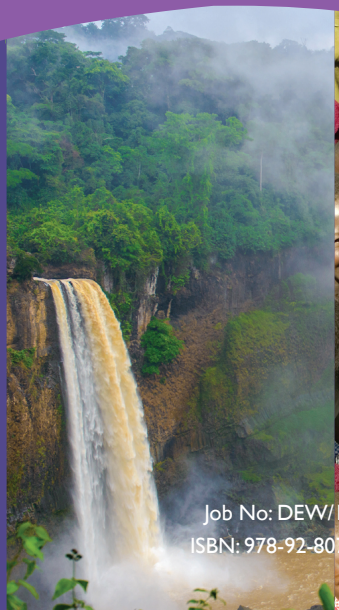
GLOBAL ENVIRONMENT OUTLOOK

GEO-6

REGIONAL ASSESSMENT FOR AFRICA











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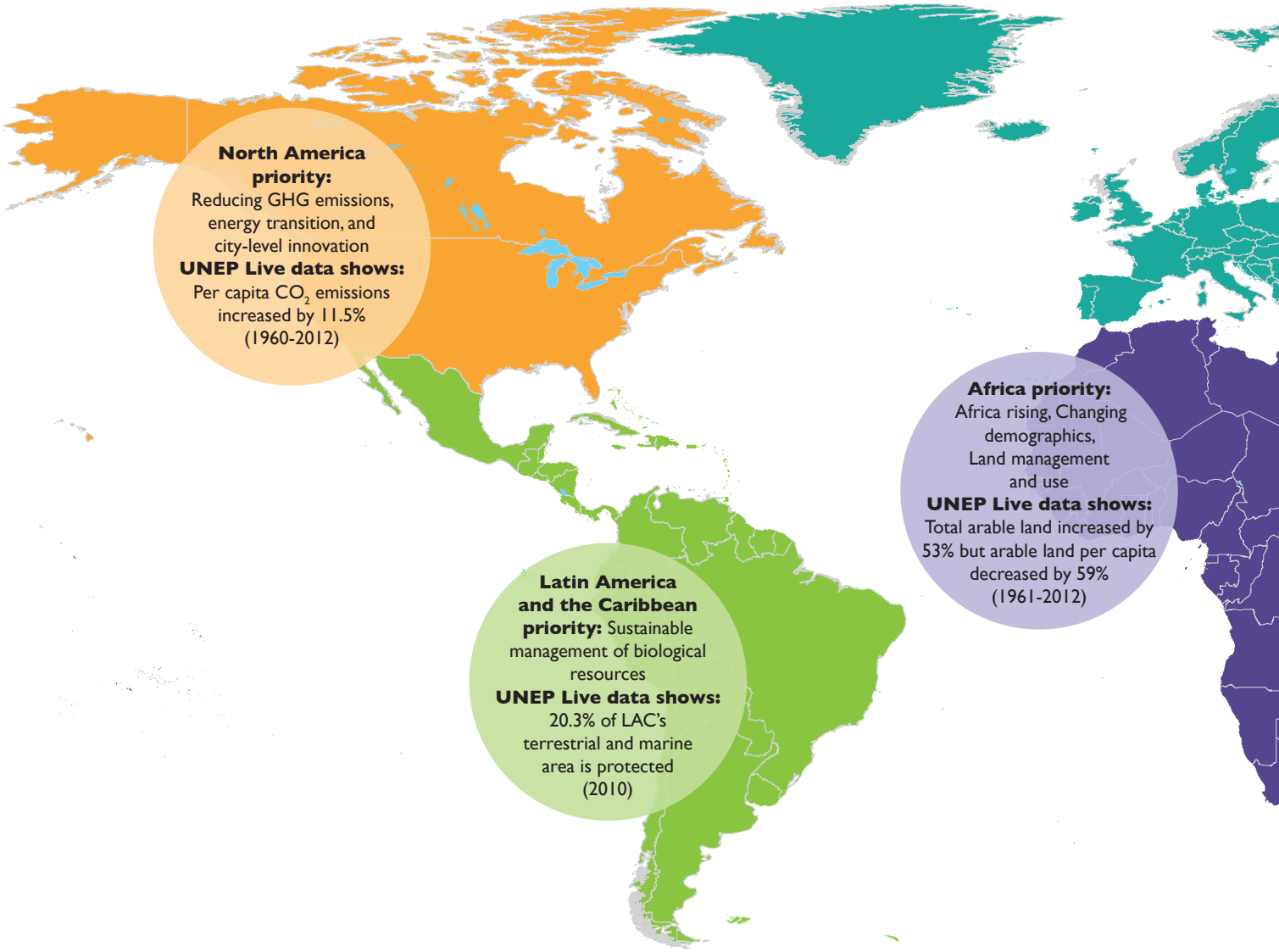
GLOBAL ENVIRONMENT OUTLOOK

GEO-6

REGIONAL ASSESSMENT FOR

AFRICA

UNEP


North America priority: Reducing GHG emissions, energy transition, and city-level innovation
UNEP Live data shows: Per capita CO_2 emissions increased by 11.5% (1960-2012)
Africa priority: Africa rising, Changing demographics, Land management and use
UNEP Live data shows: Total arable land increased by 53% but arable land per capita decreased by 59% (1961-2012)
Latin America and the Caribbean priority: Sustainable management of biological resources
UNEP Live data shows: 20.3% of LAC's terrestrial and marine area is protected (2010)

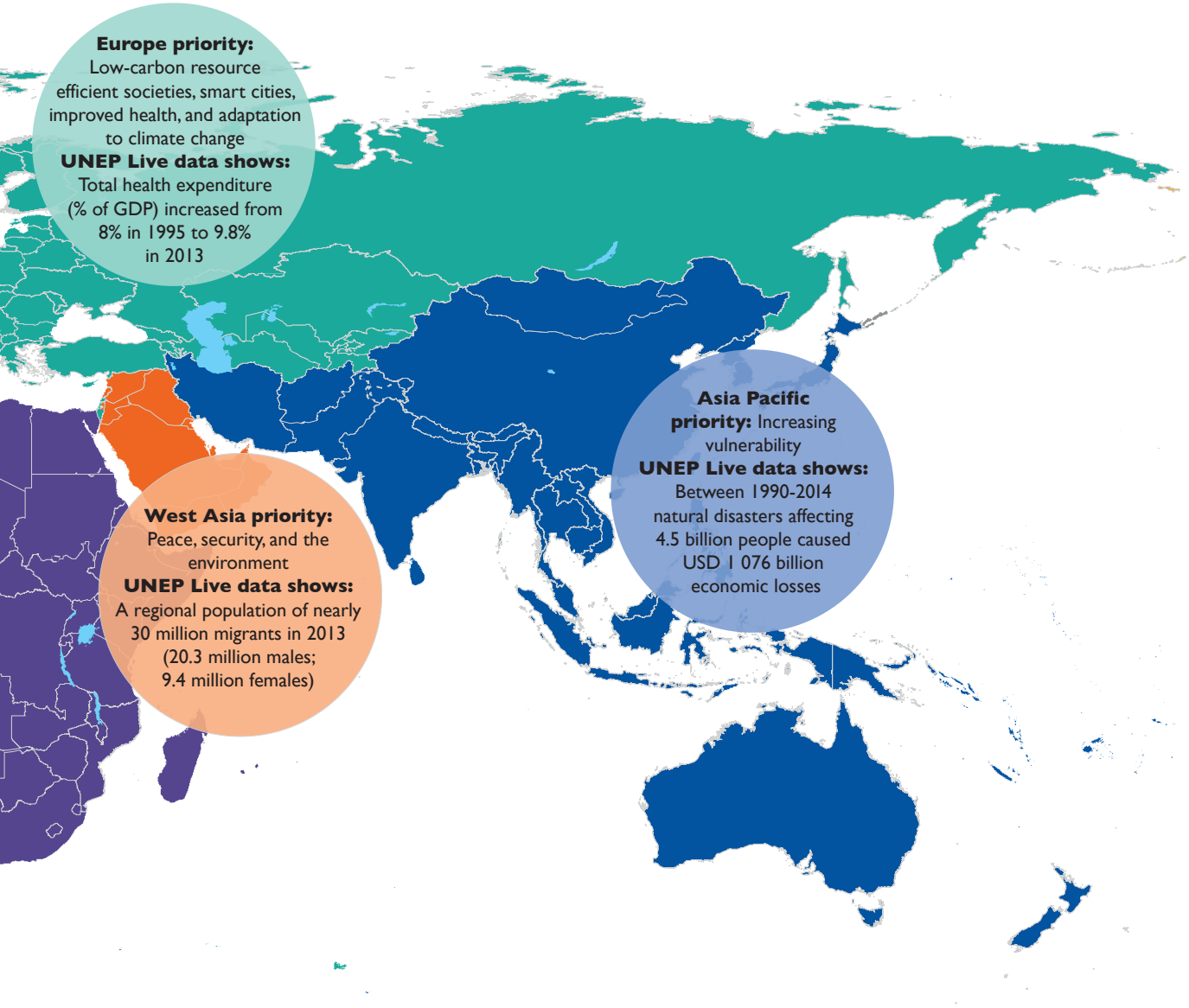

Europe priority:
Low-carbon resource efficient societies, smart cities, improved health, and adaptation to climate change
UNEP Live data shows:
Total health expenditure (% of GDP) increased from 8% in 1995 to 9.8% in 2013
Asia Pacific priority: Increasing vulnerability
UNEP Live data shows:
Between 1990-2014 natural disasters affecting 4.5 billion people caused USD 1 076 billion economic losses
West Asia priority:
Peace, security, and the environment
UNEP Live data shows:
A regional population of nearly 30 million migrants in 2013 (20.3 million males; 9.4 million females)

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Foreword

The sixth *Global Environment Outlook (GEO-6) Regional Assessment for Africa* paints a comprehensive picture of the environmental factors contributing to human health and well-being at the regional level. Backed by a large body of recent, credible scientific evidence, regional-wide consultations and a robust intergovernmental process, the assessment demonstrates significant economic growth in the continent. It also highlights the complexity of the interlinked environmental, social and economic challenges now confronting decision makers.

The launch of the *GEO-6 Regional Assessment for Africa* comes at a critical time. The world is on a new pathway to combat climate change and unleash actions and investment towards a low carbon, resource-efficient, resilient and sustainable future. At the same time, the 2030 Agenda for Sustainable Development provides a clear pathway to a world in which everyone can enjoy prosperity within the ecological limits of the planet.

This regional assessment recognizes Africa's rich natural capital – its diversity of soil, geology, biodiversity, water and habitats. If wisely managed, this rich natural legacy holds the promise to lead the region to a future where ecosystem integrity, human health and well-being are continuously enhanced. The economic development of Africa clearly hinges on the sustainable management of this natural capital for today's population and future generations. This requires both the protection and valuation of these natural assets, as well as effectively communicating their importance.

Africa's natural capital is challenged by competing uses, illegal off-take, weak resource management practices, climate change and pollution. This calls for forward looking, flexible, inclusive and integrated approaches in the formulation and implementation of policies. Africa has an opportunity to use its large young population to drive its growth. To that end, low-carbon, climate-resilient choices can develop its infrastructure, accelerate industrialization, increase energy and food production, and promote sustainable natural resource governance.

I would like to extend my gratitude to the large body of policymakers, leading scientists and representatives from major stakeholder groups and partners who contributed to this comprehensive and illustrative assessment report. I extend an invitation to all countries in the region to engage with this report and use the opportunity provided to transform the vision of the 2030 Agenda for Sustainable Development and its Sustainable Development Goals into a reality for Africa.



Achim Steiner

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

Key Findings and Policy Messages

Overall picture

Spurred by its Agenda 2063, Africa aims to establish a prosperous region characterized by sustainable inclusive growth, peace and good governance. The region's growth path shall be led by increased agricultural productivity, industrialization, investment in infrastructure development and renewable energy, conservation of biodiversity, sustainable and fair and equitable use of its genetic resources, clean air and water, and better adaptive capacity to climate change.

Africa faces a great challenge of sustaining rapid economic growth as its population is expected to double to approximately 2.5 billion by 2050, while safeguarding the life-support system provided by its rich natural capital, which underpins the realization of its long term vision. It is therefore imperative that such growth must consider the region's relatively weak environmental governance and a paucity of accurate and up-to-date environmental and socio-economic data for evidence-based decision-making.

Key findings

The GEO-6 Regional Assessment for Africa affirms the importance of both Agenda 2063 and Agenda 2030 as defined by the Sustainable Development Goals (SDGs). Both contain common elements for a development trajectory that will provide Africa with a healthy living environment while ensuring good health and quality of life for her people. The two are also critical to preserving and valuing Africa's natural capital for the benefit of its citizens and their livelihoods. In order to realize these visions, Africa's public institutions are called upon to build flexible and adaptive governance structures.

Indoor air pollution is a major problem across Africa, responsible for an estimated 600 000 deaths per annum. Due to their reliance on the use of biomass sources of energy for cooking, lighting and heating, 90 per cent of the region's population is exposed to this harm. Africa is called upon to invest in quick win solutions such as better ventilated housing and clean cook stoves, while also adopting medium to long-term measures to provide clean forms of energy such as electricity.

Growth in urbanization, industrialization, motorization and the emission of mineral dust from deserts have increased **outdoor pollution** in Africa. The transboundary transport, dispersion and eventual deposition of pollutants also contribute to raise outdoor pollution levels in the region. Especially for urban areas, the observed trend in levels of outdoor pollution requires the implementation of transport solutions that include setting standards for the condition of road vehicles and investing in sustainable mass transport systems

Off-grid electricity supply in remote rural areas and greater uptake **of renewable forms of energy** such as solar, hydropower and wind provide a promising and realistic basket of possibilities for meeting Africa's energy needs. With only 10 per cent of the region's hydropower potential exploited, there is considerable scope to use this source of energy in Africa for the generation of electricity, subject to careful consideration of the environmental consequences of proposed schemes.

Despite recent improvement, about 40 per cent of Africa's population still does not have access to **potable water**, and 70 per cent lack adequate sanitation facilities. As a result, water-borne diarrheal infections are responsible for almost 8 per cent of annual deaths in the region. This calls for an urgent need to invest in low-cost technologies for the management of wastewater, as well as the delivery of safe drinking water.

Groundwater represents a significant under-exploited water resource, but as an initial priority there is a need to substantially improve the information base regarding this resource. With 63 shared river basins, Africa is strongly urged to engage in effective integrated water resources management for the better protection of catchments and increased intra-basin cooperation for equitable use of limited water resources.

Many of Africa's **fisheries**, both inland and marine, face overexploitation from illegal, under-reported and unregulated fishing. Aquaculture holds great promise for exploiting this potentially sustainable source of protein, but it is a necessary pre-requisite to take biodiversity and other environmental implications into account when promoting this industry.

Regarded as Africa's most valued asset, **land** is a critical resource for all aspects of life and development. However it faces new challenges from changing use practices, including urbanization, mining, deforestation, agricultural expansion and infrastructure development. Sustainable land management practices are needed to reconcile the diverse uses of this resource.

The region has six of the world's top ten countries experiencing rapid **urbanization**, and as a consequence faces far reaching changes in settlement patterns in the years ahead. The movement of an estimated 450 million people from rural to urban areas by 2050 will place enormous strains on urban institutions, infrastructure, and financial and other resources, while also exacting huge demands on land for settlement. Combatting this challenge will require good spatial planning at all levels of government to ensure that cities have the capacity to cope with growing populations. Making rural areas more attractive to the youth through investment in rural development is another important intervention.

Africa has 60 per cent of the world's unconverted arable land, indicating a great potential for investment in **food production** on a massive scale, which if realized could enable the region not only meet its own food needs, but also export globally. Unlocking this potential represents an important challenge, particularly bearing in mind other competing land uses, including for pasture and cultural values. Currently, land productivity remains low in the region; a result of mineral poor soils and land degradation caused by inappropriate farming practices, deforestation, mining activities, and desertification. Africa is therefore called upon to embrace the Comprehensive Africa Agriculture Development Programme and its associated technologies for irrigation and fertilizer use, whilst nurturing the continent's agro-biodiversity and agro-ecological knowledge, to result in higher yields per unit area.

A further issue of concern is poorly defined **land tenure** arrangements. Securing land tenure for both women and men will ensure Africa's land capital is both valued and protected. Africa is therefore urged to develop best practice guidance regarding tenure arrangements and processes, and institute appropriate legislative and administrative reforms to ensure that meaningful progress is made towards achieving a land market built on a range of secure tenure options and increased land productivity.

Africa's rich **biodiversity** has been a basis for ecosystems services including food, clean water and air. However, this critically important natural capital faces significant threats from illegal trade in wildlife, mono-cropping, air and water pollution, forest loss, climate change, and increased prevalence of invasive alien species. The link between biodiversity and human health and wellbeing is increasingly better understood, but further research is required, especially with regard to zoonoses.

The weak valuation of biodiversity as an asset for economic development contributes to weak conservation efforts and undermines its importance to agriculture, for example in protecting pollinators and maintaining diversity to adapt to climate change. It is recommended that Member States actively include a system of factoring biodiversity and ecosystem services into national accounting systems. Africa should also ensure that the African Union strategy on illegal

trade in wildlife is translated into action, fully implemented and regularly monitored.

Africa faces both enormous challenges in relation to environmental management, and equally huge opportunities for 'doing things better'. The goal to build an integrated, prosperous and peaceful region that is resilient to future shocks can only be reached with the understanding that clean and healthy air, water, land and biodiversity are necessary to support this transformation. All efforts must thus be taken to ensure the protection and integrity of these resources that are critical life-support systems for sustained human wellbeing.

Whilst the inherent uncertainty and diversity in potential futures makes it tenuous for a set of prescriptive policies to be established, policy decisions should aim to minimize environmental and developmental trade-offs, and maximize Africa's ability to safeguard its natural capital effectively. Emphasis should be placed on improving protection of the environment, addressing critical data gaps, and developing the human and technical capacities required for a sustainable future.

The assessment concludes that low-carbon, climate-resilient choices in infrastructure, energy and food production coupled with effective and sustainable natural resource governance are key to protecting the continent's ecological assets that underpin a healthy society.

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Introduction

This assessment is founded on the understanding that Africa has the potential to significantly contribute to the world economy and to ensure healthy living conditions for its citizens. It also recognises the abundant natural assets that the region possesses, and the various threats they face. The purpose of this assessment is to evaluate and analyse Africa's state of the environment, and use the scientific evidence so generated to support environmental policy and decision making.

The decision to undertake regional assessments was made at the Global Intergovernmental and Multi-Stakeholder Consultation held in Berlin in October 2014, where participants suggested that the sixth edition of the Global Environment Outlook (GEO-6) should be built on regional assessments conducted in a similar format as the global assessment. The Consultation derived its mandate from the first United Nations Environment Assembly (UNEA-1) held in Nairobi in June 2014. The UNEA-1 requested, *"the Executive Director, within the programme of work and budget, to undertake the preparation of the sixth Global Environment Outlook (GEO-6), supported by UNEP Live, with the scope, objectives and procedures of GEO-6 to be defined by a transparent global intergovernmental and multi-stakeholder consultation informed by document UNEP/EA.1/INF/14, resulting in a scientifically credible, peer-reviewed GEO-6 and its accompanying summary for policy makers, to be endorsed by the United Nations Environment Assembly no later than 2018".* Member States also requested: *"the Executive Director to consult with all United Nations Environment Programme regions regarding their priorities to be taken up in the global assessment."*

Following this request, regional priorities for water, land, marine resources, biodiversity, air, climate change and waste management were established through the Regional Environmental Information Network (REIN) conference for Africa held in April 2015 in Johannesburg, and these priorities have been used to anchor the analysis in this assessment.

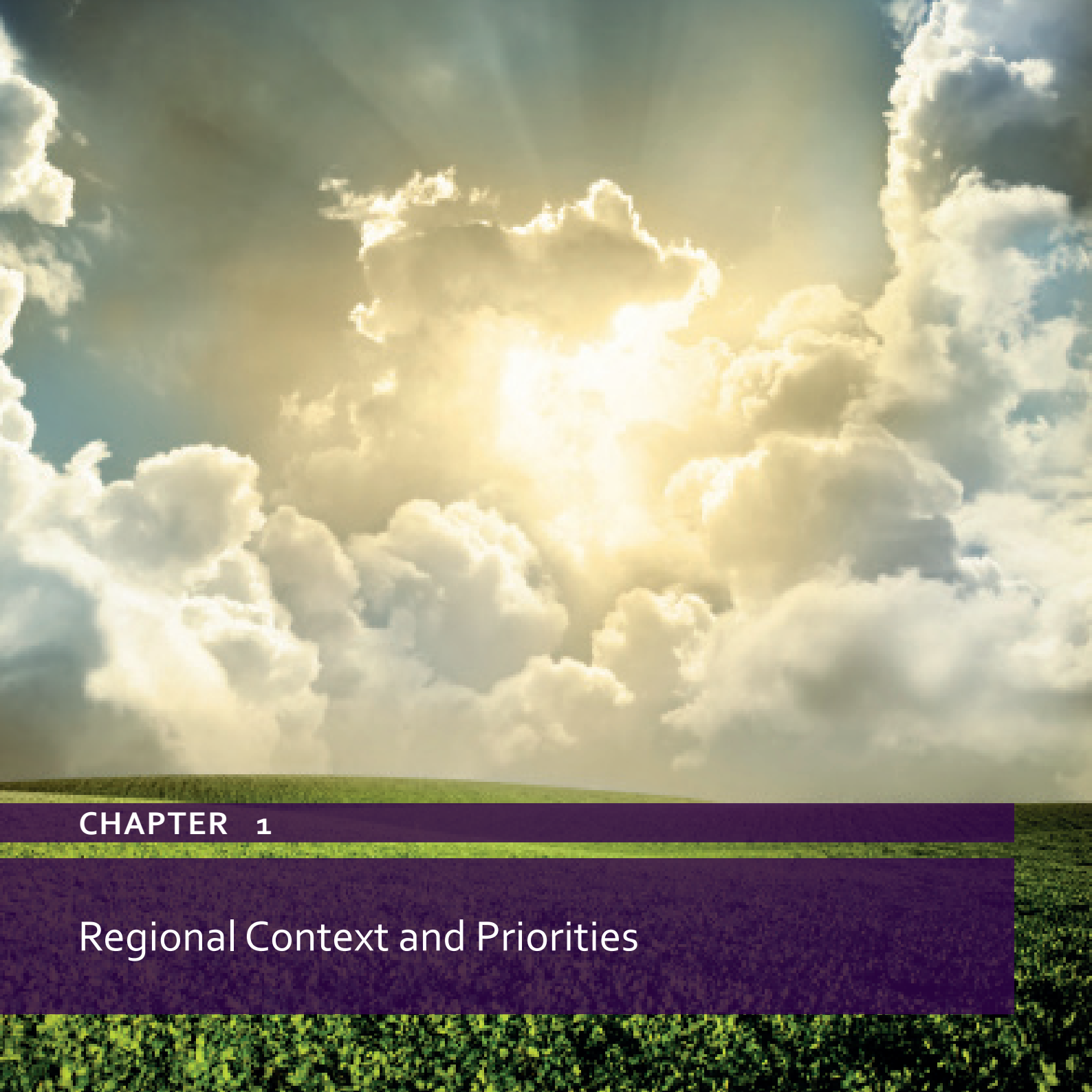
The Africa regional assessment is guided by the Drivers-Pressure-State-Impact-Response analytical framework to provide a better understanding of the current state of the region's environment, and explore a number of scenarios that provide an insight of what the future may portend under each of them.

The assessment is structured in three main chapters as follows:

- **Chapter 1** sets out the regional context;
- **Chapter 2** establishes the state of the environment in the region clustered under four key themes (air, land, water and biodiversity), and analyses key state and trends for various environmental issues affecting Africa, while also describing the policy response. The chapter also discusses policy effectiveness, with a particular focus on the conditions that enable the success of some policy actions.
- **Chapter 3** covers the outlook, with a focus on a set of four possible future scenarios for Africa, and suggests possible policy options necessary to achieve a more sustainable future.

The data underpinning the assessment can be found in UNEP Live **(uneplive.unep.org)**. The full assessment is also available through UNEP Live as a PDF and as an eBook.

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CHAPTER 1

Regional Context and Priorities

1.1 Context

Africa is experiencing steady economic growth, with real gross domestic product (GDP) rising at an average of 4.9 per cent per year between 2000 and 2008 (Leke *et al.* 2010). In 2013 and 2014, annual GDP growth averaged 4.5 per cent, and projected growth for 2017 is estimated at 5.1 per cent (World Bank 2015). The growth in GDP is having very little impact in alleviating poverty or improving the health of the people since the collective economic base in the 54 countries of the region is very small. Africa's combined GDP was estimated at USD 2.465 trillion in 2014, a figure that is almost equal to Brazil's GDP of USD 2.346 trillion (World Bank 2016). Of the combined 2014 GDP of Africa, Nigeria and South Africa contributed the biggest chunk of 23 and 14 per cent, respectively.

Key Messages

- Africa's modest growth in gross domestic product (GDP) averaging over 4 per cent per annum is from a small economic base estimated at USD 2.465 trillion, of which Nigeria and South Africa make the biggest contribution. Unexploited potential in energy and agriculture, as well as the huge appetite for infrastructure development and the high ratio of people of working age could spur Africa's economic growth even in the face of falling commodity prices and environmental challenges such as land degradation and the illegal off-take of wild fauna and flora.
- Competing uses, poor management practices and pollution, among other factors, are a threat to the state of Africa's environment. Land continues to be degraded, reducing its productivity, while the quality of air is a growing concern in crowded urban centres particularly in the slums. The region's adaptive capacity to climate change is low, while early warning systems for climate related disasters are weak. The weakness in early warning systems is at a time when the frequency and intensity of floods and droughts in Africa is increasing. Africa is therefore called upon to strengthen its preparedness to climate-related disasters, as well as to decouple its economic growth from carbon emissions.
- Limited use of data sharing platforms such as the Internet is slowing down Africa even though significant efforts are underway to take advantage of internet of things. Access to hard copy historical records remains a challenge, and efforts aimed at digitizing the records need to be speeded up, while restrictions on data sharing need to be lifted.
- Despite the extractive sector constituting one of Africa's major economic sectors, data since the 1970s show a bare increase in the value and quantities of the extracted materials. The recorded decline in Africa's share of the extractive sector at a global scale declined from 7.9 per cent in 1970 to 7 per cent in 2010 is a reflection of significant under-reporting, especially by the informal artisanal sector.
- Africa has the potential to feed itself, and to register significant economic growth, by fully utilising the productive capacity of its land, water and oceans, as well as tapping into its growing labour and markets. Provision of clean forms of energy, particularly renewable electricity, will catalyse Africa's development while also ensuring healthy living conditions.

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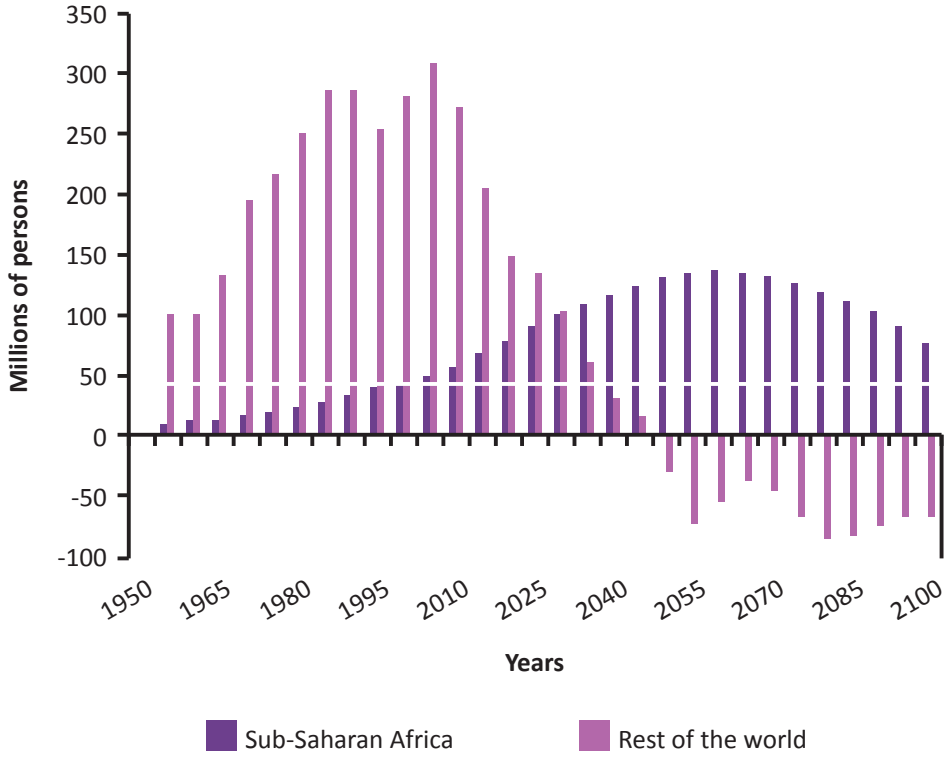
The region's economic growth is driven by an extensive natural capital base that includes 60 per cent of the world's unconverted arable land, and large potential for hydropower, of which only 10 per cent is harnessed (WWF/AfDB 2015). Ambitious plans to 2040 for infrastructure investments estimated at USD 400 billion (WWF/AfDB 2015), natural resources demand due a rapidly growing population, as well as an expanding extractive sector imply that the integrity of Africa's ecosystems is under threat in the same way that the health of its residents is affected by the changing state of the environment.

Africa's economic growth is being helped by the rising proportion of the population, which is expected to grow from 54 per cent in 2010 to 64 per cent in 2090, thereby increasing productivity potential, with transformational effects on Africa and the global economy (Drummond *et al*. 2014). With a small industrial base, Africa will continue to have excess labour unless this is absorbed into the world labour market where shortages are expected as shown in **Figure 1.1.1.** The largely unemployed youth will continue to engage in low-cost investment ventures such as farming and panning for precious minerals, including practices that degrade the environment while posing human health challenges.

Despite the positive economic growth trends, Africa's socio-economic outlook also faces downside risks such as low commodity prices and unstable global financial systems. The region also has to deal with an array of regional environmental issues, including illegal trade in wildlife, low access to clean forms of energy, weak environmental governance systems, loss of biodiversity, inadequate waste management practices, and climate change and variability. The emergence and re-emergence of diseases such as Ebola, as well as the expansion of areas at risk of diseases such as malaria, show the strong connection between the state of the environment and human health.



Figure 1.1.1: Change in working age population, 1950–2100



Source: United Nations, Department of Economic and Social Affairs Population Division 2015

1.2 Regional environmental priority issues

Africa is richly endowed with natural capital, but this is under threat from competing uses, unsustainable management, climate change and pollution, among others. Economic growth and human livelihoods hinge on the sustainable management of Africa's natural capital, which involves reconciling wise stewardship with human development for today's population and future generations. The region would benefit from better protection as well as better capturing of the true value of its natural capital.

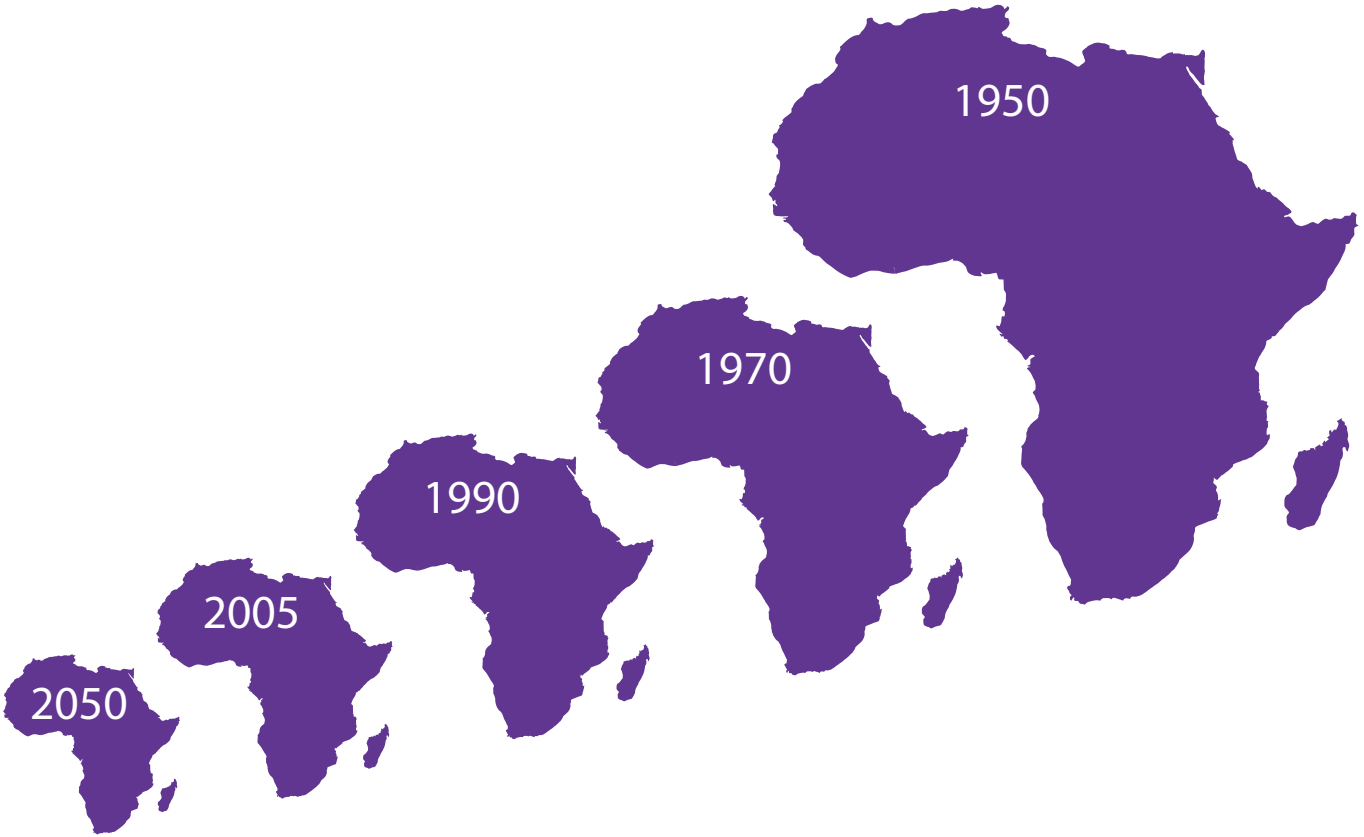
Land, which is one of Africa's most prized natural assets, is under increasing pressure stemming from competition for access, changing global and regional consumption patterns, and the drive for greater economic growth. These pressures are leading to its degradation, loss of access, inequity and encroachment on fragile and protected ecosystems. In order to produce more food, improve livelihoods and increase incomes, there is a need to promote integrated sustainable land management and to reinforce policies that

◄ Credit: Shutterstock/Lucian Coman

control degradation of land for the improvement of human well-being. With the world's fastest growing population, per person land availability in Africa continues to dwindle (**Figure 1.1.2**), and efficient food production technologies are needed to meet the region's nutritional needs while also preserving the integrity and health of land resources.

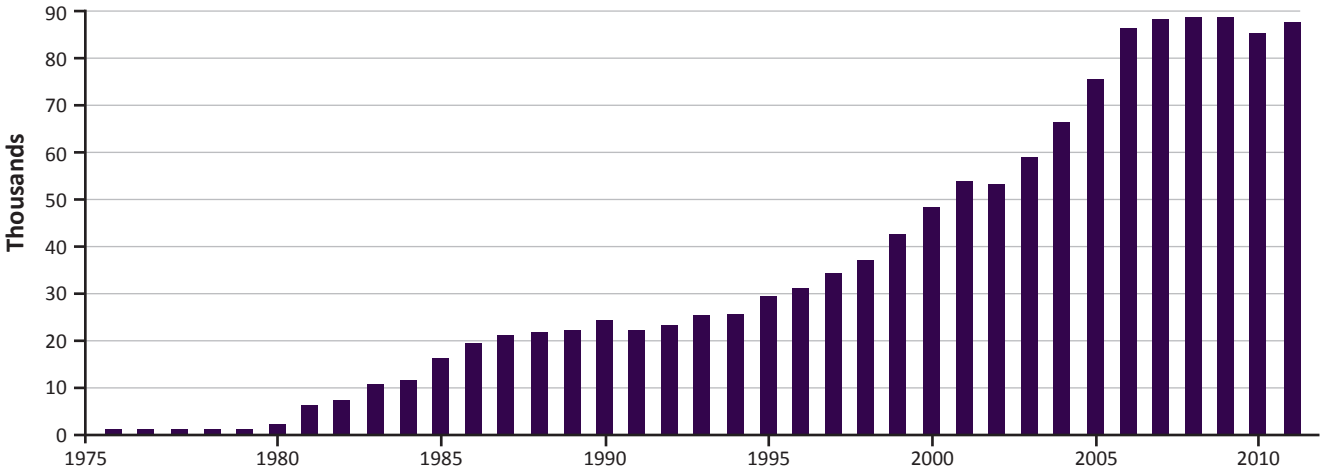
Equally important are the region's biodiversity assets, offering opportunities for benefit sharing, as well as human health risks associated with zoonosis. Africa's biodiversity is under threat from habitat loss and modification, illegal off-take and climate change. Efforts to protect biodiversity are undermined by increased criminal activity and weak institutions, as well as poor understanding of the availability, extent and value of biodiversity. The illegal off-take of wildlife and timber has had dramatic effects on the population of some species, such as the black rhinoceros (*Diceros bicornis*) (**Figure 1.1.3**).

Figure 1.1.2: Shrinking per person land availability in Africa, 1950–2050



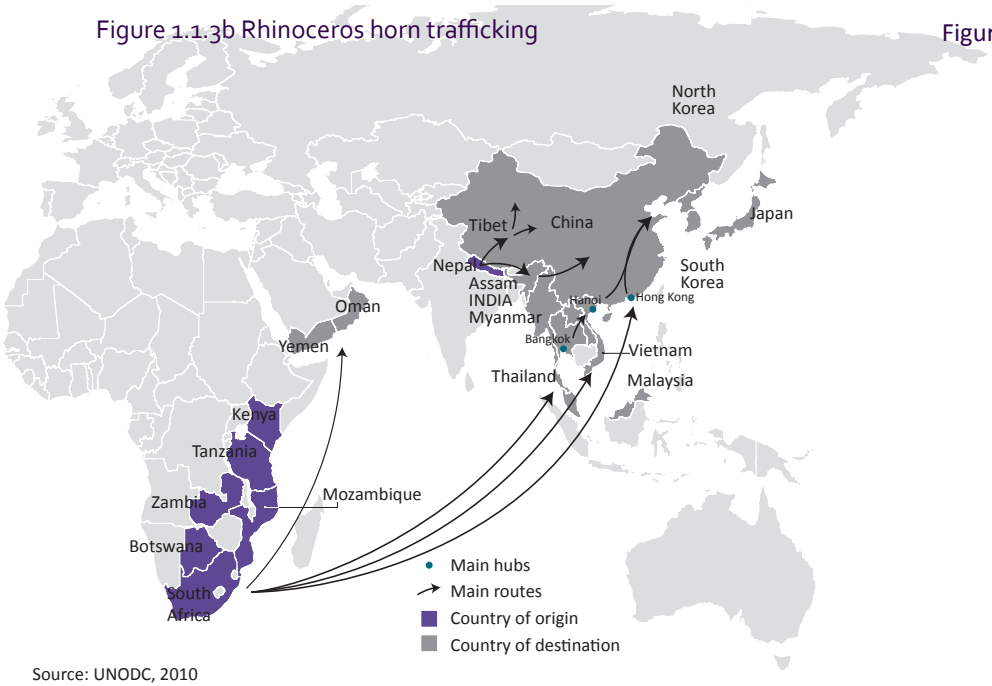
Source: UNEP 2008

Figure 1.1.3a: The effect of illegal wildlife trafficking on the black rhinoceros



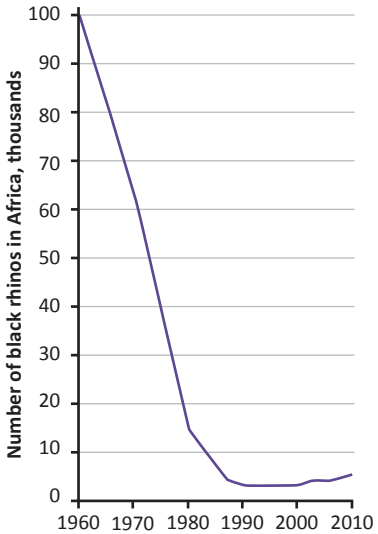
Source: UNEP-WCMC 2015 derived from CITES

Figure 1.1.3b Rhinoceros horn trafficking



Source: UNODC, 2010

Figure 1.1.3c Number of black rhinos



Source: TRAFFIC, 2012

Air pollution is fast becoming an important human health, economic and development issue for Africa, especially in high-density urban areas such as slums. The continent's anthropogenic emissions and organic carbon emissions are on the increase from forest fires, vehicles, domestic fires and industry emissions. Africa also has enormous opportunities for carbon sequestration through restoration, regeneration and reforestation.

Demand for freshwater is increasing with rising population and economic development, although this resource is under threat from pollution and climate change. While some progress has been made in improving access to safe drinking water and sanitation, Africa remains plagued with water-borne diseases such as cholera. Ill-defined rights and access to water as well as competition for water resources is driving prices and local-level conflicts, with impacts on freshwater-dependent economic activities such as agriculture and electricity generation. Cooperation at the national and regional levels and between sectors and technology is considered an important intervention for the sustainable management of water resources in the region.

Marine, ocean and coastal resources support a growing proportion of economic and livelihood options, including fisheries, oil and gas, and transportation. The resources are key assets for resilience against climate change and variability. However, Africa's marine and coastal resources are under increasing threat from pollution, unregulated economic development and climate change.

With 131 billion barrels of oil, 17 trillion cubic metres of natural gas and 120 million tonnes of proven coal reserves (UNEP 2014), Africa's energy landscape is dominated by fossil fuels. The region's prospective solar and hydropower is also huge, with only 10 per cent of potential hydropower capacity currently being harnessed (OECD/IEA 2014). Despite such huge energy resources, 620 million people have no access to electricity (UNEP 2014). As **Figure 1.1.4** shows, electricity coverage in the region is very low: about 60 per cent of people do not have access to a reliable source of energy (AfDB 2014). The region has a major opportunity to develop and scale-up renewable and more sustainable forms of energy, although significant challenges remain with regard to pricing and subsidies.

Africa's social and economic infrastructure is vulnerable to climate change. Natural capital is a critical part of building resilience and increasing adaptive capacity. There is a need to address climate justice, legal frameworks and the cost of inaction, and to improve knowledge, particularly in the area of climate science and early warning systems. The region needs to build adaptive capacity to climate change, including strengthening preparedness and decoupling economic growth from carbon emissions.

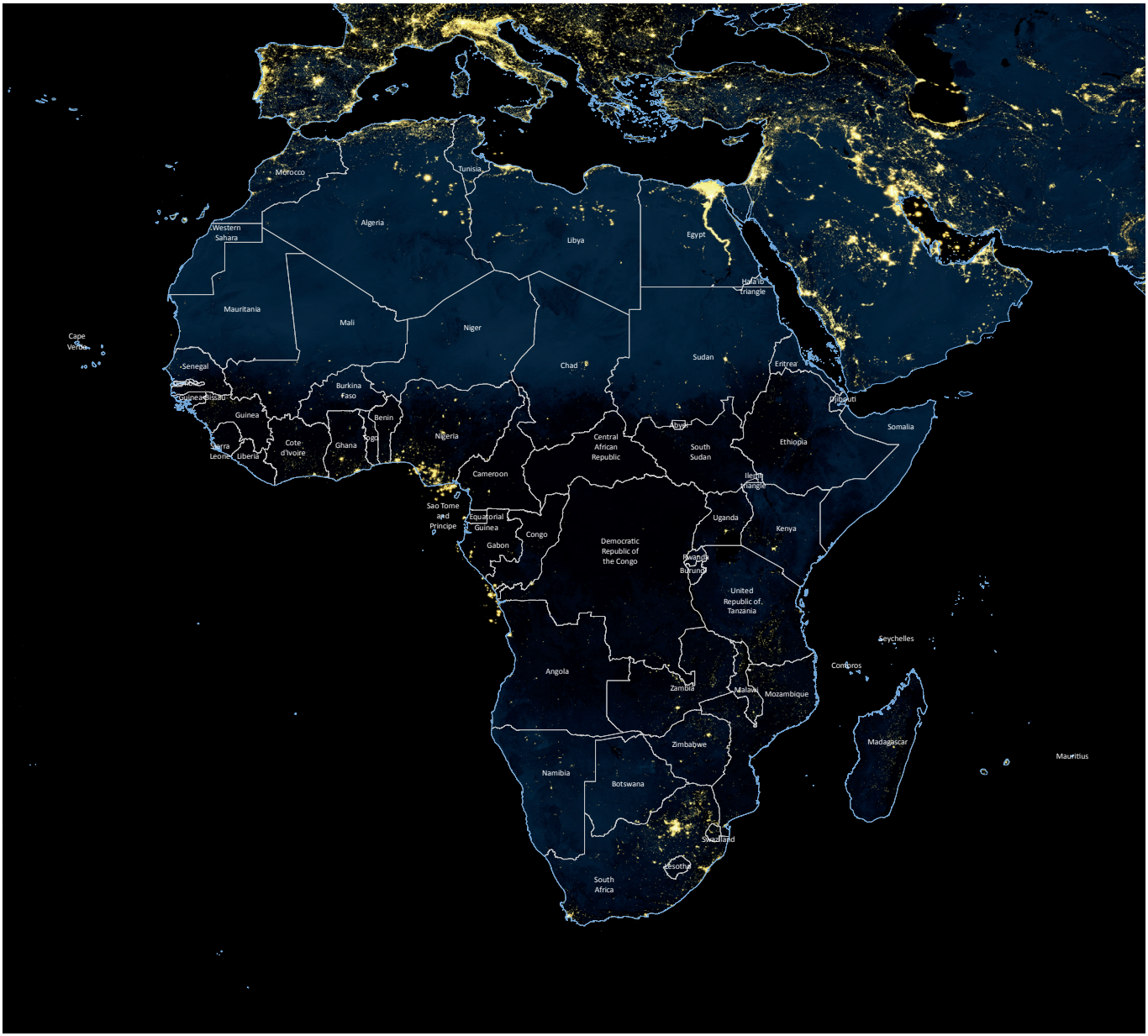
The frequency and intensity of extreme events such as floods and droughts is increasing, with impacts on natural capital and social and economic infrastructure. Lack of institutional robustness is exacerbating the spread and impact of disease. Increased levels of movement of communities and a high density of informal settlements put Africa at risk. Human-based approaches to early warnings, including the use of traditional knowledge, are often looked down on.

Africa faces varied and complex waste management problems. Waste is typically disposed of without consideration of environmental and human health impacts, leading to its accumulation. Dumpsites are largely uncontrolled or poorly managed. Hazardous and non-hazardous wastes are often disposed of together. Typically, only about 40–50 per cent of waste is reportedly collected (UNEP 2013).

1.3 Emerging issues and Africa's ecological future

Africa is increasingly asserting its role as a global player while simultaneously lifting millions of citizens out of poverty (WWF/AfDB 2015). The region's demographic dynamics and urbanization trends present a mixed picture of challenges and opportunities, and factoring of these social phenomena into a structural transformation agenda for Africa is important. The region is witnessing increased access to data and information, although much more needs to be done.

Figure 1.1.4: Africa at night



Source: NASA Earth Observatory 2015

1.3.1 Data revolution

Africa has made significant progress in the frequency and quality of censuses and household surveys, but challenges remain due to institutional weaknesses, low funding, limited usability of the collected data, and poor coverage of other sectors, including the environment (Centre for Global Development 2014). The region is keen to improve access to data, including building open data systems through the facilitation of the African Charter on Statistics (UNECA 2015) and new technologies, including the internet of things.

Some countries in the region are taking advantage of internet of things technologies, including mobile money payments, tracking usage and pre-empting surges in demand or faults in electricity supply, and tracking the health of outpatients by doctors. However, Africa's low mobile internet penetration rate of 17 per cent, and with 8 out of the world's 10 countries with the lowest levels of internet availability located on the continent (GSMA 2014), the use and application of new technologies for data and information sharing remains a challenge.

1.3.2 Changing demography

Africa's population reached 1 billion in 2009, with estimates that it will double by 2050 (AfDB 2011). Between 2000 and 2100, Africa's share of the world's population is expected to rise from 13.1 to 24.9 per cent (UN 2004). Africa's population is not only the fastest growing in the world, but also the most youthful (AfDB et al 2015). A rapidly growing population stresses ecosystems by increasing demand for food, energy, medicines and water, while bringing distortions to land tenure arrangements, as well as accelerating environmental degradation through soil erosion, deforestation and biodiversity loss (World Bank 2008). In extreme cases, competition over scarce resources leads to conflict. In addition, a rapidly growing population presents financial and logistical challenges in service provision, especially in the areas of education, health, safe drinking water and sanitation.

1.3.3 Industrialization

Africa is committed to industrialization as a way to diversify the region's economies, build resilience to shocks, and develop productive capacity for high and sustained economic growth. This commitment saw the adoption of the New Partnership for Africa's Development (NEPAD) in 2001, which identifies economic transformation through industrialization as a critical vehicle for growth and poverty reduction. In 2008, the Plan of Action for the Accelerated Industrial Development of Africa (AIDA) was adopted. In this plan primary industry, focused on agriculture and the extractive sector dominates industrial activity in the region, which is likely to cause localized environmental damage such as pollution of water bodies and land degradation.

Africa's industrialization takes advantage of the region's abundant and diverse resources, including agricultural and mineral assets. However, the process should benefit from green economy approaches for better resource efficiency and clean production, including benefits from reducing greenhouse gas emissions. As **Figure 1.1.5** shows, the region's domestic extraction of materials has barely increased since 1970, with estimates showing a decline of the region's global share from 7.9 per cent in 1970 to 7 per cent in 2010 (UNEP 2015). As Africa's industry is largely concentrated around the extractives sector, the data on regional domestic extraction could reflect large-scale under-reporting (**More...1**).

1.3.4 Climate change

Low adaptive capacity makes Africa highly vulnerable to the impacts of climate change (Engelbrecht *et al.* 2015; UNECA 2014; Niang *et al.* 2014; Boko *et al.* 2007). The region is warming faster than the global average, with projections of a rise of 3–4˚C this century. This makes climate change a considerable health and economic challenge for the continent. Climate-sensitive diseases such as cholera, meningitis, malaria and Rift Valley fever are likely to spread faster (Niang *et al.* 2014; Guernier *et al.* 2004; Hay *et al.* 2002).

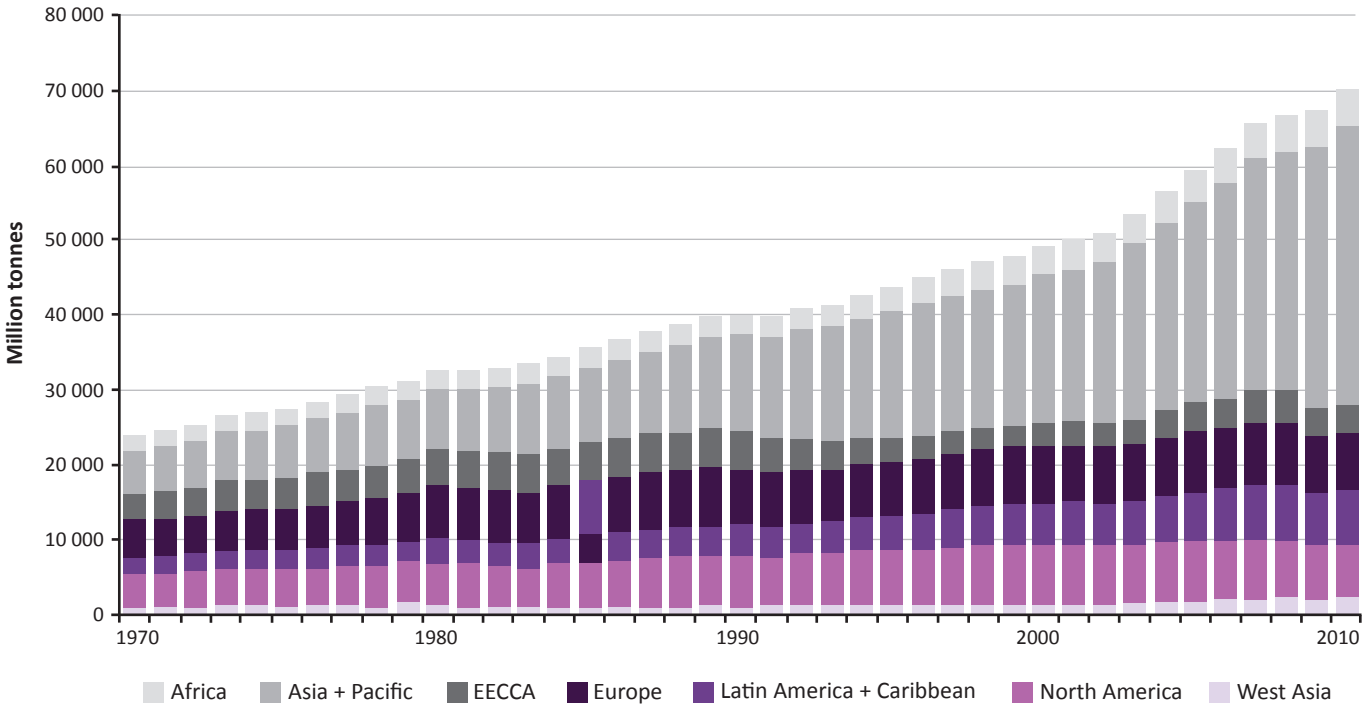
In some areas, the warming is likely to reduce crop yields and livestock productivity, and cause water scarcity. Extreme weather and climate events such as droughts and floods are expected to be more frequent, with negative impacts on human life and health (UNEP 2013). Climate change will also lead to wildlife migration due to habitat loss (UNECA 2014) (**More...2**).

1.4 Africa on the rise

Africa has enormous potential to feed itself and eliminate hunger and food insecurity while also playing a major role in global food markets. This potential lies in the region's land, water and oceans, labour and markets. The Comprehensive African Agricultural Development Programme (CAADP) will be central to the contribution of agriculture to the growth of the region's economies by facilitating an increase in investment in agriculture, as well as fostering entrepreneurship and investment in agribusiness (NEPAD 2013). Countries that have increased investments in agriculture in line with CAADP targets have seen a reduction in hunger and poverty and an increase in productivity. These include Burkina Faso, Burundi, Ethiopia, Ghana, Malawi, Mali, Niger, Republic of Congo, Senegal, Togo and Zambia (NEPAD 2013).

Despite rapid urbanization, Africa's rural population has continued to increase in absolute terms. Agriculture absorbs

Figure 1.1.5: World domestic extraction by region, 1970–2010



Source: UNEP 2015

a large proportion of the region's working population, and this coupled with increases in productivity per unit area means that the region is poised for higher agriculture-driven growth.

In addition to investment in agriculture, the economic rise of Africa will be facilitated by investments in the supply of reliable energy. The region is rich in energy resources yet very poor in supply. The delivery of reliable and affordable energy will spur development in Africa, a region that accounts for only 4 per cent of world energy demand (OECD/IEA 2014). Significant growth in energy generation is being witnessed, with sub-Saharan Africa's energy production sector having increased by 45 per cent since 2000 (OECD/IEA 2014). Provision of clean forms of energy will help in the fight against human health challenges associated with indoor air pollution.

Africa has started to unlock its vast renewable energy resources with the aim of increasing the share of hydropower from the current 20 per cent to 50 per cent of total energy supply by 2040 (OECD/IEA 2014). Off-grid power from mini-hydropower sources, solar and bio-energy will also add to the region's energy mix in the future. A stable supply of energy is a critical engine for inclusive economic and social growth.

Africa's development also hinges on the growth of the water sector to ensure safe drinking water and sanitation, with positive results for poverty alleviation while ensuring people's constitutional rights to safe and reliable drinking water. Access to safe water and adequate sanitation is vital to human health, and can be achieved by investment in adequate supply infrastructure and wastewater management, while reducing pollution of water sources and discouraging poor hygiene (UNEP 2013).

See references for Chapter 1

▶ Credit: Shutterstock/Damian Ryszawy





CHAPTER 2

State and Trends

2.1 Air

2.1.1 Introduction

With a largely rural setting where about 60 per cent of Africa's population live (United Nations 2010), the region generally enjoys clean air. While this should translate into positive benefits for human health and climate, poorly ventilated housing and the high dependence on biomass for energy, result in high levels of indoor air pollution, causing diseases such as acute respiratory infectious diseases, especially in women and children. With increasing trends in urbanization, and in human activities such as quarrying, thermal power generation and transportation, together with natural activities such as desert storms, Africa's otherwise clean air is threatened by outdoor pollution, including trans-boundary emissions and depositions.

Key Messages: Air

- Indoor air pollution is a major problem across Africa to which 90 per cent of the region's population is exposed due to their reliance on the use of biomass sources of energy for cooking, lighting and heating. With an estimated 600 000 deaths per annum attributable to indoor air pollution, Africa is called upon to invest in quick win solutions such as better ventilated housing and clean cook stoves, while also adopting medium to long-term measures to provide clean forms of energy such as electricity.
- Off-grid electricity supply in remote rural areas and greater uptake of renewable forms of energy such as solar, hydropower and wind provide a promising and realistic basket of possibilities for meeting Africa's energy needs. With only 10 per cent of the region's hydropower potential exploited, there is considerable scope to use this source of energy in Africa for the generation of electricity, subject to careful consideration of the environmental consequences of proposed schemes.
- The increasing levels of outdoor pollution, especially in urban areas, require transport solutions that include reducing the need for travel and investing in sustainable mass transport systems.
- In spite of the above, Africa does not have sufficient observational data to draw conclusions about long-term trends in air pollution, temperature and precipitation over the past century. Areas where sufficient data is available show very probable decreases in annual precipitation over the past century over parts of the western and eastern Sahel region in northern Africa, Eastern and Southern Africa. Similarly, near surface air temperature anomalies in Africa were significantly higher for the period 1995–2010 compared to the period 1979–1994, indicating an increase in mean annual temperature over the past century over most of the region.
- Climate change mitigation and adaptation measures are needed not only to address the negative impacts of extreme climate-related risks such as floods and droughts, but also to optimize the use of renewable energy resources on the continent.
- There is a very high potential of harnessing solar and wind energy in Africa. Exploitation challenges such as technology can be surmounted.
- Monitoring of indoor and outdoor air quality, including health related parameters, is needed across the continent.
- Adverse urbanization impacts on air quality should be forestalled through appropriate preventive measures such as early warning systems and design of indoor and outdoor environments to address ventilation issues, among others.

