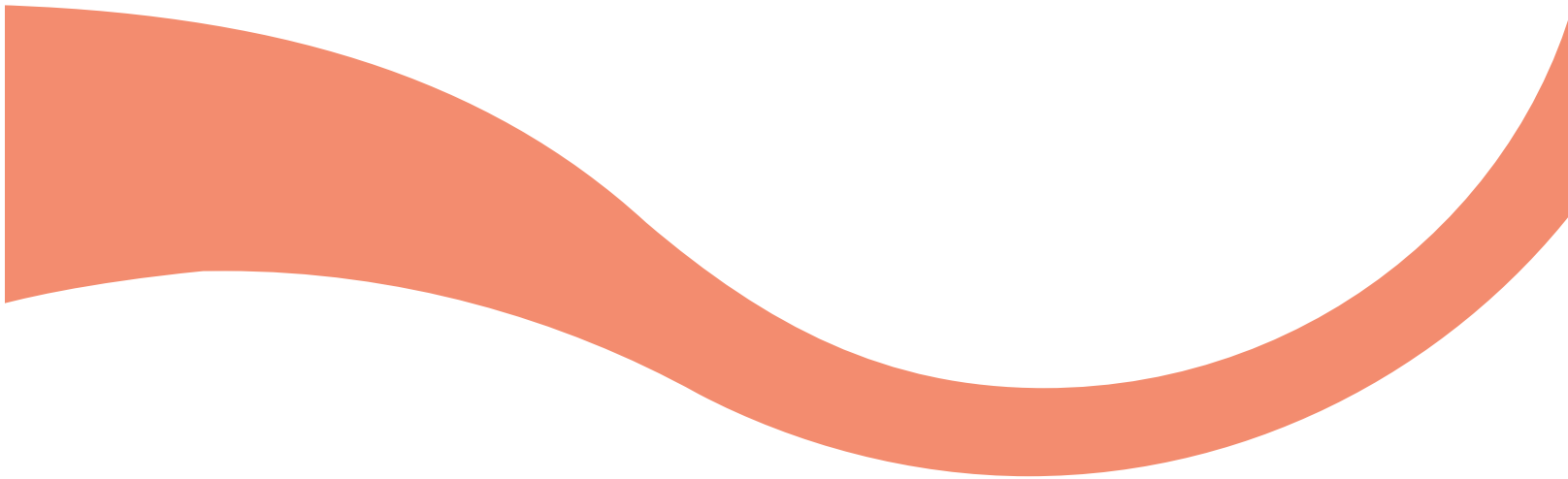
GLOBAL ENVIRONMENT OUTLOOK

GEO-6

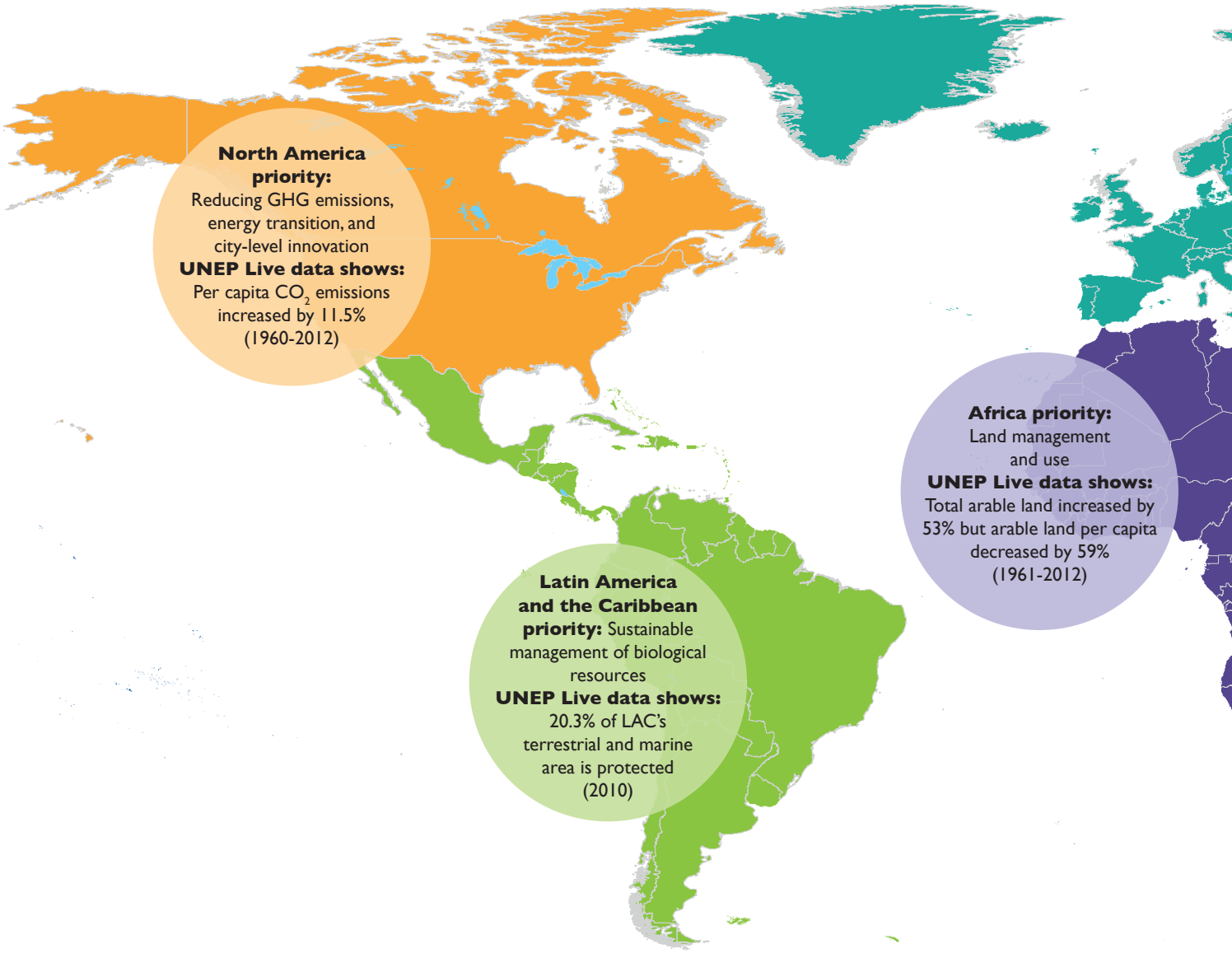
REGIONAL ASSESSMENT FOR

WEST ASIA





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:
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)

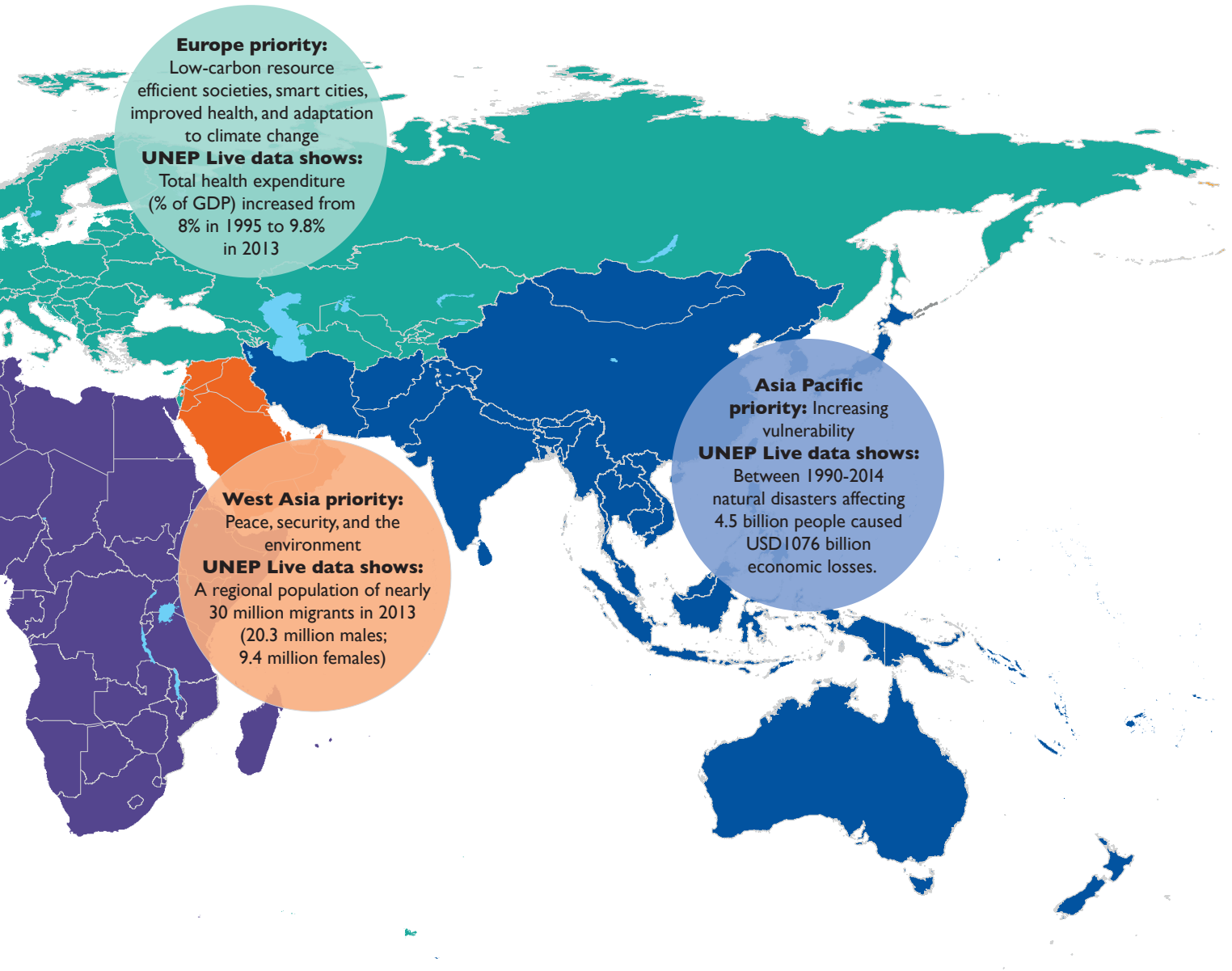

Europe priority:
Low-carbon resource efficient societies, smart cities, improved health, and adaptation to climate change
UNEP Live data shows:
Total health expenditure (% of GDP) increased from 8% in 1995 to 9.8% in 2013
West Asia priority:
Peace, security, and the environment
UNEP Live data shows:
A regional population of nearly 30 million migrants in 2013 (20.3 million males; 9.4 million females)
Asia Pacific priority: Increasing vulnerability
UNEP Live data shows:
Between 1990-2014 natural disasters affecting 4.5 billion people caused USD1076 billion economic losses.

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Foreword

The sixth *Global Environment Outlook (GEO-6) Regional Assessment for West Asia* 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 highlights the complexity of the interlinked environmental, social and economic challenges now confronting decision makers.

The launch of the GEO-6 Regional Assessment for West Asia 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.

Environmental governance is the mechanism through which peace and resilience can be realized in West Asia. Good governance implies that issues such as conflict resolution, food, water and energy are examined in a holistic framework. Economic, social and environmental spheres must be integrated into a multi-sectoral policy design within the goals of sustainable development.

Sustainable growth in the economies of West Asia will enable progress on food security, sustainable water sources, reduced vulnerability to natural and man-made disasters, reduced risks of climate change, permanent energy solutions and conservation of natural resources. The outlook calls for concerted efforts by governments, civil society and the private sector in West Asia to address environmental challenges in the region.

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 in West Asia.



Achim Steiner

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

Key Findings and Policy Messages

The GEO-6 Regional Assessment[1] for West Asia[2] is guided by seven regional priorities: water, land, marine resources, biodiversity, air, climate change and waste management. These were identified by member States and stakeholders at the Regional Environmental Information Network (REIN) Conference held in Amman, 10-14 May 2015. Along with the identified regional priorities, 2 themes governed the West Asia assessment report; Peace, Security and Environment, along with the water, energy and food nexus. This document provides a summary of key findings and policy messages.

State and Trends of the West Asia Environment: Following trends highlighted in previous editions of the GEO report series, the current analysis of drivers, pressures, state, impact and responses of the West Asia environment, shows that a holistic and integrated approach is needed to identify challenges related to the environment and address the two themes. Several regional environmental challenges that are continuing include:

- Despite some efforts on integrated water resource management and the short lived solutions applied for managing increasing water demand, there is deteriorating water quality, in addition to persistent overexploitation of groundwater resources;
- Shared water resources continue to be a source of major regional concern due to lack of regional cooperation;
- Unsustainable consumption patterns threaten water, energy and food security;
- Biodiversity loss, desertification and ecosystem degradation are ongoing challenges;
- Air pollution continues to greatly impact human health and the environment;
- Waste management continues to be addressed through ad-hoc initiatives without an integrated waste management outlook;
- Energy efficiency and energy mix continue to be a priority; and
- The environment continues to be threatened by and a cause for lack of peace and security and increasing levels of conflicts.

The assessment report offers a visionary outlook scenario over the next 25 years, 10 years after achieving the Sustainable Development Goals. Adopting this positive vision, several outcomes can be achieved including: healthy people, clean water and good hygiene, green energy, responsible consumption and production, climate change impacts addressed, protected marine life and conserved land resources, regional cooperation ensuring peace, justice and security for all.

Policy options are needed to achieve the above scenario related to good governance, regional cooperation, data availability and sharing, capacity development and transitioning to an inclusive green economy.

Good governance assuming multi-level and pluralistic mechanisms in key areas including: transboundary cooperation, increased public participation in decision-making, cooperative financing, streamlining of data sharing and use as well as capitalising on partnerships with the private sector and civil society. Future efforts should focus on overcoming fragmentation and adoption of an integrated approach to Sustainable development. Full participation of all countries in Multilateral Environmental Agreements (MEAs) would require the implementation of commitments; addressing gaps in coverage of environmental policies; greater integration related to environmental social and economic policies and Strategic Environmental Assessments (SEA) corresponding to the global Integrated Environmental Assessment (IEA) frameworks.

1 The GEO-6 West Asia Regional Assessment is one of a series of six UNEP regional assessments which will underpin the global GEO-6 assessment.

2 In the context of the present document the term "West Asia" applies to the GCCs and Mashriq regions and Yemen.

Data collection, processing and sharing at both regional and national levels to enable a needed infrastructure to measure progress. Research and development, coupled with science based decision making, to provide leverage for informed policies. The 2030 Agenda for Sustainable Development presents an opportunity of focused strategies for successful transition. Redefining the measures of progress to reflect ecosystem well-being is an important part of this. National Information Systems will further support assessment and evidence-based policy making.

Building **knowledge-based societies** at the national and regional levels that leverage the social capital and youth capacity, to develop the required capacity and provide new job opportunities in the context of inclusive green economy. Opportunities for economic diversification in West Asia using sustainable consumption and production, green and circular economy principals present sustainable pathways to sustainable human development. Some of these opportunities are:

- Scaling up successful regional water-energy-food initiatives that will ensure food waste reduction, sustainable agriculture and carbon neutral sectors.
- Mega-renewable energy projects and energy efficiency initiatives that are already being implemented in West Asia show promising results in terms of economic payoff and good environmental outcome.
- Sustainable transportation and building sectors provide additional economic diversification opportunities, environmental and health benefits.

Addressing interconnected **vulnerabilities** in effective sustainable socio-economic and environmental policies will reduce the impact of climate change and natural hazards including drought, dust storms and flash floods, and maintain good environmental health.

Institutionalizing these types of policies and regulatory frameworks can be captured in ripple effects across different sectors and lead to greater well-being of society in West Asia.



Introduction

Welcome to the GEO-6 Regional Assesment for West Asia. This assessment provides an evaluation and analysis of regional issues designed to support environmental decision making. Existing knowledge has been assesed to provide scientifically credible answers to policy-relevant questions, including:

- What is happening to the West Asia environment and why?
- What are the consequences for the environment and the human population of West Asia?
- What is being done and how effective is it?
- What are the prospects for the environment?
- What actions could be taken to achieve a more sustainable future?

The decision to undertake regional assessments was taken at the Global Intergovernmental and Multi-stakeholder Consultation in Berlin, October 21-23, 2014. Participants at the consultation suggested that the sixth edition of the Global Environment Outlook (GEO-6) assessment should build on regional assessments which would be conducted in a similar fashion to the global GEO process (UNEP/IGMS.2 Rev.2).

Member States attending the first United Nations Environment Assembly (UNEA-1) in Nairobi, June 2014, 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"

In addition, Member States also requested (UNEP/EA.1/10):

"the Executive Director to consult with all United Nations Environment Programme regions regarding their priorities to be taken up in the global assessment"

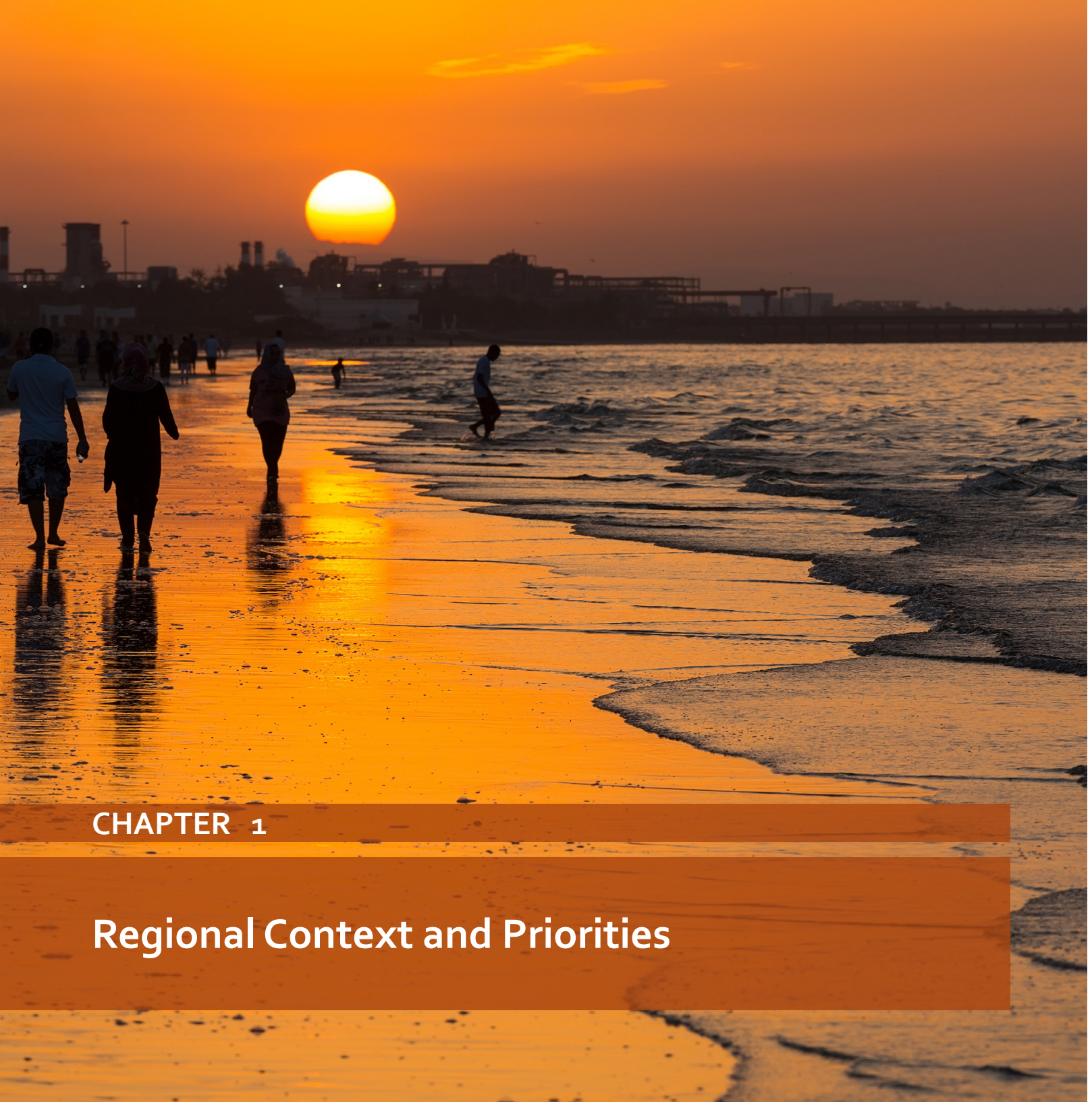
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Following this request, regional priorities for water, land, marine resources, biodiversity, air, climate change and waste management were established through the Regional Environmental Information Network (REIN) conference for the West Asia region (May 10-14 2015, Amman, Jordan) and used to guide the analysis in this assessment.

The assessment is structured in three main sections:

- **Chapter 1** reviews the context and regional priorities established at the REIN conference and explains why each priority is of importance to the region. It considers peace, security and the environment together with the nexus elements for security (water, energy and food) in order to bridge regional priorities and establish common goals.
- **Chapter 2** establishes the state of the environment in the region following seven key themes (water resources, land resources, coastal and marine resources, biodiversity, air, climate change, waste management). It provides an overview of regional priorities, analyses the key trends for each environmental issue, followed by possible policy-relevant options. Some of these options require increases in efficiency; others require departures from business-as-usual scenarios.
- **Chapter 3** reviews the main trends that will affect the region's environment in the future and analyses the actions needed to achieve a more sustainable future. It presents possible environmental outlooks for West Asia together with projected emerging environmental issues. The section also considers the role of teleconnections between West Asia and other regions, making the world smaller with respect to the environment. The Chapter presents a scenario (the Oryx scenario) with a vision of environmental and social sustainability and the tenets of sustainable environmental outlooks.

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.



CHAPTER 1

Regional Context and Priorities

The West Asia region can be classified as two distinct sub-regions according to water availability, population growth and economic activity: the Mashriq: Iraq, Jordan, Lebanon, the Occupied Palestinian Territories (OPT), Syria; and Yemen and the Gulf Cooperation Council (GCC) countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates (UAE). The two sub-regions have different levels of naturally endowed resources, socio-economic institutions, diverse legal and political frameworks, variable embedded technology, and different labour force compositions with varied levels of know-how and educational systems. Both sub-regions have high dependencies on imports, low productivity, and system inefficiencies. They share high vulnerability to external natural and human-induced stresses such as the variability of rainfall, population growth (**Figure 1.1.1**), pollution levels, and inefficient water and waste management practices (UNESCWA 2006).

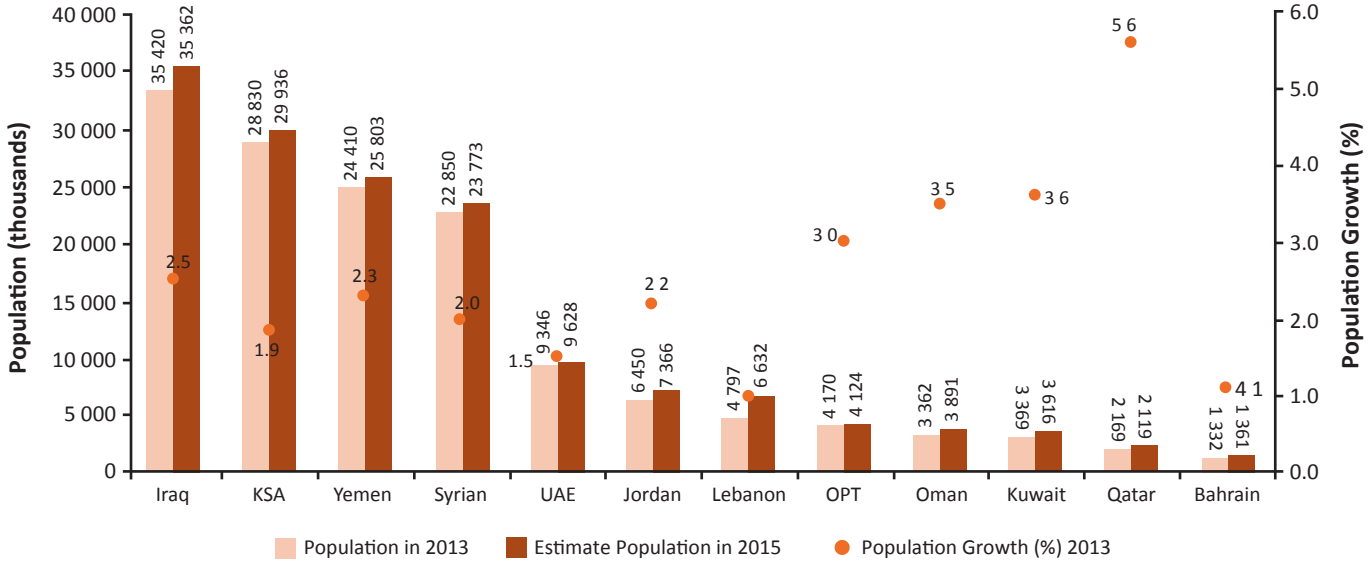
West Asia has a significant geopolitical location as it is the link between three continents: Asia, Europe and Africa; there are large differences in economic performance as measured by gross domestic product (GDP) (**Figure 1.1.2**).

West Asia also has one of the world's largest oil and natural gas reserves. Saudi Arabia, Iraq, Kuwait, UAE, and Qatar are among the major oil producing countries, and oil is the major driver of global economic growth, with high GDP per person (**Figure 1.1.3**).

West Asia's geopolitical location, coupled with its endowment of oil resources and other factors, has made the region the scene of armed conflicts and rivalries that have swept the region and had serious impacts on the population and the environment, including oil pollution.

However, the demand for these strategic commodities has seen setbacks, such as those in the mid-1980s and recently

Figure 1.1.1: West Asia, population growth and growth rates by country, 2013



Source: World Bank 2015

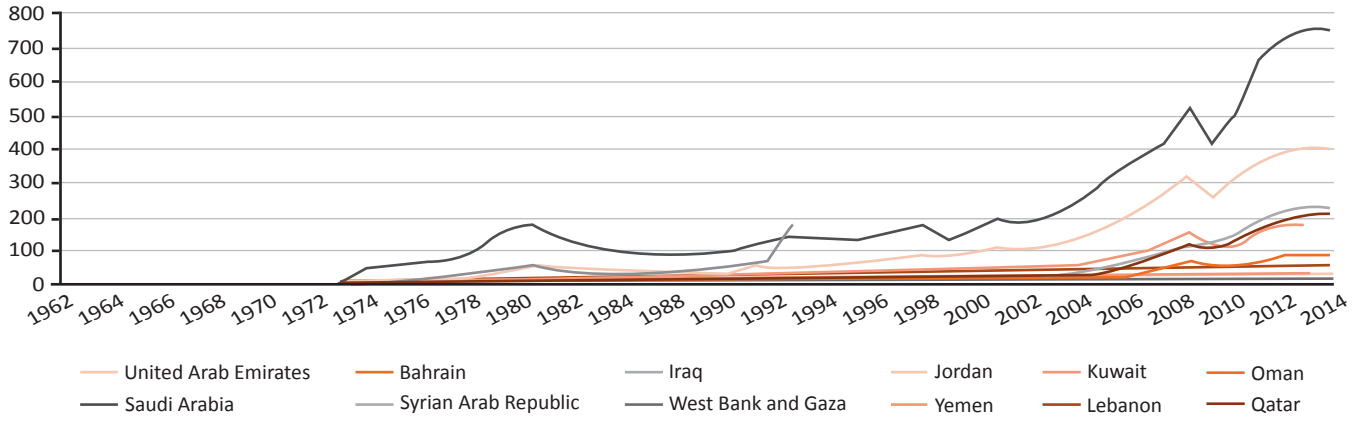
◄ Credit: Shutterstock/ Ivan Pavlov

in 2015. The GCC countries are pushing for economic diversification, self-sufficiency, and innovative approaches to address many national scarcities, including of food and water. The effects of these external shocks have not yet levelled out and it will be some time before their full effects are realised. The decrease in oil prices have had a direct impact on the GCC sub-region and would have the same ripple effects in the Mashriq sub-region. The aftermath of these effects in the Mashriq sub-region can be seen in aid reduction and budget deficits which implied a call for lifting subsidies on basic necessities and for increased efficiencies across sectors. Furthermore, recent internal dynamic changes in West Asia are surfacing and manifesting themselves in the form of conflict. While the root causes are hard to pinpoint, economic disparities, systematic inefficiency and corruption, coupled with short-lived solutions, are currently the main focus of discussion.

