information on biodiversity is inadequate in several respects:

- It is biased towards terrestrial biodiversity, and towards large mammals and birds. The greatest proportion of Africa's biodiversity, invertebrates, is not well known to science.
- For most species, only parts of their distribution ranges are documented. In many areas there is inadequate documentation, including in Ethiopia, the Congo basin, Angola and Mozambique.
- Information on the biodiversity actually conserved in protected areas (eg in the form of species inventory lists) is widely lacking but is essential to document the success of conservation measures currently undertaken and to guide further conservation activities.
- A vast amount of locally and regionally available biodiversity information is not connected and standardized, which is a significant impediment to making priorities comparable at regional to global scales.
- Data on biodiversity condition (ie population size and trend, rather than simple presence or absence) is virtually absent. This information is essential for effective conservation of viable populations (Gaston and Rodrigues 2003) and for giving warning of impending problems well before they are irremediable.
- Biodiversity measures are still commonly restricted to how many species there are, while there is very little information on qualitative aspects of biodiversity such as phylogenetic or functional diversity.

Other important areas of research that would support effective biodiversity policy include: quantification of the current and potential economic benefits provided by ecosystem services, and the consequences and costs of ecosystem destruction; understanding the link between ecosystem diversity and ecosystem integrity; methodologies for the integration of climate change adaptation strategies into conservation planning; and the development of a conceptual basis and methodology to incorporate biodiversity sustaining and generating processes and functional biodiversity into conservation strategies.

SUB-REGIONAL OVERVIEW

The sub-regional overviews focus on selected issues and thus need to be read in the context of the regional synthesis and in relation to the issues covered in the other sub-regions.

CENTRAL AFRICA

Overview of resources

The vast equatorial forests of the Congo basin, which dominate Africa's tropical realm, contain a huge variety of life (Table 1). Due to its inaccessibility and a history of conflict, its ecology remains poorly studied. Within Central Africa, only Chad does not contain tropical rain forest, while in Cameroon, CAR and the DRC rain forest transitions from evergreen forest to deciduous forest, to wooded, open, and Sahelian savannahs, each transition signifying a huge shift in species composition and diversity. Plant diversity is high, with well over 10 000 species, 8 000 of which are found in the forest zone, of which 80 per cent are endemic (White 2001).

Three of the four species of great ape, the closest evolutionary relative to humans, still occur. The sub-region has the highest primate diversity in Africa (Harcourt 2000).

The Congo River is the second largest river system on Earth, containing at least 669 species of fish (Champan 2001), many of which are important sources of protein for the local population.

Challenges faced in realizing opportunities for development

Biodiversity faces various threats, including increasing trade. Although forest elephants, gorillas, forest buffalo, bongo, okapi and giant forest hogs continue to live in large numbers in Central Africa's forests, these species and their habitat face an uncertain future. Forest

Forest leopards (*Panthera pardus*) hold a vital ecological role as the sole large mammalian predator in Gabon's forest habitats.

Source: P. Henschel/WCS

Table 1: The biodiversity features of Central Africa

		Biodiversity opportunity						Threat	Response
		Mammals		Birds		Plants		% of land	% of land
Country	Area km²	Endemic	Total	Endemic	Total	Endemic	Total	transformed	protected
Cameroon	475 440	14	409	8	690	156	8 260	9	7
Central African Republic	622 980	2	209	1	537	100	3 602	2	12
Chad	1 284 000	1	134	0	370		1 600	14	9
Congo	342 000	2	200	0	449	1 200	6 000	3	14
DRC	2 344 860	not known	not known	not known	not known	1 100	11 007	3	5
Equatorial Guinea	28 050	1	184	3	273	66	3 250	7	17
Gabon	267 670	3	190	1	466		6 651	3	0
São Tomé and Príncipe	960	4	8	25	63	134	895		
All countries	5 365 960	27		38		2 756		6	7

Sources: Biodiversity information taken from Groombridge and Jenkins (2002). Calculation of the proportion of transformed land was based on the reclassification by Hoekstra and others (2005) of the GLC3 Global Landcover Classification (Mayaux and others 2004). Hoekstra and others (2005) defined four classes of transformed land: 1) Artificial surfaces and associated areas, 2) Cultivated and managed areas, 3) Mosaic: cropland/treecover, and 4) Mosaic: cropland/ other natural vegetation. In this chapter, all four classes have been integrated into the calculation of the proportion of transformed land. The area covered by classes 3 and 4 was divided by two, assuming that this reflects their mosaic character with a certain proportion of land remaining untransformed. Note that this method does not account for the degree of fragmentation within the mosaic landcover classes. Data on protected areas (IUCN class I-V) were obtained from WRI 2005

elephants once roamed over most of the nearly 2 million km² of the Congo basin forest. Considerable evidence, including that from landscape scale inventories by the Monitoring of the Illegal Killing of Elephants program (MIKE) of CITES, suggests that the elephant range has been dramatically reduced due to illegal killing for ivory and bushmeat, as well as increasing human encroachment into forest lands. Elephants may be increasingly confined to protected areas and their immediate peripheries (Blake 2002). Great apes face similar challenges, with the added spectre of disease, such as Ebola, reducing populations to a fraction of their original abundance (Walsh and others 2004).

The logging industry dominates land use and the economy in forested areas. Since its coastal beginnings, in colonial times, logging has spread to the deep interior of the forest (Bikié and others 2000, Collomb and others 2000). Logging is mostly selective due to high production costs. Canopy damage is typically 10-20 per cent, meaning that forest cover remains post-logging, but the forest ecology is significantly modified. Furthermore, logging and logging roads bring immigration into formerly remote areas, opening up the interior to use, stimulating the development of cash economies, and allowing access to distant markets (Wilkie and others 2000).

The expansion of bushmeat hunting is a major threat: between 1 and 5 million tons is harvested annually, well above sustainable levels (Robinson and Bennett 2002, Robinson and Bennett 2004). Casualties of the bushmeat trade include the great apes (gorillas, chimpanzees, and bonobos), which coupled with the real and growing threat from the Ebola virus could be driven to the verge of extinction within a decade (Walsh and others 2004). With limited national capacity for sustainable land-use planning and law

The bushmeat trade comes with both costs and benefits. It offers nutrition for many poor people, but at times threatens biodiversity. Cameroon.

Source: CARPE

enforcement, logging has become a major vehicle for a dramatically expanding illegal bushmeat trade to supply local, national and international commercial markets. Recognizing the seriousness of the threat, efforts are underway toward sustainable management of the main bushmeat species, and to promote alternative sources of protein in logging concessions and other rural and urban settings, and to diversify incomes for bushmeat hunters (CBFP 2005).

The use of bush fires in the clearing of land for agriculture and settlement as well as a hunting technique is the second major threat to biodiversity resources. Slow-growing species at the edge of the forests are disappearing and gradually being replaced by pioneer species. Regeneration of slow-growing species, which have high value timber, requires long fallow periods, which is often not allowed by the bush fires (UNEP 2004a). There is therefore a risk of forest areas disappearing and being replaced by savannah.

Inter-basin transfers of water pose several threats to biodiversity. For example, proposals have been made to divert large volumes of water from the Ubangui River (part of the Congo River basin) northwards through the CAR and Chad, and to discharge this water into the Logone-Chari rivers feeding Lake Chad (Kuwairi 2004). The proposed water transfer would have the effect of dramatically increasing the flooded extent of Lake Chad and restoring livelihoods of residents living along its shorelines, most of whom subsist on products from their livestock and on blue-green algae and fish harvested from Lake Chad, but runs the risk of transferring an unrelated set of species into the Lake Chad basin. These proposals (Kuwairi 2004) also suggest that a scheme to divert water from the Ubangui River could be enlarged sufficiently so that additional water could be diverted via a pipeline further northwards into southern Libya. Whilst such water transfers could enhance the biodiversity of Lake Chad and its immediate surroundings, there is a strong possibility that such a scheme could have significant adverse effects on the Congo River system to the south.

Strategies to enhance the opportunities for development

Sustainable and equitable natural resource management is the key not just to the maintenance of biodiversity but equally to human development and well-being. Conservation and wildlife management has lagged behind the rest of the region, though one of Africa's first national parks, the Virunga National Park, was created here in 1925. The costs of conservation are far from trivial. It is estimated that successful management of a minimal network of protected areas in forests alone would require an investment of over US$1 000 million over 10 years, followed by recurrent costs of nearly US$90 million per year; current investment is probably about US$15 million per year (Blom 2004).

Much of the remaining biodiversity is held outside national parks (Sayer and others 1992). Thus, broad-scale resource management systems which combine protected areas with areas of increasing human use can be an important intervention. Initiatives such as the Yaoundé Process, which led to the Yaoundé Declaration in 1999, made a formal commitment to the conservation and sustainable management of tropical forests, and helped catalyse the *Plan de Convergence* (COMIFAC 2005), the creation of Gabon's network of 13 national parks (Gabon National Parks undated), and the Congo Basin Forest Partnership (CBFP), consisting of 27 public and private partners (CBFP undated). USAID's Central Africa Regional Project for the Environment (CARPE) and the European Commission's Ecosystems *Forestiers d'Afrique Centrale* (ECOFAC) contribute to this partnership. An important task for the CBFP is the development of a monitoring system to provide a periodic assessment of the forest and biodiversity of the Congo basin (see Box 5).

EASTERN AFRICA

Overview of resources

Eastern Africa's biological diversity reflects its position astride the equator and the high variability of landscapes and aquatic ecosystems. These conditions provide suitable habitat for a large variety of living organisms,

Nectophrynoides viviparus is one of the few frogs that give birth to live young. This vulnerable species occurs in the Uluguru and Udzungwa mountains in the southern highlands of Tanzania.

Source: D. Moyer/WCS

some with very limited ranges. For instance, the Bonga Forest in Ethiopia contains more than 15 species of highland birds; the Metu-Gore-Tepi forest has more than 16 species of birds of which at least two are endemic, while the Tiro Boter-Becho forests have more than 32 highland biome species of birds (EWNHS 1996). Owing to its combination of semi-arid savannahs, lowland and montane rain forests, vast wetlands, and an Afro-alpine zone which ranges in altitude from 650 to 5 000 m, Uganda has over 1 000 species of birds (Carswell and others 2005), a significant percentage of Africa's 2 313 bird species (BirdLife International undated). From its scorching sub-desert flatlands to its mist-enshrouded evergreen montane forests, Eritrea's diverse habitats hold a wide variety of birds, many of which are confined to the Horn of Africa. To date, a total of 107 mammal species have been recorded in Burundi (Groombridge and Jenkins 1994). The Masai Mara in Kenya is world-famous for big game. A total of 277 species of mammals are known in Ethiopia, of which 29 are endemic and almost exclusively confined to the central plateaus (Yalden and others 1986). In the semi-desert grasslands and shrublands of Djibouti, *Acacia nilotic* sub species, *tomentosa* forms nearly pure stands on silty-clay soils subjected to seasonal inundation in association with *Ziziphus abyssinica* as a minor associate (White 1983). Although Djibouti does not have any endemic mammals, the following threatened terrestrial and marine species occur: *Lycaon pictus* (African wild dog), *Dorcatragus megalotis* (Beira antelope), *Gazella dorcas* (Dorcas gazelle), *Dugong dugon* (dugong), *Otomops martiensseni* (large-eared free-tailed bat) and *Gazella soemmerringii* (Soemmerring's gazelle) (Baillie and Groombridge 1996).

Challenges faced in realizing opportunities for development

Maintaining biodiversity is essential for ensuring that the environmental goods-and-services are maintained.

Eastern Africa contains some of the world's oldest and richest protected areas (Table 2), such as the Tsavo, Queen Elizabeth and Serengeti national parks. The principle which guided establishment of most protected areas was that strict protection was essential for effective conservation of biological resources and therefore the exclusion of humans, livestock and fire was considered necessary. This protectionist approach was based on the USA's Yellowstone National Park (McNeely and others 1994). These protected areas were established in the hope that they would continue to exist in pristine state and effectively conserve the inherent biological diversity, especially the characteristic large mammal aggregations. This idea was enshrined in such notable MEAs as the London Convention of 1933 and the ACCNNR of 1968 (McNeely and others 1994). While the present distribution of protected areas embraces a more modern view of the broader biodiversity concept, it still reflects a preoccupation with the large mammal concentrations. The long-term viability of the ecological systems and processes on which such areas depend remains questionable. The exclusion of humans and most of their activities notwithstanding, species loss has continued. In nearly all cases, park boundaries were established with little regard for the year-round needs of resident fauna. For example, the Nairobi National Park and Masai Mara reserve in Kenya were originally designed to conserve

Table 2: The biodiversity features of Eastern Africa

		Biodiversity opportunity						Threat	Response
		Mammals		Birds		Plants		% of land	% of land
Country	Area km²	Endemic	Total	Endemic	Total	Endemic	Total	transformed	protected
Burundi	27 830	0	107	0	451	not known	2 500	37	5
Djibouti	23 200	0	61	1	126	6	826	1	1
Eritrea	117 600	0	112	0	319	not known	not known	19	4
Ethiopia	1 104 300	31	277	28	626	1 000	6 603	39	5
Kenya	580 370	23	359	9	844	265	6 506	13	6
Rwanda	26 340	0	151	0	513	26	2 288	52	8
Somalia	637 660	12	171	11	422	500	3 028	6	0
Uganda	241 040	6	345	3	830	not known	4 900	36	7
All countries	2 758 340	72		52		1 797		24	4

Source: Methodology and sources as for Table 1

populations of migratory mammals whose movements have since been severely restricted. Land conversion and encroachment of these areas, and virtually all other protected areas, have led to serious ecological isolation with negative effects on species richness, abundance and genetic vigour.

In several areas, such as the Nairobi and Mkomazi parks, large mammal populations have become more compressed, and animal and plant species diversity has decreased. Rapid biodiversity loss in some of Kenya's protected areas is also closely linked with the explosion of tourism, rapid coastal development, and spread of human settlements since the 1970s. The large mammal populations of Uganda's Murchison Falls National Park came under heavy pressure during the years of civil strife, leading to huge species declines and directional vegetation change. In Ethiopia's Awash, Abijata Shalla and Nechisar national parks, encroachment and settlement forced many wildlife species out of the park due to increased competition for forage (Hilman 1991, GebreMichael and others 1992, Jacobs and Schloeder 2001).

Although biodiversity loss can be attributed to multiple causes, a large part is accounted for by the real and widespread conflict between people and wildlife. Eastern Africa has a high human population (FAO 2003). The spread of cultivation and settlement has meant that pastoralists and their livestock have been squeezed into increasingly smaller areas. There is increasing competition between people, and between people and wildlife, for grazing land and water resources. Local people and their livestock are still viewed by the national law and policy as alien to parks, reserves and sanctuaries. The loss of key dispersal areas for wildlife leads to greater pressure within the protected areas, and heightened human-wildlife conflict. Hostilities have built up as consecutive governments ignore the hardship that wildlife causes people (Yeager and Miller 1986, Western 1997). Despite the obvious economic benefits that wildlife brings, many farmers, herdsmen and ranchers living adjacent to parks look upon wild animals with considerable disdain (Kaltenborn and others 2003). Wildlife periodically decimates crops,

Wandering mountain gorilla (*Gorilla spp.*). The Bwindi Forest, Uganda, can be seen in the background.

Source: C. Lambrechts/UNEP

causes injuries or death to people and livestock, and spreads diseases.

Strategies to enhance the opportunities for development

Since the early 1990s, there has been a growing policy change focus on sustainable use and increased local participation. There is a realization that a "fences-and-fines" approach leads to even more conflicts, unacceptable social inequity, and ultimately the destruction of the resources themselves. A "use it or lose it" philosophy has taken root (Swanson 1992). The various community-based natural resource management (CBNRM) approaches have yielded mixed results (Agrawal and Gibson 1999, Gibson 1999, Songorwa and others 2000). Nearly all countries are providing greater legitimacy for the involvement of people in natural resources management. A slow but steady change in focus is under way, shifting from the biological challenges to confronting the social and economic issues. In Kenya, for instance, a national land policy is being formulated through a consultative and participatory process. This should open up new opportunities for people wishing to invest in conservation and the sustainable use of biological diversity.

NORTHERN AFRICA

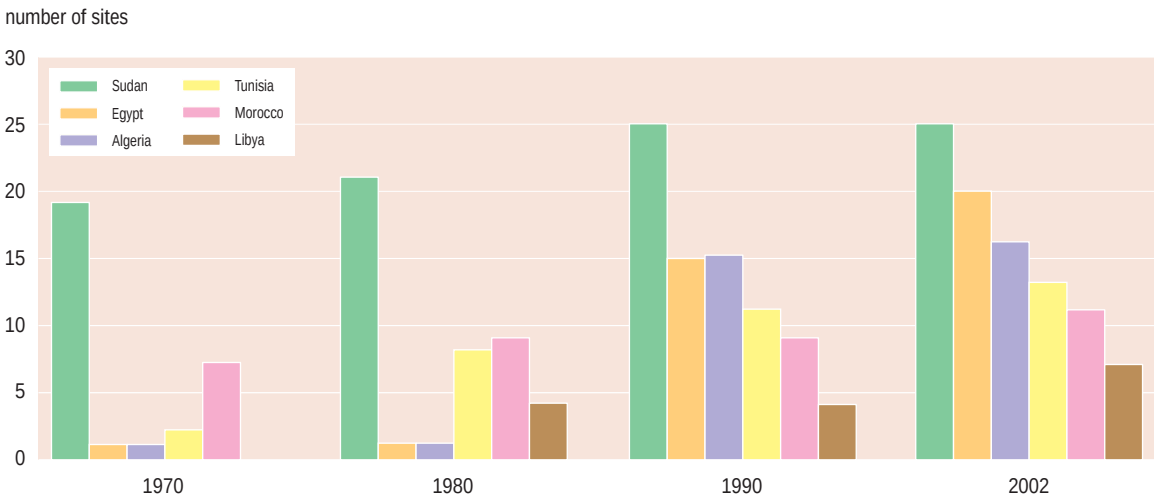
Northern Africa falls within the arid belt extending from the Atlantic to central Asia. Aridity and the geographical location of its six countries determine its biodiversity. The occurrence of long shores with vast coastlines, oases in the Sahara and the different landforms create considerable habitat and species diversity.

The sub-region is vulnerable to desertification and drought. However, due to particular climatic conditions, it is rich in biodiversity, with many species being endemic. The total number of known endemic species of flora is 1 129, of mammals 22, of birds 1, of reptiles 20, and of amphibians 4. At the country level, the highest numbers of endemic biota are mostly found in Morocco, with recorded higher plant species ranging from 1 875 in Libya to 3 675 species in Morocco. Mammals range from 76 species in Libya to 267 species in Sudan. The number of bird species varies from 80 in Libya to 938 in Sudan. Reptiles and amphibians are still underinvestigated in most of the countries, but the numbers of known reptile and amphibian species in Egypt are 83 and 6, respectively.

The major part of the biodiversity of Northern Africa is drawn from the pool of species broadly represented in the Mediterranean basin. There are locations of endemism in the Atlas Mountains of Morocco, Algeria and Tunisia accounting for about a fifth of the plant species in the sub-region (Table 3). Since Northern Africa has been the location of successive civilizations over a period of up to eight millennia, the landscape and its biodiversity are highly transformed in the areas of human settlement.

Hundreds of plant species are used in traditional medicine and represent a wealth of genetic resources rarely found elsewhere (IUCN undated – b). Pharmacopoeial plants include *Hyoscyamus muticus*, *Urginea maritima*, *Colchicum autumnale*, *Senna alexandrina*, *Plantago afra*, *Juniperus communis*, *Anacyclus pyrethrum*, and *Citrullus colocynthis*. Endemic plants, some of which are endangered, include *Argania spinosa*, *Arbutus pavari*, *Cedrus atlantica*, *Euphorbia echinus*, *Euphorbia resinifera*, *Senecio*

Figure 4: Protected areas (IUCN Categories 1-VI): Northern Africa



Source: UNEP 2005b

Table.3: The biodiversity features of Northern Africa

		Biodiversity opportunity						Threat	Response
		Mammals		Birds		Plants		% of land	% of land
Country	Area km²	Endemic	Total	Endemic	Total	Endemic	Total	transformed	protected
Algeria	2 381 740	2	92	1	192	250	3 164	1	5
Egypt	1 001 450	7	98	0	153	70	2 076	4	5
Libya	1 759 540	5	76	0	91	134	1 825	0	0
Morocco	446 550	4	105	0	210	625	3 675	20	1
Sudan	2 505 810	11	267	1	680	50	3 137	17	4
Tunisia	163 610	1	78	0	173		2 196	9	0
All countries	8 258 700	30		2		1 129		7	3

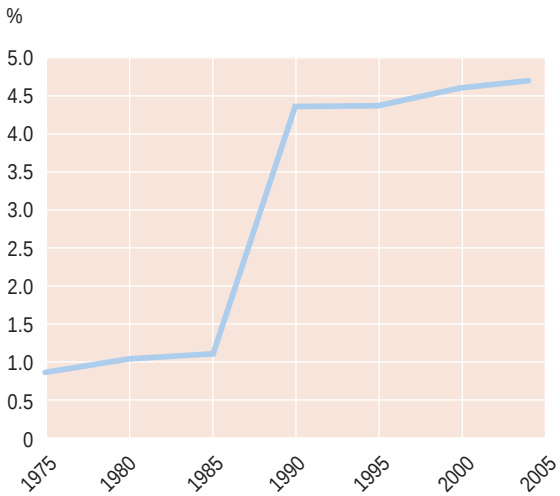
Source: Methodology and sources as for Table 1

antieuphorbium, *Thymus algeriensis*, and *Thymus broussonettii* (Batanouny 1999). To date, they have not been studied in detail or valued. About 70 per cent of wild plants are known to be useful in more than one context, of which 35 per cent are under-utilized.

Challenges faced in realizing opportunities for development

The major underlying threats to biodiversity include population growth, agricultural and urban expansion to ecologically important areas, poverty, unsustainable use of biota, and macro-scale stresses such as drought. Emerging factors threatening biodiversity include IAS and the use of GM species, which may result in an increasing homogenization of the biota (Hegazy and others 1999). Chapter 9: *Genetically Modified Crops* and Chapter 10: *Invasive Alien Species* consider some of these challenges. The depletion of underground water level in many countries has led to the deterioration and loss of unique water springs and wetlands with their associated biota.

Figure 5: Protected areas (IUCN Categories I-IV): percentage of total area in Northern Africa



Source: UNEP 2005b; data from World Database of Protected Areas 2004

Human settlement patterns and activities are located close to available water resources and compete with biodiversity. In such a dry landscape, perennial rivers, oases and ephemeral moist areas, such as *wadis*, are inevitably the focus of people and biodiversity. Northern Africa straddles the migratory bird flyways between Europe and SSA and is an important stopping-off point for an estimated billion migratory raptors, passerines and Palaearctic waterbirds.

The Nile is a key biodiversity corridor across the arid Sahara and Sahel belt, but is highly impacted by human actions in its lower reaches. The functioning of this system (specifically the periodic flooding and discharge to the sea, which brought large amounts of sediment and nutrients to the river banks and delta) was substantially altered by completion of the Aswan Dam in 1934 and the subsequent construction of the Aswan High Dam in 1965. As a result of the intensive water use in Egypt, there is virtually no discharge into the Mediterranean Sea, and only small pockets of relatively undisturbed coastal marshland remain in the delta. New irrigation schemes may further diminish water supplies in the lower Nile system and impose additional threats to the biodiversity. Similarly other development projects, including those related to hydropower, will increase demands on the existing water resources and this, in turn, will exert additional pressures on the basin's ecosystems and biodiversity.

In the coming decade, the abuse of agrochemicals and uncontrolled fishing and hunting are expected to

put more pressure on the fragile ecosystems and the threatened endemic species, particularly in hotspots. Protection of critical sites is imperative. The growing need for transborder conservation is also an emerging issue in some areas, such as the borders between Egypt and Sudan, and between Morocco and Algeria.

STRATEGIES FOR ENHANCING BIODIVERSITY VALUES

There are ongoing schemes to establish protected areas and biosphere reserves throughout the sub-region. The total area of official protected areas remains less than 5 per cent of the land area, which is below the CBD standard of 10 per cent. Nevertheless, some countries aim to increase their protected areas to more than 15 per cent within the next three decades. Currently, Northern Africa has over 90 protected areas and 12 biosphere reserves. Many other sites are proposed for protection (Hegazy and others 2001).

SOUTHERN AFRICA

Southern Africa is a globally recognized centre of biodiversity richness and endemism, as shown in Table 4. The Western Cape, the Karoo and the Miombo woodlands are of particular significance (Burgess and others 2004).

Biodiversity underpins the economy, including tourism. (Krug and others 2002). Southern Africa has placed increasing importance on conservation and sustainable use and has invested in several initiatives in support of those objectives, notably the transfer of ownership of biodiversity from the state to the private and community sectors, and the development of transboundary parks.

The coelacanth, a 400 million year-old "living fossil" fish, occurs in the waters of the WIO islands.

Source: Estate of J. Metzner/Still Pictures

The current condition and trend of biodiversity has recently been assessed as part of the Millennium Ecosystem Assessment (MA): averaged across all terrestrial species of plants and vertebrates, it is estimated that about 84 per cent of the pre-colonial populations of wild organisms persisted in the year 2000 (Biggs and others 2004, Scholes and Biggs 2004, Scholes and Biggs 2005). The rate of decline in "biodiversity intactness" is about 0.8 per cent per year for the 1990s (Scholes and Biggs 2005). Most of the organisms that persist occur outside the comprehensive and generally well-run system of protected areas.

Table 4: Biodiversity richness and endemism in Southern Africa

		Biodiversity opportunity						Threat	Response
		Mammals		Birds		Plants		% of land	% of land
Country	Area km²	Endemic	Total	Endemic	Total	Endemic	Total	transformed	protected
Angola	1 246 700	7	276	12	765	1 260	5 185	4	4
Botswana	581 730	0	164	1	386	17	2 151	9	18
Lesotho	30 350	0	33	0	58	2	1 591	16	0
Malawi	118 480	0	195	0	521	49	3 765	29	9
Mozambique	801 590	2	179	0	498	219	5 692	11	4
Namibia	824 290	3	250	3	469	687	3 174	2	4
South Africa	1 221 040	35	247	8	596		23 420	22	5
Swaziland	17 360	0	47	0	364	4	2 715	0	2
Tanzania	945 090	15	316	24	822	1 122	10 008	25	15
Zambia	752 610	3	233	2	605	211	4 747	9	8
Zimbabwe	390 760	0	270	0	532	95	4 440	32	8
All countries	6 930 000	65		50		3 666		13	7

Source: Krug and others 2002

Table 5: Average prices of live game (2000)

Species	Price (US$)
Grey duiker	75
Impala	150
Kudu	370
Blue wildebeest	450
Zebra	580
Springbok	670
Red hartebeest	700
Waterbuck	1 000
Bushbuck	1 000
Giraffe	2 700
Hippo	4 000
Sable antelope	10 300
Roan antelope	14 200
Buffalo	16 700
White rhino	25 000

Source: SADC and others 2005

The various species of fauna and flora found in the vast range of terrestrial, freshwater and marine ecosystems are also an important source of food, medicines, research and regional integration through transboundary conservation. They are also an important source of income for communities through CBNRM programmes.

Land-use systems that are based on wildlife utilization are more ecologically sustainable than other uses. For example, wildlife makes better use of vegetation compared to livestock, and has many marketable uses in addition to meat production. Income from wildlife is significant. One of Southern Africa's most prestigious and largest wildlife auctions for live game is organized by the KwaZulu Natal Conservation Service in South Africa. Excess animals from public parks are sold to private wildlife areas predominantly in Southern Africa. Table 5 provides average auction prices for live game in 2000, during which the prices ranged from US$75 for a grey duiker to US$25 000 for a white rhino (SADC and others 2005).

Safari hunting is the main income generating form of consumptive wildlife utilization. However, the most common and widespread use of wildlife is non-consumptive tourism, which takes place in areas where densities of wildlife are high.

Since the 1970s, several initiatives in Mozambique, Namibia, South Africa and Zimbabwe began to transfer use rights and responsibilities to the landholders. In most Southern African countries, wildlife historically belonged to the government, and not to the people who owned or lived on the land. Thus there was little incentive for landholders to conserve or enhance wildlife stocks. In Zimbabwe, the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) programme targeted sparsely populated communal land adjacent to national parks or hunting areas. It demonstrated that economic returns from sustainable use of wildlife (largely through trophy hunting) exceeded the returns from marginal cultivation or cattle ranching, and schemes were devised to return the proceeds of wildlife utilization to the local communities. In South Africa, a simple change in the provincial wildlife protection legislation lifted many of the restrictions relating to the use of wildlife for those landholders who erected a game-proof fence around their land. Large parts of the country that had been used unprofitably for livestock ranching rapidly began to farm wildlife, initially for the trophy hunting market, and later for the wildlife tourism market (Scholes and Biggs 2004). In Namibia, many experiments in CBNRM have been launched, and several have proven sustainable for long periods.

Transboundary parks have been a "peace dividend" following the achievement of political stability in Southern Africa. Established examples include the Greater Limpopo Transfrontier Park initiative between Mozambique and South Africa, the Kgalagadi Agreement establishing a park between South Africa and Botswana, and the Tuli Park between South Africa, Botswana and Zimbabwe (Mohamed-Katerere 2001). Several more are in advanced stages of implementation. While many of the drivers and benefits of transboundary protected areas are political and economic, there are also significant biodiversity advantages: large parks have lower operational costs; bigger wildlife populations are less prone to loss when conditions fluctuate; and ecosystems seldom follow national jurisdictions.

Given that the biodiversity of Southern Africa is remarkably intact, the most immediate challenge is to avoid degradation of habitat in the extensive areas which are used for activities such as livestock ranching, while simultaneously maintaining viable livelihoods for the people who live in these areas.

Challenges faced in realizing opportunities for development

The invasion of ecosystems by alien species has caused significant economic losses. Such species have been deliberately or accidentally introduced by humans. Only a fraction of such introductions become problem

Lantana camara, an IAS, first introduced as an ornamental plant. invades various habitats, decreasing agricultural productivity and transforming many forest ecosystems.

Source: V. Rabesahala

species, but when they do the consequences can be severe for local biodiversity, ecosystem services and human well-being. For instance, it has been calculated that the additional water use by alien trees in South Africa (excluding those in plantations and orchards) is between 1 400 and 3 300 million m^3/year (Görgens and van Wilgen 2004). Chapter 10: *Invasive Alien Species* looks at these issues more closely.

Climate change is also emerging as a major threat to biodiversity in Southern Africa, with some symptoms already manifest (Rutherford and others 1999). While extreme climate variation is not new, the magnitude and rapidity of climate change likely to occur in the 21st century is greater than the capacity of many organisms to respond by adaptation or migration. Migration to areas with a suitable climate is severely hampered by barriers such as roads, fences, urban areas and cultivated fields. The highly diverse and unique succulent flora of the winter-rainfall regions in the southwest of Africa is projected to be particularly threatened (Rutherford and others 1999). There is emerging evidence that the effects of climate change are already apparent there (Foden and others 2003). Chapter 3: *Land* examines some of the challenges associated with climate change.

WESTERN AFRICA

The wide range of ecosystems – forests, savannahs, deserts, rivers, mountains, mangroves and seas – makes the sub-region rich in biodiversity. The Sahelian zone has several wetlands, including the Niger and Senegal rivers, Lake Chad and floodlands in Senegal and Niger which are very important for migratory birds. The inner Niger delta is a vast floodplain (more than 30 000 km^2) situated in the middle of the Sahelian landscape, rich in natural resources and featuring varied ecosystems (lakes, forest floodplains, flooded grasslands and savannah) which supports the livelihoods of 1 million people. The delta is also well known as a wintering and staging area for million of migratory birds. Other important sub-regional biodiversity values include the west African manatee, a globally endangered species (Beintema and others 2001). The Guinea forest contains half the mammal species on the African continent, including the rare pygmy hippopotamus, the zebra duiker and the drill, the most threatened primate (UNEP and NESDA 2004)

Table 6: The biodiversity features of Western Africa

		Biodiversity opportunity						Threat	Response
		Mammals		Birds		Plants		% of land	% of land
Country	Area km²	Endemic	Total	Endemic	Total	Endemic	Total	transformed	protected
Benin	11 2620	0	188	0	307	0	2 500	9	6
Burkina Faso	274 000	0	147	0	335		1 100	48	12
Cape Verde	4 030	0	5	4	38	86	774		
Gambia	11 300	0	117	0	280	not known	974	42	0
Ghana	238 540	1	222	0	529	43	3 725	17	5
Guinea	245 860	1	190	0	409	88	3 000	14	0
Guinea-Bissau	36 120	0	108	0	234	12	1 000	7	
Côte d'Ivoire	322 460	0	230	2	535	62	3 660	25	6
Liberia	111 370	0	193	1	372	103	2 200	30	1
Mali	1 240 190	0	137	0	397	11	1 741	15	4
Mauritania	1 025 520	1	61	0	273	not known	1 100	3	0
Niger	1 267 000	0	131	0	299	not known	1 460	2	8
Nigeria	923 770	4	274	2	681	205	4 715	34	4
Senegal	196 720	0	192	0	384	26	2 086	47	11
Sierra Leone	71 740	0	147	1	466	74	2 090	38	2
Togo	56 790	0	196	0	391	not known	3 085	7	8
All countries	6 138 030	7		10		710		16	4

Source: Methodology and sources as for Table 1

Challenges faced in realizing opportunities for development

Land degradation and desertification are major causes of biodiversity loss. Three factors contribute:

- A relatively dense and growing population with strong dependence on natural resources:
- Relatively easy access to resources; and
- Recurrent droughts.

These processes affect grasslands, steppes, savannahs and woodlands:

- They fragment forests and alter their structure and composition, especially when they are followed by recurrent forest and bush fires;
- They reduce surface water points and their associated plants;
- They strongly deplete animal populations and notably reduce a number of rare and vulnerable species through habitat degradation, sport hunting and especially through exploitation for bushmeat, which is exacerbated by drought-related food deficits.

Dust storms, forest fires, locust outbreaks and population displacement are all linked to the phenomenon of desertification, and have strongly negative consequences for people, in particular through the loss of livelihood and economic opportunities.

Land degradation is a persistent reduction in the capacity to support life and supply ecosystem services. It affects biological diversity directly and indirectly. It may affect the survival of species and alter processes that support their life, or it may trigger socioeconomic phenomena that impact on living species and their ecosystems. Land degradation phenomena directly affecting biodiversity include water and wind erosion. Along major river basins siltation processes accumulate debris and materials that engulf natural vegetation, such as the *Acacia nilotica* riparian forests. Trees may survive for years, but the diverse understorey may not. Soil erosion contributes to moving the seed capital of the ground, uprooting grassy as well as woody species, and in accumulation areas it smothers valuable species. This occurs in the sand dune areas of countries such as Mauritania, Mali, Niger, Nigeria and Senegal.

Indirect factors associated with land degradation that impact on biodiversity include the coping strategies people adopt to deal with environmental change. The movement of people south towards sub-humid to humid tropical areas has resulted in depletion

of natural resources: loss of primary forests and woodlands, repeated logging of the secondary vegetation, and depletion of a number of species. The influx of refugees from war-stricken areas also triggers severe land degradation in host regions and the overuse of wildlife resources. More diffuse degradation of land resources also occurs in the arid and sub-humid parts. These include the extraction of tree resources outside forests for charcoal making (about 150 million tonnes/year from the savannahs and woodland areas), and the use of high-value woods. Most affected are the Meliacaea family (*Khaya* species), *Pterocarpus erinaceus*, and *Dalbergia melanoxylon*.

The degradation and fragmentation of natural landscapes is caused by agricultural expansion. Agricultural expansion affects the survival and regeneration of animal populations, destroys the structure of wildlife habitat, and strongly contributes to reduction of wildlife populations. The number of species threatened continues to grow; these include lion, elephant, most of the greater antelopes, and water-dependent species such as manatees and crocodiles, which could form the basis of a tourism industry.

Strategies to enhance the opportunities for development

A number of conservation efforts, some involving communities, have been undertaken. An example of a successful conservation initiative involving local communities is shown in Box 6.

The West African Gaboon viper (*Bitis gabonica rhinoceros*) is a venomous and highly camouflaged snake which can fetch up to US$600 in the international exotic pet trade.

Source: J. Gerholdt/Still Pictures

Table 7 shows international protected areas in Western Africa. An example of successful cooperative is the endeavour of Benin, Burkina Faso and Niger, supported by external partners such as France, to protect the extensive transboundary complex of the Pendjari and Arly national parks. Concerted efforts have succeeded in maintaining the overall system and

Box 6: The Diawling National Park (DNP), Mauritania

In the delta of Senegal River, in Mauritania, two dams were constructed in the 1980s: the Manantali dam upstream (in 1989) for flood regulation, hydroelectricity, irrigation and navigation purposes and the Diama one downstream (in 1985), an anti-salt dam.

However, by 1997, only 100 000 ha had been equipped for irrigated agriculture, and only 44 000 ha were farmed in the end because of loss of soil fertility and increased salinity (OMVS and others 1998 cited in Hamerlynck and Duvail 2003). Hydropower production started in 2002. By 2003, no investments had been secured for the navigability scheme. Thus, the negative impacts of the Diama Dam were dire: loss of floodplains traditional functions (fishing, grazing, rain-fed cultivation, handicraft, etc). The dam also prevented exchanges between river freshwater and seawater, with the reduction of the estuary ecosystem's great productivity.

IUCN – The World Conservation Union and the Directorate-General for International Cooperation (DGIS) (Netherlands) proposed then to help restore this delta by reintroducing inundation through the sluice gates of the dam. Negotiation between the various users within the park was undertaken to come out with a consensus water management plan. A consensus scenario for opening and closing the different sluice gates was adopted. This scenario takes into account all the resources (the spawning of fish, the *Sporobolus spp.* growth, the groundwater replenishment, etc) and their behaviour related to water level.

With the return of the floods came the return of people from the cities. Floodplains traditional functions and goods (cattle grazing, artisanal mat weaving using *Sporobolus robustus* and *Acacia nilotica* seedpods (for leather tanning), fisheries, and waterbirds) returned. Thus livelihood activities, by both men and women from this Senegal River valley, were restarted, contributing to the improvement of human well-being.

Source: Hamerlynck and Duvail 2003, IUCN 2003

Table 7: International protected areas in Western Africa

	Biosphere reserve		World heritage sites		RAMSAR sites	
Country	**Number**	**Area ('000 ha)**	**Number**	**Area ('000 ha)**	**Number**	**Area ('000 ha)**
Benin	1	623	0	0	2	139
Burkina Faso	1	186	0	0	3	299
Côte d'Ivoire	2	1 480	3	1 504	1	19
Gambia	0	0	0	0	1	20
Ghana	1	8	0	0	6	178
Guinea	2	133	1	13	6	225
Guinea Bissau	1	110	0	0	1	39
Liberia	0	0	0	0	0	0
Mali	1	2 349	1	400	3	162
Mauritania	0	-	1	1 200	2	1 231
Niger	2	25 128	2	7 957	4	715
Nigeria	1	<1	0	0	1	58
Senegal	3	1 094	2	929	4	100
Sierra Leone	0	-	0	0	1	295
Togo	0	0	0	0	2	194
Total	15	31 111	10	12 003	37	3 674

data for Cape Verde not available

Source: Data from Wetlands International undated, UNESCO 2006a, UNESCO 2006b

resources in the protected areas in the three participating countries. Biodiversity is relatively well conserved in this area: avifauna is represented by around 378 species; fish species, amphibians and reptiles are prominently present; and the greater mammals of the savannahs and woodland areas are extensively featured (10 000 buffalo, 4 500 elephants, 7 500 roan antelopes, 2 000 bubals, 1 100 warthogs and 1 000 kobs). Lions, cheetahs, panthers and hyenas are also well represented. The habitat is also well conserved, and the overall trend of biological diversity is deemed very positive and on the rise.

WESTERN INDIAN OCEAN ISLANDS

Overview of resources

The WIO islands are characterized by significant plant endemism as well as other biodiversity, which is related to their island status. These islands are among the most globally important priorities for conservation, mainly due to the outstanding levels of endemism.

Madagascar has been separated from the African mainland and from India for millions of years (Goodman and others 2003). As a consequence, most of the plant and animal species present there have evolved in long isolation. Madagascar's most striking feature is its exceptionally high endemism in nearly all groups, particularly at the generic and family levels. Many groups also show very high levels of species diversity on Madagascar (Lowry II and others 1997). Plant species richness is currently estimated to be at least 12 000 species, and possibly as many as 14 000, of which more than 90 per cent are endemic. Among vertebrates, the extant mammal fauna comprises 101 native terrestrial species, none of which is found anywhere else on Earth (Goodman and others 2003).

By contrast, the other Indian Ocean islands are composed of relatively recent volcanic islands (the Mascarenes and the Comoros) or fragments of older continental material (the main group of the Seychelles). They are biologically closely linked to Madagascar, and reveal important endemic biodiversity. They add important endemic biodiversity for the total land area of 590 000 km^2 (including the Iles Esparses, a series of small French-held islands surrounding Madagascar: Les Glorieuses, Juan de Nova, Tromlin and Bassas da India).

The Mascarenes have about 1 300 vascular plant species, of which 585 are endemics, the Comoros have about 1 000 species (150 endemic), and there are about 310 species in the Seychelles of which 75 are endemic (Mittermeier and others 2004). Madagascar

Table 8: Biodiversity features of the Western Indian Ocean islands

		Biodiversity opportunity						Threat	Response
		Mammals		Birds		Plants		% of land	% of land
Country	Area km²	Endemic	Total	Endemic	Total	Endemic	Total	transformed	protected
Comoros	2 230	2	12	14	50	136	721	not known	not known
Madagascar	587 040	93	141	105	202	6 500	9 505	11	2
Mauritius	2 040	1	4	8	27	325	750	not known	30
Seychelles	450	2	6	11	38	182	250	not known	12
All countries	591 760	98		138		7 143			

Source: Methodology and sources as for Table 1

and its neighbouring island groups have a total of eight endemic plant families (with seven families endemic to Madagascar and one to the Seychelles), four endemic bird families, and five endemic primate families (Mittermeier and others 2004).

Opportunities for development

The rich biodiversity most of the WIO countries forms a significant natural resource base that provides valuable raw materials for local and commercial use. It is important for tourism, food, construction and shelter (IOC 2004a). In addition, many plant species are used medicinally and several species are being researched for commercial agricultural or pharmaceutical use (IOC 2004b). Management of these species, which offer social and economic opportunities for development, plus the management of other threatened species, are features of environmental policy and programmes in the WIO islands (IOC 2004a).

The 4 million km² of the WIO Exclusive Economic Zone (EEZ) has offered in the past, the opportunity for economic development through deep-sea fishing, but the stocks are now probably exploited to their upper limit. Biological and ecological research and the evaluation of tuna stocks have emerged in the past decade as major fields for conservation studies. These cover oceanographic and environmental aspects that impact on tuna catches, including conventional and electronic tagging for monitoring migration, numbers and size of species, for scientific and commercial purposes. (IOC 2004a, Government of Mauritius 2005). A regional project on aromatic and medicinal plants has provided an inventory of more than 600 species within the member countries, used in traditional practice, as a basis for further scientific and commercial study and development (IOC 2004b).

Challenges faced in realizing opportunities for development

Coastal and marine habitat loss threatens the survival of animal and plant species, and thus undermines livelihood and development options. As small island developing states (SIDS) the WIO islands experience many of the same problems, often linked to tourism, coastal livelihoods and overfishing, waste management, and a high level of vulnerability to natural disasters and human-induced environmental change. Important drivers of and pressures contributing to environmental change include (UNEP 2005a): unsustainable natural resource exploitation, habitat conversion and destruction, the introduction of IAS, pollution and soil degradation, coastal erosion, seawater intrusion, bush fires, overfishing in lagoons, long line and fine net fishing, coastal urban tourist development, building on wetlands, water pollution, land reclamation with its degradation of lagoons and coral reefs (Republic of Seychelles 2004), sand mining in lagoons, islets and coastal areas (Government of Mauritius 2005), hunting (Louette and others 2004), inadequate management of waste and intensive farming.

Loss of forest cover inland, in particular in upland zones, and the adverse impact of IAS, threaten the survival of endemic species. Freshwater ecosystems have been seriously impacted by IAS such as *Eichornia crassipes* (*water hyacinth*) (Langrand and Goodman 1995). Alien domestic animals, such as cattle, sheep and goats, have caused important changes in native plant communities and have helped drive many endemic terrestrial herbivores to the brink of extinction (Dewar 1997). Human activities are thought to be primarily responsible for the current pattern of vegetation change: grassland wildfires set by herders either to stimulate regrowth during the dry season or to eliminate unpalatable herbaceous species (Kull 2000), and forest clearing for agriculture, timber and charcoal production.

Mirza zaza, a new lemur species, discovered in Madagascar in 2005.

Source: D. Haring/Duke University Primate Center

In the Comoros, up to 7 per cent of the land has become deforested, and patterns of rainfall and drainage have also changed (Louette and others 2004).

The main threats to natural habitats in Madagascar and the Comoros are forest loss through slash-and-burn agriculture and fire, with logging and mining on the rise in Madagascar. In Mauritius and the Seychelles, conversion of land for housing and other uses presents the biggest threat.

These factors adversely affect biodiversity and terrestrial and marine ecosystems, including sea-grasses, mangroves and the coral reefs. The prospects for the conservation of rare animal species such as the wandering albatross, turtles, coelacanth, the Mascarene black petrel, the pink pigeon and others, critically depend upon the transformation and scaling-up of intervention from small scientific projects to major mainstream programmes.

Strategies to enhance opportunities for development

Interventions at a national and sub-regional level are important.

There is a need for developing policy-relevant environmental performance indicators for biodiversity. In addition, the identification of sustainable development goals and objectives, with clear objective verifiable indicators, the identification of lead agencies for implementation and results-based budgeting are important planning tools (Republic of Seychelles 2000, Government of Mauritius 2005). Greater technical assessment of the most appropriate means of extending pilot and project work into mainstream programmes is also needed. The work of the sub-regional bodies, such as the IOC, indicates how this technical aspect of work can be taken forward, in concert with that being established in other regions with large numbers of islands states, such as the Pacific and the Caribbean.

Regional support is also essential in human resource programmes, especially for professional, technical and managerial development (UN 2005).

At the national level, establishing protected areas is seen as a key strategy for protecting biodiversity.

Considerable progress has been made in Madagascar, where there has been renewed political commitment to conservation. In 2003, at the World Parks Congress in Durban, South Africa, Madagascar declared its intention to triple the total land area managed for conservation purposes. More recently, during the International Scientific Conference on "Biodiversity, Science and Governance", held in Paris in January 2005, the intention was reiterated and the objective of biodiversity protection was confirmed to be an essential element in decreasing poverty and increasing opportunities. Collaboration at multiple levels supports this. Government, in collaboration with scientists and conservationists, is identifying priority areas for conservation. Additionally, a multidisciplinary group of NGOs is collaborating with the government in identifying potential priority sites for conservation, the legal aspects of implementing management plans, and

the adoption of IUCN protected area categories (Robertson and Hull 2001). By 2002, Madagascar's protected areas network included 46 sites covering between 2 per cent and 2.7 per cent of the country's total surface (Randrianandianina and others 2004). Current approaches for area selection are based on biological collections and on a range of eco-geographic parameters. Thus both large and small areas with unique biodiversity have been identified for protection. During the process of identifying priority conservation areas, scientists identified important data gaps, particularly regarding marine, freshwater and mangrove environments, and also non-vascular plants (National Research Council – Committee on the Formation of the National Biological Survey 1993). Rules have been adopted for a conservation management system that gives the local community an important role. The newly-designated conservation sites will operate based on some improved management principles: more dynamic and flexible management will be encouraged than the current system which over-relies on non-use measures.

The Seychelles have about 208 km^2 of national parks, in varying degrees of implementation. Taken together, all parks, irrespective of the degree of protection, represent about 42 per cent of the land area. There are a further 228 km^2 of marine national parks. In Mauritius, there are ten protected areas within the IUCN categories I – II, with a total area of 70 km^2. In addition there are 90 km^2 of marine protected areas. In the Seychelles and Mauritius, which are economically better off than Madagascar, the factors threatening biodiversity differ substantially from those in Madagascar. Conservation strategies in Mauritius place less emphasis on rural development and poverty alleviation, and more on the political process leading to the establishment of protected areas and improved land-use planning.

In the Comoros, the situation has more in common with Madagascar. There are three protected areas covering 400 km^2, which represents 24.3 per cent of the total land area. Although levels of diversity and endemism are more modest in the Comoros, biodiversity conservation is nevertheless a high priority. In this context, the approach developed in Madagascar, in which carefully compiled and analysed data are being used to inform the process of identifying new conservation sites, could serve as a valuable model.

The principal challenge for the next decade is to convert these projects into mainstream programmes and sustain and improve on the results already achieved. This will depend on long-term political, financial and management support, together with the development of professional and technical services on a local, national and sub-regional basis. Special emphasis is needed in these programmes to link the protection of the environment to the relief of poverty, community and professional education, and the sustained use of natural resources for the benefit of social and economic development at community level. This process of transformation is also vital for continued development of programmes more directly linked to commercial development which depend upon the survival of species used in agriculture, forestry and fisheries, for food, medicine, industry and in the promotion of eco- and educational tourism (UNEP 2005a).

CONCLUSION

Biodiversity is in need of wise management, not simply to satisfy international pressures and obligations, but because it is the basis of most rural livelihoods and is the foundation of major new economic sectors that offer the prospect of better, more sustainable lives.

As NEPAD has recognized, development cannot be achieved through dependence on outside resources, but must rely on the best use of local resources. Biodiversity is one of these, and represents a formidable natural asset. For example, the international trade in flowers bred from a large number of plant species originating in Africa is worth billions of dollars

This beautiful lily, *Zantedeschia aethiopica*, is indigenous to Southern and Eastern Africa and is exported worldwide.

Source: V. Rabesahala

annually, almost all of which accrues outside Africa. For the opportunities offered by biodiversity to be realized, new strategies, which go beyond a focus on a few species and parks, will need to be adopted.

New links need to be made between protecting biodiversity and human needs. There is a need for more function-oriented conservation of ecosystem services essential for human livelihood, including the people-dominated landscapes outside parks (Adams 2001). The coincidence of centres of biodiversity, human cultural heritage and intensive land use partly defines the necessary strategy for conservation and sustainable use policy. If viable populations are to be preserved, particularly in the light of an uncertain future climate, biodiversity conservation cannot be restricted to protected areas, but has to be incorporated as part of sustainable land use even in densely settled areas (Scholes and Biggs 2005). Likewise, conservation of human culture within centres of biodiversity requires approaches different from the concept of protected areas exclusively dedicated to species conservation (Adams 2001, Adams and Hulme 2001, Jepson and Canney 2001). Except under special circumstances, for example, where nature tourism is the best economic land use (Carret and Loyer 2003), species and park-centred strategies of biodiversity conservation are unlikely to achieve poverty reduction goals. Although biodiversity conservation objectives often overlap with other priorities for sustainable use (for example, the conservation of water catchment areas), the overall outcome of such integrated strategies will need to go beyond solely biodiversity-centred conservation targets. This principle is reflected in the "ecosystem approach" adopted by the CBD in 2000 (UNEP 2004b) and underlies the interlinkages approach discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*. Clear and convergent objectives, verifiable targets, collaboration and coordination between conventions and between countries, focused and sustained capacity-building, and harmonized reporting requirements are needed to advance the regional development objectives.

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CHAPTER 8
INTERLINKAGES: THE ENVIRONMENT AND POLICY WEB

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"Environment and development are not separate challenges; they are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base; the environment cannot be protected when growth leaves out of account the costs of environmental destruction."

World Commission on Environment and Development (WCED 1987)

INTRODUCTION

Understanding the big picture of the human-environment nexus, with its complex interactions in and across ecosystems as well as in and across human systems, is essential if policy and action responses are to contribute to the goals of sustainable development and improved human well-being.

The need to focus on interlinkages and interdependencies in environmental problem solving and in defining opportunities moved to the centre of policy concerns with the 1987 report of the World Commission on Environment and Development (WCED) (also know as the Brundtland Commission) *Our Common Future*. The Brundtland report emphasizes that Africa, along with all other regions of the world, does not face separate challenges: "An environmental crisis, a development crisis, an energy crisis. They are all one" (WCED 1987).

These links, between challenges in different sectors, are the basis of an interlinkages approach. In making the case for such an approach nearly two decades ago, and long before the term came into vogue, the Brundtland Commission's visionary and agenda-setting report, identified the relationship between different sectors and the need for planning, decision making and policy frameworks that take account of these links:

> "These problems cannot be treated separately by fragmented institutions and policies. They are linked in a complex system of cause and effect."

and

> "Economics and ecology must be completely integrated in decision making and law making processes not just to protect the environment, but also to protect and promote development."

Environmental problems are never strictly linear, even though some cause-and-effect relationships can be shown, but are a part of a complex web of interactions. This chapter highlights some of the challenges facing Africa which have strong links to the environment. Some of these challenges are analysed sectorally or thematically, but they are all interlinked. Finding opportunities for improved environmental management, as well as for human development, almost always goes beyond any given sector, demanding that new levels of cooperation and collaboration are found in governance, in policy responses, and in environmental management.

Deforestation, for example, is not just about trees but about changing forest landscapes and ecosystems which have implications for biodiversity and water catchment management. Deforestation may increase

run-off, thus accelerating soil erosion and siltation of rivers and lakes (WCED 1987); it may also affect soil fertility. In addition to these biophysical interactions, there are also links between forest changes and human society. Deforestation may be the product of multiple and interlinked changes in human society, including the lack of livelihood options, new pressures brought about by demographic changes, an economic environment that does not support value-adding activities and thus results in ever higher levels of harvesting, and so on. It may also affect human well-being by closing some opportunities, threatening cultures and knowledge systems closely related to forest resources, undercutting agricultural and livestock productivity, and increasing poor health as access to medicinal plants, wild meat and wild fruits that supplement local diets are lost.

By adopting an interlinkages approach to the challenges facing Africa, policy may maximize the opportunities across a number of domains.

BUILDING INTERLINKAGES

An interlinkages approach recognizes the complexities inherent in ecosystem dynamics and their interface with the equally complex social, economic and political dynamics inherent in human development and governance, particularly policies, laws and institutions. Its value lies in the dynamic understanding and problem solving opportunities it brings to addressing complex cross-sectoral issues. The interlinkages concept stresses the importance of coordination of action across the relevant dimensions of sustainable development including environmental, social and economic issues.

Developing an interlinkages approach requires addressing the complexity of environmental challenges. Box 1 defines interlinkages.

In each situation, policymakers and resource managers will need to determine the appropriate level of interlinkages to address any particular problem. This will need to take into account the multiple scales of interaction, the high incidence of non-linear trajectories, uncertainty, time lags, and the common and conflicting interests of multiple stakeholders (Sayer and Campbell 2004). Successful approaches involve considering, among other things, that:

- Trade and investment, research and development, science and technology, and health and poverty are all important interlinked drivers of environmental change with both positive and negative impacts.
- Green environmental issues are linked to brown environmental issues, such as pollution and solid wastes, both impacting on the environment and on development opportunities.
- Processes which improve cooperation between science, policy making, practice and management can create robust and dynamic response systems that provide for better understanding of the issues and more effective responses (Keeley and Scoones 2003).
- In any given situation, there may be multiple knowledge systems related to environmental management; different stakeholders may have different interests and values, indicating a need for processes that not only recognize, but also mediate and make trade-offs between these interests.
- An added challenge is that institutions – laws and policies – operate at multiple scales. The reach and jurisdiction of organizations also vary considerably and thus interlinkages in governance are important.
- Opportunities for improved participation and the recognition of public values, concerns and priorities in shaping policies are necessary to create linkages between these diverse levels, and to build collaborative and sustainable governance and management systems. These responses should include creating opportunities for participation in regional and sub-regional processes as well as creating more effective decentralization and devolution policies at the national level.
- The complexity of environmental problems – and thus the identification of opportunities – needs to be

Box 1: Interlinkages defined

The United Nations University (UNU) has defined interlinkages as:

> "A strategic approach to managing sustainable development that seeks to promote greater connectivity between ecosystems and societal actions."

Practically, this requires a greater level of cohesiveness among institutional, and environment and development responses to the challenges of sustainable development. Additionally, linkages between international, regional and national mechanisms need to be made. The key to developing a strong interlinked approach to sustainable development is the identification of the inherent synergies that exist between different aspects of the environment and an exploration of the potential for more effective coordination between sustainable development issues and their responses.

Source: Malabed 2001

addressed through, among other things, analysing the interlinkages between and among the biophysical aspects of the environment and existing policy responses, including sub-regional, regional and international multilateral environmental agreements (MEAs), and institutions in the different sectors and at different levels, and how these affect the sustainability of the environment-human complex.

- Variations in temporal and spatial scales between different changes within the environment-human complex will need to be identified. Focusing on a single scale may obscure processes that only become obvious at finer or broader scales (Lovell and others 2003). Changes within natural systems and human systems occur at different temporal and spatial scales; for example, environmental shocks are episodic, rainy seasons are cyclic and droughts are stochastic. Stochastic events are those having a random probability distribution or pattern that can be analysed statistically but not predicted precisely. The spatial range of impact of these phenomena may vary. The multiple links between local

Box 2: Interlinkages in progress towards eradicating Guinea-worm disease

Guinea-worm disease is a debilitating and painful infection caused by a large nematode (roundworm), *Dracunculus medinensis*. It is a parasite and people are the only known host.

In the 1950s there were about 50 million cases. However, as a result of concerted efforts by the international community and the endemic countries, the number of cases of Guinea-worm disease was reduced to about 96 000 by 1999. In 2005, Guinea-worm disease was prevalent in only 13 countries in Africa including Sudan, Nigeria, Ghana, Burkina Faso, Niger, Togo and Côte d'Ivoire. A small number of cases have also been reported in Uganda, Benin, Mali, Mauritania, Ethiopia and Chad. Sudan has about 73 per cent of all reported cases. Efforts to eradicate Guinea-worm in Sudan have been affected by prolonged civil war.

Village-based volunteers demonstrating the use of a cloth filter on a clay pot to filter drinking water.

Source: WHO

The disease begins with a blister and close to the time of its eruption, the infected person may experience itching, fever, swelling and burning sensations. Infected people commonly try to relieve the pain by immersing the infected part in water, usually open water sources such as ponds and shallow wells. This stimulates the worm to emerge and release thousands of larvae into the water, which are ingested by water fleas, where they develop and become infective in two weeks. When a person drinks the water, the water flea is dissolved by the acidity of the stomach, and the larva is activated and penetrates the gut wall. It develops and migrates through the subcutaneous tissue. After about one year, a blister forms and the mature worm, 1m long, tries to emerge through the skin, thus repeating the life cycle.

For people with no access to medical care, healing of the ulcers can take several weeks. The disease can result in bacterial infection, stiff joints, arthritis and permanent debilitating contractures of the limbs. It has serious adverse effects on health, agricultural production and school attendance. People in endemic villages are often incapacitated during peak agricultural activities; this affects agricultural production and the availability of household food, and consequently the nutritional status of their family, particularly young children.

The World Health Organization (WHO), in collaboration with other international organizations, non-governmental organizations and national governments, has adopted an eradication strategy, based on community surveillance in every known endemic village. Specific interventions include health education, case containment, community-based surveillance systems and provision of safe water, including the use of filtering devices and chemical treatment of water sources. This requires a multipronged interlinkages approach.

Source: WHO 2006a; WHO 2006b

livelihood sustainability and global climate change indicate the complex and multilevel interactions and interlinkages between human and environmental systems.

The interlinkages concept promotes building cooperation across institutional boundaries and between different interests at and across multiple scales. It can, for example, be used to establish links and build synergies between departments of meteorology, water and agriculture in addressing issues related to water availability, distribution, allocation and use. In some circumstances, institutional links between institutions and organizations operating at different spatial scales will be required. Water basins, for example, cut across national boundaries and there are multiple users and stakeholders. The progress made in eradicating *Dracunculus medinensis*, Guinea worm, lies in the strong interlinkages approach taken between different sectors, such as health, education and water management, and across countries, as shown in Box 2.

A key objective of the interlinkages approach is to demonstrate the importance of the environment and its sound management to other sectors, and thus to ensure that holistic approaches are taken to problem solving so that advancements can be made in human well-being, human vulnerability to environmental change can be minimized, and the environmental base can be sustained. Box 3 emphasizes the environment-economy-human well-being interlinkage identified by the Brundtland Commission, which has since gained wide recognition in many global, regional and national policies and strategies.

Various global and regional policy responses, such as the New Partnership for Africa's Development (NEPAD) framework, the Millennium Development Goals (MDGs), and the World Summit on Sustainable Development (WSSD) Johannesburg Plan of Implementation, individually and collectively, provide opportunities for enhancing synergies, promoting interlinkages among the environmental challenges, and mainstreaming the environment within and across institutional, temporal and spatial boundaries. Box 4 highlights some of the interlinkages related to the implementation of activities, at a national level, to address the MDGs and demonstrates that the appropriateness of such an approach will vary from country to country.

Adopting an interlinkages approach in the formulation of policy and the development of programmes can help to ensure that interventions are more relevant, robust and effective, and that these policies are based on principles that are cross-sectoral and interdisciplinary. This approach can also help to sharpen the focus of policy and action, while at the same time ensuring that spatial and temporal factors across multiple sectors and ecosystems are also fully considered. Interlinkages may help bring into focus certain issues, such as gender, that are often neglected. When effective institutional systems are developed to implement an interlinkages approach, it can give policymakers the advantage of having a better grasp of the range of options available, the costs and benefits of their decisions, and how to determine the interdepartmental links that are necessary to promote "joined-up policies."

Box 3: Ecology and economy: dual factors in improving human well-being

"Economy is not just about the production of wealth, and ecology is not just about the protection of nature; they are both equally relevant for improving the lot of humankind."

"… the distribution of power and influence within society lies at the height of most environment and development challenges. Hence new approaches must involve programmes of social development, particularly to improve the position of women in society, to protect vulnerable groups, and to promote local participation in decision making."

Source: WCED 1987

Ensuring access to safe and clean water requires taking into account technology, gender issues and water tenure regimes at the national and local level. An internally displaced woman takes water from a well (provided by ACT) in Muacanhica, Moxico province, Angola.

Source: P. Jeffrey/ACT

Box 4: Interlinkages for health-related MDGs

The pursuit of the health-related MDGs may demand interventions based on interlinkages between different governmental institutions. In any given case, several different government departments' or agencies' mandate might be directly relevant to meeting the targets associated with the different goals. The choice of vehicles for these interventions may differ not only between sectors, but also at different phases of the intervention. Interlinkages between ministries and sectors will thus be vital for policy making, planning and evaluation, but the delivery of operational services may be best undertaken by one institution with integrated powers and resources.

Goal 4 of the MDGs focuses on reducing child mortality. Target 5 seeks to reduce under-five mortality rate by two-thirds from 1990 to 2015. The incidence of infant mortality varies greatly across the region, ranging from an infant mortality rate of 165 in every 1 000 in Sierra Leone, to 84 in every 1 000 in Madagascar, and 17 in every 1 000 in Mauritius. The interventions necessary to achieve this MDG target vary from country to country, depending on the levels of child health already achieved and on the primary causes of death.

In some countries, such as Seychelles and Mauritius, the principal interventions might focus on further developing the already high technology neonatal care services available in the highly specialized national paediatric units and on providing rapid emergency transport to ensure that the most vulnerable small and sick babies are referred from community services to the centralized specialist units. These specialized services in most African countries are largely controlled, funded and managed through a central health ministry. Interlinkages with other ministries and sectors are not the principal mechanism for achieving this MDG in these countries.

In countries where the infant mortality is very high, and closely linked to environmental factors, the principal interventions may be the provision of safe water, controlling atmospheric and other pollution, improved sanitation, better nutrition and providing basic primary health care to urban and rural areas. Ministries of health are not responsible for water, sanitation and food, but have an important role to play in promoting the development of the services and supporting their colleagues at cabinet level, so that they have the necessary funds and technical support to accomplish the task. Interlinkages to achieve these health objectives are vital at the policy and planning stages, as the delivery of many of these services depends on the work of ministries other than health.

Source: Roberts 2004

IMPROVING UNDERSTANDING THROUGH INTERLINKAGES

A myriad of social and economic factors, ranging from demographic changes, poverty and health, industry and trade, economic liberalization including structural adjustment programmes (SAPs) and resource extraction impact on and shape the environmental challenges facing Africa. Thus understanding problems and defining effective responses to the challenges presented often requires multilevel and inter-sectoral cooperation.

Directly and indirectly, anthropogenic activities affect ecosystem health and productivity. Economic factors, particularly trade, and science and technology, are major recurring themes that affect, and in many cases exacerbate, problems.

A key challenge facing Africa is the entrenched nature of poverty, which traps people into unsustainable livelihoods and perpetuates their dependency on the primary use of natural resources. This subsistence-based existence is further compromised by extreme weather events, such as droughts, and cumulative environmental change. Box 5 highlights the interlinkages between environment and human society and looks at how environmental change and in particular the disappearance of the Alemaya lakes in the Ethiopian Highlands has changed the lives of more than half a million people of that area.

DEMOGRAPHIC AND ENVIRONMENTAL CHANGE

Demographic change impacts on the environment in many ways. The relationship between demographic factors and the environment is multidimensional and is affected by change in other sectors including trade, economic activity, investment, research and the development of technology. Poverty, health and governance systems are also closely linked to how demographic changes will impact on the environment.

Population growth and density is one of the most important drivers of environmental change in Africa, particularly as this relates to the exploitation and use of the environment as well as to waste generation and its management. In the last two decades (1980-2000), the population of Africa grew from 469 million to 798 million (FAO 2003), increasing demand for food, water, arable land and firewood as well as other material needs such as education, health care, housing, energy, transport and infrastructure. Related activities in, but not limited to, industry and trade create new environmental pressures and thus, if poorly managed, economic growth can negatively impact on the environment.

Expanded economic activities which are poorly planned and inadequately monitored can place increased pressure on ecosystems, including forests and woodlands, and coastal and marine areas, through the loss of biodiversity, habitat degradation, and water, land and air pollution. However, the pressure placed on the environment by a growing population is exacerbated by the lack of alternative livelihoods. Limited opportunity for adding value to natural resources harvested and an economy that encourages the export of unprocessed materials may lead to ever-

increasing harvests. Increased use of natural resources, for example the use of biomass in many cities in Western Africa for charcoal production to meet growing energy needs, is a result of the lack of alternative clean and environmentally friendly energies, which in turn can be attributed to the lack of investment in research and development.

The degradation of natural resources may adversely affect the very livelihoods dependent on them, forcing people to develop coping strategies that can be detrimental to ecological sustainability. The Commission for Africa (2005) finds that moving to cities is one such coping strategy. The inability of natural resources to meet needs may be more than just a matter of availability of resources but a feature of access and distribution patterns. Insecure tenure and laws prevent rural people from managing and using natural resources as assets. This undercuts productivity and efficiency. In 1980, only 28 per cent of Africans lived in cities; however by 2030, the proportion of

Box 5: Environmental change impacts lake population in Ethiopian Highlands

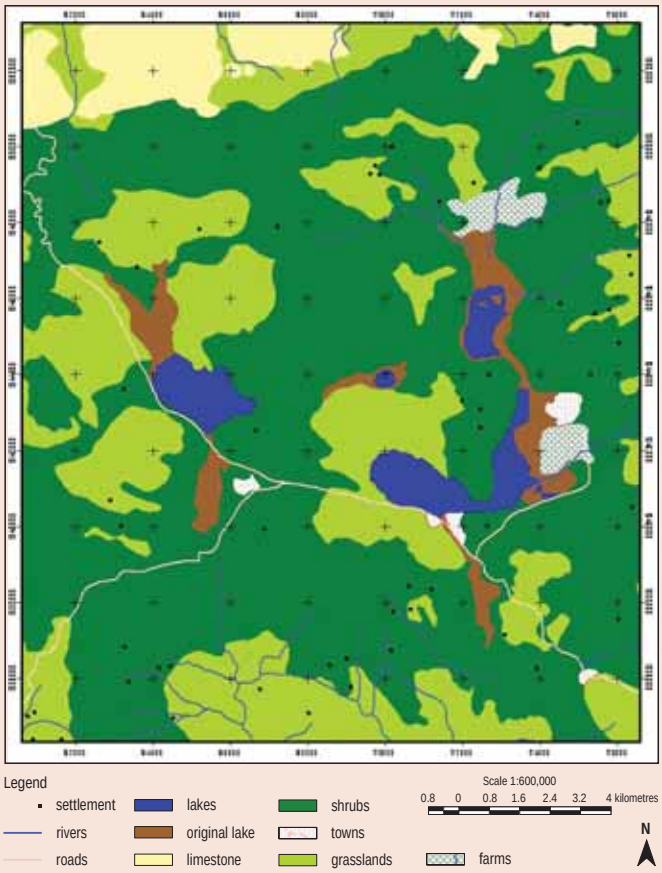
The Alemaya lakes in the Ethiopian Highlands originally covered more than 175 140 ha but had shrunk to 87 910 ha in 1985 and to a mere 58 600 ha in 2002. It is now believed that the lakes have all but completely dried up.

The loss of the lakes, which were a source of drinking water and were used for irrigation and fisheries, has affected the livelihoods and well-being of more than 550 000 people in the Ethiopian towns of Alemaya and Harar. Irrigation has had to be discontinued, effectively eliminating the supply of fresh vegetables and fruits in both towns. The people also no longer have access to fresh fish from the lakes.

Preliminary research seems to suggest that serious siltation has been a major factor in the destruction of the lakes. A dramatic increase in urban and rural settlements is also believed to have put tremendous pressure on natural resources in the area, including water resources. Engineering works, including the construction of roads and other infrastructure, may have led to the loosening of topsoil, leading to soil erosion and siltation of the lakes. The images below show the dramatic environmental change between 1985 and 2002.

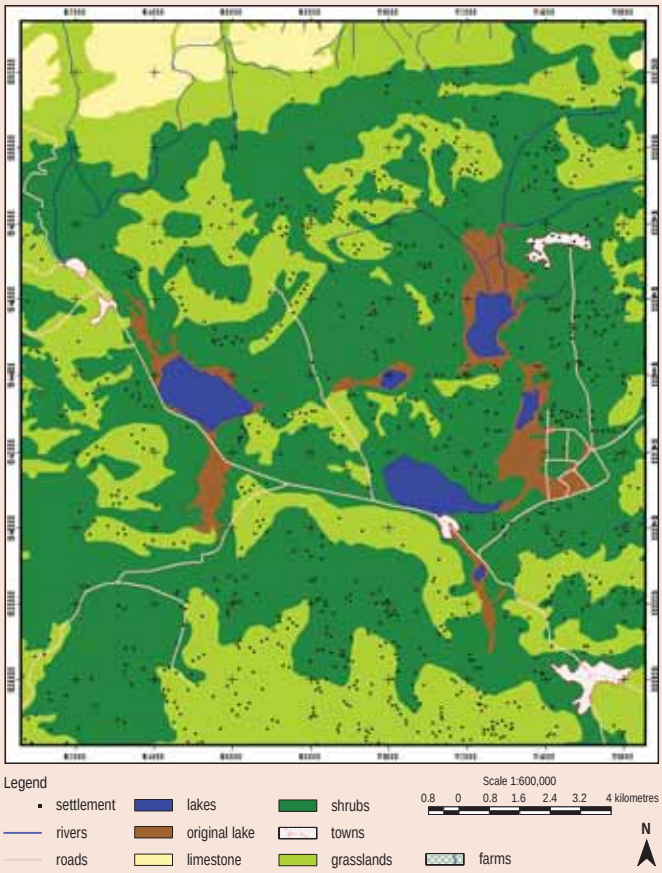
Source: RCMRD 2005

Alemaya Lakes area – land cover map 1985



Map prepared by: Regional Centre for Mapping of Resources for Development

Alemaya Lakes area – land cover map 2000



Map prepared by: Regional Centre for Mapping of Resources for Development

Governments and communities are faced with the difficult choice of reaping the immediate value of forest conversion against the values of maintaining forests.

Clear-felling of forests for agriculture.

Source: C. Lambrechts/UNEP

Slash-and-burn of indigenous hardwood forests, Liberia.

Source: Y. Katerere

Harvesting of timber logs from old forests for commercial sale.

Source: J. Maillard/ILO

Africa's urbanized population is expected to reach 53.5 per cent, compared to 39 per cent today (compiled from WRI 2005). Africa is the fastest urbanizing region in the world and it is also one of the poorest. Although urbanization is closely associated with people seeking new livelihood opportunities, rapidly growing urban environments may not be able to provide these. Urbanization may create new pressures on existing infrastructure, leading to the spread of informal settlements. Some 72 per cent of Africans living in urban areas live in slums without access to basic environmental or social services (UN-Habitat 2003). Urban livelihoods in Africa are often characterized by worsening standards of human well-being including:

- Inadequate access to shelter and security of tenure, and all the problems associated with overcrowding;
- Growing vulnerability to environmental health problems and natural disasters;
- Growing inequality and increasing crime and violence, which have a disproportionate impact on women and the poorest of the poor; and
- A lack of community participation in decision making (UN-Habitat 2003).

The extreme deprivation of health, education and other services as well as poor social relations makes breaking out of poverty difficult. These factors, along with the lack of opportunity available to poor people, have heavy environmental costs.

In the absence of viable alternative livelihoods, urbanization may, in itself, constitute an increased pressure on natural resources through direct and indirect use. Inadequate urban planning, including poor infrastructural development, and the inability of the economic sector to fully absorb growing needs, means that urban populations continue to rely on natural resources as a source of supplementary income. This may include collecting natural resources, such as wild fruit and firewood, for immediate domestic use or as the basis for commercial activity. Urban agriculture is a particularly important phenomenon. In Northern Africa, urbanization is leading to the loss of fertile land, desertification, soil erosion, clearance of forests and woodlands, and pollution of surface and groundwater. In Southern Africa, as shown in Box 6, SAPs resulted in more poor people in urban areas engaging in agriculture.

There can be remarkable damage to marine and coastal ecosystems from urban expansion and sprawl in coastal zones, as shown in Chapter 5: *Coastal and Marine Environments*. Coastal and marine pollution, and the resulting degradation of water quality, are

Box 6: Environmental and social impacts of urban agriculture

In Zimbabwe, both cropping and animal husbandry are practised extensively in cities, primarily in order to supplement nutritional needs. Women are the main participants in urban agricultural activities, possibly due to economic disadvantage, the lack of alternative opportunities and women's role in household food provision and preparation.

Urban agriculture provides important opportunities for poor people. Low-income households engaged in urban agriculture are generally better off than those not engaged in agricultural activities: they tend to have more meals per day, they can afford to purchase protein-rich foods, and they exhibit better overall health. Economic outputs are significant and self-production of food allows low-income households to save money on foodstuffs.

In the affected areas, no conservation measures were found. Urban agriculture was found to:

- Affect the cost of urban management (eg run-off increase leading to increased costs of infrastructure maintenance such as water purifying tanks);
- Result in nutrients accumulating in water bodies. Organic elements found in water were too high for human consumption, irrigation use or support for aquatic life;
- Deprive the soil of nutrients; and
- Result in tree loss from the opening up of land for agricultural production.

Source: IDRC 2002

driven by urban, residential and industrial wastes from inland systems as well as from coastal cities. Growing urban areas attract major industrial clustering. In many countries, industrial and mining activities contribute significantly to water and atmospheric pollution, placing new burdens not only on the environment and human health but also on already struggling public sector institutions, such as health services and local government institutions, which are often responsible for regulating and managing pollution management. In Eastern Africa, the clearance of mangroves for urban settlements is affecting marine and coastal ecosystems.

These environmental problems are not simply the result of population growth, but are closely linked to other social and economic factors. For example, the lack of adequate investment in infrastructural development that can support these growing communities is an important factor contributing to the lack of economic opportunity, high environmental costs and thus low levels of human well-being. High transportation costs in Africa have a severe impact on trade (UN Millennium Project 2005c), increasing the costs of products and suppressing demand. The railways and roads put in place in colonial times were primarily designed to transport minerals and other raw materials to the ports for shipping to Europe. They were not designed to encourage trade among African sub-regions. Africa's transport costs – local, national, regional and international – are twice or more than those of Asian countries (Commission for Africa 2005).

The short-term positive human well-being gains and the negative environmental costs demonstrate the need for policy approaches that can create a win-win situation. Chapters 2-7 of Section 2: *Environmental State-And-Trends: 20-Year Retrospective* consider the opportunities presented by environmental goods-and-services for human development.

Innovation and environmental change

Innovation drives human society, but brings with it both benefits and costs. Science and technology can be a double-edged sword, sometimes pushing forward economic opportunities through new applications and products, and sometimes causing adverse environment effects, such as pollution. However, improved knowledge, especially in the context of a strong science-policy link, based on African priorities and inclusive of public, private and civil actors, can lead to important initiatives that support sustainable development by addressing key challenges.

Many policy initiatives, including the WSSD Johannesburg Plan of Implementation and NEPAD, address this urgent need for investment in science and technology. Nevertheless, it is important not to see science and technological development as a silver bullet. Chapters 9 and 11 look at the challenges and opportunities of science in relation to genetically modified crops and chemicals, respectively.

One of the many benefits of science has been the improvement in society's ability to respond more effectively to environmental change and shocks. However, the opportunities available to Africa remain constrained due to low levels of technological and overall development and this has far-reaching adverse consequences for both ecosystems and human well-being. Disaster preparedness and response are closely linked to levels of investment in science and technology, and to governance systems. In much of Africa, the

Hafun village. The aftermath of the 26 December 2004 tsunami that travelled across the Indian Ocean from Indonesia to Africa hitting a 650-km stretch of coastline in north-western Somalia.

Source: UNHCR

capacity for resilience is further undermined by a variety of socioeconomic factors including poverty and the lack of public access to information and knowledge in vulnerable areas. The high level of vulnerability to environmental changes has consequences at multiple levels – and many African countries' economies are particularly susceptible, as shown in Boxes 7 and 8. These Boxes demonstrate the importance of an interlinkages approach in both problem analysis and in finding solutions: scientific and technology interventions that take into account the social and economic realities should be prioritized over the importation of technologies developed elsewhere, and closely linked to economic, environment and development strategies. Investment in education as well as in public institutions is essential.

Responding appropriately to the challenge of climate change, declining rainfall and desertification is one area where the need for increased understanding is necessary for developing appropriate early warning and mitigation strategies. The web of intertwined negative impacts of climate change is depicted in Box 7. The multiple impacts, across sectors and at different levels, indicate the need for an interlinkages approach to both research and response.

Box 7: Climate change-related interlinkages in the Sahel

In the Sahel, there has been on average a 25 per cent decrease in rainfall over three decades. Climate variability and the frequency and intensity of severe weather events are projected to increase. Africa is likely to get drier in northern and southern latitudes and wetter in the tropics. Projections further indicate that there will be variation within regions and countries: Southern Africa may be drier as a whole, but some countries may be wetter than average.

Rising sea levels, coastal erosion and flooding are projected to adversely impact coastal communities and economies. Climate-induced changes to crop yields, ecosystem boundaries and species ranges will all dramatically affect the distribution and productivity of agriculture. Climate-related threats to food security, water and energy security and the increased incidence of vector- and water-borne diseases will further undermine Africa's ability to develop. Globally, an additional 80 million to 125 million people will be at risk of hunger by 2080 – up to 80 per cent of whom will be in Africa because of its dependence on ecosystems that will be the first to disappear.

Source: Commission for Africa 2005

Economic and environmental change: the reach of global policy

Economic activities straddle national boundaries and are affected by global, regional and national processes. Global policies and practices have direct impacts, at national and regional levels, on environmental sustainability and human well-being – sometimes

increasing opportunities, but at times decreasing opportunities. An interlinkages approach can be effective in maximizing opportunities and minimizing negative impacts. Such an approach can offer opportunities for a better understanding of the global-regional-national links and set the basis for more effective institutional and policy responses.

Africa has made dramatic economic improvements since 2002 – in addition to impressive growth rates, inflation is also at an all-time low. In 2004, Africa achieved a growth rate of 5.1 per cent (OECD Development Centre and AfDB 2005), the highest in the last five years and significantly higher than the rates of 3.7 per cent in 2003 and 2.9 per cent in 2002 (AfDB 2004). However, the challenges facing Africa remain immense. Despite the richness of its biological, mineral and human resources, the region remains poor and levels of human well-being are in decline for many countries (UNDP 2005). The 2005 Human Development Index (HDI) shows that more than 20 countries in sub-Saharan African (SSA) have suffered dramatic reversals in human development since 1990. Sub-Saharan Africa must grow an average 7 per cent per year to reduce poverty by half by 2015 (AfDB 2004). Food insecurity threatens millions each year, especially in the Horn of Africa and Southern Africa. Africa is home to more malnourished people than any other continent (UNEP 2005) and hosts 27 per cent of those who lack access to safe water at the global level (World Bank 2004).

Africa and its people face many obstacles in turning their natural assets into wealth. These have their roots in policies and practices at the global level: the arenas of international trade, development aid, and international finance and investment influence the broad economic and political setting that Africa finds itself in, places it at a distinct disadvantage and perpetuates poverty (WRI and others 2005). Africa's economic, political, social and cultural systems are increasingly susceptible to globally-driven policies due to globalization. Box 8 shows how closely linked national economic performance is to the global economy as well as to environmental change. The challenge for Africa lies not only in how to make economic activity more efficient, in terms of production and environmental costs, but also in how to deal with the ramifications of global imbalance and its impacts on sustainable development and human well-being. The opportunities offered by globalization need to be harnessed while, at the same time, Africa must take measures to protect and cushion itself from potential negative effects.

Box 8: Global–national economic linkages

In the period 2004 to 2005, global economic recovery and the general rise in global commodity prices gave a positive impetus to African oil and metal exports. Some oil exporters also benefited from new oilfields in Southern and Central Africa (Angola, Chad and Equatorial Guinea). However, countries in Western Africa faced losses from lower prices for cotton and cocoa, and the persistence of cotton subsidies elsewhere.

Currency fluctuations also affected economic performance. The sharp appreciation of the euro adversely affected the franc zone countries, while the strengthening of the rand has affected the Southern African economies whose currencies are pegged to it.

This high dependency on global factors makes African economies extremely vulnerable. This is compounded by high dependency on natural resources and a relatively high level of vulnerability to environmental change. In the 2003-2004 period, favourable weather conditions in Eastern, Central and Southern Africa translated in a rebound in agricultural production (mainly in Ethiopia, Malawi, Zambia and Rwanda). In contrast, agricultural output in Western Africa suffered from locust infestation, although its impact was limited by early treatment of the affected areas.

Immature desert locust swarm (covering about 3-6 km^2) milling over a field of harvested millet north of Bambey, Senegal.

Source: M. de Montaigne/FAO

Source: OECD Development Centre and AfDB 2005

TRADE AND INDUSTRY

Trade is incredibly powerful, with taxes, tariffs, import quotas and subsidies imposed elsewhere affecting opportunities for human well-being and sustainable environmental management in the developing world, including in Africa.

The global market and the policies of multilateral economic organizations have implications for the Africa region. The balance of power in international trade organizations, such as the World Trade Organization (WTO), is tilted in favour of rich countries despite each country having an equal vote (WRI and others 2005). Trade and trade-related agreements, such as those on intellectual property, may affect the trade opportunities for African countries. Trade liberalization may make it more difficult for countries to pursue their environmental policies where these affect free market opportunities and may demand wide-scale reforms, with uncertain benefits that developing countries can ill afford. Negotiations in multilateral fora may favour those with better access to financial and human resources.

As the Commission for Africa (2005) noted, protectionist policies in some countries have adversely affected fisheries and trade in cotton and sugar in Africa. For example, despite the impressive efforts to reform the cotton sector in Benin, Burkina Faso, Chad and Mali, the persistence of cotton subsidies elsewhere has depressed world prices and damaged their cotton industry (OECD Development Centre and AfDB 2005).

Subsidies are not the only barriers that Africa faces in international trade. There are also non-tariff barriers and standards which may be difficult for many African nations to comply with. The composition of Africa's exports has essentially remained unchanged and its share of world trade has collapsed from about 6 per cent in the 1980s to 2 per cent in 2002 (Commission for Africa 2005). Had its share increased by 1 per cent, Africa's share in the world market would have earned it US$70 000 million, about five times what the region received in development aid (Watkins and Fowler 2002).

The trade situation of African countries is further worsened by the dependence on a very narrow range of primary commodities (coffee, cocoa, tea, palm oil and minerals). In SSA, for example, those commodities account for about half of merchandise exports. Table 1 shows this trend for selected African countries. The consequences of this dependency are four adverse trends that militate against increasing the countries' share in international trade (Watkins and Fowler 2002):

- Slow market growth;
- Adverse price trends;
- Low value-added; and
- Market competition.

Liberalized trade measures have led to loss of global market share and substantial income in many African countries. The share of food and agriculture in total merchandise trade fell from 17 per cent to 10 per cent from 1980 to 1997 (OECD 2000); the terms of trade for Africa's commodity exports were 20 per cent lower at the end of the 1990s than in the early 1970s. Without this, Africa's share of the world export markets would have been twice as large as it is today (UNCTAD 2001). Many agricultural markets are dominated by rich countries, which subsidize their own farmers at US$1 000 million a day (OECD 2000) or US$365 000 million annually. Trade protectionism by the rich industrialized regimes is the antithesis of free and

Table 1: The significance of trade in primary commodities

Country	Commodity	Gross national income	Percentage share of total merchandise exports	Total agricultural exports
Malawi	Tobacco leaves	23.8	59	74
São Tomé and Príncipe	Cocoa beans	16.9	69	97
Burundi	Coffee	7.2	75	83
Kenya	Tea	6.5	26	42
Guinea-Bissau	Cashew nuts	6.3	48	91
Chad	Cotton	5.7	37	71
Ethiopia	Coffee	5.4	62	69
Burkina Faso	Cotton	4.9	39	77

Source: FAO 2002

Global trade regimes and local opportunities are closely linked. Here, women in Mfoundi Market, Yaoundé, Cameroon, sell their agricultural produce.

Source: P. Nyemeck/CIFOR

liberalized trade, policies that have been recommended to developing countries.

Currently, manufacturing, trade, transportation, urbanization, and other activities in the industrialized regions put considerable pressures on the biosphere and stratosphere which influence the environment in Africa and other parts of the world. The G8 countries account for 45 per cent of global greenhouse gas emissions, which is a major cause of climate change, global warming and extreme weather events (Valente, 2005). These changes trigger a series of inter-related biophysical and socioeconomic circles such as drought, floods, hunger, displacement of people and loss of livelihoods, as shown in Box 7. These impacts are particularly severe in Africa given the dependency on natural resources for both subsistence livelihoods, and industry and manufacturing, With more than seven out of ten people engaged in resource-dependent activities, such as subsistence farming, livestock production, fishing, hunting, artisanal hunting and logging (WRI and others 2005), biophysical environment change, whether sudden or cumulative, impacts negatively on the majority of the people.

To respond affectively to these challenges, Africa needs to improve its global competitiveness. As discussed in Chapter 1: *The Human Dimension*, technological and infrastructural investment, developing niche markets, and improving economic and political governance through reducing corruption and conflict are all important strategies to respond to the environmental challenges and to enhance opportunities.

Investment, aid and debt

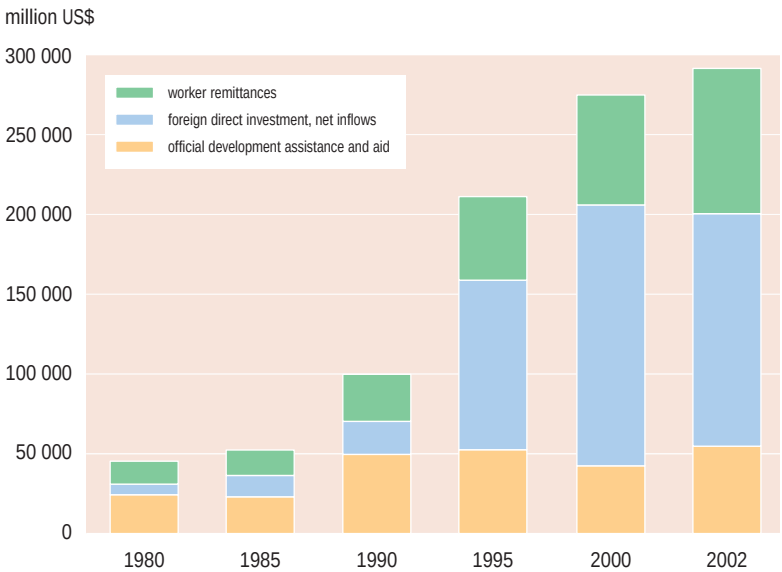
Global financial relationships have significant implications for economic, development and environmental policies. The continued imbalance makes African countries extremely vulnerable to external pressures. Various African initiatives, including NEPAD, seek to develop interlinkages between the global, regional and national levels – and to engage the global community and to promote more equitable relationships based on partnership and joint responsibility.

Africa's debt burden continues to be a major drain on economic growth and human well-being. Sub-Saharan Africa's external debt burden in 2003 amounted to US$185 000 million (Commission for Africa 2005). The average African country spends three times more on repaying debt than it does on providing basic services to its people (Katsouris 2004). By the end of 2004, Africa will spend about 70 per cent of its export earnings on external debt servicing (Katsouris 2004). Additionally, this debt burden has opened Africa up to externally driven economic and political reforms. Although, with globalization and the end of the Cold War, these ties have become less obvious, much development aid remains tied (World Resources Institute and others 2005) and thus aid remains a crucial driver of development patterns. Poverty Reduction Strategy Papers, for example, serve as a basis for countries to qualify for debt relief and donor assistance under the Heavily Indebted Poor Countries (HIPC) Initiative, concessional lending, and the World Bank's Country Assistance Strategy (Bojö and Reddy 2002).

The debt burden increased from the late 1970s until the late 1990s, as many countries sought loans to service their debts to avoid bankruptcy. The debt burden forced many African countries to liberalize their economies and adopt SAPs: this had far-reaching implications for human well-being and environmental sustainability. Standard features of the SAPs included reducing or removing subsidies on basic commodities and services, and austerity measures in government spending. They also focused on export and macro-economic stability, reduced the size of the public sector's share in the economy, liberalized trade and froze government hiring. In most cases, these policies had detrimental environmental and social impacts, as shown in Box 9. Additionally, SAPs resulted in job cuts, forcing the unemployed to clear new land for agriculture (Katerere and Mohamed-Katerere 2005), and increased dependence on natural resources. For example, many urban poor people increased agriculture in order to supplement their incomes as discussed in Box 6. Africa's growing debt burdens, and its repayment obligations, constrain the range of opportunities available to it by locking Africa into unsustainable production systems. Africa's debt burden is growing despite debt relief to HIPC. Recognizing the linkage between debt and the lack of development, two of the targets for MDG 8 specifically commit the global community to address the debt problem.

Private capital is playing an increasingly important role in shaping economic development in Africa. Foreign direct investment (FDI) has become the dominant route for financial flows to developing countries (Oxfam America 2002) as shown in Figure 1. By the mid 1990s, FDI had replaced development aid as the main form of financial inflows to Africa. Although Africa has benefited from increased FDI, its share has remained relatively small and concentrated in extractive industries. Sub-Saharan Africa's share amounts to about US$62 000 million (World Bank 2005). Capital inflows from workers' remittances are significant investment and now exceed official development assistance (Sorensen 2004). In 2000, Africa accounted for about 15 per cent of total global remittances of US$72 000 million – that is US$10 700 million (Sorensen 2004). In the same year, Africa also received US$14 413.6 million in official development assistance (ODA) and aid (WRI 2005).

Figure 1: Financial flows to developing countries 1980-2002



Source: WRI and others 2005 (data from the World Bank 2001)

Box 9: Human and environmental costs associated with structural adjustment

Structural adjustment programmes (SAPs) have contributed to increased deforestation in some countries in Africa. In Côte d'Ivoire, for example, structural adjustment measures in the agricultural sector not only increased economic performance but also led to significant changes in land use. Twenty years of export-led agricultural development seriously impacted on the environment, forcing the government to admit in a Policy Framework Paper (PFP) for 1998-2000 that the country's environment and forests are "faced with a number of problems, particularly soil degradation, deforestation, the loss of biodiversity and pollution" (Friends of the Earth 1999). While the government tried by the late 1990s to protect the country's remaining forests, illegal cocoa and coffee planters cut down trees in protected forest areas to expand cropland. In 1997, for example, 30 per cent of protected forests were "illegally occupied" by farmers growing up to 100 000 tonnes of cocoa (Friends of the Earth 1999). Long-term environmental stability was reported at that time to be at risk as cocoa and coffee production moved to new areas due to exhausted soils.

One consequence of structural adjustment has been reduced government spending on health and education – this has been very taxing to Africa's human and economic development, especially with the advent of the HIV/AIDS epidemic. The 2005 HDI shows that more than 20 SSA countries had suffered dramatic reversals in human development since 1990: HIV/AIDS and the loss of social services were important causes.

Sources: Friends of the Earth 1999, UNDP 2005

IMPROVING RESPONSES: INTERLINKAGES IN POLICY

Developing an interlinkages approach to policy responses holds promise for identifying comprehensive solutions and for building synergies between diverse policies, thus maximizing the resources available for implementation. Interlinkages between different scales – temporal and spatial – potentially enhance opportunities for implementation. The successful implementation of many policies is dependant on an interlinkages approach. Increasingly an interlinked approach is evident in policies themselves.

In the two decades since *Our Common Future* was published, governments in Africa have increasingly given policy attention to both green and brown environmental issues. Governments today are equally concerned about brown issues, which include air and water pollution, and solid waste management, and acknowledge the link with green issues. Previously, environmental management in Africa focused on the preservation of wildlife and other natural resources; in many countries, particularly in Eastern and Southern Africa, this policy was directly linked to tourism. Environmental management and policy has evolved considerably since the mid-1980s from a wildlife conservation focus to being more integrated, taking into account social and economic issues. Several policy interventions since the 1992 Earth Summit, from Agenda 21 to the WSSD Johannesburg Plan of Implementation to NEPAD's Environmental Action Plan (NEPAD-EAP) give credence to the need for an integrated approach to environmental problems. Development policies are increasingly following suit.

COMPREHENSIVE AND INTERLINKED POLICIES: THE POVERTY REDUCTION STRATEGY PAPERS

Policies that are comprehensive and adopt an interlinkages approach provide better opportunities for addressing multiple, related challenges and for developing effective solutions.

The World Bank's poverty reduction strategies (PRS) have broken with the narrower economic interventions of the 1980s and 1990s and adopted a more interlinked and comprehensive framework to reducing poverty, that is results orientated (Bojö and Reddy 2003b). Many countries in Africa have or are developing Poverty Reduction Strategy Papers (PRSPs), as shown in Table 3. In many of these PRSPs, the environment is treated as a key factor because improved environmental conditions, among other results, can help reduce poverty. The reduction of extreme poverty and hunger, and environmental sustainability – both of which are part of the MDGs – are closely linked to the poverty objectives of PRSPs.

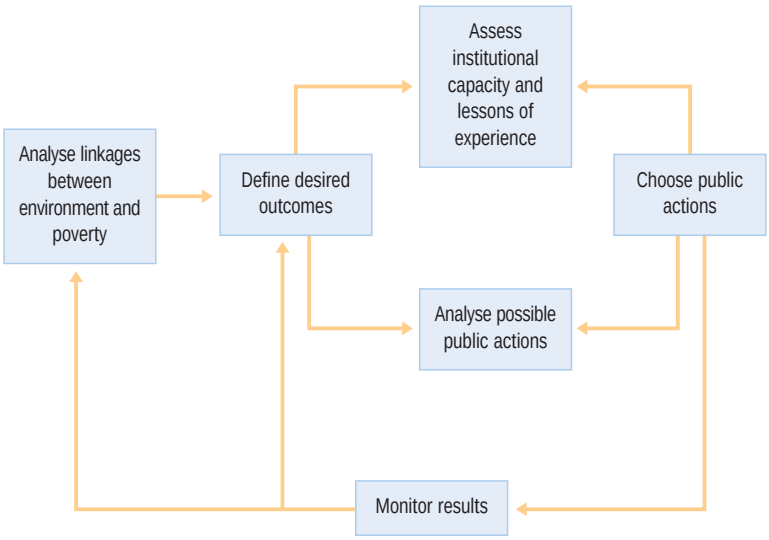
Investing in children, ICT and education increases future opportunities. Here a school supported by a horticulture company provides children with the opportunity to use computers.

Source: R. Giling/Still Pictures

For PRSPs to be successful they should take into account a comprehensive understanding of poverty in a particular country, choosing the most effective public actions to reduce poverty, and to monitor outcomes and impacts. Figure 2 shows the process of preparing environmental sections of a PRSP.

In highlighting the rationale for systematic mainstreaming of environment in PRSPs and associated processes, the World Bank stresses that environmental conditions have major effects on the health, opportunities, and security of poor people.

Figure 2: Process of preparing environmental sections of a PRSP



Source: Bojö and others 2004

For example, the World Bank reported in 2001 that the burden of disease in sub-Saharan Africa from major environmental risks was 26.5 per cent, compared to 18 per cent in all least developed countries (LDCs) (Bojö and others 2004). The environmental risks considered include poor water supply and sanitation, vector diseases (such as malaria), indoor and urban air pollution, and agro-industrial waste. Table 2 shows the main causes of mortality in Africa. Many of these, including respiratory diseases, diarrhoeal diseases and malaria, are caused by environmental factors.

While PRSPs are mainly concerned with addressing poverty, the objectives are also important for achieving sustainable development and, thus, dealing with environmental concerns. The realization of the MDG targets is closely related to reducing and eradicating

Table 2: Main causes of mortality in Africa

Communicable diseases, maternal and perinatal conditions and nutritional deficiencies

Type	Disease	Numbers of deaths	% of all deaths	Cumulative
Infectious and parasitic diseases	HIV/Aids	2 196 956	21%	21%
Respiratory infections	Lower respiratory infections	1 025 455	10%	30%
Infectious and parasitic diseases	Malaria	962 736	9%	39%
Infectious and parasitic diseases	Diarrhoeal diseases	702 822	7%	46%
Infectious and parasitic diseases	Childhood diseases	695 187	7%	52%
Perinatal conditions	Perinatal conditions	576 278	5%	58%
Infectious and parasitic diseases	Measles	426 743	4%	62%
Infectious and parasitic diseases	Tuberculosis	335 142	3%	65%
Total number of deaths from all diseases		10 681 000	100%	100%

Source: Ssemakula 2002 [Data adapted from WHO 2002, Annex Table 2]

Box 10: Incorporation of environment in Poverty Reduction Strategy Papers (PRSPs)

Mainstreaming environment into PRSPs still faces various challenges. There is considerable variation in environmental mainstreaming. It ranges from marginal attention to consistent mainstreaming across sectors. Nevertheless, there is a low but improving average for mainstreaming. The following trends are evident:

- **Full PRSPs are better mainstreamed.** In comparison to interim PRSPs, there is a tendency for full PRSPs to better integrate environmental factors. High-scoring countries include Zambia, Ghana and Mozambique.
- **Environmental priorities differ across countries.** Poverty Reduction Strategy Papers devote relatively more attention to issues such as water supply, sanitation, vulnerability to natural hazards, land tenure and institutional capacity. They devote relatively less attention to indoor air pollution, biodiversity, gender and environmental relationships, urban environment and the impacts of macro-economic policies on the environment.
- **The conditions for effective monitoring are often weak.** Few PRSPs present quantified, time-bound, costed, realistic targets and indicators relating to environment. Environmental health indicators generally get more attention than natural resources management indicators.
- **Failure to take a long-term perspective.** A few PRSPs explicitly introduce a long-term perspective and make reference to MDGs for 2015, but most do not. PRSPs that present long-term targets corresponding to the MDG 2015 horizon often present unrealistic plans without adequate budget support and institutional capacity for implementation.
- **Lack of effective monitoring and evaluation.** Implementation progress reports are generally not satisfactory in their discussions of the environmental proposals outlined in the PRSPs. Annual progress reports could provide good opportunities to address these gaps.

Source: Bojö and Reddy 2003b

poverty. Appendix 1 lists the MDG targets and shows progress towards achieving these. However, the extent to which these considerations have been included in country PRSPs varies considerably. Box 10 identifies some of the major trends and Table 3 evaluates environmental mainstreaming in PRSPs.

A review of PRSPs of some African countries already shows strong interlinkages in, between and across environmental, social and economic issues (Bojö and Reddy 2003b) as shown in Table 3. For example, the Burkina Faso PRSP notes that climatic conditions and low agricultural productivity due to soil and water degradation are major constraints to economic growth, contributing to extreme poverty and severe food insecurity in rural areas. Income from farming and livestock raising is highly dependent on rainfall, which varies considerably from year to year (Bojö and others 2004). The PRSP highlights a soil and water conservation programme to break the vicious circle of soil degradation, poverty and food insecurity.

In Mauritania, Kenya and Zambia, the PRSPs express concern about property rights related to natural resources and how this affects poverty. Kenya's PRSP proposes to implement a land law to create an efficient and equitable system of land ownership. It also notes that the violation of water rights, conflicts and pollution have increased (Bojö and others 2004).

The extent to which the MDGs are specifically addressed also varies. Box 11 gives some examples of African countries that have specifically incorporated the MDGs where these are directly relevant from an environmental perspective.

Table 3: Average country environmental mainstreaming scores

Country	PRSP type	Average environment score (scale 0-3)
Zambia	Full	2.4
Ghana	Full	2.2
Mozambique	Full	2.2
Kenya	Interim	1.9
Mali	Full	1.7
Burkina Faso	Full	1.7
Senegal	Full	1.7
Rwanda	Full	1.7
Malawi	Full	1.7
Ethiopia	Full	1.6
Guinea	Full	1.6
Niger	Full	1.5
Benin	Full	1.5
Mauritania	Full	1.4
Gambia	Full	1.2
Uganda	Full	1.1
Madagascar	Interim	1.1
Cape Verde	Interim	1.0
Tanzania	Full	0.9
Chad	Interim	0.8
Côte d'Ivoire	Interim	0.8
Cameroon	Interim	0.6
Lesotho	Interim	0.6
Sierra Leone	Interim	0.6
Democratic Republic of the Congo	Interim	0.6
Guinea-Bissau	Interim	0.5
Djibouti	Interim	0.5
Central African Republic	Interim	0.3
São Tomé and Príncipe	Interim	0.3
Average score		1.2

Source: Bojö and Reddy 2003b

Box 11: Focus on Millennium Development Goals in the PRSPs

Ethiopia: The PRSP discusses issues relating to traditional energy, water and sanitation. However, baselines and targets on water supply and sanitation presented in the PRSP appear to be ambitious considering the progress on access to water and sanitation during the period from 1990 to 2000.

Guinea: The PRSP presents targets and indicators relating to water supply and electricity in terms of coverage, service delivery and cost recovery for 2010. Indicators relating to renewable energy, infections from insanitary conditions, tenure and access to affordable housing are also proposed.

Mauritania: The PRSP presents targets and indicators relating to secure tenure, subsidized housing, and access to water and sanitation. Indicators relating to current and targeted amounts in terms of litres per capita and cost of drinking water are also considered for monitoring.

Rwanda: The targets and performance indicators relating to health, education, gender, and access to water and sanitation proposed in the PRSP coincide with the MDGs' time frame of 2015. The PRSP proposes to collect information to develop outcome, access, process and proxy indicators, and refers to relevant surveys to be used to generate the information.

Zambia: Access targets on water supply and sanitation are presented for 2015, with indicators such as number of water points, distance to water facility, volume of water treated, and number of committees strengthened to support water supply and sanitation. Targets for electrification are presented for 2010.

Source: Bojö and Reddy 2003b

Opportunities for cost-benefit analysis: the value of environmental impact assessment

The interlinkages approach has the benefit of enabling policymakers to achieve a better grasp of the costs and benefits of their decisions.

A policy geared towards enhancing utility of the forestry sector by extending commercial logging, for instance, can be very costly to a biodiversity-rich country. For example, in Cameroon – one of the most ecologically diverse countries in Africa – intensive logging threatens the country's tropical rainforests and the habitat of over 40 species of wildlife, including gorillas, elephants and the black rhinoceros, with extinction (Friends of the Earth 1999). According to research in the late 1990s, the number of logging enterprises increased from 194 to 351 in 1995, following the devaluation of the local currency in 1994. Timber exports grew by 49.6 per cent between 1995-96 and 1996-97 (Friends of the Earth 1999).

The oil industry is another high-profile issue in which interlinkages between the environment and social and economic development are important. The benefits and costs associated with the industry are often contested.

An Ijaw woman and her child fishing in a communal forest around her village in the Delta region of Nigeria. The fish catch has dropped dramatically as a result of oil spillage from a nearby oil extraction pipe.

Source: A. Arbib/Still Pictures

Although the oil industry has been linked to high levels of growth through increasing national income and employment, it can also be a cost on the environment, impacting negatively on coastal and marine environments and tourism, leading to long-term loss of jobs and thus slowing economic growth. In the Niger Delta region of Nigeria, SSA's largest oil producer, oil extraction has caused severe environmental degradation due to oil spills and lax environmental regulations (Energy Information Administration 2003). Inadequate investment, social and governance policies have meant that growth has not benefited poor people. For many, oil refineries, wells and transportation activities are opportunities to increase and diversify trade relationships with other nations and to participate in the global economy. There is often controversy around oil extraction activities. For example, the US$3 700 million Chad-Cameroon Pipeline Project, which was approved by the World Bank in June 2000, has been the target of protests from environmental and human rights groups. They argue that the project would dislocate inhabitants along the pipeline route and harm wildlife in the rainforests through which the pipeline would pass. Oil pollution is a major issue in Africa with the chronic release of oil in ports through ship leakage, ship maintenance or mishandling (Energy Information Administration 2003). According to the US Energy Information Administration, the problem of oil discharge in ports is often ignored, even though cumulatively the oil may negatively impact the surrounding ecosystem, including seabeds, wetlands and mudlands, which are environmental resources of economic significance (Energy Information Administration 2003).

Various tools and policy-making processes seek to address the complex human-environment nexus and use interlinkages to do so. These include integrative assessment processes (discussed in Chapter 9: *Genetically Modified Crops*) and inclusive policy processes (discussed in Chapter 1: *The Human Dimension* and Chapter 9: *Genetically Modified Crops*). Environmental impact assessments (EIAs) are important tools which employ an integrated and interlinked approach to evaluating relative costs and benefits in diverse spheres – demonstrating the interlinkages between environmental, social and economic issues – and creating opportunities for deciding on appropriate development opportunities. They seek to produce early and adequate information about the likely environmental consequences of certain plans and projects, to propose alternatives and to establish measures to mitigate harm. Additionally, EIAs

potentially bring a multiplicity of government agencies and institutions, organizations, experts and members of the public into the decision-making process. The need for an interlinkages approach is further demonstrated in Box 12, which considers the loss of energy in the oil production process that could be used to produce electricity. This lost opportunity is the result of a poorly developed natural gas industry. An interlinkages approach, such as through an EIA, would have helped identify these costs and benefits at an early stage and is, therefore, fundamental to identifying opportunities for development.

National oil industry practices, such as those raised above, may have a bearing on the implementation of several policy instruments, including MEAs such as the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands (Ramsar) and the United Nations Framework Convention on Climate Change (UNFCCC), global targets such as the MDGs, and regional plans and programmes such as the NEPAD-EAP, as well as African regional conventions. Box 12 shows that local activities have impacts that may be felt at different scales. Thus, in developing responses to situations like that described in Box 12, it is crucial that the link to global and regional policy instruments be made. Additionally, for Africa to benefit from the oil industry and simultaneously avoid environmental impacts of global significance, capacity needs to be improved. This can be addressed by the global community making good its pledge at the WSSD to invest in industry and sustainable production methods.

Environmental impact assessment tools are more useful in understanding the complexity of the issues at stake than traditional cost-benefit analysis, which sets out to add up in monetary terms the benefits of a public policy and compare them to the costs. There are major challenges in cost-benefit analysis. More often than not it involves comparing aspects that are fundamentally different and whose range of values cannot be reduced to purely monetary terms. The environment has both use and non-use values. (see Chapter 1: *The Human Dimension* for a discussion of the diverse values of environmental resources). Non-use values are particularly hard to quantify in monetary terms. Cost-benefit analysis cannot overcome its fatal flaw: it is completely reliant on the impossible attempt to price the priceless values of life, health, nature and the future (Heinzerling and Ackerman 2002).