◄ Credit: Shutterstock /Sunny studio

Africa's huge potential for renewable energy from solar and wind can result in health and economic benefits for the region. Most parts of the region receive sunlight for at least 320 days a year (IEA 2014). An estimated 18 of the top 35 developing countries with the highest renewable energy reserves are located in Africa (Buys *et al.* 2007). Africa could seize the opportunity of generating more electricity from such renewable sources so as to meet the demand for the 600 million people in the region who lack access to electricity in a clean and sustainable manner (AfDB, 2014), with positive benefits on the environment and human health.

2.1.2 Air Quality

Air quality in Africa's rural areas is generally within acceptable limits, although there are areas where outdoor and indoor air quality is deteriorating rapidly due to increasing traffic volumes and use of firewood and other biomass sources of energy in densely populated urban neighbourhoods. The poor indoor and outdoor air quality is blamed for premature mortality and increasing respiratory illness in the region (Robinson and Hammitt 2009).

Indoor air pollution

Indoor air pollution is a major health problem in Africa. About 90 per cent of the population in sub-Saharan Africa is exposed to such health problems as they rely on biomass to meet their domestic energy needs (Mbatchou *et al.* 2015). Pollution from biomass fuel is ranked 10th among preventable risk factors contributing to the global burden of diseases. Household air pollution (HAP) resulting from incomplete combustion of solid fuels burnt on open fires or traditional cook stoves in poorly ventilated homes (Noubiap et. al. 2015) is a major public health problem, particularly in sub-Saharan Africa where most of the population still rely on solid fuels for cooking, heating, and lighting. Together with their health impacts, released pollutants can significantly contribute to climate change. The main unhealthy compounds are suspended particulate matter (PM) (McCracken *et al.* 2012, Rehfuess and Smith 2011). Despite a decline in the global proportion of households using mainly solid fuels for cooking, heating, and lighting, 581 300 premature deaths were attributable to HAP in Africa in 2012 (WHO 2014).

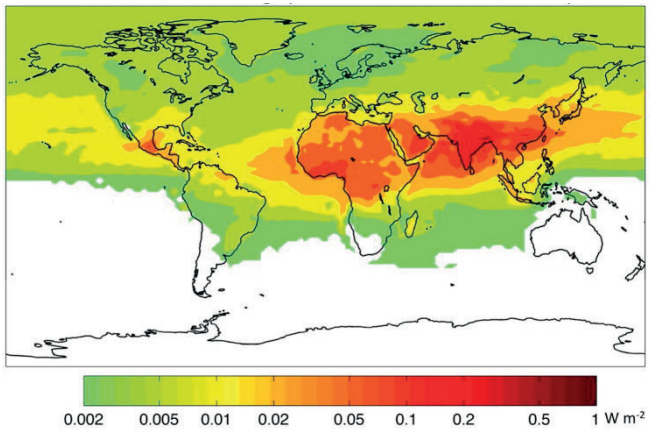
There is direct and indirect evidence of the significant contribution of HAP to cardiovascular diseases in sub-Saharan Africa. Chronic Obstructive Pulmonary Disease (COPD) attributed to exposure to biomass combustion is an important health risk, especially in rural areas. For example, Malawi reported a COPD prevalence of 16 per cent among people exposed to indoor pollution from cook stoves (Fullerton *et al.* 2011, Mbatchou Ngahane *et al.* 2015).

The use of kerosene lamps, which is widespread in Africa, results in both indoor and outdoor pollution, and contributes to climate change by emitting CO_2 in the same way as other types of fossil fuel combustion. The lamps are also significant sources of black carbon, increasing their contribution to climate change substantially. Their emissions are 20 times more than previously estimated, with 7-9 per cent of fuel burned converted into black carbon particles (Lam *et al.* 2012). As shown in **Figure 2.1.1** Africa's contribution of kerosene based black carbon is significant.



Indoor air pollution from cooking, Kokemnoure, Burkina Faso
Credit: Shutterstock/ Gilles Paire

Figure 2.1.1: Direct black carbon radiation from residential kerosene lighting (W/m²)



Source: Lam *et al.* 2012

Outdoor air pollution

Growth in urbanization, industrialization and motorization has increased pollution in Africa. Emission of air pollutants, their trans-boundary transport and dispersion, and eventual deposition, contribute substantially to pollution levels around the continent and beyond. The Sahara and its surroundings produce half of the global yearly mineral dust, and is the main source of atmospheric mineral dust of the world. Volcanic eruptions also contribute to this air pollution (Muthama et. al. 2012), and Africa has a few active volcanoes including Mount Nyamulagira.

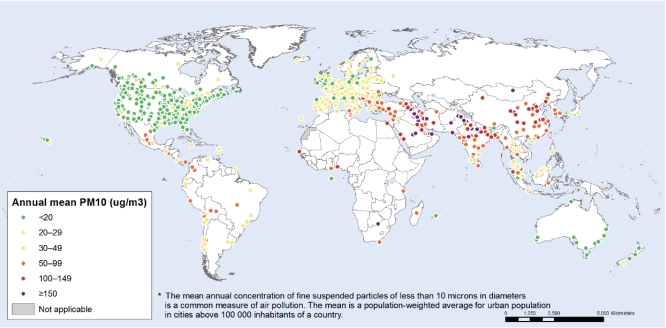
Climate change resulting from human activities is manifesting notable impacts on the continent. Short-lived climate pollutants (SLCPs), substances with a relatively short lifetime in the atmosphere, from a few days to a couple of decades, including black carbon, methane, tropospheric ozone, and some hydrofluorocarbons (HFCs), have a warming effect on the climate. SLCPs are responsible for a substantial fraction of the climate change experienced to date and will have a significant influence on the rate of warming in the near-term (the next few decades). Temperatures over the interior regions of subtropical southern and northern Africa have been increasing at a rate of about 2°C per century over the past five decades, about twice the global rate of temperature increase (Jones *et al.* 2012, Engelbrecht *et al.* 2015).

Ambient air pollution, in either gaseous or particulate forms, negatively impacts economies and livelihoods in Africa. Major sources of outdoor air pollution in the region include motor vehicles, industrial processes, power generation, and household combustion of solid fuel (Muthama *et. al.* 2015). The air pollution sources across the continent are mainly in industrial areas, urban centres and motorized highways.

Monitoring of surface ozone over southern Africa has shown that ambient concentrations often exceed a threshold of 40 parts per billion (ppb) at which they can damage vegetation (Kirkman *et al.* 2000). There are large areas in the region where surface ozone concentration exceeds 40 ppb for up to 10 hours per day, while others have exceeded 80 ppb, particularly in the winter when mean ozone concentrations are higher. The areas where the 40 ppb threshold is exceeded coincide with maize growing areas in South Africa and Zimbabwe (Kirkman *et al.* 2000), and this may negatively impact crop yields.

The scarcity of information about air quality relating to the African continent is a reality illustrated by the recent map of exposure to particulate matter (PM_{10}) in urban areas worldwide (WHO 2012). Of 1 100 urban areas listed, only ten (less than one per cent) are on the African continent, and this is six times less than the station data available in France (**Figure 2.1.2**).

Figure 2.1.2: Exposure of particulate matter with aerodynamic diameter of 10 micrometres or less (PM_{10}) in 1 100 urban areas, 2003–2010



Source: WHO 2012

Despite the large uncertainties, annual PM_{10} concentrations exceed 50 micrograms per cubic metre in all African cities represented, with Banizoumbou (South Niger) recording a high annual PM_{10} concentration of 149 µg m^{-3} in 2006 and 225 micrograms per cubic metre in 2007 (Marticorena *et al.* 2010). In Niger and Mauritania, estimates of PM_{10} concentrations showed that mineral dust accounts for 106 and 137 annual daily exceedances, respectively, of the 50 micrograms per cubic metre PM_{10} limit value (Ozer *et al.* 2007; Ozer 2005), indicating a strong likelihood of health impacts. Estimates of ambient fine particulate matter concentrations confirm that the north half of the African continent is home to the highest $PM_{2.5}$ concentrations in the world (De Longueville *et al.* 2014; van Donkelaar *et al.* 2010).

Aerosol variations and trends over different land and ocean regions, including Africa, indicate that the change of dust emissions over the Sahara and Sahel is mainly because of the change in near-surface wind speeds. The decreasing dust trend in the North African dust outflow region of the tropical North Atlantic and the receptor sites of Barbados and Miami is closely associated with an increase in the sea surface temperature in the North Atlantic. This temperature increase may drive the decrease of the wind velocity over



Outdoor air pollution in a city in West Africa.
Credit: C. Liousse, UPS/CNRS

North Africa, which reduces the dust emission, and the increase of precipitation over the tropical North Atlantic, which enhances dust removal during transport (Chin *et al.* 2014; De Longueville *et al.* 2013; Muthama 2004).

The disease burden of air pollution is substantial. The World Health Organization's International Association for Research on Cancer classified outdoor air pollution as carcinogenic to humans, and its impacts are in the same category as tobacco smoke, UV radiation, and plutonium. De Longueville *et al.* (2014) observed dust events over northern Benin during the dry seasons between 2003 and 2007, recording on average a daily PM_{10} concentration of 1 017 micrograms per cubic metre, which is 18 times higher than during the wet season. The study also highlighted a mean increase of 12.5 per cent in Acute Lower Respiratory Infection rates during the dry seasons.

Atmospheric deposition is an important source of nutrients to aquatic ecosystems (Jassby *et al.* 1994). This is partly because important inter-system exchange of various nutrients such as nitrogen and sulphur occurs *via* the

atmosphere and human activities, partly because human activities release pollutants to the atmosphere in amounts that are comparable to, or even exceed, the natural rates of mobilization (Crutzen and Andreae 1990). Tamatamah *et al.* (2005) estimated that 13.5 tonnes of phosphorus were deposited annually into Lake Victoria from the atmosphere, representing 55 per cent of the total phosphorus input to the lake. In Ghana, Breuning-Madsen *et al* 2015 noted that the Harmattan dust contributed an average 10 per cent of calcium, magnesium and potassium, and 20–40 per cent of phosphorus from natural sources to agro-ecosystems.

2.1.3 Transboundary emissions and atmospheric deposition

Much of the deposition of air pollutants across the continent is attributable to transboundary sources. This is particularly the case with large suspended particulate matter such as dust. The Sahara Desert is the main global source of dust. About 12 per cent of Saharan dust moves northwards to the Mediterranean Sea and Europe; 28 per cent westwards crossing the Atlantic Ocean to the USA, the Caribbean, and South America; and 60 per cent southwards to the Gulf of Guinea (Engelstaedter *et al.* 2006).

In West Africa, atmospheric dust, which is composed of Saharan particles and is transported by Harmattan wind, is a significant seasonal climatic event. Continental aerosols are transported by the Harmattan winds from northeast Senegal (Doumbia *et al.* 2012). The dust affects the chemical quality of rainfall, which typically is alkaline and strongly mineralized. Orange *et al.* (1993) indicated the existence of an African chemical signature of the atmospheric fluxes, which contributes a suite of chemicals ranging in mass from 1 300 kg per hectare per year in the Sahel zone to 365 kilogrammes per hectare per year in the Guinean zone.

Ozone emissions across Africa's troposphere are mainly from anthropogenic sources. For example, Aghedo *et al.* (2007) found an increase of surface ozone concentration of about 2–7 parts per billion by volume (ppbv) in West Africa due to anthropogenic emissions during the boreal summer, while estimated NO_x emission increases of 20–30 per cent from 1990 to 2010 were consistently over Réunion and the Southern Hemisphere.

2.1.4 Renewable energy resources

Solar energy

Despite receiving high solar irradiance, which averages 2 000 kilowatt hours per square meter per year, Africa's installed capacity of large-scale solar energy is quite low, having increased from 40 megawatts in 2010 to 280 megawatts in 2013 (IEA 2014). Many rural areas in Africa are isolated, and this increases the cost of infrastructure for electricity distribution. As a result, photovoltaic (PV) and concentrating solar power (CSP) systems are an ideal solution for areas without grid connection. Africa's potential solar energy output from PV and CSP is estimated at 6 567 terawatt hours and 4 719 terawatt hours per year, respectively (IRENA 2011) (**More…3**).

Wind energy

Africa has abundant wind energy sources, which could help the region to meet its future electricity demand and promote significant economic growth (Mas'ud *et al.* 2015), with positive health benefits. Wind energy markets in the region remain small, with an estimated 43 MW having been installed in sub-Saharan Africa. The low wind power installation accounts for 4 per cent of global installation, although projects to add 230 MW to the existing capacity are under consideration (Mas'ud *et al.* 2015).

Renewable energy forms such as wind power have not been a priority for Africa because of technological and funding challenges in a region that has to grapple with other pressing issues such as poverty and poor health provision. As costs related to renewables, wind technology in particular, continue to come down, Africa's installed wind energy capacity is expected to grow to 3.9 gigawatts by 2020, a figure that is dwarfed by the projected global total of 610 gigawatts by 2020 (Mas'ud *et al.* 2015).

2.1.5 Climate variability and change

The global concentration of carbon dioxide increased from 280 parts per million in 1850 to 390 ppm in 2011, making greenhouse gases the most likely cause of the observed increase of around 0.5°C in global average surface temperature over the past 50 years (WMO 2015). The increase in temperature also affected other climatic systems, including rainfall patterns.

Rainfall patterns

Most areas of Africa lack sufficient observational data to draw conclusions about trends in annual precipitation over the past century (Niang *et al.* 2014). In addition, in many areas of the continent there are discrepancies between different observed precipitation data sets (Kalognomou *et al.* 2013; Kim *et al.* 2013; Nikulin *et al.* 2012; Sylla *et al.* 2011). Areas where there are sufficient data show very probable decreases in annual precipitation over the past century over parts of the western and eastern Sahel region in northern Africa. Over the past few decades, the northern regions of North Africa (north of the Atlas Mountains and along the Mediterranean coast of Algeria and Tunisia) have experienced a strong decrease in the amount of precipitation in winter and early spring (Barkhordarian *et al.* 2013). The Sahara Desert, which receives less than 25 mm per year, shows little seasonal change (Liebmann *et al.* 2012).

Rainfall over the Sahel has experienced an overall reduction over the course of the 20th century, with a recovery towards the last 20 years of the century (Biasutti 2013; Ackerley *et al.* 2011; Nicholson *et al.* 2000). There were a large number of droughts in the Sahel during the 1970s (Greene *et al.* 2009; Biasutti *et al.* 2008; Biasutti and Giannini 2006). The recovery of the rains may be due to natural variability (Mohino *et al.* 2011) or a forced response to increased greenhouse gas concentrations (Biasutti 2013; Haarsma *et al.* 2005), or to reduced aerosols (Ackerley *et al.* 2011).

Precipitation in eastern Africa shows a high degree of temporal and spatial variability dominated by a variety of physical processes (Hession and Moore 2011; Rosell and Holmer 2007). Funk *et al.* (2008) indicate that over the past three decades rainfall has decreased over eastern Africa between March and May/June. The suggested physical link to the decrease in rainfall is rapid warming of the Indian Ocean, which causes an increase in convection and precipitation over the tropical Indian Ocean and thus contributes to increased subsidence over eastern Africa and a decrease in rainfall during March to May/June (Funk *et al.* 2008). Similarly, Lyon and DeWitt (2012) show a decline in the March-May seasonal rainfall over eastern Africa. Summer (June–September) monsoonal precipitation has declined throughout much of the Great Horn of Africa over the past 60 years (during the 1948–2009 period; Williams *et al.* 2012) as a result of the changing sea level pressure (SLP) gradient between Sudan; the southern coast of the Mediterranean Sea and the southern tropical Indian Ocean region (Williams *et al.* 2012).

Over southern Africa a reduction in late summer precipitation has been reported over the western parts, extending from Namibia, through Angola, and towards the Congo, during the second half of the 20th century (Hoerling *et al.* 2006; New *et al.* 2006). The drying is associated with an upward trend in tropical Indian Ocean sea surface temperatures (SSTs). Modest reduction trends in rainfall are found in Botswana, Zimbabwe, and western South Africa. Apart from changes in total or mean summer rainfall, certain intra-seasonal characteristics of seasonal rainfall have changed, such as onset, duration, dry spell frequencies, rainfall intensity, and delay of rainfall onset (Kniveton *et al.* 2009; Tadross *et al.* 2009).

Changes in the distribution and magnitude of extreme rainfall events observed in many parts of Africa are associated with both climate change and variability (Williams *et al.* 2010), and these changes vary between sub-regions (Omondi *et al.* 2013; van de Giesen *et al.* 2010; Muthama *et al.* 2008). Desertification, desert encroachment and an alteration of hydrological regimes have been observed in several African ecosystems and regions (Odjugo 2010; Descroix *et al.* 2009; IPCC 2007). A shortage of water can have a damaging impact on vegetation, agricultural production and livelihoods, as



Dry water source outside Moyale, Kenya.
Credit: Sarah Elliott/EPA

many African countries rely on low-productivity rain-fed agriculture (Assan *et al.* 2009; Below *et al.* 2007).

The majority of people in sub-Saharan countries (approximately 85 per cent) live in rural areas and are engaged in agricultural activities, with farming making up the main source of their livelihoods (World Bank 2009). Barrios *et al.* (2010) provide evidence that long-term trends in rainfall have affected economic growth rates in sub-Saharan Africa in the past. Recently, long-term drying trends were observed in several African regions, for example, in Nigeria (Odjugo 2010), the western Sahel (Lebel and Ali 2009), tropical North Africa (Kawase *et al.* 2010) and in the eastern part of southern tropical Africa (Yin and Gruber 2010). In contrast, a study by Capecchi *et al.* (2008) demonstrated that an increase in rainfall in West Africa between 1986 and 2000 had a positive effect on crop production, particularly on the production of millet. The re-greening of the Sahel, since the mid-eighties that followed the great drought of the seventies was also attributed to rainfall increase (Herrmann *et al.* 2005).

Inter annual rainfall variability in Africa follows a pattern that is strongly linked to the ENSO. Typically, during an El Niño event, rainfall increases in the north, northeast and east, and decreases in the southeast of Africa (Muthama *et al.* 2014; Obasi 2005; Ropelewski and Halpert 1987).

Temperature

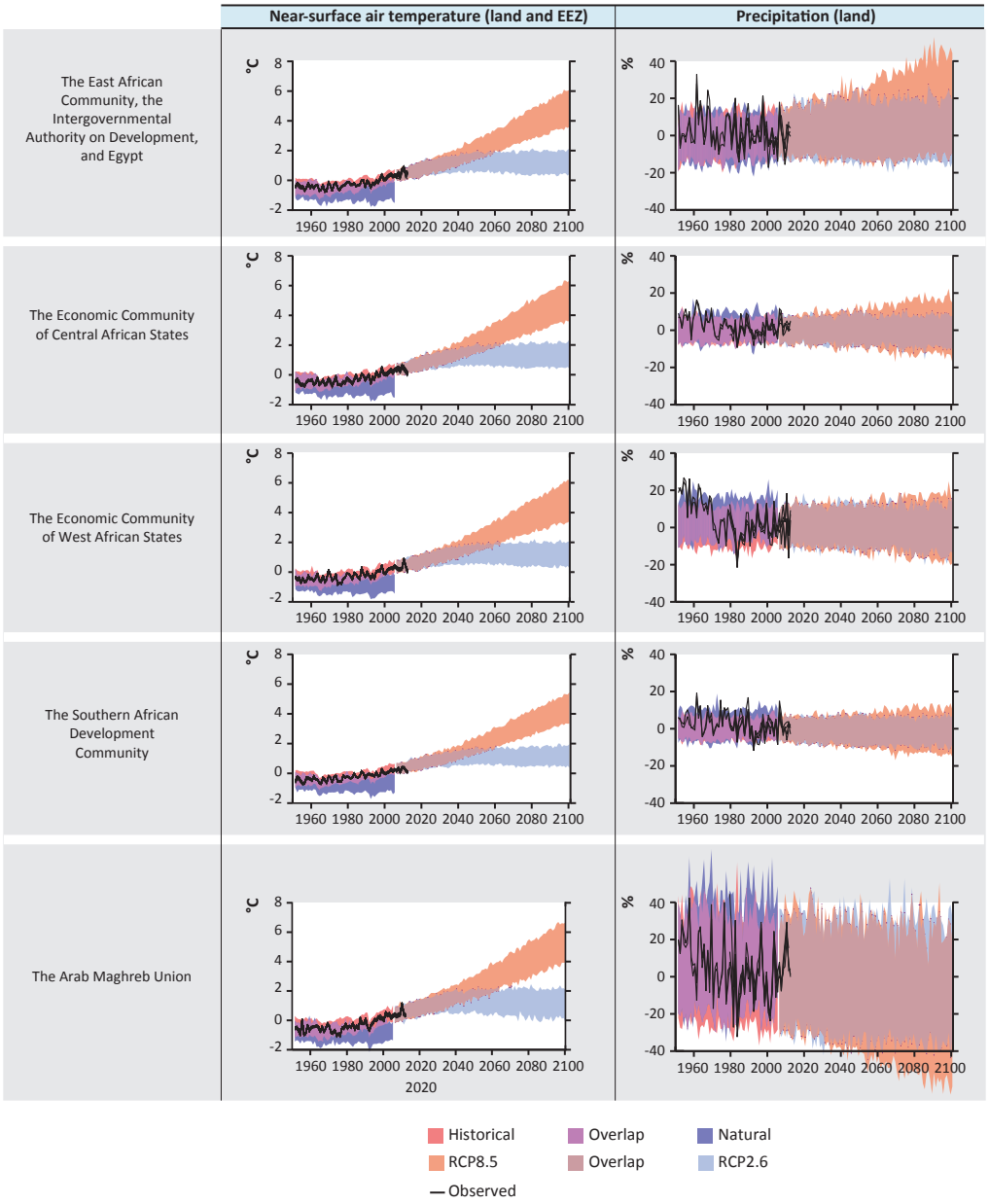
Africa's near surface temperatures have increased by 0.5°C or more during the past 50 to 100 years, with minimum temperatures increasing more rapidly than maximum temperatures (Nicholson *et al.* 2013; Funk *et al.* 2012; Collins 2011; Grab and Craparo 2011; Hoffman *et al.* 2011; IPCC 2007; New *et al.* 2006; Kruger and Shongwe 2004; Schreck and Semazzi 2004). Near-surface air temperature anomalies in Africa were significantly higher in 1995–2010 than during 1979–1994 (Collins 2011).

Figure 2.1.3 shows that, in recent decades North Africa's annual and seasonal observed trends in mean near-surface temperatures indicate an overall warming that is significantly beyond the range of changes due to natural



People arrive at their flooded homes in Chikwawa district, in southern Malawi.
Credit: Handout/Reuters

Figure 2.1.3: Observed and simulated variations in past and projected future annual average temperature over Africa



Sources: Barkhordarian *et al.* 2012a, Barkhordarian *et al.*, 2012b, Vizy and Cook 2012, Collins 2011, Kruger and Sekele 2012; Zhou *et al.* 2010, Anyah and Qiu 2012

(internal) variability (Barkhordarian *et al.* 2012a). During the warm seasons (March-April-May, June-July-August) an increase in near-surface temperature is shown over northern Algeria and Morocco that is very unlikely to be due to natural variability or natural forces (Barkhordarian *et al.* 2012b). The region has also experienced positive trends in annual minimum and maximum temperature (Vizy and Cook 2012).

Over West Africa and the Sahel, near-surface temperatures have increased over the past 50 years. The number of cold days and cold nights have decreased and the number of warm days and warm nights have increased between 1961 and 2000. Collins (2011) noted there was significant warming of between 0.5°C and 0.8°C between 1970 and 2010 over the region.

Most of southern Africa has experienced upward trends in annual mean, maximum, and minimum temperatures over large extents of the sub-region during the second half of the 20th century, with the most significant warming occurring during the period 1990-2010 (Kruger and Sekele 2012; Collins 2011; Zhou *et al.* 2010). Minimum temperatures have increased more rapidly than maximum temperatures over inland southern Africa (New *et al.* 2006).

The equatorial and southern parts of eastern Africa have experienced a significant increase in temperature since the early 1980s (Anyah and Qiu 2012). Similarly, recent reports indicate that there has been an increase in seasonal mean temperatures in many areas of Ethiopia, Kenya, South Sudan, and Uganda over the past 50 years (Funk *et al.* 2012). In addition, warming of the near surface temperature and an increase in the frequency of extreme warm events has been observed for countries bordering the western Indian Ocean between 1961 and 2008 (Vincent *et al.* 2011).

2.1.6 Achieving Global Environmental Goals for Air

Africa's air quality efforts continue to be focused around reducing air pollution in the face of expected increases in air pollution levels due to increased urbanization, motorization, industrial activity and dust storms (UNEP 2013). Selected Global Environmental Goals (GEGs) aimed at reducing air pollution and improving air quality include:

- reducing greenhouse gas emissions and associated climate change (United Nations Framework Convention on Climate Change (UNFCCC), 1994);
- controlling and eventually eliminating total global emissions of substances that deplete the ozone layer (Montreal Protocol, 1989 with 8 subsequent revisions);
- reducing respiratory diseases and other health impacts by phasing out of lead in gasoline (Johannesburg Plan of Implementation, 2002);
- reducing the dependence on solid fuels for cooking and heating by providing affordable energy (Johannesburg Plan of Implementation, 2002);
- developing and applying pollution control and measurement activities and monitoring transboundary air pollution (Agenda 21, 1992);
- cooperating at international, regional and national levels to reduce air pollution (Johannesburg Plan of Implementation, 2002); and
- prohibiting and eventually eliminating the production, use, import and export of intentionally and unintentionally produced persistent organic pollutants (POPs) (Stockholm Convention on Persistent Organic Pollutants (POPs), 2004) (**More...4**).

While Africa does not make a significant contribution to global warming, the continent is the most severely affected by the impacts of climate change as most African economies rely heavily on climate sensitive economic sectors that are exposed to climate variability, droughts and floods (AMCEN 2015). In response to this challenge, the African Union established a Committee of the African Heads of State and Government on Climate Change with the aim to ensure that Africa adapts and participates effectively in global efforts to mitigate climate change without compromising the continent's development agenda.

A High Level Framework Work Programme on Climate Change in Africa has been adopted as a guide to the AU, Member States and Regional Economic Communities in

addressing climate change. The Work Programme addresses key areas of interest to Africa, including climate financing and technology needs; an Africa-wide programme on adaptation; actions on mitigation; cross-cutting actions and participation; and international cooperation and institutional mechanisms for follow-up. At the 15th session of the African Ministerial Conference on the Environment (AMCEN 2015), Member States were requested to implement this Work Programme at a national level.

Another regional effort aimed at addressing climate change issues is the African Climate Policy Centre that focuses on generating information on climate in Africa. A national level, programmes to address climate change include the UN led initiative on Reducing Emissions from Deforestation and forest Degradation (REDD) and REDD+ (**More...5**).

Although significant progress has been made in the implementation of the Montreal Protocol, Africa recognises that there has been an increase in the production and use of hydrofluorocarbons (HFCs). At the 15th Ordinary Session of AMCEN, Member States agreed to use resources available under the Montreal Protocol to reduce the production and consumption of HFCs as well as source financial and technological support for their management (AMCEN 2015). AMCEN also agreed to implement priority areas under the Africa Sustainable Transport Forum Action Framework to reduce vehicle emissions and improve energy efficiency (AMCEN 2015).

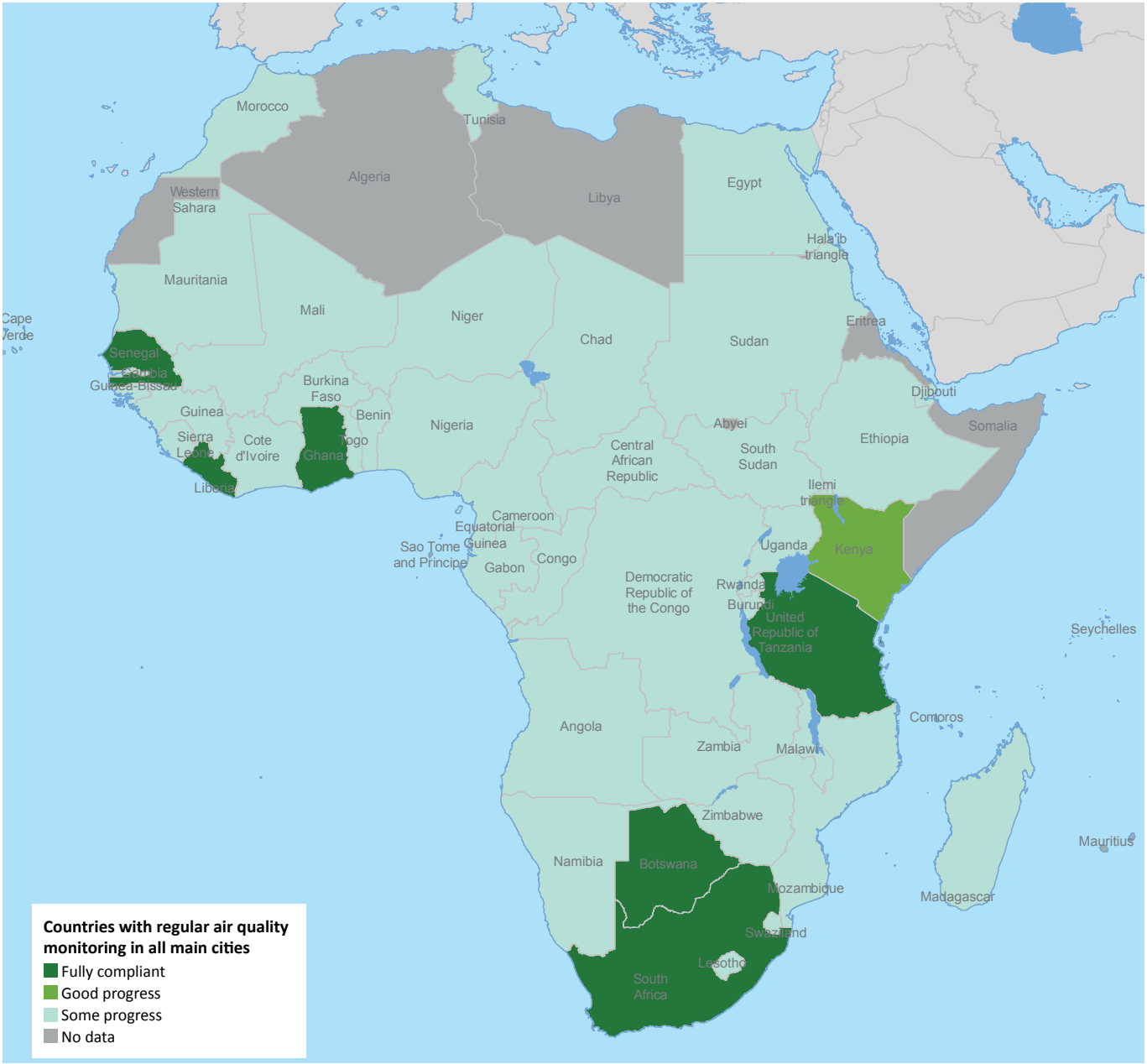
In the area of eliminating lead in gasoline, implementation of the Dakar Declaration has led to the phasing-out of the use of leaded petrol in Africa, with the exception of Algeria (UNEP/PCFV 2016). Positive results of this intervention include the drop in the levels of lead in blood observed in Ghana and Kenya (UNEP/PCFV 2016).

Solid fuels are still used by a large section of urban and rural communities for cooking and heating, contributing to indoor air pollution, deforestation and land degradation. While efforts have been made to provide affordable energy particularly to rural communities, to reduce the use of solid fuels, these are being hampered by low and unpredictable income streams which render electricity unaffordable, as well as severe shortages of electricity supply. Programmes such as the Africa Clean Cooking Energy Solutions Initiative and the Africa Renewable Energy and Access Programme seek to provide solutions for clean cooking and to help meet energy needs in an environmentally responsible way. Under these programmes charcoal producers in Rwanda and Tanzania have been trained in more efficient, sustainable production while in Uganda a pilot project generating electricity from biodegradable waste is in operation (World Bank/AFREA 2012). The World Health Organization (WHO) developed a comprehensive programme on Household Air Pollution to support developing countries in the areas of research and evaluation, capacity building, generation of evidence for policy-makers and development and maintenance of databases (WHO 2016). Other interventions to address indoor air pollution include the production of improved cookstoves such as Kenya's Ceramic Jiko stove and Zimbabwe's Tsotso stove. When properly used the Jiko stove is able to reduce fuel consumption by 20 – 50 per cent resulting in a corresponding reduction in demand for wood as a fuel source. It also has the ability to reduce emissions by 20 per cent, thereby reducing air pollution (WHO 2016).

The interventions targeted at reducing exposure to indoor air pollution have also contributed to the achievement of the Millennium Development Goals (MDGs). Most of the disease burden from indoor air pollution is on children under the age of 5 years. Therefore, a reduction in exposure to indoor air pollution contributes to a reduction in child mortality under MDG 4. In addition, one of the indicators to monitor progress towards ensuring environmental sustainability under MDG 7 was the proportion of the population relying on solid fuels. These and other efforts will also contribute to the Sustainable Development Goals (SDGs) particularly those on health, gender equality, poverty, energy, biodiversity, forests and deforestation, and sustainable consumption and production.

Information on pollution sources, levels and controls is still very limited (**Figure 2.1.4**). In an effort to address this information gap, AMCEN encourages data collection,

Figure 2.1.4: Countries with regular air quality monitoring in all main cities



Source: UNEP Africa Sustainable Transport Forum

air quality monitoring and modelling, as well as capacity building for policies, legislation, institutions, management systems, public awareness and networking (AMCEN 2015).

At sub-regional level, the framework agreements on air pollution provide for the installation of air quality monitoring stations and the maintenance of national emission inventories. For example, under the Southern African Development Community (SADC) policy framework agreement, Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe have developed country status reports that provide air quality statistics. In addition, Senegal and South Africa have established Air Quality Monitoring Centres (**More...6**).

Most African countries are parties to the global policy instruments on air pollution and air quality and notable progress has been made in cooperation at a global level. In addition, countries in the sub-regions of the continent have framework agreements on air pollution as follows:

- The West and Central Africa Regional Framework Agreement on Air Pollution (2009)
- The Eastern Africa Regional Framework Agreement on Air Pollution (2008)
- The Draft Southern African Development Community Regional Policy Framework on Air Pollution (2008)



2.2 Land

Key Messages: Land

- Regarded as Africa's most valued asset, land is a critical resource for all aspects of life and development. However, the resource faces new challenges from changing use, including urbanization, mining, deforestation, agricultural expansion and infrastructure development. Sustainable land management practices are needed to reconcile the diverse uses of this resource.
- The region has six of the world's top ten countries experiencing rapid urbanization, and as a consequence faces far reaching changes in settlement patterns in the years ahead. The movement of an estimated 450 million people from rural to urban areas by 2050 will place enormous strains on urban institutions, infrastructure, and financial and other resources, while also exacting huge demands on land for settlement. Combatting this challenge will require good spatial planning at all levels of government to ensure that cities have the capacity to cope with growing populations. Making rural areas more attractive to the youth, through investment in rural development is another important intervention.
- Africa has 60 per cent of the world's unconverted arable land, indicating potential for investment in food production on a massive scale, which if realized could enable the region not only to meet its own food needs, but also to export globally. Unlocking this potential represents an important challenge, particularly bearing in mind other competing land uses, including for pasture and cultural values. Currently, land productivity remains low in the region; a result of mineral poor soils and land degradation caused by inappropriate farming practices, deforestation, mining activities, and desertification. Africa is therefore called upon to embrace the Comprehensive Africa Agriculture Development Programme and its associated technologies for irrigation and fertilizer use, whilst nurturing the continent's agro-biodiversity and agro-ecological knowledge, to result in higher yields per unit area.
- A further issue of concern is poorly defined land tenure arrangements. Securing land tenure for both women and men will ensure Africa's land capital is both valued and protected. Africa is therefore urged to develop best practice guidance regarding tenure arrangements and processes, and institute appropriate legislative and administrative reforms to ensure that meaningful progress is made towards achieving a land market built on a range of secure tenure options and increased land productivity.

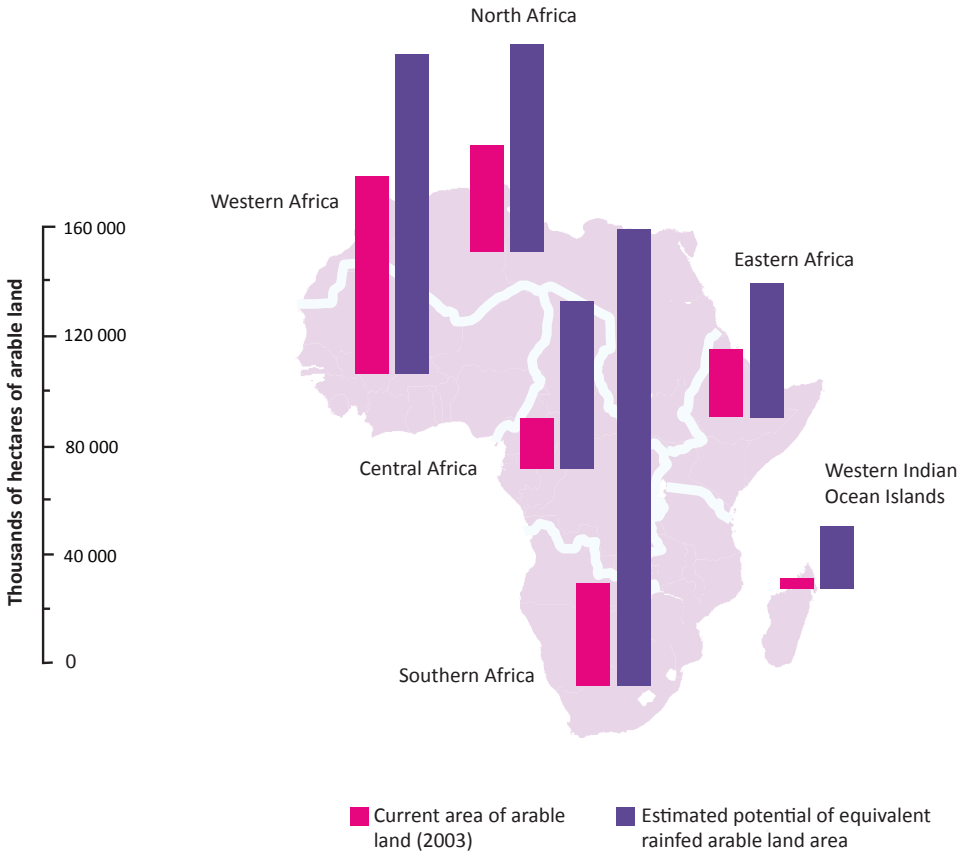
2.2.1 Introduction

Africa's landmass of 30 million square kilometres makes the region the second largest continent in the world after Asia (UNEP 2013). With maize making an annual contribution of nearly USD 21 billion in 2013 and livestock bringing in USD 65 billion (FAOSTAT 2015), land is Africa's most prized asset for food production, nutritional health and economic development. The region's land area consists of 6.7 million square kilometres of forest and woodlands and 19.8 million square kilometres of arid zones and deserts (UNEP 2013; IFAD 2010). The extent of arable land is estimated at 8.07 million square kilometres, and of this only about 1.97 million is under cultivation (UNEP 2013). As such, Africa, together with the Latin America and Caribbean region, have the world's largest reserve of agricultural land, making up 80 per cent of such land (AMCEN 2015) (**More...7**).

◄ Credit: Shutterstock/Byelikova Oksana

Demand for the region's abundant land has been increasing over the years, with population density rising from 31 persons per square kilometre in 2005 to 40 in 2015 (UNDESA 2015). Land productivity is low and declining despite a high dependence on land and its resources by the majority of people. Agriculture plays a major role in the continent's economy. Employing nearly 70 per cent of Africa's population and generating 30 per cent of gross domestic product (GDP), agricultural productivity is still too low for the region to feed itself (Benin *et al.* 2011). Africa's agro-ecological potential is considerably larger than both its current output and its food requirements. Besides agriculture, urbanization, whose trends are highest in the world, is another major factor for land use change in the region.

Figure 2.2.1: Current and potential arable land in Africa



Source: FAOSTAT 2006

2.2.2 Land productivity

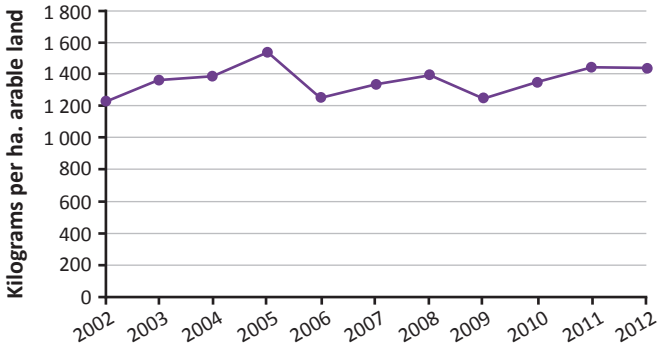
Despite having more than a quarter of the world's arable land, Africa generates only 10 per cent of global agricultural output, and has the lowest agricultural yield per unit area of any region (NEPAD 2013; Jayaram *et al.* 2010). There is potential for Africa to increase its agricultural output since the region has 52 per cent of the world's underutilized arable land (Chamberlin *et al.* 2014; Deininger *et al.* 2011), although most of this is concentrated in six countries. As can be noted in **Figure 2.2.1**, the current area of arable land in Africa is much lower than the potential of equivalent rain-fed arable land area.

Under current infrastructure conditions, production technologies and farm productivity levels, much of Africa's potentially available cropland is either economically unviable or out of reach for the majority of smallholder farmers (Chamberlain *et al.* 2014). Localized land pressure is common across Africa, with estimates showing that 21 per cent of the region's rural population lives off 1 per cent of the region's arable land (Jayne *et al.* 2014).

While access to land is the key factor for agricultural productivity in Africa, other factors such as access to finance and reliable water sources are also important. The fragmentation of farms is also a factor affecting farm productivity. Africa has 33 million family farms of less than 2 hectares, accounting for 80 per cent of farms, and only 3 per cent of farms are more than 10 hectares in size (Namubiru-Mwaura and Place 2013; NEPAD 2013). Headey and Jayne (2014) estimate that average farm sizes in land-constrained countries have shrunk by 30–40 per cent since the 1970s, and that average farm sizes for a number of African countries over the past 30 years have declined from about 2 hectares to 1.2 hectares. Much of the reduction in size of land holdings is a result of population growth, with approximately 122 million young people expected to enter the labour market between 2010 and 2020, half of them in rural areas (Jayne *et al.* 2014).

Fertilizer use, including organic manure, remains very low in Africa (**Figure 2.2.2**), and together with other technologies such as irrigation, agricultural productivity may be improved

Figure 2.2.2: Total fertilizer consumption in Africa, 2002–2012



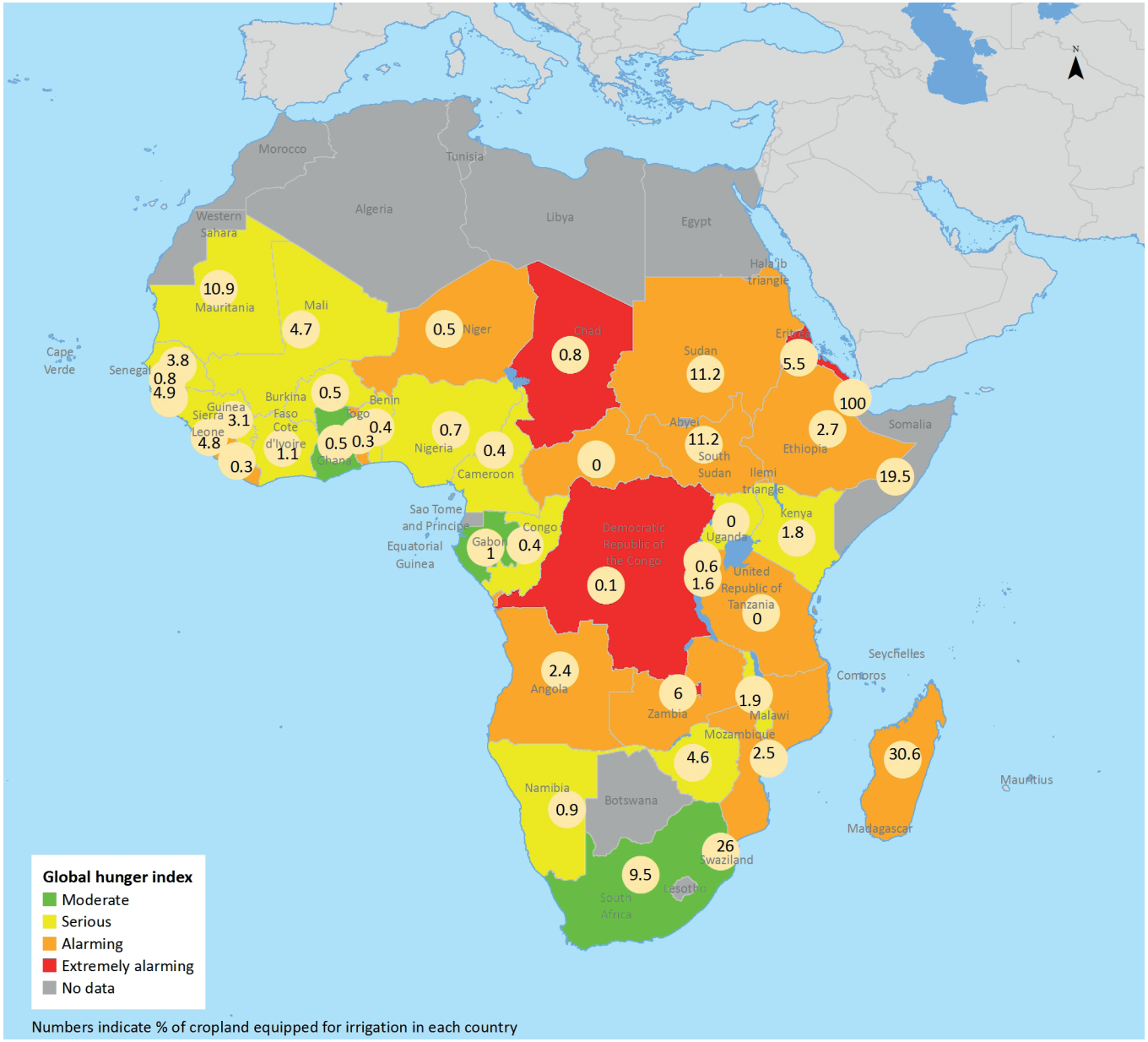
Source: FAO 2016

(Headey and Jayne 2014). Proponents of fertilizer use argue that its use would significantly improve agricultural productivity, especially on the region's poor soils.

However large scale blanket fertilizer application without assessing the soil needs produces negative results. Ethiopia has embarked on soil fertility mapping to determine the appropriate type of fertilizer for a particular soil type. This mitigates against the inappropriate use of fertilizer. The country has five fertilizer blending plants, and has conducted field demonstrations on more than 40 000 farmer's plots to date (ESSP 2015)

Africa's low agricultural productivity is partly a result of the low uptake of irrigation technology, despite many crop-producing areas receiving low amounts of rainfall or commonly experiencing mid-season droughts. At present, most agriculture is sustained through rainwater, with only 6 per cent of the total cultivated area in the region equipped for irrigation, compared to 33 per cent in Asia (Headey and Jayne 2014; You *et al.* 2011). Currently underexploited, irrigated cultivation has the potential to improve land-use efficiency and boost agricultural productivity by as much as 50 per cent. Given that the continent has large expanses of land where hunger and drought are prevalent, irrigation could be a critical factor in enhancing food security (**Figure 2.2.3**) (Burney *et al.* 2013).

Figure 2.2.3: Global Hunger Index and irrigation coverage in sub-Saharan African nations, 2011



Source: Burney *et al.* 2013



A Kenyan farmer at work in the Mount Kenya region.
Credit: Neil Palmer (CIAT)/Wikimedia Commons

The country colours in **Figure 2.2.3** show the 2011 Global Hunger Index; numbers are for the proportion of cropland equipped for irrigation.

Africa's low agricultural productivity has resulted in the region relying on food aid, which amounted to 3.23 million tonnes in 2013, while imports made up 25 per cent of the region's food grain requirement (AUC-ECA-AfDB Consortium 2010). Algeria, Egypt, Ethiopia, Kenya, Morocco, Nigeria, South Africa, Sudan and Tanzania are the largest agricultural economies on the continent, while Angola, Ethiopia, Guinea, Mozambique, Nigeria and Rwanda and are the fastest growing economies, surpassing the annual agricultural growth rate target of 6 per cent set by the Comprehensive Africa Agriculture Development Programme (CAADP) in 2003 (Benin *et al.* 2011).

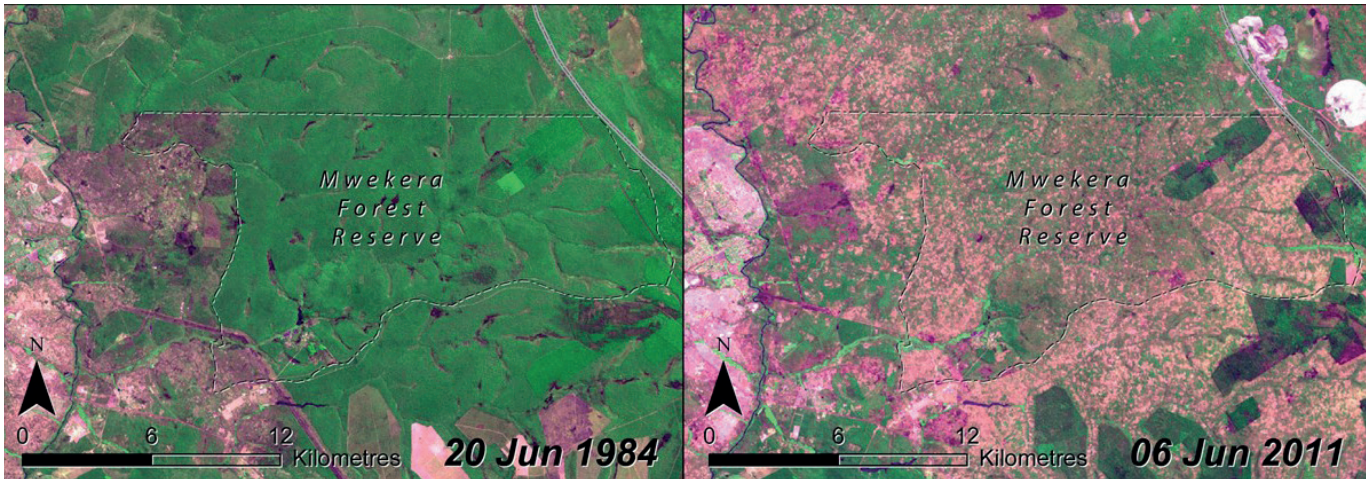
The main challenges inhibiting agricultural productivity in Africa include:

- Africa's agricultural productivity requires access to reliable and cheap finance, as well as high-quality seeds, fertilizers and water. Other essentials include: access to markets to absorb increased agricultural output, efficient post-harvest and handling mechanisms, and farmer training.
- Investment in agriculture at the continental level is very low, with only six countries having achieved the CAADP targets for increased agricultural productivity. sub-Saharan Africa alone requires as much as USD 50 billion of additional annual investments in agriculture (Benin *et al.* 2011).
- Agricultural productivity can be improved by putting in place adequate transport, electricity supplies, and other kinds of infrastructure, as well as stable business and economic conditions.
- Extension services targeting small-scale farmers are needed. Current estimates show that small-scale farmers' share of agricultural production is growing, with more than 75 per cent of the total agricultural output of Ethiopia, Kenya, Uganda and Tanzania coming from smallholder farms of about 2.5 ha (Salami *et al.* 2010).
- Due to high rates of poverty, especially in rural areas, the majority of farmers can neither adapt to improved agricultural practices nor have access to the information they need, resulting in low productivity, high post-harvest losses and the cultivation of marginal lands.

2.2.3 Land-cover change

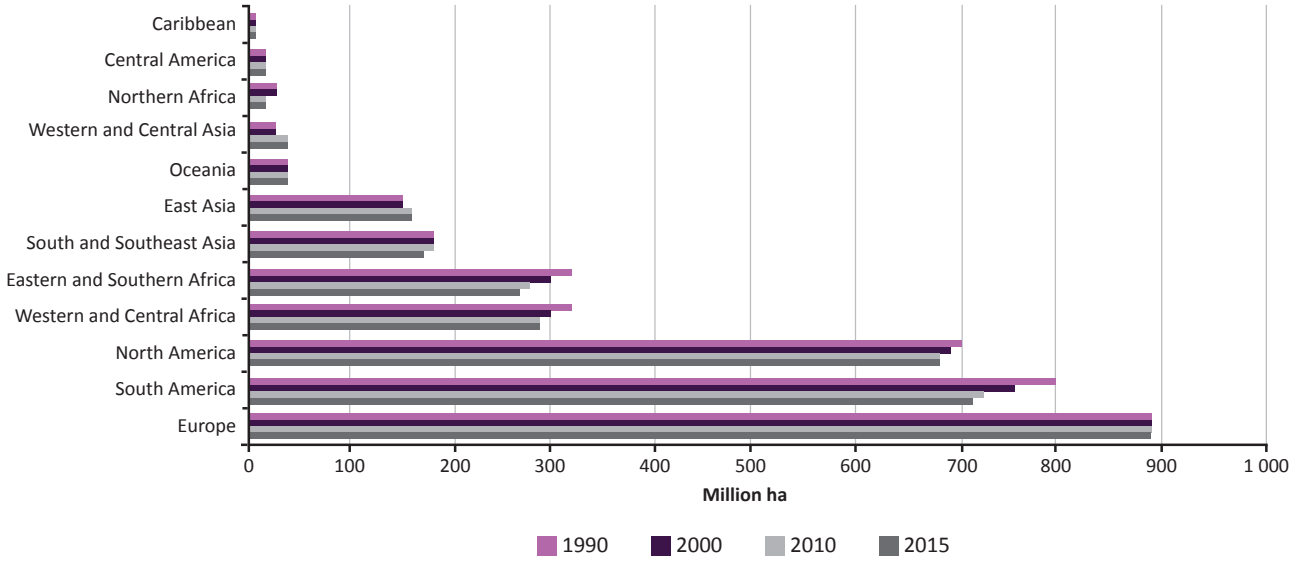
Changes in land cover and use in Africa are largely driven by population growth, urbanization and investments in large-scale commercial agriculture. As a result of population growth, new land continues to be opened up for agriculture from other uses, especially forestry. For example, the Mwekera Forest in Zambia has seen significant land-use change in the recent past due to population growth and the resultant increase in demand for firewood and cultivable land (**Figure 2.2.4**).

Figure 2.2.4: Mwekera National Forest Reserve, Zambia, 1972 and 2011



The Reserve covered 18 000 hectares when it was gazetted in 1946. Uniquely, the forest has legal human settlements, and human activity has caused rapid deforestation (shown in pink), particularly since 1997.
Source: SARDC *et al.* 2012

Figure 2.2.5: Africa natural forest area by sub-region, 1990-2015



Source: FAO 2015

Analysis at sub-regional level indicates a trend of decreasing forest cover throughout North, West, Central, East and Southern Africa between 1990 and 2015 (FAO 2015). Net annual forest change between 2010 and 2015 has been recorded at -2.8 per cent. **Figure 2.2.5** shows Africa's extent of forest cover by sub-region in relation to the rest of the world.

Forest cover is projected to continue shrinking, declining to less than 600 million hectares by 2050 due to increasing conversion of forests to agriculture to support the rising population and growing demand for firewood. Changes are expected to vary from country to country. For example, while Mali indicated that significant loss is expected by 2030, Tanzania is expecting losses observed in the past to be reversed into gains over the same period (FAO 2015).

As forests act as sinks for carbon dioxide, a drop in coverage reduces the carbon stock. The highest densities of carbon stock in Africa are in West and Central Africa, although these have been reduced significantly, declining from 46 to 43 billion tonnes between 1990 and 2005. The decline is mainly as a result of the expansion in agricultural land and unsustainable logging.

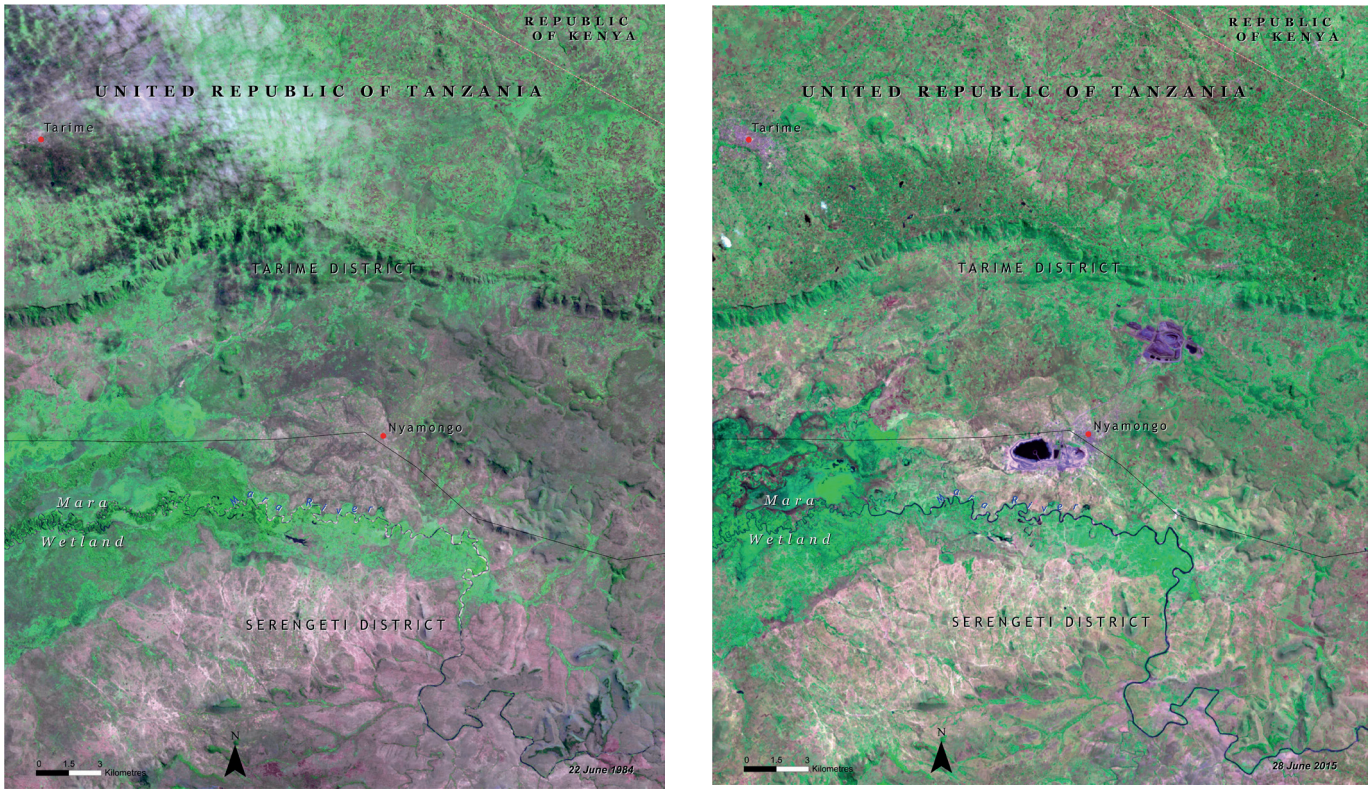
Most of Africa's forests are found in the Congo Basin and in mountainous areas. Mountain forests make up approximately 20 per cent of the region's landmass (UNEP 2014). Mountain forests are under threat from agricultural encroachment, deforestation, mining and dam construction.