In addition, the OPT have long suffered from a lack of infrastructure, social deprivation, economic alienation and a lack of sovereignty. All are causes of conflict and unrest in the region. Given the current international attention is being paid to a foe that is causing the displacement of millions of people with a catastrophic human toll, financial resources have been diverted away from earlier regional priorities and are being channelled to lessen the suffering of refugees and combatting near-term threats.

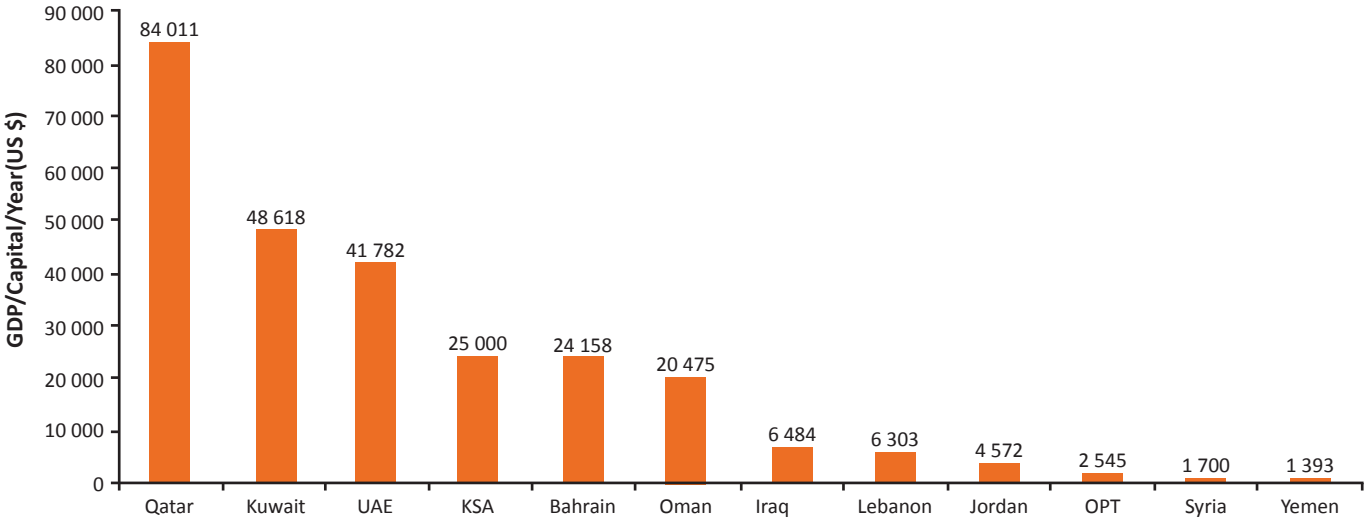
The West Asia region is currently at a crossroads with a variety of potential outcomes; leaders are aware of internal and external risks that may have lasting consequences. Answers may lie in satisfying basic human needs, from food and water security to reliable energy sources. More vision is required to make the link between sufficiency and security, to achieve the desired social and economic development goals while preserving the environment.

Figure 1.1.2: West Asia, gross domestic product, by country, current USD Billion 1961-2014



Source: World Bank 2015

Figure 1.1.3: West Asia, gross domestic product per person, per year, USD, 2015



Source: World Bank 2015

1.1 Regional priorities

The inaugural meeting of the West Asia (WA) Regional Environmental Information Network (REIN) conference was held on 10-14 May 2015 in Amman, hosted by UNEP. The 53 participants included representatives of governments (Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, the Occupied Palestinian Territories (OPT), Saudi Arabia and UAE); regional partners, including the Arab Center for the Studies of Arid Zones and Dry Lands Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), the Arab Forum for Environment and Development (AFED), the Abu Dhabi Global Environmental Data Initiative (AGEDI), the Center for Environment and Development for the Arab Region and Europe (CEDARE), the International Union for the Conservation of Nature (IUCN), the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA), and the Regional Organization for the Protection of the Marine Environment (ROPME), the World Health Organization (WHO), the United Nations Development Programme (UNDP), UNEP; and GEO experts.

Key outcomes

- The WA REIN Plenary discussed and reaffirmed the mandate and guidance given by the High Level Intergovernmental and Stakeholder Advisory Panel for GEO 6 (UNEP/GEO-6/HLG/1.4) regarding the generic structure and timing of the GEO-6 Regional Assessment.
- The Plenary elected two Co-Chairs for the duration of the first cycle of the REIN regular assessment process: Mr Fahad Hareb (UAE) and Eng. Samir Al-Kilani (Jordan).
- The Plenary recognized High Level Group members Mr Nasser Al-Amri and Mr Najib Saab, and Mrs Suzan Mohammed AlAjjawi, the WA Assessment Communities of Practice (CoP) Moderator.
- The Plenary confirmed that the GEO-6 WA regional assessment was to be submitted to United Nations Environment Assembly (UNEA-2) and its regional preparatory meetings as appropriate, in 2016.
- The Plenary acknowledged that this inaugural WA REIN meeting was being organized as the start of a regular GEO regional and global assessment and the 2030 Agenda on

Sustainable Development and Sustainable Development Goals (SDGs) reporting process, underpinned by UNEP Live and the national toolkit, knows as the Indicator and Reporting Information System (IRIS).

- The Plenary reaffirmed the importance of building on existing assessments and processes, as well as using official national, sub-regional and regional data, statistics, indicators and information as major inputs to the GEO-6 West Asia regional assessment.
- The Plenary discussed, elaborated and agreed on the following narrative for the GEO-6 West Asia regional assessment:

Peace and improved environmental governance are key factors in achieving prosperity and resilience in the West Asia region. Sustainable mechanisms need to be developed to create job opportunities, improve public participation and public health, and to enhance competitiveness and innovation. These need to be supported by strengthening the capacity of, and cooperation among, public institutions and civil society to better manage natural resources.

The Plenary agreed on the following 12 regional priorities for the GEO-6 West Asia regional assessment report:

- Peace, security, and the environment;
- Fresh water resources;
- Sustainable use of natural resources for human well-being and resource efficiency;
- Urbanization, land-use planning and their effects on ecosystems;
- Integrated waste management;
- Environment and its impact on public health and Disaster Risk Reduction (DRR);
- Biodiversity resources, conservation and management – terrestrial, coastal and marine life;
- Marine and Integrated Coastal Zone Management (ICZM);
- Improving environmental governance and regional, international cooperation;
- Energy mix and diversification and access;
- Climate change adaptation and mitigation;
- Desertification.

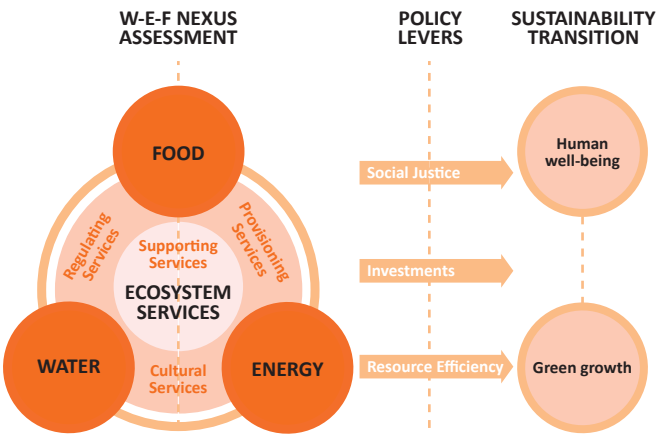
Given the overlap of regional priorities identified at the Amman Meeting (REIN May 10-14, 2015), a grouping of these priorities was called for by the co-chairs and the Scientific Advisory Panel (SAP) in order to strengthen regional priority discussions. After many rounds of discussions during the Feb 24-25, 2016 meeting held in Manama, the co-chairs along with SAP committee members and Special Lead Editors, agreed to group the regional priorities into seven priorities that relate to West Asia. The seven regional priorities are: water resources, land resources, coastal and marine resources, biodiversity, air, climate change and and integrated waste management along with two governing themes, namely the water-energy-food nexus, and peace, security and environment. The themes present an overall umbrella of discussion in the security of the identified regional priorities. Regional priorities depend on each other and achieving the targets and goals of one priority should not compromise the integrity of targets and goals in other priorities. The holistic approach of addressing WA regional priorities, provides a platform of interaction and synergies that can be captured in terms of coordinated efforts and mutually non-exclusive outcomes. Moreover, the holistic examination of priorities provides the first steps to an integrated resource management approach which West Asia countries aspire to achieve.

This section therefore demonstrates the direct links to water, energy and food using the nexus framework, together with peace, security and the environment. This is followed by discussions on environmental governance and sustainability, environmental health, and public health and the environment.

1.2 The links between regional priorities

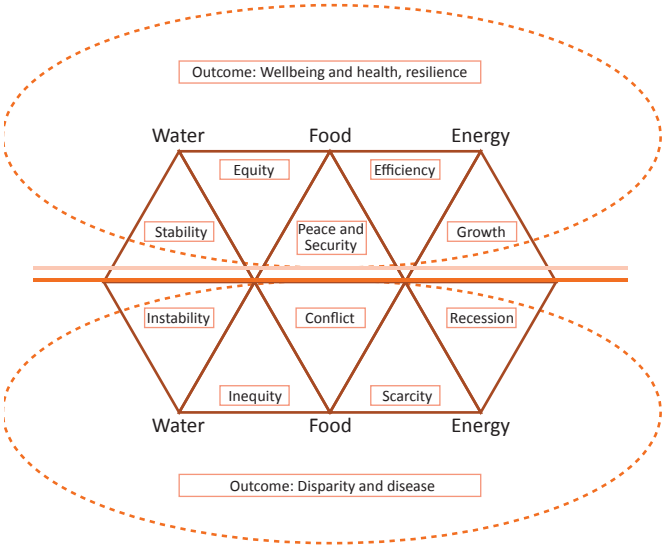
The essence of advocating for one priority over another is based on the presumption that one priority needs to be compromised for the benefit of another. This need not be the case. A closer examination of the interconnecting aspects of regional priorities, shows that the region may not be able to achieve sustainability in terms of peace, security and the environment without achieving sustainability in the water, energy and food nexus (Khagram *et al.* 2013) (**Figure 1.2.1**) (**More...1**).

Figure 1.2.1: The water, energy and food nexus



Source: Food and Agriculture Organization of the United Nations (FAO), 2014.

Figure 1.2.2: Possible nexus outcomes



Moreover, countries achieving sustainability in water, energy and food might lead indirectly to sustainability in terms of peace, security and the environment (Waslekar and Futehally 2009). This is possibly a weak assumption, but it gives more common ground to launch a discussion on regional priorities (Black *et al.* 2011). Therefore, based on this assumption, a prerequisite to achieving sustainable peace, security and the environment is to start a dialogue on sustainable access to water, energy and food, and ask if the nexus components complement one another or compromise and suppress targets for other elements in the nexus.

Typically if environmental priorities are addressed in isolation, and resources are funnelled in an uncoordinated fashion towards one element of the nexus, rather than another, security and sustainability inevitability cannot be achieved. **Figure 1.2.2** presents two extreme cases; in one, it is related to a possible utopia of peace and security, economic growth and progress. In the other, mismanagement of resources may have inefficient outcomes and regional consequences, as the problems of one country migrate to another. If elements of the nexus are viewed with equal weights this implies one element of the nexus is as vital to the economy, livelihood and sustainability as the next one. This means changing the discussion to the "outcomes" of sustainability in the nexus elements. This may also lead to the discussion on the probable sustainable outcomes of, say, two elements of the nexus; outcome of having sustainable "energy and water supplies" implies "efficiency outcome", and achieving sustainability in "energy and food supplies" implies "security outcome", and, achieving sustainability of "food and water supplies" implies "equity outcome".

When efficiency in production of water and energy is achieved, equitable distribution of water and food is achieved, and the region has secure energy and food supplies then inevitably, security and peace are realized. Lining up water, energy and food on an equal footing in terms of regional priorities, and working on the regional policies that support an holistic approach to address regional challenges may present West Asia with a roadmap to economic and social sustainably with an outcome of regional well-being, health and resilience. West Asia region can navigate the challenge of this interdependency through calculated actions that

need to be smoothly synchronized across different sectors. The ease by which a transition takes place depends mostly on national commitment and the presence of a regulatory and policy framework coupled with financial instruments to give a stable institutional setup. If equal weight is attached to the elements of the nexus and mapping of the interdependencies to SDGs, the region will most probably experience favourable future outcomes.

Currently, strategic decisions in the region, and its commitment to substantial investment to enable sustainable water, energy and food supplies, have been driven by legitimate motives. Policies in these areas are a requirement to ensure the continued rapid growth of the region's economy and enhance its overall security, stability and economic prosperity. Also, it is essential to secure sustainable solutions for access to water, energy and food to achieve the SDGs. For example, SDG 6 focuses on the entire water cycle, including the management of water, wastewater and ecosystem resources. As water is fundamental element of sustainable development, SDG 6 has strong linkages to all of the other SDGs including SDG 1 (ending poverty), SDG 2 (ending hunger), SDG 3 (healthy lives), SDG 7 (sustainable energy), SDG 8 (sustainable economic growth), SDG 12 (sustainable consumption and production), SDG 15 (sustainable use of terrestrial ecosystems). Therefore, synchronized actions among different programs will ultimately meet mutual SDG targets.

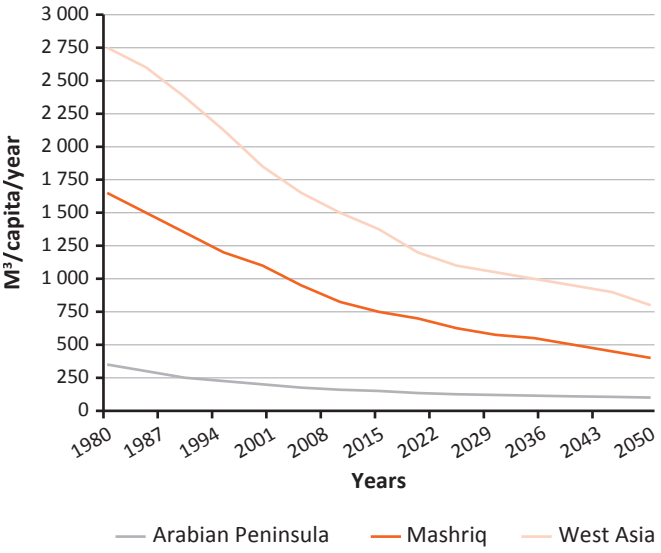
At present, sustainable development in the region is at stake, given current conflicts and economic marginalisation, reduced well-being, and increased stress on the environment and the economy in the absence of an holistic framework of environmental governance. When regional priorities are examined in isolation from social, economic and institutional priorities, the scope of the diagnoses and the impact of solutions will only be relevant in the short term, without lasting effects. Hence, achieving effective environmental governance requires an holistic examination of the nature of regional priorities, and their interdependencies, in order to propose solutions that are relevant, with more permanent outcomes that reflect the seriousness of the region's challenges.

West Asia is facing major challenges due to the scarcity of its renewable water resources, which affects the region's ability to produce enough food to meet the population's needs (**Figure 1.2.3**). The challenge is complicated by an increasing population growth rate (**Figure 1.2.4**), be it natural or otherwise, including urbanisation and industrial development needs.

The first point to note is the sustainable quantity of water (**Figure 1.2.5**), as this requires energy due to the region's reliance on traditional (and non-traditional) ways for water provision.

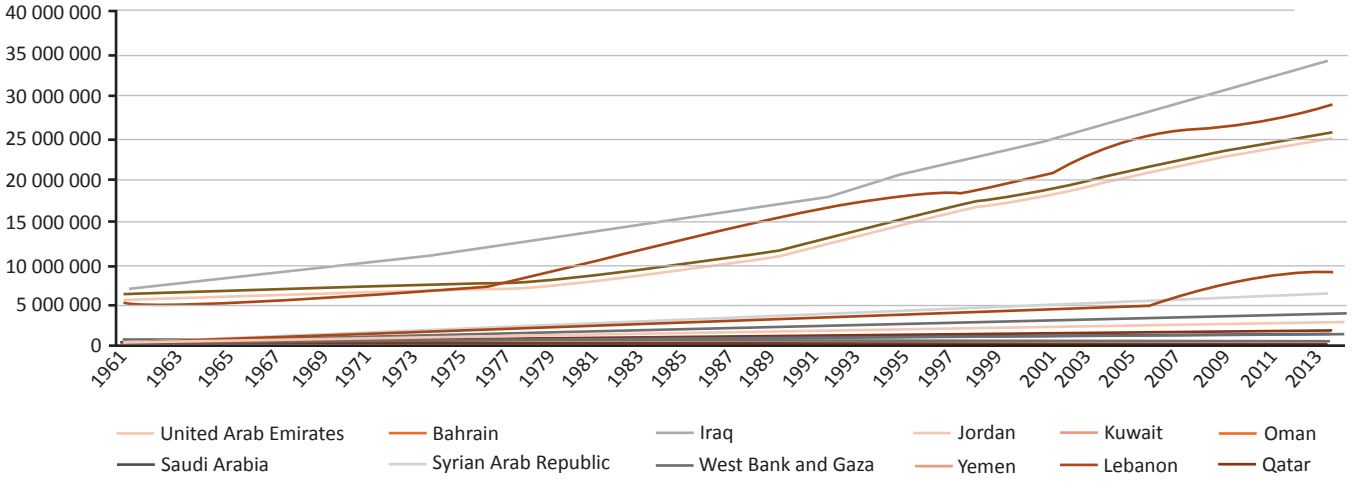
In addition, variability in water use requires different levels of treatment and energy. The sustainability of food supply requires integrated manufacturing in the food supply chain which also places demands on water and energy (**Figure 1.2.6**).

Figure 1.2.3: West Asia, per person share of renewable water resources, 1980–2050



Source: United Nation Environmental Programme (UNEP), 2007.

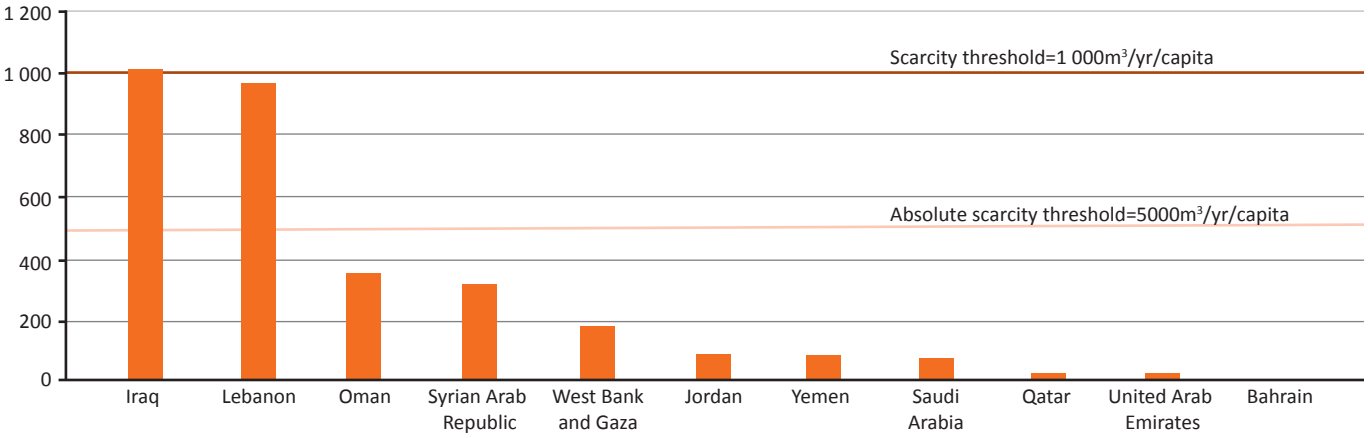
Figure 1.2.4: West Asia, population trends by country, 1961–2014



Source: World Bank 2015

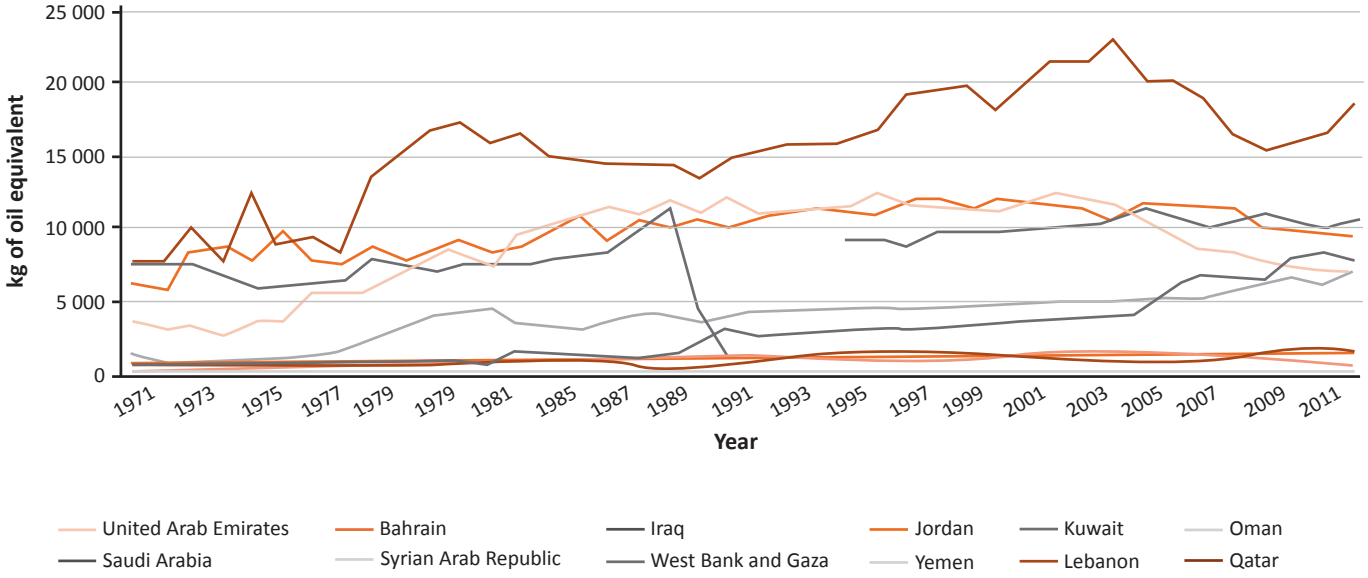
Furthermore, sustainable energy requires investment and the continuing use of current energy sources to achieve sustainable energy supply. Given the interdependency of these factors, it is critical to address priorities together in order to increase the region's social and political security and stability (Khagram *et al.* 2013).

Figure 1.2.5: West Asia, total internal annual renewable water resources per person (cubic meters), 2014.



Source: http://www.fao.org/nr/water/aquastat/data/query/results.html

Figure 1.2.6: West Asia, energy use per person by country, 1971–2011



Source: World Bank 2015

1.2.1 The impact of conflict on the environment and the nexus

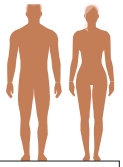
West Asia has witnessed many cycles of growth and recession, of progress and instability, and, more recently, of peace and conflict. Some cycles have had devastating impacts on the environment (**More...1**), affected social structure and health (**Figure 1.2.7**) (Hassouna and Sinclair 2012, Prüss-Ustün *et al.* 2016) (**More...2**).

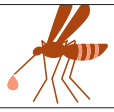
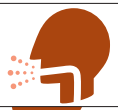
For example, due to the Palestinian-Israeli conflict, groundwater in both the West Bank and Gaza is being overexploited due to scarcity and is contaminated by unsafe wastewater disposal, resulting in poor water quality and numerous diseases in OPT (PWA 2012). Further, over-extraction of groundwater has led to seawater intrusion into as much as 74.2 per cent of Gaza's wells (Zeitoun 2008). Added to this is nitrate contamination from agriculture, leaving only 6.5 per cent of water safe for drinking (UNCTAD 2015). Together with physical water scarcity (**Figure 1.2.8**), reduced access to land can severely reduce the potential for sustainable agriculture (UNCTAD 2015) (**More...3**).

Marine life has also suffered from the conflict, as untreated sewage and other forms of pollution affect the sea, and limitations to fishing have lead to overfishing in constricted areas (Dixon and Fitz-Gibbon 2003, Poonian 2003, UNEP 2005, AFED 2008).

In Syria, due to the ongoing conflict, governmental institutions have been overwhelmed in regions where displaced people have been relocated (UNDP/UNWRA 2013; UNHCR 2015). Owing to these failures, much irrigated agricultural land has been abandoned, mainly due to salinization and destruction of irrigation systems, especially in the Euphrates basin (Hassan and Krepl 2014). Today, overgrazing has caused various fields of once rain-fed agriculture and rangelands to become prone to wind erosion. The war's toxic footprint

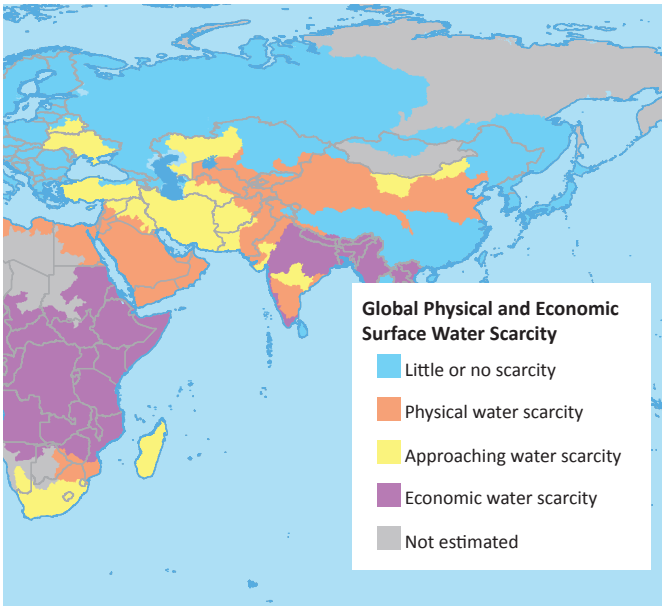
Figure 1.2.7: Healthy environment, healthy people



Disease/Injury		DALYs per year due to unhealthy environmental conditions	Ratio of disease burden linked to environmental factors	Main environment risk factor
Diarrhoea		56 million	 58%	Inadequate water, sanitation, hygiene
Lower respiratory infections		29 million	 20%	Household and outdoor air pollution
Cardiovascular diseases		23 million	 14%	Chemical, air pollution and environmental tobacco smoke exposure
Malaria		19 million	 42%	Poor water resource, housing and land use management which fails to curb vector populations effectively.
Other unintentional injuries		21 million	 44%	A wide range of home, community and industrial and workplace accidents
Road traffic injuries		15 million	 40%	Poor urban design or poor environmental design of transport systems
Cancer		14 million	 19%	Exposure to air pollution, pesticides, consumer products, radiation, biological agents, industrial chemicals etc. occurring in the home, the community or in the workplace, as well as environmentswhich are not conducive to physical activity
Chronic obstructive pulmonary disease		12 million	 38%	Use of polluting fuels for cooking, outdoor air pollution and exposures to workplace dusts and fumes
Perinatal conditions		11 million	 11%	Exposure of mothers to air pollution, tobacco smoke, pesticides and other chemicals; unsafe water and inadequate sanitation.