Box 12: Flaring: lost opportunities and environmental costs

In Nigeria, Angola, Cameroon and Gabon, due to limited gas infrastructure, natural gas which is released during oil production is often burned off, or "flared", rather than captured for use. Flaring in Africa alone could produce 200 Terawatt hours (TWh) of electricity annually, which is about 50 per cent of the current consumption of the region. This is also equivalent to more than 10 per cent of committed emission reductions by developed countries under the Kyoto Protocol for the period 2008-2012.

Flaring also has environmental impacts. It has been described as "a significant source of carbon emissions" in Africa. Nigeria is the world's highest natural gas flaring country with 42.6 per cent of its total annual natural gas production being flared. In December 2004, the government announced that the country had reduced its natural gas flaring by 30 per cent. It has been estimated that Africa every day flares gas equivalent to 12 times the energy that the region uses.

Flaring in Africa is, therefore, not only a major economic loss and a missed opportunity for development, but also a contributor to greenhouse gas emissions. An interlinkages approach would have helped identify these costs and benefits at an early stage and thus is fundamental to identifying opportunities for development. Seizing the opportunities from this process requires investment in industry and access to technology.

The Hassi Messaoud oilfields, Algeria.

Source: K. D. Francke/Still Pictures

Sources: Joseph 2004, Energy Information Administration 2003

Box 13: Building partnerships for Environmental Impact Assessments: Eastern Africa

Environmental impact assessment is an important tool for development planning and decision making. Their use ensures that potential environmental impacts are identified, assessed and taken into account at the project design phase and thus unnecessary costs are avoided.

Despite the undoubted importance of EIA as a planning tool, there are many issues and constraints related to its application in SSA. The major constraint to implementation is that there are few institutions equipped to conduct environmental impact assessments. Some countries lack established EIA systems and the resources required to train managers in EIA. The vast majority of countries with existing EIA systems have problems in implementing them due to insufficient human, technical and financial resources.

Since the African Ministerial Conference on the Environment (AMCEN) of 1995, in Durban, South Africa, the IUCN's Eastern Africa Regional Programme (IUCN-EARP) has been instrumental in facilitating consultative meetings aimed at developing a programme for EIA enhancement in Africa. This programme, which falls under the umbrella of environmental planning and assessment, is designed to raise EIA capacity in each of the ten countries covered by IUCN-EARP through the:

- Establishment and enforcement of EIA systems;
- Enhancement of capacity to effectively manage EIA;
- Encouragement of private sector participation;
- Development of expertise specific to the region;
- Integration of biodiversity in development; and
- Creation of financial stability for EIA systems.

This programme of work was designed through a consultative process with stakeholders, practitioners and experts from government agencies, research and training institutions and the private sector. IUCN coordinates this effort, and linkages are currently being made with related initiatives in Africa such us the Network for EIA in the Great Lakes Region and similar programmes in Southern Africa and Madagascar.

Sources: Joseph 2004, Energy Information Administration 2003

Despite the value of EIAs as a decision-making tool, the region faces various challenges in fully implementing this approach, particularly the lack of capacity in human, financial and technical areas. Box 13 looks at how IUCN – the World Conservation Union (IUCN) and the governments in Eastern Africa are working together to enhance EIA capacity.

Improving implementation through interlinking policies at different scales: NEPAD-EAP and the MDGs

Creating interlinkages between different policies and programmes is an effective way to develop synergies and enhance opportunities for using available resources more effectively. Interlinking policies at different scales can offer new opportunities for implementing institutions.

The environmental, social and economic challenges facing policymakers at the national level are as important as those at the sub-regional and regional levels, and often there are remarkable similarities. Through a process including national governments, the NEPAD-EAP prioritizes six environmental programme areas and three crosscutting issues. It also recognizes poverty as the main cause and consequence of environmental degradation and thus that there is an urgent need to halt the downward spiral of poverty and break the poverty-environment nexus (NEPAD 2003). While it recognizes the value of MEAs and global environmental policy processes, its focus is on responding to African national priorities. The MDGs, although globally defined targets, have to be realized in the national context, thus establishing linkages with regional, sub-regional and national programmes is critical to their realization. The MDGs can be effectively linked to NEPAD-EAP programme areas, which are:

- Combating land degradation, drought and desertification;
- Conserving Africa's wetlands;
- Prevention, control and management of invasive alien species;
- Conservation and sustainable use of marine, coastal and freshwater resources;
- Combating climate change in Africa; and
- Transboundary conservation and management of natural resources.

All these areas are important for the realization of the MDGs, for example for the goals of alleviating extreme poverty and hunger, and achieving environmental sustainability. Table 4 shows how the MDGs are linked

Table 4: Linkages between the MDGs and the environment

Millennium Development Goals	Examples of links to the environment
1. Eradicate extreme poverty and hunger	Livelihood strategies and food security of the poor often depend directly on healthy ecosystems and the diversity of goods and ecological services they provide.
2. Achieve universal primary education	Time spent collecting water and fuelwood by children, especially girls, can reduce time at school.
3. Promote gender equality and empower women	Poor women are especially exposed to indoor air pollution and the burden of collecting water and fuelwood, and have unequal access to land and other natural resources.
4. Reduce child mortality	Water-related diseases such as diarrhoea and cholera kill an estimated 3 million people per year in developing countries, the majority of which are children under the age of five.
5. Improve maternal health	Indoor air pollution and carrying heavy loads of water and fuelwood adversely affect women's health and can make women less fit for childbirth and at greater risk of complications during pregnancy.
6. Combat major diseases	Up to one-fifth of the total burden of diseases in developing countries may be associated with environmental risk factors – and preventive environmental health measures are as important and at times more cost-effective than medical treatments.
7. Ensure environmental sustainability	Current trends in environmental degradation must be reversed in order to sustain the health and productivity of the world's ecosystems.

Sources: DFID and others 2002, UN Millennium Project 2005a

to the environment. The potential for creating effective interlinkages between these areas is dependent on governance systems, human resource availability and capacity, and funding. Table 5 highlights some of the interlinkages between NEPAD-EAP and MDGs.

In addition to the linkages between the NEPAD-EAP programme areas and MDG 7, there are also links to the other MDGs and to many MEAs. Several of these agreements are directly relevant to a specific area, while others have wider-reaching implications across all programme areas. The African Convention on the Conservation of Nature and Natural Resources (ACCNNR), for example, creates a broad framework for dealing with a range of environmental challenges and is applicable to all the programme areas of NEPAD-EAP. Both the CBD and the ACCNNR are dynamic, complex and non-linear interventions which encourage both thematic and institutional interlinkages.

Partnership and institutional links can empower governmental institutions and agencies. For example, such an approach will enhance the capacity of African governments to integrate environment into social and

Table 5: Links between MDG 7: Ensure environmental sustainability and NEPAD-EAP

MDG 7: Targets	Examples of related environment programme areas (PA)
Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources.	PA1: Integrate strategies of poverty eradication into programmes and projects related to desertification control and mitigation of effects of drought. PA5: Integrate national adaptation strategies into national sustainable development planning.
Halve by 2015 the proportion of people without sustainable access to safe drinking water.	PA2: Development of plans and policies to promote the wise use of wetlands.
By 2020 to have achieved a significant improvement in the lives of at least 100 million slum dwellers.	PA1: Promotion of the development of sustainable water supply and sanitation in drylands.

Sources: UN 2005, NEPAD 2003

economic processes, and into comprehensive development frameworks, such as the poverty reduction strategies (UNEP 2003). Interlinkages are necessary to meet the MDG targets, and Box 14 on MDG implementation in the West Indian Ocean islands sub-region, illustrates this point. Success across the Africa region on achieving the MDG targets is shown in Appendix 1.

An interlinkages approach can lead to policy development which more effectively promotes trade, capacity-building and infrastructure development and addresses governance-related factors, such as high transaction costs, conflicts, debt and rent-seeking practices, and uncontrolled extractive industries and trade.

Box 14: Progress towards MDGs in the Western Indian Ocean islands sub-region

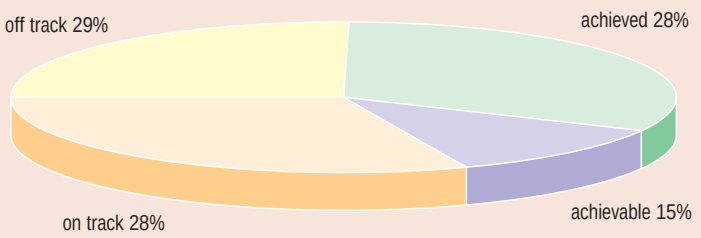
The Western Indian Ocean (WIO) islands (The Comoros, Madagascar, Mauritius and Seychelles) have made substantial progress towards achieving the MDG goals and targets. Progress is defined as target already achieved, achievable by target date or movement towards the target. Taking the four countries as a whole, 28 per cent of the targets in the MDG system have already been achieved, a further 15 per cent are achievable by the due dates if current progress is maintained, and on a further 28 per cent they are on track (UN 2005 and UN Statistics Division 2005). Of the environmental targets, nine have been achieved, and progress has been made on a total of 12.

Based on a detailed review of five countries across the globe, the Sachs studied the cost of implementing the MDGs. Based on local data and evidence of best practice, broad cost estimates for achieving the goals were identified, estimated in terms of average cost per capita, separating the different elements of the task (Sachs 2005). Applying this approach within the sub-region, the medium-term programme for pursuit of MDGs at a cost of US$74 per head per year, would require from Madagascar 10 per cent of annual Gross Domestic Product (GDP), from the Comoros 4 per cent of annual GDP, from Mauritius 0.6 per cent and from Seychelles 0.4 per cent.

Progress in the region as a whole has been mixed but there has been some success given that progress in any country is related to the baseline from which it started in 1990. Moreover, the cost of moving towards the targets differs from country to country as well as the type of interventions required.

Sources: UN 2005, UN Statistics Division 2005, Sachs 2005

Western Indian Ocean Islands progress on MDGs



Source: UN 2005, MDG Statistics, UN website January

Combating land degradation, drought and desertification

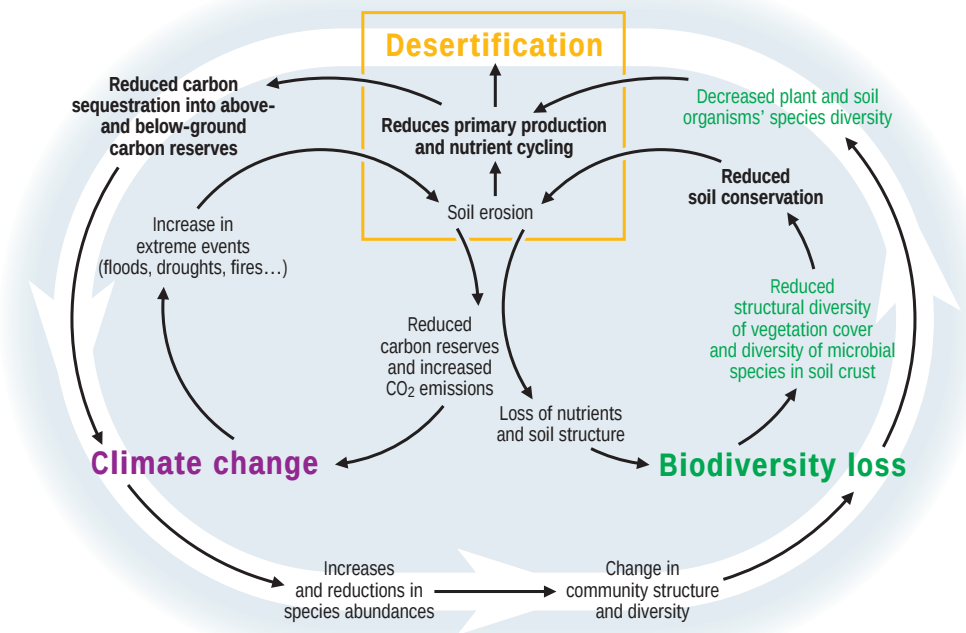
The objectives of the NEPAD-EAP first programme area – combating land degradation, drought and desertification – cannot be achieved without strong links to the conservation of Africa's wetlands, combating climate change and the transboundary conservation and management of natural resources. Land degradation is a major challenge for realizing sustainable development in Africa, affecting poverty reduction, peace and security, and economic and ecological health. About 110 million ha of Africa's 494 million ha of vegetated land have been classified as degraded. Land degradation is a major impediment on Africa's path towards meeting the MDGs; important impacts include escalating desertification, soil erosion, declining soil fertility, salinization and pollution by agrochemicals. Since 1950, an estimated 500 million hectares of Africa's land have been affected by soil degradation, including at least 65 per cent of agricultural land (Peopleandplanet.net 2003). Chapter 3: *Land* gives an overview of this resource and the challenges and opportunities it offers.

Desertification – a major environmental issue in Africa – is related to land degradation. According to the Millennium Ecosystem Assessment (MA), biological diversity is adversely affected by desertification, which also contributes to global climate change through soil and vegetation loss. Climate change may adversely affect biodiversity and exacerbate desertification due to increased evapotranspiration and a likely decrease in rainfall in drylands (MA 2005). Figure 3 highlights the interlinkages among desertification, global climate change and biodiversity loss.

The pressures leading to land degradation are socioeconomic and climatic. Poverty, conflict, intensive agriculture leading to soil loss and salinization, deforestation and land clearance for agriculture, and the cultivation of marginal lands are important contributors. Climate change pressures include reduced rainfall (or increased extreme rainfall events) and increased temperatures, which together lead to a reduction in vegetation cover and aggravated erosion by run-off and wind.

The responses to these pressures are at two levels. The first level concerns policies and management relating to land use and is potentially within the grasp of states to tackle through interdepartmental policy interventions

Figure 3: Linkages and feedback loops among desertification, global climate change and biodiversity loss



green text: major components of biodiversity involved in the linkages

bold text: major services impacted by biodiversity losses

Source: MA 2005

The major components of biodiversity loss (in green) directly affect major dryland services (in bold). The inner loops connect desertification to biodiversity loss and climate change through soil erosion. The outer loop interrelates biodiversity loss and climate change. On the top section of the outer loop, reduced primary production and microbial activity reduce carbon sequestration and contribute to global warming. On the bottom section of the outer loop, global warming increases evapotranspiration, thus adversely affecting biodiversity; changes in community structure and diversity are also expected because different species will react differently to the elevated CO_2 concentrations.

Source: MA 2005

and cooperative management at catchment and national levels, and in transboundary cases at international levels. Such interventions may relate to water use and agricultural policy, for example. The second level of responses, in respect of the climate change pressures, is at the international or intergovernmental level and is concerned with making representations for actions to tackle global warming, relevant at that level.

In trying to address the challenges of land degradation, policymakers in Africa need to explore the synergies provided by the NEPAD-EAP, the MDGs (especially MDG 1 and 7), the CBD, the United Nations Convention to Combat Desertification (UNCCD) and UNFCCC. The social, economic and environmental dimensions of land degradation are interlinked, and these cannot be considered in isolation if success is to be achieved. Interlinking these issues also provides for many different institutions and organizations which otherwise would not naturally collaborate to do so. Such interlinkages would contribute to enhancing human well-being and human sustainability.

As for land degradation, the responses are at two main levels. Interventions relate to land and water allocation and management and to policies dealing with pollution control, both from point sources and diffuse agricultural sources. Interdepartmental interests are likely to be relevant to the management of these pressures, with cooperative arrangements aiming for an equitable distribution of benefits from resource usage. The level of response in respect of the climate change pressures is at the international or intergovernmental level. At the global level the key MEA is Ramsar. Also significant, however, are the CBD and those conventions dealing with migratory species.

Conserving Africa's wetlands

Africa's inland and coastal wetlands provide a rich and broad range of resources and services, for example fisheries, and ecosystem services that are under severe threat from a combination of human activities and climatic pressures. Fish accounts for 50 per cent of animal protein sources in Africa; in some countries, including Liberia and Ghana, it constitutes as much as 65 to 70 per cent of animal protein consumed (WRI and others 2005), consequently protecting and enhancing this resource is important for meeting MDG target 2.

Given this nutritional contribution, conserving wetlands is also important for realizing the MDG health-related targets. Goods-and-services derived from wetlands can contribute to improved local incomes and thus to the realization of MDG target 1, where better opportunities for local people to manage these as assets are created. The value of this resource, including the opportunities it offers for development and improving human well-being, and threats to it, are discussed more fully in Chapter 5: *Coastal and Marine Environments*.

Human-related pressures include:

- Landfills;
- Pollution from urban, industrial, mining and agricultural sources leading, for example, to eutrophication;
- Reduction of freshwater inflow as a result of water diversion, damming within the catchment, the lowering of groundwater tables, and deforestation. In the case of coastal wetlands, reduced freshwater inflow may increase salinity and threaten biodiversity; and
- Climate change, resulting in increased evaporation and reduced rainfall, and indirectly, over the longer term, sea-level rise.

This web of pressures indicates the need for policy responses based on interlinkages.

Conservation and sustainable use of marine, coastal and freshwater resources

The effective and equitable distribution and use of water may be the most important of all the NEPAD priority issues. The state of this resource, the challenges facing its management, and the opportunities it offers for development are discussed fully in Chapter 4: *Freshwater*. Access to adequate, safe water significantly contributes to improved health and food production, an ability to earn income and self-reliance. Its management has impacts across spatial and temporal levels. Water allocation between countries may affect rights and opportunities at the local level, as well as the opportunities available to future generations. The importance of multi-stakeholder approaches, and in particular the inclusion of women at various planning levels, has been specifically acknowledged in the World Water Forums since the 1990s (UNEP 2004). Poor access to water and poor water quality may have a disproportional impact on women's health and time: women are often the main collectors of water for household use and undertake most of the household tasks, such as cooking and washing, which use water (UNEP 2004). Inadequate investment in water supply systems and poor water governance regimes are the chief anthropogenic threats to water resources in Africa (UNEP 2005).

The traditional "half-moon" technique is used to enhance water retention in rain-fed agriculture in the Sahel.

Source: J. C. Mohamed-Katerere

Coastal ecosystems, including wetlands, estuaries, mangroves and reef flats, are highly productive and rich in biodiversity, but they are at risk from physical disruption through, for example, urbanization and tourism infrastructure, eutrophication due to sewage and excessive agricultural nitrate run-off, oil pollution, solid waste and litter, and the discharge of effluents. As with other wetland systems, reduced freshwater availability due to damming in catchment and increased use of water for irrigation is also an issue. Climate change is an indirect pressure in that one effect is increasing sea surface temperatures leading to reef coral bleaching and mortality, while increased acidity of seawater may reduce the calcification of many marine organisms. The destruction of reef systems affects biodiversity and fish stocks, having major impacts on the well-being of coastal communities.

The responses to this range of pressures affecting water resources need consideration across sectors and at many levels, with national policies developed between government departments concerned with water resources, agriculture, industry, fisheries, environment etc, as well as at the intergovernmental level. There is also wide scope for community involvement in the conservation of these vital resources.

There are many policy responses dealing with water management. The CBD applies to both freshwater and coastal and marine ecosystems and sets the general framework for biodiversity conservation. The Convention on International Trade in Endangered Species of Fauna and Flora (CITES) regulates trade in endangered species. At the global level, the United Nations Convention on the Law of the Sea (UNCLOS) is the primary MEA setting out the rights and duties of nations in the use of the sea. The United Nations Convention on the Law of the Non-navigational Uses of International Watercourses provides an important framework for managing freshwater systems. There are many sub-regional and bilateral agreements which further refine this policy and managerial framework. Chapter 12: *Environment for Peace and Regional Cooperation* discusses cooperative initiatives in river basin management.

The women of this gardening cooperative in Mutenda, Zimbabwe, rely on a nearby dam for irrigation for most of the year.

Source: H. Wagner/IFAD

Combating climate change

In order to effectively address the problems of climate change, policy responses are required at the international or intergovernmental level. African countries need to engage more effectively at this level and ensure that national and regional interests are better represented in the relevant global fora. This includes investing in cost-effective and environmentally sustainable energy, promoting climate-friendly carbon and technology markets, and mainstream responses to climate change and variability (UN Millennium Project 2005b). Some responses at local to national levels may be appropriate, but these may be adaptive rather than combative, involving, for example, changes in land use. For example, reforestation may be appropriate over the long term, though the use of such approaches is controversial.

Addressing climate change is crucial to protecting food production systems. This may involve restoration and more effective management of desertified lands and is thus directly related to the achievement of targets 1 and 2 of MDG 1. Rising sea levels threaten coastal areas, and in particular small island developing states (SIDS), and thus have implications for the realization of many MDGs.

Climate change has, as discussed in Chapter 1: *The Human Dimension* and earlier in this chapter, important implications for human health. A disproportional burden of this is felt in Africa, particularly by poor people, women, the elderly and children. Combating climate change is important then for attaining the MDGs' health targets (Goals 4, 5 and 6).

EMPOWERING PEOPLE AND INSTITUTIONS: INSTITUTIONAL AND GOVERNANCE INTERLINKAGES

Throughout much of Africa, the interlinkages between institutions and within governance processes are poorly developed. Developing an interlinkages approach can improve opportunities for more effective regional cooperation, inclusive policies, improved regional-national synergies, and stronger and more sustainable partnerships.

International law and policy, at both the global and regional levels, identifies motivations as well as an overall framework for developing institutional interlinkages, as set out in Box 15. These international law principles help to address problems of unequal power between countries.

One major and crosscutting challenge for developing institutional linkages is the lack of harmonization of environmental management approaches (Mohamed-Katerere 2001). Legal systems in Africa are closely linked to their colonial past, with different countries having English, French or Portuguese legal systems. More specifically, in terms of environment, common approaches have not been developed across nations. Regional initiatives, such as the ACCNNR, set a clear basis for the harmonization of such legal and policy frameworks at the sub-regional level.

Governance regimes impact on environmental management and change, in multiple ways and at different scales, across all environmental sectors.

- First, environmental governance – and decentralization and devolution of power – affects the opportunities local users have in managing environmental resources and in particular their ability to manage natural resources as productive assets (WRI and others 2005).
- Second, political governance, and in particular how power is shared between the centre and the local, is particularly important. For example, poor governance, within inadequate levels of transparency and accountability, often results in managerial systems that are vulnerable to corruption and conflict. Conflict has multiple ramifications for economic development and trade (OECD Development Centre and AfDB 2005), environmental sustainability and human well-being. Africa has suffered more than 30 wars since the 1970s (UN 1998). According to the World Bank, in 2005 about one-fifth of Africa's people lived in countries affected by conflict and for the average African country, half of the indicators point to a risk of conflict (World Bank 2005). The poorest counties have the highest risk of new conflicts (UN Millennium Project 2005c). Chapter 12: *Environment for Peace and Regional Cooperation* highlights the interconnectedness of conflict with the loss of biodiversity, the overharvesting of ecosystems goods and services, the spread of illegal trade in natural assets and population displacement. These are all detrimental to ecosystems health and productivity. Good governance is critical for resolving conflict and building peace, mitigating its ill effects and avoiding conflict.
- Third, governance in non-environmental areas, such as trade, is also of direct significance. Corporate and trade-related governance may have important implications for environmental change. While a weak regulatory system might be attractive from an investment perspective, it can have disastrous environmental and social costs. Emeseh (2004), for example, suggests that the lack of or weak

Box 15: International law framework for improved institutional linkages

Creating opportunities for effective collaboration requires a clear and agreed framework.

The United Nations Charter urges states to cooperate in order to avoid the scourge of war, to reaffirm fundamental human rights, to establish conditions under which justice and mutual respect can be maintained and to promote social progress. It urges states to build good neighbourly relations and to employ international machinery for the promotion of the economic and social advancement of all people. In Africa, the African Union (AU), with its focus on sovereign equality; solidarity, peace and security; human rights, democracy and the rule of law; equity and mutual benefit; and the peaceful settlement of disputes complements this framework.

International law identifies several key principles that set the basis for cooperation and that can be helpful in building interlinkages. These include state sovereignty, state responsibility and good neighbourliness. Specific multilateral agreements address various aspects of human society, defining the agreed standards and frameworks, and further elaborating on the basis for collaboration. These areas include development, trade, human rights and environmental management.

Source: Mohamed-Katerere 2001

enforcement of environmental regulations in Nigeria is designed to protect international oil companies. Companies engaged in extracting timber from Liberia, diamonds from Angola and Rwanda, coltan from Rwanda, and gold from Uganda are all sheltered from environmental regulation enforcement (Watkins and Fowler 2002), creating both human and environmental costs. Similarly, the dumping of hazardous wastes in Africa has been a major problem, especially during the 1970s, 1980s and early 1990s, and has left many parts of Africa faced with the problems of stockpiles. International agreements, such as the Bamako Convention, which seek to regulate this, have not been fully incorporated into national legislation.

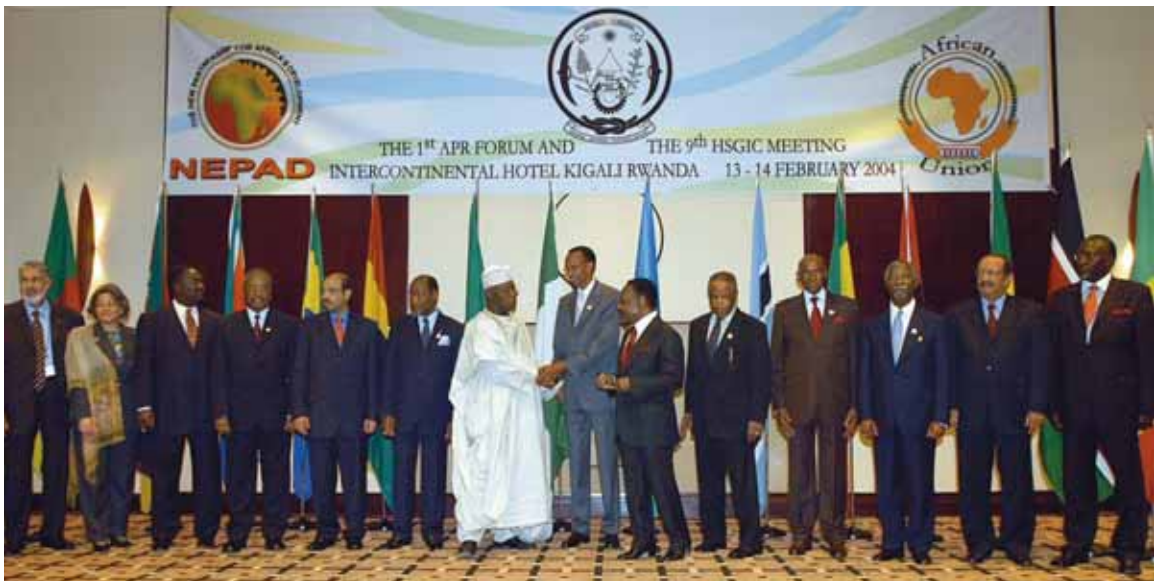
Building effective regional organization

Interlinkages between and among institutional structures dealing with environmental management and policy and those from other institutions whose area of mandate has a relationship to the environment, such as trade and health, remain weak and need to be redressed if development challenges are to be effectively addressed.

At the national level, management and governance systems are based on different sectors. The World Resources Institute (WRI) suggests that sectoral approaches to environmental management and governance at the international level mirror patterns at the national level and this remains true for Africa (WRI and others 2003).

Boxes 2 and 4 show, in relation to health issues, that responding effectively to challenges may require interventions in different sectors. In order to achieve this, mechanisms not just for coordinating response but also for coordinating problem analysis are needed. One challenge is to achieve this without overstretching the capacity of institutions that are already under considerable financial and human resource strain. Options include developing multilevel, inter-sectoral and inter-state strategies that cut across institutions and, at an early stage, developing deliberative and inclusive policy-making processes. These should be complemented by processes that review and refine policy, in order to support adaptive management.

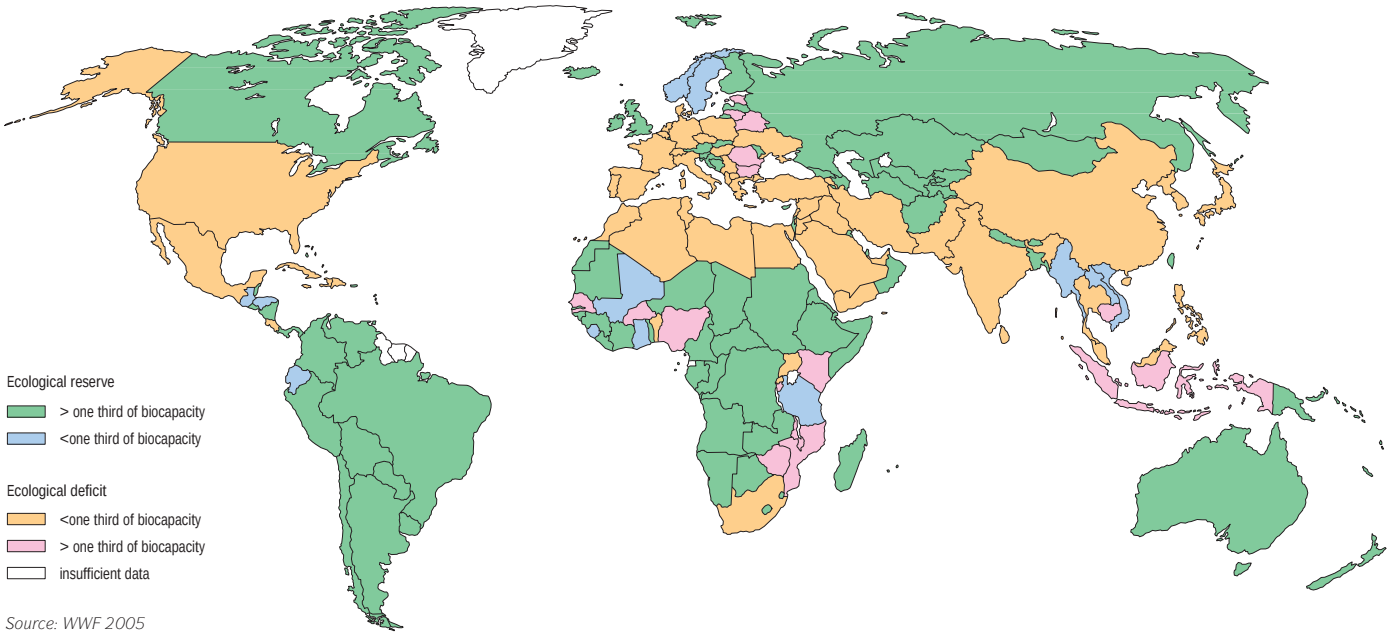
At the regional level, the main institutional responses have been sectoral. The main regional and sub-regional institutional development has been the creation of economic groups which cluster countries around common issues and specifically around economic and social development. These organizations have focused primarily on economic cooperation and trade, with less attention paid to environmental issues. The Commission for Africa (2005) reports that trade among Common Market for Eastern and Southern Africa (COMESA) countries grew by 15 per cent, from US$4 500 million in 2002 to US$5 300 million in 2003. These organizations have therefore been effective in increasing trade integration among their members. As more integrated approaches to development have emerged that focus on the links between environment, development and human well-being, these organizations have developed a broader range of interests. The Southern African Development Community (SADC), for example, has been instrumental in the development of collaborative approaches to watercourses, forests and wildlife – although the interlinkages between these issues and their relation to other issues remain relatively weak. The



Heads of State at the 1st African Peer Review meeting and the 9th Heads of State and Government Implementation Committee, 13-14 February 2004, in Kigali, Rwanda.

Source: Government of Rwanda

Figure 4: Ecological debtor and creditor countries 2001



Source: WWF 2005

role of these institutions in promoting environmental collaboration is discussed in Chapter 1: *The Human Dimension*. Chapter 12: *Environment for Peace and Regional Cooperation* considers the value of inter-state collaboration on environmental issues. The challenge now lies in taking this a step further and for these economic commissions to become effective vehicles for ensuring the integration of environment into the development process.

The African Ministerial Conference on the Environment (AMCEN) is an Africa-wide body for environmental policy development and environmental governance. It can, as discussed in Chapter 1: *The Human Dimension*, be an important vehicle for improving environmental cooperation, although it still faces various challenges in securing finance for the implementation of its programmes, the harmonization of regional and global environmental issues, and the full incorporation of these issues at the national and sub-regional levels, among many others.

A mechanism that fully addresses policy interlinkages at the regional level is yet to be developed. Given that decisions affecting the environment are most frequently taken outside "the environment sector," such as trade and finance, a regular interface between AMCEN and other equivalent bodies at the regional level needs to be strengthened. Implementation of framework MEAs such as the CBD and the ACCNNR requires multisectoral coordination and policy integration. Environment ministries and their entities, such an AMCEN, can face real challenges in such situations.

Inclusive policy processes

An added challenge for institutions is how to bring other actors into the policy-making process. The inclusion of civil and private sector groups and citizens into policy making, environmental management and decision-making processes can have positive effects.

Chapter 9: *Genetically Modified Crops* considers how such an approach can contribute to policy that responds more effectively to national and local priorities and values. As discussed in Chapter 1: *The Human Dimension*, opportunities for greater involvement in decision making are being created at the regional and sub-regional levels. However, these have not been able to effectively take on these challenges.

Linking institutional responses from national to regional level

Regional organization faces the challenge of effectively linking national responses and policies with those at the regional level – linkages need to be developed not just between countries but also within countries. Certain kinds of regional cooperation, such as the management of transboundary parks and spatial development issues, require an interlinkages approach that brings together the relevant players across, and within, countries.

How is this to be achieved in an efficient and effective manner? Large organizations and committees that bring together all stakeholders are often cumbersome, ineffective and become overly bureaucratic. One approach is to systematically develop processes for harmonizing law at the sub-regional and regional level.

In the SADC region this has been a key focus of environmental collaboration, which has developed several protocols to their founding treaty that establish an agreed approach in a given area. With this understanding, and clear and harmonized responses, the basis for partnerships and increased collaboration across sectors becomes easier. Law harmonization is a costly, intense and time-consuming process which requires extensive consultation and discussions at the national level that result in the clear identification of priority issues and the range of acceptable responses. A second option is to establish a process of regional engagement in which the different priority areas and responses are reconciled. This may require negotiation and mediation.

Evolving partnerships in natural resource-based management includes organizations for water, forests and wildlife. For example, the Nile Basin Initiative (NBI) brings together ten riparian countries to manage the entire basin of the Nile. Central African countries established the Congo Basin forest partnership to effectively manage the sub-region's forest resources. This initiative is strategic in that forests in Central Africa have been overexploited due to conflict in the sub-region. Nine countries, namely, Cameroon, Central African Republic, Republic of the Congo, Democratic Republic of the Congo, Equatorial Guinea, Chad, Burundi, Rwanda and São Tomé and Príncipe, established the Forest Commission of Central Africa under the Conference of Ministers for the Forests of Central Africa (COMIFAC). The aim of COMIFAC is to facilitate the harmonization and monitoring of forest policies in Central Africa (COMIFAC 2004).There are also examples of similar partnerships in the wildlife sector. These include the Ai-Ais/Richtersveld Transfrontier Park, an international park between South Africa and Namibia, established by a treaty in 2003, and the Great Limpopo Transfrontier Park connecting South Africa's Kruger National Park, Mozambique's Limpopo National Park and Zimbabwe's Gonarezhou National Park (Mohamed-Katerere 2001). Initiatives for collaborative marine management include the agreement between Angola, Namibia and South Africa to jointly manage the Benguela Current Large Marine Ecosystem (Mohamed-Katerere 2001).

Multilateral environmental agreements

Although the objectives of most MEAs are interlinked and an interlinkages approach to environmental challenges at a thematic level has been developed, the same levels of interaction have not been created between the administering authorities at the different spatial levels – national to global. This presents its own challenges to establishing synergies for effective implementation. There is a need to link regional institutional structures with the institutions for administering the different MEAs. Improving interlinkages between regional institutions is also important. This involves developing multilevel and cross-sectoral interlinkages.

African countries are party to a number of international and regional conventions. At a regional level these include Bamako (which deals with Hazardous Waste) and the ACCNNR. Global MEAs include Basel, CITES, the CBD, the UNCCD, the UNFCCC and Ramsar. Many African countries are still developing systems for incorporating these conventions into their programmes and policies, and thus have not yet focused on developing interlinkages between conventions. However, addressing this at an early stage – and as part of the process of implementing the conventions – may create opportunities for spreading costs and increasing synergies between these different MEAs. It is also important to develop synergies between implementing institutions for these conventions and institutions involved in poverty alleviation, health and other development needs.

Specific challenges relate to collaboration in communications as well as to information flow, particularly as it relates to reporting requirements. One way to address this is through the development of shared databases. Funding may be an important constraint, particularly as it is often given for sectoral projects and not for groups of projects that promote an interlinkages approach. Human capacity may also limit opportunities for interlinkages.

The Zambezi River in Luangwa District, Zambia, is part of the Zimbabwe-Mozambique-Zambia (ZIMOZA) transboundary management area, facilitated by IUCN, which brings governments and communities together in a partnership that aims to enhance its potential as a tourist destination.

Source: IUCN ROSA

In developing synergies it might be helpful to cluster conventions – depending on their focus – around specific themes. For example the CBD and its Cartagena Protocol, Ramsar, UNCLOS and the World Trade Organization among others are all important in the management of invasive alien species. It is helpful to create specific synergies between these conventions to develop an effective managerial regime which can be implemented at the national level. Similarly, the successful implementation of several MEAs is dependent on effective customs management. Here interlinkages between CITES, the Cartagena Protocol and the Basel and Bamako Conventions, and with customs authorities, is essential to manage trade in and movement of endangered species, living modified organisms, chemicals and hazardous waste. Developing customs capacity to meet the challenges of these conventions is best done in a holistic manner in order to avoid duplication of costs.

The United Nations Environment Programme (UNEP) can play an important role in promoting an interlinkages approach, particularly by facilitating communication among MEA secretariats and with the WTO.

COMESA, in partnership with the Regional Agricultural Trade Expansion Support (RATES) programme, is involved in addressing challenges of food security through fairer trade and food aid. COMESA truck transporting grain.

Source: RATES Trade Center

Emerging partnerships

Across Africa there are various initiatives that focus on building partnerships across sectors. For environmental policymakers these emerging partnerships present important opportunities. Policymakers are faced with the challenge of how to build collaboration between these partnerships and other processes, develop linkages and ensure the better inclusion of environmental issues in their activities.

Intra-regional trade

Trade is a major source of economic development and can boost resources available for improving social and environmental services. Given this, and the impacts of trade on environment, developing linkages with trade organizations is an important opportunity for the environment.

The Abuja Treaty of 1991 proposed the establishment of an African Economic Community by the year 2000 in order to foster the economic, social and cultural integration of the continent. An important milestone in that direction would be to establish free trade zones at the level of the existing sub-regional economic communities, since intra-regional trade can be a major boost for African economies.

Regional economic integration provides a forum for the negotiation of outstanding trade issues and can be a useful vehicle for delivering payments for ecosystem services. For instance, the NBI is an appropriate forum where upper riparian countries of Uganda and Ethiopia may negotiate funding for watershed protection from the lower riparian countries of Egypt and Sudan. In addition, the hydroelectricity power authorities in Sudan and Egypt could channel resources to support reforestation in upper riparian countries whose watersheds maintain a steady, clean and sustainable flow of water.

New Partnership for Africa's Development

The New Partnership for Africa's Development (NEPAD) is a multisectoral initiative focused on achieving economic revival in Africa; the linkages between economic development and other sectors, such as science and technology and the environment, have been clearly identified. It seeks to build partnerships and promote cooperation between African countries as well as between Africa and other international groups, such as the G8. Within Africa. an important aspect of this cooperation is the African Peer Review Mechanism (APRM) discussed in Box 16.

The APRM has developed and adopted a coherent environment action plan (NEPAD-EAP) and strategies to address the region's environmental challenge in an

Box 16: African Peer Review Mechanism (APRM)

Within the framework of the NEPAD, the members of the AU have adopted a system of voluntary peer review named African Peer Review Mechanism. It is the systematic examination and assessment of the performance of a state by other states. The ultimate goal is to help the reviewed state improve its policy making and adopt best practices. Peer review examinations and assessments rely heavily on mutual trust and understanding between the states being reviewed and reviewers.

The typical mandatory review takes place every three to five years unless under special circumstances an ad hoc review is requested. An APRM starts by developing a report (Background Documents and Draft Programme of Action) and is followed by an APRM team visit to the country concerned to discuss the report. Areas subject to review are democracy and political governance, economic governance and management, corporate governance and socioeconomic development. The programme of action should have benchmarks with specific time to measure the capabilities of a country to comply with the NEPAD objectives and commitments, including protection of human rights, free and fair political processes, sound fiscal management and macro-economic governance. The peer review is a self-assessment mechanism performed by Africa.

Source: Cilliers, undated

integrated manner. The NEPAD-EAP views better governance, poverty eradication, economic growth and income distribution as part and parcel of Africa's sustainable development. In July 2003, the second session of the Assembly of the African Union Heads of States and Government endorsed the Action Plan for the Environment Initiative of NEPAD. UNEP (2004) indicates that implementation of the plan is challenging and will require the support and active participation of African countries as well as development partners to provide finance and coordination.

The NEPAD initiative and the NEPAD-EAP recognize policy interlinkages and the relationship between biophysical and anthropogenic factors. Implementing a multidimensional plan through a sectoral structure at the national level compounds the challenge of financing, and at the same time opens up new opportunities for policy integration at the sub-regional and national levels.

SEIZING OPPORTUNITIES: INTERLINKAGES IN ENVIRONMENT FOR DEVELOPMENT

> "...today's development economics is like eighteenth-century medicine... when impoverished countries have pleaded... for help... the main... prescription has been budgetary tightening for patients much too poor to own belts..." (Sachs 2005).

Trade is the engine of development but, despite richness in natural resources, life in many African countries has been dominated by preventable poverty, malnutrition and disease. As the world markets open, so the disadvantages associated with poverty in many African countries are becoming more exposed.

A recent analysis of the Eastern and Southern African countries of the COMESA group put disparity in competitive power into sharp focus, as discussed in Box 17. Similar types of disparities have been noted by the World Bank in their comparative review of the capacities and potential of developing countries in Africa, South Asia, East Asia and Latin America for meeting the challenges of the 21st century (World Bank 2000). They found that African countries, by comparison with other countries, derive a lower level of income per capita from land resources, have lower capital stock per worker, have lower levels of human development, and that the agricultural production index for Africa whilst increasing in total was declining per capita. These findings are consistent with the disabilities that constrain the human and environmental potential of this intrinsically rich region. They do much to explain why Africa's economy has not responded better to the international support it has received or to its own efforts at development.

However, this does not sufficiently explain the African dilemma, for Africa has also been constrained by the external macro-economic environment and the development policies that have been linked to the aid that it has received. The traditional theories of free trade have taken inadequate account of the uneven playing field that holds back Africa's progress. In the face of these disparities, the former remedies proposed by international agencies for economic adjustment programmes to overcome poverty and debt have not worked well in Africa. The revised approach to the economics of development arising from the UN study directed by J. Sachs (UN Millennium Project 2005c) and his more recent commentary on reforming the framework for economic analysis for promoting growth

and reducing poverty (Sachs 2005) propose the use of a fresh evidence-based diagnosis for the analysis of macro-economic issues. This gives more hope for the future of Africa and more attention to its specific needs and potential.

The checklist for making what Sachs refers to as a "differential diagnosis" of a country's economic potential, is based on a clinical model of examination, putting the "patient" at the centre of attention (CMH 2001). This contrasts with the rather simplistic economic principles used in the past, drawn from Western macro-economic experience, which has proved largely irrelevant to the needs of developing countries. Gunner Myrdal, a Nobel Prize winner in economics, 35 years ago, exposed similar fundamental flaws in Western macro-economic and development policy in Asia (Myrdal 1968). To overcome these flaws, Sachs proposes that development studies should begin with a review of the local physical, human and natural capital, the social, epidemiological and demographic factors in poverty in the country under review, the capacity of the country's business environment, the national economic and fiscal policy, the physical geography of the country, local governance, cultural barriers and geopolitics. The essential change Sachs proposes is to avoid using a "one-solution-fits-all" approach to problem-solving and thus to develop diagnoses and remedies tailored to the needs of each country and to its specific problems and potentials. That is the new method of "clinical economics".

The results of intervention can be measured in terms of their effectiveness in attaining measurable targets such as reducing soil erosion, improving growth in crops, and reducing the burden of diseases. But results can also be valued in terms of the impact they make on

Box 17: The COMESA* countries and the uneven playing field for global trade

Developed European countries have the following advantages over COMESA countries. The Europeans have:

- 20 times the level of GDP per capita;
- Twice the percentage of population with access to safe water;
- 70 times the capacity for communication by telephone;
- 45 times the level of health expenditure per capita;
- 33 times the level of provision of physicians per 100 000 population; and
- 50 per cent more of their populations with access to essential drugs.

This comparative advantage is reflected in the levels of health and development in the COMESA countries, which by comparison with their European and developed country partners have:

- 300 times the burden of disease from HIV/AIDS, malaria and TB per million population;
- Seven times the level of infant mortality;
- Only two-thirds of the expected life span;
- Half the overall level of human development; and
- Two-thirds of the adult literacy rate.

These inherent disadvantages for Africa represent costs and constraints in international trade holding back the rate of development in COMESA countries, which are amongst the poorest and least developed in the world. Estimates have been made for tackling the problems of HIV/AIDS, TB and malaria in the COMESA countries, based on the most cost-effective interventions, as part of a programme of economic and social development. This strategy requires an investment of $1 100 million per year, or US$4 per capita, until 2007 to raise substantially the level of coverage of health programmes and to gain greater mastery over the health problems. This needs to be undertaken within the context of more general improvements in health services and other essential provisions for health such as safe water, effective communications systems and literacy programmes.

It has been estimated elsewhere, that in Africa, the gap between present spending on essential support for development is US$50 per capita per year, of which US$15 per capita represents the gap on health spending. About 28 per cent of the population of the COMESA countries is not covered by health spending at a level sufficient to provide essential services. The gap in health between the COMESA countries and Europe reflects this poverty of investment. The Copenhagen Consensus project supports the view that in economic terms the best buys to meet the most pressing global challenges include control of HIV/AIDS, malaria, and other diseases, and the provision of safe water and sanitation. But as well as financial resources the COMESA countries require international interlinkages to secure improvements in human and institutional capacity and technical transfer, together with interlinkages at local level to ensure coherent policy, planning and sustained executive action in delivery of services and the best use of resources. In addition, they need international support and reform of European economic policy to ensure that the uneven playing field in the global market does not forever exclude them from fair competition.

**The COMESA Group comprises Angola, Burundi, Comoros, Democratic Republic of the Congo, Djibouti, Egypt, Ethiopia, Eritrea, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia and Zimbabwe.*

Source: Roberts 2004

wealth, economic growth, and on the value of human and natural capital. For example, disease affects economic growth by reducing healthy life expectancy, reducing parental investment in children, and adversely affecting commercial productivity, business investment, social cooperation and macro-economic stability. It has been estimated that countries that have eradicated the environment-related disease, malaria, tend to grow more than one percentage point a year compared to countries with a high risk of malaria. This can produce a long-run average effect that a country with continued malaria risk generates half the level of per capita income than one which has eradicated the disease or has not been subject to it (Gallup and Sachs 2001). Telecommunications development can also boost economic growth (UN Millennium Project 2005b). This finding is reflected in the strong association between levels of telecommunications and GDP per capita. Telecommunications is a key element in creating the basis for interlinkages within and between sectors at national and international level and improving the efficiency of human capital.

Such measures of the value of results incorporate use values, but the environment also has a non-use or aesthetic value. This may be reflected in its use by tourists, using a method of implied valuation, but measurement of non-use values can also be assessed by indicators of willingness to pay. The principal difference between cost-effectiveness analysis and cost-benefit analysis is in the valuation of the benefits in economic terms.

In order to identify those factors which promote the best use of the environment for development, the new approach to development economics requires a detailed review of transport and trade (including ports, navigable waterways and paved roads); population density; power and telecommunications; arable land and its productivity; agronomic conditions including the length and reliability of the growing season, soils and irrigation, and climate variation; human and plant diseases, pests and animal disease. Such factors are closer to the local productive capacity, but were largely ignored in the past in macro-economic appraisals offered by Western advisers. It was the advisers, and not the local people, who became the driving forces and determined the constraints and conditions of much of the failed macro-economic aid suffered by developing countries in the past.

At country level, the macro-economic planning framework also needs to be consistent with the budgeting requirements of countries, to include a separation of capital and non-capital costs, the identification of the costs of human resources linked to local pay and also the international market for specialized labour, as well as the often neglected assessments of the costs of capital maintenance, repair and renewal. Increasingly, planners need to be informed on the unit costs of developments so that scaling-up can be done to cover the size of interventions required. Scaling-up should be based on standards derived from local experience, or failing that from experience of other countries that have adopted similar interventions.

As countries move towards a medium-term expenditure framework and results-based budget procedures, so the plans for intervention need to include the links between capital and non-capital expenditure. Results should be based on using measurable and verifiable indicators of performance. Whilst broad-brush global and regional estimates of meeting the MDGs can be derived from long-run average costing methods, at local level countries will need to assess the marginal costs of the steps needed in meeting these goals, and the relative cost-effectiveness of making progress in different areas of intervention. As countries reach close to target levels, it is likely that the next steps in intervention will be more costly and require different technology from those required in earlier phases. In such analysis, both the costs of intervention and the opportunity costs of forgoing the value of using those resources for other ends, have to be considered. The assessment of the

Massawa Harbour, Eritrea, is the main harbour on the Red Sea.

Source: R. Mulder/Still Pictures

externalities arising, for example, from the use of fossil fuels in terms of land and air pollution, should be included in analysis and, where practical, internalized in the pricing structure of the fuels themselves. It is only then that the cost of energy derived from renewable sources can be properly assessed.

Economic appraisal should not be limited to the public sector, but should also embrace private undertakings. Many companies are now responding to shareholder pressure and publishing environmental accounting statements which include the cost of environmental infringements and investment in green technology to reduce environmental damage. This is promoting a greater awareness in the private sector of environmental values and the cost and effectiveness of cleaner technologies. This is resulting in changes in design and procurement practice which should also be reflected in the public sector, which in most countries is the largest investor in new buildings, such as schools, hospitals, offices and housing, and which is the largest purchaser of equipment and furniture. Many countries have been slow to adopt environmentally friendly policies for public sector building and purchasing practices.

In addition, the use of economic and fiscal measures to supplement statutory controls and legislation is attracting more interest and could emerge as a critical new tool in promoting greater weight to be given to environmental values in Africa. What is important, however, is not the choice of instrument but the effectiveness of its use.

The essential message of economics and environment for development is to establish policy and programmes on the basis of the evidence of their costs and their effects. This means building a basis of evidence to support the diagnosis and choice of remedies. Such remedies should focus on promoting better use of environmental resources for social and economic sustainable development in Africa. To achieve this will require interlinkages at the national level, between departments of government and the private

Mount Oku, Bamenda Highlands, Cameroon. Collecting medicinal plants and making cures provides an income for many people.

Source: M. Edwards/Still Pictures

sector, and at the international level to ensure recognition of the need for equity in trading relations. More equitable trade needs to take account of current disparities in capacities for development, the underlying costs of poverty and disease, and the potential of environmental resources (see Box 17).

CONCLUSION

Africa has made tremendous progress in trying to address the environment and development challenges of the past two decades. However, results are mixed.

In many countries, new environmental institutions at different administrative levels, such as environment management agencies, have been established to tackle both green and brown environmental issues. At sub-regional and regional levels, economic groupings have accepted the challenges to develop interlinked and forward-looking strategies to ensure that Africa achieves some of the MDG targets.

Despite such progress, the environment is yet to be fully mainstreamed in all sector-specific policies and in economic development. In particular, the relationship between the environment and continued poverty has not been fully acknowledged. The conclusion reached by the Brundtland Commission in 1987 that institutions tend to be independent, fragmented, and work "to relatively narrow mandates with closed decision-making processes," remains true 20 years later. The 20 year-old challenge by the Commission to policymakers remains as relevant today as it was then, and it is fitting to repeat it:

> "The real world of interlocked economic and ecological systems will not change; the policies and institutions concerned must."

and

> "The ability to choose policy paths that are sustainable requires that the ecological dimensions of policy be considered at the same time as the economic, trade, energy, agricultural, industrial, and other dimensions – on the same agendas and in the same national and international institutions" (WCED 1987).

Interlinking the environment and human development, understanding the causes and effects of environmental change and developing appropriate policy responses remain challenges facing Africa today.

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SECTION 3

EMERGING CHALLENGES

CHAPTER 9
GENETICALLY MODIFIED CROPS

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"Because biotechnology is such a revolutionary science, and has spawned such a powerful industry, it has great potential to reshape the world around us. It is already changing agriculture and what many of us eat. Any major mistakes could lead to tragic and perhaps permanent changes in the natural world. For these reasons, future generations are likely to look back to our time and either thank us or curse us for what we do – or don't do – about GMOs and biosafety. Doing the right thing is not simple."

CBD AND UNEP 2003

INTRODUCTION

There is growing debate about the potential value of modern biotechnology, and in particular of transgenics, in helping to achieve Africa's development and food security goals. The challenge facing policymakers is not only to understand what the technology can do, or has done elsewhere, but also to establish what opportunities it presents to Africa.

There are three critical issues. First, whether or not genetically modified organisms (GMOs) offer a sustainable food security option; second, what the implications are of transgenic technologies for biosafety as well as for human health and well-being; and third, the extent of existing African capacity to undertake research, and effectively monitor and evaluate genetically modified (GM) products and their use.

Genetic modification techniques allow novel traits to be introduced into animals, crops and micro-organisms. These techniques can be used to improve livestock, poultry and fish productivity as well as their resistance to disease. Genetic modification is being used in the forest sector to create pest resistance, herbicide tolerance and wood quality traits (FAO 2005). Crops can be genetically engineered to improve appearance, taste, nutritional quality, drought tolerance, and insect and disease resistance. Thus, GM crops are often held up as the solution to yield deficits. However, achieving food security is about more than just fulfilling yield deficits. Food security is having sufficient physical, social and economic access to safe, nutritious and culturally acceptable food (Witcombe and Sanchez 2004) at the household level, without having to resort to emergency supplies. This demands either adequate food production or food imports. Agricultural choices are as much about food quantity as they are about nutritional needs, livelihoods, culture, poverty, trade and sustainable development. Genetic modification technology may be useful in addressing some of these aspects. However, the potential of such technologies is controversial. There is considerable uncertainty about the impact on human and environmental health, and also whether these products will provide a sustainable solution to food problems. The risks and benefits associated with GM technologies are difficult to quantify.

As resources for public sector research decreases, and the values that promote private sector development and interests become entrenched in global governance instruments, the growth of GM technology and applications seems certain. However, the potential role of GM crops for Africa in promoting food security and improved human well-being is far from clear, and it is uncertain how their adoption will impact on the sustainability of livelihoods and food production systems. This chapter focuses exclusively on

• Food security is having sufficient physical, social and economic access to safe, nutritious and culturally acceptable food. •

Witcombe and Sanchez 2004

Box 1: Genetic modification – just one biotechnology

Genetic manipulation is not new. For millennia, farmers have relied on selective breeding and cross-fertilization to modify plants and animals and encourage desirable traits that improve food production and satisfy other human needs (CBD and UNEP 2003).

Biotechnology includes a wide range of scientific techniques that are used in several fields including agriculture and medicine. The Convention on Biological Diversity (CBD) defines biotechnology as:

> "Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use."

Agricultural biotechnology includes bio-fertilization, tissue culture, marker assisted breeding and transgenics. For example, artisans have exploited traditional fermentation techniques to transform grains into bread and beer, and milk into cheese. Such intentional modification of the natural world has contributed enormously to human well-being. Transgenic applications involve the modification of the genetic structure of one organism through the insertion of a gene from another organism and can be used to modify plants, animals and micro-organisms. A gene is a biological unit that determines an organism's inherited characteristics.This process of modification is called genetic recombination – it adds characteristics that the original organism did not have. The resultant organisms are called "genetically modified" or "genetically engineered" or "living modified" organisms (LMOs) – these organisms have been genetically modified in a way that does not occur naturally.

Modified non-living organisms include products such as drugs, vaccines and food additives, canned, processed and preserved foods. Biotechnology techniques and products applicable in the health sector that may be of value in developing countries include molecular diagnostics, recombinant vaccines, vaccine and drug delivery techniques, sequencing pathogens, genomes, microbicides, bioinformatics, recombinant therapeutic proteins and combinatorial chemistry (Millennium Project 2005b). Environmental management techniques that may be useful include bioremediation.

Sources: CBD and UNEP 2003, Mackenzie and others 2003, UN 1992, UN Millennium Project 2005b

the debates around GM and food security; its other possible uses are not discussed.

The challenge for policymakers is how to respond to this uncertainty about the relative opportunities and threats posed by GM technologies: the dilemma is whether to adopt this new technology and face criticism for lack of precaution, or to require thorough study of potential risks and face criticism for failing to act promptly (Young 2004).

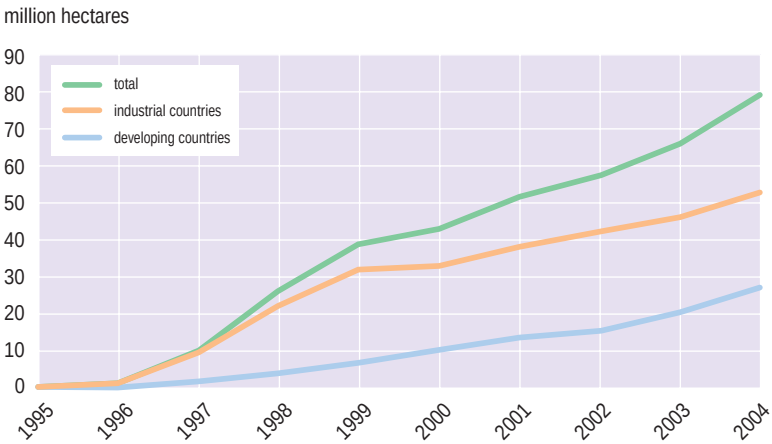
STATE-AND-TRENDS

Global growth in commercialization of GM crops

Despite a steady increase in global plantings of transgenic crops from 1996, when they were first introduced, the global percentage of land under GM crops remains relatively small. Figure 1 shows global plantings. Genetically modified crops account for only 4 per cent of total global cultivation (WHO 2005).

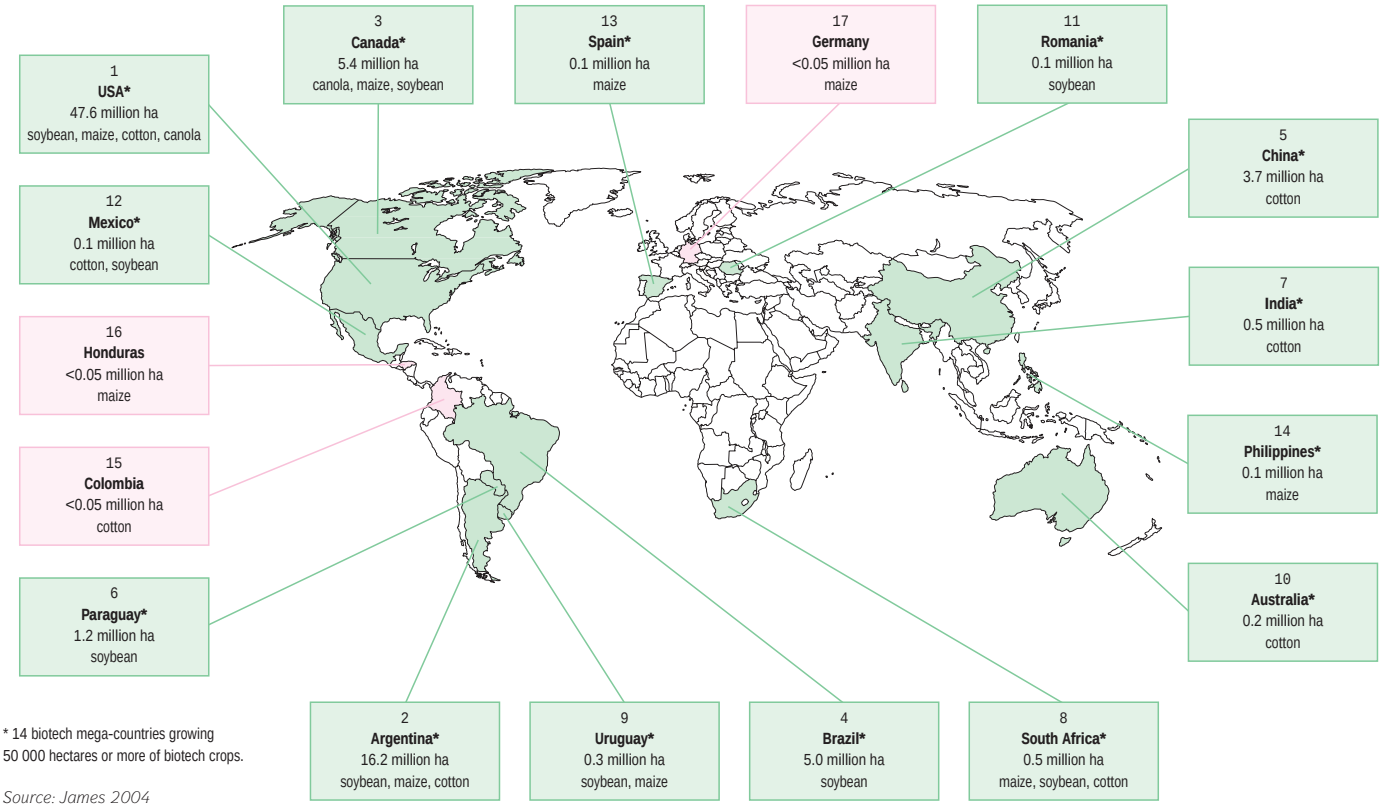
Global plantings of GM crops jumped by 20 per cent in 2004; this was the second largest yearly increase since commercial plantings began in 1996 (James 2004). In that year, land under GM crops rose to 81 million ha. For the first time, the hectarage growth in GM crop areas was higher in developing countries than in developed ones, developing countries accounting for slightly more than one-third of the world's GM crop area. (James 2004). Land under GM crops is expected to continue increasing as the sector grows in India and China and new countries introduce GM crops (James 2004). In 2004, soybean accounted for 60 per cent of all GM crops, maize for 23 per cent and cotton for 11 per cent. In the near future, GM maize is projected to have the highest growth rate as more beneficial traits become available and are approved (James 2004).

Figure 1: Global area of biotech crops



Source: James 2004

Figure 2: Biotech crop countries and mega-countries* 2004



* 14 biotech mega-countries growing 50 000 hectares or more of biotech crops.

Source: James 2004

In 2004, there were 8.25 million farmers involved in GM crop production in 17 countries (James 2004). Although 90 per cent of these farmers were from developing countries, only one of these countries, South Africa, was in Africa. The International Service for the Acquisition of Agri-Biotech Applications (ISAAA) predicts that by the end of the decade, up to 15 million farmers will grow GM crops on 150 million ha in up to 30 countries (James 2004). The global biotech crop market was worth US$4 700 million in 2004, and is projected to rise to US$5 000 million in 2005 (James 2004).

As shown in Figure 2, there are 14 countries growing over 50 000 ha of GM crops. In 2004, Paraguay, Spain, Mexico and the Philippines joined this group. However, global production is dominated by five countries. The USA with 59 per cent of global sowings has the largest share of total land under GMO production. It is followed by Argentina with 20 per cent, Canada and Brazil with 6 per cent each, and China with 5 per cent of land under GM crops globally.

In Africa, the use of GMO technology and its products is still in its infancy. South Africa is the only African

Box 2: GM crops in Egypt

Crops under field trials:

- Cucumber
- Maize (*Zea mays*)
- Maize
- Melon
- Musk melon
- Squash
- Potato (*Solanum tuberosum*)
- Cantaloupe
- Sugar cane (*Saccharum officinarum*)
- Tomato (*Lycopersicon esculentum*)
- Wheat

Crops approaching commercialization:

- Potato – Resistance to infestation by potato tuber moth
- Squash – Resistance to a major viral pathogen
- Maize – Resistance to stem borers
- Cotton – Resistance to certain insects

Source: Mansour 2005

Box 3: Bt cotton in South Africa

Bt stands for *Bacillus thuringiensis*, a toxin producing bacterium found naturally in soils. Scientist have isolated genes responsible for the production of this bacterium and inserted it through genetic modification into cotton and maize to increase pest resistance.

Smallholder farmers in the Makitini Flats, South Africa have been growing it since 1997. By 2003 it was estimated that about 75 per cent of South Africa's cotton was Bt cotton (Pschorn-Strauss 2005). In the initial period, smallholder Bt cotton appeared to be very successful. The higher cost of Bt cotton seed was offset by lower chemical use and yield increases of between 20-40 per cent (Glover 2003). However, from about 2003, there was a rapid decline in the area under Bt cotton. In the period 2003-04, only 35 700 ha of cotton was planted, amounting to an 80 per cent reduction since 2000. This is ascribed to low world prices and droughts: in 2004 -05 the area planted was 21 700 ha, an extraordinary 40 per cent drop in area planted with cotton in one year (Pschorn-Strauss 2005). Reportedly, 90 per cent of smallholders who planted Bt cotton are in debt; the total debt among small-scale cotton farmers in northern KwaZulu-Natal was estimated at over US$3 million in 2004 (Pschorn-Strauss).

Sources: Glover 2003, Pschorn-Strauss 2005

country that is commercially producing GM crops. However, Egypt is approaching commercialization of four GM crops; these are potatoes, squash, yellow and white maize, and cotton (Mansour 2005).

In South Africa, under the Genetically Modified Organisms Act of 1997, three transgenic crops – insect or herbicide resistant cotton, maize and soybean – have been approved for commercialization (Department of Health undated). GM crop plantings are growing: in 2004 South Africa had 500 000 ha under GM crops (James 2004) and growth continued in white maize used for food and yellow maize used for feed; soybean plantings increased from 35 per cent adoption rate in 2003 to 50 per cent in 2004, whilst *Bacillus thuringiensis* (Bt) cotton stabilized with about 85 per cent of producers adopting it (James 2004).

Research and development

Globally, GM research and development (R&D) is led by six large multinational life science companies independently or in collaboration with the Advanced Research Institutes (ARIs) in the industrial countries. These companies include Monsanto, Syngenta, Aventis, CropScience and Dupont. A number of developing countries (such as Brazil, Argentina, China, India, Malaysia and the Philippines) have significant R&D programmes in biotechnology and transgenic crops.

An increasing number of African countries have GM R&D capacity. South Africa, Zimbabwe, Kenya, Nigeria, Mali, Egypt and Uganda are widely acknowledged as being the lead countries. As many as 24 other African countries have some GM R&D capacity and at least 20 are actually engaged in such research (African Centre for Biosafety 2005). These countries include Benin, Burkina Faso, Cameroon, Egypt, Ghana, Kenya, Malawi, Mali, Mauritius, Morocco, Namibia, Niger, Nigeria, Senegal, South Africa, Tanzania, Tunisia, Uganda, Zambia and Zimbabwe (African Centre for Biosafety 2005).

Nine countries – Benin, Burkina Faso, Egypt, Kenya, Morocco, Senegal, Tanzania, Zambia and Zimbabwe – are known to have conducted field trials (African Centre for Biosafety 2005). Supporting legislation and policy to regulate research and commercialization processes have not kept pace with these developments.

Private sector dominance has meant that most agricultural biotechnology research focuses on developed country concerns such as improved crop quality or management rather than drought tolerance or yield enhancement, and innovations that save labour costs (such as herbicide tolerance) rather than those that create employment (Nuffield Council on Bioethics

GM trial potatoes in Makhatini, South Africa.

Source: Biowatch

Table 1: GM crop research in Africa

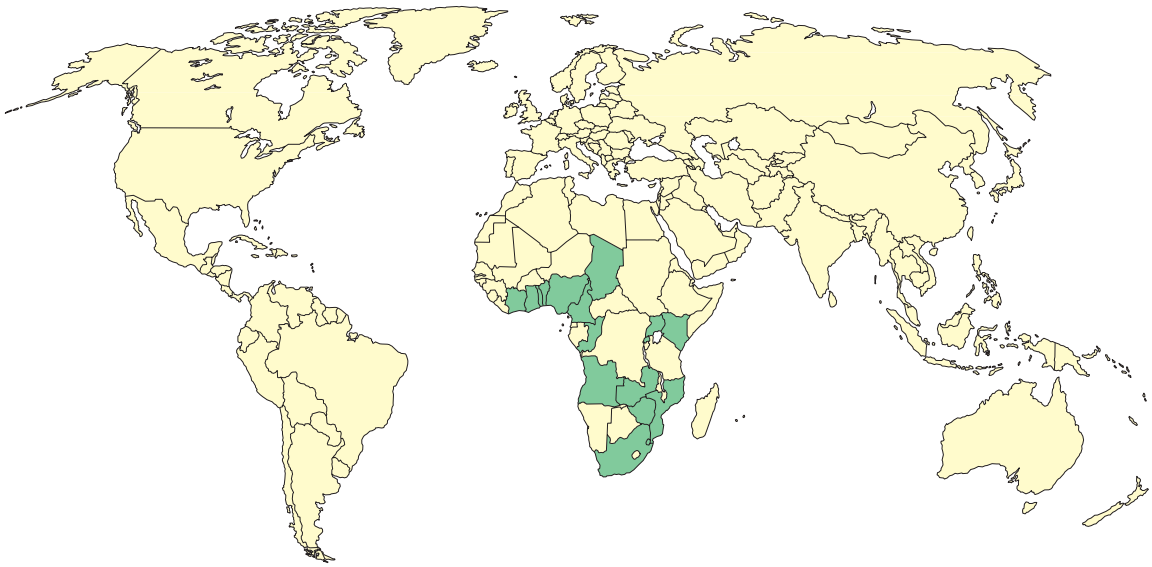
Country and Project name	Partners and Funders	Research Objective	Additional Information
KENYA Insect-Resistant Maize for Africa	Kenyan Agricultural Research Institute (KARI) in collaboration with the International Maize and Wheat Improvement Centre (CIMMYT). Funded by Syngenta Foundation for Sustainable Agriculture.	Bt maize resistant to the stem borer	Open field trials started in May 2005. Government Authorities destroy crop in August 2005 due to spraying of restricted chemicals.
KENYA	KARI MONSANTO International Service for the Acquisition of Agricultural Applications. Funded by USAID and Monsanto.	Transgenic virus-resistant sweet potato	
BURKINO FASO	In 2003, Monsanto, Syngenta and Burkina Faso's Institut National de l'Environnement et la Recherche Agronomique (INERA).	Field tests of two Bt cotton varieties	Research has taken place without the involvement or consent of the national biosafety committee which is tasked with developing a national regulatory regime for GMOs.
EGYPT	Monsanto and Egypt's Agriculture Genetic Engineering Research Institute (AGERI) currently collaborating in field trials of Bt cotton. Laboratory work is being done on GM potato, tomato, corn, faba bean, wheat, cucurbits and cotton. Field trials are being conducted for insect-resistant potato and virus-resistant cucurbits. GM crops will be available soon on the commercial level.	Multiple crops, insect resistance	Commercial introduction could take place as early as 2006.

Sources: Odame and others 2003, Glover 2003a, GRAIN 2005, Mansour 2005

1999). With the shift away from public sector research to private sector research, agricultural research has become increasingly profit-driven and less focused on needs fulfilment. There are an increasing number of research initiatives of African interest. In Africa, the main GM crops of research and commercial interest are sweet potato, maize, cotton, soybean, pigeon peas, bananas and tobacco. Much of this research is based on public-private-partnerships (PPPs) as shown, for selected countries, in Table 1. These include projects on vitamin A rice, virus-resistant sweet potato and Insect-Resistant Maize for Africa (IRMA). Insect-resistant research is seen as particularly important given the losses that are suffered as a result of insect infestations. In Kenya, for example, farmers lose about 15 per cent of the maize crop to stem borers (Glover 2003a).

Research cooperation between developing countries and institutions or companies based in the developed world has been important in promoting transgenic research in Africa. For example, the Swiss Federal Institute of Technology (SFIT) in Zurich plans to collaborate with researchers in Kenya, Nigeria, the UK

Figure 3: Distribution of cassava mosaic virus



Angola
Benin
Cameroon
Chad
Congo
Côte d'Ivoire
Ghana
Kenya
Lesotho
Mozambique
Nigeria
Rwanda
South Africa
Togo
Uganda
Zambia
Zimbabwe

Source: University of Arizona/College of Agriculture and Life Sciences 2003

and the USA on the African cassava mosaic virus (Sawahel 2005). This virus is transmitted to cassava by whiteflies when they feed on the plant. In parts of Eastern and Central Africa, epidemics of the disease can lead to total loss of harvests. Researchers at SFIT have used genes from a virus that periodically devastates cassava crops to create cassava plants that can resist the virus. Cassava is an important food crop in many parts of Africa and is strongly affected by genetic erosion, pest infestation and plant disease because it is a vegetatively propagated crop (Aerni 2005). Genetically modified cassava could save African farmers large economic losses. So far, the only way to curb the virus is by intensive use of insecticide to kill whiteflies. But this can be prohibitively expensive for subsistence farmers and can threaten their health and that of surrounding plants and animals (Sawahel 2005).

Given biosafety concerns, some countries are investing in improving their research and monitoring capacity. Zambia, for example, has begun building a modern molecular biology laboratory to detect GMOs entering the country (Ngandwe 2005). The goal of this US$330 000 laboratory facility is to be accredited as a regional and national referral laboratory that will provide research and training in collaboration with the University of Zambia and the Norwegian Institute of Gene Ecology (Ngandwe 2005). Other countries such as Madagascar have taken a more cautious approach, banning the growing or importing of GM foods due to concerns over their effect on human health and the environment (Apps 2005).

Despite the growing interest in GM crops, non-transgenic agricultural research remains the backbone of agricultural research in most African countries. In Kenya, for example, of the 17 biotechnology research and training projects only 2 use transgenic technologies (Odame and others 2003). Researchers in Côte d'Ivoire and Madagascar are engaged in non-transgenic rice research to improve yield. In Côte d'Ivoire, the Consultative Group on International Agricultural Research's (CGIAR) West African Rice Development Association (WARDA) has used an "embryo rescue" technique to cross-breed African and Asian rice. The new variety has several advantages over conventional African varieties including early maturity, improved pest resistance, drought- and acid soil-tolerance and greater height (which makes it easier to pick by hand) (Glover 2003a). Madagascar has implemented a system of rice cultivation which through improved agronomic practices, and without the use of GM varieties or chemical inputs, has shown improved yields (Glover 2003a).

GM FOOD AID

Drought, inadequate water resources and poor soils, along with other economic and social pressures, have made food shortages a problem in many parts of Africa.

From 2002, GM crops have been offered as food aid. In Southern Africa, several countries have expressed concern about the use of GM crops as food aid, given the lack of clarity about their potential impacts. During the drought of 2002-03, several countries opted to reject GM food aid. In making their decisions, countries considered not only the immediate issue of food

Box 4: Some approaches to GMO foods and food aid in Africa

ANGOLA – Banned imports of all GMO produce, except for food aid provided it was milled. The United Nations World Food Programme (WFP) reported that the additional cost of milling discouraged some food donors.

ETHIOPIA – Banned import of GMO food, saying it would undermine farmers who already have their own traditional ways of fighting pests and weeds. Debate continues over whether GMO crops could help the country out of years of serious food shortages.

KENYA – Does not permit GMO food imports, but government is in final stages of drafting legislation to govern the process of commercializing GMO products.

LESOTHO – Banned GMO food imports unless they are already processed or milled, citing concerns over environmental contamination.

MADAGASCAR – Banned growing or importing GMO foods due to concerns over the effect on human health and environment.

MALAWI – Banned GMO imports unless already processed or milled, citing concerns over environmental contamination.

MOZAMBIQUE – Banned GMO imports unless already processed or milled, citing concerns over environmental contamination.

SWAZILAND – Has no restrictions on GMO imports.

SUDAN – Has some restrictions on GM food aid.

TANZANIA – Is in the process of drafting legislation to govern the import of GMO foods.

ZAMBIA – Banned import of all GMOs, citing concerns over environmental impact and effect on human health. In response, it is alleged that the WFP moved some non-GM food aid stocks out of the country.

ZIMBABWE – Banned import of all GMO produce, except for food aid, provided it has already been milled.

Source: Apps 2005, ERA 2005

shortages and the overall implications of GM crops for human and environmental health, but also future directions in agriculture, the implications of private sector-led research, livelihood and development options, ethical issues and rights concerns (Mohamed-Katerere 2003). Similarly, public concerns are raised about the relationship between GM crops and sustainable agriculture. Participatory Ecological Land Use Management (PELUM-Tanzania, PELUM-Kenya, and PELUM-Zimbabwe), Biowatch South Africa, and national consumer councils have all been key players.

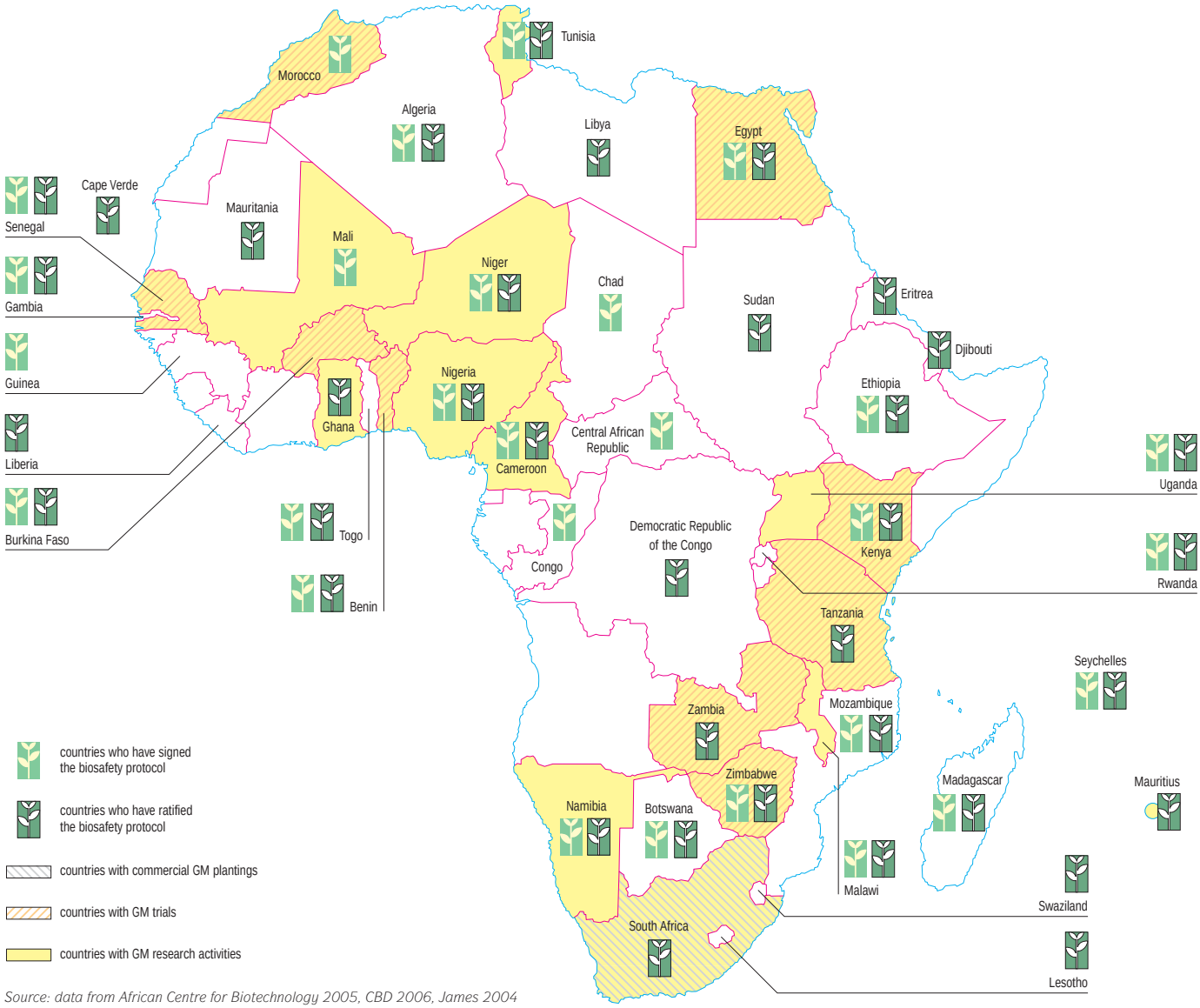
Vegetable farmers planting coriander to repel insect pests, Sudan.

Source: FAO

Some approaches to GM food aid are identified in Box 4. Mozambique raised concerns about accepting GM maize aid on biosafety and human health grounds and opted to ban its import. Zambia refused to accept GM food aid in any form; Zimbabwe, Malawi and Mozambique refused to accept GM food aid unless it was milled, this being seen as a precaution to avoid any germination of whole grains and to limit impacts on biodiversity; Lesotho and Swaziland authorized the distribution of non-milled GM food, but not before it warned the public that the grain should be used strictly for consumption and not for cultivation; and in 2004, Angola and Sudan introduced restrictions on GM food aid.

Global anti-GM food campaigns have influenced public attitudes to GM foods in Africa. Consumers International (CI), a worldwide federation of consumer organizations with 38 member organizations in about 22 African countries, has played an important role in shaping the debates around GM foods. It advocates a legal regime in which all GM foods are subject to rigorous, independent safety testing, labelling and traceability requirements, and in which producers are held liable for the environmental or health damage which their products may cause (CI 2005). There is growing acceptance of this approach globally.

Figure 4: GM status in Africa



Source: data from African Centre for Biotechnology 2005, CBD 2006, James 2004

DRIVERS AND CONSTRAINTS

As elsewhere, globalization, trade liberalization and deregulation, and the privatization of agricultural R&D lie at the heart of the push of GM technologies into Africa. Africa's receptiveness is shaped by concerns about food insecurity, growing poverty and inadequate nutrition as well as declining public agricultural research budgets and capacity.

Declining public sector African agricultural research, combined with the privatization of agricultural research, has led to a focus on providing hi-tech solutions, including transgenics, over other agricultural options (Scoones 2005). Globally-driven agricultural research and technology development, which defines Africa's food security problems as being primarily about yield, poses the "quick fix" of GM crops as particularly attractive. The multiple stressors that are driving food insecurity, including the interplay between inadequate access to water, poor soil fertility, climate change, inadequate infrastructure, weak markets, poverty, HIV/AIDS and civil war, are inadequately taken into account in developing solutions. The shortcomings of such an approach and the value of interlinkages in problem analysis as well as in defining solutions are discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*.

Although human development, food security and environmental health issues are often the focus of the marketing strategies of the main R&D companies, it is unlikely that such altruistic concerns are driving their investment. The developing world, including Africa, is an important potential market, as consumer and producer, given that Europe is not receptive to GM products and that more than 70 per cent of Africa's people are engaged in agricultural production (IFAD 2001).

The high level of investment needed in GM research and its application has constrained African participation and has led to research that primarily focuses on developed country needs. Transgenic research is very expensive when compared to more traditional biotechnology techniques. For example, the IRMA project is estimated to have cost US$6 million over 5 years and the transgenic sweet potato research US$2 million, compared to the average funding of tissue culture and marker technology projects costing on average US$300 000 (Odame and others 2003).

The absence of a supportive policy and legal framework is often cited as an inhibiting factor for the development of biotechnology. On the one hand, biotechnology companies may be reluctant to invest in costly research without the legal guarantee that they will be able to commercialize their products (Seshia 2002) Supportive legislative frameworks for research include not only clear rules for risk assessment and commercialization but also intellectual property rights (IPR) (Yamin 2003). Although IPR standards have been developed through the World Trade Organization's (WTO) Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), domestic IPR legislation in many African countries remains weak. Many countries struggle with how to reconcile IPRs with farmers' rights and other local interests. There are concerns that strong IPRs will entrench global domination of world food production by a few companies and increased dependence on industrialized nations. IPR may place restrictions on farmers, including on their existing rights to store and exchange seed. Some of the challenges regarding IPR are discussed in Box 5. On the other hand, in some instances the absence of a legal framework has encouraged research as biotechnology companies can act with few restraints and responsibilities. For example, in 1998 Monsanto engaged in the planting of GM crops in Zimbabwe as there was no regulation, although these crops were subsequently destroyed when the government established what had happened (Glover 2003a).

People accept new technologies because they believe the potential benefits outweigh the potential risks.

CBD and UNEP 2003

At a national and regional level, the lack of adequately inclusive policy processes has contributed to a polarized GM debate. Since the United Nations Conference on Environment and Development (UNCED) in 1992, civil society has been increasingly recognized as an important partner in the development of environmental policy and practice. Civil society organizations, globally and within Africa, have been very active in claiming this space around issues related to genetic modification. A range of concerns has been raised related to the debates around human health and biosafety as well as to the socioeconomic implications, especially as they relate to issues of food security, livelihoods and human well-being. As discussed in Chapter 1: *The Human Dimension*, an increasing number of intergovernmental African agencies, international organizations and national governments are recognizing the value of such approaches. For example, Benin has established a five-year national moratorium on the importation, commercialization and utilization of all GM products or products derived from GMOs to give the country time to effectively debate, develop and implement national biosafety legislation (GRAIN 2004).

Another set of concerns relating to policy-making processes is the growing influence of the scientific and private sector in policy development and how to balance this with public concerns. Issues of public trust, accountability and transparency, as well as farmers' and consumers' rights, underlie much of this.

In many arenas, public objection to and concerns about GMOs are important constraints to GM research and the commercialization of GM products. Globally, these concerns focus on health and environmental

Box 5: Intellectual Property Rights: potential conflicts and opportunities for resolution

Intellectual Property Rights affect how financial benefits are distributed. The approaches of the WTO and the CBD are quite different:

- The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) asserts IPR on life form, while the Convention on Biological Diversity (CBD) asserts national sovereignty and thus by implication the right to prohibit IPR on life forms.
- The CBD promotes equitably shared benefits from use of biological resources and protection of traditional knowledge; TRIPS promotes the private appropriation of benefits and has no mechanism for acknowledging the role of traditional knowledge in the industrial use of genetic resources.

However there are some opportunities for reconciling these differences:

- Article 1 of TRIPS provides some flexibility, allowing domestic law to exceed minimum protection standards, a provision that could allow member nations to enact legislation to protect traditional knowledge.
- Article 27.2 of TRIPS allows for the exclusion from patent ability based on public order or morality.
- Article 27.3b of TRIPS allows for the development of unique IPR protection systems for plants, animals and essentially biological processes, creating an opportunity to develop alternative IPR regimes appropriate to the needs and conditions of traditional communities.

Source: GBDI and IITA 2000

implications. These concerns stem from the continuing high levels of uncertainty around impacts and risks as well as the poor dissemination and communication of available information. No technology or human activity is completely risk-free; people accept new technologies because they believe the potential benefits outweigh the potential risks (CBD and UNEP 2003). Public mistrust of private sector motives resulting from past private sector behaviour in potentially risky areas such as tobacco, pharmaceuticals and chemicals is also a factor (Mohamed-Katerere 2003). Some are concerned about possible dumping by companies or nations in efforts to dispose of surplus stocks or to recoup the cost of R&D. In Southern Africa, some governments have expressed similar concerns about GM food aid (Mohamed-Katerere 2003). In Africa, public concerns have revolved around ethical issues, food security and livelihood concerns, farmers' and consumer rights, and non-inclusive policy processes. Farmers' organizations in West African countries have, in voicing their objection to the introduction of GM crops, focused on a range of factors that undermine the productive agricultural sector, including European Union (EU) and US cotton subsidies, and are beginning to look more critically at the dominant model of cotton production, questioning the need for chemical inputs and looking for means to reduce their dependence on cotton (GRAIN 2004). Researchers and farmers are successfully rebuilding agricultural practices based on farmer knowledge and local resources that greatly reduce the use of pesticides (GRAIN 2004).

Given the magnitude of what is at stake, these concerns remain, despite the policy and regulatory frameworks on environment and biosafety developed under the CBD in 1992 and its Cartagena Protocol in 2000, which specifically regulates the transboundary movement of living modified organisms.

OPPORTUNITIES AND RISKS

There is much controversy about the opportunities and risks posed by GM technology. This results in part from the lack of information to support policymakers and the public in evaluating the options. Much of the information that is available is oversimplified and may focus on just one aspect of the debate, thus making it an unreliable source. Better scientific information is often inaccessible to non-GM specialists. A key challenge facing African countries is how to deal with this information gap and how to evaluate the contradictory information that is available.

Farmers in Côte d'Ivoire select the NERICA rice varieties to grow during PVS trials. Here they compare panicles of rice varieties during post-harvest evaluation.

Source: World Bank

An IUCN – The World Conservation Union (IUCN) report finds that the controversies are essentially in three areas (Young 2004):

- The interpretation of science and specifically whether GMOs are inherently safe or inherently dangerous from a human and environmental perspective;
- Economic analysis and in particular how to evaluate the cost-and-benefits associated with GMOs; and
- Socio-cultural impacts and biosafety implications revolving around issues of food production and security, livelihoods, and human and environmental health.

MARKETS AND TRADE

The uncertainty about the impact of growing GM crops on markets for other crops is a concern for many countries. The European Union's *de facto* moratorium on new approvals for the production and import of GMOs is particularly important.

Traceability requirements, such as the EU's 2003 initiative on country of origin labelling, have impeded imports from the US where many GM crops are produced. Traceability requirements are designed to address problems of contamination of organic crops by GMO pollen drift, the use of contaminated seeds and

sloppy handling. Such practices have been reported (Riddle 2002) and are a trade concern. Increased commercialization of GMOs in Africa could threaten organic agriculture and agricultural exports to, for example, EU countries where GMO use remains restricted (Pruzin 2004).

An additional issue is the relationship between national safety standards and labelling requirements and global agreements. While the Cartagena Protocol allows members to develop more stringent safety standards than those it provides, there is the risk that such standards could be found to violate provisions of the WTO agreements.

Food security

An important challenge for much of Africa is how one improves food security. Determining appropriate strategies requires a clear understanding of the nature of the food security problem and an understanding of what exactly GM crops can bring to addressing this. Millennium Development Goal (MDG) 1, target 2 seeks to reduce chronic hunger by half from the 1990 baseline by 2015.

• The challenge of improving food security is more than just increasing food production. •

WCED 1987)

Genetic modification technology may contribute to food security goals through increasing crop yields, producing hardier crop varieties that can withstand heat and drought, enhancing nutritional and medicinal value, and improving storability (UN Millennium Project 2005b). Increasing crop resistance to insects and diseases and reducing weeds could help reduce crop losses and reduce dependence on costly fertilizers and herbicides, resulting in valuable savings for resource-poor farmers (Bernsten 2004). For example, the European corn borer destroys 7-20 per cent of the world's annual maize harvest (Ives and others 2001). If Bt can successfully control the corn borer, maize yields in Africa could increase significantly (Ives and others 2001). However, the potential of such innovations is highly contested.

Cajanus cajan (Pigeon Pea) is a perennial legume. This plant is drought-resistant, nitrogen fixing, and enhances soil fertility. It requires low inputs and can be intercropped with traditional crops.

Source: A. Conti/FAO

However, as the Brundtland Report cautioned as early as 1987, the challenge of improving food security is more than just increasing food production. The Brundtland Report noted that globally agriculture does not lack resources but lacks the policy to match need and production (WCED 1987). Food production is closely linked to cultural and livelihood systems. Crucial issues that need to be addressed include (Young 2004):

- The impact of reliance on GMOs to solve social and economic problems;
- The impact of the cost of GM crop production;
- The implications of expensive R&D processes;
- The equitable sharing of benefits arising from the use of genetic materials conserved primarily in the developing countries;
- The impact of GMOs on local livelihood systems; and
- The impact of GMOs on agricultural biodiversity.

The assumption that food shortages stem from a gap in food production and population growth is now widely challenged. The problem of world hunger is not a problem of food production but one of distribution. The world today produces more food per inhabitant than ever before: enough food is available to provide 1.9 kg for every person every day: 1.1 kg of grain, beans and nuts, about 0.4 kg of meat, milk and eggs and the same amount of fruits and vegetables (Altieri and Rosset 1999). The real causes of hunger are poverty, inequality and lack of access to food and land. Too many people are too poor to buy the food that is available (but often poorly distributed) or lack the land and resources to grow it themselves (Lappe and others 1998 in Altieri and Rosset 1999).

Genetically modified crops may be important from a developing country perspective because specific nutritional values can be added (UN Millennium Project 2005b). One of the best known genetic enrichment food crops is vitamin A improved rice, also called "Golden Rice." Insufficient vitamin A intake by children in developing countries is the leading cause of visual impairment and blindness, affecting over three million children in sub-Saharan Africa (SSA) (Muir 2003). Pregnant women with vitamin A deficiency (VAD) face an increased risk of mortality as well as high risk of mother-to-child HIV transmission. Thus, if effective, nutritionally enhanced "Golden Rice" could be one

Box 6: Will the use of Bt cotton result in less pest threats and pesticide use?

In 2002, Bt cotton was planted on 4.6 million ha worldwide, approximately 13 per cent of the global cotton area. Almost all of this Bt cotton acreage was sown to Monsanto's "Bollgard" variety. Bollgard is genetically modified to produce the Cry1Ac toxin of *Bacillus thuringiensis*. Monsanto has developed a second Bt cotton variety, "Bollgard II", which produces two different toxins, Cry1Ac and Cry2Ab. In 2004, Dow Agro-sciences hopes to introduce "Widestrike", another Bt cotton producing two toxins (Cry1Ac andCry1F), while Syngenta is trying to introduce its Bt cotton, "VIP Cotton".

The Bt toxins expressed by Bt cotton only target lepidopteran pests (caterpillars) and some lepidopteran pests are more susceptible than others. Bt cotton has been shown to be effective against the tobacco budworm (*Heliothis virescens*) and the pink bollworm (*Pectinophora gossypiella*), but less effective in controlling cotton bollworms (*Helicoverpa zea* and *Helicoverpa armigera*), an important cotton pest in West Africa. This is why farmers growing Bt cotton continue to use pesticides against bollworms and continue to experience damage from these pests. In the US, despite the use of supplementary insecticides, farmers growing Bt cotton lost around 7.5 per cent of their crop to cotton bollworms in 2002. During that year, 36 per cent of the Bt cotton fields in the US were sprayed with insecticides specifically targeting bollworms and other caterpillar pests. Farmers outside the US have had similar experiences. In the Indian state of Andhra Pradesh, where Bt cotton was cultivated for the first time in 2002, Monsanto's Bollgard cotton failed to control cotton bollworms.

There are many important cotton insect pests for which Bt cotton offers no control, such as sucking pests like aphids and jassids. These secondary pests can result in significant crop damage on Bt crops, which helps to explain why insecticide use remains high in Bt cotton fields. In Australia, pesticide use against bollworms has declined, but farmers still spray their Bt cotton fields with insecticides 4.6 times per year. The adoption of Bt cotton may even increase problems with secondary pests. In the Indian state of Andhra Pradesh, farmers growing Bt crops had to spray more against aphids than farmers growing conventional crops. In the US, where insecticide use against bollworms has dropped by half since the introduction of Bt cotton, total insecticide use has remained stable due to the growing importance of secondary pests.

Source: GRAIN 2005

important tool for addressing the MDG 5 on maternal health. While genetically enriched crops can be an important nutritional strategy, the efficacy of this approach is contested. It remains to be seen whether these crops will live up to the nutritional values demonstrated in the laboratory in real life. "Golden Rice" is genetically modified to produce beta-carotene, the precursor of vitamin A. For beta-carotene to be converted to vitamin A, it requires a functional digestive tract, adequate zinc, protein and fat stores, adequate energy, and protein and fat in the diet. However, in populations that suffer from VAD, the overall dietary deficiencies act as barriers to the conversion (Gola 2005). The question also arises as to whether this is the most cost-effective and sustainable way to address nutritional deficits (Muir 2003). An alternative is to promote the use of existing varieties of food crops with high levels of beta-carotene such as sweet potato. One of the main factors constraining the inclusion of adequate fruit and vegetable in rural peoples' diets is the problem of food storage. Research in some countries, including Zimbabwe, is attempting to address these shortcomings (Muir 2003).

Nutritional diversity may be threatened by GM licensing agreements and production systems which push farmers to monoculture and thus reduce the variety of crops planted for household consumption.

The livelihood implications of adopting GM technologies are still not fully understood. Biotechnology is a technology under corporate control, protected by patents and other forms of IPR, and therefore contrary to farming traditions of saving and exchanging seeds (Altieri 2002); consequently there has been considerable resistance by non-governmental organizations (NGOs) and community organizations to the adoption of GM crops. There are concerns about the impacts of the changing nature of agribusiness and its impact on poor people and their food security. Because hunger is primarily linked to poverty, lack of access to land, and the maldistribution of food, one concern is that biotechnology may exacerbate inequalities underlying the causes of hunger. Leading

GM companies have been rigorous in enforcing contractual agreements around the use, storage and sale of GM seed and products. Small-scale farmers have been prosecuted in developed and developing countries (ERA 2005).

Chemical use

Modern agriculture has had negative impacts on the environment. The high level of chemical inputs required for improved varieties, developed under the green revolution, which replaced traditional varieties has had a heavy toll.

Transgenic agriculture promises to limit the environmental releases of damaging chemicals (Cullen 2004, Bernsten 2004, and FAO 2002) by reducing the need for pesticides and herbicides, and fertilizers. However, these claims remain contested, as discussed, for example, in relation to Bt cotton, in Box 6. Whether the incorporation of the pesticide into the crop itself rather than application on the soil will be environmentally friendlier is not known (Young 2004). The challenges and opportunities associated with chemical use are considered more fully in Chapter 11: *Chemicals*.

Africa currently uses 3.6 million tonnes of fertilizer, but the potential requirement to maintain average levels of crop production without depleting soil nutrients is 11.7 million tonnes per year (Henao and Baanante 1999). The negative environmental aspects of mineral and organic fertilizers include accumulation of dangerous or even toxic substances in soil. This includes cadmium pollution from mineral phosphate fertilizers or from town or industrial waste products; eutrophication of surface water, with its negative effect on oxygen supply, which threatens fish and other forms of animal life; nitrate accumulation in groundwater, diminishing the quality of drinking water; and unwanted enrichment of the atmosphere with ammonia from organic manures and mineral fertilizers, and with nitrogen oxide (N_2O) from denitrification of excessive or wrongly placed nitrogen fertilizer (Finck 1992).

Farmer fertilizing maize crop in Burkina Faso.

Source: P. Lowrey/FAO

Biodiversity

It is not known how GM technologies will impact upon biodiversity. The CBD defines biodiversity as:

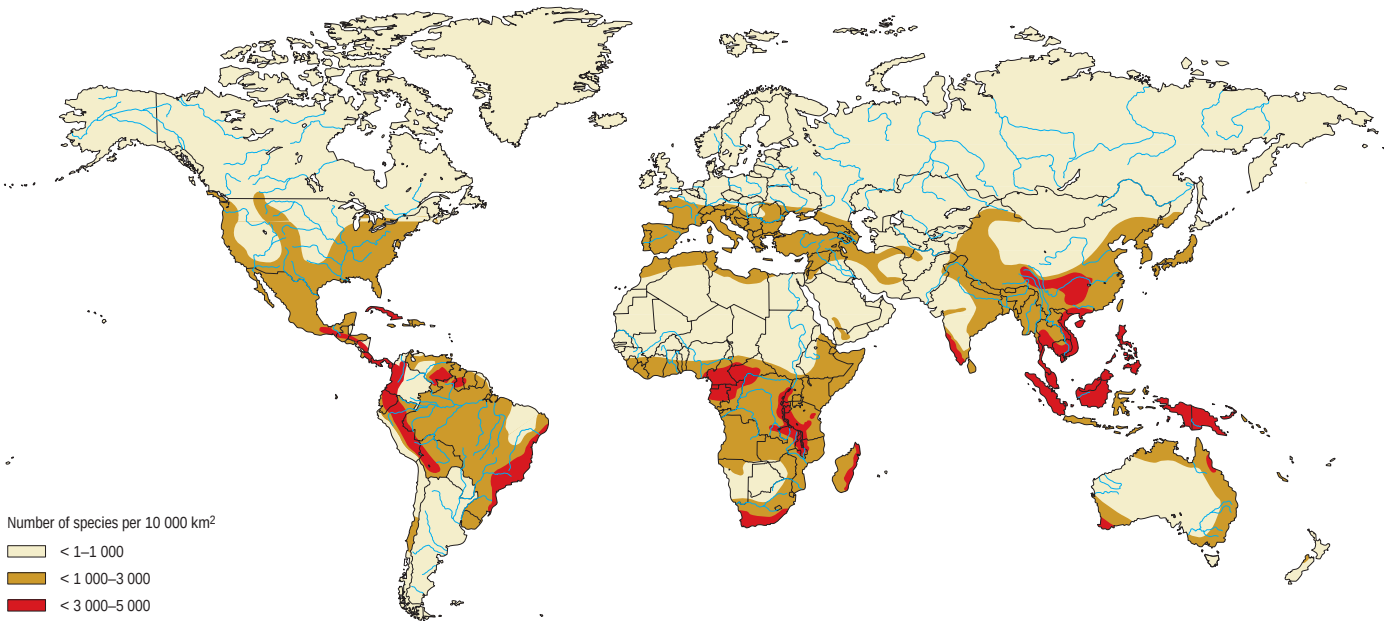
> "The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems."

The introduction of a transgene into a recipient organism is not a precisely controlled process and can result in a variety of outcomes with regard to integration, expression and stability of the transgene in the host (FAO and WHO 2003). The risks associated with modifying the genetic structure of crops are not well understood and there is little agreement on either the severity or likelihood of potential risks. This controversy emanates from a scientific dispute about how "stable" GM crops are. Several concerns can be identified.

First, GM technology could result in the contamination of crops through gene transfer – "genetic pollution" – and the development of "super weeds" (Altieri 2002, Porter 2005) and therefore have a negative impact on biodiversity. A further concern about GM crops is that the genes could "escape" and, through cross-pollination, mix with non-GM crops or their weedy relatives. For example, an herbicide-tolerant gene could be transferred to weeds in wild habitats, turning them into "super weeds" (ERA 2005). There is evidence of the unintentional spread of genes from GM crops (Monroe 2004).

Second, transgenic crops modified to be resistant to a particular pest or disease may have a negative effect on non-target species that are harmless or beneficial. For example, Bt maize pollen may be toxic to the Monarch butterfly (Losey and others 1999). Although the Monarch butterfly is native to Mexico, the United States

Figure 5: Biodiversity in mountain regions



Mountain eco-regions are exceptionally rich in biodiversity.

Source: Fleury 1999

of America and Canada (Manos-Jones 2004) it is possible that other butterfly species in Africa can be similarly affected. On the other hand, the alternative to transgenic crops could be as harmful to the environment. For instance, the practice of routine spraying of broad-spectrum insecticides is non-selective, and therefore kills all insects regardless of whether they are beneficial or harmful to the crop (Ives and others 2001). A British study on oilseed has recently concluded that it is not the GM crops that harm wildlife but the herbicides sprayed on the crops that significantly reduce the broad leaf weeds such as chickweed, a major bird food (Brown and Gow 2005). The magnitude of these GMO risks to non-target organisms, including beneficial insects, is largely unknown as there have been no comprehensive studies in Africa to date.

Third, pest resistance can occur with frequent use of any pest control product (Soil Association 2003b). Insects can develop resistance to toxins such as the Bt bacterium, reducing the effectiveness of this control method. In Australia, India and China, for example, pests are becoming resistant to some GM cotton crops that have Bt genes inserted (Spinney 1999). Research into the safety of GM crops using genes that produce toxins should precede commercialization and not follow it. Inbred pest resistance might also be toxic to people in the long term. For example, long-term consumption of peas, *Lathyrus sativus*, can cause paralysis if a toxin in the peas accumulates in people, as has happened in Bangladesh and India (Messons cited by Sawahel 2005). Bt crops have proven to be unstable and ineffective; some insects, which survive Bt, transmit genetic resistance to their immediate offspring. If Bt becomes ineffective as an implanted pest control strategy within one insect generation, then organic farmers will be robbed of a valuable biopesticide. Regional cases of Bt resistance have already been reported (Spinney 1999). Insects resistant to the genetically modified Ingard Bt cotton were reported in Australia (Australian Broadcasting Corporation 2001). Indeed, GM plants are not behaving as intended: in 1996, Monsanto's pest-resistant Bt cotton succumbed to a heat wave in the southern US and was destroyed by bollworms and other pests (Spinney 1999). In 1997, farmers who grew Monsanto's herbicide-tolerant cotton saw the cotton balls fall off their crops (Spinney 1999).

Fourth, GM crops engineered to be resistant to specific herbicides enable farmers to spray weeds without damaging crops (Soil Association 2003a). Weeds are developing resistance to these herbicides, and rogue GM plants that grow after a harvest (volunteers) have appeared and spread widely (Altieri 2002, ERA 2005). In particular, GM oilseed rape volunteers have spread quickly, and some plants have become resistant to several herbicides through cross-pollination (Brown and Gow 2005). Elsewhere, GM cotton crops have failed to impart protection from pests resulting in increased use of chemical sprays: farmers are making more frequent applications and reverting to older and more toxic chemicals (Soil Association 2003b).

Fifth, GMOs could impact on genetic diversity. The increased competitiveness of GMOs could cause it to damage biologically-rich ecosystems. Transgenic crops could encourage biodiversity loss through the establishment of monoculture agriculture which replaces traditional crops and other established varieties (Altieri 2002). Currently, the main potential cause of loss of biodiversity is agricultural expansion, which destroys habitats. The needs of a growing global population have largely been met by bringing more land into agricultural production (Ives and others 2001). Proponents of GM crops highlight this and suggest that transgenic crops may be able to help preserve uncultivated habitats by increasing yields on land already under cultivation (Ives and others 2001), reducing the need for conversion.

Sixth, ecological and health hazards are also posed by genetic use restriction technologies (GURT) which are commonly known as terminator technology (Mclean 2005). These organisms do not flower and fruit and therefore provide no food for the multitude of insects, birds and mammals that feed on pollen, nectar, seed and fruit, and will inevitably have huge impacts on biodiversity (Mclean 2005). Sterile trees can still spread by asexual means and the genes can spread horizontally to soil bacteria, fungi and other organisms in the extensive root system of the trees, with unpredictable impacts on the soil biota and fertility. As transgenic traits tend to be unstable, they could break down and revert to flower-development, spreading transgenes to native trees, or creating pollen that poisons bees and other pollinators as well as causing potential harm to human beings (ISIS 2005b). The sterile monocultures are much more likely to succumb to disease, which could potentially wipe out entire plantations (Spinney 1999). Some companies have developed GM crop seeds that use GURT. As a result, farmers become dependent on large corporations and must purchase new seeds every season (ERA 2005). In addition to social equity issues associated with these monopolistic tendencies, GURT may have environmental risks and thus the technologies require further evaluation. GM crops can be unstable (Hansen 2000, GMWatch 2005) posing risks to other plants.

Genetic diversity in maize.

Source: CIMMYT

There are counter claims to all these concerns: the use of herbicide-resistant and pest-resistant crops is believed to have positive implications for biodiversity. With non-herbicide tolerant (non-transgenic) soybean, farmers must clear the weeds before planting their seeds. With herbicide-tolerant soybean, however, the weeds can be better controlled; farmers can plant the seeds by sowing them directly in relatively undisturbed soil. This conserves moisture and soil fauna and flora and also reduces water and wind erosion (Ives and others 2001).

Human health concerns

Given the uncertainty over the risks associated with GMOs, it is not surprising that strong and often polarized opinions are held around issues of food safety and human health. Consumer and environmental organizations and several governments have adopted cautious approaches to GM-derived foods, preferring to err on the side of safety rather than take unknown risks. Similar concerns have been expressed about the use of GM ingredients in livestock production systems via incorporation of GM-derived oilseeds and cereals in animal feed. The UK, Germany and France have eliminated the use of ingredients derived from GM plants from foods manufactured for direct human consumption or that enter the food supply chain (Soil Association 2003b).

Labelling of GM foods is an important consumer concern. It provides information for consumers and users of the product and allows them to make an informed choice. On this basis the EU, for example, has adopted labelling and traceability regulations (EC 2005). In the late 1990s, Austria, France, Greece, Italy and Luxembourg imposed national bans on a number of GMO products. Poland is the second central European country to ban a GMO maize type after Hungary, which outlawed the planting of Monsanto's MON 810 hybrid seeds in January 2005 (Reuters 2005). In the United States, labelling has not received the same level of attention. In Africa, several countries have prohibited the import of GM foods, as shown in Box 4. Consumer

concerns about GM foods include health and ethical considerations (Mohamed-Katerere 2003).