Urbanization is another key demographic trend affecting land in Africa. Overall, the continent is undergoing rapid urban change. Recent studies show that the proportion of the population living in urban zones increased from 15 per cent in 1960 to 40 per cent in 2010, and is expected to grow to 53 per cent by 2035 and 60 per cent by 2050 (FAO and UNIDO 2010; UN-Habitat 2010). Between 2010 and 2040, Africa is expected to have more than 450 million additional urban dwellers (Freire 2013). UN-Habitat (2010) reports that 20 African cities will be among the largest 100 cities in the world by 2050. For example, Kinshasa is expected to grow to 35 million inhabitants while Lagos will grow to 33 million. Furthermore, 50 cities including the large metropolises of Cairo, Lagos, Kinshasa and Dar-es-Salaam, as well as Luanda, Niamey and Blantyre, will have reached 10 or more million by then. Land is critical for urban expansion and transformation, but urbanization has significant impacts on land. For example, coffee production in Kenya has fallen by more than 50 per cent due to the conversion of coffee plantations to real estate developments (Nyambura-Mwaura 2010) (**More...8**).

Significant land-use change has also occurred in Africa as a result of mining activities. Besides the clearance and digging up of large tracts of land, mining also attracts labour, whose needs for biomass energy and food often result in deforestation and conversion of forests and woodlands into pieces of land for agriculture (**Figure 2.2.6**). Besides land-use change, mining also results in waste management challenges. In Africa approximately 80 million tonnes of mining waste is dumped each year (Lloyd 2002) (**More...9**).

Located in the Mara region of Tanzania, Nyamongo Gold Mine is a combined open pit and underground operation, with capacity to process 8 000 tonnes of ore per day. During the period prior to June 1984, the Nyamongo area had no large-scale mining activity, but by June 2015, two major pits and a wastewater pond had been created, resulting in a large-scale change to the landscape (LVBC 2016).

Figure 2.2.6: Nyamongo gold mine



Nyamongo Gold Mine, June 1984 and June 2015
Source: LVBC 2016

2.2.4 Land economics and governance

The fact that many African countries produce only 25 per cent of their potential yields shows that there is room for increased yields and good returns from the agricultural sector (Byerlee and Deininger 2013). Land governance systems that provide improved access and rights to land resources are important (Namubiru-Mwaura 2014). Vibrant land markets, which are slowly developing, especially in peri-urban areas across Africa, will result in increased land productivity. Due to secure land rights, both local and foreign investors are taking up large-scale commercial agriculture, resulting in some concerns over loss of local livelihoods and access to land and water (Deininger *et al.* 2014; Jayne *et al.* 2014).

In the past few decades, and especially since the rise of world food prices in 2008, great efforts have been made to transfer land out of customary tenure to the state or to private individuals (Namubiru-Mwaura *et al.* 2012). Proponents of these efforts argue that the state and private individuals can more effectively exploit the productive potential of the land to meet national food security objectives. In Zambia, new land titles of more than 10 hectares recorded since 1995 amount to 12 per cent of the land cultivated nationally (Sitko and Jayne 2014).

Land rental markets are also sprouting up rapidly in Africa. Those who promote such markets argue that they are

important for poverty alleviation and development because they improve efficiency by transferring land from less productive users with large landholdings to farmers who are more efficient but land-constrained (Otsuka 2007; Migot-Adholla *et al.* 1994). In Ghana, for example, tenants are provided with land on which to establish cocoa farms and are supposed to give one third of their yield to the landowners as rent (**More...10**).

Schoneveld (2014) estimates that 227 000 square kilometres of arable land in sub-Saharan Africa was recently acquired by large entities, with approximately 90 per cent of this involving a foreign primary shareholding. This is equivalent to approximately 9.7 per cent of the total area under cultivation in sub-Saharan Africa, and about 35 per cent of the region's remaining potentially available cropland, if forestland is excluded (Chamberlin *et al.* 2014). Half of these investments are located in just six countries: Ethiopia, Ghana, Madagascar, Mozambique, South Sudan and Zambia. Large-scale acquisitions by domestic investors are on the rise as well. Some cross-country investments in Africa have also been highlighted, for example Libya's investments in Mali; Mauritius's investments in Mozambique; and Egypt's in Ethiopia (Zerfu and Birhanu 2012).

About 7 per cent of large-scale land investment is focused on basic food crops, 60 per cent on oilseeds, 15 per cent on timber and pulpwood trees, and 13 per cent on sugar crops (Schoneveld 2014). Large-scale land investment in the agribusiness industry can provide benefits through economies of scale, proper marketing and accountability. In the food industry it has the potential to lower the price of essential foods, improve productivity and efficiency and enable investment in innovation that ultimately benefits both large-scale investors and smallholder farmers (Deininger 2011). While some of the large-scale land acquisitions may result in improved investments in rural development, they can have significant impacts on local communities who may not have the bargaining power required to negotiate and get favourable terms. The unequal power relations in land acquisition deals can put the livelihoods of the poor and the vulnerable at risk. This problem is exacerbated by the fact that some small-scale landholders may have no formal title to land even though they own the land under customary land tenure (Borras *et al.* 2011; Von Braun and Meinzen-Dick 2009).

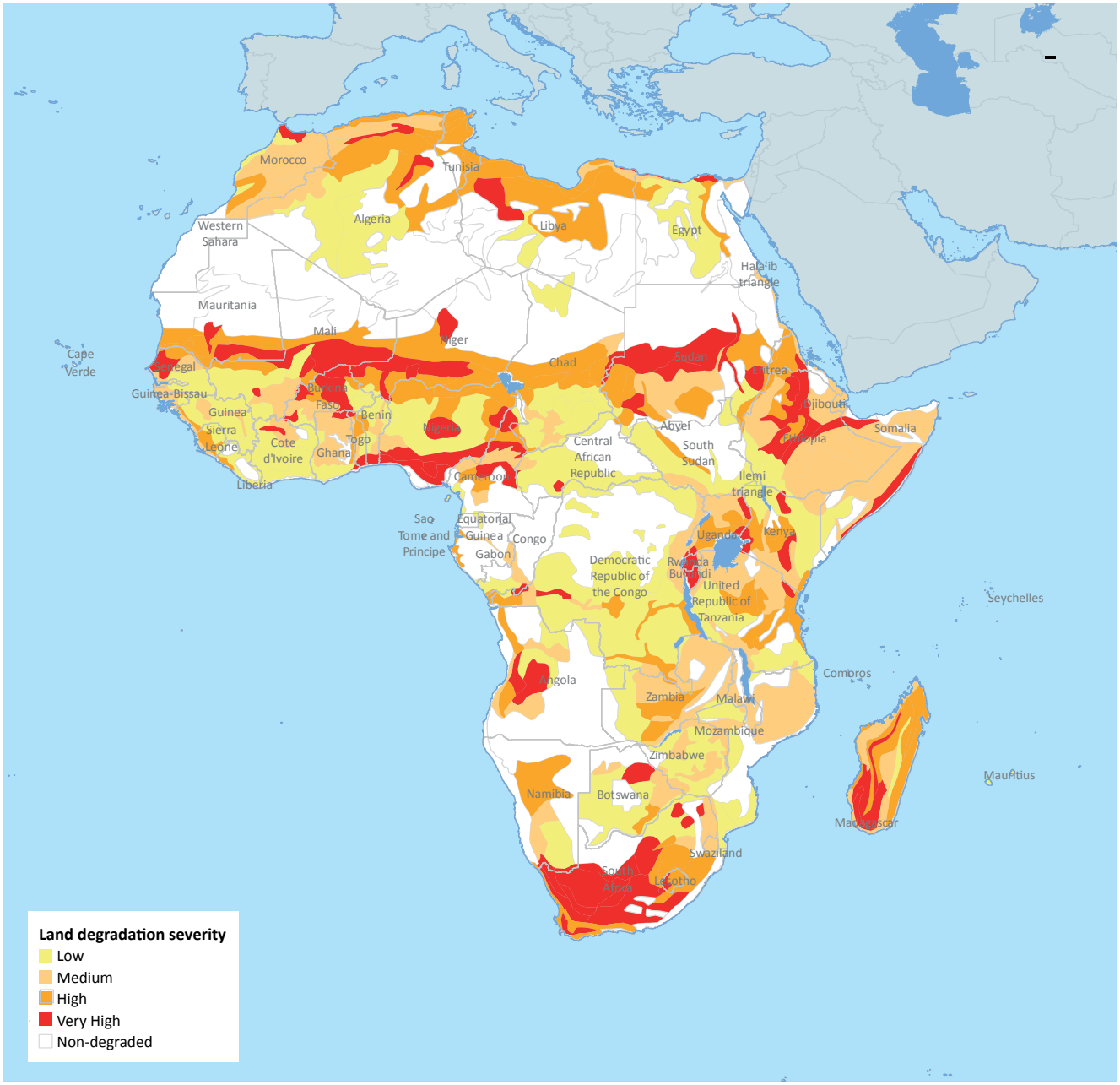
Furthermore, large-scale land acquisition sometimes ignores the other forms of land use, often practised by the poor for purposes such as grazing animals and gathering fuelwood or medicinal plants, which tend to be undervalued in official assessments due to lack of markets for these products. For example, women depend more on land-based natural resources that directly affect the day-to-day welfare of households than men. Large land acquisitions may therefore negatively affect women's income from land resources more than men's, resulting in profound consequences for household well-being. It is therefore not uncommon to find that these land transactions lead to negative livelihood processes and outcomes for women. Policy interventions designed to address local and national challenges to socio-economic and cultural development should recognize the impacts of these transactions on women and put in place appropriate measures to mitigate their negative impacts (Yengoh *et al.* 2015). Overall, there is a need for strong collective institutions that give smallholder farmers enough agency and power to voice their concerns and negotiate favourable terms (Von Braun and Meinzen-Dick 2009).

2.2.5 Land degradation

About 500 000 square kilometres of land in Africa is estimated to be degraded (UNEP 2013) due to soil erosion, salinization, pollution and desertification (**Figure 2.2.7**). Deforestation, forest fires, over-cultivation, inefficient irrigation practices, overgrazing, overexploitation of resources and uncontrolled mining activities, as well as climate change and variability are blamed for the degradation.

The impacts of land degradation include reduced agricultural productivity, with concomitant effects on food availability, nutrition and human health. This fuels social, economic and political tensions that can lead to migration, with associated

Figure 2.2.7: Land degradation in Africa



Source: UNEP 2006

health impacts such as the spread of disease, including HIV/AIDS. Between 1960 and 1980, almost 10 million people in the sub-Sahara African region had to move because of drought (El Hinnawi 1985; Jacobson 1989). Studies from a number of African countries, including Burkina Faso, Egypt, Mali, Morocco and Niger, indicate that land degradation and desertification contribute to human mobility, and to worsening living conditions for both those who leave and those who remain (UNCCD 2014).

Soil salinization

Inefficient irrigation practices and poor management of fertilizers lead to loss of top soil and salinization, resulting in loss of soil fertility and poor plant growth. Soil salinization is also caused by scarcity, variability and unreliability of rainfall and the high potential for evapotranspiration that affects the water and salt balance of the soil. With the projected increase in dry conditions in some parts of Africa as a result of climate change, this phenomenon is likely to rise.

The areas most affected by salinization are the arid and semi-arid regions of North and Southern Africa where about 30 per cent of irrigated land has been lost due to salinization, with examples from Kenya, Nigeria, Sudan and Tanzania showing losses of irrigable land of 30, 34, 27 per cent and 27, respectively (FAO 2011). In Southern Africa salinization is particularly serious in Botswana and Namibia (Sommer *et al.* 2013).

Soil erosion

Cultivation in much of Africa encroaches on environmentally fragile areas such as steep slopes, riverbanks, shallow soils and wetlands, often without appropriate conservation measures in place, leading to increased soil erosion. Due to small landholdings, farmers are forced to use their land continuously with no rotation, resulting in declining crop yields and the loosening and washing away of soil exposed to natural forces such as wind and water.

The offsite impacts of soil erosion include sedimentation of water bodies and loss of breeding grounds for fish, and destruction of infrastructure such as roads and bridges, among others. In the Shire River catchment area of Malawi, soil erosion is estimated at more than 25 tonnes per hectare per year (World Bank 2012), and this has the potential to disrupt hydropower generation on the Shire River.

Increased deforestation exposes soil to wind and water erosion. The forest stabilizes the soil and allows water and soil nutrient cycling, and its absence affects the productivity of land as well as human health. In most parts of Africa, deforestation rates exceed planting rates by a factor of 30 to 1 (FAO 2011). In Tanzania, Zambia and Zimbabwe, forest losses to deforestation during the period 2000 and 2005 ranged from 313 000 to 445 000 hectares per year, representing annual rates of 1.1, 1.0 and 1.7 per cent, respectively (Syampungani *et al.* 2012). In the Congo Basin, deforestation between 1990–2000 and 2005–2010 was variable, with a decreasing trend in Gabon due to much improved forest management practices, but a rising trend in the other Congo River Basin countries.

Desertification

Land degradation in drylands can result in desertification. The desert lands of the Sahara, Namib and Kalahari, as well as the drylands of northern Kenya, southern Ethiopia and most of Somalia, cover around 40 per cent of the land surface of Africa (European Union 2013). Coupled with climate change, increasing numbers of cattle and other livestock accelerate desertification. In some parts of Africa, such as in Botswana and Namibia, there has been an on-going trend in livestock numbers exceeding the carrying capacity of the land. For example, the cattle population in Botswana rose from just over 2.1 million in 2005 to nearly 2.6 million in 2011, exceeding the carrying capacity by not less than 40 per cent of the nation's pasture (SADC 2014). In East Africa, numbers of cattle in Ethiopia increased from 40.4 million in 2005 to 52.1 million in 2011, while in Kenya numbers increased from 13.0 million to 18.2 million over the same period (FAO 2015).

2.2.6 Sustainable land management

Sustainable land management is key to improved agricultural productivity and reduced land degradation, leading to food security, improved human health and sound environmental management. Sustainable land management measures range from land reclamation, restoration and rehabilitation, which are all responsive, to proactive practices such as afforestation and climate-smart agriculture, which includes conservation agriculture (FAO 2011; UNCED 1992), (**Table 2.2.1** and **Boxes 2.2.1-2**).

Box 2.2.1: Rangeland rehabilitation in Mount Moorosi, Lesotho

Communities in four villages in the Mount Moorosi area in Lesotho participated in a rangeland rehabilitation project, carrying out activities that included construction of physical barriers on the mountain slopes to slow runoff, trapping sediments and promoting infiltration. The project also involved physical removal of alien species, sowing grass on bare soil, and allowing grasslands to recover by minimizing grazing. At the end of the project the rehabilitated and rested rangelands had some good vegetation cover and regeneration of grasses. The silt traps built to reduce the rate of runoff and the removal of invasive bushes have had a very positive impact in reducing soil erosion and restoring the rangelands.





Source: Ha Mantsoepa project participants; Orange-Sengu River Commission 2014

Box 2.2.2: Green manuring with Tithonia in Cameroon

Tithonia diversifolia hedges grow along roadsides or farm boundaries. The green leaf biomass is suitable as green manure for annual crops, since the plant has a high content of nitrogen and phosphorus, and decomposes quickly after application to the soil, releasing its nutrients within one growing season.

At an early stage of plant growth, fresh green leaves and stems are chopped and applied on the cropland as green manure after the first ridging. The fresh material is spread over the half-made ridges at a rate of 2 kg per square metre and then covered with about 5–10 centimetres of soil to finish the ridges. Sowing of crop seeds is done only after a week or more, because the heat generation during decomposition of the leaves can damage the seeds.

Tithonia biomass enhances soil organic matter and soil fertility, resulting in higher crop yields. The treatment supplies the crop with nutrients at the early stage of the growing process, and improves the establishment of the crops through rapid development of a good rooting system. The technology is especially beneficial for maize, with yield increases of as much as 50 per cent.

Tithonia can also be applied as a mulch six to eight weeks after planting the crop. Covering the mulch with a little soil facilitates nutrient release. Tithonia green manuring before planting can be combined with later mulching, which is especially applicable to maize, beans and cabbage cultivation. Tithonia hedgerows have to be cut back regularly as it can spread fast and become a weed. Inter-planting Tithonia in the field is not recommended due to root competition with crops.



Source: FAO 2011

Table 2.2.1: Sustainable land management practices

Agronomic measures	Measures that improve soil cover (e.g. green cover, mulch); measures that enhance organic matter or solid fertility (e.g. manuring); soil surface treatment (e.g. conservation tillage); subsurface treatment (e.g. deep ripping)
Vegetative measures	Plantation, reseeding of tree and shrub species (e.g. live fences, tree rows), grasses and perennial herbaceous plants (e.g. grass strips)
Structural measures	Terraces (e.g. bench, forward/ backward sloping); bunds, banks (level/graded); dams, pans; ditches; walls and barriers
Management measures	Change of land use (e.g. enclosure); change of management/intensity level (e.g. from grazing to cut-and-carry); major change in timing of activities/control and species composition

Source: FAO 2011

2.2.7 Meeting global goals on land management

Land is the main base for other environmental and natural resources. In Africa, the sustainable use and management of land is particularly important because the majority of people, particularly in sub-Saharan Africa, rely on agriculture for food security, and therefore health and poverty reduction. The selected land-related GEGs, are contained in: (**More…11**)

- Agenda 21; General Assembly Resolution 62–98 of 31 January 2008;
- the Millennium Development Goals (MDGs);
- the Ramsar Convention on wetlands; and
- the United Nations Convention to Combat Desertification.

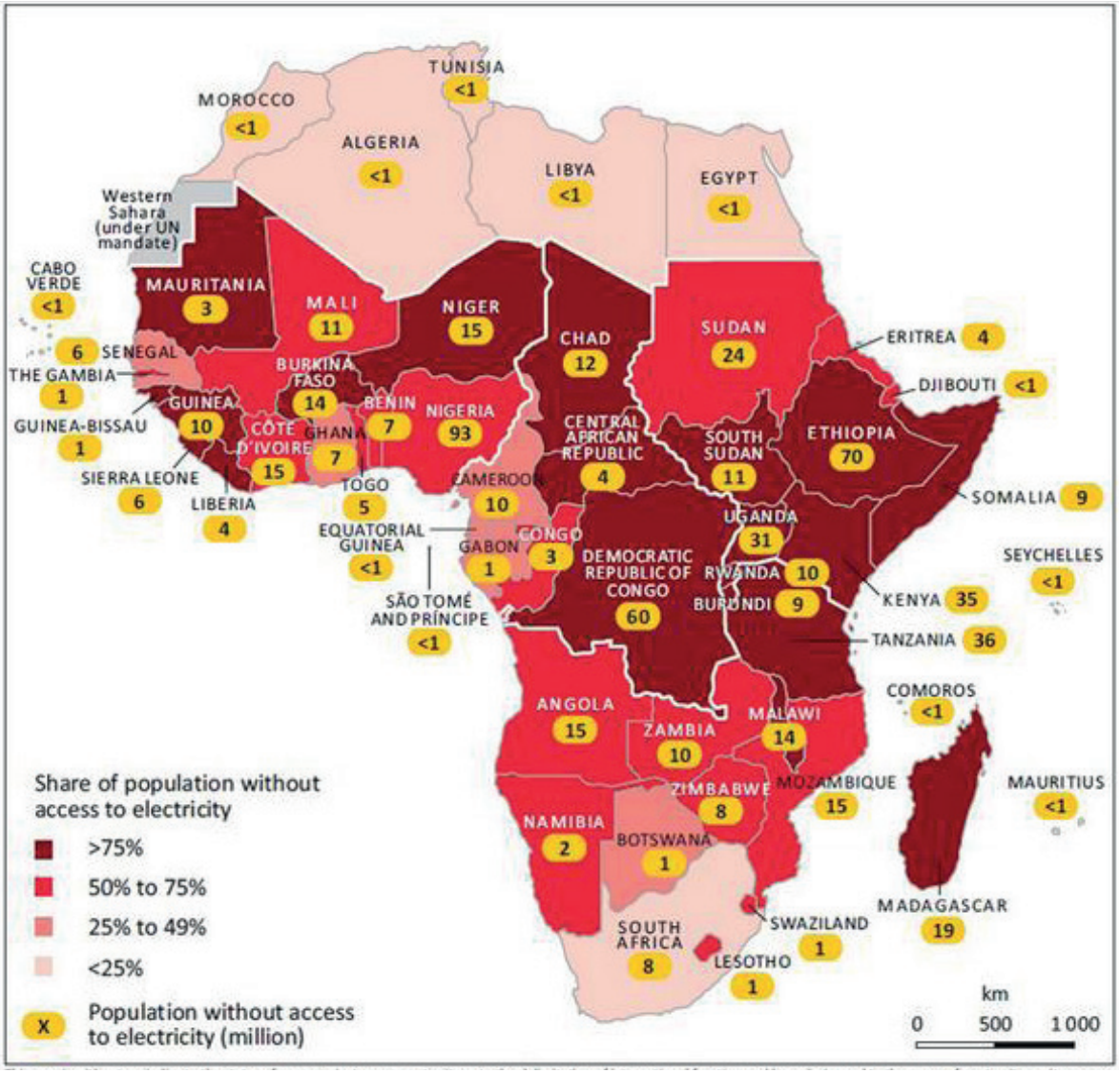
The land GEGs are complemented by SDG 15 adopted along with 16 other SDGs at the end of 2015. SDG 15 highlights both the importance of land to development and the enduring concern that unless remedial action is urgently taken, the resource faces the risk of irreversible degradation. The Goal, which seeks to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss," is further broken down into 10 Targets. Commendably, the Targets provide a roadmap for implementation of SDG 15 by stipulating that the Goal should be incorporated into national policies through local planning, development processes, poverty reduction strategies and accounts by 2020.

According to the latest national accounts global forests assessment of the Food and Agriculture Organization of the United Nations (FAO), the rate of deforestation has slowed around the world over the last five years, including in Africa (FAO 2015), a development that augurs well for the achievement of SDG 15. Moreover, Africa reported the highest annual increase in the area of conserved forest over the same period. This has been attributed to improved measuring and monitoring of forest resources and greater involvement of local communities in formulating policies (FAO 2015). However, forest degradation remains a challenge because forest erosion is gradual and more difficult to detect (Laurance *et al.* 2011), necessitating a combination of data sets to highlight its extent.

Both deforestation and forest degradation are largely driven by accelerated urbanization and industrialization, agricultural expansion, commercial logging, and increased fuelwood collection (Rudel 2013). The latter is a reflection of the region's growing energy deficit, where two thirds of the population – around 620 million people – have no access to electricity (OECD and IEA 2014) (**Figure 2.2.8**) which is at odds with SDG 7 which aims to "ensure access to affordable, reliable, sustainable and modern energy for all."

In line with MDG 1, the proportion of undernourished people in the developing regions has fallen by almost half since

Figure 2.2.8: Number and share of people without access to electricity, by country, 2012



Source: OECD/IEA 2014

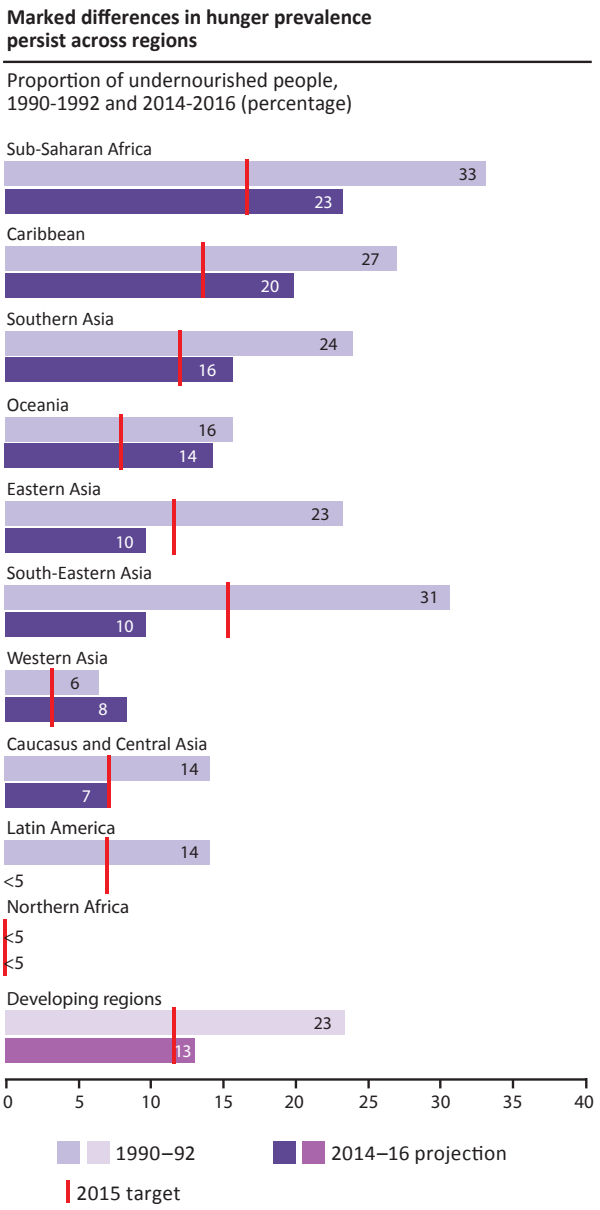
1990, from 23.3 per cent in 1990–1992 to 12.9 per cent in 2014–2016 (United Nations 2015) (**Figure 2.2.9**). However, this masks regional differences and the majority of the 780 million people (12.8 per cent of the world population) who still suffer from malnutrition live in sub-Saharan Africa (**More...12**).

The level of malnutrition in Africa is attributable to several factors, including underutilization of land (Cotula *et al.* 2009), causing per person food production to decline as a result of population growth (**Figure 2.2.10**); none use of modern farming practices such as the application of appropriate agro-chemicals and mechanization; non use of improved (high-yielding and pest-, disease- and drought-resistant) crop and livestock varieties (Leadley *et al.* 2014; Zimmermann *et al.* 2009), and strategies and technologies that reduce post-harvest losses; and the high dependence on rain-fed agriculture although the potential for irrigation is high (UNEP 2013).

The region has great potential to increase agricultural production to especially cater for the most vulnerable segments of society such as children, adolescent girls, pregnant and lactating women and the elderly. Africa's policy makers believe that "agriculture and the food industry can be the engine for growth in Africa's largely agrarian economies, with tangible and sustainable impact on improving food security and nutrition, contributing to wealth and job creation, empowering women and enabling the expansion of exports" (AU and NEPAD 2003). Under Vision 2025 on the Comprehensive Africa Agriculture Development Programme (CAADP), African countries committed to raise annual agricultural productivity by at least 6 per cent every year from 2015, largely through expanded use of technological innovations, and to increase public investment in agriculture to a minimum of 10 per cent of their annual national budgets by 2015 (AU and NEPAD 2015).

Many African countries have embraced CAADP (**Figure 2.2.11**). A key challenge is to sustain this momentum without sacrificing the other environmental imperatives such as biodiversity conservation. In addition, SDG 2 on

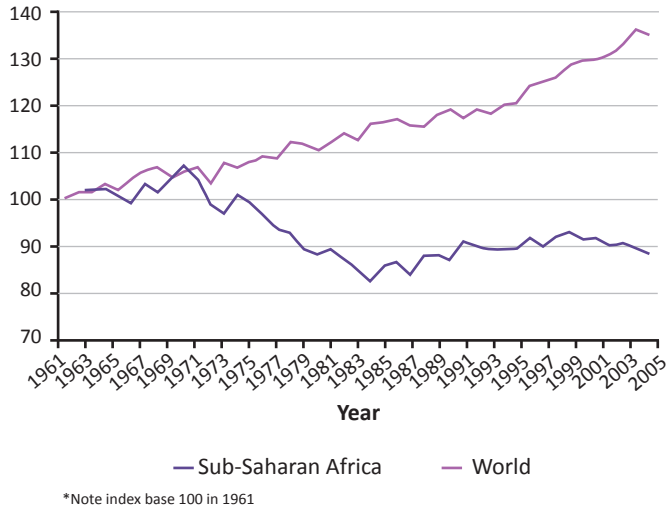
Figure 2.2.9: Progress on MDG 1, Target C to eradicate extreme poverty and hunger



Source: UN 2015

ending hunger cannot be attained until vulnerable persons have secure and equitable access to land, climate-resilient agricultural practices are implemented and the state of physical infrastructure and the delivery of agricultural extension and research services are improved. Commodity market distortions would also need to be addressed in order to better mitigate the risk of food price volatility. Fifty of the region's states are party to the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention). These are organized around three regional initiatives. The West African Coastal Zone Wetlands Network (WACOWet) covers 13 countries: Benin, Cabo Verde, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Nigeria, Senegal, Sierra Leone and Togo. The Ramsar Centre for Eastern Africa (RAMCEA) covers Burundi, Djibouti, Kenya, Rwanda, Uganda and Tanzania. The Niger River Basin Network (NigerWet)/Réseau Ramsar pour le Bassin du Niger (NigerWet) covers the Niger Basin party states: Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Guinea, Mali, Niger and Nigeria. In order to ensure the conservation and wise use of wetlands, Contracting Parties have designated several wetlands as Ramsar sites (**More…13**).

Figure 2.2.10: Per capita food production index



*Note index base 100 in 1961

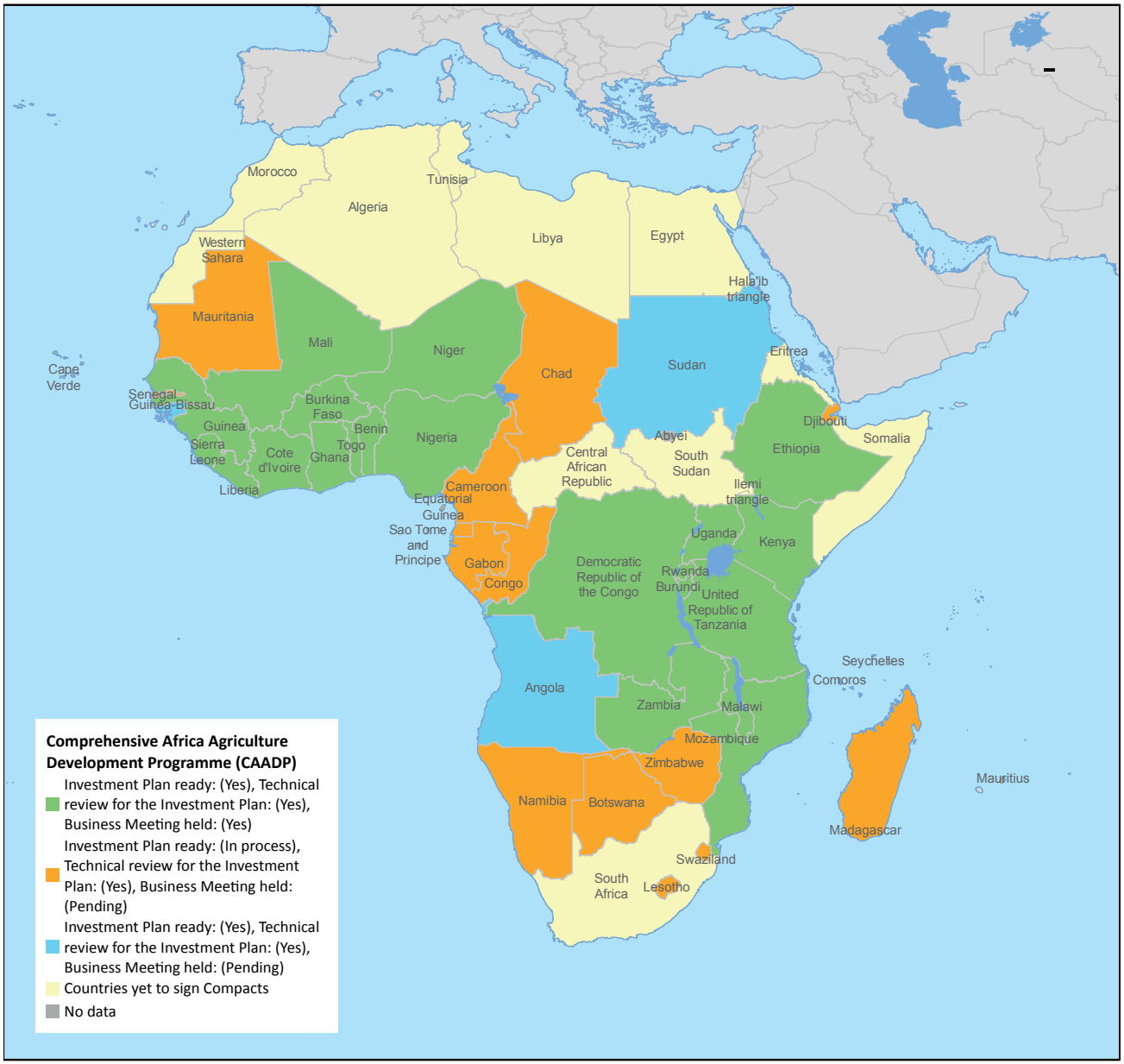
Source: UNEP 2013

To complement the Ramsar Convention, States undertook, under SDG 15 Target 1, to ensure that by 2020, wetlands are conserved, restored and sustainably used in accordance with international obligations. However, while the SDGs – including that on land – are compartmentalized for clarity and to make them more actionable, wetland degradation, (along with deforestation, land degradation and desertification) cannot be addressed independently of the other Goals that are central to true sustainable development. Sub-optimal land use is likely to lead to its degradation and diminish its capacity to eradicate poverty (SDG 1), eliminate hunger (SDG 2), ensure health and well-being (SDG 3) and safeguard access to clean and safe water and adequate sanitation (SDG 6) (Mohieldin and Caballero 2015), galvanize climate action (SDG 13), foster peace and justice (SDG 16) or take into account the numerous interlinkages between the Goals (WHO 2015). An integrated approach is therefore vital to leveraging the synergy of achieving the SDGs in a multifaceted but coordinated push.

All the region's countries are party to the United Nations Convention to Combat Desertification (UNCCD). Forty-two countries have submitted National Action Programmes (NAPs), which are the principal instruments for implementing the UNCCD at national level. Only six of these countries (Burundi, Comoros, Eritrea, Lesotho, Liberia and Namibia) have aligned their NAPs to the current UNCCD 10-year strategy. It is not clear how many NAPs have been integrated into the national development plans. Each of the NAPs feeds into one of the five Sub-Regional Action Programmes (SRAPs) and into the Regional Action Programme (RAP) (**More…14**).

Under the UNCCD process, the African Union created the TerrAfrica partnership to scale up investment, knowledge sharing and coalition building for sustainable land and water management in 24 countries. The Great Green Wall

Figure 2.2.11: CAADP country process



Source: CAADP 2016

for the Sahara and the Sahel Initiative was formed under TerrAfrica to address desertification and land degradation in the Sahel and Sahara, boost food security, and build communities' resilience to climate change. The Sahel and West Africa Programmme, which falls under the Great Green Wall Initiative, consists of an investment portfolio of USD 1 billion to support projects in 12 countries: Benin, Burkina Faso, Chad, Ethiopia, Ghana, Mali, Mauritania, Niger, Nigeria, Senegal, Sudan and Togo. To the extent that desertification is both human and climate-induced, efforts



A woman waters spring onions from an irrigation canal on a field outside Bewani, Mali.
Credit: Nic Bothma/EPA

should be made to address climate change (SDG 13). Many African countries have enacted national policies on climate change mitigation and adaptation and are aggressively promoting programmes such as REDD+ and its derivatives. However, given the feedback loop between climate change and human health, livelihoods, economies, biodiversity, land, the marine environment and a host of other areas, the national policies on each of these themes and the SDGs need to be implemented in an integrated manner in order to draw on the attendant synergies. For example, both because there is a weak link between environmental policy and economic policy and in the few instances where there are inter-linkages, economic imperatives invariably supersede their environmental counterparts, it is arguable that environmental improvements cannot be achieved without economic policy reform. This is borne out by research demonstrating that the prevalent, conventional macroeconomic models and indicators typically fail to account for ecological deterioration, including depreciation of natural capital (Obst and Vardon 2014, Harris and Roach 2013). On the other hand, because green accounting takes environmental degradation into account when computing national income estimates (El Serafy 2013), it has the potential to better entrench the more sustainable blue economy and green economy concepts, the latter of which is detailed in the Rio+20 outcome document.



Banana Plantation, Cameroon
Credit: Shutterstock /Matthias G. Ziegler

2.3 Water

Key Messages: Water

- Freshwater resources are unevenly distributed in Africa. With large disparities in access to safe water between urban and rural communities, there are economic opportunities for financial investments to increase water supply coverage areas and provide low cost solutions for water harvesting and efficient use.
- Despite recent improvements, about 32 per cent of Africa's population still does not have access to potable water, and 70 per cent lack adequate sanitation facilities. As a result, water-borne diarrheal infections are responsible for almost 8 per cent of annual deaths in the region. This calls for an urgent need to invest in low-cost technologies for the management of wastewater, as well as the delivery of safe drinking water. Appropriate technologies and innovative solutions to transform wastewater to valuable products, as well as water conservation strategies will go a long way toward protecting human and ecosystem health.
- Groundwater represents a significant under-exploited water resource, but as an initial priority there is a need to substantially improve the information base regarding extent and availability of the resource. Besides transboundary groundwater aquifers, Africa's 63 shared river basins call for the region to engage in effective integrated water resources management for the better protection of catchments and increased intra-basin cooperation in the equitable use of limited water resources.
- Despite unequal capacities across African states to generate hydropower, only 10 per cent of hydroelectricity potential is currently being exploited. Increasing the potential contribution of hydroelectricity for improved energy access will boost economic development, protect the environment from deforestation, and ensure healthy lifestyles.
- The degradation of coastal wetlands and unsustainable use of natural resources are impacting on the functioning of these ecosystems thereby affecting the livelihoods of communities that directly and indirectly depend on them. Assessing the economic value of these resources and incorporating community ownership for sustainable management will enhance existing strategies towards successful implementation.
- Many of Africa's fisheries, both inland and marine, face overexploitation from illegal, under-reported and unregulated fishing. Aquaculture holds great promise for exploiting this potentially sustainable source of protein, but it is a necessary pre-requisite to take biodiversity and other environmental implications into account when promoting this industry. The post-harvest losses in the fisheries sector also need to be curtailed.
- The potential carbon sequestration by the vast ecosystems of Africa's coastal and marine environment is not fully explored, and can provide an excellent opportunity for African states to contribute to and economically benefit from global mitigative actions on climate change.

2.3.1 Introduction

The availability of freshwater in Africa is uneven in distribution and prone to unreliable rainfall patterns. The availability varies according to climatic conditions, with tropical countries having large rivers and lakes while arid countries depend on groundwater, of which considerable amounts are largely untapped. The majority of countries in the arid and semi-arid North and Southern Africa sub-regions have lower per person internal renewable freshwater levels than the rest of the continent as **Figure 2.3.1** shows. With an average annual per person consumption of 31 cubic metres, Africa uses much less water than regions such as North America, which consumes 221 cubic metres per person per year (UNESCAP 2007). Agriculture and domestic consumption are the biggest users of freshwater in Africa, though there is great potential for using the resource for hydropower generation, with 90 per cent of the region's realizable hydropower capacity as yet undeveloped (IEA 2013).

Africa's expanding economies are resulting in greater demands for freshwater, but its quantity and quality are decreasing as a result of over-exploitation, climate change and pollution, while the growing population means that average internal renewable water resources will continue to dwindle. The proportion of the population served with clean water is increasing in proportional terms, from 64 per cent in 2005 to 68 per cent in 2012 (**Figure 2.3.2**) (UNEP 2015), although absolute numbers of population without safe drinking water remain high. More than half of the population in sub-Saharan Africa still does not have any access to improved sanitation, compared to 90 per cent coverage in North Africa, with a vast difference between urban areas (which are better served) and rural areas (AMCOW 2012). African megacities such as Cairo, Kinshasa and Lagos, and emerging megacities such as Dar es Salaam, Johannesburg and Luanda, face challenges from poor management of sanitation services due to inadequate and deteriorating infrastructure resulting from underinvestment. This has contributed to prolific unsanitary activities such as open defecation, and poor solid waste and wastewater disposal resulting in high pollutant loads of heavy metals, persistent organic pollutants and biological contaminants in water resources.

Land-based activities causing pollution of freshwater bodies ultimately impact coastal and marine resources. Africa's

Figure 2.3.2: Africa's access to drinking water, 2005–2012

Figure 2.3.2a

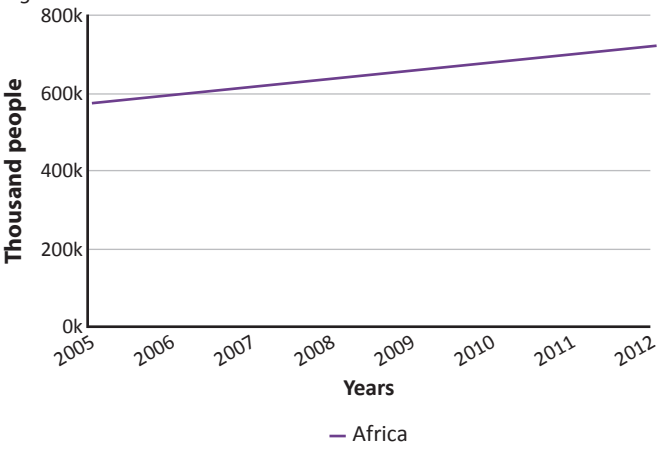
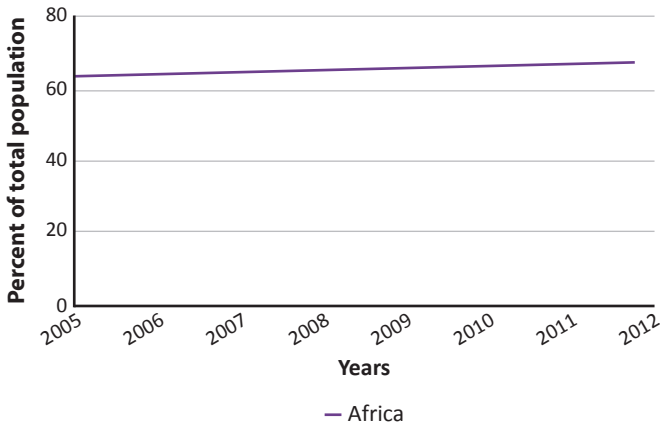
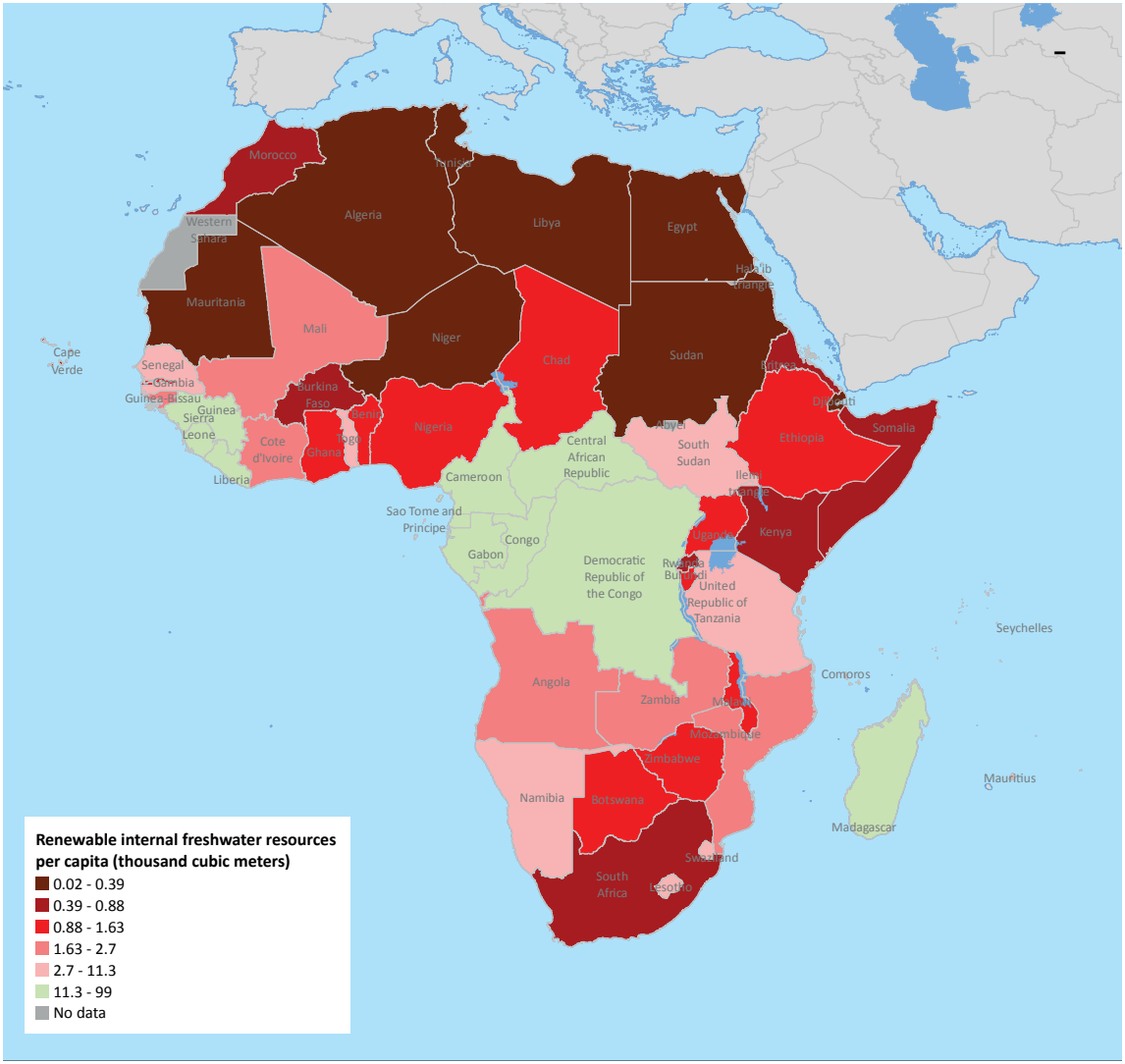


Figure 2.3.2b



Source: World bank 2016

Figure 2.3.1: Renewable internal freshwater resources per person in 1 000 m³



Note: The dark-red shaded countries have low per person renewable water availability, however, north African countries have other water sources from non-renewable aquifers

Source: FAO 2016

coastline measures 45 649 kilometres (Vafeidis *et al.* 2005). Bounded by the Mediterranean Sea, Atlantic Ocean, Indian Ocean and Red Sea, 33 of the region's 48 mainland countries have a coastline, while six others are island nations (Brown *et al*. 2011). The region's coastal and marine resources are important economic assets, providing fish, tourism services, trade access, and non-renewable resources such as minerals and gas. There are 320 coastal cities in Africa (UN-Habitat 2008), with associated high levels of economic activity, such as mining, oil and gas exploration, extraction and refining, and transportation. These economic activities attract large populations, and as a result, marine and coastal resources are prone to overfishing, pollution and coastal degradation.

2.3.2 Water quality and quantity

The quantity of water available for a range of human needs is variable, depending on the climatic and geological setting. Africa's main water consumer is agriculture, which often results in unwanted wastage through evaporation and runoff. In regions where water is a critically limited resource, there is increasing awareness of the use of water-harvesting technologies in agriculture to overcome shortages during dry spells and droughts, including rainwater harvesting, floodwater harvesting and groundwater recharge (**Box 2.3.1**).

Owing to their easy accessibility, lakes, rivers and streams are the main recipients of pollution across Africa and the quality of the water is often compromised. These aquatic systems, used as an immediate source of water for large cities, may not be suitable for direct consumption and such water is either wasted or requires expensive treatment. According to UNEP (2015), nutrient pollution in rivers is caused by runoff from agricultural activities, sewage and atmospheric nitrogen deposition. Estimates, for example, show a 10-80 percent increase in total nutrients exported by rivers to coastal areas between the period 1970-2000 and projections of higher total loads of dissolved nitrogen and

Box 2.3.1: Water harvesting, examples

A commercial horticultural farm situated along the banks of the Athi River outside Nairobi, Kenya, harvests 60 per cent of its 300 000 cubic metres water requirement from rainwater.

Water harvesting from Charco dam, as well as a storage tank at the South Pare Mountains, Tanzania, is crucial for livestock watering in the region.

Rainwater harvesting at Sekkouma –Irzaine, Morrocco, and Kiffa, Mauritania, has proven benefits for farmers and the environment.

Roof to surface catchments, reservoirs and tanks are key sources of domestic and agricultural water supply in Botswana, Kenya, Mali, Tanzania and Togo.

Runoff irrigation, floodng, micro-basins and rooftop water catchment are common practices in Ethiopia.

Sources: IRC (1990); Alem (1999); Kahinda *et al.* (2007); UNEP (2009)

phosphorus for future years (2000-2050) (Yasin *et al.* 2010) . This increases the risk of eutrophication in rivers, which can pose a threat to environmental and human health, affect tourism and lead to loss of livelihoods.

In addition to threats to water quality such as sedimentation, eutrophication and acidification of surface waters, climate change, the decommissioning and removal of dams from waterways, the discharge of chemicals into surface waters, and the identification of new and emerging pathogens pose challenges to maintaining water quality (UNEP/GEMS 2008). Few dams have been decommissioned in Africa, including the Wiken Weeg in the Kruger National Park in South Africa (Wray 2016). The removal of dams, which act as sinks for pollutants and silt, increases pollution loads downstream. However, the increase of dams in Africa both for water supply and energy is beneficial. The quality of freshwater from rivers is also affected by mine-water discharges containing toxic chemicals, though in the West Rand gold field of South Africa, for example, the discharge of acid mine water can, after expensive treatment, help to ensure the return of relatively clean water to the environment. At the same time, the direct flow of untreated mine water through the streams and rivers into the Hartbeespoort Dam may be having a negative impact on irrigation water owing to the concentration of toxic chemicals (Abiye 2014; Abiye *et al.* 2015). Environmental contaminants such as the highly persistent organochlorine pesticides (OCPs) which are used in industry and agriculture, especially have deleterious effects on aquatic ecosystems and organisms, as well as bio-accumulate in the fatty tissues of organisms. In Zimbabwe, for example, the use of DDT (dichlorodiphenyltrichloroethane) for control of malaria mosquitoes and tsetse flies was responsible for the high levels found in the Lake Kariba ecosystem (Berg 1995) and accumulated levels in human breast milk (Chikuni *et al.* 1997)

Due to its hidden nature within rock interstices and fractures, groundwater is less known to consumers, making uncontrolled land-use activities more likely to deteriorate its quality. Shallow groundwater is compromised by poor sanitation through the use of pit latrines. In the Sorou Valley in Burkina Faso, for example, shallow wells that are important local sources of drinking water are highly polluted with coliform levels of 1 x 104 cfu/100 ml, compared to WHO standards of 0 cfu/100 ml (Boubacar *et al.* 2013). In south-east Botswana, the government is working on the water quality, which deteriorated due to poor sanitation, to make it potable. Naturally high fluoride content, such as in the East African Rift valley groundwater, makes the water unfit for consumption. In addition, large-scale irrigation and industrial and mining pollution also play a significant role in making groundwater unfit for use by consumers. For example,



West Rand acid mine discharge, South Africa
Credit: Tamiru Abiye



Mine water treatment facility, West Rand, South Africa
Credit Tamiru Abiye

fluoride concentration in the groundwater of the Ethiopian Rift valley reaches 98 milligrams per litre, 180 milligrams per litre in the Kenyan Rift valley, and about 63 milligrams per litre in Tanzania, when the WHO drinking water standard limits for fluoride concentration is 1.5 milligrams per litre (Abiye 2010).

Gordon *et al.* (2013) observed that high population growth rates and associated impacts of reduced land cover and deforestation, coupled with global climate change, are affecting the ecological condition of the Volta River Basin. Increasing demand for water, in combination with reduced precipitation, has depleted stream flow by 50 per cent or more in some catchments (UNEP-GEF Volta Project 2013). There has also been an increase in the number of both large and small dams as a consequence of growing populations in settlements in Ghana, Benin and Burkina Faso. The construction of these dams has caused contamination, reduced water storage capacity and resulted in loss of aquatic ecosystems due to increased sedimentation, invasive aquatic species, increased proliferation of aquatic weeds, and downstream changes to the delta zone that affect estuarine processes and cause coastal erosion. The magnitude of sediment loads transported by rivers has important implications for ecosystem functioning through their influence on material fluxes, geochemical cycling, water quality, channel morphology, delta development and the aquatic ecosystems and habitats supported by the river. In Ghana, for example, the total fluvial sediment input to the coast has fallen from about 71 million cubic metres per year before 1964 (before the construction of the Akosombo Dam) to about 7 million cubic metres per year (Boateng *et al.* 2012), affecting the morphology and dynamics of the Volta delta area (Anthony 2015). The movement of sediments from soils exposed by deforestation and burning of farmlands, poor farming practices along steep slopes and river banks, overgrazing by livestock, intensive harvesting of fuelwood for energy, sand mining, and unplanned settlements, has removed land cover, increasing the storm-water runoff that carries sediments, nutrients and pesticides into rivers. For example, it has been estimated that 50 per cent of the soil eroded upslope is deposited within the White Volta sub-basin in West Africa (Tamene *et al.* 2008).



Students using borehole in the town of Torit, South Sudan
Credit: Shutterstock /John Wollwerth

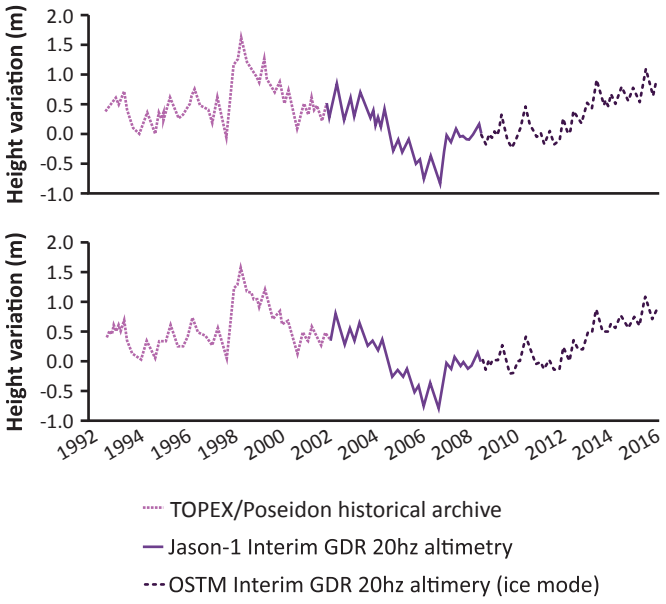
Energy production requires large quantities of water. As long as the demand for energy (oil, gas and electricity) in Africa increases, the energy sector's demand for water will also increase, exacerbating competition for the resource. Demands for freshwater and energy will continue to increase significantly to meet the needs of growing populations and economies, changing lifestyles and evolving consumption patterns, greatly amplifying existing pressures on limited natural resources and ecosystems (UNESCO 2014). Sparks *et al.* (2014) reported that South Africa's energy company, Eskom, uses 2 per cent of the country's national freshwater per year, which is equivalent to 0.6 per cent of annual Nile River flow or 0.3 per cent of Lake Victoria storage.

The impact of climate change on water quantity threatens Africa's aspirations to have adequate power from renewable sources such as hydropower. This is true for dams that are

mainly used for hydropower such as Kariba, where the water level dropped by 11.6 metres between 1981 and 1992 due to a series of droughts (SARDC and HBS 2010), resulting in reduced capacity to generate electricity (SARDC *et al.* 2012). Kling *et al.* (2014) reported that, based on modelling of the hydrological impact of water resource development and climate change scenarios on discharge conditions in the Zambezi basin, there is a decline in water levels in the major dams (Kariba and Cahora Bossa), which could affect water availability for irrigation and hydropower. Lake Victoria's water levels (**Figure 2.3.3**) have also been observed to be sensitive to climatic factors, with a declining trend recorded between 2003 and 2007 (Awange *et al.* 2008).

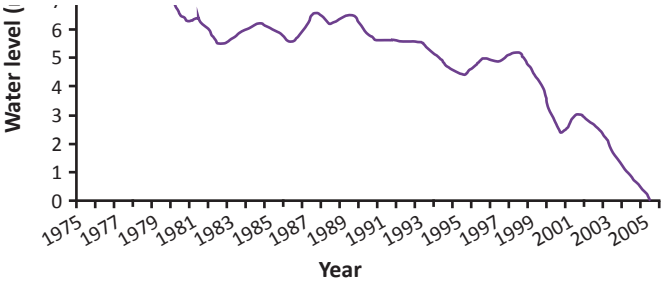
Over-abstraction to meet the needs of a growing population is blamed for the drying up of Lake Haromaya in Ethiopia at the end of 2005 (**Figure 2.3.4**), the main cause being rising demand for irrigation.