Source: UNEP 2016

Figure 1.2.8: Physical and economic water scarcity, 2012



Source: WWAP 2012

is also severe, contaminating the natural environment and affecting human health through the release of heavy metals from munitions and the destruction of infrastructure, including hospitals, schools and community centres (SCPR/ UNRWA/UNDP 2014; UNHCR 2015) (**More...4**).

In Lebanon, in the last few years, stresses on natural resources have been intensified by the Syrian crisis and the resulting influx of refugees (El-Zein *et al.* 2012; UNHCR 2015). Lebanon hosts the highest per person concentration of refugees (**Figure 1.2.9**) in the world, mainly affecting communities which already suffer from marginalisation and neglect, in regions with poor access to resources and health services. The environmental impact of the influx of refugees is greatly intensified by the refusal of governments to acknowledge informal settlements and, subsequently, to provide adequate stabilization solutions (OCHA 2014; UNHCR 2014) (**More...5**).

In Yemen, environmental degradation resulting from armed conflict has already affected millions of people, and violence across the country persists. The situation is made worse by refugees from other countries, who combined with internally displaced inhabitants amount to 658 000 people. This pressure on the population is aggravated by a lack of proper access to health care, mostly due to inadequate stocking facilities and resources (FCNL 2014) (**More...6**).

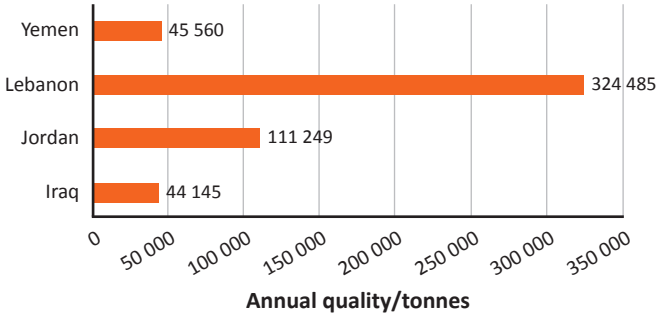
In general, indirect impacts often create a chain of effects which continue long after the end of a conflict. For instance, the region has witnessed considerable displacement of people, leading to numerous environmental stresses to which refugees themselves are the most vulnerable. Furthermore, the forms of governments and types of policies

Destroyed residential area in the city of Homs Syria, September 2013



Source: Shutterstock/ ART production

Figure 1.2.9: West Asia, refugee waste generation, 2015



Source: Compiled by the author based on data from different sources such as UNHCR, SWEEP-NET

established during and post-conflict, as well as unsustainable and inefficient coping strategies, have been shown to aggravate the consequences of conflict (UNESCWA 2002). Another indirect impact hindering both economic and social development is the tendency of conflicts to reverse the recovery process achieved during times of relative peace and security, further reinforcing the negetive trend (AFED 2008; UNESCWA 2015a) (**More...7**).

1.2.2 Scarcity of resources as a driver of conflict

Just as conflict results in environmental degradation, the environment has been the source of conflicts in the quest for security through access to natural resources (Spring 2001). Moreover, efforts to secure energy sources have led to significant environmental damage. In Iraq, the military conflict, spanning three decades of continuous wars, has led to the greatest level of environmental degradation in the region (Waslekar and Futehally 2009). Of particular significance was the burning of 15 million barrels of oil and 1.5 million cubic meters of petroleum products. Recent droughts have also aggravated the water crisis; the amount of water available per person anually in Iraq fell from 5 090 cubic meters in 1997 to 2 400 in 2009. Several studies warn that the Tigris and Euphrates might dry up by 2040 (Rowling 2014). Coupled with poor water quality, these stresses have displaced people, mainly farming communities, who seek access to better drinking water and livelihoods (Heinrich Böll Foundation 2006; UNEP 2007; Rowling 2014). In Lebanon, failures in resolution and management of these environmental challenges culminated in a recent garbage crisis that stirred social unrest and increased attention to several issues of corruption, leading to political unrest (Kadi 2015). The current waste crisis (**Box 1.2.1**) in Lebanon is simply a manifestation of the breakdown of institutions that support and govern good civil life (Kadi 2015; Samaha 2015; Stel *et al.* 2015).

Box 1.2.1: Waste crisis in Lebanon

In mid-July 2015, a crippling garbage crisis swept over Beirut and the surrounding mountains as collections were stopped following the closure of the main Naameh landfill due to it being (over)full. Piles of garbage bags accumulated on roadsides while the government was unable to find an alternate solution. This waste crisis served to highlight existing concerns over waste management and environmental governance in Lebanon, as the Naameh landfill was opened as a short-term measure but could not be closed due to the inability of the government to agree on a more lasting solution.

Source: Samaha 2015; Stel *et al.* 2015

Before the war, Syria was affected by persistent drought, unsustainable agricultural policies and governance of natural resources, which intensified environmental degradation, (Aw-Hassan *et al.* 2014; De Châtel 2014). The catastrophic droughts and absence of food support in the Euphrates region, forced thousands of families and ranchers to abandon their villages. Three hundred thousand people moved to urban centres in 2009 across the country (Syrian Arab Republic, Ministry of Environmental Affairs 2009).

In Yemen, water scarcity led to power struggles for resource control, which combined with food insecurity, increased the number of internally displaced people, as well as refugees and migrants (Glass 2010; USAID 2014). In turn, poverty has reinforced overexploitation and environmental degradation. With ever-increasing social stratification, exacerbated by conflicts and tensions, a vicious cycle has been created leading the way towards climate-induced conflicts (Sipkin 2012). Building further momentum are other numerous environmental concerns, including pollution, degradation of soil, coastal erosion, destruction of key habitats and loss of species, desertification and the lack of waste management (EEAS 2013).

1.2.3 The nexus and economic development

The natural resource systems of water, energy and food are complex and inextricably linked, so that any decision about one issue can have significant ripple-down effects for others, not only in the environment, but also for social and economic stability. Rather than view these interactions as a hindrance, their relationships should be seen as an opportunity to tackle development issues through a multi-sectoral approach. The nexus approach aims to understand how the water, energy and food (agriculture) sectors relate to each other and how this understanding can be used to make policy decisions that promote sustainable development (Bizikova *et al.* 2013). In practice, the nexus presents a conceptual approach to better understand, manage and systematically analyse the interactions (and dependencies) of the natural environment with human activities, and to investigate ways to coordinate management of water, energy and the demand for food, given the availabilities of these natural resources across sectors and scales.

Table 1.2.1: West Asia, water stress, 1995–2010

Country	Water Resources Stress Index			
	1995	2000	2005	2010
Bahrain	0.56	0.65	0.67	0.81
Kuwait	0.77	0.78	0.84	0.87
Oman	0.0	0.31	0.35	0.37
Qatar	0.53	0.54	0.68	0.71
Saudi Arabia	0.31	0.52	0.59	0.61
UAE	0.55	0.58	0.63	0.65
Yemen	0.79	0.82	0.94	0.97
Jordan	0.67	0.88	0.90	0.94
Lebanon	0.0	0.27	0.35	0.41
OPT	0.88	0.93	0.95	0.98
Syria	0.15	0.36	0.49	0.51

Note: Values of 1 indicate high stress and 0 indicate least stress
Source: UNEP 2012

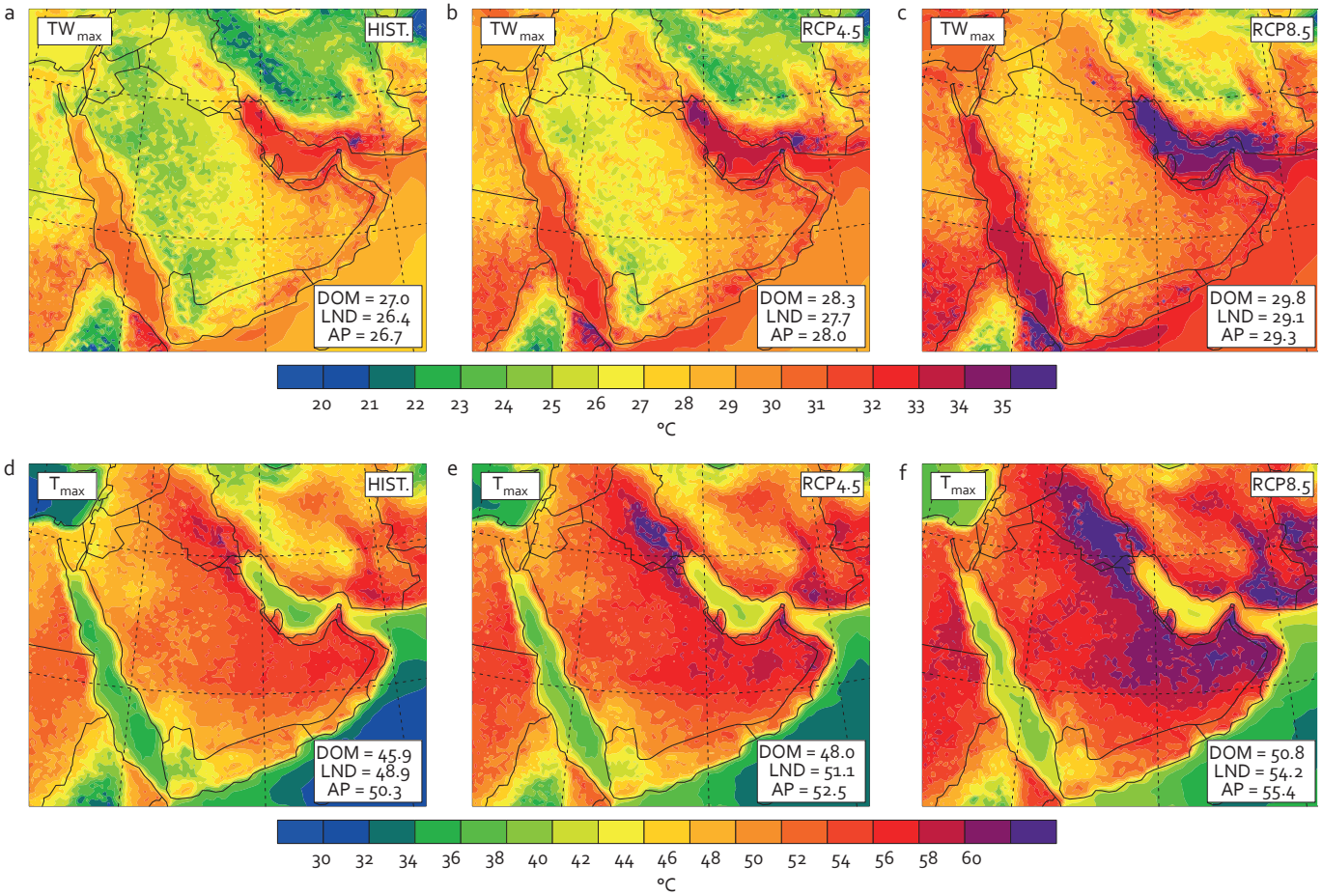
Water and economic development

West Asia has experienced different degrees of natural and anthropogenic water stress **(Table 1.2.1)** affecting the sustainability of scarce water resources and the preservation of ecosystem equilibrium.

The fragile and vulnerable arid environment and its low resilience in the face of external natural and anthropogenic activities, including the projected impacts of climate change (**Figure 1.2.10**), present a major challenge to decision makers who must achieve adequate, safe and dependable water and food supplies in the future to improve human well-being in their societies, and to meet the requirements of future generations (**More...8**).

Water scarcity and shortage are attributable to large temporal and spatial variations in most hydrological

Figure 1.2.10: West Asia, medium (centre) and high (right) climate change scenarios, showing spatial distribution of extreme temperatures towards the end of the 21st century compared to observed temperatures (left)



Source: Pal and Eltahir 2015

parameters, especially precipitation and evaporation rates. The most significant parameter causing environmental stress is the rainfall pattern, which influences the generation and dependability of available freshwater in terms of volume, frequency and distribution. Recent studies indicate that climate change will exacerbate existing water stress in the region by affecting precipitation, temperature, evaporation and relative humidity, all of which influence water availability and demand (Sipkin 2012). These impacts will lead to a reduction in the quality and quantity of water resources and increase the variability and frequency of extreme events (Ministry of Environmental Affairs 2009, Glass 2010, Aw-Hassan *et al.* 2014, USAID 2014; De Châtel 2014) (**More...9**).

Food and economic development

Climate change will also threaten water and food security in the region due to the projected decrease in available freshwater resources for agricultural and food production (Almazroui 2012; UNESCWA 2015b). Moreover, under these unfavourable and uncertain conditions, it is expected that food self-sufficiency **(Table 1.2.2)** will decrease with time, resulting in a failure to implement adopted agricultural policies.

It is therefore necessary to prepare for and respond appropriately to the potential negative impacts of climate change in West Asia. The ability of urban and rural areas in these countries to grow, attract the necessary investment, meet the fundamental needs of their populations, and ensure environmental protection will be increasingly threatened if scarce freshwater resources are not wisely and sustainably managed. Freshwater scarcity means greater risks for a community's long-term viability and has a negative impact on economic competitiveness. It also means that a community's ability to grow and create jobs will continue to be vulnerable (ACSAD 2009, UNEP, LAS and CEDARE 2010, AFED 2014).

Energy and economic development

Access to energy and use (**Figures 1.2.6 and 1.2.11**) vary significantly across the region. The GCC countries produce, use and export large quantities of oil and gas while the Mashraq countries have few endogenous fossil fuel energy resources. Countries in conflict or affected by sudden large influxes of displaced people face challenges to satisfy energy needs. Lack of access to energy hinders economic development and creates pressures on the environment and public health.

An example of this is the increase in deforestation in the region and the high exposure to air pollutants due to burning of materials such as plastic, tyres and other waste in uncontrolled conditions for heating purposes. Competing demands and international interest in energy resources have also played a role in the political, social and environmental stability of the region (AFED 2014). An emerging issue is the competing interest for access to and development of natural gas resources in the Mediterranean Sea. The region's high reliance on fossil fuels is leading to detrimental impacts on the economy and the ecosystem, the environment and public health (ACSAD 2009).

Table 1.2.2: Selected West Asian countries, food self-sufficiency ratio, 2005 and 2011

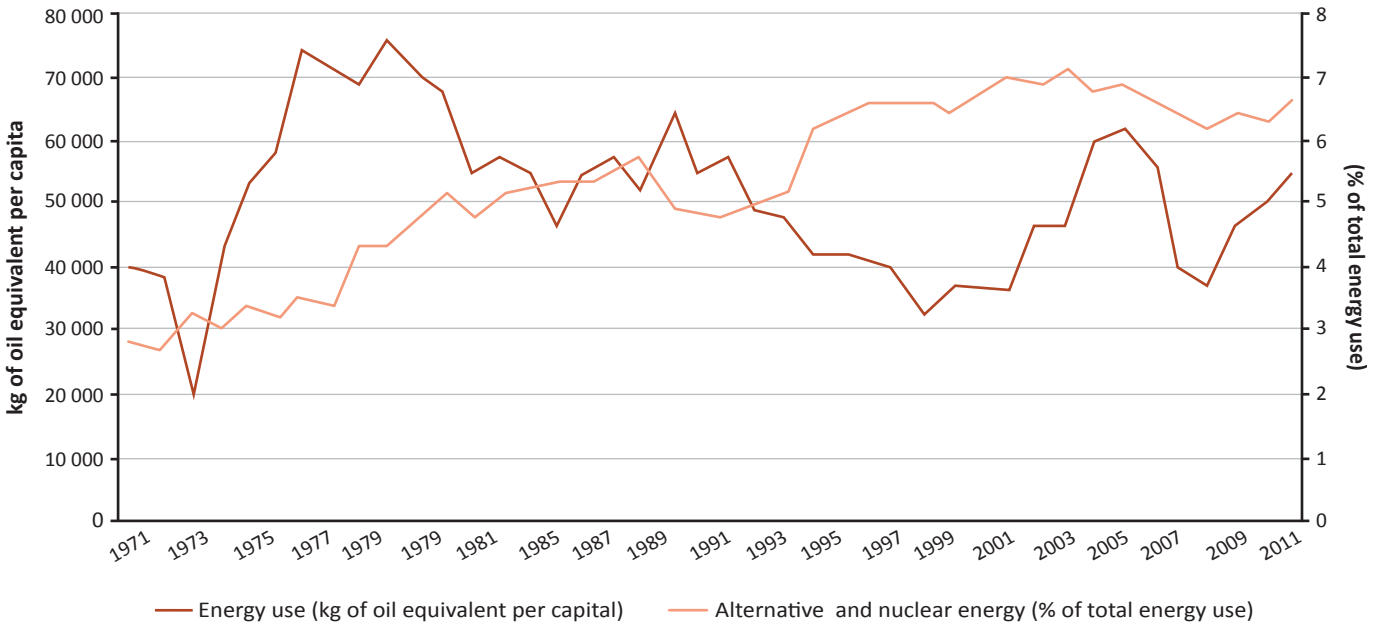
Country	2005 (%)	2011 (%)
Bahrain	12.96	12.81
Iraq	75.34	82.84
Jordan	56.26	53.09
Kuwait	28.38	21.68
Lebanon	73.23	61.03
Oman	45.21	34.52
OPT	81.55	72.26
Qatar	12.18	9.90
Saudi Arabia	44.52	34.49
Syria	85.23	80.62
UAE	21.10	18.60
Yemen	51.53	31.45
West Asia	**48.96**	**42.77**

Source: Compiled by the authors based on data in AOAD, 2007 and 2012

1.2.4 For further consideration

The complexity and interaction of the three elements of the nexus cannot be looked at in isolation from one another, for a given socio-economic setting. Most importantly, the interaction needs to be addressed from the wider context of transformational processes, or drivers of change, that need to be taken into account for economies to grow and develop.

Figure 1.2.11: West Asia, energy use per person, 1971–2011



Source: World Bank 2015

Water and food

One of the most important tools for integrated and sustainable management of water resources is demand-side management. There are a number of ways in which demand-side management can be implemented, mainly: technology enabled water management, policy and legal frameworks to enable demand management and, using economic incentive mechanisms in water demand management coupled with public awareness campaigns and the involvement of businesses and community.

Technology enabled water management can be done in many ways such as improving farm water management; this could have the greatest impact on irrigation water use and reuse. New innovative technologies could also help to improve the efficiency of water use and increase the productivity of both water and food sectors (Al Zubari 1997). Many technologies are available such as precision irrigation, trickle and sprinkler systems, laser levelling and hydroponic agriculture. All could contribute to substantial improvements in water application and distribution efficiency in the agricultural sector. Potential marginal water resources include brackish groundwater and agricultural drainage water.

Economic incentives can be introduced through differential pricing and quotas for water usage, with careful consideration of the competing demands on the water sector (i.e. from domestic, industrial and agricultural sources). How the demand for water is managed among the named sectors depends on states' current planning options and future strategic directions. As food security is a national priority in West Asia, decision makers face trade-offs in how to manage current domestic and industrial needs at the same

time as satisfying the prerequisites for current and future food security within a viable agriculture sector. Involving communities and individual members of the public in adopting new water strategies could also increase acceptance of new water systems. Stakeholder participation is an important element in ensuring the success of water-saving strategies at the community level as well as encouraging the establishment of water-user associations. Such changes may involve legal and institutional reform, reorganising the public and private sectors, and the participation of non-governmental organizations (AFED, 2014).

Brackish groundwater can also be used directly for irrigation of salt-tolerant plants or for after desalination, as it is cheaper than desalinating seawater (Dawoud 2011). In Abu Dhabi, 30 small-scale desalination units have recently been constructed to use brackish and saline groundwater in remote areas where there are no links to the water supply network (Dawoud 2012).

Parallel actions could include the implementation of policies and legal frameworks to regulate and reduce water abstraction, and improving water-use efficiency. Also, separating the role of regulator and operator is crucial for effective and efficient management of energy sources, with implications for public safety, related, for example, to nuclear energy.

However, complicated systems of water rights, land rights and civic institutions, and legal regimes, especially for transboundry shared water resources, can sometimes undermine water management. Institutional and legal reform could improve how surface and groundwater resources (**Table 1.2.3**) are regulated, planned and managed (Dawoud 2011).The fact that cooperation between riparian countries is limited further impedes the development of a common vision of shared water resource management (**Table 1.2.4**). Existing bilateral agreements focus on water allocation, with an emphasis on infrastructure development and use; water quality is not addressed in these agreements. While there are no river basin associations in place, bilateral cooperation over surface water does take place through technical committees and local projects

Table 1.2.3: West Asia shared surface water basins

Shared basin	River	Countries	Main shared tributaries
Euphrates-Tigris Shatt al Arab Basin	Euphrates River	• Iraq • Syria • Turkey	• Sajur River Jallab • Balikh River • Khabour River
	Tigris River	• Iran • Iraq • Syria • Turkey	• Feesh Khabour River • Greater Zab River • Lesser Zab River • Diyala River
	Shatt al Arab River	• Iran • Iraq	• Karkheh River • Karun River
Jordan River Basin	Jordan River	• Israel • Jordan • Lebanon • OPT • Syria	• Hasbani River • Banias River • Yarmouk River
Orontes River Basin	Orontes River	• Lebanon • Syria • Turkey	• Afrin River • Karasu River
Nahr el Kabir Basin	Nahr el Kabir	• Lebanon • Syria	-
Qweik River Basin	Qweik River	• Syria • Turkey	-

Source: UNESCWA and BGR (United Nations Economic and Social Commission for Western Asia (UN-UNESCWA) and Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) 2013

(Bundesanstaltfür Geowissenschaften und Rohstoffe, 2013). Achievements vary across countries in West Asia based on their policies and priorities among the various sectors, namely water supply and sanitation coverage, increases in food production, allocation of sufficient funds to invest in infrastructure, and the provision of financial support to increase agricultural and industrial productivity (Dawoud 2011).

Table 1.2.4: West Asia, shared groundwater aquifer systems

Shared groundwater aquifer system	Countries
Saq-Ram Aquifer System (West)	• Jordan, Saudi Arabia
Wajid Aquifer System	• Saudi Arabia, Yemen
Wasia–Biyadh-Aruma Aquifer System (South): Tawila-Mahra/Cretaceous Sands	• Saudi Arabia, Yemen
Wasia–Biyadh-Aruma Aquifer System (North): Sakaka-Rutba	• Iraq, Saudi Arabia
Umm er Radhuma-Dammam Aquifer System (South): Rub' al Khali	• Oman, Saudi Arabia, UAE, Yemen
Umm er Radhuma-Dammam Aquifer System (Centre): Gulf	• Bahrain, Qatar, Saudi Arabia
Umm er Radhuma-Dammam Aquifer System (North): Widyan-Salman	• Iraq, Kuwait, Saudi Arabia
Tawil-Quaternary Aquifer System: Wadi Sirhan Basin	• Jordan, Saudi Arabia
Ga'ara Aquifer Systema	• Iraq, Jordan, Saudi Arabia, Syria
Anti-Lebanonb	• Lebanon, Syria
Western Aquifer Basin	• Egypt, Israel, OPT
Central Hammad Basina	• Jordan, Syria
Eastern Aquifer Basina	• Israel, OPT
Coastal Aquifer Basin	• Egypt, Israel, OPT
North-Eastern Aquifer Basina	• Israel, OPT
Basalt Aquifer System (West): Yarmouk Basin	• Jordan, Syria
Basalt Aquifer System (South): Azraq-Dhuleil Basin	• Jordan, Syria
Western Galilee Basina	• Israel, Lebanon
Taurus-Zagrosb	• Iran, Iraq, Turkey
Jezira Tertiary Limestone Aquifer System	• Syria, Turkey
Neogene Aquifer System (North-West), Upper and Lower Fars: Jezira Basin	• Iraq, Syria
Neogene Aquifer System (South-East), Dibdibba-Kuwait Group: Dibdibba Delta Basin	• Iraq, Kuwait, Saudi Arabia

Source: UNESCWA and BGR 2013

Energy

There is a push for improvement in energy efficiency and diversification of the energy mix for security, financial, environmental and health reasons. In oil- and gas-producing countries there is an opportunity cost associated with increasing domestic energy demand as fewer resources become available for export. Promoting renewable energy is perceived as a potential economic growth sector and there are already several renewable energy projects on the ground, for example in Iraq, Jordan, Qatar, Saudi Arabia and the UAE (AFED, 2014). Growth in the renewable energy sector can be facilitated by the creation of a dynamic market with participation and investment from the private sector. This can be achieved by addressing existing energy monopolies and by deploying policies and measures that reduce investment risks. Investment risks associated with renewable energy options can deter the natural evolution of this sector and

hence hamper the commercialization stage of the renewable energy sector (Simpson and Zimmerman 2013). Therefore, government support in reducing investment risk is key to a successful integration of renewable energy in all aspects of society and economy.

Transport is another sector that requires improvements in energy efficiency; this can be achieved through integrated urban transport planning and investment in public transport infrastructure.

The West Asia region could navigate the challenge of these interdependencies through synchronised actions across different sectors. The ease by which the transition takes place depends mostly on national commitment and the presence of regulatory and policy frameworks, coupled with financial instruments, under stable institutional conditions. A stable and holistic approach that addresses basic needs requires three other regional priorities to be addressed: waste management (**Videos 1.2.1-3**), integrated coastal zone management and land reclamation, and the adoption of climate change mitigation measures (**Table 1.2.5**).

Table 1.2.5: West Asia, emission reduction potential for shortlisted mitigation technologies

Technology	Emission reduction potential (tCO_2e/ tonne waste)
Incineration with energy recovery	0.23
Composting	0.11
Co-firing in cement kilns	0.40
PET recycling	1.76
Paper recycling	0.72
Glass recycling	0.25
Textiles recycling	3.38

Data Source: OECD 2012

Reclamation and dredging activities in the ROPME Sea Area



Credit: Humood Naser

Video 1.2.1: Dawoodi Bohras cleanliness drive in Sana'a



Video 1.2.2: Municipal waste management in Oman



Video 1.2.3: Global Waste Challenge



1.3 Environmental governance and sustainability

Environmental governance is the means by which society determines and acts on goals and priorities related to the management of natural resources. It includes the rules, both formal and informal, that govern human behaviour in decision-making processes as well as the decisions themselves. Appropriate legal frameworks at global, regional, national and local levels are a prerequisite for good environmental governance. Thus, environmental governance refers to processes of decision-making to control and manage the environment and natural resources that build on principles such as inclusiveness, participation, accountability, efficiency and effectiveness. Environmental governance aims to ensure sustainable development through the good management of the environment including social, economic and political aspects. It involves or presupposes the adoption of an holistic approach that takes into consideration all stakeholders from public (governmental institutions) to private (individuals and businesses) as well as civil society (non-governmental and civil society organisations).

1.3.1 Governance and sustainability

Throughout West Asia, governments and stakeholders are increasingly interested in environmental matters including governance, even though their ability to act remains crucially limited due to institutional weakness and a lack of adequate resources devoted to the sector, including legislation with a defined role.