Some human and animal health risks have been identified (Spinney 1999, Cox 1995). Most of the examples are from regions where GMO technology has been in use far longer than it has in Africa. This information provides important lessons for Africa – a region that is now a target for rapid expansion of GMO technology. The limited experience with GMOs indicates some possible risks.

First, increased use of herbicide-tolerant GM crops may pose new risks for environmental and human health. For example, glyphosate is a major formulation of "Roundup Ready" crops and is now the world's best-selling "total" herbicide. Due to the introduction of GMO-Roundup Ready crops, human and environmental exposure to the herbicide is expected to increase (Brown and Gow 2005). However, there is strong evidence that glyphosate-containing products are acutely toxic to animals and humans (ISIS 2005a).

Second, there are new medical risks from GM technologies. For example, gene therapy involves the use of a virus to carry a modified DNA segment and the virus is potentially pathogenic. The risks of these treatments are largely unknown. There are concerns that medical applications involving genetic engineering may produce cancer-causing genes from normal human genes (Portfolio 21 2005).

Third, the insertion of genes from one crop into another may increase allergic reactions, especially where consumers are not informed about the origins of the transgene. For example, soybean seeds genetically modified to include a gene from Brazil nuts in order to fortify a protein supplement containing soy resulted in people allergic to Brazil nuts reacting to the soy product (Mills 2005). The modified soy product indicated no negative reactions when it was tested on animals, illustrating the difference between the reactions of laboratory animals and humans to GM food products. This warrants further study of this new technology before it is widely embraced. The soil bacterium *Bacillus thuringiensis*, from which endotoxin (Bt) genes are extracted and widely incorporated into GM crops as biopesticide, is a close relative of the anthrax bacterium, *Bacillus anthracis*, and exchanges genes with it. Potentially this can generate more deadly pathogens (Altieri 2002, ISP 2003). Some Bt genes are known to cause toxic or allergic reactions in humans (ISP 2003). However, GM technology can also be used to prevent food allergies by deleting the major allergen, such as the case with soybean developed by Pioneer International (Mills 2005).

The labelling of foods provides important information for consumers.

Source: bounford.com

Fourth, increased antibiotic resistance may result. For example, Novartis' Bt maize contains a marker gene, which codes for antibiotic resistance in *E.coli*. There is a risk that if animals or humans consume Bt maize-based products such as cattle feed or starch, some antibiotics would be rendered useless (Spinney 1999).

Fifth, vitamin toxicity from nutritionally enhanced crops may be an unintended consequence. When GM crops such as rice and rapeseed with high vitamin A concentrations are planted, there will be no way to distinguish them from normal crops, with the contingent risk of liver damage if too much vitamin A is consumed (Spinney 1999).

Ethics

GMO and ethics issues centre among other things on patenting, cloning of life forms and biopiracy. These concerns have a direct bearing on achieving sustainable livelihoods and conservation of environmental resources. In Africa, many communities and consumers express ethical concerns about "playing god" as plants are transformed in unnatural ways and about the implications for traditional beliefs and values.

If not properly managed, gene patents could be instrumental in promoting and institutionalizing social inequity (Portfolio 21 2005, ERA 2005). Patenting genetic material traditionally available to a community, without allowing the community free use of the material or providing any return to the community, affects the fair and equitable distribution of resources, a necessity in the development of a sustainable society

(ERA 2005). There is concern that the access and intellectual property issues related to "terminator gene" technologies will lead to increasing dependence on industrialized nations by African countries, and domination of world food production by a few multinational companies.

Biopiracy is also of growing concern, particularly as many African countries lack the legislative and enforcement systems to control illegal extraction of genetic resources. Additionally, the benefit sharing systems for the use of these assets and of traditional knowledge are poorly developed.

The issues of proprietary science have complicated the ethical and safety issues of GM technology. In particular there are challenges around reconciling the rights of product developers with those of consumers. Many public protests have centred on ethical or ecological grounds, the uncertainty about the impacts of the technology, and the public right-to-know and to have access to information, including through labelling.

In several countries, concerns have been raised as to whether "the technology is tantamount to playing god, interfering with nature, contrary to local ethics and also whether gene insertion would play havoc with the totem system that lies at the heart of local cultural association" (Mohamed-Katerere 2003).

RESPONSES

There are a wide range of responses, at multiple levels, to the growing challenges posed by the development of GM technologies and products. These include global and regional intergovernmental responses, science-based responses and civil society initiatives. As a whole, the overall approach of African governments has been to encourage a range of biotechnology research (both transgenic and non-transgenic) while recognizing biosafety concerns and establishing systems to limit its impact.

Biosafety approaches have been shaped by the worldwide acknowledgement of the growing threats which ecosystems and biodiversity face from human activity, and the long-term implications this has for development and human well-being. The CBD secretariat along with UNEP for example notes:

"The stakes are high: although some 40% of the world economy is derived directly from biological diversity, humanity is pushing ecosystems, species and gene pools to extinction faster than at any time since the dinosaurs died out 65 million years ago. At present, natural habitats and ecosystems are being destroyed at the rate of over 100 million ha every year. More than 31 000 plant and animal species are threatened with extinction; according to the Food and Agriculture Organization of the UN, at least one breed of livestock dies out every week. Band-aids are not enough: only a fundamental and far-reaching solution can ensure a biologically rich world for future generations" (CBD and UNEP 2003).

The range of actors involved in policy development has increased dramatically. Governments, scientists, the private sector and civil society have all become active players. The extent to which the concerns and interests of these respective groups are acknowledged varies between countries and across issues. However, as Box 7 shows, given the complexity of the issues and the risks associated with them, a growing number of policymakers, at the national, regional and global levels, are acknowledging the importance of inclusive policy processes. Box 8 looks at one initiative that

Box 7: Doing the right thing is not simple

Governments cannot achieve biosafety on their own; they need the active involvement and cooperation of other stakeholders:

- Agricultural and health-care research institutes and the biotechnology industry can play a particularly important role. Biotechnology researchers and companies have the expertise, the resources and the incentive for keeping biotechnology and its products safe and beneficial.
- Civil society, individual citizens and non-governmental organizations need to understand the issues and make their views clear to both policymakers and industry.
- The media have a vital watchdog role to play.

Because biotechnology is such a revolutionary science, and has spawned such a powerful industry, it has great potential to reshape the world around us. It is already changing agriculture and what many of us eat. Any major mistakes could lead to tragic and perhaps permanent changes in the natural world. For these reasons, future generations are likely to look back to our time and either thank us or curse us for what we do – or don't do – about GMOs and biosafety.

Doing the right thing is not simple.

Source: CBD and UNEP 2003

Box 8: The African Biotechnology Stakeholders Forum

The African Biotechnology Stakeholders Forum (ABSF) is a not-for-profit and non-sectarian organization funded by the United States Agency for International Development (USAID). It provides a platform for sharing, debating, and understanding issues pertaining to biotechnology in agriculture, health, industry and the environment. The African Biotechnology Stakeholders Forum represents stakeholders in biotechnology in Africa. It currently has individual members in Kenya, Uganda, Tanzania, Ethiopia, South Africa, Ghana and Nigeria; small and medium sized enterprises involved in research, development, testing and commercialization of biotechnology in Tanzania, Ethiopia, Uganda and Ghana. Through its membership and linkages, ABSF is a voice for many biotechnology stakeholders, including farmers, scientists, consumers, politicians and government bodies.

The ABSF objectives are to:

- Provide a forum for sharing and exchanging experiences and practices in biotechnology with a view to strengthening its application for increased food security, health improvement, poverty alleviation, industrialization and environmental conservation in Africa.
- Improve public understanding of biotechnology through provision of accurate and balanced information to consumers, media and policymakers to ensure that biotechnology is accurately represented at all levels of society.
- Explore innovative and appropriate biotechnology applications and facilitate their adoption and use in sustainable development and poverty alleviation in Africa.
- Build capacity for information generation, dissemination and wise use of biotechnology.
- Facilitate research, development, education and training on biotechnology as well as policy and infrastructure development for meeting Africa's needs in biotechnology.

Source: ABSF undated

brings together stakeholders at the regional level. Annex 3, Table 1 shows some of the national, sub-regional and regional organizations active in biotechnology issues.

Science-based risk analysis

Risk analysis is concerned with how to evaluate, contain or avoid negative impacts resulting from the uncertain behaviour of GM products and processes. To be effective, such assessments need to address all costs-and-benefits, and not be restricted to financial expenditures and profits (Young 2004). It needs to address direct and indirect costs-and-benefits, as well as opportunity costs, such as the impact on environmental goods-and-services as well as on agricultural and social systems. Field trials and how crops behave in conditions similar to those following actual release are a critical step in the assessment process, allowing product developers to address problems arising. They play an important role in identifying risks and creating an opportunity for mitigation and adaptation prior to full release.

However, the standardized approach to risk assessment does not allow for such levels of complexity. Most national risk analysis frameworks focus on risk-benefit assessments that are derived from economic cost-benefit type analysis. In general, they adopt narrow technical approaches, which focus on the characteristics of the host organism and the resulting GMO, the expression and properties of the gene product and the biophysical features of the recipient environment (Mohamed-Katerere 2003). These approaches and their general principles have been developed over several decades in response to technological development in the chemical and pharmaceutical industries. These standardized approaches are particularly attractive to companies and governments as they are simplified and avoid the costs of case-by-case analysis.

Two factors underlie the analysis of risk (Young 2004):

- The magnitude of each potential harm or benefit that might occur; and
- The likelihood of its occurrence.

Magnitude is particularly important from a human and environmental perspective; certain kinds of changes, such as biodiversity loss, may be irreversible. Magnitude is difficult to ascertain where there is insufficient experience with a product or activity. Likelihood is based on comparison with similar situations in the past.

Substantial equivalence and familiarity

In the area of GM crops, many national assessment systems are based on the concepts of "substantial equivalence" and "familiarity" to determine the likelihood of potential harm (Scoones 2002) and to decide on further product testing and development as well as commercial release. In general, it neglects the socioeconomic aspects.

The concept of familiarity has been used in the chemical industry to determine safety levels on the assumption that closely related chemicals will behave in the same way. This approach is now used in GM risk assessment. Such models have a high level of appeal because they do not require regulators to deal with complex and case-specific factors. This framework neglects the issue of magnitude and rare but significant impacts. It may not be as well suited to LMO as these can behave in unpredictable ways.

Substantive equivalence between organisms is used as an indication of how they will behave. The concept was originally developed as a way for determining food safety (Scoones 2002). If a new GM product is substantially equivalent in chemical composition to its natural antecedent then it is assumed to be safe. This approach neglects the uncertainties around the actual modification of DNA.

Integrative approaches

Risk is different from cost because, on the one hand, a certain level of risk is necessary for social, political and economic advancement and, on the other, risk is by its nature uncertain. The challenge in the area of GM is that risks posed by this technology are fundamentally different from those posed by earlier agricultural technologies. The range of uncertainties is greater than ever before and includes fundamental scientific uncertainties and ignorance about the potential environmental and health risks, as well as wider uncertainties about the impact on agricultural systems and rural livelihoods (Scoones 2002). The importance of recognizing uncertainties and ignorance is evident from the Bovine Spongiform Encephalopathy (BSE) crisis, or mad cow disease, which resulted in major economic and health costs in the UK and Europe. Classical assessment approaches which treat scientific aspects separately from ethical, moral, social and economic considerations may be inappropriate and have been widely criticized over many years (Scoones 2002). In this context of uncertainty, other approaches, including the precautionary approach, can be a valuable part of risk assessment. Taking a precautionary approach requires acknowledging the potential for unforeseen consequences, complex effects and ignorance (Scoones 2002). The precautionary approach offers the opportunity to address normative values of justice, fairness and responsibility which classical risk assessment does not do (Mohamed-Katerere 2003).

A further challenge for risk assessment processes is that the range of actors in the development of new policy making and the negotiation process of regulatory and policy frameworks is wider than ever before: it includes global institutions, multinational companies, NGOs, governments and intergovernmental bodies, scientists

25-29 January 2006. A "citizens' jury" – 43 small and medium-size farmers – meets in Mali to hear evidence from 14 international witnesses, representing a broad range of views on GM crops. Witnesses included biotech scientists, FAO, and GM farmers from South Africa and India. The jury decided against introducing GM crops and instead made recommendations to strengthen traditional agricultural practice and support local farmers.

Source: M. Pimbert

and farmers acting at and across national, regional and global levels. This highlights the need for deliberative participatory processes over simple consultation. Participation is successful when it promotes responsiveness to local and national needs, legitimacy and "ownership" of policy and law. Thus, the processes for participation need to be appropriate and relevant to the country concerned (Glover 2003b). Many African countries have recognized this: participatory approaches have been used in policy development in relation to national law and policy development.

Current risk assessment processes are closely allied to globalization in which individual (R&D, economic and propriety) rights trump social and cultural rights and concerns; these issues are assumed to be adequately addressed through the market and consumer choice (Mohamed-Katerere 2003).

A range of approaches that deal with such complex decision making have been developed which recognize the plurality of views as well as a level of uncertainty and ignorance. These include quantitative approaches designed to examine the multicriteria important in decision making, scenario approaches which systematically analyse future options, and deliberative participatory approaches; these approaches introduce rigour not by limiting the issues under consideration but by being transparent and addressing the full complexity of the issues (Scoones 2002).

Legal and policy responses

The introduction of GMOs has brought new challenges for authorities and policymakers who have to consider impacts on human health, poverty and hunger, livelihoods and food security, free trade and international markets, and the environment, particularly biodiversity. Laws and institutions need to ensure that an acceptable trade-off between competing and often conflicting interests is maintained. As GMO technology is relatively new, governance systems are also in their infancy and have not been able to take all these challenges on board.

Africa is responding to these challenges at multiple levels. It has supported initiatives at the global level such as the CBD and its Cartagena Protocol. It has developed cutting-edge solutions at the regional level such as the African Union's (AU) Model Law on Safety in Biotechnology (African Biosafety Model Law) and has begun to develop national frameworks for GMO development and biosafety. The AU has also adopted a Model Law for the Protection of the Rights of Local Communities, Farmers, Breeders and Regulation of Access to Biological Resources.

Bacillus thuringiensis.

Source: University of Georgia

The AU's Comprehensive Africa Agriculture Development Programme (CAADP) promotes an integrated multilevel response to the challenges of agriculture. This framework should serve as the basis for developing agricultural strategies. As the Millennium Task Force on Science and Technology cautions, technology cannot of itself determine social change but it can be a useful tool when aligned with development goals and when supporting governance structures are created (UN Millennium Project 2005b).

Cartagena Protocol

At a global level, the key response to concerns about biosafety is the Cartagena Protocol on Biosafety adopted in 2000 under the CBD of 1992. The Protocol is primarily concerned with transboundary movement of LMOs; it provides a framework for countries to assess risks associated with LMO prior to authorizing importation. It seeks to ensure:

> "An adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements" (Secretariat of the CBD 2000).

Two key concepts, biosafety and precaution, form the basis for the framework developed in the Protocol. Biosafety is based on the concept of precaution and

Box 9: Precaution

Principle 15 of the Rio Declaration provides that:

> "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

The Cartagena Protocol applies precaution not just to biodiversity, but to potential risks to human health as well. Additionally it gives importing countries the right to take into account socioeconomic concerns (provided their actions are "consistent with their international obligations"). Such concerns could include the risk that imports of genetically engineered foods may replace traditional crops, undermine local cultures and traditions or reduce the value of biodiversity to indigenous communities.

Source: Secretariat of the CBD 2000, UN 1992, CBD and UNEP 2003

implies minimizing the risk to human, animal and environment health (see Box 9). It includes a range of measures, policies and procedures to minimize potential risks. The precautionary approach has been specifically incorporated in the Protocol.

Although there remains much controversy about what exactly constitutes a precautionary approach, there is evidence of wide support for it as reflected in Box 10. The Cartagena Protocol applies the precautionary approach to biodiversity and to human risks. It gives importing countries the right to take socioeconomic considerations into account, as long as these are consistent with their international obligations. The Protocol allows governments on the basis of precaution to prohibit the import of a GMO, even where there is insufficient scientific evidence about potential adverse effects (CBD and UNEP 2003).

The Protocol entered into force in July 2003. Although the Protocol has been signed by 37 African countries, many of these have not yet ratified it or developed laws to incorporate it into their legal framework (CBD 2006): Algeria, Benin, Botswana, Burkina Faso, Cameroon, Cape Verde, Democratic Republic of the Congo, Djibouti, Egypt, Eritrea, Ethiopia, Gambia, Ghana, Kenya, Lesotho, Liberia, Libya, Madagascar, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Sudan, Swaziland, Togo, Tunisia, Uganda, Tanzania, Zambia, and Zimbabwe. Table 2 shows the status of the Cartagena Protocol in African countries.

African countries are faced with the challenge of dealing with transboundary movement of GMOs and illegal use or research activities. Some African country borders are porous, difficult to police and at times subject to bribery (GMWatch 2005). GM maize and rice

Box 10: IUCN-The World Conservation Union calls for precaution

IUCN is a global union of governments, civil society organizations (CSOs) and experts; it brings together 82 state members, 112 government agencies, 784 national NGOs, 33 affiliate members and 84 international NGOs. Consequently it is an important global voice.

In 2002, IUCN adopted a resolution on GMOs, which noted the lack of knowledge of the effects on biodiversity and on the potential role of GMOs in "achieving global food security." which it notes "has not been adequately demonstrated so far." It focuses on the need to adopt a precautionary approach to GMO as set out in Principle 15 of the Rio Declaration and the Cartagena Protocol on Biosafety. To this end it calls "upon key private sector companies to integrate biodiversity into their corporate social responsibilities and actions."

In 2004, IUCN, at its 3rd World Conservation Congress held in Bangkok, Thailand, passed a resolution, which calls for "a moratorium on further environmental releases of GMOs until they can be demonstrated to be safe beyond reasonable doubt." It also requests the IUCN Council to:

- Prepare policy guidance for sustainable GMOs through a multifaceted approach;
- Promote and support initiatives to ratify the Cartagena Protocol on Biodiversity; and
- Encourage public awareness and promote access to information.

While the resolution was sponsored by most state and NGO-members, state members such as Japan, The Netherlands and Sweden were against the resolution. The US government and agency members refrained from the deliberations.

Source: IUCN 2004

Table 2: African countries status on Cartagena Protocol on Biosafety

Country	Signature	Ratification/accession	Entry into force
Algeria	25 May 2000	5 August 2004	3 November 2004
Angola			
Benin	24 May 2000	2 March 2005	31 May 2005
Botswana	1 June 2001	11 June 2002	11 September 2003
Burkina Faso	24 May 2000	4 August 2003	2 November 2003
Burundi			
Cameroon	9 February 2001	20 February 2003	11 September 2003
Cape Verde		1 November 2005	30 January 2006
Central African Republic	24 May 2000		
Chad	24 May 2000		
Comoros			
Congo	21 November 2000		
Côte d'Ivoire			
Democratic Republic of the Congo		23 March 2005	21 June 2005
Djibouti		8 April 2002	11 September 2003
Egypt	20 December 2000	23 December 2003	21 March 2004
Equatorial Guinea			
Eritrea		10 March 2005	8 June 2005
Ethiopia	24 May 2000	9 October 2003	7 January 2004
Gabon			
Gambia	24 May 2000	9 June 2004	7 September 2004
Ghana		30 May 2003	11 September 2003
Guinea	24 May 2000		
Guinea-Bissau			
Kenya	15 May 2000	24 January 2002	11 September 2003
Lesotho		20 September 2001	11 September 2003
Liberia		15 February 2002	11 September 2003
Libya		14 June 2005	12 September 2005
Madagascar	14 September 2000	24 November 2003	22 February 2004
Malawi	24 May 2000		
Mali	4 April 2001	28 August 2002	11 September 2003
Mauritania		22 July 2005	20 October 2005
Mauritius		11 April 2002	11 September 2003
Morocco	25 May 2000		
Mozambique	24 May 2000	21 October 2002	11 September 2003
Namibia	24 May 2000	10 February 2005	11 May 2005
Niger	24 May 2000	30 September 2004	29 December 2004
Nigeria	24 May 2000	15 July 2003	13 October 2003
Rwanda	24 May 2000	22 July 2004	20 October 2004
São Tomé and Príncipe			
Senegal	31 October 2000	8 October 2003	6 January 2004
Seychelles	23 January 2001	13 May 2004	11 August 2004
Sierra Leone			
Somalia			
South Africa		14 August 2003	12 November 2003
Sudan		13 June 2005	11 September 2005
Swaziland		13 January 2006	13 April 2006
Tanzania		24 April 2003	11 September 2003
Togo	24 May 2000	2 July 2004	30 September 2004
Tunisia	19 April 2001	22 January 2003	11 September 2003
Uganda	24 May 2000	30 November 2001	11 September 2003
Zambia		27 April 2004	25 July 2004
Zimbabwe	4 June 2001	25 February 2005	26 May 2005

Source: CBD 2006

are already being planted illegally in various regions of Tanzania (Balile 2005). Adoption and ratification of the Protocol could be a useful option. In the absence of effective monitoring and enforcement, bans on the import of GM seeds are of no effect (Balile 2005). The shipment of grain requires leak-proof containers to avoid unintended GMO product contamination. Therefore, responsible deployment of GM crops needs to encompass the whole technology development process, from the pre-release risk assessment, to biosafety considerations, to post-release monitoring (FAO 2005). Monitoring GM crops will provide information for policies and regulations; it will give producers and policymakers better information to help them develop safer adoption processes.

Regional responses

The African Biosafety Model Law was adopted by the AU at its 74th Ordinary Session in Lusaka, Zambia, in July 2001, and urged member states to use the African Biosafety Model Law to draft their own national legal instruments.

The seed bank at the KwaNgwanase Farmers' Association nursery in northern KwaZulu-Natal.

Source: Biowatch

This model law emanated from a highly participatory process which included researchers, governments, and civil society groups. It reflects a broad consensus on issues of biotechnology development. The regulatory framework utilizes the discretion given by the Cartagena Protocol on Biosafety for countries to adopt more stringent protective measures than the agreed minimum set out in the Protocol. The African Biosafety Model Law recognizes the importance of Africa as a centre of origin and a centre of diversity with regard to food and other crops. It makes provision for considering socioeconomic factors in assessing risks and opportunities. Key legal principles and approaches incorporated include:

- Precautionary;
- The sovereign right of every country to require a rigorous risk assessment of any GMO for any use before any decision regarding the GMO is made; and
- A liability and redress regime.

The African Biosafety Model Law provides a holistic and comprehensive set of biosafety rules including issues that are not dealt with by the Biosafety Protocol. These include mandatory labelling and identification or traceability requirements for GMOs and GM food, and liability and redress for harm caused by GMOs to human health and the environment, and for resultant economic loss (Mayet 2003).

Sub-regional approaches

Six regional economic communities in Africa, namely the Economic Commission of West African States (ECOWAS), the East African Community (EAC), the Economic Community of Central African States (ECCAS), the Intergovernmental Authority on Development (IGAD), the Southern African Development Community (SADC) and the Arab Mahgreb Union (AMU) have taken the lead in developing policy guidance on GMO research, production and marketing in their respective regions.

In Kampala, in November 2002, agricultural ministers of the Common Market for Eastern and Southern Africa (COMESA), agreed to create a regional policy on GMOs. Similarly, the SADC established an advisory committee on GMOs to develop guidelines and to assist member states in guarding against potential risks in food safety, contamination of genetic resources, ethical issues, trade-related issues and consumer concerns. These are set out in Box 11. The EAC has recommended reviewing and developing a common policy on GMOs. The IGAD members formed a Verification and Monitoring Team (VMT) to ensure that food assistance be certified as free

Box 11: SADC recommendations on genetically modified organisms

The following recommendations were formulated by the SADC Advisory Committee on Biotechnology and Biosafety and were approved by the SADC in August 2003 as interim measures aimed at guiding the region on issues relating to biotechnology and biosafety.

Handling of food aid

- The Southern African Development Community should develop and adopt a harmonized transit information and management system for GM food aid designed to facilitate transboundary movement in a safe and expeditious manner.
- The Southern African Development Community is encouraged to source food aid preferably from within the region, and advise all cooperating partners accordingly.
- Donors providing GM food aid should comply with the Prior Informed Consent principle and with the notification requirements in accordance with Article 11 of the Cartagena Protocol on Biosafety.
- Food aid consignments involving grain or any propagative plant material that may contain GMOs should be milled or sterilized prior to distribution to the beneficiary population.
- Food aid in transit that may contain GMOs should be clearly identified and labelled in accordance with national legislation.
- Southern African Development Community countries managing or handling food aid in transit that may contain GMOs are encouraged in the absence of national legislation to make use of the requirements under the African Biosafety Model Law and/or the South African Guidelines on the handling of transit material which may be GM.

Policy and regulations

- Each member state should develop national biotechnology policies and strategies and expedite the process of establishing national biosafety regulatory systems.
- All member states should sign and ratify the Cartagena Protocol on Biosafety to the CBD.
- The region should develop a harmonised policy and regulatory systems based on the African Biosafety Model Law and the Cartagena Protocol on Biosafety and other relevant international processes.
- Member states without a regulatory framework for GM crops should use approved guidelines and should not import genetically modified grain for seed before approved guidelines are in place.
- Risk assessments should be done on a case-by-case basis and every genetic modification should be tested in the environment under which it will be released.

Capacity-building

- Member states should develop capacities at national and regional levels in order to develop and exploit the benefits of biotechnology.
- The Southern African Development Community should allocate resources for capacity-building in management of biotechnology and biosafety.
- The Southern African Development Community should encourage member states to commission studies on the implications of biotechnology and biosafety on agriculture, environment, health and socioeconomics as part of an integrated monitoring and evaluation system.

Public awareness and participation

- Member states should develop public awareness and participatory programmes on biotechnology and biosafety that involve all stakeholders.

Sources: SADC 2004

of GMOs. Fifteen members of ECOWAS attended a meeting to better understand and discuss the benefits and threats of GMOs.

National Policy and Law

The need for adequate national policies and laws to regulate biotechnology research and establish effective assessment processes which safeguard human and environmental health is widely acknowledged. There is a need to develop harmonized approaches to biotechnology and the African Biosafety Model Law provides a good basis for this, as does the Model Law for the Protection of the Rights of Local Communities, Farmers, Breeders and Regulation of Access to Biological Resources. Other region-wide organizations such as New Partnership for Africa's Development (NEPAD), and its Science and Technology Secretariat could have an important role.

At least nine countries have biosafety legislation or guidelines including Benin, Cameroon, Malawi, Mauritius, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. Ghana, Kenya, Lesotho and Swaziland all have draft legislation that addressees the issue of biosafety, the commercialization of GM crops and the importation of GM foods.

Developed country aid agencies and international organizations have had a keen interest in supporting the development of an enabling legal environment for

transgenic research and biosafety. Some of these initiatives appear in Annex 3 Table 2. The United States Agency for International Development is the most active in this area. The US has been a keen supporter of GM crop development, offering it as food aid, and the US is also the largest producer of GM crops. Several African countries have or are in the process of developing biosafety policies and law through a United Nations Environment Programme (UNEP) – Global Environmental Facility (GEF) initiative. This capacity-building project supported 100 developing countries to prepare national biosafety frameworks. Thirty-six African countries have or are participating in this project. An AU biosafety capacity-building project designed to spearhead the harmonization of biosafety legislation between member states based on the African Biosafety Model Law has been developed.

THE WAY FORWARD: OPPORTUNITIES AND CONSTRAINTS

Africa's experience with GM technologies is still relatively new compared to other regions and it is faced with many challenges on how best to proceed. Knowledge, transparency, fairness and containment are four key points in formulating a sound African policy on GMOs.

Cotton weaving in Essaouira, Morocco. Cotton is an important part of livelihoods in many African countries.

Source: J.C. Mohamed-Katerere

INCLUSIVE POLICY PROCESSES

Inclusive policy processes, based on adequate information, are essential to developing appropriate national and regional responses. The potential risks and opportunities posed by GM technologies are immense.

Decision making is a process of accountability – to one's constituency, one's country and the world – and as such it must necessarily be based on a weighing of evidence, not only evidence that a decision might pose a particular risk or benefit, but also evidence about the potential dimensions of that risk or benefit, about the likelihood of harm or advantage, about the efficacy of available measures to prevent or mitigate risks, and about other factors and situations within and outside the decision-maker's jurisdiction that affect the decision (Young 2004). Thus it is crucial for decision-makers, legislators, governments and the civil society, to have access to adequate supporting information.

Given the complexity of the issues at stake from biosafety considerations, human health concerns and socioeconomic implications, it is essential that policy processes use a range of techniques that are able to support effective valuation in these areas.

In it is also important, given the range of interests at stake, that policy processes become more deliberative, transparent and accountable.

WEIGHING THE CHOICE OF AGRICULTURAL OPTIONS

A crucial issue facing African governments is determining what kind of development and agricultural strategies can best meet long-term objectives and medium- to short-term goals. A viable agricultural strategy should contribute to the realization of the MDGs and targets including:

- Eradicating extreme poverty and hunger;
- Ensuring environmental sustainability;
- Reducing child mortality;
- Improving maternal health; and
- Combating HIV/AIDS, malaria and other diseases.

Defining such a strategy and identifying appropriate solutions is dependent on research that accurately understands the nature of the problem. Declining African agricultural research has meant that, increasingly, research priorities are often externally driven on the basis of assumptions that are not shared. Much global agricultural research is based on models which focus on production deficits and fails to take into account the multiple factors that are driving food crises including globalization, environmental degradation and HIV/AIDS. The opportunities of and challenges faced by agricultural

production systems are discussed in Chapter 3: *Land* and Chapter 4: *Freshwater*. The problems of food security are complex and can probably not be resolved through a "technological fix." Instead they require multisectoral and multilevel (local, national, international) interventions. Nevertheless, GM technologies offer promise for meeting some areas of greatest challenge in Africa. Benefits to the environment can be summarized to include: "friendly" bioherbicides and bio-insecticides, and conservation of soil, water, and energy. Increased food security for the growing populations may result from GM enhanced crop and livestock productivity.

New GM technological advances may create ethical controversies around tampering with nature, from, for example, mixing genes among species and related objections to consuming animal genes in plants and vice versa.

Like all new technologies, they also pose some risks, both known and unknown. Potential environmental impacts include: unintended transfer of transgenes through cross-pollination, unknown effects on other organisms (eg soil microbes) and loss of flora and fauna biodiversity. Traditional agricultural systems have played an important role in maintaining crop diversity. Certain human health impacts have been identified. The impacts on livelihoods, food security and rural options are not well understood.

Although genetic engineering may offer important opportunities for development and achieving the MDGs, it is important to strengthen existing local production systems and not compromise the existing systems. Clear cost-benefit analysis about the efficacy of different kinds of technological options need to be undertaken alongside locally-driven priority-setting exercises. The question remains as to whether development of genetic engineering is a priority for African governments at this point in time.

The value of existing agricultural approaches and non-transgenic approaches for Africa need to be considered. Achievements that have been made, including improving yields, better management of insects. pests, plant diseases and weeds without the use of synthetic pesticides, and the maintenance of soil fertility without chemical fertilizers (ERA 2005), should be consolidated. The value and productivity of traditional agriculture in development and its genetic diversity should not be underestimated. Africa has more than 2 000 native grains, roots, fruits and other food plants (National Research Council 1996).

The issue of IPRs will need to be addressed to ensure that there are no adverse consequences for food productivity, through, for example, the weakening of farmers' rights. In addition to directly protecting farmers' rights, measures to protect genetic resources and ensure benefit sharing may be valuable. These may include:

- Fair and equitable allocation of profits to local communities from which genetic material was obtained;
- Adhering to local law and respecting and protecting local cultures and resources; and
- Adhering to the CBD, particularly Article 8J, and the International Labour Organization (ILO) Convention No. 169 Concerning Indigenous and Tribal Peoples in Independent Countries.

In 1998, the Council of Ministers of the AU adopted the Model Law for the Protection of the Rights of Local Communities, Farmers, Breeders and Regulation of Access to Biological Resources. This serves as a basis for African countries to develop national law which fulfils their obligations to TRIPS and to the CBD, while protecting the collective social process of knowledge and technology generation.

Box 12: Developing sustainable agricultural production systems

The Millennium Project Task Force on the Environment identified the following as critical to enhancing sustainable agriculture techniques to preserve natural assets:

- Protect and improve soils, including enhanced carbon sequestration.
- Use water sustainably.
- Maintain crop genetic diversity.
- Mobilize local knowledge and experience.
- Improve crop research, management storage, and use.
- Restore and manage desertified lands.
- Adopt prevention strategies to protect arid ecosystems.
- Mobilize information and technology.
- Protect surrounding natural habitat.
- Rationalize land-use planning.
- Set up systems of communal ownership and management rights.

Source: UN Millennium Project 2005a

Biosafety and risk assessment

A biosafety approach would include taking measures to minimize risks to human and environmental health. This could include:

- Ensuring that thorough information is available and that risks are understood and mitigated;
- Products containing GMOs must be clearly labelled and information readily available;
- Clear and fair liability laws and producer responsibility; and

- Genetic and biological material should be managed and contained to high standards.

Evidence-based GMO risk assessments to assure transparent decision making based on human health and ecological data need to be developed. Risk assessments should be on a case-by-case basis as results obtained from other countries might not be replicable. Deliberative approaches should be considered.

The controversy around risks and opportunities demonstrates the need for effective multilevel assessment procedures that incorporate a precautionary approach as envisaged under the Cartagena Protocol. This policy and legislative approach needs to be complemented by capacity development. Countries need to have the capacity to identify GMOs and also to evaluate the risks associated with them.

Risk management

Possible mitigation plans should be in place in case undesirable outcomes are experienced. This requires that African countries should establish efficient traceability systems as part of their mitigation measures.

Research priority-setting

Agricultural research, including transgenic research, needs to focus on African realities and needs. African agriculture is largely small-scale and relies on poly-cultures, which consists of many crops being grown on the same plot with possibilities of symbiotic leguminous relationships providing nitrogen fixation (Makanya 2004). In addition to intercropping, trees and shrubs (agroforestry) are the anchor perennial species, providing *mycorrhiza* for mobilizing phosphorus and other nutrients. and these trees and shrubs promote soil protection against erosion by wind and water. Also, each of Africa's main staples and about 300 leafy vegetables have perennial cultivars and provide a starting point for the genetic selection and breeding of the best cultivars to incorporate into the traditional tree-and-shrub poly-culture in farming households (Odhiambo 2001). Development of GMOs should aim to tap these special qualities of Africa's native flora and fauna in the efforts to improve food security and make genetic engineering beneficial to Africa's environment and development.

Research will need to be based on meaningful partnerships between users and researchers if it is to be more responsive to local needs (Jones 2005). Given

Genetic engineering, Egypt. Agriculture project researching into GM foods.

Source: J. Schytte/Still Pictures

Box 13: Biotechnology for smallholder farmers

Biotechnology research that is appropriate for smallholder farming includes biotechnologies which:

- are affordable;
- do not restrict or prohibit farmers from saving and exchanging seed;
- are responsive to local livelihood contexts;
- are appropriate to patterns of labour availability;
- are suitable for use in a multicrop system;
- have traits such as increased drought tolerance, nutrient-use efficiency and disease resistance;
- are suitable and safe for the local ecosystem; and
- are backed by appropriate support, including access to credit, markets and extension services.

Source: Glover 2003a

the multiplicity of CSOs and other public interest groups. there is considerable opportunity for developing such partnerships.

Partnerships with the private sector are essential for the sharing of technologies, information and knowledge.

Sound Legal and Policy Framework

A sound legal and policy framework for assessing risks and benefits, regulating research, monitoring research and commercialization, as well as protecting rights, is essential. There needs to be complementarity between the various levels of law and policy, from the global to the local, as well as across different sectors (eg agriculture and technology) and different sets of rights (eg IPRs and farmers' rights).

Legal frameworks need to recognize key legal principles and rights that are applicable to the development and application of GM technologies. These include precaution; rights to participation and access to information; rights to development as well as a safe and healthy environment; IPRs, indigenous knowledge and farmers' rights; and issues of legal responsibility. Useful measures that can support an effective legal framework could include labelling and risk assessment and management. For traceability of GM products, country of origin labelling should be fully enforced also for the purposes of record-keeping and informing the public who can then make a choice whether or not to use the products.

Although, under WTO agreements, countries need to adopt IPR legislation, in doing so they have a fair amount of latitude. They need to tailor IPR legislation so that it supports them in achieving their development objectives. They can address concerns about domination of world food production by, for example, excluding plants and animals from patent protection. Farmers can be protected by explicitly allowing them to save, re-use and exchange harvested seed. There may be a need to engage and negotiate with multinational corporations through their global federations (such as Crop Life International). Lessons can be learnt from the experience of countries such as India which have succeeded in attracting investment in this area while at the same time protecting the interests of small farmers.

Capacity-building

Building capacity in biosafety is a broad task. It includes training individuals in the scientific, legal and policy aspects of risk assessment as well as enhancing research capacity. There needs to be capacity-building of existing institutional talent and establishment of sound research, development, and extension, marketing and monitoring units. Efforts to foster cooperation and scientific advisory committees at sub-regional levels are encouraged.

Agricultural research throughout Africa has yielded high returns financially and improved livelihoods. However, today agricultural research is under threat from decreasing capacity as a result of inadequate government investment and a series of externally imposed conditionalities (Scoones 2005). Privately-driven R&D has been unable to fill this gap and it is crucial that Africans increase investment in research systems.

Partnership is central to building capacity in R&D. The application of modern biotechnology to agricultural research systems across the developing world calls for new investments, changes in resource allocations and new responsibilities for policymakers, research managers and scientists alike. Improving research capacity through developing partnerships, to solve local problems, with institutions that have advanced technologies, human resources, laboratory infrastructure and funds for routine administrative work are necessary. African countries might benefit from the pooling of resources for R&D of GMO technologies. Where patentable products are developed, there will be a need for serious consideration on the subsequent equitable utilization of the accrued income. African countries need to increase their own investment in capacity-building.

The application of biosafety principles serves to minimize the risks of GM technologies. Agenda 21, and the CBD and its Cartagena Protocol on Biosafety (2000) are international instruments that address biosafety issues. Many African nations do not have the capacity

to implement this protocol; they lack capacity in terms of expertise, equipment, infrastructure, legislation and regulatory systems (Diouf 2001).

Capacity needs to be built to enable African countries to engage more effectively in global policy fora so that multilateral instruments do not compromise Africa's interests.

CONCLUSION

Developing a sustainable agricultural strategy that ensures food security, does not threaten the environment or biodiversity, and promotes human well-being must be a priority for Africa. Africa is faced with the decision of whether GM crops can be part of this, and if so, how to manage the risks and uncertainties associated with GM technology. In evaluating the options, Africa needs to consider the potential benefits from possible yield gains and a decrease in the need for chemical use against the threats posed to biodiversity, livelihoods and cultural systems.

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CHAPTER 10
INVASIVE ALIEN SPECIES

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"Invasive alien species are emerging as one of the major threats to sustainable development, on a par with global warming and the destruction of life-support systems. These aliens come in the form of plants, animals and microbes that have been introduced into an area from other parts of the world, and have been able to displace indigenous species."

PRESTON AND WILLIAMS, WORKING FOR WATER PROGRAMME/SOUTH AFRICA 2003

INTRODUCTION

Alien – that is non-native – species have been introduced both accidentally and intentionally. Intentional introductions are, and have been, motivated by economic, environmental and social considerations. In the forest sector, for example, *Pinus*, *Eucalyptus* and *Acacia* species are important sources of pulp, timber and fuelwood, yet at the same time they have placed tremendous strain on water resources. In Southern and Eastern Africa, these species are the backbone of plantation forestry, bringing in valuable foreign currency, yet at the same time decimating land and water resources. In South Africa, for example, they consume 7 per cent of available water (Preston and Williams 2003). Many introductions, however, are unintentionally coming into countries with other goods and, in the case of marine IAS, in the ballast water of ships.

Although only a small percentage of these alien species will become invasive, when they do their impacts are immense, insidious and usually irreversible, and they may be as damaging to native species and ecosystems on a global scale as the loss and degradation of habitats (IUCN/SSG/ISSG 2000). In Africa some important ecosystems are under threat, consequently undermining development and livelihood opportunities, increasing human vulnerability and threatening human well-being. Thus, IAS have a direct bearing on Africa's ability to meet the Millennium Development Goals (MDGs) and their targets. (These goals and targets, and progress towards meeting them, are set out in Annex 1).

Although not all alien species will become invasive or threaten the environment, this is an area in which a clear policy approach is necessary because of its potentially wide-ranging impacts when they do become invasive, and because of the difficulties, including financial costs, in reversing its impacts. One experience which illustrates this dilemma is the introduction of *Lates niloticus* (Nile perch) into Eastern Africa. The Nile perch has had immense economic value in the countries where it has been introduced, but it has also wreaked havoc in the ecosystems, resulting in the loss of endemic species and altered ecosystems with knock-on effects for livelihoods. Alien species, such as *Bufo marinus* (cane toad) and *Chromolaena odorata* (bitter bush) (IUCN/SSG/ISSG 2004) have been used for biological control and as an ornamental, and then subsequently become invasive.

Increased mobility and human interaction have been key drivers in the spread of IAS. On the one hand, increasing global connectedness – through trade, travel and tourism – has enriched the lives of people all over the world, through increased opportunities for sharing information and knowledge as well as improved access to a range of biodiversity (McNeely and others 2001).

Box 1: Invasive alien species

IAS are also commonly referred to as invasives, aliens, exotics or non-indigenous species.

IAS are species, native to one area or region, that have been introduced into an area outside their normal distribution, either by accident or on purpose, and which have colonized or invaded their new home, threatening biological diversity, ecosystems and habitats, and human well-being.

The extent to which introduced species may proliferate and spread is affected by the state of the receiving ecosystem. An alien species may find a vacant niche and spread, or it may compete for one already occupied by a native species. Some IAS proliferate because they find no natural enemies in their new habitat.

Although some species have invaded habitats on their own, human activity such as exploration, colonization, trade and tourism has dramatically increased the diversity and scale of invasions by alien species.

Sources: CBD 1992, Shrine and others 2000, ESA 1998

Increased access to biodiversity has created new opportunities for forestry, agriculture, aquaculture, horticulture, and biodiversity-based industries including the pharmaceutical sector. However, this increasing interaction has had its costs too:

> "It has broken down the natural barriers of oceans, mountains, rivers and deserts which for millennia provided the isolation essential for unique species and ecosystems to evolve. In just a few hundred years these barriers have been rendered ineffective by major global forces that combined to help alien species travel vast distances to new habitats and become alien invasive species" (IUCN/SSG/ ISSG 2000).

The impacts of IAS are immense, insidious, and usually irreversible and they may be as damaging to native species and ecosystems on a global scale as the loss and degradation of habitats.

IUCN/SSG/ISSG 2000

The challenge facing Africa is how to respond – to known IAS and to new introductions of alien species that could potentially become invasive. First, Africa needs to develop systems for evaluating the risks and benefits associated with alien species, and for deciding when to use them and when to prevent their introduction or eradicate them. This entails considering the economic, development, environment and human well-being costs-and-benefits, and recognizing the close relationship between these sectors. Second, Africa faces the challenges of how to translate its policy objectives into effective management practice. When species are identified as a threat, appropriate responses may include establishing systems for their eradication, as well as for controlling and monitoring their introduction. When alien species are used, developing early warning and assessment systems regarding their behaviour as well as effective response systems is essential.

STATE-AND-TRENDS

Africa is home to hundreds of IAS – both plant and animal – but the magnitude of the problem varies from country to country, and from ecosystem to ecosystem. In many parts, freshwater ecosystems are particularly at risk – with IAS surpassing habitat loss as the number one cause of biodiversity loss.

Invasive alien species are a problem in diverse ecosystems in Northern, Western, Central, Eastern and Southern Africa and in the Western Indian Ocean (WIO) islands: they affect both savannahs and tropical forests and they are found on land, in freshwater systems, along the coast, and in the ocean. (UNEP 2004).

Virtually all countries in the region are affected by IAS. In 2004, IUCN – the World Conservation Union (IUCN) identified 81 IAS in South Africa, 49 in Mauritius, 44 in Swaziland, 37 in Algeria and Madagascar, 35 in Kenya, 28 in Egypt, 26 in Ghana and Zimbabwe, and 22 in Ethiopia (IUCN/SSC/ISSG 2004). (See Figure 1). In some countries there may be under-reporting of the incidence of IAS.

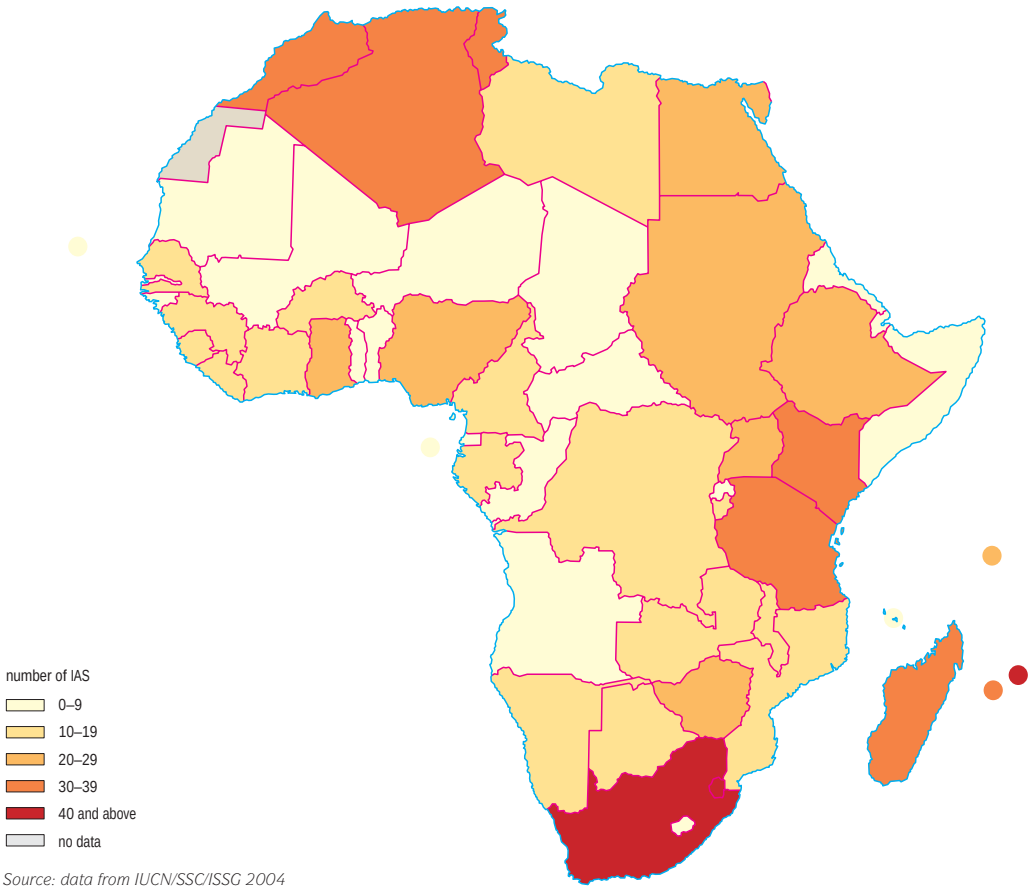
Many IAS found in Africa are included on a global list of the 100 worst IAS (IUCN/SSG/ISSG 2004). These include the infamous, *Eichhornia crassipes* (water hyacinth) (see Box 5); economically important species including the Nile perch, *Oreochromis mossambicus* (Mozambique tilapia) and *Acacia mearnsi* (black wattle) (see Box 6); species introduced for biological control, such as *Acridotheres tristis* (Indian myna) (see Box 3) and *Bufo marinus* (cane toad); and ornamentals such as *Lantana camara*. There are many other IAS which present serious challenges to regional efforts to conserve the environment and to meet development objectives – the foundation of social, economic and environmental sustainability in Africa.

In some countries, IAS have become a major ecological, social and economic problem despite the existence of legal measures and substantial funding to control them. The extent of this is discussed further in this chapter in the section *Challenges faced in realizing development opportunities*.

POTENTIAL GROWTH

With increasing globalization, the threat posed by IAS is likely to increase through both intentional and accidental introductions. Human movement and the

Figure 1: The incidence of IAS in Africa



Source: data from IUCN/SSC/ISSG 2004

movement of goods are key drivers in the spread of IAS. With improvements in communications and infrastructure, this is likely to increase. Historically, IAS have been spread through colonization and exploration. Today, mobility through tourism, business travel and migration continues to be an important factor. Many IAS have been introduced to Africa in, for example, soil, plants, luggage, vehicles and aeroplanes (Kirby 2003).

Trade – both legal and illegal – particularly in, but not limited to, plants and animals, is particularly important. Many species have been introduced through trade in manufactured goods contaminated with seeds or insects. Trade has contributed not only to the introduction of species that colonize and fundamentally alter receiving ecosystems but that are also a factor in the growing incidence of disease. *Aedes albopictus* (Asian tiger mosquito), for example, is associated with the transmission of dengue fever and is believed to have been first introduced through a shipment of tyres from Japan to South Africa in 1989. By 1999 these mosquioes were found to be present in Douala, Cameroon's main commercial harbour (Fontennille and Toto 2001).

Invasive alien species have also been spread through the provision of humanitarian emergency food aid. For example, the weed *Parthenium hysterophorus* is a recent introduction to Africa through grain shipments for famine relief to Ethiopia (McNeely and others 2001). The weed was first seen in 1988 near food-aid distribution centres in Ethiopia. Buried seeds of the weed can lie dormant for as long as 20 years before germinating (GISP 2004).

Research activities and agricultural extension have also been a factor, as shown in Box 10.

Disturbed ecosystems are particularly vulnerable to invasion by alien species. In Tanzania, for example, *Maesopsis eminii* has become dominant in logged forests. It is also capable of regenerating in natural forests, particularly where there are large gaps caused by tree-falls (Bingelli and others 1998). In both Eastern Africa and WIO islands, the woody shrub *Clidemia hirta* is also increasingly common in natural forest gaps (Bingelli and others 1998). With high levels of environmental change, such as deforestation and growing extractive timber use, IAS are likely to be a growing problem. Climate change – through its impact on ecosystems – may also favour the spread of IAS. Section 2: *Environmental State-and-Trends: 20-Year Retrospective* considers the major environmental changes occurring in land, freshwater, coastal and marine environments, and biodiversity.

Box 2: IAS, the biotic integrity of communities and the functioning of ecosystems

The Millennium Ecosystem Assessment (MA) found that trends in species introductions, as well as modelling predictions, strongly suggest that biological invasions will continue to increase in number and impact. A further concern is that multiple human impacts on biodiversity and ecosystems will decrease the natural biotic resistance to invasions and, therefore, the number of biotic communities dominated by invasive species will increase. However, research suggests that maintaining native species assemblages may diminish the ability of exotic species to become invasive.

A further important finding is that there is a positive correlation between the richness of native and exotic species across habitats – as the factors that promote the richness and coexistence of native species, such as benign climate, intermediate levels of disturbance, and habitat heterogeneity, also promote the richness and coexistence of exotic species. This suggests that hotspots for diversity are particularly at risk of invasion by introduced species, and that the loss of native species (from communities of low or high native species richness) is expected to increase.

Source: MA 2006

Increased trade is also associated with increased transportation. As already noted, ballast water, and its associated sediment, has been identified as an important route for the introduction of marine IAS: 14 billion tonnes of ballast water are transferred globally each year and more than 7 000 species of marine organisms may be present in ballast water at any given time (GISP 2004).

Even if these human drivers are more effectively dealt with, the problem of IAS is likely to continue as natural processes, such as cyclones and water currents, may also be a factor in their distribution. The Swaziland National History Society, for example, notes that an IAS known locally as demonia weed was blown into Swaziland by a cyclone in 1984; this has subsequently rendered large areas of formerly productive agricultural land useless (IRIN 2002).

IMPACTS ON BIODIVERSITY AND ECOSYSTEMS

Although IAS come from diverse taxonomic groups they share some similar impacts. Tree species such as the black wattle from Australia, *Prosopis spp.* (mesquite tree) from Mexico, and *Leucaena leucocephala* (the conflict tree) behave in a similar way to invasive alien fish species, such as *Cyprinus carpio* (the common carp), *Micropterus salmoides* (American black bass), *Oreochromis nilotica* (Nile tilapia) and Mozambique tilapia, and out-compete native species and convert receiving ecosystems.

Invasive alien species may threaten native species as direct predators or competitors, as vectors of disease, or by modifying the habitat or altering native species dynamics (MA 2006). The threat posed to biodiversity by IAS is considered second only to that of habitat loss (CBD 2005). On small islands, it is now comparable with habitat loss as the lead cause of biodiversity loss (Baillie and others 2004).

Invasive species may out-compete native species, repressing or excluding them and, therefore, fundamentally change the ecosystem. They may indirectly transform the structure and species composition of the ecosystem by changing the way in which nutrients are cycled through the ecosystem (McNeely and others 2001). Entire ecosystems may be placed at risk through knock-on effects. Given the critical role biodiversity places in the maintenance of essential ecosystem functions, IAS may cause changes in environmental services, such as flood control and water supply, water assimilation, nutrient recycling, conservation and regeneration of soils (GISP 2004, Levine and others 2003). Chapter 7: *Biodiversity* discusses the complex relationship between biodiversity and the maintenance of essential ecosystem functions.

Invasives may also affect native species by introducing pathogens or parasites that cause disease or kill native species.

Among other things, both old and newly established IAS contribute to land degradation through soil erosion and the drawing down of water resources, reducing resources available to people and indigenous plants. Others produce leaf litter which poisons the soil, suppressing the growth of other plants, and in particular that of the understorey (UNEP 2004). They may alter the environment in directions that are more favourable for them but less favourable to native species. This could include altering geomorphic processes (soil erosion rates, for instance, or sediment accretion), biogeochemical cycling, hydrological cycles, or fire or light regimes (MA 2006; Levine and others 2003). For example, invading trees in the fynbos of the Cape Floral Kingdom reduce stream-flow from mountain catchment areas and change the overall hydrological regime of the entire area, which in turn prevents the germination and growth of native species (MA 2006).

Wattle trees and mesquite can sink their roots deeper into the soil than indigenous trees, sucking out massive volumes of water and out-competing

Box 3: Invasive bird species

Over the last 500 years, IAS have been partly or wholly responsible for the extinction of at least 65 bird species, making this the most common contributory factor in recent losses to the world's avifauna (BirdLife International 2006).

Invasive bird species include: *Passer domesticus*, (house sparrow) which out-competes many small, native African birds, and Corvus splendens,(Indian house crow) which has spread from the Tanzanian coast inland over the last 20 years, and *Acridotheres tristis* (common or Indian myna).

The Indian house crow destroys the habitat of many other birds and as a result in the Tanzanian capital, Dar es Salaam, there are now only a few other common bird species (Howard 2003). The house crow came with ships from India – probably as early as the late 1800s. It now extends to Cape Town and has been recorded in Port Sudan and even in Cairo. This bird kills other species, destroys nests, and steals eggs and chicks of the domestic chicken. It also spreads disease and is generally a serious pest in towns along the coast of Eastern Africa (Howard 2003).

Indian mynas were introduced to reduce the insect population in agricultural areas. Mynas inflict damage to grape and other fruit crops like apricots, apples, pears, strawberries and gooseberries (IUCN/SSC/ISSG 2004). They also reduce biodiversity by competing for nesting hollows, destroying chicks and eggs and evicting small mammals.

Indian house crow feasting on a small mammal, Kenya.

Source: J. Chenje

Source: Birdlife 2006, GISP 2004, Howard 2003, IUCN/SSC/ISSG 2004, UNEP 2004

indigenous plants for nourishment (Preston and Williams 2003). In some environments, invasive trees, like the black wattle, increase rainfall interception and transpiration, which causes a decrease in stream-flow (IUCN/SSC/ISSG 2004).The leaves and branches of the black wattle are believed to have allelopathic properties – that is the chemical inhibition of growth and seed germination of other plants. Highly combustible, fire-tolerant alien plants may also alter the fire regime, and combined with competition for light, nutrients, water and space, this is believed to be an important factor in extinctions (Richardson and van Wilgen 2004).

Marine IAS are a growing problem in Africa's coastal waters, estuaries and lagoons. Many of these introductions are related to sea vessels and aquaculture. *Hypnea musciformis* (hypnea) is red algae, originally from Trieste in Italy, and is now distributed throughout the world. It occurs in coastland, estuaries and marine habitats where it attaches to coral, stones or shells on sheltered tropical reef flats. Its success is related to its rapid growth rate, ability to epiphytize other algae and easy fragmentation (IUCN/SSC/ISSG 2004). In Africa, it is present in the coastal waters of Morocco, Namibia, Angola, Congo, Gabon, São Tomé, Cameroon, Nigeria, Togo, Ghana, Côte d'Ivoire, Liberia, Sierra Leone, Guinea-Bissau, Gambia, north Senegal, the Cape Verde Islands, Mauritania, Ethiopia, Egypt (Red Sea), Djibouti, Kenya, Tanzania, Mozambique, South Africa, Madagascar, the Seychelles, Mauritius and Réunion. Invasion pathways include aquaculture and dispersal by boats and other vessels (IUCN/SSC/ISSG 2004).

Box 4: Aliens from Planet Earth

- IAS, especially predators, directly threaten more than 300 bird species.
- One of the most notorious plant IAS in Africa is the water hyacinth. It costs some countries tens of millions of dollars annually to control. The water hyacinth grows quickly and harms wetland ecosystems by blocking sunlight and oxygen, altering water-flows and increasing evapotranspiration.
- The water fern enhances the breeding of mosquitoes and snails that carry bilharzia, which infects about 300 million people annually in the tropics.

Source: BirdLife International 2004, GISP 2004

CHALLENGES FOR REALIZING DEVELOPMENT OPPORTUNITIES

Many alien species, including some that are invasive, have had tremendous economic value for Africa. However, overall their impact on the sustainability of the resources, upon which livelihoods and development are often based, has been adverse, undercutting opportunities, human well-being and contributing to increased human vulnerability. Invasive alien species are a serious impediment to the sustainable use of global, regional and local biodiversity (CBD 2005); this has implications for freshwater and marine resources, tourism, and forest and woodlands.

Invasive alien species may affect livelihood and other economic opportunities in multiple ways. In addition to their impact on the supply of environmental goods, they also affect the integrity of ecosystems, undercutting essential environmental services. The various chapters of Section 2: *Environmental State-and-Trends: 20-Year Retrospective* considers the environmental goods-and-services provided by the atmosphere, land resources, freshwater systems, coastal and marine environments, forests and woodlands, and biodiversity and the opportunities these resources present for development. Thus IAS, through their impact on the environment, contribute indirectly to poverty, food insecurity, ill health and poor water quality (UNEP 2004, NEPAD 2003). They have multiple level and complex impacts on human well-being and the ability to achieve development targets, such as those set out in the MDGs.

FOOD SECURITY, LAND DEGRADATION, AGRICULTURE AND LIVESTOCK PRODUCTION

Invasive alien species impact on land resources, and agriculture and livestock production systems, in multiple ways, potentially threatening food security.

Weeds may affect the productive capacity of the land and increase agricultural labour time, affecting human well-being by threatening the availability of food as well as reducing the time people have for recreation and other non-work activities, such as participation in community events. Most often the responsibility for weeding falls on women and children. In many societies women are the last to eat in times of food shortages.

Some IAS transform grasslands that support grazing. For example, *Lantana camara* poisons cattle and destroys understorey species (IUCN/SSC/ISSG 2004). The conflict tree, which is seedy and thornless, can form dense monospecific thickets. It is difficult to eradicate once established, making extensive areas unusable and inaccessible, and threatening native plants. *Chromolaena odorata* – first introduced to Côte d'Ivoire as a biological control – also forms dense thickets. It is particularly virulent in disturbed ecosystems, and thus can be associated with agriculture, and in particular slash-and-burn activities (IUCN/SSC/ISSG 2004). When it is dry it is highly combustible, promoting flash fires. In Africa, it is known to be a problem in Benin, CAR,

Water hyacinth (*Eichhornia crassipes*) is a major invasive alien species in Africa, clogging many water bodies.

Source: M. Chenje

Congo, Côte d'Ivoire, DRC, Liberia, Mauritius, Nigeria, Senegal, South Africa, Swaziland and Togo. Some tree species, such as the black wattle, also affect the viability of grass species.

Many IAS grow faster than native plants and reproduce quickly, and thus replace indigenous plants and completely alter the composition of the area they have colonized. It has been reported that agricultural and grazing land, as well as protected areas, are threatened by rapidly growing species of plants that were introduced during colonialism as garden plants and windbreaks (Hall 2003).

Parthenium hysterophorus (congress weed) invades disturbed land, including overgrazed and recently cleared or ploughed land. Once present, it is easily spread through seed dispersal – its seeds can remain viable for up to two years and buried seeds can stay dormant for up to 20 years – and as a result of its allelopathic character (GISP 2004). Because it is unpalatable to livestock its colonization of rangelands results in grazing shortages, placing livestock production at risk. In some countries, such as Ethiopia, where it was originally introduced through contaminated food imports, it has had devastating impacts on agriculture – earning it the local name, "no crop" (GISP 2004). It is also a problem in subtropical areas, affecting sugar cane and banana plantations in South Africa, Mozambique, Swaziland, Zimbabwe and Madagascar.

Viruses, such as Rinderpest and Avian Influenza Virus, can become invasive, seriously placing livestock production and livelihoods at risk. The spread of Avian Influenza Virus is closely associated with the live bird, and in particular the poultry, trade. Outbreaks of Avian Influenza in Nigeria were probably the result of illegal poultry trade with China and Turkey (BirdLife International 2006).

Freshwater and livelihoods

As discussed in Chapter 4: *Freshwater*, these systems have a central role in local livelihoods, providing food and water, water for agriculture, tourism, recreation and hydrological power. The introduction of IAS has placed these opportunities under threat. Non-native species of fish and plants have been introduced into freshwater systems to enhance food production, control pests such as mosquitoes, and to promote water purification. However, in many cases they have had adverse effects.

Although the use of alien species in aquaculture has had many positive effects, when these species escape or become invasive they can cause significant ecosystem

Table 1. Effects of some characteristic aquaculture-related introductions in Africa

Aquaculture Introduction	Environmental Impact
Oreochromis niloticus to Kenya	Displaced endemic *Oreochromis esculentus* in Lake Victoria
Tilapia zillii to Uganda	Displaced *Oreochromis variabilis* in Lake Victoria
Osphronemus goramy to Mauritius	Naturalized, minimal
Oreochromis macrochir and *Tilapia rendalli* to Cameroon	Naturalized, unknown
Cyprinus carpio to Kenya	Displacement of local species
Cyprinus carpio to Zambia	Not established
Cyprinus carpio to Malawi	Not established
Cyprinus carpio to Zimbabwe	Naturalized
Oreochromis niloticus to Zimbabwe	Introgression and reduced catches of indigenous tilapias
Clarias gariepinus to Cameroon	Naturalized
Carassius auratus to Madagascar	May have introduced parasites
Chinese carps to Ethiopia	Reportedly naturalized
Ctenopharyngodon idella to South Africa	Introduced fish tapeworm
Cyprinus carpio to Madagascar	Naturalized
Cyprinus carpio to South Africa	Reduced catches of local species; introduced 7 exotic parasites
Heterotis niloticus to Côte d'Ivoire, Cameroon, CAR, Gambia, Congo	Naturalized, unknown Naturalized
Oncorhynchus mykiss to Morocco	Unknown
Salmo trutta to South Africa	Eradication of local species
Oreochromis niloticus to Madagascar	Genetic introgression and replacement of local species

Source: Brummet 2002

damage. The Mozambique tilapia is an invasive in Northern Africa and has spread worldwide through introductions for aquaculture, as well as into the coastal waters of several WIO countries (IUCN/SSC/ISSG). Established populations in the wild are the result of intentional releases as well as escapes from fish farms. The same is true of the Nile tilapia, from Northern Africa, which has become an IAS in Southern Africa. This species can hybridize with the Mozambique tilapia, threatening its very existence in its native habitat (van der Vaal 2002).

Procambarus clarkii (Louisiana crayfish) has been introduced for aquaculture as well as a biological control agent for snail hosts of bilharzia. It escaped from aquaculture sites and is responsible for the disappearance of water lilies and submerged vegetation, as well as many species of snails, in the wetlands of Eastern and Southern Africa (Howard and Matindi 2003). It threatens the existence of smaller fish, and its habit of burrowing can result in damage to dams and reservoirs. It tolerates a wide range of salinities, oxygen-poor conditions, high pollution and fluctuating water levels. These factors, along with the ability of adult crayfish to travel long distances across land, have made it an effective invasive species (GISP 2004). In Kenya, it was introduced into Lake Naivasha where it has supported a lucrative export industry to Europe. The crayfish has become a keystone species in the lake, resulting in a cyclical boom-or-bust scenario with plants and other fish disappearing and then recovering (GISP 2004).

Services, infrastructure and shelter

The changes IAS cause in the environment may threaten human settlements. Not only do IAS reduce the availability of environmental goods-and-services, but they may also increase the physical threats to human habitat. For example, many invasives enhance the frequency and intensity of fires. Numerous invasive grasses produce a great deal of flammable standing dead material and many resprout quickly after fires, giving them a competitive advantage over native species. This may threaten homes and other infrastructure.

Aquatic IAS may clog waterways used for transportation and enter hydropower facilities, threatening the provision of electricity.

Box 5: Water hyacinth wreaks havoc

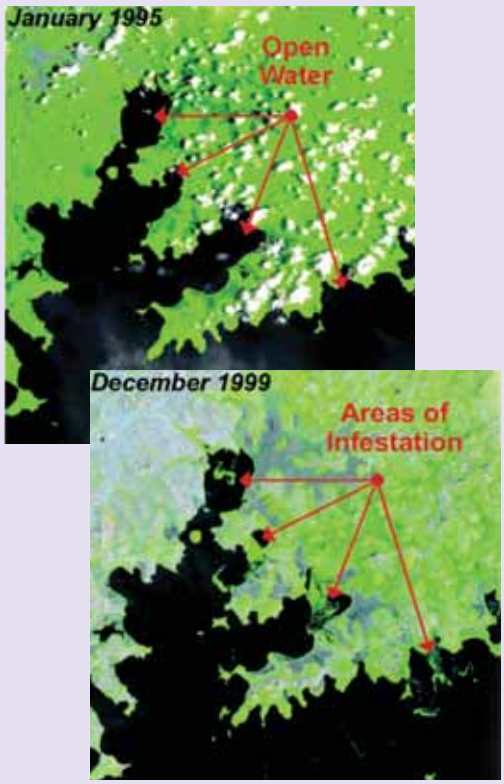
The water hyacinth (*Eichhornia crassipes*), imported into Africa from the Amazon River Basin in South America, is exploding into large infestations and is causing serious disruption to environments, economies and societies. Rivers, dams, lakes and other water bodies have become infested.

Lake Victoria is one of the most affected lakes. Although it is not known when or how the plant first entered the lake, reports suggest that it has been present in the lake since the 1980s. By 1998 it covered about 20 000 ha and huge mats paralysed activities in ports, villages and bays. At times it has even prevented large and small boats from leaving their harbours. Through biological control methods the water hyacinth has been effectively brought under control, and now only covers 2 000 ha of the lake surface.

In West Africa, the water hyacinth is a major problem, affecting more than 550 km along the Niger River. Countries such as Niger, Mali, Côte d'Ivoire, Nigeria and Senegal use various approaches to control its spread. The measures include chemical, biological and mechanical control.

The economic impacts of the water hyacinth, in seven African countries, have been estimated at between US$20-50 million every year. Across Africa costs may be as much as US$100 million annually.

Sources: UNEP 2003a, McNeely and others 2001, GISP 2004



Extent of water hyacinth coverage in Murchison Bay, Lake Victoria, Uganda (1995, 1999).

Source: UNEP/GRID and USGS EROS Data Centre in UNEP 2004

Invasive termites damage homes and other infrastructure. *Coptotermes formosanus* ((Formosan subterranean termite) lives in damp, woody conditions. It is native to China, but has spread around the world, including to many African countries. It not only feeds on timber in buildings but may also nest in homes and other structures (IUCN/SSC/ISSG 2004). The species is very aggressive and out-competes native termite species. The Louisiana crayfish, through its burrowing habits, can cause extensive damage to dams and reservoirs (GISP 2004).

Tourism

The conversion of native biotic communities to invasive-dominated communities also has aesthetic and cultural impacts and this directly affects tourism. Some IAS directly threaten the habitat of species that are key to the tourism industry. *Chromolaena odorata*, for example, affects the nesting sites of crocodiles, directly placing these populations at risk. Water hyacinth, by clogging waterways, affects water-based recreational activities. Species loss also has adverse impacts on tourism. For example on the Seychelles' Bird Island, where *Anoplolepis gracilipes* (crazy ant) displaced about 60 000 pairs of *Sterna fuscata* (sooty terns), tourism was adversely affected (CBD 2003).

Health

The relationship between human health and IAS is complex, with patterns of human settlement, economic activities, environmental change and disease virulence, as well as the interactions between these, being crucial (GISP 2004). Where IAS pose human health threats it may place added strain on already fragile health systems.

International trade introduced the Asian tiger mosquito, which carries dengue fever, to the Americas and to Africa. First introduced in South Africa, it is now present in Cameroon, Madagascar, Nigeria, Réunion, the Seychelles, Kenya, Mozambique, Djibouti and Somalia. Increased exposure to vector diseases such as malaria, dengue fever, *schistosomiasis* (bilharzia) and *trypansomiasis* (African sleeping sickness) is associated with large development projects, environmental change such as forest loss, and human settlement. Forest loss, for example, has widened the transmission of some diseases previously restricted to wild animal hosts (GISP 2004). Trade has also spread the life-threatening bacteria E. coli in meat exports (CBD 2005).

Vibrio cholerae (Asiatic cholera) is the bacteria that causes cholera and is an IAS. Cholera is endemic or epidemic in areas with poor sanitation. Although cholera may cause mild or unapparent infections, in its extreme manifestation cholera is one of the most rapidly fatal illnesses known. It occurs in both marine and freshwater habitats including lagoons, estuaries, lakes and wetlands in association with aquatic animals. In coastal regions it may persist in shellfish and plankton. It may also be associated with algal blooms (plankton), which are influenced by the temperature of the water. Rising water temperature, through for example climate change, may increase the potential risk of this. Cholera is spread through the live food trade, and the contamination of water sources.

IAS (*Pinus spp.*) encroach on Zimbabwe's Nyanga National Park, potentially threatening biodiversity and tourism.

Source: J.C. Mohamed-Katerere

HIGH COSTS

Many countries face high costs – economical, environmental and social – due to the presence of IAS. The financial and management costs associated with their eradication are astronomical and their proliferation affects the potential of countries to meet their development and environmental objectives. Resources spent on trying to control IAS could be redirected to other development initiatives, such as the implementation of the MDGs. This is an important reason to adopt approaches which control and prevent introductions.

Invasive alien species cost millions of US dollars annually in terms of lost revenue and expenditure on control measures. While the actual costs of IAS are unknown, they are believed to be substantial. The global economic costs of IAS are estimated by IUCN to be about US$400 000 million annually (UNEP 2003); IUCN also finds that IAS threaten the success of current and planned World Bank projects to the value of more than US$13 000 million (UNEP 2004).

Currently, Africa spends an estimated US$60 million annually on the control of IAS (CBD 2005). The African Ministerial Conference on the Environment (AMCEN) plans to raise a further US$265 million to fund various projects related to IAS in Africa over the next three to five years (UNEP 2004).

In South Africa, alien plant species now cover more than 10.1 million ha, threatening indigenous plants

Box 6: Black wattle: weighing the costs-and-benefits

The black wattle tree has been used in Africa as a commercial plantation species for many years. It has a variety of important uses (IUCN/SSC/ISSG 2004):

- Tannin compounds extracted from the bark are used in the production of soft leather.
- Resins, thinners and adhesives, can be made from bark extracts.
- The timber is used for building materials.
- Charcoal produced from wood is used for fuel.
- The pulp and woodchips are used to produce paper.

It also has some well known medical applications, including its use as an astringent. Plantings of wattle tress have also been used as a soil stabilizer to decrease erosion. The agroforestry industry promotes the use of the species (among other similar species) as a potential "soil improver."

It is nevertheless a highly invasive species – it produces large amounts of long-lived seeds – and it competes with and replaces indigenous vegetation. It may replace grass communities, reducing the carrying capacity of the land (IUCN/SSC/ISSG 2004). By causing an increase in the height and biomass of vegetation, black wattle infestations increase rainfall interception and transpiration, which causes a decrease in stream-flow. The soil underneath becomes desiccated more quickly than it does under grass. Black wattle stands also destabilize stream banks and support a lower diversity of species.

In South Africa, authorities are fighting to combat black wattle, which was introduced about 150 years ago to provide bark products. The black wattle is one of about 110 IAS of almost 750 tree species and 8 000 shrubby and herbaceous species that were imported into South Africa from countries in North America, South and Central America, Australia, Europe, Oceania and Asia (Sweet 1999). It has been described as "the number one threat to biodiversity in the Cape Floral Kingdom" (de Bakker 2003). Of the remaining natural areas of the Cape region, 17-24 per cent have been invaded by acacias (Musil 1993). The Cape Floral Kingdom, a biodiversity hotspot at Africa's south-westernmost tip, is of huge importance because it contains 1 per cent of the world's total plant species as endemics (de Bakker 2003).

Cape Fynbos.

Source: M. Chenje

Efforts to eradicate black wattle have come at tremendous cost:

- Since 1995, the financial cost of control comes to US$70 million (Preston 2004) and about 40 000 workers have been involved in removing the black wattle together with other invasives.
- More than 5 000 million invasive alien trees, of which many are black wattle, have been removed since 1995 (de Bakker 2003).
- It costs the South African government an estimated US$40 million annually for manual and chemical control of IAS in the Cape Floral Kingdom (IUCN 2001).

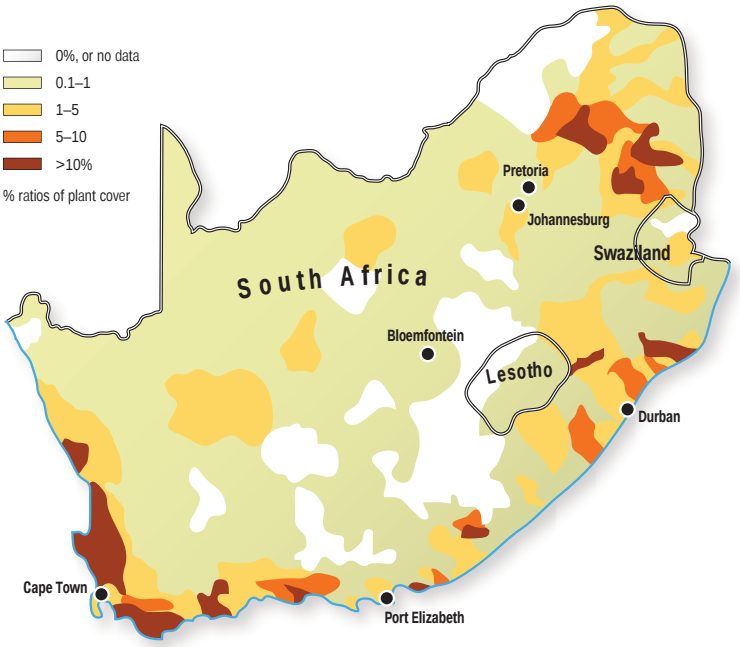
Sources: de Bakker 2003, IUCN 2001, IUCN/SSC/ISSG 2004, Musil 1993, Preston 2004

(ITC undated). (See Figure 2). Freshwater systems and the Cape Floral Kingdom (a global centre of biodiversity) are particularly at threat and the South African government therefore established the "Working for Water" programme. This programme seeks to remove IAS infestations from water catchment, and at the same time provide poverty relief (van Wilgen and others 1998). In South Africa, in addition to altering water-flow, IAS have had other important impacts on endemic biodiversity and ecosystem services. Nitrogen-fixing plants such as *Acacia saligna* alter the nitrogen cycle, impacting on native plants adapted to low nutrient conditions, such as, for example, many of the fynbos species. The costs associated with eradicating IAS, as shown in Box 6, have exceeded US 100 million.

In the Western Indian Ocean (WIO) countries, IAS pose a serious threat to forests and thus place biodiversity, including many endemics, at risk. Among these invasive woody species are *Paraserianthes falcataria* (Albizia), *Adenanthera pavonia* (Agati), *Clidemia hirta* (Creole name: *Faux Watouk*), *Cinnamomum verum*, *Chrysobalanus icaco (Prune de France)*, *Psidium cattleianum* (wild guava), *Syzygium jambos*, *Astonia macrophylla (Bois jaune)* and *Tabebuia pallida* (Calice du pape) (IUCN/SSG/ISSG). In addition to the costs to biodiversity, governments incur substantial financial and management costs. In the Seychelles, for example, the Ministry of Environment is involved in a programme for the eradication of IAS, including those listed below, and the replanting of indigenous species; public education is seen as an important aspect of this (Ministry of Environment Seychelles, undated):

- *Clidemia hirta* grows quickly, particularly in disturbed areas, and displaces native plants. It competes effectively for light and soil nutrients and is therefore a successful invasive.
- *Cinnamomum verum*, introduced in the 1970s for economic reasons, has spread so rapidly that today it is the most widely distributed and probably the most numerous plant in the Seychelles.
- *Chrysobalanus icaco* was originally introduced to prevent erosion on steep slopes. Dense thickets of this species have now become established on many steep erosion slopes. It is difficult to get rid of this species once it has become established. It also invades areas where the indigenous forest had been cleared.
- *Syzygium jambos* (Jambrosa) tends to replace the naturally occurring vegetation, including forests in river ravines. Jambrosa is native to Indo-Malaysia and was recorded as being well established in the Seychelles as early as the 1870s. It is still planted by many people for its edible fruits.

Figure 2: Estimated percentage invasion per tertiary catchment



Source: Versfeld and others 1998

Across Africa, IAS in the genus *Striga* have a direct impact on local livelihoods, affecting more than 100 million people and as much as 40 per cent of arable land in the savannahs. The cost of eradicating it is reportedly between US$7-13 000 million annually (UNEP 2004). These invasives stunt maize plant growth by attacking the roots and sucking nutrients and water (Ithula 2004) and thus in addition to the direct financial costs have implications for food security.

Small Island Developing States

While islands may not be more susceptible to invasions by alien species than continental landmasses, they are, however, considered to be particularly vulnerable to the impacts of such invasions (CBD 2003 and IUCN/SSC/ISSG 2001). On islands, IAS are now on a par with habitat loss as the lead driver of species extinctions over the last 20 years (Baillie and others 2004).

Important opportunities exist for effective control for terrestrial IAS. These can be effectively controlled through customs and border monitoring; these measures have greater potential for success on islands than in countries that share boundaries (IUCN/SSC/ISSG 2001 and Wittenberg and Cock 2001). In terms of responses on islands, research shows that the experience of one island country can be invaluable in managing IAS on another island even where there are major differences in climate and ecological systems. Key similarities such as the role and nature of trade may be significant. Areas where a cooperative initiative

on island IAS may be especially valuable include (IUCN/SSG/ISSG 2001):

- Undertaking the eradication of IAS;
- Undertaking the management of IAS where eradication is not currently feasible, to low levels that allow recovery of biodiversity values;
- Training and other capacity enhancement activities; and
- Undertaking quarantine and contingency response activities to prevent the establishment of new populations of IAS that might threaten ecosystems or species (including the control of movement in the country).

DEVELOPING EFFECTIVE RESPONSES

Although Africa has recognized the problems associated with IAS for several decades, a comprehensive approach to IAS is still to be developed. However, as discussed in Box 8, considerable progress has been made towards this with the adoption of the New Partnership for Africa's Development (NEPAD) Environmental Action Plan (NEPAD-EAP).

Understanding the factors driving the spread of IAS and their impacts is essential to developing effective responses. Where species have become invasive they are an important factor in environmental change, contributing to or exacerbating human vulnerability, and in some cases foreclosing livelihood and development options (UNEP 2004). Globalization – with its expanding trade and increased human movement – is likely to increase the risk of IAS. The inadvertent ending of millions of years of biological isolation has created major ongoing problems that affect both developed and developing countries (IUCN/SSC/ISSG 2004). Given that the threat posed by IAS stems from transnational processes, responses need to be based on collaborative measures. Further, the potential severity of IAS needs to be acknowledged; this includes its impacts on socioeconomic systems as well as the costs of eradication. On the basis of a global assessment, the MA found that climate change and the introduction of IAS are the two drivers of environmental change that are the most difficult to reverse (MA 2006).

The threats of IAS cannot be treated in isolation. They are part of a complex set of pressures and drivers of biodiversity loss and environmental change. As discussed in Chapter 1: *The Human Dimension*, social, political and economic drivers are growing in both scale and scope. The underlying causes are a complex tangle, rooted both in our expanding demands on the planet and the unfair ways that we share our resources (BirdLife International 2004). Rising individual consumption and material expectations, especially in rich nations, are driving agricultural intensification, habitat destruction and overexploitation elsewhere (BirdLife International 2004). Poverty, along with inequity, particularly in trade, access to technology, and the distribution of benefits from the use of biodiversity, make sustainable use and development particularly challenging for developing countries (WRI and others 2005). Therefore, responses need to go beyond short-term crisis-focused approaches. They need to be at multiple levels, and in many incidences an interlinkages approach – which takes into account the horizontal linkages between environmental sectors as well as the links between development and social objectives – will need to be adopted. Policies across different sectors as well as at different scales, including the national and regional, will need to be harmonized. Chapter 8: *Interlinkages: The Environment and Policy Web* considers this approach to decision making and responses more fully.

Traditionally, environmental law has focused on protected areas and species protection, and it has failed to take into account the multiple drivers affecting the environment, and consequently environmental protection has been insufficient. Developing an effective legal framework demands adopting appropriate measures at multiple scales: in the case of IAS this may include, among others, having more effective customs controls, appropriate trade measures, and sanitary and phytosanitary provisions for imports and transportation vessels. Legal and policy

Box 7: Key facts

- Invasive alien species threaten all sub-regions in Africa.
- Invasive alien species occur in all major taxonomic groups. They include viruses, fungi, algae, plants, fish, amphibians, reptiles, birds and mammals.
- Numerous species – including as high as 10 per cent of the world's 300 000 vascular plants – have the potential to invade other ecosystems.
- IAS affect wetlands, forests, drylands, marine and coastal and other ecosystems, contributing to biodiversity loss and ecosystem degradation.
- IUCN has estimated that, worldwide, the total economic cost of invasives is US$400 000 million annually.
- The CBD estimated that Africa spends as much as US$60 000 million annually to control IAS.
- Invasive alien species flourish in areas disturbed by human activities.

Sources: IUCN/SSG/ISSG 2004, Howard and Matindi 2003, McNeely and others 2001, MA 2006

Box 8: NEPAD makes IAS a priority

The NEPAD-EAP has prioritized IAS. The reasons are simple:

- Alien species are second only to habitat loss as a cause in endangering species and their extinction (IUCN/SSC/ISSG 2004).
- IAS affect Africa's forestry, horticulture, trade and tourism industries, as well as other sectors of the economy.
- IAS affect human well-being by indirectly contributing to poverty, food insecurity and ill-health.

The control of IAS is an important aspect of biodiversity conservation. A NEPAD thematic workshop on prevention, control and management of IAS which was held in Pretoria in January 2003, identified 14 project proposals for the implementation of this programme area. The sub-programme areas include: prevention of IAS; awareness-raising and provision of information; training and capacity-building; aquatic IAS; terrestrial IAS; ballast water; and African islands.

Sources: NEPAD 2003

approaches to IAS need to be at multiple levels, from the local, to national, to regional, to global, and law at these different levels needs to be harmonized. Policies and laws across different sectors, such as trade and environment, need to reinforce overall social priorities and not pull in different directions.

IAS are a constant and potential threat, and thus require strategic policy responses and action.

Making choices

It is important that an informed approach be taken to new introductions of IAS as well as to decisions related to existing ones. Policy and decision-making processes that evaluate the various benefits and risks associated with IAS need to be adopted. (Box 6, for example, looks at the benefits and costs of the black wattle tree). Chapter 8: *Interlinkages: The Environment and Policy Web* considers the opportunities offered by interlinking policies as well as the use of management tools that integrate development and environmental considerations. Among these are environmental impact assessments (EIAs) and valuation techniques. Chapter 9: *Genetically Modified Crops* assesses the value of risk assessment processes that effectively link uncertainty, scientific knowledge, and social and economic objectives. It considers the opportunities of inclusive policy processes that draw on a wide range of expertise and values. Given the central role that the general public, and in particular the business sector, plays in the proliferation of IAS, this is perhaps an important tool for decision making related to IAS.

Building partnerships

Managing and controlling IAS presents special challenges. The public are particularly important partners because of their role in introducing and maintaining IAS. Many introductions occur because the importer or user is unaware of the environmental, social and economic costs of a given species and thus information and its effective communication are critical. Even where there is an appreciation of these costs, many IAS are maintained because the public do not identify them as such or see them as a threat. This is particularly true of ornamental plants, exotic pets and economically valuable species which have been used over long periods. Bringing in the public and the business sector as partners must be a cornerstone of any effective IAS policy.

Investing in research and capacity

It is widely acknowledged that good information and understanding is the basis for sound policy and management. While considerable knowledge exists about IAS, there are still many gaps. Some of these gaps relate to the impacts of specific species on other species and ecosystems, while others relate to management strategies. For example, while we know that *Suncus murinus* (the Asian musk shrew or house shrew) is a rapid colonizer and a growing ecological threat, preying on or competing with many animal species and that it has a large and expanding range in Africa, very little research has been carried out on how to effectively manage the species.

It is critical for Africa to invest in and to cooperate in building better understanding and capacity to deal with these and other management challenges. This involves, as discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*, empowering institutions and people. Direct investment in research and technical agencies is an important aspect of this, as is the development of good institutional and governance systems.

Investment in management is essential – and this too needs to be at multiple levels. Different management techniques are needed for new and established IAS. Techniques that focus on the eradication of specific species need to be complemented by more integrated approaches to ecosystem management. For example,

• Climate change and the introduction of invasive alien species are the two drivers of environmental change that are most difficult to reverse. •

MA 2006

integrated water resource management (IWRM) can complement chemical, biological and manual eradication. Management needs to be closely linked to monitoring and evaluation and adapted accordingly.

Regional and global cooperation

Given that IAS are essentially related to trade and human mobility, it is essential to improve regional and global cooperation. The NEPAD-EAP sets the basis for such cooperation in Africa. The opportunities it presents are complemented by the development of sub-regional organizations throughout Africa which focus on harmonizing trade, customs and immigration policies and practices. These institutional arrangements are discussed in Chapter 1: *The Human Dimension*.

These specific African initiatives are complemented by various global responses, in which Africa and other developing regions have played an important role. There is a gamut of different agreements dealing with different aspects of IAS that are relevant in terms of controlling their movement and possible invasive nature. These range from the multidimensional CBD, to the conservation framework of MEAs concerned with migratory species and the aquatic environment, to biosafety laws, to sanitary and phytosanitary measures, to transport, and to trade.

Since 1992, the CBD along with Agenda 21 has set the general global framework for addressing the problems associated with IAS. The CBD recognizes the need for conservation and development as well as the close relation between them. The approach of the CBD is based on Article 8(h) of the Convention (see Box 9), and encompasses all IAS which threaten biodiversity, whether or not they remain under human control. Under this broad definition, alien plantations may also be considered to fall within the ambit of the Convention (Shrine and others 2000). The CBD provides the basis for taking preventative and mitigation measures to address the full range of threats posed by IAS to genetic diversity, species diversity, ecosystems and habitats.

Through the CBD Conference of the Parties (COP), a comprehensive framework for addressing these problems has been developed. The CBD has developed a sequenced approach to managing IAS (Shrine and others 2000). At the 2000 Conference of the Parties (COP), parties agreed:

- To give priority to preventing entry of IAS within and between states; and
- Where entry has already taken place to prevent the establishment and spread of such species.

The COP identified the eradication of such invasives as the preferred response and, where this is not feasible, the adoption of cost-effective, containment and control measures. This approach is echoed in MEAs for protecting migratory species, as well as those concerned with coastal and marine environments, the United Nations Convention on the Law of the Sea, the Ramsar Convention and the Convention on the Law of Non-Navigational Uses of International Watercourses.

A woman holds a huge Nile perch skeleton, Kisumu, Lake Victoria, Kenya.

Source: T. Bolstad/ Still Pictures

Box 9: Convention on Biological Diversity

Article 8(h) of the CBD calls on Parties as part of *in situ* conservation measures and as appropriate to:

> "Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species."

Source: UN 1992

Aquatic environments may be extremely vulnerable to IAS and eradication of such species more difficult than in terrestrial habitats. Consequently, there has been a strong focus in multilateral law on preventative measures for marine and coastal environments.

In the management of IAS, partnerships between different sectors and disciplines, as well as between the public and private sectors, is acknowledged as important. The Global Invasive Species Programme (GISP) is an initiative closely linked to the CBD and is a partnership which seeks to build global cooperation. It brings together several international non-governmental organizations (NGOs), such as IUCN and the Nature Conservancy, scientists including those from IUCN's Invasive Species Specialist Group, DIVERSITAS and its International Programme of Biodiversity Science, Australia's Commonwealth Scientific and Industrial Research Organization, South Africa's National Botanical Institute, local projects involved in IAS eradication and control such as Working for Water in South Africa, and the United Nations Environment Programme.

The GISP has proposed 10 strategic responses to control IAS; these are (IUCN 2001):

- Building management capacity at national and international levels;
- Building research capacity using cross-sectoral and multidisciplinary approaches;
- Sharing information to, among other reasons, alert management agencies to potential dangers of new introductions;
- Developing economic policies and tools;
- Strengthening national, regional and international legal and institutional frameworks;
- Instituting a system of environmental risk analysis;
- Building public awareness and engagement;
- Preparing national strategies and plans;
- Building IAS issues into global change initiatives; and
- Promoting international cooperation.

Biosafety, sanitary and phytosanitary measures

Africa has, over a long period, recognized the importance of controlling the introduction of alien species that can be potentially damaging to ecosystem:

- The African Convention on the Conservation of Nature and Natural Resources, adopted in 1968,

FAO staff providing technical advice on IAS Tilapia management near Bouak, Côte d'Ivoire.

Source: M. Pickstock/FAO

requires Parties to prohibit the entry of "zoological or biological specimens, whether indigenous or imported, wild or domestic" that may cause harm to protected areas.

- The Protocol concerning Protected Areas and Wild Fauna and Flora in the East Africa Region (1985) calls for the adoption of appropriate measures to prohibit the intentional or accidental introduction of alien or new species which may cause significant or harmful changes to the sub-region.
- Other protocols developed by sub-regional bodies also address some aspects of controlling IAS. Examples include the treaty for the Establishment of the Eastern African Community (EAC), the treaty of the Southern African Development Community (SADC) and the treaty establishing the Common Market for Eastern and Southern Africa (COMESA).

The African Convention on the Conservation of Nature and Natural Resources (ACCNNR) – which revised the 1968 convention and was adopted in 2003 – requires parties to strictly control the intentional and accidental introduction of alien species, including modified organisms and to endeavour to eradicate those already introduced where their consequences are detrimental to native species or to the environment in general (AU 2003).

Sanitary and phytosanitary measures focus primarily on import and export regimes and provide for quarantine periods to ascertain safety as well as for the destruction of specimens. Relevant instruments and institutions include:

- The World Health Organization's (WHO) International Health Regulations;
- The International Plant Protection Convention (IPPC);
- The World Trade Organization's (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures; and
- The Inter-African Phytosanitary Council, which was established in 1954.

Under the IPPC, special measures have been adopted for the importation and release of alien biological control agents. However, with globalization, and the legal dominance of the WTO, managing these threats in a way that is compatible with environmental concerns, national interests and unfettered or free global trade is an increasingly complex challenge. The WTO has 148 members and creates a binding, and enforceable, set of rules designed to ensure that governments extend free market access to each others' products and services (Shrine and others 2000). Box 11 sets out the essential aspects of the WTO approach.

However, as IUCN has noted: "Customs and quarantine practices, developed in an earlier time to guard against human and economic diseases and pests, are often inadequate safeguards against species that threaten native biodiversity" (IUCN/SSG/ISSG 2000). New challenges include addressing the relationship between environmental change and trade, as well as growing problems of uncertainty.

Important lessons can be learnt from the legal regime developed to deal with the impact living modified organisms (LMOs) will have on biodiversity, ecosystems and human health, livelihood systems and development opportunities, as these organisms present many of the same challenges. Sanitary and phytosanitary measures historically have focused on protecting people, plants and animals from pests and diseases. However, the challenge of IAS goes beyond this to include uncertainty about possible impacts and potential conflicts between environmental, social and economic concerns.

The Cartagena Protocol on Biosafety, which entered into force in 2003, sets out the first comprehensive regulatory system for ensuring the safe transfer, handling and use of LMOs. The focus is on regulating the movement of such organisms across national borders. It is concerned with both intentional environmental introductions and LMOs that are to be

Box 10: The need for vigilant phytosanitary measures

Imported plants, including those for research and agricultural use, may introduce exotic pathogens or parasites if adequate phytosanitary checks are not undertaken on imported plants. For example:

- A new high-yielding maize variety imported into Senegal in 1948 brought in a new strain of rust which killed off local maize.
- In 1971, a Ugandan university lecturer brought back a new variety of cassava from Brazil and planted it on a university field station. Unfortunately there was a new strain of mealie bug on the imported cassava and this spread to all the cassava growing area in Central Africa.
- FAO introduced sweet varieties of cassava from South America to replace the bitter varieties used in Africa. Unfortunately, with these varieties they also introduced a mite pest of cassava which has since spread widely.

Imported plants should therefore be held in quarantine and checked for parasites and disease before the crop is released into a new environment.

Source: TAA 2000

Box 11: The WTO Agreement on Sanitary and Phytosanitary Measures 1995

This agreement seeks to promote free trade and thus provides for:

- Internationally-determined standards for SPS measures;
- Risk assessment based on scientific principles and evidence;
- Consistency in the application of appropriate levels of protection;
- Least trade restrictive alternatives;
- Acceptance of equivalent measures; and
- Transparency through notification of trade measures.

Source: Shrine and others 2000

used as food or feed, and for processing. Such organisms are also alien species and currently the extent to which these will threaten biological diversity, ecosystem and habitats is poorly understood – much remains uncertain and there are fundamental areas of ignorance and gaps in knowledge. In addressing this, the Protocol:

- Adopts a precautionary approach; and
- Establishes an advanced informed agreement system.

These approaches could be replicated to deal with IAS more widely, and are increasingly recognized as key components of a response strategy (McNeely and others 2001). The essence of this approach lies in the right to notification and prior informed consent. It includes the right to undertake risk assessment and to refuse entry of organisms due to their biological, environmental and socioeconomic impact or due to insufficient information. The African Union (AU) has developed a regime for biosafety in its Protocol on Safety in Biotechnology based on these principles. This and how to develop responses to deal effectively with scientific uncertainty are considered more fully in Chapter 9: *Genetically Modified Crops*.

CONCLUSION

The management and control of IAS present some important challenges for decision-makers. Globally, preventing their introduction is seen as the cornerstone of effective measures for dealing with IAS. This approach is believed to be the most cost-effective and environmentally-sound approach as once an invasive species becomes established, eradication may be impossible and ecological damage irreversible (Shrine and others 2000). This obligation to control IAS needs

Protecting endemic species, such as the sooty tern (*Sterna fuscata*) of the Seychelles, is an important conservation objective.

Source: Seitre/ Still Pictures

to be balanced against international trade obligations as well as social and economic concerns. Developing systems for making sound choices must be a priority for African governments.

Although the NEPAD-EAP identifies IAS as an important programme area, it is not clear how it will be addressed. The development of programmes and strategies will need to be based on a comprehensive analysis of IAS, and their associated costs-and-benefits. The need for strategic research to support this cannot be overemphasized. Research may include compiling a complete inventory of all alien species, including non-invasive ones, determining the impacts to date on ecosystems, and assessing the financial resources needed as against the cost of inaction. This will require new levels of investment in research. Partnerships and collaboration are essential for effective research. For example, the private sector could play a role in supporting research and development. Regional cooperation may help lower research costs.

The NEPAD-EAP will need to be complemented by national and sub-regional interventions. National strategies would need to identify the goals and objectives of an alien species plan. Such strategies will need to draw on existing knowledge and establishment management approaches. The shift that has taken place from species preservation to ecosystem integrity may form the basis of these responses.

Legal and institutional frameworks at national, sub-regional and regional levels will need to be refined to establish complementarity between different sectors. While the region has taken significant steps to address the problem by adopting the ACCNNR, its successful implementation will be long-term since out of the 33 countries that have signed it, only four had ratified it by March 2006 (AU 2003).

Legislation will need to create effective frameworks that are consistent with international obligations. These could benefit from the use of established legal approaches and principles, such as precaution, cost-recovery measures, rights of public participation, and rights of access to information. Other important management and decision-making tools that could be incorporated in national, sub-regional and regional frameworks include risk analysis and assessment systems, environmental impact assessment and cost-benefit analysis.

Partnerships, with a cross-section of actors at multiple scales, are an important aspect of developing appropriate responses. The inclusion of different stakeholders, from communities, NGOs, research organizations, the private sector and government, is important for developing appropriate policy as well as identifying effective interventions. Information, and its communication, is critical to bringing diverse sectors on board as effective partners. Environmental education initiatives should also highlight the problems of IAS and how they influence environmental change, which among other impacts, exacerbate human vulnerability.

The spread of IAS is directly linked to trade and human mobility. Reconciling these, and developing mechanisms that deal effectively with this challenge, is undoubtedly a priority area for policy and response.

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CHAPTER 11
CHEMICALS

Lead Authors: Nelson Manda, Jennifer Mohamed-Katerere

"The goal of balancing the economic and social benefits of chemicals with their health and environmental risks is easy to understand and agree to. But how to achieve this balance is a highly complex problem – or rather, it requires understanding and solving many complex problems. Managing the risks of chemicals is interconnected with many other issues, including wastes and pollution, global warming, resource depletion, agriculture, biotechnology, loss of biodiversity, poverty and women's rights."

UNEP 2004a

The use of chemicals has brought immense benefits to humankind, and at the same time it has had negative impacts on human health and safety, particularly for the poorest and youngest people, on the integrity of terrestrial and marine ecosystems, and on air and water quality. The unsound management and use of chemicals poses threats to human well-being at many levels: it threatens the sustainability of the environment which provides essential goods-and-services for livelihoods, it undermines human health, it threatens physical security, and it reduces the ability of communities to care for themselves and, especially, for children.

Chemicals present both known and unknown risks. Some chemicals, including heavy metals, persistent organic pollutants (POPs) and poly-chlorinated biphenyls (PCBs), present known risks. Lead and mercury, for example, have serious and irreversible impacts on the mental development of children. Over the past half-century there has been an accelerated release of artificial chemicals into the environment, many of which are long-lived and transformed into by-products whose behaviours, synergies and impacts are not well-known (MA 2006). New research indicates that many chemicals widely in use, including in household and personal care products, that are assumed to be safe by consumers and downstream users, pose significant threats to people and biodiversity (WWF 2004b). As chemical production increases globally, wildlife contamination has become even more pervasive, and troubling health threats are ever more apparent (WWF 2004a). Establishing and implementing systems for the sound management of chemicals must be a priority for Africa. A key challenge is how to account for this aspect of uncertainty.

Chemical substances, and their derivatives, are widely used in many development and economic sectors including industry, agriculture, mining, water purification, public health – particularly disease eradication – and infrastructure development. However, production, storage, transportation, and removal of these substances can pose risks to people and the environment. The challenge facing Africa is how to harness the benefits of chemicals, while minimizing the costs. While Africa has made significant progress in developing a regional framework for the management of chemicals throughout their life cycle – production, transportation, storage, use and disposal – much still needs to be done in integrating this approach into national and sub-regional systems for implementation.

Although Africa is currently neither a major consumer nor producer of chemicals in global terms, the level of risk faced by poor countries is disproportionately higher than in those with sufficient resources to effectively manage and monitor chemical use. Additionally, many poor people have weakened immune systems, making them more vulnerable to

chemical-related illness; their well-being may be further compromised by lack of access to information about the impact of chemicals, and their living conditions and work places may leave them exposed to the hazards of toxic chemicals (UNEP 2006). With economic growth, Africa is likely to grow as both a producer and consumer of chemical products, increasing the importance of this issue. There is also a trend to relocate chemical production away from the Organization for Economic Cooperation and Development (OECD) countries to developing countries (OECD 2001).

STATE-AND-TRENDS

The global chemical industry has experienced steady growth in production, consumption and trade over the last 35 years. The value of the chemical trade rose from US$171 000 million in 1970 to US$1.5 million million in 1998 (Buccini 2004). The sector is expected to continue to grow until 2020. Four broad trends are evident (Buccini 2004):

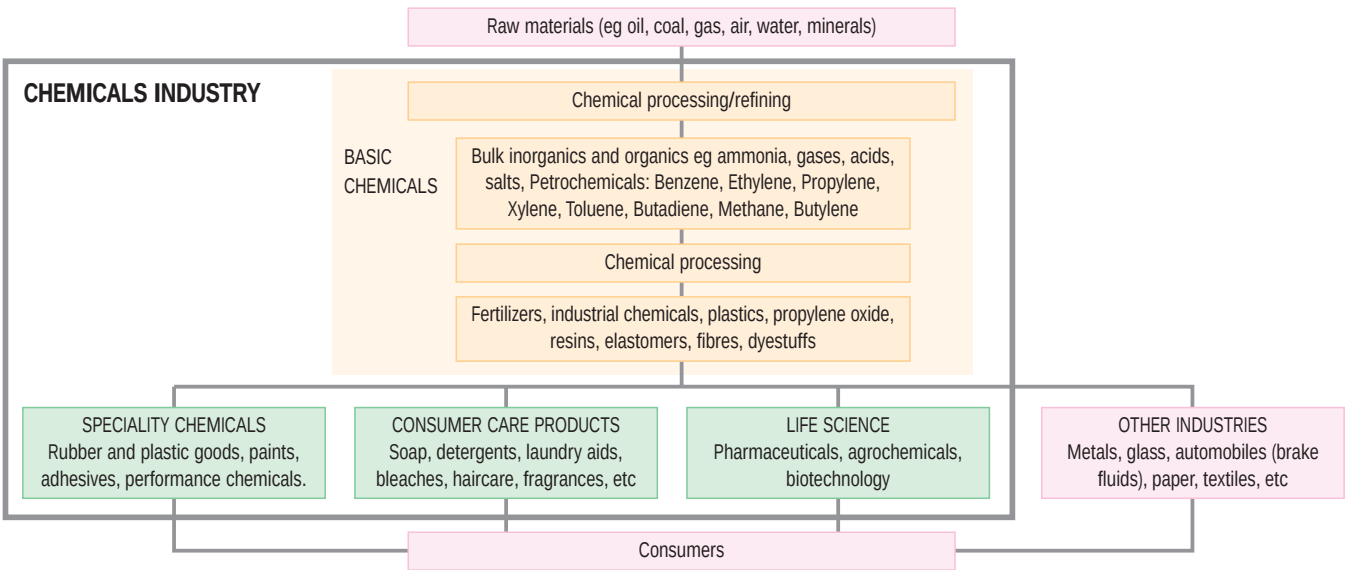
- Global chemical output will continue to rise. In 2010, it is predicted to increase by 63 per cent compared to 1996. Estimated annual growth rates for the global industry range from 2.6 to 3.5 per cent, corresponding to the predicted rate of growth for global gross domestic product (GDP). By 2020, global output is expected to increase by 85 per cent over 1995 levels.
- Globally, per capita consumption is increasing.
- There will be a shift in chemicals production from OECD countries to non-OECD countries. Nevertheless, OECD countries will remain the largest producers in 2020, but their share will decrease to 69 per cent of total world production, that is 10 per cent below 1995 levels.
- Total demand for chemicals will increase more rapidly in the developing than in the developed world. By 2020, the developing world will increase its share from 23 per cent of global chemical demand and 21 per cent of production in 1995 to 33 per cent and 31 per cent, respectively.

The global chemical industry is still concentrated in 16 countries that account for about 80 per cent of global production. These are the US, Japan, Germany, China, France, UK, Italy, Korea, Brazil, Belgium, Luxembourg, Spain, Netherlands, Taiwan, Switzerland and Russia (Buccini 2004). Key developing country producers include the Republic of Korea, India, Brazil, China, Mexico, Singapore, Argentina, Turkey, Saudi Arabia, Malaysia, Indonesia and the Philippines (OECD 2001). Figure 1 gives an overview of the chemical industry.

PRODUCTION AND CONSUMPTION PATTERNS

Although Africa's contribution to value-added production is very small, current trends suggest that its contribution to global production of chemicals will continue to grow. Between 1976 and 1996, this sector grew by 2.5 per cent per year (OECD 2001). Given that projections indicate that chemicals manufacturing will be relocated from OECD countries to developing countries in the

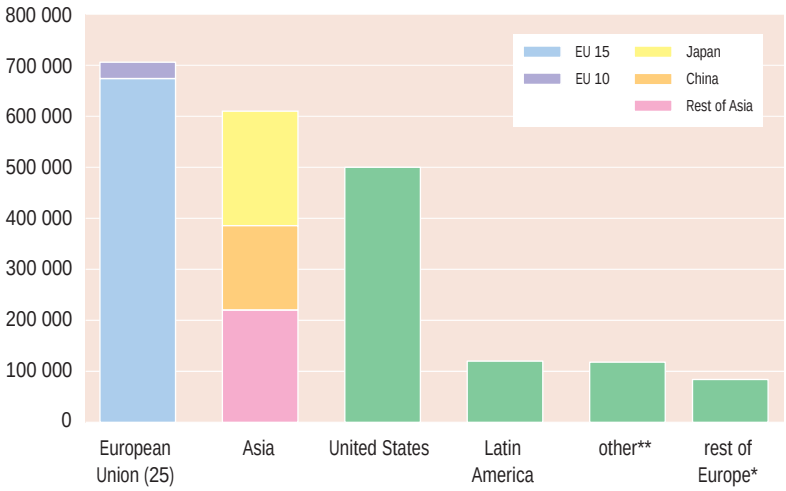
Figure 1: The general structure of the chemical industry



Source: OECD 2001

Figure 2: World chemicals production 2004

chemical sales (US$ million)



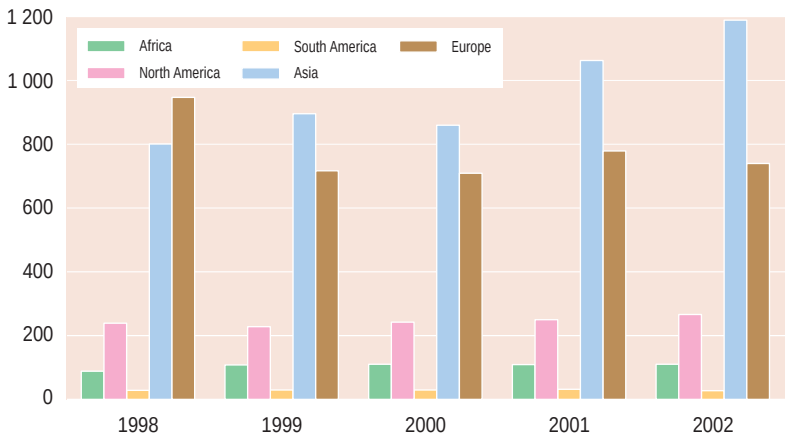
** Switzerland, Norway, and other Central & Eastern European countries (excluding the new EU 10 countries)*
*** including Canada, Mexico, Africa & Oceania*

Source: CEFIC 2005

medium term, this sector can be expected to grow. The shift in production from OECD countries to developing countries is directly related to the rise of multinational chemical companies, who have been able to relocate and invest in developing countries (Buccini 2004). This move may also be related to growing public concerns in developed countries about chemicals and the hazards they pose, as well as lower labour costs and a less regulated production environment in developing countries. Increasing consumption, directly linked to economic growth and improved levels of per capita GDP, underlies market development. There has also been an increase in international trade as tariffs and non-trade barriers have been removed in order to comply with the provisions of the World Trade Organization (WTO).