Figure 2.3.3: Annual water-level variations in Lake Victoria



Source: USDA 2015

Figure 2.3.4: Declining water levels in Lake Haromaya, Ethiopia, 1975–2005



Source: Alemayehu *et al.* 2007

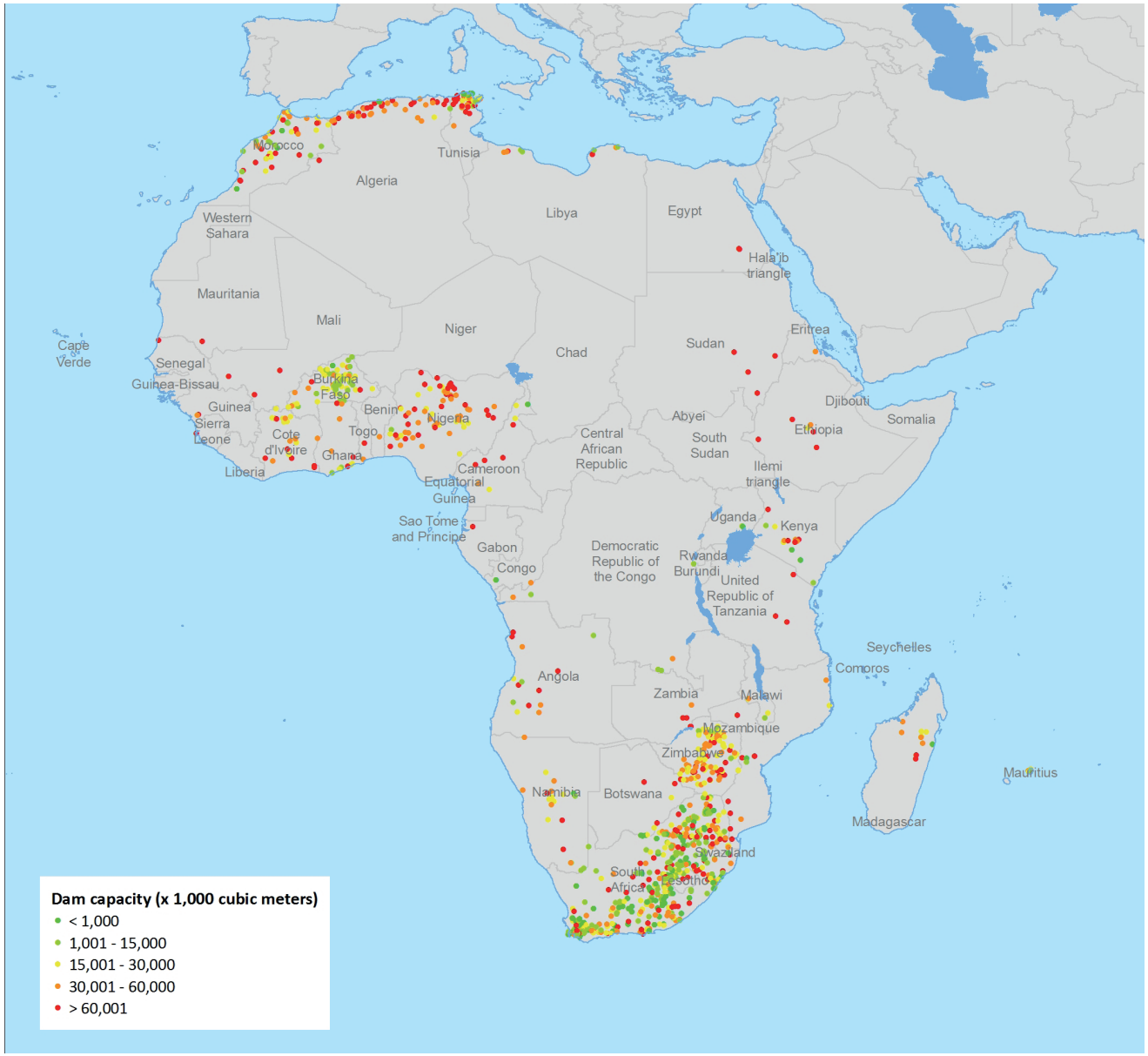
2.3.3 Availability and distribution

The main source of water for surface and groundwater storage is rainfall. Rainfall amounts are highly variable across Africa, from negligible over arid parts of the continent to very high in tropical countries. As a consequence, Africa's hydrology shows great variability in evaporation and stream discharge. The long dry season of more than five months over much of Africa increases reliance on groundwater storage (MacDonald *et al.* 2009).

More than 1 270 dams have been built on African rivers to store and supply water for hydropower and irrigation (UNEP 2008). Most of the supply dams are in North, West and Southern African countries (**Figure 2.3.5**), and are for the purpose of domestic water supply for large settlements, agriculture and hydropower generation (**More...15**).

Ahmed *et al.* (2014) revealed that large sections of Africa are undergoing significant variations in the total amount of water stored on land after precipitation has fallen as rain or accumulated as snow, filtered into the ground, or evaporated or departed from a basin as stream flow, with quantities ranging from more than 44 millimetres per year to less than 15 millimetres per year due to both natural and anthropogenic causes (**Figures 2.3.6** and **2.3.7**). Specific causes and variations include:

Figure 2.3.5: Distribution of dams across Africa



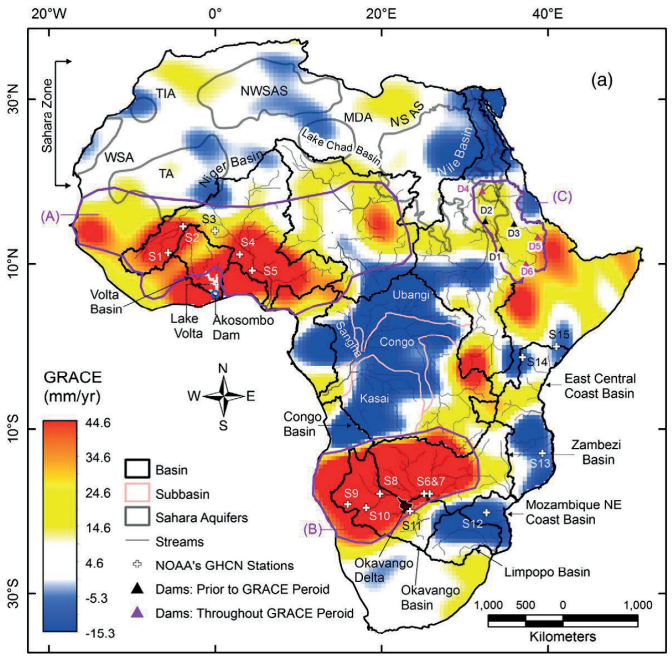
Source: UNEP 2010

- warming of the tropical Atlantic Ocean, intensifying Atlantic monsoons and increasing precipitation and total water storage over West and Central Africa;
- warming of the central Indian Ocean, decreasing precipitation and total water storage over East Africa;
- a high frequency of flooding events, increasing total water storage in the Zambezi and Okavango Basins;
- extraction of fossil groundwater, decreasing total water storage in Saharan aquifers;
- deforestation, decreasing total water storage in the three sub-basins of the Congo River Basin, namely Ubangi, Congo and Sangha;
- the construction of dams, increasing total water storage in the Blue Nile and Atbara sub-basins.

In addition, mountainous and forested areas that replenish many of the continent's river flows, or 'water towers', are under extreme pressure due to deforestation and encroachment (McClain *et al.* 2013). The water towers of Kenya, for example, are key national assets to the country's economy (UNEP 2012), however many areas of the Mau Forest Complex, the largest of the water towers, have been converted to agriculture and pasture land.

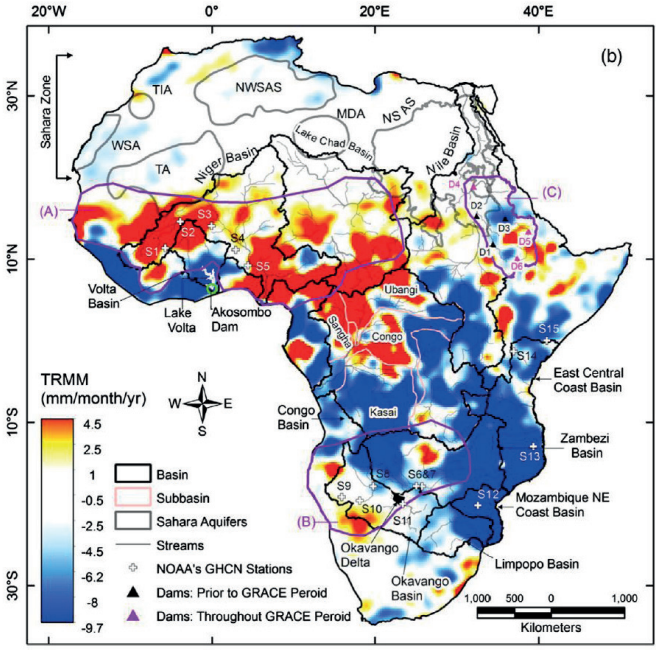
According to MacDonald *et al.* (2012), groundwater is a major source of Africa's drinking water, while its use for irrigation is projected to increase substantially to combat growing food insecurity. Some quantitative continent-wide

Figure 2.3.6: Total water stored in the land annually in Africa, 2003–2012



Note: Colour-coded linear images generated over Africa for the period 01/2003–09/2012 (GRACE data)
Source: Ahmed *et al.* 2014

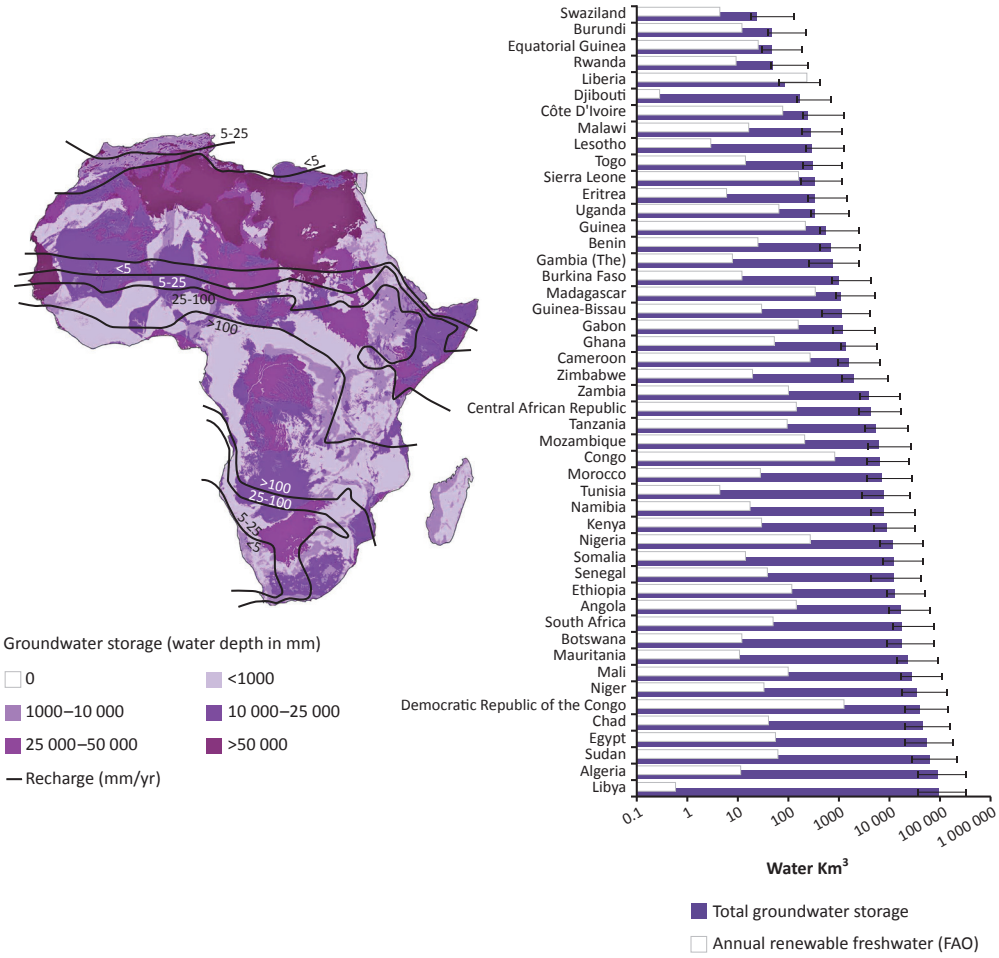
Figure 2.3.7: Annual precipitation over Africa, 2003–2012



Note: Colour-coded linear images generated over Africa for the period 01/2003–09/2012 (Tropical Rainfall Measuring Mission (TRMM)
Source: Ahmed *et al.* 2014

maps of aquifer storage and potential borehole yields in Africa have been constructed, based on an extensive review of available maps, publications and data. Through this method, total groundwater storage in Africa is estimated at around 0.66 million cubic kilometres (0.36–1.75 million cubic kilometres). However, not all stored groundwater is available for abstraction, owing either to its deep location making it difficult to access or to it being very saline. The estimated groundwater volume is more than 100 times that of annual renewable freshwater resources in Africa (MacDonald *et al.* 2012). The largest groundwater volumes are found in the extensive sedimentary rock aquifers in Libya, Algeria, Egypt and Sudan (**Figure 2.3.8**) (**More...16**).

Figure 2.3.8: Groundwater storage in Africa



Source: MacDonald *et al.* 2012

2.3.4 Transboundary water resources

There are 63 transboundary river basins in Africa, covering 64 per cent of the continent's land area and containing 93 per cent of its total surface water resource (UNEP 2010). Water supplies for big cities and irrigation are drawn from major dams erected on both local and international rivers where lake and river basin commissions are responsible for the management of these shared resources. Riparian countries often have varying requirements. On the Nile, for example, Uganda is highly dependent on the river for hydropower, while in Egypt much of the water is used for agriculture and domestic purposes.

Africa also has transboundary aquifers, found mainly in zones of high water demand. Some transboundary aquifers, such as the Nubian Sandstone Aquifer System, contain non-renewable water that was stored a long time ago. The water demand that results from population increase and stress induced by climate change may increase aquifer uses and rates of depletion, thus increasing the complexity and challenges of aquifer management.

Figure 2.3.9: Transboundary aquifers and international river and lake basins in Africa



Source: Altchenko and Villholth 2013

Aquifers in arid and semi-arid regions such as North, Southern and West Africa are likely to be affected by high temperatures, decreased precipitation and increasing water scarcity, as well as greater water use. An estimated 75 per cent of Africa's population is dependent on groundwater resources (Altchenko and Villholth 2013) (**Figure 2.3.9**).

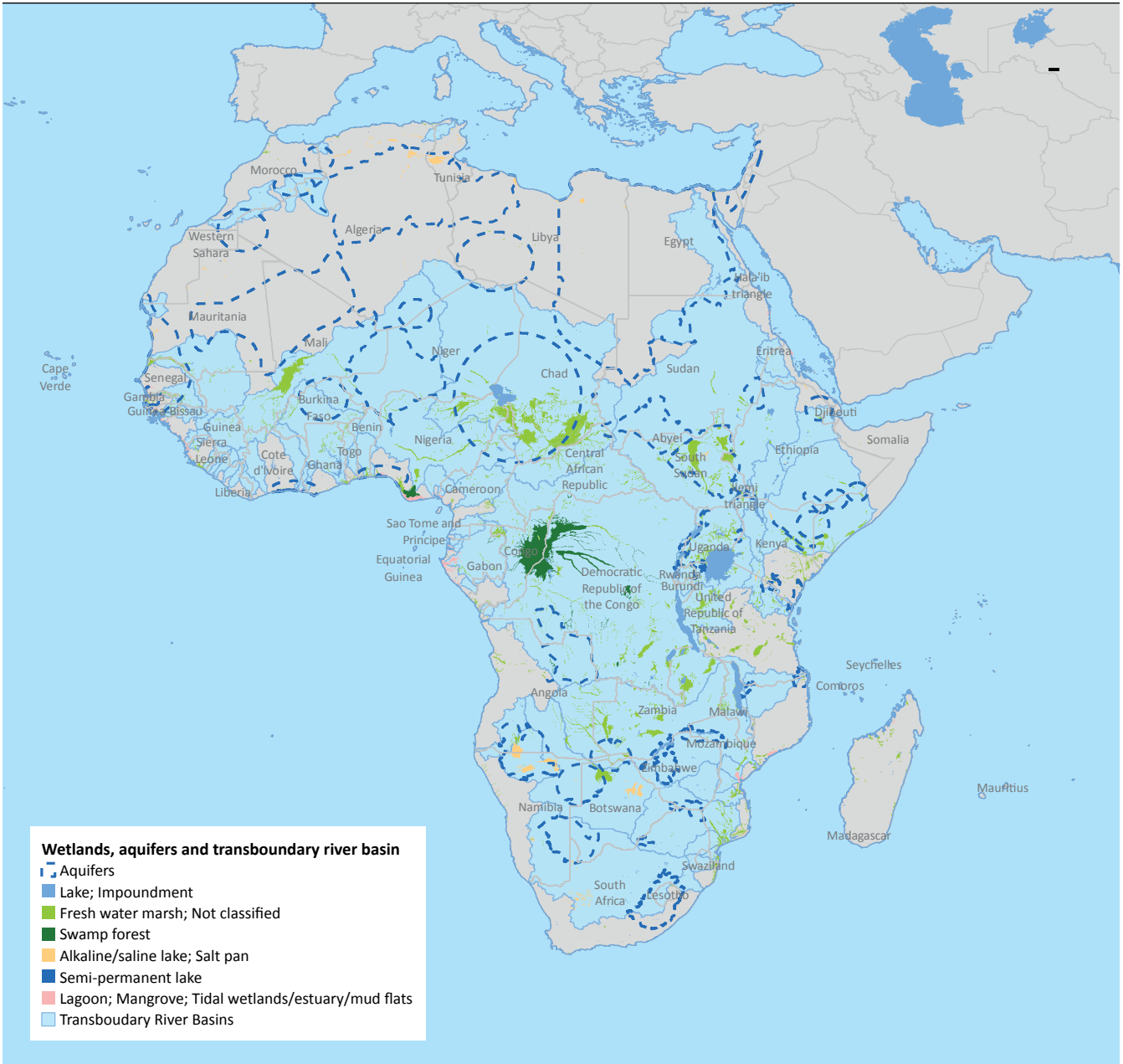
2.3.5 Wetlands

A wide range of wetland types is found in Africa, including natural and constructed freshwater marshes, river floodplains, swamps and peat lands, in addition to those containing a mixture of salt and freshwater such as estuaries and coastal lagoons (UNEP 2010). Wetlands constitute 1 per cent of Africa's total surface area, with the largest concentration of natural wetlands occurring in the Nile, Niger, Congo and Zambezi River Basins; Lake Chad and the wetlands of the inner Niger Delta in Mali; the East African Rift valley lakes; the Sudd in Southern Sudan and Ethiopia; and the Okavango Delta in Botswana (**Figure 2.3.10**).

Constructed wetlands are designed for the treatment of wastewater from settlements and mining, while natural wetlands are under immense pressure from human activities, the most important being wastewater discharge from agriculture, settlements and industry (Abiye 2015). In South Africa, for example, wetlands are in high demand for the treatment of mine-water pollution in the gold-mining areas of the Witwatersrand. Small constructed wetlands are often used to treat wastewater, enabling biological oxygen demand to be reduced by 60 per cent and microbial load by 100 per cent (Abiye 2015).

Mangrove forests inhabit many of the saline and brackish coastal and marine areas of the continent's coastline, in East Africa stretching from the coastal cities of Kismayu in Somalia to Maputo in Mozambique, on the West African coastline

Figure 2.3.10: Africa's major wetlands



Source: UNEP-WCMC 2006

stretching from northern Angola to their northern limit north of Tidra Island in Mauritania, together covering a total area of approximately 1.7 million ha (Kabii 1997). Mangroves are essential ecosystems, providing multiple ecological services including fisheries, shoreline stabilization, nutrient and sediment trapping and high biodiversity. The economic value of 1 square kilometre of mangroves is estimated to range between USD 200 000 and USD 900 000 annually (GEF *et al.* 2011). Mangroves in western Central Africa are among the most carbon-rich ecosystems in the world, with estimates that 1 299 tonnes of carbon dioxide would be released per hectare of pristine mangrove if cleared (Ajonina *et al.* 2014).

Mangroves are threatened by overharvesting for firewood, timber and charcoal; conversion to land for other uses including agriculture, aquaculture, infrastructure development, tourism and salt production; pollution, including from oil and gas exploration; increased sedimentation; and changing hydrology.

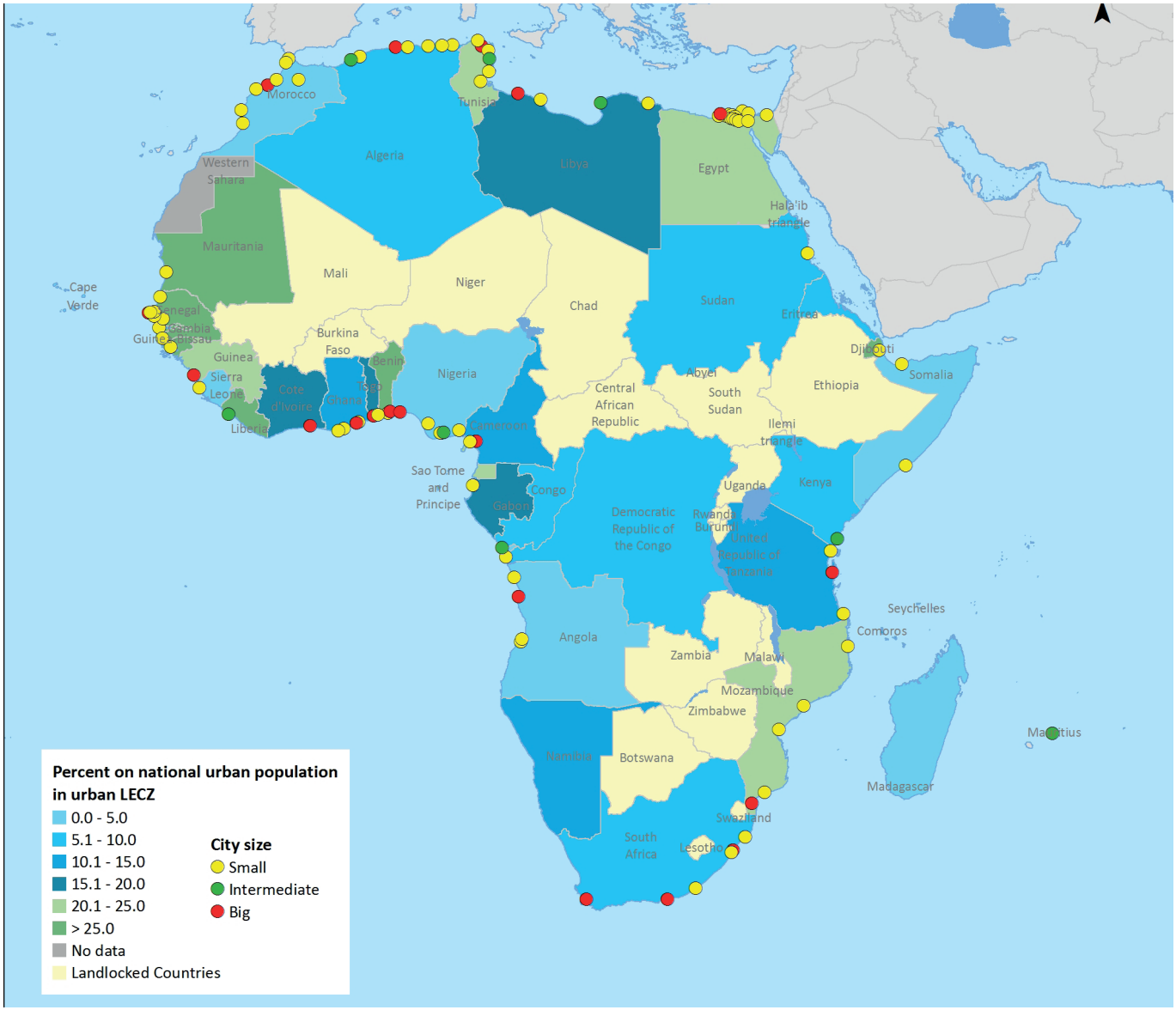
With projections of sea level rise along Africa's coastal zones by 2100 approximately 10 per cent higher than the global mean (Schellnhuber *et al.* 2013), the coastal wetlands of 37 countries will be vulnerable at various spatial and temporal scales. Densely populated low-lying coastal and estuarine zones, including small islands such as Seychelles, Comoros and Mauritius in the Western Indian Ocean, will be most affected. With a 1-metre sea level rise accompanied by 10 per cent intensification of storm surges, the mangrove areas of Gabon, Cameroon, Guinea, Guinea Bissau and Nigeria and the coastal lagoons of Angola and Ghana, in addition to low-lying coastal urban centres and ports, will be inundated (Dasgupta *et al.* 2011; Donkor and Abe 2012) (**Figure 2.3.11**) .

Salinity is an environmental stress and limiting factor for agriculture. Salt prevents, limits or disturbs normal metabolism, and affects water quality and nutrient uptake of plants and soil biota. One of the main characteristics of salt-affected soils is their temporal variability. Prolonged rainfall can lead to a temporary leaching of salt from the surface layers. In many salt-affected areas, small ponds are dug to



Anyanui mangrove market on the eastern coast of Ghana
Credit: Adelina Mensah

Figure 2.3.11: African cities at risk due to sea-level rise



Source: UN-HABITAT 2008

drain the saline water from the soil thus allowing limited agriculture on other parts of the land. The white deposits on the banks of the pond are evaporated salt crystals.

Coastal zones are subject to natural erosion and sedimentation processes, including high wave energy and strong littoral transport, but these are intensified by human activities such as sand mining, river damming, port construction, dredging, and mangrove deforestation. Harbour construction has altered long-shore current transport of sediment leading to erosion and siltation (**More...17**).

2.3.6 Fisheries

The fisheries sector contributes significantly to Africa's economies, providing income and employment to local fishers, local and foreign investors. More than 12.3 million people directly or indirectly depend on fisheries, including inland and marine, post-harvest activities and logistical support (FAO 2014). Women represent 27.3 per cent of the total workforce in the fisheries sector in Africa, with the majority engaged in post-harvest and less than 10 per cent working as inland fishers and in aquaculture. Of the global population engaged in aquaculture, Africa contributed more than 10 per cent in 2012, with the fastest annual growth rate of 11.7 per cent between 2000 and 2012 (FAO 2014) (**More...18**).

The fisheries sector contributes 1.26 per cent of Africa's total GDP, with estimates of more than USD 24 billion per year from inland and marine capture fisheries, and almost USD 3 billion per year from aquaculture in 2011 (de Graaf and Garibaldi 2014). Aquaculture production in inland waters increased from 639 000 tonnes in 2005 to nearly 1.4 million tonnes in 2011, representing an increment of 117 per cent, and this has put growing pressure on freshwater habitats (**Figure 2.3.12**).

Despite the increase in value of the fisheries sector, production in Africa is declining due to overexploitation and habitat degradation. In the Southeast Atlantic, for example, production fell from 3.3 million tonnes annually in the 1970s to 1.2 million tonnes in 2011 (FAO 2014). High



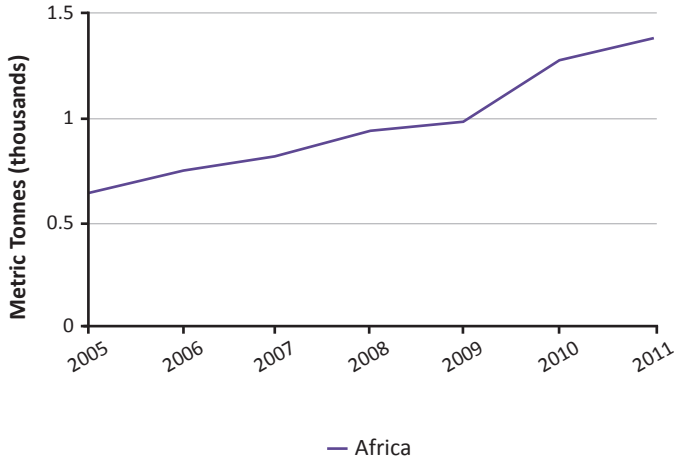
Sand being transported to communities upstream of the Volta estuary, Ghana
Credit: Adelina Mensah

post-harvest losses and poor quality of produce, due to the lack of adequate infrastructure and services for conserving and transporting fish, also contribute to food insecurity. Although many people resort to traditional methods such as salting, drying and smoking, losses are still high, with estimates of up to 40 per cent in Uganda (FAO 2010a).

In West Africa, destructive fishing practices among artisanal fishermen, including fishing with lights to attract small pelagic fish, use of small mesh, fish aggregating devices, poisons and explosives, have contributed to diminishing fish stocks, usually composed of lower fish diversity and juveniles. In Ghana, for example, overfishing has led to increased landings of smaller sized commercial species that would otherwise have a higher commercial value at a larger size.

Fishery losses to illegal, unregulated and unreported fishing are a rising concern in the region, especially as only 25 per cent of the marine catch is taken under agreement by non-African countries (de Graaf and Garibaldi 2014). Losses to

Figure 2.3.12: Aquaculture catch in Africa, 2005–2011



Source: FAO 2016

unsanctioned fishing are valued at USD 3.3 billion, which is eight times the current USD 0.4 billion earned through fisheries agreements with foreign nations (de Graaf and Garibaldi 2014).

In The Gambia, Liberia and Namibia, representing the Canary, Guinea and Benguela Current Large Marine Ecosystems (LMEs) respectively, there is large-scale under-reporting of domestic catches. In The Gambia and Liberia under-reporting is more than twice the levels reported to the FAO (Belhabib *et al.* 2015) (**Figure 2.3.13**), while in Namibia 9 per cent was under-reported, indicative of the strict management measures in place since 2006.

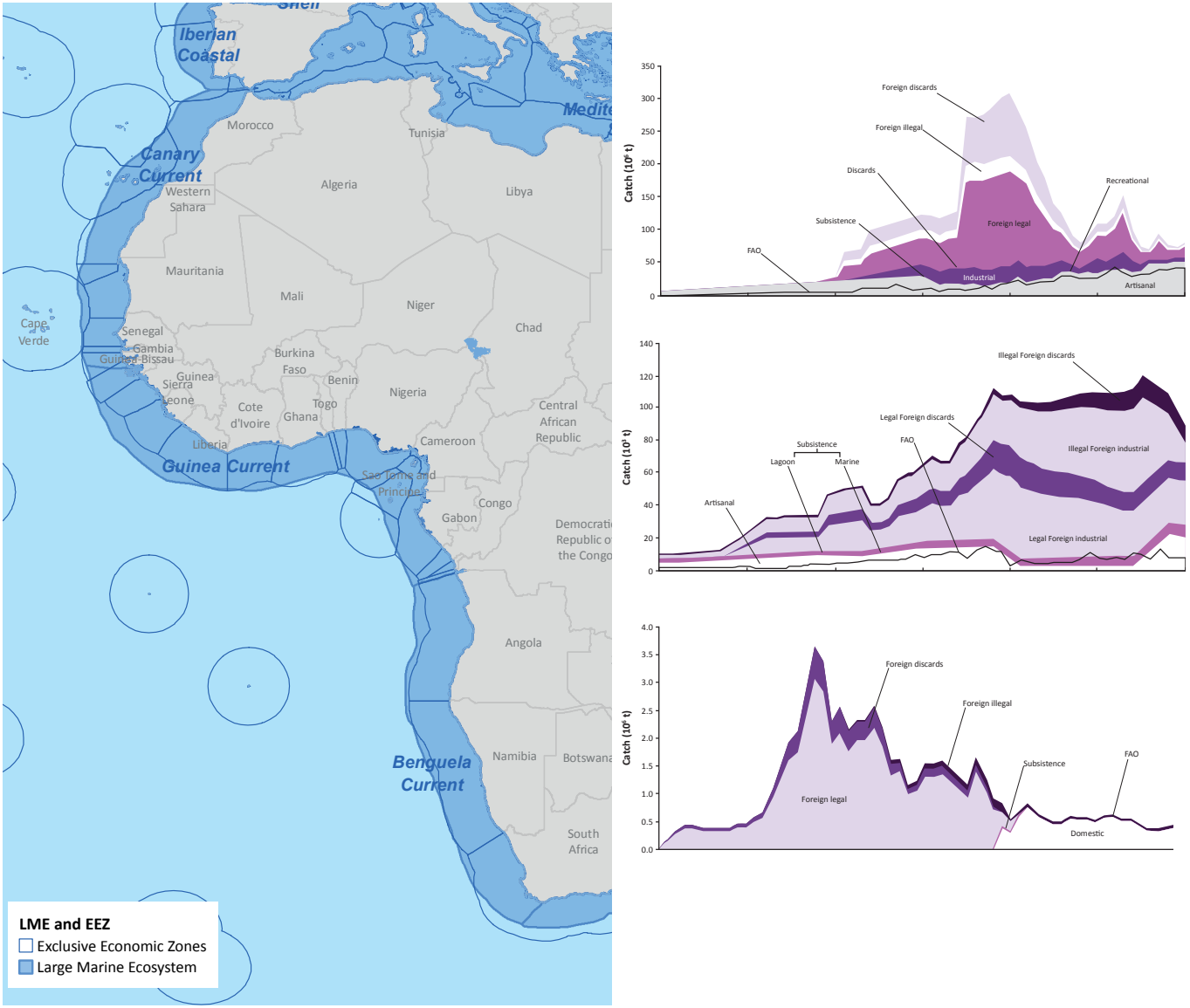
Fishery productivity is also affected by major climatic drivers such as ocean warming and acidification (Niang *et al.* 2014). In 2015, for example, intense upwelling in the southeast Atlantic and between the eastern coast of Africa and the Seychelles resulted in colder-than-usual sea surface temperatures with higher levels of chlorophyll, creating optimal conditions for fish growth (MESA 2015). In the north Mozambique Channel and the Canary LME, low chlorophyll in the former and an unusually warm sea surface temperature in the latter, could have influenced biological productivity. In East Africa, an increasing sea surface temperature has the potential to cause substantial declines of productivity in coral reefs, with implications for fish production and the livelihoods of communities (Cinner *et al.* 2012). West Africa is expected to face a substantial reduction in marine fish production and





Small-sized landed marine commercial fish, which are being landed in huge quantities in small sizes in Ghana Flying fish (*Fodiator acutus*) (on the left) Seabream (*Dentex spp*) (on the right)
Credit: Francis Nunoo

Figure 2.3.13: West African Large Marine Ecosystem boundaries for the Canary, Guinea and Benguela Current LMEs, and reconstructed marine catches by fishing sector for the Gambia (a), Liberia (b) and Namibia (c), respectively representing the LMEs



Source: Belhabib *et al.* 2015

fish protein supply by the 2050s (Lam *et al.* 2012), resulting in a 21 per cent drop in annual landed value, a 50 per cent decline in fisheries jobs and a total annual loss of USD 311 million to the regional economy. In South Africa, cooling rather than warming trends have been observed in offshore sea surface temperatures, with associated retraction of warm water species (Mead *et al.* 2013; Blamey *et al.* 2015) (**More...19**).

2.3.7 Blue economy

The blue economy plays a central role for coastal countries and island nations. For example, the six African small-island developing states of Cabo Verde, Comoros, Guinea-Bissau, Mauritius, Sao Tome and Principe and Seychelles are all highly dependent on blue economy sectors, and this represents both challenges and great potential. Fish exports are of particular importance to Seychelles, Cabo Verde and Mauritius, respectively representing 52 per cent, 43 per cent and 15 per cent of their total exports (UNECA 2014). Tourism makes a direct and indirect contribution to the GDP of Africa's island nations. Cabo Verde and Seychelles are particularly dependent on the tourism industry, with indirect contributions as high as 43 per cent in Cabo Verde and 57 per cent in Seychelles (UNECA 2014).

Africa's small island states are dependent on fossil fuels, and most of them spend at least 30 per cent of their annual foreign exchange earnings on oil imports while their vast renewable energy resources remain undeveloped (UNECA 2014). Currently they do not produce natural gas or oil, though favourable geological conditions suggest that oil and gas reserves may be found in the ocean around the islands. The territorial waters of Sao Tome and Principe, for example, are reported to hold exploitable reserves of oil and gas (UNECA 2014; PWC 2014). Massive gas finds have been made in the waters off Mozambique and Tanzania, while in 2012 Comoros granted its first licence for oil exploration and production (UNECA 2014).

The extraction of diamonds and metals, including gold and tin, from placer deposits in marine sediments and materials such as aggregates for construction and land reclamation have mostly taken place in near-shore areas (UNECA 2014). The United Nations Economic Commission for Africa (UNECA 2014) indicated that the small-island developing states are believed to have placer minerals along the coasts, phosphorites on the shelf, cobalt-rich crusts on the seamounts, massive sulphide deposits on the mid-oceanic ridges, and polymetallic nodules (ferromanganese nodules) on the deep abyssal seafloor. Exploration of seabed mineral availability has only seriously taken place in Mauritius and Seychelles and has not resulted in commercially viable production. Polymetallic nodules and polymetallic massive sulphides are the two mineral resources of primary interest to developers in the Indian Ocean (UNECA 2014).

Renewable blue energy from wind, solar, geothermal and ocean energy are a viable solution for island nations wishing to meet growing demand. According to UNEP (2013), investments in the green economy simulated in the South African Green Economy Model positively contribute to additional restored land without leading to a reduction in land requirements in the agriculture sector. The simulated scenario reveals an additional 46.4 per cent of restored land by 2030 and higher water availability. The carbon tax proposed in South Africa (Republic of South Africa 2013) will have a unique attribute in that it makes provision for the use of offsets to mitigate the tax liability of greenhouse gas emitters in the country. Through the Mikoko Pamoja project (Plan Vivo 2010), forest protection and planting activities helped to increase the quality and extent of the forest cover and maintain and enhance carbon sinks while raising income to the Gazi Bay community group in Kenya. Coral reefs play a significant role in tropical Africa and Red Sea through tourism and fisheries. Therefore, their protection is paramount to harness the benefit of marine resources for economic development.

2.3.8 Blue carbon

Nellemann's 2009 study indicated that although parties to the United Nations Framework Convention on Climate Change developed strategies and mechanisms to enhance terrestrial green carbon sinks, less attention was given to marine and coastal ecosystems, despite their capacity to

sequester comparable amounts of carbon both in their tree biomass and in the deep mud that accumulates around root systems. The abundance of mangrove forests, seagrasses and tidal marsh ecosystems in Africa is vital for global carbon sinks and sources and makes blue carbon useful as a means of meeting the need to reduce carbon in the atmosphere (**More…20**).

Chevallier (2012) indicated that coastal ecosystems of tidal marshes, mangroves and seagrasses capture and store large quantities of blue carbon in the plants and in the sediment below them. Degradation of the coastal ecosystems compromises their resilience and erodes their natural capacity for carbon sequestration.

Wetland mangroves are identified as the most carbon-rich ecosystem in the tropics. A study by Vasconcelos *et al.* (2015) conducted in Guinea-Bissau indicated that avoiding mangrove deforestation could contribute to mitigation of climate change in addition to preserving the many other vital services that these ecosystems provide. The study further indicated that if the price of avoided carbon dioxide emissions is more than USD 6.69 to USD 7.20 per tonne, and governance risks could be contained. It is possible to delineate cost-effective activities to avoid deforestation of mangroves and promote climate change mitigation activities in Guinea-Bissau using carbon revenues alone. The main blue carbon sink corridors along the coast of Africa take the form of seagrasses, mangroves and salt marsh communities.

2.3.9 Meeting Africa's goals for water

Africa's aspirations for the management and use of its water resources are contained in the Africa Water Vision 2025 (UNECA *et al.* 2000). While there appears to be a substantial supply of water on the continent, some countries continue to experience growing water scarcity. A growing population, increasing urbanization and increased industrial activity have resulted in an upsurge in both demand for and negative impacts on the resource. Consequently, the focus of Africa Water Vision 2025 is "… to ensure that water available in the future is sustainable and adequate in quantity to meet competing demands in the long run" (UNECA *et al.* 2000).

There are several GEGs on the management of water resources, including:

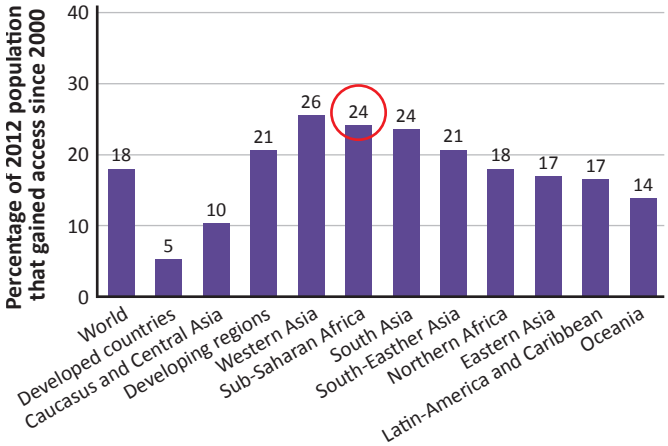
- providing access to safe and adequate water supply and sanitation services (SDG 6);
- stopping groundwater depletion (SDG 6);
- improving water use efficiency (Johannesburg Plan of Implementation);
- preventing freshwater pollution (Johannesburg Plan of Implementation), and
- preventing marine pollution (United Nations Convention on the Law of the Sea (UNCLOS)) (**More…21**).

The provision of safe drinking water and sanitation is a major challenge in Africa, with significant but not enough progress having been made in meeting global goals (UNEP 2013). In terms of achieving the MDG target for water supply, by 2015 Africa had reduced the percentage of the population without access to water supply by 21 per cent, the second highest jump in the world (**Figure 2.3.14**). Water coverage increased from 56 per cent in 1990 to 65 per cent in 2013. However, significant differences between populations in urban and rural areas exist. Over 90 per cent of the populations in urban areas use improved water sources with over 60 per cent having piped water. In rural areas, piped water is virtually non-existent in the poorest 40 per cent of households and less than half of the population use any form of improved source of water (UNDESA 2014).

According to the AU 2015, 54 per cent of the population in 47 African countries are still lacking adequate sanitation facilities. There have been various initiatives aimed at addressing this challenge, including:

- **Lake Victoria Region Water and Sanitation Initiative,** an initiative of the Governments of Kenya, Tanzania and Uganda and UN-Habitat aimed at addressing the water and sanitation needs of the population, particularly the poor, in the secondary urban centres around Lake Victoria.
- **Water for African Cities,** whose aim is to facilitate the adoption of measures to ensure access to

Figure 2.3.14: Percentage of the 2012 global population that gained access to water supply



Source: WHO and UNICEF 2014

environmentally sound water and sanitation service provision to the un-served and to improve access of under-served populations of target cities.

- **Water and Sanitation Programme: Economic Sanitation Initiative-Africa,** a programme that highlights how good sanitation policies and practices can underpin socio-economic development and environmental protection.

Inadequate levels of funding have been identified as a major limitation to achieving global and regional targets for water and sanitation. This, coupled with expected increases in populations on the continent, will continue to challenge attainment of SDGs 6.1 and 6.2 on achieving universal access to safe and affordable drinking water and adequate and equitable sanitation and hygiene. However, efforts are being made to address this through commitments contained in the July 2008 Sharm El Sheik Declaration to increase domestic funding allocation for sanitation development; the 2008 eThekwini Declaration of allocating 0.5 per cent of GDP to sanitation and hygiene; and the 2003 Pan African Implementation and Partnership Conference on Water Declaration to allocate 5 per cent of national budgets to water and sanitation (AU 2015). Ethiopia has since developed a plan to meet its sanitation commitment in line with the eThekwini Declaration and it is expected that other countries on the continent will follow suit (AU 2015).

Groundwater is the largest and most widely distributed store of freshwater in Africa. It is estimated to be 100 times the annual renewable freshwater resource and 20 times the amount stored in African lakes. While there is limited quantitative information on groundwater on the continent, its strategic role in addressing regional water issues is recognized. The 6th Ordinary Session of the African Ministers' Council on Water (AMCOW) held in Brazzaville made recommendations on the "Groundwater Initiative in Africa" and proposed the establishment of the Africa Groundwater Commission. The Groundwater Commission was expected to produce an inventory and map of existing groundwater resources, including hot-spots, and to provide strategic advice on the management of groundwater resources in Africa.

A rapidly growing population, urbanization, sanitation deficiencies and impacts of climate change on water availability continue to place tremendous demands and pressures on Africa's water resources. In response to these pressures, many African countries have internalized generally accepted principles of effective water resources development, management and utilization. Many African Union Member States have developed policies, plans and strategies on water efficiency, integrated water resources management (IWRM), climate change and disaster risk management.

Africa has 63 transboundary river basins. With this common resource having been recognized as a driver for economic growth on the continent, numerous policy and institutional frameworks have been developed to facilitate its cooperative management and to minimize conflict between riparian states. The African Network of Basin States was created in 2002 to facilitate and support the establishment and



strengthening of basin organizations in Africa based on the principles of IWRM.

There are approximately 80 international river and lake basins in Africa. (UNECA *et al.* 2000) with varying management frameworks. These include the Nile Basin Initiative, the Lesotho Highlands Water Project and the Zambezi Watercourse Commission. The SADC Protocol on Shared Watercourse Systems is identified by the AU, in its Africa Water Vision, as a model for what can be achieved when countries cooperate in the management of their shared water resources.

2.4 Biodiversity

2.4.1 Introduction

Africa is home to globally important biodiversity assets and ecosystems, including the Congo Basin rainforest, which is the second largest tropical rainforest in the world, and Lake Victoria, the second largest freshwater lake in the world (Myers *et al.* 2000). The continent has 119 terrestrial and 93 freshwater and associated wetland ecological regions (Thieme *et al.* 2005). Africa is home to 1 220 important bird areas (IBAs) (BirdLife International and AZE 2015), and has eight out of the 34 biodiversity hotspots in the world (Myers *et al.* 2000).

The variety of habitats across a range of ecological regions implies that Africa holds exceptional concentrations of biodiversity, including a high proportion of endemic species. Overall, there are 7 291 known species (IUCN 2015a) of which 1 229 are mammals, more than 2 000 are birds and 950 are amphibians (Scholes *et al.* 2006). Africa's continental freshwater ecosystems hold 2 945 fish species. The eight biodiversity hotspots in the region are important, concentrating 1 500 endemic vascular plants (Levêque *et al.* 2008) while it is estimated that there are 5 015 endemic species continent-wide (IUCN 2015b). Yet, habitats and species of the continent are also increasingly threatened (Myers *et al.* 2000). Forty-nine species have been documented to have gone extinct in the recent past across the continent, and there are as many as 1 258 threatened species in 2015 (IUCN 2015a). All the sub-regions present negative weighted annual change in the Red List for mammals (range between -0.18 and -0.38), birds (range between -0.08 and - 0.48) and amphibians (range between -0.40 and -0.99), therefore contributing negatively and significantly to the overall annual change in the global Red List Index between 1980 and 2008 (IUCN and BirdLife International 2015). However, significant efforts have been invested by national governments, international institutions and donors to preserve that biodiversity. There has been a significant increase in the creation of protected areas of all categories. Hence more than 4.5 million square kilometres, representing 10 per cent of all ecological regions, have been set aside to preserve biodiversity across the continent (IUCN and UNEP-WCMC 2015).

Key Messages: Biodiversity

- Africa's rich biodiversity is a base for various ecosystems services including food, clean water and air. However, this critically important natural capital faces significant threats from illegal trade in wildlife, mono-cropping, air and water pollution, forest loss, climate change, and increased prevalence of invasive alien species.
- Despite illegal trade in wild flora and fauna being a global problem, it poses serious economic and security risks for Africa. The region is called upon to ensure that the African Union strategy on illegal trade in wildlife is translated into action, fully implemented and regularly monitored.
- The link between biodiversity and human health and wellbeing is increasingly better understood, but further research is required, especially with regard to zoonoses.
- The weak valuation of biodiversity as an asset for economic development contributes to inadequate conservation efforts and undermines its importance to agriculture, for example in protecting pollinators and maintaining diversity to adapt to climate change. It is recommended that Member States actively include a system of factoring biodiversity and ecosystem services into national accounting systems.

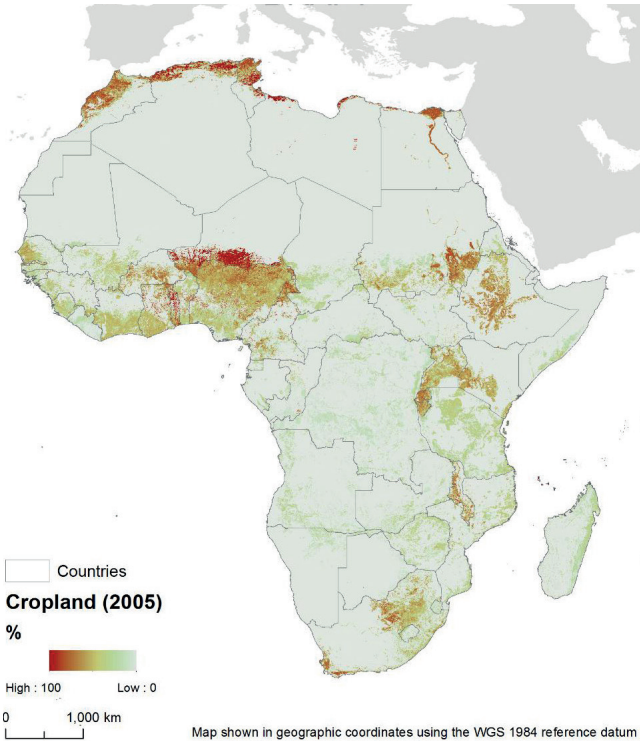


Flamingos on Lake Nakuru, Kenya
Credit: Shutterstock/Alan Ward

Major threats to biodiversity in Africa include habitat destruction, deforestation, habitat conversion and disturbances such as habitat fragmentation, overexploitation of some species, invasive alien species, pollution, and climate change and variability. Changes in land use and lack of appropriate land-use planning contribute to loss of habitats and biodiversity. Agricultural expansion (**Figure 2.4.1**), establishment of settlements in biodiversity-rich ecosystems and sensitive areas, expansion of livestock into wildlife management areas, excessive collection of firewood and construction materials, and illegal exploitation of wildlife also contribute to biodiversity loss. Invasive alien species of both plants and animals are a serious threat to local biodiversity in the region. Noble interventions such as aquaculture have been observed in some cases to disrupt ecosystems with negative impacts on biodiversity. Diana (2009) observed that species escaping from aquaculture can become invasive in areas where they are not native, while effluents from aquaculture can result in eutrophication.

Loss of biodiversity and ecosystem services could result in depletion of food, raw materials and medicines, with negative impacts on human health. Environmental services such as ecosystem stability depend on the richness of species diversity (Blench and Sommer 1999). For example, where biodiversity is conserved, post-drought recovery of ecosystems is rapid (Blench and Sommer 1999). Reductions in biodiversity also lead to lost income from wildlife and nature-based tourism, particularly for countries such as Ghana, Kenya, Rwanda, South Africa, Tanzania and Zimbabwe, where wildlife-based tourism contributes significantly to gross domestic product (GDP).

Figure 2.4.1: Cropland in Africa - expansion of the area under cultivation is a major threat to biodiversity loss



Source: Fritz *et al.* 2015

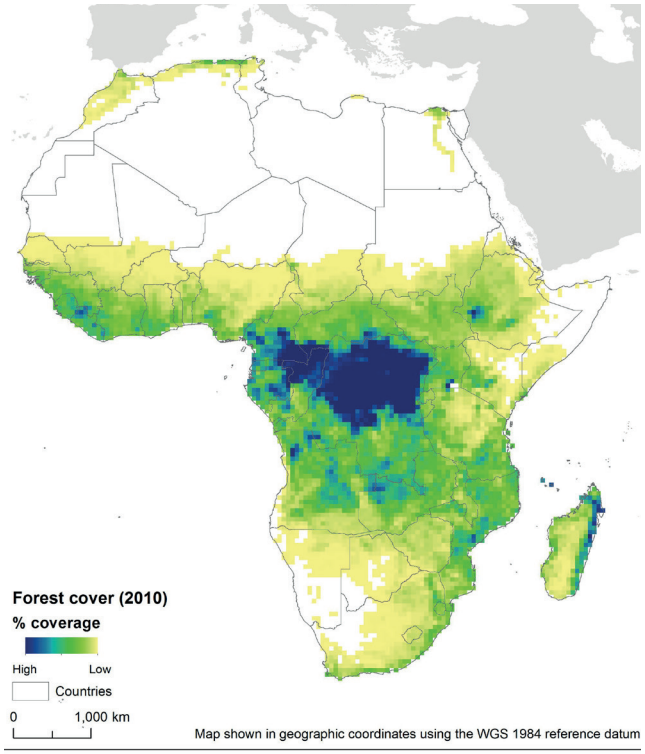
2.4.2 Biodiversity loss

Forests and woodlands constitute major habitats in Africa (**Figure 2.4.2**). They occupy 23 per cent of the region's land area (FAO 2010b) and represent 16.8 per cent of global forest cover (Sebukeera *et al.* 2006). Climatic events in the Pleistocene period shaped the current geographic spread of African forests (Marley 2014), with savannahs covering large areas of Africa during an arid climate phase, then retreating when humid conditions returned, enabling forests to recolonize the savannahs from forest refugia. This forest history shows how sensitive African forests have been to climate change in the past, and it presents a pointer for the potential shifts in forest cover in the future should mitigation efforts to curb the effects of climate change fail. The central mass of Africa's forest is within the Congo Basin and includes the Guineo-Congolian Forest, a complex and diverse botanical region with between 1 500 and 2 000 vascular plant species, of which 10 per cent are endemic (White 1983). The rest of Africa harbours dry and woodland forests dominated by woody plants in climates with a dry season of three months or more (Timberlake *et al.* 2010).

Africa's forests provide several key and irreplaceable ecological functions that sustain the availability of key resources such as drinking water, animal and fish proteins, energy, medicines and cultural values for communities. Almost all the water used in the dry season for drinking and hydroelectricity generation for Dar es Salaam, Tanzania, comes from the cloud forests of the Uluguru Mountains, while in Kenya, water from Mount Kenya generates 97 per cent of the country's hydroelectric power and provides water for drinking and domestic purposes to more than 7 million people (Gratzer *et al.* 2011). Meat from wild terrestrial or semi-terrestrial species is a significant source of animal protein in African countries and constitutes a crucial component of food security and livelihoods in rural areas (Van Vliet *et al.* 2010). In the Congo Basin, 1–5 million tonnes of meat are consumed annually (Van Vliet *et al.* 2010).

With a rapidly growing human population, African forests and biodiversity are under threat. The region's high reliance on natural assets means that most of Africa's economic sectors are dependent on extracting raw materials such as timber from forests. With a net deforestation rate of 0.17 per cent in 2010, the Congo Basin forest was, in comparison with other forests of the world, the least logged (Ernst *et al.* 2010). This figure masks variations between countries, with Democratic Republic of the Congo – which holds more than 50 per cent of the Congo Basin's forests – losing about 0.32 per cent (19 800 square kilometres) of forest cover annually between 2005 and 2010. Besides logging, other factors such as fuelwood collection, mining and oil extraction, and agriculture threaten Africa's forests and biodiversity. Some pristine forests have been converted to monocultures of palm and sugar cane, among other crops. According to

Figure 2.4.2: Africa's forests: some of the continent's most important habitats



Source: WCMC 2015



Seed heads of sorghum in a field in Africa.
Credit: Shutterstock /ChWeiss

Blein *et al.* (2013), recent decades have seen large-scale investment contracts in Africa, including 20 million hectares of monocultures of industrial crops such as sugar cane, a landmass equivalent to the arable land area of South Africa and Zimbabwe combined.

The impacts of timber logging on forest cover vary between countries. A common concern of significant importance across Africa is that in many countries timber logging is now reaching the margins of sustainability. Industrial logging represents an extensive land use in the Congo Basin where 44 million hectares of forest is under concession, and this represents 25 per cent of the total dense lowland forest area (Lescuyer *et al.* 2010). Industrial logging produced 8.4 million cubic metres of timber in 2007 from Gabon, Cameroon and the Democratic Republic of the Congo. Lescuyer *et al.* (2010), however, noted that small-scale artisanal logging is an equally important cause of ecological, economic and social impacts. Artisanal logging covers most of the domestic timber market but has also become part of the informal traffic in biological assets. Artisanal logging in the Democratic Republic of the Congo produces five to eight times more than official industrial timber production (Lescuyer *et al.* 2010). Logging clears canopies and opens linear gaps in the forest, in the process fragmenting habitats for wildlife species by creating small isolated islands (Laurance *et al.* 2009). Other deleterious impacts of logging on forest species biodiversity include physical disturbance, chemical pollutants, edge effects, and road-related mortality and barrier effects. Infrastructure associated with logging can have major impacts on local soils, hydrology and aquatic ecosystems, leading to upstream flooding and downstream water shortages, which can be lethal for patches of wetland vegetation (Laurance *et al.* 2009; Saunders *et al.* 1991). Apart from the habitat fragmentation it causes across the continent, the effects of logging include reductions in primate abundance and diversity in Central Africa (Remis and Robinson 2012), while in Uganda, group sizes for black-and-white *Colobus* populations have been found to be significantly smaller in cleared forests than in continuous canopy forests (Onderdonk and Chapman 2000). Fragmented Ugandan forests have also been found to have lower seedling density and fewer species of seedlings, which suggests that disrupting the complex interactions between primates and fruiting trees by logging can have negative and possibly cascading effects on ecosystem processes (Chapman and Onderdonk 1998). The effects of logging on Ugandan birds have been documented to last for as long as five decades after logging has ceased (Dale *et al.* 2000). Similar effects have been reported from other parts of Africa, including in West Africa where habitat fragmentation has affected chimpanzee populations (Torres *et al.* 2010), and in South Africa where the abundance of some species of bees has been negatively affected (Donaldson *et al.* 2002), with the potential to impact pollination processes.

Some 80 per cent of African people are dependent on fuelwood – either as charcoal or as wood – as their sole source of energy. This figure increases to more than 90 per cent in rural parts of the continent and particularly in East, West and Southern Africa (Sebukeera *et al.* 2006), and becomes as high as 95 per cent in countries of the Congo Basin such as Democratic Republic of the Congo (UNEP 2001). This

situation, in combination with increased populations and trade in fuelwood and charcoal, depletes significant areas of forests across the continent. The depletion is extensive in peri-urban areas. For example, fuelwood and charcoal collection and production are estimated to have caused about 24.6 per cent (29 268 hectares) and 19.58 per cent (23 308 hectares) of the degradation and deforestation of closed woodland, respectively, in areas around Dar es Salaam, Tanzania, and to have depleted 92 761 hectares (50.8 per cent) of open woodland in the same area (Malimbwi and Zahabu 2008). According to Megevand *et al.* (2013), Kinshasa, a megacity of 8–10 million inhabitants, consumes about 5 million cubic metres of fuelwood annually, which is harvested from degraded forest galleries within a radius of 200 kilometres of the town. Similar findings have been reported for most of the other cities in Central Africa, including Kisangani, Brazzaville, Pointe Noire, Libreville, Franceville, Port Gentil, Douala, Yaoundé and Bata. It is also worth noting that charcoal production in the Congo Basin increased by about 20 per cent between 1990 and 2009 (Megevand *et al.* 2013).

Beyond the threats related to habitat fragmentation and destruction, poaching too has become a significant menace to African biodiversity, causing alarming declines in species, particularly large-bodied ones, including mammals, birds and amphibians. Large mammalian species are particularly targeted for their meat and commercial value. Recent research indicates that charismatic species such as elephants will become extinct if current rates of poaching continue (Maisels *et al.* 2013), with the northern white rhinoceros (*Ceratotherium simum*), a species endemic to Democratic Republic of the Congo, nearly extinct in the wild because of poaching. Large forest tracts, such as the Salonga National Park in Democratic Republic of the Congo, have become vastly less densely occupied by large mammals. To many conservation biologists practising in Africa, poaching is a major driver of diminishing species populations across the continent. Another potential threat is disease outbreaks, especially among primates (Inogwabini and Leader-Williams 2012) such as chimpanzees and gorillas, which can contract serious human diseases. The 2003/2004 Ebola outbreak in the range of the western lowland gorilla wiped out large numbers of individuals and could, if prolonged, have exterminated the whole species (Walsh *et al.* 2007; Walsh *et al.* 2003).

In addition to forests, Africa has extensive rangelands, which include natural grasslands and savannahs, covering 65 per cent of the region's total land area and providing habitat for domestic livestock, wild plants and wild animals (Niamir-Fuller *et al.* 2012). Rangelands are rich in floral diversity as demonstrated by the average areal richness of savannah, which is about 1 750 species per 10 000 square kilometres, compared to 2 020 species per 10 000 square kilometres in rainforest (Menaut 1983). Blench and Sommer (1999) reported that the rangelands of East and Southern Africa shelter the greatest diversity of large mammals in the world.