Institutionally, West Asian environmental governance can be categorized into six broad types:

- inter-ministerial environmental Councils **(Box 1.3.1)** with environmental secretariats, as in Bahrain and Kuwait: these are inter-ministerial bodies with technical secretariats that take action on specific decisions endorsed by the council;
- environmental directorates within line ministries, as in Saudi Arabia: typically, an environmental directorate is an agency or department within a ministry;
- combined ministries, as in the United Arab Emirates (UAE) and Yemen: in these cases responsibility for environmental matters is included in the mandate of a larger ministry responsible for a related area of government policy, such as tourism, water resources or planning, reflecting a shift in priorities regarding the relative importance of environmental issues in these sectors;
- semi-independent environmental agencies, such as in Occupied Palestinian Territories (OPT) and Syria: the environmental agency may have its own Minister of State, but is usually represented in the Council of Ministers by the minister of an associated line ministry;

- autonomous ministries of the environment or their equivalent, as in Iraq, Jordan Lebanon, Oman and Qatar: with their own technical staff, budget allocation and the mandate to implement action, they are legally empowered with the status of other line ministries, but in practice tend to be politically weaker than economic and sectoral ministries.
- autonomous ministries of the environment with additional responsibilities for sustainable development, as in Oman.

In many countries in West Asia, environmental governance is government-led, centred and regulated and, in most cases, institutions in charge of environmental governance are also assigned the overall responsibility for managing sustainable development, which tends to lessen implementation outcomes (Kanan 2012; UNESCWA 2015a).

These institutions are also less influential in governmental decision-making processes than other ministries, notably those in charge of the economy, finance, social, and more political or parliamentary issues, and so greater high-level commitment is needed to implement environmental policies and strategies. In some cases, environmental programmes become highly dependent on financial and technical support from international development agencies, which is an indicator of a lack of willingness or resources on the part of national governments to allocate appropriate resources and commitment to environmental issues.

The Lebanese Ministry of Environment, for example, has conducted a diagnosis of the status of national environmental legislation, and found that from 1993 to 2014 about 20 laws promoting environmental sustainability were adopted. Some of these laws and decrees, however, have yet to be enacted. The diagnosis also found that its institutional capacity to monitor and enforce most environmental laws remains weak (El-Baba 2015).

Jordan is also noted for its numerous laws related to environmental management and protection. These are not limited to environmental institutions and instruments, but are included in other sectoral plans and legislation such as those on agriculture, energy, health and water. The multiplicity of these plans and legislation, the high number of responsible actors and the dispersion of functions across various institutions render the environmental governance relatively weak. However, civil society plays an important role in monitoring the environment (World Bank 2009).

Yemen has enacted various laws and set up a related institutional framework to enhance environmental

Box 1.3.1: The Council of Arab Ministers Responsible for the Environment

Within the framework of the League of Arab States, CAMRE was established as a high-level institution to ensure the proper coordination of environmental policies in the Arab region, which includes all the countries of the West Asia region. CAMRE aims to identify major environmental problems, set priorities and address issues related to a sustainable environment. CAMRE has played, and continues to play, a major role in the coordination of environmental policies of the Arab countries at regional and global levels and has ensured a certain level of replication of environmental policies among West Asian countries. In addition, CAMRE ensures that all League of Arab States institutions address environmental issues in a comprehensive and harmonized manner.

Source: UNEP 2012

governance. The National Environmental Action Plan and the National Strategy for Environmental Sustainability determine overall environmental goals and objectives while the Environmental Protection Authority is the main national environmental institution, though it works alongside other institutions such as the Ministry of Water and Environment. However, there are several other institutions and laws with overlapping scope and responsibilities (Almutawakel 2015; International Business Publications 2013; UNDP 2012). Additionally, inadequate technical and financial resources and a lack of access to appropriate information may hinder environmental governance in Yemen. These three countries mirror the status of environmental governance in many parts of West Asia.

Several countries in the region, including Bahrain, Jordan, Lebanon, Saudi Arabia and Syria, specifically address the issue of environmental governance in their national plans. All countries address environmental issues through multiple plans, such as those related to climate change, ecosystem management, harmful and hazardous waste, disasters and conflicts, resource efficiency, and sustainable consumption and production. Even when countries of West Asia do address the environment, most of their resources are devoted to other matters that are perceived as more pressing, such as security and/or the economy, as public awareness of environmental issues remains low. The result is that governments are not pressed to devote additional effort and resources to address and streamline environmental issues (UNEP-ROWA 2015).

1.3.2 Enhancing environmental governance

Participation

Effective governance requires that institutions are able to provide services to their constituents and that they have good relationships with other organisations, especially those representing stakeholders. The coordination of actors and programmes within the environment sector is a challenge everywhere, and more so in countries of the region where capacity and resources are often inadequate. This makes environmental governance an even greater cause of concern. Rivalries are common among institutions, especially when there are many laws and strategies that often overlap, and as a result stakeholders become tangled in a web of rules and regulations over which they have little say or control (UNDP 2013).

It is important that stakeholders are involved in environmental decision-making processes, particularly as many of these decisions ultimately impact them or their immediate environment, for example waste collection and management, water and sanitation, and air and noise pollution. To date, environmental issues remain largely in the realm of national governments, with little participation from local authorities except to enforce or implement decisions (Samaha 2015; Stel *et al.* Husseini 2015).

Accountability and effectiveness

Involving stakeholders, including civil society organisations (CSOs), in decision-making processes and reaching decisions through consensus are key factors for accountable and effective environmental governance. In addition, involving stakeholders in follow-up activities can make public administrators and institutions more accountable. National capacities for accountability **(Box 1.3.2)** can be further improved through better access to data management and monitoring, human and financial resources, effective engagement of the private sector and civil society, and the generation, processing, analysis and dissemination of information in a transparent and enabling manner (Ghrer 2013; UNDP 2013).

Equality and equity

Since the environment generates benefits, it has a value, which should be protected by all those involved, including public, private and civil society organizations. Appropriate and fair policies are necessary to support social equity and equality, and could be achieved through a greater inclusion of all stakeholders, regardless of status, gender, age or power. Equality and equity, both within and between generations,

Box 1.3.2: Selected key messages on an accountability framework for the Arab region

- An effective multi-layered mechanism for monitoring accountability and follow-up is needed.
- Make resources available for such an accountability framework.
- Build on successful experience from the region in areas such as trade, human rights, investment and environmental management, notably by engaging key stakeholders in related dialogue to strengthen ownership and sustainability.
- Economic integration, human rights and democracy should be at the core of a transformative accountability framework.
- An effective mechanism would be multi-layered, comprising global, regional and national components though national leadership is critical.
- At regional level, the framework should rest within the existing institutional architecture, notably the League of Arab States.

Source: UN and LAS 2014

improvements in efficiency, and the maximization of benefits will require a policy and legislative framework that puts emphasis on rights, inclusiveness and fairness, while also aiming to improve livelihoods and well-being. Good environmental governance can be achieved if equity and equality are reflected in policy formulation, strategies and programmes at all levels (Waslekar 2011, UN and LAS 2014).

1.3.3 Policy implementation

While environmental legislation in West Asia has been considerably strengthened in recent decades, including through international technical assistance, enforcement may be constrained by limited technical capacity and financial resources (UNESCWA 2012). It is critical that implementation of the outcomes of decision-making processes is underpinned by clear mechanisms, directives and regulations, defining roles and responsibilities of all relevant stakeholders and describing formal structures. The capacity to implement effective and comprehensive environmental policies requires the availability of the technical knowledge, human and financial resources, and political consensus necessary to mobilize resources in favour of agreed environmental goals.

However, the on-going conflicts facing the region which are negatively affecting all aspects of the environment can undermine its ability to achieve the SDGs, in particular, Goal 16 on peace, justice and strong institutions and Goal 17 on means of implementation and partnership (UNESCWA 2003).

1.4 Public health and the environment

Worldwide the greatest effects on the health of individuals and populations result from environmental degradation and social injustice. The WHO has estimated that modifiable environmental risk factors are responsible for almost one quarter of the total global burden of disease (WHO 2016) (**Figure 1.2.7**).

In the West Asia region, there are more than 229 500 premature death each year because of specific environmental risks and, 8.24 million healthy life years are being lost because of these risks (**Table 1.4.1**). In other terms, every individual in the West Asia region is losing 17.0 days of life annually

Table 1.4.1: West Asia, burden of disease of environmental risk factors, 2004 and 2013 (estimated)

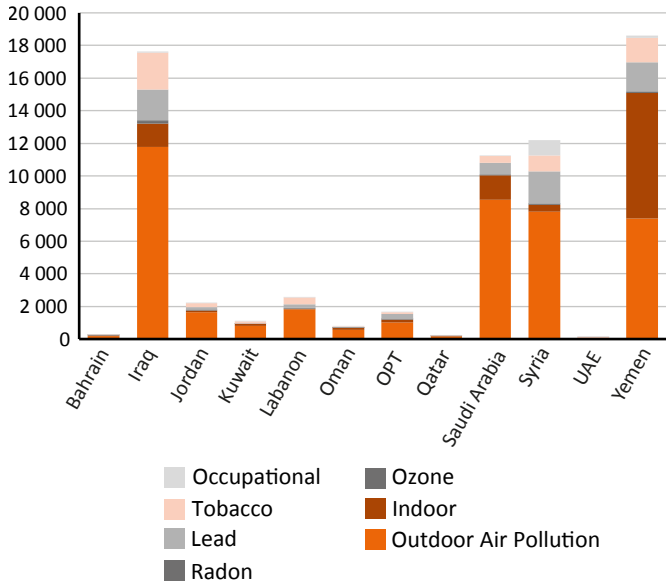
Country	Environment attributable DALYs per 100 000 people	Environment attributable deaths per 100 000 people	Environment attributable DALYs	Environment attributable deaths	Environment attributable DALYs	Environment attributable deaths
	2004	2004	2004	2004	2013	2013
Bahrain	1 639	58	11 665	411	21 946	773
Iraq	11 687	316	3 221 343	87 234	4 104 013	111 137
Jordan	2 511	83	135 559	4 456	175 549	5 771
Kuwait	1 415	33	37 028	852	47 163	1 085
Lebanon	3 001	132	120 871	5 298	133 373	5 846
Oman	1 899	55	48 813	1 416	66 876	1 940
OPT	**					
Qatar	1 361	32	10 851	252	35 878	833
Saudi Arabia	3 027	91	698 105	20 962	818 117	24 566
Syrian Arab Republic	2 293	72	424 435	13 275	510 675	15 972
UAE	1 438	33	56 561	1 313	125 563	2 915
Yemen	9 309	247	1 901 457	50 533	2 209 630	58 723
Total			**6 666 688**	**186 002**	**8 248 783**	**229 561**

Source: WHO 2008

because of modifiable environmental risk factors. The top modifiable risk factors are air pollution (**Figure 1.4.1**); lack of access to safe water and adequate sanitation; climate change; exposure to hazardous chemicals and wastes; emergencies and disasters; and exposure to radiation (WHO, 2008). Recent burden-of-disease studies by the Institute for Health Metrics and Evaluation (IHME), emphasize that this same level of burden of disease still prevails in the region but the population is increasing dramatically, which means that both the number of deaths and the number of lost years is increasing. The IHME estimated that air pollution alone was responsible for more than 70 000 premature deaths in West Asia in 2010 (IHME 2013).

Armed conflicts also have direct and immediate impacts on human life and health. Military activities have serious health consequences through their impact on the physical, biological, economic, and social environments in which people live. West Asia has suffered from ongoing wars and political conflicts. This situation has resulted in major environmental health issues including radioactive health impacts resulting from missiles, soil and water contamination with hazardous chemical residues due to explosives, and localized air pollution due to burnt plastics and other manmade materials. These impacts are considered to be serious causes of death for children, women and older people. For example, military activities in Syria have led to severe environmental and health impacts that have been aggravated by the lack of proper access to health care (Waslekar and Futehally 2009; UNHCR 2015).

Figure 1.4.1: West Asia, deaths attributed to different types of air pollution, 2013



Source: IHME 2013

Environmental degradation is a major issue that is linked to access to water, food and energy. For instance, absence of agreement on shared water resources, as well as pollution of water bodies, complicates water management in the region, resulting in food security issues, human health risks and socio-economic instability. Similarly, the region's high reliance on fossil fuels leads to detrimental impacts on the economy, the environment and public health.

Following the adoption of the SDGs, new environmental and health objectives and instruments will be created, and resources deployed to support monitoring and reporting on the implementation of these goals, particularly Goal No.3 that deals with healthy lives and well-being. With this understanding, it is essential to adopt and implement an integrated ecological public health approach, which recognises the complex interactions between biological, behavioural, environmental and social factors. Monitoring activities conducted in support of achieving the SDGs and their related targets offer an important opportunity to build national capacity for the identification and tracking of key environmental and health risks in the West Asia region.

See references for Chapter 1

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CHAPTER 2

State of the Environment and Policy Responses

All the GEO-6 regional assessments follow the Drivers, Pressures, State, Impacts and Response (DPSIR) assessment framework; looking at each of the elements of this framework within a regional context. For West Asia the main drivers of environmental change include economic development and population growth. However, as highlighted in the regional priorities, another significant driver is the nexus between water, energy and food, which leads to its own drivers and pressures on local populations and human health.

This section considers the main drivers and the pressures they exert on the environment by analysing recent trends in the state of the environment as well as the policy responses that could help address these impacts. The analysis is conducted according to seven environmental themes:

- Water resources;
- Land resources;
- Coastal and marine resources;
- Biodiversity;
- Air;
- Climate change;
- Waste management.

Table 2.1: Summary of pressures and policy responses extracted from West Asia regional assessment using DPSIR

	Pressures	Policy Responses
2.1 Water resources	• Water demand • Groundwater depletion • Climate change impacts • Extreme weather events	• Moving towards integrated water resources management • Water sector reallocation • Enhancement of water availability • Desalination • Treated wastewater reuse • Regional cooperation on water management
2.2 Land resources	• Population growth • Past and current conflicts • Climate change and mismanagement of groundwater resources	• Concentrate on securing food in the first place and preserving and enhancing natural resources • Capitalize on tradition and local knowledge of land resources • Implementing synergistic activities related to combating land degradation, biodiversity conservation and adaptation and mitigation activities related to climate change • Strengthening institutional capacity and updating laws for better planning of land resources

Contd...

◄ Credit: Shutterstock/ Africa Studio

	Pressures	Policy Responses
2.3 Coastal and marine	• Dredging and reclamation • Marine water desalination • Oil and gas exploration, production and transportation • Pollution and water quality deterioration • Overfishing • Climate change	• Strategic planning • Integrated coastal zone management • Ecosystem-based management • Legal frameworks and environmental impact assessment • Restoration and rehabilitation of degraded coastal and marine ecosystems • Marine protected areas • Fisheries management • Ecotourism • Valuation of ecosystems services • Capacity Building
2.4 Biodiversity	• Encroachment on natural habitats • Conflicts and social unrest • Climate change • Invasive species • Degradation of ecosystems • Overriding the carrying capacity of ecosystems • Illegal trade in wildlife	• Joining international efforts to conserve biodiversity • Research and development • Knowledge and human capital for evidence-based decision making • Financial resources to implement plans • Protecting woodlands and other plant habitats • New technologies supporting genetic research • Ecosystem restoration and habitat remediation
2.5 Air	• Frequent dust storms • Man-made sources of air pollution	• Establishment of dust storm early warning and information systems • Removal of lead from petrol • Protection of the stratospheric ozone layer
2.6 Climate change	• Increased CO_2 and GHGs emission	• Energy efficiency • Environmental education and public awareness
2.7 Waste	• Generation of municipal solid waste • Composition change • Over-use of land area	• Treatment technology • Involvement of management agencies

2.1 Water resources

Key messages: Water resources

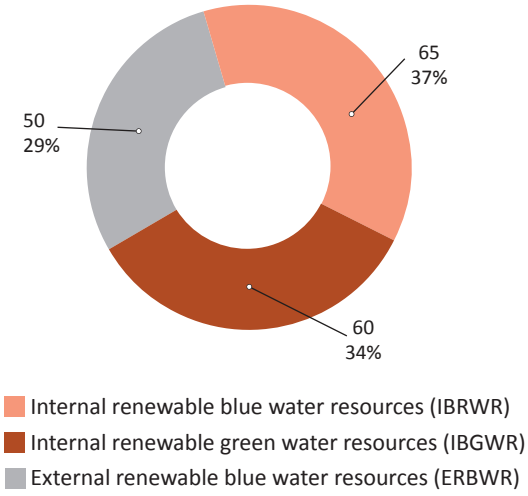
- Water demand in West Asia has been increasing, resulting in a diminishing per-person availability of water. Only 4 out of 12 countries in West Asia are above the water scarcity limit of 1 000 cubic metres per person per year.
- The overexploitation of groundwater resources throughout West Asia has resulted in a deterioration of water quality, seawater intrusion, depletion and salinization of aquifers, and rising pumping costs.
- GCC countries produce about 60 per cent of the world's desalinated water. While the need for desalination in GCC countries is inevitable, associated environmental impacts need attention.
- Climate scenarios project changes in the region's temperature, rainfall and sea level, which will have impacts on both the availability and use of water resources.
- Extreme weather events including number of flood events have occurred in West Asia in the last two decades.
- Introducing non-conventional water resources, such as the reuse of domestic wastewater, recycling of agricultural drainage water, groundwater inter-basin transfer, seawater and brackish water desalination, use of brackish and seawater for bio-saline and halophyte agriculture desalination, can enhance the water availability throughout the region.

2.1.1 Water resources in the West Asia region

Renewable water resources

The West Asia region has several sources of renewable water resources (Abuzeid 2014; CEDARE *et al.* 2014). The large proportion is internal blue water, which includes surface water and groundwater within national borders. This is followed by green water, which includes water made available through precipitation and used directly in rain-fed agriculture, natural pasture and forest. The region has external blue water resources, which corresponds to the total inflow of transboundary surface and groundwater from upstream countries into West Asia. (**Figure 2.1.1**).

Figure 2.1.1 West Asia renewable water resources as percentages of blue and green water

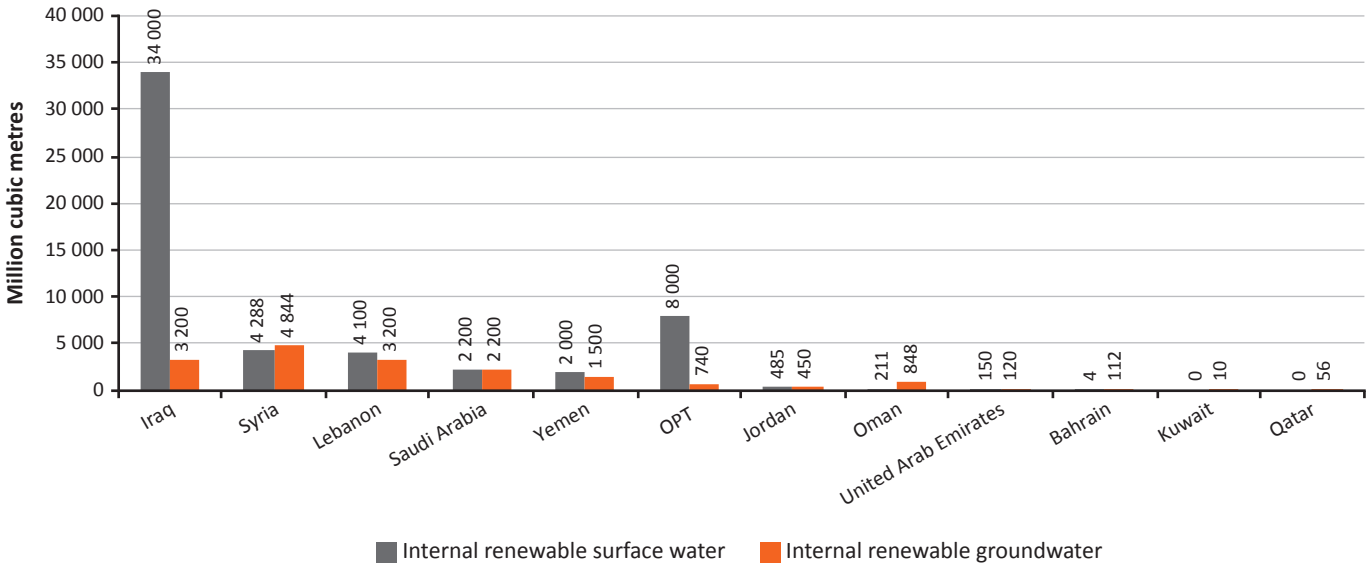


Source: Abuzeid 2014; CEDARE et al. 2014

West Asia's internal and external renewable blue water resources vary considerably from country to country (**Figure 2.1.2, Figure 2.1.3**). Iraq has large internal renewable blue water resources, while for countries such as Kuwait and Bahrain the resource within their borders is very limited, and they depend almost entirely on non-conventional sources such as desalinated seawater and treated wastewater (CEDARE and AWC 2014).

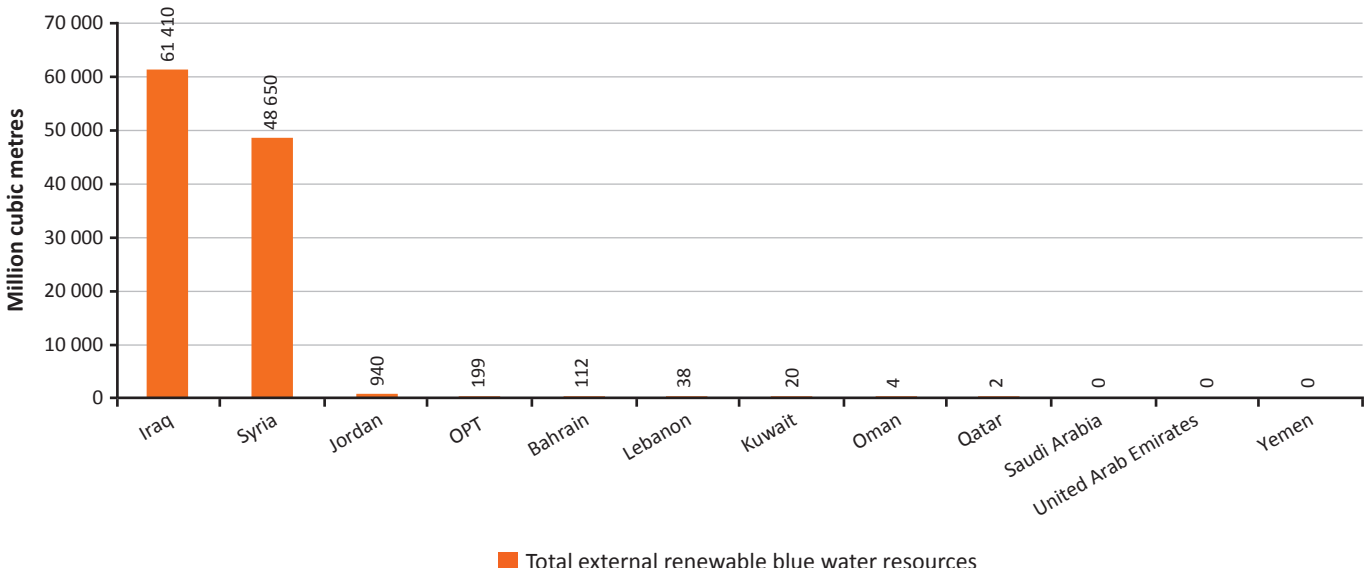
Total renewable blue water resources are calculated as the total renewable blue surface water and the total renewable blue groundwater, excluding the overlap between them, taking into consideration the net external blue surface and groundwater resources by subtracting the outflows from the inflows. A more precise estimate of the total annual renewable water resource requires inclusion of both green and blue water resources (Abuzeid 2014; CEDARE *et al.* 2014).

Figure 2.1.2 West Asia annual internal renewable blue surface water and groundwater, by country



Source: CEDARE et al. 2014

Figure 2.1.3: West Asia total annual external renewable blue water resources, by country



Source: AbuZeid *et al.* 2014; CEDARE et al. 2014

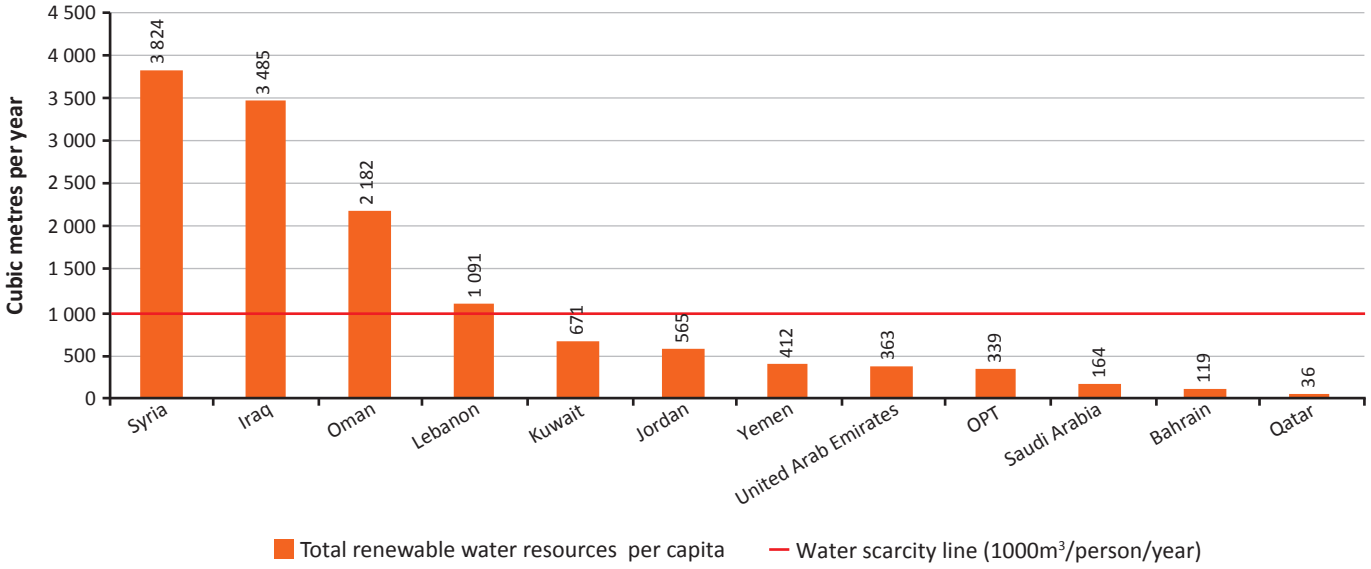
The region has two major shared rivers, originating outside its boundaries. (the Euphrates and the Tigris) and several smaller rivers. The major shared deep groundwater sources are the Eastern Arabian Aquifers (Um Err Raduma, Dammam, and Wajeed), located on the Arabian Peninsula. The region also includes several transboundary groundwater basins including the Dissi Aquifer shared between Saudi Arabia and Jordan, who have started to exploit the aquifer (UNESCWA 2013). Other aquifers shared between the GCC countries also exist and are being exploited at different levels (**More...10**).

In many cases, hydropower generation and abstraction from shared water resources is not just a national concern, as potential conflicts could result especially when upstream riparian states of a shared river basin construct hydraulic dams without consulting downstream countries. While there is some sharing of information and consultation between countries, this needs to be given further attention in the near future.

Per person water availability

Only 4 out of 12 countries in West Asia are above the water scarcity limit of 1 000 cubic metres per person per year, when considering internal and external blue water and green water sources (**Figure 2.1.4**). Some countries, like the United Arab Emirates (UAE), are above the physical water scarcity limit when considering the use of non-conventional water resources like desalinated seawater (Abuzeid 2014; CEDARE *et al.* 2014).