Figure 3: World production of insecticides, fungicides and disinfectants

thousand tonnes



Source: UNSTATS 2005

The most advanced chemical industries in the region are found in Northern, Western and Southern Africa. The development of chemical industries in these sub-regions has been facilitated by access to larger markets and by the presence of natural resources that can support growth in this sector, such as natural gas and oil, and well-developed infrastructure and communications. In Northern Africa, there are strong chemicals industries in Algeria, Egypt, Libya, Morocco and Tunisia (MBendi 2002). In Western African, Nigeria is the main producer and user of chemicals. In Southern Africa, the prime market and producer is South Africa. South Africa is also the only African country with a chemicals company listed among the top 30 in the world (the South African company is number 16) (CEFIC 2005). South Africa's chemical industry differs from others in the region in that energy use is largely based on coal.

Although it is relatively small by international standards, South Africa's chemical industry is the largest in Africa, contributing about 5 per cent of GDP and employing approximately 150 000 people. Annual production of primary and secondary process chemicals is in the order of 13 million tonnes, with a value of around US$2 825.75 million (UNEP 2004b).

Industry predictions are that future global growth in the chemicals industry will be led by pharmaceuticals, followed by specialty chemicals, agricultural chemicals, textile fibres and industrial chemicals (Buccini 2004). Currently, petrochemical commodities, polymers and fertilizers are the main products of the African industry (MBendi 2002). However, a number of African countries have capacity in pharmaceuticals production and many are investing in oil and gas, which are key drivers for the chemicals industries. The production of agricultural chemicals is a key focus of the chemical industry in Africa. Africa contributed approximately 4 per cent to total world pesticides (insecticides, fungicides, disinfectants) production in 1998, and approximately 5 per cent in 2002 (CropLife Africa Middle East undated, UNSTATS 2005). Global trade in this sector is shown in Figure 5.

In 2002, Africa contributed only about 3 per cent of total world nitrogenous fertilizer production – with most coming from Egypt and South Africa; however, production from these two countries has declined between 1998 and 2002 (CropLife Africa Middle East undated). In 1998 Africa's contribution to global production of phosphates fertilizer was approximately 7 per cent, but this has also declined from 537 tonnes in 1998 to 369 tonnes in 2002 (CropLife Africa Middle East undated). The capacity to produce agricultural chemicals requires investment in

Table 1: Chemical production in 2001

Product	Production in metric tonnes: Global	Production in metric tonnes: Africa	Africa as percentage of global production	Biggest producers in Africa: Country	Biggest producers in Africa: Tonnes
Gasoline	771 101	24 095	3.12	South Africa	7 948
				Egypt	5 616
Naphthas	183 226	10 401	5.68	Egypt	2 801
				Libya	2 606
Kerosene	82 882	6 280	7.58	Nigeria	1 210
				Egypt	966
Diesel	1 102 541	36 055	3.27	South Africa	7 150
				Egypt	6 635
Lubricants	39 229	1 123	2.86	South Africa	402
				Egypt	277
LPG from natural gas	145 913	10 334	7.08	Algeria	569
				Egypt	517
LPG from natural petroleum refineries	100 011	2 572	2.57	South Africa	7 150
				Egypt	6 635

Source: UNSTATS 2005

technology, access to finance and raw materials. It is notable that the top two producers of pesticides in Africa, Egypt and South Africa, are also leaders in the production of oil-related products.

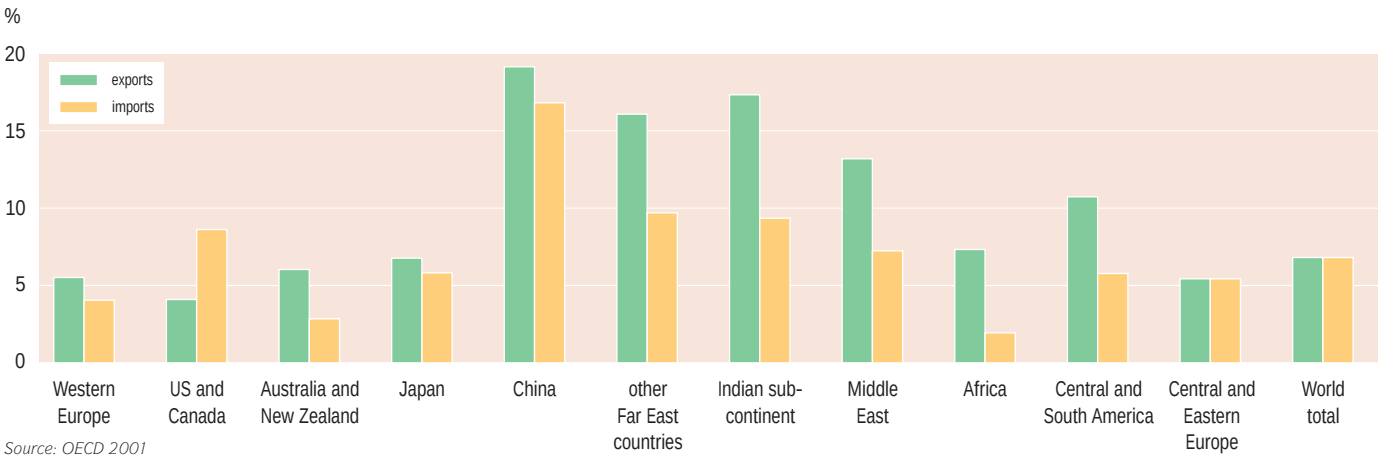
Mining chemicals produced in Africa include explosives and accessories such as fuses and detonators, mineral processing chemicals such as leaching agents, floatation agents, smelting and refining chemicals.

Trade

The chemical market in Africa is primarily targeted at meeting local needs rather than being export-orientated. Nevertheless, the import and export of chemicals are on an upward swing; this trend is expected to continue given the increasing demand for chemicals by Africa's growing economies (MBendi 2002). In the case of the Northern African Mediterranean countries, the proximity to European markets has led to a greater export focus than in other areas.

Although in all chemical sectors consumption is currently higher in developed countries than in developing countries, demand for chemicals and chemical products is likely to increase as disposable income grows. Globally, there is a correlation

Figure 4: Growth in trade in chemicals between 1979-96 (real terms, per cent/year)



Source: OECD 2001

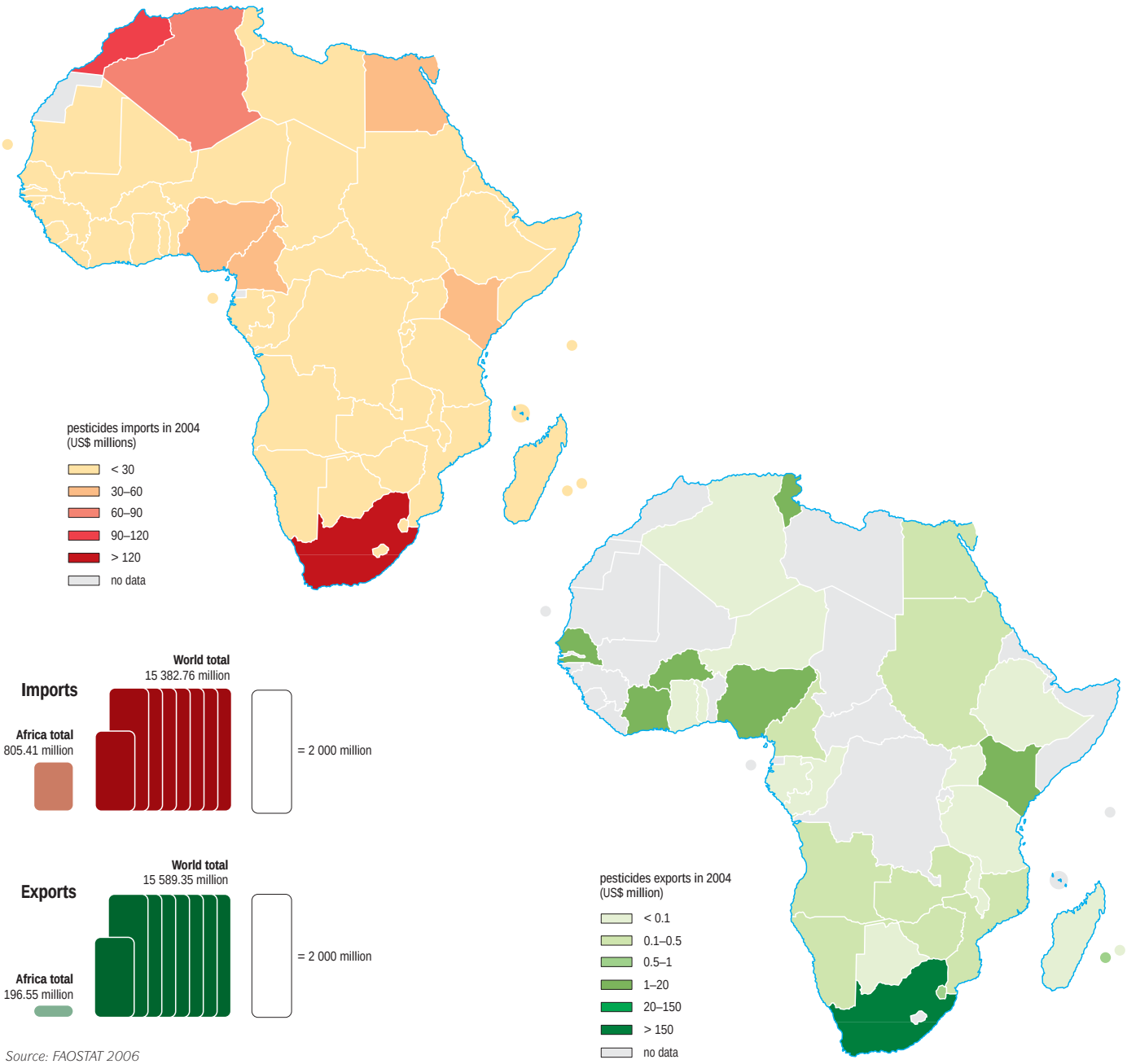
between chemical consumption and GDP per capita, which suggests that there is tremendous scope for increased consumption of chemicals in developing countries (OECD 2001). Still Africa's share of the global market is currently very small (Figure 4). These chemicals come from a range of countries: China and India are emerging as the major exporters of chemicals to Africa.

Generally, imports of chemicals exceed exports due to a mismatch in production and the size of the market. Figure 5 illustrates this in relation to trade in pesticides: most African countries were net importers of pesticides (FAOSTAT 2006).

OPPORTUNITIES AND RISKS

The chemicals industry and its products have many potential benefits particularly related to improving and sustaining human capital through new opportunities for employment, improved health and nutrition. At the same time the production and use of chemicals creates risks at all stages of their life cycle. The generation and release of intentionally and unintentionally produced chemicals, has contributed to environmental contamination and degradation at multiple levels – local, regional and global – and in many instances the impact will continue to be felt for generations.

Figure 5: Import and export of pesticides



Source: FAOSTAT 2006

Industry provides new opportunities for employment

Growth in the industrial sector creates new opportunities for employment and can also help diversify the economy. This is especially important given the high level of urbanization, and growing levels of unemployment and poverty in many cities. Unemployment is particularly high and an important factor in continued levels of low human well-being and slow growth: in 2003 the average rate of unemployment was 10.9 per cent in sub-Saharan Africa and 10.4 per cent in North Africa and these percentages have remained relatively stable over the last ten years (ECA 2005). Women and youth are among the most disadvantaged. These figures do not include those that are unemployed but not actively seeking employment.

Africa needs to find opportunities for expanding its industrial sector. The US Africa Growth and Opportunity Act, for example, provides some trade preferences that the chemicals sector in Africa could use.

Investing in research and development

The development of new chemical products is closely linked to investment in research. Currently most research takes place in developed countries and within large multinational companies. Investments in this area can help expand Africa's share of trade, especially in potential niche markets such as naturally-derived pharmaceuticals and cosmetics.

Africa, along with other countries in the tropics, is a major source of genetic resources that could support a growing localized industry and ensure that a higher percentage of the profits generated from pharmaceuticals remain in Africa. The development potential of the pharmaceutical industry is closely related to biodiversity, and research and development activities in this area. Opportunities associated with this development are discussed in Chapter 1: *The Human Dimension* and Chapter 6: *Forests and Woodlands*. It is estimated that less than 1 per cent of the world's 250,000 tropical plants has been screened for potential pharmaceutical applications (Groombridge and Jenkins 2002). At current extinction rates of plants and animals, the Earth is potentially losing one major drug every two years. Africa could effectively link the development of the pharmaceutical sector to its objectives of sustainable use of biodiversity.

Additionally, such investment may have positive spin-offs in other sectors – for example making medicinal care more accessible. In Africa many cannot afford commercially produced medicine, in Western Africa, for example, as many as 80 per cent of the people depend on traditional medicines (IDRC undated). Africa's market share in pharmaceuticals accounted for only 1.3 per cent in 1997, with the total trade worth about US$291 million million (Kanali 1998).

Pharmaceutical production at EPHARM in Addis Ababa, Ethiopia.

Source: P. Virot/WHO

Africa needs to be strategic about its research investments in this area. On the one hand increasing its share of global trade is important; on the other it needs to focus on meeting urgent health needs within Africa. Research partnerships, including multilateral and public-private-partnerships, as well as the regional or sub-regional pooling of resources can be important factors in creating a resource base for effective research and innovation (UN Millennium Project 2005b).

Agriculture

Increasing agricultural production is widely acknowledged as a priority area for Africa, and essential in addressing food security problems, human vulnerability to environmental change, and achieving Millennium Development Goal (MDG) 1 to eradicate extreme poverty and hunger (NEPAD 2002, UN Millennium Project 2005c). One key challenge, as discussed in Chapter 3: *Land* and Chapter 9: *Genetically Modified Crops*, is the problem of land productivity and related low crop yields. In Africa, low productivity is a factor of the ecological reality and low investment in agriculture. Productivity is further threatened by human-induced changes and natural processes; key among these are climate change and variability, and invasive alien species.

Synergistic growth in the chemicals industry could have positive spin-offs for the development of agriculture (UN Millennium Project 2005c). The use of agricultural chemicals, including fertilizers, herbicides, fungicides and insecticides can help improve yields, for example. Chemicals may also be beneficially used in livestock production as vaccines and in animal feed.

Chemical use in the African agricultural sector is likely to increase as a result of the growing commercialization as well as the growing focus of development agencies on improving yields of small farmers. In Africa the *per capita* use of fertilizers is relatively low, as shown in Figure 6. The UN Millennium Project notes the need for small farmers to be supplied with soil nutrients and other related technologies (UN Millennium Project 2005c), while at the same time recognizing that there must be increased use of sustainable agricultural practices if natural assets are to be preserved (UN Millennium Project 2005a). Environmentally-friendly options may include the use of nitrogen-fixing plants and agroforestry, as well as the application of bio-fertilizers, such as animal waste and plant mulch.

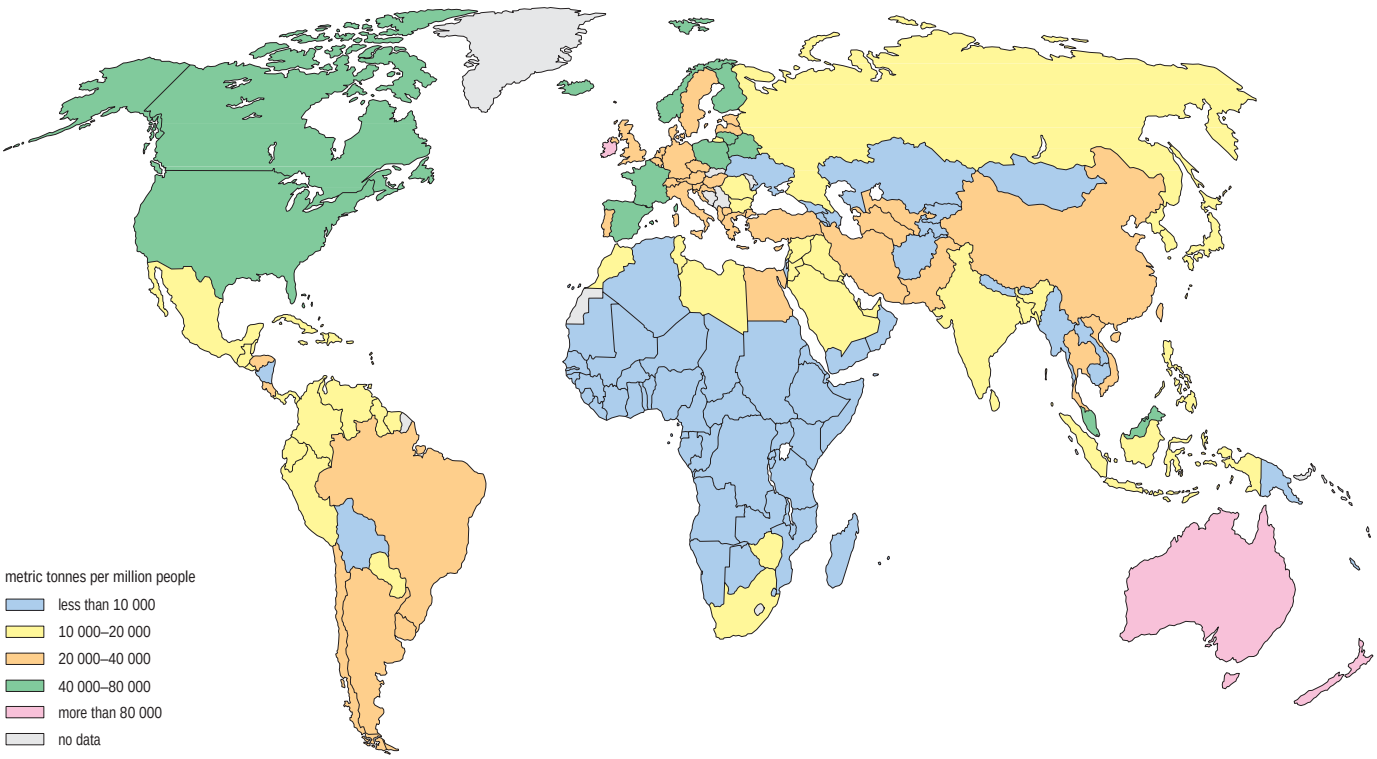
Agricultural extension and aggressive corporate marketing have contributed to increased use of agricultural chemicals. In many places, small farmers under pressure to engage in the market, produce improved crops and increase yields have abandoned traditional, more environment-friendly, practices. This may have a range of negative environmental impacts including on soil and water quality. In Africa, despite the poor levels of comparable data over the last five decades, trends indicate an increase in the concentration of nitrates and phosphates at river mouths, this mirrors the trends in developing economies elsewhere including in Southeast Asia (UNEP 2002). Inappropriate fertilization and irrigation practices can result in salinization and acidification of soil, and in Africa, chemical-related soil degradation affects 51 million ha of land, with about 40 million of these being nutrient-deficient and salinity affecting about 6 million ha (ECA 2001).

Food security and pest management

As discussed elsewhere in this report (Chapter 3: *Land* and Chapter 9: *Genetically Modified Crops*) the challenges of achieving food security are complex and require a multidimensional approach. In many parts of Africa, pests pose a significant threat with locust invasions, for example, repeatedly threatening food security especially in Western Africa (See Chapter 3: *Land*).

Chemicals are an essential aspect of pest management and Africa has relied extensively on the use of POPs (Box 1). However, it is important for Africa to begin to look for alternatives to many of the highly toxic chemicals it uses in pest control. Chemical use is a costly option. The

Figure 6: Global fertilizer consumption 2001



Source: UN Millennium Project 2005c; data from World Bank 2004

Box 1: What are POPs and PCBs?

Persistent Organic Pollutants (POPs) are chemicals that:

- Are extremely stable and persist in the environment;
- Bio-accumulate in organisms and food chains;
- Are toxic to humans and animals and have chronic effects such as the disruption of reproductive, immune and endocrine systems, as well as being carcinogenic; and
- Are transported in the environment over long distances to places far from the points of release.

Poly-Chlorinated Biphenyls (PCBs):

- Are persistent organochlorines;
- Permeate the air, water, and soil;
- Are toxic to humans;
- Bio-accumulate in organisms and food chains; and
- Settle into fats and oil. So fatty fish and marine mammals can provide rich sources of these pollutants. Cows grazing on contaminated grasslands or eating tainted fodder can transfer PCBs into the fat in their meat and milk. In fact, most foods can carry tiny traces of these toxic chemicals.

Source: Mörner and others 2002

highly toxic chemicals used to deal with locust plagues, for example, not only affect locusts, but also humans, animals, including livestock, and the environment. Apart from these dangers, spraying also requires huge logistical resources, which many of the poor countries most affected by locusts cannot afford (IRIN 2004). Additionally, storage of chemicals and the re-use of chemical containers also threaten human health.

Termites threaten infrastructure and food security

In many African countries, termites present a huge problem, threatening both infrastructure and food production and thus directly affecting human well-being and the potential for economic growth. Termites also pose significant threats to other goods including household furniture, paper products, many synthetic materials and food items. Globally, each year, hundreds of thousands of structures (bridges, dams, decks, homes, retaining walls, roads, utility poles, and underground cables and pipes) require treatment for the management of termites (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003).

Africa has high termite diversity of about 1 000 different species, reflecting its topological and climatological diversity. In particular, the tropical forests of Central Africa and all of the countries in Southern Africa contain diverse and abundant termite fauna. Genera infesting wooden structures include *Reticulitermes*, *Coptotermes*, *Psammotermes* (Family *Rhinotermitidae*), *Anacanthotermes* (*Hodotermitidae*), and several species of *Kalotermitidae*. Mound-building species occur throughout most of the African landscape. Some species have been transported over much of Africa due to commerce and nomadic migration (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003).

Some species directly threaten agricultural systems, as shown in Box 2. There are approximately 20-50 damaging termite species in savannah and forest ecosystems in the family *Termitidae*. The majority of species feed on plant material, living or dead, dung or soil rich in organic material. The greatest pest potential exists within the subfamily *Macrotermitinae*, which has a symbiotic association with the fungus *Termitomyces* (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003). The most economically important genera throughout Africa are *Macrotermes*, *Odontotermes*, *Pseudacanthotermes*, *Ancistrotermes* and *Microtermes*. These differ characteristically in their biology and mode of attack (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003):

- *Macrotermes spp.* build large mounds from which they forage outwards for distances up to 50 m in galleries. They attack plants at the base of the stem, ring-barking or cutting them through completely.
- *Odontotermes spp.* build both subterranean and epigeal nests. Damage is due to feeding either under soil sheeting on the outer surface of the plants or on the roots.
- *Microtermes spp.* and *Ancistrotermes spp.* have diffuse subterranean nests and attack plants from below ground by entering the root system and tunnelling up into the stem, hollowing it out and frequently filling it with soil.

Termite control measures vary considerably across Africa, and range from manual removal of queens and nests by hand, to soil applications (topical and injection) with termicides, to baiting. For termites that attack dry wood, fumigation with methyl bromide and topical and subsurface chemical injections are the standard practice. Chlordane is widely used. The costs associated with chemical use are extensive and include (Mörner and others 2002):

- health costs (treatment, working days lost by those ill and by those taking care of the ill);
- costs of exceeded residue levels (leaving a proportion of produce unfit for marketing);
- costs related to pesticide resistance and resurgence;
- pesticide-related research;
- costs of pesticide quality control and residue monitoring;
- costs of pesticide regulation; and
- costs of pesticide-related extension.

Alternatives to chemical use vary in efficiency depending on climatic factors and the species. It is imperative given the agreements under the Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention) for countries to begin to develop management systems based on alternatives. Alternatives include improved building practices such as building design (site preparation, construction and regular building maintenance and inspections), physical barriers, using preservative treated timber, space fumigation, baiting systems, thermal and biological control, and safer chemicals (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003). In general, however, changing from one chemical to another is not a long-term solution (UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003).

Box 2: Major crops attacked by termites

Termites threaten key agricultural crops, which form the basis of household nutrition in much of Africa, including groundnuts, maize, sugar cane, yams and cassava. Cotton is also threatened.

Groundnuts

Microtermes and *Odontotermes* species cause damage to groundnuts in semi-arid tropical countries of Africa, resulting in yield losses of between 10 and 30 per cent. Management measures include the use of resistant groundnut varieties, cultural practices, botanical insecticides and minimal application of synthetic insecticides either to the soil or as a seed dressing. These treatments form a barrier, which repels or kills foraging termites.

Maize

Among cereal crops, maize is the most often damaged by termites. Yield losses of from 30 to 60 per cent have been reported in some parts of Africa. *Microtermes* and *Ancistrotermes* species attack maturing and mature maize plants, while *Macrotermes spp.* cause damage to seedlings. Species of *Odontotermes*, *Allodontermes* and *Pseudacanthotermes* can defoliate maize seedlings or consume the entire plant. Maize plants attacked early in the season can compensate damage with new growth. One of the options for farmers to manage termites is to sow at a higher rate. The other option is to dress the seeds with insecticides.

Sugar cane

The most damage to sugar cane is done by genera *Amitermes*, *Pseudacanthotermes*, *Macrotermes*, *Odontotermes*, *Microtermes* and *Ancistrotermes*. Yield losses can be very high. In Sudan losses of 18 per cent have been recorded and in Central Africa losses of 5-10 per cent are common. In Nigeria plant germination failure of up to 28 per cent has been reported. The most common damage to sugar cane is the destruction of the planting material (setts). The usual method of prevention is to dip the setts in various formulations of chlorinated hydrocarbons before planting, or to spray them in the furrows before filling in.

Yams and cassava

Yams and cassava are grown from tubers and stem cuttings, respectively, and are consistently attacked as seed pieces by Amitermes, a predominantly root-feeding species. *Ancistrotermes*, *Macrotermes*, *Odontotermes*, *Microtermes* and *Pseudacanthotermes* are also involved in damaging the maturing crops by hollowing out stems at ground level. The current management strategy consists of treating setts with aldrin dust.

Cotton

Termite species in the genera *Allondotermes*, *Ancistrotermes*, *Hodotermes*, *Microtermes* and *Odontotermes* have been reported to damage cotton especially in the drier parts of Africa. Management measures include broad-scale application of chlorinated hydrocarbons or seed dressings, and baiting with chopped grass treated with insecticides.

Source: UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003

Complete prevention and eradication of termites is not a plausible management objective; instead the focus should be on better management, and on reducing the costs to people and the environment. Successful termite management is a process that includes the talents of construction, pest management, and building management professionals. Lastly, termite management systems are most successful and least expensive when implemented pre-construction. Conversely, they are often less successful and more expensive post-construction.

Control of diseases

Chemicals are widely used in the control of diseases. Persistent organic pollutants (POPs) are used in vector control for diseases such as malaria. Pesticides such as dichlorodiphenyltrichloroethane (DDT) are used primarily to control malaria as well as in the veterinary sector to control plague-transmitting fleas and trypanosomiasis-transmitting tsetse flies (Mörner and others 2002). The use of these chemicals presents special challenges for Africa; the negative environmental impacts need to be weighed against the gains made from disease control.

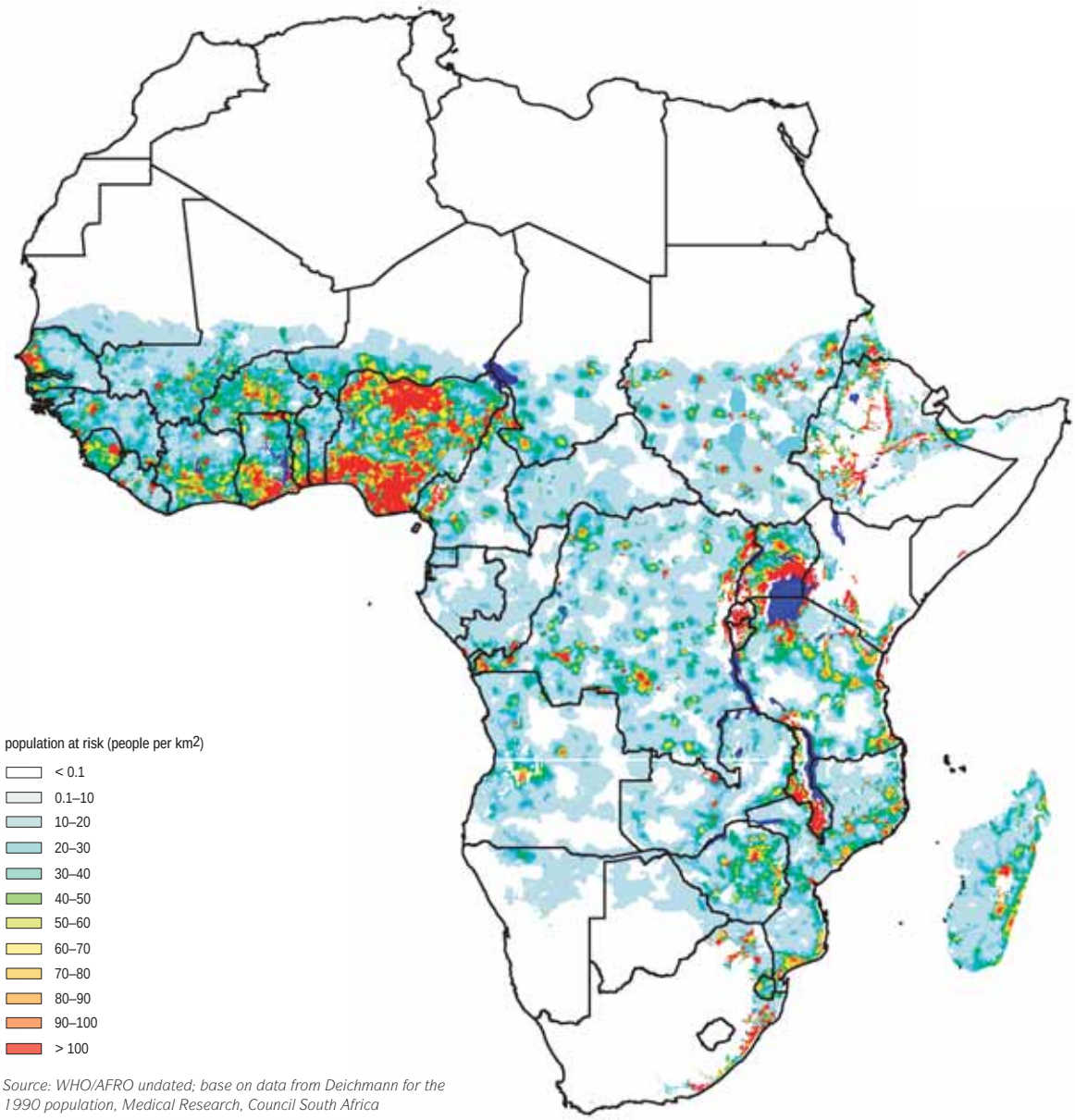
The high incidence of some diseases is not just a challenge in relation to mortality levels, but also threatens economic prospects. Malaria for example is still a primary killer in Africa (see Figure 7 for populations at risk). In 2001, there were an estimated 270-480 million cases per year with approximately 900 000 people dying from the disease annually (WHO/AFRO 2001). Malaria has slowed annual economic growth by 1.3 per cent, imposing a loss of US$12 000 million on the region per year (RBM/WHO 2003). Despite the environmental threats it poses, DDT has been the most cost-effective and efficient way of controlling malaria. This is the main justification for its continued use and its exemption under the Stockholm Convention until such time that alternatives are found. South Africa's experience is illustrative. When South Africa stopped using DDT in 1996, the number of malaria cases in the KwaZulu-Natal province rose from 8 000 to 42 000 by 2000 (Tren and Bate 2004). South Africa tried various alternatives but they proved less effective. Since reintroducing DDT, it has been able to reduce the number of deaths in the province to less than 50 per year (Tren and Bate 2004)

However, while DDT is important for disease control, there are concerns that its continued use constitutes a health risk especially for countries with limited chemical management infrastructure. DDT has also been found to bioaccumulate especially in aquatic species including crayfish, prawns and fish, and in this way poses a further threat to human health. With climate change, the incidence and range of malaria is predicted to increase (see Chapter 1: *The Human Dimension*) potentially increasing the need for the continued use of this highly toxic chemical.

DDT spraying in Namibia.

Source: N. Duplaix / Still Pictures

Figure 7: Population at risk from malaria



Source: WHO/AFRO undated; base on data from Deichmann for the 1990 population, Medical Research, Council South Africa

Freshwater systems and access to safe water

Pollution places freshwater systems at risk and threatens the availability of safe water for human consumption, by disrupting essential ecosystem services. Ecosystems provide effective mechanisms for cleansing the environment of wastes; this service is now overtaxed in many settings, leading to local and sometimes global waste accumulation (MA 2006). Well-functioning ecosystems absorb and remove contaminants. For example, the role played by wetlands in maintaining freshwater quality by the removal of excess nutrients is well-established. As the Millennium Ecosystem Assessment (MA) notes, these systems are under threat and this poses new challenges for management (MA 2006):

- Where excessive wastes are discharged into ecosystems, ecosystems are unable to cope and waste treatment technologies are required to restore or preserve ecosystem balance, and thus reduce or eliminate the risks to human health.
- Recycling can be an important environmental management strategy, however where waste contains POPs or heavy metals, recycling can lead to the accumulation of these pollutants and increased human exposures through food and water

Meeting water needs is a priority for Africa, and countries have agreed, in terms of the MDGs and the Africa Water Vision 2025, to increase the number of people with access to safe water (see Chapter 4: *Freshwater*). The lack of safe water poses a major threat

Children filling used containers with water for cooking and drinking, Rwanda.

Source: A. Mohamed

to human well-being. In 2002, 303 million people across Africa still did not have access to safe water (WHO and UNICEF 2004). The lack of access to safe water is a product of many factors including increasing pressure on limited resources by population growth and a lack of priority given to this issue. Access to safe water varies within countries, with poor and rural people being at the greatest disadvantage. For example, in Congo, 77 per cent of city and town dwellers have access to safe drinking water but only 17 per cent of rural inhabitants do (TWAS 2002). About 627 000 children die annually from diarrhoeal illnesses, related to a large extent to unsafe drinking water (Gordon and others 2004).

Inorganic chemical compounds and POPs in food and water present risks to people. Such contamination may be the result of natural processes (as in the case of fluoride or arsenic contamination of water sources) or from human releases of toxic chemicals into the environment (through, for example, pesticide use). In small quantities fluoride is good for teeth, however in high concentrations it destroys teeth and accumulates in bones resulting in crippling skeletal damage (Gordon and others 2004). Because they are still growing, children are at highest risk (Gordon and others 2004). As of 2004, cases of dental and skeletal defects have been reported in Ethiopia, Eritrea, Kenya, Niger, Nigeria, South Africa, Sudan, Tanzania and Uganda (Gordon and others 2004).

Inorganic nitrogen pollution of inland waterways has more than doubled globally since 1960 and increased by a factor of over ten for many industrialized parts of the world (MA 2006, UNEP 2002). As already noted, pollution impairs the ability of ecosystems to provide clean and reliable sources of water. Deterioration of freshwater quality is magnified in cultivated and urban systems (due to high use and high pollution sources) and in dryland systems (due to high demand for flow regulation and absence of dilution potential) (MA 2006). This is particularly significant for Africa, given the extent of drylands within the region (see Chapter 3: *Land*).

There is also an increasing presence of pharmaceutical products or residues in the environment from sewage and solid waste discharges, however the health risks these chemicals pose have not yet been quantified (WWF 2004a, MA 2005).

In addition to the threats posed by pollutants, water quality is also affected by pathogens, which fall into three general categories: bacteria, viruses and parasitic protozoa. Bacteria like *Vibrio cholerae*, *Salmonella typhii* and several species of *Shigella* routinely inflict serious diseases such as cholera, typhoid fever, and bacillary dysentery, respectively. Chemicals can play an important role in the treatment of water against such pathogens.

Given the general non-availability of piped water to homes people have to collect water from shared wells, rivers or community access points. Many people are forced to use old containers for collecting water. Due to a lack of awareness, agricultural chemical containers are often used and illness can often result.

Chemical exposure

Toxic chemicals can cause a variety of adverse health effects. Toxic substances such as arsenic, cadmium, lead and sulphuric acid contaminate water and soil, and affect human health. More than 50 000 tonnes of obsolete pesticides have been stockpiled in Africa contaminating tens of thousands of tonnes of soil. These obsolete pesticides represent a major threat for human health (NEPAD 2003). Low-level exposure to some chemicals present in industrial effluent or used as pesticides, such as PCBs, dioxins, and POPs such as DDT, may cause endocrine disruption, undermining disease resistance and affecting reproduction (MA 2006). They are also responsible for more acute health impacts, including poisoning. Persistent organic pollutants cause a range of health problems, even at low levels of exposure, including reproductive and developmental disorders, damage to the immune and nervous systems, and a range of cancers (Gordon and others 2004, MA 2006). Exposure during key phases of foetal development can be particularly damaging (IPEN 2002). Heavy metals pose serious threats, particularly to children and during foetal development (Gordon and others 2004). In Africa, between 18 and 24 per cent of children have concentrations of more than 10 micrograms per decilitre (µg/dl) of blood

Box 3: Lead poisoning and the tragedy of a mining boom

Lead exposure may come from contaminated air, water or food. Motor vehicle exhaust fumes from leaded fuel, smelters, lead manufacturing and recycling industries, waste sites (eg contaminated landfills), old lead water piping and lead-combining solders, and leaded paint are common sources of lead contamination. The amount of lead that may dissolve in water depends on acidity, temperature, water hardness and standing time of the water. Secondary pollution from industry can contaminate water through the effluents produced. Other sources include the use of lead-containing ceramics for cooking, eating or drinking. In some countries, people are exposed to lead after eating food from cans that contain lead solder in the seams.

In many mining centres, average atmospheric lead concentrations reach 0.3-0.5 µg/m^3 and exceed 1 000 µg/g in dust and soils. The people of Kabwe, in Zambia, face a serious threat from lead and zinc mining activities. At its peak, Kabwe was the largest and richest lead mine in Africa. Unfortunately there were few pollution controls. The mine closed in 1994 and since then the town and province have not only faced growing economic hardship but also the risk of lead poisoning. The vegetation, water and soil are contaminated and about 90 000 children are at risk from lead poisoning. Concentrations of 5 µg/dl threaten brain development; in Kabwe, many children have concentrations exceeding 300 µg/dl. Average blood level is 60-120 µg/dl.

Lead can damage the nervous and reproductive systems, and the kidneys, and it can cause high blood pressure and anaemia. Lead accumulates in the bones and lead poisoning may be diagnosed from a blue line around the gums. Children are amongst the most vulnerable. Lead is especially harmful to the developing brains of foetuses and young children and pregnant women. Lead interferes with the metabolism of calcium and Vitamin D. High blood lead levels in children can lead to irreversible learning disabilities, behavioural problems and mental retardation. At very high levels, lead can cause convulsions, coma and death.

To address the problem of lead pollution in Kabwe, the Zambian government has adopted various programmes. There are proposals to either cover the mine dumps with vegetation or cap them with concrete to prevent air pollution. In 2003, the Zambian government asked 2 000 residents to vacate their canal-side homes so that the waterways could be dredged. However, for most residents, finding alternative accommodation is not a reality.

Preventive measures are clearly more appropriate than remedial measures. The World Health Organization (WHO) identifies the following options:

- Environmental standards that remove lead from petrol/gasoline, paint and plumbing;
- Removal of lead pipes, or flushing pipes with cold water each morning before drinking if they cannot be removed;
- Enforcement of occupational health standards;
- Surveillance of potentially exposed population groups, especially the vulnerable ones (small children, pregnant women, workers);
- Water treatment;
- Removal of lead solder from food cans;
- Use of lead-free paint in homes; and
- Screening of children for blood levels over acceptable limit and referral for medical care as necessary.

Source: UNEP/FAO/Global IPM Facility Expert Group on Termite Biology and Management 2003

(Gordon and others 2004). Box 3 gives an overview of problems associated with lead contamination, with a special focus on mining in Central Province in Zambia.

With growing production and consumption, and new economic development, the risks associated with chemical use will increase. This will place new demands on Africa's chemical management institutions. In addition to intended environmental releases, there is also an increased risk of accidental releases and chemical-related accidents. Examples of hazardous incidents include the misuse of mercury in small-scale mining, PCBs in the electricity sector, DDT in the health sector and pesticides in the agricultural sector.

These chemicals pose serious risks that are exacerbated by the lack of adequate access to information regarding safe handling, use and disposal of chemicals. See for example the risks associated with Lead in Box 3 and DDT in Box 4. Poverty and lack of access to information may exacerbate these negative impacts. In the context of scarce resources, chemical containers are often re-used by rural people for household purposes including the collection of water and can result in poisoning. More than 11 million poisoning cases by pesticides occur annually in Africa (NEPAD 2003), yet few African countries have specialized poison centres. In 2004, only ten African countries had poison centres, and none had more than five (Gordon and others 2004). Further, since agriculture is the main employer for women and children, they are the most exposed to chemical risks. In many cases, both for subsistence and commercial farming, producers and workers have insufficient knowledge about the health risks posed by chemicals and therefore fail to take adequate protective measures.

Box 4: Health and environmental effects of DDT on health and environment

- DDT disturbs sexual development and behaviour in birds such as gulls.
- The capacity of the immune system is impaired by DDT, and also by certain synthetic pyrethroids – pesticides that have been promoted as DDT alternatives.
- The nervous system can suffer permanent damage from exposure during the foetal stage or early in life.
- Lactation in women can be impaired by DDT – providing a possible link with oestrogen mimicry.

Source: Mörner and others 2002

Natural resource use and adverse environmental impacts

The chemical industry is dependent on raw materials including coal, gas, air, water, minerals and genetic resources. With increased production the demand for these resources will also increase. Promoting sustainable use of natural resources and the adoption of cleaner production must, therefore, be a focus of industrial management. The industry itself is increasingly recognizing this through, for example, environmental standards adopted by the International Standards Organization (ISO). Consumers are also increasingly demanding such integrated approaches.

Industrial processes require large amounts of water and energy. In non-OECD countries, the use of energy for chemical production has increased. Given the shift of the industry to developing countries there has also been a shift in the share of energy use in these countries from 20 per cent in 1971 to 43 per cent in 1998 (Buccini 2004). Increasing energy use also results in increased emissions of greenhouse gases (GHG) that contribute to climate change (see Chapter 2: *Atmosphere*). Specific threats posed by climate change and variability are discussed in Chapter 1: *The Human Dimension* (health), and Chapter 3: *Land* (food security). The chemicals industry accounts for one-quarter of the total releases of CO_2 from industrial sector operations, although this amounted to only 4 per cent of the emissions from all sources in 1997 (Buccini 2004).

Impacts on biodiversity

While many environmental contaminants degrade quickly in the environment, others (Buccini 2004):

- Are released in quantities, concentrations or under conditions so that elevated concentrations are sustained in the environment; and
- Have a combination of physical and chemical properties so that, once released to the environment, they degrade very slowly and remain present in the environment and organisms for many years or even decades, even when released in relatively small quantities. These chemicals are said to be persistent.

Persistent chemicals can, through natural environmental processes, be distributed over long distances, leading to regional and global contamination (Buccini 2004). Many of these enter the food chain and are retained in organisms at concentrations higher than those in food and water – a process known as biomagnification. These

Box 5: Impacts of chemicals on fish catch and wetlands in Senegal

Water pollution by biomedical waste and agricultural and industrial chemicals affects wetlands and favours invasion of these areas by invasive species such as *Typha* and *Salvinia molesta*. The potential of Senegalese fisheries resources is decreasing significantly due to the destruction of the plankton by chemicals released by agricultural and industrial sectors. This has resulted in a continuous decrease in the catches and a loss of quality. From 1969 to 1988, official catches decreased from 20 000 to 8 000 tonnes.

Source: CSE 1999

substances are said to be bioaccumulative. In recent decades, there has been increased attention paid to addressing the risks posed by substances that are persistent, bioaccumulative and toxic (PBT), POPs and some metal compounds. However, many other chemicals, thought to be less harmful, are having significant negative impacts on biodiversity and human health (WWF 2004a).

Chemical pollution compromises the integrity of ecosystems, and thus directly threatens biodiversity. The increased discharge of nitrogen compounds from fertilizers in rivers can result in the eutrophication of surface and coastal seawater, and, in extreme cases, a state of complete oxygen depletion (anoxia) which severely affects the ecosystem and results in fish deaths. Excessive use of chemical fertilizers also contributes to the degradation of land through salinization, thus limiting agricultural production potential.

Chemicals pose many threats to wildlife. Research over many decades has demonstrated the adverse and often irreversible effects of POPs, PCBs, and heavy metals on the endocrine systems, especially reproductive hormones (WWF 2004a). These disruptions are now understood to have much more extensive effects including on thyroid and pituitary systems. Neurological damage is a common feature of chemical poisoning and many chemicals are carcinogenic. With the increase in chemical use these impacts on wild animals have increased (WWF 2004b). Chemicals previously thought to be safe, but with negative impacts on wildlife include (WWF 2004a):

- Perfluroocatanes – these are widely used as surfactants and emulsifiers. They are used as water protectors for carpets, textiles, leather, food packaging and other containers. They are also used in the production of shampoo and dental cleaners, and as lubricants for bicycles, tools and zips.
- Phtalates – this group of chemicals are used as softeners in a variety of plastic products including in medical equipment, building products, car products, upholstery, clothing and children's toys.
- Phenols – these are used in the production of polycarbonate plastics that are widely used in electrical appliances.
- Polybrominated flame retardants – these are widely used in furniture, building materials and clothing.

Increasing human consumption and poor waste management are key factors in this growing threat to biodiversity.

MANAGEMENT CHALLENGES

Africa needs to address the threat that existing and increasing chemical use will have on human and environmental health. As the International Conference on Chemicals Management (ICCM) noted:

> "The sound management of chemicals is essential to achieve sustainable development, including the eradication of poverty and disease, the improvement of human health and the environment and the elevation and maintenance of the standard of living in all countries at all levels of development" (SAICM 2006).

Developing a more effective chemical management system requires addressing the specific challenges Africa faces in management. There is already an extensive global system for chemical management, and it is important not to duplicate efforts but to create synergies and better systems for implementation. Africa faces challenges related to the availability of information and the communication of this to users, inadequate capacity to effectively monitor the use of chemicals, lack of access to cleaner production systems and technologies for waste management, as well as poor capacity to deal with poisoning and contamination. The management of obsolete chemicals, stockpiles and waste presents serious threats to human well-being and the environment in many parts of Africa.

As chemical use and production increases Africa's chemical management institutions, which already have limited resources and capacity, will be further constrained and overburdened and will not cope. Measures and

systems need to be developed to reduce exposure to negative impacts and to reduce human vulnerability.

Management of obsolete pesticides

Contaminated sites and obsoletes stocks present serious problems for Africa and require immediate actions. Estimates suggest that across Africa at least 50 000 tonnes of obsolete pesticides have accumulated (NEPAD 2003). Box 6 describes the extent of the problem in Tanzania. These hazardous pesticides are contaminating soil, water, air, and food sources. They pose serious health threats to rural as well as urban populations and contribute to land and water degradation.

Poor people often suffer a disproportionate burden. In poor communities these dangers are compounded by a range of factors including unsafe water supplies, poor working conditions, illiteracy, and lack of political empowerment (ASP 2003). Poor communities often live in closer proximity to obsolete pesticide stocks than wealthy people. Children may face heightened exposure and where they do are at higher risk than adults. The WHO estimates that pesticides may cause 20 000 unintentional deaths per year and that nearly three million people may suffer specific and non-specific acute and chronic effects, mostly in developing countries (ASP 2003). The risk faced by poor communities is exacerbated by inadequate access to healthcare systems; this is particularly the case for farming communities.

As in other fields of environmental management, partnerships that bring together a range of actors

Low-cost mosquito netting – as on the windows of this hut – can reduce the need for chemical sprays to control mosquitoes.

Source: P. Virot/WHO

Box 6: The challenge of obsolete pesticides in Tanzania

The exact quantity of obsolete pesticides in Tanzania is not known, since a comprehensive study to determine location, quantities, types and state has not been carried out. Nevertheless, information gathered through surveys and public complaints provides a conservative estimate of more than 90 tonnes.

Preliminary data on obsolete pesticides at Arusha and Tanga, Tanzania*

Trade name	Common name	Quantity
Gesaprim	Atrazine	470 litres
Actellic super dust	pirimiphos methyl + permethrin	10 kg
Benlate	benomyl	11 kg
DDT		40 tonnes
Thiodan	endosulfan	8 tonnes
DNOC		3 000 litres

* collected by a team of experts formed by NEMC

Other significant stockpiles include:

- Unused or obsolete pesticides on private farms and in warehouses of cooperatives in cotton and coffee growing areas. An inventory conducted in seven regions in October 1989 by National Environment Management Council (NEMC), in collaboration with Tropical Pesticides Research Institute (TPRI) revealed these stocks including 18 tonnes of DDT and DDT formulations.
- There are about 11 000 litres and 350 kg of the organophosphates Damfin P (methacrifos) and phosphamidon and the fungicide Thiovat (sulphur) in the Co-operative and Rural Development Bank (CRDB) warehouse in Mikocheni, on the outskirts of Dar es Salaam, since 1988.
- About 40 000 litres of expired pesticides are located in cotton growing regions of Mwanza and Shinyanga in the southern part of Lake Victoria. The products, which include endosulfan, flumeturon, atrazine, malathion and methidathion and DDT were found during a baseline survey conducted by the Tanzania-Germany Project on Integrated Pest Management (IPM) in 1993.
- Between 15 and 20 tonnes of expired Decis 0.5 per cent (deltamethrin), DDT 75 per cent, Thiodan (endosulfan) and Cottoran 500 (fluometuron) are stored in the Tanzania Cotton Marketing Board warehouses, Eastern zone.
- A dump of 50 tonnes at Vikunge farm in the coastal region consists of DDT, aldrin and endrin. This is part of a consignment bought as aid through the Ministry of Agriculture from Greece in 1987.

Source: Rwazo 1997

Box 7: Global support to reduce Africa's chemical stockpiles

The Rabat Programme of Action (Basel Convention) agreed to enhance the capacity of the region to:

- prevent the future accumulation of unwanted stocks of pesticides (including DDT), PCBs, and used oils;
- dispose of existing stocks of unwanted pesticides, PCBs, and used oils in a manner that is environmentally-sound, and socially and economically acceptable;
- develop a partnership with all stakeholders to address the environmentally-sound management of unwanted stocks of pesticides, PCBs, and used oils; and
- strengthen existing logistical and financial approaches, and pursue alternative and innovative approaches at the national, sub-regional, regional, and global levels to prevent and dispose of unwanted stocks of pesticides, PCBs, and used oils.

Source: CSE 1999

including the private sector, non-governmental organizations (NGOs) and governmental organizations can be an effective way of addressing problems. The Africa Stockpiles Programme (ASP) is a global programme supported by the Global Environment Facility (GEF). Prominent partners include the World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), WWF – the World Wide Fund for Nature (WWF), the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The objective of ASP is to clean up and safely dispose of all obsolete pesticide stocks in Africa and to establish preventive measures to avoid future accumulation so as to protect human and environmental health. Box 7 gives an example of one global initiative that supports Africa's efforts to reduce its chemical stockpiles.

POPs and PCBs

Although the use of POPs is regulated under international law, specifically in the Stockholm Convention, some are exempt from its provisions. In Africa these include DDT and Chlordane. The reasons for these exemptions are multifold, with both cost of alternatives and effectiveness being important considerations. In some cases, such as for DDT and chlordane, the objective is to give the exempted countries the opportunity to find suitable alternatives that are consistent with their social and economic situation before completing phase-out. The lack of public knowledge about possible alternatives is undoubtedly a factor in their continued use.

Poly-chlorinated biphenyls are mainly used in the manufacture of electrical equipment for electrical insulation. They are used in transformers and capacitors. These are persistent chemicals that do not break down easily and therefore their control and management is a serious challenge for Africa. Management requires undertaking complete inventories, preventing further releases into the environment, managing the stocks and contaminated sites and finally disposal. These challenges are enormous especially if considered within the context of the socioeconomic context of African countries.

Controlling emissions of dioxins and furans also presents a formidable challenge to African countries because of the potential impact on human health and environment. Technical and operational modifications to the industry and related attitude changes are required.

RESPONSES: POLICY AND INSTITUTIONAL ARRANGEMENTS

Recognition of the risks that chemicals pose to the human health and the environment has led to significant progress being made at the international levels to address this. Important recent landmarks include:

- Agenda 21 (1992);
- The World Summit on Sustainable Development (WSSD) (2002);
- The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) (1998) which entered into force in 2004; and
- The Stockholm Convention (2001) which entered into force in 2004.

These multilateral environmental agreements (MEAs) complement the more established global regime that includes:

- International Labour Organization (ILO) conventions dealing with workplace safety (including Convention 170 on Safety in the Use of Chemicals at Work and Convention 174 on the Prevention of Major Industrial Accidents);

- MEAs regulating trade in hazardous waste including Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, 1989 (Basel) (which entered into force in 1992) and Africa's Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, 1991(Bamako) (which entered into force in 1998); and
- MEAs dealing with marine pollution.

Chemical management

In 1992, the United Nations Conference on Environment and Development (UNCED) focused world attention on concerns related to the risks inherent in chemical production, transportation, distribution, storage, handling and disposal of unused materials and wastes. It adopted Agenda 21 – a global programme of action. Several chapters of Agenda 21 deal directly with the use of chemicals. These focus on environmentally-sound management of toxic chemicals (see Box 8). including the control of illegal international traffic (Chapter 19), the management of hazardous waste (Chapter 20) and capacity-building in developing countries (Chapter 38) (UN 1992a). This further refined the global approach to environmental problems by emphasising the link between environment and development, the need for integrated responses, and global cooperation and responsibility.

The WSSD reviewed progress made towards achieving the targets set out by Agenda 21. It agreed to ensure that by 2020 chemicals are used and produced in ways that minimize the significant adverse impacts on human health and the environment. It recognized that to achieve this, new management approaches would need to be adopted including the use of transparent, science-based risk assessment and management procedures based on the precautionary approach, as set out in principle 15 of the Rio Declaration on Environment and Development (UN 1992b). Chapter 9: *Genetically Modified Crops* provides a full overview of science-based risk assessment and how it can be used to support informed decision making. WSSD also committed the global community to support developing countries in enhancing their capacity for the sound management of chemicals and hazardous waste by providing technical and financial assistance – endorsing the UNEP-led Strategic Approach to International Chemicals Management (SAICM) in pursuit of these goals.

The Stockholm Convention deals specifically with chemical management and in particular with POPs, PCBs and dioxides. The objective of this convention is to protect human health and environment. Parties are required to take action on an initial group of 12 specified chemicals. This treaty was adopted in May 2001 but, however it only entered into force in May

Box 8: Agenda 21, Chapter 19: Priority programme areas for managing toxic chemicals

1. **Expanding and accelerating international assessment of chemical risks.** Objective: to strengthen international risk assessment, assess several hundred priority chemicals or groups of chemicals by 2000, and produce exposure guidelines for a large number of toxic chemicals.
2. **Harmonization of classification and labelling of chemicals.** Objective: to develop, by 2000, a globally harmonized hazard classification and labelling system, including material safety data sheets and easily understandable symbols.
3. **Information exchange on toxic chemicals and chemical risks.** Objective: to increase the exchange of information on chemical safety, use and emissions among all involved stakeholders, and achieve full participation in and implementation of the procedure for PIC by the year 2000.
4. **Establishment of risk reduction programmes.** Objective: to eliminate unacceptable or unreasonable risks posed by toxic chemicals and, where economically feasible, to reduce such risks through risk reduction and precautionary measures based on life-cycle analyses.
5. **Strengthening of national capabilities and capacities for managing chemicals.** Objective: all countries should have in place, by 2000, national systems for the sound management of chemicals.
6. **Prevention of illegal international traffic in toxic and dangerous products.** Objective: to reinforce national capacities to detect and prevent traffic in toxic and dangerous products that contravenes national legislation or international legal instruments.

Source: Buccini 2004

2004 and it currently has 122 parties including over 30 African countries (Figure 8).

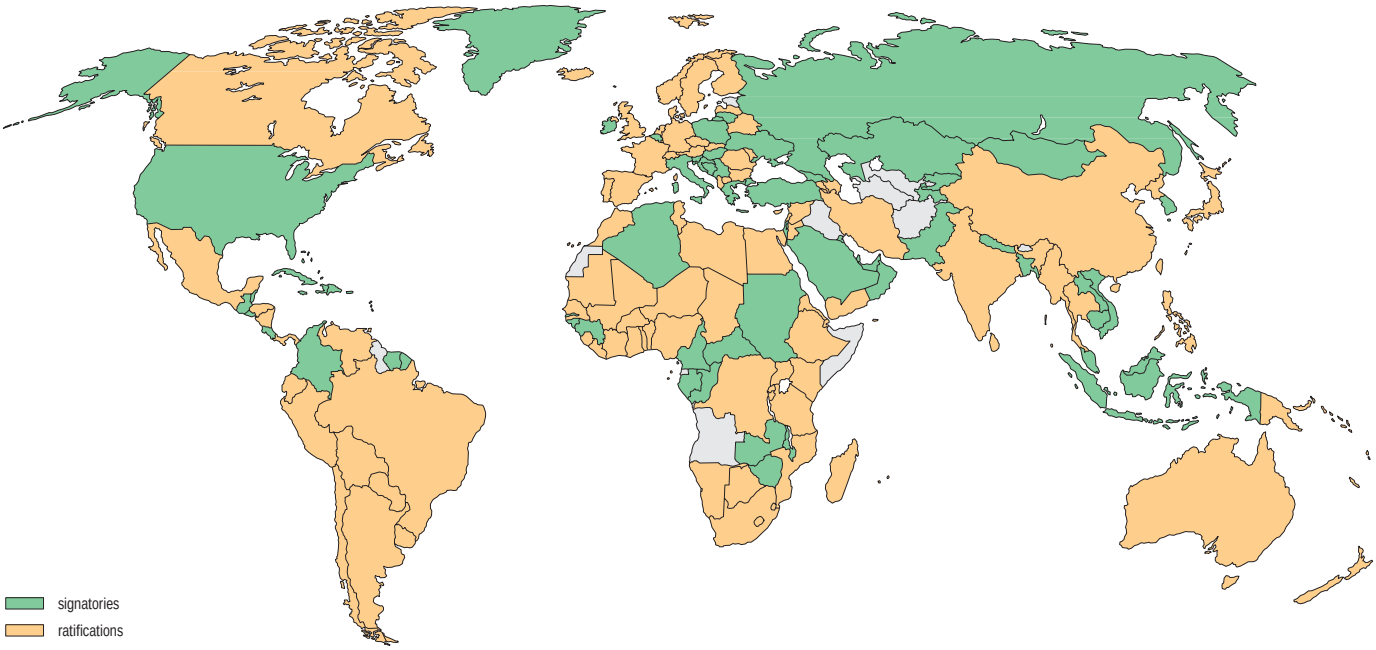
Parties are required, at a minimum, to reduce the total toxic releases from listed chemicals but also to work towards the overall goal of continuing minimization and, where feasible, ultimate elimination. Parties are also required to reduce or eliminate release from stockpiles and waste. They must develop and implement strategies to identify stockpiles and wastes containing POPs and to manage these in an environmentally-sound manner. Further, parties are required to develop national implementation plans (NIPs) within two years of entry into force of the Convention.

Within Africa there have been several important responses to improving chemical management. At a regional meeting in Abuja, Nigeria, in May 2004, African governments committed themselves to promote synergies and coordination among chemical regulatory instruments and agencies, and specifically proposed the following activities, (SAICM 2004):

- Manage chemicals at all stages of their life cycle, using the principles of "cradle-to-grave" life cycle management.
- Target the most toxic and hazardous chemicals as a priority.
- Ensure full integration of chemicals management and better coordination among stakeholders.
- Increase chemical safety capacity at all levels.
- Ensure that children and other vulnerable people are protected from the risks of chemicals.
- Promote corporate social responsibility and develop approaches that reduce human and environmental risks for all, rather than transferring the risks to those least able to cope with them.
- Incorporate the legal approaches or principles of precaution, polluter pays, and the right-to-know. This must be complemented by a commitment to substitution of toxic chemicals by less harmful alternatives and promote more environmentally-friendly practices by industries. This can be achieved through, among other measures, encouraging the private sector to seek compliance with the ISO 14000 standards.
- Integrate the precautionary, life cycle, partnership, liability and accountability approaches in management.

The NEPAD Environmental Action Plan (NEPAD-EAP) sets an Africa-wide approach to environmental management. Although chemical management is not one of the programme areas, it is identified as a key crosscutting issue. At the national and regional level, environmental action programmes will need to respond to the challenges of chemical management. Some of the actions that could be included are emergency response plans, prevention of illegal transboundary movement of chemicals, capacity-building of regional centres for the management of dangerous waste in the context of the Stockholm Convention, and the development and implementation of programmes for reducing hazardous waste.

Figure 8: Parties to the Stockholm Convention



Source: Stockholm Convention on Persistent Organic Pollutants 2006

International trade

The impacts of trade in chemicals on environmental sustainability and human well-being and development are key motivations for law development in this area. However, as the global trade regime strengthens it is uncertain whether such initiatives will come under threat from powerful trading blocs.

The Rotterdam Convention was adopted in 1998 in response to gaps within international law related to trade in hazardous chemicals. The Rotterdam Convention has 106 parties – including 37 African countries – and entered into force in 2004 (Secretariat of the Rotterdam Convention 2006). The rapid growth in chemical production and trade during the last three decades and the associated risks posed by hazardous chemicals and pesticides was an important motivation. It was evident that many countries lacked the institutional and infrastructural framework to effectively monitor import and use of such substances. The Convention seeks to promote shared responsibility and cooperative efforts in such international trade in order to:

- Protect human health and the environment from potential harm; and
- Contribute to their environmentally-sound use of chemicals by facilitating information exchange about their characteristics, providing for a national decision-making process on their import and export.

Two other treaties deal specific with the problem of the transboundary movement and disposal of hazardous waste. Africa's Bamako Convention was adopted by the Organization of African Unity (OAU) in 1991 because the approach of the global Basel Convention was seen as not sufficiently strong to protect Africa from the threat of hazardous waste dumping. The Convention has 29 signatories, 21 of which have ratified it, and entered into force in 1998 (AU 2005). However, many more African countries are party to the more trade-friendly Basel Convention.

The Basel Convention has 168 parties, of which 46 are Africa countries; it entered into force in 1992 (Secretariat of the Basel Convention 2005). The focus of this convention is to control the movement of hazardous waste, taking into account social, technology and economic aspects, to ensure the environmentally-sound management and disposal and to prevent illegal waste traffic. It recognizes the importance of the reducing hazardous waste generation, the centrality of information for effective management and the obligation to inform the importing country in advance. In 2001, the Conference of the Parties undertook to enhance capacity in Africa to deal with problems associated with stockpiles (see Box 7).

African has three Basel Convention Training Centres. These centres were established under the Secretariat of the Basel Convention with the specific objective of enhancing capacity-building. However, in recent years their mandates have expanded to include other activities related to the Rotterdam and Stockholm Conventions. The centres will support countries to synergize their chemical management-related activities at national level.

Toxic waste dump, Koko, Nigeria.

Source: C. Secrett/Still Pictures

New partnerships: a strategic approach to international chemicals management

At a global level, there has been long-standing cooperation in the management of potentially harmful chemicals. Development of legislation often focuses on a specific problem that needs to be remedied – this can result in a poorly harmonized approach that fails to create a holistic framework for tackling the depth and breadth of the issue. The development of treaties for chemical management faces precisely this problem. There has been a steady increase in global support for the development of an approach to chemicals that takes into account issues of human well-being, environmental sustainability and development and that provides a comprehensive managerial framework.

Since 2003, international organizations, governments and other stakeholders have come together in a UNEP-led initiative, SAICM. This initiative seeks to promote synergies and coordination among regulatory instruments and agencies; it includes an overarching strategy, a global plan of action and a high level declaration (UNEP 2005). The initiative was endorsed by the WSSD in Johannesburg in 2002. SAICM's policy strategy establishes objectives related to risk reduction, knowledge and information, governance, capacity-building and technical cooperation and illegal international traffic, as well as underlying principles and financial and institutional arrangements. To this end it has adopted a Global Plan of Action, which sets out proposed "work areas and activities" for implementation of the Strategic Approach.

Horticulture earns Africa millions of dollars, however it is also a major user of chemicals contributing to both soil and water pollution.

Source: M. Chenje

National legislation

Environmental law has been strengthened across Africa since UNCED. Environmental rights approaches have been developed in many African countries, including Benin, Ethiopia, Eritrea, Ghana, Malawi, Mozambique, the Seychelles and Uganda. Such approaches create a sound basis for dealing with the problems posed by chemicals, protecting human health and a safe environment, while promoting sustainable development.

The development of national legal instruments to implement a comprehensive approach to chemicals, however, has lagged behind. This is exacerbated by shortages of resource allocation for enforcement, monitoring, and training. Effective legislation will require the monitoring as well as the establishment of proper management and disposal systems. Establishing such systems and obtaining the requisite equipment is expensive. Opportunities to bring chemical producers in as part of a solution may be difficult. While it is important for legislation to create proper liability and cost-recovery measures, through, for example, the incorporation of the polluter pays principle, it is also important to look at possible incentives. Public knowledge and information about chemicals and their impacts, underlies the choices of consumers and, should be promoted. Consumer and shareholder values, interests and concerns can be an important shaper of corporate policy.

Technology and capacity issues will also need to be addressed in the implementation of legislation. For example, the development of environmentally acceptable disposal facilities requires a delicate balance between technology complexity and applicability. The requirement of the Stockholm Convention, that the parties develop NIPs, provides unique opportunities for countries to reassess their strengths and weakness in the area of chemical management at national level with global support.

Institutional arrangements for the sound management of chemicals

Institutional arrangements for the sound management of chemicals in African vary from one country to another. In many countries responsibility lies with several agencies. For example, Zimbabwe has four different ministries that administer chemical-related environmental laws, Botswana also has four ministries, while in South Africa responsibility is shared among departments for environment and tourism, agriculture and the provincial governments.

During the 1990s, most African countries established a wide variety of new institutional

arrangements for environmental management, protection and restoration. For example, many countries in Northern and Southern Africa created new environment ministries while most Eastern African countries favoured separate environmental protection agencies, as in Uganda and Kenya. Western and Central Africa have a mixture of both. However, the absence of coordination seriously undermines the formulation of a strategic approach and the translation of treaties related to chemical management into country programmes. When sectoral approaches dominate, the mechanisms for cooperation and coordination among different agencies are often ineffective.

Most countries face problems of access to adequate financial resources. Environmental ministries often have smaller budgets and weaker political voices than, for example, those that directly manage productive natural resources such as agriculture or determine economic policy. The result has been uncertainty and a reduced ability to plan and carry out core activities. Effective budgets for agencies have also shrunk. Competing for scarce funds and political commitment, existing institutions are frequently torn between competing priorities. The provision of budgets that cover the operations of institutions will remove some of the bottlenecks experienced. However, there is a need to identify new and additional sources for financial assistance. New financial resources are needed to undertake the programmes related to:

- Ensuring the protection of children and other vulnerable populations from the risks posed by chemicals, while increasing chemical safety at all levels.
- Promoting corporate social responsibility through the development of approaches that reduce human and environmental risks for all and do not simply transfer risks to those least able to address them.
- Promoting best practices in the manufacture, distribution, trade, use and disposal of chemicals and products required to meet sustainable development objectives.
- Reducing the risks posed by chemicals to human health and the environment, with a focus on measurable indicators.
- Updating and bringing laws in line with current scientific knowledge.
- Clarifying and harmonizing responsibilities of different ministries.

Table 2: Priority areas for promoting best practice in chemicals management and usage

Priority areas	Actions
Mining	Improve laws, licensing, surveillance and enforcement; health and safety, education and training at community to regional levels.
Agricultural usage	Improve monitoring, education and training at community and industry levels.
Petrochemical production and usage (including plastics)	Improve laws, licensing, surveillance and enforcement; health and safety, education and training.
Waste management and pollution control	Improve local waste services, sewage systems, industrial and agricultural effluent control; improve compliance with marine disposal convention (e.g. International Convention for the Prevention of Pollution from Ships (MARPOL)), health and safety standards.
Distribution, storage and disposal (including illegal dumping)	Improve laws, licensing and enforcement; health and safety, education and training; improve enforcement of existing conventions (eg Bamako); apply technological developments.
Inter-sectoral and intergovernmental cooperation	Promote consultation and engagement between stakeholders, locally, at the catchment level, nationally and internationally, especially in respect of air- and water-borne chemical dispersal.
Information systems, monitoring, Research and Development (R&D)	Apply ground-truthing and remote-sensing monitoring techniques, standards for monitoring, establish performance indicators, improve evidence base including community reporting, costing.
Human and operational capacity	Develop professional, technical and managerial resources; equipment and physical infrastructure investment and maintenance.

Source: Buccini 2004, ECA 2001, SAICM 2004, UN 1992, UNEP 2006

- Identifying and filling in gaps in the legal framework for environmental protection.

In order to promote the sound management of chemicals in Africa, it is essential that appropriate institutional, policy, legal and administrative arrangements are in place in all countries in the region. Although institutional arrangements for chemical management will vary from country to country due to different socioeconomic conditions, there are some essential elements for the sound management of chemicals that should be included.

An effective legal and policy framework for the management and control of chemicals should be multisectoral with the ability to promote a coherent and coordinated approach. This requires:

- Information gathering and dissemination systems;
- Risk analysis and assessment systems;
- Risk management policies;
- Implementation, monitoring and enforcement mechanisms;
- Effective management of wastes at source;
- Rehabilitation measures for contaminated sites and poisoned persons;
- Effective education and information communication programmes;
- Labelling requirements that support sound use and consumer choice;
- Emergencies and disaster responses;

Box 9: Systematic chemical assessments

Systematic assessments are used for ascertaining the nature and extent of impacts and risk posed by individual chemicals at the local, regional and global levels. The assessment of chemical related risks must be based on a life cycle assessment. This requires considerations of the wide spectrum of activity related releases including:

- Manufacturing;
- Processing;
- Handling;
- Transportation;
- End use; and
- Disposal.

Such assessments are essential for determining release conditions and whether the distribution should be broad, or preferentially concentrated in one medium.

Source: CSE 1999

- Liability and responsibility rules; and
- Environmental impact assessments and social impact assessments.

This could be supported through

- Multi-stakeholder participation;
- Rights of access to information;
- Application of the precautionary approach or principle;
- Cost-benefit analysis; and
- Adoption of the polluter pays principle (PPP).

CONCLUSION

Although the use of chemicals has supported the development of industry and agriculture, and generated broad health benefits through the management of disease, there are serious risks to human health and environmental sustainability associated with chemical use, making this a critical area to which Africa needs to turn its attention. The global nature of chemicals issues requires a comprehensive and global approach that brings together all stakeholders.

Several social and economic trends make sound management essential if development options are not to be foreclosed. Africans will face increased exposure to chemicals as a result of the growth of global trade in chemicals, changing production patterns and the predicted relocation of chemical production to developing countries, the growing market for chemical products, increasing urbanization and the lack of adequate resources for infrastructural development and maintenance particularly in the water sector, and increased industrial employment and corresponding work place exposure to chemicals

There is a need for improved coordination and cooperation between global, regional and national levels to identify gaps, reduce duplication, maximize institutional efficiency and develop synergies. However the success of MEAs must ultimately be assessed at the national level. It is essential for Africa to focus on creating an integrated policy approach and viable institutional mechanisms to support this. At the national level chemical environmental laws will need to be updated in line with the current scientific knowledge.

In facing the increased management challenges, national governments could, in line with regional and global trends, focus their attention specifically on (UNEP 2006):

- Risk reduction – prevention of and preparedness for accidents and natural disasters.
- Information and knowledge – improving the accessibility of information on hazardous chemicals.
- Governance – integration of SAICM objectives into national development planning.
- Capacity-building and technical assistance – promotion of life cycle approaches to chemicals management.
- Illegal international traffic – symposium on illegal international traffic in chemicals and hazardous wastes

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CHAPTER 12
ENVIRONMENT FOR PEACE AND REGIONAL COOPERATION

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"Safeguarding the environment is a crosscutting United Nations' activity. It is a guiding principle of all our work in support of sustainable development. It is an essential component of poverty eradication and one of the foundations of peace and security."

Kofi Annan, United Nations Secretary-General, 1997

INTRODUCTION

Peace is a prerequisite for human development and effective environmental management, both of which are critical to Africa achieving national and regional goals, such as those of the New Partnership for Africa's Development (NEPAD) and its environmental action plan (NEPAD-EAP), as well as globally agreed objectives, including those of the Millennium Development Goals (MDGs). The New Partnership for Africa's Development, which focuses on promoting economic development with a view to eradicating poverty and placing countries – individually and collectively – on a path of sustainable growth and development, recognizes the importance of peace:

> "The three pillars of sustainable development, however, cannot be achieved without peace and security on the continent" (NEPAD 2003a).

and

> "We are determined to increase our efforts in restoring stability, peace and security in the African continent. These are essential conditions for sustainable development, alongside democracy, good governance, human rights, social development, and the protection of the environment and sound economic management" (NEPAD 2002).

Cooperation at different levels – from local to national, to sub-regional, to regional, and to international – and peace represent the key to unlock many opportunities for sustainable development.

Conflict can only continue to exacerbate the problems faced in the region, as it impacts directly on economic potential and human well-being, shattering the very foundations of society. The data and information on the impacts of conflict in Africa are staggering: since 1970, more than 30 wars have been fought in Africa, seriously undermining regional efforts to ensure long-term stability, prosperity and peace (UN 1998). More than 350 million people in Africa live in countries that are affected by conflict (Michailof and others 2002). This has multiple implications for the real opportunities available to people, and it undercuts their capability to lead lives that they value. There is a strong negative correlation between conflict and human development: in 2005 most of the countries with the lowest Human Development Index (HDI) rankings were also those immersed in conflict or had recently emerged from it (OSAA 2005). The resources available to people are diminished – for example, through the loss of access to land and other natural resources on which livelihoods are based, and the loss of access to education and health care – and so is their freedom to

Peace, development and environmental protection are interdependent and indivisible.

Principle 25, Rio Declaration

choose. Severe military conflict in sub-Saharan Africa (SSA) is reported to cut life expectancy by four to six years and to contribute to a rise in infant mortality (Ghobarah and others 2001). Conflict increases the threat of bodily harm, and destroys the social and political networks on which social cohesion is based, consequently increasing the incidence of social exclusion (OSAA 2005). Women and girls face the risk of rape and kidnapping; in many of Africa's conflicts this assault on women has been used as a weapon (OSAA 2005). In Rwanda, for example at least 250,000 women were raped during the 1994 genocide, and many were deliberately infected with HIV/AIDS; 17 per cent of internally displaced women and girls surveyed in Sierra Leone had experienced sexual violence – both war- and non-war-related – including rape, torture and sexual slavery (Rehn and Johnson Sirleaf 2002). During South Africa's anti-apartheid struggle, the systematic physical abuse of women prisoners was an important aspect of that conflict (Truth and Reconciliation Commission 2003, Russel 1989) Recognizing the importance of gender in conflict, in 2000 the United Nations (UN) Security Council adopted Resolution 1325 on Women, Peace and Security.

By the end of 2003, more than half of the total 24 million internally displaced people (IDP) worldwide were found in 20 African states (Norwegian Refugee Council 2004). In 2004, there were almost 2.9 million officially registered refugees in Africa (UNHCR 2004), and many more people living outside of their country of origin without legal protection. By 2005, this number had risen to 4.9 million. Refugees and IDPs are amongst the most vulnerable people.

Then ANC President Nelson Mandela and ex-South African President F W de Klerk receive the Nobel Peace Price (1993) for their work for the peaceful termination of apartheid and laying the foundations for a new democratic South Africa.

Source: Associated Press

Armed conflict is a major expense, resulting in the diversion of essential resources from human and economic development. For example, the diversion of resources to finance war in Central Africa was about US$1 000 million annually, and more than US$800 million in Western Africa (World Bank 2000). Refugee assistance is an additional cost and has been estimated at more than US$500 million for Central Africa alone (World Bank 2000).

For Africa, therefore, there can be no alternative to peace and regional cooperation, and the environment is a key factor. Principle 25 of the Rio Declaration on Environment and Development emphasizes (UN 1992):

> "Peace, development and environmental protection are interdependent and indivisible."

However, the issue of peace is much broader than simply armed conflict. The report of the UN High-level Panel on Threats, Challenges and Change – *A More Secure World: Our Shared Responsibility* – states:

> "... we know all too well that the biggest security threats we face now, and in the decades ahead, go far beyond states waging aggressive war. They extend to poverty, infectious disease and environmental degradation ..." (UN 2004).

Africa has made considerable progress towards building peace. In 1998, there were 14 countries who were in engaged in armed conflict or civil strife; by August 2005, the UN Secretary-General reported that only 3 countries were engaged in major conflict although many more countries were involved in civil strife of a lower intensity (UN General Assembly 2005). Most countries have greatly improved their governance systems, yet for many a combination of historical, external and internal factors continue to contribute to conflict.

REGIONAL COOPERATION FOR SUSTAINABLE DEVELOPMENT

Africa has a long history of regional cooperation, with many sub-regional and regional institutions and frameworks established and maintained long before the 20-year period of this environmental assessment report. While most of them focus on political and economic issues, others are concerned with the sharing and management of natural resources. In particular these include multilateral environmental agreements

(MEAs), river basin commissions (RBC), and institutions concerned with biodiversity conservation and the utilization of transboundary resources.

From the United Nations Charter and the Constitutive Act of the African Union (AU) on one hand, to the sub-regional economic groups such as the Economic Commission for West African States (ECOWAS) and the Southern African Development Community (SADC) on the other, the region has many mandates and institutions which promote – directly and indirectly – peace and conflict resolution. The negotiation and adoption of regional and sub-regional MEAs and protocols, over the last 20 years, has facilitated the establishment of a more reliable body of laws and institutions to respond to the needs of Africa in a globalized world. Revitalized RBCs, some dating back to the colonial period, recently established transboundary national parks, and many other governance structures provide the foundation upon which the region is taking a more assertive role in resolving and avoiding conflict, and building opportunities for development.

The African Union

In 1999, the Organization of African Unity (OAU) embarked on the process of establishing the African Union (AU) – which was launched in 2002. The AU's objective is to accelerating the process of regional integration to enable Africa to play its rightful role in the global economy while addressing multifaceted social, economic and political problems, compounded as they are by certain negative aspects of globalization. The AU is Africa's principal organization for the promotion of accelerated socioeconomic integration.

The AU builds on the long history of collaboration established by the OAU. The many achievements of the OAU include the adoption of the Lagos Plan of Action (1980) and the African Charter on Human and People's Rights (1981). In the 1990s, the OAU committed to place the African citizen at the centre of development and decision making and the AU has continued to adopt measures to support this. In 1993 the OAU adopted the Mechanism for Conflict Prevention, Management and Resolution – a practical expression of the determination to find solutions to conflicts, and to promote peace, security and stability. In 2000 this was complemented by the adoption of the Solemn Declaration on the Conference on Security, Stability, Development and Cooperation which establishes fundamental principles for the promotion of democracy and good governance.

Building on this history, the AU strives to build a partnership between governments and all segments of civil society, in particular women, youth and the private sector, in order to strengthen solidarity and cohesion amongst the peoples of Africa. A key focus is on the promotion of peace, security and stability as a prerequisite for the implementation of the development and integration agenda of the Union. Its organs include a Peace and Security Council, the Pan-African Parliament, and specialized technical committees.

The AU's Constitutive Act (Box 1) is the compass by which member states should avoid the pitfalls of conflict and it provides the road signs they should follow to ensure sustainable development.

Box 1: Provisions of the Constitutive Act of the African Union

The AU objectives and principles are key to promoting peace and security for sustainable development of which environment is an important factor. The AU Constitutive Act states that the scourge of conflicts in Africa constitutes a major impediment to its socioeconomic development. It highlights the need for the following responses:

- Promote peace, security and stability as a prerequisite for the implementing the region's development and integration agenda.
- Achieve greater unity and solidarity between the African countries and the peoples of Africa.
- Defend the sovereignty, territorial integrity, and independence of member states.
- Promote peace, security, and stability in Africa.
- Peaceful resolution of conflicts among members through appropriate means decided upon by the Assembly of Heads of State and Government.
- Prohibition of the use of force or threat to use force among members.
- Peaceful coexistence of members and their right to live in peace and security.

The Act also provides for the Assembly to give directives to the AU Executive Council on the management of conflicts, war and other emergency situations and the restoration of peace.

Source: AU 2000

The United Nations

All 53 countries in Africa are members of the UN. The UN Charter emphasizes a global vision of peace as the basis for development, with a special focus placed on "fundamental human rights, the dignity and worth of the people, equal rights of men and women, and of nations large and small" (UN 1945). To this end, two essential purposes of the UN are:

- To maintain international peace and security, and to that end to take effective collective measures for the prevention and removal of threats to peace and the suppression of acts of aggression or other breaches of the peace. Collectively, countries agree

to bring about by peaceful means, and in conformity with the principles of justice and international law, the settlement of international disputes or situations which might lead to a breach of the peace.

- To achieve international cooperation in solving international problems of an economic, social, cultural, or humanitarian character, and to promote and encourage respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language or religion.

For the UN, environment is an important aspect of its peace-building goals:

> "Safeguarding the environment is a crosscutting United Nations activity. It is a guiding principle of all our work in support of sustainable development. It is an essential component of poverty eradication and one of the foundations of peace and security" (Annan 1997).

The UN has, over decades, organized various international conferences in which Africa has participated, that focus on strengthening cooperation in sustainable development efforts. For example, the 1992 UN Conference on Environment and Development (UNCED), also known as the Earth Summit, adopted Agenda 21 – a blueprint for sustainable development which emphases the value of cooperation. A decade later, the World Summit on Sustainable Development (WSSD), held in Johannesburg in 2002, further emphasized the centrality of peace and security in Africa to achieving environmental goals. Chapter 8 of the WSSD Johannesburg Plan of Implementation, which focuses on Africa calls on the global community to:

> "Create an enabling environment at the regional, sub-regional, national and local levels in order to achieve sustained economic growth and sustainable development and support African efforts for peace, stability and security, the resolution and prevention of conflicts, democracy, good governance, respect for human rights and fundamental freedoms, including the right to development and gender equality" (UN 2002).

Regional fora on environment and development

Regional processes, such as the African Ministerial Conference on the Environment (AMCEN) and African Ministerial Council on Water (AMCOW) provide leadership on environment and freshwater. AMCEN has been in existence since 1985, while AMCOW was launched in 2002. Both mobilize political and technical support to address diverse environmental issues, such as land degradation and desertification, chemicals management, access to safe water and sanitation, and integrated water resource management (IWRM).

Refugees who fled violence in Fugnido camp (Ethiopia) construct new shelters in Bonga camp, Ethiopia, 2003.

Source: N.Behring/ UNHCR

From the outset, AMCEN has sought to strengthen cooperation in environmental policy responses in the region. In its inaugural declaration adopted at the end of the 1985 meeting in Cairo, AMCEN highlighted its major objective as strengthening cooperation between African governments in economic, technical and scientific activities, with the prime objective of halting and reversing the degradation of the African environment in order to satisfy food and energy needs (AMCEN 1985).

African ministers have also pursued cooperative initiatives on critical environmental issues, such as energy use, the phase-out of lead fuel, and chemicals. They have also adopted an agricultural initiative (Comprehensive Africa Agriculture Development Programme) to boost food production and help the region attain food self-sufficiency (see Chapter 3: *Land*). Through the NEPAD process, African governments have also produced a health strategy, which among other issues, recognizes the centrality of health to development, and that poverty cannot be eradicated – or substantially alleviated – as long as disease, disability and early mortality continue to burden Africa's people (NEPAD 2003b). For example, malaria has slowed annual economic growth by 1.3 per cent, imposing a loss of US$12 000 million on the region per year (RBM/WHO 2003).

Africa has adopted a number of MEAs that address regional concerns. These include the Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (Bamako)(see Chapter 11: *Chemicals*) and the 2003 African Convention on the Conservation of Nature and Natural Resources (ACCNNR) (see Chapter 1: *The Human Dimension* and Chapter 8: *Interlinkages: The Environment and Policy Web*). Although implementation of both remains a challenge due primarily to the lack of resources, these two conventions show the spectrum of regional cooperation in environmental issues. These are complemented, as discussed below by various sub-regional agreements and initiatives.

The launch in October 1999 of the African Renaissance Institute played an important role in developing a framework for enhancing cooperation. South Africa's President Thabo Mbeki, who launched the Institute, encouraged the mobilization of all African countries, including their people and organizations, to promote the objectives of an African Renaissance – the rebirth and renewal of the region (Mbeki 1999, Box 2)

Regional Economic Communities

There are a number of regional economic communities (RECs) in Africa. These include, among others, the:

- Community of Sahel-Saharan States (CEN-SAD);
- Economic Community of Central African States (ECCAS);

Box 2: African Renaissance to promote regional cooperation

For Africa, the future of all countries is interdependent: meaningful peace, stability, sustained development and improved human well-being in one country is only possible where all countries in the region have achieved that.

In facing the challenges of development, the region has to overcome its negative history, which includes:

- Unstable political systems, in which one-party states and military rule prevailed, led to conflict, civil wars and genocide that contributed to the displacement of millions of people and the creation of refugee populations;
- Predatory elites, who have thrived on looting national wealth and the entrenchment of corrupt practices;
- The growth of the international debt burden, to the extent that in some countries, combined with unfavourable terms of trade, it makes negative growth in national per capita income inevitable; and
- Declines in the standard of living and the quality of life for hundreds of millions of people.

The tasks of the African Renaissance include:

- Establishing institutions and procedures, which enable Africa to collectively deal with challenges of democracy, peace and stability;
- Achieving sustainable economic development, that results in the continuous improvement of the standards of living and the quality of life of the masses of the people;
- Qualitatively changing Africa's place in the world economy, freeing it from its international debt burden, and transforming it from being a supplier of raw materials and an importer of manufactured goods;
- Ensuring the emancipation and equality of the women;
- Successfully confronting the scourge of HIV/AIDS; and
- Strengthening the genuine independence of African countries and Africa, as a region, in their relations with the major powers, and enhancing their role in the determination of the global system of governance in all fields, including politics, the economy, security, information and intellectual property, the environment, and science and technology.

Source: Mbeki 1999

- Common Market for Eastern and Southern Africa (COMESA):
- Intergovernmental Authority for Development (IGAD):
- Southern African Development Community (SADC);
- Arab Maghreb Union (UMA); and
- Economic Commission of West African States (ECOWAS).

All of these RECs are actively engaged in promoting cooperation, although primarily with a focus on economic development. Principles and motivations underlying their formation generally include sovereign equality; solidarity, peace and security; human rights, democracy and the rule of law; equity, mutual benefit; and the peaceful settlement of disputes. Several have embarked on extensive environmental collaboration.

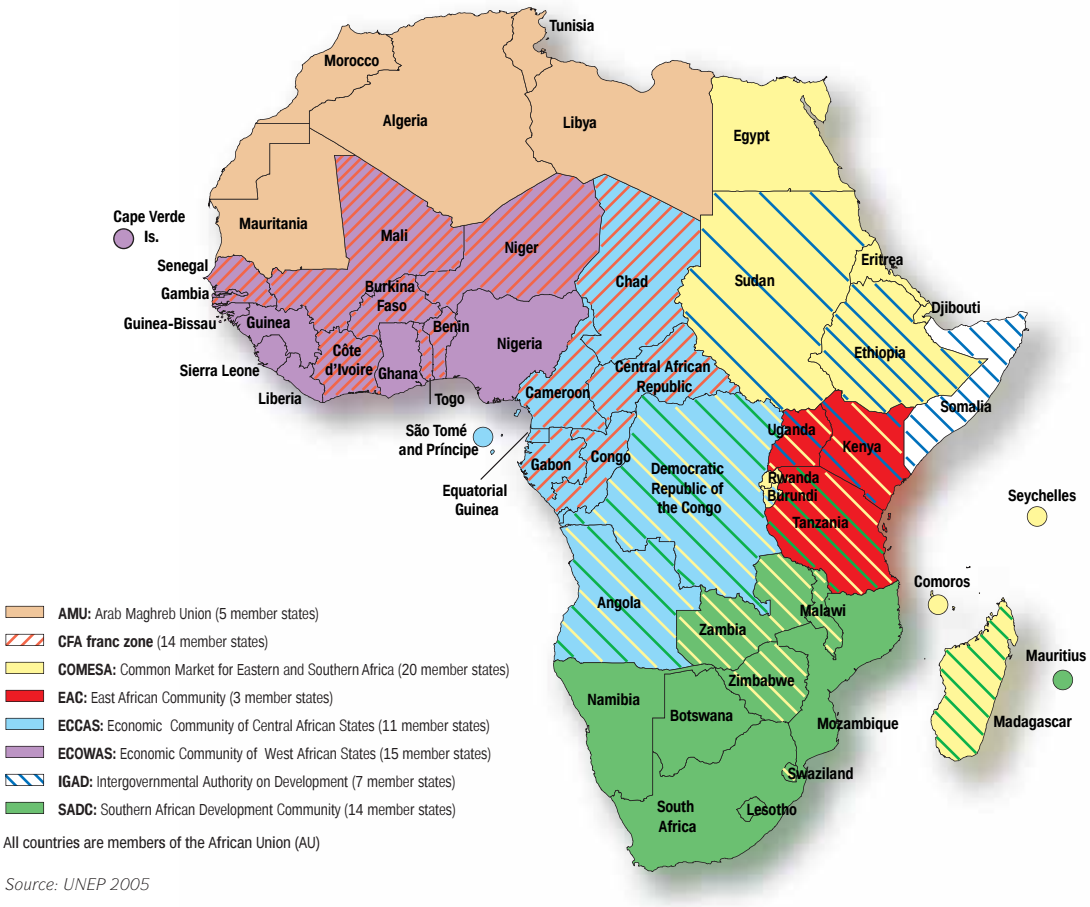
At the sub-regional level, the SADC Treaty recognizes peace and security provisions, alongside cooperation in natural resource management (NRM), as essential to meeting its objective of achieving sustainable utilization of natural resources and effective protection of the environment (SADC 1992). In support of this, various protocols that establish shared institutions have been adopted, these include:

- The Protocol on Shared Watercourse Systems, which was signed in 1995 by the member countries and amended in 2000 to harmonize it with the most important aspects of the 1997 UN Convention on the Law of Non-Navigational Uses of International Water Courses.
- The Protocol on Energy, 1996.
- The Protocol on Transport, Communications and Meteorology, 1996.
- The Protocol on Wildlife Conservation and Law Enforcement, 1999.

Another example of cooperation in SADC is the establishment, in 2004, of the Zambezi Basin Commission after more than two decades of on-and-off negotiations among the eight riparian states.

A number of other recent initiatives at the sub-regional level hold promise for enhanced regional cooperation in a number of different areas, including the environment. In Eastern Africa, for example, the revival of the East African Community (EAC) in 1999 is intended to widen and deepen cooperation among the member

Figure 1: African economic regions fostering cooperation



Source: UNEP 2005

states – Kenya, Tanzania and Uganda – in many areas, including environmental management (Box 3).

In the Great Lakes Region (GLR), where conflict has been an obstacle to regional cooperation, the link between environmental quality, and peace and security has been articulated by policymakers. Meeting in Nairobi in September 2004 for the UN Great Lakes initiative, stakeholders from seven countries proposed principles and actions critical to addressing suspicion and conflict, and for encouraging cooperation among the member states. The principles focus on peace and security, democracy and good governance, economic development and regional integration, and humanitarian and social issues (ICGLR 2003).The following actions and principles were seen as essential for development in the GLR (UNEP 2004b):

- Environmental quality and sustainable NRM are a precondition for peace and security in the GLR. Peace and security are a precondition for good environmental quality and sustainable resource management. Given this close relationship between peace and environment, it was emphasized that management plans should include provisions which encourage equitable access to and sharing of benefits from natural resource use, so as to avoid competition for natural resource control. These plans should also identify and support opportunities through which environmental management can contribute to peace and peaceful coexistence.
- Political commitment to the tenets of democracy and good governance are critical for the sustainable management of environmental resources. This includes strengthening national capacities, and fostering regional cooperation through the development of sustainable NRM programmes. Such programmes should focus on strategic transboundary resources such as lakes, river basins, mountain ecosystems, protected areas, and unique cultural, biodiversity and historical sites.
- Environmental management and protection should be an integral part of economic development and regional integration for sustainable development. This includes the use of sustainable transboundary natural resource management (TBNRM) as an opportunity for regional economic development and integration.
- Armed conflicts result in diverse humanitarian and social situations that have environmental implications, such as increased environmental degradation. This, in turn, leads to – or exacerbates – poverty which, in turn, further increases environmental degradation through unplanned development of human settlements and the overharvesting of resources. Effective responses include considering environmental sustainability in decisions related to the location and establishment of refugee camps, to avoid increasing stress on already fragile environments, and encouraging cooperation between the host and refugee populations, especially on the use of natural resources, by taking into account the needs of the host community.

Box 3: Main organs of the East African Community

The EAC is an intergovernmental organization comprised of Kenya, Uganda and Tanzania. The cooperation and integration envisaged in the EAC is broad-based. It includes:

- Trade, investment and industrial development;
- Monetary and fiscal affairs;
- Infrastructure and services;
- Human resources, science and technology;
- Agriculture and food security;
- Environment and natural resources management;
- Tourism and wildlife management; and
- Health, social and cultural activities.

Its main organs are the Summit of Heads of State and/or Government; the Council of Ministers; a coordination committee; sectoral committees; the East African Court of Justice, the East African Legislative Assembly; and the Secretariat. Environmental cooperation is facilitated by the Sectoral Committee on Environment and Natural Resources, which has four working groups that focus on terrestrial ecosystems, aquatic ecosystems, pollution and related matters, and policy, legal and institutional frameworks (Sikoyo and Wakhungu 2003). The recommendations of the working groups are provided to the three heads of state to assist them in their decision making on environmental issues.

The community has developed, "*A Vision and Strategy Framework for the Management and Sustainable Development of the Lake Victoria Basin.*"Among the various responsibilities of the Council of Ministers is the management of the Lake Victoria basin, and fisheries. This includes, for example, agreeing to controls on container boats on Lake Victoria as these are believed to be involved in smuggling fish, and allowing small-scale cross-border fishing and trade.

Source: LVDP undated, Sikoyo and Wakhungu 2003

The Katse Dam is part of the Lesotho Highlands Water Project, an export-import activity between Lesotho and South Africa.

Source: L. Schadomsky/Still Pictures

Cooperation in freshwater resources management

River basin agreements

With over 50 significant international river basins (OSU and others 2002), Africa has the second largest number of such basins in the world, providing opportunities for regional cooperation and transboundary management of the resource. River basin institutions have been established to jointly manage water resources, and some of these institutions date back to the colonial period. For example, Africa's largest river, the Congo – which is over 4 000 km long – had its first treaty adopted in February 1885 as part of the Berlin Conference (OSU and others 2002).

Some rivers have more than one treaty governing water resources management. For example, the Senqu/Orange basin which includes South Africa, Namibia, Botswana and Lesotho has at least five agreements, four of which relate to the Lesotho Highlands Water Project. This project is possibly Africa's most significant water export-import activity between countries. The agreements between Lesotho and South Africa treat water as a commodity, from which the former earns revenue in foreign currency and the latter imports a much needed resource for human consumption and industrial operations, mostly in the Gauteng Province. This province generates about 60 per cent of South Africa's industrial output and 80 per cent of its mining output, and is home to more than 40 per cent of the country's population (Southafrica.info 2004). The project also generates hydropower for Lesotho. The Lesotho Highlands Water Project, which started in 1984, will cost about US$8 000 million by the time it is completed in 2020 (Southafrica.info 2004). Despite the successes at a bilateral level, a shortcoming is that it has not included all basin states and therefore may affect the rights and interests of other states, for example, water availability in Namibia and the Orange River estuary (Mohamed-Katerere 2001). The project has also placed new pressures on local riparian people, undercutting human well-being by directly threatening food security and agriculture-derived income (Akindele and Senyane 2004). In particular, there have been problems with resettlement and the restoration of livelihoods of those whose lands were submerged due to dam construction (Hoover 2001). Local people displaced by the dam have not enjoyed the benefits of this project – hydropower. None of the ten villages promised connection have yet been connected to the electrical grid (Hoover 2001). These impacts on human well-being could increase the potential for conflict at the local and national level. These lessons demonstrate the need for collaborative approaches that take account of all interests including those of states and communities.

Many other initiatives exist related to water resources management in the region. Some have more challenges than others. Perhaps two of the most visible, often pitting environmentalists against developers or spawning national security fears, are the Okavango and the Nile basins. The strategic importance of water – including for food security, energy generation, and transport among other uses – has caused some to speculate about the possibility of conflict over watercourses in Africa and elsewhere. However, through a variety of technological, policy and institutional innovations, water management in Africa also has the potential to act as a source of cooperation and mutual benefit between communities and nations.

Okavango delta – a challenge for sub-regional cooperation

The Okavango basin is a good example of a situation which holds promise, as well as many challenges. The Okavango River rises in the highlands of Angola (where it is known as the Cubango River) and crosses into north-eastern Namibia's Caprivi Strip before flowing into Botswana. The Okavango River is the only exploitable perennial river in Botswana and Namibia, which are extremely arid countries. The delta, which is in the middle of the Kgalagadi (Kalahari) Desert, is a highly significant area of biodiversity (NHI and others 2005). The basin, which is relatively undeveloped, partly as a result of about three decades of conflict in

Angola and also because of the international importance of the flora and fauna in the Delta, has gained the attention of many major environmental conservation organizations. Significantly, two of the three riparian countries are also among the most economically active in Southern Africa.

The peace now prevailing in Angola provides opportunities for development in the remote and marginalized watershed areas. But unregulated increased industrialization could result in increased pollution and increased abstraction of water from the Okavango River. The increasing demands potentially pit one state against the other (Swatuk 2002). The SADC Protocol on Shared Watercourse Systems (referred to above) has proved to be a very useful tool for collaborating and resolving these kinds of concerns.

Information on hydrological phenomena and the wider environmental context is crucial for effective management and reconciling differences. Often the different priorities pursued by different users (whether at the community or state level) are justified by contrasting narratives and competing sets of "expert discourses" (Swatuk 2002). One important way of finding solutions and moving beyond disagreements is to develop a set of data on water-flows and other basic indicators that all riparian countries agree on (Turton 2002).

Nile Basin Initiative

Through information sharing, capacity-building, and joint projects, it is possible to create "transnational communities" of scientists, civil society organizations, and other stakeholders (Conca and Dabelko 2002). The Nile Basin Initiative (NBI) is an example of a high-level forum that has combined aspects of "high politics" with technical cooperation and information sharing. This is, in part, is intended to foster trust and build confidence of the riparian countries in each other. The vision of the NBI is "to achieve sustainable socioeconomic development through the equitable utilization of, and benefit from, the common Nile Basin water resources" (Government of Uganda 2002).

The NBI has emerged from several decades of cooperative work between the riparian states, initially based around scientific information sharing. Such projects include the Hydrometeorological Survey of the Catchment of Lakes Victoria, Kyoga and Albert (HYDROMET) (1967-1992), funded by the United Nations Development Programme (UNDP), the Technical Cooperation Committee for the Promotion of the Development and Environmental Protection of the Nile Basin (TECCONILE) which was founded in 1993, and a series of ten "Nile 2000" conferences which were funded by the Canadian International Development Agency (CIDA) (ECA 2000).

Bujagali Falls, the Nile, Uganda. The Government of Uganda, with help from the World Bank, hopes to construct a 200-megawatt dam in this vicinity, just downstream from two other large dams.

Source: IRN

The objective of TECCONILE was to enable sustainable development of Nile waters through basin-wide cooperation and equitable use of water (Abrams 2001). This has been described as a "revolutionary" initiative since it was the first to bring together all riparian states for the stated aim of equitable use of the Nile (Kivugo 1998). To this end, donors have assisted member states in developing national water master plans and integrating these into a Nile Basin Development Action Plan (Abrams 2001). They also supported activities to build capacity for IWRM. While TECCONILE was successful at many levels, some downstream riparian states did not participate fully.

In 1997, the Council of Ministers of Water Affairs of the Nile Basin States (Nile-COM) requested the World Bank to coordinate and lead donor activities, and since then from that time CIDA, UNDP and the Bank have worked in concert (NBI 2005). In early 1999, the NBI was launched, as another "transitional institutional mechanism" for riparian cooperation (Government of Uganda 2002).

The highest decision-making body of the NBI is Nile-COM which encourages the active participation of all states through among other measures, a rotational one-year chair. Technical support is provided by the Nile Technical Advisory Committee (Nile-TAC), with one member (backed up by one alternative member) from each state. The NBI Secretariat (Nile-SEC) is the implementation arm, directed by the former Director of the Water Resources Department of Tanzania.

The objectives of the Nile River Basin Strategic Action Programme are to (Nile-COM 1999):

- Develop the water resources of the Nile basin in a sustainable and equitable way to ensure prosperity, security and peace for all its peoples;
- Ensure efficient water management and the optimal use of water resources;
- Ensure cooperation and joint action between the riparian countries;
- Seek win-win solutions;
- Target poverty eradication and promote economic integration; and
- Ensure that the programme results in a move from planning to action.

Under the NBI, the 1929 Nile Waters Agreement is being renegotiated (Kameri-Mbote 2004). One of the key aspects of this process is the finalization of the Nile Basin Cooperative Framework (project D3 of TECCONILE) which lays out the ground rules for legal and institutional arrangements (Abrams 2001). The finalization of the draft framework, by a panel of experts from each country as well as a negotiation committee, is under way.

Cooperation in wildlife and biodiversity management

Africa has a long history of cooperation in wildlife management, dating back to old agreements, such as the 1933 London Convention Relative to the Preservation of Fauna and Flora in Their Natural State. The management of wildlife has evolved since then –

Koekoboom tree at sunrise in South Africa's Richtersveld National Park which is part of the Ai-Ais/Richtersveld Transfrontier Park.

Source: Howes/UNEP/ Still Pictures

from preservation to sustainable utilization. More recently, some countries have adopted a transboundary approach to wildlife management, establishing TBNRM areas. Southern Africa has been a major player, in redefining and shifting the conservation agenda, as well as a pioneer in the development of TBNRM. It has adopted and implemented a wide range of such initiatives, from those that establish transboundary parks, to mountain conservation areas, to integrated management frameworks for shared marine ecosystems, to spatial development initiatives (Mohamed-Katerere 2001).

Ai-Ais/Richtersveld Transfrontier Park

The Ai-Ais/Richtersveld Transfrontier Park is a new transboundary park between South Africa and Namibia, which was proclaimed in 2003. It has been described as a collection of "jigsaw pieces" to eventually create one of the world's greatest coastal sanctuaries to protect a unique desert ecosystem across three countries, covering about 180 000 km^2 (Marshall 2003).

It is intended to eventually include Angola. Namibia has signed a memorandum of understanding with Angola to pursue the establishment of a similar transfrontier park across the Kunene River. The three countries expect to establish by 2006 a super park – which would be about the same size as Uruguay (Marshall 2003) – bringing these various areas together. Encompassing an arid landscape, the "super park" will be long and thin, stretching for about 2 400 km along Southern Africa's Atlantic seaboard, and crossing the boundaries of South Africa, Namibia and Angola. The first step to the realization of this super park is the treaty between South Africa and Namibia to establish the Ai-Ais/Richtersveld Transfrontier Park, which spans the Orange River boundary to link South Africa's Richtersveld with Namibia's Ai-Ais and Fish River Canyon National Park (Marshall 2003).

Great Limpopo Transfrontier Park

The 35 000 km^2 Great Limpopo Transfrontier Park connects South Africa's Kruger National Park, Mozambique's Limpopo National Park, and Zimbabwe's Gonarezhou National Park (Marshall 2003), and is seen as an integral part of the Maputo Development Corridor (Mohamed-Katerere 2001). This megapark, which will be more than three times the size of Yellowstone National Park in the United States and almost as big as The Netherlands, will be one of the biggest conservation areas in the world.

The Great Limpopo Transfrontier Park is a huge ecosystem that is home to a wide variety of wildlife, including those most sought after by tourists – *Panthera leo* (lion), *Ceratotherium simum* (white rhinoceros), *Diceros bicornis* (black rhinoceros), *Giraffa camelopardalis* (giraffe), *Loxodonta africana* (elephant), *Hippopotamus amphibius* (hippopotamus) and *Syncerus caffer* (buffalo) (African Wildlife Foundation 2003). It will also help strengthen economic relations between the three Southern African neighbours by attracting greater numbers of tourists: "creating new jobs and fortifying a tourism base not yet meeting its full potential" (African Wildlife Foundation 2003). The park will allow managers from the three different parks to consolidate their infrastructure development, law enforcement, and fire management strategies and thus effectively lower costs. It also addresses the most serious worldwide threat to wildlife: the loss and fragmentation of habitat.

The CITES listing of the African elephant (*Loxodonta africana*) is one of Africa's most divisive policy issues – but elephant and other wildlife offer immense opportunities for improving tourism and transboundary cooperation.

Source: B. Belcher/CIFOR

Congo Basin Forest Partnership

Central African countries have taken the lead in trying to effectively manage the sub-region's forest resources. A recent example is the meeting of the Conference of Ministers for the Forests of Central Africa (COMIFAC) in Yaoundé, Cameroon, in January 2003. It highlighted the fact that African tropical forests constitute significant natural wealth for present and future generations. They urged the new partnership to:

- Be well-balanced, responsible, transparent and to promote agreement among the parties;
- Reconcile conservation objectives with development requirements;
- Ensure the conservation of the Congo basin forests through implementation of the *Plan de Convergence* priority actions;

Logging should be based on collaborative agreements if the Congo basin forest is to be managed sustainably.

Source: E. Dounias/ CIFOR

- Help reduce poverty in Central Africa through greater involvement of communities and local non-governmental organizations (NGOs) in conserving ecosystems;
- Strengthen and develop national capacities; and
- Include all international organizations that are willing to participate in efforts for sustainable management of the Congo basin forests.

Given the global significance of the Congo basin forest – it is the second largest forest in the world after the Amazon, and plays an important role in climate regulation, as well as being a huge repository of biological diversity – the countries of the Congo basin appealed for broad international solidarity to execute the UN Resolution No 54/214 of December 22, 1999, and support their effort for conservation and sustainable management of these forest ecosystems (COMIFAC 2004). The partnership has been supported by the second Summit of Head of States of Central Africa on the Conservation and Sustainable Management of the Forest Ecosystems, held in Brazzaville in February 2005. The Central African leaders adopted a declaration and an agreement, which commits the parties to:

- Recognize, as a national priority, the conservation and sustainable management of forests as well as the protection of their environment.
- Accelerate the establishment of the necessary instruments for sustainable development, particularly internationally accepted certification systems and to build the requisite capacity for their implementation.
- Put in place measures aimed at incorporating conservation and sustainable management of ecosystems into other development sectors including transport and agriculture.
- Establish in every country, sustainable financial mechanisms for the funding of the forest sector.
- Speed up the creation of transboundary protected areas between Central African countries.
- Strengthen participatory mechanisms aimed at increasing the consultation and participation of rural populations in the planning and management of forests.
- Develop the partnership with the international community to attract the necessary funds to finance these activities.

To facilitate the implementation of the agreement and promote the harmonization and monitoring of forest policies in Central Africa, the nine countries of Cameroon, Central African Republic (CAR), Congo Republic, Democratic Republic of the Congo (DRC), Equatorial Guinea, Chad, Burundi, Rwanda and São Tomé and Príncipe, established COMIFAC.

ARMED CONFLICT A THREAT TO REGIONAL COOPERATION

Political and governance systems, investment and economic growth, and environmental conservation and stewardship in Africa are all at risk due to wars and other civil conflicts. War, and post-conflict situations, places stress on the environment, sometimes contributing to the overexploitation of natural resources. Environmental resources have been acknowledged as a factor in influencing or prolonging some conflicts in Africa (UN 1998). Despite being one of the richest regions, in terms of both human and natural resources, extreme poverty and hunger abound in the region.

Armed conflict has – along with large populations of displaced people and refugees and the HIV/AIDS pandemic – been identified as a major factor in slowing down the achievement of the MDGs (UN DPI 2004). The resources spent on warfare could, if redirected, make a significant contribution to addressing the MDGs and

other development targets. For example, SSA has the lowest access globally to improved drinking water supply, with only 58 per cent of the population having such access in 2000 (UN DPI 2004).

Often, food production is drastically affected by armed conflict. According to some studies, areas affected by conflict suffer annual losses of more than 12 per cent of production, although the figure varies widely from country to country (Messer and others 1998). In the extreme case of Angola, for example, production was reduced by 44.5 per cent, and less than 4 per cent of arable land was under commercial or subsistence production in 2000 (Stites and Leaning 2002).