Arid and semi-arid rangeland ecosystems are characterized by seasonal climatic extremes and unpredictable rainfall patterns, but they contain a great variety of biodiversity, much of which is highly adapted to dryland ecology. Species in these drylands have developed unique strategies to cope with low and erratic rainfall. They are drought tolerant and also highly resilient, recovering quickly from disturbances such as fire, herbivore pressure and drought.

Africa's rangelands are under threat of biodiversity loss due to the degradation of ecosystems and habitats caused by encroachment by woody plants, high livestock and human populations, weakening of traditional resource management strategies, uncontrolled fire, expansion of villages and towns, expansion of crop cultivation, recurrent droughts and invasive alien plant species (Kebede 2009; Gemedo Dalle *et al.* 2006; Oba and Kotile 2001; Oba *et al.* 2000; Scholes and Archer 1997). Conversion of rangeland to cropland and other land-use types also causes rangeland degradation and biodiversity loss (Gemedo Dalle *et al.* 2006).

The many and diverse aquatic ecosystems such as wetlands, rivers, lakes and coastal environments provide habitat for a rich and unique aquatic biodiversity. Equally important are marine ecosystems. According to PERSGA GEF (2003),

as cited in the fifth National Report of Eritrea (de Grissac and Negussie 2007) the Red Sea represents a complex and unique tropical marine ecosystem with extraordinarily rich biodiversity and a remarkably high degree of endemism. It is one of the most important repositories of marine biodiversity on a global scale and features a range of significant coastal habitats. The southern part of this sea is rich in marine plants, especially seagrasses, which are the only group of higher plants (flowering plants) adapted to life submerged under the sea. The Eritrean Red Sea ecosystem hosts 12 of the world's 60 existing seagrass species (Grissac and Negussie 2007), and is also known for diverse coral reefs, with about 38 coral reef genera and 220 species recorded in the area. The Eritrean coastline and islands are vegetated with different species of halophytes and a few non-halophyte plants such as grasses and trees, including several mangrove species: *Avicennia marina, Ceriops tagal, Avicennia tagal* and *Rizophora mucronata*.

Thieme *et al.* (2005) attributed threats to aquatic ecosystems to the disturbance of water bodies by damming, water diversion and pollution. Additionally, activities on land adjacent to water bodies have significant impacts on the health of aquatic ecosystems (Stiassny *et al.* 2011). These activities include major urban development along rivers and lakes, inland agricultural activities and forest logging. The introduction of alien species has been observed to affect some freshwater bodies.

Developments currently underway in most African countries will have severe effects on freshwater bodies and associated wetlands. All four major rivers (Congo, Niger, Nile and Zambezi) have dams and three of them (Niger, Nile and Zambezi) have already been significantly affected by their presence. The construction of a large dam on the Nile will certainly affect the freshwater habitats of the river, while the projected Grand Inga Dam in the Democratic Republic of the Congo will have a similar impact if constructed without proper environmental impact assessment and well-planned scenarios to mitigate potential future effects.

In recent years, the impacts of mining on the waters and soils of African ecosystems have been identified and are considered very serious. For example, the upper reaches of the Olifants catchment (South Africa), which is part of the larger Limpopo Basin and hosts large-scale coal mining, coal-fired power generation plants and a diverse array of heavy and light industries (Ashton 2010), contains high concentrations of trace metals. These concentrations are suspected of causing the large-scale fish deaths that were observed over the last few decades in Lake Loskop, which is at the heart of the Olifants catchment (Oberholster *et al.* 2011; Ashton 2010). This type of problem has also been documented for many of the rivers and water bodies of Southern Africa (Ochieng *et al.* 2010). Beyond the biodiversity impacts of mining, the accumulation of high levels of metal ions in African rivers renders fish unfit for human consumption and poses problems for irrigated crops and domestic use of water from affected freshwater bodies. Contamination of freshwaters in Africa and its potential effects on biodiversity as well as humans, has also been reported in other regions, including the upper Congo (Atibu *et al.* 2013).

The scramble for cultivatable lands will also affect freshwater bodies and associated wetlands. This includes the recent acquisition of large land areas by commercial interests for agriculture in Ethiopia, Ghana, Mali, Mozambique, Senegal, Tanzania (Kachika 2011) and South Sudan (De Schutter 2011). Major agricultural developments have been reported in Kenya (Klopp 2000), and agricultural expansion is also slowly entering the Congo Basin, where massive projects have been initiated. A quantitative inventory conducted in Ethiopia, Ghana, Madagascar, Mali, Mozambique, the former Sudan and Tanzania (Cotula *et al.* 2009) found schemes to bring 25 000 square kilometres under cultivation for large agricultural development. Such land-use change may deplete forest biodiversity and, as documented by Foley *et al.* (2005), demands on water resources for irrigating the arid zones of the continent have a significant impact on water stocks, draining groundwater and freshwater ecosystems and associated wetlands. Furthermore, clearing forest and other land habitats leads to erosion, which if combined with

the use of chemicals will affect water quality and, therefore, the diversity of fish and other water-dependent organisms.

In addition to the above threats to the health of freshwater environments and ecosystems, the direct off-take of fish poses serious problems in many African lakes, rivers and swamps. Overfishing and the use of techniques that are destructive to both the environment and fish stocks have caused declines in fish stocks in Lake Victoria (Goudswaard *et al.* 2002; Marten 1979), the central Congo Basin (Inogwabini 2013) and Lake Chad (De Young *et al.* 2011). A further threat comes in the form of natural changes that could easily be linked to climate change, though this is still to be proven. For example, the Lake Chad water basin has been shrinking over recent decades (De Young *et al.* 2011), while a trend of dramatic decline has been documented for the waters of Lake Tumba in the central Congo Basin (Inogwabini *et al.* 2006).

Africa's biodiversity is under threat from invasive alien species, with all countries affected – including South Africa, where 81 invasive alien species have been identified, Mauritius with 49, Swaziland with 44, Algeria and Madagascar with 37 each, Egypt with 28, Ghana and Zimbabwe with 26 each, and Ethiopia with 22 (UNEP 2013). The threat of extinction of two thirds of the 300 haplochromine cichlid fish species in Lake Victoria is a result of predation by Nile perch (UNEP 2013).

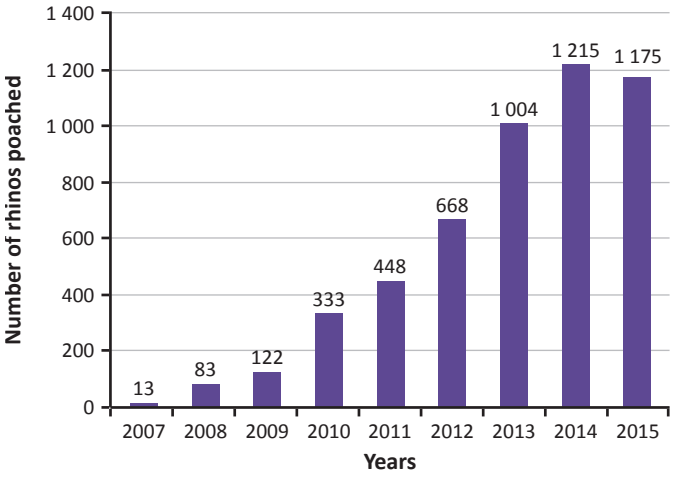
2.4.3 Illegal trade in wild fauna and flora

Africa's biological resources have multiple applications that the region has not yet exploited, including the sustainable use of wild fauna and flora for the purpose of sustainable development. Illegal trade in these resources, however, causes damage to ecosystems and rural livelihoods, and threatens national and regional stability. The increasing scale of poaching and illegal trade in wild species and their products has adverse economic, social and environmental impacts. For example, illegal trade in animals (including fish) and plants (including in the form of timber and charcoal) is one of the largest sources of criminal earnings in the world, estimated to be worth USD 50–150 billion per year (UNEP 2014). As **Figure 2.4.3** shows, poaching of rhinos in South Africa has been increasing since 2000 when only 13 rhinos were poached compared with 1 175 that were poached in 2015 (South Africa Department of Environmental Affairs 2016).

Cognizant of the negative impacts of poaching, the African Union developed a strategy to combat illegal exploitation of and trade in wild fauna and flora in Africa in May 2015. Such trade involves harvesting, procurement, transport and distribution, both domestically and internationally, of animals and plants as well as their parts and derivatives, in violation of the laws and treaties of the region (AU 2015). It ranges in scale from single items traded locally to commercial containers shipped worldwide to international markets.

The African Union strategy document states that the livelihoods and socio-economic development of communities in Africa depend heavily on the use of wild fauna and flora, so

Figure 2.4.3: Recorded number of rhinos poached in South Africa



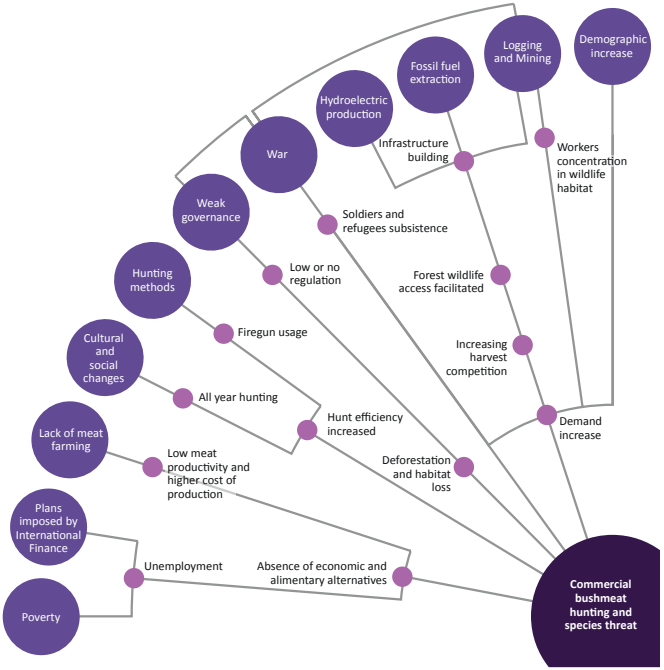
Source: South Africa Department of Environmental Affairs



Smoked monkey for sale at a local market in Brazzaville, Republic of Congo
Credit: Shutterstock/Sergey Uryadnikov

the loss of African wildlife directly and indirectly affects the livelihoods of African people. The document further points out that the growing involvement of organized criminal networks in illegal wildlife trade supply chains (**Figure 2.4.4**), and the links established to some non-state armed groups in Africa have given rise to additional security and governance concerns.

Figure 2.4.4: The bushmeat chain reaction



Note: Illicit trade in bushmeat involves a series of underlying socio-economic factors, including rising population densities, and leads to local depletions of wildlife species.
Source: Redmond, I., et al., Recipes for Survival:Controlling the Bushmeat Trade, WSPA Report 2006.

Illegal trade in wild animals and plants contributes to the threat of species extinction and loss of Africa's biodiversity. UNEP (2014) reported that rhino and elephant are threatened with extinction because of the illegal wildlife trade, driven by growing demand primarily from South East Asia and China. For example, the African black rhinos that were estimated in the millions at the start of the 20th century had been reported to be lost or to have gone extinct in 2007 (UNEP 2014). Similarly, official estimates showed that close to 25 000 elephants were killed in 2013 to supply the illegal ivory trade.

The African Union strategy to combat illegal exploitation of and trade in wild fauna and flora has the following objectives (AU 2015):

- increase the level of political commitment to prevent, combat and eradicate illegal exploitation and illegal trade in wild fauna and flora, and recognize illegal trade in wild fauna and flora as a serious crime;
- improve governance integrity and enhance regional and inter-regional cooperation;
- enhance engagement with consumer states to reduce demand, supply and transit of illegal products of wild fauna and flora;
- increase the capacity of source and transit states in detecting illegal wild fauna and flora products, including at exit and transit points;
- promote the participatory approach to economic development and community livelihoods through sustainable use of wild fauna and flora;
- reduce, prevent and eliminate the economic, security and stability impact of wildlife crime;
- increase capacity, information, advocacy and public awareness.

2.4.4 Zoonotics

The effects of Ebola on western lowland gorillas in the early 2000s (Walsh *et al.* 2007; Bermejo *et al.* 2006; Walsh *et al.* 2003) brought to international attention the previously under-estimated threat that infectious diseases pose to wildlife (Voyles *et al.* 2009). Studies have shown that although many infectious agents are species-specific, a number of pathogenic organisms cross the species barrier and cause severe clinical diseases in new hosts (Walsh *et al.* 2007). Other studies have acknowledged human-borne parasites as a threat to a range of different species of wildlife (Inogwabini and Leader-Williams 2012; Cunningham *et al.* 2003; Vitousek *et al.* 1996). While bi-directional zoonotic movements of disease between humans and wildlife have been documented, response efforts have mostly focused on the potential impacts on humans – the primary aim being to prevent catastrophic effects on human well-being. Risks are exacerbated because even if pathogens are mild in their original host species, when they cross natural barriers they may emerge as a new infectious disease with unpredictable and potentially severe impacts on the new host community (Dobson and Foufopoulos 2001; Daszak *et al.* 2000). Because of the unpredictability in the severity of any potential impact of human diseases on wildlife, and particularly great apes, such transmission should be a central conservation concern and justifies recent efforts to investigate diseases that are thought to cross natural barriers. This is of particular interest for great apes because of their genetic proximity to humans, which would increase and ease the bi-directional zoonotic flow.

The African great ape species – bonobos (*Pan paniscus*), chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla*) – have been observed to contract similar diseases to those that affect human communities. Evidence of zoonoses being transmitted between humans and these species of great apes continue to accumulate and became of particular concern during the recent Ebola crisis that struck human populations in Central and West Africa in 2014–2015 (Baize *et al.* 2014). These epidemics have brought to the forefront the often ignored reality that humans are part of the ecosystems wherein they reside and are susceptible to sicknesses that often appear irrelevant given the genetic distance they have from other species. In view of this perception, there is a risk that humans concentrate on Ebola as the only potential zoonosis affecting both humans and other mammalian species. But there are others with this characteristic, including anthrax, herpes, HIV/AIDS, influenza, malaria, measles, monkey pox, poliomyelitis, para-influenza, pneumonia, salmonella and trypanosomiasis. The effects of some of these on humans are well known and treatments are available; but for wildlife species most of them have effects that are only just becoming known, and treatments will be much more difficult to provide. Anthrax (Leendertz *et al.* 2006) and trypanosomiasis (Inogwabini and Leader-Williams 2012), for example, are potentially lethal to wildlife species.

Given that human populations are increasing in most of Africa, wild habitats will become more and more occupied by human settlements. This will increase the interactions

between humans and wildlife species, which will increase the transmission of zoonoses back and forth between humans and wildlife. This is likely to increase the frequency of disease outbreaks and the associated lethal effects on both sides. There is therefore a need to rethink the nature of the relationships between human geography and the survival of Africa's wealth of biodiversity.

2.4.5 Species and ecosystem restoration

Land degradation resulting from agricultural expansion, soil erosion, deforestation and low vegetative cover is among the major conservation and development challenges in many African countries. Ecological restoration is a critical tool for rehabilitation and restoration of degraded ecosystems, biodiversity conservation and sustainable development. It is a fundamental element of ecosystem management that improves biodiversity conservation, human livelihoods and ecosystem productivity. Principles of good ecological restoration practice include incorporating biological and environmental spatial variation into the design, allowing for links within the larger landscape, emphasizing process repair over structural replacement, allowing sufficient time for self-generating processes to resume, treating the causes rather than the symptoms of degradation and including monitoring protocols to allow for adaptive management (Rodrigues 2014). Engaging all relevant sectors of society and disciplines, providing short-term benefits leading to the acceptance of longer-term objectives, enabling the accrual of ecosystem goods and services and striving towards economic viability are also important. There is a need to follow and use nature-based solutions to the land degradation, poor agricultural productivity and poverty that remain practical challenges in many developing countries, including in Africa. Application of the principles and methods of species restoration and ecosystem rehabilitation contribute to achieving many of the interrelated objectives of conservation and productivity. It can be concluded that ecological restoration will improve the biological diversity of degraded landscapes, increase the populations and distribution of rare and threatened species, enhance landscape connectivity, increase the availability of environmental goods and services, and contribute to the improvement of human well-being.

2.4.6 Meeting Africa's Biodiversity Targets

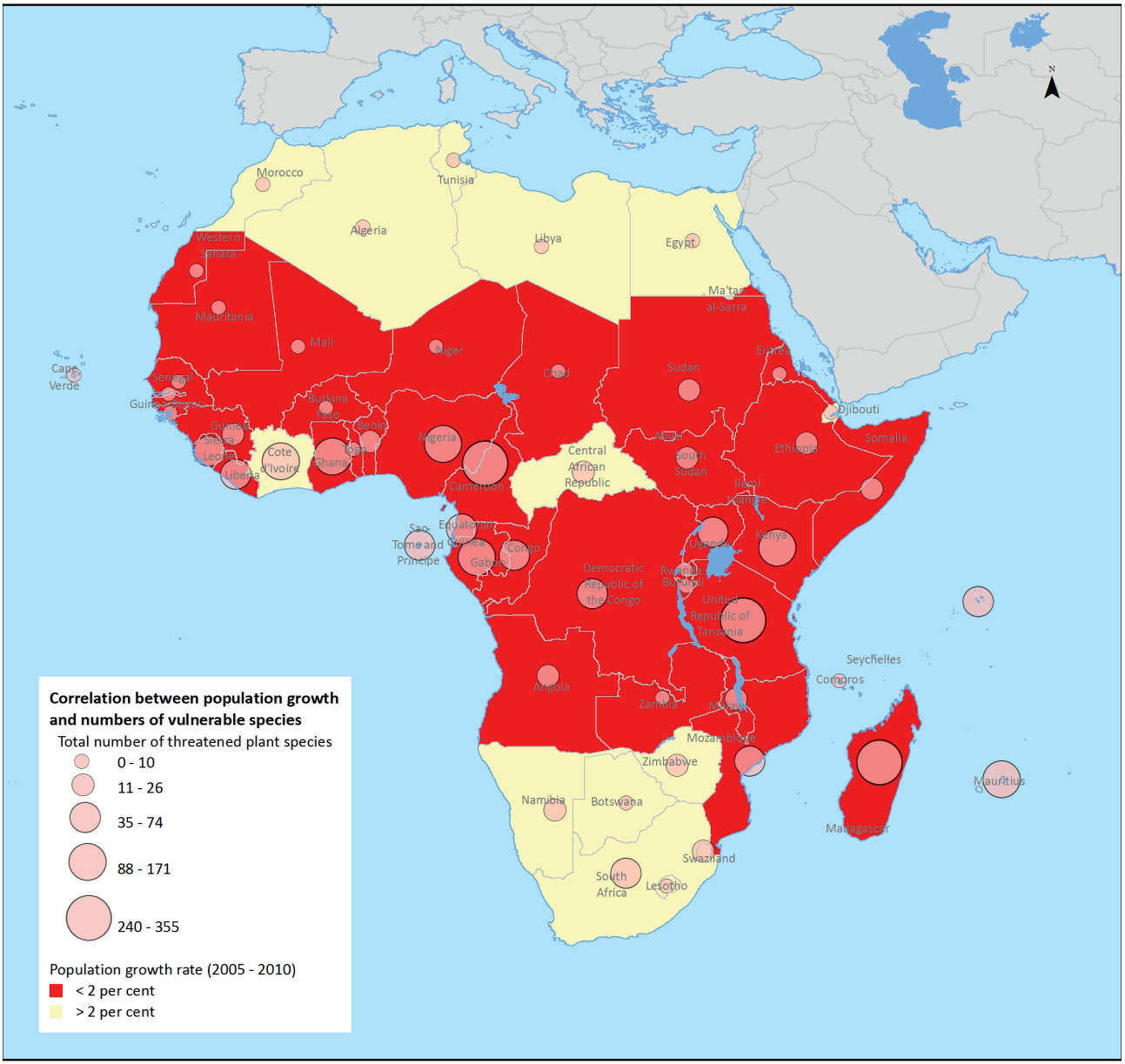
Biodiversity has intrinsic value and is the foundation of all life forms, including human beings. It maintains ecosystem balance, provides a range of social benefits and is a source of vital resources such as food and medicine. The dependence of 80 per cent of Africa's rural population on traditional medicine attests to the importance of biodiversity to human health (UNEP 2013; WHO 2003).

Some of the biodiversity GEGs are encapsulated in the Convention on Biological Diversity (CBD) and its Aichi Targets, the Johannesburg Plan of Implementation and SDGs. They cover halting or reducing habitat loss and degradation; sustainable agriculture; controlling invasive alien species; increasing the size of terrestrial and marine protected areas; maintaining genetic diversity, and fair and equitable sharing of genetic resources (**More…22**).

Successful conservation efforts need to be scaled up in order to better protect the region's biodiversity-rich habitats that are under threat. These threats are compounded by the fact that the terrestrial habitats of the region's vulnerable species are also the areas that have recorded the highest human population growth (**Figure 2.4.5**). Continuing deforestation and forest degradation do not augur well for the region's biodiversity because forests harbour much of it, providing a habitat to over half of the terrestrial species of animals, insects and plants (FAO 2015). Further, increasing dependence of the region's population on oceans for food and income have resulted in marine pollution, depleted fisheries, and loss of coastal habitats. These points underscore the inter-linkages between biodiversity, land and marine resources that are highlighted in SDGs 14 and 15.

In the wake of resurgent markets and a rise in organized crime, global trade in illegal wildlife, which is estimated to exceed USD 213 billion each year (Nellemann *et al.* 2014), poses a rising threat to Africa's biodiversity. It is driven by consumer demand for trophies, pets, bush meat, ornaments, collectibles and traditional medicine (Rosen and Smith 2010). Recognizing this threat, the African Union in June 2014 prepared the African Common Strategy on Combating

Figure 2.4.5: Correlation between population growth and numbers of vulnerable species



Source: UNEP 2013

Illegal Trade in Wild Fauna and Flora, and requested AMCEN and other partners to spearhead this effort. At its 15th Ordinary Session in Cairo in March 2015, AMCEN encouraged stakeholders to contribute to the formulation of the Strategy. While this Strategy would complement existing initiatives such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the sub-regional Lusaka Agreement on Cooperative Enforcement Operations directed at Illegal Trade in Wild Fauna and Flora and a series of national laws and policies, it would promote a coordinated regional response to safeguard Africa's wildlife. Another important development in stemming this set of environmental crimes is the decision of the Assembly of the African Union at its 23rd Ordinary Session to expand the jurisdiction of the African Court of Justice and Human Rights to include illicit exploitation of natural resources (AU 2014).

With little use of agrochemicals (Druilhe and Barreiro-Hurlé 2012), much of the agriculture in Africa is organic, although few farmers in the region have obtained the necessary certification because of its prohibitive cost (Yussefi and Willer 2003). Organic farming has positive effects on species richness and the attendant soil organisms and ecological services such as pollination that are essential to agriculture. Yet because Africa's arable land is underused, there is scope to sustainably increase agricultural productivity. After all, agricultural species are part of biodiversity, and agriculture needs other biodiversity as well, so increasing agricultural productivity and conserving biodiversity need not be incompatible goals. In this regard, farmers should be sensitized to desist from detrimental agricultural practices such as slash-and-burn farming, overgrazing, cultivation of marginal land, and draining of wetlands.

Parties to the CBD set 2020 as the deadline for identifying, prioritizing and managing invasion pathways in order to prevent the introduction and establishment of invasive alien species. Target 8 of SDG 15 reiterates this objective, stressing that the attendant actions should focus on the invasive alien species that inhabit both land and water ecosystems.

All the region's 54 countries have either developed or are developing National Biodiversity Strategies and Action Plans (NBSAPs), which are the principal instruments for implementing the CBD at national levels. Most of these NBSAPs contain action plans on preventing, controlling and eradicating invasive alien species. In addition, some of the region's countries – such as South Africa and Swaziland – have established databases on invasive alien species. Establishing national inventories in the other countries, filling the data gaps (Genovesi *et al.* 2013) and creating standardized meta-databases (Faulkner *et al.* 2015) would accelerate achievement of this target. Globalized transport, trade, and tourism that facilitate deliberate human release and species escapes (CBD 2010) and parasite and pathogen transmission by wildlife, as well as unaided transboundary spread (Hulme 2015) have increased the number of invasive alien species in the region (Irlich *et al.* 2014; NEMA 2011) and continue to impede attainment of this target worldwide. Better monitoring would help to bridge the achievement gap.

Despite Africa's considerable human population pressure, the region records a high proportion of terrestrial protected areas. This has been largely attributed to the rise in the number of private, community-based and co-managed protected areas (Stolton *et al.* 2014). If this momentum is sustained, Africa will surpass the target of establishing 17 per cent of its total terrestrial area as protected by 2020 (CBD 2012). Madagascar's Makira National Park management model profiled in **Box 2.4.1** showcases ways in which seemingly discrete goals can be accomplished with careful planning. While increasing the size of protected areas is vital to protecting biodiversity, stricter enforcement of laws and bylaws establishing these areas is equally important.

Under the auspices of the Eastern Africa Regional Seas Programme (which has 10 participating states) and the Western Africa Regional Seas Programme (which has 22 participating states), notable progress has been made in establishing marine protected areas in coastal waters. As

Box 2.4.1: Makira National Park - A Model for Balancing Biodiversity Conservation, Sustainable Livelihoods and Climate Change Consideration

The Government of Madagascar, the Wildlife Conservation Society (WCS), and other national and international partners embarked on the creation of Makira National Park in 2003. Although its establishment was completed in 2012, it was officially inaugurated in 2015 as the first of 95 new protected areas planned in Madagascar, which will together cover more than 6 million hectares.

It is an example of the range of seemingly discrete benefits stakeholders can achieve when they cooperate. These benefits touch on increasing the size of terrestrial protected areas, biodiversity conservation, supporting local livelihoods, and carbon finance as highlighted below:

- Increasing the size of terrestrial protected areas. The Makira project protected one of the largest remaining pristine but threatened rainforest ecosystems in Madagascar. It spans an area of 372,470 hectares, making it the largest protected area on the island.
- Conservation of unique biodiversity. It is a habitat for a range of wildlife species including 20 species of lemur (four of these species: the indri, the silky sifaka, the red-ruffed lemur, and the black-and-white ruffed lemur are critically endangered). It is also home to over 50 per cent of Madagascar's recorded plant biodiversity.
- Supporting local livelihoods. Makira National Park is managed in collaboration with 67 community associations that represent a population of nearly 48,000 people who live around the park. In addition to precincts of the park, these communities established contracts with the Malagasy Government to enable them to directly manage 335 173 hectares surrounding the park. These community associations are the entry points for a number of development services such as education and health facilities, community-based ecotourism, agricultural extension services, and better and more lucrative access to international markets for vanilla, cocoa, cloves and raphia that are grown or produced around the park.
- Carbon finance. Makira National Park is playing a central role in the climate change discourse. It is an innovative REDD+ project that sells carbon credits and 1.8 million carbon credits were traded between 2005 and 2013 alone. In addition, six carbon sales were concluded by the Malagasy Government on the voluntary market between December 2013 and April 2015. Half of the net income generated from the carbon trading is used to fund the local community development services alluded to in the preceding paragraph.

Source: Adapted from Wildlife Conservation Society

such, protected areas now cover 2.4 per cent of the marine areas within national jurisdiction (0–200 nautical miles) in Africa. This is admittedly lower than the comparable global average of 8.4 per cent (Deguignet *et al.* 2014) (**Figures 2.4.6** and **2.4.7**). given both the vastness of the global oceans which largely comprise Areas Beyond National Jurisdiction (ABNJ), and that global marine protected areas cover just 3.4 per cent of these (Juffe-Bignoli *et al.* 2014), when recent trends are extrapolated, Africa's efforts are unlikely to ensure that 10 per cent of the total marine area is protected by 2020. In the medium to long term, resolute implementation of the 2050 Africa Integrated Marine (AIM) Strategy and African Union Agenda 2063 can bridge this gap. Together, these policies provide a broad framework for the protection and sustainable use of Africa's marine domain for optimum well-being and wealth creation, primarily through the development of the blue economy. AIM, for example, envisages the utilization of maritime spatial planning to balance seemingly competing interests of use and conservation while Agenda 2063 prioritizes conservation of marine habitats and biodiversity under its goal of building environmentally sustainable and climate-resilient economies and communities. However, these must be underpinned by addressing marine pollution, especially from land-based activities as emphasized in SDG 14 Target 1. In addition, increasing the economic benefits Small Island Developing States (SIDS) draw from marine biodiversity and other resources as envisaged by SDG 14 Targets 7 and 8 is not just equitable; it will incentivize these SIDS to promote sustainable management of fisheries, aquaculture and tourism. This will result in a win-win scenario for both these States and the environment.

The conservation and maintenance of genetic resources and genetic diversity highlight the intrinsic value of these resources (Freeman III *et al.* 2014). In addition, they can be harnessed to increase plant and animal productivity and to adapt to a changing climate (in line with SDG 13), drought and disease prevalence (Leadley *et al.* 2014). Therefore, as posited by ELI (2004), genetic resources are vital for food security (SDG 2), human health (SDG 3) and poverty reduction (SDG 1).

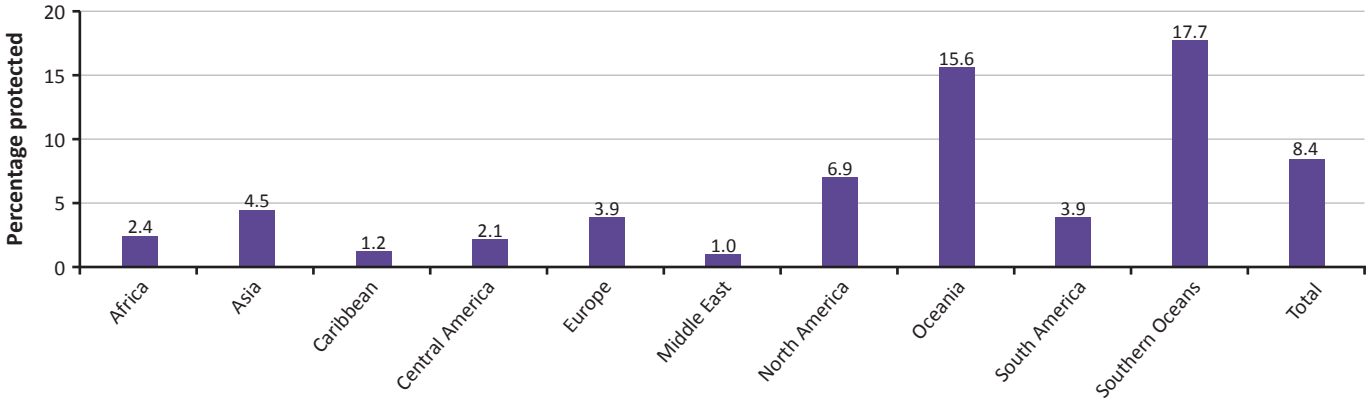
The majority of Africa's genetic varieties with a known status are classified as not at risk. An evaluation of Africa's avian and mammalian breeds classified 289 (31.8 per cent) of them as not at risk, 42 (4.6 per cent) as endangered, 22 (2.4 per cent) as critically endangered and 34 (3.7 per cent) as extinct (FAO 2013) (**Table 2.4.1**). Measures should be instituted to assess the status of 520 species (57.3 per cent) that currently have an unknown risk status so that commensurate conservation measures can be designed (Leadley *et al.* 2014).

Table 2.4.1: Risk Status of Mammalian and Avian Livestock Breeds

	Critical	Endangered	Extinct	Not at risk	Unknown	Total
Africa avian	8	12	2	69	132	223
Global avian	261	466	64	580	930	2 301
Africa mammalian	14	30	32	220	388	684
Africa avian and mammalian	22	42	34	289	520	907
Global mammalian	432	722	564	2 396	1 847	5 961
Global avian and mammalian	693	1 188	624	2 976	2 777	8 262

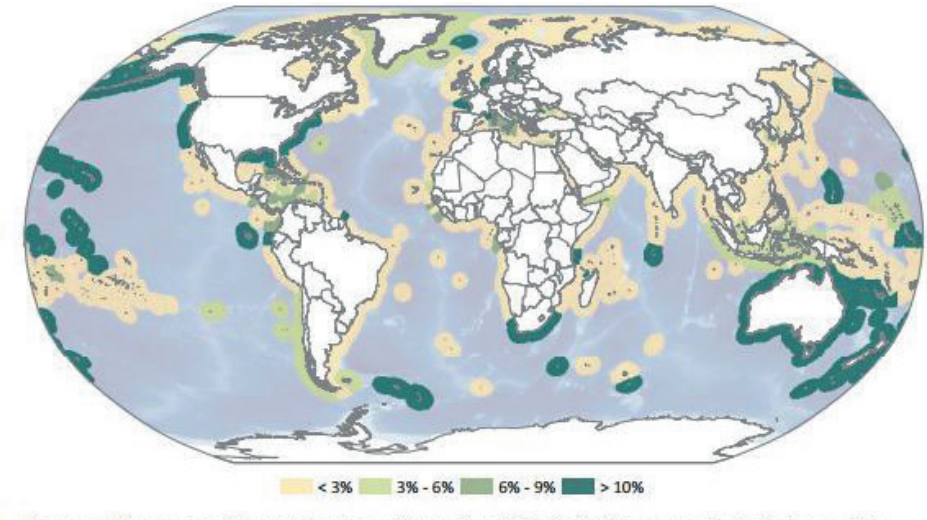
Source: Abridged from FAO 2013

Figure 2.4.6: Percentage of the marine areas within national jurisdiction (0–200 nautical miles) covered by protected areas for each CBD region



Source: Juffe-Bignoli *et al.* 2014

Figure 2.4.7: Percentage of the marine areas within national jurisdiction (0–200 nautical miles) covered by protected areas



Source: Juffe-Bignoli *et al.* 2014

▶ Credit: Shutterstock/Mr.prasong

Although micro-organisms and invertebrates provide important ecosystem services, their roles remain largely under-appreciated as they are some of the least explored biodiversity resources on earth (Griebler *et al.* 2014). The partnerships envisaged in SDG 17 provide an avenue for the region to marshal the requisite finances, technology transfer and capacity building to address this research gap.

In an effort to assure food security by conserving plant genetic resources, many African countries have signed up to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which is in harmony with the Convention on Biological Diversity. These genetic resources are vital for increasing the quality and productivity of crops, particularly in Africa where there is considerable scope for improvement (**More…23**).

The Treaty facilitates the exchange of seed and other building blocks of the genetic diversity of the world's food crops in order to avert the effects of climate change and improve food security. Under the Treaty, a global gene pool with 1.6 million samples of genetic material, including some of Africa's main food crops, such as cassava, maize and rice, has been created and needs to be widened. Similar efforts to map and safeguard the existing animal gene pools should also be instituted.

Twenty-nine African countries are party to the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization (Nagoya Protocol) to the Convention on Biological Diversity, which entered into force on 12 October 2014. Africa accounts for nearly half of the Parties to the Protocol. The Protocol aims to ensure that the benefits arising from the utilization of genetic resources are shared in a fair and equitable way. By so doing, it helps to bridge the trust gap between the providers and custodians of genetic resources, such as local communities and indigenous peoples referred to in Article 8(j) of the CBD – and who are estimated to conserve as much area as formally designated protected areas (Kothari *et al.* 2012) – and those who commercially extract and use these resources (**More…24**).



2.5 Policy analysis

Key Messages: Policy analysis

- Environmental challenges are multi-faceted, requiring holistic and cross-sectoral policies and institutional arrangements. Many countries in Africa often lack non-segmented, coherent, efficient and effective regulatory policy and institutional frameworks.
- Africa requires strong evidence-based policy formulation processes that are premised on adequate and reliable data. The absence of credible data implies that the inter-connectedness of the environment with other sectors, including health and the economy, is often not clear in current policies.
- The role of science and data provision in policy formulation should be fully recognized if Africa is to address the current deficiencies and weaknesses in policy and institutional arrangements.
- Strong international support is needed for research and development on tropical diseases that are common to Africa, and whose emergence and management is strongly connected to the state of the environment.
- While Africa has a plethora of institutions at national and regional levels, such institutions often operate independent of each other, to the extent of competing against each other for budgetary support, recognition and human resources. This creates unnecessary silos and also stretches the already limited financial resources.
- Stakeholder involvement in policy-making and implementation is widely advocated for and provided in policy instruments in use on the continent. This is in recognition that greater information and broader experiences significantly contribute to the development of more realistic and effective policies, as well as improve their implementation. However, financial resources and political will for stakeholder involvement are necessary to achieve this.
- Once policies are enacted and institutions are established, adequate human and financial resources, matched by the will to monitor and evaluate their effectiveness, are essential to address common impediments in implementation. There is also need to provide for the evolution of policies and institutions to suit changing landscapes.

2.5.1 Introduction

Human health is inextricably linked to the environment, with successes and failures in the environmental arena directly or indirectly impacting human health. Thematic analyses of relevant Global Environmental Goals (GEGs) show that Africa has recorded a mixed picture in meeting the targets that its member states signed up to. Many states have made commendable progress in meeting international commitments by enacting national policies. In addition, several home-grown policies have been enacted at the regional level to complement international obligations and to clarify and coordinate the region's unified position. Both developments have borne fruit, leading to a number of successes such as increasing the number and size of protected areas and phasing out leaded gasoline. These have in turn led to falling morbidity and mortality levels relative to a decade ago (Prüss-Üstün *et al.* 2016). However,

because of policy gaps (for example on intellectual property rights, trade and benefit sharing) and weak implementation of many policies, significant environmental challenges that adversely impact human health persist. As such, Africa continues to account for a disproportionate share of the deaths attributed to the environment according to the World Health Organization (WHO) (Prüss-Üstün *et al.* 2016) as shown in **Figures 2.5.1** and **2.5.2**. The policy gaps and weak policy implementation may also be attributed to the failure to place sufficient financial, biophysical, human health and well-being, and cultural values (Guerry *et al.* 2015; Myers *et al.* 2013) on Africa's natural capital and the ecosystem services they provide.

This section discusses the conditions that determine the degree of policy effectiveness and in turn positively or adversely impact human health and well-being. With the broadening of the policy arena following the recent adoption of the Sustainable Development Goals (SDGs), it is anticipated that the key messages will offer the Member States a fresh, broader and inter-sectoral perspective that can be harnessed to foster innovative policy formulations and implementation approaches that will better position them to transition towards the desired sustainable development pathway, and help to deliver a number of environmental health co-benefits.

2.5.2 Determinants of policy effectiveness

Comprehensive, evolving policy frameworks

For policies to be effective, they need to be comprehensive and holistic to cater for complex interactions and impacts at several levels. Human beings rely on their physical and non-physical environments not just for their very survival (food, water and air) but also livelihoods (**Figure 2.5.3**) as the

Figure 2.5.1: Global age-standardized environmental deaths, 2012



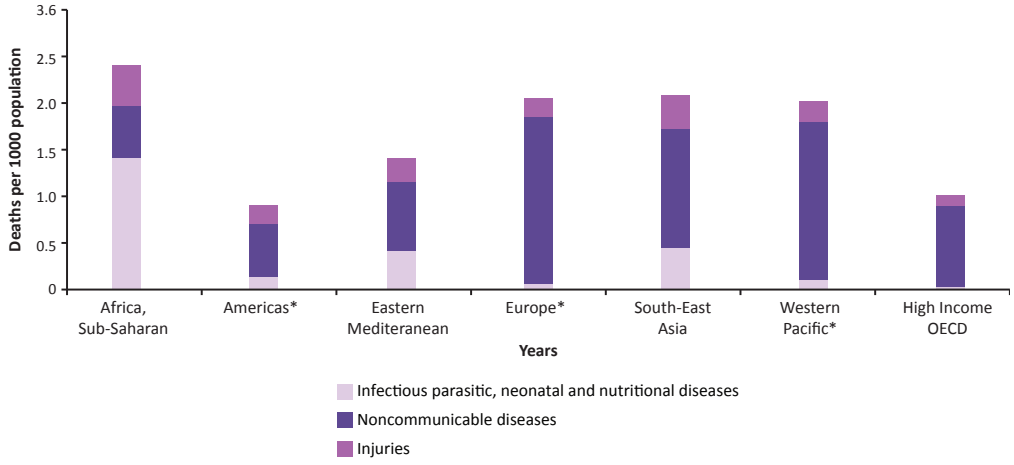
Source: Prüss-Üstün *et al.* 2016

Health Synthesis of the Millennium Ecosystem Assessments (Corvalan, Hales and McMichael 2005) makes clear. However, these interactions, which may be characterized as dependence, adaptation or modification, lead to human-induced environmental changes, which in turn affect human health and well-being, creating a cycle that repeats itself continuously.

Human-induced changes in one aspect of the environment (such as air quality) can impact other aspects of the environment (such as climate change) and vice versa. For example, in Africa, climate change has been associated with rising anthropogenic greenhouse gas levels, and higher pollen levels which lead to higher incidences of allergic respiratory diseases such as rhinitis (Lin and Zacharek 2012) and asthma (Beggs 2014), which in turn increase the burden on the already stretched health care system. Climate change is also responsible for extreme weather events and many natural disasters (Braman *et al.* 2013).

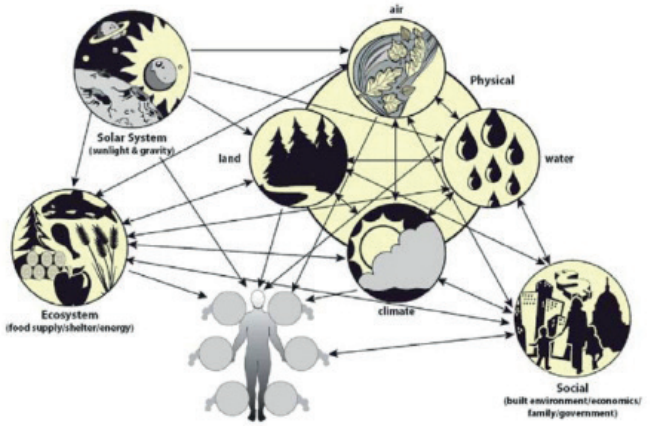
The interdependence of regional and global states has been thrust into the limelight following transboundary pollution in Southern Africa and other sub-regions of the world. Likewise, increasing globalization with faster travel and international trade, has potentially raised the risk of zoonotics transmission as illustrated by the recent outbreak of Ebola in West Africa and the Zika virus in Latin America and the Caribbean. Admittedly, Africa has not reported recent cases of infection with the Zika virus which is transmitted by the mosquito *Aedes africanus* and is associated with microcephaly (characterised by abnormal smallness of the head due to incomplete brain development) and other congenital birth defects (CDC 2016). However, the pace of globalization and the facts that the virus was first isolated from a sentinel rhesus monkey captured from the Zika Forest in Uganda in 1947 (Haddow *et al.* 1964; Kindhauser *et al.* 2016), and the first human cases were detected in Uganda and the United Republic of Tanzania in 1952 and thereafter in

Figure 2.5.2: Deaths attributable to the environment, by region and disease group, 2012



Source: Prüss-Üstün *et al.* 2016

Figure 2.5.3: Basic needs, shelter factors, personal factors and endogenous factors interact in a holistic network to determine health outcomes



Source: Gohlke and Portier 2007

Central and West Africa and other parts of the world (WHO 2016), call for increased surveillance (**More… 25**).

Since environmental health problems are so multi-faceted and do not respect political borders, there is need for holistic policymaking that incorporates the inputs of experts from environmental, health, finance, economic planning and other government departments. A multi-disciplinary team would also need to continually survey the policy landscape and fill any gaps that are identified. Besides assuring the buy-in of various government departments that would then work cooperatively to achieve the anticipated policy outcomes, such an interdisciplinary approach would ensure that hazards are not simply shifted from one geographic location to another, or one medium to another, such as toxic fumes from industries to the ambient environment or industrial waste from factory dumpsite to communally shared water resources.

Another benefit of the inter-sectoral approach is that it can use economic tools to quantify the environmental and health impacts of several alternatives and translate these impacts into the monetary terms that can then inform decision making. Moreover, "using the tools of economic valuation to address health and environmental problems creates other synergies. It contributes to a greater appreciation of the goods and services provided by natural ecosystems. It can help decision-makers to identify mutually beneficial strategies that simultaneously promote human well-being and environmental protection and development, as well as poverty reduction" (WHO and UNEP 2004). **Box 2.5.1** demonstrates the extent to which economic valuation tools helped the Kenya Government to better appreciate the ecosystem services provided by its montane forests. Following publication of the report from which the Box is excerpted, the Kenya Water Towers Agency was established in April 2012 to "coordinate and oversee the protection, rehabilitation and conservation, and sustainably manage all the critical water towers" which consist of 18 gazetted montane forests (Kenya Water Towers Agency 2016).

Box 2.5.1: The economic value of Kenya's montane forests

In the 10-year period 2000-2010, deforestation in Kenya's Water Towers amounted to an estimated 50 000 ha. By 2010 such deforestation of montane forests yielded 250 m^3 per ha of timber and fuelwood. Until 2010 the forests were being deforested at an estimated annual rate of 5 000 ha, causing significant losses in ecosystems services and revenues. Revenue streams from such deforestation provide an incentive for illegal deforestation activities. However, this cash revenue comes at a large cost to the national economy, through losses in regulating services. Whereas the cash value of forest products has a once-off value, the benefits of regulating services in preceding years continue to be felt in the economy in every subsequent year that the national asset, the Water Towers, is degraded. By 2010, the cumulative negative effect of deforestation on the economy through reduction in regulating services was an estimated USD 36 million per year, more than 2.8 times the cash revenue of deforestation.

The largest component of the loss in revenue was attributable to changes in river flows resulting from a reduction in dry-season river flows, which reduced the assurance of water supply to irrigation agriculture. This reduced agricultural output by USD 26 million in 2010 (UNEP 2012a). Reduced river flows also lowered hydropower revenue by USD 0.12 million. Although not a very high value in relative terms, the multiplier effect of hydropower on the rest of the economy is considerable. In 2010, reduction in water quality due to siltation and elevated nutrient levels running off degraded land into freshwater systems reduced inland fish catches by USD 0.86 million and increased the cost of water treatment for potable use by USD 1.9 million. Well-managed montane forest cover reduces malaria prevalence. Incidence of malaria as a result of deforestation is estimated to have cost Kenya almost USD 4 million by 2010. This resulted in additional health costs to the Government of Kenya and through losses in labour productivity. Forest loss is also detrimental to the global carbon cycle. The above-ground carbon storage value forgone through deforestation was estimated at USD 3 million in 2010 (UNEP 2012a).

The benefits of forests have an economy-wide effect with a considerable multiplier effect. An industry that directly depends on regulating services generates demand upstream (for intermediates from other industries) and also supplies inputs to other industries downstream. Taking into account these interdependencies between sectors, the decrease of regulating services due to deforestation caused a total impact of USD 5.8 million in 2010. This means that the cost of limiting regulating ecosystem services as a production factor for the economy was all in all 4.2 times higher than the actual cash revenue of USD 1.3 million (UNEP 2012b).

The challenge for Kenya (and other countries facing natural-resource degradation) is to institutionalise incentives for internalising the benefits of sustainable management of forests. For instance, in the case of the UN's Reducing Emissions from Deforestation and forest Degradation (REDD+) initiative, a hypothetical carbon value of USD 6/ton provides insufficient economic incentive to compensate for deforestation. However, this analysis shows that the total ecosystem service value of the montane forests far exceeds the carbon-storage value. Carbon, as a proxy for regulating ecosystem services, has a regulating-service multiplier effect of more than seven (UNEP 2012a).

It is clear from the analysis given above that appropriate and well-funded policies, policy instruments and response strategies are required to protect the natural assets that Kenya's Water Towers represent.

Source: UNEP 2012

Data availability and reliability

Evidence-based policy formulation must be premised on adequate and reliable data sets. Africa experiences paucity of data on environmental issues (UNEP 2013 – AEO3) while WHO also acknowledged that due to limited data on the prevalence of diseases, many of the computations in their report on preventing disease through healthy environments are based on assumptions and extrapolations which are generally considered to be weaker categories of evidence (Prüss-Üstün *et al.* 2016). This is especially true for neglected diseases which mainly afflict low-income and middle-income countries. According to Røttingen *et al.* (2013), *"diseases of relevance to high-income countries were investigated in clinical trials seven-to-eight-times more often than were diseases whose burden lies mainly in developing countries"* and only about 1 percent of all health research and development investments were allocated to the neglected diseases in 2010. The neglected tropical diseases include intestinal worms, rabies, dengue, African trypanosomiasis, Chagas disease, trachoma and yellow fever (Hotez, Savioli and Fenwick 2012). Coble *et al.* (2009) also suggest that existing health data ignores emerging areas such as genetics, although these are vital to better understanding the field of environmental health. In addition, further research is needed in order to evaluate some emerging risks such as *"more intensive agricultural practices and zoonoses, the effects of many long-term chemical exposures on cancers or endocrine disorders, and the impact of electromagnetic and other exposures from new technologies"* (Prüss-Üstün *et al.* 2016).

The availability of data becomes an even more serious determinant of policy effectiveness when the suggestion to "shift the focus from the statistics of death, disease, and disability... to remedial measures outside the health care system to solve health problems" (Listorti and Doumani 2001) is revisited. This would imply the need to gather data from sectors that have traditionally been perceived as falling outside the realms of environment and health as well as multidisciplinary human resource capacity to analyse this data.

Social and gender equity

Within social classes, women bear the brunt of the environmental health burden owing to the division of labour along gender lines. For policies to be effective, Africa has to eradicate this environmental health divide along social and gender lines. One of the ways of doing this is supporting local livelihoods through the community based natural resources management (CBNRM) which Madagascar's Makira National Park management model profiled in **Box 2.4.1** showcases.

Box 2.5.2: Building good working relationships among different stakeholders – success story from Tunisia

An important factor in the application and effectiveness of EIA is the working relationship established among the different stakeholders. In this regard, Tunisia has over the years forged good working relationships among stakeholders to building a credible and trusted EIA system.

The EIA team members of the National Agency for the Protection of the Environment (ANPE *in French*) possess many years of experience and a deep knowledge of the respective sectors to which they have assigned. They have benefited and continue to benefit from general and specialized training, which allows them to excel in their work and gain credibility and respect in the eyes of other stakeholders.

In the same vein, ANPE gives particular attention to strengthening the capacities of various stakeholders involved in one way or other, in the EIA process. These include consultants, experts of other agencies, project proponents and developers as well as others implicated in different stages of the assessment. Further, economic operators are sensitized about EIA requirements at the time when new investments, likely to affect the environment, are proposed.

The harmonization of competencies and skills of different stakeholders and the establishment of working meetings throughout the process of development and evaluation of EIAs has, over the years, improved the convergence of views, and improved understanding of expectations and constraints faced by all. For example, whereas in the past, requests made by ANPE for the improvement of EIA studies were often perceived by developers and some consultants as an unnecessary requirement. All parties now understand that ANPE's concern for obtaining improvements in the analyses allows for a better evaluation of the impacts and by the same token, a better determination of these impacts for the protection of the environment. EIA is now appreciated in many sectors and its application has now become common practice.

Source: Economic Commission for Africa 2013

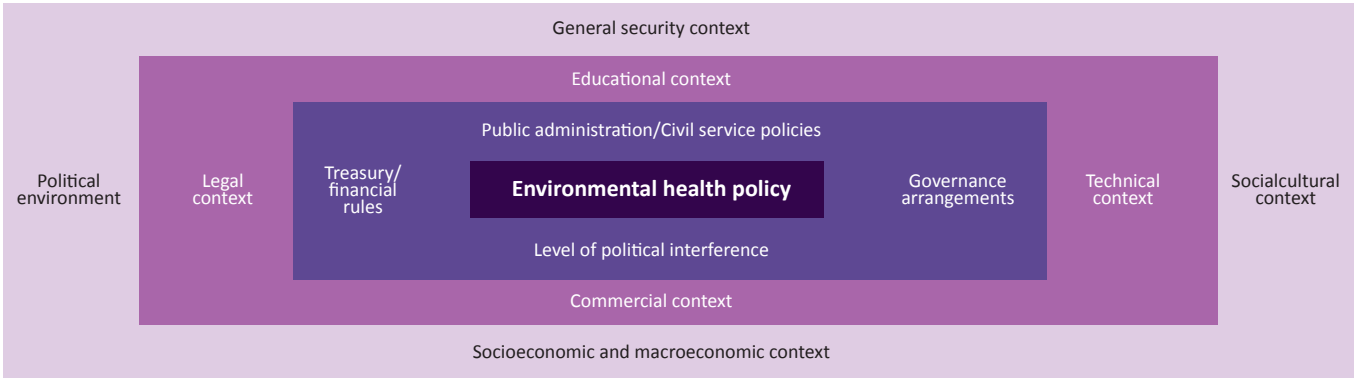
Education and awareness
Formal education curricula, which inculcate the importance of environmental health, would contribute to policy effectiveness. In addition, this would produce a critical mass of professionals who would be well-placed to formulate and implement environmental policies. Parallel outreach campaigns to sensitize the populace, particularly the vulnerable groups, about the indirect and long-term effects of adverse environment-health linkages, would help to take adequate preventive measures to protect themselves.

Monitoring and evaluation
With the many environmental and health challenges that Africa still faces, the tendency is to develop and implement more policies and projects to address the continent's concerns. However, there has not been a corresponding rise in assessments of policies and projects, resulting in a general lack of knowledge about their effectiveness. Assessments are an important tool that can provide answers to the important questions about whether policies and projects are working or have worked, whether they are cost-effective or not, how they can be improved, and what difference they make in the broader context of sustainable development. The assessment of policies and projects will help balance societal needs for a policy measure against its final impacts on the environment and health and other broader societal objectives.

Establishing rigorous monitoring and evaluation systems with an emphasis on dissemination of lessons learned would help replicate and scale up what works and adjust what does not. Given that, environment and health are *"both inextricably linked and cross-sectoral in nature"* (UNEP 2013 – AEO3), it would be important to forge inter-institutional collaboration that fosters alignment, eliminates duplication and promotes synergies in order to achieve the intended policy outcomes.

Broader context
Policies do not operate in a vacuum. Even the most innovative policies will need to be complemented by optimal wider systems in the political, legal, economic, educational and administrative spheres (Potter and Harries 2006), as is illustrated in **Figure 2.5.4**.

Figure 2.5.4: Broader context which determines policy effectiveness



Source: Largely adapted from Bocij *et al.* 2006

Box 2.5.3: Nine component elements of systemic capacity building

- Performance capacity: Are the tools, money, equipment, consumables, etc. available to do the job?
- Personal capacity: Are the staff sufficiently knowledgeable, skilled and confident to perform properly? Do they need training, experience, or motivation? Are they deficient in technical skills, managerial skills, interpersonal skills, gender-sensitivity skills, or specific role-related skills?
- Workload capacity: Are there enough staff with broad enough skills to cope with the workload? Are job descriptions practicable? Is skill mix appropriate?
- Supervisory capacity: Are there reporting and monitoring systems in place? Are there clear lines of accountability? Can supervisors physically monitor the staff under them? Are there effective incentives and sanctions available?
- Facility capacity: Are training centres big enough, with the right staff in sufficient numbers? Are there enough offices, to support the workload?
- Support service capacity: Have the necessary support services been clearly identified and are they available? They may be provided by the private sector.
- Systems capacity: Do the flows of information, money and managerial decisions function in a timely and effective manner? Is there good communication with the community? Are there sufficient links with civil society?
- Structural capacity: Are there decision-making forums where inter-sectoral discussions may occur and corporate decisions made, records kept and individuals called to account for non-performance?
- Role capacity: This applies to individuals, to teams and to structure such as committees. Have they been given the authority and responsibility to make the decisions essential to effective performance?

Source: Adapted from Potter and Brough 2004

Broader stakeholder involvement

Stakeholder involvement in policy-making and implementation is widely advocated for and provided in policy instruments in use on the continent. This is in recognition that greater information and broader experiences greatly contribute to the development of more realistic and effective policies, as well as improve their implementation. It is also in line with global instruments such as Agenda 21, which call for greater involvement of individuals and communities at all levels of decision-making (UNCED 1992).

Most countries have enacted legislation that provides for engaging and involving stakeholders through the environmental impact assessment (EIA) process. While this has taken varying forms shaped by individual country, peculiarities and sensitivities, common principles and practices such as eliciting public comments on EIA reports, publicising public hearings, notifying stakeholders of decisions and informing them of appeal process, are present. Local communities and other interest groups routinely demand EIAs on new projects in their areas.

Stakeholder involvement in policy-making and implementation, whether through the EIA or other processes, has generally proved to be essential and can lead to substantial benefits for all parties concerned. Where it is ignored, it can lead to conflicts and problems for policy implementation, acceptability and sustainability (see **Box 2.5.2**).

2.5.3 Africa's policy environment

Many countries in Africa have signed up to an array of international obligations, but there are disparities in policy formulation and implementation across the region. These disparities are primarily attributed to disparate local and national conditions. The above discussed enabling conditions will enhance the effectiveness of existing, nascent and envisaged policies and will help to bolster the capacity of the under-achieving States to play their part in realizing Global Environmental Goals.

In the context of Africa, the enabling conditions will enhance protection, valuation and sustainable use of its natural capital in order to improve human health and reduce poverty levels, particularly by tapping into the priority areas of agricultural productivity and food security, energy, infrastructure and extractives, as well as water, where the AU Regional Economic Communities and national governments continuously provide policy direction.

See references for Chapter 2

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CHAPTER 3

Outlook

3.1. Setting the scene

3.1.1. Ecosystem assets

Africa is richly endowed with a diversity of natural capital, which includes a range of ecosystem services such as carbon capture, food provisioning, water purification and biomass for energy. The region's ecosystem assets (**Figure 3.1.1**) include vegetation cover, renewable fresh water resources and biodiversity richness.