Figure 2.1.4: West Asia total renewable water resources per person, by country



Source: AbuZeid *et al.* 2014; CEDARE et al. 2014

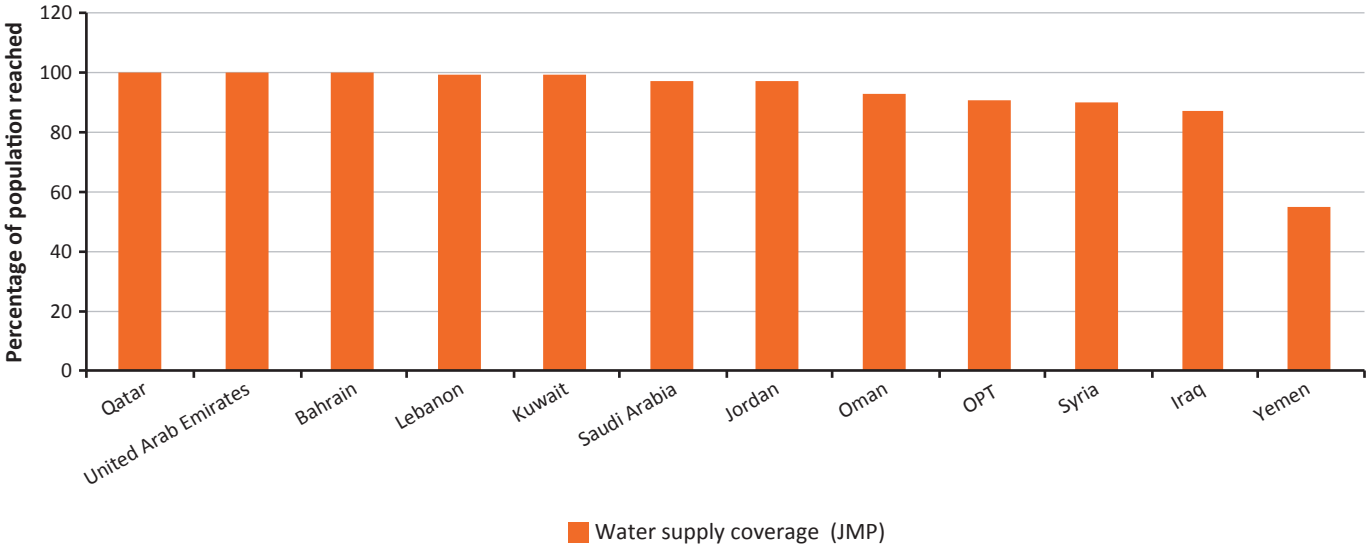
It is also important not to downplay the role of green water, where rain contributes to rain-fed agriculture, pasture land or forests which in turn play an important role in the region's socio-economic development.

Water supply and sanitation services

Access to water and sanitation was recently declared a human right by the United Nations and Sustainable Development. Moreover, the Sustainable Development Goals (SDGs) have a dedicated goal for water, where an important target for all countries will be to reach universal coverage by 2030. **Figure 2.1.5** shows the water supply coverage in selected West Asia countries in 2014 according to the Joint Monitoring Programme (JMP), while **Figure 2.1.6** shows sanitation coverage (Abuzeid 2014; CEDARE *et al.* 2014; JMP 2015).

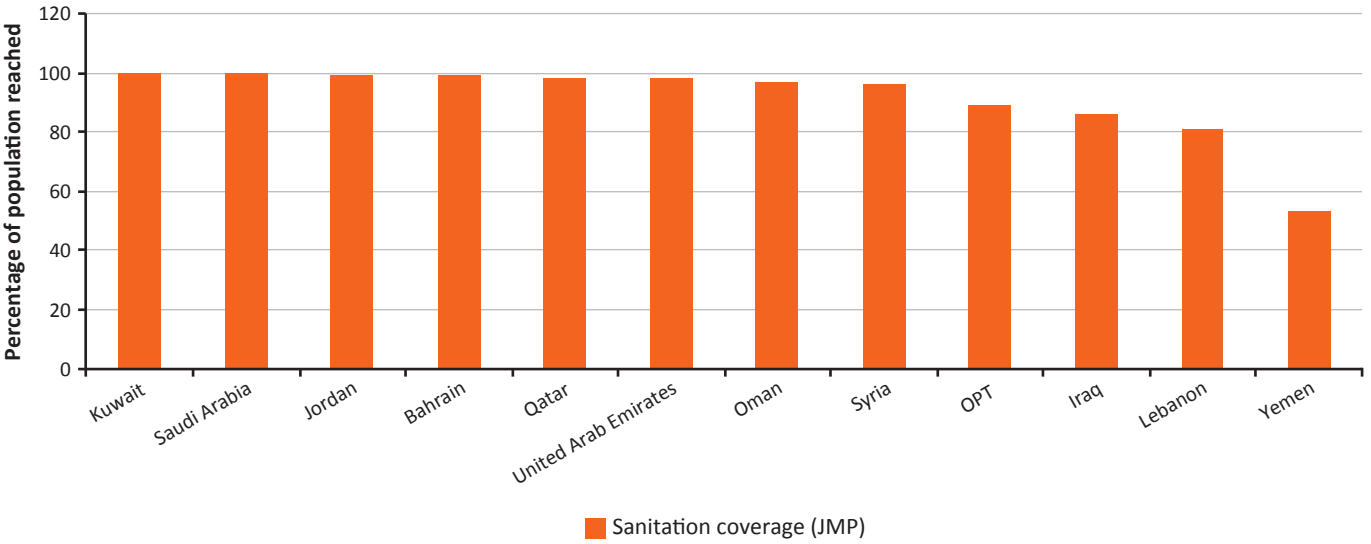
In 2012, cost estimates for reaching universal coverage in West Asia totalled of about USD10.3 billion for water supply and USD5.8 billion for sanitation. Coverage is not the only significant criterion in service provision; reliability and continuity of service are also important, and this can be lacking, especially in occupied lands and conflict zones.

Figure 2.1.5: West Asia water supply coverage, by country



Source: Joint Monitoring Programme (JMP) 2015; AbuZeid *et al.* 2014; CEDARE et al. 2014

Figure 2.1.6: West Asia sanitation coverage, by country



Source: JMP 2015; Abuzeid 2014; CEDARE et al. 2014

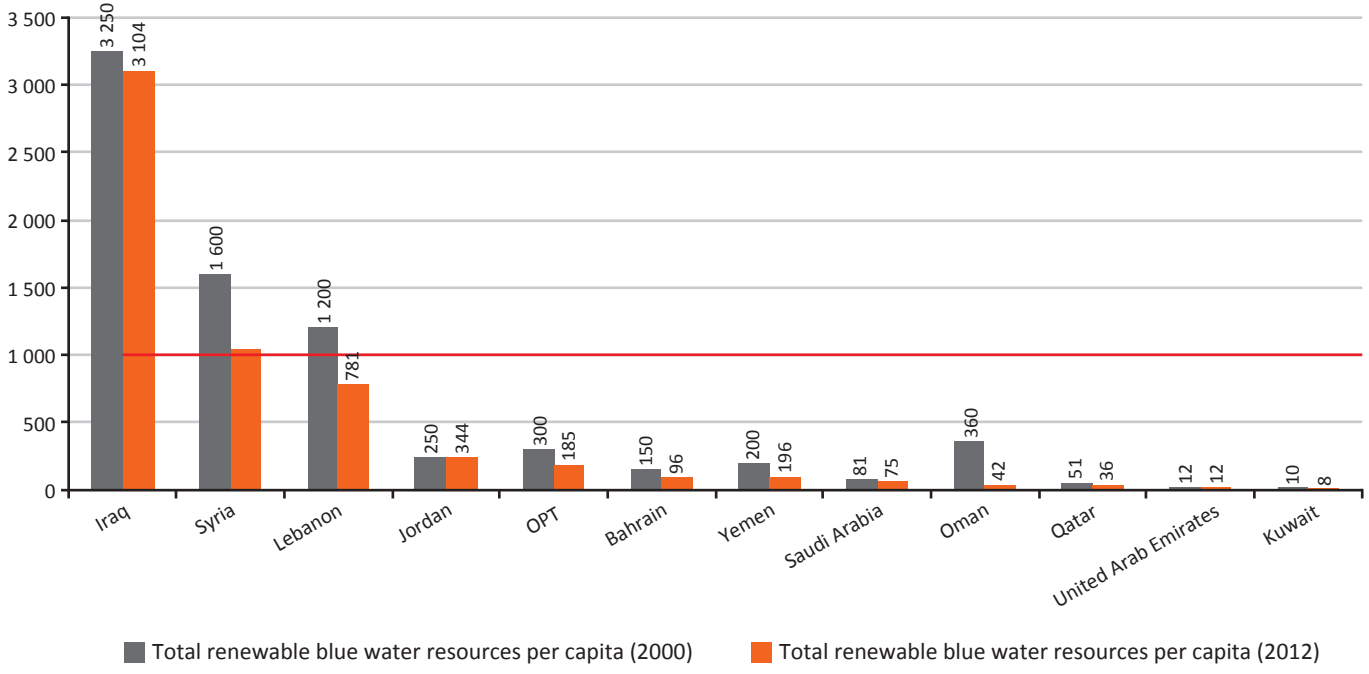
2.1.2 Pressures on water resources

Water demand

Water demand in West Asia has been increasing, resulting in a diminishing per-person availability of water. The increase in water demand has been the result of population growth, the use of subsidies that encourage inefficient and discourage wasteful use of water resources, and the recent increase in the cross-border influx of refugees. The political unrest that has recently arisen in several countries in the region, including Iraq, Syria and Yemen, is also having an impact on water supply and sanitation services.

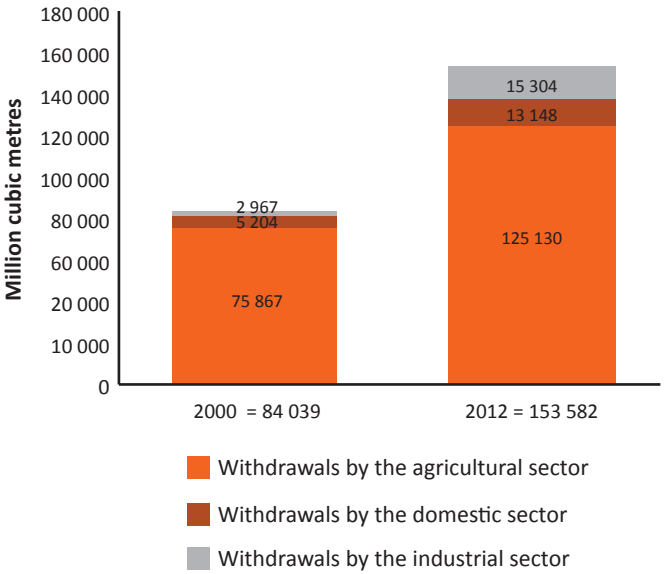
Figure 2.1.7 shows a reduction in the per-person availability of renewable blue water resources by country between 2000 and 2012. The number of countries below the water scarcity limit of 1 000 cubic metres per person per year increased from nine in 2000 to ten in 2012 (Abuzeid 2014; CEDARE and AWC 2014). **Figure 2.1.8** shows an increase of about 82 per cent in the region's total blue water withdrawals for agriculture, industry and domestic use between 2000 and 2012, reaching a total of around 153 billion cubic metres per year in 2012. In almost all countries the agricultural sector is by far the biggest consumer of water resources. (Abuzeid 2014; CEDARE *et al.* 2014).

Figure 2.1.7: West Asia total renewable blue water resources, by country (2000 and 2012)



Source: Abuzeid 2014; CEDARE et al. 2014

Figure 2.1.8: West Asia blue water withdrawals, by sector (2000 and 2012)



Source: Abuzeid 2014; CEDARE et al. 2014

Groundwater depletion

The overexploitation of groundwater resources throughout West Asia has resulted in a deterioration of water quality, seawater intrusion, depletion and salinization of aquifers, and rising pumping costs. Depletion of non-renewable groundwater has been observed with the expansion of agriculture in desert areas. Although the agricultural expansion in desert areas may be motivated for food security purposes, it has been argued that it is not economically feasible to use scarce water reserves for high-consumptive uses and it could be more strategic to preserve groundwater water reserves for drinking purposes in potential emergency situations (Abuzeid 2014).

Climate change impacts on freshwater resources

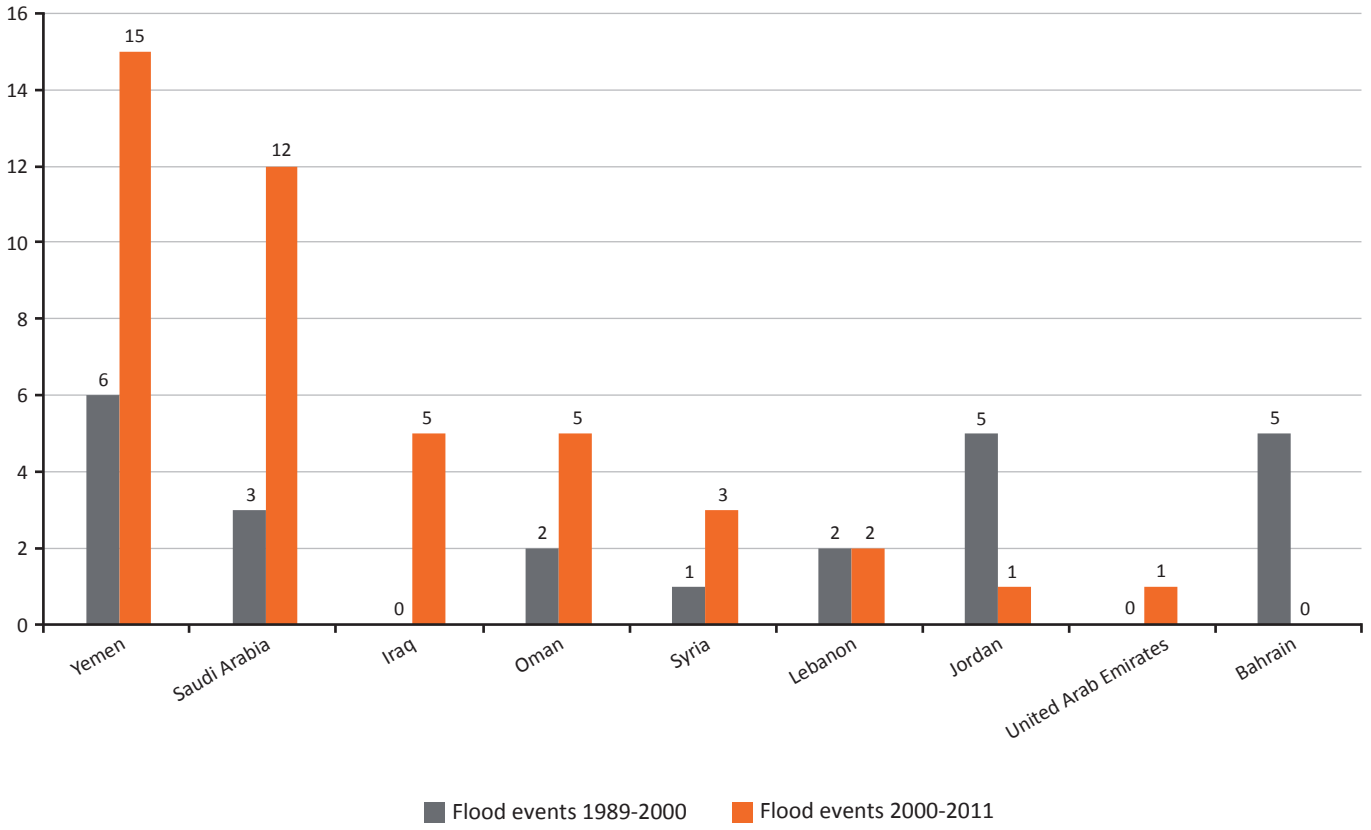
Climate scenarios project changes in the region's temperature, rainfall and sea level (**Figures 1.2.10 and 2.6.7**), which will have impacts on both the availability and use of water resources. Changes in precipitation patterns – amount, intensity, duration, distribution and seasonality – will influence the availability and dependability of water resources (UNDP 2006). According to most global climate models, projections suggest a decrease in rainfall in the region by 20 per cent over the next 50 years, while in the Mashriq sub-region it may diminish by 25 per cent with 40 per cent reductions in some locations (Meslemani 2008).

Recent studies indicate that the degree of expected impacts will vary between countries, with the GCC countries particularly affected. The climate change global index study classified countries in different parts of the world according to their degree of exposure to climate change (Abdel Hamid 2009). This index classified Iraq as the fifth most vulnerable country in the world to decreased water and food availability, extreme temperatures and associated health problems. The rest of the GCC countries are rated as highly vulnerable and Yemen as extremely vulnerable.

Extreme weather events

Extreme weather events are, for the most part, unpredictable. However, statistical records of such events could provide useful information for development plans. **Figure 2.1.9** shows the number of flood events that occurred in West Asia in the last two decades according to the flood observatory of Dartmouth University.

Figure 2.1.9: West Asia flood events, by country (1989–2000, 2000–2011)



Source: Abuzeid 2014; CEDARE et al. 2014

2.1.3 Policy responses for water resources management

Moving towards integrated water resources management

Current water scarcity issues are associated with an absence of holistic planningand comp;icated systems of water rights, land rights, social and civic institutions, and legal regimes which can undermine water management. Integrated water resources management requires the application of good water governance that emphasises the importance of effective institutional and legal frameworks.

Currently, the water sector in several countries in the region lacks appropriate governance. This is due to inadequate institutional arrangements and the difficulty of implementing policy reforms, which include water scarcity considerations in socio-economic development. As a result, existing water policies are fragmented and focused on increasing water availability and supply, with little focus on demand-side management or integrated water resources management (Khordagui 2007). Some changes have been

seen, for example in Jordan, where all responsibility for resource planning and monitoring has been placed under the Ministry of Water and Irrigation (**More...11**).

The Arab Regional Strategy for Sustainable Consumption and Production developed by the Council of Arab Ministers Responsible for the Environment calls for the adoption of market-based instruments including policies for water cost recovery. Although volumetric cost recovery of water services may be a tool for demand management, governments may still fully or partially subsidize the services for the poor, especially in light of the recent United Nations resolution of considering water and sanitation as a human right.

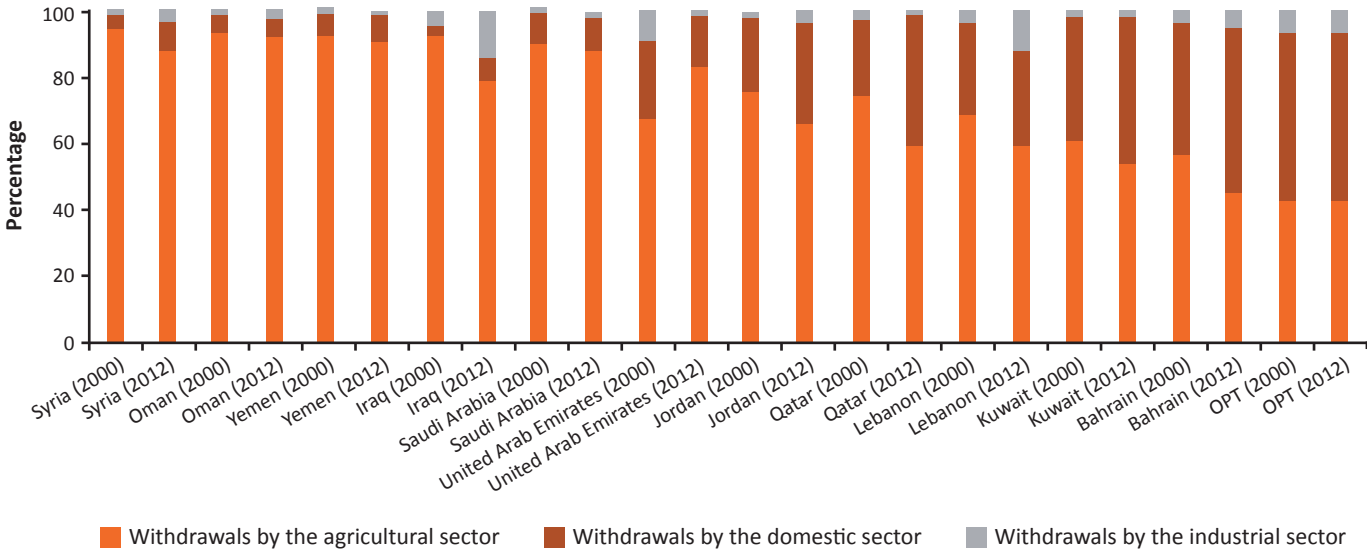
Water sector reallocation

For most countries in the region, reallocating water away from agriculture, towards the domestic and industrial sectors, may be a critical and controversial way to adjust to water scarcity. Although sector water reallocation may not have been announced as policies, the natural increase in population and the higher priority given to domestic water use have resulted in water reallocation from agriculture to the domestic and industrial sectors (CEDARE *et al.* 2014).

With the exception of the UAE, the percentage of freshwater allocated to agriculture compared to other sectors fell between 2000 and 2012.

Figure 2.1.10 shows that, Iraq, Jordan and Qatar have witnessed significant sector water reallocation. The trend of reallocating freshwater for domestic use and allocating non-conventional water, such as treated wastewater to agriculture, is likely to be part of future water management in the region (Abuzeid 2014).

Figure 2.1.10: West Asia sector share of blue water withdrawals, by country (2000 and 2012)

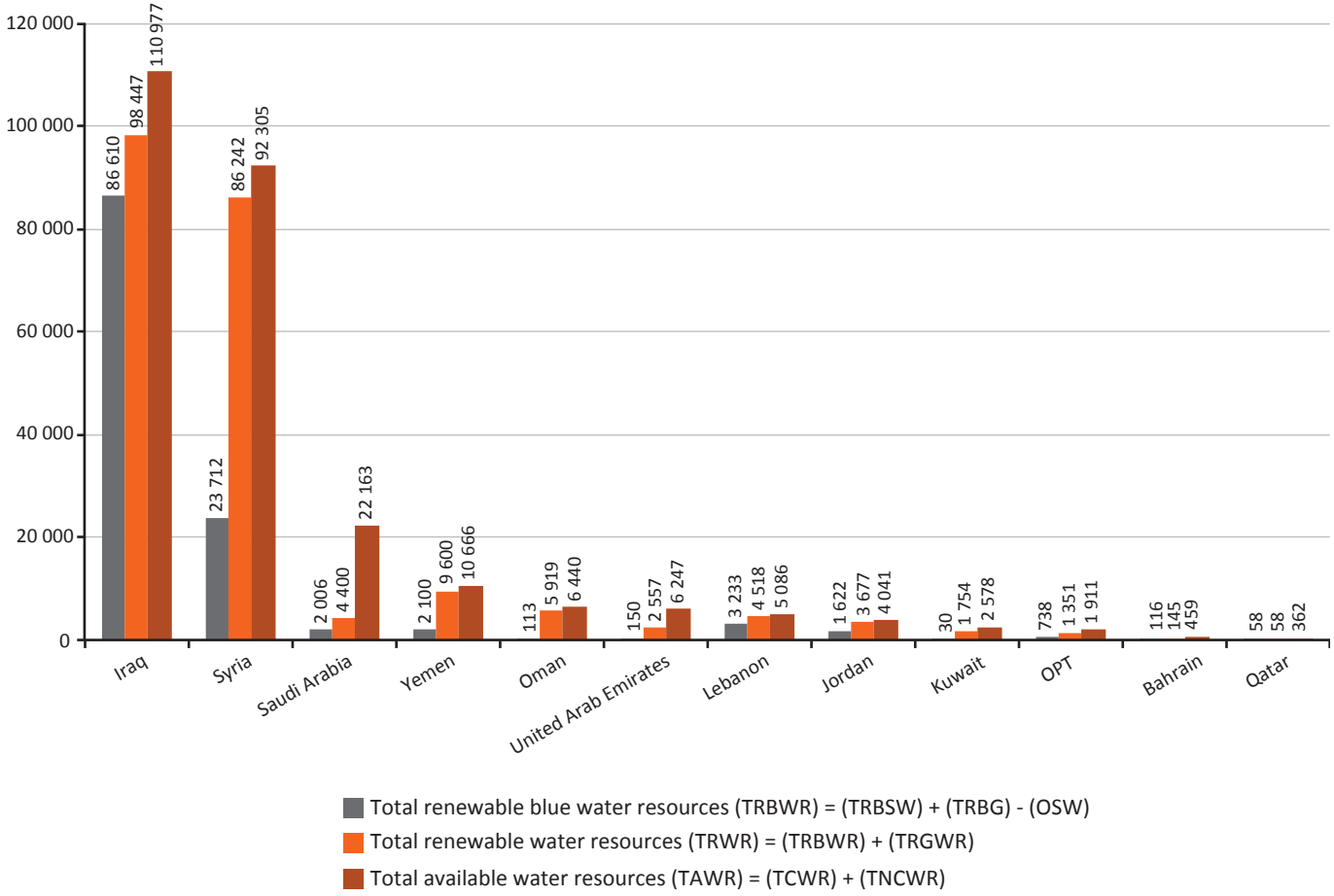


Source: CEDARE and AWC 2004; CEDARE et al. 2014

Enhancement of water availability

The most favoured options for enhancing water availability in West Asia include: reuse of domestic wastewater, recycling of agricultural drainage water, groundwater inter-basin transfer, seawater and brackish water desalination, use of brackish and seawater for bio-saline and halophyte agriculture, and cloud seeding (at the experimental stage). **Figure 2.1.11** shows how the available water resources for each country could actually be enhanced if green water is also considered part of the total renewable water resource.

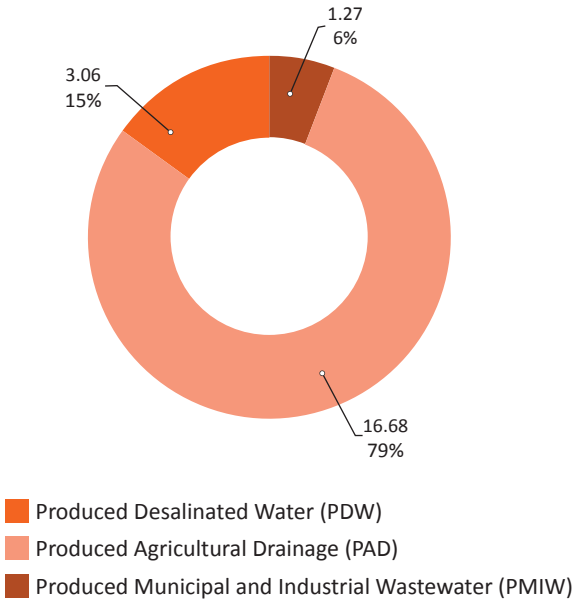
Figure 2.1.11: West Asia total available water resources and renewable water resources, by country



Source: Abuzeid 2014; CEDARE et al. 2014

Introducing non-conventional water resources, such as desalination, reuse of wastewater and agricultural drainage, can also enhance the availability of water, and to some extent it is already being practised in the region. Potential non-conventional water resources in West Asia are estimated at 1.27 billion cubic metres of treated wastewater (6 per cent), 16.68 billion cubic metres of agricultural drainage water (79 per cent) and 3.06 billion cubic metres of desalinated water (15 per cent) (**Figure 2.1.12**, Abuzeid 2014; CEDARE *et al.* 2014).