The root causes of conflict in Africa have been the subject of much debate. Unfortunately, the nature of violence has been poorly understood. In contrast to the stereotypes of "ethnic" conflict in Africa, evidence appears to show that Africa's great ethnic diversity actually reduces, rather than increases, the chances of conflict occurring (Elbadawi and Sambanis 2000). However, in some cases it seems that where one ethnic group is numerically dominant (eg if the majority forms more than 45 per cent of the total population) this may increase the chances of conflict (Collier and Hoeffler 2004). Even in these cases power, and the manipulation of ethnic identity by elites, is a major driving force.

The sources of conflict in Africa reflect the diversity and complexity of Africa's past and present. Some sources are purely internal, some reflect the dynamics of a particular sub-region, and some have important international dimensions (UN 1998). Despite these differences the sources of conflict in Africa are linked by a number of common themes and experiences (UN 1998). According to the Commission on Human Security (2003), causes of internal conflict include:

- Competition over land and resources (see Box 4);
- Sudden and deep political or economic transitions;
- Growing inequity among people and communities;
- Increasing crime, corruption and illegal activities;
- Weak and unstable political regimes and institutions; and
- Identity politics and historical legacies, such as colonialism.

In several places, economic motivations have been a critical factor (UN 1998):

- The international arms trade is very high on the list of those who profit from conflict in Africa, and the protagonists themselves.
- In Liberia, the control and exploitation of diamonds, timber and other raw materials was one of the principal objectives of the warring factions. Control over those resources financed the various factions and gave them the means to sustain the conflict.
- In Angola, difficulties in the peace process owed much to the importance of control over the exploitation of the country's lucrative diamond fields.
- In Sierra Leone, the chance to plunder natural resources and loot Central Bank reserves was a key motivation of those who seized power from the elected Government in May 1997.

Up in smoke: over 3 800 weapons were destroyed in Nairobi on 29 June 2005, in an effort of Norwegian Church Aid (NCA) and partners to bring lasting peace to the GLR and the Horn of Africa. The NCA is committed to the destruction of small arms and light weapons, a major cause of human insecurity and crime.

Source: I. Kipyegon/NCAEA

Evolution of armed conflicts in Africa

In many ways, the conflicts now being experienced in many parts of Africa are influenced by problems rooted in the past. The militarization of societies and the social tensions which these create often linger long after violence subsides, having long-term affects on opportunities for development and improving human well-being.

Box 4: Access to land and violent conflict in Africa

Land and conflict are closely linked. Historically, land has been seen as a "war prize," with the victors seizing territorial control at the expense of losing groups, who would often be forced to flee, relinquishing their homes, fields and properties. More recently, however, increased interest in conflict analysis has revealed various complex relationships between control over land (and land-based resources) and conflict. Internal conflict – by far the most significant kind of conflict today – is often motivated by disputes around access to land, fairness and justice. Additionally, during conflict land access is affected. For example, entire communities, who become targets of violence due to the ethnicization of conflict, may be displaced and therefore lose entitlement to land and land resources.

In many countries, there are important issues around land, citizenship and migration, often stemming from events in the colonial era, which generate conflict. In Southern Africa, for example, these are often related to the economic dominance and control over prime land exerted by white settler communities. The land rights of migrant farm workers are also an increasingly important issue. In the GLR land disputes are often closely linked to migration (pre-colonial, colonial and post-colonial) and the arbitrary delineation of borders by colonial powers, which resulted in forced displacement. In Eastern Africa too, land, in combination with inequitable resource access, resource degradation and demographic pressures, has been a key driver in violent conflict. This volatile issue of land rights is being addressed differently in the various countries, with varying rates of progress. Foreign support for land administration systems and reform, has often focused on ensuring maximum security of tenure for commercial activities in urban areas as well as large rural farms, and has neglected equity issues. While there is some justification in this approach – based on the assumption that improved tenure security will lead to increased domestic and foreign investment, and hence economic growth – it should not be pursued at the expense of the rights of the rural majority, as this has in many instances led to sustained conflict, sometimes with disastrous economic consequences.

A further problem is the mismatch between customary land tenure systems, which are undergoing changes related to modernization and globalization, and state systems based on western models. Reconciling these different normative frameworks is essential for improving NRM and establishing widely accepted land tenure systems. Governance systems, which value and recognize these multiple values, establish negotiation and mediation processes, and that are based on principles of transparency, accountability and a right-to-know can be an important tool for reducing potential conflict.

Land issues may also be "embedded" within other struggles, including those related to control over mining rights, protected areas, or hunting concessions. In many places control over natural resources defines the opportunities individuals and communities have. Conflict may be manifested at many levels, including over the individualization of rights previously held communally, which results in the loss of access, and opportunity, for some.

In post-conflict situations, the land and shelter needs of returning IDPs and refugees must be carefully managed to avoid further disputes and violence. Land problems are often compounded by the challenging structural nature of ownership and management – gross inequalities between and within communities, and inadequate land administration – demographic pressure, and different conceptions of land rights. Therefore, land policies in post-conflict contexts need to address these multiple factors.

A range of important questions remain about the nature of policy reforms necessary to address land issues in order to prevent violence, during and following conflict. The transition between "conflict" and "post-conflict" is never clear. In terms of the causes of violence, conflict may never be fully resolved; in terms of the violence itself, it may continue sporadically well past the official declaration of "peace". Certain areas may be particularly affected, and indeed may not come under the control of the post-conflict government for months, or years. This is especially true where remote areas are inaccessible due to lack of infrastructure. In such cases, given the long-term nature of insecurity, land issues in remote areas should not be neglected until "peace" comes. Solutions, no matter how imperfect, should be found.

Sources: Gasana 2002, Huggins 2004, Juma and Ojwang 1996, Katerere and Hill 2002, Mohamed-Katerere and van der Zaag 2003, Moyo 2003

During the 1960s and 1970s, many countries achieved political independence from direct colonial control. However in several countries, particularly in Southern Africa, western countries continued to play a pivotal role. In several countries, the anti-colonial struggles which endured for many years had a very destructive impact on social and political life, as well as environmental resources. Indeed, current tensions in several African countries cannot be fully understood without reference to these early struggles.

In Angola, for example, three different groups fought for independence since the 1950s and 1960s. With the ousting of the Portuguese president in 1974, the new military government in Portugal declared a truce with those fighting for independence, and entered into talks. However, conflict between the rebel groups continued, and some residents of oil-rich areas expressed a desire to secede. While the *Movimento Popular da Libertação de Angola* (MPLA) took over government, two other armed groups, the *União Nacional para a*

Box 5: Darfur – a region in crisis

The Darfur region in the western part of Sudan is a huge area, the size of Kenya. It ranges from arid rangeland with sandy soils in the north, to the medium-rainfall savannah and forested mountains of the resource-rich Jebel Marra of the west, to the woodland plains of the south.

Rainfall has been steadily declining over the last 30 years, which has had negative impacts on farming communities and pastoral peoples. Many pastoralists migrate seasonally with their animals from the drier north, which is part of the Sahara, to the more agriculturally productive south. The region is home to about 90 ethnic groups.

The root causes of the conflict have been identified as drought and creeping desertification, access to land and water, deforestation and local environmental governance:

- Land: The northern part of Darfur is affected by Sahelian drought cycles. Drought has been almost continuously experienced since 1967, with only short interruptions. This area is widely believed to be undergoing creeping desertification. Environmental stress is increasing due to the combination of drought and high livestock numbers. Increasing stock numbers are related to falls in export prices and, in other instances, to bans on exports. By the 1980s, serious degradation was evident including the clearance of tree cover in water catchment.
- Water: There is a perpetual cycle of conflict around water provisioning: migrating communities rely on access to water pumps which are usually maintained by local (settled) communities. However, conflict leads to population displacement, and water pumps are, therefore, not maintained. The falling number of water points then contributes to new pastoral movements, which can further exacerbate the conflict.
- Forests: Deforestation is also a cause of conflict. Nomadic communities are accused by agricultural communities of cutting down palatable trees to allow goats to browse on higher branches. In some places farmland has been encroached on as established migration patterns have changed due to an increasing incidence of drought and desertification in northern Darfur.
- Local environmental governance: Until the 1970s, access to natural resources was determined according to customary law. However, the government abolished this system in the early 1970s but were not able to effectively implement the new system. In the vacuum that resulted, governance and managerial conflicts emerged: some ignored the traditional regulations and yet at the same time new systems where not full adopted. Changes in village level governance systems were also an important factor. The power of local traditional leaders was effectively curtailed in the early 1980s, when government administrators took responsibility for local affairs. However, these administrators are often seen as inexperienced and lack credibility and have been unable to establish effective laws. For example, in the past, local leaders enforced strict regulations on the timing and route of pastoral migrations; however, these have since broken down.

This conflict has had multiple negative effects on development, human well-being and environmental resources. In addition to displacing millions of people, the following are important areas of concern:

- Water and waste management issues are critical in some camps;
- Environmental considerations and available solutions are not consistently integrated into relief efforts; and
- A relief assistance gap forces internally displaced peoples to deplete natural resources to survive, with significant humanitarian and environmental consequences.

Sources: Gasana 2002, Huggins 2004, UNEP and OCHA Environment Unit 2004

Independência Total de Angola (UNITA) and the Front for the Liberation of Angola (FNLA) continued to oppose the MPLA, and intermittent but extremely destructive conflict continued right up to the beginning of the 21st century.

The 1980s were the height of the Cold War, and this had an undeniably strong influence on events across Africa (UN 1998). During the 1990s conflict in Angola was increasingly determined by struggles for diamonds, oil and other resources. This is part of a wider trend in Africa and elsewhere, in which the struggle for access and control of high value natural resources has resulted in, or perpetuated, conflicts. With the end of the Cold War and the loss of external funding from superpower rivalries control over these resources have become much more important to insurgents (Ross 2003). Arvind and Vines (2004), for example, found that UNITA financed its war largely through taxes on the illicit trade in diamonds, particularly between the mid-1990s and 2002. From 1999-2002, UNITA is reported to have earned about US$300 million per year from illicit diamond sales. In Sierra Leone, the Revolutionary United Front (RUF) financed its war by trading in illicit diamonds. In the DRC, struggles over the control of diamonds, coltan and timber has prolonged civil war (Arvind and Vines 2004).

One part of the Africa region which has received global attention due to conflict is the Darfur region of Sudan where 1.6 million people were internally displaced in the 2002-03 period and 200 000 others forced to flee as refugees into neighbouring Chad. This

ongoing conflict has strong links to environmental and natural resource issues (UNEP and OCHA Environment Unit 2004), as is highlighted in Box 5.

Defining problems and finding solutions

Over the past decade, significant international attention has been devoted to conducting research into the links between environmental factors and conflict. To some extent, there has been a mismatch between "northern" emphases and "southern" perspectives on the environment and security debate. Much of the early work in this field originated in northern universities or think tanks and in addressing developing world issues, focused on those aspects which were likely to affect the north – such as the possibility of large-scale movements of environmental refugees, for example. Much attention was also paid to demographic issues related to high population growth rates. Many in the developing world felt that such issues did not represent their key concerns, and that the "environmental security" concept was "a rich country agenda serving rich-country interests of access and control" (Conca 2002). More recently, and partly due to conscious efforts to bridge the gap between northern and southern debates, more consensus is emerging around some of the root causes of conflict and the links between the environment, peace and security; however, more remains to be done (EDSP undated).

Box 6: Land, water and conflict in the Senegal River basin

In the Senegal River basin during the late 1980s, plans to construct a major dam, which would change the flow of water in the region and allow for increased agricultural opportunities, had unexpected consequences. The market value of some land increased greatly and elite groups moved into the area, disenfranchising many local inhabitants, especially those with secondary user rights, in order to benefit. This legal move was accompanied by a campaign to strip many of the affected people of their citizenship. This increased tensions between two neighbouring countries, and triggered a tit-for-tat cycle of expulsions and violence.

The dam project was initiated in order to increase irrigated agriculture, generate electricity, and make the river navigable. However, the resulting land use changes indirectly contributed to massive social upheaval, inequitable land reform, and a situation of potential international conflict. Land degradation was part of the context of these events, because (in combination with a devastating drought), it made land-use changes a priority for the government. More sustainable use of land and water resources could have minimized the political and economic pressure for the dams and therefore avoided conflict.

Sources: Homer-Dixon 1994, ACTS, CISDL and UNDP 2003

In particular, an influential strand of research has built upon analysis of "war economies," originally developed from within the humanitarian literature (Keen 1997 and Duffield 1998), and has focused on "conflict resources". This research conceptualizes natural resources as valuable commodities, used to fund armed groups and, therefore crucial in perpetuating conflict. Nevertheless, it recognizes that conflict can be motivated by other factors, including ideological differences, but concludes that often, maintaining access to valuable natural resources can become an end in itself, rather than the means to an end. Members and clients of armed groups at all levels – but particularly at leadership levels – stand to benefit economically from the control of resources (Nitzschke 2003).

The plethora of research into natural resource conflict provides a useful lens through which to view conflicts across Africa. However the analysis, often based around detailed case studies, has not always succeeded in providing effective recommendations for moving forward, resolving conflict, and enhancing post-conflict development. For example, awareness that natural resources have fuelled conflict has often resulted in calls for embargoes on particular goods originating in conflict zones.

Unfortunately, there is sometimes insufficient recognition that trade in these resources is essential to local livelihoods, and embargoes on some resources may further undermine local people's abilities to survive. In the words of one commentator, "the shadow economy has revitalized old markets and created new ones through demands for local goods and all types of services... the transborder networks that support organized violence in one location have encouraged autonomous and resistant processes of actually existing development in other areas" (Duffield 2002).

In addition, there is often a simplistic line drawn between "conflict resources" – which are seen as illegitimate – and resource extraction in a post-conflict scenario, which is assumed to be legitimate. There is often an emphasis on "illegal" resource exploitation, which is identified as the problem. In fact, resource extraction in some countries was unsustainable and exploitative prior to the conflict; and a return to the *status quo* will simply result in continued marginalization of the poor. As noted by participants at a conference on transforming war economies: "These economic relationships tend to persist after the formal resolution of active hostilities. In these settings, a main challenge for peacebuilding efforts is to address the dysfunctional elements of the shadow economy, while retaining its socially beneficial aspects" (Nitzschke 2003).

The issue is not to "legalize" trade. Instead, there is a need for an overhaul of the systems and standards in place (Global Witness 2004). A useful strategy, in areas which continue to be characterized by lack of respect for the rule of law, may be to use a combination of disincentives against the use of violence and incentives for good business practices. This approach may include punitive measures and controls on financial transactions, as well as creating avenues for integration into legal systems for those who accept reform, reject violence and are willing to become more accountable. This pragmatic approach could make some companies and networks more accountable and less violent, while avoiding marginalizing them completely and hence risking a return to conflict.

In recent years, there has been a realization that there is a need to go beyond the "resource war" concept and focus on the potentially positive aspects of the environment. It has been noted that when parties are involved in bitter violent conflict over values and visions, environmental issues can be less divisive than other issues, and can provide practical means for cooperation and local development. Environmental issues may, therefore, represent a platform for dialogue between warring parties and an opportunity for practical cooperation (Parker and others 2004). At the same time, because of the great importance of natural resources at both the local and national levels, environmental issues are the stuff of "high politics" (Conca and Dabelko 2002).

Consequently, more attention has been paid to cooperation over potentially contested resource claims – whether at local, national or sub-regional levels. There has been recognition that, in general, there have been few real efforts to identify the specific pathways through which competition over resources can be transformed into cooperation and synergy. Often, competing claims over resources are seen as "zero-sum" struggles where only one actor may win, and all others must logically lose. This is the idea of "resource capture" in which each actor endeavours to take as big a slice of the environmental "pie" as possible (Homer-Dixon 1994, Conca and Dabelko 2002). However, through reconceptualizing the nature of the resource and acknowledging the multiple uses to which it could be put, as well as the relationships between the various actors, the "zero-sum" outcome can potentially be transformed into a "plus-sum" outcome, with enhanced stakeholder confidence and regional security as a major "value-added" (Turton 2002). The diversity of cooperation models which are possible could enhance regional stability and result not in a "negative peace", characterized by the absence of war but the also the absence of trust, but a "positive peace" which opens new doors for collaborative approaches (Ohlsson 1995, Turton 2002, and Conca and Dabelko 2002).

The available environmental resources in Breidjing refugee camp in eastern Chad have been under tremendous strain from overcrowding (2004).

Source: J. Clark/UNHCR

Another focus has been on conflicts arising in situations of abundance. Despite the great economic value of environmental resources, revenue derived from its use is not always directed towards the public good. Many countries which are rich in oil and minerals, for example, have not managed to develop equitably. This is often dubbed a "resource curse". This is closely related to economic booms. Booms may be caused either through price increases or new discoveries of natural resources. Export booms cause major distortions in economies through their effect on structure of production and investment, domestic income, savings, government expenditure and prices in different sectors of the economy (Auty 1993). Export booms increasing foreign exchange in the sector concerned (and not others), which may lead to an appreciation in the real exchange rate. In turn, this reduces the relative prices of tradable manufactured products to non-tradable goods and services.

One study found that countries with a high dependency on oil and mineral exports tend to have high mortality rates for children under five (Ross 2003). Although local communities often do not see the benefits of these economic activities, they frequently

bear the brunt of the negative environmental and social impacts of natural resource extraction. These may include land expropriation, pollution and immigration of labour from other parts of the country (Ross 2003). Changes to the local economy may be associated with increased social breakdown manifested in increases in prostitution, and drug and alcohol abuse, effectively undermining human well-being and entrenching social exclusion. In Nigeria, annual oil revenues are around US$40 000 million. Despite this, the per capita income is only about US$290 per year (Douglas and others 2003). In oil-producing areas, both environmental and human well-being are directly impacted upon. Oil spills, among other things reduce fish catches undercutting nutrition and income-earning opportunities. The flaring of gas during the extraction process, occurs with a far greater frequency in Nigeria than is generally permitted in other countries, and is a major air pollutant. Such impacts, as well as the uneven distribution of benefits, associated with inter-communal rivalry around territorial claims to oil-producing areas, such as access to employment with oil firms, have contributed to the rise of violence. Countries with high levels of inequity tend to be prone to social conflict. In Nigeria, the richest fifth of the population earns 55.7 per cent of income while the poorest fifth earns just 4.4 per cent (WRI 2003) and 70 per cent of Nigerians live on less than US$1 a day.

These patterns of conflict and inequitable development are not inevitable, and can be avoided through astute economic management. Botswana, for example, has adopted socially responsible reinvestment systems, reinvesting most of its mineral revenues in accordance with criteria explicitly aimed at sustainability and the development of physical and human capital, guided by a series of six-year National Development Plans (NDPs) and, more recently the objectives of Vision 2016. As a result, the country has accumulated a substantial portfolio of international financial assets, valued at $6 300 million, or approximately 130 per cent of GDP, at the end of 2000. This ability to transform one form of wealth – non-renewable minerals – into other forms of productive wealth is the key to successful economic development of resource-rich economies (Lange and others 2002).

ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS OF ARMED CONFLICT

Armed conflict has multiple, long- and short-term impacts on development, and on environmental and human well-being. The affects, even of internal conflicts, are felt at various spatial levels, within the immediate area of conflict, and often in neighbouring countries. Conflict undercuts or destroys environmental, physical, human and social capital, diminishing available opportunities for sustainable development.

Conflict impacts on human well-being, reducing quality of life, the capabilities of people to live the kinds of lives they value, and the real choices they have. It results in the loss of lives, livelihoods and opportunity, as well as of human dignity and fundamental human rights.

Conflict in Darfur, Sudan, has displaced thousands of people. Here IDP with makeshift shelters in a temporary camp in northern Darfur, December 2004.

Source: J. Prinsloo

Livelihoods are directly affected through decreased access to land, and inadequate access to natural resources, as a result of exclusion, displacement and the loss of biodiversity. Conflict can set in motion a cycle of degradation and human vulnerability. Human vulnerability refers not only to the exposure to negative environmental change, but also to the ability to cope with such change through either adaptation or mitigation. Conflict contributes to the breakdown of social cohesion and the disruption of local governance systems; this in turn may result in established safety nets becoming unavailable. The increase in social and economic vulnerability, as result of conflict, may in the face of environmental and land degradation, trigger new tensions and conflict over critical resources, such as water or food (Homer-Dixon and Blitt 1998). The incidence of poverty may increase, not only through the loss of livelihoods but also as a result of a growing inability of people to cope with change. This loss of resilience is also directly linked to diminished access to public services, resulting in, for example, an increasing incidence of ill health, a contraction in formal employment opportunities, the destruction of subsistence livelihoods, and other entitlements failures which affect consumption and nutrition, as well as the weakening of social cohesion and heightening insecurity (Luckham and others 2001). The use of landmines, for example, has severely limited access to land, both during the conflict and in the long term. Conflict is estimated to result, on average, in production losses of 12 per cent and to undercut growth in the agricultural sector by 3 per cent per year (DfID 2001). War, therefore, by increasing the gap between food production and need, aggravates poverty and hunger, and consequently promotes continued dependence on food aid.

The full impacts of landmines on human well-being and livelihoods, and ecosystems are not well understood; and there is a need for systematic and comprehensive study of their impacts (Nachon 2004). These costs cannot be measured in only economic terms; landmines are designed to maim, and the resulting bodily harm, for example to limbs and reproductive organs, can have severe psychological impacts on those affected. For example, due to prejudice and cultural factors in some communities, injured unmarried women may have reduced opportunities to marry and have children (Swart 2003). Landmines are cheap to use but extremely expensive to decommission. A single mine can often be bought on the black market for US$3, but may cost anything between US$200-1 000 to remove, depending on where it is placed (Swart 2003).

Landmines have severe human costs.

Source: P. Jeffrey/ACT

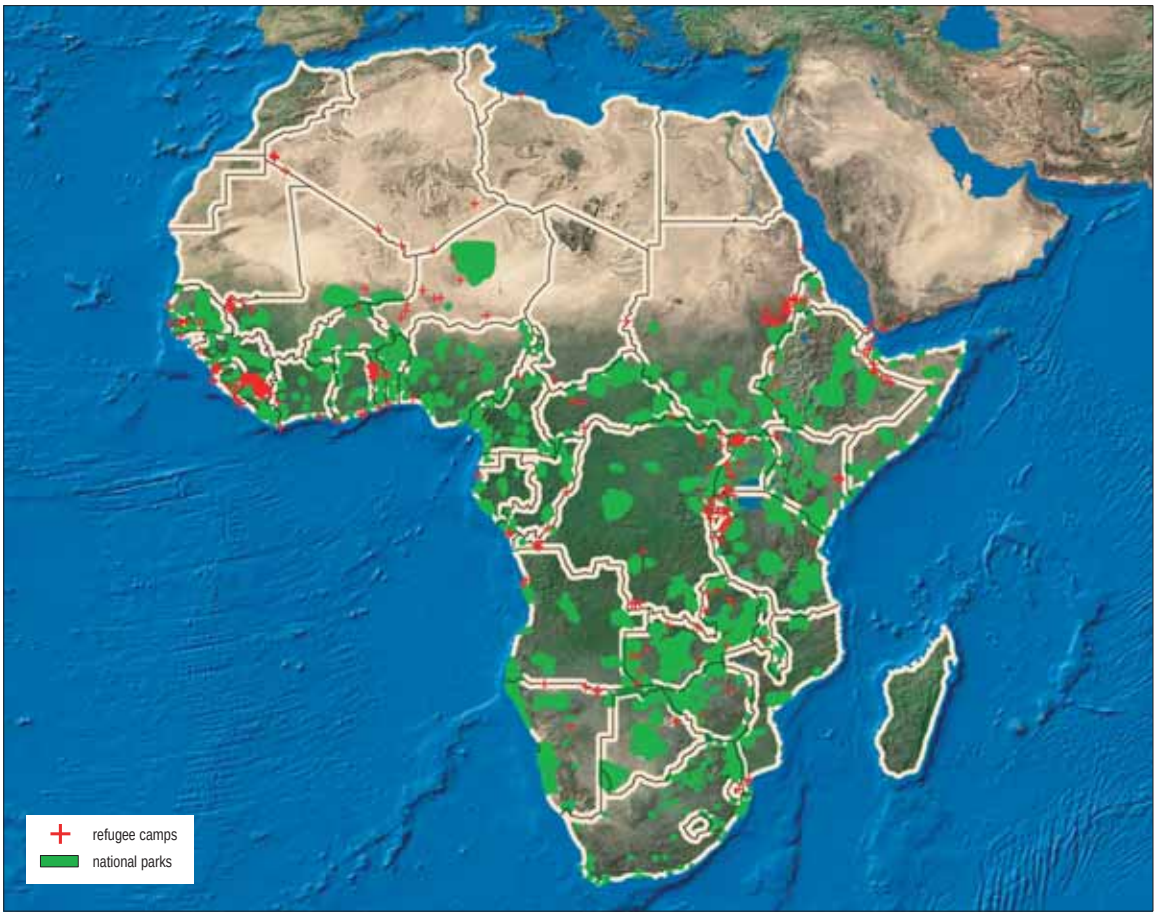
The destruction and decay of infrastructure not only affects the provision of essential services but leads to a breakdown in communication, through the loss of roads and telecommunications. This may increase the extent of isolation already experienced by rural communities; it may further diminish their sense of citizenship and contribute to a shrinking of civil society (Luckham and others 2001). Infrastructural decay results in the loss of market and other economic opportunities. DfID reports that in the 20 years from 1980 to 2000, Africa lost over 50 per cent of its infrastructure as a result of conflict (DfID 2001). For example, in southern Sudan there is no viable road network, and Angola and DRC are entirely dependent on air transport due to the collapse of infrastructure.

Local, national and international issues are all significant in generating and perpetuating conflict, and interact in different and changing ways. At the local level, controversies over resource access can be a factor in the formation of armed groups, which are often linked to larger national or international "political" conflicts or economic interests. This may result in the militarization of the local socioeconomic space, including increasingly bloody competition over economic infrastructure and resources, extraction systems and trade networks. In some cases, this may be manifested in rent-seeking behaviour by those with access to military power, or even direct appropriation and transfer of assets (Luckham and others 2001). This militarization may limit access to markets for local people, pushing up transaction costs and effectively driving up the cost of living.

The displacement of people is a major social and economic cost of serious conflict, in the short term as well as in post-conflict periods. Typically, the casualties of modern armed conflicts are civilians. Because conflict often takes on ethnic overtones, and because modern African conflicts generally involve militias and guerrillas rather than regular troops, it is all too easy for civilians to be targeted just because they share the same ethnic or cultural identity as an "enemy group." Since 1960, more than eight million people have died directly or indirectly as a result of war in Africa, and projections suggest that by 2020 injuries caused by war will have become the eighth most important factor placing a disease burden on society (DfID 2001). In a significant number of conflicts, violence has taken new forms, with the deliberate targeting of civilians and an increasing incidence of mutilations, violent rituals and rape (DfID 2001). Specific groups, who rely on the collection of natural resources, or farming, as many people in rural Africa do, may be targeted. Women, for example, are often specifically targeted as they collect firewood or water. This "total war" effect, as well as ruthless counter-insurgency strategies employed by some states, can lead to forced displacement and the destruction of homes, crops and food stocks, exacerbating extreme poverty and food insecurity. As a result of the targeting of civilians, large areas can become depopulated and output of agricultural or pastoral production reduced, thus affecting local livelihoods and the national economy. Northern Uganda, where almost 2 million people are displaced on a regular basis (ACTS 2005), is a case in point. One major, and often lingering effect of such violence, is damage to the social fabric, including informal networks of trust and support, undermining governance and often NRM. This hinders the resurgence of institutions, including markets and NRM institutions, in the post-conflict period.

Children are a major target of conflict and violence. In a significant number of conflicts, including in Uganda, Rwanda, Sierra Leone, Angola and Mozambique there has been the forced recruitment of child soldiers through, among other things, abductions. In 2001, there were estimated to be 200 000 child soldiers in Africa (DfID 2001). Children may be killed or maimed by one

Figure 2: Refugee influx adjacent to national parks



Source: UNEP/DEWA/GRID 2005; data from UNHCR 2004

group in order to undermine the morale of the other side. As a result of violent conflict, there has also been an increase in the numbers of street children (UN 1999).

Displacements impact directly on neighbouring countries, as refugees flee across international boundaries. However, impacts on neighbouring countries are not limited to these population movements and there may be multiple affects on social cohesion and economic opportunities. There are often complex cross-border links at different levels and between different actors, this includes cross-border operations of armed opposition groups, the international and local arms trade, and the sale of natural resources, narcotics, and other commodities used to sponsor conflict. Around centres of conflict, there are often extended zones of "bounded instability" which experience sporadic violence. Long-term situations of "neither peace nor war" can therefore ensue. International border zones are especially conflict-affected. Typically, these zones of friction are the most politically and economically marginalized, with weak state administrative structures. They are often also, because of their remote nature, havens of biodiversity. The influx of refugees across national borders into areas adjacent to national parks has contributed to immense pressure on these protected areas, often undermining NRM.

Displacements of people also have direct impacts on receiving communities and countries. The burden placed on local infrastructure such as schools, hospitals and sanitation facilities may be considerable and difficult to bear.

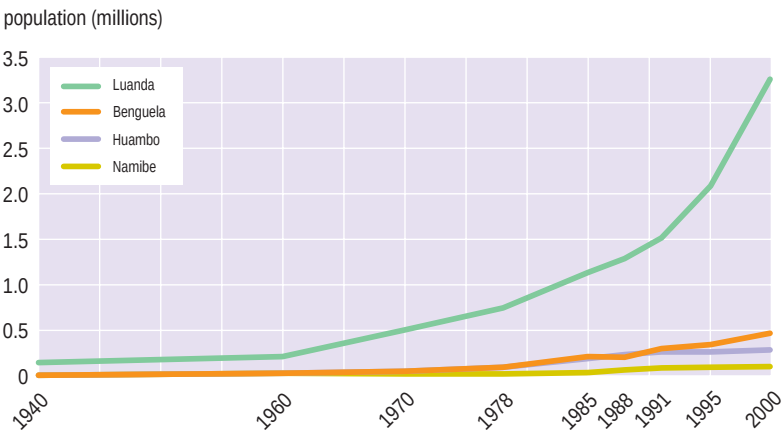
Conflict also has macro-level impacts. These include a decline in state capacity, associated with a shrinking revenue base and reduced public spending, and economic stagnation as a result of a fall in exports, hyper-inflation, exchange rate depreciation, disinvestment, and capital flight (Luckham and others 2001). The economic impacts, however, are seldom confined to the country of conflict. Countries bordering conflict zones may need to increase security expenditure in military and non-military sectors. Additionally, they may incur new costs in relation to refugees and losses from deteriorating regional trade.

A further feature of conflict is the collapse of public institutions or the inability of these institutions to cope. Conflict can lead to large areas coming under the control of non-state actors. There may be a weakening of environmental institutions and governance systems, resulting in lower managerial capacity. Environmental and other relevant agencies are handicapped through lack of funds or loss of personnel (Vanasselt 2003). Low levels of monitoring and evaluation may contribute to biodiversity loss and encourage illegal and unsustainable trade in natural resources. Natural resources in these zones may be exploited at unsustainable rates in order to purchase weapons, or simply to enrich members of the controlling forces. Foreign or multinational companies are often involved in resource exploitation in such zones, for example timber in eastern DRC.

Some of the environmental problems associated with landmines include: habitat degradation, reduced access to water points and other vital resources, species loss, alteration of the natural food chain, and additional pressure on biodiversity. When landmines are found in national parks, game reserves and other conservation areas, they undermine the tourist trade and affect the ability of managers and others to do their work. Endangered or vulnerable species can also be directly affected by landmines. In Angola, thousands of animals including antelopes and elephant fell prey to landmines, and in Mozambique, more than 100 elephants have died (Nachon 2004). In some cases, landmines have even been used by poachers, as a field of mines can kill or wound an entire herd of elephants (Nachon 2004), to obtain ivory illegally. Conflict may also have negative impacts on biodiversity in neighbouring countries. In the CAR, for example, traditional hunting of elephants using spears was transformed when small arms started to become readily available due to conflict in neighbouring Chad and Sudan. By the late 1990s, the elephant population had fallen by about 90 per cent from levels known during the 1970s, and the rhinoceros population had completely disappeared (Blom and Yamindou 2001).

In some cases, conflict can lead to "positive" outcomes for the environment – for example, some areas that become "no-man's lands" can become havens for wildlife – but the livelihoods of the majority of people rarely, if ever, improve through conflict.

Figure 3: Conflict contributes to rapid urban growth in Luanda, Angola



Source: Cain 2004

Impacts of conflict on urban areas

It is estimated that one in three African city-dwellers lives in life-threatening conditions, with the number of the urban poor expected to reach 404 million in 2015, or 46 per cent of the population, compared to 241 million people in 1990; this percentage is expected to increase (Auclair 2005). Conflict can have a distorting affect on settlement and production systems, making a bad situation even worse.

Increased urbanization can be a factor. In Angola, for example, a combination of war-related factors resulted in rapid and unplanned urbanization. The population of the capital city, Luanda, doubled from 1990 to 2001, and the proportion of the total population living in the capital is the highest of any country in SSA (Tvedten 2001). This was in part due to the effects the war had in rural areas, including reduced access to agricultural land because of landmines, related chronic food insecurity, isolation from markets, and the general threat of violence against civilians. Displacement was used as an instrument of war by all parties to the conflict. Between 1.3 million and 2 million people fled their homes from 1992 to 1994, moving primarily to urban areas. Between 1998 and 2002, when hostilities ended, an additional 3.3 million persons were forced to flee their homes (Watchlist 2002).

Infrastructure deterioration is particularly significant, due to a loss of investment as well as a reduced ability to maintain these structures. This has implications for health, communications, education and overall well-being. More than 50 per cent of Luanda's population, and most that live in the *musseques*, do not have access to piped water (Cain 2004). The peri-urban and *musseque* population is forced to pay for water pumped from the Bengo River

Box 7: Impacts of war and peace

Angola and Mozambique – who share a similar colonial history and the same year of national independence – are good examples of the influence of peace and armed conflict on development and the standard of living of the people.

Although both followed a similar process to peace in 1992, after more than two decades of armed conflict, only Mozambique managed to sustain its peace process, and effectively open up the democratic space for opposition politics. It has been recording unprecedented economic growth and development over the past 15 years of peace. It grew on average at 6.7 per cent annually between 1993 and 1999 and by more than 10 per cent annually between 1997 and 1999. Although the devastating floods of early 2000, which slowed growth to a 2.1 per cent, Mozambique achieved a full recovery, notching 14.8 per cent growth in 2001. The government projects the economy to continue expanding between 7 and 10 per cent annually for the 5 years from 2004 to 2009 (US Department of State 2006b).

Angola, however, slid back into armed conflict after the 1992 peace agreement and subsequent parliamentary elections failed to erase decades of suspicion and conflict between the government and UNITA, the rebel movement. The result was continued under-development despite the abundance in crude oil, diamonds and other natural resources. Poverty is extreme in Angola, for example, in 1999 alone, about 3.7 million people (Arvind and Vines 2004), including internally displaced persons, required humanitarian assistance from the UN or NGOs. The country ranks in the bottom 20 of almost every socioeconomic indicator as a result of war. Despite abundant natural resources, output per capita remains among the world's lowest (UNDP 2005). It has however recently showed signs of improved growth directly related to the establishment of peace, and an improved investment climate. In 2004, it grew at 11.5 per cent, however, inflation remains high (56.1 per cent) and savings low (34 per cent) (ECA 2005).

With the return of peace and investment, Maputo is now a bustling and growing city.

Source: Y. Katerere

Sources: Arvind and Vines 2004, ECA 2005, UNDP 2005, US Department of State 2006a, US Department of State 2006b

and distributed by informal sellers. Incredibly, the poor in Luanda pay up to 10 000 times more per litre for water than do the wealthier inhabitants who live in formal settlements (Cain 2004).

The population of Maputo, the capital city of Mozambique, has also suffered greatly as a result of war. As in Angola, urbanization rates increased rapidly because of the war, with, for example, rates of 40 per cent in Maputo Province in 1991 (Baden 1997).

Conflict timber

In several parts of Africa, timber has become associated with violent conflict. The links between timber exploitation and conflict are essentially of two broad types:

- First, revenues from the timber trade may be channelled towards activities that perpetuate conflict, such as the purchase of weapons. Thus, "conflict timber" is defined as "timber that has been traded at some point in the chain of custody by armed groups, be they rebel factions or regular soldiers, or by a civilian administration involved in armed conflict or its representatives, either to perpetuate conflict or take advantage of conflict situations for personal gain… conflict timber is not necessarily illegal" (Global Witness 2002 cited in Le Billon 2003).
- Second, the exploitation of timber may itself be a direct cause of conflict (Thomson and Kanaan 2003). This may be because of disputes over, for example, ownership of forest resources, the distribution of benefits, local environmental degradation, or social conflicts caused by immigration of timber workers. In some countries, especially when other sources of income are lacking, there is little attempt to ensure that timber production is sustainable or socially responsible.

Poorly defined or unjust land tenure regimes may exacerbate local struggles over access to timber, which can lead to displacement of forest-dwelling communities. Also, timber exploitation may have secondary effects, such as increased cultivation along new "timber roads" and the clear-felling of forests may exacerbate local tensions. More dramatically perhaps, military intervention in another country (often through proxies) may be motivated by a desire to control timber trade in that country (Global Witness 2002).

Timber is a commodity that can be easily transformed into cash to perpetuate conflict. It is relatively simple to extract and process, requiring only chainsaws and vehicles for transportation, rather than the sophisticated equipment used in oil exploration or deep underground diamond mining. Although it is bulky and has a relatively low weight-to-value ratio (especially compared to diamonds, for example), it is a common commodity and therefore, illegal operators can be difficult to trace among the large numbers of buyers and sellers on the global market.

In conflict and post-conflict situations, the sustainable management of forest resources faces many challenges.

Source: D. Wilke

Armed conflict can have very different effects on timber production, depending on the actors involved, the geographical location of forests, and other factors. In Liberia, civil war allowed powerful actors to take control of the timber industry, grant timber concessions to unscrupulous firms, and buy weapons with the proceeds. Indeed, some timber operators doubled as middlemen in arms deals and in the trade in "blood diamonds" (Global Witness 2002). Usual guidelines for timber harvesting were not followed and those protesting against the trade were beaten, tortured and illegally detained. According to some estimates, the trade in 2000 should have generated a total of US$106 million in taxes. However, only US$6.6 million in tax was actually collected by the government. Sanctions on the timber trade were imposed by the UN in 2003 through Security Council Resolution 1521 and the situation remains problematic, with groups of former rebel troops controlling key timber-producing areas and imposing illegal "taxes" on those transporting timber and other goods.

In the DRC, by contrast, conflict had the effect of reducing the amount of timber being harvested in some areas. The rebel groups, who took over much of the country in the late 1990s, imposed such heavy taxes on timber companies, and the security situation was in

general so poor, that many ceased to operate. Some armed groups, having looted the remaining stocks of felled timber, appropriated the equipment belonging to timber companies, making further large-scale timber production difficult (Thomson and Kanaan 2003). In some areas, timber was extracted to the benefit of local armed groups, as well as neighbouring countries involved in the conflict (Keen 2003). At least one neighbouring country that intervened in the conflict was rewarded with logging concessions (Global Witness 2002).

Timber exploitation has negative effects even in countries which are unaffected by violent conflict. As mentioned above, the timber trade, particularly when unregulated, may be associated with negative social and environmental impacts. The opening of new roads in remote forest areas permits the expansion of illegal trade in bushmeat; while logging methods often reduce biodiversity and have a major impact on the livelihoods of poor, resource-dependent communities. At the macro-level, and especially in countries with few valuable resources other than timber, the trade is associated with corrupt practices, nepotism and tax-dodging. This undermines democracy and reduces the amount of money available for government-led development. Globally, illegal logging on public lands is estimated to result in annual losses of revenues and assets of more than US$10 000 million (World Bank 2003). Losses are estimated at US$5.3 million annually in Cameroon, US$4.2 million in Congo, US$10.1 million in Gabon, and US$37.5 million in Ghana (World Bank 2003).

Regulation of "conflict timber" has been even more problematic, due partly to lack of political will in importing countries (Verbelen 2002). However, there have been efforts at the international level to address the issue more comprehensively. The Africa Forest Law Enforcement and Governance (AFLEG) process, which has been facilitated by the World Bank and other organizations, is designed to fit within the NEPAD umbrella. It aims to galvanize international and multi-stakeholder commitment at high political levels to strengthen capacity for forest law enforcement in Africa, especially in regard to illegal logging and associated trade. At a Pre-Ministerial Meeting in 2002, government representatives from across Africa recognized that armed conflicts have had disastrous impacts on many forests in Africa, and that illegal logging has funded conflicts which have resulted in the destruction of both traditional and modern forest management institutions, rendering law enforcement impossible. The AFLEG Ministerial Conference convened in Yaoundé, Cameroon from 13 to 16 October 2003, brought together ministers from Africa, Europe and North America to consider how partnerships between producers and consumers, donors, civil society and the private sector could address illegal forest exploitation and associated trade in Africa.

Infrastructural damage is a serious consequence of war and conflict. Shown here what remains of the airport at Greenville, Liberia, in 2005.

Source: Y. Katerere

Environmental impacts of conflict in Liberia

Liberia has been affected by a total of 14 years of civil war. The conflict has had grave social, economic and environmental impacts. In 1990, one million people – almost a third of the entire population, estimated at 3.3 million – fled the country (UNEP 2004a). By the end of 2003, about a third of these people was still living as refugees in neighbouring countries. Since 1989, about half a million people have been killed in war-related circumstances, and of these, 50 per cent were civilians. The conflict also involved large numbers of child soldiers, often supplied with narcotics by militia commanders, and involved in traumatizing attacks on civilians and other atrocities.

The war devastated the economy, which was struggling even before violence broke out, halving GDP and completely halting production in key sectors of the economy such as the export trade in iron ore (UNEP 2004a). Since the end of hostilities, the economy has begun to recover, growing at around 15 per cent in 2004, primarily as a result of donor support.

One side effect of the conflict is the increasing pressure that has been put on forests. This was particularly the case after sanctions were imposed on the trade in diamonds, which was linked to the arms trade and enduring violence in Liberia and the sub-region. With diamonds becoming harder to sell, increased emphasis was placed on the production of timber. In 2002, timber exports accounted for more than half of the foreign exchange coming into the country, and more than a quarter of total GDP (UNEP 2004a). Since then, in terms of the UN Security Council Resolution 1521 of 2003 an embargo on the export of timber from Liberia has been imposed.

Deforestation is also the result of increased dependence on charcoal for fuel. Due to infrastructural breakdown as a result of the war, the current availability of mains electricity is just 1 per cent of what it was prior to the war. Supplies of kerosene and cooking gas were also disrupted by the war (Satia 2000). Consequently, charcoal is the only option for 99 per cent of the population. As a proportion of the GDP, charcoal production increased from 2 to 9 per cent in 1999. However, during the most violent and unstable periods of conflict (between 1994 and 1996) commercial production of charcoal actually decreased, because of the dangers and difficulties of transporting the commodity in the war zone (Satia 2000).

Between 1990 and 2000, forest cover was reduced by 2 per cent per year, which amounts to 76 000 ha per year (FAO 2005). The Forestry Development Authority, which is meant to regulate the industry has been unable to fulfil its mandate due to lack of capacity. For example, the Authority has only received a fifth of its annual budget since 1990 and employees are owed large sums in unpaid wages. Access to many parts of the country is difficult, due both to the lack of official transport, and the continued presence of armed groups (of ex-combatants) in many areas.

The formal sector has been badly hit, not just in terms of reduced markets but also war-related damage to public infrastructure and private facilities. Fuel storage depots in Monrovia harbour, for example, have been poorly maintained and sustained damage, leading to extensive localized pollution.

Mining is also a problematic sector, but one on which thousands of Liberians rely upon for their livelihoods. For example, prospecting and mining, and hunting have became widespread in Sapo National Park (SNP) due to conflict. Since 2003, intensive mining in the park has occurred and two major mining settlements – called Iraq and Baghdad – were established with a population of between 3 500-5 000 people (SDI 2005). Research, in the region of Iraq, showed that gold mining and trading is was the main economic activity, generating for some miners about 198.45 gram of gold a week. At a minimum price of U$9 per gram in Monrovia, this amounts to an income of U$1 786 a week (SDI 2005). "Even though the actual income that accrues to the miners themselves may not be this high, it certainly points to the fact that the mining is actually paying off for

Where natural resource management systems break down, the illegal use of snares to support the bushmeat trade may increase.

Source: D. Wilke

the various actors in this economy" (SDI 2005). The various negative environmental impacts of the alluvial mining techniques are barely regulated. Mining results in the discharge of large amounts of suspended solids into watercourses, and the release of large amounts of poisonous chemicals into the environment. For example, it is thought that for every gram of gold extracted, two grams of mercury are released into the environment.

Another problem is the extent of landmines and unexploded ordinance (UXO) littering parts of the country. In 1995, it was estimated that there were seven minefields in the country, containing a total of some 18 250 mines (HRW 2004). Many of these have since been removed, although information is lacking on the exact number of landmines removed and the location of de-mining operations. Also, there is no systematic collection of data on landmine casualties. Human casualties continue to be a problem. In 2003, two children were killed and another three injured when an anti-vehicle mine found in a swamp exploded after they tried to open it. In 2004, UXO that detonated in an agricultural field killed one person; a boy was injured in the capital city while playing with a hand grenade, and six people were injured in a UXO explosion in Monrovia (HRW 2004). There is no mine/UXO risk awareness education being conducted. There is only one prosthetic workshop in the country, the other one having been destroyed in fighting in 2003, and access to healthcare for those injured by UXO is extremely limited. It has been estimated that only one in ten Liberians have access to any formal health care (HRW 2004).

The trade in bushmeat – which includes endangered species, such as *Pan troglodytes* (chimpanzee) – has become so lucrative that many farmers have actually abandoned agriculture and now rely on hunting as their main livelihood strategy. *Manis gigantea* (giant pangolin) are sold for about US$1 000 each while a medium-sized *Cephalophus niger* (black duiker) goes for between $400-500. *Colobus cercopithecidae* (red colobus monkey) is sold for about US$200 (SDI 2005). According to the Sustainable Development Institute's research, the bushmeat trade appears to also be providing employment for many traders, mostly from Monrovia and other urban towns.

It is not just terrestrial animals that suffer – all six Atlantic species of sea turtles *Chelonia mydas* (green turtle), *Dermochelys coriacea* (leatherback), *Eretmochelys imbricate* (hawksbill), Lepidochelys olivacea (olive ridley), *Caretta caretta* (loggerhead) and *Lepidochelys kempii* (Kemp's ridley) fall prey to poachers (Formia and others 2003). Years of political instability and civil wars have hampered conservation activities and sea turtle conservation initiatives in these countries may be negated by difficulties in establishing safe, long-term field projects and enforcing national legislation, or by shifting pressure on natural resources (Formia and others 2003). Marine ecosystems are also affected by pollution from the many ships that have been damaged and sunk in the harbour. Furthermore, many ships are believed to fly under a Liberian "flag of convenience" (ie they are registered in Liberia for financial reasons). Some of these ships do not comply with international standards on the discharge of waste products, and have been associated with serious environmental pollution in the past.

Impacts on national parks in the Great Lakes region

For many years, the GLR has been characterized by a high level of insecurity and political instability; this has impacted negatively on the livelihoods of rural communities and the environment. Three of the four countries have experienced civil unrest and sporadic episodes of violence since independence; this has had cross-border effects particularly the movement of refugees and has contributed to regional tensions.

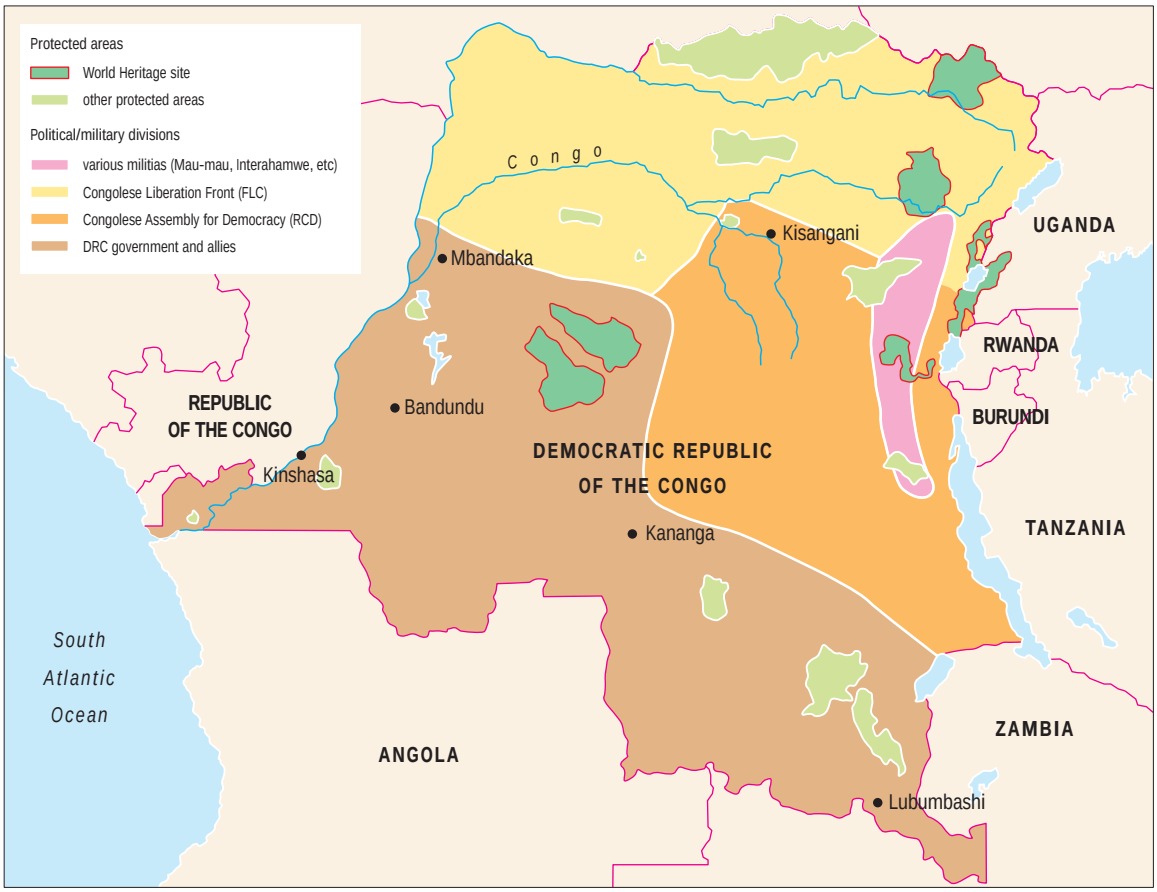
The most dramatic events unfolded in the early 1990s, when communal violence erupted in parts of eastern DRC, and there was a resurgence of civil war in

Table 1: Affected populations in the Great Lakes Region

Country	IDPs	Refugees	Total affected populations
Burundi	432 818	28 800	461 618
DRC	2 045 000	361 720	2 406 720
Tanzania	not available	543 145	543 145
Uganda	535 107	175 819	710 926
Total	3 012 925	1 143 418	4 156 343

Source: UNS/SCN 2002

Figure 4: Protected areas of the Democratic Republic of the Congo and major political/military divisions 2001



Source: adapted from Hart and Mwinyihali 2001

Burundi due to the assassination of the president, followed by genocide in Rwanda in 1994 during which more than 500 000 people are reported to have been killed. The resulting refugee flow into the DRC had a massive effect on the Virunga volcanoes region, as around 850 000 refugees (and *genocidaires* – those who had committed genocide) were living in close proximity to the Virunga National Park, relying upon it for firewood, timber and food to supplement that supplied by relief agencies. This resulted, among other impacts, in the loss of some 300 km^2 of forest. As many as 40 000 people entered the park each day to harvest forest products and hunt wild animals, including elephant, hippopotamus, and buffalo (McNeely 2002). This blow to regional biodiversity was compounded by the resettlement of many refugees, who had been in exile for many years, in the Akagera National Park of Rwanda. In 1956, the Akagera was 331 000 ha; it has as a result of this settlement been reduced to 90 000 ha, less than a third of its original size.

The Virunga National Park is located in an area of high population density, and is used by some communities for firewood, charcoal, artisanal mining and limited cultivation. Given the high level of land scarcity in the vicinity, there are many requests from local people, supported by local chiefs, that the park boundaries be revised and its area reduced. The Virunga and other national parks in the DRC suffered overexploitation during the war with different military groups establishing control of the parks (see Box 8).

Currently, one of the most serious problems for park management is the murderous activities of the remnants of former *Interahamwe*/Rwandan Armed Forces who carried out the Rwandan genocide and are intent on gaining control of neighbouring Rwanda through force. At least 80 of Virunga's park staff have been killed by insurgents (McNeely 2002). These forces also remain a threat to local people, on whom they prey in order to survive. Their raids on local villages – which reportedly include villages of Hutus who refuse to send men to join them – are characterized by severe brutality and widespread sexual violence against women (ACTS 2005). They are reported to have bases in the Virunga National Park, and their presence has also been one of the reasons for international tensions and fighting between troops of various forces. Militia activities have also affected management of the Kahuzi-Biega National Park in eastern DRC, where fighting and widespread

human rights abuses in and around South Kivu in late 2004 affected the ability of NGOs to help develop the capacity of the park management (ACTS 2005).

In Rwanda, there were serious environmental impacts of the civil war (1990-1994). Hundreds of hectares of high-altitude forest were cut down for fuelwood and timber by IDP, many of whom were forced onto steep, ecologically fragile hillsides in the densely-populated northwest. About 15 000 ha of plantation forest were destroyed, and 35 000 ha damaged, during the conflict and the immediate aftermath (Kairaba 2002). The resulting degradation has forced rural people into a vicious cycle of poverty (Gasana 2002).

The lack of protection for the national parks meant that poaching and harvesting of natural resources greatly increased. Indeed, the Rwandan Patriotic Front (RPF) used the *Parc National des Volcans* (PNV) to launch their incursion, and the area suffered as a result of the military activities there. For example, in 1991 the *Forces Armées Rwandaises* (FAR) cut a swathe 50-100 m wide bordering an important trail through the bamboo forest in the park, in order to reduce the threat of ambush (Shambaugh and others 2001). Many animals were also killed in the Akagera National Park by the military (FAR and RPF) between 1990 and 1993 (Plumptre and others 2001).

In the south of the country, the Nyungwe Forest Park which is contiguous with the Kibira Forest Park in neighbouring Burundi, was affected by poaching in the years after the genocide. The last elephant was killed in 1999, and the number of ungulates was also seriously affected. In the PNV, on the DRC border in the northwest, the aftermath of genocide and war has been widespread poverty, which combined with few other livelihood options, encourages poaching. Research suggests that many households living within 2.5 km of the park are involved, either in terms of hunting wildlife in the park, killing wildlife that stray into fields, or buying bushmeat (Plumptre 2002). The survey, which is likely to have produced conservative figures because of the sensitivity of the issue, suggests that 11 per cent of households near the PNV hunt in the park use snares. Almost a third admitted to killing animals that stray onto their fields, while a further third admitted to buying wild meat. Hunting was strongly associated with poverty, as well as close proximity to the park. In addition to local sale, animals are sometimes caught for sale further afield: in early 2004, a live baby gorilla (*gorilla spp.*) was found by police in a house in Ruhengeri, while poaching of chimpanzees was recorded in the same area in 2003. Birds are also reportedly poached for sale.

Uganda's biodiversity has also been affected by violence, especially during the periods of extreme civil instability in the 1980s. During these periods, there was a breakdown in government capacity to manage protected

Box 8: Democratic Republic of the Congo: national parks overexploited

The Democratic Republic of the Congo (DRC) is one of the richest countries in Africa, possessing more species of birds and mammals than any other African country and other natural resources. It is also the poorest, arguably suffering the most due to overexploitation caused by armed conflict, particularly over the last 15 years. Both protected and unprotected areas have suffered looting and plunder as revenue has been ploughed back into war.

In the absence of a strong government and institutions to "protect its natural heritage, the known value of valuable resources – gold, diamonds, timber, and tantalite – becomes the only credible tender for profiteers of all political labels."

While details of the environmental impacts of the war in the DRC are sketchy, and sometimes completely absent, there is evidence of overexploitation; this was particularly evident near refugee camps between 1994 and 1996. During the refugee crisis, which saw close to one million people settled in refugee camps in and around Africa's oldest national park and a natural World Heritage Site – the Virunga National Park – large-scale destruction occurred. Large numbers of animals such as hippos, buffalo and antelope were targeted by both militias and the military. Poaching for bushmeat escalated alarmingly everywhere. Deforestation in the park was also a major problem as refugees cut down trees for fuelwood. An uncontrolled incremental increase in logging has become serious in unprotected forests, which have been severely looted and trampled, particularly along the eastern border with Uganda.

In the 4 900 km^2 Garamba National Park, in northern DRC along its border with Sudan, law enforcement capacity was severely crippled when the entire park's logistical equipment (including fuel, radios and vehicles) was looted and national park guards disarmed. The Garamba was one of the first protected areas in the DRC affected by armed conflict, when 80 000 refugees fleeing the civil war in Sudan were set up in camps starting in 1991 on the park's borders.

Elephant poaching as well as illegal "coltan" (colombo-tantalite) and gold mining have since 2000, become major problems in the 13 400 km^2 Okapi Faunal Reserve.

Source: Hart and Mwinyihali 2001

areas, and there was massive exploitation of the unique Bwindi forest, in terms of gold extraction, timber harvesting, and hunting of wildlife (Hamilton and others 2000). This impacted negatively on the tourism industry (Kalpers 2001). In 2006, as a result of over 20 years of civil war in northern Uganda, up to 70 per cent of the population live in extreme poverty (IRIN 2006).

Damage to national parks and biodiversity in southern Sudan

Southern Sudan is a haven for many species of rare and endangered wildlife, including the *Kobus kob* (white-eared Kob), elephant, black and white rhino, and many bird species. There are 19 conservation areas, three gazetted national parks, and a biosphere reserve (ACTS 2005). However, many species have been overhunted and have migrated from the country due to conflict-related disturbance. One example is the overhunting of antelope by the Murle people of Pibor state. The Murle live in a remote, marginal area with minimal links to markets and very little international assistance. Due to food insecurity, and also due to the availability of automatic weapons because of the war, antelope hunting has become much more destructive than in the past, and now threatens supplies of meat for local people and limits future potentials for wildlife tourism. A peaceful Sudan could attract significant revenue from adventure tourism, if wildlife can be sustainably managed (ACTS 2005).

In Western Equatoria, exotic forest plantations, including *Tectona grandis* (teak) and *Khaya spp.* (mahogany), are of considerable economic value. One tonne of dry teak is worth about US$5 435 on the world market, while green teak is valued at US$6 020 (Boateng 1998). During the war, hundreds of hectares of teak trees were harvested from Western Equatoria with the involvement of foreign companies. The trade was not conducted in a transparent way, and it is unlikely that many local people received any benefits. Trade in mahogany is also worth large amounts of money that, in peacetime, could be invested in education and health. During the war, revenues have financed the military campaigns – or private bank accounts – of the warring parties. Lack of accountability has often led to the exploitation of community resources by "connected" individuals.

The mineral-rich south holds potential for intensive and small-scale mining. Chromite reserves in the southern Blue Nile are estimated at one million tonnes, but production has fallen by 80 per cent since the 1980s due to the escalation of the war in this area (Economist Intelligence Unit 2001). The Suri people of Boma County used to be able to make their livelihoods through their skills in gold prospecting, however, opportunities in this sector has decreased by two-thirds due to conflict and insecurity. Gold is also present in moderate quantities in Eastern Equatoria, and copper and diamonds have also been found, though the conflict has limited the extent of mineral surveying.

Such "war economies" give military leaders a vested interest in continued conflict, as the current situation of instability allows them to monopolize such trades, and avoid legal controls and taxation. Local communities should be granted rights to sustainably benefit from such resources (ACTS 2005).

Peace agreements ensuring sustainable management of natural resources

It is increasingly common to address key sustainable development and environmental management in conjunction with other issues during peace negotiation processes. This is important because in post-conflict situations in countries particularly badly affected by war, peace agreements often serve as interim national constitutions.

The various protocols signed during negotiations for the end of the conflict in southern Sudan are good examples of this trend. The exploration of oil has been linked to the conflict for a number of reasons:

- First, many of the oilfields are located near the historical boundary between the northern and southern parts of the country; these boundaries have been a source of controversy, especially since oil was discovered, because of potential revenue earnings.

A woman collects firewood in Darfur, Sudan, December 2004.

Source: J. Prinsloo

- Second, the oil installations have been the target of attack, and counter-insurgency operations have involved massive displacement of people as well as gross human rights abuses and thousands of deaths.

Under the Protocol on Wealth-sharing, signed by the Sudan People's Liberation Movement/Army (SPLM/A) and the Government of Sudan on 7 January 2004, 50 per cent of net oil revenue derived from oil-producing wells in southern Sudan is to be allocated to the government of southern Sudan at the beginning of the pre-interim period. The remaining 50 per cent is to go to the national government and states in northern Sudan. In the case of some boundary areas, a share of revenues will be distributed directly to representatives of the local communities. According to the Protocol on the Resolution of Conflict in Abyei (signed 26 May 2004), residents are to be citizens of both north and south Sudan. Net oil revenues will be divided six ways during the interim period: 50 per cent for the national government, 42 per cent for the government of South Sudan, and 2 per cent each for (southern) Bahr el Ghazal region, (northern) Western Kordofan, Ngok Dinka people and Misseriya people.

During the Somali peace talks facilitated by IGAD in Nairobi, Kenya in 2003, a special technical committee was established in order to examine problems arising from conflicts over land access, which date back to colonial times (Huggins 2002). The committee advised the federal government to form and institutionalize a proper land tenure system, which pays special attention to properties currently or previously held by women (Farah 2005). Further, the committee recommended that at least a quarter of the posts in all bodies of the legislature and the executive should be held by women (Farah 2005). This was considered necessary because of the high level of gender inequality in land and property rights, a product of both cultural and war-related factors. The declaration requests the neighbouring countries to assist in the return of both public and private properties looted from Somalia by individuals, and it also calls for international organizations to assist in the return of Somali professionals from the diaspora and provide incentives to those willing to return.

In an effort to preserve the environment and also give back to the host country, UNHCR sponsors tree planting programmes in Mkugwa camp, Tanzania, 2002.

Source: L.Taylor/UNHCR

CONCLUSION

Africa is both rich in human and natural resources, yet the poorest region the world, often depending on food aid and imports to supplement the needs of its food insecure population. There are many factors which influence underdevelopment in the region, many external but many others which are internal, including war.

A crisis of governance – weak political processes and institutions, weak legal systems, poor economic performance and debt, and underdevelopment and poverty – contributes to undermining the well-intentioned institutions and measures that have been established to promote and strengthen regional cooperation in Africa.

Regional cooperation has many dividends for the region, fostering investor confidence and encouraging investment in science and technology, and many other opportunities for sustainable development. Environment is a major factor in promoting such cooperation, building upon established frameworks such as MEAs, river basin commissions and transboundary national parks. Conflict and war, however, show the immense cost to both human and natural resources when cooperation breaks down. Many millions of people who should otherwise be contributing to national and regional development are often denied this opportunity through displacement and forced migration. Millions of others die prematurely, having made limited contribution to society and Africa's development. In such a situation, efforts aimed at attaining the MDG targets are bound to fail.

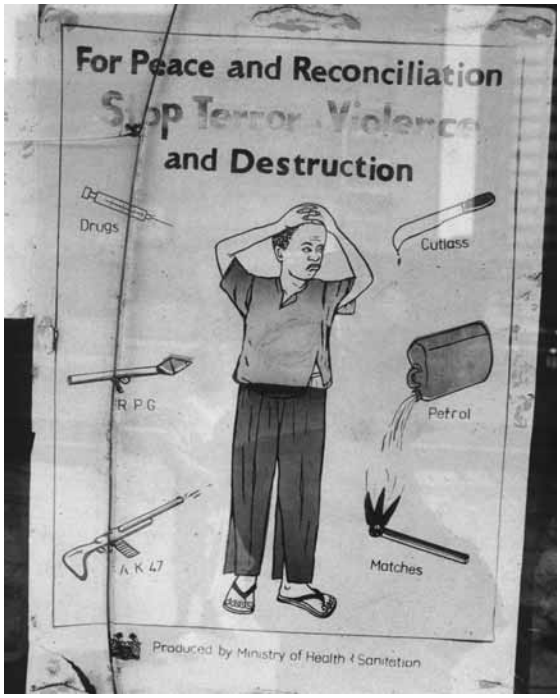
Conflict has affected some of the poorest countries in the region, and has made them even poorer. This can sometimes result in a vicious cycle – therefore, the need for adequate, sustained, well-coordinated post-conflict rehabilitation strategies. Essential aspects of this include providing training and supporting demobilization programmes of former combatants, to enable them to achieve a

sustainable lifestyle. Access to land and natural resources is an important part of this in Africa, especially in densely populated areas, as is innovative utilization of natural resources including expansion into new regional and global markets.

The NEPAD African Peer Review Mechanism (APRM) may provide leaders in Africa with an opportunity to make regional cooperation in environmental management a key component of the criteria for peer assessment. Existing mechanisms for conflict resolution and peace-keeping, such as those of the AU and sub-regional organizations, should be strengthened through consensus building. However, there is a need to avoid competition and duplication between different institutions.

Developed countries, for their part, need to support African efforts by fulfilling financial pledges and privileging humanitarian ideals above geo-strategic interests. Such support would be in the spirit of MDG 8. Aid and trade agreements should take greater account of the actual and potential conflictual aspects of natural resource extraction, processing, and sale. For example, aid packages to countries where natural resource extraction is problematic could be conditional on improved accountability of related financial transactions, and/or effective environmental and social impact assessments. This will require a shift away from the current security focus (international terrorism) by most major donor agencies (Le Billon 2003). However, external regulation is affected by various technical and political constraints, and hence good domestic governance is a more effective means of limiting the capacities of actors to use natural resources to finance conflict (Le Billon 2003).

In order to prevent conflict, the root causes of conflict should be addressed, and sustainable and equitable development must take place. Such development would go beyond macro-economic expansion, and would be pro-poor in nature, geographically balanced within each particular country, and would involve the enhancement of the skills-base in each country. Equity needs to be a key feature of national and sub-regional economic development. This kind of thinking is reflected in the various founding documents of the AU, SADC, NEPAD and other African institutions. There is a large degree of convergence on issues of security: most see development, freedom and peace-building as essential parts of a multidimensional approach to addressing Africa's problems (Ginwala 2003). The importance of a comprehensive, structural approach has also been described in the Carnegie Commission's report on Preventing Deadly Conflict (Carnegie Commission on Preventing Deadly Conflict 1997).



A government poster to promote peace and reconciliation. Freetown, Sierra Leone, 2000.

Source: T. Voeten/ILO

Africa's governments need to remember:

> "There can be no peace without equitable development, and there can be no development without sustainable management of the environment in a democratic and peaceful space."
>
> PROFESSOR WANGARI MAATHAI
>
> NOBEL PEACE PRIZE LAUREATE 2004 CITED IN LEAN 2005

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SECTION 4

OUTLOOK

CHAPTER 13
THE FUTURE TODAY

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"Africans declare that we will no longer allow ourselves to be conditioned by circumstance. We will determine our own destiny and call on the rest of the world to complement our efforts."

NEPAD 2001

INTRODUCTION

Scenario analysis offers a way to consider long-range futures in light of uncertainties and to examine the requirements for a transition to sustainability. Scenarios are possible sets of future events which, unlike projections of trends in human affairs, may be legitimate over the short term, but not as time horizons expand over months and years to decades and generations (Gallopin and others 1997). They are stories about the future with a logical plot and narrative governing the manner in which events unfold (Schwartz 1991, Cole 1981, Miles 1981) and they illuminate long-range problems and possibilities.

Scenarios are indispensable tools for environmental management that focus on large-scale, long-term interactions between development and environment (Toth and others 1989). Scenarios have two particularly advantageous qualities:

- First, they provide a coherent framework for analysis of how various issues or sectors impinge on one another and interact; and
- Second, they serve as tools to foster creativity, stimulate discussion, and focus attention on specific points of interest for policy on environment and development, and for opening up a constructive analysis of future problems.

The integration of scientific knowledge helps scenario development, as a tool for "peeping" into the future, to look more closely into what types of development and environmental strategies are risky and how they can be avoided, as well as into which ones are plausible and need to be reinforced. A scenario approach can be valuable for stimulating analysis and sorting out urgent policy issues, and as a means of communication between scientists and policymakers. However, it should be strongly emphasized that scenarios are simulations: they make an effort to introduce analysis of different "what if?" developments and should therefore be distinguished from projections.

This chapter provides qualitative and quantitative documentation of the scenarios developed during the *Africa Environment Outlook 2* (AEO-2) process. It analyses four development scenarios adopted in the AEO-1 process (UNEP 2002a): *Market Forces*, *Policy Reform*, *Fortress World* and *Great Transitions*. Although different in nomenclature, these are similar to those used in the ongoing Global Environment Outlook (GEO) processes: *Market First*, *Policy First*, *Security First* and *Sustainability First* (UNEP 2002b). Both AEO and GEO highlight the environmental implications over the period 2005-25. The underlying assumptions of both sets of scenarios are also similar.

Developing scenarios

Comprehensive information on the future state of environmental elements is required to assess the social, economic and environmental consequences of policy and other development actions. Scenarios of environment and development issues have been developed to help assess possible effects of different biophysical, social and economic processes on the future state of the environment in selected themes and issues. The aim of this chapter is to provide guidance to the regional, sub-regional and national policy community for converting the threats to and opportunities for environment and development into practical policies and actions. They can be an important tool for defining strategies to achieve the aspirations of Africa's leaders and people:

> "We are convinced that an historic opportunity presents itself to end the scourge of underdevelopment that afflicts Africa. The resources, including capital, technology and human skills, that are required to launch a global war on poverty and underdevelopment exist in abundance and are within our reach. What is required to mobilize these resources and to use them properly, is bold and imaginative leadership that is genuinely committed to a sustained human development effort and the eradication of poverty, as well as a new global partnership based on shared responsibility and mutual interest" (NEPAD 2001).

Box 1: PoleStar and T21

PoleStar is a software tool for mounting economic, resource and environmental information, and for examining alternative development scenarios. It is an adaptable model-building framework designed to assist the analyst engaged in sustainability studies – not a rigid model reflecting one particular approach to environment and development interactions (SEI 1999).

T21, an integrated computer development model, is a quantitative tool for integrated, comprehensive development and policy planning. The model is transparent, collaborative, interconnected, valid and customizable. It supports the larger process of planning by facilitating information collection and organization, and analysis of development strategies. It can provide insight into the potential impact of development policies and strategies relative to desired goals and objectives (MI 2002). The existing T21-Malawi Model was customized to enhance its environmental modelling capability for the production of the case study. Malawi was chosen since it allowed the model to be easily customizable to address environment issues given the existing datasets.

Sources: Raskin and others 1999, MI 2002

The scenarios described in this chapter are based on qualitative narratives and quantitative back-ups that have been developed using the Stockholm Environment Institute's (SEI) PoleStar® system and the Millennium Institute's (MI) Threshold 21 (T21).

The four scenarios

The scenarios provide narratives about four possible futures that may result from different policy choices at the regional and sub-regional levels. All four scenarios are plausible but not equally probable. They have been considered because they incorporate alternative social visions and values, highlight significant causal processes and provide critical pointers for environmental responses. The narratives are also intended to provide a common framework for diverse stakeholders, including policymakers, to address the critical concerns related to the environment and development of our time, as well as a forum for discussion and debate on sustainable environmental management.

Scenarios since AEO-1

While it is too early to fully assess how these scenarios have played since the production of the AEO-1, selected regional trends are consistent with environmental implications which were highlighted in the scenarios of that report. For example, the expansion in use of genetically modified organisms (GMOs) has continued to be controversial, with countries divided over whether to welcome it as a necessary technology to help resolve Africa's food security problems or to reject it due to uncertainty about its impacts on environmental and human health . The AEO-1 report stated that the "release of GMOs threatens agricultural biodiversity in some areas, especially where farmers depend on maintaining a mix of species and races as a hedge against annual and seasonal variations in farming conditions" (UNEP 2002a). At the sub-regional level, in 2002, economic communities including the Common Market for Eastern and Southern Africa (COMESA) and the Southern African Development Community (SADC) developed policies for dealing with GMOs. At the global level, IUCN – the World Conservation Union (IUCN) declared a moratorium on the

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NEPAD 2001

use of GMOs (IUCN 2004) citing poorly understood human and environmental health risks. Concerns around environmental and human health were highlighted in the *Fortress World* scenario of AEO-1. The debate continues and so does the expansion of the use of GMOs. South Africa has become a leader in the use of GMO technology, and in 2004 passed legislation to regulate GMO use. In Egypt, the National Environmental Action Plan (NEAP) of Egypt 2002-2017 has proposals for legislation on the intentional and unintentional release of GMOs that need to be passed by the People's Assembly. These concerns have been identified as an emerging issue in AEO-2 and they are discussed in Chapter 9: *Genetically Modified Crops*.

However, in other instances the scenarios developed in AEO-1 have not been realized. Under the *Policy Reform* scenario, the AEO-1 report stated that the dependence on biomass by the majority of the people would be reduced, because there would be more energy choices available (UNEP 2002a). Although the issue is on the agenda of African Ministers for Energy, the region has yet to make significant progress in this area. Chapter 2: *Atmosphere* and Chapter 6: *Forests and Woodlands* of this report suggest that Africa's achievements in the field of renewable energy are modest while the rate of deforestation due, in part, to fuelwood demand and charcoal production, continues to be high; this is contrary to the AEO-1 report's assertion that this dependence would be "reduced considerably."

In other instances, one scenario has been played out and not another. The *Fortress World* scenario of the AEO-1 painted a negative picture concerning regional cooperation on transboundary water issues. It suggested that cooperation would be weakened further and strained by escalating tensions and conflicts, as openness and transparency are eroded. However, given the policy choices the region has made, a different trend is evident. Contrary to the *Fortress World* scenario, there have been increased efforts to promote regional cooperation in managing transboundary resources. For instance, after more than two decades of negotiations, in 2004 the eight states of the Zambezi River basin concluded an agreement establishing the Zambezi River Commission (ZAMCOM). Although not highlighted in the scenario narrative, Africa also has witnessed the birth of the African Ministerial Council on Water (AMCOW) in 2002. These developments mirror the narratives presented on two of the AEO-1 scenarios – *Policy Reform* and *Great Transitions*.

Different scenarios have been and will continue to play out in the region, combining and overlapping to chart a new course. The overlaps and contradictions, in and between different scenarios, are the essence of any narratives – they are not laboratory experiments with predetermined controls to achieve the desired results. Scenarios address the question "what if?" and the resultant narrative follows an "if...then" logic. In so doing, scenarios help in preparing for different possibilities, and in enabling policymakers to deal effectively with new challenges and minimize impacts on people and the environment. With this in mind, the chapter presents scenarios focused on the regional and sub-regional levels.

The AEO-2 scenarios presented here are founded on the commitments countries in Africa have made, along with the international community, to meet the targets of the Millennium Development Goals (MDGs). And they build on the analysis of this report which, among other things, demonstrates that the challenges faced in achieving the MDG targets are still real and will continue to demand prudent policy responses. The underlying assumptions of the four scenarios have been refined to reflect changes since AEO-1, and to purposively highlight a limited number of the environmental issues over the course of the next twenty years. The 20-year period has been chosen to allow meaningful assessment of the driving forces and indicators of the selected issues – over the ten years leading up to and the ten years following 2015, ie, the MDGs target year. The driving forces have also been refined to better address the more recent policy decisions contained in initiatives such as the MDGs and the New Partnership for Africa's Development (NEPAD) Environment Action Plan (NEPAD-EAP).

The future is uncertain, with many possible pathways.

Source: M.Chenje

THE CHARACTERISTICS OF THE FOUR SCENARIOS

THE MARKET FORCES SCENARIO

The *Market Forces* scenario is defined in terms of prevailing economic growth paradigms based on the experience of the developed countries, mostly of Europe and America, and it is premised on the belief that this model of development is appropriate for the rest of the world, or that it is the ultimate model that the whole world would rely on, or adopt for development. Central to the thinking of this paradigm is the existence of the invisible hand of market mechanisms, which control the allocation of resources and the distribution of the benefits of growth. Essentially, the operation of market mechanisms means the economy is increasingly privatized and that there is a gradual withdrawal of government as principal actor in the development process. Thus, in this scenario, the government provides the enabling environment for economic growth while the private sector is the impetus for this growth. Consequently, opportunities are defined by market mechanisms with no significant intervention from government. The private sector maximizes profits, always seeking out sub-regions with the cheapest labour to produce high-value or brand products. People's search for satisfaction is based on increased acquisition and therefore consumerism becomes the socially defining value. The world economic system responds by increasing production of goods and services with increased burdens placed on natural resources.

Under the *Market Forces* scenario, barriers to trade between countries and regions continue to break down, especially as a result of globalization and because countries agree to unhindered flow of trade and resources, including financial resources. The economic environment becomes very conducive to research and development (R&D) initiatives. People do their best to maximize the benefits of economic freedom and motivation arises from this. Motivated by the benefits of economic freedom, people exercise their utmost efforts to maximize their profits. All these factors continue to stimulate economic growth through greater and more efficient use of available opportunities and resources. The operation of the principle of comparative advantage becomes important in the organization of economic activities between and within countries.

Opportunities are defined by market mechanisms with no significant intervention from government.

As a result of the increasing trade between nations as well as the removal of obstacles to the flow of ideas, information, labour and capital within a context of the efficient use of resources, the need arises for the emergence of new institutions to manage the new economic order and the emerging political arrangement.

New economic and political groupings, such as the existing African Union (AU), Arab Maghreb Union (AMU), COMESA, Economic Commission for Africa (ECA), Economic Community of Central African States (ECCAS), Economic Community of West African States (ECOWAS), Indian Ocean Community (IOC) and SADC emerge and indeed become more fashionable and imperative. The new groupings share more characteristics, becoming economic and financial groupings in addition to being political associations. Democracy becomes the accepted form of governance in more countries and the involvement of civil society organizations (CSOs) and community groups increases people's participation. In this way, the dividends of democracy become internalized into the development process.

The Policy Reform scenario

The narrative of the *Policy Reform* scenario is in many ways similar to that of the *Market Forces* scenario. However, unlike the *Market Forces* scenario, there is the realization of the need to address the negative fallouts of the driving forces through concerted efforts by governments and civil society. Consequently, the impact of market mechanisms is tempered by the inclusion of programmes to mitigate the negative impacts of such development. The argument is that the socioeconomic and political considerations may make it expedient for governments to take actions that favour citizens, rather than wait for the operation of the market to correct these ills.

For instance, instead of allowing the redistributive arm of the market to address the increasing numbers of poor people within a long-time frame, policies and programmes are adopted to actively counter serious negative social and environmental impacts. In terms of this scenario policies are put in place and executed to address specific and anticipated problems that arise from the operations of the market. For example, the state can be expected to intervene through policy and planning development in the management of fragile coastal ecosystems and require the adoption of integrated coastal zone management (ICZM) programmes that directly affect the allocation of resources and the distribution of the benefits of growth.

Policy reforms focus on engineering development through positive and proactive interventions even on such issues as privatization.

Essentially, policy reforms focus on engineering development through positive and proactive interventions even on such issues as privatization. While accepting the desire for a gradual withdrawal of government as principal actor in the development process, government is not content with just providing the enabling environment for economic growth, and it puts in place a monitoring and evaluation system that ensures that these operators of the economy follow laid-down policies which are beneficial to the people.

As in the case of the *Market Forces* scenario, barriers to trade between countries and regions of the world break down under the *Policy Reform* scenario. This is the result not only of globalization and information and communication technology (ICT) but also of the deliberate efforts of governments and regional groupings. Nevertheless, new institutions are established to manage the new economic order and the emerging political arrangement or rearrangement of nations. Economic and political groupings such as the existing AU, AMU, COMESA, ECA, ECCAS, ECOWAS, IOC and SADC flourish and reorganize themselves as stronger economic unions. Many sub-regional and international research centres, such as the existing Centre for Environment and Development for the Arab Region & Europe (CEDARE), Network for Environment and Sustainable Development in Africa (NESDA), and the Southern African Research and Documentation Centre (SARDC) are established. The development of new initiatives and ideas is greatly stimulated.

The Fortress World scenario

The *Fortress World* scenario emerges as a result of the struggle for power between two or more groups of people in a nation, identified here as the elites and the masses. The elites have access to resources of economic growth and monopolize them for their own development, while the masses have few resources and are left at the mercy of the elites. The masses depend on the leftovers from the elites and are often not in a position to decide their own destiny. As a result of the need to protect themselves and their investments, the elites organize themselves into enclaves, strongholds or garrisons. These enclaves are connected through treaties and alliances with each other at the national and regional levels, and through networks of economic interaction at the global and international levels. They are often well connected with multinational companies which operate in these enclaves.

Two variants of the *Fortress World* scenario, with similar consequences, may occur in Africa. The first may result from conflicts around religion and ethnicity, while the second is based on global relations. The second is a

global fortress world where the forces of separatism derive from the collapse of the world economic, social and political systems. Organizations like the AU may easily adjudicate in the prevention of fortress worlds of the first type. However, certain clauses in the laws setting up the organization have to be more alive to the issues involved in the second type of fortress world, as these require economic restructuring and empowerment of the deprived class.

The *Fortress World* scenario is a crystallization of certain patterns of historical behaviour among peoples and nations where inequalities abound, and where efforts have not been taken or mechanisms put in place for the mitigation of effects of inequalities. In such areas, the struggle for power often leads to the existence of "protected areas" for the elite who hold on to power at all costs. The remaining persons are forced into enclaves that display different characters from those of the "protected areas." Thus, while amenities and technological development could be at maximum development in the areas of the elite, the areas of the marginalized masses are depressed, often lacking all amenities and are considered as the backwaters of development. Economic and social welfare are not directed at improving the general well-being of everybody, but at protecting the privileges of the rich and powerful elite. In this scenario there is a growing divide between rich and poor people. This situation paves the way for increasing disputes between individuals, institutions and governments over resources for production, particularly land, and increases the likelihood of tensions over issues of wealth and its distribution. It is the continued play of these situations that leads to the establishment of the fortress to avoid total breakdown of law and order.

Although the fortress world situation may not yet be a reality, its elements are rife in many countries in Africa. The fenced and highly-secured residences of elites in many cities in the region, described cynically as the "architecture of fear", are an indication of the possibility of its emergence, as is the high level of social inequity between rich and poor, men and women, rural and urban, and different regions. The degree of social inequity can be measured using various tools including the Gini coefficient, gender-related development index (GDI) and gender empowerment measure (GEM). Another indication is the are constant agitation over resources in different parts of Africa, including Sudan, Rwanda and Côte d'Ivoire. The ongoing unrest in the Niger delta in Nigeria over petroleum is also a good example of the seeds for the emergence of a fortress world situation, if not properly redressed.

The elites have access to resources of economic growth and monopolize them for their own development, while the masses have few resources and are left at the mercy of the elites.

The Great Transitions scenario

The *Great Transitions* scenario seeks to adapt the good aspects of the other scenarios to strengthen the three pillars of sustainable development – environment, society and economy. This scenario views neither the *Market Forces* nor the *Policy Reform* as sufficient to address the ills that economic growth has placed on the environment, but sees the need for the evolution of a new development paradigm in which the sustainability of the environment is not compromised. It is envisaged that behavioural patterns that characterize modern societies, such as consumerism, give way and that instead people define a new level of satisfaction that is not materialistic. Furthermore, in this scenario it is envisaged that there will be a cultural renaissance that de-emphasizes the current "craze" for imports of food items, consumables and luxury goods (UNEP 2002a).

The major paths through which the *Great Transitions* scenario evolves include a new set of strategies that differs from current strategies and approaches, and that approaches development at conceptual, methodological, institutional, operational and financial levels. The "African Renaissance" can represent a major conceptual basis for this scenario, as it (Achebe and others 1990):

- Argues that future development paths must be, unlike conventional approaches which are unilinear and crisis-driven, dialectic and crisis-free;
- Has a vision that is methodologically "surprise-rich, inductive and retroductive, as opposed to the conventional wisdom that is surprise-free, deductive and predictive";
- Is locally owned and initiated, and is supportive and nurturing of people and promotes people-intensive development; in this respect it departs from the donor-fed and controlled development paths that are directive and capital-intensive visions; and
- Departs from the existing institutional set-up that is state-centred, concentrated and monopolistic to promote an approach that is "grassroots-oriented, multiple, dispersed and pluralizing."

Central to the *Great Transitions* scenario is the general disillusionment with dominant societal values, such as

consumerism, and the prioritization of the economy over the environment with its negative impacts on human well-being, development, and the environment itself. In this scenario, a new generation of thinkers – scientists, leaders, civil society organizations (CSOs) and activists – come together and shape national and global dialogue and policy towards promoting the interlocked goals of environmental sustainability and development. Africans show disenchantment with present values and see that the only development that is acceptable is sustainable development that respects the environment. Against this development it assesses what remains of environmental resources and identifies the opportunities these present for development. The vision of Jeffrey Sachs, in *The Africa challenge: the mission – how Africa lit up the world*, echoes the promise of the *Great Transitions* scenario:

> "It is 2025, and Africa is booming. Conflict has been resolved, democratic leaders have established unprecedented calm. And as the fight against disease gains momentum, it is African scientists who offer salvation to the rest of the world" (Sachs 2005).

The attributes of the *Great Transitions* scenario are based on visions of a desirable and environmentally sustainable future. The feasibility of a *Great Transitions* scenario for Africa is supported by the body of ideas among great thinkers in Africa and beyond, and in the development of the Omega and Millennium Plans of Action. Many events in Africa since the turn of the century have already set the stage for such a possibility. The renewed determination of the leaders of Africa to advance pan-Africanism, and to reactivate and rejuvenate inter- and intra-African partnership, including partnership between Africa and the international community, within the principles enshrined in the Lagos Plan of Action (LPA), is historically very significant (Nyong'o and others 2002, OAU 1980). The strategy adopted by NEPAD for achieving sustainable development in the 21st century goes beyond all previous initiatives. The Revised Framework of Opportunities for the Implementation of the New International Order in Africa, produced by the ECA, postulates that a credible and appropriate development strategy for Africa must satisfy four basic principles:

- Self-reliance;
- Self-sustenance;
- The democratization of the development process; and
- A fair and just distribution of the fruits of development through progressive eradication of unemployment and mass poverty.

The *Great Transitions* scenario can be made to embrace the MDG, as a mechanism for turning around both strategy and methods of development. Using the MDG targets, the scenario can be made to actively and consistently adopt the targets as the minimum conditions to be met by the year 2025 in the case of the sustainability of the environment and earlier in the case of others. Achieving these targets necessitates constant and extensive interactions between all stakeholders, a process that, though cumbersome, becomes beneficial as it is inclusive and democratic.

There is general disillusionment with dominant societal values, such as consumerism, and the prioritization of the economy over the environment with its negative impacts on human well-being, development and the environment.

Africa beats its own drums for sustainability, addressing its environmental challenges and enhancing opportunities for its people.

Source: M. Chenje

DRIVING FORCES

The development of scenarios is based on the identification and articulation of some underlying factors – the driving forces. Driving forces are elements that cause change to occur and their unfolding and interaction is responsible for the trends envisaged in each scenario. Some driving forces are not directly controllable and these have to be addressed in the scenario. Controlled forces are those that can be shaped and these form the basis for the recommendations and means of implementation prescribed in the scenarios. Driving forces are sufficiently strong to direct the course of growth of the society and change in environment. They set the initial course for development, and their impacts are potent enough to change the course of development. Therefore, they define departure points for the environmental issues that they influence. Their effects can be short and sharp, or long-lasting. Furthermore, driving forces operate at different scales of intensity and magnitude, reverse direction, appear or disappear as the case may be. The major driving forces defined for the AEO-2 are demographics, health, economics, social issues, culture, technology, governance, peace and conflict. (An overview of these is given in Chapter 1: *The Human Dimension* and the relationships between them is further developed in Chapter 8: *Interlinkages: The Environment and Policy Web*.) To these drivers we may add climate change and natural disasters. Depending on the environmental or development issues, some of the driving forces may take the form of pressures and/or responses. This section highlights how each of these may influence environment and development in Africa, and establishes their significance for the scenarios. The specific influence of the driving forces on selected issues is discussed subsequently under the four themes identified for AEO-2 scenario analysis (land, freshwater, atmosphere, and coastal and marine environments). The overall trends and implications of these drivers for the state of the environment are considered in Section 2: *Environment State-and-Trends: 20-Year Retrospective*. As the driving forces have not changed since the AEO-1 report this discussion draws extensively on that report.

Demographics

Population remains a major factor for the growth of societies and a significant driving force for development and the future state of the environment. Changes in population numbers over time, demographic characteristics, including migration and urbanization patterns, health, and levels of skill are important considerations. Some of these characteristics are reflected in UNDP's human development indices (HDI).

The population of the region continues to grow rapidly (see Figure 1), changing from 221 million in 1950 to about 786 million in 2000 (UN Population Division 2003). At a rate of 2.1 per cent annually, Africa is the world's fastest-growing region and it is expected to have a population of 1 300 million in 2025 (UN

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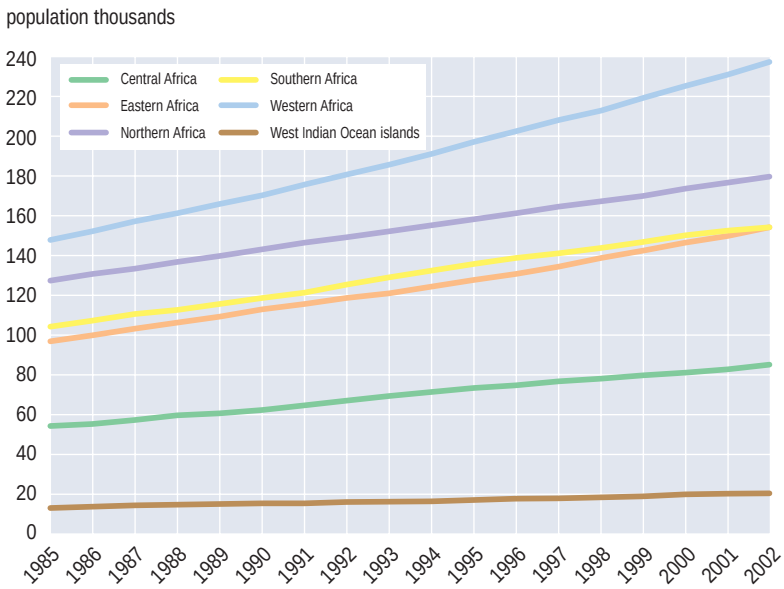
UN Population Division 2005

Figure 1: Population trends in the various sub-regions



Source: UNEP 2005; data from UN Population Division 2003

Population Division 2005, 2004). This phenomenal rise in population is due to high fertility rates and improved health, as a result of, among other things, improved medical access. This growth will continue to exert pressure on the environment in many ways.

The population of Africa is characterized by a large number of persons in the dependency age cohort of 1 to 14 years, and this has multiple implications for ongoing population growth and the direction and pace of development. Although estimates vary, about 43 per cent of the population is under the age of 15 and only 2.5 per cent over 65 (UNDP 2005). The 15-24 age group numbered 149 million in 1998, constituting about 20 per cent of the total African population, and represents a workforce bulge; this can be the basis for more investment, greater labour productivity and rapid economic development (see Figure 2 and Makinwa-Adebusoye 2000). However, youth unemployment is a major problem. At 21 per cent in sub-Saharan Africa (SSA) and 22.8 per cent in Northern Africa, the unemployment rate for youths aged 15-24 was twice that of the overall labour force in 2003 (ECA 2005). Therefore, if Africa does not generate more employment and opportunities, and invest in skills and capacity-building this group could place tremendous strain on the economy as well as environmental resources. Investment in human resources development is essential, and could help attract foreign direct investment (FDI).

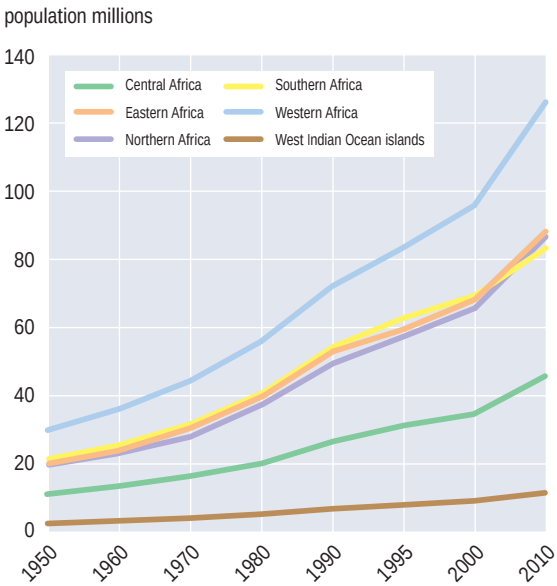
Rapid population growth and changes in demographic characteristics put pressure on African countries to improve standards of living and to provide essential social, economic and environmental services. These factors also limit their capacity to deal with the problem of poverty. Further, in the absence of cooperation, rapid population growth rates may lead to political and social conflicts among different ethnic, religious and social groups over environmental resources. However, in the long run, population growth rates are expected to decline, for multiple reasons including the HIV/AIDS pandemic and the fact that African countries are addressing issues of population growth in a purposeful and concerted way. In SSA, for example, population growth rate between 1975 and 2003 was 2.7 per cent, and it is expected to slow to 2.2 per cent for the period 2003-15 (UNDP 2005).

As discussed in Chapter 1: *The Human Dimension*, Africa is also the fastest urbanizing region of the world. In 2000 the urban population of 318 million was only 38.2 per cent of the total population, whereas, by 2025 the urban population is expected to have risen to 681 million, representing 50.67 per cent of the total population (UN Population Division 2005, 2004). If the shift in spatial distribution of population is not carefully addressed, governments will see the multiplication of poorly-serviced informal urban settlements which are the cradle of crime and in which human vulnerabilities are accelerated by limited access to water and sanitation as well as other social services. This would also result in environmental problems like pollution due to inferior waste management. These challenges are also highlighted in Section 2: *Environmental State-and-Trends: 20-Year Retrospective.*

Unemployment among youth is a particular problem in Africa. At 21 per cent in sub-Saharan Africa and 22.8 per cent in North Africa, the unemployment rate for youths aged 15-24 was twice that of the overall labour force in 2003.

ECA 2005

Figure 2: Africa's economically active population



Source: UNEP 2005; data from ILO 2005

Health

Health is a major issue and a critical driving force. It is particularly important in a developing country context.

Since independence many African countries have made significant improvements in health care. This includes expanding access to primary health care, increased spending on the health sector and addressing socioeconomic inequities associated with access to quality health care systems. Across Africa, there were improvements in key health care indicators, such as infant mortality rates and life expectancy. Across SSA, the 1970s saw significant increases in life expectancy, from an average 44 years to more than 50 years. The period of the 1980s and 1990s, however, witnessed cutbacks in health budgets and privatization of health services. These policies exacerbated poverty and thus provided a fertile ground for the spread of infectious diseases and nutrition-related illnesses. Life expectancy was 50 in 1990 and dropped to 46 in 2002 (World Bank 2005a). The current health priorities will continue to influence decisions that impinge on the environment and overall economic development.

Health as a driving force has a direct relationship with environmental management and development. As demonstrated by the impact of HIV/AIDS and malaria, among other diseases, ill health has economic costs, and contributes to increasing poverty. The two most debilitating diseases in Africa, malaria and HIV/AIDS, remain major health concerns. HIV/AIDS affects the economically active population, consequently negatively affecting the potential to realize development and environmental management goals. Given the links between these sectors, as discussed in Chapter 1: *The Human Dimension*, investments in environmental management may help achieve the health-related targets of the MDGs.

Economic drivers

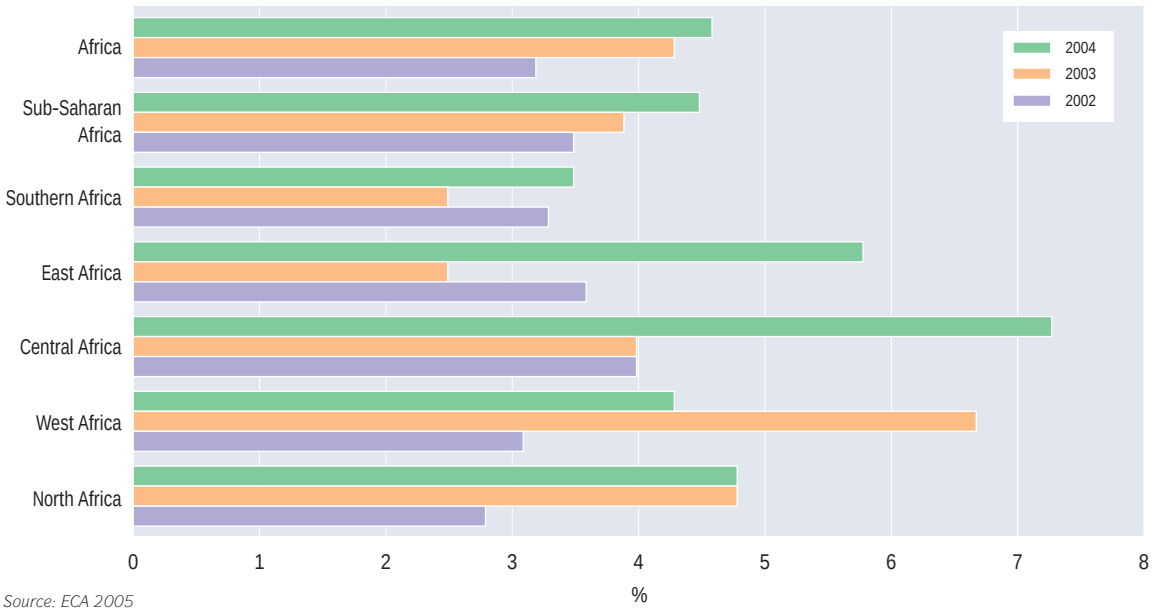
Although Africa is richly endowed with natural and human resources, it remains relatively underdeveloped. Nevertheless, there are significant indicators of improved economic performance. Economic growth rates have been improving steadily. In 2004, Africa grew at 5.1 per cent (OECD Development Centre and AfDB 2005), an increase from 3.7 per cent in 2003 (AfDB 2004), and a significant improvement over the average annual growth rates of 2.6 per cent between 1990 and 2003. However, this has not translated into a decrease in the percentage of people living on less than a dollar a day. This failure to ensure that economic growth contributes to poverty reduction may be attributed to various factors, including an inadequate rate of growth, low labour absorption into the primary growth sectors, and inequitable distribution of the opportunities created by growth (ECA 2005). The lack of access to other secure sources of income compounds the incidence of poverty (ECA 2005). If these patterns continue, then even with improved economic growth, Africa will not be able to meet key development targets and improve human well-being. This will in turn perpetuate the poverty-environmental degradation cycle.

The economies of most countries are characterized by dependence on the extraction and export of natural resources, and thus by a high level of vulnerability to global economic fluctuations, especially in mineral and

• The share of the total population living below the $1-a-day threshold of 46 per cent is higher today than in the 1980s and 1990s – this despite significant improvements in the growth of African GDP in recent years. •

ECA 2005

Figure 3: GDP growth by ECA sub-region



Source: ECA 2005

agricultural commodity prices. Chapter 8: *Interlinkages: The Environment and Policy Web* considers how global policy and practice in trade, aid and investment affect economic performance in Africa.

Many economies reflect a dualism, with a relatively small monetized structure, consisting of such sectors as government, commerce and industry, and a large subsistence and informal sector. Low levels of industrialization, characterized by relatively little value-adding, have environmental and development implications that impact on overall levels of human well-being. For example, although industrial emissions of greenhouse gases (GHG) are low, the per capita emissions per unit of industrial and manufactured output are relatively high because of the relatively old and inefficient equipment and technologies used by industry.

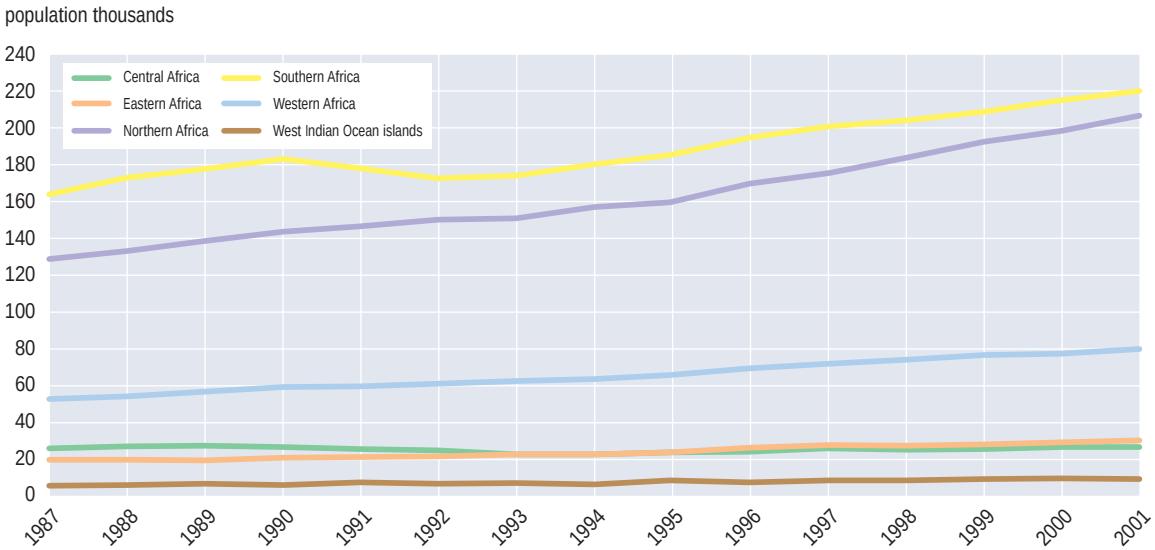
Africa's share in world trade remains small. It is being met with fierce competition from the other regions of the world that have faster and more sustained economic growth, particularly from Southeast Asia. Africa's share of world exports declined from about 6 per cent in 1980 to approximately 2 per cent in 2003 (ECA 2005). However, in 2004 trade performance improved and exports continued to grow at high rates: 8 per cent in volume and 23.5 per cent in value (ECA 2005). This is primarily linked to the growth of the oil sector. In other sectors Africa has continued to be severely marginalized in the global economy as it continues to face formidable barriers to northern markets. Given the small size of domestic markets, exports are essential for increased economic growth. However, trade has continued to be on unfair terms, primarily as a result of the rules governing world trade, which were set largely by the industrialized countries over the course of the 1986-94 Uruguay Round of WTO talks.

The economic underdevelopment of Africa partly reflects its history of economic and political colonization, and partly the economic and other policies adopted by governments since independence. The latter include wage and price controls, widespread subsidies of basic commodities, a burgeoning civil service, fixed currency exchange rates that lead to overvaluation of currencies, high tax rates, and disincentives for potential external investors. In the 1980s and 1990s, the World Bank and the International Monetary Fund (IMF) imposed Structural Adjustment Programmes (SAP) on some of the countries, often as a condition for being granted loans. The features of these programmes vary somewhat from country to country but common elements include:

- Strict controls on public expenditure;
- Reforms of the structure and functioning of the civil service;
- Reductions in barriers to trade;
- The removal of domestic subsidies;
- Opening up of the economy to external investment; and
- Allowing the value of the national currency to be determined by the operations of the market.

As discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*, notwithstanding the appearance of burgeoning economies, SAPs led to rising prices of basic commodities, unemployment, increasing poverty and the breakdown in health-care systems. These impacts had significant environmental and social implications.

Figure 4: Gross Domestic Product by sub-region



Source: UNEP 2005; data from World Bank 2003

Debt, too, remains a major challenge. (See Chapter 8: *Interlinkages: The Environment and Policy Web*.) The burden of debt repayment is enormous, resulting in the diversion of funding away from, among other things, public services. Some countries faced with a huge debt burden spend all their earnings on servicing their debts rather than providing basic social services. A combination of internal and external factors continues to perpetuate the debt problem. Debt cancellation by the Group of 8 (G8) nations in favour of 13 selected poor countries (by the beginning of 2006) is still viewed as too insignificant to have an impact on environment and development in the region.

Social issues

Levels of human well-being affect the range of opportunities available to people and the kinds of choices they are able to make. Health and education, as well as access to material assets, directly affect capabilities and, in turn, impact on the environment (MA 2005). African nations rank, on average, lower than any other continent on the Human Development Index (HDI). In recent years there has been a decline in the quality of life, as measured by the HDI, in many African countries (UNDP 2005).

Although there has been an improvement in quality of life across the globe, Africa has lagged behind in some key areas:

- Half of the population in Africa lack access to health services. Health challenges are monumental in a region with the highest rates of fertility, maternal and childhood mortality, malnutrition, two-thirds of world's known AIDS cases, 90 per cent of world's yearly malaria fatalities, and where half of the female population is illiterate.
- In rural Africa, about 50 per cent of the population are without access to adequate water supply, and 70 per cent are without access to adequate sanitation (WHO and UNICEF 2004). In urban areas, about 20 per cent and 40 per cent of the population are without access to adequate water supply and sanitation respectively (WHO and UNICEF 2004).
- Although there has been significant progress in education in Africa over the last two decades, there is much to be done. Primary school enrolment in 16 countries is below 60 per cent, and there are more children between the age of 6 and 11 out of school than was the case in the 1990s. The average adult illiteracy stands at 43 per cent.
- Life expectancy at birth in SSA has been reduced from 50 in 1990 to 46 in 2002 (World Bank 2005a).

The incidence of poverty and the pervasiveness of inequities, as discussed in Chapter 1: *The Human Dimension*, remain major challenges for development and sustainable environmental management. Poverty is both a cause and effect of environmental degradation (MA 2005). Poverty can be reduced by either increasing economic growth or by reducing inequity. For Africa to halve its poverty level by 2015, as envisaged under the MDG, it will need to achieve an average annual GDP growth rate of 7 per cent (AfDB 2004).

Gender inequity remains a challenge. Although African women have made tremendous progress over the past four decades, there is still a significant gap between rhetorical commitment to gender equity and actual actions adopted to address this. Most African countries continue to rank very low on the GDI although there has been some improvement in GEM (UNDP 2005). GDI focuses on levels of development including life expectancy, literacy, education and income, whereas GEM considers the extent of social inclusion through measures related to parliamentary seats held by women, the percentage of female professional and technical workers, and the ratio of female to male income (UNDP 2005). Important gains have been made in political representation, with Africa leading the world with the highest proportion of women in parliament (UNIFEM 2002). Nevertheless, economic and legal barriers associated with social discrimination continue to prevent women in Africa from improving their status and productivity, and from achieving their full potential. In many countries women continue to face the denial of basic human rights and are often victims of violent crime.

Poverty is both a cause and effect of environmental degradation.

MA 2005

At independence, most African countries inherited a system where government was absolutely responsible for providing basic services and amenities almost at no direct costs to consumers. Over the years, the ability of government to meet the demands for providing basic services and utilities has decreased tremendously and the effect has been one of aggravating social conditions. Much has been said as to what is the right strategy for providing services in developing countries, particularly in Africa. The privatization of public services is a strategy being promoted in an increasing number of African countries. This involves the reduction of public subsidies and, in some cases, the introduction of cost-recovery measures. This development, while having some benefits, could present major causes for concern. For instance, access to clean water is a vital public health necessity and a basic human right and its privatization may lead to reduced access to safe water for poor communities. In Ghana, the recent moves towards water privatization

are opposed by CSOs for this reason. Already, according to the Ghanaian Ministry of Health, half of all clinic visits in Ghana are due to water-borne illnesses. Privatization may further reduce access to safe and affordable water in urban areas.

Culture

Cultural norms and values shape people's perceptions, aspirations and attitudes, and therefore their actions. Culture influences choice of livelihood activities, with direct and indirect influence on the pace of environmental change and development.

Among the many factors shaping culture are ethnicity and religion. As in some other parts of the world, religion in Africa has served as a strong unifying force in some areas, and as a potentially divisive one in others. Ethnic tensions in many areas, driven by historical animosities, themselves often exacerbated by religious, economic and social tensions, are also potentially divisive and inhibitory to development and may precipitate conflict over natural resources. However, this diversity is not always divisive. Chapter 12: *Environment for Peace and Regional Cooperation* considers this sensitive subject and how the environment can promote cooperation, which in turn may enhance good social relations (including social coherence) and other aspects of human well-being.