Key Messages

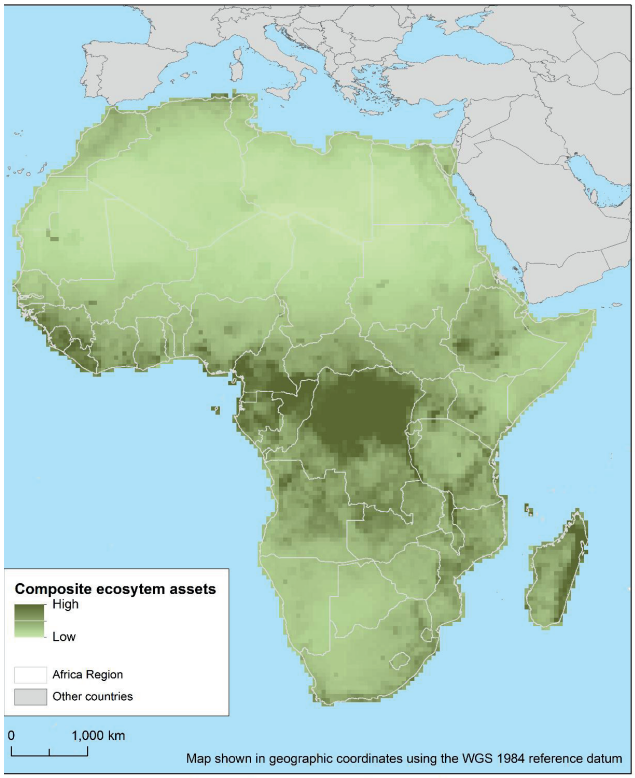
- Africa's natural capital faces threats from a variety of development trends including the expansion of oil and gas fields, urbanization and climate change. Vulnerable hotspots with high biodiversity include the Congo Basin, the West African coast, sections of the East African coast, as well as the east coast of Madagascar. The continent thus faces a great challenge of sustaining rapid economic growth while reducing its ecological footprint and safeguarding the life-support system provided by a healthy environment.
- Africa's future is shaped by many uncertain drivers of change whose interactions might result in different pathways for development and impacts on natural resources. Scenarios offer a particularly useful tool to help explore implications of different possible futures in order to test and develop strategies and plans that yield the most desired outcome for development, environment and societal well-being.
- The scenarios provide a legitimate, credible and salient set of future pathways, and the implications of each pathway for natural capital. They are imagined so that they can be useful both as 'contextual' and 'strategic' scenarios (demonstrating the benefits and risks associated with actively pursuing a certain path). By identifying challenges and opportunities, responses and possibilities for leverage across different scenarios, it is possible to recognize the most valuable actions in the face of diverse possible futures.
- Four scenarios are discussed, exploring the consequences of an intra-Africa versus global trade focus, and centralized versus decentralized governance, for the future of natural capital. The feasibility of the African Union's 2063 goals, as well as the progress towards the Sustainable Development Goals, is assessed for 2030 and 2063. The scenario analysis emphasizes the use of the SDGs as interconnected goals that should always be considered as a full set rather than treated selectively.
- In the *Good Neighbours* scenario there is strong political will for sustainable development and environmental governance, providing many opportunities that can be leveraged while challenges and responses mainly revolve around capacity to enforce, manage and stimulate good governance of natural resources, while supporting socio-economic development.
- In *Going Global*, economic development is unleashed, and while the political focus on 'green economies' and urban development can be leveraged, economic connectedness creates new vulnerabilities, and environmental impacts can be locally detrimental, requiring approaches that recognize the importance of natural environments across the continent.
- In the *All In Together* scenario, the main challenge, and the main opportunity, is to complement the flurry of local-level innovations and community action with higher-level support, legislation, monitoring and enforcement by state and non-state actors, while providing leadership in the face of larger-scale challenges.
- In *Helping Hands*, challenges are many and there is a strong gap and need in the governance of economic development to be more inclusive and environmentally sustainable. Engaging companies in collective business stewardship and strategy change is a way to leverage the strong agency of the private sector in this scenario.

Continued...

◄ Credit: Shutterstock/Take Photo

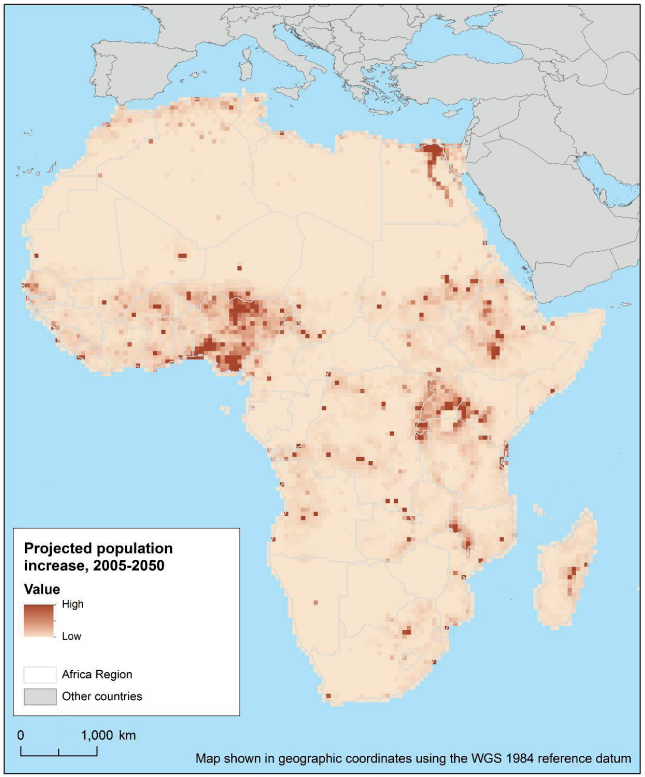
- The scenarios highlight the need to truly integrate sustainable and systemic thinking that understands the interlinked nature of natural and human systems into everyday practice and longer-term planning at all levels and sectors of government. Effective governance will come from empowering institutions at local to regional scales, building government capacity to monitor, improving civil society participation and strengthening political will and social responsibility.
- Africa's transformation must realise adaptive policy pathways that can rapidly implement the 2030 Agenda for Sustainable Development with the Sustainable Development Goals (SDGs) at its base while continuing to use the roadmap outlined in Agenda 2063 as the primary guide to advance a home-grown agenda.

Figure 3.1.1: Ecosystem assets



Note: The ecosystem asset component sums up 1), tree cover from MODIS VCF (DiMiceli *et al.* 2011) 2), renewable fresh water resources and water stored in large lakes and reservoirs from Dickson *et al.* 2014 and 3), biodiversity based on the geometric mean of species richness and range-size rarity based on IUCN species ranges (IUCN 2014).
Source: UNEP-WCMC 2015

Figure 3.1.2: Projected population increase, 2005- 2050



Source: Schaldach *et al.* 2011

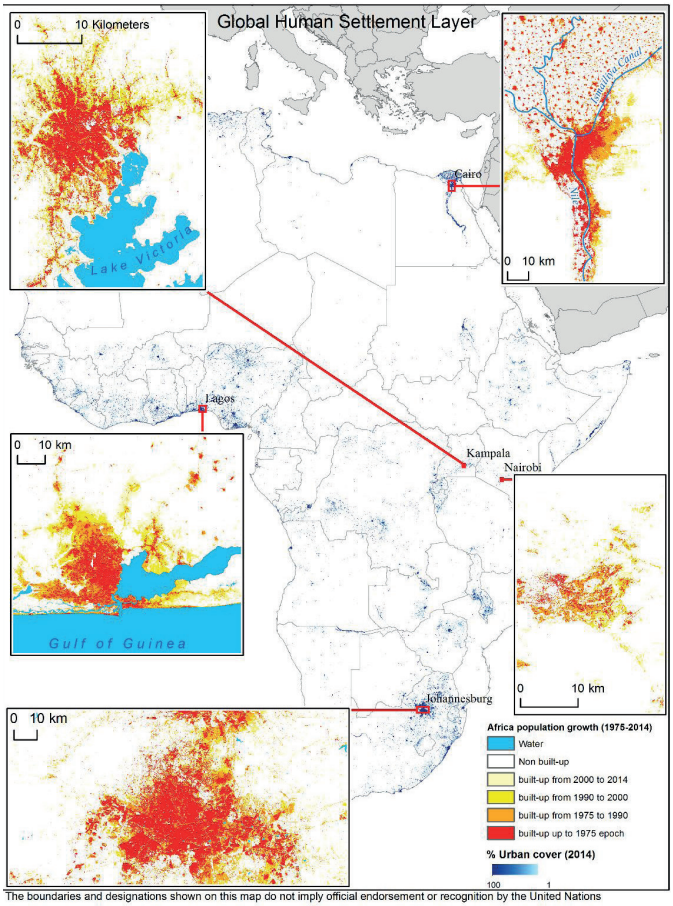
There are development trends in the region that pose a threat to Africa's assets, especially as the population on the continent continues to grow and concentrate in particular areas as shown in **Figure 3.1.2**. The provision of food, energy and water depends on the region's rich natural capital base, but it is imperative that this development takes place sustainably and does not over-exploit the continent's natural capital for short-term gains (**More... 26**).

Furthermore, the spate of conflicts on the continent show a worrying trend to detract the region from investing in proper environmental governance. In some cases the cause of these conflicts can be traced back to issues over resources. The importance of good environmental governance and the development and implementation of effective natural resource policies is therefore central to limiting these conflicts (**More... 27**).

Rapid urbanization is a key trend in the region that will have a big impact on natural capital. Africa's urban population is estimated at 40 per cent of the region's total population (Phillips 2014), and the ratio is projected to increase to 50 per cent by 2030, with some cities swelling by up to 85 per cent (Pesaresi *et al.* 2013). **Figure 3.1.3** shows how some urban centres in Africa have grown over the past 30 years.

Urban centres rely on natural assets, especially water and energy, for the well-being of their populations. If urban planning is undertaken in a way that can address Africa's growing urban population and provide them with resources like water and energy in a sustainable manner, then the region's natural capital will contribute to the increased well-being of the region's people. However, if there is an increase in slums where people do not have access to adequate services, then there is a huge risk that urbanization will be a key factor in the erosion of Africa's natural capital.

Figure 3.1.3: Urbanization in parts of Africa during 1975, 1990, 2000 and 2014



Source: Urban change data: Global Human Settlement Layer (GHSL), Pesaresi *et al.* 2013, Joint Research Centre, Italy, Rivers: Natural Earth (1:10m); Country and Region boundaries: UNEP-WCMC 2015.

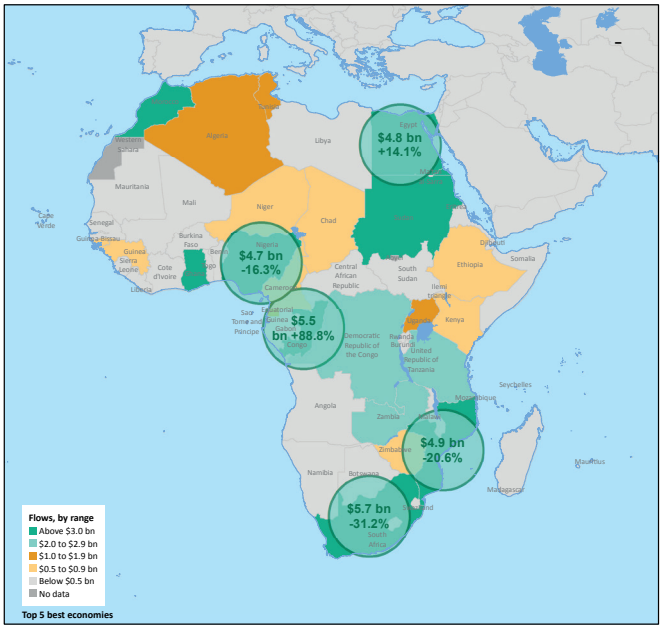
3.1.2 Development trends

Africa is on the rise with growing foreign investments now the largest source of capital flows into the region (**Figure 3.1.4, Table 3.1.1**). The rest of the world is taking note of Africa's rich potential, and in particular its growing population's demand for services and its rich natural resource base that has the capacity to meet these needs and to create economic gains in return.

Increasing investment in Africa is targeted at infrastructure development projects, with the expectation that this trend will continue (**Figure 3.1.5**). Telecommunications have taken the highest proportion, but energy infrastructure, in particular for electricity, has also seen an increase in investment commitments over the past two decades.

Several development corridors spanning the continent are planned to come into effect by 2040 (PIDA 2011). Transport corridors to encourage regional integration as well as to link urban and rural areas are central to Africa's development plans. Transport routes have been planned to link the major production and consumption centres, while ports and railway

Figure 3.1.4: Foreign Direct Investment into Africa



Source: UNCTAD, 2014

Source: UNCTAD 2015

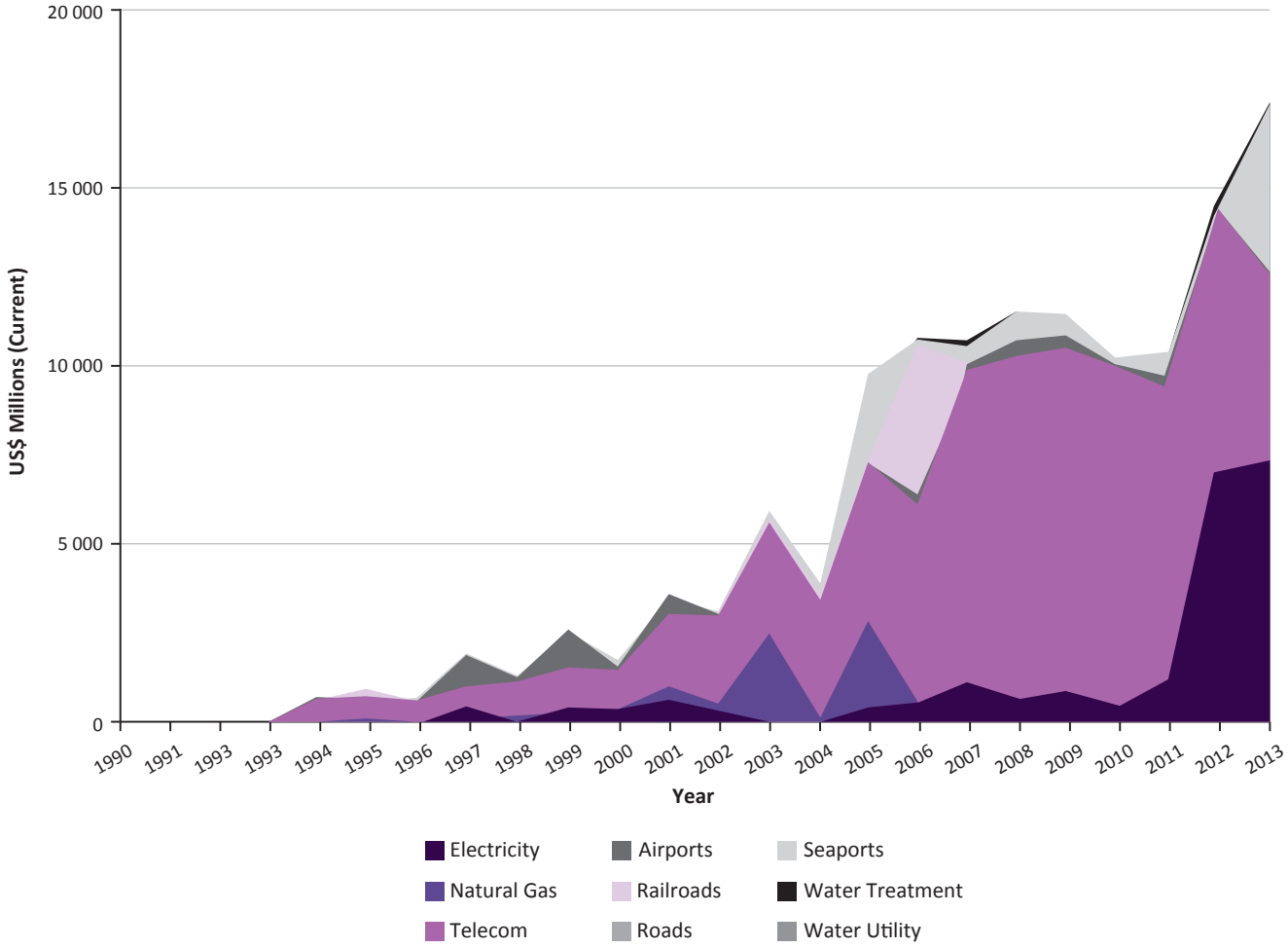
Table 3.1.1: Trends in foreign direct investment into Africa, 2000–2015

Foreign investments (both direct and porfolio) now largest source of capital flows to Africa (USD b)																
	2000		2002		2004		2006		2008		2010		2012		2014E*	2015P*
Foreign direct investments	12.5	23.3	20.0	23.4	25.4	33.8	35.4	52.8	66.4	55.1	46.0	49.8	49.7	54.2	49.4	55.2
Portfolio investments	1.5	-3.6	-0.4	-0.7	6.9	6.3	22.5	14.4	-24.6	-03	21.5	6.8	25.7	21.5	13.5	18.4
Official development assistance	15.5	16.8	21.4	27.4	30.0	35.8	44.6	39.5	45.2	47.9	48.0	51.7	51.3	55.8	56.3	54.9
Remittances	10.9	12.1	12.8	15.4	19.5	33.3	37.3	44.0	48.0	45.2	51.9	55.7	61.2	60.6	61.8	64.6
% GDP	6.8%	8.4%	9.3%	9.3%	9.7%	11.0%	12.3%	11.4%	8.7%	10.0%	9.6%	8.6%	8.3%	8.2%	7.3%	7.2%
Total	40.4	48.7	53.8	65.5	81.9	109.2	139.7	150.6	135.0	147.9	167.3	164.0	187.9	192.0	181.1	191.5

*E=estimate, P=projection

Source: EY 2015

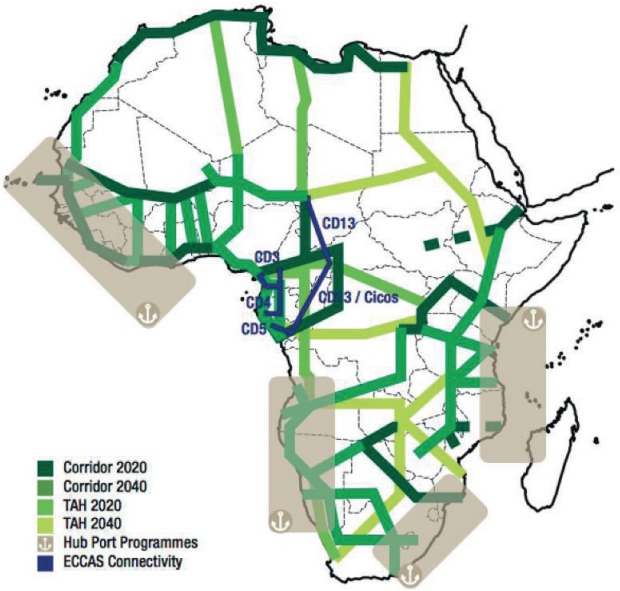
Figure 3.1.5: Infrastructure investment commitments in sub-Saharan Africa, 1990–2013



Source: Gutman *et al.* 2015

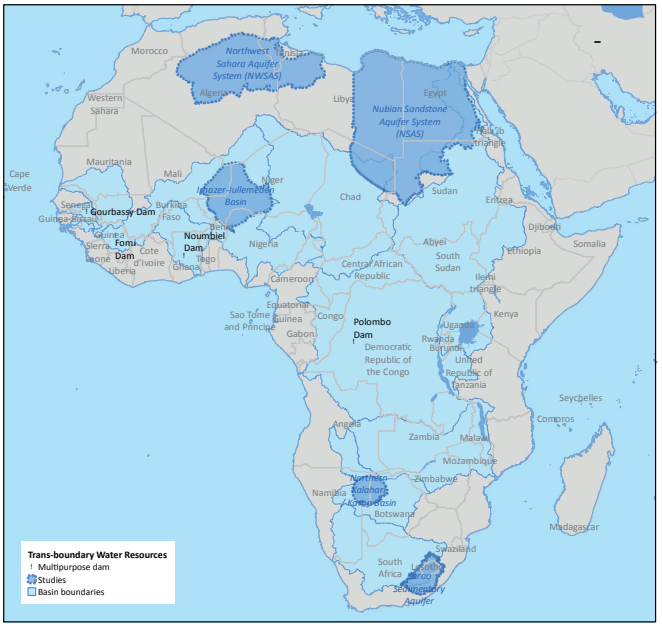
routes enable increased trade between land-locked and coastal countries (**Figure 3.1.6**). The African Development Bank has also identified important infrastructure projects to meet the water and energy needs of Africa's citizens. Planned water initiatives are targeting the development of multipurpose dams to enable regional cooperation while boosting food production through aquaculture and irrigated farming (**Figure 3.1.7**). The energy infrastructure programme prioritizes major hydroelectric projects and inter-state power pools, as well as regional petroleum and gas pipelines (**Figure 3.1.8**). The extraction of resources such as timber, minerals, oil and gas, has been identified as central to Africa's development trajectory and in particular to meeting its energy needs (**More... 28**).

Figure 3.1.6: Major transport route development



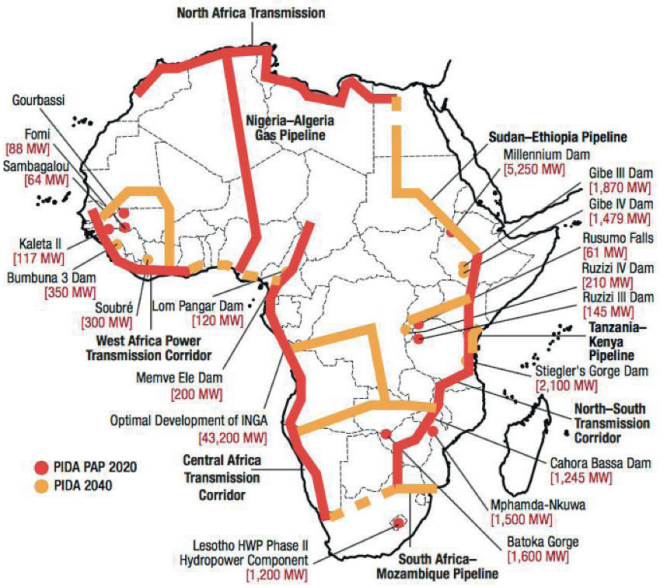
Source: AfDB *et al.* 2012

Figure 3.1.7: Transboundary water initiatives



Source: AfDB *et al.* 2012

Figure 3.1.8: Africa's energy infrastructure programme



Source: AfDB *et al.* 2012

3.1.3. Climate change

Climate will have a big impact on Africa's future, with serious implications on the availability of arable land and freshwater. The region's vulnerability to the impacts of future climate change is worsened by its comparatively low adaptive capacity and the relatively strong climate change signals that are projected for the region (Niang *et al.* 2014).

Temperatures in the region have been rising rapidly over the past five decades, at around twice the global rate in the subtropical parts of Southern and North Africa (Engelbrecht *et al.* 2015; Jones *et al.* 2012). Further increases are projected for the 21st century (Engelbrecht *et al.* 2015; Niang *et al.* 2014; James and Washington 2013). For example, in a low-mitigation future for the period 2071–2100, a rise of 4 to 6°C is likely to occur in Africa's subtropics relative to 1971–2000, with smaller increases projected for the tropics. These increases are associated with a rising incidence of extreme temperature events, such as very hot days when the maximum temperature exceeds 35°C, heat waves, and days of high fire danger (Engelbrecht *et al.* 2015; Niang *et al.* 2014; Vizy and Cook 2012). Impacts are likely to be significant across a wide range of sectors, including agriculture with, for example, decreases in the maize yield anticipated in Southern and East Africa (Thornton *et al.* 2011); loss of biodiversity, with bush encroachment in the grasslands of the African highlands (Engelbrecht and Engelbrecht 2015; Midgley and Bond 2015); and water security challenges, through enhanced evaporation from reservoirs and more evapotranspiration from the land surface (Engelbrecht *et al.* 2015; Conway and Schipper 2011). By exceeding critical human and animal thermal-comfort levels, oppressive temperatures are likely to have a direct impact on human and animal health (Garland *et al.* 2015). The energy sector will also to be affected, with an increase in energy demand for achieving human comfort in houses and factories.

Under a low-mitigation future, Africa will have to deal with the adverse impacts of rapidly rising temperatures and associated extreme events during a period considered particularly important for its development (2021–2065) (African Union Commission 2015). A high-mitigation climate future may hold significant advantages for Africa.

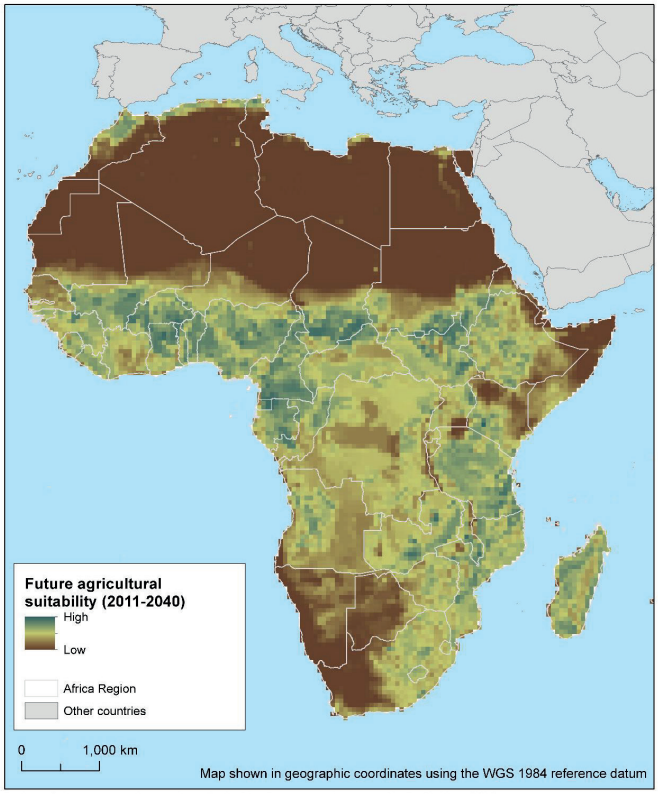
Africa's rainfall futures are less certain than the corresponding temperature futures (Niang *et al.* 2014). However, a generally drier climate is likely for the Mediterranean coast of North Africa, for the winter rainfall region of southwestern South Africa, and the larger summer rainfall region of Southern Africa (Niang *et al.* 2014; James and Washington 2013; Engelbrecht *et al.* 2015). General increases in precipitation are projected for East Africa, while over West Africa and the Sahel, there is a mixed signal of both increases and decreases.

A drier future is projected for Southern Africa not only in terms of total rainfall, but also in terms of more frequent occurrence of dry spells and seasons of drought (Engelbrecht *et al.* 2015; Niang *et al.* 2014). At the same time, projections of a general increase in rainfall over East Africa also indicate an increase in large-scale flood events (Niang *et al.* 2014;

Seneviratne *et al.* 2012). Tropical cyclone tracks are expected to shift northwards over the southwestern Indian Ocean, with a higher frequency of landfall over northern Mozambique and a lower one over the southern portion of the country under low-mitigation futures (Malherbe *et al.* 2013).

Climate change will have direct impacts on food provisioning services on the continent. Increased temperatures and shifts in rainfall patterns will have an impact on the suitability of land for agriculture (**Figure 3.1.9**).

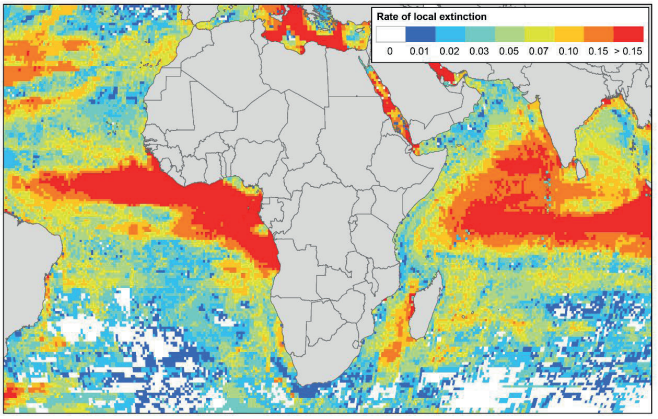
Figure 3.1.9: Agricultural suitability, 2011-2040



Source: Zabel *et al.* 2014

Climate change will also have a detrimental impact on the marine environment and fisheries. **Figures 3.1.10** and **3.1.11** show rates of species extinction and species invasion off the African coastline by 2050. Although less stress is coming from species invasions, it is evident that there is a large hotspot between the West and Central African coasts as well as along the western coast of Madagascar, Africa's mediterranean coastline and in the Red Sea. This has an impact on the catch potential of fisheries, which is expected to decline in similar hotspot areas (**Figure 3.1.12**).

Figure 3.1.10: Local species extinction by 2050 relative to present



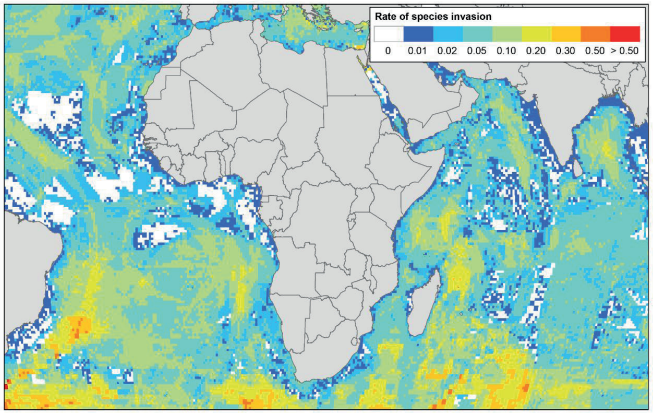
Source: Jones and Cheung 2014

3.1.4. Regional hotspots: high ecosystem assets and high vulnerability to threats

Africa's ecosystem assets face threats from a variety of factors, but certain hotspots will be more vulnerable to these stressors because of their location. A combination of threats, including change in population densities, impact of potential future transport corridors, changes in the suitability of agricultural land, and the impact of the extractives industry as shown in **Figure 3.1.13** places much of Africa's natural capital under significant threat.

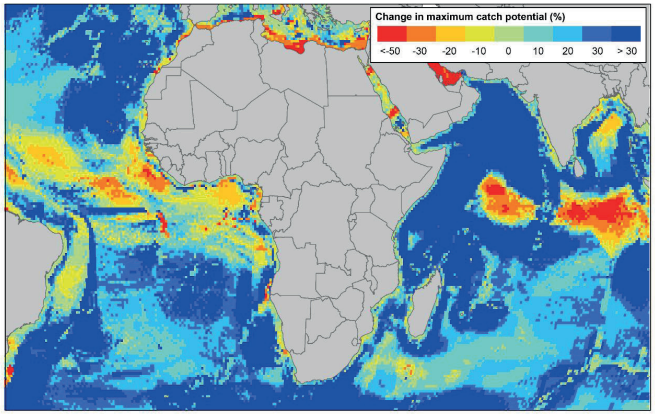
The future threat component sums change in population density between 2005 and 2050 (Schaldach *et al.* 2011), regional development plans (Verhoot *et al.* 2014), future transport corridors for 2040 (PIDA 2011), agricultural suitability for 2011-2040 (Zabel *et al.* 2014), and oil and gas exploitation (IHS 2014).

Figure 3.1.11: Species invasion by 2050 relative to present



Source: Jones and Cheung 2014

Figure 3.1.12: Change in maximum catch potential by 2050 relative to 2000



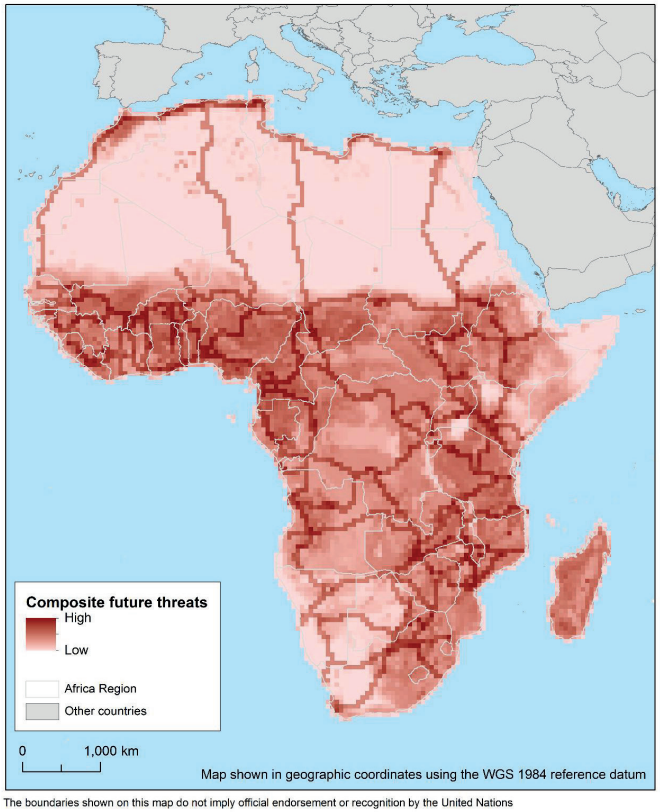
Source: Cheung *et al.* 2010

Africa's natural capital faces threats, and depending on the development trajectory that the region follows in order to meet the food, energy and water needs of the citizens, various future scenarios are possible. In anticipation of the various futures, the region needs to develop a contingent of policy options that could help the continent to develop sustainably while still meeting development needs.

3.1.5 Africa's vision

Agenda 2063 will spur Africa's future, with a focus to establish a prosperous region characterized by sustainable inclusive growth, peace and good governance. The region's growth

Figure 3.1.13: Composite future threats



Source: Zabel *et al.* 2014

path shall be led by increased agricultural productivity, industrialization, investment in infrastructure development and renewable energy, conservation of biodiversity, sustainable and fair and equitable use of its genetic resources, clean air and water, and better adaptive capacity to climate change. However, Africa's growth pathway is faced with challenges of sustaining rapid economic growth as its population is expected to double to approximately 2.5 billion by 2050, and the need to safeguard the life-support system provided by its rich natural capital. It is therefore imperative that such growth must consider the region's relatively weak environmental governance and a paucity of accurate and up-to-date environmental and related data for evidence-based decision-making.

As an affirmation of the importance of both Agenda 2063 and Agenda 2030 as defined by the Sustainable Development Goals (SDGs), Africa's future will contain common elements for a development trajectory that will provide the region with a healthy living environment while ensuring good health and quality of life for her people. The two are also critical to preserving and valuing Africa's natural capital for the benefit of its citizens and their livelihoods (**More... 29** and **30**).

3.2 Scenario analysis

Africa's future is shaped by many uncertain drivers of change whose interactions might result in different pathways for development and impacts on natural resources. It is therefore dangerous to rely on projects with a 'most likely' future. Instead, policy makers and other societal actors must acknowledge future uncertainty, and take a range of different possibilities into consideration when developing strategies and plans to increase their feasibility.

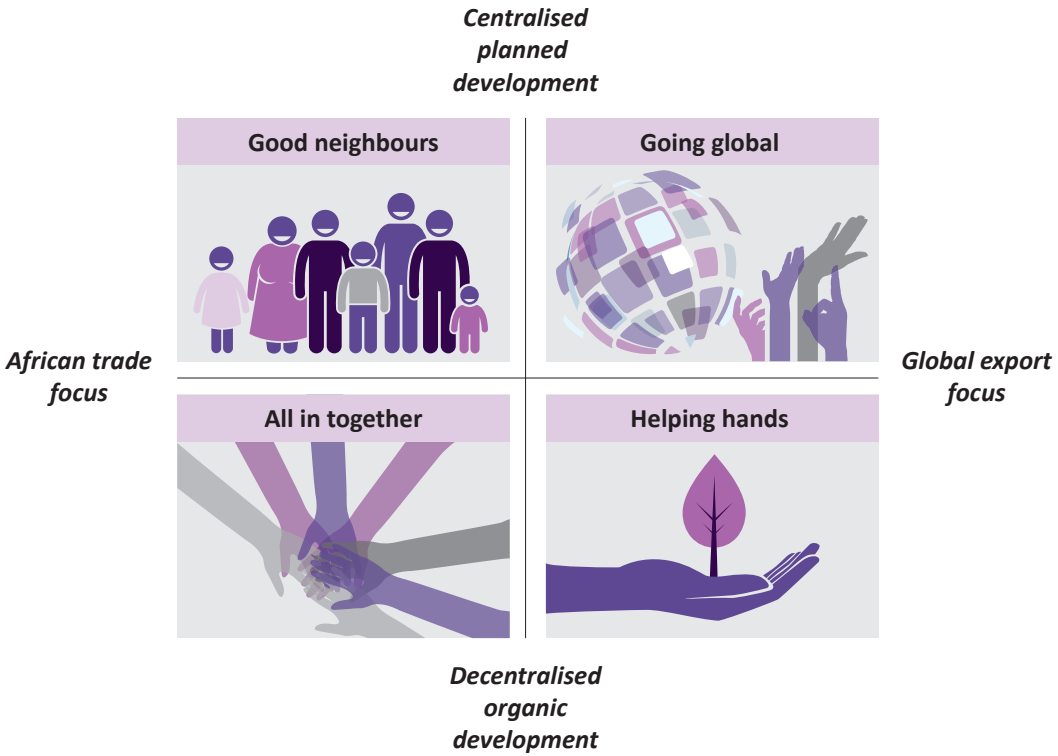
Scenarios offer a particularly useful tool for exploring the implications of different futures (Wilkinson and Eidinow 2008). Scenarios are 'what if' narratives, creating a range of different future worlds, each exploring a different direction in which drivers of change could develop and interact. Scenarios have been used effectively as a tool to test and develop plans and policies for development, environment and adaptation (Vervoort *et al.* 2014) .

This outlook is based on four scenarios described in the WWF/African Development Bank 2015 *African Ecological Futures* report (WWF/AfDB 2015). After a process of developing sectoral scenarios with various stakeholders on the continent, this final set of scenarios was developed at the 15th African Ministerial Conference on the Environment (AMCEN) in Cairo in March 2015 and published in May 2015, making it the most recent set of regionally-applicable participatory scenarios for the continent, which provide a legitimate, credible set of future pathways (Chaudhury *et al.* 2013). Two critical, but uncertain, factors are used to create a set of axes on which the four scenario pathways are developed. The first is that of governance and decision-making around infrastructure/land development and natural resource use, where centralized and coordinated, or top-down planning is contrasted with more organic decentralized decision-making. The second axis relates to economic production and the focus of trade in Africa and whether it is global export-oriented or more intra-African and driven by domestic urban and rural consumption. **Figure 3.2.1** outlines where the four scenarios – *Good Neighbours, Going Global, All in Together and Helping Hands* – fit relative to the development and trade options.

The scenarios outline a future Africa in which governance is more centralized and planned or more decentralized, and where trade is more regionally focused on the continent or looks more to global exports.

The *GEO-6 Africa Outlook* builds on these existing scenarios and adapts them to a discussion of Africa's natural capital. The narratives in this section offer discursive storylines around different potential futures, depending on the directions in which the key drivers (trade focus and level of centrality) might develop. They are not intended to be projections of a 'most likely' set of futures, since it is accepted that such claims are difficult and dangerous. Instead, they offer diverse, but plausible (believable if we accept that drivers of change could evolve in certain directions) future worlds, that

Figure 3.2.1: African ecological futures scenarios



Source: WWF/AfDB 2015

can enable decision makers to make better decisions today by examining the feasibility of policies and plans in the light of diverse future conditions (Vervoort *et al.* 2014). Their value is not in predicting the future, but in testing and examining strategies from diverse, challenging perspectives.

The scenario analysis specifically sets out to understand the extent to which the Sustainable Development Goals (SDGs) and the African Union's Agenda 2063 Vision are or are not achieved, depending on the scenario. The analysis emphasizes the use of the SDGs as related goals that should always be considered as a full set rather than treated selectively.

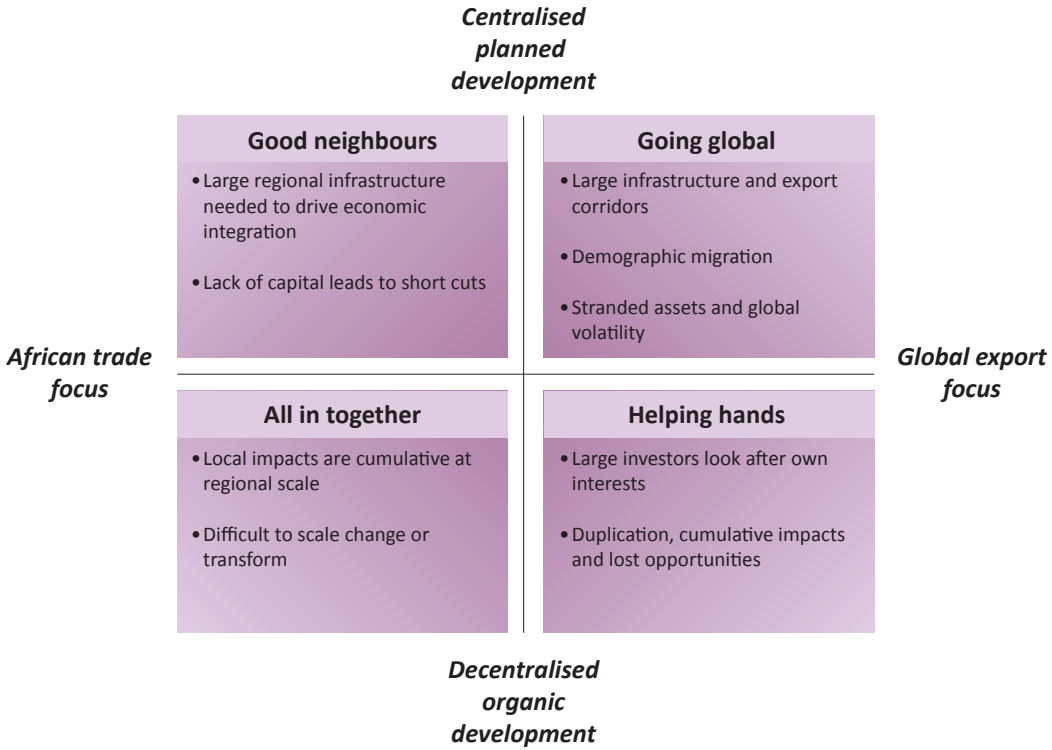
The narratives are complemented by a set of impact tables developed in collaboration with experts. The assumptions outlined in **Figure 3.2.2** form the basis of the analysis conducted by experts of the impacts that particular pathways might have on Africa's land, air, water and biodiversity.

Section 3.4 explores the implications for action in these four scenarios, examining both scenario-specific implications and action points across the entire set.

3.2.1 Good Neighbours

A difficult but ultimately largely successful transition to centralized planning forms the core of Africa's governance

Figure 3.2.2: Key assumptions of the four scenarios



Source: Nel 2015

structure by 2030 and beyond, backed by increased intra-Africa trade over global exports. Following the vision outlined in Agenda 2063, and supported by the AfDB's Programme for Infrastructure Development in Africa (PIDA), there is major investment in infrastructure for energy supply, water, food security, and transport and trade.

Africa is witnessing increased investments in the water and energy sectors, and road infrastructure. This leads to the region partially achieving energy security goals under the SDGs by 2030, and more fully by 2063, while also increasing food security and working towards an end to hunger and malnutrition. However, the large-scale investments in infrastructure and the heavy dependence on the region's abundant natural resources take a heavy toll on biodiversity and ecosystems, and resulting feedbacks on ecosystem services counteract the achievements toward the SDGs to some degree. While centralized planning systems increase efforts to minimize impacts through implementation of environmental regulatory measures, transboundary agreements and protected areas, the risks of environmental degradation persist due to large regional infrastructure expansion into previously inaccessible areas coupled with the development of trade corridors. There is localized dispossession of land among families living in the paths of such infrastructure projects.

Although agricultural production continues to be a primary focus, prompting large-scale land acquisitions driven by centralized planning strategies, increased domestic consumption through a rising middle class intensifies pressures on coastal and marine resources. State-led institutions take a top-down approach, increasing production from large-scale commercial fisheries in order to meet demand. While this improves social and economic conditions in the short term, it erodes long-term sustainability and results in significant impacts on marine resources and biodiversity. In addition, large-scale, highly coordinated food and energy production in the hands of a few can mean that past social inequalities persist, particularly in North and Southern Africa, unless properly managed. The trend in democratization can temper this by leading to improved civil society engagement and increased recognition of the importance of the rule of law, in turn strengthening both justice and social equity.

With a primary focus on domestic needs, the centralized planning and targeted economic development seen in this scenario improve overall socio-economic conditions and societal well-being. State-led institutions expand mining, oil and gas development while continuing to focus on agricultural production and trade in primary resources. In order to increase trade and economic cooperation between countries, leaders agree to soften borders and trade tariffs, building on the successes of the South African Development Community (SADC) and Common Market for Eastern and Southern Africa (COMESA). The increased movement of goods and services across Africa's hinterland, however, increases the vulnerability of land, water and biota to pollution and degradation. While there is a rapid increase in migration to urban areas, coordinated government planning ensures that the necessary infrastructure is available and minimum requirements for clean water and sanitation are met. This requires large water withdrawals from natural sources, leading to further pressure on freshwater ecosystems, especially in North and southern Africa, where there is a strong reliance on groundwater sources that take a long time to replenish.

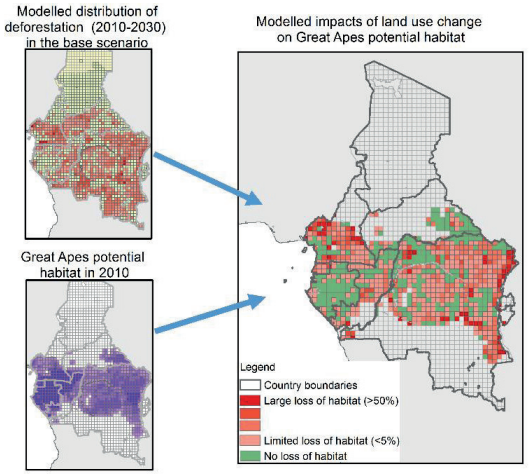
Despite the advent of large-scale infrastructure development that relies heavily on natural resource extraction, leaders are driven by the new global agenda for sustainable development and recognize the co-benefits of mitigating climate change and improving air quality through emission reductions. There is therefore a doubling of efforts to decouple emissions from economic growth. This is achieved by reducing the carbon intensity of energy, having an overall positive impact on public health, particularly in areas near power plants.

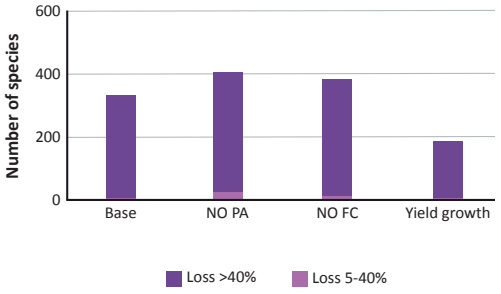
The location of infrastructure investments is also well managed to minimize impacts on sensitive ecosystems, although land degradation continues to increase due to large-scale infrastructure and agricultural expansion. As an added adverse side effect, the prevalence of large-scale infrastructure increases vulnerability to potential shocks and climate variability as larger numbers of people rely on that infrastructure for basic services.

While it is recognized that sustainable management of shared resources can be achieved through centralized planning and regional cooperation, there is an initial lack of coordination in regional strategic and spatial planning which leads to certain resource-scarce areas being negatively affected. This is most prevalent in the case of water, as increased domestic demand coupled with large-scale development puts pressure on freshwater resources, resulting in inequalities between areas with abundant resources and those without. However, strong effective leadership recognizes the importance of regional integration and pooled resources in this scenario, opting to band together as good neighbours for mutual benefit, with the Central African Forests Convergence Plan (**Box 3.2.1**) being an example.

Box 3.2.1: Land-use change for the Congo Basin

Reducing emissions from deforestation and forest degradation, plus the conservation of forest carbon stocks, sustainable management of forests, and enhancement of forest carbon in stocks (REDD+) is of increasing importance to member countries of the Central African Forestry Commission (COMIFAC). REDD+ and related policies will have impacts on future land use and in turn countries' approaches to addressing and respecting the UNFCCC REDD+ safeguards, as well as their efforts to achieve the Aichi Biodiversity Targets.





Note: The figure shows the number of species losing habitat within the region under scenarios where: there is no land-use change in protected areas or forest concessions (Base); protected areas do not prevent land-use change (No PA); forest concessions do not prevent land-use change (No FC), there is an expansion in protected areas (PA+) or agricultural yields increase (Yield growth)

In the Congo Basin, the management of Forest Concessions (FCs) and Protected Areas (PAs), as well as increasing agricultural yields, are potentially important options for achieving REDD+ objectives. Through the REDD-PAC project, an economic land-use model (GLOBIOM) has been used to assess the potential impacts of changes in effectiveness of FCs and PAs, and of increases in agricultural yields, in preventing land-use change. The model projections show that, even assuming full enforcement of the current protected areas and forest concessions (i.e. no land-use change within them), land-use change is likely to cause substantial adverse impacts on biodiversity and related ecosystem services by 2030 (with over 370 of 2115 mammals, amphibians and birds projected to lose over 10 per cent of their potential habitat).

The Congo Basin is home to several threatened Great Ape Species, which have the potential to support the development of eco-tourism activities, a key ecosystem service. Likely changes in Great Apes habitat are assessed by combining information on projected change in forest cover (2010-2030) with information on potential species occurrence.

To examine further the impacts of forest concessions, protected areas and changes in agricultural yields, the model was run for scenarios in which forest concessions and protected areas do not constrain land-use change. In this scenario protected areas coverage expands to 17 per cent and one in which agricultural yields increase.

The results suggest that the role of both PAs and FCs in maintaining forest cover may play an important part in conserving species habitat. Increasing agricultural yields on existing croplands, has a potential to decrease the need for further deforestation, depending on how it is implemented. Combinations of these approaches along with other measures may be key to successful REDD+.

Source: UNEP-WCMC based on their work with REDD-PAC (see Tadoum *et al.* 2016)

3.2.2 Going Global

Africa's socio-economic growth is based on the extraction and export of commodities, including timber, minerals, oil and gas. Both the Africa 2063 Vision and the Africa Mining Vision 2050 are central, as they seek to increase the benefit that Africa receives from its natural capital for the prosperity of its people. Areas with abundant resources develop their primary resources industries quickly, but there are risks to ecosystems from the expansionist nature under this scenario, and its focus on exports means that there is potential for exacerbating inequalities, as those with access to foreign investment get ahead of the game.

Sub-Saharan Africa continues to increase its exports as it did at the turn of the century, when it gained market share everywhere except in Latin America. At that time (1996–2010), the region's strongest increase in market share was in the Asia-Pacific market, where Africa expanded its share from below 0.8 per cent to 1.2 per cent (International Trade Centre 2012). At the same time, intra-regional trade expanded from 9 per cent to 14 per cent, indicating strong regional integration (International Trade Centre 2012). Large regional projects with global support are developed, for example the Grand Inga Mega-project (**Box 3.2.2**).

Under the *Going Global* scenario, unexploited oil and gas fields are developed to ensure greater value of exports, and the AfDB PIDA planned development corridors become a reality. There is a large focus on agricultural intensification, increasing the use of forestry resources and aquaculture. This focus on a green economy rather than a blue economy results in less pressure on marine resources, and, where there has been an increase in the export of marine resources, this has been mainly from large-scale aquaculture projects, so fisheries are starting to recover. However, this has also meant that artisanal fishers have been forced either to enter the formal fisheries sector or to seek alternative employment in some of the large-scale development projects that are underway. At the same time, centralized planning and a recognition of the importance of healthy ecosystem functioning has led to an increase in the number of protected areas. Outside these protected zones, however, there is little to no biodiversity, and species are concentrated in a few hot-spots. A benefit of the increase in protected areas is a boom in eco-tourism as foreign investment flows into luxury resorts – particularly in East and Southern Africa – as Africa becomes the last continent with areas of pristine environment. By 2040, Africa is the centre of the world's eco-tourism industry. While this leads to job creation in many areas, most of the wealth still makes rich overseas investors richer and does not contribute as significantly as it could to the local economy.

With a focus on planned development corridors and economic processing zones, certain key urban areas develop rapidly, with Kampala, Johannesburg, Lagos, Accra and Nairobi fast becoming global technology and innovation hubs, increasing their global connectivity. In order to maximize production of export crops such as coffee, tea, cocoa and tobacco, many of the 33 million 2-hectare farms are merged, resulting in the loss of land for some rural farmers, who in turn flock to cities to find jobs. This results in an increase in the informal sector economy, but the rise in foreign investment and concomitant advances in city governance mean that those living in cities have access to cleaner technologies, which prompts a vast improvement in (urban) health. However, the need for transporting goods over vast distances across the continent means that carbon emissions also increase, and industrialization decreases air quality and increases health expenses. In rural areas where most of the large-scale development is taking place, no progress is made towards increasing access to both clean air and water, although due to the emphasis on agriculture, the continent is now food secure; in some countries the majority of rural people now buy their food rather than growing it themselves.

3.2.3 All in Together

This scenario is characterized by national sovereignty and action at local levels, where there is widespread community action towards more sustainable resource use, more climate-smart agricultural practices and more integrated conservation efforts, supported by international funding from donor countries, social entrepreneurs and other funding sources. However, the scenario is also characterized

Box 3.2.2: The Grand Inga mega-project under the *Going Global* scenario

With rolling blackouts affecting South Africa in 2015, there is a complete lapse in economic growth in southern Africa as its superpower's economy continues to slide. This energy crisis sparks a renewed emphasis on large-scale renewable energy projects and the cooperation treaty signed in 2013 between South Africa and the Democratic Republic of the Congo for the development of the Grand Inga hydroelectric power station comes into the spotlight. The Grand Inga becomes the poster child for development in the region as it is the world's largest proposed hydropower scheme (generating 40 000 megawatts – double that of China's Three Gorges Dam) and is central to the grand vision of developing a continent-wide power system. As such, the Grand Inga mega-project is the priority project for a number of African development organizations, including the New Partnership for Africa's Development (NEPAD), SADC, the East African Power Pool (EAPP) and ESKOM, Africa's largest power utility.

The current and planned Inga dams are located in western Democratic Republic of the Congo, 50 kilometres upstream of the mouth of the Congo River, and 225 kilometres (140 miles) southwest of Kinshasa on the Congo River. The Congo River empties into the equatorial Atlantic Ocean creating what is known as the Congo Plume, which is one of the largest carbon sinks in the world. The dam site is on the largest waterfall in the world by volume, the Inga Falls, and at the Grand Inga site the Congo River drops 96 metres in a run of 14.5 kilometres.

The continent's global outlook has attracted a lot of interest from overseas consortia and eventually a Chinese developer wins the tender to build the Grand Inga, which further entrenches ties between China and the African continent. According to the timeline, in late 2016, construction begins on Inga III, the first of six phases of the proposed project, with funding coming from the World Bank, the AfDB and the European Investment Bank. Due to the G20 push for large infrastructure investments, the World Bank updated its infrastructure investment strategy to allow for finances from both private and public sources. The Grand Inga, excluding transmission lines across the continent and to Europe, is thus being financed under a public-private partnership structure and is listed by the G20-Multilateral Development Banks as one of the top 10 Exemplary Transformational Projects.

Inga III is up and running on schedule by 2022, just in time to meet the AfDB's long-term strategy goals. Eskom duly buys its allocated 2 500 megawatts of the total 4 800 megawatt capacity of Inga III and South Africa's economy starts to boom. Unfortunately, the transmission cables into East Africa are not ready on time as their financing fell through, and so the excess generation capacity is wasted. Despite the argument being proposed that the electricity generated from the dam would go to the Congolese people, no inroads have been made and all the transmission cables still run only to areas where there are large extractive industries. The county's electrification rate has improved by only 5 per cent and is now at 14 per cent. Nevertheless, the Grand Inga project continues to be developed, but there is less attention on the project now that South Africa's energy woes are behind them and the region's economy once again begins to boom thanks to the extractive industries.

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The main reason for the funding of the transmission lines falling through is that in order for these lines to be built, huge corridors of forests would need to be cleared in the Democratic Republic of the Congo, which is home to the world's second largest rainforest. With the SDGs taking centre focus, no more international funding was forthcoming for projects that have such a considerable environmental impact. This puts a spanner in the works for the success of Grand Inga, as the initial hype surrounding the project was to generate energy for the whole continent. Furthermore, other ecological impacts of the project itself are coming under the spotlight. Due to nutrient and sediment trapping, losses in the mid-Atlantic plume are anticipated, which would have a negative impact on coastal fisheries. Furthermore, it was necessary to divert the river to create a reservoir, which flooded the Bundi valley. This has had a disastrous impact on agricultural productivity and has also resulted in high amounts of methane emissions – the ecosystem asset that was once a carbon sink is now becoming a source of carbon. This flooded area has also provided the perfect breeding ground for water-borne vectors like mosquitoes. The incidence of malaria in the area is therefore on the rise.

With pressure building on the Chinese to meet the SDGs, the developer eventually withdraws from the Grand Inga project in 2028, leaving it half-finished and at risk of becoming a stranded asset. However, all hope is not lost. A technology company in Lagos has recently developed a cable that can transmit power, but which does not require the extensive transmission lines of traditional cables. With finance pouring in from all around the world, the first major development project using this technology is for electricity distribution from the existing Inga dams, that together amount to 20 000 megawatts, which was the grid-based capacity of West Africa in 2012 (International Energy Agency 2014). The electrification of Congolese cities and villages – as well as those in Zambia and Angola – has sparked a revolution in adding value to the agricultural products that were previously being exported without processing. The people that were displaced by the construction of the dam, and who were left largely without livelihoods, are now able to take part in this new industry that is creating many new jobs. By 2063, agro-processing for both domestic and export consumption is the primary economic activity in the sub-region, and it has led to job creation and prosperity for many.

Less than the projected 50 per cent of the Congo River's annual discharge had been diverted by 2030, which means that the ecological integrity of the river system has remained largely intact. Furthermore, a new technology that allows for the release of sediment and nutrients from dams has been incorporated into the most recent dams, so the Atlantic plume has not suffered the anticipated losses. A Mozambican hydroelectric company that made its name in turning Cahora Bassa into a flagship project for the country has been brought in to train the local team on best management practices for hydroelectric facilities. This knowledge sharing within the region has started southern Africa down the promised path towards more peaceful relations, as was one of the original aims of the Grand Inga project.

Source: International Rivers 2015

by a failure to take this diversity of social and technical innovations to a higher scale. In this scenario, Africa's efforts to manage its natural capital sustainably are hampered by pockets of conflict, with regional efforts playing a leadership role in conflict resolution through Regional Economic Communities (**Box 3.2.3**).

While Africa is a vibrant place full of creative practices and local innovations, many people continue to suffer away from the public eye due to conflicts. These not only disrupt normal lives, but result in widespread poaching, plunder and other environmental crimes. At the same time, there is an enormous diversity of approaches to generating flexible, local renewable energy. Urban growth is fast due to peace prevailing in these areas, but urban areas are poorly administered, leading to the flourishing of informal settlements. Mining and oil and gas extraction expand but revenues are not well managed.



African migrants arriving in Sicily, Italy
Credit: EPA

In order to fight lawlessness and cross-border crime, sub-regional communities become more integrated as a way of bringing peace. Eventually, pockets of ecosystems flourish in well-managed agricultural areas and community-supported protected areas. Transboundary natural resources such as freshwater and fish stocks are most affected by the lack of effective governance at the international level.

Overall, there is a strong risk of leaving behind those who are not able to access the social, knowledge and financial capital to join the 'new Africa' of sustainable local innovation. Natural environments and resources also risk degradation and fragmentation outside these sustainable innovation hotspots. Africa's vulnerabilities to shocks have to do mainly with the focus on local resilience to relatively local stressors. Large-scale shocks such as prolonged droughts, migrations, conflicts, and shocks because of mismanagement of transboundary resources (such as sudden changes to river systems) are difficult to deal with at the local level.

3.2.4 Helping Hands

Africa's future is based on increased levels of direct foreign investment and overseas development assistance. Foreign investment into the region is currently uneven, but has grown over time. The region's trade focus is global, and its development is organic and decentralized, but driven by multinational corporations (**Box 3.2.4**).