Figure 2.1.12: West Asia non-conventional annual water resources

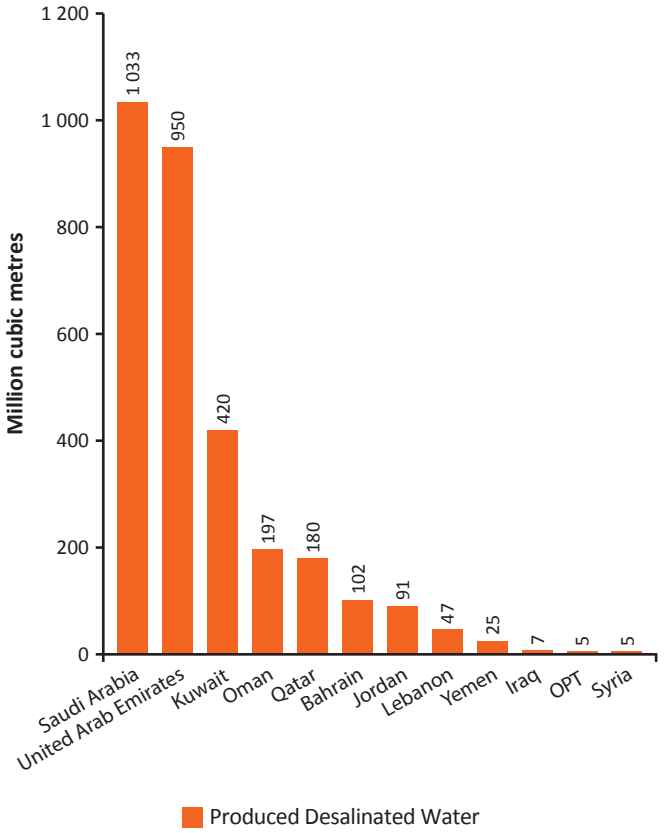


Source: Abuzeid 2014; CCEDARE et al. 2014

Desalination

GCC countries produce about 60 per cent of the world's desalinated water. Around 30 per cent of the regional total is in Saudi Arabia, which has facilities on the coasts of both the Red Sea and the Gulf. In Abu Dhabi, thirty small-scale desalination units have been constructed to utilize brackish and saline groundwater in remote areas where there are links to the water supply network. **Figure 2.1.13** shows the production of desalinated water by countries in West Asia (Abuzeid 2014; CEDARE *et al.* 2014).

Figure 2.1.13: West Asia annual desalinated water production, by country, million cubic metres



Source: AbuZeid *et al.* 2014; CEDARE et al. 2014

While the need for desalination in GCC countries is inevitable, associated environmental impacts that need

attention include damage to and death of aquatic creatures in desalination plant intakes; and the discharge of hot brine, residual chlorine, trace metals, volatile liquid hydrocarbons (VLHs) and anti-foaming and anti-scaling agents to the near-shore marine environment. There is a need to improve understanding of the impact of desalination on ecosystems and to deploy mitigation measures (Dawood 2012).

Treated wastewater reuse

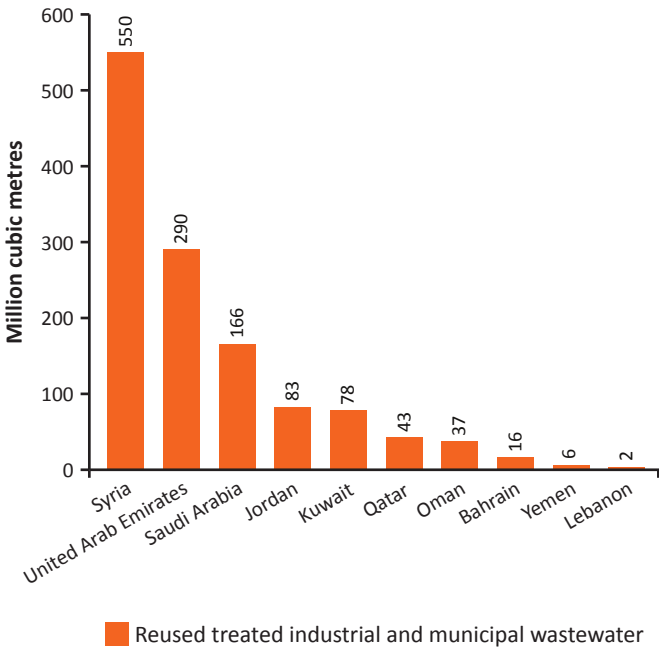
Measures undertaken to cope with water scarcity in the region's countries include the reuse of treated wastewater and agricultural drainage. Agricultural runoff in some countries often contains untreated domestic and industrial effluents, degrading the water quality in rivers with toxic trace metals, micro-organisms, pathogens, pesticides, trace nutrients and biodegradable organic loads.

Wastewater can be called the "renewable water resource of the future for agriculture expansion" (AbuZeid, K. *et al.* 2014). Although Syria is ranked first in wastewater treatment volumes among Arab countries, current annual treatment in this country has still not reached half the amount of wastewater produced. In many other West Asian countries, there is a good match between the produced and the treated wastewater. Nevertheless, the treated amount is too small to contribute significantly to the national water budget (CEDARE *et al.* 2014).

Figure 2.1.14 shows the amounts of municipal and industrial treated wastewater reused in different West Asian countries. It is clear that all the treated volumes are being reused in Syria. The UAE also reuses all its treated wastewater, which amounts to 290 million cubic metres per year, while Saudi Arabia reuses 166 million cubic metres of the 240 million produced annually. Agricultural drainage also represents a considerable resource for reuse, reaching about 7 billion cubic metres annually in Iraq and 4 billion in Syria.

Wastewater in the Mashriq, outside large cities, is discharged into watercourses and only part of it is used for irrigation purposes. Excess irrigation water inflitrates the

Figure 2.1.14: West Asia reused treated industrial and municipal wastewater, by country, million cubic metres



Source: Abuzeid 2014; CEDARE et al. 2014

lower horizons to reach the groundwater table; only in Saudi Arabia's Al Hassa oasis is irrigaion water reused in agriculture by mixing it with groundwater.

Regional cooperation on water management

The region has developed cooperation efforts to develop regional water strategies including involvement with the Arab region in elaborating a 2030 Arab Water Security Strategy, and a GCC Unified Water Strategy. Furthermore, realizing the importance of continuous assessment of the water situation in West Asia, the region's countries have been involved, with the rest of the Arab countries, in the development of the State of the Water Reporting initiative, with Arab State of the Water reports published in 2004 and 2012 (**More...12**).

2.2 Land resources

2.2.1 Land resources in West Asia region

Land, in its wider sense, includes soil, water, vegetation, landscape, animals, humans and the microclimatic components of an ecosystem. West Asia is one of the regions most affected by land degradation, as shown by increased desertification, water scarcity, reduced productivity, increased pollution and deterioration of biodiversity and ecosystems as a whole. Deserts and drylands occupy around two thirds of the West Asia region, including rangeland. Cultivated land makes up 4.8 per cent and forests 1.4 per cent of the total area (AOAD 2014).

Key messages: Land resources

- The spread of land degradation and desertification and its economic and environmental consequences are the most critical challenges facing West Asian countries.
- Continuous shrinkage of agricultural lands due to population growth, urbanisation, land degradation and desertification will jeopardize food security in the region, especially in the Mashriq countries and Yemen.
- Policies to combat land degradation and desertification have to consider the multiple drivers and pressures of the problem in the region as well as evaluate its socio-economic and environmental impact.
- Coupled with relatively high population growth and continuous conflicts and wars, the carrying capacity of the land has become too low to support people with freshwater and food, leaving aside the needs of ecosystems.
- A prevalence of climate extremes and forecasted climate change may exacerbate the extent of land degradation and water scarcity in the region.
- Lack of accurate data and information on land degradation and desertification in West Asia makes it difficult to precisely assess the extent and magnitude of the problem. Thus, integrated monitoring is essential to better understand the causes and consequences of the phenomena. Furthermore, efforts to combat land degradation and desertification in the region should capitalize on science and technology for devising and up-scaling remedial and preventive measures.
- Forests and rangelands are important natural ecosystems in the region for the conservation of biodiversity and for counteracting and mitigating the effect of climate change. Increasing the resilience of these ecosystems requires sound planning and integrated management strategies.
- Regional cooperation is key for combatting desertification, drought and dust storms. To this end, collaborative action and development of a regional early-warning system for drought and dust storms are essential steps towards alleviating the impacts of land degradation on human health and ecosystem functioning.
- Sustainable management of land resources requires comprehensive policies backed by all-encompassing national legislation in countries of the region as well as cooperation among countries.

Arable land

Arable land per person in West Asia countries varies significantly from less than 0.1 hectares in most Gulf Cooperation Council (GCC) countries, where the percentage of agricultural land is only 2.2 per cent of total land area; to less than 0.3 hectares per person in Syria (FAO 2014). Agricultural production that is dependent on irrigated and rain-fed cultivation faces competition for water resources from other sectors (FAO 2014).

All countries of the region depend on imports to sustain their supply of food and forage, but to very different extents, with the percentage of food inadequacy ranging from 5 to 100 per cent. Continuous shrinkage of agricultural lands due to population growth, urbanisation, land degradation and desertification will jeopardize food security in the region, especially in the Mashriq countries and Yemen where people depend mainly on local products (FAO 2014).

Deserts and dryland

About 40 per cent of West Asia's land area is subject to desertification. The region is affected by severe to very severe vegetation degradation: 6 per cent of the region's land area is slightly desertified, 21 per cent is moderately desertified, 31 per cent is severely desertified, and 11 per cent is very severely desertified. It is reported that 83 per cent of the marginal lands of West Asia are considered to be in danger of desertification. In the Arabian Peninsula, 89.6 per cent of the land is degraded (AOAD 2014; Abahussain *et al.* 2002).

Desertification in the arid and semi-arid drylands of West Asia can be traced back through several decades (AOAD 2014; Abahussain *et al.* 2002). The underlying causes of desertification include low and variable amounts of precipitation, increases in temperature and evapotranspiration rates, changes in land-use patterns and practices, and recent trends in climate change (AOAD 2014; Abahussain *et al.* 2002). Wind erosion accounts for 27 per cent of land degradation (ACSAD/CAMRE/UNEP 2004). Soil erosion, salinisation of agricultural land, dust storms and active sand dunes have significantly increased in the region, in turn giving rise to increased desertification (Al-Saady *et al.* 2013). **Box 2.2.1** provides an overview of land degradation and desertification in Iraq.

Rangeland

Rangeland constitutes two thirds of the total area of the region, consisting of arid to semi-arid territories (AOAD 2014). Rangeland is partially covered with grass and shrubs, while experiencing low rainfall (less than 200 millimetres annually), and is a source of forage for livestock and of cultural and social value for the people. **Box 2.2.2** provides an overview of rangeland in Jordan, Saudi Arabia and Syria.

Forest and woodland resources

West Asia's forests are principally concentrated in mountainous areas of the Mashriq countries and in the western mountains of Saudi Arabia, with little occurrence of natural forests and woodlands in other countries. The total forest area is about 6 million hectares, and ranges from 0.6 per cent of total land area in the GCC countries to 13.4 per cent in Lebanon (Abahussain *et al.* 2002; AOAD 2014).

Major obstacles to assessing forest cover in the region include information gaps and low reliability of existing information, ineffective policy and legislative frameworks and weak institutional capacity. Nevertheless, these ecosystems are experiencing heavy wood-cutting rates and forest fires, especially in war-torn countries (FAO 2008, 2011).

Box 2.2.1: Land degradation and desertification in Iraq

In Iraq 97 per cent of its total area is arid, about 50 per cent of which is desert. Desertification affects 39 per cent of the country's surface area with an additional 54 per cent under threat. Arable land degradation is ongoing, caused by various factors including mismanagement, climate change and water scarcity, and has accelerated the rise of soil salinity, increased the rate of soil erosion and converted wetland to dryland.

It is estimated that Iraq loses around 250 square kilometers of arable land annually. Although Iraq has the largest area of available farmland in the region, it suffers the most from soil salinity and wind erosion. In Mesopotamia, where the majority of the fertile land exists, the near-surface water table associated with a very high evaporation rate has created ideal conditions for soil salinization.

Source: FAO 2011

Box 2.2.2: Rangeland in Jordan, Saudi Arabia and Syria

Rangeland in Jordan covers more than 80 per cent of the country's total area, mainly used for pastoralism and agriculture. It is mostly under tribal rights, which have created land-use conflict and mismanagement leading to overgrazing, land degradation and ultimately desertification. Human impacts through livestock overgrazing are, possibly, the main cause of the land's deterioration, to such a degree that it is no longer able to support the livestock that used to graze there. Practising rain-fed agriculture in semi-arid rangeland has a different land degradation effect, causing soil erosion and dust-storm formation during drought seasons.

A similar situation exists in Saudi Arabia, where rangelands are estimated at 146 million hectares, most of which receives rainfall of less than 100 millimetres per year. About 33 per cent of rangelands are in average condition with dry matter productivity of 88 kilograms per hectare per year, whereas 28 per cent are in poor condition with dry matter productivity of 35 kilograms per hectare per year. Overgrazing and woodcutting continue to be major pressures on these resources despite regulations. It is perceived that better transport, increased access to water points and subsidies given to shepherds and herd owners in Saudi Arabia were the main reasons for rising pressure on rangelands, which in turn led to their degradation by heavy grazing.

In Syria, 10 million hectares of rangelands, officially known as the Badia, represent 55 per cent of the Country's land area. Rangelands are found in the central and eastern provinces of Syria. Within this area, 8–12 million animals, predominantly sheep, are freely grazed by Bedouin communities. The area's contribution to sheep feed requirements in the year 2000 had fallen by more than 50 per cent compared to 1993. The situation is unlikely to have improved since the onset of conflict in the country.

Source: Jordan Ministry of Agriculture 2014; AOAD 2015; IFAD 2012

2.2.2 Pressures on land resources

Pressures on land in the West Asia region are in part a consequence of population growth, inefficient resource management and conflict, and in part to climate and climate change.

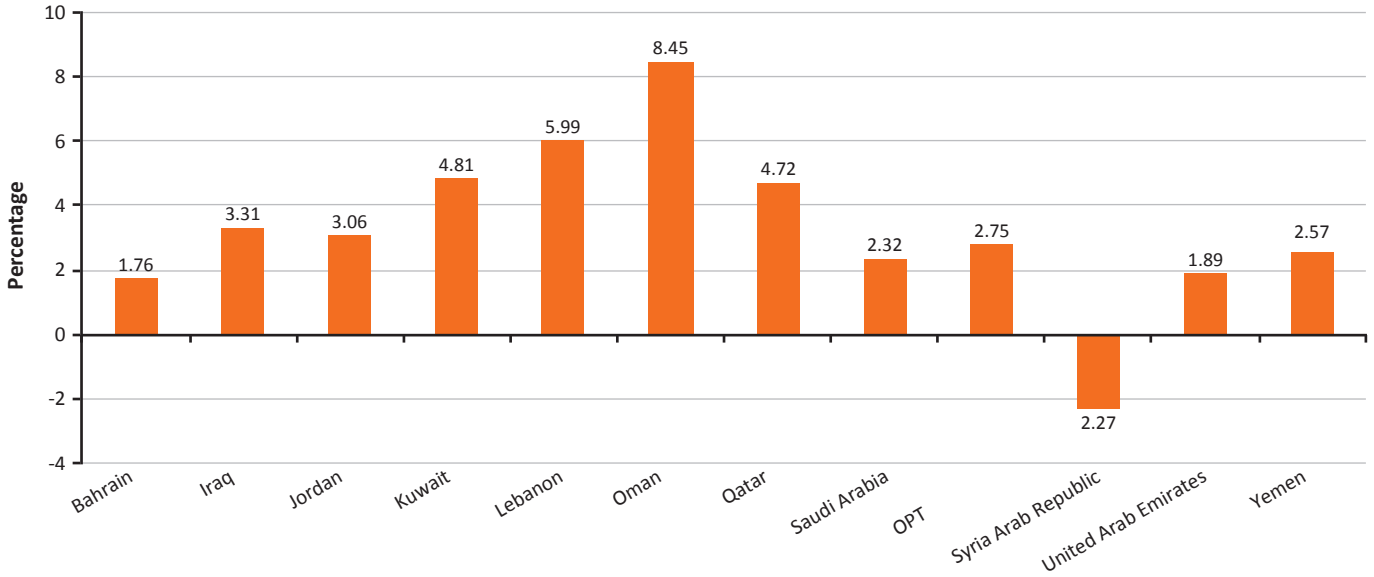
Population growth

Population growth in most West Asia countries, alongside increased urbanisation and industrialization, has resulted in greater demand for water, land and food. Population is expected to increase by 40–50 per cent over the next two decades (Khordagui 2015). Given an annual growth rate of around 3 per cent (**Figure 2.2.1**), the population is expected to reach 205 million by 2030. It is forecast that 78 per cent of the population in West Asia will be urban in 2020 (UNEP 2012). The high population and urban growth rates, together with current consumption patterns, compound pressure on the region's limited land and water resources.

Past and current conflicts

Violent conflicts in the region have caused enormous and massive migration inside these countries as well as across and beyond the region. Millions of refugees and displaced people have been pushed to abandon their lands, which has led to a contraction in supply through a breakdown in production, the destruction of physical capital and the dislocation of labour, thus deteriorating both land and economy.

Figure 2.2.1: Average annual population growth rates, by country in West Asia, per cent, 2010–2015



Source: UN Population Division 2015, World Population Prospects: The 2015 Revision4

Climate change and mismanagement of groundwater resources

The arid and semi-arid climate of the region and climate change constitute major drivers affecting land, resources and humans alike, working as a determinant of land productivity and economic development. The most limiting factor for development is water scarcity, which is expected to reach severe levels by 2025.

What is historically known as the Fertile Crescent – Iraq, Syria, Jordan, Lebanon and the Occupied Palestinian Territories (OPT) – is now likely to fall short of all soil fertility requirements and might altogether disappear before the end of the century, mainly because of a deteriorating supply of water from surface and groundwater sources (Tolba and Saab 2009).

Mismanagement of groundwater resources, coupled with increasing surface temperatures, evaporation rates, and reduced rates of precipitation, has led to salinization of water and soils in several countries of West Asia. The phenomena vary in extent and magnitude from one country to another, and sulphates and chlorides are the main salts increasing in the waters and soils of the region. **Box 2.2.3** provides an overview of salinization of soil and water in Oman and Iraq.

Box 2.2.3: Salinization of soil and water in Oman and Iraq

Since the 1990s the salinity of soil and groundwater has been increasing in two of the major agricultural areas of Oman - Al Batinah and Salala, where values of 30 000 parts per million have been reported for groundwater salinity, significantly reducing farm profitability. Groundwater over-extraction was reported to be the main cause of the problem.

Iraq has experienced the formation of extensive salt crusts on the surface of large areas of agricultural land. This phenomenon results from the reduced mobility of near-surface groundwater, seepages from the Tharthar, Razzazza and Habbaniya lakes in the north towards Mesopotamia in the south, and increased surface temperatures in the region, exceeding 50°C in recent summers.

The elevation of the Mesopotamian Plain of Iraq ranges from less than 1 metre to about 60 metres above mean sea level. The hydraulic gradient, which is a measure of groundwater flow rate, is estimated to be 0.0002 and groundwater mobility is less than 10 metres per year.

The groundwater salinity in this giant flood plain, once considered the most fertile land in the world, is several times higher than that of seawater; up to 200 grams per litre have been recorded compared to 35 grams per litre in seawater. It is noteworthy that about 60 per cent of Iraq's population lives in this region.

The continual decline in water flows in the lower Tigris and Euphrates has led to infiltration of saltwater from the Arabian Gulf into the Shatt Al-Arab River in southern Iraq. The salinity level in this river was recorded at up to 40 000 parts per million in 2009 at the peak of a severe drought, and 12 000 parts per million since then. In 2009 the saltwater reached beyond Basra and further north, about 150 kilometres inland. This has decimated agriculture that relies on the river water, as well as freshwater fisheries, crops, livestock and the famous groves of date palms, which have been abandoned.

2.2.3 Policy responses for land resources management

Currently, land resources management in West Asia is fragmented among different national institutions, leading to inefficient sectoral policies. The accumulative effects of these policies, together with extreme climatic conditions, have contributed to increased degradation of natural resources including soil, forest and rangelands. Sustainable management of land resources requires comprehensive policies backed by all-encompassing national legislation in countries of the region as well as cooperation among countries. The aspired policies and strategies for management of forest, rangeland resources and agricultural soils, should concentrate on securing food in the first place and preserving and enhancing natural resources. In this context, it is perceived that the national action plans for combating desertification must guide activities related to these resources. Special emphasis should be given to capitalising on tradition and local knowledge of land resources, implementing synergistic activities related to combating land degradation, biodiversity conservation and adaptation and mitigation activities related to climate change. Strengthening institutional capacity and updating laws for better planning of land resources remain the crucial issue to sustain these resources. Peace and security are fundamental to move land resource issues from second rank to a place of priority.

Agriculture terrace cultivation on the Saiq Plateau, Oman



Credit: Colourbox/ Wolfgang Zwanzger

2.3 Coastal and marine resources

Key messages: Coastal and marine resources

- More than 40 per cent of the coasts of the GCC countries have been subjected to modification, resulting in significant loss of biodiversity and productivity.
- Discharges from desalination and power plants constitute 48 per cent of the total industrial effluent volume load flowing directly into the marine environment of the ROPME Sea Area.
- Around 20 per cent of mangroves on the eastern coast of Saudi Arabia and about 50 per cent of the coral reefs were affected by oil contamination during that oil spill.
- In the Gaza Strip (OPT), around 60 per cent of sewage effluents are treated and the remaining 40 per cent are discharged to the sea without treatment due to the limited capacity of wastewater treatment plants.
- The rate of exploitation of living marine resources in the region has increased dramatically. Catches of marine fish in the GCC countries, have doubled over two decades.
- It is projected that 83 square kilometres, or 11 per cent of the total land area of Bahrain, would be lost by 2050 as a result of a 0.3 metre increase in mean sea level. Around 23.89 square kilometres of Syrian beaches and agricultural zones could be lost by 2100 through a 1.3 metre rise in sea level. The predicted sea level rise along the Lebanese coastline might increase by 22–45 centimetres by 2050, with severe impacts on economic, agricultural and tourist activities.
- Introduction of aquatic invasive species is considered one of the major threats facing the marine environment in West Asia.
- Several countries have embarked on updating their strategies and action plans according to international targets, however, implementing effective, participatory and updated national biodiversity strategies and action plans, which can contribute to the protection of coastal and marine ecosystems in West Asia, is essential.

2.3.1 Coastal and marine environments in West Asia

Marine environments in the West Asia region can be divided ecologically into three regions: the Regional Organization for the Protection of the Marine Environment (ROPME) Sea Area, which includes Iraq and the Gulf Cooperation Council (GCC) states of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates (UAE); the Gulf of Aden and Red Sea (Jordan, Saudi Arabia and Yemen); and the south-eastern part of the Mediterranean (Lebanon, Syria and the Gaza Strip in the OPT).

The region's coastline totals approximately 14 000 kilometres: 506 kilometres of the Mediterranean Sea, 3 016 kilometres of the eastern Red Sea and the Gulf of Aden, 4 000 kilometres of the Arabian Sea and 6 485 kilometres around the ROPME Sea Area. West Asia hosts some of the world's most important coastal and marine environments with a considerable wealth of biodiversity.

The region is home to habitats such as mangrove stands, coral reefs, seagrass beds, algal beds and productive wetlands including mudflats, saltflats and sandflats. It also supports some of the most vulnerable and endangered species on the planet, including dugongs, with the world's second largest population in the ROPME Sea Area; turtles; dolphins; and Socotra cormorants, with the Hawar Islands in Bahrain hosting one of the world's largest breeding colonies. The region is characterized by high levels of endemism. The

Mediterranean hosts 4–18 per cent of the world's marine species.

In addition to their intrinsic value and role in maintaining biodiversity, healthy coastal and marine ecosystems provide a large array of goods and services vital to human existence. The people of West Asia are socially, culturally and economically linked to the sea. The pearl industry was the mainstay of the economy for the GCC countries before the discovery of oil. Most of the fresh water needs in the GCC countries are obtained from seawater through various processes of desalination. Coastal and marine resources continue to be the principal food source of local communities, and fisheries provide a source of income, employment and recreation while contributing to cultural heritage and food security.

The upwelling that occurs during monsoons supports a valuable fishing industry in the Arabian Sea and Gulf of Aden. Fish production in Oman reached 191 000 tonnes in 2012, with a value of OMR 142 million (USD370 million) (Belwal *et al.* 2015). Fisheries in Yemen support the livelihoods of 3.2 per cent of the national population, and contributed 1.9 per cent of Yemen's gross domestic product (GDP) in 2009 (Alabsi and Komatsu 2014). Fishing in the Mediterranean has grown by about 12 per cent in the last decade, with substantial exploitation of demersal and pelagic stocks (UNEP-MAP RAC/SPA 2010). Lebanon's fishing fleet landed an estimated total of 4 850 tonnes with a value of USD26.98 million in 2011 (Pinello and Dimech 2013).

The tourism industry is also growing rapidly in the West Asia region, at 5–18 per cent per year on average (Gladstone *et al.* 2013). Coastal and marine environments in the ROPME sea area and the Red Sea and Mediterranean provide many opportunities for recreational and tourist activities. The amenities and recreational opportunities for tourism provided by the Mediterranean's marine and coastal ecosystems form the foundation of more than 68 per cent of the total value of economic benefits provided by these ecosystems and about 17 per cent of total international tourist spending (UNEP/MAP 2012). Tourism constitutes around 20 per cent of Lebanese GDP (UN-Habitat 2011). Coral reefs in the Red Sea represent important tourist attraction sites. In 2010, Jordan accounted for 14 per cent of total tourist arrivals in the Red Sea (Gladstone *et al.* 2013).

2.3.2 Pressures on coastal and marine environments

Dredging and reclamation

Coastal and marine environments in the West Asia region have become the focus of a wide variety of industrial, commercial and recreational activities. Rapid economic development, especially in the GCC countries, has resulted in urbanisation and infrastructure expansion proceeding at a fast pace in association with a dramatic increase in the human population (Burt 2014). By the early 1990s, more than 40 per cent of the coasts of the GCC countries had been subjected to modification, resulting in significant loss of biodiversity and productivity (Hamza and Munawar 2009).

The construction of ports and artificial islands through dredging led to changes in topography and bathymetry, alterations in tidal currents and sediment transport pathways, and increases in suspended sediment concentration, organic material, heavy metals and other pollutants *(***Box 2.3.1***)*.

Many valuable coastal habitats including mudflats, mangrove swamps and rocky shores have been lost due to intensive dredging and reclamation activities. Mangrove forests along the coasts of the ROPME Sea Area and the Red Sea are experiencing pressures due to a combination of effects, mostly attributed to large-scale development along the coasts (PERSGA 2004a).

Dredging and reclamation activities have impacts on marine life, including decreasing the abundance and diversity of benthic organisms, degradation of coral reefs and seagrass ecosystems due to sediment runoff and turbidity, and loss of spawning nursery and feeding grounds for fish, crustaceans and wading birds. Dugongs have been heavily affected by marine construction activities that have destroyed large parts of the seagrass beds on which they feed **(Box 2.3.1)**.

Marine water desalination

Due to low precipitation and high aridity, seawater desalination is currently the best option to supply the growing demands for freshwater in the GCC countries. Marine water desalination is widely used in the West Asia region, especially along the coastlines of the ROPME Sea Area and the Red Sea.