Africa, with its diversity of peoples and languages, has a rich and strong traditional culture that can serve both as a bulwark against outside influences and as a conduit through which new ideas can be assimilated (UNEP 2002a). Historically, indigenous systems of social governance, provision of services, maintenance of social cohesion, and even economic development, were based on the norms these cultures followed. But culture is not static, especially in this era of increasing economic and political globalization. People around the world are being increasingly exposed to the norms and values of other cultures, sometimes creating tensions within their own culture but in many instances resulting in substantial modification or replacement of some of its elements.

Other cultures have fundamentally changed African society. While western cultures dominate many economic and political spheres, at the more local level traditional norms often prevail. At the sub-national level, governance is increasingly shaped by "democratic ethics" intermingled with traditional values. The traditional support systems, which served as social securities for the aged, the homeless, the sick and the poor, have generally been displaced. However, these have not been replaced by efficient public structures. Similarly, in many places traditional environmental management systems have also been displaced or significantly modified (Mohamed-Katerere and van der Zaag 2003). In some instances new environmental values have begun to emerge and shape governance and management (Steytler 1997, Mohamed-Katerere 1997).

Consumption patterns increasingly mirror western-style consumer culture, and to a large extent this is a result of a shift to market-based development and globalization. This influences both trade and investment patterns, particularly by creating a demand for imported consumer goods while, at the same time, serving as an incentive for some of the multinational corporations to enter local markets directly through investment, partnerships or take-overs. In some instances these increasing consumer demands produce very direct threats to the environment, as discussed in Section 2: *Environment State-and-Trends: 20-Year Retrospective* and in relation to chemicals in Chapter 11.

As a driving force, western culture continues to play a central role in development in Africa. Changing lifestyles create demand for environmental goods-and-services that occasions change in environmental and natural resources exploitation. Increasing consumerism, for instance, can be expected to lead to overexploitation of resources to meet increasing wants. Depending on the measures of control put in place by societies, these developments may or may not be beneficial to the environment. Nevertheless, this consumer culture may be expected to reach a peak where people begin to see the differences between needs and wants, and lead therefore to a return to healthier and more holistic lifestyles that focus on the overall context of human well-being and the relationship to the environment.

Technology

African economies during pre-colonial times were able to avoid any large-scale environmental degradation, partly because the population was small and partly because the demands on the economy were small (UNEP 2002a). More importantly, the technology was appropriate and adequate, as the people learnt over centuries to adapt systems of extraction of natural resources to be commensurate with the dictates of the environment. In contrast, modern economic practices have introduced increased demands on human and natural resources and the available technology has proved inadequate. Africa needs to improve and diversify the range of technological options available if the demands of change are to be met (UN Millennium Project 2005a, UN Millennium Project 2005b). New technologies often come with new costs, including high demands for fuel and increased pollution, and new

• Africa needs to improve and diversify the range of technological options available if the demands of change are to be met. •

UN Millennium Project 2005a, UN Millennium Project 2005b

risks, such as uncertainty about the environmental and human health impacts of genetically modified (GM) crops and chemicals. Chapter 1: *The Human Dimension* considers the developments in the pharmaceutical sector, and the potential economic opportunities investment in genetic resource R & D can bring for Africa, particularly in rural communities. Section 3: *Emerging Challenges* considers the challenges and opportunities associated with GM crops (Chapter 9) and chemicals (Chapter 11).

In the 20th century, Africa's role in the development of science and technology remained small. Historical factors contributed to this. Colonization inhibited the development of indigenous technology and destabilized some of the existing processes of technical growth. Indigenous manufacturing capability was deliberately undermined to facilitate European exports for which captive markets were created. Further, Africa has not only been a user of technologies developed in the west, but has also served as a dumping ground for obsolete technologies abandoned in the west. Africa remains on the technological fringes, and in the absence of large-scale investment in this area this is not likely to change. Africa in general has a high dependence on imported technology. As the World Summit on Sustainable Development (WSSD) noted, addressing this is critical if development targets are to be met. Stimulating R & D in this sector requires not only an improved economic environment but also better infrastructure and efficient communications systems. Africa needs to increase investment in this area, and focus on the development of appropriate technologies (ECA 2005). The growth of ICT has been an important driver of economic growth and the diversification of opportunity in the economies of Southeast Asia. Chapter 1: *The Human Dimension* describes the current state of ICT and considers the opportunities this sector can bring for development. The Global System for Mobile Communication (GSM) technology offers significant opportunities. The introduction of GSM in many African countries and the deregulation of the telecommunications sector have energized private companies to embark on aggressive telecommunications development programmes across the region. This trend is expected to become a major catalyst for development through improvements in information access. Modern ICT will assist the emergence of micro-power technologies to revolutionize energy sources. While many African countries continue to see modern information technology and industrialization as principal agents for economic development, some countries will recognize the importance of sequencing in harnessing technology and integrate these into the process of development including environmental management. With the introduction of cleaner fuels, swift transition to renewable resources and greater concern for the environment, the impact of industrialization and technological advancement on the environment is reduced to the barest minimum.

Institutions and governance

Institutions refers generally to the set of instruments through which people, living in a state and believing in common core values, govern themselves and includes policy, laws, rules and regulations as well as custom. Governance refers to the processes through which these institutions are implemented. Governance is based on values and principles that a society – local, national, regional or global – holds. Governance invariably relies on interaction between the state, civil society and the private sector, although the relative roles of these sectors differ depending on the priorities and values of a given social system. For example, the extent of public participation in decision making is often a reflection of this.

In 2002, the AU noted that Africa was losing $150 000 million a year to corruption, which increases the costs of goods by as much as 20 per cent.

NEF 2005

Governance takes place within all domains including the economic, political and administrative, and its form affects development, including the potential for market efficiency, sustainable environmental management and the realization of rights. Good governance practices improve the potential for economic growth and create new opportunities for development and improving human well-being (WRI and others 2004, World Bank 2005b). Such measures may include elevating environmental management as a policy priority and allocating the necessary resources for the implementation of measures, assigning accountability for failures, and facilitating participation from civil society. It may, as proposed in Chapter 8: *Interlinkages: The Environment and Policy Web*, require linking the economic, political and administrative aspects of governance more directly with environmental policy and practice, and developing appropriate legal and management tools to ensure this. Or, as discussed in Chapter 9: *Genetically Modified Crops*, demand establishing better integration between science, public values and policy. It may also, as discussed in Chapter 12: *Environment for Peace and Regional Cooperation*, require improved regional cooperation, greater transparency and higher levels of accountability to avoid conflict and promote the fairer distribution of benefits, and costs, associated with environmental use.

It is impossible to achieve sustainable economic development without good governance, and peace and security are essential aspects of this (UN 1998). In many

countries poor governance practices have resulted in military coup d'états and electoral systems that were essentially symbolic and not designed to allow for changes in government. Military interventions have led to various forms of instability and the rise of insurgencies, riots and ethnic strife and rivalries. Military costs have placed an enormous strain on economies. Corruption, and the embezzlement and externalization of public funds remain critical problems, with estimates that such externalization amounts to as much as a quarter of GDP (NEF 2005). In 2002, the AU noted that Africa was losing $150 000 million per year to corruption, which increases the costs of goods by as much as 20 per cent (NEF 2005).

However, as the new millennium approached, once again "winds of change" blew across Africa, as people in many countries, as well as at the regional level, demanded greater accountability from their elected leaders. They called for fairer and more transparent public processes, and respect for human rights. With increasing social consciousness, new forms of organizations have emerged. Civil society organizations have emerged in large numbers and their influence is steadily increasing. These serve as important checks on government.

As poor governance practices have been called into question, citizens have demanded the right to be involved in decisions that affect their well-being, including in the environmental sector. Local participation in environmental decision making has increased considerably (Keeley and Scoones 2003). The opportunities increased public participation presents for development and good policy making are discussed throughout this report. Chapter 1: *The Human Dimension* examines the increasing role of civil society in the environmental sector and the chapters in Section 2: *Environment State-and-Trends: 20-Year Retrospective* consider the opportunities such involvement creates in specific environmental sectors, including forests, freshwater and coastal and marine environments. Section 3: *Emerging Challenges* considers the importance of public participation in developing policy responses in the critical areas of GM crops, invasive alien species, chemicals and conflict.

The opportunity for improving governance is constrained by several factors including weak states, weak democratic processes that feature personalized power and corruption, and inequity. Inequity and poverty shape the capacity to participate effectively in public life, as is evident from the marginal role that women still play in governance.

Nevertheless, in facing these governance challenges, a wide range of responses have been adopted by governments at the regional, sub-regional and national levels. At the regional level, these responses include the AU Convention on Preventing and Combating Corruption and the African Peer Review Mechanism (APRM) developed by NEPAD. For a full discussion of the APRM see Chapter 8: *Interlinkages: The Environment and Policy Web*. All efforts are made to reduce conflicts in countries where they presently exist through assistance to provide basic services and through the breaking of the poverty trap.

> Since 1970, more than 30 wars have been fought in Africa, and the vast majority of them were intra-state in origin.
>
> Kofi Annan, Secretary-General of the United Nations (UN 1998)

Peace and conflict

Conflict is a major driver of environmental change, and it has significant implications for development and human well-being (Ghobarah and others 2001, Rehn and Johnson Sirleaf 2002, Luckham and others 2001). Many of the conflicts in the region are internal and cross-border disagreements often relate to natural resource use. The challenges posed by conflict are discussed fully in Chapter 12: *Environment for Peace and Regional Cooperation*.

As discussed in that chapter, the implications of conflict are far-reaching:

- Conflicts have led directly and indirectly to the deaths of many thousands of civilians. In 1998, Kofi Annan, the Secretary-General of the United Nations (UN), noted that, "since 1970, more than 30 wars have been fought in Africa, and the vast majority of them were intra-state in origin" (UN 1998).
- Conflicts affect how the environment is used. For example, landmines and unexploded ordinance (UXO) make land inaccessible and pose a physical threat to people and animals.
- Conflict diverts financial resources away from development for the purchase of weapons and other military equipment.
- Conflict threatens human well-being by increasing food insecurity, ill health, violence and crime. It may also affect education and health opportunities. It reduces access to essential material assets, including natural resources, which are the basis of livelihoods and well-being. This may include access to land, markets and information.
- Conflict results in the destruction of infrastructure, and the deterioration of services due to neglect is common. Infrastructure such as roads, bridges, markets, clinics and schools are often targeted by combatants.
- Conflict results in displacement of people, and the breakdown of social cohesion. Cross-border movement of people impacts on host countries, for example in terms of increased demands on natural resources. Refugee populations are among the most vulnerable social groups in the world.

The impacts of conflict cannot be assessed in quantitative terms alone. For example, there are unknown opportunity costs in terms of possible avenues for development which are blocked by insecurity. Conflicts can result in the transformation of the social, political and economic space, and often have the result of "militarizing" many aspects of life. Violence occurs not just between combatants, but also in the domestic sphere: the pressures of life during wartime often result in an increase in gender-based violence (Rehn and Johnson Sirleaf 2002) and the abuse of children. Conflicts and peace breaches make it more difficult to achieve cooperation, including cooperation over the environment. Women, in particular, become vulnerable to attack as they access natural resources such as firewood and freshwater in periods of war. The cultural fabric that constitutes communities can be torn apart. Management of natural resources is an important part of this cultural fabric, and one which is also vital for the provision of basic needs such as food, warmth and shelter.

The regional impacts of conflict are in many ways an incentive for regional solutions and cooperation, and there have been multiple regional responses that seek to improve cooperation around the environment. The AU, along with sub-regional bodies, plays a critical role in peace-building and cooperation. There is enhanced openness on the part of many African governments to discuss problems of conflict which were previously treated as "internal" and to seek regional or international solutions.

Natural disasters and climate change

A disaster is said to occur when abnormal or infrequent hazardous events impact on vulnerable communities, causing substantial damage, disruption and casualties, and leaving the affected communities unable to function normally without external assistance. A disaster is therefore a severe disruption of the survival and livelihood systems of a society or community, resulting from their vulnerability to the impact of one or a combination of hazards, and involving loss of life and/or property on a scale which overwhelms the capacity of those affected to cope unaided (DfID 2000). Natural hazards may be hydrometeorological or geophysical and include floods, droughts, wild-fires, storms, cyclones, earthquakes, volcanic eruptions and landslides. Some of these hazards can lead to disasters. Disasters, whether natural, technological, biological or arising from internal conflicts within nations, are often shaped by anthropological factors.

Africa faces food insecurity that is a result of a combination of natural hazards and human factors (WFP 2006). Climate change and variability are being driven by various anthropological factors including increased demands for energy, and have impacts on environment and development, as well as land productivity. These impacts are discussed throughout Section 2: *Environment State-and-Trends: 20-Year Retrospective* and more specifically in Chapter 2: *Atmosphere* and Chapter 3: *Land*. Global warming will lead to higher temperatures estimated to be between 0.2 and 0.5 °C per decade for Africa (Hulme and others 2001). It is also likely that extreme events such as El Niño are being experienced more frequently, and have become more intense (IPCC 2001, Watson and others 1998), causing wide-ranging agricultural, hydrological, ecological, economic and health impacts (Adger and others 2002). Land degradation and vulnerability to erosion is directly linked to climatic factors. Extreme climatic events also lead to natural disasters like drought and floods which directly affect the health of the environment.

One effective response to address human vulnerability to environmental change is to strengthen mechanisms for early warning. Many actions can be taken to protect life and property if warning is received in time. While certain threats are inherently unpredictable, many of those arising from threats from environmental degradation and mismanagement, and from human activities, can now be anticipated with some precision. Early warning capacities are increasing steadily with technological advances in environmental observing, assessment and communications. Examples include the cyclone early warning systems that have been established in the Western Indian Ocean (WIO) islands.

Global warming will lead to higher temperatures estimated to be between 0.2 and 0.5 °C per decade for Africa.

Hulme and others 2001

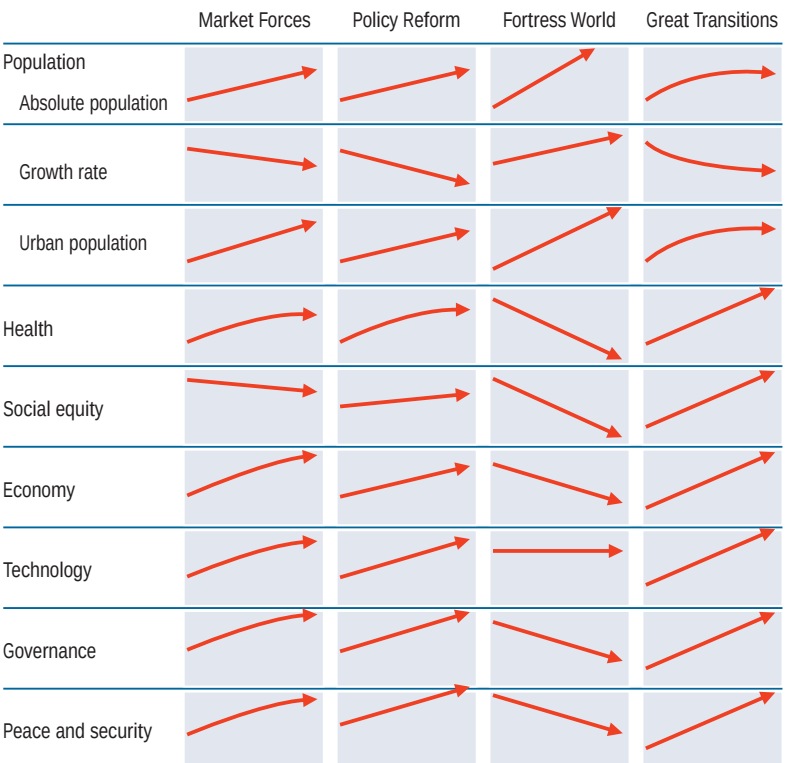
Which road to the future will Africa choose?

Source: Y. Katerere

REGIONAL SCENARIO NARRATIVES

The interfacing and changes in these key driving forces, as used in the narratives in this chapter, are assumed to take the patterns reflected in Figure 5. The narratives presented in the subsequent sections are based on these patterns of change in the main driving forces.

Figure 5: Illustrative patterns of the changes over time of key scenario assumptions



In order to provide a holistic storyline, the regional and sub-regional narratives have been integrated for some issues while stand-alone sections have been reserved for issues more directly relevant to specific sub-regions. The four regional narratives focus on transboundary aspects and ecosystems at sub-regional and regional levels, and discuss the implications of policy choices for meeting the MDG targets by 2025. The analysis is undertaken in the context of the Opportunity Framework (see Introduction). The policy lessons from the scenarios are closely related to the future state of the environment as presented in Section 2: *Environment State-and-Trends: 20-Year Retrospective*.

LAND

The future status of land resources has important development and human well-being implications. Therefore, the substantive analysis of land-use patterns and their implications for sustainable development is crucial. Such analysis requires a long-time frame and needs to incorporate uncertainty. Fundamental uncertainty is introduced both by our limited understanding of human and ecological processes, and by the intrinsic indeterminism of complex dynamic systems that characterize the environment. Outcomes are predicated on policy choices, which are yet to be made, and natural occurrences that are out of the control of humankind. Nevertheless, there is a huge

amount of temporal, spatial and socioeconomic land-use information that can form the basis of such analysis.

There are many environmental, technological and socioeconomic factors driving changes in land resources. How these factors evolve will shape the regional and sub-regional development and future opportunities. Box 2 presents a summary of the most important factors that influence the state of land and land-use change in the region. An analysis of how these factors will prevail under each scenario forms the basis of the narratives in this section. Among the factors that are especially important in Africa are agriculture, forestry, demography, market developments, environmental conditions, social context (including the history of a sub-region) and policies related to land-use planning.

Chapter 3: *Land* considers the current state and major trends affecting land resources. These trends include:

- An increase in agricultural land, both arable and marginal, over the past three decades and a corresponding decrease in forest cover;
- A sharp increase in heavily degraded lands from a combination of drivers and pressures, including desertification, climate change, chemical pollution from industry and agriculture, and armed conflict;
- A diversification in the uses of land resources, including tourism and mining, with demonstrated increased earnings from these sectors.

Other land-use changes, such as increased urban and infrastructural development, have been minimal but will continue to play a significant role in land-resource availability and condition in many parts of Africa. Widespread problems also concern decline in soil fertility, soil contamination, land management and conservation, gender imbalances in land tenure, and conversion of natural habitat to agricultural or urban uses. The threat to land resources posed by invasive alien species (IAS) remains a challenge (see Chapter 10: *Invasive Alien Species*). Inequitable land distribution patterns remain a problem, as discussed in Chapter 3: *Land* and Chapter 12: *Environment for Peace and Regional Cooperation*, and this has implications for environmental management and human well-being. Land tenure policies will continue to have an important effect on environmental change. Assessing how these trends will be played out in future, and identifying appropriate responses to mitigate negative impacts, requires considering the major drivers and pressures. The core driving forces include demography; technology; economy; political and social institutions; climate and environment; culturally determined attitudes, beliefs, and behaviour; and information and its flow.

The most critical issues for scenario analysis include identifying opportunities for Africa to meet the MDG targets and effectively implement NEPAD-EAP programme areas, addressing desertification and food security. One such opportunity is the expansion of irrigated land, and this resonates well with attempts by Africa to achieve enhanced food security, eradicate poverty and increase the productivity of land-use management. These narratives focus on the opportunities of increasing irrigated land. The key threats addressed, as the storylines unfold, include land tenure and ownership,

Box 2: Factors influencing land-use change in Africa used in the scenario analysis

1. Former and current land-use systems and changes
   - Forestry and agriculture
   - Protected areas
   - Land tenure and ownership structure
   - Traditional land use
2. Economic context
   - GDP contribution (agriculture, forestry, industry and others)
   - Contribution to employment (agriculture, forestry, industry, others)
   - International market links and opportunities
   - Local markets for agricultural and forestry products
   - Production structure
   - Land holding size (including farms, forests and protected areas)
3. Environmental conditions
   - Climate, topography, soil characteristics and water availability
   - Environmental quality, including pollution
4. Social context
   - Demographic factors
   - Attitudes and values
   - Resource use conflicts
   - Regional and sub-regional geopolitical conflicts
5. Institutions
   - Development plans
   - Legal frameworks (land-use planning, land-use policy)
   - Policies (subsidies, taxes, agricultural pricing policies, special short-term measures, incentives for forestation, environmental incentives, etc.)

Sources: Raskin and others 1999, MI 2002

Box 3: Imagine...extreme land degradation in Western and Central Africa...

Over 60 per cent of Western and Central Africa's population depends directly on the land for survival. Extreme land degradation in the two regions may result from a complex interaction of several natural and anthropogenic processes: deforestation, rangeland deterioration, wildlife depletion, soil erosion, declining soil fertility, salinization, solution and desertification. The available cultivable area in the region would be greatly restricted. The issues which may hasten land degradation in the two sub-regions include unsustainable agricultural and livestock production practices, deforestation, land tenure systems and unsustainable land use and demographic pressures.

The effects of the degradation of agricultural land would include:

- Increased agricultural labour demand and material input for given levels of productivity;
- Declining animal productivity in the Sahel;
- Scarcity of non-timber forest products (NTFPs), such as fruits, nuts and mushrooms;
- Shortage of fuelwood;
- Landlessness in some areas;
- Declining water supplies with consequences for irrigated agriculture:
- Food shortages and famine in drought years;
- Disease and ill health; and
- Migration to urban areas or to more fertile farming areas.

The net effect of all the above is poverty and frustration. Future outcomes will be shaped by the policy paths these sub-regions choose, and whether they are able to address the environmental issues of land degradation and its root causes. A range of policy options are possible. One set could include policies such as:

- Reforming land tenure based on a refined understanding of the socio-cultural conditions and local politics of individual countries to ensure land security and encourage investment;
- Intensifying agricultural production systems through sustainable production practices;
- Pursuing rational population policies that realistically address issues such as birth control, primary health care delivery systems and population movement in order to ease pressure on land;
- Promoting alternative employment policies to reduce overdependence on land and land resources while addressing people's inadequate capacity to embark upon alternative livelihood activities; and
- Creating enabling social, economic and political environments for all reforms to operate and facilitate environmentally sensitive economic liberalization and good governance.

land degradation (soil fertility, water scarcity, desertification and erosion vulnerability, and salinization), poor agricultural practices, IAS and inundation of habitats as a result of damming.

Market Forces scenario

In the course of development, human activity alters the landscape. The dynamics of land change are complex, depending on settlement patterns, agricultural practices, economic growth and natural resource industries. Several key developments shape land use in the *Market Forces* scenario. These developments relate to human settlements, pastures and rangelands, cropland expansion and land degradation as well as the "built environment."

In the Market Forces scenario there unfolds greater than normal demand for agricultural products which in turn results in agricultural expansion, exposing more land to water erosion.

The "built environment" encroaches on natural environments (such as forests) and near-natural environments (such as agricultural and grazing land) as populations grow and economies modernize. The settled area per person has been increasing historically and is currently estimated at 0.14 ha per capita in Eastern Africa. However, in Southern Africa, per capita land access has dwindled from 20.09 ha in 1985 to 13.16 ha in 2000, and continues to decline. Given the current low population densities and horizontal, as opposed to vertical, settlement, population growth places significant pressure on agricultural lands and valued ecosystems. In the *Market Forces* scenario, the dominant change at the regional level, is the conversion of forest to grazing and pasture land. To a lesser extent, natural forest is lost to expanding areas of built environment, cropland and forest plantations.

The utilization of land for grazing livestock changes for several reasons. The intensity of livestock production (output per hectare) changes in response to changing pasturing practices and improved livestock characteristics from scientific developments. Despite the increased intensity of use, the extent of grazing areas

increases in all sub-regions. The increase is at the expense of cropland, forests, and marginal land. Changing pastureland requirements is indicative of trends in land degradation. New agricultural land comes from forest conversion, grazing and rangeland, with the shares varying by sub-regions. In addition, in some sub-regions, agriculture expands onto marginal land, and this requires considerable input and careful management.

Unsustainable land-use practices can lead to, or exacerbate, various forms of land degradation including wind and soil erosion, soil compaction, waterlogging, salinization and nutrient depletion. In the *Market Forces* scenario, in all the sub-regions severe degradation is witnessed with more and more agricultural land becoming degraded. This is the result of intensified agricultural practices driven by profit goals. Although attempts are made to protect and partially rehabilitate damaged ecosystems, this is outstripped by the high land degradation rates occasioned by the economic attractiveness of market-based production. The rate of land degradation in the region varies from 25-35 000 ha per year under this scenario. This rate varies from sub-region to sub-region and will intensify after 2015. The land degradation rates are higher than those registered in the past.

In the *Market Forces* scenario there unfolds greater than normal demand for agricultural products which in turn results in agricultural expansion, exposing more land to water erosion. A shift away from less intensive crop and livestock production to more intensive, but environmentally insensitive, practices leads to a greater risk of water erosion. A greater percentage of land converted to agriculture is evident in Central and Western Africa. The effects of population pressure are greatest in Southern and Eastern Africa. In the long term, the effects of land degradation are reflected in diminished yields and increased deforestation rates. The current upward swing in the quantity of land so severely degraded that it has to be removed from agriculture production continues under the *Market Forces* scenario. The combined effect of the various driving forces results in changes in land cover and the exposure of more and more land to degradation through erosion. In particular, the area under forest cover declines drastically during the 2005-2025 period.

Policy Reform scenario

The *Policy Reform* scenario is growth-oriented but assumes a comprehensive policy response to the environmental and social risks associated with land use. The scenario does not assume major deviations from the conventional development paradigm, values and institutional structures, but within those constraints incorporates rapid economic growth, greater distributional equity and vigorous attempts to protect the environment. The definitive reference for this vision is the Brundtland Commission's report, *Our Common Future* (WCED 1987).

Change under the *Policy Reform* scenario ushers in an era of economic growth, based on policies that sustain and expand the land resource base. Comprehensive and coordinated government action is taken in pursuit of this. In this context, an integrated set of land reforms and land management initiatives are crafted and implemented, including economic reform, regulatory instruments, land tenure system changes, social programmes, and technology development for sustainable land use.

The often conflicting goals of providing space for human settlements, protecting ecosystems, and feeding human populations are reconciled through a combination of measures all centred on policy-driven sustainable land use.

The main contours of a *Policy Reform* scenario comprise high income and economic growth, improving environmental conditions, greater equity and reduced conflicts over land. There is a far greater efficiency of land resource use, more reliance on renewable land resources and less environmental pressure. The often conflicting goals of providing space for human settlements, protecting ecosystems and feeding human populations are reconciled through a combination of measures all centred on policy-driven sustainable land use.

The transition to agricultural sustainability requires a "doubly green" revolution, in which agricultural productivity continues to improve but is coupled with practices that preserve the environmental foundation for the long term (Conway 1997). In this scenario, a campaign for sustainable agriculture is launched, resulting in a gradual shift towards ecologically sound practices rather than the replication of high-input farming. The challenge is to maintain yield improvements at something like *Market Forces* scenario levels, while avoiding degradation. As part of the pollution-reduction goals of this scenario, fertilizer and pesticide use per hectare decline. To maintain yields, the nutrient requirements of plants must be met and pests kept in check in other ways. Nutrient

recycling partly substitutes for fertilizer, for example, by using livestock manure in combined crop-livestock systems and through large-scale composting. The poverty alleviation goals of the scenario support these trends, as increasing income allows farmers to diversify their production (Scherr and Yadav 1996). Additional actions needed include the development and application of biotechnology and other research (eg, disease-resistant varieties), education and training of farmers, land reform, infrastructure development and reform of economic policies. Programmes for sustainable agriculture are carried out in cooperation with farmers and targeted to local needs.

Changes in grazing land for livestock production are the result of various trends. Economic growth pushes the demand for livestock products higher. Agricultural production expands to meet increasing livestock feed demand so as to reduce the need for grazing land, and this approach has the net effect of reducing pressure on forests and other ecosystems. In addition, some improvement in grazing land productivity is evident due to the adoption of modern practices. Similarly, increased investments in R & D leads to improvements in herd quality. At the same time, policies are adopted to ensure that grazing practices are more sustainable in order to reduce environmental destruction. The transition to sustainable livestock practices can be achieved through a variety of interventions, including by providing information through extension services, and by enforcing overgrazing laws. In arid lands, where the availability of forage can vary greatly from year to year due to climate fluctuations, policies to provide timely access to markets and land can allow producers to cope without overtaxing biomass resources.

Driven by the combination of food and feed requirements, regional cropland area expands by about 20 per cent between 2005 and 2025, a larger increase than the 11 per cent of the Market Forces scenario.

Driven by the combination of food and feed requirements, the regional cropland area expands by about 20 per cent between 2005 and 2025, a larger increase than the 11 per cent of the *Market Forces* scenario. However, because of land and water constraints in many sub-regions, there is considerable variation between and within sub-regions. The largest increases occur in where there are the least land and water constraints. This implies more extensive trade in food commodities. In Eastern Africa, where cropland grows by over 40 per cent, some of the increase is met by returning to production land held by the government. Regionally, a greater share of the cropland is on rain-fed land than in the *Market Forces* scenario. Expansion of irrigated land is discouraged by increases in water prices, as countries try to limit the incidence of water stress.

Consistent with the sustainability goals and livelihood strategies discussed in Chapter 1: *The Human Dimension*, the rate of land degradation slows between 2005 and 2015. Depending on the nature of the land and its use, degradation is reduced through different means:

- Improving drainage and delivery systems for irrigation water can restore irrigated land subject to waterlogging and salinization, and conserve water resources at the same time;
- Nutrient loss from shifting cultivation can be reduced by lengthening fallow periods; and
- Loss of land through water erosion can be reduced by building terraces and through conservation tillage.

Up to 2015, croplands are degraded at a rate assumed to be less than the *Market Forces* rate. This rate slows down further after 2015. Further opportunities available for redress include integrated land and water resources management; the sustainable management of wetland resources; sustainable agriculture and rural development; technology transfer; and the development of early warning systems and assessment of land degradation. The establishment of regional and sub-regional early land degradation warning systems are pursued under this scenario. Efforts by countries to implement NEPAD's initiatives to combat desertification and land degradation are reflected in land use and land reform policies. Land reform policies take the centre stage through attempts to modernize land use, especially in Southern Africa where obvious imbalances have persisted in land ownership and tenure.

The expansion of the built environment is curtailed in the *Policy Reform* scenario, as concerns for protecting productive cropland, forests and other ecosystems lead to urban planning policies that favour more compact settlement patterns. This is supported by a higher value being placed on arable lands, as a result of increasing domestic demands and, in some sub-regions, profitable opportunities for increased trade. The preservation of forests and other valued ecosystems is recognized as a key sustainability goal. Specifically, the rate of forest loss gradually decreases in the scenario to zero by 2025 and the extent of forest areas begins to increase thereafter. Between 2015 and 2025, there is net reforestation. This

is achieved through forest protection policies and land-use strategies that support more compact settlements, the contraction of grazing lands and land restoration. In this scenario, the amount of forest land set aside as protected areas increases. Increased emphasis is placed on the preservation of established forests and other ecosystems that support biodiversity. Also, opportunities are developed for encouraging the sustainable use of forest products among poor people, such as by granting secure land rights.

Unexploited grasslands and savannah are placed under grazing, especially in Southern Africa. The rapid expansion of the built environment and grazing land that occurs in the period 2005 to 2015 is slowed or reversed between 2015 and 2025. Eventually, agricultural land grows to supply the increasing food demands of countries facing land and water constraints.

The successful transition to sustainability requires:

- Widespread awareness of the issues and the conviction that action is necessary;
- Adequate institutions, policies and technologies; and
- Sufficient political will to accept the costs of carrying out the required actions.

Changes in the *Policy Reform* scenario are the same for all sub-regions except in Central Africa where the need for irrigation continues to be limited. The scenarios for Northern Africa show essentially the same trends, despite tying irrigation to rice production. In Northern Africa, in the *Policy Reform* scenario, water-conservation policies increase the cost of water, so irrigation water is increasingly diverted to higher-valued uses, leading to a decrease in the irrigated area. At the same time, the efficiency of application of irrigation water improves. Reduced production is made up in part through increased imports, a strategy often described as one of importing "virtual" water contained in the crops. In the *Policy Reform* scenario, irrigated area increases from 12.6 million ha in 2005 to 17 million ha in 2025.

Fortress World scenario

In the *Fortress World* scenario, a few powerful regional, sub-regional and international actors are able to rally together and secure control over land resources; they are sufficiently organized to protect their own interests and to create lasting alliances between them. Land-based wealth, resources and conventional governance systems for most are eroding. The elite retreat into protected enclaves. Outside the fortress, the majority is mired in poverty, denied access to scarce land resources and restricted in mobility and basic rights such as freedom of association and expression. The authorities employ active means of repression to guarantee exclusive access to needed resources (such as oil fields and key mines) and to stop further degradation of the regional and sub-regional land resources. Strategic mineral reserves, freshwater and important biological resources are put under strict control. Technology is maintained in the fortresses, with some continued innovation, but deteriorates elsewhere.

Outside the fortress, the majority is mired in poverty, denied access to scarce land resources and restricted in mobility, and basic rights such as freedom of association and expression.

Pollution within the fortress is reduced through increased efficiency and recycling. Waste is exported outside the enclaves, contributing to the extreme environmental deterioration induced by the unsustainable practices of the desperately poor and by the extraction of resources for the wealthy. However, favoured resort areas including nature and hunting reserves are declared ecological protection zones, from which poor people are excluded.

In this scenario, the major line of conflict is between rich and poor people, a new functional divide replacing the old North-South notion. Socioeconomic equity is very low, at the national and sub-regional levels, though it is higher within the fortress and outside. This social system is contingent on the organizational ability of the privileged enclaves to maintain control over the disenfranchized.

Land developments in the *Fortress World* scenario relating to human settlements, pastures and rangelands, agricultural land expansion, and land degradation paint a bleak future for the marginalized majority. The growing population of the underprivileged is not matched by an equivalent increase in requisite land resources. The "fortress dwellers" continue to have biggest share of land resources for settlement and agricultural production. Expansion of settled areas places significant pressure on agricultural lands and valued ecosystems. Proliferation of poorly serviced and densely populated urban settlements is witnessed as other settled areas expand into agricultural, forest, rangeland or other land types with the shares varying from sub-region to sub-region.

Larger tracts of rangelands are reserved for grazing livestock. Grazing areas increase in all sub-regions. The increase is at the expense of cropland, forest and marginal

lands and human settlements. Land degradation escalates subsequently. In some sub-regions agriculture expands onto marginal land, which requires considerable input and careful management. Poor people lack adequate input and resources to sustainably manage their land, which is predominantly in damaged environments; in contrast the rich own prime land and have an unparalleled share of resources. Pollution is rife and unsustainable land-use practices lead to various forms of land degradation, including wind and soil erosion, soil compaction, waterlogging, salinization, and nutrient depletion. The state of land resources deteriorates between 2000 and 2015 and continues to worsen at a faster rate in the 2015-2025 period. A larger proportion of the population is forced to produce food on increasingly less productive land. The risk of water erosion increases as more land is brought under intensive agriculture and there is a high rate of conversion of natural and semi-natural areas into built-up areas for industrial activities, infrastructure and tourism. Land remaining under agriculture is more vulnerable to water erosion.

In countries and sub-regions where the majority of farmers are smallholders, the rate of degradation is higher owing to the poor quality of available land and inadequate financial and human resources. Highly degraded agricultural land remains under production due to the lack of availability of alternatives as most land, including protected areas, forests, wetlands and woodlands, has been expropriated and managed by those in the "fortresses" and the few prosperous people from the minority enclaves. Human vulnerability to environmental change increases. The lower yields of traditional staple food crops, such as maize in Eastern and Southern Africa and yams in Western Africa, indicate continued production in degraded lands.

The Great Transitions scenario

In the *Great Transitions* scenario, regional, sub-regional, national and local society, rather than descending into cruelty and chaos, evolves to a higher stage as a new land-use paradigm emerges.

This transition requires structural rather than incremental changes in social practices and therefore a discontinuity with the current trajectory. Such transition may take two forms.

First, *Eco-communalism* envisions a patchwork of semi-isolated and self-reliant communities of land users. In this world, there are high levels of equity (with regard to land ownership), low economic growth, and low population growth.

Second, the *New Sustainability Paradigm* is a constructive and popular basis for social and environmental reconstruction, and redressing tensions. In this paradigm sensitive governments emerge to both express and stimulate the process of sustainable land management, balancing the three pillars of sustainable development: society, environment and economy. Science and technology form the backbone of land management. The values of simplicity, tranquillity and community begin to displace those of consumerism, competition and individualism. Slowly, these processes coalesce into a region-wide approach, with many people searching for new ideals, meaning and forms of social existence based on the pursuit of intergenerational equity. Equity and sustainability, rather than economic growth, come to define land development. Agricultural and industrial technology transfer and joint sustainable development initiatives usher in a new era of cooperation between all socioeconomic segments of the region and sub-regions. All sub-regions pioneer land-use technologies and development approaches that conform to their unique climate, geography, resources, demographics and religious and cultural traditions. In the new economic arrangements, markets are used to steer agricultural production and product distribution efficiency, but within the limits of market as required by defined social, cultural and environmental goals.

A variety of policy mechanisms are used to achieve the sustainability programme. These include a revised tax system and other market signals to discourage poor land-use practices. The polluter pays principle is implemented in all sub-regions. Antisocial corporate behaviour is discouraged by, among other methods, the public disclosure of information. Well-designed environmental, economic and social indicators measure the effectiveness of policies, giving the public an informed basis for seeking change. Devolved forms of governance evolve; land stewardship, and mechanisms for land-use decision making are established from local to regional scales. In this nested structure, Africa's sub-regions, nations and communities have considerable control over socioeconomic decisions including approaches to agricultural production and environmental conservation.

Regional governance is based on a federation of regions, which, through a rejuvenated AU and a truly regional civil service, effectively fosters cooperation, security and quality of land. Population growth slows and then stabilizes at relatively low levels as poverty is eliminated and women become equal participants in the life of communities. Inherited environmental problems are abating, though some effects linger for many decades. Land-based conflicts are resolved by negotiation, collaboration and consensus. The exhilaration of

pioneering a socially and environmentally superior way of life becomes a powerful attracting force for land users.

The main defining contours of the *Great Transitions* scenario are seen in positive indicators of human settlements, pastures and rangelands management, agricultural land expansions, the expansion of irrigated land, and the reduction in land degradation from water erosion, salinization and fertility loss. The socioeconomic and environmental impacts of these positive developments set in largely after 2015 and continue to be entrenched in land-use practices up to 2025. Economic growth ideals drive the demand for livestock and crop products higher but these are tempered by environmental concerns. Pressure on forests and other ecosystems, such as wetlands and rangelands, is reduced through careful land-use planning. Definite improvement in grazing land productivity can also be expected due to the adoption of sustainable livestock management practices and improvements in herd quality. Agricultural extension propels the transition to sustainable livestock practices.

Agricultural land expands by about 10 per cent between 2005 and 2025, a larger increase than the 5 per cent of the *Policy Reform* scenario. The increases in agricultural land are based on sustainable land-use principles, and land and water constraints at the sub-regional and country levels. In Southern and Eastern Africa, where agricultural land increases by about 20 per cent, some of the increase is met by returning to production land held by the government. Much of the increase in agricultural production is made possible through increase in irrigated land. Expansion of irrigated land is encouraged by decreases in water prices. More secure access to water is ensured in most sub-regions as regional and sub-regional structures are developed to facilitate cross-border water resources management. The rate of land degradation slows between 2005 and 2015. Loss of agricultural land due to severe degradation drops to 0.1 million ha per year over the first half of the scenario, 10 per cent of the rate assumed in the *Policy Reform* scenario. From 2015 to 2025, degraded agricultural land is greatly restored, leading to increased availability of land for agriculture, forests and other uses. More land is protected by local and national or sub-regional regulatory and governance mechanisms. Land degradation is greatly reduced through drainage, irrigation and land reclamation systems.

In this scenario, per capita consumption of agricultural products (meat, milk, grains) is lower, leading to a smaller area required for crop production and livestock grazing. This lowers the risk of water erosion, particularly after 2015. Efficient soil and water conservation systems are put in place to complement sustainable land management practices. Expansion of settlement areas is controlled and is less significant in conversion of natural and semi-natural systems. This is markedly different from the situation envisaged in the *Market Forces* scenario. The expansion of the built environment is contained as in the first half of the *Policy Reform* scenario, as concerns for protecting productive cropland, forests and other ecosystems lead to urban planning policies that favour more compact settlement patterns and limit the proliferation of poorly serviced slums.

Sensitive governments emerge to both express and stimulate the process of sustainable land management balancing the three pillars of sustainable development: society, environment and economy.

Containment of negative land-cover changes and forest-cover loss are key sustainability goals. The rate of forest loss gradually decreases in the scenario to zero by 2015 and forest areas increase thereafter. Forest protection policies and land-use strategies that support more compact settlements, the contraction of grazing lands and land restoration support the maintenance of the integrity of agro-ecosystems. The sustainable use of forest products is encouraged.

Policy lessons from the scenarios

An analysis and synthesis of the overall regional and sub-regional conditions, policies and initiatives in land resources demonstrates the value of appropriate policy responses, which can maximize development opportunities while ensuring environmental quality. An understanding of the driving forces, indicators and policy options under each of the four scenarios is a prerequisite for positive action. Policy responses are needed to alleviate, mitigate or suppress driving forces that may worsen land degradation.

The scenarios explored in the land theme show succinctly that different policy options exist. The scenarios are tools for integrating scientific knowledge about the consequences of anthropogenic pressures and natural processes, and for elucidating potential environmental options. The range of available opportunities, although affected by the magnitude and nature of the driving forces, depends mainly on institutionalizing sustainable land management practices.

The objective of achieving food security for a rapidly growing population, while maintaining the productivity of

Figure 6. Regional projections of land under irrigation in the four scenarios

area under irrigation (million ha)

agricultural land and forests and avoiding land degradation, presents numerous challenges. There is no simple recipe for achieving this. The scenario narrative presents a picture of how this might be accomplished under different development pathways. It reveals the multidimensional character of the problem, the variety of initiatives needed to address these problems, as well as the immense policy challenge. Concerted government action will be needed to build the required capacity for R & D activities and extension services, provide well-functioning markets and adequate infrastructure, counter the perverse subsidies in developed countries, and implement incentives for a shift toward more ecologically friendly agriculture, forestry, and land-use practices. The adequacy of water resources will play a critical role in achieving these goals. A substantial increase in irrigated land and availability of irrigation water will go a long way in helping achieve food security goals. This will demand prudent management of the freshwater resources.

Improving the distribution of wealth, access to resources and economic opportunities are key factors to the success of regional, sub-regional and national land policies (SARIPS 2000). The mitigation measures that would make land use environmentally sound revolve around improved conservation, and the effective use of marginal and low-potential agricultural lands. The measures to stem the increasing risk of water erosion must be revised in order to adapt to climate change, avoid the conversion to agriculture of other natural and semi-natural systems and address the consequences of agricultural intensification.

There is an urgent need to develop well coordinated country-specific and sub-region-specific land degradation monitoring programmes. These programmes would produce and share information needed for land-use decision making and policy development on degradation, and in particular for disaster preparedness, mitigation and management. The large differences in the estimated

Figure 7: Sub-regional changes in land use under the different scenarios

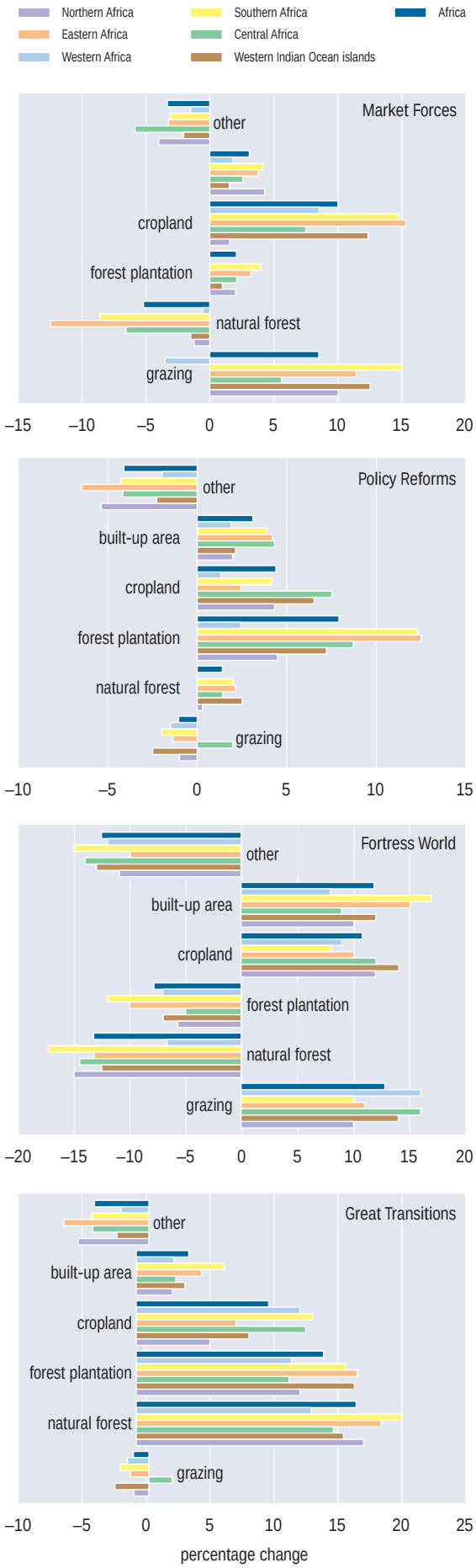
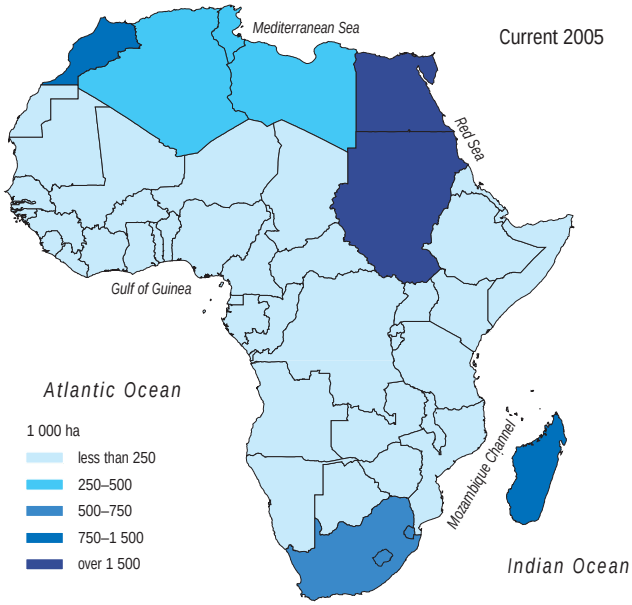
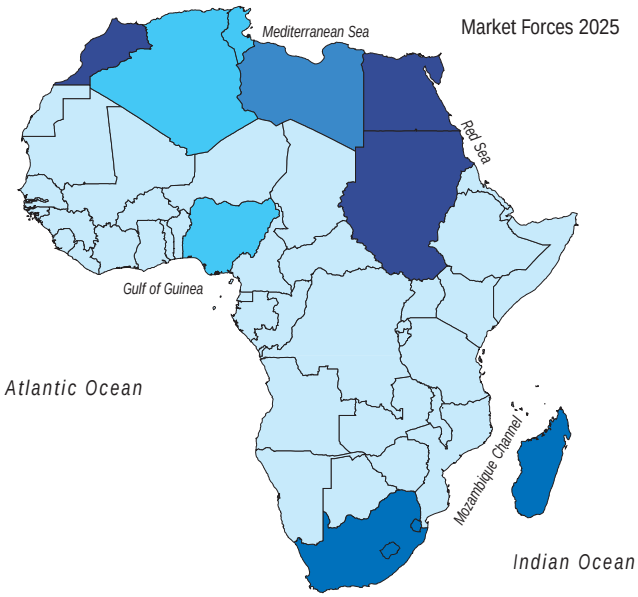
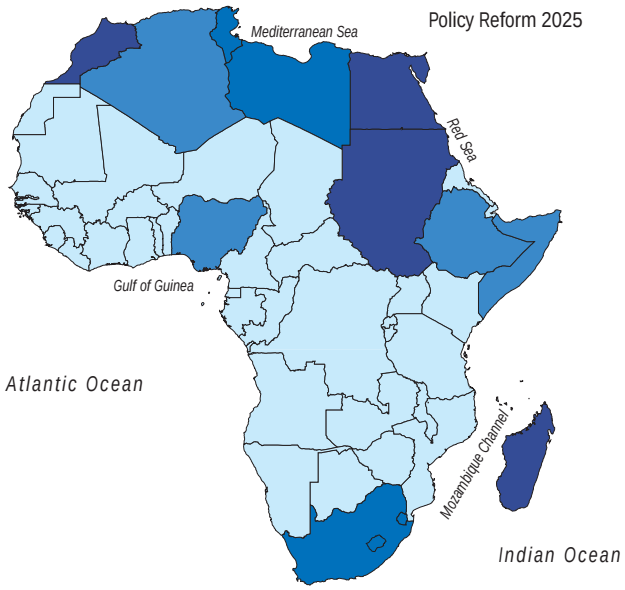


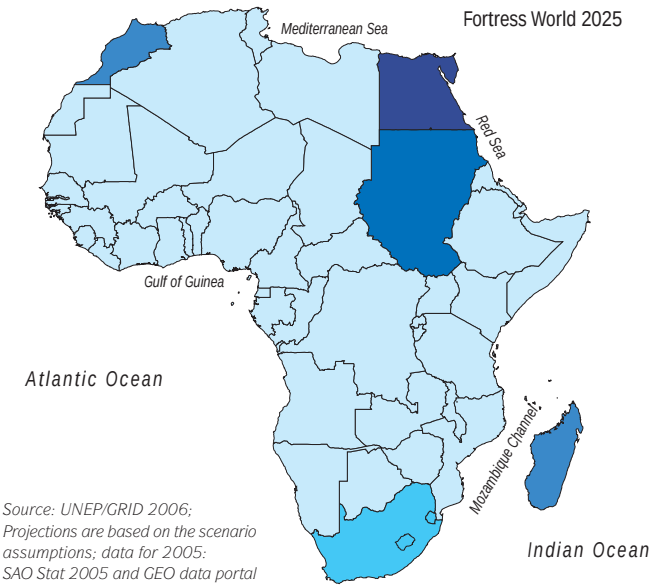
Figure 8: Changes in total irrigated land area

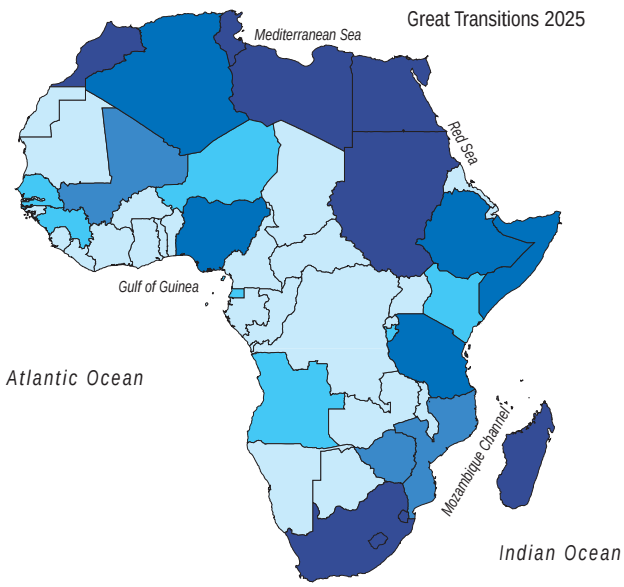


Irrigated area (million ha)						
Scenario	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**
Market Forces	12.0	12.6	13.2	13.8	14.4	15.0
Policy Reform	12.0	12.6	13.5	15.17	16.84	17.0
Fortress World	12.0	12.0	10.5	9.0	7.5	6.0
Great Transitions	12.0	13.8	15.9	18.0	21.5	25.0









Source: UNEP/GRID 2006; Projections are based on the scenario assumptions; data for 2005: SAO Stat 2005 and GEO data portal

Figure 9: Sub-regional picture of degraded cropland by 2025 under the various scenarios

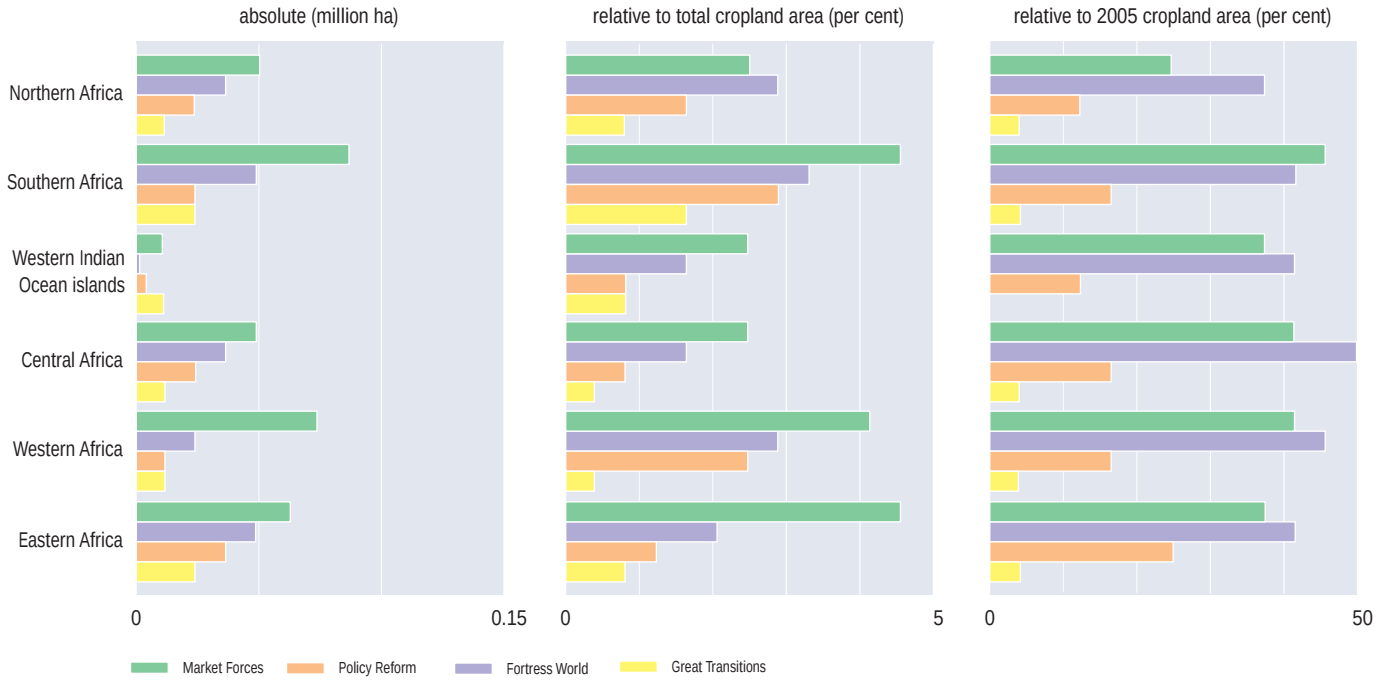
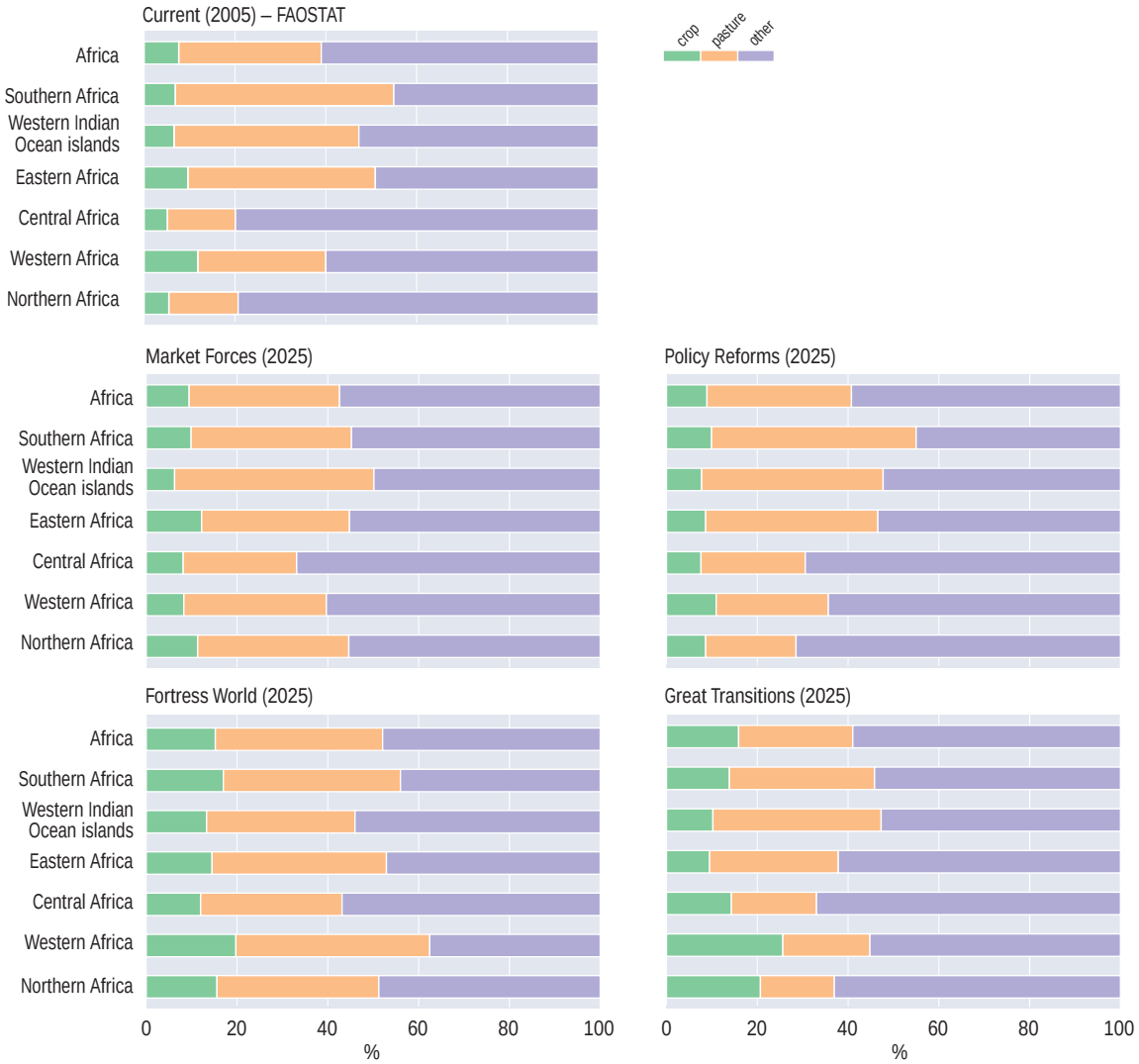


Figure 10: Estimated land use intensity based on crop and pasture under different scenarios



extent of land degradation under the different scenarios demand a policy-sensitive early warning system that is able to make quick and effective responses.

FRESHWATER

The key issues, for which scenarios have been presented under the freshwater theme, revolve around transboundary water resources management. As discussed in Chapter 4: *Freshwater*, the potential methods for increasing the opportunities associated with Africa's freshwater resources include the adoption of river basin or catchment management, improved regional cooperation, enhanced and more equitable distribution of water, better sanitation and the recognition of water as an asset for environmental management. Opportunities can only be harnessed if the issues and threats facing resource sustainability are understood and addressed. Issues regarding water quality and quantity, availability, variability and accessibility, low levels of investment in water infrastructure and technology, exploration and assessment of freshwater (including groundwater) potential, water-borne diseases (such as schistosomiasis (bilharzia) and onchocerciasis (river blindness)), invasive alien species (IAS) and competition (conflict) over resources are critical to sustainable management of Africa's water resources and achieving the MDG 7 targets of halving the proportion of people without improved drinking water in urban and rural areas, and halving the proportion of people without sanitation in urban and rural areas.

The main driving force and pressure for changes in the state of freshwater is population growth, although climate change is also a driver. This is evident in Chapter 4: *Freshwater* and it was also highlighted in the AEO-1 scenarios. The availability of water, both absolute and per capita, is a consequence of the growing number of people in Africa. There is growing demand for water for agricultural and industrial development, which can potentially lead to water scarcity. Population increases can also precipitate competition and conflict over available freshwater. Such conflicts may be between different economic sectors and, in some cases, between countries, or between communities which share common water bodies. Other drivers that affect the state of freshwater resources, and thus development opportunities, include climate, technological developments and socioeconomic and health factors. These driving forces are assessed in the following scenario narratives. The scenario narratives reveal the implications of different policy choices for realizing key objectives.

Market Forces scenario

Increasingly, Africa will be the home to environmentally-harmful industries, including the chemical industry (see Chapter 11: *Chemicals*). This trend is related to increased measures for environmental protection in developed countries and an increasingly active civil society (OECD 2001). In these circumstances, investors and industries target the still less restrictive legal systems, which are found predominately in the developing world. Northern Africa, given its strategic location close to Europe, and South Africa, with its more developed markets, become focuses of investment. Many new factories are established to manufacture the goods in Africa and then export them to Europe. The move appeals to and is welcomed by the local African governments, as it seems to be a magic solution to their struggling economies.

Rapid population growth does not seem to be a problem because the flourishing industry absorbs some of the unemployed population. However, the capacity of the African countries to develop their water resources and use them more efficiently still remains very low. Total annual water use amounts to 381 km^3, that is about 10 per cent of available resources. With the population reaching 1 766 million by 2050, per capita water share is very low at 216 m^3/year. However, large variations are witnessed among the sub-regions.

There is an increase in industrial water use (16 per cent) in order to produce and ensure continued FDI.

Competition over limited water resources rises between some sectors. Agriculture, the main water consumer, enjoys a large share of the resource (66 per cent of the total) as it feeds the industries with some raw materials and exports agricultural products to foreign markets. There is also an increase in industrial water use (16 per cent) in order to produce and ensure continued FDI. Domestic water use is 18 per cent of the total. Surface water is mainly used for irrigated agriculture, whereas industry and some urban areas rely more on groundwater.

Overharvesting of groundwater by the industrial sector poses a serious risk to the sustainability of the resource, but governments feel unable to impose strict regulations on that powerful sector. In response, the governments try to reduce water use in public irrigation schemes and reduce expenditure in water utilities by privatizing them or turning them over to the beneficiaries. This move is intended to improve resource-use efficiency and bring the costs of operation

and maintenance down. However, some of the utilities need large investments in order to rehabilitate them and make them profitable. The private sector makes those investments but also raises service fees. The prices of potable water in some urban centres and large cities become very high and unaffordable for many people. Therefore, although more people are connected to the water networks, the number of people who can afford to pay for it decreases. Alternative cheap, but unsafe, water sources emerge and the use of these increases. Many people are affected by water-borne diseases, which add to the strain on the national economies.

In this scenario, the economic and technological gap between urban and rural areas increases and there is a concentration of economic activities, particularly industry, around the urban areas. Typically, many people are attracted to move from rural to urban areas in search of better lives and incomes. However, because they are mostly unskilled labourers, they can only secure low-income jobs and hence find themselves unable to cope with the high living costs in the urban areas. Slums proliferate on the outskirts of the large urban areas. Services are very minimal and of low quality. Untreated sewage water poses a serious risk to those communities as well as to surface and shallow groundwater resources in the downstream areas.

Policy Reform scenario

In this scenario, there is a clear shift in the development policies of countries, with water, along with other environmental resources, taking a higher priority than before. The new policies are centralized around some main goals: better availability of and access to water resources, equitable distribution of the resources among all beneficiaries, and the sustainable use of water resources in terms of both quantity and quality.

The availability of better water supply without improved sanitation results in substantial health hazards as well as environmental risks, as people simply dump their increased volumes of untreated sewage water in watercourses.

Overall, Africa is not short of water resources, but it is the spatial distribution of the resource that is rather uneven. Some countries, notably in Northern Africa, the Horn of Africa, and Southern Africa are experiencing water stress, while others, in Central Africa for example, have ample resources that are as yet untapped (UNEP 2002c). This opens up opportunities for cooperation between different groups of riparian countries for the optimum use of the water resources for the benefit of all nations.

Nevertheless, until the above efforts materialize and start to achieve their goals, water availability is restricted by technical and financial obstacles. Despite a moderate increase in the population (1 678 million), total annual water use is only 292 km^3 or just 8 per cent of available resources. The per capita water share is therefore very low at 174 m^3/year.

In meeting policy goals attention is given to rural populations who have long been neglected. New water supply projects, financed by international donors and lending agencies, provide good quality and safe potable water to the rural populations. The objectives are two-fold:

- Safe potable water should improve population health leading to significant savings in expenditure on health care.
- Improving the quality of life in the rural areas should help reduce the tide of urbanization.

However, some difficulties are experienced. First, the cost of tap water is relatively high, and unaffordable for most people in the rural areas. Second, the availability of better water supply without improved sanitation results in substantial health hazards as well as environmental risks, as people simply dump their increased volumes of untreated sewage water in watercourses. The problems are well known to the governments, but they are unable to take timely action due to limited financial resources. Technocrats and environmentalists advocate that rural areas should be provided with sanitation first, whereas politicians believe that water supply should take the first priority as water is an essential requirement for life.

Similarly, urban areas also benefit from the new policies and more people are connected to water supply networks. More people have access to safe potable water. Water tariffs also increase, and they are higher than those in the rural areas. Water use for domestic purposes is at a record high of 27 per cent of total water use. As technical solutions are not available to protect the quality of water resources, governments adopt laws and regulations to protect water quality. It takes time, though, until the public begin to adopt sustainable water-use practices. Law enforcement along with public awareness campaigns, financial incentives and other economic instruments are among the tools used to promote more efficient and sustainable use.

The use of groundwater is rationalized through new policies, which target integrated water resource

management (IWRM). Water resources have become so vulnerable that any further misuse can lead to a state that will be extremely difficult to remedy. In response, priority for groundwater use is given to small communities and industries. Small communities mainly use shallow groundwater for domestic purposes, which can be easily contaminated if not properly protected. Industries rely more on deep groundwater, which requires good management to maximize the lifespan of the wells. Many countries acknowledge the fact that some of their deep groundwater aquifers are shared with their neighbours. For the first time, those countries sit together and draw plans for the sustainable utilization of this common resource, an act that has for long been limited to riparian countries only.

Fortress World scenario

In many developing countries the differences between rich and poor are phenomenal and growing. Wealth and poverty are closely related to dispossession and deprivation, and to the extent of capabilities people have to make livelihood choices they value (Sen 1999). In many countries, the middle class is gradually diminishing and this trend is expected to continue under this scenario. The gap between rich and poor people gets wider, increasing the potential for conflict over natural resources. Although much smaller in numbers, the rich have the upper hand and therefore manage to control almost everything; this is done at the expense of the environment and sustainable water resources management.

Water availability varies considerably across Africa (UNEP 2002c). In all societies, irrespective of social values or wealth, water is a vital resource. In the *Fortress World* scenario, the elite are very keen to maintain full control of this resource. Their control is not limited to the use and distribution of internal waters but goes beyond national boundaries, as a result of their influence on water management institutions in neighbouring countries. Transboundary technical and economic cooperation is minimal, with each country focusing on its own needs. In pursuit of huge profits, the elite focus on industry and trade with the West. They take advantage of the low cost of raw materials available in Africa and of abundant cheap labour. Water use by the industrial sector is high at 32 per cent of the total use, and is at the expense of the agricultural sector and domestic water use among poor people. Many industries produce environmentally-hazardous waste that is disposed of without any treatment, further threatening freshwater systems.

Potable water supply to the elite urban areas is secured. Domestic water use accounts for 11 per cent of the total annual water use of 312 km^3. Per capita water share is very low at 148 m^3 per year due to the large increase in population (2 102 million). However, water availability and distribution is skewed with the elite taking much higher shares than poor people. About 30 per cent of the population, mainly poor people, have inadequate access to water resources and are not able to meet their basic needs. This deteriorating situation is just one factor undercutting the opportunities available to poor people. Faced with no access to resources – natural resources, education, health care, among others – poverty increases. Agriculture is embarked upon primarily to meet subsistence needs, however the lack of water availability makes this a challenge. Water that is available is of poor quality, and the impact of this on the quality of agricultural products and soils, from salinization and other pollutants, is evident.

About 30 per cent of the population, mainly poor people, have inadequate access to water resources and are not able to meet their basic needs.

Domestic water availability for poor people, whether in rural areas or on the fringes of urban areas, is very limited. The shortage of potable water is so acute that people have to use low-quality water. Disputes on access to potable water arise almost daily with the stronger getting higher shares than the weak. Female-headed households are at a particular disadvantage. Used domestic and industrial wastewater is disposed of in open watercourses causing serious damage to ecosystems and biodiversity, as well as to the health of poor people living in downstream areas. There is an outbreak of water-borne diseases such as malaria, bilharzia and diarrhoea. Most affected are poor people, particularly children under five, due to inadequate access to good health care, and infant mortality is high.

Groundwater resources are not spared. The elite overharvest deep groundwater for their new modern urban compounds and leisure centres. Well-digging is neither regulated nor documented. No databases for the numbers and locations of wells exist. The exact amount of annual groundwater use is not known. The typical symptoms of groundwater degradation, such as declining water tables and increased well salinity, are evident. Many poor rural areas have to use shallow

groundwater for domestic purposes. This water is not completely safe, but it is of better quality than that from many surface sources. Shallow groundwater is polluted by both seepage from polluted surface water sources and the poor management of the wells by the users themselves. Many wells are in very bad condition and need urgent rehabilitation, but the users, who are poor, lack the required technical and financial resources.

Great Transitions scenario

In this scenario, African countries fundamentally transform their water management policies and practices. The reforms aim at ensuring the sustainable use of all natural resources while at the same time improving living standards and well-being.

Agricultural practices which adversely affect water sustainability are no longer tolerated as there is proper enforcement of the law. For example, the use of cheap and illegal chemicals is successfully prevented through better monitoring and law enforcement, and public education. Modern irrigation systems that are highly efficient in water use become common practice in most of the better-off countries. As an incentive to farmers, the governments set special energy tariffs for agricultural uses. The tariffs, however, are not so low so as to encourage unsustainable energy and water use. Agricultural water use is successfully controlled at only 56 per cent of the total water use, a significant reduction from current trends where as much as 85 to 90 per cent of water use is for agricultural purposes (UNEP 2002c).

The reform in the agricultural sector encourages many foreign investors to establish farms. The availability of good land and water resources, low-cost labour and enabling national policies and laws encourages this development. The industrial sector also flourishes in light of the reform in policies and availability of raw materials. Industrial water use therefore increases to 19 per cent of the total use. Improved regulations require that industrial waste must be properly treated before it is disposed of. Samples of industrial wastewater are collected randomly and analysed to ensure that they comply with the regulations and are safe for disposal, and systems for self-monitoring are also established. This level of monitoring and enforcement is made possible through increased investment in human resource capacity.

Special attention is paid to the rural population. International aid and donors focus on water supply and sanitation projects in these areas. The target is to develop sustainable means of water supply and sanitation, using appropriate technology, which meets the needs of rural people. Partnerships are developed with potential users, who provide in-kind contributions. As an integral part of this investment, public education activities are embarked upon that focus on maintaining the new systems and infrastructure, to ensure the sustainability of supply. These initiatives are complemented by national level reforms, including in supply and treatment of water resources. Privatization of the water supply utilities, especially those supplying water to the urban areas, is seen as a necessity if the efficiencies of those utilities are to be increased. However, privatization usually comes with a higher cost of services and tariffs to the users. The tangible improvements in the quality of the services justify the higher costs to the users. In addition, higher living standards as a result of economic reforms and growth mean that most of the population can afford the high service fees and tariffs.

Nevertheless, as more people are provided with safe potable water, and due to the higher living standards, domestic water use sharply rises to 36 per cent of the total use. This is not necessarily a good indicator of better water availability to more people, but is related to overuse of water among the more wealthy in urban areas. In fact, although rapid population growth is successfully controlled through better education of young people, 26 per cent of the 1 581 million people in Africa still have inadequate access to water. Public campaigns and awareness programmes target wasteful use of water. Every saved drop of water simply means better water availability to others in the same country and across the boundaries in downstream countries.

Many African governments adopt new policies or re-emphasize existing policies for stakeholder participation in management and decision making in water-resources-related issues. The rationale is that if the stakeholders are involved in water resources management, they will develop a sense of ownership and become key players in sustaining those resources. Formal and informal water-user associations are established to promote better communication and exchange of information between government and users. One of the lessons learned is that illiteracy is not a justification for excluding users from decision making. These associations are successful and are replicated at the national level.

Policy lessons from the scenarios

The different scenarios illustrate the potential for meeting agreed goals and targets, such as those of the Africa Water Vision 2025 (ECA and others 2000) and the MDGs under different policy options. In particular, opportunities for realizing the MDG targets related to access to water and sanitation are revealed. In addition,

the different scenarios hold distinct potentials for meeting economic and development opportunities. Similarly, as illustrated in Box 4, different governance choices will also affect opportunities.

Figure 11: Population experiencing inadequate access to water in the different scenarios

Figure 12: Water availability and use under the different scenarios

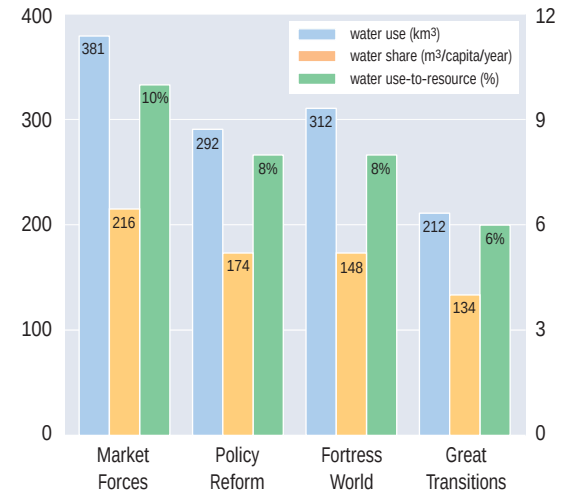
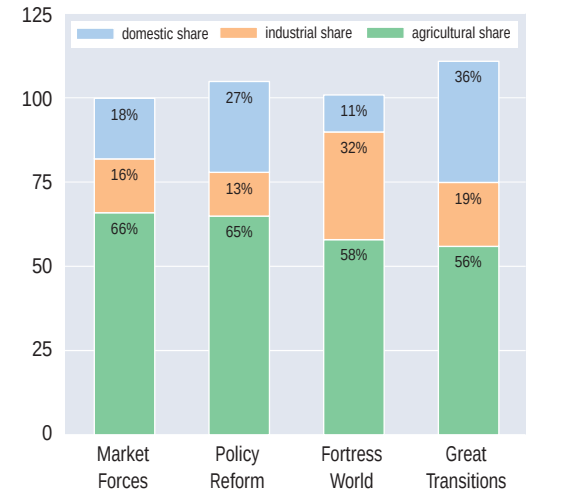


Figure 13: Water use by sector under the different scenarios



Taken as a whole, the scenarios demonstrate the complexity of the challenge of optimizing water use so as to meet human well-being and development targets, while ensuring the sustainability of the resource. One policy lesson that comes from various scenarios is the opportunities at all levels offered by

Box 4: Making the choice to increase stakeholder participation...

African governments follow the global move and start adopting policies to facilitate public participation in decision making regarding planning, development and management of the countries' water resources. The main objective of the reform is to adopt policies requiring open channels within the government agencies that provide for interactive two-way stakeholder participation in water development, management and decision making, and to describe mechanisms and procedures for implementing those policies.

Based on experiences from other leading countries in public participation, there is recognition that such participation in the decision-making process strengthens the fulfilment of public policies and contributes to the transparency of public and private action by providing opportunities for cooperation and coordination between government and stakeholders. This builds trust among the participants and leads to the creation of long-term collaborative relationships. This is particularly true in dealing with issues related to the environment and sustainable development and management of basic resources, such as water, which affect people from all segments of society.

However, the introduction of participatory decision making is a relatively long process within the context of the institutional, social and economic characteristics of the African societies and is faced with some difficulties. Lack of a clear distinction between the responsibilities and duties of government organizations and the private stakeholders causes some confusion to both. Low education percentages in some of the countries make it difficult for the larger sector of the public to grasp the concept. For many, having a say in decision making is seen as a tool for achieving personal benefits instead of aiming at the national scale. Training and public awareness programmes are started to help tackle some of these difficulties.

Some of the stakeholders are cautious when introduced to participatory decision making. They fear that their involvement in resource management will come at large financial costs to them. Infrastructure maintenance has been in many cases very poor under government spending. The stakeholders are worried that they will have to come up with the large sums of money required for maintaining the deteriorated infrastructure.

Despite the slow progress in activating participatory decision making in the water resources sector, the positive results are both encouraging and promising. For instance, the negotiations between the various water-user sectors on their water allocations are now carried out by the stakeholders. The general public develops better understanding of the severe water shortage problem in the region and starts to come up with its own demand-management actions. Contacts and links between government agencies and the private sector are improved. The management and operation burden on governments is reduced leaving them to focus more on the environment.

adopting IWRM. Addressing and reconciling different needs in an equitable and productive manner will require policy and law reform, as well as investment in technology. Building human resource capacity also emerges, in several scenarios, as an invaluable means for enhancing opportunities. Further, establishing collaborative management regimes at the national as well as at the inter-state level is paramount to achieving sustainable water management.

ATMOSPHERE

Energy is essential for the effective functioning of human society; however, its production and use come with environmental costs. Energy plays a critical role in the development process, as a domestic necessity but also as a factor in production. The cost of energy directly affects prices of other goods and services, and the competitiveness of enterprises. The opportunities and challenges associated with this sector are discussed more fully in Chapter 2: *Atmosphere*. This section presents scenarios which focus on the different policy options in the energy sector and how this may impact on goals and the available resources.

The opportunities for creating a sustainable energy supply are closely related to investment in renewable energy, the development of appropriate energy technology, and the strengthening of existing energy resource monitoring programmes. The search for abundant and cheap energy could focus on rationalizing the territorial distribution of existing but unevenly allocated energy resources. Goals in the energy sector include:

- Developing cleaner energy sources;
- Improving access to reliable and affordable commercial energy supply;
- Improving the reliability, as well as lowering the cost, of energy supply to productive activities; and
- Reversing environmental degradation that is associated with the use of unclean fuels.

The main threat to achieving these goals is climate change and variability, and its impact on environment, health, food security and human settlements.

Improvements in energy infrastructure occur, including the development of pipelines and electricity grids, to ensure better supply to consumers.

Market Forces scenario

Under the *Market Forces* scenario, manufacturing accounts for more of Africa's economy and employment, and this results in an increase in air pollution. Additionally, under this scenario, there is an increase in available commercial energy resources. Improvements in energy infrastructure occur, including the development of pipelines and electricity grids, to ensure better supply to consumers. Per capita consumption of conventional energy resources increases as economic developments in the *Market Forces* scenario make inroads into widespread and severe poverty. This also results in a declining reliance on biomass.

As Chapter 3: *Land* shows, the region is rich in mineral resources; however, there is considerable variation between the sub-regions, and energy production patterns reflect this. Coal production is concentrated in Southern Africa (mainly South Africa). Natural gas production, on the other hand, is overwhelmingly concentrated in Northern Africa (mainly Algeria and Egypt). Crude oil production takes place in all sub-regions except Eastern Africa. Nevertheless, the top crude oil producers are concentrated in Northern Africa (Algeria, Egypt, and Libya), Western Africa (Nigeria) and Southern Africa (Angola and South Africa). In several countries, oil has been a significant driver of economic growth (ECA 2005). Against this backdrop, in the *Market Forces* scenario emphasis is placed on energy production, trading and transportation.

African carbon emissions from fossil fuel consumption (excluding natural gas flaring) have been growing rapidly, although from a very small base. However, as shown in Chapter 2: *Atmosphere*, contributions to carbon emissions are relatively small, with Africa contributing only about 3.6 per cent of total emissions (UNSTAT/CDIAC 2005). In this scenario, with a growing focus on renewable energies including natural gas, hydropower and nuclear energy, emissions of carbon from coal fall from 42 per cent of Africa's emissions in 1997 to less than 33 per cent in 2020.

Carbon emission levels generally mirror patterns of energy use; thus South Africa and Libya have among the highest emission levels, and Swaziland and Mauritania among the lowest (UNSTAT/CDIAC 2005). Under the *Market Forces* scenario, energy use increases more rapidly in some areas, as a result of higher levels of industrialization and increased domestic appliance use. However, the relatively high emissions from transportation decrease.

As shown in Chapter 6: *Forests and Woodlands*, woodfuel is the primary energy source in rural Africa.

This high dependence has implications for pollution and deforestation, which in turn impacts on the sustainability of other environmental goods-and-services, including land resources. As shown in Chapter 2: *Atmosphere*, the high dependency on biomass contributes to indoor pollution, which has direct implications on the health of women and children, particularly those under five (Gordon and others 2004). Under the *Market Forces* scenario, the fuels available to and use patterns by the poorest communities do not change appreciably, and thus patterns of environmental and human health deterioration continue. Consequently, finding alternatives to woodfuel becomes a concern under the *Market Forces* scenario.

Africa is home to the world's second-largest rain forest, in the Congo basin, and consequently plays an important global role as a carbon sink. Under the *Market Forces* scenario, this becomes the basis for increasing global interest in Africa.

As discussed in Chapter 8: *Interlinkages: The Environment and Policy Web*, gas flaring has considerable environmental and social costs. It not only contributes to GHG emissions but is a waste of potentially valuable energy sources. The gas is burned off rather than captured for use because of limited gas infrastructure. Under the *Market Forces* scenario, gas flaring gives way to gas utilization as a result of improved market conditions and improved opportunities for investment in advanced technology.

The key policy lessons from the *Market Forces* scenario include: the need to minimize the impact of the global economy by adopting more interventionist mechanisms; the promotion of entrepreneurship at the local level through the adoption of financing mechanisms and providing subsidies that encourage the adoption of sustainable energy options; and diversifying the economy. Integrating the economies of AU member states is seen as an important intervention to support sustainable energy approaches.

Policy Reform scenario

In the *Policy Reform* scenario, concern mounts over the impact of increased noxious and GHG emissions due, in part, to heightened industrial development and growing consumption. While in the *Market Forces* scenario, demographic, economic and technical factors drive energy use, in the normative *Policy Reform* scenario climate change mitigation targets drive the trends of the energy sector.

Governments introduce environmental and social policies to improve environmental stewardship and social equity. At the regional level, AU members agree to adopt legislation that requires energy and environmental audits. Consequently, this becomes one criterion for evaluating the performance of member states under the APRM. It also results in energy service providers improving efficiency and adopting demand-driven management projects, on behalf of clients mainly in the commercial, mining and industrial sectors, for a fee. The fee is based on the extent of reduction in energy consumption as indicated in the billing system. More consumers accept responsibility for environmental restoration, paying the private sector to undertake these activities. Payment is determined by the extent of environmental reparation. These initiatives have several important spin-offs, including job creation. This in turn makes a contribution towards the MDG target to halve by 2015 the proportion of people living on less than a dollar day and those suffering from hunger.

An Africa-wide environmental and social scorecard system is introduced in industries, the mining sector and commercial firms to accelerate the drive to balance the three pillars of sustainable development.

As a result of regional protocols introduced to control noxious and GHG emissions, tradable pollution permits are put in place to curb the emissions burden. An Africa-wide environmental and social scorecard system is introduced in industries, the mining sector and commercial firms to accelerate the drive to balance the three pillars of sustainable development. The scorecard provides credit points to industries and mining and commercial firms that undertake noteworthy environmental and social projects. The credit points are taken into account during the awarding of government contracts. Non-governmental organizations (NGOs) take the scorecard issue further by educating and urging civil society to base their patronage of firms on accumulated credit points. In this context NEPAD publishes accumulated credit points every six months to facilitate access by the public. The public continues to show a keen interest in the scorecard by making regular phone calls to a dedicated hotline set up for this purpose.

Meanwhile a recommendation of a NEPAD task team, established to ensure the adoption of programmes and institutions in support of sustainable development targets, which identifies the achievement of sustainable energy systems as a major driver to economic development is adopted. The recommendation includes practical and implementable measures for the efficient use of energy,

energy supply, the adoption and development of cleaner technologies, and the use of new and renewable sources of energy. These strategies are similar to those already being promoted to address increasing energy demand, from economic and population growth, such as use of a mix of fuels, technology improvement, the alteration of energy prices, and abatement measures (UNEP 2002a).

Improved technologies for domestic use in rural areas are also an important focus; these include investing in the development of energy-efficient charcoal kilns, and in improved and environmentally-sound stoves. In this scenario, all countries move towards using sustainable energy sources and systems – in particular those pertaining to new and renewable sources of energy, cleaner energy technologies and energy-efficient practices. Countries introduce legislation to discourage the supply of energy from unclean sources, including those that are carbon-intensive and contribute to the burden of global climate change. Given the unsustainable harvesting of trees for charcoal production, governments put in place incentives to turn marginal lands into plantations for use as fuelwood and for production of charcoal.

Simultaneously, legal measures that promote more efficient energy use and cleaner production, and discourage consumption are adopted. These measures encourage FDI and donor support for the development of home solar energy systems, wind turbines, geothermal energy, tidal wave energy, bio-energy and small hydropower schemes. To encourage investment and the development of cleaner technologies governments waive duties and taxes on new and renewable energy equipment and machinery.

Legal measures that promote more efficient energy use and cleaner production, and discourage consumption are adopted.

Considering the fact that finance plays a major role in the adoption and roll-out of technologies, member states of the AU introduce innovative policies, after consulting financial institutions, to facilitate the granting of loans to projects on energy and environment.

At the request of the AU, governments enact regulations concerning the practice of bush burning for hunting game and also slash-and-burn agriculture. This contributes to improvements in air quality and a decrease in the emission of GHG. As a result farm owners begin to explore the opportunity of earning carbon credits under the World Bank's Community Development Fund of the Prototype Carbon Fund. Some of the farmers apply directly to the Designated National Authorities in the various countries to register projects under the Clean Development Mechanism (CDM) with a view to monetizing their share of accrued carbon credits.

The policies that governments introduce under the *Policy Reform* scenario contribute to improvement in environmental accountability and reduction in poverty. To curb rising pollution from increasing industrial activity, governments enact environmental regulations. Government officials study the costs-and-benefits of the polluter pays principle as a tool to control pollution. Governments become proactive and focus on improving the performance of their own energy facilities. Sustainable energy technology transfer begins to show results, as home solar energy systems are increasingly being installed in the region.

Fortress World scenario

Under the *Fortress World* scenario, atmospheric quality does not improve. Environmental policies are inward-looking, and focus predominately on improving the immediate opportunities available to the elite.

Under this scenario, there is little investment in alternative energy, and Africa continues to rely on biomass for its energy needs. Consequently, deforestation persists with run-on problems such as erosion and decreasing availability of non-timber forest products (NTFPs), which in turn impacts negatively on rural livelihoods. Negative health effects increase, due to the smoke generated in the use of woodfuel. Since the availability of medical facilities is restricted to elites, the average life span continues to decline. Meanwhile, the production of energy using established fuels is insufficient to satisfy rising demand and, in the absence of alternative fuel, the poorest communities rely more heavily on forest resources thus perpetuating the cycle of environmental degradation.

Under the *Fortress World* scenario, addressing global climate change is not a top priority. Deforestation continues unabated and there is little interest in the implications of this for global warming. Gas flaring continues to be practised. Increasing climate variability has environmental and human well-being impacts. Decreasing rainfall places stress on already fragile subsistence agriculture that forms the basis of many rural livelihoods, increasing food insecurity and ill health. These areas are poorly resourced, and most people are unable to mitigate, adapt to or cope with climate change. For example in Uganda, in the absence of temperature-resistant coffee varieties, a temperature increase of 2° C can lead to the devastation of most of

the coffee plantations, severely impacting on the macro-economy of the country (UNEP 2002b). Forest cover and agricultural activities continue to suffer due to adverse impacts of climate change, particularly in the areas outside the walls of the enclaves.

Demand for renewable energy technologies declines. Investment in energy-supply strategies based on equity and increasing rural opportunities, such as national electrification programmes, also declines. As poverty increases in the rural areas the disposable income of domestic consumers decreases, and this, along with decline of public sector energy budgets, results in the declining use of solar energy in rural electrification. Despite the fact that in Africa hydroelectric power is the only significant grid-connected renewable energy source, hydroelectricity's share of total installed electric capacity declines as inadequate maintenance causes installations to become less efficient. Unexploited hydropower potential in the Congo, Nile and Zambezi basins is not developed.

Under the *Fortress World* scenario, the concentration of businesses and commercial concerns in the hands of the relatively small elite, who erect strong entry barriers against outsiders, continues to prevail. Frustration, despair and gloom continue to define the fate of the disadvantaged majority whose lives are characterized by a vicious cycle of poverty. Continued emissions, mainly from combustion of fossil fuels in internal-combustion engines, exacerbate air pollution problems, especially in urban areas. Given the focus on the needs of a minority, investment in vehicles for public transportation and the lower end of the market is not a priority. Therefore, vehicle age increases and maintenance standards decline.

Great Transitions scenario

In this scenario, an increased emphasis is placed on the opportunities that scientific and other forms of knowledge and technology offer for improved environmental management. This includes ensuring that proper systems are developed for the collection, coordination and dissemination of data.

Increasing attention is paid to finding alternatives to carbon-intensive energy given its contribution to climate change and environmental pollution. The supply of new and renewable energy resources becomes the norm as consumers reduce patronage of goods and services produced using so-called dirty fuels and inefficient energy systems. Consumer action is based on improved awareness of negative environmental impacts, and a growing commitment to the ideals of sustainable development. This development takes place against the backdrop of governments mainstreaming the environment in all development policies and programmes. With the growing importance of the global media, consumers are wary of the increasing incidence of floods, drought, extreme weather conditions, malaria and other diseases, and the loss of coastal resorts and recreational facilities due to sea level rise. Meanwhile the insistence of the West on patronizing of goods from Africa which are manufactured by cleaner production and sustainable energy accelerates the drive towards the harnessing of new and renewable sources of energy.

Sustainable energy strategies focus on the needs of rural communities and in particular poor people.

The fact that energy systems underpin economic, social and cultural growth leads to investment in sustainable energy. Achieving equity and eradicating poverty are widely accepted goals. Consequently, sustainable energy strategies focus on the needs of rural communities and in particular poor people. Reducing dependence on biomass in rural areas is an important objective, and clear targets are established as the basis for monitoring progress in this area.

Meanwhile, advocacy and education by NGOs and government-led interventionist strategies in partnership with the donor community continue to bring good results. Throughout the region, cleaner production methods, lower consumption, and supply and demand management become commonplace. Financial institutions adopt green policies, including, for example, reducing interest rates on loans that are used to fund sustainable energy and environmental reparation activities. This triggers a deluge of applications for loans for such activities, which results in more investments flowing into this sector. The public shows support for efforts to provide sustainable energy by agreeing to pay premium prices for it. Existing bagasse-fired power stations undergo revamping to increase their installed capacity as more investments flow into the sugar-cane industry.

The effect of these actions leads to improvement in air quality, considerable reduction in transboundary air pollution, effective mitigation of GHG emissions and improvements in health. Premium electricity tariffs are reinvested in modernizing existing power plants. Workers join newly formed safety, health and environment associations in their places of work, while

education authorities make energy and environment studies compulsory in schools and colleges. Energy and environmental management in industries, mining and commercial operations are made mandatory for AU member states under the auspices of a newly formed regional sustainable energy and environment accountability agency. The use of aerosol sprays that harm the ozone layer is discontinued due to availability and application of cheaper ozone-friendly substitutes. Incidences of acute and mild respiratory illness among workers and schoolchildren continue to decline resulting in less worker absenteeism, enhanced productivity and increased attendance at schools.

Natural resources accounting, in particular cost-benefit analysis of GHG and noxious gas mitigation measures, continues to inform GDP calculations among environmentally conscious AU member states. This increases GDP, facilitating budgetary allocations to areas of the economy previously deemed not quantifiable. A regional commission for economic analysis is established under NEPAD to support the inclusion of natural resources accounting. There are various regional and sub-regional initiatives focusing on building the capacity of additional AU members to undertake natural resources accounting. Additionally, these AU member states invest in peer learning from those already using these accounting techniques. Business leaders in collaboration with intergovernmental regional organizations establish a company to buy carbon credits from Africa-wide NEPAD projects. This results in the establishment of a secretariat at the Head Office in Addis Ababa to administer the exchange, with local offices in various AU member countries. Governments set up monitoring systems to ensure that investors comply with directives to transfer

Box 5: Opportunities offered by planting woodlots on marginal land…

Women and girls in rural areas spend a considerable amount of time searching for woodfuel for cooking, space-heating and warming. This leaves these women little time to engage in commercial activities, other household chores and recreation. Environmental degradation results from unbridled harvesting of trees for use as woodfuel and perpetuates the cycle of poverty. Rural communities have less access to modern energy sources like electricity, liquefied petroleum gas and kerosene. As a consequence of government concerns about the energy demand situation in rural areas, including its effect on the well-being of women and girls, they contact NEPAD for assistance in finding a solution to this problem.

NEPAD tasks its research and development arm to conduct intensive research into finding appropriate energy for use mainly in rural areas. The idea of woodlots crop up. However, the problem with this is the fact that many countries grapple with drought for a considerable length of time in the year. One researcher identifies a drought-resistant species, *memuna*, which requires relatively less water to grow, and matures within two years of planting. Pilot farms are established on marginal lands in six climatic zones and produce remarkable results within two years. Governments put in place policies motivating the use of marginal lands for planting *memuna*. *Memuna* is regarded as a means for poverty alleviation and an antidote to environmental degradation, particularly in rural areas. *Memuna* catches the attention of rural communities who work with NGOs and donor agencies to develop plantations on marginal lands. The NGOs are sponsored by donor agencies to undertake courses in silviculture, including proper harvesting methods and making of charcoal from *memuna*. The skills are imparted to some of the rural dwellers. A thriving industry is established in which *memuna* is used to make charcoal and for direct use as woodfuel. Residues from harvesting *memuna* are found to contain wood alcohol which is then used in industrial applications.

Entrepreneurs in the communities form cooperatives to export *memuna* to markets in Europe, earning a lot of foreign exchange. The communities set up artisan shops to sell crafts made from *memuna*. Furthermore, small-scale biomass-fired power stations are established, using *memuna* as the feedstock. These power stations provide heat and power to the communities. Environmental degradation resulting from unbridled harvesting of trees is reduced to the barest minimum due to the planting of *memuna* on marginal farms and its use as an energy carrier. The creation of jobs helps to alleviate poverty and extreme hunger – a contribution towards achieving the MDGs.

The United Nations Environment Programme (UNEP) bestows a prestigious award on NEPAD for instigating the research leading to the discovery of the drought-resistant *memuna*, with its manifold but important uses on the African continent. More importantly, the award recognizes use of marginal lands that would otherwise have been left fallow for the cultivation of *memuna*.

appropriate technologies on renewable energy systems and improvement in energy efficiency of goods and services. Additionally, operating obsolete and inefficient energy systems attracts surcharges.

Improvement in sustainable energy supply leads to significant reduction in transboundary pollution, improving health. There is continued commitment to promoting and developing new and renewable sources of energy. Globally, there are reports of energy shortages. Corporate Africa, concerned with the impact of energy shortages on their businesses, invests in new and renewable sources of energy. Furthermore, corporate Africa begins to use eco-friendly cars and patronize companies producing and marketing bio-fuels. The assembly of eco-friendly cars increases to meet the rising demand. The proactive harmonization of energy policies and legislation across African countries lead to cross-border energy trade, providing the best opportunity for sharing the region's energy resources. This is noteworthy, considering the uneven endowment of energy resources across Africa.

Policy lessons for the *Great Transitions* scenario include encouraging and mobilizing public-private-partnerships to uplift and empower poor people, creating an enabling environment to facilitate the development of sub-regional energy pools, integrating economies and promoting trade in energy, attracting private-sector investments in the energy and transport supply, and involving poor people in the decision-making process.

Policy lessons from the scenarios

Given the multiple impacts of unsustainable energy use at different spatial levels (local, national, regional and global) and for different sectors (industry, human settlements, health, agriculture biodiversity, especially forests, and climate) within in various time frames, this must become a key policy focus. The scenarios offer multiple lessons for addressing the energy issues.

As the impacts of unsustainable energy use are not restricted to the country where such practices occur but are felt globally, this is an area where transboundary cooperation is essential. Without successful global cooperation the measures adopted in one country are unlikely to have a significant impact. Africa needs to focus on the opportunities for such global cooperation, while at the same time taking action at the regional, sub-regional and national levels. In all scenarios economic growth is a priority; however, the form of this growth will have important implications for atmospheric integrity. Adopting policies which promote the adoption of cleaner technologies is an important aspect of this. The scenarios offer various opportunities for this, including the use of market mechanisms, increased investment in R & D, and increasing engagement with the public.

COASTAL AND MARINE ENVIRONMENTS

Coastal and marine environments are important to the overall development of Africa in general and to some countries in particular. Chapter 5: *Coastal and Marine Environments* considers the opportunities and challenges these resources offer for development. The condition of coastal and marine resources is an indicator of overall environmental health. As the interface between the land and the ocean, it will always be prone to interferences from man and nature, the sources of the main driving forces and pressures affecting the coastal environment. Coastal and marine resources have a marked potential for tourism, biodiversity conservation, energy generation through tidal waves, oil and gas. These resources are threatened by coastal erosion, sea-level rise, destruction of coral reefs with the accompanying loss of coastal and marine biodiversity, solid waste management, pollution, salt intrusion in low-lying areas, and uncontrolled urbanization. The scenarios presented here look at the interplay between various drivers and how they influence the state of coastal and marine resources and the storylines offer options for policy packages that address these issues and threats in the region.

The condition of coastal and marine resources is an indicator of overall environmental health.

Market Forces scenario

In this scenario, the current trend of migration to the coast (UNEP 2004c) is likely to continue, and therefore coastal areas will continue to be areas for economic production. Coastal areas by their very nature are centres for commerce and trade. As economic centres, and because of the rich mosaic of environmental goods, coastal areas attract more and more people seeking to take advantage of those opportunities. Increasing concentrations of people live within 100 km of the coast. They migrate to these areas not only to exploit the available coastal and marine resources but also to explore the increasing opportunities for economic development being concentrated along the coastal areas. Coastal areas offer employment opportunities,

economic prosperity, new industries, improved regional infrastructure, enhanced educational opportunities and increased tax revenues. However, as coastal populations grow, so does the stress placed on the environment. A major assumption of this pattern of development is that an economic base is developed from which funds can be provided to ameliorate the impacts of growth.

As a result of this growing population, there is likely to be increasing demand for both marine and land-based resources. Demands for energy and natural resources promote offshore exploration, drilling and mining. These activities impact on marine habitats and water quality through physical disturbances, introduction of pollutants and suspension of sediments in the water.

The growing populations result in the conversion of open land and forest for activities such as commercial development, agriculture, forestry and other activities that provide economic growth. In addition to physically altering the habitat, coastal development reduces permeable surface area, thereby increasing the rate of run-off and impacting on water quality by transporting sediments, toxic chemicals, pesticides, herbicides, pathogens, nutrients and other pollutants to local waterways. With the loss of biodiversity, and other damage to the ecosystem, the self-cleansing properties of water will be reduced (MA 2006).

Fewer and fewer original coastal people have direct access to the resources that these coastal environments provide, as tourist establishments "privatize" the coast.

The demand for water, especially for agricultural, industrial and urban domestic uses, increases. In an attempt to meet these demands, more dams are built and more groundwater is extracted, and this affects coastal environments such as wetlands and mangrove forests. In the *Market Forces* scenario, attempts to correct these imbalances are made through the introduction of new water pricing systems. These are used to recoup the costs of supply and establish a mechanism for the economically efficient allocation of a limited resource. It is also plausible that as water is more highly valued, water recycling will be encouraged. To complement these market tools, regulations to control pollution of water bodies by agricultural, industrial and domestic effluents are introduced. As urbanization and inland activities increase, so do the volumes of municipal and industrial waste discharged into local waterways. This impairs water quality, while at the same time demands for potable water and wastewater treatment increase. Whether from run-off or discharges, excessive nutrients, sediments, pathogens and toxic chemicals can impair water quality which in turn results in the reduction or loss of fishing opportunities, changes in wildlife populations, a reduction in the value of wetlands and estuaries, decreases in wetlands available for water treatment and decreased protection from storms. The problem of waste and litter further exacerbates the situation. The impacts of pollution worsen through eutrophication of coastal waters and the intensification of hypoxia and anoxia.

In bustling centres of development, both fisheries and tourism grow and these place severe pressure on coastal areas. Important impacts on the environment include the degradation or loss of coral reefs, mangroves and coastal flats. Fewer and fewer original coastal people have direct access to the resources that these coastal environments provide, as tourist establishments "privatize" the coast. Coastal erosion is also often related to patterns of human settlement. However, if properly managed, tourism can create incentives and generate the money needed for managing these coastal and marine resources. The need for careful management of these resources emerges as a concern but it will not necessarily be attended to. In other areas, where careful coastal zone planning is implemented and maintained, the high environmental qualities of these ecosystems are maintained and sustainable benefits accrue.

Increasing demands for shellfish and commercial fish spur competition and technology improvements to increase fishing capabilities. Overexploitation, in concert with impacts from pollution, habitat degradation, habitat modifications such as dams, and by-catch waste, results in a depletion of fish stocks, placing some ecosystems on a path towards unsustainability, and threatening the viability of the fishing industry. The deliberate introduction of IAS to promote economic interests results in unexpected ecological impacts to the coastal and marine environments, with longer-term socioeconomic impacts. Predation and competition by these non-indigenous species results in the eradication of some native populations and the drastic reduction of others. The colonization of ecosystems by IAS results in the degradation and loss of wetland vegetation and other submerged aquatic vegetation. When these problems arise, the market sets in motion mechanisms for their correction.

The operation of the *Market Forces* scenario leads to major modifications of the coastal and marine environment through, among other things, development of dams, flood control channels, dredging, water

diversions and development in wetlands. These modifications have profound impacts on coastal and marine habitats, changing the natural flow, timing and volume of freshwater inflow and sediment depositional patterns in bays and estuaries. Alteration of flow impacts on marine systems by transporting pollutants and resuspending sediments and toxic chemicals and consequently increases the potential for concentration of toxins in marine organisms, and in people.

Policy Reform scenario

In this scenario, coastal areas will remain important centres of human activity. Massive tourist enterprises interspersed with coastal and marine industries are evident along the coast. Policymakers faced with the degradation of coastal and marine environments, including the loss of coastal flats and sand-dune degradation, focus on reclamation of intertidal and sub-tidal mudflats and sandbanks and damage to coral reefs. The increased use of coastal resources for tourism and recreation alongside human dependence on the coastal and marine zone for development, trade and food will be sufficiently high to make ICZM a priority. The goal of ICZM is to "attain sustainable development of coastal and marine areas, to reduce vulnerability of coastal areas and their inhabitants to natural hazards, and to maintain essential ecological processes, life-support systems and biological diversity in coastal and marine areas" (Cicin-Sain and Belfiore 2003). It is "multipurpose-oriented; it analyses implications of development, conflicting uses, and interrelationships among physical processes and human activities, and it promotes linkages and harmonization between sectoral coastal and ocean activities" (Cicin-Sain and Knecht 1998).

The coastal and marine areas, especially those of the WIO islands, are prone to natural disasters such as tropical cyclones and tsunamis. These disasters will continue to occupy a focal point not only for discussion but also for the institution of mechanisms for their prevention. While many of these disasters may not be averted, their effects can be reduced considerably through the institution of early warning systems. In the *Policy Reform* scenario formalized early warning systems will be instituted and many of these will be based on inter-state cooperation.

There is a cautious approach to creating new policies, and attempts are made to harmonize existing initiatives. There are concerted efforts to revitalize existing MEAs and establish systems to promote the realization of agreed objectives. At the same time countries develop more forceful policies and will put in place mechanisms for realizing the goals of government policy. The *Policy Reform* scenario integrates environmental objectives into economic development plans at different levels. Institutions are empowered to effectively enforce and monitor the implementation of environmental laws, sub-regional and regional protocols, as well as MEAs. Sub-regional organizations undertake environmental audits of their member states to determine whether or not they are implementing their own set environmental policies. This is incorporated in the APRM. Assessing progress towards achieving the MDGs takes into account environmental, social and economic interests. Efforts are made to take into account gender dimensions in articulating policy reform at different levels and, pursuant to this, an African gender and development index is introduced in all 53 African countries.

At the national level, policies and activities are adopted to address the plethora of problems, but these will have varying levels of success:

- Policies to help people to adapt to the potential marine inundation of low-lying areas from sea-level rise are adopted.
- Policies and action for reducing marine pollution include developing infrastructure for treating wastewater before it is disposed of in the sea are introduced.
- Laws and regulations are issued or revised in order to protect the coastal areas and water bodies from unplanned development and the associated environmental impacts. Environmental impact assessments (EIAs) are routinely carried out for projects with potential impact on the coastal and marine resources. Field inspection by specialized government agencies ensure that these projects follow the mitigation measures proposed in their EIAs. New coastal areas and inland water bodies will be protected by means of laws and good policies for the management of coastal areas.
- Pollution and waste management laws to reverse the current tend of dumping solid wastes on beaches and in the sea are adopted. International conventions against the dumping of hazardous wastes are respected.
- Appropriate laws for the control of erosion become instituted to reduce overall levels of loss of coastline from development, including the ever-expanding tourism sector.
- Re-establishing inshore fishing proves more protracted than envisaged due to continual infringement of close season rules and the use of fine nets for coastal fishing in small boats.

- Deep-sea protection arrangements prove satisfactory but the region is slow to respond to the opportunities, with continual haggling over the internal division of the territory and the sharing of protection and development costs.

Fortress World scenario

In this scenario, urbanization and migration to coastal areas will increase, placing new demands on coastal and marine resources for food. Tourism grows, as the elite aggressively markets coastal areas for tourism through multinational companies. Increasing tourism opportunities, particularly in the ecotourism sector, contribute to better management of environments, such as forests and wetlands, that are integral to tourism. However, as a result of increasing population and tourism, there is overfishing and fish stocks are depleted.

Growing human settlements generate new sources of pollution and waste. Coastal and marine pollution increases, as investment in public sector services, including the treatment of sewage, declines. Valuable coral reefs and mangrove forests become increasingly vulnerable and threatened as a result of poor environmental management, development and tourism. Despite the existence of laws controlling the exploitation of coastal resources (mangrove swamps, fishing), development activities continue and contribute to increasing coastal erosion.

Coastal and marine pollution increases, as investment in public sector services, including the treatment of sewage, declines.

Infrastructural and service development is concentrated in the tourism sector and inadequate attention is given to non-elite settlements. The rate of infrastructure development is much slower than the rate of population increase, leading to growing incidence of slums and pollution. People in the fortresses take some care to minimize or mitigate the magnitude of the adverse environmental impacts on new tourism developments. However, to support the construction industry, the elite overexploit the soil along the coasts, contributing to coastal erosion and damaging coastal ecosystems. Many rare marine species are threatened or become extinct. The current practice of groundwater abstraction increases, which in turn increases the incidence of seawater intrusion, which renders many wells unusable.

Coastal and marine areas are seriously affected by military operations, piracy and overfishing using fine nets, dynamite and seabed trawling. Oil pollution from major tanker spills and accidents at deep-water oil wells have scarred coastlines and caused irretrievable damage to marine stocks. These trends continue.

Great Transitions scenario

In this scenario African countries recognize the importance of their coastal and marine environments, not only for their intrinsic value but as valuable resources capable of transforming lives and economies. Consequently, there is general agreement that these environments must be well protected and managed.

Regional organizations increasingly come to view the problems of coastal and marine environments as those of both landlocked countries and coastal counties. Organizations for managing shared waters are formed and work actively to identify the full suite of challenges faced in coastal areas throughout Africa. They also identify and reach consensus on practical steps necessary for cooperative management of coastal and marine resources. This positive development leads to the formulation of laws about resource conservation and utilization along coastal areas. The links between freshwater and coastal systems are acknowledged, and there is increasing cooperation with catchment management authorities around issues of discharge of water, and pollution from sediments and nutrients. Collective responsibility for pollution and waste management becomes the basis for action. These developments lead to decreases in the overall pollution of coastal and marine environments and to an increase in the breeding of fish and the growth of the fishing industry. Furthermore, the harbours become more environmentally friendly.