From 2015 to 2030 in the *Helping Hands* scenario, investors, local and multinational, have increasingly focused on the continent and its abundant resources, their main activities being large-scale mining and commercial farming. Many of these companies tend to focus on the same areas, leading to a concentration of enterprises in resource-rich areas. This has sparked a sharp increase in urbanization as rural people are increasingly attracted by the employment opportunities provided by big companies. In addition to mining, the exploitation of oil and gas by international firms has increased. New roads and non-road infrastructure have been developed all over the continent and this has meant that previously inaccessible areas now have access to markets and basic services.

Box 3.2.3: *All in Together* in Western Africa

Throughout the 2010s, West Africa has been plagued with large economic and political instability, in addition to public health crises such as the Ebola epidemic in Liberia and Sierra Leone. Extremist factions such as Boko Haram and Al Qaida in the Islamic Maghreb (AQIM) have further destabilized large areas of the sub-region, causing a large efflux of refugees and migrants, and internally displaced people. The instability in the region has compromised the strength of governments and in turn bolstered civil society in its wake.

In the late 2010s, civil society in West Africa has successfully leveraged its global partners to intervene in Mali in a humanitarian way rather than a military, destructive way, bringing stability to the region. Eventually, northern Nigeria and the Lake Chad region are also returning to peace in the early 2020s, as Boko Haram's terror has finally been quashed.

In 2030, West Africa is a vibrant region in which civil society organizations and non-governmental organizations (NGOs) are collaborating with local communities towards a more community-oriented, sustainable future. At the same time, an active private sector has emerged in the region, pushing for large-scale commercial development. The relationship between civil society and the private sector is two-fold: they collaborate as well as compete for influence.

Rural communities are benefiting from improved livelihood conditions and knowledge. This leads to greater community self-organization and professionalism, making them more self-empowered. Gender relations have changed, as women are increasingly being educated and are allowed to own more land.

Civil-society organizations and the private sector are successfully working together in the health sector, which has a moderate effect on the availability of health care. The incidence of malaria is slowly decreasing. Because of better health education, people are more aware of health risks.

During the 2010s, environmental degradation continues. This is largely due to growing populations and their energy needs, leading to excessive, illegal wood cutting for firewood and charcoal, accompanied by frequent bush fires. As NGOs were gaining power towards the 2020s, they pressured governments to successfully implement environmental policies. This eventually led to the development of the Great Green Wall to counter progressing desertification of the Sahel. Terrestrial biodiversity loss rates decreased as a result. However, in some parts of West Africa, including areas in northern Nigeria, Burkina Faso and Niger, large-scale agriculture has led to irreversible soil degradation. In these areas, alternative sources of income are increasingly found through solar energy farms throughout the 2030s and 2040s.

Source: Palazzo *et al.* 2014

Box 3.2.4: *Helping Hands* in East Africa

From 2015, governments and particularly, the private sector in Burundi, Ethiopia, Kenya, Rwanda, Uganda and United Republic of Tanzania are pushing for regional development. In addition, big companies from China, India and the Arab Gulf States are making large investments in the region. Their focus, however, is on industry, services, tourism and, especially, export agriculture. As a consequence, food security, environments and livelihoods are low on the agenda. A region-wide one-sided emphasis on economic growth makes East African countries vulnerable to global market forces and environmental degradation. But continuing regional integration leads to a better functioning East African Community, and in 2028, a single East African currency is introduced, making the region more economically independent and bringing greater stability.

Agriculture is mostly focused on cash crops such as coffee, tea, cotton and tobacco, mainly for export. Food security is not highlighted in policies; therefore, food crop production for regional consumption is on the decline. However, because of a higher GDP, the living standards of the middle-income class have improved, and imported food meets their demands. Increasingly, the region's neglect of environmental issues is compromising its competitiveness on the global market, affecting its exports. Consequently, international companies are starting to leave East Africa throughout the 2020s.
In addition, a period of severe drought strikes the sub-region in the early 2020s, leading to even more food insecurity among rural communities. International food aid from Europe and Asia minimizes famine in most parts of the sub-region, at least in the short-term. In South Sudan and Somalia, however, continuous drought leads to mass starvation. In other parts, new health issues start to emerge due to changing food consumption practices, and a sharp increase is observed in non-communicable diseases such as obesity, diabetes and cardiovascular complaints.

The severe drop in agricultural productivity causes massive waves of migration towards the cities. These new, poor city dwellers experience inadequate housing and a lack of clean water and sanitation, leading to a lower quality of life.
As a consequence of the one-sided focus on economic growth through export, the sub-region is unable to react adequately to the massive drought that hits the land during the early 2020s. Export demands are no longer met, leading to a bending of the rules by East African governments to attract new external investment. This, in turn, triggers further decline in both ethical and environmental standards.

Environmental degradation starts to show from 2020 onwards. The region's Great Lakes, once part of a key characteristic physical landscape, are shrinking steadily. Africa's largest lake in terms of surface area, Lake Victoria, sees a drop in water level of approximately 2.5 metres, while Kenya's Lake Nakuru is suffering a fate similar to the Aral Sea in the former Soviet Union: during the dry season, the lake's surface area is regularly less than half of its size back in 2015. In addition, the overcrowded cities and more intensive forms of agriculture and industry exert increased pressure on these aquatic ecosystems in the form of pollution. This leads to eutrophication, causing fish stocks to decline and invasive algae and weeds to bloom.

From 2030 onwards, as foreign companies have largely left East Africa, joint efforts to counter environmental degradation and related food insecurity are proving successful in some parts of the region, including the areas surrounding Kampala,

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Lake Kivu, Serengeti National Park and Nairobi. Here, awareness of the importance of using natural resources sustainably has led to initiatives for green growth and better protection of ecosystems. Eco-tourism in the borderlands of the Democratic Republic of the Congo and Uganda, Lake Victoria and the Serengeti, prompts better preservation and environmental management through collaboration between governments, the private sector, civil society and NGOs, as it is an increasingly important source of income. These initiatives slowly spread to other parts of East Africa. Yet, as economic growth in the other East African countries continues, aid programmes to help South Sudan and Somalia are initiated within the region, eventually leading to an end of the seemingly interminable conflicts there. In the 2040s, well-functioning governments are helping these countries to get back on track.

Source: Palazzo *et al.* 2014

Populations and urbanization are on the rise. Cities located in the proximity of valuable resources are particularly increasing in size. Natural resources are heavily exploited, and as ecosystems deteriorate and compromise the needs of local populations, conflicts between companies and local communities arise. Agriculture focuses mostly on high-value cash crops. Land is increasingly degraded as a result of mining and farming activities and the appropriation of space for infrastructure. Because of the focus on cash crops, overall food security is declining in the remote rural parts of the region. Mining activities and large-scale farm activities have a severe impact on freshwater resources, leading to deterioration of freshwater ecosystems. As populations increase, fisheries are also increasing, and, due to a lack of central governance, unsustainable fishery methods are widely used. As a consequence of greater industrial activity, carbon emissions are increasing excessively. Air quality in urban areas is getting worse, particularly around mining sites and processing plants.

Local populations that are not benefiting from the activities of the big mining and farming companies are engaging in forestry in mostly informal and unsustainable ways, leading to further degradation of forest ecosystems and biodiversity loss. The lack of effective and coordinated governance leads to poor law enforcement across the continent. This has a negative effect on protected areas, as they are increasingly subjected to illegal resource extraction and poaching. Due to growing pressure on ecosystems, which leads to a diminishing surface area as well as fragmentation, species diversity is decreasing, as are ecosystem services.

From 2030 to 2063, a large portion of the social and environmental problems that were already apparent in 2030 have worsened. This has prompted many of the big international companies to leave Africa in search of more attractive places for investment. In response, local enterprises begin to increase in number. In some parts of the continent, joint efforts of governments, private sector and civil voluntary organizations have emerged to counter the negative spiral in which the continent has found itself. In these countries, green growth is promoted. In fact, as early as in 2010, the first seeds towards green growth were already planted, making Ghana the country with the second highest gross domestic product (GDP) per capita in 2025, quickly followed by United Republic of Tanzania and Gabon. This has inspired people and governments all over the continent. In the 2050s, Angola, Benin, Cameroon, Côte d'Ivoire, Kenya, Nigeria, Rwanda, Togo and Uganda are catching up on those developments. However, many parts of Africa are still plagued by poverty, hunger and conflict, amplified by environmental degradation and the effects of climate change.

3.3 Progress toward the SDGs and Agenda 2063 goals in each scenario

Table 3.3.1 maps out possible futures under the Sustainable Development Goals and the African Union 2063 agenda as envisioned under each of the four scenarios against a time horizon to 2030 and 2063.

Table 3.3.1: Progress towards the Agenda 2063 aspirations and goals in all four pathways

On a scale from +++ to ---: +++ = goal fully met; 0 = no progress; --- = highly negative trend

Aspirations & Goals	Corresponding SDGs	Pathway	2063	Why?
Aspiration: A prosperous Africa, based on inclusive growth and sustainable development				
1. A high standard of living, quality of life and well-being for all citizens	1, 2, 8, 11	*Good Neighbours*	++	Overall, there is a lot of progress. Socio-economic conditions and societal well-being have improved significantly. This, however, comes at the expense of the continent's natural resources to some degree.
		Going Global	+	In this pathway, the focus is on increasing Africa's benefit and the prosperity of its people as a result of utilizing its natural capital. However, as those with access to foreign investments get ahead of the game, inequalities persist.
		All in Together	0	Although developments towards more sustainable resource use and agriculture appear throughout the continent – leading to higher quality of life - those who are not able to access necessary resources are left behind.
		Helping Hands	0	This pathway is characterized by local action towards more sustainable practices, leading to better livelihoods. However, because of lack of coordination, many local communities are left behind and pockets of conflict persist.
2. Well educated citizens and skills revolution underpinned by science, technology and innovation 18. Engaged and empowered youth and children	4	*Good Neighbours*	+++	Sub-national implementation of plans and policies around education is now widespread.
		Going Global	++	Education continues to focus mostly on commercial models, but information technology has increased access to information and education channels for vulnerable communities.
		All in Together	++	Quality education becomes more widespread, but its availability is entirely dependent on local and regional initiatives and some areas are still missing out.
		Helping Hands	+	Access to quality education in the most successful urban agglomerations of the continent improves, but in large parts of the continent, education remains out of reach.

3. Healthy and well-nourished citizens 5. Modern agriculture for increased productivity and production	3	*Good Neighbours*	+++	Decades of learning across successes and failures lead to robust action to end hunger. Due to modernization of the agricultural sector, productivity significantly improves and food security increases.
		Going Global	++	An increase in incomes for many on the continent in combination with agricultural modernization means food security improves substantially. The main challenge is the volatility of global markets on which Africa is now dependent.
		All in Together	++	Local communities overcome the challenge of hunger, but many are still left behind. Agricultural modernization remains patchy and access to food unevenly distributed.
		Helping Hands	++	Food security, but not nutrition security, increases in urban areas. Rural communities in areas where resources are irreversibly degraded are less food secure than in 2015.
4. Transformed economies	8, 9	*Good Neighbours*	+++	Increased democratization and the growth of civil society initiatives helps complement the limits of the centralized organization of economic growth to a good degree.
		Going Global	++	Economic growth is high, and generates work. opportunities, predominantly in cities, but though green growth is the guiding principle and high-profile nature areas are firmly protected and cultivated, rapid expansion leads to widespread environmental impacts elsewhere.
		All in Together	++	Africa is covered in hotspots of inclusive, sustainable economic growth, innovation and work opportunities, but many areas are still underdeveloped and become less attractive.
		Helping Hands	+	Ownership of companies is localised, with a focus to create fair local employment.
6. Blue/ocean economy for accelerated economic growth	14	*Good Neighbours*	-	Government priorities remain focused on other issues, though civil society and NGOs attempt to turn the tide.
		Going Global	+++	Centralized policies on ocean resources and environments steer economic development away from maritime regions, allowing a flourishing of marine life.
		All in Together	--	Many freshwater and coastal communities work hard to govern water life, but this is threatened by lack of legislation around water resources at higher levels
		Helping Hands	---	Marine resources continue to be degraded, prompting many to find other livelihoods.

7. Environmentally sustainable and climate resilient economies and communities	6, 7, 13, 15	*Good Neighbours*	+	Flexible and adaptable small-scale energy solutions are ubiquitous, complemented by larger-scale energy projects. The sustainable energy pathway continues to develop, although infrastructure remains fragile. As climate impacts increase, vulnerable communities are affected, though they have more support structures to fall back on. Governments and investors continue to attempt sustainable expansion, but regulation of the indirect effects of expansion continues to prove difficult.
		Going Global	0	The lack of climate adaptation planning in diverse growth sectors leaves the continent vulnerable in a number of spheres, primarily infrastructure and agriculture. There is a strong division between high-profile protected areas that see a flourishing tourism industry, and the degradation of less important areas.
		All in Together	0	Changes in temperature and precipitation (both averages and patterns/extremes) are a challenge for Africa. By 2063 there are widespread examples of successful climate adaptation, but these do not reach all who need this adaptive capacity. Depending on local initiatives, life on land flourishes.
		Helping Hands	--	African companies take over from foreign investors and are more interested in creating fair local employment than in sustainable economic growth. Initiatives to increase climate adaptation have done battle for decades and have learned much, becoming better at finding resources from the green growth movements to help foster climate adaptation. Sustainable growth movements attempt to stop or revert the decline of terrestrial ecosystems, garnering some first successes, but decline continues overall.
Aspirations & Goals	**Corresponding SDGs**	**Pathway**	**2063**	**Why?**
Aspirations: - An integrated continent, politically united, based on the ideals of Pan Africanism and the vision of Africa's Renaissance - A peaceful and secure Africa				
8. A United Africa (Federal or Confederate)	-	*Good Neighbours*	+++	A successful transition to centralized planning takes place. Following the vision outlined in Agenda 2063, and supported by the African Development Bank's Programme for Infrastructure Development in Africa (PIDA), there is major investment in infrastructure for energy supply, water, food security, and transport and trade.

		Going Global	+	Both the Africa 2063 Vision and the Africa Mining Vision 2050 are central, as they seek to increase the benefit that Africa receives from its natural capital for the prosperity of its people.
		All in Together	++	In this pathway, a United Africa is not yet a reality, but regional trade opens up this space considerably. National sovereignty is important action towards sustainable resource use and agriculture takes place at the local level.
		Helping Hands	---	Africa's future is based on increased levels of foreign direct investment and overseas development assistance. The region's trade focus is global, and its development is organic and decentralized, but driven by multinational corporations. After 2030, interest of international companies fades, and a United Africa is far from reality.
10. World class infrastructure criss-crosses Africa	9	*Good Neighbours*	++	Lessons are learned on the construction of resilient infrastructure, but while projects are always designed with the objective of minimizing environmental impacts, the consequences of many new regions having been opened up are difficult to manage.
		Going Global	++	Development corridors are established, but their resilience in the face of climate change and other stressors proves weak; the scale of expansion of cities, industry and extractive practices is difficult to manage in terms of environmental impacts, apart from protected/tourist areas.
		All in Together	++	Industry and innovation flourish in many areas.
		Helping Hands	++	There is an inspiring upsurge of interest in creating more sustainable industries, but the reality means that past trajectories are difficult to change.
		Going Global	++	There has been an increase not just in international and national institutional strength, but also in local-level institutions, particularly in cities.
		All in Together	0	International attempts at managing conflicts and providing effective legislation continue to yield unsatisfactory results; strong voices from local and sub-national governing bodies keep pushing for relative independence and bringing competing demands and interests to negotiations.
		Helping Hands	-	Various initiatives aim for greater regional stability, with limited success.

Aspirations & Goals	Corresponding SDGs	Pathway	2063	Why?
Aspirations: - Africa with a strong cultural identity, common heritage, values and ethics - An Africa whose development is people-driven, relying on the potential offered by African people, especially its women and youth, and caring for children				
17. Full gender equality in all spheres of life	5	*Good Neighbours*	++	In the later decades, increasing democratization promotes a culture of gender equality despite the relative ineffectiveness of targeted gender policies.
		Going Global	++	Gender equality has increased significantly in Africa's hubs, both through targeted programs and the availability of opportunities and resources. By contrast, successes in remote areas are still few.
		All in Together	++	Many communities have either self-organized for gender equality or mobilized external support and resources – but many are still waiting to follow these examples.
		Helping Hands	+	Gender remains a side concern, with progress made mostly due to civil society groups who are going against the grain.
		Going Global	++	Partnerships toward the SDGs have been strong on points of economic development and the management of protected areas, but less effective on aspects related to climate change and broader environmental governance.
		All in Together	+	In the decades toward 2063, the SDG local network partnerships have much to show for themselves, but they cannot claim universal success across the continent due to a failure of higher-level policies and institutions.
		Helping Hands	+	Green growth partnerships have emerged and started to become a significant voice.

(**More... 31, ...32, ...33, ...34, ...35, ... 36, ...37** and **...38**)

3.4 Options for action

The different exploratory scenarios outlined in section 3.3 each offer unique challenges and opportunities, encouraging the consideration of strategies that are able to deal with a wide range of possible futures. **Tables 3.4.1, 3.4.2, 3.4.3, 3.4.4** provide a starting point for considering such responses to future challenges, and ways to leverage opportunities, drawing from and expanding on insights from WWF/AfDB 2015. By identifying challenges and opportunities, responses and possibilities for leverage across different scenarios, it is possible to recognize the most valuable actions in the face of diverse possible futures.

3.4.1 Scenario-specific insights for action

In the *Good Neighbours* scenario, there is strong political will for sustainable development and environmental governance, providing many opportunities that can be leveraged; challenges and responses revolve mainly around capacity to enforce, manage and stimulate good governance of natural resources while supporting socio-economic development (**Table 3.4.1**).

Table 3.4.1: *Good Neighbours* scenario – challenges/opportunities and responses/leverage

Challenges	Responses
Large regional infrastructure required to drive economic integration	Regional participatory strategic and spatial planning, collaborating across nations, informed by ecosystems/environmental research and at-risk stakeholders
Lack of capital leads to short-cuts	Capacitate regional and national institutions to legislate and monitor development
Environmental degradation due to infrastructure expansion	Regional strategic and spatial planning taking ecosystem preservation into account
Controlling resource extraction	Support transparent and effective legislation, enforcement and monitoring of sustainable resource extraction
Increasing pressure on marine resources and biodiversity despite efforts at sustainable development	Participatory policy development and implementation for sustainable fisheries
Increasing pressure on freshwater ecosystems	Enhance the effectiveness of policies to restrict polluting mining and other industrial activities; enforcement of rules
Opportunities	***Leverage***
Centralized planning and political will leads to better coordinated conservation and sustainability efforts	Building on political will and planning reforms, connect conservation and sustainability efforts across levels, and build enforcement, monitoring and evaluation capacities at all levels. Promote systemic and long-term thinking and planning.
Trend in democratization	Support democratization to help build stability and transparency and legitimacy of governance across levels from local to regional.
Improvement in overall socio-economic conditions and societal well-being	Find opportunities for sustainable development building on increased livelihood and educational options

In *Going Global*, economic development is unleashed, and while the political focus on green economies and urban development can be leveraged, economic connectedness creates new vulnerabilities, and environmental impacts can be very severe locally, requiring approaches that recognize the importance of natural environments across the continent (**Table 3.4.2**).

Table 3.4.2: *Going Global* scenario – challenges/opportunities and responses/leverage

Challenges	Responses
Large infrastructure and export corridors	Participatory, research-supported spatial planning for large infrastructure projects
Demographic migration	Help build security and an even distribution of livelihood opportunities across regions
Stranded assets and global volatility	Encourage economic diversification
Outside protected areas there is little to no biodiversity	More systemic and comprehensive approaches to conservation; promote systemic and long-term thinking and planning.
Carbon emissions have increased	Promote alternative sources of energy; enact and enforce emissions policies - INDCs
Access to clean air and water remains poor	Enact and enforce limits on waste and air pollutants
Opportunities	**Leverage**
There is a political focus on green economy	Promote, support and monitor/evaluate green enterprise; leverage technical and financial support
Boom in eco-tourism	Co-develop nature reserves and eco-tourism in a participatory fashion
Improvement in (urban) health	Bring urban health innovations to rural contexts

In *All In Together*, the main challenge, and the main opportunity, is to complement the flurry of local-level innovations and community action with higher-level support, legislation, monitoring and enforcement by state and non-state actors, while providing leadership in the face of larger-scale challenges (**Table 3.4.3**).

Table 3.4.3: *All In Together* scenario – challenges/opportunities and responses/leverage

Challenges	Responses
Local impacts are cumulative at regional scale	Strengthen regional institutions in terms of governing, enforcing, monitoring and evaluating impacts, with strong connections to other levels.
Difficult to scale change or transform	Foster learning networks, build institutional capacity at higher levels to stimulate and finance the up-scaling of change. Promote systemic and long-term thinking and planning.
Fragmented landscape of ecosystem governance successes and failures	Strengthen institutional capacity to support and spread successes and mitigate damaging practices
Pockets of conflicts persist	Regional cooperation to build peace; strengthen institutions across levels
In areas of conflict poverty persists, leading to poaching and other environmental crimes	Strengthen local institutions
Expanding natural resource extraction	Build capacity in governments and other actors to monitor and manage resource extraction
Opportunities	**Leveraging**
Widespread community action towards sustainable resource extraction and climate-smart agriculture	Promote learning between initiatives; build institutional structures at higher levels to take on larger-scale challenges while supporting community action
Creative practices and local innovations through socially responsible businesses	Create networks and institutional support for local-level business innovations
Diversity of approaches to generate flexible, local renewable energy	Strong political support for renewable energy – funding and beneficial higher level institutional structures. Lower barriers of entry for clean technology.

Table 3.4.4: *Helping Hands* scenario - challenges/opportunities and responses

Challenges	Responses
Large investors look after own interests	Innovative partnerships between businesses and communities encouraged by governments and civil society organizations
Duplication, cumulative impacts and lost opportunities	Collective business stewardship; strengthening of coordination and policy enforcement capacity of governments
Heavy resource exploitation leads to ecosystem deterioration	Strengthening of policy enforcement and monitoring capacity of governments; work with private sector toward more sustainable strategies incentivized by better government regulations
Focus on cash crops leading to increase of food security among rural poor	Support the marketing of diverse food and cash crops; support livelihoods for the rural poor; increase capacity of governments to legislate and enforce rural policies; work with private sector toward more diverse and inclusive food production and trade
Deterioration of freshwater ecosystems	Build government capacity to legislate and enforce environmental policies; foster collaboration between governments, businesses and communities, aided by ecosystems research
Decrease in air quality	Enhance government capacity to legislate and enforce pollution laws
Increase in carbon emissions	Help develop effective emissions policies – INDCs. Lower barriers of entry for clean technology.
Opportunities	**Leverage**
Overall food insecurity on the decline	Support livelihoods that minimize environmental damage
In the long run, green initiatives are set up in parts of the continent	Enhance the capacity of governments, the private sector, civil society and other actors to quickly learn from, share and support green initiatives to speed up this trend

In the *Helping Hands* scenario, the challenges are many and there is a strong gap and need in the governance of economic development in a more inclusive and environmentally sustainable fashion. Engaging companies in collective business stewardship and strategy change is a way to leverage the strong agency of the private sector in this scenario (**Table 3.4.4**).

3.4.2. Across the scenarios: responding to challenges and leveraging opportunities

A number of common challenges emerge from the scenarios, although the degree to which they are relevant differs. They include:

- lack of control and information on economic development in all its manifestations, and its (potential) impacts on different resources;
- lack of scalability of local initiatives – in some scenarios these exist but are not supported; in others, change is enforced in a more top-down fashion;
- lack of capacity in governments and other societal actors to monitor and enforce natural resource management and sustainable development – even when political will exists, the capacity to enact that will, and the data needed to make informed decisions may be lacking;
- lack of transparency in government and other sectoral processes and the existence of debilitating corruption limits the effectiveness and willingness to implement effective natural resource management across all scenarios (albeit to different degrees); and
- an absence of links in terms of action and knowledge exchange between governance levels, leading to conflicts and limited effectiveness of higher-level strategies and policies and a limited voice of local communities.

A number of common responses to these challenges, and strategies for leveraging opportunities, also emerge:

- **Rule of law; transparent, enforced polices; clear mandates**

Effective governance will come from empowering institutions at local to regional scales, building government capacity to monitor, greater civil society participation, and strengthening political will and social responsibility. Strengthening the rule of law can curb potential conflict by improving both justice and social equity.

- **Enhance capacities for informed governance**

A key capacity among governments and other organizations is access to data and information to help monitor and evaluate progress and to enforce legislation. Develop support tools for ecological assessment and data, management information and decision support frameworks (WWF/AfDB 2015).

- **Collaboration between nations**

As in the Good Neighbours scenario, unhealthy competition between nations can severely hinder progress. Nations must therefore band together to mobilize domestic resources in order to fund Africa's home-grown transformation, focusing on the importance of regional integration and pooled resources. Use regional economic integration to build resilience (WWF/AfDB 2015).

- **Linking across levels**

Promoting systemic approaches to foster communication, planning and action across jurisdictional/geographical levels will enhance the effectiveness of plans and policies and allow better opportunities for communities to express their interests.

- **Fostering local innovation and cross-sectoral partnerships**

Governments and other actors operating at national, regional, continental and global levels can facilitate innovative, community-scale social and technological initiatives, as in the *All In Together* scenario, and help them overcome challenges of up-scaling and play a role in policy and strategy development.

- **Enhancing financial and technical support**

Learning from the *Going Global* scenario, which is relevant for the other scenarios, it is important to enhance financial and technical support from international partners in order to ease the transition to inclusive, sustainable development. In addition, as in the *All In Together* scenario, resource mobilization from overseas partners and social entrepreneurs can support widespread community action

towards sustainable resource use, climate-smart agricultural practices and integrated conservation efforts .

- **Building integrated, systemic and long-term planning and thinking**

The scenarios highlight the need to truly integrate sustainable and systemic thinking that understands the interlinked nature of natural and human systems into everyday practice and longer-term planning at all levels and sectors of government. This affirms the critical understanding that the *"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"* (UNCED 1992; reaffirmed at Rio+20).

- **Lowering barriers of entry for technology**

Lowering the barriers of entry for technology is key to increasing connectivity and building a home-grown data revolution. Coordinated resource allocation coupled with coherent policy frameworks can facilitate a boost to information and communication technology (ICT), increasing connectivity, local entrepreneurship and innovation, as in the *All In Together* scenario. This boost can also lead to bridging the digital gap between rural and urban areas, further developing skills through access to information, and playing a key role in building a knowledge-based economy.

Table 3.4.5: Suggested policy pathways

Sector	Policy Pathways
Air Quality	Increase effort to achieve widespread deployment of renewable energy, including off-grid energy infrastructure, as this is key to reducing outdoor pollutant emissions from energy and industry. Target investment in electrification, increased energy efficiency and increased demand-side management to reduce transport and industrial emissions, improving overall air quality with co-benefits of climate change mitigation. Minimize barriers to social entrepreneurship and technological innovation in order to enable improvements in cooking stoves, household ventilation and cooling systems which can benefit both indoor and outdoor air quality.
Land and Agriculture	Ensure the National and Regional Agricultural Investment Plans focus on strategies that improve land productivity instead of large-scale agricultural expansion which undermines the integrity of land and soils as well as biodiversity through habitat loss and degradation. Regulate large-scale land investments to ensure they do not threaten food and livelihood security. Support targeted investment in basic transport infrastructure in urban and rural areas, which can increase markets access and lower transportation costs. Enable small-holder farmers (for example, with improved irrigation, fertilizer and seeds, as well as in conservation agriculture and agro-ecological practices) in order to increase land productivity whilst minimizing agricultural expansion and land degradation. Increase support for the African Climate Change Fund that oversees adaptation and technology development and the African Agribusiness and Agro-Industry Development Initiative. Develop a guiding adaptation strategy for the continent and ensure all developmental activities are climate-resilient in line with this strategy.

Sector	Policy Pathways
Biodiversity	Mainstream ecological and climate considerations into all planning for infrastructure projects and enforce regular environmental audits of these projects. Promote trans-frontier conservation areas as well as benefit sharing and participatory management approaches – such as community-based natural resource management. Payments for ecosystem services are also key to safeguarding biodiversity throughout the region. Other key priorities include implementing policies to halt the illegal wildlife trade, poaching, deforestation, wetland conversion and coastal and marine degradation.
Water	Implement integrated water resource management strategies. Focus on increasing water use efficiency by households, industry and particularly agriculture. Enforce integrated coastal zone management, while improving ocean surveillance as a way to reduce illegal, unregulated and uncoordinated fishing, can improve the health and sustainable management of coastal and marine resources.
Marine	Cultivating the blue economy must be planned carefully to enable sustainable ocean management in consideration of the full potential and value of services provided by the marine ecosystem. Opportunities for broad adoption of aquaculture, especially poly-culture, should be explored, however, all precautions should be taken to ensure implementation at a scale that does not damage natural ecosystems. Proper assessment of trade-offs as well as evaluations of the benefits provided by ecosystem services should be undertaken prior to development in this sector.
Energy	Decoupling emissions from economic growth can be achieved by fast-tracking the African strategic vision of at least 50 % share of renewable energy to total energy production and extending regional grid integration projects such as the East and Southern Africa Clean Energy Corridor initiative with increased government support and policy direction for effective financing. Rapid expansion of renewable energy infrastructure can be realized through the development of a continent-wide renewable energy strategy, phasing out fossil fuel subsidies, promoting off-grid solutions in rural contexts, introducing effective carbon prices, and making the right low-carbon energy choices for increased energy efficiency. Coordination with Power Africa and the African Climate Change Fund can also help to achieve this goal.
Economic Growth	Promote and strengthen the capacity of Regional Economic Communities (RECs) and boosting intra-African trade while ensuring that the development of Regional Industrialization Hubs and Regional Power Pools does not come at the cost of vital ecological infrastructure. Enhance government, private sector, and civil society capacity to quickly learn from, share and support green initiatives. Facilitate the creation of networks and institutional support for local-level business innovations and community action towards ecosystem stewardship that can improve livelihoods, promote economic growth and maintain environmental sustainability.

- **Fostering local innovation and cross-sectoral partnerships**

The private sector plays a strong role in all scenarios, whether as large companies or SMEs. Fostering social entrepreneurship, corporate social responsibility and highlighting opportunities inherent in sustainable business and innovation is key. It is necessary to help realize the benefits of the green economy by establishing transparent and simple rules to guide investment and encourage development of private-sector guidelines on responsible practices. Investment safeguards and frameworks must also be implemented (WWF/AfDB 2015).

3.4.3. Specific actions highlighted from environmental and development domains

A number of actions can be highlighted that focus on specific environmental and development domains. The policy pathways in **Table 3.4.5** highlight the importance of minimizing environmental and developmental trade-offs, and maximizing Africa's potential to reach a sustainable, inclusive development path that effectively safeguards its land, water, air and biodiversity:

- **Infrastructure**

Expanding core infrastructure in urban areas and increasing basic transport infrastructure and energy supply are key to quality growth. However, this must be done while also ensuring that there is a transformative shift away from carbon-intensive development as well as strengthening effective spatial and coordinated strategic planning. It is imperative that all infrastructure policy, planning and implementation explicitly recognizes the value of ecological assets (WWF/AfDB 2015).

- **Land**

In terms of land, options for action should include regulating large-scale land investments to ensure they do not threaten food and livelihood security. In addition, targeted investment in basic transport infrastructure, which can increase access and lower transportation costs, as well as enabling small-holder farmers, particularly for improved irrigation coverage and efficiency, fertilizer and high-yield seeds, can lead to increased land productivity, minimizing agricultural expansion and land degradation.

- **Air quality**

In order to improve air quality, increased effort to achieve widespread deployment of renewable energy, including off-grid energy infrastructure, can be key to reducing outdoor pollutant emissions from energy and industry. Targeted investment in electrification, increased energy efficiency and increased demand-side management can also lead to reduction of transport and industrial emissions, improving overall air quality with co-benefits of climate change mitigation. Indoor air quality can also be improved by promoting the uptake of improved cooking stoves and better household ventilation.

- **Water**

The thematic area of water can see significant improvements through the implementation of integrated water resource management strategies. Focus should be on increasing water-use efficiency by households, industry and particularly agriculture. Enforcing integrated coastal zone management while improving ocean surveillance as a way to reduce illegal, unregulated and unreported fishing can improve the health and sustainable management of coastal and marine resources.

- **Biodiversity**

In terms of biodiversity, key policy priorities are in the area of halting poaching, deforestation, wetland conversion and coastal and marine degradation. Promoting trans-frontier conservation areas as well as benefit-sharing and participatory management approaches, such as community-based natural resource management as has been done in Namibia, and payments for ecosystem services, are also key to safeguarding biodiversity throughout the region.

- **Aquaculture**

Developments in the *Going Global* scenario illustrate that increasing management of cross-boundary resources, coupled with targeted investment in large-scale aquaculture, can curb the adverse impacts of increased exploitation on coastal and marine resources due to maritime development and rise in food demand from the rapidly expanding population and middle class (as seen in the *Good Neighbours* and *Helping Hands* scenarios). Ensuring that large-scale aquaculture does not replace and undermine natural ecosystems will however remain a challenge that will require evaluation of the benefits provided by ecosystem services and assessing trade-offs between various options.

- **Energy**

The pathways also highlight the importance of recognizing that, while energy is a key enabler of economic development and poverty alleviation, the impacts of climate change are likely to undermine development gains, increasing the risk to society and ecosystems through pressure on land, water, biodiversity, and air. A low-carbon development path in line with a green growth strategy as in the *Helping Hands* scenario is thus key to building a healthy and thriving future. Leaders must take strong, rapid action to decouple emissions from economic growth in order to solve Africa's energy challenges and increase energy access from the current 33 per cent while avoiding a dangerous climate future (Cartwright 2015; Africa Progress Panel 2015). The pathway to de-carbonization can be enabled by phasing-out fossil fuel subsidies, introducing effective carbon prices, and making the right low-carbon energy choices for increased energy efficiency and use of renewables, which will continue to be cost-competitive with fossil fuels as global installed capacity increases and fossil fuel subsidies are reformed. In addition, policy makers striving to move to inclusive, low-carbon development should consider the co-benefits of decentralized, off-grid energy sources (Africa Progress Panel 2015). This pathway can lead to increased socio-economic benefits through improved public health, increased environmental security, and technological innovation.

3.5 Conclusion

Africa's transformation will revolve around the 2030 Agenda for Sustainable Development, with the Sustainable Development Goals (SDGs) as its base while continuing to use the roadmap outlined in Agenda 2063 as the primary guide to advance a home-grown agenda that reduces poverty, and strengthens local infrastructure and energy supply, while improving environmental governance.

Africa's agenda 2063 provides a guiding framework for sustainable and resilient development that focuses on promoting economic growth and social well-being while maintaining a healthy planet. Much of the region's development will continue to hinge around its natural capital with land as the most prized asset.

Maintaining the current pace of Africa's economic growth comes with great challenges that are needed to reduce the region's ecological footprint and safeguard the life-support system provided by healthy land, water, biodiversity and air.

The four scenarios described for Africa outline plausible visions of the future and are useful to inform policy and decision makers of the consequences of various actions and plans made today. Trends across the four scenarios highlight that low-carbon, climate-resilient choices for infrastructure, energy and food production, coupled with effective and sustainable natural resource governance, are key to protecting the continent's ecological assets that underpin a healthy society.

See references for Chapter 3



Supplementary Information

1. Contribution of Industry to GDP, 1970 - 2008.

Africa's potential for industrialization is generally under-utilized as shown by the low contribution of industry to GDP. Current regional efforts towards beneficiation of the large natural asset base could trigger Africa's economic growth.

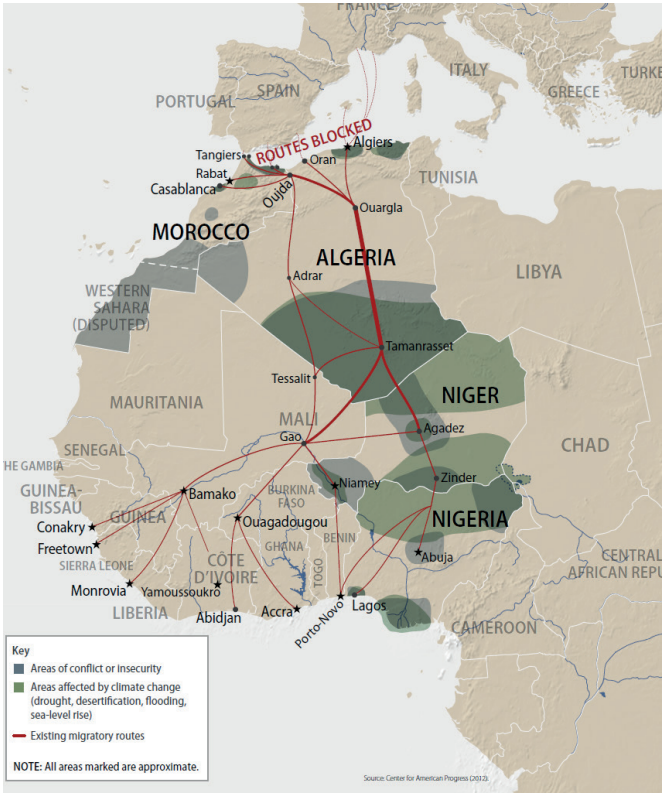
	% Share of GDP	1970	1980	1990	2000	2005	2008
World	Industry	36.9	38.1	33.3	29.1	28.8	30.1
	Manufacturing	26.7	24.4	21.7	19.2	17.8	18.1
	Mining & Utilities	3.9	7.1	5.2	4.5	5.5	6.2
Developing Economies	Industry	27.3	41.1	36.8	36.3	38.9	40.2
	Manufacturing	17.6	20.2	22.4	22.6	23.3	23.7
	Mining & Utilities	5.7	14.7	8.9	8.3	10.1	10.9
African developing economies	Industry	13.1	35.6	35.2	35.5	38.8	40.7
	Manufacturing	6.3	11.9	15.3	12.8	11.6	10.5
	Mining & Utilities	4.8	19.3	15.2	18.4	23.0	25.8
Eastern Africa	Industry	3.1	7.8	20.6	18.6	20.6	20.3
	Manufacturing	1.7	4.9	13.4	10.4	10.3	9.7
	Mining & Utilities	0.8	1.5	3.3	3.1	3.6	3.7
Middle Africa	Industry	34.2	38.4	34.1	50.4	57.9	59.8
	Manufacturing	10.3	11.8	11.2	8.2	7.3	6.4
	Mining & Utilities	19.1	21.2	18.9	39.3	47.9	50.5
Northern Africa	Industry	34.2	50.0	37.4	37.8	45.0	46.0
	Manufacturing	13.6	9.7	13.4	12.8	11.3	10.7
	Mining & Utilities	15.7	33.0	17.2	19.5	28.2	29.8
Southern Africa	Industry	38.2	48.2	40.6	32.7	31.7	34.5
	Manufacturing	22.0	20.9	22.9	18.4	17.9	18.2
	Mining & Utilities	12.0	24.0	14.3	11.7	11.2	13.1
Western Africa	Industry	26.7	43.3	34.5	39.8	36.7	37.4
	Manufacturing	13.3	16.8	13.1	7.8	6.0	5.0
	Mining & Utilities	7.7	21.3	18.8	29.3	27.7	29.6

Source: UNIDO/UNCTAD 2011.

◄ Credit: Shutterstock.com /Villiers Steyn

2. Climate, security and migration in West Africa

The impact of changing climate on economies and livelihoods is partly blamed for the high levels of out-migration from Africa. Migration in West Africa is largely linked to economic poverty exacerbated by climate change impacts on a sensitive and fragile sub-region's natural environment on which there is high dependence for livelihoods.

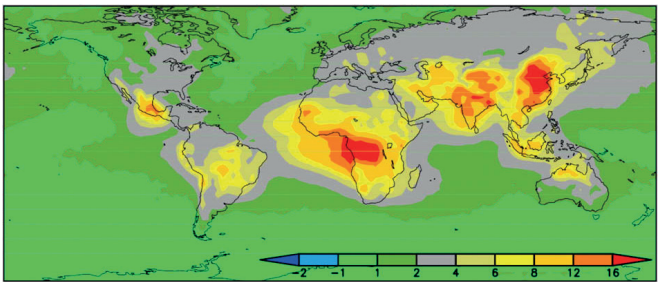


Source: Center for American Progress 2012

3. Air

While solar provides the potential for Africa's quest for cheap, clean and sustainable forms of energy, a gradual decline in solar radiation is being observed globally (Liepert 2002, Stanhill and Cohen 2001). Called 'global dimming', this is presumed to be a consequence of an increased amount of scattering and absorbance of aerosols and gases in the atmosphere from human activity (Roderick and Farquhar 2002). Alpert *et al.* (2005) estimated that urban activities between 1964 and 1989 explained the relatively large reduction over larger cities, estimated at a maximum of 0.41 watt hours per square metre per year, compared to the much smaller reduction in rural areas. The reduced solar radiation is having little consequence as improvements in technology are resulting in the generation of more electricity with low levels of radiation.

The absorption of solar radiation by the atmosphere due to atmospheric 'brown clouds'



Source: Chung *et al.* 2005

4. The intentions of the various GEGs to which the majority of countries in Africa are party

Climate Change	
The Cancun Agreements, Decision 1/CP.16 of the Conference of the Parties of the UN Framework Convention on Climate Change. The Paris Agreement, which is not yet in force, calls for efforts to limit global average temperature increases to 1.5ºC above pre-industrial levels.	... deep cuts in global greenhouse gas emissions are required according to science ... with a view to reducing global greenhouse gas emissions so as to hold the increase in global average temperature below 2ºC. Countries have outlined the actions they intend to take – known as Intended Nationally Determined Contributions (INDCs). These will be a key determinant in the achievement of the Agreement, and a commitment to stay on a trajectory to a low-carbon, climate-resilient future.
Control of Global Emissions of Ozone-depleting Substances	
Montreal Protocol on Substances that Deplete the Ozone Layer, Preamble	Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination ...
Phasing-out Lead in Gasoline	
Johannesburg Plan of Implementation, Paragraph 56(b)	Reduce respiratory diseases and other health impacts resulting from air pollution, with particular attention to women and children by ... supporting the phasing out of lead in gasoline.
Reducing Dependence on Solid Fuels	
Johannesburg Plan of Implementation, Paragraph 56(d)	[Assist] developing countries in providing affordable energy to rural communities, particularly to reduce dependence on traditional fuel sources for cooking and heating, which affect the health of women and children.
Measuring and Monitoring Air Pollution	
Agenda 21	Developing and applying pollution control and measurement activities and monitoring transboundary air pollution.
Cooperating at International, Regional and National Levels	
Johannesburg Plan of Implementation, Paragraph 39	Enhance cooperation at the international, regional and national levels to reduce air pollution, including transboundary air pollution [and] acid deposition...
Eliminating Persistent Organic Pollutants	
Stockholm Convention on Persistent Organic Pollutants	Each Party shall ... prohibit and/or take the legal and administrative measures necessary to eliminate its production ... use ... import and export of chemicals listed. In Annex A...

5. REDD+

REDD is aimed at creating financial value for carbon which is stored in forests. It offers incentives for developing countries to reduce emissions from forests and invest in low-carbon paths to sustainable development (UN-REDD+ 2016). REDD+ goes beyond deforestation and forest degradation and includes the role of conservation, sustainable management of forests and the enhancement of forest carbon stocks (UN-REDD+ 2016). The REDD and REDD+ programmes are currently providing support to 28 African countries.

Legal Preparedness for REDD+ refers to countries' efforts to establish robust and coherent sets of national and sub-national legislation for the implementation of REDD+.

In 2009, the Democratic Republic of Congo adopted a decree establishing a structure for implementing REDD. Following on from this, the country assessed its forest-related legal framework and analysed the challenges and opportunities for REDD+ law reform and implementation. The DRC is currently one of only six countries globally that have developed subsidiary legislation to implement REDD+.

6. Air quality monitoring

At sub-regional level, the framework agreements on air pollution provide for the installation of air quality monitoring stations and the maintenance of national emission inventories. For example, under the Southern African Development Community (SADC) policy framework agreement, Botswana, Malawi, Mozambique, South Africa, Zambia and Zimbabwe have developed country status reports that provide air quality statistics. In addition, Senegal and South Africa have established Air Quality Monitoring Centres.

The Senegalese Air Quality Monitoring Centre

The Senegalese Air Quality Monitoring Centre was established in 2009 under the Ministry of Environment and Sustainable Development. It operates under the supervision of the Directorate of Environment and Classified Establishments and is jointly funded by the Senegalese government and the Nordic Development Fund.

The objectives of the Centre are to:

- monitor ambient air pollution;
- advocate for realistic measures for improving air quality;
- promote the establishment of a committee on air quality; and
- inform the public on air quality in the country and provide information to relevant authorities for decision making.

The Centre has five monitoring stations located in Dakar and a reference laboratory. Pollutants measured by the Centre include:

- particulate matter from diesel engines, power plants, industries, wind-blown dust, combustion sources, mines and unpaved roads;
- carbon monoxide emissions from vehicles, industries and open burning;
- nitrogen oxides from vehicles, combustion sources and coal-burning stoves;
- sulphur dioxide emissions from combustion sources, refineries and coal combustion;
- ground-level ozone; and
- Benzene, toluene and xylene (BTX).

Short-term and medium- and long-term outlooks have been developed under the Centre.

Short-term outlooks include measures to:

- rehabilitate and integrate a mobile laboratory in the network;
- measure exhaust gas of 1 000 vehicles;
- assess atmospheric emissions of factories.

Medium- and long-term outlooks include measures to:

- extend air quality monitoring to other regions of the country;
- assist in the implementation of the law on air pollution;
- correlate pollution episodes with epidemiological data to better assess the morbidity and mortality related to air pollution;
- bring more dynamism to the Air Quality Observatory.



Credit: www.air-dakar.org

On-going projects under the Centre include the project on monitoring of air pollution from traffic and the project on improving air quality monitoring in Dakar and at other sites.

Source: Centre can be accessed at: Centre de Gestion de la Qualité de L'air 2016. www.air-dakar.org

7. Land

Africa, together with the Latin America and Caribbean region, have the world's largest reserve of agricultural land making up 80 per cent of such land (AMCEN 2015). (see Table)

Land availability in Africa

Country	Non-forested underutilized land[a] ('000 hectares)	Proportion (%)	Cumulative proportion (%)
Democratic Republic of the Congo	84 824	46.5	46.4
Angola	18 889	10.4	56.9
Republic of the Congo	12 872	7.1	63.9
Zambia	10 834	5.9	69.9
Cameroon	10 447	5.7	75.6
Mozambique	8 994	4.9	80.5
Central African Republic	7 049	3.9	84.4
Gabon	6 534	3.6	88.0
Sudan	5 803	3.2	91.2
United Republic of Tanzania	4 313	2.4	93.5
Madagascar	2 718	1.5	95.0
Zimbabwe	2 142	1.2	96.2
Chad	1 520	0.8	97.0
South Africa	1 219	0.7	97.7
Kenya	807	0.4	98.2
Mali	800	0.4	98.6
Burkina Faso	655	0.4	99.0
Ethiopia	651	0.4	99.3
Rest of Africa	1 259	0.7	100

Notes: Estimates of underutilized land extents are drawn from Fischer and Shah (2010). The methods are explained in Chapter 3 of Deininger *et al*. 2011.
a Defined by Deininger and Byerlee as land with fewer than 25 people per square kilometre.

Source: (Jayne *et al*. 2014)

8. Coffee plantations

Coffee production in Kenya has fallen by more than 50 per cent due to the conversion of coffee plantations to real estate developments (Nyambura-Mwaura 2010).

The population density of Kiambu was 194 people per square kilometre in 1969, a figure that is estimated to have grown to 638 in 2011 – fuelling pressure on the land. Recently, coffee production has started to be replaced by real estate development, and the few coffee farms that remain have responded by increasing management intensification in order to maintain their productivity.

Source: Jalamillo *et al.* 2013

http://live.worldbank.org/harnessing-urbanization-for-growth-and-shared-prosperity-in-africa

9. Mining

Mining waste management challenges**.** In Africa approximately 80 million tonnes of mining waste is dumped each year (Lloyd 2002).

Environmental impacts of gold-mine tailings on the Witwatersrand, South Africa

Numerous old gold sand and slimes dumps on the Witwatersrand have been reprocessed since the 1980s for residual gold extraction using cyanide. There are numerous technologies available by which many cyanide species may be decomposed. However, at most gold mines in South Africa, cyanide is simply discharged with the effluent and tailings on the assumption that it will decompose within a relatively short period of time. The distribution and fate of cyanide in the environment upon release from the tailings dumps depends on its physical-chemical speciation. A study was carried out to assess the characteristics of cyanide in the superficial deposits of a reprocessed gold tailings dump in the two years after slurry re-deposition by the cycloning method, and the implications for its potential release and redistribution during the hydraulic re-working and re-deposition of old tailing slurries. Sampling was done in 2006 and 2007 on a third-generation gold slimes dam to assess the impact of tailings acidification immediately after deposition on cyanide release over that period. The total concentrations of cyanide observed were higher than could be accounted for by the most recent processing event, suggesting that residual cyanide from the historical processing had persisted in the tailings since the original deposition – a period of 30–80 years, depending on the tailings facility. The re-working of the old slurries in the new facility resulted in a fairly rapid decline in pH of the superficial drying layer of the facility after deposition ceased. Elevated concentrations of total cyanide and weak acid dissociable cyanide were obtained for 2006. The concentrations of free cyanide, cyanates and thiocyanates were higher for 2007 than for 2006, and conversely the concentrations of metal cyanide complexes were higher in 2006 than 2007. These findings indicate that metal cyanide species in the superficial layers of the tailings rapidly degraded post-deposition as a result, primarily, of a decrease in pH.

Gold mining with mercury in Ghana

Artisanal gold mining using mercury is on the increase in the Pra River basin in Ghana. Even though mercury levels determined in water, soil and sediments are below WHO safe guideline values, the current state of affairs poses a serious environmental threat. The majority of those engaged in gold mining are unaware of the dangers posed by the use of mercury in mining operations. Once mercury is exposed to atmospheric, aquatic and terrestrial influence, it may undergo transformation, eventually becoming Methyl-mercury. This is the most toxic form of the metal. Methyl-mercury is easily incorporated in living organisms and accumulates in the food chain. Consequently, fish and other aquatic species are contaminated, also endangering populations consuming the fish. In addition, mercury entering the environment is transported downstream of river systems, probably reaching the coastal region in the Gulf of Guinea. A legal instrument that governs artisanal mining could lead to a transformation of the sector into a regulated industry, and minimize the impact on the environment.

Source: Fourie *et al.* 2008; Donkor 2006

10. The evolution of land rental markets in Ghana

In Ghana, for example, tenants are provided with land on which to establish cocoa farms and are supposed to give one third of their yield to the landowners as rent.

For the landless poor, especially women and migrants, land rental arrangements remain an important means of accessing land in most rural farming communities in Ghana. These arrangements have been in existence in parts of southern Ghana since the pre-colonial era. In recent times, land rental arrangements are expanding spatially and assuming diverse forms. These arrangements not only increase access to land but also increase productivity, and yet are usually neglected, with emphasis placed on land ownership and land titles.

In Ghana there is growing evidence that land rental markets are evolving in rural farming communities under the influence of demographic and economic factors. There is also change in land rental arrangements from non-monetary and non-market-based transactions to monetary and market-based ones in many rural parts of the country.

In some cases, the evolution of land rental arrangements has proven to be a relatively safe route to ownership of agricultural land. Rural farming communities are experiencing a gradual shift from customary rental arrangements to formalized systems involving cash transactions and documentation of arrangements, thus transforming land renters into land owners.

Source: Zacharia 2013

11. Global Environmental Goals for Land

Land is the main base for other environmental and natural resources. In Africa, the sustainable use and management of land is particularly important because the majority of people, particularly in sub-Saharan Africa, rely on agriculture for food security, and therefore health and poverty reduction. The selected land-related GEGs, (details of which are in the Table) are contained in:

Agenda 21; General Assembly Resolution 62–98 of 31 January 2008; the Millennium Development Goals (MDGs); the Ramsar Convention on Wetlands; and the United Nations Convention to Combat Desertification.

Combat Deforestation and Promote Sustainable Forest Management	
General Assembly Resolution 62–98 of 31 January 2008, Section IV, Global Objective 1	Reverse the loss of forest cover worldwide through sustainable forest management, including protection, restoration, afforestation and reforestation, and increase efforts to prevent forest degradation.
Reduce Hunger	
Millennium Development Goal 1, Target C	Halve, between 1990 and 2015, the proportion of people who suffer from hunger.
Conservation and Wise-use of Wetlands	
The Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Ramsar Convention), Article 3(1)	The Contracting Parties shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory.
Combat Desertification	
United Nations Convention to Combat Desertification, Article 2(1)	The objective of this Convention is to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification, particularly in Africa, through effective action at all levels, supported by international cooperation and partnership arrangements, in the framework of an integrated approach which is consistent with Agenda 21, with a view to contributing to the achievement of sustainable development in affected areas.

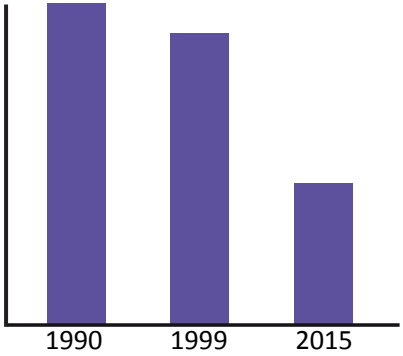
12. Poverty and Hunger

In line with MDG 1, Target C - to eradicate extreme poverty and hunger, the proportion of undernourished people in the developing regions has fallen by almost half since 1990, from 23.3 per cent in 1990–1992 to 12.9 per cent in 2014–2016 (UN 2015). However, this masks regional differences and the majority of the 780 million people (12.8 per cent of the world population) who still suffer from malnutrition live in sub-Saharan Africa.

Extreme poverty rate in developing countries



Global number of extreme poor



Source: UN 2015

Extreme poverty has declined significantly over the last two decades. In 1990, nearly **50%** of the population in the developing world lived on less than less than **USD 1.25** a day; that proportion dropped to **14%** in 2015.

Globally, the number of people living in extreme poverty has declined by more than half, falling from **1.9 billion** in 1990 to **836 million** in 2015. Most progress has occurred since 2000.

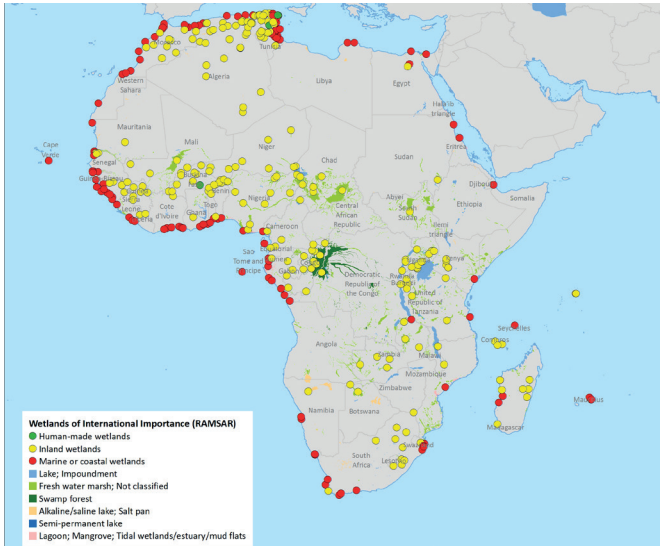
The number of people in the working middle class – living on more than **USD 4** a day – has almost tripled between 1991 and 2015. This group now makes up half the workforce in the developing regions, up from just **18%** in 1991.

The proportion of undernourished people in the developing regions has fallen by almost **50%** since 1990, from **23.3%** in 1990-1992 to **12.9%** in 2014-2016.

13. Ramsar sites in Africa

In order to ensure the conservation and wise use of wetlands, Contracting Parties have designated several wetlands as Ramsar sites.

Ramsar sites



Source: Ramsar 2016

14. Farming for Profit in the Egyptian Desert

Agriculture is an important sector in the Egyptian economy. It provides livelihoods for 55 per cent of the population, employs 30 per cent of the labour force, accounts for 20 per cent of exports and foreign exchange earnings and nearly 14 per cent of GDP (IFAD 2013).

Following the Arab spring that disrupted transport and exports and led to the depreciation of the Egyptian pound and rising fuel costs, the Egyptian government and rural populations redoubled their efforts to reduce poverty and improve their standard of living. The government adopted a multi-faceted strategy that prioritizes economic growth in order to increase employment opportunities; improvements in the efficiency of the agriculture sector by improving land and water use in order to increase yields, income and food security; and participatory governance.

Egypt's Sustainable Agricultural Development Strategy towards 2030 has six major strategic objectives:

- use natural resources more sustainably by improving water-use efficiency in irrigated agriculture;
- increase the productivity of both land and water units;
- enhance food security;
- increase the competitiveness of agricultural products;
- improve the economic climate in order to attract agriculture investments; and
- enhance creation of job opportunities, particularly for rural youth.

The Strategy also prioritizes the need to strengthen smallholder producer associations, improve access to market information for better marketing of smallholder farmers' production, and make market information more readily available. Incrementally realizing these objectives necessitates an intricate policy mix.

The IFAD-supported West Noubaria Rural Development Project is helping the new settlers to reclaim desert land,

and avails them of credit and technical expertise. Farmers are trained to grow various high-value, high-yielding horticultural crops that are suitable for export, and coached on soil quality, water conservation, pest control and the need to maintain an ecological balance. By using creative partnerships between smallholder farmers and buyers through contract farming, the local economy is gradually strengthening. In addition, West Noubaria now has clean piped water and consistent electricity supply, and a network of well-maintained roads and health facilities, schools and mosques.

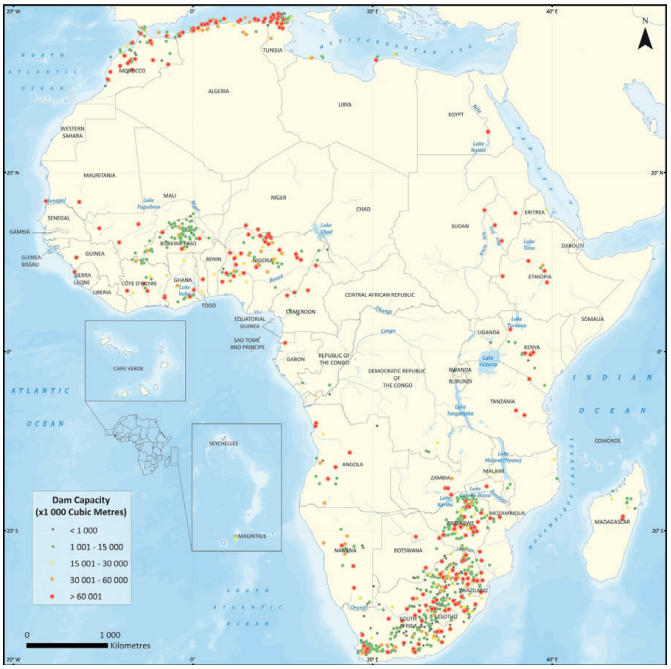
Source: Adapted from IFAD o 2013

15. Water

Hydropower generation.