The desalination process is associated with several impacts that may physically and chemically alter the characteristics of the receiving marine environment, particularly water temperature and salinity. Discharges are also associated with harmful chemical components including heavy metals and antiscaling and anticorrosion additives.

Box 2.3.1: Dredging and Reclamation Activities in Saudi Arabia, Bahrain and United Arab Emirates



In Saudi Arabia, almost 50 per cent of the mangroves have been lost to reclamation (Spalding *et al.* 2010). The total area of Bahrain was increased by 88.5 square kilometres (13.36%) from 1964-2007 as a result of reclamation activities (Loughland and Zainal 2009). Between 2004 and 2014, around 327.6 million cubic metres of dredged material were utilized to reclaim 62.34 square kilometres of coastal and shallow subtidal areas in Bahrain (Naser 2015).

The United Arab Emirates has witnessed large-scale coastal developments. Artificial islands such as 'Palm Islands' and 'The World' along the coastline of Dubai are considered among the largest artificial islands in the world. Several touristic developments including hotels, resorts and marinas are constructed along the coastline of Lebanon. However, some of these projects are unlicensed developments. The total area occupied by unlicensed developments along the coastline of Lebanon in 2009 is about 4.5 square kilometres (Ladki and El Muouchi 2013).

Satellite imagery for the construction of the large-scale artificial "Palm Islands" and "The World" along the coastline of Dubai, UAE

Source: NASA Earth Observatory/International Space Station Program, October 22, 2006

Alterations in seawater quality, temperature, dissolved oxygen and salt concentration may severely affect several marine organisms and assemblages (Saif Uddin 2014). Discharges from desalination and power plants constitute 48 per cent of the total industrial effluent volume load flowing directly into the marine environment of the ROPME Sea Area (ROPME 2013).

Oil and gas exploration, production and transportation

The GCC countries are considered the largest reserve of oil in the world, with more than 25 000 tankers navigating the ROPME Sea Area each year. The Strait of Hormuz, the Bab Al-Mandab Strait and the Suez Canal are strategically important oil shipping routes. Around 25 000–30 000 ship transits through the Red Sea and Gulf of Aden transport about 7 per cent of global sea-borne oil annually. Oil exploration, production and transportation have been major contributors to pollution in the West Asia region. Sources of oil pollution include offshore oil wells, underwater pipelines, oil tanker incidents, oil terminals, loading and handling operations, weathered oil and tar balls, illegal dumping of ballast water and military activities.

Small-scale incidents of oil pollution are also frequent due to leaks in pipelines, over-flooding of containers, weathered oil and tar balls, and incidents during loading of tankers at the terminals. Chronic oil pollution has already been observed in the immediate vicinity of major ports in the Red Sea and the Mediterranean, as a result of operations at oil terminals. It is estimated that more than 5 000 tonnes of oil have been spilled in the Red Sea. The ROPME Sea Area was the scene of one of the world's major oil-spill incidents: during the 1991 Gulf War, an estimated 10.8 million barrels of oil were spilled in ROPME waters.

Oil pollution adversely affects marine ecosystems by reducing photosynthetic rates, accumulating toxic chemicals in several benthic organisms, and contaminating human food chains with carcinogenic substances. Seabirds and intertidal waders are predominantly vulnerable to oil pollution. Several seabird species suffered severe mortality

Tar balls, a source of oil pollution in the West Asia region



Credit: AlAnoud Alkhatlan

(22–50 per cent) during the 1991 oil spill in the ROPME Sea Area. Around 20 per cent of mangroves on the eastern coast of Saudi Arabia and about 50 per cent of the coral reefs were affected by oil contamination during that oil spill.

Pollution and water quality deterioration

A broad range of pollutants including nutrients, hydrocarbons and heavy metals are being introduced into the coastal and marine environments of West Asia through a variety of routes. Land-based pollution accounts for the larger share, generated mainly by urban and industrial activities.

Discharges of sewage, processing wastes and drainage from urban and industrial facilities are of particular concern. Sewage treatment plants exist in all the countries that

border the sea, but the level of treatment varies and the capacity is not sufficient to deal with existing loads. In the Gaza Strip (OPT), around 60 per cent of sewage effluents are treated and the remaining 40 per cent are discharged to the sea without treatment due to the limited capacity of wastewater treatment plants. High loads of contamination due to sewage disposal can affect the water quality of the coastal aquifer in Gaza Strip.

The coastal area of Lebanon is exposed to a number of chronic anthropogenic stress factors from untreated sewage and industrial effluents, which can lead to high levels of organic pollutants and human pathogens in many locations. Elevated levels of organic pollution were reported in sediments from Tripoli harbour in Lebanon. Signs of eutrophication including red tides were observed in Kuwait Bay and in the coastal waters of Muscat (Oman), Dhahran (Saudi Arabia), Abu Dhabi (UAE) and Bahrain (**Figure 2.3.3**).

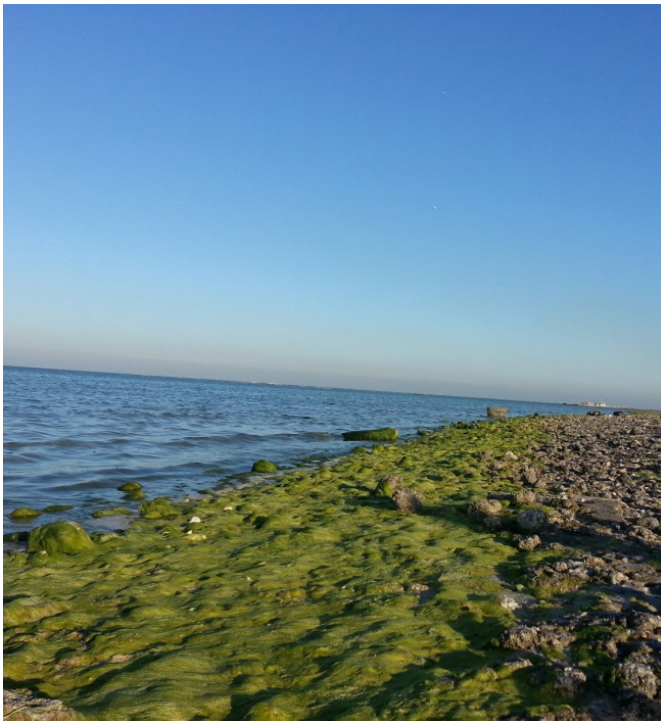
Heavy metal pollution due to continued industrial, agricultural and domestic discharges from major cities such as Jeddah (Saudi Arabia) and Hodeida (Yemen) into the Red Sea can pose a threat to both marine biota and public health. Activities such as oil extraction, shipping, dredging, recreational boating and fishing in the region also cause pollution of the marine and coastal environment.

Overfishing

Human communities in coastal areas depend mainly on fish and other seafood as their primary source of protein. The rate of exploitation of living marine resources in the region has increased dramatically. Catches of marine fish in the GCC countries, for example, have doubled over two decades (**Figure 2.3.1**).

The increased demand coincided with mechanisation of the fishing fleets and the introduction of new technology that enhanced fishing capacity, and pressure on the resource base was further exacerbated by habitat loss and fragmentation associated with coastal development. Consequently, most of the fisheries in the area are either fully or overexploited.

Excessive algal growth due to discharges of secondary treated sewage



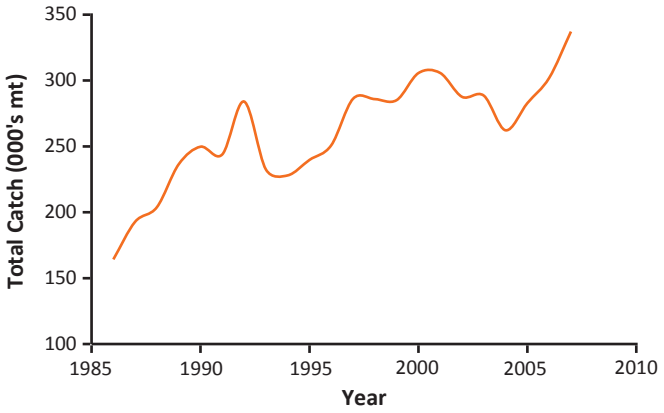
Credit: AlAnoud Alkhatlan

Overfishing is considered to be responsible for the decrease in landings of major commercial species in recent years in Kuwait. Overfishing in the Red Sea and Gulf of Aden has caused declines in catches of finfish, lobsters, scombrids and cuttlefish. Overfishing is also becoming a major threat to the fishing industry in Yemen. Several species are overexploited in the Mediterranean. Due to the high density of fishermen in the Gaza marine zone (723 boats on 660 square kilometres), overfishing is a major threat to the fishing industry.

Climate change

Major threats associated with climate change include the effects of sea level rise and the impacts of increased temperature, salinity and acidification on marine biodiversity.

Figure 2.3.1: GCC countries, landed fish catches 1986–2007



Source: Grandcourt 2012

Warming seawaters can affect all levels of diversity in the marine environment in a number of ways, including changes in the morphology, behaviour and physiology of organisms, recruitment and dispersal of populations, and interactions between ecosystem components.

The increase in the frequency and prolongation of positive seawater temperature anomalies is probably the greatest threat to coral reefs in the ROPME Sea Area and Red Sea. The ROPME waters witnessed massive coral bleaching and mortality in 1996 and 1998, with maximum sea-surface temperatures reaching 37.3°C in 1996 and 38.0°C in 1998.

Sea level rise poses threats on coastlines. Flooding of coastal areas with seawater will reduce agricultural land and destroy economic and population centres. A 1 metre rise in sea level is expected to directly affect 41 500 square kilometres of coastal area, mostly in Kuwait, Qatar, Bahrain and the UAE (**Figures 2.3.2**).

It is projected that 83 square kilometres, or 11 per cent of the total land area of Bahrain, would be lost by 2050 from a 0.3 metre increase in mean sea level (Al-Jeneid *et al.* 2008).

Around 23.89 square kilometres of Syrian beaches and agricultural zones could be lost by 2100 through a 1.3 metre rise in sea level. The sea level along the Lebanese coastline might increase by 22–45 centimetres by 2050, with severe impacts on economic, agricultural and tourist activities.

Sensitive coastal and intertidal ecosystems such as mangroves and mudflats in the ROPME Sea Area and the Red Sea are susceptible to sea-level rise. Climate change, including warming associated with multiple coastal stressors, is associated with the disappearance or reduction of *Posidonia oceanica* meadows in Syrian and Lebanese waters.

Invasive species

Invasive species in the marine environment are globally one of the most serious threats to marine biodiversity. Activities such as shipping, aquaculture and fisheries contribute to the spreading of invasive species into coastal and marine habitats. (Otero *et al.* 2013). Introduction of aquatic invasive species is considered one of the major threats facing the marine environment in West Asia (**More...13**).

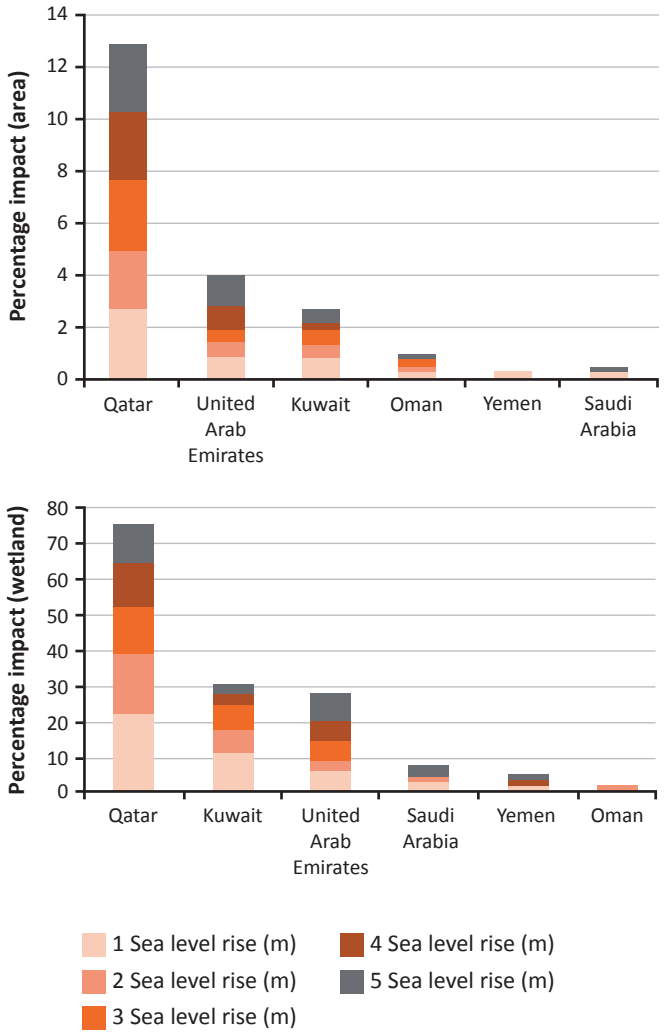
Ballast water is a major source of invasive species. It is estimated that around 2.7 million cubic metres of water from different regions of the world may be transported to ROPME waters and the Arabian Sea each year. Around 14 species have been identified as suspect alien introductions in the ROPME Sea Area. Impacts of invasive species range from displacing native species to altering food-web dynamics and changing habitat type (Naser 2014).

2.3.3 Policy responses for coastal and marine resources management

Strategic planning

Several countries in West Asia, such as Bahrain, Jordan, Iraq, Oman, Qatar, Saudi Arabia and the UAE, are increasingly incorporating environmental concerns, including those related to the marine environment, into their strategic plans and visions. Such initiatives can form important platforms for the management of coastal and marine environments.

Figure 2.3.2: The impact of sea-level rise on selected coastal land areas in West Asia



Source: Tolba and Saab 2009

Implementing effective, participatory and updated national biodiversity strategies and action plans can contribute to the protection of coastal and marine ecosystems in West Asia. Several countries have embarked on updating their strategies and action plans according to the Aichi Targets of the Convention on Biological Diversity.

Integrated coastal zone management

The main long-term objective of integrated coastal zone management is to maintain a balance between the economic benefits of development and human uses of coastal zones, and the functions, dynamics and carrying capacity of coastal and marine ecosystems. While some countries in West Asia have active coastal planning and management programmes, effective implementation of these might be limited.

A key requirement for effective integrated management of coastal zones is the formulation of specific policies that take into account natural and anthropogenic impacts; involvement of all stakeholders is important for the effective implementation of these polices. Several legislative instruments that enable an integrated approach to management are in place in most West Asia countries. However, there is a need to strengthen enforcement of existing regulations. Informed and coordinated management requires integrated coastal and marine spatial planning, which could be facilitated by adopting geographic information system techniques. Capacity building and institutional strengthening might be required in some West Asia countries to enable effective integrated management of coastal environments.

A regional approach to integrated management is the best option to protect and sustain coastal and marine ecosystems. ROPME and the Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA) are playing important roles in coordinating such efforts. The Mediterranean Action Plan, together with the Barcelona Convention and related protocols, form an important legal and institutional framework for cooperation between all Mediterranean countries to address the challenges of environmental degradation and promote sustainable resource management.

Ecosystem-based management

Ecosystem-based management is a comprehensive strategy for the integrated management of land, water and living resources that promotes conservation and sustainable development. This approach aims at achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity. It considers the cumulative impacts of various sources and the balance of conflicting uses, and includes multiple factors such as pollution, coastal development, harvest pressure and other ecological interactions.

Generally, integrated coastal zone and ecosystem-based management are broadly consistent in promoting holistic and adaptive approaches to natural resource management and contributing to sustainable development in coastal areas. However, integrated coastal zone management tends to focus more on the institutional and governance aspects of the coastal zone, while ecosystem-based management tends to present a long-term ecosystem perspective (Haines-Young and Potschin 2011) (**More…14**).

Legal frameworks and environmental impact assessment

A range of environmental legislation related to the protection of the marine environment in West Asia has been developed on the basis of a range of national, regional and international laws, regulations, protocols and conventions. However, the appropriate enforcement of this legislative body is a critical challenge for the region.

Environmental impact assessment is considered a standard tool for decision-making in most countries throughout the world and is frequently used in coastal planning and management. It is increasingly contributing to overall environmental policy and the promotion of sustainable development in West Asia (Naser 2015).

However, several shortcomings need to be addressed in order to further strengthen current assessment systems. These include lack of adequate legal and regulatory frameworks, limited public participation, inadequate guidelines on the assessment procedure, and lack of provisions related to cumulative impacts and strategic environmental assessment. Further integration of environmental considerations related to coastal zones in higher-level decision-making processes may enhance understanding of the consequences of coastal development for the integrity of coastal and marine ecosystems.

Applying the best available technologies to prevent pollution is an essential strategy for protecting coastal and marine environments. These may include adopting environmentally sound technologies for dredging and reclamation to minimise habitat destruction, sedimentation and pollution; installing technology to reduce corrosion during the desalination process; and limiting the environmental impacts of refinery facilities.

Restoration and rehabilitation of degraded coastal and marine ecosystems

Restoration and rehabilitation of degraded coastal and marine ecosystems are important approaches to enhance marine biodiversity and productivity. The approaches may include deployment of artificial reefs and plantation of mangroves. Abundant and diverse communities of reef fish, coral and benthic organisms can develop on artificial structures (Feary *at el.* 2011). Successful mangrove plantation programmes have been reported in Kuwait, Qatar, and in the United Arab Emirates. Large-scale cultivation programmes have been initiated in Abu Dhabi, UAE to mitigate environmental impacts of coastal developments (**More…15**).

Marine protected areas

Marine protected areas (MPAs) are recognized as effective tools for protecting and conserving marine biodiversity. Designation and effective management of MPAs are critical for the protection of coastal and marine ecosystems. Several MPAs have been designated or proposed in the West Asia region. About 38 designated MPAs (18 180 square kilometres) have been established in the ROPME Sea Area, (Van Lavieren

et al. 2011) and a regional network of 12 representative MPAs covering more than 11 000 square kilometres has been recognised in the Red Sea (Goldstone *et al.* 2003). Limited technical capacity and lack of comprehensive management plans for most of these MPAs are the main constraints in the region.

Fisheries management

Fisheries regulations in the West Asia region include banning of trawling, monitoring fishing gear specifications and banning fishing in specific areas in specific seasons. However, the enforcement of management regulations is limited. There are also limitations in the underlying fisheries legislation, which is often designed as a basis for the administration of fisheries rather than a reflection of an explicitly stated policy framework for the long-term management of the sector.

Given the multitude of threats to fish populations and declining trends in abundance, measures to manage fisheries in the West Asia region are needed. These may include setting up networks of effectively managed MPAs to fulfil their potential to achieve a combination of fisheries, biodiversity conservation and socio-economic objectives. Fish-stock assessment studies are required to define the targets for fisheries management. By-catch and discards also need to be addressed. Establishment of integrated monitoring programmes in the ROPME Sea Area and the Red Sea, and the application of the precautionary approach to the management of fisheries resources can contribute to the efforts of marine conservation. Regional-level strategies are required to manage highly migratory species.

Ecotourism

Ecotourism can provide local economic benefits while maintaining ecosystem integrity. The West Asia region has witnessed several initiatives to promote ecotourism programmes, particularly in the Red Sea. The Aqaba Ecotourism Development Plan (2014) is a major initiative aiming at promoting biodiversity-friendly investment and development of the Aqaba Special Economic Zone(UNDP 2014).

Valuation of ecosystems services

Valuation of ecosystem services is an essential effort in protecting biodiversity and promoting the conservation of coastal and marine environments among all stakeholders. The economic value of ecosystem services provided by the Saudi Arabian Red Sea coral reefs is estimated to be around USD7 000 per square kilometre (Hoagland *et al.* 2013). The contribution of biological processes to carbon sequestration has been found to range between EUR100 million and EUR1 500 million per year for the Mediterranean Sea (Canu *at el.* 2015). The economic loss of not effectively protecting wetlands in the West Asia region by 2050 is estimated at USD2.3–7.2 billion (Eppink *et al.* 2014).

Capacity Building

Building capacity towards scientific research in the field of environment and conservation biology is important in order to effectively conserve and manage marine ecosystems. There is therefore a need for improvement in the number and quality of programmes related to marine sciences in higher education.

2.4 Biodiversity

Key messages: Biodiversity

- There is considerable wealth of both aquatic and terrestrial biodiversity components in West Asia, well adapted to the arid environment. These biological resources support people through products and services. The potential of this natural wealth is not fully explored and should be embraced from an eco-disaster risk-reduction perspective as well as a valuation perspective.
- Current conflicts and instability have resulted in environmental impacts that put biological resources at risk resulting in a number of critical challenges to biodiversity, causing further biodiversity degradation. Presently, the region's biodiversity is under threat, and is principally vulnerable to anthropogenic pressure in the form of urban expansion, pollution, overconsumption of biological resources beyond the biocapacity of ecosystems, and modification of habitats. The dual effect of continued anthropogenic activities and climate change will further undermine biodiversity.
- Reducing the direct pressures on biodiversity and promoting sustainable use require that conservation policies be integrated into national and regional planning, implementation and regulatory frameworks. In this regard, capacity building in biodiversity planning, information management, and enforcing laws and regulations are key tools for the conservation and sustainable use of biodiversity in the region.
- Conservation of biodiversity requires a collaborative and regional approach. Joint research, information sharing and collaboration between the countries of the region are crucial for developing solutions for better conservation and sustainable use of biodiversity and transboundary resources.
- West Asian countries have become signatories to biodiversity-related international agreements, with 11 countries having developed and in the process of updating their policy instruments. Nevertheless, the pace remains slow, owing to the overwhelming nature of the task for government officials and the lack of effective implementation mechanisms.

2.4.1 Biodiversity in West Asia

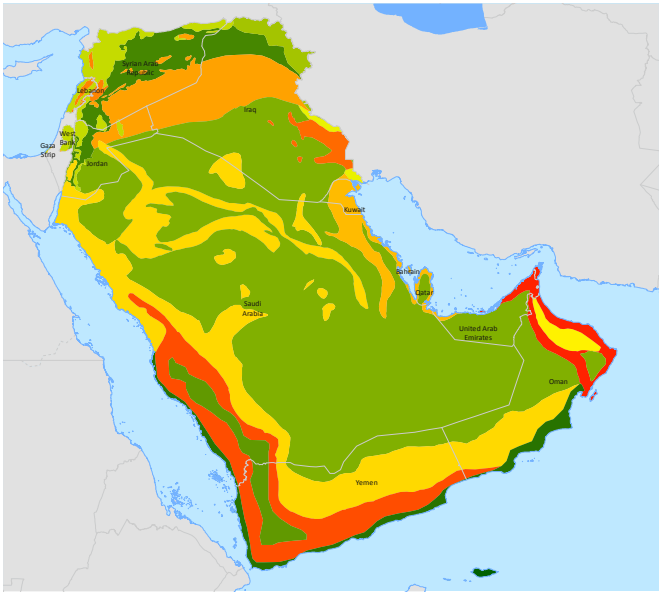
The West Asia region has a considerable wealth of biodiversity encompassing unique terrestrial and aquatic ecosystems. West Asia is home to Mediterranean forest in the north and sandy desert in the south – the Empty Quarter, Al-Rub Al-Khali. Between these two extremes various ecosystems are determined principally by harsh climatic conditions and a range of landforms **(Figure 2.4.1)**. West Asia also has two distinctive World Heritage Sites, Wadi Rum protected area in Jordan and the Socotra Archipelago in Yemen (UNESCO 2015; Abulhawa *et al.* 2014) (**More...13**).

Terrestrial ecosystems

Terrestrial ecosystems have largely been classified as 'least threatened'. The principal exceptions are the three habitat types in West Jordan, all of which are classified as threatened. Most notably, the Forest and Non-Forest Mediterranean Ecosystems are both endangered and in need of further protection.

The Euphrates and Tigris are the two major freshwater ecosystems that feed the Mesopotamian marshlands – the largest wetlands in West Asia – eventually joining up to form

Figure 2.4.1: Ecological habitat map of the Arabian Peninsula



Terrestrial Ecoregions

- Al Hajar montane woodlands
- Arabian Desert and East Sahero-Arabian xeric shrublands
- Arabian Peninsula coastal fog desert
- Eastern Mediterranean conifer-sclerophyllous-broadleaf forests
- Gulf of Oman desert and semi-desert
- Mesopotamian shrub desert
- Middle East steppe
- Persian Gulf desert and semi-desert
- Red Sea Nubo-Sindian tropical desert and semi-desert
- Socotra Island xeric shrublands
- South Iran Nubo-Sindian desert and semi-desert
- Southern Anatolian montane conifer and deciduous forests
- Southwestern Arabian foothills savanna
- Southwestern Arabian montane woodlands
- Tigris-Euphrates alluvial salt marsh
- Zagros Mountains forest steppe

Source: Olson *et al.* 2001

the Shatt Al-Arab waterways. Other minor rivers include the Asi-Orontes, Litani and Afrin, which feeds into the Mediterranean Sea. The Jordan River enters Lake Tiberias and ends at the Dead Sea. These rivers, along with a number of natural lakes and hundreds of natural springs in the Mashriq countries, have created unique riparian ecosystems.

Marine ecosystems

The region is surrounded by major saline water bodies: the Red Sea, the Sea of Oman, and the Regional Organization for the Protection of the Marine Environment (ROPME) Sea Area. Relatively rich biodiversity exists in these major seas and along their coastal areas. Such diverse terrestrial and marine ecosystems provide products and services to the people of the region as well as to the international community.

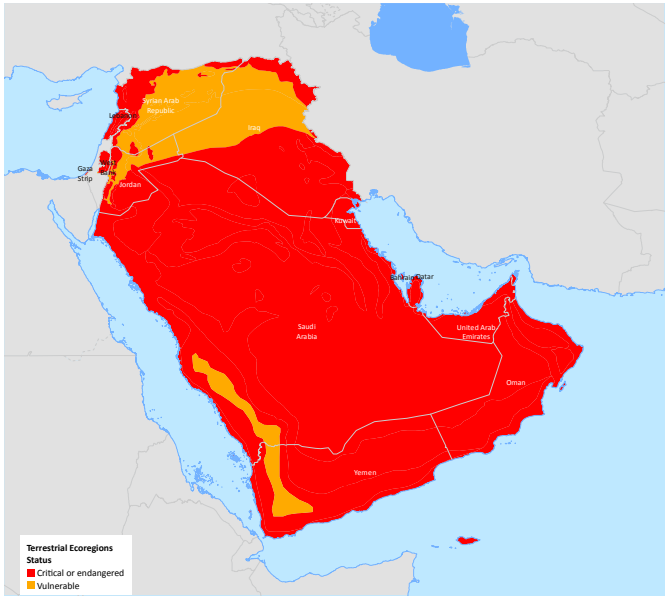
A number of globally important biodiversity features, including wetlands and marshlands, support a large population of migratory birds. Furthermore, coastal and marine habitats, especially mangroves, salt marshes and coral reefs, and the region's populations of dugongs, are also of global importance, particularly in light of global declines in species and degradation of ecosystems.

Seagrass beds are one of the Gulf's most productive coastal ecosystems and cover large areas of shallow water habitats (less than 15 metres deep) throughout the ROPME Sea Area. Of the world's more than 50 species of seagrasses, three occur in ROPME waters. About 9 per cent of the Gulf's faunal taxa have been estimated to occur in its seagrass meadows, around half of which are molluscs. Seagrasses also sustain the world's second largest population of the vulnerable dugong (Preen 2004) and are important foraging areas for the endangered green turtle (Sheppard *et al.* 2010).