The formation of international cooperation initiatives also improves relations between adjacent states with contiguous coastal lands. For instance, coastal lands in Western Africa are treated as one long continuous zone requiring integrated planning and development. The current trend of creating transboundary natural resource management areas, such as the Benguela Current Large Marine Ecosystem (BCLME) established by Angola, Namibia and South Africa in 1999, continues and new joint-management areas and marine parks are established.

There is the realization in all coastal countries that these environments are clearly under serious stress and in need of an integrated and effective planning and management regime. Consequently, ICZM has gained growing acceptance as the logical approach to facilitate vertical and horizontal integration within governments

and ensure multi-stakeholder involvement in developing solutions. Therefore, as an aspect of the management of coastal and marine areas, planners work with coastal communities, state coastal zone managers, NGOs and other stakeholders. Effective integrated management leads to sustainable use and management of coastal and marine resources. Under the *Great Transitions* scenario, coastal and marine zone management involves:

- Strengthening inter-sectoral management through improving training, legislation and staffing;
- Preserving the biological diversity of coastal ecosystems by preventing habitat destruction, pollution and overexploitation;
- Promoting the rational development and sustainable use of coastal resources;
- Prohibiting or controlling developments in sensitive areas along the coasts;
- Prohibiting the direct disposal of all types of waste, including chemical and toxic wastes, into the sea;
- Refusing licences for projects that affect sedimentation or erosion of shorelines; and
- Issuing guidelines to boats, divers and fishers regarding safe practices in territorial waters and protection of marine life.

Policy lessons from the scenarios

Coastal and marine environments are particularly sensitive. They face increasing pressure and threats from development and economic activities. These areas also have a high level of vulnerability to climate change and sea-level rise, and natural phenomenon and disasters. Consequently, coastal and marine areas require a high level of care.

The scenarios presented here have shown how coastal and marine areas will fare under the assumptions of the *Market Forces*, *Policy Reform*, *Fortress World* and *Great Transitions* scenarios. It is clear that to promote sustainable development in these environments, the "business as usual" approach of the *Market Forces* scenario is not feasible. Responses under the *Fortress World* scenario exacerbate stress rather than mitigate it. The choice for Africa is to be guided in its developmental efforts by either the *Policy Reform* or the *Great Transitions* scenarios.

The *Policy Reform* scenario has its attractive qualities for development in general and coastal and marine areas development in particular. First, it adopts an incremental approach to planning and decision making. It will usually involve the periodic setting of objectives and goals on aspects of the environment, and then putting in place mechanisms for attaining these goals. For much of the history of African development, this has been the approach taken. The fact that environmental problems, especially along the coasts, have neither been eradicated nor seen to be decreasing at acceptable rates is an indication that a *Policy Reform* scenario for coastal and marine area management is inadequate. The *Great Transitions* scenario seems to offer better opportunities for development that is consistent with Africa's aspiration. The challenge is how to translate the charts of the *Great Transitions* to viable policies for the development of the coastal and marine areas.

The adoption of the Great Transitions scenario implies the acceptance of the need to define a sustainable future on the one hand and to institute the mechanisms for attaining this future on the other.

The adoption of the *Great Transitions* scenario for coastal and marine environments implies the acceptance of the need to define a sustainable future on the one hand and to institute the mechanisms for attaining this future on the other. This requires major shifts in current practice. Very few coastal countries in Africa have embarked on ICZM, and the practice in many countries is to concentrate on exploiting coastal resources such as petroleum and fishing. The implementation of MEAs remains a challenge. Nevertheless, there are some promising trends including the adoption of the NEPAD-EAP and the MDG 7. We can expect such a move to achieve some or all of the following objectives necessary for sustainable coastal and marine development:

- Integrate environmental issues into national development frameworks, especially in respect of poverty reduction efforts, including those of the MDG targets.
- Strengthen the decentralization of the management of coastal and marine areas and the role of civil society.
- Reduce environment-related conflicts between estate developers, civil society, industry and tourism.
- Enhance access to environmentally-sound and appropriate technology.
- Strengthen resource rights along the coasts and marine areas to reduce the vulnerability of poor people.

The doors we open and close are our choice.

Source: J.C. Mohamed-Katerere

SUB-REGIONAL SCENARIOS

EASTERN AFRICA

Energy and high levels of dependency on biomass in Eastern Africa present special challenges for human well-being and development.

Sustainable energy is about using energy wisely. This includes increasing use of energy produced by clean technologies or from renewable sources. Renewable energy sources (RES) include all sources of energy that are captured from natural processes, including water, solar, wind, geothermal and biomass. Some of these alternative energy sources are discussed more fully in Chapter 2: *Atmosphere* and Chapter 4: *Freshwater*. The scenario analysis reveals the different trends and opportunities associated with different policy choices.

Market Forces scenario

In this scenario, the sub-region focuses on the modernization of the industrial sector and greater integration into the regional and global economy. This is complemented by international commitments to investing in the transfer and development of sustainable energy technologies in order to improve the quality of life in developing countries, as agreed to at WSSD in 2002. Achieving this requires the commercialization of renewable energy technologies through innovative financing mechanisms, targeted subsidies and financing to reach the grassroots. Privatization is a key aspect of this. There is increased support to small and medium enterprises (SMEs) to help them become involved in the provision of rural energy and the maintenance of equipment. This improves levels of efficiency in the energy sector, and has the added benefit of freeing government funds, which can now be invested in the provision of social services.

There is increased support to small and medium enterprises to help them get involved in the provision of rural energy and the maintenance of equipment.

Policy implementation and reform is driven by the desire for economic growth. Agricultural modernization policies result in increasing agricultural commercialization and export-orientated production. This results in increased demand for energy to support production. Rural energy services adequately support improved productivity and reduce post-harvest losses through better preservation. There is marked expansion in the processing and export of commodities such as coffee, fish and cut flowers. The requirements set out by EIAs and environmental audits are enforced but only so as to avoid costly mistakes, such as in the Hola irrigation scheme along Tana River in Kenya that collapsed in 1989 due to a change in the course of the river (Blank and others 2002).

Land reform seeks to empower women and strengthen women's land rights, so as to make them

more effective producers. Improved land rights will be helpful for women seeking small loans or other support, and this may help increase investments in agriculture and thus productivity. Increased support to agricultural extension services, including powered irrigation and water supply, results in improved food production and this has positive implications for household nutrition and food security at the national level.

Improved regional cooperation leads to an improvement in the overall security situation in the sub-region. This along with the economic boom results in increased tourism. It is hoped that this may help reduce the conflict between communities and wildlife, for example in Il Ngwesi and the Trans Mara area in Kenya where they have been experimenting with a range of community and private enterprises. Chapter 3: *Land* discusses these tensions.

Industry and service sectors grow and opportunities for employment are rife. In order to reduce costs and profit losses due to climate-induced power shortages, energy-intensive industries like sugar and cement manufacturing increasingly employ strategies for co-generation of electricity using by-products of the agro-processing industry like bagasse, ethanol and coffee husks. Increasingly, China is looked to for lessons in mitigating climate extremes and achieving remarkable economic growth, based on its successes over the last decade.

Policy Reform scenario

Ensuring the availability of energy for development and improving the capacity for adaptation to climate change and variability are key focuses in this scenario.

Energy strategies to improve the opportunities available to poor people are incorporated into the national development frameworks. In particular, almost all the national Poverty Reduction Strategies explicitly state that improved energy services are required to achieve their poverty reduction goals. In one country, a target to increase access to energy by 10 per cent by 2012 is set. Although the government is committed to a programme of gradual substitution of woodfuel (which constitutes 96 per cent of domestic energy supply) by rural electrification, the associated costs mean that this process will be slow. The national target is not met. Given the continued dependence on biomass, deforestation increases and water catchment areas are degraded. This also impacts on the availability of water and thus the achievement of development targets to increase access to safe water. The water table recedes further, and, consequently, harnessing groundwater requires deep drilling, which in turn has cost implications for using groundwater. It is predicted that the target of reducing by half the number of people without access to safe water will only be met by 2025.

Governments invest in the development of large dams and reservoirs on the various river bodies to provide energy to the growing urban centres. This helps support increased economic activity and a middle class that can afford electricity begins to emerge. This has positive impacts for the environment as pressure on forests for charcoal for urban areas is reduced.

Energy strategies to improve the opportunities available to poor people are incorporated into the national development frameworks.

With climate change models indicating that lead time to GHG stabilization is at least 50 years, the governments of the sub-region realize that adaptation is just as important as mitigation. And although the sub-region is not a major contributor to the causes of climate change, the issue of implementation of the CDM takes centre stage. Countries of the sub-region prepare to cooperate with industrialized countries in order to enable them to comply with the emissions reductions requirement of the Kyoto Protocol. The planned adaptation projects are "climate-friendly" and designed to reduce the vulnerability to climate change by increasing the opportunities currently available. Collaborative rural electrification programmes are developed to increase access in rural areas to energy supplies through grid extension, independent power producers and solar or renewable energy. The emphasis is on small-scale projects in the renewable energy sector, such as solar photovoltaic (PV) systems. These are installed in rural areas, and distributed to ensure energy supply for clinics and hospitals, water pumps, schools, communications and domestic lighting purposes. In one country, the distribution of energy-efficient stoves gradually replaces the traditional stoves.

Fortress World scenario

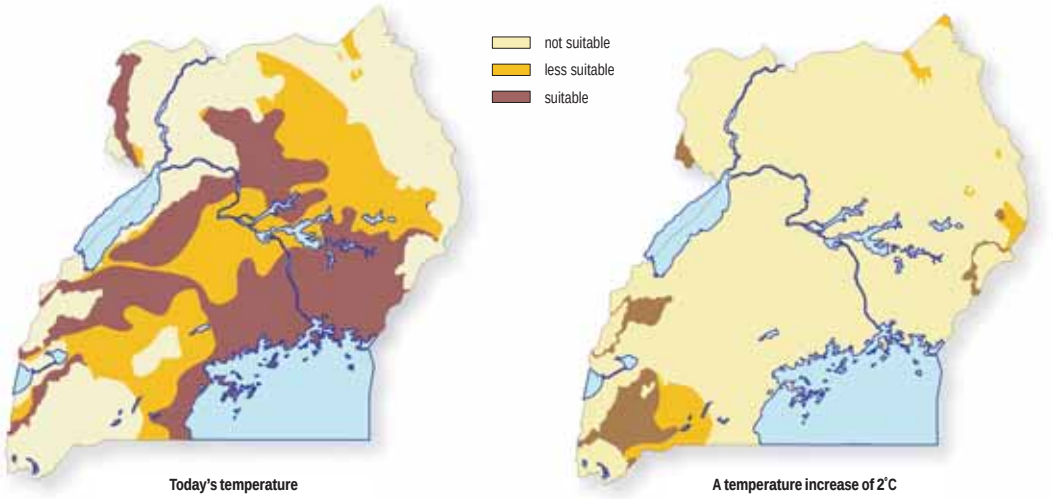
The ever-growing population will increase pressure on the environment, and many of these changes will have multiple effects on development and livelihood opportunities. Land resources will be particularly hard-hit. For example, there will be negative impacts on soils including increased loss through erosion, decreasing soil fertility and poor moisture retention. The changing soil quality further destabilizes the equilibrium of the

Box 6: Imagine an increase in temperature in the sub-region...

Current temperatures and rainfall permit growing of coffee in most parts of Uganda. Over the next decade the country experiences an increase of 2º C. This has a significant impact on the coffee-growing areas and on the whole economy. Ethiopia is the most important centre of genetic diversity for Arabica coffee, sorghum, finger millet, perennial cotton, castor bean, sesame and other crops (UNEP 2002a).

In the absence of appropriate technologies to mitigate the effects of climate variability, investments are made in biotechnology. Coffee varieties that are able to withstand increasing temperatures and reductions in rain are developed and grown. This biotechnology is also extended to other plantation crops grown in the sub-region like tea and sugar cane.

Global warming could shrink Uganda's coffee growing areas



Source: UNEP/DEWA/GRID 2005. Based on Simonett 1989

natural hydrological cycle. In an attempt to curb the impending population explosion, strict population control policies are enforced.

Policies in the water, land and forestry sectors are reviewed in a bid to address the impacts of climate variability, but are not wide-reaching and focus primarily on the needs of the elite. Land reform policies, meant to improve tenure through individual ownership and thus encourage people to manage their land responsibly, result in poor landholders being bought out by the rich. Increasingly, poor people are squeezed into fragile and marginal lands. In the many mountainous areas in the sub-region this leads to mudslides, increased soil erosion, and increased flood run-off. This decline in environmental quality leads to a decline in overall quality of life.

The majority of the population cannot afford to invest in technologies that support the more efficient use of energy and therefore biomass resources are increasingly depleted.

Indigenous people are pushed off their traditional grazing lands. Conflicts over freshwater resources increase as the landowners fence off their land, including the water sources on them which traditionally acted as dry-season watering holes for migratory and pastoral peoples, undermining their established coping strategies. Given the increasing pressures on and conflicts over land, water and forest resources, strict measures are adopted to protect the remaining resources. These are based on exclusion, and command-and-control strategies. However, this exclusion exacerbates the situation.

In another country, the charcoal trade continues to be a source of finance for local warlords and factions, despite the fact that export is banned. The politically unstable situation makes the enforcement of regulations difficult. This trade fuels more conflict, because militias can spend the profits on arms and a vicious cycle sets in. These patterns have been evident in some countries in the sub-region, such as Somalia, where port towns like

Kismayu are fought over by rival groups keen to control the charcoal trade (UNEP 2005). Negative impacts of deforestation are seen along coastal areas which are now affected by creeping desertification. At this rate, land degradation, loss of biodiversity and the degradation of freshwater, coastal and marine resources are likely to continue beyond 2015.

Due to poverty, the majority of the population cannot afford to invest in technologies that support the more efficient use of energy and therefore biomass resources are increasingly depleted. As a result of deforestation, there is increased sediment in rivers and consequently there is a silting up of dams. This affects reservoir capacity and undermines the generation of hydropower energy. Biomass resources such as animal waste, which have traditionally been used to enhance soil fertility, are not ploughed back into the land since they are being utilized as sources of energy. The impacts of climate variability, declining crop yields, the spread of diseases and pests and reduced economic potential threaten food production and security, human health, economic growth, lives, livelihoods and infrastructure.

In this context, power rationing is adopted, further threatening already dwindling economies. This trend is expected to continue. In nearly all countries, the manufacturing sector has been growing at a rate of 10 per cent annually; however, this growth is now under threat from the declining energy situation. In this scenario the cost of energy is about 45 per cent of the total cost of production. The sub-region may therefore experience declining levels of FDI.

Some countries in the sub-region decide to focus on large-scale electrification policies based on the development of hydropower. This hydropower development results in the displacement of riparian communities and has negative impacts on dry-season availability of water.

Great Transitions scenario

In this scenario there is an increasing focus on good governance and this results in significant political developments. Inclusive democracy within the sub-region means that there is an independent judiciary, an open civil society and a free media as well as a broad commitment and respect for human rights, sustainable development and transparency in government. Development assistance recognizes that "one size does not fit all" and that development initiatives must be tailored to the needs of specific groups, and their interests and priorities need to be specifically taken into account. Also, an increased emphasis is placed on broad participation in defining solutions. Therefore, poor people are included in policy processes designed to meet their energy needs and provide long-term solutions. Governments become more interested in the well-being of their people, ensuring among other things that affordable energy services are made more accessible.

To forestall the looming energy crisis, the power sectors in the different countries are integrated to more effectively share the available energy resources in the sub-region. A protocol is adopted under which a master plan for the sub-region is developed. Cooperation with other sub-regions is also promoted.

The power sectors in the different countries are integrated to more effectively share the available energy resources in the sub-region.

Bilateral trade and aid policies in the energy sector, which currently focus on fossil fuel technologies, are reoriented towards sustainable energy and seek to encourage investment in the renewable energy sector. Although industrialized countries are at the forefront of this sector, governments address the need to support the development of local technical skills and knowledge. The private sector – particularly in the technology and banking sectors – is encouraged to form partnerships with SMEs for the supply of energy services which are accessible to and appropriate for poor people. For example, increased access to and availability of energy increases ICT usage at schools, opening up additional educational opportunities like distance learning. Empowered by their raised literacy levels, women are able to use reliable energy to improve scope for their enterprises, creating opportunities for employment and income generation.

There is increased investment in more efficient biomass energy technologies. This has a number of positive impacts. It reduces the share of household income spent on cooking, lighting and keeping warm. Additionally, it reduces the time women and children spend on collecting wood, leading to an increase in the number of girls attending school (WRI and others 2005). It also has some positive health impacts, including the reduction of indoor pollution (Gordon and others 2004). Previously, the heavy loads of fuelwood carried by women and children affected their health. There are environmental benefits too: as pressures on forests start to decrease, catchment areas are preserved and this contributes to better quality of water. Improved grazing areas and availability of water

leads to reducing conflict between pastoralists, and between migratory peoples and permanent settlements.

Encouraged by their shareholders, multinationals, such as the cement industry, undertake restoration activities, including site restoration, for example through tree planting or conversion of non-productive mines into nature reserves. These attract large numbers of tourists and contribute to the livelihoods of communities in their immediate environment through the provision of jobs, while also supporting the learning objectives of schools. Waste products like bagasse and coffee husks are also used in the generation of electricity.

Existing monitoring programmes, for example the IGAD Climate Prediction and Applications Centre (ICPAC) (formerly the Drought Monitoring Centre – Nairobi) in Kenya, continue to be expanded and the development of sub-regional databases for early warning purposes is supported. At national level, disaster preparedness improves. Past experiences become an important factor in shaping policy responses. For example, experiences around drought and changing rainfall patterns become the basis for new early warning system. Programmes that promote the integrated management of transboundary resources, such as the Nile Basin Initiative (NBI), take on renewed importance.

Box 7: Possible policy messages

Market Forces

- Develop grassroots financing mechanisms.
- Target trade and aid support to sustainable energy options for poor people.
- Diversification of the economy.

Policy Reform

- Ensure energy is incorporated into poverty reduction strategies.

Fortress World

- Policy reform processes should be more inclusive and allow for equitable access, control and use of the resources.
- Conflict avoidance, resolution and management methodologies should be actively employed as part of environmental governance.

Great Transitions

- Encourage private sector and other partnerships to target the poor.
- Create an enabling environment that will facilitate the development of regional energy. pools, cross-border trade in energy and attract private sector investors in the energy supply industry.
- Give a voice to poor people.

Policy messages from the scenarios

Policy messages of the four scenarios are presented in Box 7. From each of these scenarios, positive lessons for policy choices can be identified.

CENTRAL AFRICA

Forest and woodland resources in Central Africa are an important environmental resource that can play a central role in economic development. Owing to its vastness, the protection of this resource is not only significant to the countries within the sub-region, but also to the rest of Africa and the world (WWF 2005). Central African forests and woodlands play a crucial role in carbon sequestration. The full costs of deforestation for the sub-region are not completely understood. Deforestation has multiple negative impacts: it threatens biodiversity, water and energy resources, and contributes to trace-gas emissions. It may contribute to changes in ecosystem function including biogeochemical cycles and climate patterns through altering local rainfall and hydrological processes, and desertification. The degradation of vegetation cover has caused some parts of Central African countries that were previously under forest to change to savannah grasslands and degraded savannah (WCMC 1992). It will also have direct economic costs including the loss of future wood for forest industry and loss of biological diversity. The current and future state of the Congo basin forest reserves will reflect the overall environmental health in the sub-region, and will affect the development opportunities available.

This resource, however, is under threat from a variety of socioeconomic factors. Deforestation in the sub-region is closely tied to demographic conditions; the highest levels of deforestation have occurred in countries with higher population growth rates and higher population densities (FAO 2005b). Human settlement and economic activities result in infrastructural development (roads), increased agriculture, bush fires, overharvesting of timber and NTFPs; all these activities impact on environmental change. Chapter 6: *Forests and Woodlands* presents an overview of how forest cover is changing in Central Africa, and the most important drivers of this change. As discussed in Chapter 12: *Environment for Peace and Regional Cooperation*, conflict and poor governance have exacerbated environmental change, and improved cooperation offers important opportunities for environmental sustainability and expanding the range of available opportunities.

Since AEO-1, there have been several conservation-focused initiatives that have significantly contributed to forging a new vision within the Congo basin on

development and implementation of transboundary conservation programmes. Some of these initiatives give snapshots of scenarios presented at the time. The main milestones have been:

- A strategic plan called the "*Plan de Convergence*" for the implementation of the Yaoundé Declaration was finalized and endorsed by the Central Africa Forests Commission (COMIFAC). This involved the compilation of the different action plans identified by the member states. Priority activities were later identified from the *Plan de Convergence*.
- Sustainable financing of conservation work has become a priority for Central African governments and partners.
- The Congo Basin Forest Partnership (CBFP) was launched to help conserve 29 protected areas, and promote sustainable forestry and community-based conservation in 11 priority landscapes spanning the Congo basin. Figure 14 shows areas of conservation importance.

The following scenario exercises help make an assessment of how future trends may be affected by policy choices.

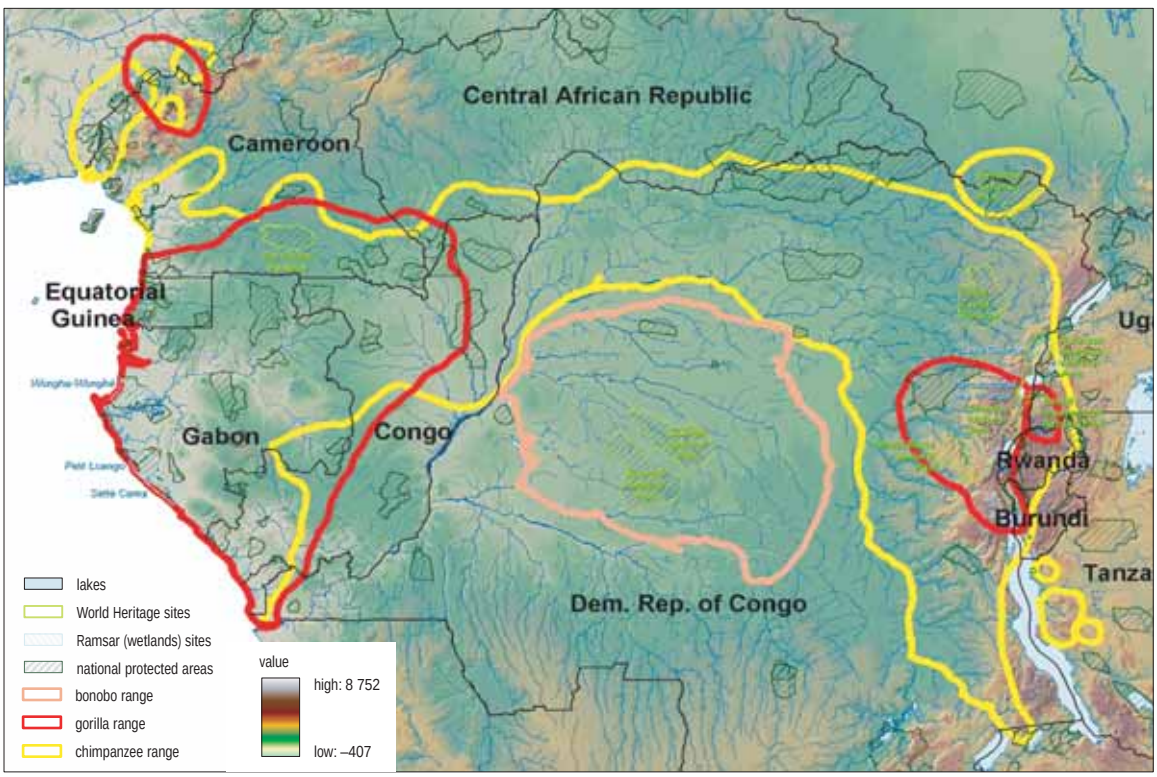
Market Forces scenario

In this scenario, the existing trend of deforestation and degradation of forest areas continues, as a result of both the need for more land for human settlement and agriculture, and the drive to exploit forest resources (mainly timber) to boost economic development, particularly export earnings.

The rate of deforestation and land conversion, however, slows down, due to forestation initiatives and the gradual implementation of existing MEAs to use forests in a sustainable manner. Increased investment in the tourism sector, and in particular in ecotourism, provides additional incentives to conserve forests, though this is offset to some extent by the increase in land pressures. In order to secure the future of forested areas, as well as to spread the benefits of their conservation more widely, communities living in the forests and surrounding areas are encouraged to take part in their management, sustained use and conservation. This, too, contributes to slowing down the rate of deforestation. The world market demands for medicinal plants and other NTFPs increase and this too

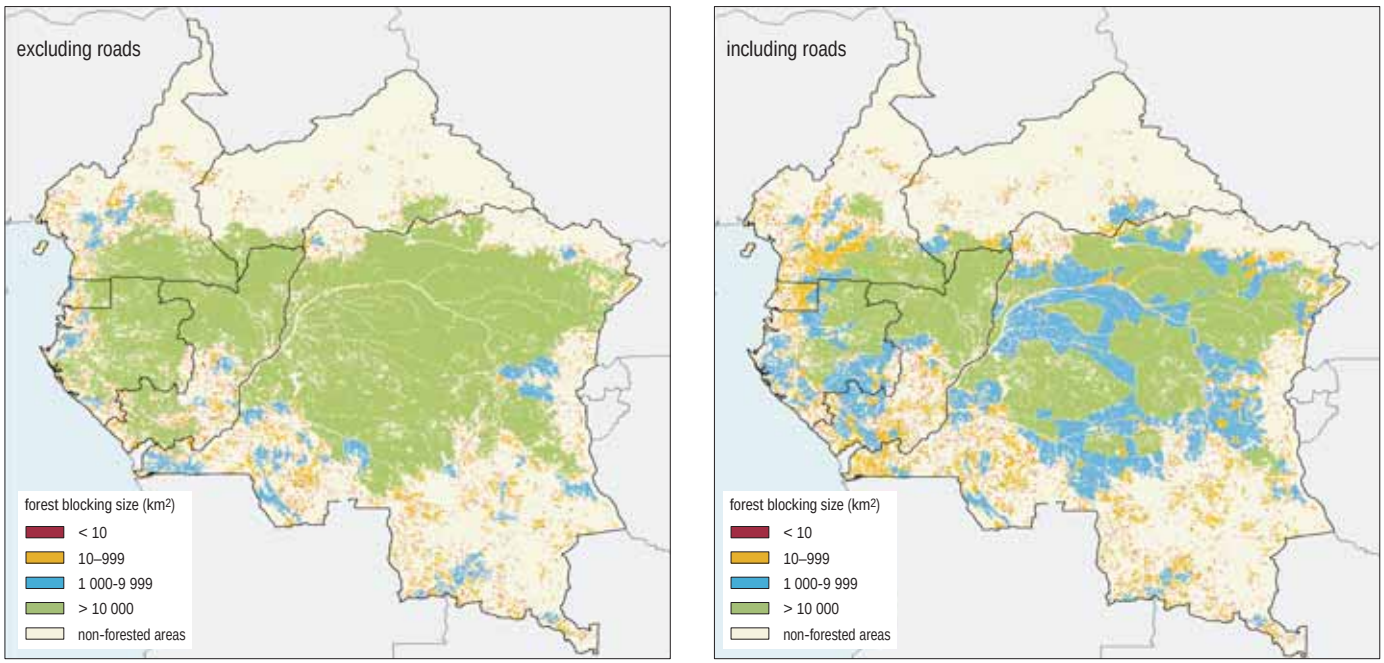
The expansion of physical infrastructure is an important aspect of this, and it has the added benefit of bringing new opportunities to forest dwellers. However, road development also leads to fragmentation of forest.

Figure 14: Priority areas for conservation



Source: UNEP/DEWA/GRID 2001; Data sources: Great apes ranges: Instituto Ecologia Applicata (IEA) Rome 1998, African Mammals Databank (AMD) for the Directorate-General for Development (DGVIII/A/1) of the European Commission. Project No, B7-6200/94-15/VIII/ENV; Ramsar sites, World Heritage sites and national protected areas: UNEP-WCMC; Digital Elevation Model of the Land: Environmental Systems Research Institute (ESRI) Base maps (country boundaries, lakes and rivers): Digital Chart of the World. Projection: Geographic

Figure 15: Fragmentation of forests by infrastructure such as roads



Source: WRI 2005

serves as a conservation incentive. The emergence of global carbon markets encourages Central African countries to protect forest resources and to make economic benefits from these resources.

However, in order to seize the opportunities in these new sectors (including tourism, pharmaceuticals and NTFPs) and increase profits, a new level of investment in forest areas is required. The expansion of physical infrastructure is an important aspect of this, and it has the added benefit of bringing new opportunities to forest dwellers. However, road development also leads to fragmentation of forest (see Figure 15). Trade liberalization, with appropriate technologies, improves the quality of logging. The industrial and artisan exploitation of wood increases the pressure on forest resources. The strategies to protect the forest, and ensure rational management of forest resources, are difficult to apply, in spite of the number of conventions and initiatives developed to this effect.

Policy Reform scenario

In the *Policy Reform* scenario, dependence on biomass, the traditional fuel in Central Africa which supplied 60 per cent of all energy requirements at the end of the 20th century (WRI and others 1994), is reduced, because people have more energy choices. Public and private power utilities compete to provide electricity to both urban and rural areas, making such services more reliable. The result is that the rate of deforestation due to fuelwood demand and charcoal production is reduced considerably.

Policy and legal reforms promote involvement of the local population and defines, with their participation, the conditions of their involvement. Local populations participate in the conservation of forest resources, and obtain a share of benefits from this. Forest industries have to utilize forests resources within this new legal framework. New technologies are developed and are introduced in logging.

A close relationship between knowledge and policy evolves. Research work takes into account the concerns of local users and other stakeholders, including managers of forest, through inclusive priority setting. New protected areas are created as a result. Also, there is an increased focus on the opportunities that markets for environmental services can bring. Governments recognize and set up policies to encourage benefits from carbon commoditization. There is a deliberate effort to strengthen the existing forestry management programmes such as Central Africa Regional Programme on the Environment (CARPE), COMIFAC and Central African Protected Areas Network (RAPAC) for regional cooperation in transboundary forest management.

Fortress World scenario

In the *Fortress World* scenario, deforestation and degradation of forest areas generally continue at high rates. However, there are pockets of restoration.

The elite, tempted by the high demand for forest products in the global market, act as resource extractors, and overexploit the forest resources.

Ironically, they safeguard some forest areas under international pressure. Some of the remote forest areas, away from population pressure, are also saved. Commercial exploitation of medicinal plants contributes to accelerated deforestation. Given limited opportunities, poor people fall back on extensive use of the forest resources to which they have access, as a source of energy, food and shelter. Forest wood is also used commercially for the production of crafts for trade.

The increase in the poverty of farmers, and the fall in prices of agricultural produce, leads to more pressure on the forests, which are the primary sources of revenue. Unregulated logging increases. Industries which are involved in logging do not take the regulations into account and, engage in illegal logging activities. The export of roundwood means that the full potential earnings of timber products are not realized. There is a boom in the development of NTFPs, as well as an increase in their domestic use.

The consequences of deforestation and desertification are disastrous for the Sahelian areas (northern Cameroon, Central African Republic and Chad). The creation and strengthening of forestry training institutions at the national and sub-regional levels, to provide qualified human power and technology to the forestry department, is an emerging challenge for Central African countries, but this is not a priority for the elites. The option of strengthening forestry sub-regional cooperation by harmonizing legislation and creating and managing transboundary protected areas for sustainable development is not taken up and in general environmental and human well-being continue to deteriorate.

Great Transitions scenario

In the *Great Transitions* scenario, real recognition is given to sustainable uses of forest resources for medicinal and other purposes, and opportunities for improving livelihoods are directly sought. This is balanced with environmental objectives. Consequently, sensitive and important habitats are protected, and systems for the sustainable use of biodiversity outside these protected areas are established.

Stakeholders, including users and owners, are brought into management. Education and the promotion of a shared value system are key focuses. Communities are environmentally aware, and are empowered to care for the Earth. This is made possible by moving from a restrictive legal regime that focuses on command-and-control regulations to one that is more empowering and consistent with the Convention on Biological Diversity and promotes the fair and equitable sharing of benefits arising from the use of biodiversity. Areas of forests increase and forest quality improves, as a result of the realization of the true value of forest resources, and improved forest management. Integrated and sustainable development management ensures minimal degradation of the human environment system. Human and environmental vulnerability are minimized. The capacity of NGOs and civil society is enhanced, and they are empowered to play a more significant role in environmental management. Higher protection of the environment and of fragile ecosystems is a prime focus for all stakeholders in the forest industry.

This sub-region continues with the development and use of light technology by trained people, in order to make rational use of forest resources. The existence of research institutes, and training in forestry (wood-based occupations), makes Central Africa a specialist in forestry training and research. All countries ratify and implement the main conventions regarding sustainable management of the environment and local, national and sub-regional actions reflect policies directly targeting NEPAD environment initiatives.

There is a move from a restrictive legal regime that focuses on command-and-control regulations to one that is more empowering and consistent with the Convention on Biological Diversity, promoting the fair and equitable sharing of benefits arising from the use of biodiversity.

Policy lessons from the scenarios

The Central African forest basin is undergoing fundamental change as a result of, among other things, logging. Governments of Central Africa, donor agencies and private forestry companies must act urgently to address the rapid acceleration of forestry operations in the basin and the negative impacts provoked by these activities.

Investment now in establishing systems of proper forest management will avoid huge costs in the future, including the forgone benefits of squandered forest resources, the costs of resource restoration and rehabilitation, the loss of wildlife and its potential for alternative revenue generation, and the social costs associated with all of the above. From the various scenarios, a mix of policy actions may be appropriate. Specific policy action may focus on:

- Establishing forest zoning through an assessment of concessions based on zoning categories which

include protected areas, sustainable use areas, zones designated for agriculture or other land uses.

- Promoting transparency in the allocation of forestry concessions and revenue generation.
- Improving forestry practices to reduce undue damage to the remaining forest, reduce timber waste, and protect the regenerative capacity of the forest.
- Institutionalizing measures, especially on government land, to ensure that endangered species are protected on their lands, and that export of wildlife products from their concessions is not facilitated by their operations.
- Enhancing local participation in forest management, in which local interests and cultures are safeguarded.
- Designating new protected areas in the forest, especially in light of the uncertainty of the sustainability of logging practices, and ensuring effective management of these.
- Accelerating research on the sustainability of forestry operations in the basin (including autecology – the characteristics of individual species, the life history of commercial species, regeneration dynamics).

The window of opportunity to improve management is very short. In five years it will be difficult to establish sustainable management schemes in Central Africa. In much of the forest, it will simply be too late.

A monetary value can be attached to environmental benefits coming from forestry activities aimed at reducing carbon emissions. Central African countries can find secure opportunities to convert this into monetary gains at the carbon world markets. There is a need to strengthen capacity-building in the assessment of the economic value and potential of Central African forest resources to this end.

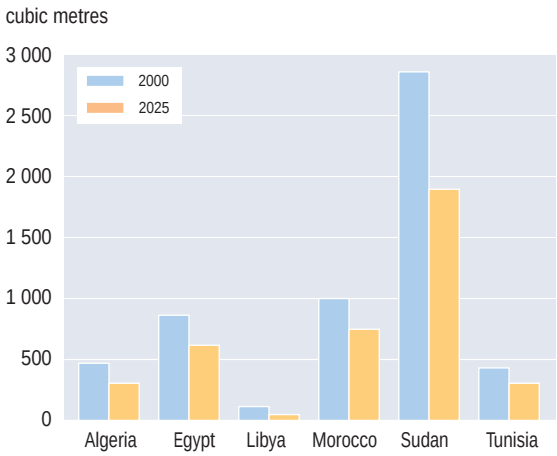
Making these changes a reality requires political will of all governments in Central Africa. Donor agencies must assist in providing technical and financial support. Private companies must commit to responsible, sound practice and assume more of the costs of their impacts. With these stakeholders working in concert, the forest of the Central African basin may continue to yield biological, economic and social benefits well into the future. The window of opportunity to do this is very short. In five years it will be difficult to establish sustainable management schemes in Central Africa. In much of the forest, it will simply be too late.

NORTHERN AFRICA

The scenarios for this sub-region focus on the future trends of freshwater resources, as the challenges associated with the availability of freshwater are likely to increase in the future. The current and estimated 2025 levels of renewable water resources in the countries of the sub-region are as illustrated in Figure 16.

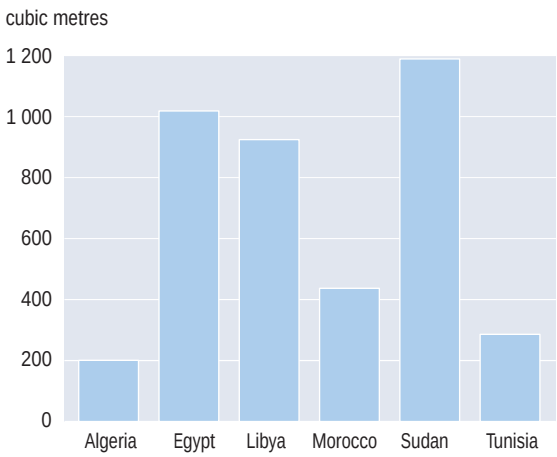
Water stress and scarcity is a growing problem. The available annual water resources per inhabitant vary substantially between different countries, as shown in Figure 18. In terms of internal water resources, it is the poorest sub-region in Africa, accounting for only 1.2 per cent of the region's total internal water resources, but it is also the sub-region with the highest access to external water resources (63 per cent) due to the Nile (FAO 2003). Agriculture is the main water consumer, accounting for more than 88.2 per cent of water uses (FAO 2003). Chapter 4: *Freshwater* examines the current state and trends of these resources, and the key pressures placed on them.

Figure 16: Per capita renewable water resources in Northern Africa



Source: UNEP 2005

Figure 17: Water use per capita 2000



Source: UNEP 2005; data from FAO 2003

Figure 18: Impact on selected water indicators in Africa as per AEO-1 scenario model

Source: UNEP 2002a

The AEO-1 report presented the impacts in key water resource indicators: water use, domestic share, agricultural and industrial share, and water use-to-resource ratio (Figure 18).

Market Forces scenario

In the context of globalization and the opportunities international trade brings, Northern Africa seeks to export more goods to Europe and to the rest of Africa. Agricultural products are among the goods identified for increased exports, but they must meet the standards of the target markets. The private sector takes the lead in opening up new foreign markets. New product standards require regulation of the quality of irrigation water as well as fertilizers and other chemicals used in agriculture. This has positive impacts on the quality of soil, shallow groundwater and drainage water.

Competition for water resources between the production of food for local consumption and export increases. The private sector, with larger landholdings, bigger investments and stronger influence on local government, competes with poor small farmers for the limited water resources. The private sector is encouraged to adopt IWRM focusing on conjunctive use of surface and groundwater resources. However, there is overharvesting of groundwater resources, leading to accelerated decline in the groundwater table and salinization of underground water.

Similar competition exists between the other main water users, namely industry and municipalities. The industrial sector increasingly focuses on exports, as greater profits can be made through these markets than in the local market. The large volumes of untreated industrial wastewater pose high risks to the environment, and in particular heavy metals and noxious chemicals are the main lethal pollutants. Increasing levels of water and air pollution create new levels of environmental and social stress, especially because many are dependent on the re-use of water. The vulnerability of poor people and urban dwellers increases.

As part of their economic reform, the Northern African governments privatize some of the public services, including water supply and sanitation. The private companies who run the services cannot offer these at the same low tariffs as were offered when the facilities were under public operation, as these had been highly subsidized. The tariffs for water supply and sanitation increase and many low-income people

The private sector, with larger landholdings, bigger investments and stronger influence on local government, competes with poor small farmers for the limited water resources.

can no longer afford these. This reform, that was intended to increase the availability of safe water, has the opposite effect. The qualities of the services have not improved significantly as a result of privatization, due to low investment and the absence of effective regulation through monitoring and enforcement. Despite these problems the pressure on some Northern African governments to treat water as an economic good is increasing. The agricultural sector is under continuous threat to have some of its "free" water allocated to other sectors that pay for water. The governments continue to oppose water pricing to protect small and poor farmers, but this policy is more rewarding to the private estate farms that enjoy the use of the free vital resource while selling their agricultural products at high market prices.

There are at least three ongoing problems as a result of this policy approach:

- Pollution of water from poorly treated industrial effluents, untreated sewage, run-off of agricultural chemicals, and mining wastes constitute a growing problem.
- Unsafe drinking water, combined with poor household and community sanitary conditions, is a major contributor to disease and malnutrition, particularly among children.
- Contaminated wastewater is often used for irrigation, creating significant risks for human health and well-being.

Policy Reform scenario

Given the critical role water resources play in development and the increasing problems of water scarcity and stress related to high population growth, the sustainable management of water resources becomes an important policy focus. This is particularly important as the potential for finding new water sources is very limited. The reality is that most of the water required to meet the new demands must come from water saved from existing uses, and consequently demand management is adopted

Demand management focuses on physical water savings and also economic savings, through increasing water-use efficiency, reducing water pollution and minimising irrecoverable water losses. Most countries adopt comprehensive reforms of water policies. Such reforms are not easy because long-standing practices, and cultural and religious beliefs, have treated water as a free good. Additionally, powerful interests benefit from the existing system of subsidies and administered allocations of water.

One policy reform aimed at improving efficiency is the increased and active participation of users in the management and planning of water resources. Some Northern African countries have already established water-user organizations, but this has not been the case with all users (El-Fattal 2006). The activities of these organizations are continuously reviewed, building on the experiences gained, with a clear target of promoting more rational and efficient use of this vital resource. The improved and fairer access to water resources results in higher levels of social equity, and better opportunities for poor farmers.

Institutional reform of the public sector, which has become overly bureaucratic, receives increasing attention and promises long-term progress in improving performance and hence water-use efficiency. Reforms include reorganization of irrigation agencies into a semi-independent or public utility mode, applying financial viability criteria to irrigation agencies, franchising rights to operate publicly constructed irrigation facilities, and strengthening accountability mechanisms. Following the success of other countries, control of water demand through pricing is adopted by some countries in Northern Africa, but with some caution. The internal conflict and unrest in some countries make this issue very sensitive. Nonetheless, the results are encouraging. Urban and industrial water consumption is reduced, resulting in saving some valuable freshwater. The reduction in water consumption and consequently the reduced quantities of sewage and wastewater relieves the pressure on the water treatment plants. Because many countries still dispose of treated and untreated wastewater in the northern lakes and in the Mediterranean Sea, improving the quality of this water can have positive impacts on the biodiversity dependent on these water bodies.

But the high prices of urban water and sanitation leave many poor people more vulnerable and insecure. Savings made by the state in privatizing this service are negated by increased costs in the health sector. Consequently, further reforms are introduced. Scaled tariffs are applied to reduce the costs to small consumers and make large consumers pay more. Savings in industrial water use are also achieved through restrictive water licences, the introduction of

The improved and fairer access to water resources results in higher levels of social equity, and better opportunities for poor farmers.

water-saving technologies and subsidized financing for investment in water-saving processes. In addition, industries are encouraged to use more recycled water.

The value of groundwater is recognized and tighter controls are imposed on its use. Quantity-based control mechanisms include well and pump permits that grant the right to install and operate a well of a particular capacity, and pumping quotas that specify a fixed annual rate of extraction for each water user. Pumping permits for new wells also impose size and spacing specifications to attempt to optimize extraction rates. The overall objective is to benefit from water resources while at the same time preserving their quality and sustainability.

The subsidies on energy prices (eg electricity, diesel, gasoline) are gradually reduced; the aim of this is to discourage overpumping of groundwater due to cheap energy costs. In countries where farmers pump water from canals to their fields this also discourages unnecessary or wasteful use of surface water. There are some disadvantages, though. The increased prices of diesel raise transportation costs which in turn raise commodity prices in the local markets.

Some general trends are evident in this scenario:

- Some countries seek to increase the use of Nile water and they focus on integrating their development projects and improving cooperation. Groundwater-recharging schemes are adopted in some while in others there is a focus on drought management.
- New laws are passed which set penalties for quantitative and qualitative water misuse.
- Extensive public campaigns are launched to educate the people about the water resources problem.
- A legal basis for controlling water pollution already exists in all Northern African countries, but the laws and regulations have mostly been unenforceable. The regulations are amended to be more realistic and to rely on incentives rather than restrictions. More industries comply with the amended regulations, leaving industrial waste cleaner and less polluted.

Fortress World scenario

This scenario is characterized by pronounced social, economic and environmental inequities between various groups of people. The elite, wealthy and generally better-off groups enjoy monopoly and full control of all services, resources and important economic activities. Poor people are deprived of the most basic services and resources, and generally lack opportunities to improve their quality of life.

At the national level, all Northern African countries focus on utilizing their internal water resources without paying much attention to external resources. This does not seem to cause a serious problem to the Maghreb countries, whose water resources mostly originate from inside their boundaries with very limited transboundary exchanges. Egypt and Sudan continue relying heavily on the Nile waters. Lack of cooperation with the rest of the Nile riparian countries threatens the sustainability of the river flows, and peace within the sub-region. With external technical and financial support, the upper Nile countries embark on building large numbers of small dams for utilizing some of the river's water. The dams have limited capacities, yet any reduction in the river flows reaching downstream countries could have huge negative impacts on development.

Despite increased demand for water, the opportunities for developing new water resources or adopting demand management techniques are not explored by the dominant wealthy groups, who do not feel the strain of the problem. The distribution of resources per capita is skewed among the various groups, with the wealthy taking the lion's share of the resources, especially land and water. Water allocation to the various water-user sectors follows a similar pattern. Being industry-driven, the elite allocate more water to the industrial sector, depriving irrigated agriculture from a much needed vital input. Urban water supplies are concentrated in the areas of the wealthy groups. Water use in those areas is wasteful, generating large volumes of sewage and wastewater. Groundwater use is dominated by the wealthy groups in the society who can afford the costs of extraction. Overuse of fossil groundwater depletes those resources and endangers their sustainability. Large declines in the water tables are observed and well salinization becomes a problem. Accordingly, the cost of groundwater extraction rises and this is translated into similar increases in the costs of the final products for which this water is used.

Municipal water supplies in the poor areas are largely unsafe, creating high risks for the majority who cannot afford good health care.

Low-income activities, such as subsistence agriculture and basic industries, are forced to use marginal and unsafe water. Municipal water supplies in the poor areas are largely unsafe, creating high risks for the majority who cannot afford good health care. The low-tech industries in the poor areas are forced to

recycle and re-use water. But with very limited financial and technical resources, they are unable to recycle and re-use water safely. The food industries are the most vulnerable as the use of unsafe water in their products can lead to food-transmitted diseases.

The quality of agricultural drainage and sewage water deteriorates due to repeated re-use of the water. Industrial waste also adds to the acuteness of the problem as industries dispose of mostly untreated wastewater. Weak monitoring and enforcement of laws encourages the wealthy industry investors not to treat their industrial waste before disposing it in watercourses and public sewage networks. Water heavily polluted with industrial waste is sometimes re-used in downstream areas, creating serious environmental damage and health risks in those areas.

Investment in water-development projects is directed towards meeting the needs of elite groups, who make the investments. These projects usually have limited scope and target small groups of people. The general public do not benefit from these projects, apart from income earned as a result of supplying cheap labour. State-run utilities and services suffer from underinvestment, causing the services to further deteriorate and the infrastructure to run down. This is evident in the rapid silting-up of the reservoirs of the large number of dams in the Maghreb countries. But the larger cost to the economies is the lost resources from leakages, high water evaporation in large reservoirs and pollution.

In summary, freshwater shortages continue to be experienced in most Northern African countries, albeit with varying degrees. The key aspects of this scenario are:

- A focus develops on using internal water resources with little attention being given to exploring the potential of external resources.
- The improper management of water increases pollution, resulting in the degradation of surface water and increasing the incidence of soil erosion and salinization.
- Water shortages and pollution limit development and perpetuate economic and social inequities, leaving many people increasingly vulnerable.

In Great Transitions intergovernmental cooperation in the management of the Nile waters is improved, and extended beyond existing users to include all riparian countries.

Great Transitions scenario

The water scarcity problem currently existing in Northern Africa is given the full attention and consideration of the governments of the sub-region. As a result a variety of measures to ease the problem are adopted. Besides carefully managing the conventional water resources in a sustainable way, non-conventional techniques such as rainfall harvesting, desalination and water recycling are employed. Increased industrialization helps lower the cost of these new techniques and they become affordable to many sectors.

In addition, all the countries adopt IWRM programmes to effectively manage all available water resources. They are implemented through developing national legislative and institutional frameworks. Intergovernmental cooperation in the management of the Nile waters is improved, and extended beyond existing users to include all riparian countries. The NBI achieves remarkable goals, planning and implementing win-win water resources development projects to most riparian countries. Water master plans are drawn around IWRM as the key solution to the problem. Integrated water resources management frameworks which integrate the technical, hydrological, economic, environmental and social aspects are formulated and implemented under the appropriate institutional frameworks. There is also increased sharing of best practice. Experiences gained by the Northern African countries in implementing IWRM are shared at the sub-regional level, and this increases the use of adaptive management which has important gains for sustainable management.

National plans are prepared for rehabilitating the ageing agricultural system, the main water user. Groundwater abstraction is controlled. Water re-use is abandoned and is replaced with water recycling. Due care is given to the problem of loss of agricultural land due to soil salinization, erosion and degradation. Soil rehabilitation schemes include banning of the use of chemicals and replacing them with organic fertilizers. A switch to cash crops for export assists the move to organic fertilizers. Research focuses on producing new crop varieties that are more drought- and salt-tolerant, have shorter life cycles and require less water. The water-use efficiency of the agricultural sector is closely monitored. As a result, less agricultural drainage water is generated, reducing the pollution it causes to the Mediterranean Sea and the other water bodies where drainage water is disposed of.

Food security is no longer a key issue in government policies. As the economies of many Northern African countries improve, their ability to

Box 8: Facing the challenge of limited groundwater resources...

Groundwater resources constitute a major part of the total water resources of many Northern African countries. Apart from Egypt and Sudan, the Maghreb countries rely heavily on groundwater. The majority of this water is fossil water from deep aquifers that are mainly non-renewable. Renewable groundwater resources are in the form of shallow alluvial aquifers recharged from the main rivers in the sub-region or directly from precipitation in limited coastal areas. These include the Nile valley and its delta, tropical areas in Sudan and scattered strips along the Mediterranean coast.

According to the current practices, the use of groundwater resources in Northern Africa is neither safe nor sustainable. Overmining of the fossil aquifers and overabstraction from the renewable shallow aquifers result in accelerated decline in groundwater levels and rapid deterioration of groundwater quality due to saltwater intrusion. This interferes with well productivity affecting yield levels and shortening their lifespan, thus raising the cost of groundwater. In addition, overuse of groundwater is usually coupled with overuse of energy for water pumping, which in turn causes more pollution and gas emissions from power plants.

Some of the large groundwater aquifers in the region are shared by many countries. For example, the Nubian Sandstone Aquifer, which is a non-rechargeable basin, is shared by Egypt, Libya and Sudan and the Eastern Erg aquifer is shared by Algeria and Tunisia. This makes the issue of managing and controlling the use of these aquifers sensitive and complicated.

Building on the success of the NBI between the Nile riparian counties and responding to the critical situation of groundwater resources in Northern Africa, a groundwater sustainability initiative is launched by all the countries in the region. The key target is to work toward achieving safe and sustainable use of the vital resource. The move is supported by large donor and lending agencies by providing the technical and financial support required for implementing some of the proposed projects.

Several actions are taken and agreements are reached through this initiative:

- Some countries cooperate and develop joint groundwater recharge schemes and conjunctive use models.
- The transboundary use of water resources is based on cooperation. All countries who share transboundary groundwater reservoirs agree on applying and enforcing new regulations for control, management and protection of those reservoirs.
- A groundwater monitoring network is established in all the countries. The information is reviewed periodically and is made available to the general public through a dedicated web site.

This initiative helps increase the awareness of the Northern African people of the importance and value of groundwater for the future development of their region. Public participation in achieving sustainability of groundwater resources is achieved through demand management. For instance, irrigated agriculture which depends primarily on groundwater is only allowed to use modern irrigation techniques. Industry is highly encouraged to recycle water. The volumes of water supplied to urban areas are controlled (eg by not making the water supply available throughout the day). Stopping the rapid deterioration of the quantity and quality of groundwater resources in Northern Africa, while at the same time meeting the increased demands for water, signals the success of the Initiative.

import food from the global market increases without the need for debts or loans. Water allocations to the various sectors are reviewed, with more shares allocated to the industrial and municipal uses. The flourishing industry is more efficient in water use in terms of economic returns per unit of water. Agricultural reform through land consolidation proves to be beneficial to all those involved:

- Larger landholdings for the farmers change the nature of their agriculture from subsistence to commercial. Consequently, they are able to invest more in their irrigated agriculture by buying better inputs and hiring more experienced labourers or moving to mechanization. The end result is a more efficient irrigated agriculture. The whole rural community also benefits from higher agriculture returns. More children in the rural areas now attend school to the secondary level. The services in the rural areas noticeably improve, with more people having access to safe drinking water and sanitation, better health care, etc.
- Large numbers of the unskilled labourers who used to work in agriculture are absorbed by the growing

industry. They receive on-job training which raises their skills and make them a more productive force in the society. Their living standards also improve, with their family members benefiting from better education, health care, housing, access to safe drinking water and sanitation, etc.

Water pumping is still a major environmental concern in many of the Northern African countries as the majority of the pump sets are diesel-driven. Gas emissions, water and soil pollution by fuel and oil, and noise pollution are some of the negative impacts. The use of electric motors for water pumping is promoted in order to ease the problem. Incentives include reduced motor and spare parts prices and low electricity tariffs. There are fears, though, that such policies could encourage overuse of water resources, especially groundwater. Control and monitoring of groundwater use ensure that such fears do not become reality.

Policy lessons from the scenarios

Given the hydrological status of Northern Africa the management of freshwater resources will remain a challenge, with major implications for the overall prosperity of the sub-region – in terms of the opportunities for both economic growth and improving human well-being. All the scenarios point to the need for management approaches that are based on IWRM and acknowledge the links between surface and groundwater. Closely related to this is the transboundary nature of the available resources. Here the policy lessons are clear: to improve opportunities throughout the sub-region and to reduce the possibility of conflict, cooperative approaches must be adopted.

All economic development choices are dependent on a reliable water supply. The scenarios reveal various policy options for promoting this including market mechanisms, management focused on improving efficiency, more equitable access rights and increased

Box 9: Harnessing the opportunities of participatory management...

Even though there are currently various management practices that create the opportunity for interactive participation by stakeholders in water development and management decision making, such participation is not mandatory and there is no clear designation of responsibility for integrating such participation into cohesive programmes. Consequently, such participation takes place only in isolated activities such as the formation of water-user organizations and one-way public awareness activities.

Based on experiences from other countries in public participation, there is increasing recognition that participation in the decision-making process strengthens policy making processes and provides an avenue for ensuring transparency and accountability in public and private actions. This builds trust among the participants and leads to the creation of long-term collaborative relationships. Northern African governments start adopting policies to facilitate public participation in decision making regarding planning, development, and management of the countries' water resources.

However the introduction of participatory decision making is a relatively long process given the institutional, social and economic context in Northern Africa and some difficulties are experienced. The lack of a clear distinction between the responsibilities and duties of government organizations and the private stakeholders causes some confusion. Low levels of education in some countries make it difficult for the larger sector of the public to participate effectively. For many, having a say in decision making is seen as a tool for achieving personal benefits instead of aiming at the national scale. Training and public awareness programmes are started to help tackle some of these difficulties.

Some of the stakeholders are cautious when introduced to participatory decision making. They fear that their involvement in resource management will come at large financial costs to them. Infrastructure maintenance has been in many cases very poor under government spending. The stakeholders are worried that they will have to come up with the large sums of money required for maintaining the deteriorated infrastructure.

Despite the slow progress of achieving participatory decision making in the water resources sector, the positive results are both encouraging and promising. For instance, the negotiations between the various water-user sectors on their water allocations are now carried out by the stakeholders. The general public develops better understanding of the severe water shortage problem in the sub-region and starts to come up with its own demand management actions. Contacts and links between government agencies and the private sector are improved. The management and operation burden on governments is reduced.

public participation. Each of these policy options has opportunities and costs.

WESTERN AFRICA

Western Africa is made up of two eco-geographical areas: first, the Sahel countries, including Burkina Faso, Cape Verde, Gambia, Guinea-Bissau, Mali, Mauritania, Niger and Senegal, which make up the dry region of West Africa, and, second, the countries of the Gulf of Guinea, including Benin, Côte d'Ivoire, Ghana, Guinea, Liberia, Nigeria, Sierra Leone and Togo, which make up the humid region of Western Africa.

The climatic characteristics of the sub-region are discussed in Chapter 2: *Atmosphere*. It is subject to tropical climatic variations, resulting in high annual temperatures and heavy rainfall which steadily decline towards the Sahara Desert. Rainfall is of vital importance in determining climate in tropical areas in general, and in Western Africa in particular, because it varies so widely from area to area and season to season it represents a limiting factor for rain-fed agriculture, which provides the economic base of the countries. In the Sahel region, there is one rainy season, lasting between two and five months, while the Gulf of Guinea countries have two rainy seasons. Western Africa is characterized by four types of climate (GRAIN 2002):

- Sahelian climate: the rainy season lasts no longer than three months; rainfall is irregular and does not exceed 500 mm;
- Sudanian climate: rainfall does not exceed 800 mm in northern Nigeria, and is no more than 1 000 mm in southern Mali; and
- Humid tropical climate: distinguished by a bimodal rainfall pattern, with average annual rainfall of 1 500 mm;
- Equatorial climate: localized essentially along the Gulf of Guinea, where rainfall can exceed 2 000 mm.

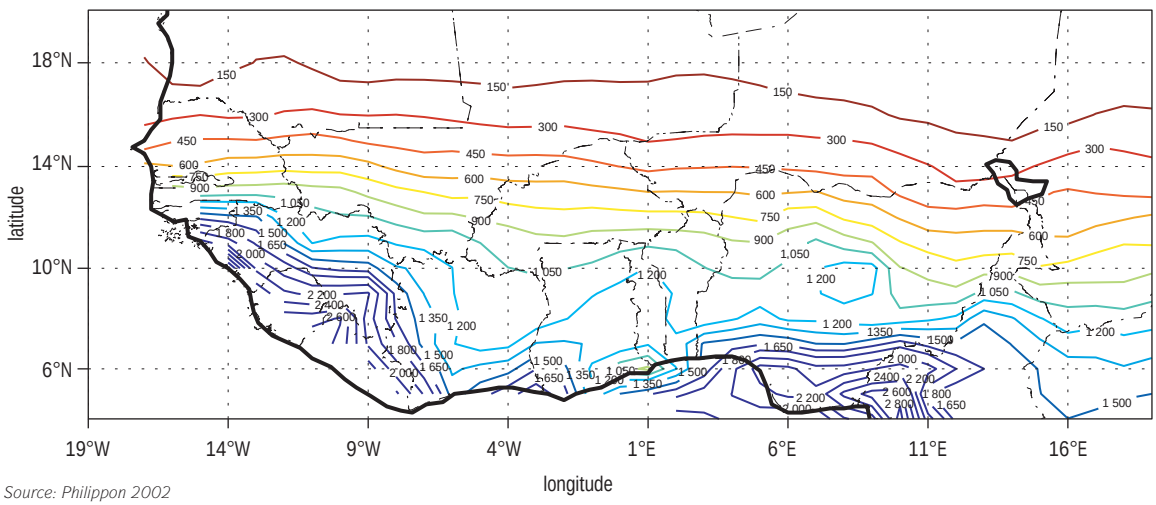
Market Forces scenario

In this scenario, agricultural production prevails over the other sectors. This results in a market economy that does not take environmental matters into account and undermines government initiatives. Growing trade, driven by the forces of globalization, results in more extensive farming and an increase in the area of cultivated land. Food production levels rise at the cost of environmental considerations. Where necessary, technology is brought into play to meet international trade demands and production requirements. As a consequence, soil erosion due to overproduction worsens, and this situation is exacerbated because of the increasing incidence of droughts.

Deforestation associated with high levels of GHG emissions could cause acid rain, further contributing to soil erosion. These changes have implications for food security in Western Africa, particularly in the most vulnerable region of the Sahel. Increasing concentrations of GHG emissions in the atmosphere affect climate variability, including shorter rainy seasons, and lead in the long term to climate change.

Locust invasions increase due to climate change continue to cause food deficits as no action is being taken to reverse this. Consequently, the food situation worsens in certain areas of Burkina Faso, Chad, Mali, Mauritania, Niger and northern Senegal. The invasion of the desert by locusts is a consequence of climate variability. The unexpected rains provoke a proliferation of locusts, which are normally in a state of dormancy (FAO 2004). The changing climate (in this case an upsurge in rainfall) cause the disruption of this dormant

Figure 19: Average cumulative rainfall (mm) in Western Africa 1968–1998



Source: Philippon 2002

state. Damage to millet crops and grazing land attributable to such agro-climatic conditions has been recorded throughout Cape Verde and on a more localized scale in Burkina Faso, Mali, Mauritania, Niger and Senegal (FAO 2005a). This trend is likely to worsen.

Accordingly, the overall production of cereals (millet and sorghum), the largest food crops of this part of Africa, declines, increasing food insecurity and affecting prices for consumers. Even the coastal countries (Gulf of Guinea, humid Western Africa), which have until now enjoyed a certain measure of climate security (abundant rainfall), see their resources dwindle under the influence of environmental degradation and they too become vulnerable. Decreased rainfall and increased evaporation linked to high temperatures leads to water shortages and deterioration in water resources. Hydrological imbalances cause the collapse of certain economic activities. Reduced river flows have a negative impact on hydroelectric production. And, hydroelectric energy production is affected in Benin, Côte d'Ivoire, Ghana and Togo. This is a replica of the events of February 1998, when Ghana faced an energy crisis caused by a drop in the water level of Lake Volta (Niasse and others 2004). Successive years of drought continue to reduce the size of humid zones in many regions. Despite some patchy rains, the general decline in rainfall continues. Sporadic droughts affect river systems, agricultural production, supplies of drinking water and hydroelectric production.

Policy Reform scenario

In this scenario, politicians become increasingly aware of environmental concerns. At the international level, a common will to correct development options emerges. As a result, MEAs on water, humid zones, climate change and desertification are ratified and implemented. At the regional level, these include the African Convention on the Conservation of Nature and Natural Resources (ACCNNR), for the use and conservation of soils, water, fauna and flora, the Abidjan Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, and the Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa, which aim to protect the marine environment, coastal zones and domestic watercourses shared under the jurisdiction of the countries of Western and Central Africa.

The revitalization of African agriculture is central to all efforts to alleviate the impacts of climate variability and change.

Countries continue to be affected by climate variability and the productivity of marginal lands continues to decrease. In response, adaptation initiatives are launched to address increasing levels of vulnerability. Measures are taken to increase agricultural production with the aim of maintaining a satisfactory level of food security. These measures include the setting up of IWRM programmes and, in the agricultural sector, the selection of drought-resistant species. The creation of water reservoirs makes an increase in agricultural production, despite climate uncertainties, possible. Thus, the availability of food and the level of food security are maintained.

Facing up to climate change also involves strengthening climate forecasting and early warning systems. Climate change will cause changes in rainfall distribution (Watson and others 1998) and will affect the availability of water for food production. To avoid this happening, as a preventive measure, systems are set up to collect water for irrigation and even for domestic use. Sub-regional institutions, such as the Permanent Inter-state Committee for Drought Control in the Sahel (CILSS), establish and strengthen their early warning systems and cooperate with other initiatives in the Famine Early Warning Systems Network (FEWS-NET), in order to pool their results. Policies are adapted to fit in with efforts to strengthen local means of subsistence and poverty reduction.

Cooperation in the management of transboundary waters enables the demand for water to be better managed and regulated while promoting regional development activities. Such cooperation is a potential conflict-prevention tool.

The revitalization of African agriculture is central to all efforts to alleviate the impacts of climate variability and change. It involves taking into account the traditional responses of rural communities to climate crises and integrating the necessary technological innovations to increase the agricultural potential of the land and to tighten control of water resources. Opportunities provided by the use of biotechnology are considered. Improvements in science and technology can bring new opportunities to farmers, allowing them to produce improved varieties of corn, cassava and rice. Investment in this sector is increased and complemented by a regulatory framework for the protection of intellectual property rights and biosafety.

Fortress World scenario

The current global situation is redefined by the international fight against terrorism. New economic dynamics initiated by the most powerful countries, prioritizing their own social and economic needs to the detriment of the environment, influence policy under this scenario. As policies are increasingly geared to meeting the needs of a few, a general rise in poverty is evident. This feature of social inequity has been evident for some time (World Bank 2005b). Growing inequity leads to increasing environmental and human vulnerability. Some countries face an increasing risk of food insecurity.

Given weak environmental policies globally and at the sub-regional level, climate variability continues unabated. Environmental degradation leads to increasingly frequent extreme climate events, such as sandstorms, drought and floods, especially in the Sahel. Rainfall levels decline and more intense climatic extremes (droughts and floods) become the norm. The drought in the Sahel worsens and extends, covering a vast area of land and posing a grave climate danger to agriculture, water supplies and ecosystems. As droughts become more frequent, widespread and lengthy, the viability of the sub-region's crop systems is severely undermined. As previously, people move to more drought-resistant areas and land that was previously used for grazing and left to lie fallow is now under permanent cultivation, causing serious damage to crop systems (Watson and others 1998). There are very heavy agricultural losses due to the vagaries of the climate.

Coastal areas are threatened by erosion, floods and exceptional atmospheric phenomena. Floods pose particular dangers for sea-level cities such as Banjul, Abidjan and Lagos: these become particularly vulnerable (Watson and others 1998). In Gambia, it is expected that floods will cause the loss of 92 km^2 of land following a one-metre sea-level rise. The coastline is likely to recede by 6.8 metres in steep areas and around 880 m in areas that are flatter and more sandy (Jallow and others 1996). With a sea-level rise of one metre and in the absence of any protective measures being taken, the entire city of Banjul, capital of Gambia, would disappear over the next 50 to 60 years as most of the city is lower than one metre of altitude. According to the Intergovernmental Panel on Climate Change (IPCC), the rise in temperature could be as high as 1.6° C in the Sahara (Watson and others 1998) and the semi-arid regions of SSA (Hernes and others 1995; Ringius and others 1996). As a result, food security is seriously jeopardized by the risk of famine, leaving people more vulnerable and causing conflicts linked to the use of the few remaining natural resources. The more wealthy countries invest in agricultural technologies to the detriment of those countries that have already been affected by the extreme climate events.

The rise in sea level will also cause the disappearance of large areas of mangroves in humid coastal zones. These humid coastal areas are ecologically important as they provide unique habitats for species of migratory birds and a variety of local species. Changes in sea level will cause the habitats found in these humid areas, including all the mangrove forests, to disappear. In addition, these areas are a main source of food supply for the sub-region and so environmental change threatens food security. Coastal and offshore zones, together with estuaries and lagoons, are an important source of livelihood for small-scale and industrial fisheries, and in the *Fortress World* this dependency increases to more than 75 per cent of the sub-region's catch.

The drought in the Sahel worsens and extends, covering a vast area of land and posing a grave climate danger to agriculture, water supplies and ecosystems.

As well as reducing the area of cultivable land, the rise in sea level could have serious consequences for human settlements, causing the loss of residential areas and economic infrastructure. A large proportion of the urban population of Western Africa lives in coastal towns and cities. In Nigeria, for example, around 20 million people (22.6 per cent of the total population) live in the coastal zone (UNCHS 2001, Chidi Ibe 1996) and in Senegal, around 4.5 million people (66.6 per cent of the total population) live in the coastal zone around Dakar, where approximately 90 per cent of industry is located (Watson and others 1998). In Benin, Côte d'Ivoire, Ghana, Nigeria, Sierra Leone and Togo, most of the activities related to the production of goods and services, which are the linchpin of the economies of those countries, take place in the coastal zone.

Increased social vulnerability is also to be expected as high levels of acid rain may jeopardize agricultural production and food security. Added to which, people use biomass as their sole source of energy, thereby contributing to the decrease of forested and wooded areas and promoting deforestation. This will also lead to a lessening of carbon sequestration. Deforestation also leads to an increase in the phenomenon of desertification. In

some countries, such as Niger, trees also serve to keep dunes in place and prevent sandstorms.

Other serious impacts linked to climate variability and extreme weather events include those on health. These include, among others, emerging and re-emerging diseases linked to water and climate variations, such as meningitis and malaria.

Great Transitions scenario

The *Great Transitions* scenario is characterized by the will to achieve sustainable development. It is based on a new balance between a market economy that is strong and a policy context in which environmental concerns are taken into account by decision-makers and improving human well-being is a priority.

Policy measures are adopted to ensure the effective implementation of MEAs and to strengthen existing early warning systems. The loss of human life and economic disruption caused by extreme weather events are considerably reduced due to the strengthening of early warning systems. Measures to combat drought are aimed first and foremost at ensuring the livelihood of households and improving the resilience of people to cope with environmental change. Measures are adopted to alleviate the effects of reduced rainfall. Recent scientific progress in understanding the climate and forecasting seasonal droughts is used in defining strategies for reducing human vulnerability. Seasonal rainfall forecast systems are set in operation in a number of countries and provide forecasts for periods of over three months. The possibility of longer-term forecasts exists and research results make possible drought-related forecasts in the management of agriculture, water and energy.

To prepare people to adapt to the increasing incidence of droughts, numerous research organizations introduce programmes to monitor climate, agriculture, plant life and natural resources. They also focus on the elaboration of early warning systems and participate in multidisciplinary research while encouraging the establishment of action plans. International agencies and national and sub-regional organizations develop more effective partnerships for addressing these challenges. At the sub-regional level, the Centre for Agrometeorology and Operational Hydrology (AGRHYMET), a specialized CILSS institution, located in Niamey, Niger, was created in the wake of the devastating droughts experienced in the Sahel in the 1970s. The institution also has an early warning system which includes the artificial production of rain. Institutions such as these are strengthened.

The loss of human life and economic disruption caused by extreme weather events are considerably reduced due to the strengthening of early warning systems.

Increased attention is given to developing systems for more effective participatory management of natural resources and the environment. This involves many different areas including forestation programmes and R & D programmes in areas such as carbon sequestration and clean technologies.

Water management is essential for addressing the threats posed by climate variability to food security. Consequently, there is investment in establishing water reservoirs, to strengthen food security and boost income-earning opportunities. More consideration is given to agricultural planning. Crop area and yield are determined entirely by prices, investment in irrigation and technological innovations. Production and stocks are replenished and demand for food is satisfied.

Policy lessons from the scenarios

With the support of the international community, countries must undertake the adoption of new practices and legislation, and give consideration to scientific and technical aspects. Under its climate change strategy, NEPAD should without delay implement the various projects that it has proposed, namely:

- Elaboration of decision-making tools to evaluate climate vulnerability;
- Promotion of renewable energy initiatives and strategies; and
- Evaluation of the synergetic effects of adaptation and mitigation activities through agroforestry pilot projects, including in the areas of land stabilization, income generation, improving water storage and biodiversity conservation (NEPAD 2003).

Where receding coastlines and coastal erosion are concerned, mitigation techniques might include the construction of floodwalls and the relocation of vulnerable human settlements and social and economic infrastructure. Technology related to genetically modified organisms and its application should be the subject of extensive research and all the countries of the sub-region should develop and strengthen their biosafety legislation.

New environmental policies and legislation should be adopted and applied in poverty-reduction efforts. Furthermore, if sustainable development is to be assured, climate evolution parameters must be incorporated in

national and regional policies. Taking climate change into account will prove to be a determining factor in a future vision for the development of the sub-region.

WESTERN INDIAN OCEAN ISLANDS

The management of coastal areas in the WIO presents special challenges, as these are a vital resource underlying the development of all countries, and opportunities for improving human well-being.

The scenarios in AEO-1 (UNEP 2002a) made the following projections for the WIO islands:

- *Market Forces* scenario: coastal waters become increasingly polluted and overfished, and deep-sea fishing is industrialized and internationalized with the region failing to take advantage of its legitimate rights in extended territorial waters;
- *Policy Reform* scenario: the loss of coastal land due to coastal erosion, as a consequence of natural processes, is reduced but expanded coastal development continues to exert pressure on resources. Deep-sea activities prove satisfactory but the sub-region is slow to respond to opportunities;
- *Fortress World* scenario: coastal and marine areas are seriously affected by overfishing. The negative effects on marine resources as a result of overexploitation by foreign vessels are compounded further by major tanker spills;
- The *Great Transitions* scenario: a regional integration movement is revived to save the marine and coastal livelihood of onshore fishers and interest in deep-sea fishing is reawakened with new technologies to detect fish shoals and ensure the sustainable exploitation of living and non-living resources.

Since AEO-I, various policies have been implemented and legislation promulgated to reverse the trend in coastal degradation. These include:

- In Mauritius, legislation in force as from October 2001 banning sand extraction in the lagoon has started to bear fruits. A survey in 2004 shows that ex-sand sites are slowly recovering and new coral and sea-grass colonies have reappeared. As at June 2003, about 3 300 households have been connected to the Baie du Tombeau wastewater treatment plant in the northwestern part of the island to reduce the discharge of untreated effluents in the lagoon. Further expansion in this connection is ongoing in other regions (Government of Mauritius 2005).
- The Seychelles has established 11 sites for water quality and coastal erosion monitoring to obtain vital data to address beach erosion and coastal degradation issues (IOC 2004);
- Comoros has established a Marine National Park at Moheli and plans are underway to establish another one at Coelacanthé (Ahamada and others 2004);
- In Madagascar, ecotourism to relieve the pressure on coastal resources is being promoted. Public awareness on the vulnerability of coastal resources is being enhanced and public participation in coastal zone management encouraged with the establishment of appropriate structures to facilitate the integration process.

However, in spite of the above measures, coastal and marine degradation continues. The rate of investment in coastal development to cater for the growing tourism industry has accelerated with limited consideration for the environment. Urbanization of the coastal region is increasing. In Seychelles for instance, coastal population density on the east coast of Mahé is expected to grow from 161 to 203 persons per km2 by 2015.

The following narratives consider the implications of policy choices for the future condition and health of coastal and marine resources and the consequences of this for development.

Market Forces scenario

As the world becomes increasingly integrated, economically and culturally, the globalization of products and labour markets catalysed by free trade agreements prompts the WIO islands to export more goods, especially to countries in the developed world. The manufacturing industry is the main benefactor, as countries in the sub-region take advantage of the African Growth and Opportunity Act (AGOA) opening new markets for textiles in the USA. Cheap labour, particularly in Madagascar and Comoros, encourages an increase in FDI, and this results in building more factories to cope with the flourishing market. Labour is exchanged freely between the countries, but at the same time, skilled labour from countries in Asia, including China and India, makes up for the increased demand in workforce. Many textile dye industries are established. These developments, however, give rise to increasing discharge of effluents, which pollute the lagoon environment.

Massive investment from foreign companies, particularly from China and Japan, to establish tuna factories and gear development make the region a seafood hub.

The fishing sector is another industry which is intensively solicited for development. Massive investment from foreign companies, particularly from China and Japan, to establish tuna factories and gear development make the region a seafood hub. Development of offshore fishing is intensified but without much consideration to its sustainability for future generations. Some countries sell the fishing rights to their exclusive economic zones (EEZs), complicating regional cooperation. Governments in the sub-region invest increasingly in education and health care to provide the necessary skilled and healthy labour to support the developing economic sectors. Regional groupings emerge to establish centres of excellence for regional training, with external assistance, in areas such as offshore fishing, canning industries and shipping crew.

Employment is created; the standard of living of all the islands is increased and there is a substantial decrease in poverty. However, with the increase in cash flow, consumerism and materialism prevail. Imports of foreign goods increase, and there is increasing adoption of western lifestyles with gradual erosion of traditional cultures and their environmental values. Uncontrolled deep-sea fishing depletes fish stocks. Oil slicks from increased shipping activities further degrade the marine environment. These give rise to a decrease in fish catch resulting in substantial fall in FDI.

Policy Reform scenario

Confronted with increasing coastal and marine degradation and loss of marine biodiversity, the WIO islands take drastic measures to address the issues.

The sewage treatment system is expanded over all the islands, and all coastal hotels and private bungalows are connected to the public sewage systems.

Wastewater management is given urgent attention. The sewage treatment system is expanded over all the islands, and all coastal hotels and private bungalows are connected to the public sewage systems. Strict regulation for hotels and bungalows to thoroughly treat wastewater so that it can be re-used for irrigation purposes is enforced to limit coastal pollution. These measures improve the water quality of the lagoons and there are positive impacts on marine life.

On all the islands, ICZM is promoted. Native coastal plant species are reintroduced along the beach. Pathways are created to avoid walking on coastal vegetation and the use of beach areas by vehicles is banned. Increased active stakeholder participation in the management and utilization of coastal and marine resources is encouraged through meetings and committees with the public sector as facilitator. All coastal development projects are discussed with all the actors and civil society before implementation, and this increases support for these activities. The fishing communities, among the poorest communities, benefit considerably from these measures.

Soft engineering solutions such as beach nourishment and forestation to address coastal erosion are resorted to. The use of hard engineering structures – seawalls, groynes, revetments and breakwaters – is generally discouraged. Their use is only allowed where it is absolutely necessary. New building regulations are developed including the obligation to set buildings back at least 40 m from the high-water mark. This is rigorously enforced in erosion-prone beach sites. These measures reduce coastal erosion and overall levels of loss of coastline. The number of marine parks and marine protected areas is increased. New beach-clearing schemes are established and additional licences for pleasure boats are granted. These measures encourage the creation of jobs, including some for sand extractors who have lost their jobs as a consequence of new regulation on sand mining.

However, the arrival of more tourists, in line with government policies to increase revenue in this sector, without adequate consideration of the islands' carrying capacity exerts more pressure on coastal resources. In spite of political will to avoid further degradation of the coastal zone, with the promulgation of new laws and legislation, ill-planned littoral development and ever-expanding tourism increasingly affect coastal ecosystems and boost coastal pollution. These effects undercut local livelihoods, especially those of the fishing community.

Fortress World scenario

With the increase influx of tourists, due to this becoming a preferred tourism destination as a result of the higher vulnerability of southeastern Asian islands to tsunamis, the elite and multinationals seize the opportunity to invest massively in hotel construction. Aggressive marketing at global scale is done through multinational companies. The price of coastal land goes up significantly, making it affordable only to the rich. Poor people in these coastal areas are displaced,

effectively forced inland and onto marginal lands to make room for coastal development to accommodate a flourishing tourist industry.

The rich, having financial resources and political influence, bribe public officials and bypass restrictions imposed in the EIA for coastal construction. Coastal vegetation is removed, buildings are constructed near the shoreline to satisfy tourist aspirations to be on the seafront, and a series of breakwaters are placed to protect the coast from erosion. Such measures give rise to conflict between the elites and fishers, who increasingly find obstacles in reaching their fishing grounds, and the public who are deprived of free access to the beach. The best sandy beaches are appropriated by the elite, in connivance with officials with high political influence, to construct luxurious villas and bungalows for sale to overseas millionaires and retired people with very high income. Several enclaves are thus created. In the face of growing social breakdown, violence and crime increase. Much pressure is exerted on the police force to protect a disproportionately few people, on account of their influence, to the detriment of law and order at national level.

The construction of hotels and private bungalows on the beachfront, which had provided unobstructed views of the lagoon, gives rise to increasing erosion. Hard engineering measures are taken to protect the eroded beaches with seawalls and groynes. Climate change and sea-level rise exacerbate the erosion problem. The protection measures adopted are of short duration and further erosion takes place, necessitating further protection. Eventually, a long wall costing millions of dollars is built, depriving the public and fishers of free access to the beach. In the worst scenario, the bungalows and hotels are abandoned, leaving the beach, deprived of its sand and vegetation, rocky and barren.

Mass mortality of fish occurs in the lagoons as a consequence of pollution from effluents discharged from the hotels and bungalows. Coral reefs are massively bleached and mangrove forests are threatened. The fishing community are deprived of their livelihoods, thus exacerbating further social decay and resulting in unrest. The offshore fishing industry is controlled by multinationals. Local fishing companies are unable to compete with the foreign investors who employ most of the professional fishers, offering them better pay packages. The local fishing companies become bankrupt and are forced to abandon fishing. The EEZs of the islands are exploited to the maximum without any regard to the renewal of fish stock.

Great Transitions scenario

The sub-region is fully conscious of the coastal degradation problems and decides to give them full attention and consideration, and a holistic approach replaces the hitherto piecemeal solutions.

National and sub-regional surveys are conducted to collect data and information in order to identify the root causes of the problems rather than just giving consideration to the symptoms. Discussion is held with all stakeholders – public, private, NGOs, civil society and experts – at national and sub-regional level to decide on the most appropriate global solutions.

Discussion at the national, sub-regional and regional level is facilitated though a network established within the UNEP Africa Environmental Information Network (AEIN) programme, which all the countries are implementing fully. Data collection and analysis are now harmonized at the sub-regional level with the use of the UNEP Africa Environment Outlook – Environmental Information System (AEO-EIS) toolkit. The ICZM programme is further developed and strengthened in each country of the sub-region. A sub-regional approach is adopted. It is implemented within the necessary legislative and institutional framework. A sub-regional steering committee with high officials involved in decision making is established with regular annual meetings to discuss activities of mutual interest, exchange views and experience on ICZM and review progress.

National plans are prepared for the two most promising economic sectors, namely tourism and fishing, clearly articulating strategies with sound policies to keep them sustainable, taking into account the health of the environment.

National plans are prepared for the two most promising economic sectors, namely tourism and fishing, clearly articulating strategies with sound policies to keep them sustainable, taking into account the health of the environment. For coastal hotels and other development infrastructure, setback distance based on reliable data and extensive fieldwork is enforced. The height of buildings is limited to two storeys. The Creole architecture most suited to local conditions is adopted, minimalist architectural patterns are recommended and developers follow this guidance. There is a general recognition of the importance of coastal vegetation in controlling beach erosion and its upkeep and replantation is promoted.

Publicity for the tourism industry is shifted from the traditional sea-sun-sand focus to the promotion of cultural dimensions. Tourism activities are oriented more towards the discovery of local cultural diversity. Small musical groups formed to give shows in hotels and public places proliferate and the number of "*table d'hôte*" (modestly-priced local cuisine) restaurants increases. More people become conscious of the traditional cultural richness of the sub-region, leading to a decrease in influence of western lifestyle and a preservation of traditional environmental management rules and values.

The fishing industry is revitalized. Incentives such as loans with low interest to procure vessels and fishing equipment are provided by governments to encourage offshore fishing. Training is provided through government-initiated projects to artisanal fishers to entice them to indulge more in open-sea fishing. These steps relieve the overfished lagoon from fishing pressure and polluting activities. Consequently, coral reefs and sea-grasses start to thrive. The diversity of fish species increases and the lagoons become repopulated. More people are employed in the fishing industry. Access to income and other material resources is secured and this has implications for the overall improvement in the quality of life in fishing communities, including in health and education. Energy sources from the sea are exploited. New technical breakthroughs in the conversion of wave energy to electricity enable the sub-region to take advantage of this new source of energy. This makes the sub-region less dependent on fossil fuels, and foreign currency savings are directed towards other development programmes.

The management framework adopted integrates technical, economic, environmental and social aspects. It is discussed with all stakeholders – public, private, NGOs and civil society – and implemented under an appropriate institutional framework only after a consensus has been reached. Conflict of interest between and within communities is as far as possible avoided. In response to sound policies implemented, and effective measures taken, the economies of all the countries flourishes. A mechanism for free exchange of trade and labour is put into place.

Policy lessons from the scenarios

The management of coastal and marine resources presents special challenges related to the high vulnerability of these resources and people living along the coast. The interface between the human and environmental systems is very sensitive to changes in either. The scenarios, in examining this complex interaction, point to the importance of ICZM, and the need for inter-state collaboration in managing marine resources and developing early warning systems. The *Market Forces* and *Fortress World* scenarios indicate minimal opportunities for meeting these challenges.

The *Policy Reform* and *Great Transitions* scenarios both demonstrate the positive effects of wise policy interventions. A key policy lesson is the need for management and planning systems which recognize all three sustainable development pillars and the importance of good governance practices to ensure this. Policy opportunities from the scenarios include more accountable and transparent decision making and increasing public participation.

The importance of R & D as well as investment in human capacity to complement and support management is also evident.

Dawn to dusk… the possibilities are endless.

Source: A. Mohamed

CONCLUSION

From the scenario narratives it is clear that contrasting yet plausible stories can be created as to how Africa and its sub-regions will develop in the next 20 years. Each has fundamentally different implications for the environment. The scenarios constructed here are based on the understanding of current conditions and driving forces, a vision of the future and a coherent story of a process of change, leading to that future. Specific assumptions have been made across a range of dimensions and issues: economic growth and structure, population, technology, resources and the environment. The alternative possibilities that emerge are significant as points of departure that can guide policy for the harnessing of environmental resources for sustainable development. Although there can be marked delays between human actions, including policy decisions, and associated impacts on the environment, positive long-term impacts of the policy decisions obviously outweigh the cost of inaction. The achievement of widely-agreed environmental, economic and social goals will require dramatic and coordinated action, starting now and continuing for a number of years. Steps must include proactive policies based on prevention and adaptation that address issues of development and human vulnerability.

The scenarios presented here demonstrate the importance of interlinkages between the environmental, social, economic and political spheres, both within and across sub-regions. Environmental and sustainable development policy must look for the synergies or "co-benefits" and conflicts between policies must be avoided. The establishment of strong institutions for environmental governance, as policy, is a prerequisite for almost all other policies. The political will and vision of governments and other authorities determine, above everything else, whether environmentally sustainable development comes within reach of countries in the region. The mainstreaming of environmental issues in the development process will demand that timely access to accurate information is ensured as this in itself is a robust policy. The achievement of environmental goals will require decisive action, will encounter unforeseen eventualities and will not happen overnight. AEO-1 noted that, "Fortunately or unfortunately, much of the success or failure of this endeavour is in our hands. The four scenarios show that the future is not something that we should wait for passively" (UNEP 2002b). The choice is up to us, in the words of Nelson Mandela, first president of democratic South Africa:

> "Sometimes it falls upon a generation to be great. You can be that great generation."
>
> NELSON MANDELA,
> SPEAKING IN TRAFALGAR SQUARE, LONDON,
> 3 FEBRUARY 2005 (MAKE POVERTY HISTORY 2005).

Fortunately or unfortunately, much of the success or failure of this endeavour is in our hands. The four scenarios show that the future is not something that we should wait for passively.

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SECTION 5

POLICY OPPORTUNITIES

CHAPTER 14

BACK TO OUR COMMON FUTURE: A RENAISSANCE FOR THE ENVIRONMENT

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"To live is to choose. But to choose well,
you must know who you are and what you stand for,
where you want to go and why you want to get there."

Kofi Annan

Secretary-General of the United Nations

The message of the Brundtland Commission, in its report *Our Common Future* nearly two decades ago in 1987, that people's "well-being is the ultimate goal of all environment and development policies," remains as relevant and urgent today as it was then. Since then, significant progress has been made to address the region's environmental challenges and to enhance human development. However, the expansion of capabilities – the extent to which people have the ability to live the kinds of lives they value – is still limited. Millions live in extreme poverty and hunger, are victims of HIV/AIDS and other diseases such as malaria, are illiterate, are discriminated against, are threatened by violent conflict or denied a political voice. As a result of these ills and other challenges, human development, which in essence is about freedom (UNDP 2005), is compromised. Despite the many achievements, including improved economic growth (OECD Development Centre and AfDB 2005) available evidence indicates that similar achievements have not been made in improving overall well-being. The United Nations' (UN) Millennium Project notes, Africa "most dramatically, has been in a downward spiral of AIDS, resurgent malaria, falling food output per person, deteriorating shelter conditions, and environmental degradation, so that most countries in Africa are far off track to achieve most or all of the Goals" (UN Millennium Project 2005a). Africa needs to face this challenge head-on.

Poverty in Africa is a product of its history and of ongoing injustices and inequities, such as unfair trade, conditionality in aid which demands among other things the privatization of essential services, structural adjustment, and global patterns of consumption and production which effectively export vulnerability to developing regions. Indeed, as the World Summit on Sustainable Development (WSSD) recognized, eradicating, or even just alleviating, poverty requires global action – and that the developed world has a special responsibility for this. Nevertheless, Africa should act in its own interest, taking responsibility for improving the lives of its peoples.

The previous chapters have highlighted the many environmental changes and challenges that the region faces, as well as the opportunities its remaining assets provide to sustainably advance human development. Africa's environmental assets offer opportunities for it to attain the objectives of the New Partnership for Africa's Development (NEPAD) and to achieve the targets of the Millennium Development Goals (MDGs) to which it along with other regions signed up at the turn of the century. As highlighted by the Commission for Africa, "Africa holds 7 per cent of the world oil reserves and generated 11 per cent of global oil exports in 2000. By 2015, West Africa will provide 25 per cent of oil imports into the United States. And its richness in natural resources is not confined to the more traditional

commodities. It is the primary source of coltan, the essential component of the world's mobile phones. As the world changes and grows it is likely that Africa's rich resources will continue to be vital to the world's prosperity" (Commission for Africa 2005). This wealth sets the basis for:

> "...a new era of economic growth...based on policies that sustain and expand the environmental resource base...such growth is absolutely essential to relieve the great poverty that is deepening in much of the developing world" (WCED 1987).

To enable the African environment to contribute to both the MDGs and the NEPAD objectives, it is imperative that Africa curbs ongoing environmental degradation and seizes the development opportunities offered by its wealth of natural resources. Success on these fronts requires that policymakers ensure, in addition to other actions, the following:

- Proper valuation of natural and environmental resources;
- Effective conservation, management and use of environmental resources;
- Effective compliance with, and enforcement of, laws designed to conserve the environment and promote sustainable development (Zaelke and others 2005); and
- Undertake strategic investments that enable the environment to benefit from development. Examples include investments in the development of markets for forest environmental services, such as carbon sequestration, biodiversity conservation, watershed protection and landscape values.

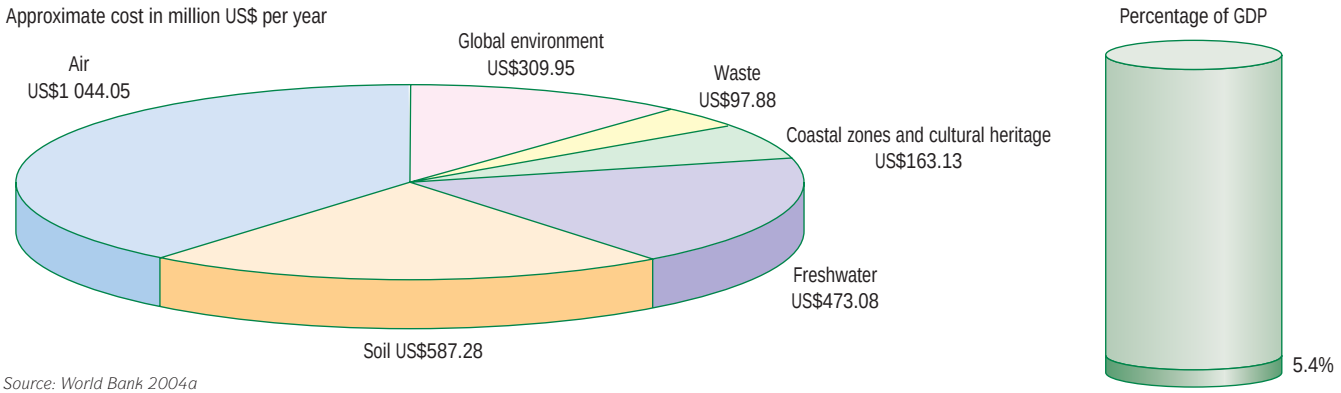
African policymakers can ill afford to ignore environmental degradation, because it impacts on economic performance and ultimately human development. Extreme poverty and environmental degradation "is a waste of opportunities and of resources... it is a waste of human resources" (WCED 1987). For example, research in 1999 concluded that the cost of environmental degradation in Egypt amounted to about EGP14 500 million (or approximately US$2 365 million) annually or 5.4 per cent of its gross domestic product (World Bank 2004a). That cost has been described as "substantial" and is twice as high as that in industrialized countries. In addition to the public benefits, a growing body of literature suggests that improved pollution prevention and environmental management encourages private sector innovation, leading to increased competitiveness in the market-place (Porter and van der Linde 2005). The main reasons for the substantial cost include a significant disease burden associated with lack of safe water and sanitation, substantial health impacts of severe air pollution and productivity losses associated with soil degradation (World Bank 2002).

To postpone policy actions now in the hope of taking them at a time when greater resources are available may not be wise. Although rehabilitating degraded environments diverts resources away from important development activities, including improving social services such as educational and health delivery, it also impacts on governments' abilities to maximize available opportunities. This close relationship is increasingly recognized. For example, in 2004, Mali was awarded a Global Environment Facility (GEF) grant of US$5.5 million from the World Bank to stop or reverse biodiversity degradation trends in key conservation areas and other specific sites in the Gourma. The Gourma, which covers three million hectares and is home to Africa's northernmost elephant population (350 strong), is experiencing high degradation, including local extinction of animal and plant

Well-being is the ultimate goal of all environment and development policies.

Brundtland Commission (WCED 1987)

Figure 1: Annual costs of environmental degradation in Egypt



Source: World Bank 2004a

populations and overall desertification (World Bank 2004b). The project aims to build local capacity and enhance the development opportunities available to the communities in the area by conserving biodiversity, extending the role of communities in management, and acknowledging them as beneficiaries.

The AEO-2 report, especially in the environmental state-and-trends chapters, shows that Africa has many opportunities to utilize the environment for development, but only if the discerned challenges are dealt with effectively. The analysis also reveals some emerging environmental challenges – such as genetically modified (GM) crops, invasive alien species and chemicals – which require immediate and long-term strategies and interventions by African policymakers. The report also highlights positive lessons from transboundary natural resource management and from regional cooperation for sustainable environmental management that can be replicated or developed further.

Although some AEO-2 findings are not groundbreaking, their continued high profile on the African environmental agenda is a cause for careful retrospection by policymakers on how effectively the existing policy and institutional arrangements have served Africa's sustainable development goals. That retrospection could yield insights on how policymakers can foster a creative and strategic shift from the reactive mode of dealing with the problems of environmental change and human vulnerability, to a more proactive mode whose impact would include enhancing human well-being. Such a proactive mode would require capacity development at disparate levels to enable, for instance, effective adaptation to and management of socioeconomic and environmental change.

Policymakers face the challenge of meeting livelihoood and settlement needs.

Source: CIFOR

This chapter considers some of these policy actions:

- The issues which have been identified by policymakers in the region are highlighted.
- The medium-term outlooks on the issues are provided as a basis for specifying the actions that could be taken.
- The roles of the various stakeholders in implementing the proposed actions are also highlighted.
- The periods for achieving the targets are identified.

The policy options, adopted by African environment ministers at a meeting in Dakar in 2005, provide a sufficient basis for governments to tailor their policy responses to their national situation. This is an acknowledgement that policy processes have a time and space, and respond to political processes which are bound by other demands and deadlines.

POLICY OPTIONS FOR ACTION

THE HUMAN DIMENSION

Issues

Poverty has many faces. It includes extreme or absolute poverty, relative poverty and social exclusion.

Extreme poverty and underdevelopment continue to plague the region with hundreds of million of people, particularly women and children, affected. Poverty is not just about the lack of access to financial resources but also the lack of other resources required for survival; poverty is the denial of opportunity. Extreme poverty has been described as "poverty that kills," depriving individuals of the means to stay alive in the face of hunger, disease and environmental hazards (UN Millennium Project 2005a). Relative poverty refers to the level of inequity and inequality – the differences between rich and poor.

The health burden due to HIV/AIDS, malaria and other diseases is a major factor for such underdevelopment. For example, malaria which kills more than 900 000 people in Africa per year (WHO 2001), mostly women and children, has been described as a slow-onset "tsunami" (Sachs 2005) whose impact is shielded from television cameras while its davastating

effect on household security and national development is massive. It is a major threat to human well-being in Africa. As long as extreme poverty and disease continue to ravage the people in Africa, the realization of NEPAD goals, the objectives of Poverty Reduction Strategies and the Millennium Development Goals (MDGs) will continue to be elusive. The MDGs are a "life-and-death issue" (UN Millennium Project 2005a) seeking to address the most extreme aspects of poverty. Achieving them is but one stepping stone on the path to overall African aspirations for development and human well-being. The goals for hunger and disease relate to human capital. The goals for water and sanitation and slum dwellers are part of those for infrastructure. The goal for environmental sustainability is part of protecting natural capital (UN Millennium Project 2005a).

Poverty, poor health and education, poor economic performance and environmental degradation are liabilities; they impede the region's ability to realize the opportunities provided by the environment for development. With vast natural resources in Africa and the majority of the people directly dependent on agriculture and these natural resources for their livelihoods, it is ironic that the highest percentage, globally, of poor people are found in the region. Poor people cannot invest in the environment nor do they have the power and resources to limit damage to local resources, particularly where ill-conceived policies and greed are factors in, for example, soil nutrient depletion, deforestation, overfishing and other environmental damage (UN Millennium Project 2005a). The vicious circle of poverty exacerbates environmental degradation, which in turn limits opportunities for development.

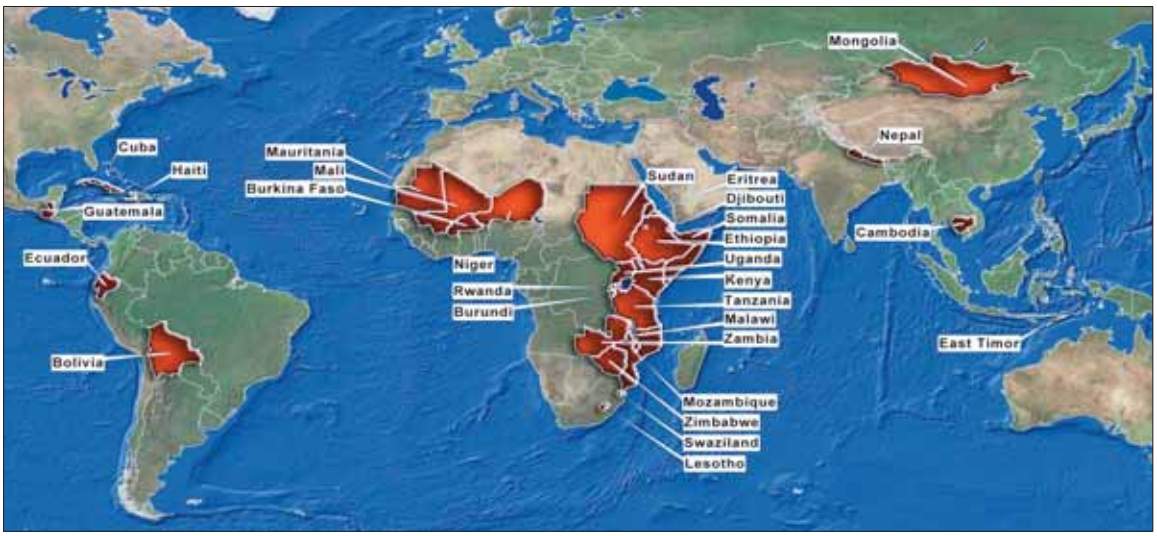
While the formulation and implementation of Poverty Reduction Strategies as a policy response has gained currency in Africa, the weak integration of environment into these strategies has partly contributed to poor performance so far on MDG7. However, countries such as Zambia, Ghana and Mozambique have progressively improved the environmental contents of their strategies, providing useful leads for the other countries. Given the intricate links between environment and other facets of poverty, persistent neglect of environmental issues in the Poverty Reduction Strategies can undermine the prospects for sustainable growth in the medium term and, therefore, of poverty reduction and the attainment of the other MDGs. The Commission for Africa recommendation that African governments include environmental sustainability in their Poverty Reduction Strategies is in recognition of this strong environment-poverty linkage (Commission for Africa 2005).

Africa has the highest rate of urbanization in the world (3.4 per cent) and poverty in these areas is likely to be a growing problem. These slums are home to 72 per cent of Africa's urban citizens. That percentage represents a total of 187 million people (UN-HABITAT 2003).

Outlook

Without innovative interventions which tackle the root causes of poverty, rather than its symptoms, extreme poverty and hunger will continue to be critical issues in Africa. Although there may still be much that we do not know about poverty and how it is related to environmental degradation, we know enough for this to be an area of urgent activity. It is important to go beyond

Figure 2: Countries affected by food insecurity due to natural hazards during the 2005-06 cropping seasons



Source: WFP 2006

policy discussions and focus on the implementation of policy so as to make a difference to the hundreds of millions of people who live in poverty. Poverty will be a growing problem in both urban and rural areas. In urban areas population growth will continue to outstrip the rate of infrastructure development, leading to an ever-increasing problem of shanty towns and slums. Reducing the vulnerability of poor people to natural disasters and other environmental change is essential. This requires increasing the capabilities people have to adapt to and mitigate such change.

The region has signed up to policy responses such as NEPAD and the MDGs. These provide opportunities to seriously address the socioeconomic problems currently facing Africa. Trends show the interest and commitment of countries in the region to alleviate extreme poverty and hunger, address health and education, and provide more services and so on. Action is now required on these commitments in advancing Africa's sustainable development agenda.

Foreign Direct Investment (FDI), overseas development assistance (ODA) and debt relief are some of the tools available. These need to be complemented with structural changes that address gender issues, access to resources and secure tenure to those resources. Effectively tackling extreme poverty and hunger translates into providing universal education, reducing child mortality, improving maternal health and reducing the disease burden exacerbated by HIV/AIDS, malaria and other water-borne diseases. Success in these areas would facilitate building the resilience of Africa and helping in realizing its opportunities. The UN Millennium Project (2005) argues that "geographical vulnerabilities (which are common in Africa) can and need to be offset by targeted investments in infrastructure, agriculture and health." By the end of 2005, under the Heavily Indebted Poor Countries (HIPC) Initiative, 24 African countries have benefited from debt relief (IMF 2005a). In terms of the Group of 8's (G-8) Multilateral Debt Relief Initiative, by the end of 2005, a total of 19 countries had been granted total debt relief – or debt forgiveness (IMF 2005b). Of these 13 are in Africa (IMF 2005b). This debt relief increases the prospects for enhanced investment in Poverty Reduction Strategies and if those strategies are MDG-based, then the likelihoods of enhanced performance on both the MDGs and the NEPAD goals are high.

The production of herbs and plants used in traditional medicine. Ethiopia supports local livelihoods and increases the value placed on indigenous knowledge systems.

Source: P. Virot/WHO

Action

While improved governance is necessary, it alone cannot guarantee poverty alleviation. There are critical policy and institutional changes that deserve serious consideration (UN Millennium Project 2005). Discussions and decisions on the relevant policy and institutional changes should involve all stakeholders, including the private sector and civil society.

It is proposed that policymakers in Africa take serious consideration of the actions that have already been proposed in relation to poverty-environment linkages and reaffirmed by both the UN Millennium Project and the Commission for Africa:

- Strengthen the resource rights of poor people.
- Enhance the capacity of poor people to manage the environment.
- Expand access to environmentally-sound and locally appropriate technology.
- Reduce environmental vulnerability of poor people.
- Integrate poverty-environment issues into economic policy reforms.
- Increase the use of environmental valuation.
- Encourage appropriate private sector involvement.
- Implement pro-poor environmental fiscal reforms.
- Incorporate gender-based measures in social, economic and environmental policies and ensure that data collection and analyses are gender-disaggregated.
- Promote indigenous knowledge systems in strengthening education for sustainable use and management of the environment.

- Invest in improving the quality of life in urban areas, including through the better provision of essential services and diversifying the livelihood opportunities available to urban dwellers.
- Improve urban planning to minimize the impact of settlements on the environment, particularly the encroachment and conversion of habitats and ecosystems.
- Lobby for improving the international and industrial country trade policies.
- Ensure that foreign direct investments are more pro-poor and pro-environment.
- Negotiate effectively to ensure that the implementation of multilateral environmental agreements benefit poverty reduction.

Stakeholders

Tackling extreme hunger and poverty is not exclusive to governments, but should also involve poor people, civil society, the private sector including big businesses, research institutes and other stakeholders. Partnerships between and among all relevant players are critical to the success of tackling extreme poverty and hunger, and other socioeconomic issues.

Result and target date

Governments should work to meet the MDG targets to halve extreme poverty and hunger by 2015. These issues should remain top on the agenda into the future. However, it is worth noting that it is hardly possible to completely eradicate extreme poverty and hunger.

Atmosphere

Issues

The issues range from extreme weather events, such as drought and floods related to climate variability, to access to energy for the majority of the people in the region. These extremes in weather mean too much rain in some areas or too little rain in others. The consequence of such extremes is that ecosystem functions are disrupted, with disastrous consequences for biodiversity and the people who are affected. For example, both drought and floods negatively impact food production and food security as well as hydroelectricity generation which supplies energy for domestic and industrial use.

Oxides of sulphur and nitrogen emissions resulting from the use of fossil fuels such as coal and diesel in the power generation and smelting industries are important contributors to air pollution. In trying to address the negative aspects of the atmosphere there is a tendency to focus on such emissions and air pollution, while taking the assets inherent in the atmosphere for granted.

The atmosphere, and maintaining its integrity, is essential for environmental and human well-being. All weather takes place in the troposphere, which is 14 km above the Earth's surface. Weather patterns and climate are key components in Africa, influencing seasonal and annual variations in temperature and rainfall patterns in and between sub-regions and countries. The stratosphere and the ozone layer, which are above the troposphere, absorb ultraviolet radiation from the sun. Without absorption, ultraviolet radiation is hazardous to life, and the Africa region is part of international efforts to phase out the use of fluorocarbon compounds which deplete the ozone layer.

Outlook

With the slow pace of industrialization, many African countries will continue to be minor contributors to industrial air pollution. In the foreseeable future, low-income consumers will continue to purchase and use reconditioned vehicles that fail to meet air quality standards and that may contribute to increased levels of local vehicular emissions. Some industrialists' antipathy against air quality standards is likely to continue for a while, especially given the political tendency to pitch environmental concerns against those for employment and economic empowerment of the poor. The uptake of cleaner production technologies is likely to remain slow, in line with the overall pace of industrialization. However, increasing involvement of the private sector in the formulation and implementation of air quality standards may improve the efficiency and compliance of local industries, as illustrated by the example of the cement

The Global Atmospheric Watch Station at Mount Kenya provides important data collection and atmospheric monitoring and assessment services.

Source: C. Lambrechts/UNEP

industry in Uganda. The monitoring and enforcement of atmospheric quality standards is likely to remain a challenge in the face of lack of investment in institutional and human capacity-building.

A serious problem across Africa is that of indoor air pollution, given the heavy dependence of the population on biomass fuel for cooking and the inadequate ventilation of the kitchen (Gordon and others 2004). The respiratory diseases associated with indoor air pollution may persist for a while unless measures are taken to introduce affordable cleaner energy systems for the poor.

Action

Policymakers could consider the following actions:

- Develop appropriate air quality policies and standards with the active involvement of all stakeholders, and effective systems for their implementation.
- Review the components of the transport and taxation policies that relate to better management of emissions from motor vehicles.
- Introduce or improve the management of a carbon tax, the revenues from which could be used to develop green belts in urban centres to serve as carbon sinks.
- Promote access to clean energy systems for the rural and urban poor in order to reduce health problems associated with indoor air pollution.

Stakeholders

The stakeholders include government, the private sector and civil society. Partnerships with the scientific and health communities are essential in developing appropriate standards.

Result and target date

Countries should aim at having policy and standards in place by 2010 and reducing the levels of indoor air pollution by 50 per cent through a combination of improved technologies, such as more efficient stoves, and other affordable cleaner energy systems by 2015.

Land

Issues

Land resources in Africa are priceless, as they support the majority of the people, particularly in terms of agriculture and livestock production. Land is an environmental, social and economic good and is a key resource for the realization of development opportunities. Trends show continued degradation of the resource, particularly due to desertification and climate change, but also as a result of poor management and planning. Such degradation undermines productivity and the achievement of the MDGs, especially those pertaining to hunger and poverty.

Although land degradation is usually defined by reference to productivity, its effects may include diminished food security, reduced calorie intake,

Livestock offer opportunities for rural communities across the region providing household security including during periods of drought.