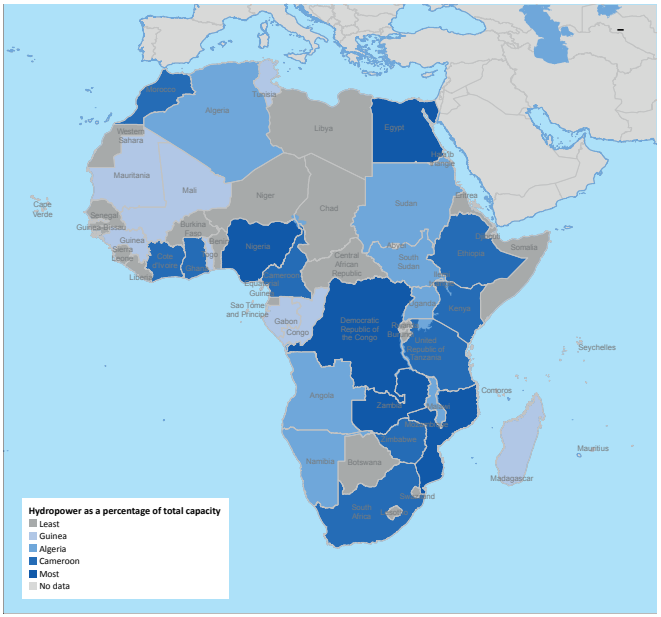
The International Energy Agency reports that installed hydropower capacity in Africa produced 102 terawatt-hours of electricity in 2009 although the continent has a technical potential output of 1 174 terawatt-hours per year (IEA 2013). Africa's hydropower potential is underdeveloped, with only 10 per cent of its potential exploited (WWF and AfDB 2015). The numbers are even lower for full range of renewable energy sources where only 3 per cent of Africa's potential has been developed compared with 45 percent in OECD countries and 21 percent in Latin America (UNEP 2010). Africa's principal hydropower dams are shown in the figure below and the total amount of electricity produced from hydropower continues to increase.

Distribution of dams across Africa



Source: UNEP 2010

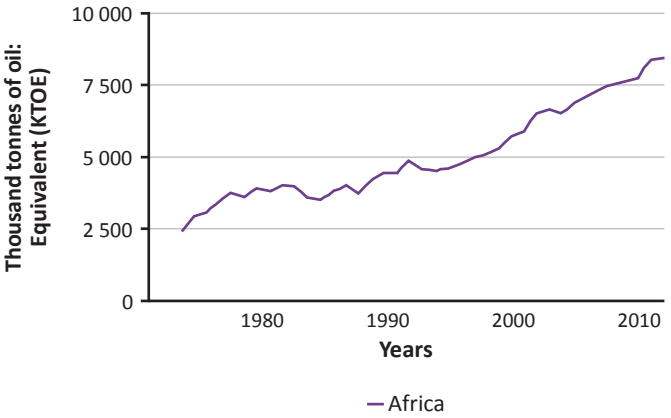
Hydropower dams in Africa



Note: The darker the shade of a country the greater its hydropower capacity; the size of the circle reflects the capacity of the dam. Dams are represented by circles, the size of the circle reflecting the capacity of the dam.

Source: Cole *et al.* 2014

Hydropower energy production, 1970–2010



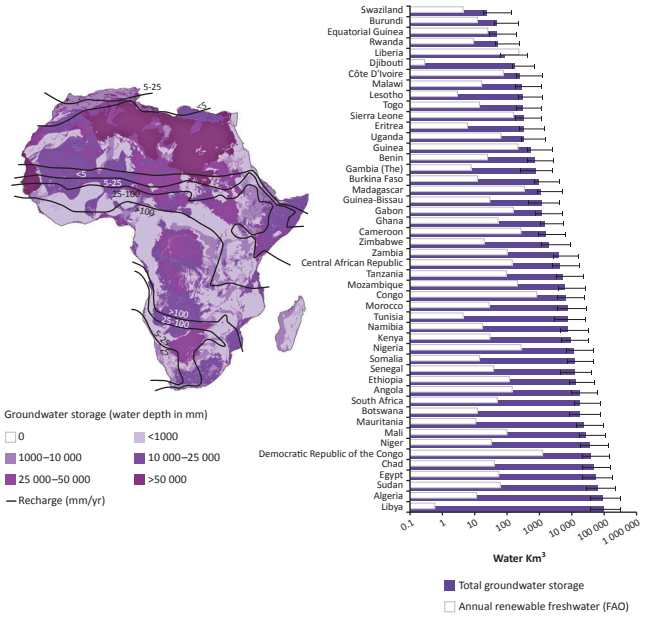
Note:[1] tonne of oil equivalent (toe) is equal to 11.8 megawatt hours

Source: UNEP Live 2015

16. Extensive sedimentary rock aquifers in Libya, Algeria, Egypt and Sudan.

High rainfall regions may not always have huge groundwater reserves. For example, the Congo basin is ranked relatively lower than the northern African countries even though rainfall in the Congo basin is high. The Congo Basin does not feature highly in the groundwater storage because of the crystalline nature of the geology of the area.

Groundwater storage in Africa

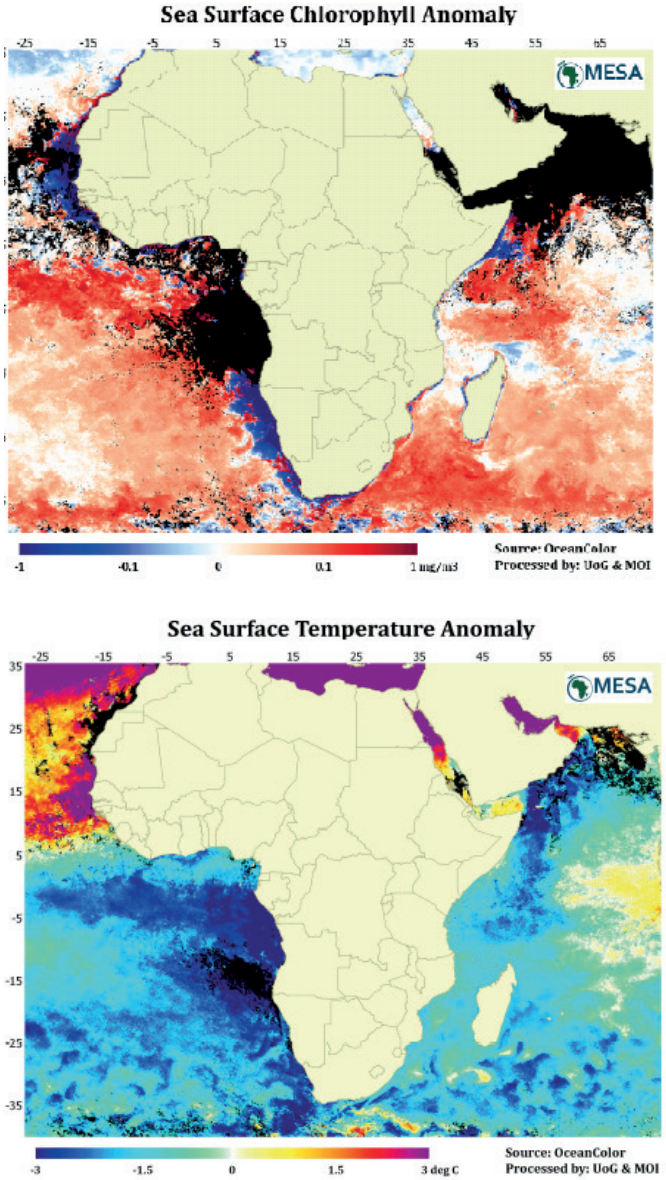


Note: Estimates are based on effective porosity and saturated aquifer thickness.
Source: MacDonald *et al.* 2012

17. Impact of sea surface temperture

Intense upwelling in the southeast Atlantic and between the eastern coast of Africa and the Seychelles in 2015 resulted in colder-than-usual sea surface temperatures with higher levels of chlorophyll, creating optimal conditions for fish growth (MESA 2015). In the north Mozambique Channel and the Canary LME, low chlorophyll in the former and an unusually warm sea surface temperature in the latter, could have influenced biological productivity. In East Africa, an increasing sea surface temperature has the potential to cause substantial declines of productivity in coral reefs, with implications for fish production and the livelihoods of communities (Cinner *et al.* 2012). West Africa is expected to face a substantial reduction in marine fish production and fish protein supply by the 2050s (Lam *et al.* 2012), resulting in a 21 per cent drop in annual landed value, a 50 per cent decline in fisheries jobs and a total annual loss of USD 311 million to the regional economy. In South Africa, cooling rather than warming trends have been observed in offshore sea surface temperatures, with associated retraction of warm water species (Mead *et al.* 2013; Blamey *et al.* 2015).17.

Sea surface temperature and chlorophyll anomalies around Africa, April–July 2015

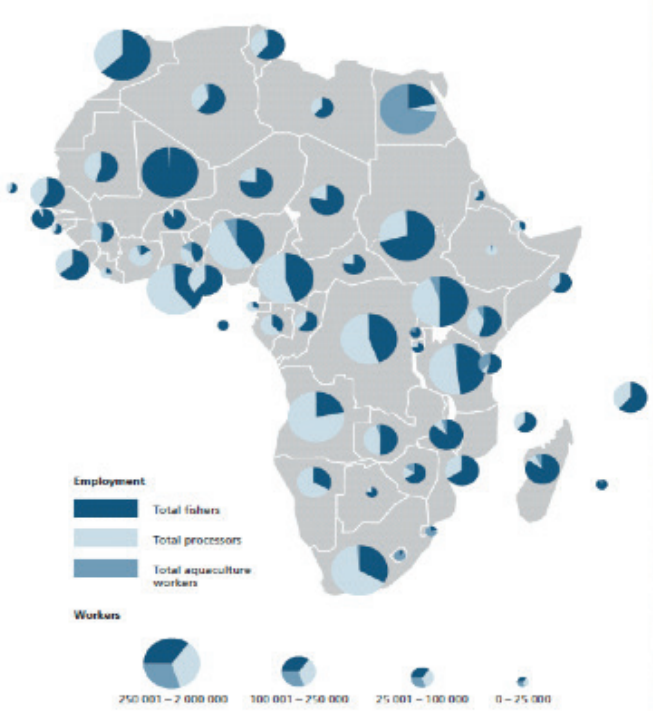


Source: MESA 2015

18. Employment in fisheries

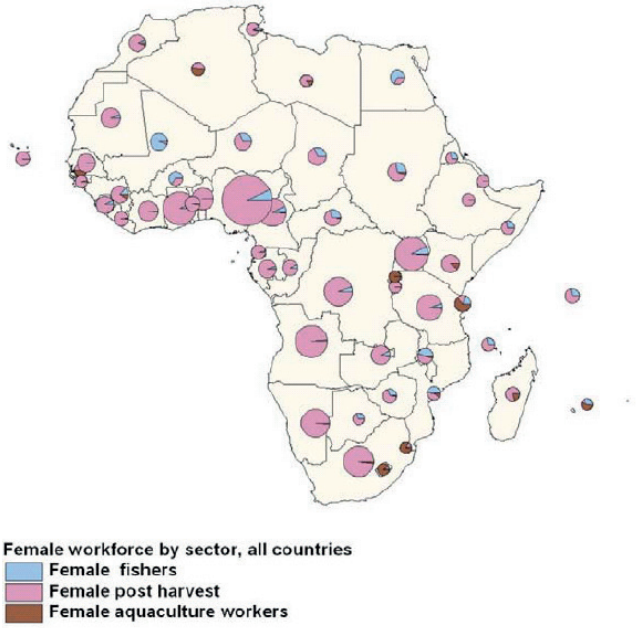
Women represent 27.3 per cent of the total workforce in the fisheries sector in Africa, with the majority engaged in post-harvest and less than 10 per cent working as inland fishers and in aquaculture. Of the global population engaged in aquaculture, Africa contributed more than 10 per cent in 2012, with the fastest annual growth rate of 11.7 per cent between 2000 and 2012 (FAO 2014).

Employment in African fisheries in 2011, by subsector



Source: FAO 2014

Female employment in fisheries by type of work, 2011



Note: The size of the pie indicates the relative size of the total female workforce.

Source: de Graaf and Garibaldi 2014

19. Blue economy

The blue economy focuses on areas such as fishing; shipping and maritime transport; coastal tourism; marine energy including both fossil and renewable, such as wind and tidal power and energy derived from marine microbial fuel cells; pharmaceutical and cosmetic industries; genetic resources; general sea-based products; and blue carbon trading opportunities (UNECA 2014). The blue economy approach offers the prospect of sustained, environmentally sound but also socially inclusive economic growth based on small-island strengths in the coastal and marine sectors (UNECA 2014).

20. Blue carbon

Terrestrial carbon stored in plant biomass and soils in forested land, plantations, agricultural land and pastureland is often called green carbon. Blue carbon is the carbon captured by the world's oceans and represents more than 55 per cent of total biological carbon (Nellemann *et al.* 2009). It is stored or sequestered in marine and coastal ecosystems including mangrove forests, tidal salt marshes and sea grass meadows, as well as coral reefs and oceanic carbon sinks in the form of marine algae. These habitats provide important ecosystem services as spawning habitat and defence against storms, and for nutrient cycling and pollination, and they provide economic resources including livelihoods and food, materials and medicine. Yet they are largely disregarded in international climate change mitigation and adaptation frameworks (Nellemann *et al*. 2009).

21 . Water Global Environmental Goals

Access to safe drinking water	
Sustainable Development Goal 6, Target 1	By 2030, achieve universal and equitable access to safe and affordable drinking water for all.
Access to basic sanitation	
Sustainable Development Goal 6, Target 2	By 2030, achieve access to adequate and equitable sanitation and hygiene for all....
Groundwater depletion	
Sustainable Development Goal 6, Target 5	By 2030, implement IWRM at all levels, including through transboundary cooperation as appropriate.
Water-use Efficiency	
Johannesburg Plan of Implementation, Paragraph 26 (c)	Improve the efficient use of water resources and promote their allocation among competing uses in a way that gives priority to the satisfaction of basic human needs ...
Freshwater Pollution	
Johannesburg Plan of Implementation, Paragraph 25 (d)	Intensify water pollution prevention to reduce health hazards and protect ecosystems by introducing technologies for affordable sanitation and industrial and domestic wastewater treatment, by mitigating the effects of groundwater contamination and by establishing, at the national level, monitoring systems and effective legal frameworks.
Marine Pollution	
United Nations Convention on the Law of the Sea, Article 196, Paragraph 1	States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control ...
Extreme Events	
Johannesburg Plan of Implementation, Paragraph 134	Support efforts to prevent and mitigate the impacts of natural disasters.

22. Biodiversity Global Environmental Goals

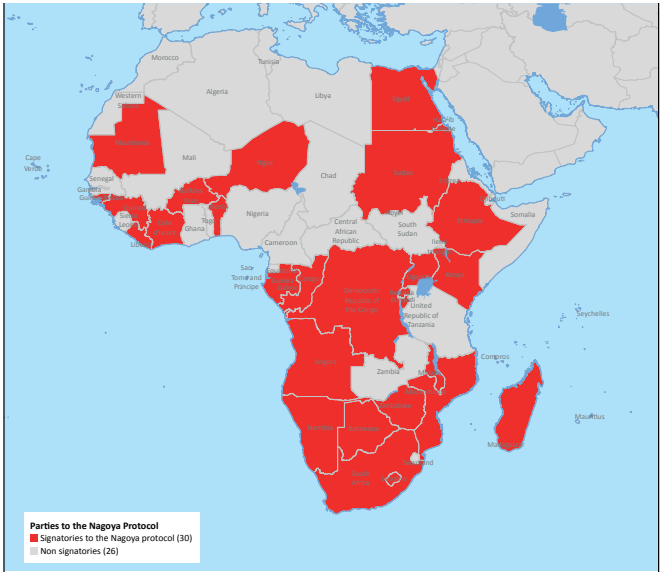
Halting or Reducing Biodiversity and, Habitat Loss and Degradation	
Millennium Development Goal 7 Target B	Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss.
Aichi Biodiversity Target 5	By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.
Achieving Sustainable Agriculture and Fisheries	
Aichi Biodiversity Target 7	By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.
Johannesburg Plan of Implementation, Paragraph 31(a)	To achieve sustainable fisheries, the following actions are required at all levels: (a) Maintain or restore stocks to levels that can produce the maximum sustainable yield with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015.
Controlling Invasive Alien Species	
Aichi Biodiversity Target 9	By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.
Increasing the Size of Protected Areas	
Aichi Biodiversity Target 11	By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.
Conserving and Maintaining Genetic Resources and Genetic Diversity	
Aichi Biodiversity Target 13	By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socioeconomically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.
Fair and Equitable Sharing of Benefits Accruing from Genetic Resources	
Convention of Biological Diversity, Article 8(j)	Each Contracting Party shall, as far as possible and as appropriate... (j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices.
Aichi Biodiversity Target 16	By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

23. African membership for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)



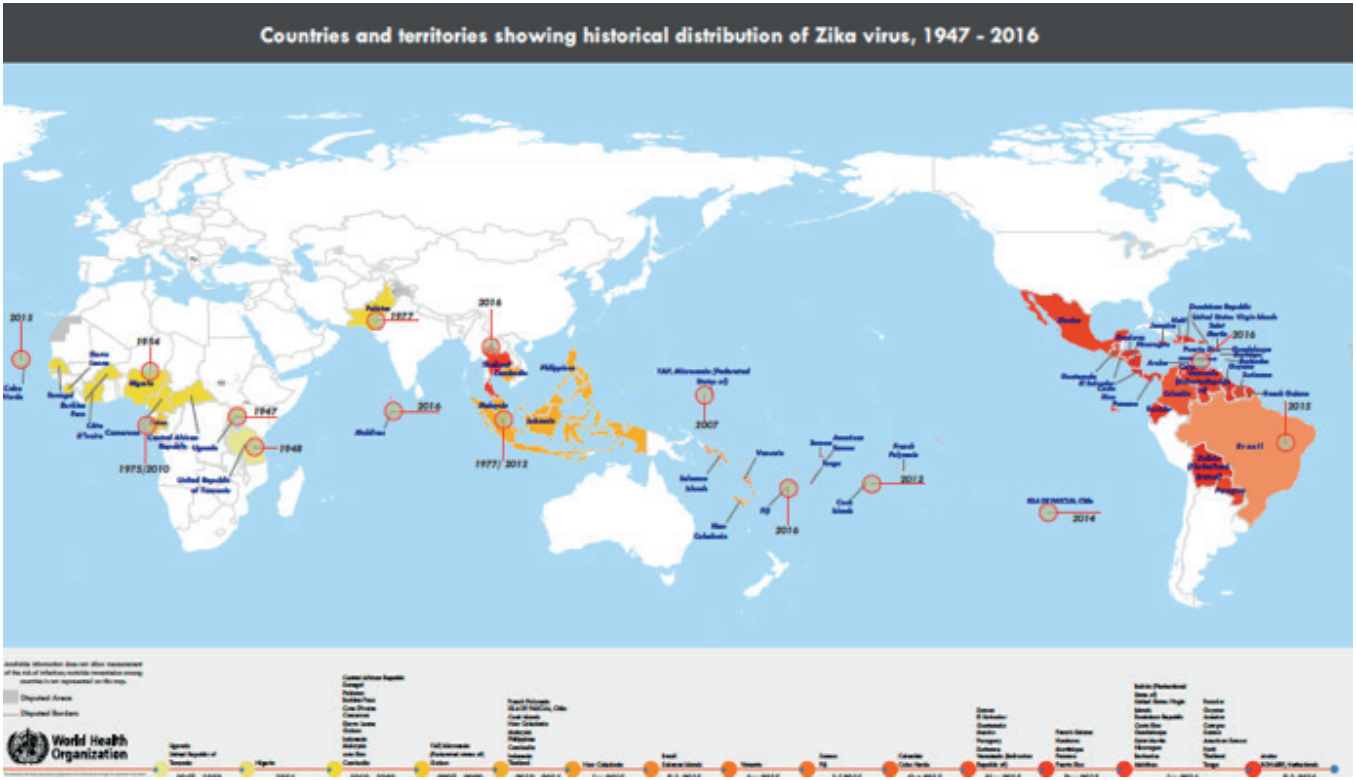
Source:ITPGRFA

24. African countries that are Parties to the Nagoya Protocol



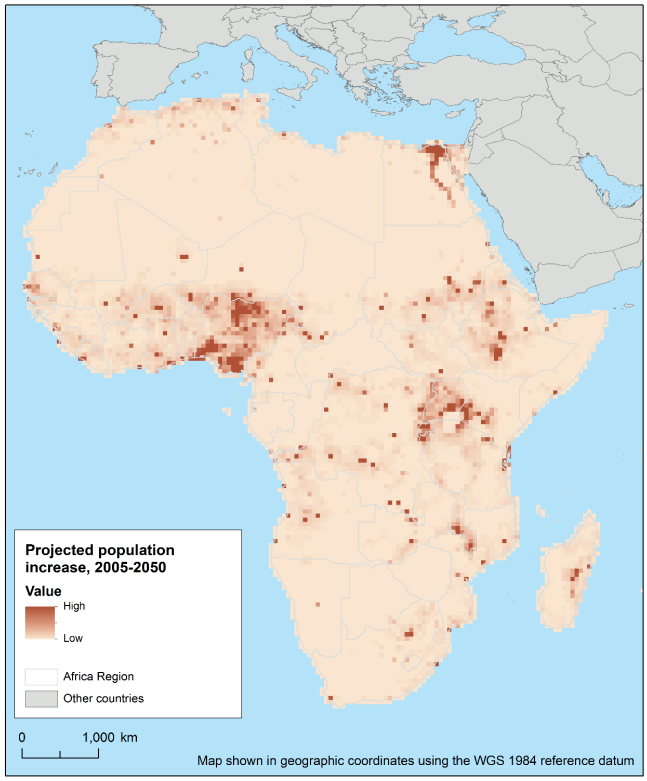
Source: CBD

25. Distribution of the Zika virus, 1947-2016



Source: WHO 2016

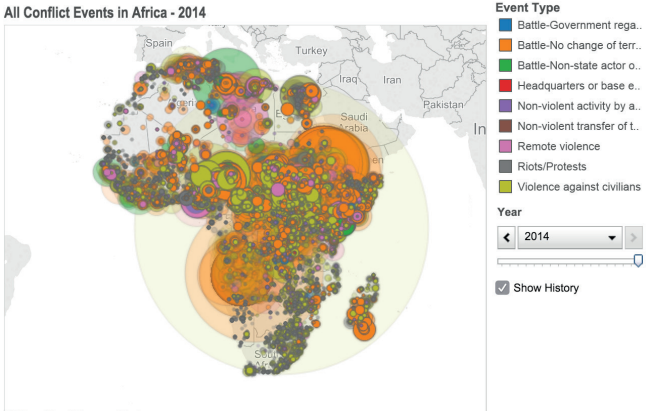
26. Projected population increase 2005- 2050



The boundaries shown on this map do not imply official endorsement or recognition by the United Nations

Source: Schaldach *et al.* 2011

27. Spates of conflicts in Africa



Source: OpenStreetMap contributors, 2014

28. Development Corridors

Planned development corridors can potentially impact the environment negatively, unless mitigation and protection measures are put into place. Africa's severe lack of infrastructure is demonstrated by the low road access rate of 34 per cent compared with 50 per cent in other parts of the developing world, as well as transport costs that are comparatively higher by 100 per cent. About 30 percent of the population has access to electricity compared to 70–90 per cent in other parts of the developing world, while water resources are under-used with 4 per cent of water resources developed for water supply, irrigation and hydropower use (PIDA 2011). It is proposed that improving infrastructure will help African countries to grow economically and provide for their citizens, particularly those in sub-Saharan Africa who are currently among the least competitive in the world (PIDA 2011). The proposed infrastructure development programme articulates short- (2020), medium- (2030), and long-term (2040) priorities for meeting identified infrastructure gaps in transport, energy, transboundary water and internet and communication technologies (ICT) (PIDA 2011).

Laurance *et al*. (2015) identified 33 transport corridors in Africa, of which 10 were active in 2015. The corridors run through a variety of biomes, with the highest impacts on forests and savannah woodland, and will also have a major impact on existing protected areas as the 50 km wide band overlaying each corridor includes 2 168 protected areas, with roads and railways bisecting 408 protected areas (Laurance *et al*. 2015). The estimated potential for transportation improvements to increase agricultural production varied considerably between different corridors, with those in savannah areas having a higher potential than those in rainforest areas, and that there is little association between conservation potential of the land and its agricultural production potential, which suggests that there may only be limited direct trade-offs that need to be addressed in managing corridor development (Laurance *et al.* 2015).

29. The African Union Agenda 2063 Goals

1. High standard of living, quality of life and well-being for all citizens
2. Well-educated citizens and a skill revolution, underpinned by science, technology and innovation
3. Healthy and well-nourished citizens
4. Transformed economies
5. Modern agriculture for increased productivity and production
6. Blue (ocean) economy for economic growth
7. Environmentally sustainable and climate-resilient economies and communities
8. A united Africa (federal or confederate)
9. Continental financial and monetary institutions, established and functional
10. World-class infrastructure criss-crossing Africa
11. Democratic values, practices, universal principles of human rights, justice and the rule of law entrenched
12. Capable institutions and transformative leadership in place
13. Peace, security and stability is preserved
14. A stable and peaceful Africa
15. A functional and operational ASPA
16. African cultural renaissance is pre-eminent
17. Full gender equality in all spheres of life
18. Engaged and empowered youth and children
19. Africa as a major partner in global affairs and peaceful co-existence
20. Africa takes full responsibility for financing her development

30. The Sustainable Development Goals (SDGs)

1. End poverty
2. Zero hunger
3. Good health and well-being
4. Quality education for all
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Conserve life below water
15. Conserve life on land
16. Peace, justice and strong institutions
17. Partnerships for the goals

[1]This outlook is based on four scenarios described in the WWF/African Development Bank 2015 African Ecological Futures report (WWF/AfDB 2015). http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/xwwf_african_futures_report_english-lo-rez.pdf

[2]This outlook is based on four scenarios described in the African Union 2063 agenda as envisioned under each of the four scenarios against a time horizon to 2030 and 2063.
http://agenda2063.au.int/en/sites/default/files/Final%20Draft%20Agenda%202063%20Framework%20-Formatted%20TOC-1.pdf

31. Progress towards the SDGs in the *Good Neighbours* scenario

On a scale from +++ to ---: +++ = SDG fully met; 0 = no progress; --- = highly negative

Sustainable Development Goal	2030	Why?	2063	Why?
1. End hunger	++	Strong centralized strategies, but implementation takes time to become effective.	+++	Decades of learning across successes and failures have led to robust action to end hunger.
2. End poverty	++	Developments of infrastructure and energy bolster economies, but the benefits have yet to reach all.	+++	Governments and international cooperation programmes have become increasingly effective in poverty alleviation.
3. Ensure healthy lives for all	++	International learning between governments and other sectors leads to a number of large-scale successes.	+++	Lessons from previous decades are widely and successfully implemented across the continent.
4. Ensure quality education for all	++	Governments across the continent have a number of large-scale early successes on education, but access for all remains a challenge.	+++	Sub-national implementation of plans and policies around education is now widespread.
5. Achieve gender equality and empower all women and girls	+	Large-scale policies struggle to address gender inequality and sometimes exacerbate it.	++	In the later decades, increasing democratization promotes a culture of gender equality despite the relative ineffectiveness of targeted gender policies.
6. Ensure clean water and sanitation for all	++	Rapid investment in water infrastructure leads to significant improvements in water and sanitation.	+++	Expertise on quality water and sanitation is now widespread; where large-scale infrastructure is not available, more flexible solutions complement it.
7. Ensure access to sustainable energy for all	++-	Through coordinated effort, Africa quickly becomes a leading region on many flexible sustainable energy solutions, though providing access for all proves difficult.	+++	Flexible and adaptable small-scale energy solutions are ubiquitous, complemented by larger-scale energy projects.

Sustainable Development Goal	2030	Why?	2063	Why?
8. Promote sustainable economic growth and employment for all	++	The continent-wide push for infrastructure and innovation leads to economic growth and increased employment opportunities, though the centralized organization of development projects means that providing equal work opportunities is a challenge.	+++	Increased democratization and the growth of civil society initiatives helps complement the limits of the centralized organization of economic growth to a good degree.
9. Build resilient infrastructure, promote sustainable industrialization	+	Strong efforts are made to make the rapid development of infrastructure and industry sustainable, but the prevention of ecosystem degradation is only partially successful, and infrastructure turns out to be less resilient than expected.	++	Lessons are learned on the construction of resilient infrastructure, but while projects are always designed with the objective of minimizing environmental impacts, the consequences of many new regions having been opened up are difficult to manage.
10. Reduce inequality within and between countries	++	Strong collaboration at the continent level means that inequality between countries diminishes, but the top-down organization of economic growth does not deal well with in-country inequalities.	+++	Inequalities between countries continue to decrease; and in these later decades, the growth of democratization has meant that civil society has pushed government policies to be more effective at reducing inequality.
11. Make cities inclusive, safe, resilient and sustainable	++	Strong efforts are made on making cities more livable and sustainable, but effective implementation takes time.	+++	Cross-city learning networks have ensured that the most effective approaches have now spread across the continent.
12. Ensure sustainable production and consumption patterns	+	Though sustainable production and consumption patterns are among the ambitions of governments, agricultural expansion, population growth and higher incomes prove to be strong drivers of unsustainable growth.	+	Energy production has become much more sustainable, but agricultural expansion has had negative impacts on natural areas; increasing populations and incomes have put strong pressure on Africa's resources, though many programmes are in place to mitigate their impacts.

Sustainable Development Goal	2030	Why?	2063	Why?
13. Take urgent action to combat climate change and its impacts	+	There is strong investment in sustainable energy production. While infrastructure proves to be more fragile than hoped for, more resources and knowledge are available to farmers for dealing with climate change impacts.	+	The sustainable energy pathway continues to develop, although infrastructure remains fragile. As climate impacts have increased, vulnerable communities are affected, though they have more support structures to fall back upon.
14. Conserve and sustainably use the oceans, seas and marine resources	-	Government policies struggle to govern marine resources properly.	-	Government priorities remain focused on other issues, though civil society and NGOs attempt to turn the tide.
15. Protect and sustainably use terrestrial ecosystems, halt land degradation	-	Massive expansion of infrastructure and extractive industries, though planned with the minimization of impacts in mind, opens up natural areas, leading to degradation of terrestrial ecosystems.	-	Governments and investors continue to attempt sustainable expansion, but regulation of the indirect effects of expansion continues to prove difficult.
16. Promote peaceful and inclusive societies, provide justice for all	++	Regional and continental efforts to create more stable societies are very successful; social inclusion is slower to develop.	+++	The continent continues to be peaceful; citizen organizations help create more inclusive societies.
17. Strengthen the means for implementation and revitalize global partnership for sustainable development	+	The continent is largely focused on internal development rather than global partnerships; but the SDGs are used as a guideline for policy.	++	With an increasingly flourishing continent, external investors are becoming more eager for collaboration, but they are tightly managed.

32. Progress towards the SDGs in the *Going Global* scenario

On a scale from --- to +++: +++ = SDG fully met; 0 = no progress; --- = highly negative trend

Sustainable Development Goal	2030	Why?	2063	Why?
1. End hunger	++	Increased incomes and availability of food products from trade result in better food security overall, though the most vulnerable groups are not always able to benefit from the fast development; large-scale migrations also contribute to food insecurity.	++	An increase in incomes for many on the continent means food security has increased substantially; the main challenge is the volatility of global markets on which Africans are now highly dependent.
2. End poverty	++	Economic growth is strong and creates incomes for many, though direct poverty alleviation is not as high a policy priority.	++	Standards of living for many on the continent, and especially in the largest urban hubs, have continued to increase, though greater dependence on global markets creates periods of instability.
3. Ensure healthy lives for all	++	Health care becomes available for more and more people, though mainly through commercial channels rather than health care programmes – so the most vulnerable are still often left out.	++	Health care continues to be fairly accessible for most individuals and families whose incomes have increased over the decades, though a significant number of people cannot afford commercial medicines; centralized support programmes have become more effective, but pollution has contributed negatively to health.
4. Ensure quality education for all	+	Education is increasing in quality, but is mostly affordable only to the middle class and upwards, with little government funding going to the poorest.	++	Education continues to focus mostly on commercial models, but information technology has increased access to information and education channels for vulnerable communities.

Sustainable Development Goal	2030	Why?	2063	Why?
5. Achieve gender equality and empower all women and girls	+	There is some progress on gender equality because of increased options for women and girls in terms of education and health care, but there are few targeted or effective government gender programmes for remote and vulnerable areas.	++	Gender equality has increased significantly in Africa's hubs, both through targeted programs and the availability of opportunities and resources. By contrast, successes in remote areas are still few.
6. Ensure clean water and sanitation for all	+	Innovative water and sanitation projects are established in the African urban hubs and in other areas where an increase in the standard of living has commercial benefits;. elsewhere, progress is slow	++	The big African hubs have developed strong water and sanitation infrastructure; for those in rural areas, water and sanitation are still a challenge, though flexible and mobile technologies are available if people can afford them.
7. Ensure access to sustainable energy for all	++	Energy development is linked to private-sector investment, focusing on urban areas and prime tourist regions, amongst others, but leaving less attractive regions behind.	++	The divide between high-profile and low-profile areas in terms of energy development continues, though there is more funding available for governments to bridge the energy gap.
8. Promote sustainable economic growth and employment for all	++	Economies grow rapidly with skillful and centralized management of foreign investments and trade, translating to job possibilities for the majorities of national populations. The availability of jobs in cities as compared to the countryside drives rapid urbanization. Governments aim for green growth but impacts of the expansion of multiple sectors on ecosystems and environments are still significant.	++	Economic growth has been immense, and has generated diverse work opportunities, predominantly in cities, but though green growth has been a guiding principle and high-profile nature areas are firmly protected and cultivated, rapid expansion has had widespread environmental impacts elsewhere.

Sustainable Development Goal	2030	Why?	2063	Why?
9. Build resilient infrastructure, promote sustainable industrialization	++	Infrastructure and industry expand rapidly, but resilience and sustainability are challenges.	++	Development corridors have been established, but their resilience in the face of climate change and other stressors has proven weak; the scale of expansion of cities, industry and extractive practices has been difficult to manage in terms of environmental impacts, apart from protected/tourist areas.
10. Reduce inequality within and between countries	+	Increasingly centralized efforts to manage and guide the continent's trade and economic development struggle with large gaps between and within countries.	++	Centralized management of economic growth has led to a coordinated development of countries that were previously lagging behind – still, Africa's major urban hubs have seen faster growth; within countries, inequalities are still large with the incomes of some having skyrocketed, though there is less poverty overall.
11. Make cities inclusive, safe, resilient and sustainable	+	Cities initially struggle with the influx of so many migrants and with the guiding of rapid economic growth.	++	City-level governance with higher-level support has become increasingly effective, and the quality of life in cities has increased.
12. Ensure sustainable production and consumption patterns	+	Governments have a difficult time implementing sustainable production and consumption policies while both grow rapidly.	+	Green growth principles have guided production and trade in Africa, but the sheer scale of production and consumption has still meant significant environmental impacts.
13. Take urgent action to combat climate change and its impacts	0	Fast growth in all sectors does not take climate adaptation into account.	0	The lack of adaptation planning in diverse growth sectors has left the continent vulnerable in a number of spheres, primarily infrastructure and agriculture.
14. Conserve and sustainably use the oceans, seas and marine resources	++	The increasingly centralized management of cross-boundary resources achieves a re-direction of maritime developments that has begun to avoid degradation of marine resources and ecosystems.	+++	Centralized policies on ocean resources and environments have steered economic development away from the maritime, allowing a flourishing of marine life.

Sustainable Development Goal	2030	Why?	2063	Why?
15. Protect and sustainably use terrestrial ecosystems, halt land degradation	+	Governments work hard to cultivate their high-profile natural environments for eco-tourism.	++	There is a strong division between high-profile protected areas that see a flourishing tourist industry, and the degradation of less important areas.
16. Promote peaceful and inclusive societies, provide justice for all	++	The desire to increase stability in Africa prompts increasingly centralized governance – but implementation at sub-national levels is still difficult.	++	There has been an increase not just in international and national institutional strength, but also in local-level institutions, particularly in cities.
17. Strengthen the means for implementation and revitalize global partnership for sustainable development	+	Networks emerge around all SDGs, but those that align most closely with national and international development interests (focused on economic growth and eco-tourism) gain most traction.	++	Partnerships toward the SDGs have been strong on points of economic development and the management of protected areas, but less effective on aspects related to climate change and broader environmental governance.

33. Progress towards the SDGs in the *All in Together* scenario

On a scale from +++ to ---: +++ = SDG fully met; 0 = no progress; --- = highly negative trend

Sustainable Development Goal	By 2030	Why?	By 2063	Why?
1. End hunger	+	Hunger is closely tied to poverty levels; overall hunger decreases but degrees are dependent on local initiatives.	++	More and more local communities manage to overcome the challenge of hunger, but many are still left behind.
2. End poverty	+	Poverty levels go down; changes in poverty levels are also very uneven and depend on local conditions.	++	Poverty levels continue to drop, though increases in population pose a challenge, and the scattered nature of local community successes means that there are still large differences in poverty levels.
3. Ensure healthy lives for all	+	Health and well-being increase along with income and access to food in many areas, while others still lag behind.	++	Local practices contributing to health and well-being are spreading, but continental coverage is still uneven.
4. Ensure quality education for all	+	Many local and regional initiatives focus on education as a pillar of growth; but there is no strong government support – education is still poor in many areas.	++	Quality education has become more and more widespread, but its availability is entirely dependent on local and regional initiatives and some areas are still missing out.
5. Achieve gender equality and empower all women and girls	+	Gender equality initiatives flourish both in urban and rural environments, but they are mostly an example and a source of hope for the future	++	Many communities have either self-organized for gender equality or mobilized external support and resources – but many are still waiting to follow these examples.
6. Ensure clean water and sanitation for all	+	Local and regional initiatives work towards clean water and sanitation in a number of example case studies throughout the continent.	++	Clean water and sanitation practices are fairly widespread, but not ubiquitous.

Sustainable Development Goal	By 2030	Why?	By 2063	Why?
7. Ensure access to sustainable energy for all	+	Many initiatives are experimenting with affordable and clean energy innovations.	++	Africa is one of the global places for energy innovation that is cheap and flexible. But still not everyone can get access: such innovations require community knowledge and social capital to work.
8. Promote sustainable economic growth and employment for all	+	Communities are creating local and regional opportunities for work and green economic growth – especially in resource-rich areas – and increased participation of vulnerable groups. However, no overarching government plans are in place and many slip through the cracks.	++	Africa is covered in hot-spots of inclusive, sustainable economic growth, innovation and work opportunities. But many areas are still underdeveloped and become less attractive.
9. Build resilient infrastructure, promote sustainable industrialization	++	Industry and innovation accelerate in hot-spots throughout Africa.	++	Industry and innovation have flourished in many areas, having quickly outpaced less developed regions.
10. Reduce inequality within and between countries	-	Inequalities between those in resource-rich developing areas and those elsewhere increase.	-	Inequalities between the resource-rich, socially innovative areas and communities and less developed, low-potential areas are larger than before.
11. Make cities inclusive, safe, resilient and sustainable	+	Initiatives working for sustainable cities and communities are emerging throughout the continent.	++	Many cities and communities have become more sustainable locally, but sustainably managing transboundary resources is still a challenge.
12. Ensure sustainable production and consumption patterns	+	Consumption and production levels rise, but their impacts are beginning to be dampened by sustainable local production and consumption initiatives.	+	Population pressures on consumption and therefore production are serious, but sustainable initiatives throughout Africa meet part of the growing demand.

Sustainable Development Goal	By 2030	Why?	By 2063	Why?
13. Take urgent action to combat climate change and its impacts	+	Many, though by no means all, communities are making big steps towards becoming more climate-smart in their agriculture and other livelihood sources, as well as in the development of infrastructure.	++	Though changes in temperature and precipitation (both averages and patterns/ extremes) prove to be a massive challenge for many regions in Africa by 2063, there are widespread examples of successful climate adaptation, which nevertheless do not reach all who need this adaptive capacity.
14. Conserve and sustainably use the oceans, seas and marine resources	--	There is a lack of management of water life internationally; local initiatives aim for better management of water ecosystems.	--	Many freshwater and coastal communities have worked hard to govern water life, but it is threatened by lack of legislation around water resources at higher levels.
15. Protect and sustainably use terrestrial ecosystems, halt land degradation	-	Life on land continues to decline, but examples of successful local conservation start to emerge.	o	Depending on local initiatives, life on land flourishes or has been diminished severely.
16. Promote peaceful and inclusive societies, provide justice for all	o	Because of a relative lack of international-level governance and state power, tensions between regions, communities and countries can run high; local institutions tend to be strong in many cases.	o	International attempts at managing conflicts and providing effective legislation continue to yield unsatisfactory results; strong voices from local and sub-national governing bodies keep pushing for relative independence and bringing competing demands and interests to negotiations.
17. Strengthen the means for implementation and revitalize global partnership for sustainable development	+	Partnerships around the SDGs mostly exist as networks of local initiatives supported by global donors.	+	In the decades toward 2063, the SDG local network partnerships have much to show for themselves, but they cannot claim universal success across the continent due to a failure of higher-level policies and institutions.

34. Progress toward the SDGs in the *Helping Hands* scenario

On a scale from +++ to ---: +++ = SDG fully met; 0 = no progress; --- = highly negative trend

Sustainable Development Goal	2030	Why?	2063	Why?
1. End hunger	+	Food in urban areas has become more affordable for the poor. However, nutrition security has not increased, as most of the affordable food is of low nutritional value; in rural areas, hunger persists.	++	Food security, but not nutrition security, increases in urban areas. Rural communities in areas where resources are irreversibly degraded are less food secure than in 2015.
2. End poverty	+	The economy of most African countries is growing, but profits are not equally distributed; poverty in rural areas and slums has increased.	+	Income gaps in urban areas remain, though African companies taking over are more interested in providing fair incomes; in some areas resources are irreversibly degraded, leading to economic stagnation and decline.
3. Ensure healthy lives for all	-	Overall public health is decreasing because of increasing industrial activities.	-	Health care remains insufficient for many vulnerable groups, and the impacts of industrial activities and urbanization on health continue.
4. Ensure quality education for all	+	The rich have access to quality education. Education has also become more accessible for the middle class, albeit focused on fields related to lucrative forms of agriculture and resource extraction.	+	Access to quality education in the most successful urban agglomerates of the continent has improved, but in large parts of the continent, education remains out of reach.
5. Achieve gender equality and empower all women and girls	+	Gender equality is a priority for donors, but not for policy makers.	+	Gender remains a side concern, with progress made mostly due to civil society groups who are going against the grain.

Sustainable Development Goal	2030	Why?	2063	Why?
6. Ensure clean water and sanitation for all	-	Freshwater availability has diminished as a consequence of increased use for industrial activities; industrial activities have polluted many of Africa's freshwater reserves.	+	Green growth initiatives are starting to provide better water. Still, clean water and sanitation are not available in large rural areas, causing out-migration to urban centres.
7. Ensure access to sustainable energy for all	+	Industrial, urban and infrastructure growth bring wider energy access, but vulnerable groups are largely left out.	+	As a side effect of increased industrial expansion, energy supply has become more reliable throughout the continent. However, as the energy infrastructure is primarily developed to serve industrial purposes, it remains largely unavailable for the (rural) poor.
8. Promote sustainable economic growth and employment for all	0	Economies are growing as a whole and employment in industry has increased. At the same time, rural employment rates have dropped dramatically as much of the arable land is now in commercial hands.	+	African companies are taking over from foreign investors and are more interested in creating fair local employment.
9. Build resilient infrastructure, promote sustainable industrialization	+	Industry has expanded; innovation largely focuses on profitable activities. Infrastructural development is driven by the private sector and primarily serves their goals.	++	There is an inspiring upsurge of interest in creating more sustainable industries, but the reality means that past trajectories are difficult to change.
10. Reduce inequality within and between countries	-	In-country and between-country inequality increases.	-	Collaborative efforts are made by governments and civil societies to build more equal societies, but it is a struggle to change past trends.
11. Make cities inclusive, safe, resilient and sustainable	--	Cities develop quickly and in a haphazard fashion.	-	Increasing resources become available to try and improve living conditions in cities, but effective plans are few and far between.

Sustainable Development Goal	2030	Why?	2063	Why?
12. Ensure sustainable production and consumption patterns	-	Responsible consumption and production has not increased, and with larger populations and rising incomes for the middle class, the impacts of consumption and production have grown.	-	Green growth initiatives with foreign support are attempting to make production and consumption more sustainable, but struggle to move beyond their first successes.
13. Take urgent action to combat climate change and its impacts	0	Although local initiatives to act against climate change exist, they struggle to affect adaptive capacity on the national, regional or continental scale.	+	Initiatives to increase climate adaptation have done battle for decades and have learned much, becoming better at finding resources from the green growth movements to help foster climate adaptation.
14. Conserve and sustainably use the oceans, seas and marine resources	--	Fishery activity has increased and, as a consequence, fish stocks are on the decline, affecting aquatic ecosystems.	---	Marine resources continue to be devastated, prompting many to find other livelihoods.
15. Protect and sustainably use terrestrial ecosystems, halt land degradation	--	Environmental degradation as a consequence of large-scale agriculture, industrial activity and resource extraction has affected terrestrial life significantly.	-	Sustainable growth movements attempt to stop or revert the decline of terrestrial ecosystems, garnering some first successes, but decline continues overall.
16. Promote peaceful and inclusive societies, provide justice for all	--	Weak governments and institutions are unable to address conflicts over land and other resources adequately.	-	Various initiatives aim for greater regional stability, with limited success.
17. Strengthen the means for implementation and revitalize global partnership for sustainable development	0	Partnerships for the SDGs fail to impact rapid, destructive and unequal growth trends.	+	Green growth partnerships have emerged and started to become a significant voice.

35. Specific policy-related AU goals in the *Good Neighbours* scenario

On a scale from +++ to ---: +++ = goal fully met; o = no progress; --- = highly negative trend

AU Agenda 2063	2063	Why?
Sustainable exploitation	-	Strong policy efforts are in play to make exploitation more sustainable, but the sheer scale of resources needed and the indirect effects of extractive industries and infrastructure development prove to be damaging.
Modern, efficient, reliable, cost-effective, renewable and environment-friendly regional energy pools and production	+++	The continent has made enormous strides in sustainable energy: large energy infrastructure projects are complemented by diverse agile and flexible small-scale energy solutions.
Climate resilience (Comprehensive Africa Agriculture Development Programme – CAADP)	+	Infrastructure proves to be more fragile than expected; expansion has made many natural areas more vulnerable, but increased government support is available for vulnerable communities to deal with climate change.
High-speed rail	+++	High-speed rail is among the big and successful infrastructure projects proliferating across the continent.
Information and communication technology (ICT)	+++	ICT resources and capabilities are at a very high level, with many tech hubs existing across the continent and widespread networks available.
Africa Mining Vision 2050	++	Mining has expanded widely; it has proved difficult to combat the indirect impacts of this expansion on ecosystems.
Oil, water, gas pipelines	+	Strong investments had initially been made in fossil fuels; however, later renewable energy sources became dominant.
Intra-Africa trade: 50 per cent by 2045 (12% per cent global)	+++	Intra-Africa trade has flourished.

36. Specific policy-related AU goals in the *Going Global* scenario

On a scale from --- to +++: +++ = goal fully met; 0 = no progress; --- = highly negative trend

AU Agenda 2063	2063	Why?
Sustainable exploitation	+	Exploitation has grown exponentially, and despite government guidelines for sustainable growth, the sheer scale of expansion has meant that environmental degradation has increased substantially. At the same time, high-priority nature sites have seen fierce protection and cultivation for eco-tourism.
Modern efficient, reliable, cost-effective, renewable and environmentally friendly regional energy pools and production	++	The development of energy infrastructure has focused mainly on areas with private-sector interests, either in urban or in attractive rural areas – with governments attempting to bridge the energy gap with other areas.
Climate resilience (Comprehensive Africa Agriculture Development Programme – CAADP)	0	Climate resilience has not been a development priority, leaving many vulnerable both, because of problems with infrastructure and in farming.
High-speed rail	++	High-speed rail has been developed to provide easy connections between high-profile urban and natural areas.
Information and communication technology (ICT)	+++	ICT has flourished in the big African hubs.
Africa Mining Vision 2050	++	Mining has expanded enormously. It has not touched high-profile eco-tourism areas, but has been highly impactful on natural areas. According to the Mining Vision, mining has been positive for local communities.
Oil, water, gas pipelines	++	Though green growth has gained in prominence, the fossil-fuel sector is too profitable to be diminished significantly and the extension of pipelines has increased. Water infrastructure has been developed primarily to suit diverse commercial interests.
Intra-Africa trade	++	Africa is a major exporter in diverse sectors and has market shares all around the world; trade within Africa does not develop quite as fast.

37. Specific policy-related AU goals in the *All In Together* scenario

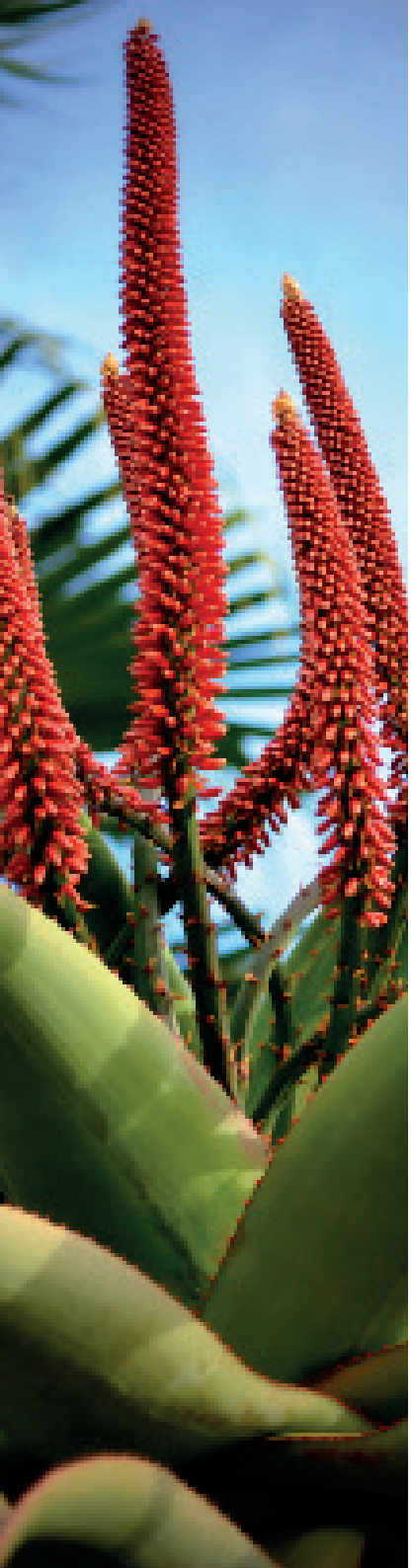
On a scale from --- to +++: +++ = goal fully met; o = no progress; --- = highly negative trend

AU Agenda 2063	2063	Why?
Sustainable exploitation	+	Headline-grabbing sustainable resource use operations and community initiatives can be found everywhere in Africa. At the same time, however, destructive resource extraction continues away from the public eye.
Modern efficient, reliable, cost-effective, renewable and environmentally friendly regional energy pools and production	++	Many parts of the continent, especially the most resource-rich parts, have rural electricity due to local efforts with international funding.
Climate resilience (Comprehensive Africa Agriculture Development Programme – CAADP)	++	Though changes in temperature and precipitation (both averages and patterns/extremes) prove to be a massive challenge for many regions in Africa by 2063, there are widespread examples of successful climate adaptation, which nevertheless do not reach all who need this adaptive capacity.
High-speed rail	+	Local and national train networks have increased, but this has not yet led to strong international connectivity.
Information and communication technology (ICT)	+++	Africa has grown into a vibrant network of ICT innovation hot-spots.
Africa Mining Vision 2050	++	Though mining and extractive industries have had a heavy impact on environments, they have also provided work opportunities for the growing youthful population. In a number of cases, good community management of mining efforts has led to flourishing local areas, though there are also many less successful examples.
Oil, water, gas pipelines	+	As with mining, a number of oil and gas extraction sites have been managed to provide benefits to local communities, but such approaches have not been taken up everywhere; international tensions around oil and gas lines are often unresolved.
Intra-Africa trade: 50 per cent by 2045 (12 per global)	++	Intra-Africa trade has gone up, but trade regimes are fragmented and constitute a combination of local and bilateral/international trade; no strong trade institutions exist.

38. Specific policy-related AU goals in the *Helping Hands* scenario

On a scale from +++ to ---: +++ = goal fully met; 0 = no progress; --- = highly negative trend

AU Agenda 2063	2063	Why?
Sustainable exploitation	-	Exploitation of resources grows at a rapid rate; sustainability concerns only become a significant policy issue in the last decades before 2063.
Modern efficient, reliable, cost-effective, renewable and environment-friendly regional energy pools and production	+	The use of renewable and environmentally friendly energy is promoted in some successful large-scale regional projects by 2063. The focus is, however, still on largely fossil-fuel driven energy production. Hydroelectric dams have also proliferated.
Climate resilience (Comprehensive Africa Agriculture Development Programme – CAADP)	+	Climate adaptation initiatives have existed for decades and have learned much, but they still struggle to have a large impact on the adaptive capacity of the most vulnerable in Africa.
High-speed rail	+	High-speed rail is developed to meet the objectives of large investors.
Information and communication Technology (ICT)	+++	ICT is improving massively in urban areas, mainly to support large private-sector activities. As a side effect, urban populations are also benefiting.
Africa Mining Vision 2050	+	Mining has expanded throughout Africa, but sustainability concerns are largely ignored.
Oil, water, gas pipelines	+	New oil, water and gas pipelines are developed throughout the continent.
Intra-Africa trade: 50 per cent by 2045 (12 per cent global)	+	Large private-sector actors and global investors dominate trade in Africa for most of the period up to 2063, though in the last two decades, new African trade networks with more social responsibility emerge.



Acronyms and Abbreviations

ABNJ	-	Area Beyond National Jurisdiction
AEO	-	Africa Environment Outlook
AfDB	-	African Development Bank
AFREA	-	Africa Renewable Energy Access
AIDA	-	Accelerated Industrial Development of Africa
AIMS	-	Africa Integrated Marine Strategy
AMCEN	-	African Ministerial Conference on the Environment
AMCOW	-	African Ministerial Conference on Water
ANPE	-	National Agency for the Protection of the Environment (Tunisia)
ASPA	-	African Peace and Security Architecture
AQIM	-	Al Qaida in the Islamic Maghreb
AU	-	African Union
CAADP	-	Comprehensive African Agricultural Development Programme
CBD	-	Convention on Biological Biodiversity
CBNRM	-	Community Based Natural Resources Management
CITES	-	Convention on International Trade in Endangered Species of Wild Fauna
COMESA	-	Common Market for Eastern and Southern Africa
COMIFAC	-	Central Africa Forestry Commission
COPD	-	Chronic Obstructive Pulmonary Disease
CSP	-	Concentrating Solar Power
DDT	-	Dichlorodiphenyltrichloroethane
EAPP	-	East African Power Pool
EIA	-	Environmental Impact Assessment
ELI	-	Environmental Law Institute
ENSO	-	El Niño–Southern Oscillation
FAO	-	Food and Agriculture Organization of the United Nations
FAOSTAT	-	Food and Agriculture Organization of the United Nations Statistics Division
FC	-	Forest Concession
GDP	-	Gross Domestic Product
GEGs	-	Global Environment Goals
GEO-6	-	Sixth Global Environment Outlook
GHSL	-	Global Human Settlement Layer
GLOBIOM	-	Global Biosphere Management Model
HAP	-	Household Air Pollution
HIV/AIDS	-	Human Immunodeficiency Virus/acquired immunodeficiency syndrome
HFCs	-	Hydrofluorocarbons
IBAs	-	Important Bird Areas
ICT	-	Information and Communication Technology
IEA	-	Integrated Environmental Assessment
IGMS	-	Global Intergovernmental and Multi-Stakeholder Consultation
IPCC	-	Intergovernmental Panel on Climate Change

◄ Credit: Shutterstock/ West Coast Scapes

IRENA	-	International Renewable Energy Agency
ITPGRFA	-	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	-	International Union for Conservation of Nature
IWRM	-	Integrated Water Resources Management
LMEs	-	Large Marine Ecosystems
MDGs	-	Millennium Development Goals
MODIS	-	Moderate Resolution Imaging Spectroradiometer
NBSAP	-	National Biodiversity Strategies and Action Plan
NEPAD	-	New Partnership for Africa's Development
NGO	-	Non-Governmental Organization
NOx	-	Nitrogen Oxide
OCPs	-	Organochlorine pesticides
OECD	-	Organization for Economic Cooperation and Development
PA	-	Protected Area
PCFV	-	Partnership for Clean Fuels and Vehicles
PIDA	-	Programme for Infrastructure Development in Africa
PM	-	Particulate Matter
POPS	-	Persistent Organic Pollutants
PPB	-	Parts Per Billion
PPBV	-	Parts Per Billion By Volume
PV	-	Photovoltaic
PWC	-	Price Water House Coopers
RAMCEA	-	Ramsar Centre for Eastern Africa
REC	-	Regional Economic Community
REDD	-	Reducing Emissions from Deforestation and forest Degradation
REIN	-	Regional Environmental Information Network
SADC	-	Southern African Development Community
SDGs	-	Sustainable Development Goals
SIDS	-	Small Island Developing States
SLCPs	-	Short-Lived Climate Pollutants
SLP	-	Sea Level Pressure
SME	-	Small and Medium Enterprise
SST	-	Sea Surface Temperature
UN	-	United Nations
UNCED	-	United Nations Conference on Environment and Development
UNCTAD	-	United Nations Conference on Trade and Development
UNEA	-	United Nations Environment Assembly
UNECA	-	United Nations Economic Commission for Africa
UNESCAP	-	United Nations Economic and Social Commission for Asia and the Pacific
UNEP	-	United Nations Environment Programme

UNESCO	-	United Nations Educational Scientific and Cultural Organization
UNFCCC	-	United Nations Framework Convention on Climate Change
UNIDO	-	United Nations Industrial Development Organization
USA	-	United States of America
UV	-	Ultra-Violet
VCF	-	Continuous Vegetation Fields
WACOWet	-	West African Coastal Zone Wetlands Network
WCMC	-	World Conservation Monitoring Centre
WCS	-	World Conservation Society
WHO	-	World Health Organization
WMO	-	World Meteorological Organization
WWF	-	World Wildlife Fund

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Chapter 1

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