Source: M. Chenje

economic stresses and loss of biodiversity (Stocking and Murnaghan 2000). Land can be degraded or lost through unplanned and badly planned activities related to agriculture, forestry and industry, as well as urban sprawl and infrastructure development. Natural disasters, such as cyclones and floods, result in land loss and deterioration in the functional capabilities of soil. Industrial pollution is increasingly contributing to land degradation as well. An estimated 500 million hectares of land in Africa have been affected by soil degradation since about 1950 (Oldeman and others 1990), including as much as 65 per cent of the agricultural land (Oldeman 1994). This includes 25 per cent or 320 million hectares of Africa's susceptible drylands (Secretariat of the CBD and others 2001), and the degradation-drought-famine linkage exacerbates vulnerability to livelihood insecurity. Recurrent droughts increase soil degradation and this soil degradation then magnifies the effects of drought (Ben Mohamed 1998). This situation, therefore, has implications for the attainment of many of the MDGs and the NEPAD goals.

Increasing population pressure on land combined with reduced fallow periods, inequitable land tenure regimes and poor land-use planning contribute to overcultivation. While overgrazing is a common problem in countries with large livestock populations, the conversion of traditional grazing land into protected areas, use of perverse subsidies that encourage overstocking, poor siting of watering points and the imposition of sedentary agriculture or ranching on pastoral communities also contribute to overgrazing.

These factors have negatively impacted on the capacity of Africa's biologically productive land to sustain its population at current consumption levels. This is referred to as its ecological footprint (Stocking and Murnaghan 2000). The estimated per capita productive land available in Central and Eastern Africa varies from the low of 0.69 ha in the Democratic Republic of the Congo, 0.75 ha in Burundi, 0.85 ha in Ethiopia, 0.88 ha in Uganda, 0.89 ha in Cameroon, 0.90 ha in Rwanda, to 1.12 ha in the Central African Republic, 1.15 ha in the Congo and 2.06 ha in Gabon. Other things being equal, increasing consumption levels will definitely put severe pressure on the ecological footprint.

Africa is extremely dry, in both percentage terms (43 per cent of the land area is classified as drylands), and in total available moisture (5 000 m^3 per capita per year). These drylands are unevenly distributed in the region. For example, the percentage of total land area considered semi-arid and arid is low in the Democratic Republic of the Congo (3 per cent), Burundi (5 per cent), the Central African Republic (12 per cent), Cameroon (17 per cent), Rwanda (19 per cent) and Uganda (25 per cent) and high in Chad (no percentage given), Ethiopia (74 per cent) and Kenya (87 per cent). The percentage of the country populations having to derive their livelihoods from such lands are 2 per cent in the Democratic Republic of the the Congo, 4 per cent in Burundi, 9 per cent in the Central African Republic, 10 per cent in Rwanda, 16 per cent in Uganda, 23 per cent in Cameroon, 39 per cent in Kenya and 42 per cent in Ethiopia (UNSO/UNDP 1997).

Countries such as Ethiopia and Kenya have hotspots within their drylands where a combination of land degradation and grinding poverty seriously undermine income and food security, exacerbating human vulnerability. These hotspots present serious development challenges, requiring a thorough understanding of the poverty-environment nexus to implement programmes which enhance human well-being and effective environmental management. Opportunities exist for investment in drylands to fight poverty and promote sustainable human development. For example, focusing on high-value crops, such as fruit and vegetables, can intensify cash crop production. New opportunities for livestock production can be found, including the range farming of game animals. Ecotourism with fair and equitable benefit-sharing arrangements with local communities can be promoted in wildlife reserves to the benefit of both people and biodiversity (Dobie 2001). Small-scale irrigated agriculture can more equitably expand the frontiers of opportunity for the poor in the drylands of Africa.

Throughout Africa cotton is a valuable drylands crop and securing favourable market terms will help improve livelihoods. Burkina Faso.

Source: D. Tiveau/CIFOR

Africa cannot realize the full opportunities associated with its natural resources if it does not address its infrastructural problems.

Source: Z. Tchoudjeu

In Africa's Small Island Developing States (SIDS) heavy pressure on land has resulted in the conversion of natural vegetation, clearing of forests, loss of productivity and soil erosion. In Mauritius, for example, land degradation is a major problem such that only 1.5 per cent of the original native vegetation cover remains (IOC 2004). In addition, agricultural trade in Small Island Developing States (SIDS) has declined and continues to be threatened, mainly due to the fact that they are small, vulnerable and remote, and also as a result of the changing international trading environment (FAO 2004).

The issues of land tenure and land-use management are critical in ensuring that land is effectively used to benefit poverty reduction and sustainable livelihoods in Africa. In many countries this will require fundamental land-tenure reform. A related issue is that of land conflict, which, if not properly managed, can have adverse consequences for livelihood security.

Africa's main policy responses to the land issues highlighted above have included reforms in land-tenure policies and laws, and the translation of the UN Convention to Combat Desertification into strategies and plans for sustainable land management. Tenure reforms have yielded mixed results with access and control as issues of contestation. Rarely have efforts been made to take due account of the links between land and water rights, yet that link is fundamental to land productivity. While progress has been made on the formulation and implementation of the National Action Plans to Combat Desertification (NAPs), their effectiveness has tended to be undermined by the failure to integrate the NAPs into national policies and strategies and/or other relevant action plans such as those for biodiversity conservation and adaptation to climate change.

Outlook

Given the slow development of the industrial and service sectors in many African countries, huge sections of the population will continue to depend directly on land for their livelihoods. Overall, land degradation is likely to continue in the short to medium term. The worsening poverty situation, sustained high rates of population growth, and negligible growth in the industrial and service sectors will combine to perpetuate extensive rather than intensive land use with little or no application of productivity-enhancing inputs. The upshot of this is likely to be increasing costs on people, economies and the environment. Climate change and desertification will also continue to be limiting factors well into the future.

The adoption of integrated planning that embeds the NAP requirements into the budget and land reforms, which are pro-poor and rationalize the protection of both land and water rights, may attract technological investments in agriculture, improving the prospects for productive land use with positive effects on reducing poverty and hunger. Countries that adopt measures to promote agricultural and rural development, especially the policy action on doubling the area of arable land under irrigation by 2015, might also accelerate the attainment of the MDGs on poverty and hunger (Commission for Africa 2005). The Africa Water Vision 2025 sets a target of a 25 per cent increase in irrigated land by 2015 and a 100 per cent increase by 2025.

Action

The UN Millennium Project (2005) has highlighted the need to focus on rural development, and to achieve a 21st century revolution in agriculture as well as strategies to make Africa's fast-growing cities more productive, through a focus on labour-intensive exports. It noted that many countries in the region "require a big push in public investments to overcome the region's high transport costs, generally small markets, low-productivity agriculture, adverse agroclimatic conditions, high disease burden and slow diffusion of technology from abroad."

In practical terms, policymakers could consider the following actions in the light of the realities facing them:

- Ensure that land tenure policy and law provide for equal opportunities to access land and protect the property rights of vulnerable groups, including but not limited to, women, children and the elderly, through effective land registry and control mechanisms, based on adequate information to enable efficient and sustainable use of land resources.
- Institute effective mechanisms for implementing land policies and laws towards effective land use as a means of reducing land degradation and desertification.
- Formulate and implement adaptation measures to minimize the impacts of climate change on land and freshwater resources, taking advantage of resources available under the Montreal and Kyoto protocols.
- Expand the area under irrigation to reduce dependence on rain-fed agriculture, while ensuring that promotion of irrigated agriculture does not yield undue social and environmental problems, such as erosion, salinity and siltation.
- Develop and/or strengthen measures to facilitate peaceful resolution of land-related conflicts which will promote social stability and economic growth and protect natural resources.
- Promote market access for products in dryland areas to broaden the opportunities to improve income and livelihood security.

Stakeholders

The success of these and other policy reforms not only depend on governments but other stakeholders as well. These include civil society, farmers, the private sector, research organizations, banks and the international community.

Result and target date

The UN Millennium Project suggested 2005 as the start of "a decade of bold action" for governments to ensure the success of the MDGs. In the nine years left to 2015 – the MDG target year – strategies should be in place to address land degradation, improve food production and cut down food imports, and enhance household and national resilience in the face of natural disasters. Such strategies would not only be in line with the provisions of the UN Convention to Combat Desertification, but also with the MDG and NEPAD targets. In fact, such strategies would help strengthen the NEPAD priority programme to combat land degradation, drought and desertification. Some of the actions identified above would extend beyond the next nine years, but the foundation should be laid during this period.

Freshwater

Issues

Access to safe drinking water and sanitation is critical to maintaining and improving health. In general, poor water supply and sanitation is a major public health problem throughout Africa. More than 50 per cent of people in Africa suffer from water-related diseases such as cholera and infant diarrhoea (UN Millennium Project 2006). Improvements in safe water supply, and in particular in hygiene and sanitation, can reduce the incidence of cholera, diarrhoea as well as the number of deaths of children under five. Poor access to safe water and sanitation has been described as "the silent humanitarian crisis that each day takes thousands of lives" (UN Millennium Project 2005b). Conventional wisdom suggests that no single type of intervention has had greater overall impact upon economic development and public health than the provision of safe drinking water and proper sanitation. "Expanding water and sanitation coverage is not rocket science. It requires neither colossal sums of money nor breakthrough scientific discoveries and dramatic technological advances" (UN Millennium Project 2005b).

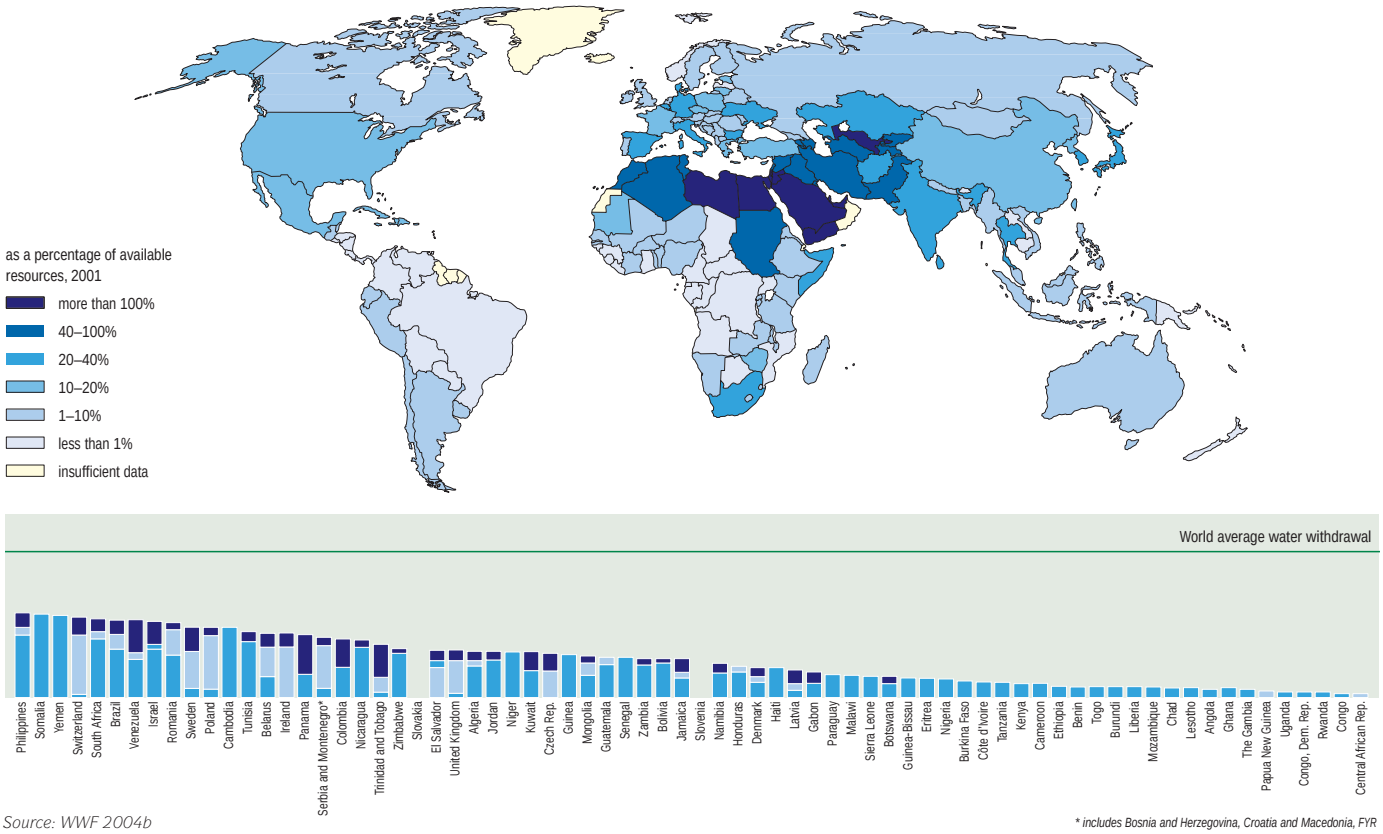
Freshwater resources have been described as life itself because they drive human life and activities, including agriculture, manufacturing, tourism, fisheries, and forestry, and they sustain the environment and biodiversity. Access to water has also been recognized as a fundamental human right. Water availability and access impacts on all three components of sustainable development: environment, society and economy. For example, about 180 million people in Africa –

> Most countries require a big push in public investments to overcome the region's high transport costs, generally small markets, low-productivity agriculture, adverse agroclimatic conditions, high disease burden and slow diffusion of technology from abroad.
>
> UN Millennium Project 2005a

Reservoir for sprinkler irrigation, Ribeira Grande, Cape Verde.

Source: M. Marzot/FAO

Figure 3: Water withdrawals by country



Source: WWF 2004b

** includes Bosnia and Herzegovina, Croatia and Macedonia, FYR*

pastoralists, farmers and other land users – live on fragile drylands where growing numbers compete for water and land. More than 20 per cent of the regional population's protein comes from freshwater fisheries (Curtin 2003).

Despite their centrality to human and environmental vulnerability, and their potential to enhance the resilience of both, freshwater resources are not evenly distributed across the region. Some sub-regions and countries, for example Central Africa and the Democratic Republic of the Congo, have more resources. Others, such as North Africa and Egypt, have less. Some of the sub-regions receive more than adequate rains, leading to devastating floods, while others are prone to severe droughts, impacting food production and exacerbating poverty and hunger.

In addition to issues related to access, availability and distribution, increasing pollution is presenting a serious challenge. Freshwater resources are also increasingly being polluted through human activity such as agriculture and mining. This compounds human health and well-being issues. At the beginning of 2005, a total of 280 million people in sub-Saharan Africa (SSA) had no access to safe water and 454 million had no access to improved sanitation (UN Millennium Project 2005a). Projections show that if current trends continue, by 2025 about 67 per cent of the world's population will be facing serious water shortages or have no water all (UN 2002).

In the interest of sustainable water use, Africa has to devise effective ways of dealing with the pertinent economic, social and ecological challenges. The economic challenge pertains to maximizing social and economic benefits from available water resources, while ensuring that basic human needs are met and the environment is protected. The growing competition between water users has to be effectively managed, and water disputes and conflicts avoided or adequately resolved. The social challenge is to ensure equitable access to safe water. This should be complemented by actions focused on reducing the vulnerability of poor people (especially women and children) to health hazards associated with water pollution. Meeting this objective requires that sufficient and priority attention is paid to the rehabilitation of water-supply systems destroyed by conflict or water-related disasters (floods, droughts). And, the ecological challenge is to ensure sustainable water use in terms of protecting the quality and quantity of the water resource in order to safeguard the needs of future generations.

These challenges become even more complex given that much of Africa's freshwater resources are transboundary. Africa has 50 significant international river basins, each of which is shared by two or more

countries. For 14 countries their entire territory is within international river basins. There are at least 83 river and lake basins shared by a number of countries: 11 in Northern Africa; 29 in Western Africa; 8 in Central Africa; 20 in Eastern Africa; and 15 in Southern Africa (Giordano and Wolf 2003). Africa has a number of significant lakes. Lake Victoria is the largest tropical lake and the second largest freshwater lake by surface area in the world. With the potential negative impacts of climate change on the region's water resources, freshwater stress and scarcity are likely to continue to be major issues.

Policies and legislative and institutional responses at the national and sub-regional levels have been adopted to deal with these challenges. Cooperation, decentralization, privatization and integrated water resources management (IWRM) have been strategies adopted in pursuit of sustainable water resources management. The adoption of cooperative approaches, such as establishing river basin organizations and action plans, have been critical in moving towards a more sustainable, fairer and equitable regime for transboundary management. River basin organizations, over the years, have encountered serious problems, including: lack of strong, sustained political commitment from member states; overly-ambitious programming and lack of focus on priority areas; administrative, managerial, technical, and financial problems; and political instability and civil strife (ECA 2004).

Outlook

Freshwater issues have been on the regional and international agendas for many decades and will remain so for many more decades as demand on the resource grows. African governments established the African Ministerial Council on Water (AMCOW) to provide regional leadership and strategic responses to the challenges of providing safe water and sanitation to the growing population. The role of AMCOW, along with other sub-regional and regional organizations, individual governments and civil society organizations, will continue to evolve as demands on managing the resource change. Water stress and scarcity, transboundary water resource management, irrigation expansion, pollution, climate change and other factors demand responses in the short, medium and long term.

The challenges are massive but not insurmountable. In terms of access to safe water and sanitation:

- An additional 405 million people must have improved access to safe drinking water by 2015, from January 2004, an average of more than 36 million each year, 690 000 each week.

Mother washing her baby under a newly-installed public water tap, Comoros.

Source: H. Wagner/FAO

- An additional 247 million people must have improved sanitation by 2015, with an average of more than 22 million every year, 425 000 people every week, from January 2004 (UNEP 2003).

While Northern Africa had by the beginning of 2005 met the MDG target to "halve the proportion of people without improved drinking water in urban areas," the rest of Africa had not registered any change (UN Millennium Project 2005a). In the short term, most of Africa will continue to lag behind in terms of trying to meet the MDG targets on access to safe water and sanitation in urban and rural areas. Debt relief along with national-level responses may improve the opportunities for meeting these targets.

This may, for example, include more effective management of transboundary water resources through the rationalization of the multiple institutional arrangements, guided by the principles of equitable rights and sustainable and efficient water use (ECA 2004). At the inaugural meeting of the African Ministerial Conference on the Environment (AMCEN) in Cairo in 1985, the ministers placed water issues high on the agenda for regional cooperation. They encouraged the establishment of regional technical cooperation networks

FAO supervisors demonstrating pressure testing of irrigation sprinkler systems to local technicians in Harare, Zimbabwe.

Source: FAO

on environment to adopt, among other objectives, "comprehensive soil and water development and conservation measures in irrigated and rain-fed agricultural areas in Africa" (AMCEN 1985). Many such networks are at work involving governments, sub-regional and regional organizations as well as the UN system. These networks can provide an effective basis for action.

Action

The objective of action should be "an Africa where there is an equitable and sustainable use and management of water resources for poverty alleviation, socioeconomic development, regional cooperation, and the environment" (ECA and others 2000). This requires action at multiple levels, within different time frames. (Irrigation targets are dealt with under the preceding section on land.) The following are some of the many necessary types of urgent policy action:

- Ensure that water safety and sanitation issues remain key areas for attention. The Africa Water Vision 2025 sets the target to reduce by 75 per cent the proportion of people without access to safe and adequate water supply by 2015. By 2025 this should be reduced by 95 per cent. And by 2015, the proportion of people without access to safe and adequate sanitation should be reduced by 70 per cent. By 2025 this should be reduced by 95 per cent.
- Promote integrated water resources management (IWRM) strategies, including water harvesting technology. Under the Africa Water Vision 2025, African countries agreed to aim to implement measures in all countries to ensure the allocation of sufficient water for environmental sustainability, as well as measures to conserve and restore watershed ecosystems by 2015. By 2025 this should be extended to all river basins.
- Promote water re-use and recycling, and encourage introduction of necessary wastewater treatment before release into the environment.
- Harness water resources for hydropower generation, tourism, and industry to enhance the process of development, while at the same time ensuring that comprehensive environmental impact assessments are conducted. By 2015, countries should aim, as per targets set in the Africa Water Vision, to realize 10 per cent of the development potential of water for these sectors, and by 2025 to increase this to 25 per cent.
- Mainstream freshwater issues in all development initiatives to facilitate effective, efficient and equitable use, and properly value its contribution to sustainable development.
- Develop national, sub-regional and regional strategies for climate change adaptation to minimize its potential negative impacts on freshwater resources.
- Strengthen early warning systems through working closely with UNEP and other relevant organizations to mitigate the effects of extreme weather events such as droughts and floods.

Stakeholders

The stakeholders are governments, the private sector, communities, non-governmental organizations and civil society.

Result and target date

The result should be effective management of the resource which ensures improved access to safe water and sanitation to people in Africa, builds the resilience of people to overcome the impacts of extreme weather events and other disasters, and enhances food production to alleviate hunger. The target dates are 2015 and 2025, but water issues will continue to be an ongoing challenge for people in Africa and their governments.

Coastal and marine environments

Issues

Africa has some 40 000 km of coastline, extending over 32 countries. Coastal areas are the locus of rapid urban and industrial growth, including tourism, the development of oil and gas resources, and port development. The seas surrounding Africa are

endowed with rich fisheries and varied coastal ecosystems, including wetlands, coral reefs and mangroves. Coastal areas host a wealth of historic sites and the western and northern parts of Africa are well endowed with oil and gas resources, some of which are offshore. The rich biodiversity, the historic heritage, and the fisheries and energy resources, coupled with an amenable climate, are key assets for the development of opportunities to improve the economic and social well-being of the population.

However, coastal and marine resources are under considerable threat from degradation. The main concerns are the loss of habitats and the modification of coastal ecosystems, leading to species loss. These adverse impacts are due primarily to the pressures of human activities, both land-based and marine. The pressures include: urbanization and industrialization resulting in pollution, eutrophication and loss of habitats; damming and agricultural irrigation leading to coastal erosion and saline intrusion; and the overexploitation of marine fisheries. There is also ongoing concern about the potential impacts of climate change and the anticipated sea-level rise, particularly with regard to coastal erosion and the inundation of coastal lowlands (IPCC 2001). Another concern is the introduction of IAS from ballast waters of marine vessels. Oil and gas development will lead to an increased problem of marine and coastal pollution from terminals, tankers and offshore wells.

A number of initiatives have been put in place, at different levels, to address the environmental issues and threats to the marine resources in the region. Many of these are based on the integrated coastal zone management (ICZM) programme. Cooperation through MEAs is an important aspect of sub-regional response to the challenges faced:

- Countries in Northern Africa are party to either the Convention for the Protection of the Mediterranean Sea against Pollution (the Barcelona Convention) or the Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (the Jeddah Convention), or, in the case of Egypt, both.
- Eastern African countries are party to either the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) or the Jeddah Convention.
- Countries in Western Africa are party to the Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan Convention).

The Cape Town Declaration on an African Process for the Development and Protection of the Coastal and Marine Environment, adopted in 1998, committed Africa's leaders to promoting cooperation and supporting the implementation of the existing global and regional agreements. The African Process identified coastal erosion, pollution, sustainable use of living resources and management of key habitats, ecosystems and tourism to promote sustainable economic development as important areas for future action.

The NEPAD-EAP programme area on coastal and marine resources builds on these MEAs and identifies six priority focuses: pollution, physical changes to the coastal and marine environment, biodiversity, integrated management approaches, environmentally sustainable economic development, and climate change.

Outlook

Coastal and marine areas will continue to be hubs for industrial and commercial activities in the region for the foreseeable future. The major focus will continue to be oil and gas production and processing, fisheries and tourism, all of which have a potential for supporting medium- to long-term development. These developments will continue to induce environmental changes which threaten ecosystem health, human well-being and future development potential. This creates various challenges for environmental management which, if not addressed in a pre-emptive manner, may undermine the potential of these resources.

The ocean holds immense opportunities – from wave energy to fish to oil. Ensuring it is sustainably used is a priority. Morocco.

Source: J.C. Mohamed-Katerere

Many of Africa's SIDS, such as the Seychelles, have idyllic beaches that support a vibrant tourism industry.

Source: M. Chenje

Mass coastal tourism development, as is already happening in Egypt, Algeria, Kenya and South Africa will result in rapid urban sprawl, habitat and biodiversity loss from construction, solid waste and sewage discharge, and coral bleaching as a result of climate change and increased pollution loading. Tourism, especially where it displaces people who are dependent on coastal and marine resources, can lead to conflict and affect local livelihoods. The concentration of growing numbers of people along the coast will increase their exposure to extreme events. In the absence of effective coping and mitigation strategies, including early warning systems and disaster preparedness, it may also increase their vulnerability. Reducing the vulnerability of these populations will emerge as a key policy challenge. The tsunami which occurred in Indonesia on 26 December 2004, some 7 000 km away, was able to cause significant damage on the east African coast seven hours later. More than 200 people were reported killed in the town of Hafun, in Somalia (CARE 2005). Several fishing boats and facilities were damaged on the Tanzanian and Kenyan coasts. The impact of such incidences is likely to increase with the increasing population on the coastline and in absence of any practical mitigation plans.

A growing fisheries sector will place new pressures on the environment, from overharvesting and by-catch problems. Additionally, the growing commercial (and often foreign) sector will place increasing pressures on artisanal fishers and in particular on coastal communities that depend on the nearshore fisheries resource for food (NOAA 2003). This becomes particularly serious in a context of growing population of coastal areas.

The problem of reduced freshwater discharge from rivers will become more significant as more rivers are dammed inland to provide water for irrigation and supply for the cities. This will impact adversely on wetlands, mangroves, and coastal flats and have direct costs for livelihoods utilizing these resources.

Action

The multiplicity of MEA and regional and sub-regional initiatives demonstrate collective commitments and goodwill. However, individual governments need to undertake the following specific actions:

- Introduce stringent measures to abate marine and coastal pollution, through incorporating the polluter pays principle into the legal framework and strengthening the institutional capacities for enforcement.
- Enhance public awareness on the issues of land-based pollution, such as waste discharge and soil erosion.
- Identify coastal areas which are sensitive and crucial for maintenance of ecosystem integrity and designate them for conservation or regulated development.
- Ensure better coordination at the national level in the granting of fishing access rights to industrial fleets, taking into account social and environmental considerations. There is an urgent need for more effective transboundary cooperation in managing fishstocks, including better monitoring, control and surveillance, and the enforcement of regulations. These actions are best complemented by international agreement on fisheries regulation, and this could be an important area for advocacy.

Stakeholders

Although public participation is crucial in coastal and marine management, governments will continue playing a leading role, especially in monitoring and enforcement. Support from development and donor partners is important.

Result and target date

Results in terms of restoration and recovery of ecosystems can be realized within three to five years, while some other processes such as coral reef regeneration may take as long as ten years.

Forests and woodlands

Issues

The forest sector plays an important role in the economic development of many countries and livelihoods of many communities in the region. On average, forests account for 6 per cent of GDP in the Africa region, which is the highest in the world (NEPAD 2003). They provide resources for energy, food and medicines, as well as timber and non-timber forest products (NTFP) which have considerable potential to generate income. Forests and woodland can contribute to the long-term social and economic development goals of NEPAD. They are also key environmental components, and have a fundamental link to the provision of other environmental goods-and-services. They are critical to the success of the other aspects of NEPAD's Environmental action Plan (NEPAD-EAP) programmes, including combating land degradation and climate change, conserving wetlands, coastal and freshwater resources, and controlling alien invasive species.

Forests and woodlands have multiple values at all levels of human society, including the community, national, sub-regional, regional or global levels. At the local (community) level forests and woodlands have multiple uses, which vary extensively with the type of forest, and the community. These include construction materials, foods, energy, medicines, catchment protection, soil protection, shelter and shade, habitat for wild life and grazing as well as cultural values (sacred groves, shade, peace trees and plants, meeting places, boundaries, training areas). Local communities therefore use forests and their products in a multitude of ways that differ from direct commercial exploitation or conversion to agricultural land. At the national level and regional level forests and woodlands also play an important role in catchment protection for water quality, hydropower, and regulation of river flows, prevention of soil erosion, timber products, biodiversity, non-timber forest products (food, materials, and medicinal substances), energy and leisure. At the global level they are valued for their role in climate regulation and as repositories for biodiversity.

However, forests in the region are declining in quantity and quality, due to a number of factors. Chief among them are demand for fuel and agricultural land, livestock production and plantations (rubber, coffee and cocoa), population growth, and infrastructure development. Other pressures include inappropriate forest policies, lack of enforcement, weak forest departments, and low investments in research, training and management. Management challenges include incomplete inventorying, poor monitoring and enforcement, poor governance (such as inadequate community involvement and decentralization) and inadequate valuation of natural resources (goods-and-services).

Urbanization is also a major driver of environmental degradation in its immediate vicinity, particularly deforestation due to increasing fuelwood demand from the urban poor and pollution resulting from improper location of garbage disposal sites.

Conflicts have also taken their toll on forests, especially in the Great Lakes Region (GLR) and parts of western Africa. In these areas, conflict has rendered state agencies ineffective, peacetime efforts at forest protection are suspended, and illegal loggers, even if not directly involved in the conflict, can proceed unchecked. In the Democratic Republic of the Congo (DRC), a series of civil wars in the 1990s created a power vacuum and broke down conventional forest management regimes, fostering illegal logging and other resource conflicts (Renner 2002).

Adding value to timber is essential for improving national and local income. Craftsperson making wooden furniture.

Source: J. Maillard/ILO

The impact of forest and woodland degradation is having undesirable manifestations. In many countries, the change in area and quality of forest cover has resulted in catchment destruction, siltation, loss of hydroelectric power and soil erosion. Timber products are becoming scarcer in a number of countries, including Uganda and Kenya, who have imposed restrictions on harvesting in natural forests. Collaborative forest management and developing markets for environmental services exemplify innovative policy responses in dealing with the problem of deforestation. They represent part of a new paradigm that explicitly recognizes the need to bridge the interests of communities that are dependent on forests as well as landholders and those of the conservation agencies and external beneficiaries, while ensuring tangible benefits for conservation and livelihoods (CIFOR 2005, Brown 1999).

Outlook

In view of the low investment in the forest sector, increasing population pressure and weak public sector institutions responsible for forestry resources management, deforestation and declining forest quality will continue in most countries over the next decade. This will reduce the ability of forests to provide environmental services such as climate modification, biodiversity reserves, desertification control and protection of water catchment.

Nevertheless the state and integrity of forest and woodland resources will continue playing a major role in the livelihoods of many, including communities living in close proximity to forests. As forests in catchment areas are destroyed, water quality, quantity and stability will be adversely affected, as exemplified by the situations in Kenya, Ethiopia and some countries in southern Africa. The loss of water quality will increase the incidence of water-borne diseases, as many people depend on untreated water from streams and rivers for their domestic water supply. Decreasing water quantity will impact on water supply for cities.

Increasing woodfuel shortage will affect the overall well-being of more people as more time and resources will be diverted to procurement of the woodfuel. Communities who rely on staple foods that take long to cook will be forced to resort to types of food that are less demanding on biomass energy, with adverse consequences for nutrition and health.

Housing quality in some areas is already declining and is likely to continue to do so as construction timber becomes unaffordable, especially for poor people.

Establishing systems for managing timber extraction is essential. Officials check log numbers of timber intended for market.

Source: J. Vanday/CIFOR

Action

It is imperative to build on existing commitments, such as the NEPAD-EAP which recognizes the importance of forests and woodlands and incorporates them as part of Programme Area 6, *Transboundary conservation or management of natural resources*. It emphasizes the protection and sustainable management of Africa's forest resources through:

- Strengthening national plans and programmes for forest management, inventory and monitoring. This includes the participation of stakeholders, such as communities and the private sector, new approaches and initiatives, and the promotion of the wide range of roles and values played by all forest areas.
- Maintenance of protected areas, by improving capacities, forming partnerships with other countries, and the restoration of landscapes, etc.
- Strengthening forest law and governance by encouraging sharing of information on trade in illegally harvested forest products, participation in international forums and international agreements, and implementing measures to curb corruption.

These focal points within NEPAD-EAP provide a viable framework for governments to implement the following actions:

- Strengthen institutions responsible for implementing national plans and programmes for forest and woodlands resources management, and actively engage the private sector and civil society.

- Promote protected areas management by providing adequate incentives for adjacent communities through better benefit sharing and increased participation in management.
- Review the legal and institutional capacities of public sector institutions responsible for forestry resources management, to give them overall responsibility for all forests and woodlands resources, including those outside protected areas.
- Strengthen capacities for controlling illegal trade in forest and woodlands products through better enforcement of forest laws, sharing of information, and participation in international forums and agreements.
- Undertake comprehensive inventory and valuation of the forests and woodland resources, and introduce mechanisms which encourage optimum utilization of the resources, including issuing concessions on standing volumes rather than harvested volumes.

Managing transboundary resources increases the opportunities for all countries. The tropical moist rain forest of the western Congo basin, Gabon.

Source: M. Harvey/Still Pictures

Additionally, investing in alternative energy development to alleviate the pressure placed on forests and woodlands is an important action. The opportunities offered by growing markets for environmental services should be considered.

Stakeholders

The above policy actions can only bear fruit when governments enter into functional partnerships with other stakeholders such as the private sector, civil society, farmers, research organizations and the international community.

Result and target date

The actions can be implemented in the short to medium term (five to ten years) as one of the bold steps towards the MDG targets of reducing extreme poverty through equitable distribution of resources and enhancing the quality of the environment.

Biodiversity

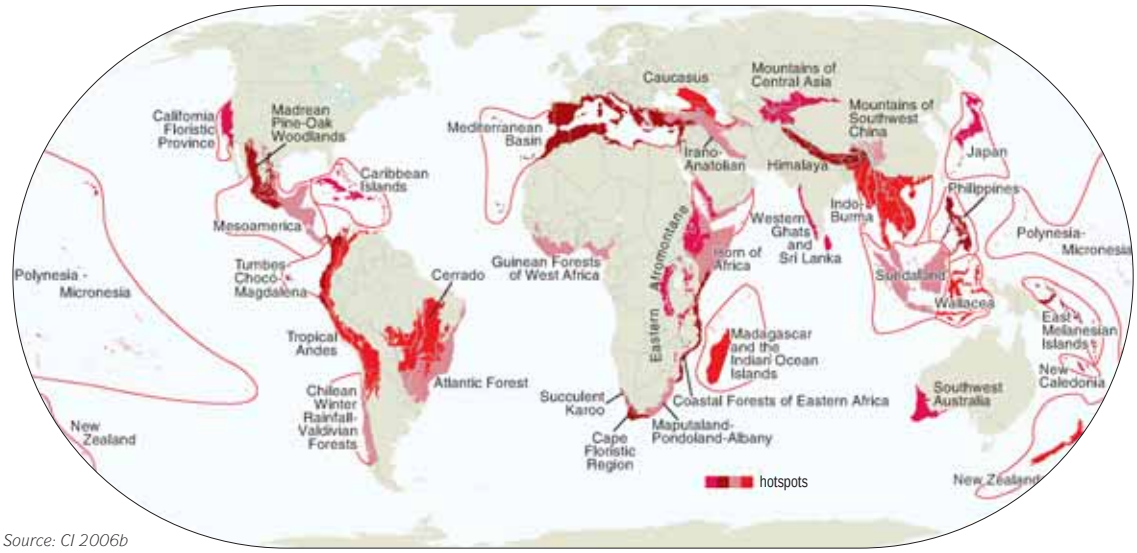
Issues

Africa's biodiversity wealth is an important feature of its environment (UNEP 2002). Biodiversity plays a role in poverty reduction through contributions to food security, health improvement, income generation, reduced vulnerability to climate change and provision of ecosystem services such as the cycling of nutrients and the replenishment of soil fertility (WEHAB Working Group 2002). This wealth of biodiversity is unevenly distributed throughout Africa. South Africa, for example, has over 23 000 plant species, compared to Cameroon's approximately 8 260 species and Kenya's 6 500 species (Groombridge and Jenkins 2002). Some African countries, such as Madagascar, the DRC and Cameroon, are known for their rare internationally recognized plant and animal species. Some of Africa's plant species have also contributed immensely to the world's pharmaceutical industry. Noteworthy among these are *Ancistrocladus korupensis* (Cameroon), *Pausinystalia yohimbe* (Nigeria, Cameroon and Rwanda) and *Catharanthus roseus* (Madagascar), which are being used in pharmaceutical research in industrialized countries. This also is the case in Botswana and South Africa, where indigenous peoples' and rural communities' knowledge and use of a cactus (*Hoodia gordonii*) has become the basis for substantial investment in developing a dietary drug.

There are of course microbial and other species that offer potential for scientific development in agriculture and medicine. The diversity of fish species includes some of the most economically significant species such as *Thunnus thynnus* (tuna), *Tetrapturus albidus* (white marlin), *Makaira indica* (black marlin) and *Istiophorus albicans* (billfish). In countries such as Namibia the fisheries sector contributes substantially to both GDP (over 35 per cent) and employment. The Eastern Afromontane Hotspot is an extremely important area for freshwater fish diversity, with more than 620 endemic species (CI 2006b).

Africa's dryland ecosystems are also rich in biodiversity. Although the diversity of species in the

Figure 4: Biodiversity hotspots



Source: CI 2006b

drylands is quantitatively lower than in other ecosystems, that diversity is marked by its tremendous qualitative value. There are exceptions to this: some areas with harsh climates including the Namib Desert and the Karoo in the west of South Africa have an estimated 4 500 plant species, a third to one-half of which are endemic (Davis and others 1994). The ecological conditions within drylands require species to become resilient or tolerant to drought and salinity, to be able to grow readily and to set seeds within a very short time frame. Such genetic traits are of global value and are particularly important to populations living in drylands (Kingdom of Swaziland 2003). Some of the plant species in the drylands of Ethiopia and Madagascar, for instance, are valuable alternative food sources during drought.

Overall, Africa is home to eight of the 34 internationally recognized biodiversity hotspots in the world. These are the Cape Floristic Region, Coastal Forests of Eastern Africa, Eastern Afromontane, Guinean Forests of West Africa, the Horn of Africa, Madagascar and the Indian Ocean Islands, Maputaland-Pondoland-Albany and the Succulent Karoo (CI 2006a).

Biodiversity has influenced the culture and development in the region over centuries. There is a correlation between centres of biodiversity richness and human settlement. Historically, biodiversity has been at the core of livelihoods, and this remains true for many peoples, especially those who have maintained a traditional lifestyle, including forest dwellers in the Congo basin and the nomadic peoples of Eastern Africa and Southern Africa. At the regional level, biodiversity has played an important role in food security by ensuring the availability of a genetic base for improved local varieties, both crops and animals. In the tourism sector, which is a major income earner for many countries in the region, it is the foundation on which tourism is built. These resources are also supporting vibrant fisheries and pharmaceutical industries.

Disturbance and loss of habitat has, however, resulted in the loss of species and, combined with agricultural practices which focus on a few crops, is narrowing the genetic base. The impact of genetic modification of these resources remains uncertain. Invasive alien species pose a significant threat to biodiversity and to the survival of many native species, causing substantial economic losses and threatening livelihoods. The erosion of Africa's biodiversity wealth arising from human activities is a serious problem. In the 1990s threats to higher plants included loss of 67 species in Cameroon, 69 in DRC, 125 in Ethiopia, 130 in Kenya, 255 in Madagascar, 326 in Tanzania, and 1 875 in South Africa (WRI and others 2000).

In response, African governments have, among other things, established protected areas, of which there are, for instance, 405 in South Africa, 68 in Kenya, 54 in Uganda, 45 in Madagascar and 39 in Ethiopia (Secretariat of the CBD and others 2001). In some countries, the management of the protected areas has not been effective because of the tendency to focus heavily on biodiversity protection at the expense of people's livelihoods, therefore turning the affected communities against conservation. Another response has been the ratification of biodiversity-related multilateral environmental agreements (MEAs) such as the UN Convention on Biological

Diversity (CBD), Ramsar and the Convention on International Trade in Endangered Species (CITES). However, for many of these reporting and implementation remains weak. For example, until the year 2000, performance on CITES reporting requirements was mixed.

However, most biodiversity occurs outside of protected areas, and if it is to be effectively conserved then alternative measures need to be adopted. The integration of conservation measures into other land-use systems is essential, and ensuring a fair and equitable sharing of the benefits from biodiversity use is a fundamental component of this. Experience throughout the region has demonstrated the value of community involvement in biodiversity conservation and ensuring its sustainable use.

Although some countries have incorporated the MEAs into national policies and framework laws, few have succeeded in achieving the enforcement of policies and laws. Similarly, while 37 countries in Africa have ratified the Cartagena Protocol on Biosafety (CBD 2006), less than ten have put in place mechanisms, including the legal and institutional frameworks, to operationalize it. The implementation of the national biodiversity strategies and action plans (BSAP) by a number of African countries has yet to generate the expected impacts in terms of conservation, sustainable use and equitable sharing of benefits accruing from commercial transactions on biodiversity.

Outlook

Biodiversity will continue to be the most important resource endowment for many countries in the region, sustaining both national economies and community livelihoods. As the population grows, demands on the resource to meet basic needs will intensify. Expanding economic activities and human settlements will encroach on important habitats thus compromising the survival of many species. Reduced access to the resources for medicine and food will adversely affect the livelihoods of many communities. With increasing scarcity, more and more biodiversity resources, including wildlife, woodlands, medicinal plants, etc. will be managed for commercial purposes to the exclusion of the poor. This too will impact on livelihoods and overall levels of well-being. Most biodiversity will continue to be located outside protected areas.

With the continued realization of the importance of biodiversity resources in national development, efforts will be pursued to safeguard the resource. Financial commitments and support will be required to finalize these frameworks and start the implementation.

Action

Africa's commitment and goodwill on biodiversity conservation have been reasserted in the Environment Initiative of NEPAD. The 2010 targets adopted by the CBD and reiterated at WSSD in 2005 are important global targets that Africa has also committed to. The priorities for biodiversity include:

Baboon (*Papio anubis*). Nakuru National Park, Kenya.

Source: C. Lambrechts/ UNEP

- Supporting and improving implementation of the objectives of the CBD, in particular the sustainable use and fair and equitable sharing of benefits and the development of an ecosystem approach to sustainable management.
- Bringing communities and other resource users on board as both managers and planners. This could include support for and the development of community conservation areas based on multiple land uses and the objectives of the CBD.
- Implementation of the African Protected Areas Initiative (APAI).
- Supporting and implementing the CBD's Bonn Guidelines on Access to Plant Genetic Resources and Fair and Equitable Sharing of Benefits Arising from their Utilization.
- Preventing and controlling invasive alien species, through control of entry points, awareness raising, aquatic and terrestrial programmes, and developing a special programme on control of invasive alien species on Africa's SIDS.
- Adopting or strengthening measures in line with the CBD 2010 targets to promote the conservation of ecosystems, as well as species and genetic diversity. Such measures may include better integration of land use, development, and conservation by recognizing that most species will occur outside protected areas.

The following actions can be implemented by governments in the short to medium term:

- Strengthening national conservation programmes through increased financing and introducing innovative means of generating revenues from biodiversity assets. This revenue can provide additional funding for conservation programmes, some of which can be targeted at enhancing support to planning, research, monitoring and public awareness.
- Instituting and/or strengthening a system of transfers of benefit accruing from biological resources to communities through collaborative management of ecosystems.

Stakeholders

Partnerships with other stakeholders are essential to implementing the recommended actions. These partnerships in the first instance should be with resource users and managers, such as local communities and other landholders. For some areas partnerships with the private sector, civil society organizations, farmers, the scientific and research community, and the donor community will be important.

Result and target date

The actions can be implemented in the short to medium term (five to ten years). However this is an area that will require ongoing attention.

Genetically modified crops

Issues

The introduction of genetically modified organisms (GMOs) in Africa probably equals the CITES listing of the African elephant as the most divisive issue among policymakers in the region. Already there is an apparent split with some countries taking a lead in introducing GMOs in agriculture, and others opposed to even importing GMO food which is unprocessed. The issue is not limited to Africa but has international dimensions involving agricultural production and food security, pesticide use and environmental pollution, organic agriculture and the risk to biodiversity, as well as the role of the private sector and international trade.

Controversy revolves around (Young 2004):

- The interpretation of science, specifically whether GMOs are inherently safe or inherently dangerous from a human and environmental perspective;
- Economic analysis and in particular how to evaluate the cost-and-benefits associated with GMOs; and
- Socio-cultural impacts and biosafety implications concerning food production and security, livelihoods, and human and environmental health.

Already, IUCN-the World Conservation Union (IUCN), which brings together government, civil society, and experts from a wide range of disciplines, has declared "a

Consumers protest about genetically modified foods and assert their right to choose.

Source : Biowatch

moratorium on further environmental releases of GMOs until this can be demonstrated to be safe for biodiversity, human and animal health beyond reasonable doubt." A further concern is that the introduction and promotion of GMOs "are driven primarily by the private sector, whose interests in development and marketing may be greater than in assessing potential risks to biodiversity, human and animal health" (IUCN 2004a). But this decision is controversial, with some members such as Japan, The Netherlands and Sweden opposed to the resolution. The United States Government and its agencies did not take part in the deliberations. Recognizing the controversy around this issue, IUCN also called for "substantive work, within reasonable time and within reasonable resources, to develop credible knowledge and information concerning biodiversity, nature conservation and associated risks of GMOs." It further requested IUCN to promote and support initiatives to ratify and implement the Cartagena Protocol on Biosafety (IUCN 2004b).

IUCN has more than 1 000 members, of which more than 30 are African government departments or statutory bodies (IUCN 2005). Many of these, including departments and civil society organizations, would have participated in the debates on these two resolutions at IUCN's World Conservation Congress in Bangkok in 2004.

Outlook

Although GMO technology is relatively new and many countries still do not have strong governance structures for monitoring and enforcing its use, it is poised to gain more ground over the coming decades. Data and information on GMO impacts on the environment will possibly lag behind and it may take even longer for the region to have comprehensive knowledge of such impacts.

Controversy over whether or not it can be a panacea to food insecurity in Africa as well as potential risks to the environment will continue to rage. More governments may follow the lead of South Africa, which in 2004 passed the National Environmental Management: Biodiversity Act, which regulates the release of GMOs in the environment. The new law requires an environmental impact assessment to be approved before the government will permit any GMO to be released into the environment, either on a trial or a general basis (Government of South Africa 2004). The effectiveness of such laws, however, depends on national and regional capacities for enforcement as well as scientific assessments of risks and benefits.

Action

African governments, individually and collectively, are faced with an enormous challenge given the high levels of uncertainty surrounding this technology. At the centre of a government's response package should be a commitment to making the best decision possible based on all relevant available information, and taking into account the priorities and values of its people.

Genetic improvement of coffee (*coffea spp.*) through hybridization is used to enhance yield and quality. However, the success of the hybrid Catimor (above) grown in Malawi in achieving this is disputed.

Source: A. Conti/FAO

Governments will need, according to their development priorities and values, to develop appropriate laws, policies and regulations to govern GMO and strengthen the institutions for effective decision making as well as the monitoring and enforcement of such decisions. The AU's Model Law on Safety in Biotechnology is a valuable starting point for all countries in developing national frameworks. This will include incorporating legal principles and processes that they have adhered to in MEA, including the CBD and the Cartagena Protocol. In particular, legislation will need to incorporate the precautionary approach. This will require investing in building individual and institutional capacity. Where appropriate, governments will introduce measures requesting manufacturers to label all food products which contain GMOs. They will also ensure that consumers are provided with adequate information to exercise their right of product choice.

Those governments that opt to allow GM products onto their markets will need to provide the relevant legal framework for the private sector to operate, and in some cases to undertake research. Regulation will need to fully incorporate a precautionary approach, including measures to evaluate risk and monitor the release of GM products into the environment.

The following immediate actions are required:

- Develop and implement national biosafety frameworks comprising national biosafety policies, regulatory regimes, systems for making informed decisions, mechanisms for monitoring and evaluation and public participation mechanisms.
- Require the private sector to engage in substantial monitoring and evaluation (M & E) of the impact of GMO releases on the environment. This will need to be complemented by governments investing in their own capacity to evaluate such M & E activities and enforce regulations.
- All M & E evaluation of all GMOs should be ongoing from "cradle-to-grave".
- Introduce measures to ensure that food security is not compromised by monoculture. The measures should also decouple GMO technology from fertilizers and pesticides manufactured by the supplying manufacturer. Such measures should also contain anti-trust provisions.
- Protect indigenous crops from biotechnology manipulation which may threaten biodiversity and also lead to the inaccessibility of new varieties to the majority of indigenous farmers.
- Guarantee for farmers the choice to either use GMO technology or refuse it. Accidental cross-pollination should not be subject to intellectual property legal challenges.
- Work with the private sector, farmers and scientists to make reliable and appropriate information on GMOs available to all stakeholders.

Stakeholders

In addition to governments, other stakeholders include the private sector, civil society, research organizations, universities, farmers and consumers. Each of these stakeholders should work to ensure that relevant information is accessible for informed decision making. Regular consultations among these groups should be facilitated.

Result and target date

The desired result is a comprehensive regional strategy on genetically modified organisms, and this should be ready by 2010. The strategy should be the basis for sub-regional and national strategies on GMOs. Countries which are already advanced in this area are encouraged to share their experiences in order to strengthen capacity in the region.

Invasive alien species

Issues

Invasive alien species (IAS) have become a major threat to sustainable development in Africa, forcing governments to divert millions of dollars a year to fight the spread of such species. In South Africa, for example, it has been estimated that invasive alien trees and shrubs, which consume about 7 per cent of the country's freshwater, will double in 15 years if they are not controlled. It has been estimated that economic losses due to IAS amount to about 5 per cent of the world economy or about US$1.4 million million annually. This is about three times the gross national product of all

Many exotic species have mixed impacts. *Eucalyptus spp.* are an important source of firewood but at the same time threaten indigenous species through invasion and high water usage.

Source : R. Faidutti/FAO

countries in Africa (National Botanical Institute and Global Invasive Species Programme 2004).

Invasive alien species pose a serious threat to ecosystems and biodiversity, and are second only to habitat loss as a cause of biodiversity loss. The loss of biodiversity presents a serious threat to the sustainability of human society, as it undermines the provision of essential ecosystem functions and reduces the availability of environmental goods.

Outlook

Invasive alien species will not be eradicated, at least in the foreseeable future. The only options available to policymakers are to control and manage the species which are already creating havoc for people's livelihoods, economies and ecosystems. The costs of managing IAS will continue to be high.

Action

Urgent action is required to undertake a comprehensive inventory of both floral and faunal IAS, including spatial extent in the region and impacts on people, various economic sectors such as agriculture and forestry, and on endemic species.

Policymakers should also undertake the following:

- Develop a list of IAS and facilitate its publication and distribution on a regular decadal period.
- Mount a massive public campaign across the region to inform people about the impacts of IAS on biodiversity, economic activity and their livelihoods.
- Implement stringent measures to control the export and import of living organisms from one territory to another, particularly where information on a particular organism is lacking.
- Introduce regulatory measures which control the marketing and distribution of GMOs whose impact on biodiversity is unknown, and for which comprehensive information on their properties is lacking.
- Fund research on various IAS and encourage the development of technology that could assist in controlling the further spread of such species.
- Introduce measures to comprehensively cost the impacts of IAS on the environment and on socioeconomic development.
- Make the eradication and control of IAS the first focus of government policy. To achieve these objectives innovative ways of engaging with the private sector, including micro-, small- and medium-scale enterprises, should be considered. This may include encouraging the use of IAS in manufacturing, provided that this investment does not lead to the continued propagation of IAS. Additionally, it must be recognized that the control of IAS is crucial for restoring ecosystem well-being and enhancing environmental services; this may serve as an important basis for engaging with the private sector.

Protecting indigenous species such as the *Protea spp.* (Cape Fynbos ecosystem) from invasive alien species is an important conservation objective.

Source: M. Harvey/Still Pictures

Stakeholders

Governments, the public, the private sector, research organizations and regional and sub-regional organizations have a stake in ensuring that the issue of IAS is high on the agenda. The sharing of information among and between these stakeholders is important.

Result and target date

IAS is an ongoing challenge for policymakers at different levels, and cannot really be tied down to a specific date in terms of control. However, the development of strategies and programmes for individual national and collective sub-regional and regional action is critical. It is important that such strategies and programmes be fully operational by the beginning of the next decade.

Chemicals

Issues

Although currently Africa is neither a major consumer nor producer of chemicals in global terms, the level of risk faced by poor countries is disproportionately higher than in those with sufficient resources to effectively manage and monitor chemical use. With economic growth, Africa is likely to grow as a producer and consumer of chemical products, increasing the

Waste management is an important part of effective chemical management, Egypt.

Source: Topham/UNEP

importance of this issue. In particular, Africa will face a growing challenge in the management and monitoring of chemicals due to inadequate human capacity and the lack of technology required for effective M & E.

The increased use of chemicals, particularly in the agricultural sector, may lead to increased contamination of water sources, with adverse effects for both human and ecosystem health (MA 2006). The increased exposure to agricultural and industrial chemicals and waste exacerbates the impacts of traditional environmental health risks in many developing countries. Contaminated sites and obsolete stocks present serious problems for Africa which require immediate actions. Estimates suggest that across Africa at least 50 000 tonnes of obsolete pesticides have accumulated (NEPAD 2003). Continued trade in hazardous waste is likely to exacerbate this problem. And, toxic chemicals that enter the environment place a serious threat to biodiversity and ecosystems, causing disease and undermining essential functions (WWF 2004a).

Outlook

As Africa's economy grows and GDP per capita increases, the consumption of chemicals for domestic use as well as in the agricultural and industrial sectors is likely to grow (OECD 2001). With the growing use of chemicals there is likely to be increased exposure to them in the workplace as well as in the home. In the agriculture sector, this will put women and children at increased risk of chemical exposure. In many cases, both in subsistence and commercial farming, producers and workers have insufficient knowledge about the health risks posed by chemicals and therefore do not adopt personal protective measures. The increased use of chemicals will place new demands on the already fragile health sector.

Increased chemical use will contribute to increased environment degradation and pollution. Developments in the agricultural sector may lead to the increased use of agricultural chemicals, contaminating water sources and threatening ecosystem viability. These developments will place both human and environmental health and well-being at risk (UN 2004). The contamination of water sources may lead to a decrease in the environmental goods-and-services freshwater systems supply, as well as reduce the ability to meet the MDG targets on the provision of safe water.

Increased chemical use will increase the risk of chemical production accidents and the likelihood of pollution through industrial waste discharge. This will place a new burden on chemical management systems, and place new challenges on governments to effectively regulate and develop appropriate M & E systems.

Action

Governments should put in place legal and institutional frameworks which ensure effective management of chemicals and embrace core principles as outlined in Agenda 21, including the precautionary approach, producer liability principles, the polluter pays principle, and comprehensive right-to-know laws (UN 1992) and that build on the wide range of MEAs which directly address specific chemical issues.

In developing a framework for chemicals management, an approach that focuses on sound management throughout their life cycle is essential. Specifically, governments' actions should relate to (UNEP 2006):

- Risk reduction – prevention of and preparedness for accidents and natural disasters.
- Information and knowledge – improving the accessibility of information on hazardous chemicals.
- Governance – integration of Strategic Approach to International Chemicals Management (SAICM) objectives into national development planning.
- Capacity-building and technical assistance – promotion of life cycle approaches to chemicals management.
- Illegal international traffic – symposium on illegal international traffic in chemicals and hazardous wastes.

At a regional meeting in Abuja, Nigeria in May 2004, African governments adopted a position on SAICM, which seeks to promote synergies and coordination

among regulatory instruments and agencies. It proposed the following, among other activities, (SAICM 2004):

- Manage chemicals at all stages of their life cycle, using the principles of "cradle-to-grave" life cycle analysis.
- Target the most toxic and hazardous chemicals as a priority.
- Ensure full integration of chemicals management and better coordination among stakeholders.
- Increase chemical safety capacity at all levels.
- Ensure that children and other vulnerable people are protected from the risks of chemicals.
- Promote corporate social responsibility and develop approaches that reduce human and environmental risks for all, rather than transferring the risks to those least able to cope with them.
- Incorporate the legal approaches or principles of precaution, polluter pays and the right-to-know. This must be complemented by a commitment to substitution of toxic chemicals by less harmful alternatives and promotion of more environmentally-friendly practices by industries. This can be achieved through, among other measures, encouraging the private sector to seek compliance with the ISO 14000 standards.
- Integrate the precautionary, life cycle, partnership, liability and accountability approaches in management.

The statement urges that SAICM should be established at national, regional and international levels as a coordinating structure for harmonizing legal instruments and organizations responsible for chemicals management (SAICM 2004).

Stakeholders

Collaborative efforts between governments, NGOs, the private sector and civil society organizations are essential for building a collaborative and sustainable approach to chemical management. In particular, stakeholders from agriculture, environment, health, industry, labour, consumers and science have a specific interest. The Africa Stockpile Programme (ASP) has prominent partners, the World Bank, FAO, UNEP, World Wildlife Fund, the Africa Union and NEPAD, who can also play a key role in chemicals management and use.

Result and target date

SAICM implementation is to take place within a 15-year time frame, corresponding to the WSSD Johannesburg Plan of Implementation's 2020 target for the sound management of chemicals (UNEP 2006). The Johannesburg Plan of Implementation envisaged that by this time chemicals should be produced, managed and used in ways that minimize significant adverse effects on human health and the environment.

Many African governments still need to develop effective systems for chemical management. Pesticide factory, Matola, Mozambique.

Source: J. Schytte/Still Pictures

Governments should develop tools for participatory risk assessment analysis and procedures for chemical management. Mechanisms for ensuring access to relevant data and information on chemical management issues should also be developed and adopted at the national, regional and international levels. Tools should also be developed for monitoring the effects and impacts of industrial and domestic chemicals while existing laws on chemical management should be enforced.

Environment for peace and regional cooperation

Issues

Regional cooperation has been part of Africa's strategy for economic transformation for more than three decades – and in some cases almost a century (ECA 2004). African countries continue to "build upon a rich history of bilateral and multilateral water treaties, spanning nearly 1 200 years across the world" (Giordano and Wolf 2003). More than 3 600 treaties relating to international water resources, dating back to AD 805 have been identified, and about 300 treaties negotiated since 1814 deal with water specifically as a limited consumable resource (Giordano and Wolf 2003). In Southern Africa, for example, an Anglo-

The Victoria Falls are a natural attraction shared by Zambia and Zimbabwe.

Source: P. Springett/Still Pictures

Portuguese Convention on the Zambezi River was signed in Lisbon in 1891 and covered the main river and its tributaries (Chenje 2003). These and other agreements on water resources laid the foundation for regional cooperation in conflict resolution and environmental management in Africa.

The body of regional policies, and bilateral and MEAs has grown over the decades, and now include the management of transboundary national parks, large marine ecosystems, forest resources, and mountain ranges as well as hydropower generation and exploitation of oil. Regional cooperation now also extends to trade and economic sectors such as tourism.

Despite these successes, regional integration has a long way to go in achieving concrete results in terms of accelerating growth and promoting regional trade. A recent assessment by the ECA pointed to a number of constraints including (ECA 2004):

- Multiple and overlapping membership;
- Reluctance by member states to adhere to integration programmes;
- Insufficient technical and analytical support;
- Divergent and unstable national macro-economic policies;
- Inadequate capacity and resources to spearhead the integration process;
- Lack of coherence and links among sectoral cooperation programmes and the macro-economic policies pursued by regional economic communities;
- Missing or ineffective mechanisms for organizing, implementing, controlling, monitoring and revising the integration process;
- Lack of national mechanisms to coordinate, implement, and monitor integration policies and programmes; and
- Inability to make integration objectives, plans and programmes part of national development framework.

There have been some important developments related to cooperation in the management of transboundary freshwater resources. The Southern African Development Community (SADC), which has the most advanced water sector integration among the regional communities, is the only regional economic community (REC) with a special protocol for addressing water issues. While recognizing that SADC has a way to go, especially in harmonizing national water laws and policies, the ECA opines that SADC's protocol "shows that members are committed to integrated water management" making SADC "a model for cooperation between river basin organizations and regional economic communities across Africa" (ECA 2004).

Despite these and other cooperative activities, Africa has also experienced many major armed conflicts, which have left millions dead, hundreds of millions displaced in their own countries or forced to flee across national borders, and the environment has

been seriously threatened. In 2003, for example, Africa had the largest number of refugees: of the more than 9.7 million refugees reported worldwide, about 2.9 million were Africans. About half of the world's refugees were female (49 per cent), and in Africa, more than half of the refugees were under 18 years (UNHCR 2004). Conflict impacts upon people in multiple ways; it especially threatens human security. Human security, is more than just freedom from fear and the threat of physical harm, it is also about having sufficient capabilities – such as access to material goods (including natural resources on which many livelihoods are based), good health, adequate education etc which are the foundation of opportunities – to lead a good and fulfilling life. Conflict has impacts at all these levels, and detracts from the opportunities people have as well as their quality of life. Many people face starvation as a direct result of conflict, and women and girls face the risk of rape and kidnapping (OSAA 2005a). Conflict destroys social and political networks, consequently increasing the incidence of social exclusion.

Settlements of refugees and internally displaced persons (IDPs), especially in the GLR and Western Africa, present special challenges for achieving environmental and human well-being goals. Virtually all of these settlements were not planned to support the numbers of people which now inhabit them. In many areas this has resulted in a high level of environmental vulnerability. For example, refugee settlements alongside the Virunga National Park in the DRC placed considerable strain on its resources. Such settlements may also have undesirable impacts on the host communities and resource use by the host communities.

Armed conflict is a serious threat to regional priorities in focusing on the opportunities which are provided by the environment for sustainable development. It also contributes to the diversion of scarce resources to the war effort, the breakdown of environmental management systems, and overexploitation of natural resources to fund wars. Recent actions by the AU, ECOWAS and the Inter-Governmental Authority on Development (IGAD) to foster peace and security in the region are, however, commendable.

Outlook

In Africa a combination of historical, internal and external factors converge to exacerbate conflict. Internal factors include patterns of governance, poverty and competition over resources. (OSSA 2005a). Unless Africa invests in conflict avoidance and peace-building efforts, by improving governance, addressing poverty and increasing cooperation, conflicts are likely to increase. And because there is a direct correlation between social conflict and environmental degradation (MA 2006) this will increase the negative impact on the environment, which in turn has economic and social implications. The World Bank, for example, estimates that conflict in Africa results in an annual loss of 2 per cent economic growth (DfID 2001).

Africa has adopted a number of instruments which facilitate regional cooperation, including the Constitutive Act of the African Union (AU), which among other objectives, promote peace, security and stability as a prerequisite for the implementation of the region's development and integration agenda (AU 2000). Protocols of sub-regional economic groupings also highlight the need for regional integration and development. These arrangements will continue to be strengthened in the years ahead across areas critical to sustainable development. Such developments can only provide an atmosphere for the region to exploit the opportunities available, particularly in terms of the environment.

Given that, at the national level efforts to avoid and resolve conflict are also important. Moves towards greater democratization, and more transparent and equitable systems for sharing of benefits from natural resource use is important. Increased stakeholder participation is also key to enhancing the opportunities for peace.

Regional and international collaboration is an important part of peace-building. In addition to peace-keeping, the UN Mission in Liberia offered essential support, including transportation, to the transitional government. UN helicopter, Liberia, 2005.

Source: Y. Katerere

Greater democratization in Africa has resulted in more freedom of expression. Here, the people in Mbale demonstrate in support of President Museveni in the run-up to elections in Uganda, 2001.

Source: J. Schytte/Still Pictures

Action

While Africa has many examples of successful regional cooperation and conflict management, more needs to be done to focus on the opportunities for cooperation and conflict reduction. Below are some of the areas which require attention and action:

- Implement realistic measures which address poverty. Research has shown a strong causal impact of poverty on the onset of conflict. Poverty creates the conditions for igniting and sustaining conflict (UN Millennium Project 2005a).
- Adopt the environment as one of the key areas to be included in the NEPAD peer review mechanism. At present, the environment is not one of the criteria used to review the performance of each other's governments.
- Designate urban areas and human settlements as one of the programme areas of the NEPAD-EAP. Settlements of refugees and IDP could be an important focus.
- Rationalize the multiplicity of sub-regional and regional organizations with competing environmental mandates and interests, ensuring synergy among them, and the ways in which they all feed into decision-making processes of the AU.
- Negotiate, collectively through the AU, across different sectors and issues, including foreign aid, technology and trade (UN 2004) in order to meet the challenges of sustainable development.
- Lobby for the AU Constitutive Act, particularly its conflict management provisions, to be applied in trying to resolve disputes over natural resource use or access.
- Recognize the crucial role that regional economic communities, such as IGAD, ECOWAS, and SADC, have played in promoting peace and sub-regional cooperation. And, in support of this, further strengthen these organizations and encourage the sharing of best practice between them.

Stakeholders

All governments and institutions, the private sector, civil society, universities and the public have a stake in ensuring that regional cooperation is a major consideration in their activities.

Result and target date

Regional cooperation, conflict management and peace build investor confidence and encourage investment. The UN Millennium Project (2005) has reported that investing in development is important to reduce the probability of conflict. Regional cooperation is not automatic nor is it a given; it needs commitment and action – from governments right down to the public. The main target for cooperation should be the AU, and through its institutions the implementation of programmes to support sustainable development and achieve the MDG targets.

Vulnerability of small island developing states

Issues

The vulnerability of African SIDS, along with other SIDS, was highlighted at the 2005 Mauritius international meeting to review the 1994 Barbados Programme of Action (BPoA) for the sustainable development of these countries. For most SIDS their small land size and limited natural resources create a serious challenge for meeting the needs of their growing populations, and the related demands for more food, jobs and other services. Extreme poverty in some SIDS remains a challenge. Achieving a balance between conserving their land and marine environments and promoting economic sectors such as tourism, agriculture and manufacturing is a challenge. In terms of environmental issues, SIDS are threatened by IAS, pressures on endemic species, land degradation, climate change and increased frequency of natural disasters, freshwater availability, solid waste and wastewater management.

The African SIDS have made significant progress in drawing international attention to the many challenges they face, as well as establishing intergovernmental institutions to address these issues. These include the Indian Ocean Commission

(IOC) and Alliance of Small Island States (AOSIS), who, along with regional institutions such as the AU, ECA and the African Development Bank (AfDB), will continue to be key players in assisting governments to tackle problems which threaten their sustainable development.

Outlook

The challenges facing the African SIDS will continue to be a major policy issue in the decades ahead, requiring innovative and strategic interventions to respond to both traditional and emerging issues. The greatest challenge is presented by climate change whose impacts may threaten the very existence of some communities. Mass tourism and overexploitation of coastal and marine resources may exacerbate the degradation of these environments. Tourism also affects demands for freshwater and contributes pollution through increased waste generation and general land degradation.

Action

From the 1992 Earth Summit, to the 1994 BPoA, to Rio +5, to the 2002 WSSD and the 2005 Mauritius international meeting, many policies have been adopted. However, many of these still face implementation challenges. In support of these and regional and sub-regional responses, the following actions are critical to support sustainable development in SIDS in Africa:

- Develop strategies that balance economic development of sectors such as tourism with the cultural needs of the people including the promotion of indigenous knowledge related to nature management.
- Allocate adequate resources in annual national budgets to strengthen environmental monitoring and enforcement.
- Allocate adequate resources to universities and research organizations to conduct integrated research which brings together data and knowledge from scientific, social, economic and environmental disciplines to facilitate planning and management.
- Install both low- and high-tech early warning systems which are appropriate at different levels, from household and community to national and sub-regional.
- Develop professional exchange programmes among themselves and other SIDS regions to build capacity in environmental management.

Stakeholders

The stakeholders include governments, sub-regional and regional socioeconomic groupings, the private sector and big business, civil society and the public.

Public-private partnership can make a valuable contribution to GDP: vanilla production in Madagascar.

Source: J.L.Maher/WCS

Promoting technology use in SIDS will contribute to meeting the needs of their populations. A sophisticated irrigation system being tested at an agricultural centre in the Seychelles.

Source: W. Wagner/FAO

Result and target date

Strategies for sustainable development in the context of the NEPAD environment action plan should be finalized, and implementation should start, in five years. However, the targets of the MDGs are also critical in the SIDS and remain the overall target.

Policy interlinkages

Issues

The global environment, in its entirety, is composed of complex, interrelated ecosystems. To protect and preserve this complex environment requires a holistic approach that better integrates environmental problem-solving at the local, national and international levels. The human and environment systems are intricately connected. On the one hand the human system is dependent on the environment for its survival, and on the other the environment is constantly changing from anthropogenic activities. Within the human system itself, a set of interconnections also exist between the social, economic and political needs and aspirations of a population. Furthermore, in a rapidly globalizing world, policy responses at the international level have ripple effects at the regional, sub-regional, national and local levels.

Because of these interlinkages between the environment and human systems, and within each, it is imperative that the implications for the environment of all policy responses, whether in environmental or non-environmental sectors, are given due consideration. For example, macro-economic reforms undertaken by a government may impact on the effectiveness of policies governing the environment and social services. Similarly, as environmental policies are being developed or modified, their implications for policies in other sectors must also be considered (Stahl 2005). The objective in doing so is to enable a country or the region to reap the benefits of policy convergence and synergies and reduce policy conflicts.

The same holds true at the international level. It is important to consider how MEAs relate to and impact on the objectives of each other. The case of the three Rio Conventions is illustrative. The common objectives and implementation requirements of the CBD, the UN Framework Convention on Climate Change (UNFCCC) and the UN Convention to Combat Desertification (UNCCD) constitute a clear case of interlinkages, which if carefully considered can enable a more synergistic approach to the implementation of these conventions. The issue of biodiversity, for instance, is not only important in terms of the CBD but also for the UNCCD, regarding the impact of desertification on biodiversity, and the UNFCCC in terms of the relationship between biodiversity loss and climate change. For Africa, all three conventions directly relate to the issue of local livelihoods and their sustainability:

- The CBD in addressing issues of biodiversity links the need for conservation directly to sustainable use, and the fair and equitable sharing of benefits arising from the use of biological resources.
- The UNCCD addresses processes of desertification and land degradation, which are directly related to the ability of people to meet their material needs, including food security.
- The UNFCCC addresses climate change and its impacts. Climate change and variability potentially impact on freshwater resources, food production and both household and national food security.

The similar requirements of these conventions on monitoring, reporting and assessment provide an excellent opportunity for common data collection (Raustiala 2001). Synergistic approaches to the implementation of these conventions will help reduce transaction costs and avoid overstretching the limited institutional capacities in developing countries (Blaikie and Simo 2000). Such an approach can, however, be undermined by the machinery of governments, especially bureaucratic arrangements and the fragmentation of environmental functions across ministries and other institutions. These institutional arrangements, although intended to enhance efficiency, encourage policy responses that tend to overlook collaboration. Often a policy response in a given sector,

such as water, is taken without due consideration of its consequences for policy performance and outcomes in other sectors, such as land, agriculture and industry. In the absence of mechanisms that foster inter-sectoral collaboration in policy development and policy implementation, interlinkages cannot be developed, and the benefits associated with an interlinkages approach will not be realized. Interlinkages create opportunities for minimizing policy conflicts, creating synergies and sharing costs. Some countries have made progress in instituting inter-sectoral collaboration in policy development and implementation.

Outlook

The medium term outlook is both encouraging and challenging. While the issue of policy interlinkages is gaining greater currency in development dialogue and practice in Africa, the capacity for such integrated policy analysis is a constraint. This is being addressed at various levels. AMCEN, for example, emphasizes the need for evidence-based policy making as well as capacity development for policy analysis. The increasing recognition of the usefulness of inter-sectoral approaches, based on multi-stakeholder involvement, augurs well for more effective environmental decisions and management. The growing interest in rationalization and harmonization of policies at the sub-regional and regional levels also makes the outlook more positive. Nonetheless, the identification and management of synergies and conflicts among the various policy responses at the different scales and over time will continue to be a challenge. In the short run, it may be prudent to limit this effort to polices that have direct impact on the environment such as economic, fiscal, trade, industry, agriculture, energy and minerals policies.

Action

The actions that could be taken in the short to medium term are:

- Institutionalize an inter-sectoral and inclusive approach to policy development.
- Strengthen the data and information systems in the various sectors, including development of indicators, so that they are available for understanding the nature and impact of policy interlinkages (Markowitz and others 2005).
- Strengthen the national capacity for policy analysis, so that stakeholders have ready access to information on the critical policy interlinkages in order for them to make better-informed decisions at both the national and sub-regional levels.
- Use the Africa Finance Ministers' Forum, that is periodically organized by the ECA, to hold a joint session with AMCEN Ministers on economic, financial and environmental policy linkages.
- Support a limited number of case studies that demonstrate the national-regional-global policy interlinkages between trade and sectors such agriculture and fisheries.

Sustainably managing water resources - for energy, social needs and biodiversity – requires interlinkages between environment and development sectors. Nyanga, Zimbabwe.

Source: Y. Katerere

Stakeholders

Governments and their ministries and departments are key players in this area. Regional and sub-regional organizations as well as the UN organizations can play an important role in facilitating interaction and action. The private sector and civil society also have a critical role to play.

Result and target date

The result would be greater understanding of the interlinkages of human development and environmental sustainability in the context of issues such as poverty and hunger, consumption and obesity, land degradation and desertification, climate change and freshwater stress and scarcity, agricultural production and food security as well as legal and institutional frameworks. The results should be evident from 2010 onwards.

CONCLUSION

The challenge facing Africa is not new. Africa must harness the resources available to it – human, physical, financial and environmental – to realize fundamental human and development goals. Developing and implementing an effective environmental strategy can have wide-ranging crosscutting benefits for human well-being and economic development, and can be an essential tool in ensuring that the NEPAD aspiration for the 21st century to be Africa's century is realized (NEPAD 2001).

An effective strategy will need to be based on purposeful and clearly articulated goals, with achievable time-bound targets. Existing MEA and other global commitments should be seen as a platform for action, and not a ceiling.

Actions need to be strategic, focusing on those areas where investment, whether in environmental management or human and physical capital, will have multiple follow-on impacts. For example, relatively small investments in improving water quality will not only have important environmental outcomes but can increase opportunities for access to safe water, resulting in improvements in human health, decreasing overall vulnerability and increasing human capability. Such investments may as a consequence result in improved economic growth.

Just as Africa has begun to make fundamental improvements economically and politically, an environmental turnaround is within its reach – and in its interest.

An old mosque at Bobo Dioulasso, Burkina Faso, built in 1880. Africa has a glorious past – and it can claim the future.

Source: C. Cossalter/CIFOR

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ANNEXES

ABBREVIATIONS

CONTRIBUTORS

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ANNEX 1
MILLENNIUM DEVELOPMENT GOALS

Table 1

Millennium Development Goal	Target
Goal 1: Eradicate extreme poverty and hunger	Target 1: Reduce by half the proportion of people living on less than a dollar a day Target 2: Reduce by half the proportion of people who suffer from hunger
Goal 2: Achieve universal primary education	Target 3: Ensure that all boys and girls complete a full course of primary schooling
Goal 3: Promote gender equality and empower women	Target 4: Eliminate gender disparity in primary and secondary education, preferably by 2005, and at all levels by 2015
Goal 4: Reduce child mortality	Target 5: Reduce by two-thirds the mortality rate among children under five
Goal 5: Improve maternal health	Target 6: Reduce by three-quarters the maternal mortality ratio
Goal 6: Combat HIV/AIDS, malaria and other diseases	Target 7: Halt and begin to reverse the spread of HIV/AIDS Target 8: Halt and begin to reverse the incidence of malaria and other major diseases
Goal 7: Ensure environmental sustainability	Target 9: Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources Target 10: Reduce by half the proportion of people without sustainable access to safe drinking water Target 11: Achieve significant improvement in the lives of at least 100 million slum dwellers by 2020
Goal 8: Develop a global partnership for development	Target 12: Develop further an open trading and financial system that is rule-based, predictable and non-discriminatory; includes a commitment to good governance, development and poverty reduction – nationally and internationally Target 13: Address the least developed countries' special needs. This includes tariff- and quota-free access for their exports; enhanced debt relief for heavily indebted poor countries; cancellation of official bilateral debt; and more generous official development assistance for countries committed to poverty reduction Target 14: Address the special needs of landlocked and Small Island Developing States Target 15: Deal comprehensively with developing countries' debt problems through national and international measures to make debt sustainable in the long term Target 16: In cooperation with the developing countries, develop decent and productive work for youth Target 17: In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries Target 18: In cooperation with the private sector, make available the benefits of new technologies – especially information and communications technologies

Table 2: Progress towards achieving the Millennium Development Goals

		Goal 1 Eradicate extreme poverty and hunger	Goal 2 Achieve universal primary education	
Targets		Halve the % of people suffering from hunger	Ensure that all children complete primary school	
Indicators		Undernourished people	Net primary enrolment ratio	Children reach grade 5
HDI rank		(as % of population)	(%)	(%)
106	Algeria	Slipping back	On track	On track
161	Angola	Slightly off	On track	Data unavailable
158	Benin	On track	On track	Data unavailable
126	Botswana	Slipping back	Achieved	On track
169	Burkina Faso	On track	Slipping back	Data unavailable
171	Burundi	Slipping back	Slightly off	Data unavailable
135	Cameroon	Slightly off	Slightly off	Data unavailable
100	Cape Verde	Cape Verde	On track	Data unavailable
165	Central African Republic	Far behind	Far behind	Data unavailable
166	Chad	On track	Far behind	Far behind
137	Comoros	Slipping back	Slightly off	Data unavailable
136	Congo	Slightly off	On track	Data unavailable
155	Congo, Dem. Rep. of the	Slipping back	Data unavailable	Data unavailable
156	Côte d'Ivoire	Slightly off	Slipping back	Far behind
149	Djibouti	On track	Slipping back	Slipping back
115	Egypt	On track	On track	Data unavailable
111	Equatorial Guinea	Data unavailable	On track	Data unavailable
157	Eritrea	Far behind	Slightly off	Data unavailable
168	Ethiopia	Slipping back	Far behind	Data unavailable
117	Gabon	Slipping back	Achieved	Data unavailable
160	Gambia	Far behind	On track	Data unavailable
129	Ghana	Achieved	On track	Data unavailable
159	Guinea	Slipping back	Far behind	Data unavailable
167	Guinea-Bissau	Data unavailable	Far behind	Data unavailable
134	Kenya	Far behind	Achieved	Data unavailable
132	Lesotho	Slightly off	Achieved	Data unavailable
999	Liberia	Slipping back	Slightly off	Data unavailable
64	Libya	Achieved	Achieved	Data unavailable
147	Madagascar	Slipping back	Achieved	Data unavailable
163	Malawi	On track	On track	Data unavailable
164	Mali	Far behind	Far behind	On track
152	Mauritania	On track	On track	Slipping back
67	Mauritius	On track	Achieved	On track
123	Morocco	Slipping back	On track	Far behind
170	Mozambique	Slightly off	Slipping back	Data unavailable
122	Namibia	Achieved	Achieved	Data unavailable
172	Niger	Slightly off	Far behind	Data unavailable
148	Nigeria	Achieved	Slightly off	Data unavailable

Goal 3 Promote gender equality and empower women		Goal 4 Reduce child mortality	Goal 7 Ensure environmental sustainability target	
Eliminate gender disparity in all levels of education		Reduce by 2/3 under-5 infant mortality rates	Halve the % of people without access to safe water	Number of Goals on target to be achieved
Female primary ratio as % of male ratio	Female secondary ratio as % of male ratio	Under-five mortality rates (per 1 000 lives)	Access to improved safe water (%)	
On track	On track	Slipping back	Slipping back	4 of 7
Data unavailable	Data unavailable	Slipping back	On track	2 of 7
Far behind	Far behind	Far behind	On track	3 of 7
Achieved	Achieved	Slipping back	On track	5 of 7
Far behind	Data unavailable	Far behind	On track	2 of 7
Far behind	Data unavailable	Far behind	On track	1 of 7
Data unavailable	Data unavailable	Slipping back	On track	1 of 7
Achieved	Achieved	On track	On track	5 of 7
Data unavailable	Data unavailable	Far behind	Achieved	1 of 7
Far behind	Far behind	Far behind	On track	2 of 7
Data unavailable	On track	On track	Achieved	3 of 7
On track	Far behind	Far behind	Achieved	2 of 7
On track	Data unavailable	Far behind	Data unavailable	1 of 7
Far behind	Far behind	Slipping back	Data unavailable	1 of 7
Far behind	On track	Far behind	Achieved	3 of 7
On track	On track	On track	Achieved	6 of 7
Data unavailable	Data unavailable	On track	Data unavailable	2 of 7
Data unavailable	Data unavailable	On track	On track	2 of 7
Slipping back	Slipping back	Far behind	Slightly off	0 of 7
Achieved	Data unavailable	Far behind	Data unavailable	2 of 7
On track	On track	Far behind	Data unavailable	3 of 7
On track	Data unavailable	Slightly off	Achieved	4 of 7
On track	Far behind	On track	Far behind	2 of 7
Data unavailable	Data unavailable	Data unavailable	Data unavailable	0 of 7
Achieved	On track	Slipping back	Slightly off	3 of 7
Achieved	Achieved	Far behind	On track	4 of 7
Data unavailable	Data unavailable	Far behind	Data unavailable	0 of 7
Data unavailable	Data unavailable	On track	Far behind	3 of 7
Achieved	Achieved	Far behind	Far behind	3 of 7
Achieved	On track	Slightly off	Slightly off	4 of 7
On track	Slipping back	Far behind	On track	3 of 7
On track	Far behind	Far behind	Far behind	3 of 7
Achieved	Achieved	On track	Achieved	7 of 7
On track	On track	On track	On track	5 of 7
Far behind	Far behind	Far behind	Data unavailable	0 of 7
Achieved	Achieved	Far behind	Achieved	5 of 7
Far behind	Data unavailable	Far behind	Data unavailable	0 of 7
Slightly off	Data unavailable	Far behind	Slightly off	1 of 7

Table 2: Progress towards achieving the Millennium Development Goals *continued*

		Goal 1 **Eradicate extreme poverty and hunger**	**Goal 2** **Achieve universal primary education**	
Targets		Halve the % of people suffering from hunger	Ensure that all children complete primary school	
Indicators		Undernourished people	Net primary enrolment ratio	Children reach grade 5
HDI rank		(as % of population)	(%)	(%)
162	Rwanda	Far behind	Achieved	Data unavailable
119	São Tomé and Príncipe	Data unavailable	On track	Data unavailable
154	Senegal	Slipping back	On track	On track
47	Seychelles	Data unavailable	Achieved	On track
173	Sierra Leone	Slipping back	Data unavailable	Data unavailable
999	Somalia	Slipping back	Data unavailable	Data unavailable
107	South Africa	Data unavailable	On track	Data unavailable
139	Sudan	On track	Slightly off	Data unavailable
125	Swaziland	Far behind	On track	Far behind
151	Tanzania	Slipping back	Achieved	Far behind
141	Togo	On track	On track	Data unavailable
97	Tunisia	Achieved	Achieved	On track
150	Uganda	Slightly off	On track	Data unavailable
153	Zambia	Slipping back	Slipping back	Data unavailable
128	Zimbabwe	Far behind	On track	Data unavailable
	Achieved	5	12	0
	On track	10	19	7
	Slightly off	8	7	0
	Far behind	8	7	5
	Slipping back	16	5	2
	Data unavailable	6	3	39
	Total	**53**	**53**	**53**
	Satisfactory performance ratio (Achieved and On track)	28.3%	58.3%	13.2%

Source: OECD Development Centre and AfDB 2005

Reference

OECD Development Centre and AfDB (2005). *African Economic Outlook 2004/2005*. Development Centre of the Organisation for Economic Co-operation and Development and the African Development Bank. Organisation for Economic Co-operation and Development, Paris

Goal 3 Promote gender equality and empower women		Goal 4 Reduce child mortality	Goal 7 Ensure environmental sustainability target	
Eliminate gender disparity in all levels of education		Reduce by 2/3 under-5 infant mortality rates	Halve the % of people without access to safe water	Number of Goals on target to be achieved
Female primary ratio as % of male ratio	Female secondary ratio as % of male ratio	Under-five mortality rates (per 1 000 lives)	Access to improved safe water (%)	
Achieved	Data unavailable	Slipping back	Data unavailable	2 of 7
Data unavailable	Data unavailable	Far behind	Data unavailable	1 of 7
On track	Far behind	Far behind	On track	4 of 7
Data unavailable	Data unavailable	On track	Data unavailable	3 of 7
On track	Data unavailable	Far behind	Data unavailable	1 of 7
Data unavailable	Data unavailable	Far behind	Data unavailable	0 of 7
On track	Achieved	Slipping back	On track	4 of 7
Slightly off	On track	Far behind	On track	3 of 7
On track	On track	Slipping back	Data unavailable	3 of 7
Achieved	On track	Far behind	Achieved	4 of 7
Far behind	Far behind	Far behind	Far behind	2 of 7
Achieved	On track	On track	On track	7 of 7
On track	Far behind	Slightly off	Slightly off	2 of 7
On track	Data unavailable	Slipping back	On track	2 of 7
Achieved	Far behind	Slipping back	On track	3 of 7
13	7	0		8
16	12	11		19
2	0	3		5
9	11	27		5
1	2	11		1
12	21	1		15
53	**53**	**53**		**53**
54.7%	35.8%	20.8%	50.9%	

ANNEX 2
SOCIOECONOMIC INDICATORS

Table 1a: Sub-Saharan Africa socioeconomic indicators

Population (millions 2003)	Population (average annual % growth 1990-2003)	Population (density people per sq km 2003)	Gross national income (GNI)a (thousand millions of dollars 2003)	Gross national income (GNI)a (per capita dollars 2003)	PPP gross national income (GNI)b (thousand millions of dollars 2003)	PPP gross national income (GNI)b (per capita dollars 2003)	Gross domestic product (per capita % growth 2002-2003)	Life expectancy at birth (years 2002)	Under-5 mortality (rate per 1 000 2002)	Adult literacy rate (% of people 15 and above 2002)	Carbon dioxide emissions (millions of tonnes 2000)
702.6	2.5	30	346.8	490	1 243	1 770	1.3	46	174	65	478.8

Source: World Development Report 2005

Table 1b: Sub-Saharan Africa socioeconomic indicators

Gross domestic product (avgerage annual % growth 1990-2003)	Agricultural productivity Agricultural value-added per agricultural worker (dollars 1988-90)	Agricultural productivity Agricultural value-added per agricultural worker (dollars 2000-02)	Value-added as % of GDP Agricultural 2003	Value-added as % of GDP Industry 2003	Value-added as % of GDP Services 2003	Household final consumption expenditure % of GDP 2003	General government's final consumption expenditure % of GDP 2003	Gross capital formation % of GDP 2003	External balance of goods-and-services 2003
2.7	382	360	14	29	57	68	16	18	-1

Source: World Development Report 2005

Reference

World Bank (2005). *World Development Indicators 2005*. World Bank, Washington D.C. http://devdata.worldbank.org/wdi2005/index2.htm

ANNEX 3
GENETICALLY MODIFIED ORGANISMS

Table 1: National, sub-regional and regional biosafety organizations

Organization	Countries	Purpose
Southern Africa Regional Biosafety (SARB) 2000-2001	Malawi, Mauritius, Mozambique, Namibia, South Africa, Zimbabwe, Zambia	• Support capacity-building for countries to develop biotechnology-related regulations and successfully implement them. • Develop a regional approach to policy and the harmonization of regulations. • Promote market access for biotechnology products from the public and private sectors.
Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) 1999-2000	National Agricultural Research institutes from Burundi, DRC, Eritrea, Ethiopia, Kenya, Madagascar, Tanzania, Rwanda, Sudan, Uganda	• Increase the efficiency of agricultural research to support economic growth, food security and sustainable agriculture.
Eastern and Central Africa Programme for Agricultural Policy Analysis (ECAPAPA) created by ASARECA	National Agricultural Research institutes from Burundi, DRC, Eritrea, Ethiopia, Kenya, Madagascar, Tanzania, Rwanda, Sudan, Uganda	• Improve agricultural policy analysis. • Bring the national agricultural research systems (NARS) into the policy process. • Increase the ability of individuals and agricultural institutions to influence and to apply agricultural policies through capacity-building and other support. • Develop policy recommendations that can be used to inform policy-making processes through data collection, analysis, dialogue and action. • Provide agricultural policy information.
ABSP Technical Support to ASARECA	Eastern and Central Africa	• Provide technical support to ASARECA throughout the planning process. • Ensure that ASARECA members have access to expertise in agricultural biotechnology and biosafety. • Develop an inventory of agricultural biotechnology for Eastern and Central Africa.
African Biotechnology Stakeholders Forum (ABSF)	Eastern Africa	• Create an enabling environment in which African countries can participate and benefit from biotechnology in a responsible and sustainable manner. • Promote understanding and awareness of all aspects of biotechnology and biosafety.
The African Centre For Technology Studies (ACTS)	International (based in Nairobi)	• Harness science and technology for Africa's sustainable development. • Implement biotechnology and biosafety projects building a regional approach and common position to biotechnology and biosafety in the ASARECA/COMESA region.
Biotechnology Trust Africa (BTA)	Africa	• Promote the development and application of biotechnology with emphasis on agriculture, health, environment and industry. • Support the development of appropriate policy.

Table 1: National, sub-regional and regional biosafety organizations *continued*

Organization	Countries	Purpose
		• Facilitate biotechnology research and development, biosafety and the development of related intellectual property rights (IPR). • Support capacity-building in biotechnology, biosafety and IPR. • Support networking and build awareness on biotechnology, biosafety and IPR.
The Africa Agricultural Technology Foundation (AATF) African Harvest Biotech Foundation International	Sub-Saharan Africa Africa	• Facilitate and promote partnerships with public and private sectors to remove the barriers that prevent small farmers from gaining access to existing agricultural technologies that could help improve food security and reduce poverty. • Promote the use of science and technology, including biotechnology, to fight hunger, malnutrition and poverty by increasing agricultural yields and incomes.
Program for Biosafety Systems (PBS)	Global program including Africa Biowatch (South Africa) University of Malawi, National Research Council (Malawi), National Biotechnology Development Agency (Nigeria), Biotechnology and Nuclear Agriculture Research Institute (Ghana), Institute of Rural Economy (Mali), Ministry of Environment Permanent Technical Secretary (Mali)	• Address biosafety issues within a sustainable development strategy through agriculture-led economic growth, trade and environmental objectives.
Environment Information Systems in sub-Saharan Africa (EIS-SSA)	Sub-Saharan Africa	• Develop capacity for the management of environmental information as an integral component of the sustainable development process. • Ensure access to environmentally relevant data by a wide variety of potential users at the national, sub-regional, continental and ultimately global levels through the development of strategies, policies and procedures, data management, communication tools and networking mechanisms.
Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN)	SADC	• Coordinate, influence and facilitate policy analysis, research, information and data collection, and capacity-building.
East African Research Network for Biotechnology, Biosafety and Biotechnology Policy Development (BIC EARN)	Ethiopia, Kenya, Tanzania, Uganda	• Promote research and related policy development. • Capacity-building.
West Africa Rice Development Association (WARDA)	Western Africa	• Strengthen capacity for technology generation, technology transfer and policy formulation for sustainable production of rice.
International Institute for Tropical Agriculture (IITA)	Western Africa	• Conduct research, including in collaboration with ASARECA and CORAF.
West and Central African Council for Agricultural Research and Development (CORAF)	Western and Central Africa: Association of national agricultural research organizations in Western and Central Africa	• Collaborate in research and development activities.

Table 1: National, sub-regional and regional biosafety organizations *continued*

Organization	Countries	Purpose
Kenya Agricultural Research Institute (KARI), National Council of Science and Technology (Kenya), Kenya Plant Health Inspection Service, National Council of Science and Technology (Uganda), National Agricultural Research Organization (NARO) (Uganda), Tropical Pesticides Research Institute (TPRI) (Tanzania)	Eastern Africa	• Research. • Information and data collection. • Undertake monitoring and evaluation. • Participate in the Program for Biosafety.

Table 2: Some biosafety policy initiatives in Africa

Initiative	Partners/donors	Objective and outputs
African Union: African Model Law on Safety in Biotechnology	National governments and NGOs	Provide guidance on the development of biosafety regulations. Outputs include: • African Model Law on Safety in Biotechnology adopted by the Council of Ministers at 74th Ordinary Session (Lusaka, July 2001).
SADC: Advisory Committee on Biotechnology and Biosafety	SADC Council of Ministers for Food, Agriculture and Natural Resources (FANR)	Provide advice on issues pertaining to GM food aid. Outputs include: • Guidelines on the measures that should be taken to deal with GMO-related risks.
NEPAD Science and Technology Secretariat		Develop a common Africa-wide policy on biotechnology and biosafety. Outputs include: • African Advisory Panel of Experts to advise heads of state. • Centres of Excellence Program: including four biosciences agricultural research facilities in Kenya, Ghana, South Africa and Egypt. • The African Policy Dialogues on Biotechnology.

Table 2: Some biosafety policy initiatives in Africa *continued*

Initiative	Partners/donors	Objective and outputs
ASARECA (Association for Strengthening Agricultural Research in Eastern and Central Africa)	USAID	Strengthen the capacity of ten Eastern and Central African countries to engage in biotechnology and biosafety policy debates.
Program for Biosafety Systems (PBS)	USAID Coordinated by CGIAR's Washington D.C based International Food Policy Research Institution (IFPRI)	Develop biosafety systems and assist in biosafety decision making.
Biosafety regulatory assistance to ECOWAS	USAID	Targeted assistance on Bt cotton field trials and GM food aid.
FARA (Forum for Agricultural Research in Africa)	Network of African agricultural research institutions and partner of the World Bank	Adding policy value to research of other regional actors such as ASARECA and NEPAD.
ISAAA (International Service for the Acquisition of Agri-Biotech Applications)		Industrial biotechnology advocacy and research. Africa programme focuses on GM bananas and GM sweet potatoes.
AATF (African Agricultural Technology Foundation	Public -private-partnership. Donors include USAID, Rockefeller Foundation, OECD, DANIDA, DFID and private companies	Promote access by small farmers to GM technologies through technology transfer.

ABBREVIATIONS

AAT	Animal African Trypanosomiasis
ABSF	African Biotechnology Stakeholders Forum
ACCNNR	African Convention on the Conservation of Nature and Natural Resources
ACT	Action by Churches Together
AEC	African Economic Community
AEIN	Africa Environmental Information Network
AEO	Africa Environment Outlook
AEO-EIS	Africa Environment Outlook – Environmental Information System
AfDB	African Development Bank
AFLEG	Africa Forest Law Enforcement and Governance
AGERI	Agriculture Genetic Engineering Research Institute
AGOA	African Growth and Opportunity Act
AGRHYMET	Centre for Agro-meteorology and Operational Hydrology
AIACC	Assessment of Impacts and Adaptations to Climate Change
AMCEN	African Ministerial Conference on the Environment
AMCOW	African Ministerial Council on Water
AMMA	African Multidisciplinary Monsoon Analysis
AMU	Arab Maghreb Union
ANBO	African Network of Basin Organizations
ANC	African National Congress
AOSIS	Alliance of Small Island States
APAI	African Protected Areas Initiative
APRM	African Peer Review Mechanism
ARI	Acute respiratory infections
ARI	Advanced Research Institute
ASAL	Arid and semi-arid lands
ASP	Africa Stockpiles Programme
ATO	African Timber Organization
AU	African Union
bbl/d	barrels per day
BCLME	Benguela Current Large Marine Ecosystem
BOTT	Build, Operate, Train and Transfer
BPoA	Barbados Programme of Action
BSE	Bovine Spongiform Encephalopathy
Bt	Bacillus thuringiensis
CAADP	Comprehensive Africa Agriculture Development Programme
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
Cap-Net	Capacity Building for Integrated Water Resources Management
CAR	Central African Republic
CARPE	Central African Regional Program for the Environment
CBD	Convention on Biological Diversity
CBFP	Congo Basin Forest Partnership
CBNRM	Community-based natural resource management
CBO	Community-based organization
CDM	Clean Development Mechanism
CEDARE	Centre for Environment and Development for the Arab Region and Europe
CEMAC	Economic and Monetary Community of Central Africa
CEN-SAD	Community of Sahel-Saharan States
CEOSS	Coptic Evangelical Organization for Social Services
CFC	Chlorofluorocarbon
CGIAR	Consultative Group on International Agricultural Research
CI	Conservation International
CI	Consumers International
CIDA	Canadian International Development Agency
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
CIMMYT	International Maize and Wheat Improvement Centre
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna
CMS	Conservation of Migratory Species of Wild Animals
COMESA	Common Market for Eastern and Southern Africa
COMIFAC	Central Africa Forests Commission

COP	Conference of the Parties
COTS	Crown-of-thorns starfish
CPUE	Catch per Unit Effort
CRDB	Co-operative and Rural Development Bank
CRIC	Committee for the Review of the Implementation of the Convention (UNCCD)
CSIR	South African Council on Scientific and Industrial Research
CSO	Civil society organization
DANIDA	Danish International Development Agency
DDT	Dichlorodiphenyltrichloroethane
DGEF	Division of Global Environment Facility Coordination
DGIS	Netherlands Directorate General for International Cooperation
DIVERSITAS	Integrating Biodiversity Science of Human Well-being
DNA	Deoxyribonucleic acid
DNOC	DiNitroOrthoCresol
DRC	Democratic Republic of the Congo
DTF	Devolution Trust Fund
EAC	East African Community
ECA	United Nations Economic Commission for Africa
ECCAS	Economic Community of Central African States
ECOFAC	Ecosystèmes Forestiers d'Afrique Centrale
ECOSOC	United Nations Economic and Social Council
ECOSOCC	Economic, Social and Cultural Council of the AU
ECOWAS	Economic Community of West African States
EEZ	Exclusive Economic Zone
EGRAP	Ethiopian Groundwater Resource Assessment Programme
EIA	Environmental impact assessment
EIB	European Investment Bank
EMS	Environmental management systems
ENGDA	Ethiopian National Groundwater Database
ENSO	El Niño/Southern Oscillation
EPARM	Ethiopian Pharmaceuticals Manufacturing
EPZ	Export Processing Zone
ESA	European Space Agency
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAR	Forces Armées Rwandaises
FAS	Femmes Africa Solidarité
FAWE	Forum for African Women Educationalists
FDI	Foreign direct investment
FEWS-NET	Famine Early Warning Systems Network
FNLA	Front for the Liberation of Angola
FRIEND	Flow Regimes from International Experimental and Network Data
G8	Group of 8
GAFRD	General Authority of Fish Resources Development
GBM	Green Belt Movement
GCM	General Circulation Model
GDI	Gender-related Development Index
GDP	Gross Domestic Product
GE	Genetic engineering
GEF	Global Environment Facility
GEM	Gender Empowerment Measure
GENØK	Norwegian Institute of Gene Ecology
GEO	Global Environment Outlook
GFMC	Global Fire Monitoring Centre
GHG	Greenhouse gases
GISP	Global Invasive Species Programme
GIWA	Global International Waters Assessment
GLCN	Global Land Cover Network
GLR	Great Lakes Region
GM	Genetically modified
GMMR	Great Man-Made River
GMO	Genetically modified organism
GNP	Gross National Product
GSM	Global System for Mobile Communication
GURT	genetic use restriction technologies
GWP	Global Water Partnership
HAT	Human African Trypanosomiasis
HDI	Human Development Index
HIPC	Heavily Indebted Poor Countries
HYDROMET	Hydrometeorological Survey of the Catchments of Lakes Victoria, Kyoga and Albert
IAS	Invasive alien species
IATC	Inter-Agency Technical Committee
IBA	Important Bird Area

ICAM	Integrated Coastal Area Management
ICCM	International Conference on Chemicals Management
ICPAC	IGAD Climate Prediction and Applications Centre
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IDPs	Internally displaced persons
IFAD	International Fund for Agricultural Development
IGAD	Intergovernmental Authority on Development
ILO	International Labour Organization
ILRI	International Livestock Research Centre
IMF	International Monetary Fund
INERA	Institut National de l'Environnement et la Recherche Agronomique
IOC	Indian Ocean Commission
IOC	Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization
IPCC	Intergovernmental Panel on Climate Change
IPCC	International Plant Protection Convention
IPM	Integrated Pest Management
IPR	Intellectual property rights
IRMA	Insect-Resistant Maize for Africa
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
ISO	International Standards Organization
ITC	International Institutions for Geo-Information Science and Earth Observations
ITCZ	Intertropical Convergence Zone
ITDG	Practical Action (Formerly the Intermediate Technology Development Group)
IUCEA	Inter-University Council for East Africa
IUCN	IUCN – The World Conservation Union
IUCN-EARP	IUCN's Eastern Africa Regional Programme
IUU	Illegal, unregulated and unreported
IWRM	Integrated water resources management
KARI	Kenyan Agricultural Research Institute
KWS	Kenya Wildlife Service
LADA	Land Degradation Assessment in Drylands
LCBC	Lake Chad Basin Commission
LDCs	Least Developed Countries
LEAP	Local Environment Action Program
LEED	Leadership Energy and Environment Design
LME	Large Marine Ecosystem
LMO	Living modified organism
LNG	Liquefied Natural gas
LOICZ	Land-Ocean Interactions in the Coastal Zone
LPA	Lagos Plan of Action
LPG	Liquid propane gas
LPG	Liquefied Petroleum Gas
LVD	Lake Victoria Development Programme
LVEMP	Lake Victoria Environmental Management Programme
MA	Millennium Ecosystem Assessment
MANR	Ministry of Agriculture and Land Reclamation (Egypt)
MARPOL	International Convention for the Prevention of Pollution from Ships
MARWOPNET	Mano River Women's Network
MDG	Millennium Development Goal
MEA	Multilateral environmental agreement
MedWet	Mediterranean Wetlands Initiative
MI	Millennium Institute
MIKE	Monitoring of the Illegal Killing of Elephants
MJO	Intra-Seasonal Oscillations
MPA	Marine Protected Area
MPLA	Movimento Popular da Libertação de Angola
MSY	Maximum sustainable yield
NAP	National action programmes
NAP	National Action Plan
NAPA	National Adaptation Program of Action
NASA	National Aeronautics and Space Administration
NBCBN-RE	Nile Basin Capacity Building Network for River Engineering
NBI	Nile Basin Initiative
NCA	Norwegian Church Aid
NEAP	National Environmental Action Plan
NEH	Northern Energy Highway
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme

NEMC	National Environment Management Council
NEPAD	New Partnership for Africa's Development
NEPAD-EAP	New Partnership for Africa's Development Environment Action Plan
NERICA	New Rice for Africa
NESDA	Network for Environment and Sustainable Devel-opment in Africa
NGO	Non-governmental organization
Nile-COM	Council of Ministers of Water Affairs of the Nile Basin States
Nile-SEC	NBI Secretariat
Nile-TAC	Nile Technical Advisory Committee
NIP	National implementation plan
NPACD	National Action Plan to Combat Desertification
NTBF	New technology-based firm
NTFP	Non-timber forest product
O&M	Operations and maintenance
OAU	Organization of African Unity
OAU/SEAF	Organization of African Unity Special Emergency Assistance Fund for Drought and Famine in Africa
ODA	Official development assistance
ODA	Overseas development assistance
ODS	Ozone Depleting Substances
OECD	Organization for Economic Co-operation and Development
OHADA	Organisation d'Harmonisation du Droit des Affaires en Afrique
OPEC	Organization of Petroleum Exporting Countries
PA	Programme Area
PANAFCON	Pan-African Conference on Implementation and Partnership on Water
PBT	Persistent, bioaccumulative and toxic
PCB	Poly-chlorinated biphenyls
PCFV	Partnership for Clean Fuels and Vehicles
PELUM	Participatory Ecological Land Use Management
PERSGA	The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
PFP	Policy Framework Paper
PIC	Prior Informed Consent
PLEC	People, Land Management and Environmental Change
PM	Particulate Matter
PNV	Parc National des Volcans
POP	Persistent organic pollutants
PPP	Purchasing Power Parity
PPP	Public-private-partnership
PPP	Polluter pays principle
PRS	Poverty Reduction Strategies
PRSP	Poverty Reduction Strategy Programme
PRSP	Poverty reduction strategy paper
PV	Photovoltaic
PVS	Participatory Varietal Selection
QBO	Quasi-Biennial Oscillations
R&D	Research and Development
RAP	Regional Action Programme
RAPAC	Central African Protected Areas Network
RATES	Regional Agricultural Trade Expansion Support
RBDA	River Basin Development Authorities
REC	Regional economic community
REFAD	Renewable Energy for African Development
RELMA	Regional Land and Water Management Unit
RES	Renewable energy sources
RISDP	Regional Indicative Strategic Development Plan
RUF	Revolutionary United Front
SABRE-Gen	South African Bulk Renewable Energy – Generation
SADC	Southern African Development Community
SADC-DMC	Southern African Development Community Drought Monitoring Centre
SAICM	Strategic Approach to International Chemicals Management
SAP	Structural Adjustment Programme
SARCOF	Southern Africa Regional Climate Outlook Forum
SARDC	Southern African Research and Documentation Centre
SARS	Severe Acute Respiratory Syndrome
SDC	Swiss Agency for Development and Cooperation
SDI	Spatial Development Initiatives
SEI	Stockholm Environment Institute
SFIT	Swiss Federal Institute of Technology
SHS	Solar home system
SIDS	Small Island Developing States

SME	Small and medium enterprises
SNEL	Société Nationale d'Electricité
SOI	Southern Oscillation Index
SPLASH	Special Program on Learning and Awareness on Species and Habitats
SPLM/A	Sudan People's Liberation Movement/Army
SPS	Sanitary and Phytosanitary
SRAP	SADC Sub-Regional Action Programme
SSA	Sub-Saharan Africa
STAP	Short-term action plan
STAP-TWR	Short-term action plan for Transboundary Water Resources
SWIOFP	South West Indian Ocean Fisheries Project
T21	Threshold 21
TARDA	Tana and Athi Rivers Development Authority
TBNRM	Transboundary natural resource management
TDR	Special Programme for Research and Training in Tropical Diseases
TECCONILE	Technical Cooperation Committee for the Promotion of the Development and Environmental Protection of the Nile Basin
TIGER-SHIP	Earth Observation for integrated water resources management in Africa
TPN	Thematic Programme Network
TPRI	Tropical Pesticides Research Institute
TRIPS	Trade-Related Aspects of Intellectual Property Rights
TWh	Terawatt hours
ULIMO	United Liberation Movement for Democracy in Liberia
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organization's Institute for Water Education
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNITA	União Nacional para a Independência Total de Angola
UNSO	Office to Combat Desertification and Drought
UNU	United Nations University
UNU-INWEH	UNU's International Network on Water, Environment and Health
USAID	United States Agency for International Development
UV	ultra violet
UXO	Unexploded ordinance
VAD	Vitamin A deficiency
VMT	Verification and Monitoring Team
WA-Net	West Africa Capacity Building Network
WARDA	West African Rice Development Association
WAVE	Women as the Voice of the Environment
WCD	World Commission on Dams
WCED	World Commission on Environment and Development
WDM	Water demand management
WFP	United Nations World Food Programme
WHO	World Health Organization
WIMSA	Working Group of Indigenous Minorities in Southern Africa
WIO	Western Indian Ocean
WIO-LaB	Addressing Land-Based Activities in the Western Indian Ocean
WMO-DMC	World Meteorological Organization Drought Monitoring Centre
WRI	World Resources Institute
WRM	Water Resources Management
WSP	Water and Sanitation Program
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWF	WWF – the World Wide Fund for Nature
ZAMCOM	Zambezi River Commission
ZIMOZA	Zimbabwe-Mozambique-Zambia Transboundary Natural Resource Management Initiative

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"Economic development in Africa is underpinned by the quality and integrity of the natural resource base. The region's environmental assets provide opportunities for Africa to achieve the objectives of the New Partnership for Africa's Development (NEPAD) and make good progress towards meeting the targets of the Millennium Development Goals (MDGs). Africa cannot, therefore, afford to lose its environmental assets through degradation. Hundreds of millions of people depend directly or indirectly on these resources. "

Dr. Abdul-Hakim Rajab Elwaer,
Secretary of the Peoples' Committee of Environment General Authority, Libyan-Jamahiriya and
President of the African Ministerial Conference on the Environment (AMCEN)

AEO-2 provides a comprehensive assessment of environmental state-and-trends, and the implications of this for human well-being and development. The assessment includes an analysis of policy responses and the opportunities available to policymakers to maximize the benefits offered by the environment. It addresses five consecutive and inter-related questions:

- How and why is the environment important from a human perspective?
- How is the environment changing, and why, and what opportunities does it hold?
- Are there special issues, which affect the environment and development, that require immediate attention and new approaches?
- How will different policy choices affect the future?
- What can be done to ensure that environmental value is retained and the lives of people are improved?

AEO

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