Most coastal ecosystems in Arabia have been classified as vulnerable, having lost significant portions of their original extent, and in need of further representation in the protected area network. Coral reefs in the Gulf, Gulf of Aden and Gulf of Oman, for example, are all critically endangered. Mangroves and seagrass and macro-algal beds are similarly threatened.

The shallow water habitats within the Red Sea and western Arabian Sea are generally less threatened, as are the deeper water habitats in all eco-regions (**Figure 2.4.2**).

Figure 2.4.2: Ecosystem threat in the Arabian Peninsula



Source: Olson *et al.* 2001

Mangrove ecosystems

Black mangrove occurs in the ROPME Sea Area, and it seems likely that the red mangrove may have grown there in historical times (Tengberg 2002). The latter still grows naturally along the Red Sea coast of Saudi Arabia in 104 locations with an estimated total area of 3 452 hectares (NCWCD/ PERGSGA 2015). The environmental benefits of these systems include provision of habitat for many species of fishes, birds and invertebrates, as well as naturally storing carbon over millennia. While habitat restoration initiatives have led to an increase in the mangrove areas in the southern Gulf, mangrove ecosystems along the coasts of Arabia as a whole are dwindling in size and becoming fragmented. Nearly 40 per cent of the mangrove area along the coasts of the ROPME Sea Area has been lost during the past few decades. Losses in wetland areas was noted to vary between 0.01 per cent and 29 per cent, with the highest loss recorded in Jordan and the lowest in the UAE, both of which are considered the highest in terms of vulnerability (CBD 2015).

Economic losses due to biodiversity degradation vary from one country to another in the region. The cost of degradation is associated either with coastal development, land conversion and mining or with low investment in habitat conservation. For instance, for Bahrain, with the highest relative risk in terms of wetland loss, annual welfare losses were estimated at USD865 000 in 2015 (CBD 2015).

Coral reefs

Coral communities in the inner ROPME Sea Area are low diversity assemblages dominated by relatively stress-tolerant species. These corals have been shown to house a unique species of coral-associated symbiotic algae that confers superior thermal tolerance, prevalent in the Gulf but unknown outside the Arabian region (Hume *et al.* 2015; D'Angelo *et al.* 2015). As a result of this unique coral-algal association, corals from the Gulf tend to experience lower levels of bleaching and mortality at elevated temperatures than corals from other regions (Hume *et al.* 2013), with bleaching thresholds several degrees above that normally observed in the tropics (Riegl *et al.* 2011).

The north-eastern Arabian Peninsula contains several unique biogeographic provinces for coral. Although tending to be more resilient than in other regions, the thresholds have been reached for certain coral reefs in north-eastern Arabia, which have undergone considerable decline in recent decades as a result of both global climate impacts and local pressures. Unusually warm sea temperatures associated with an El Niño event in 1996–1998 resulted in the loss of more than 90 per cent of corals from many parts of the ROPME Sea Area through coral bleaching . Weaker but recurrent bleaching events were also observed in the Gulf in 2002,

2007, 2010 and 2012, limiting the recovery of ecosystems that had been devastated in the late 1990s (Riegl and Purkis 2015). Coastal development and dredging associated with ports and industries have also resulted in substantial loss of live coral from a number of Gulf countries, directly burying or removing reefs or indirectly affecting them through sedimentation and hydrodynamic changes.

In the Gulf of Oman, coral loss has mainly been associated with recurrent outbreaks of predatory starfish, the 2007 cyclone Gonu, a 2008/2009 harmful algal bloom, and damage caused by fishing activities (Coles *et al.* 2015). The condition of coral reefs across the region has declined markedly in recent decades, but there is currently only limited information available on the location and condition of specific coral habitats. Regional mapping and assessment efforts are required to determine the status of coral reefs and to prioritise future conservation and management efforts (Burt *et al.* 2015).

Rich and diverse vegetation

West Asia has rich and diverse vegetation distributed in different habitats includinghigh mountains, upland plateaus, inland, riverine and coastalplains, sand deserts and wetlands (EOAR 2010).

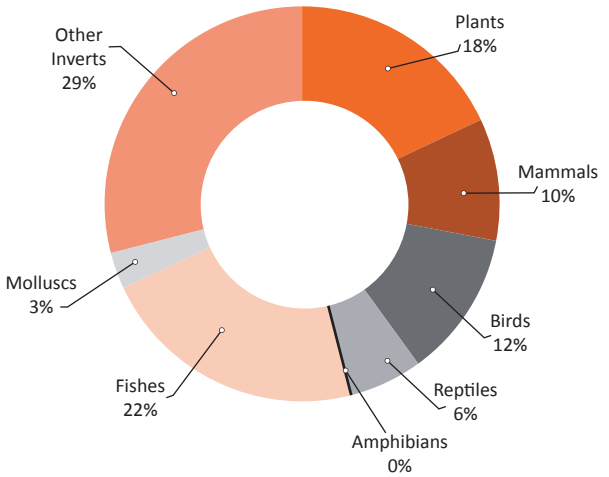
Five major phytogeographic regions, the Saharo-Sudanian regional zone, the Irano-Turanian, Somali Masai and Mediterranean regional centres of endemism, and the Central Asia region cross this territory and house more than 5 500 endemic species. This region also forms a centre of diversification of several genera, notably in the Asteraceae (sunflower), Caryophyllaceae (pinks and carnations) and Lamiaceae (mint) families. It is a very important region for landraces and wild progenitors of our crops, including cereals, pulses, oil- and fibre-yielding plants, vegetables and fruits, all of which need research and protection (Zohary *et al.* 2012).

West Asia is not yet fully explored botanically. The floras of many of the countries are outdated or incomplete and very few have a red list of plant species (Ghazanfar and McDaniel 2015). However, indications of the region's rich biodiversity can be found in the many wild relatives of fruit trees found in Lebanon, Jordan and Syria. These species and genera have adapted to harsh conditions including extremes in temperature combined with extended drought and low soil fertility. They are excellent resources for future research into rootstocks for, among other characteristics, dwarfism and drought or calcareous soil tolerance. Medicinal plants are widely distributed in Jordan and are massively used by local people in folk medicine as hot or cold drinks, and are chewed fresh or as dry raw materials.

Decline of species

According to the IUCN Red List of Threatened species 2015, 22 per cent of West Asian fishes are threatened while the number of threatened animals reaches 10 per cent. The list includes taxa from all countries of the region and in all categories except amphibians, (**Figure 2.4.3**), reflecting the threat that species are facing in the region.

Figure 2.4.3: West Asia's threatened species, by category



Source: IUCN Red List 2015

In the Arabian Peninsula, for instance, the two countries which have the highest levels of endemic plants, Yemen (including the Socotra Archipelago) and Oman, have Red List assessments of plants; listing 699 endemic taxa (69 per cent of the endemic flora of this area), of which 476 have been assessed for the global IUCN Red List.

Of these, 220 are threatened with extinction, with 20 classed as critically endangered, 38 as endangered and 162 as vulnerable.

In Bahrain, two of the seven species of marine turtle - the hawksbill and the green turtle - occur in the waters of the ROPME Sea Area. Worldwide, the IUCN Red List classifies the hawksbill turtle as critically endangered and the green turtle as endangered. At the local and regional level, the populations of these species are threatened and the number of foraging habitats and nesting grounds are continually declining.

At least 21 species of cetaceans are known in West Asia. Only a few of these have been studied in any detail. One example is the humpback whale, the distribution of which appears to be centred in the Arabian Sea of Oman. Humpback whales are also known to occur, albeit less regularly, in the ROPME Sea Area, Oman Sea and the Red Sea. Estimates of the Arabian Sea humpback whale population from studies in Oman suggest that fewer than 100 individuals remain.

Increasing threats from human activities cause this population to be in danger of extinction and urgent conservation action is required. The only other population data for cetaceans in the region is an assessment of trends for dolphins in the ROPME Sea Area, in which a statistically significant decline in the population – of more than 70 per cent – was documented over a period of little more than a decade.

In Iraq, where habitat modification in the form of water diversion, dredging, pollution and overfishing are contributing to species loss, 20 freshwater fish species are threatened, constituting 50 per cent of the native freshwater fish species in the country.

Whilst it is true that plants can be cultivated elsewhere and saved from extinction, the cultural history that a plant carries with it in its native habitat cannot be maintained through cultivation in another region. There are several examples of plants used in traditional medicine in the region that are now threatened due to overharvesting.

2.4.2 Pressures on biodiversity

Encroachment on natural habitats

The rapid increase in population coupled with unprecedented growth in urbanisation puts pressure on biodiversity through encroachment on fragile natural habitats. For instance, in the Gulf, urbanisation coupled with coastal development involving intensive reclamation and dredging activities is leading to habitat destruction and biodiversity loss (Halpern *et al.* 2008; Van Lavieren *et al.* 2011). It is estimated that more than 40 per cent of the Gulf coast has been developed (Hamza and Munawar 2009) due to rapid economic, social and industrial growth (Halpern *et al.* 2008). This comes as a result of the shortage of available land in some countries and relatively inexpensive reclamation costs (Burt *et al.* 2012).

In the Mashriq countries, a significant portion of the East Mediterranean coastal landscape has undergone a concentration of populations and economic activities. For instance, 55 per cent of Lebanon's population is concentrated in five large cities along the coast. This negatively affects biodiversity and natural ecosystems (Lebanon, Ministry of Environment 2010). It has been reported that numbers of plant species and plant families in the waterfront of the city of Beirut have been reduced by almost 64 per cent and 75 per cent respectively compared to 1930s numbers (Chmaitelly 2007).

Mass-scale development affects the hydrology of coasts and natural coastal features such as mangrove swamps, reefs and beaches, leading to biodiversity loss. This is shown in the tourism development on the Red Sea and in many coastal areas of the Gulf Cooperation Council (GCC) countries (Gelil 2008). Increasing investment plans for

tourism developments are ultimately expected to induce environmental impacts on a regional scale (PERSGA 2005).

Marked by the rapid expansion of cities and high levels of urbanisation, the region is undergoing various social, economic and demographic changes. The GCC countries' average ecological footprint (5.7 hectares per person) exceeds the global average of 2.6 hectares per person (Saab 2012),with the highest ecological footprints in West Asia recorded in Kuwait (9.7) and Qatar (11.7), while the lowest are in the OPT (0.5) and Yemen (0.9) (Saab 2012).

Rising trends in population and urbanisation and the many large ecological footprints negatively affect biodiversity in the region. These effects can be seen in the form of degradation and fragmentation of ecosystems, dredging and land reclamation activities, and decline of species **(Box 2.4.1)**.

Conflicts and social unrest

Political instability and the toll it is taking on human well-being and social dynamics – at both regional and national levels in various parts of West Asia – have resulted in environmental impacts that put biological resources at risk. Armed conflict and post-conflict relapse pose a number of critical challenges to biodiversity, causing further biodiversity degradation. The negative impact of instability on biodiversity and protected areas has been observed in several West Asian countries such as Iraq, OPT, Syria and Yemen. In Syria during the period 2011–2015 it was reported that 1 880 fires burned through natural ecosystems and protected areas, with negative impacts on wildlife, clearly seen through the local extinction of the critically endangered northern bald ibis and the loss of enormous numbers of Arabian oryx in Palmyra.

Climate change

Biodiversity is affected by climate change through shifting habitats and migrations of species. Alteration of distribution ranges is a consequence of rising temperatures and diminishing rainfall **(Figure 2.4.4)**.

Box 2.4.1: Land reclamation in Bahrain

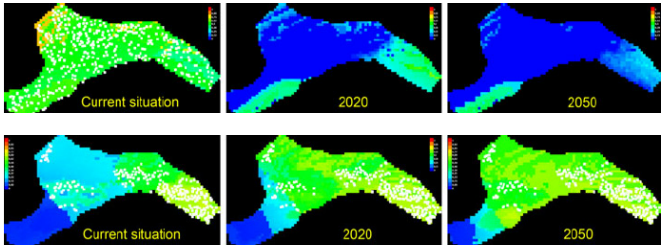
In Bahrain, more than 80 per cent of the coastline has been extensively modified, with land reclamation adding 11 per cent to Bahrain's total land area. Dredging and reclamation activities have resulted in the loss of prime mudflats supporting shorebird populations, degradation of coral reefs due to sediment runoff, increased levels of turbidity, and loss of seagrass beds due to direct physical removal and burial. Deposited dredged material may result in physically smothering the coastal and sub-tidal habitats and thus deoxygenating the underlying sediments. The area of Tubli Bay has decreased by 60 per cent since the 1950s.



Modification of Bahrain's coast by reclamation and dredging between 1973 (dark shading) and 2012 (light shading).

Source: Burt *et al.* 2012

Figure 2.4.4: Geographical distribution of *Salsola vermiculata* (above) and *Haloxylon salicornicum* (below) in the Syrian Badia under the present climate and the HADCM$_3$ global circulation model for 2020 and 2050.



Source: Louhaichi and Belgacem 2015

A northern and high-altitude species migration is expected due to these changes. A shift in species distribution may affect the integrity of plant as well as animal communities, making them more fragile and prone to external effects and the invasion of pest species. For instance, a change in the hydraulic regime will push the historic cedar of Lebanon to the edge of its habitat tolerance as reductions in snow cover of 40 or even 70 per cent are projected by 2040 under increases in temperature of 2°C and 4°C respectively (Lebanon, Ministry of Environment 2010). Other forest species are considered vulnerable Among the most important climate change impacts is a decline in the capacity of traditional agro-biodiversity systems to provide food, forage and environmental services to local communities.

Coastal and marine ecosystems will be affected by climate change. The dual effect of sea level rise and land reclamation associated with urbanisation, especially in lowland areas along the coasts of Arabia, will have a negative effect on marshland habitats and mangrove ecosystems. This in turn may adversely affect migratory and resident populations of birds. Coral reefs in the marine bodies of the region will be affected by the rise of sea level and possible salinity increase.

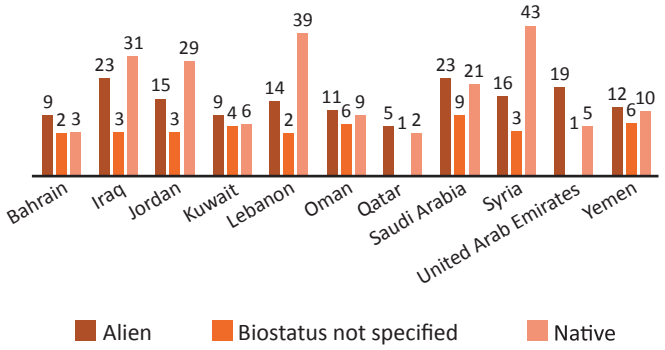
Invasive species

Invasive alien species are common in the region's terrestrial, marine and freshwater environments. Although accurate and up-to-date data and information on these invasions are lacking, they are considered a major threat to all types of ecosystems and species as well as to human welfare in West Asia.

In 1999 the Global Invasive Species Programme (GISP) database listed a total of 394 invasive species in the countries of the region. Some 41 per cent of them were classified as aliens and 48 per cent as native, while the bio-status of 19 species was yet to be identified. At the regional level the number of invasive cross-referenced species was 169, of which 69 were aliens, 81 native, and 19 had unidentified bio-status (**Figure 2.4.5)**. These species affect ecosystems and cause economic damage.

The cost of eradicating unintentionally introduced invasive species such as the red palm weevil may reach up to USD26 million in the region for a 5 per cent farm infestation (El-Sabea *et al.* 2009). There are no signs of reduction in this pressure on biodiversity and there are indications that it is increasing. A gap in knowledge exists in the identification of invasive taxa and introduction pathways, and in the assessment of associated risks and management plans.

Figure 2.4.5: West Asia invasive species by country, 1999



Source: GISP 1999

Degradation of ecosystems

Habitat destruction is one of the major impacts of human activity, together with associated effects including species loss, genetic loss and simplification and deterioration of ecosystem services. Habitat degradation puts at risk a whole range of species – estimated to number 1 166 (IUCN 2015), including neglected crops and wild relatives of fruit trees and other plants found in extreme environmental conditions, such as in Jordan, Lebanon, Syria and Iraq, all of which hold genes that are considered important resources for future research on new crop varieties (Gurevitch and Padilla 2004; Lebanon 2009; Syrian Arab Republic 2009; CBD 2014;). In most West Asian countries, there is a high risk of losing habitats such as wetlands, forests and coastal areas due to overgrazing, wood harvesting, conflicts, and droughts and desertification. One of the main reasons is the low investment in wetland conservation and marine protected areas (Eppink *et al.* 2014).

Overriding the carrying capacity of ecosystems

The biocapacity of terrestrial ecosystems in the region has been surpassed many times over. Wood cutting, overgrazing and illegal hunting contribute to the degradation of biological resources and remain the most significant threats to the vegetation in this area (IUCN WDPA 2012).With forests and woodlands covering only about 1.9 per cent of its total land area, West Asia's forests account for 0.6 per cent of the world total (FAO 2014). In the region, only Lebanon has more than 10 per cent forest cover and nine countries have forests that cover less than 1 per cent of their total land area.

These ecosystems are not well managed and are particularly prone to fires and wood cutting. Intensive grazing practices are still a common source of livelihood in some countries of the region. Overgrazing leads to land degradation and soil erosion, decreases land productivity and threatens wildlife, as has happened in Jordan. In all of West Asia, local communities depend on economic and medicinal plants for subsistence, health care and bioprospecting (CBD 2014),with high numbers of aromatic and medicinal plant species widely distributed in Jordan, Lebanon, OPT and Syria (Syrian Arab Republic 2009). These are massively used by local people in folk medicine (Grandcourt 2012), which is causing serious threats to natural habitats.

Even though hunting is regulated in all West Asian countries, illegal hunting remains common in the region, with twice as many illegal hunters as legal ones (Merlo and Croitorou 2005). The main reasons for hunting include sport, the use of animals in traditional medicine and as a source of food, and illegal trade in exotic animals. For example, in Iraq, hunting has been the main source of income for most rural and urban communities, resulting in the loss of many wild species including globally endangered ones (Republic of Iraq 2014). The application of regulatory measures is hindered in most countries by weak law enforcement coupled with inadequate implementation mechanisms and tools.

The status of marine biodiversity is not much better than that of terrestrial ecosystems. Studies have now suggested that fishery resources are overexploited and that regional management of marine resources is underdeveloped. Threats to species from overfishing and by-catch are increasing and are exacerbated by rising fishing capacity and effort, particularly in the dominant artisanal fisheries. It is reported that as many as 98 species of fish are currently overfished in the Gulf, especially the majority of demersal species (Grandcourt 2012). Illegal fishing methods in the eastern Mediterranean Sea such as the use of poison, dynamite and electrical devices are also commonplace (UNEP 2010). Although statistical catch data remain inaccurate in the region, recent reports suggest that many of these fisheries are unsustainable and require immediate action (De Young 2006).

Despite the existence of institutional and legal mechanisms for fisheries management, a series of problems have been identified (PERSGA 2002). The existence and magnitude of the problems vary from country to country. A general but non-exhaustive list includes: shortage of qualified staff and lack of financial resources to increase their number; shortage of operating funds for existing institutions; outdated and inefficient legislative and management frameworks and, in particular, lack of strength and clarity in the laws for effective management, monitoring, control and surveillance, all of which contribute to a lack of or poor enforcement of fisheries

laws and ineffective sanctions for violations to the law; lack of co-management systems and integrated coastal zone management approaches; and high illiteracy rates among fishing communities.

Illegal trade in wildlife

Globally, the illegal trade in wildlife has recently reached unprecedented levels, estimated to be worth USD20 billion a year (CITES 2015). The surge in illegal trade has been documented in the West Asia region, with countries such as Jordan, Syria, the United Arab Emirates (UAE) and Yemen serving as transit hubs for smugglers from and to African and Asian countries (Jabado *et al.* 2015; Abido 2010).

Each year, hundreds of millions of plants and animals from tens of thousands of species are killed, caught or harvested from the wild and then sold as food, pets, ornamental plants, leather, tourist trophies and curios, and medicine. While a great deal of this trade is legal and is not harming wild populations, a worryingly large proportion is illegal and threatens the survival of many endangered species. Products being traded include birds, python skins, reptiles, tigers, and ornamental and medicinal plants such as oregano and sage. In Jordan, 23 per cent of traded bird species are listed in CITES appendices II and III, whereas one species of reptile is listed by CITES (Eid *et al.* 2011).

One study in Saudi Arabia found the price of birds to range from USD2 for a common quail to USD7 332 for a peregrine falcon, whilst for mammals, it ranged from USD27 for a cape hare to USD800 for a grey wolf (Aloufi and Eid 2014). Regulatory measures are in place for most of the region, but implementation mechanisms are still lagging behind. Trade in wildlife species disturbs biological resources as part of a linked ecological system, causing remarkable changes in this system and having profound effects on local communities and their ecosystems (Gurevitch and Padilla 2004) (**Box 2.4.2**, Aloufi and Eid, 2014).

2.4.3 Policy responses for biodiversity management

Biodiversity provides many key benefits to humans; hence losing it has negative impacts on several aspects of human well-being, including food security and access to clean water and raw materials, all of which affect human health. For instance, salt marshes are considered to be transporters of nutrients between land and water. They remove pollutants and pathogens from natural wastewater before it reaches coastal waters and estuaries, thus contributing to water quality. As a result, West Asian countries are showing increasing commitment to biodiversity conservation.

Joining international efforts to conserve biodiversity

West Asian countries have joined biodiversity-related agreements, with 11 countries having developed and in the process of updating their policy instruments in this regard (**Table 2.4.1**). Nevertheless, the pace remains slow, owing to the overwhelming nature of the task for government officials and the lack of effective implementation mechanisms.

Research and development

The management and conservation of important regional terrestrial and marine ecosystems have been hampered by the limited availability and/or low quality of scientific data that could be used to drive management and policy-making decisions. For example, despite the Red Sea containing coral reefs that are hotspots of endemism, and ecosystems in the ROPME Sea Area that can serve as models for the study of life in extreme environments, scientific publication on the region's reefs is limited compared to that of other regions (Berumen *et al.* 2013; Burt 2013).

Furthermore, aside from the high variability in the amount of science being performed, research in the region has generally focused on some of the most iconic or commercially important species, while many of the more threatened species have received scant attention and little is known about their status, distribution or taxonomy.

Box 2.4.2: Addressing illegal wildlife trade in Saudi Arabia

In order to protect wild species of fauna from hunting for the purpose of trade, several laws and regulations have been promulgated by the government of Saudi Arabia. In 1989, a hunting law was established which banned hunting without a license, defined regulations governing such practices and identified the consequences of non-compliance through a set of penalties. In 1996 the government of Saudi Arabia acceded to CITES, which regulates international trade in listed species, and CITES legislation was introduced in 2001. Despite the presence of laws and regulations controlling wildlife trade in Saudi Arabia, there have been few reports of violations or ensuing prosecutions relating to illegal trade, or of its magnitude or any associated conservation implications.

A study performed by Aloufi and Eid (2014) shows the urgent need to strengthen law enforcement as well as establish an awareness campaign to conserve the country's threatened species. In order for law enforcement of wildlife trade to be an effective conservation tool, it is crucial that the implementing agencies recognize the scale of national trade in animal species, especially birds, which constitute the majority of specimens traded in the market.

Table 2.4.1 West Asia, parties to biodiversity-related conventions (CBD 2015)

Country/ convention	Convention on Biological Diversity (CBD)	Cartagena Protocol on Biosafety	Nagoya Protocol on Access to Genetic Resources	International Treaty on Plant Genetic Resources	Convention on International Trade in Endangered Species (CITES)	Convention on Migratory Species (CMS)	Ramsar Convention on Wetlands
Bahrain	x	x					x
Jordan	x	x	x	x	x	x	x
Iraq	x	x		x	x		x
Kuwait	x			x	x		x
Lebanon	x	x		x	x		x
Oman	x	x		x	x		x
Qatar	x	x		x	x		
Saudi Arabia	x	x		x	x	x	
OPT	x						
Syria	x	x	x	x	x	x	x
UAE	x	x	x	x			x
Yemen	x	x		x	x	x	x

Information is difficult to obtain without undertaking field surveys, which are labour-intensive and require long-term projects. Moreover, many of the studies undertaken in the region form the basis of environmental impact assessments that are often confidential, so the results cannot be disseminated. Meanwhile results from other projects are rarely disseminated or published in peer-reviewed journals.

Knowledge and human capital for evidence-based decision making

The gaps in knowledge in the region are hindering evidence-based decisions, resulting in a major drawback on sustaining biological resources. Scattered databases and grey literature in addition to working documents must be collated through regional or sub-regional initiatives. It is important to mobilise West Asian citizens to play a role in biological resource conservation, thus infusing it into societies and transforming social dynamics, in addition to creating potential for various opportunities, such as the creation and promotion of green jobs. The handful of citizen science initiatives that currently exist in the region are proving that short-term initiatives involving citizens are very successful. For example, in Qatar, a project used smartphone technology to bring the public and researchers together to create awareness in addition to mapping the countries' mangrove forests and the flora and fauna that inhabit them.

By 2050, it is projected that there will be 100 million young people in the Middle East and North Africa region, approximately half of which will be in West Asia. Countries in the region are known to be home to the youngest populations, for example in Jordon more than 70 per cent of the population is under 30 years of age (Jordon 5NR 2015). Investment in youth can therefore be an instrument for national development and sustainability. The scientific deficit in GCC countries is also noted to be substantial, both in terms of research activity and advanced education, with few scientists, minimal research funding, despite the countries' wealth, and limited research output (Van Lavieren *et al.* 2011).

Financial resources to implement plans

The availability of financial resources for biodiversity conservation – rather than the compliance of Parties to biodiversity conventions – is still the key to successfully increasing implementation. West Asia includes developing countries that depend on donors to support the development of a framework of priorities and plans and their implementation. Financial support for biodiversity conservation is essential for addressing the key gaps identified in national biodiversity strategies and action plans.

Protecting woodlands and other plant habitats

Most of West Asia's Terrestrial Protected Areas (TPA) have been established for the protection of terrestrial animals and very few for the protection of woodlands or other plant habitats. Although nature reserves also provide protection to plants, many in special niche habitats are neglected, especially endemic or near-endemic species, and many comprise small populations of relict species. Such species provide important information on the biogeography, evolutional history and past climates of a region, and are worthy of protection for both in and ex situ programmes.

In some parts of the region, for example the Arabian Peninsula, the protection of plants has been done through an old system of designated areas called hema that provide rotational use of plants, mainly for fodder. However, hemas have declined rapidly in the last 50 years, especially in Saudi Arabia as a result of changing life styles; in addition, hemas do not provide full protection, especially to species that are endemic and rare and may be present outside the hema. This system, though functional in conserving biodiversity in years gone by, is not sufficient to protect the plant diversity of today. New methods for protection and conservation have to be planned and implemented to ensure the conservation of plant life.

The UNEP/IUCN World Database on Protected Areas (WDPA) 2014 Map of Protected Areas shows the proportion of protected area by country, ranging from under 5 per cent in Syria and Yemen, to 5 per cent in Iraq and Oman, and more than 17 per cent in Saudi Arabia. Hence, there is an urgent need to expand

the protected area systems of the region to include different types of biologically productive vegetation – the wetlands, woodlands, coastal sites and deserts that constitute the habitats of the majority of the region's flora and fauna. Nature reserves such as the Dana Nature Reserve in Jordan illustrate the value of protecting different habitats for plants, terrestrial animals and birds. The Dana Nature Reserve also provides opportunities for ecotourism, which benefits local communities.

New technologies supporting genetic research

Several studies have now been undertaken in the region using new technology and genetics to provide a better understanding of the movement patterns, behaviour and population structure of threatened species in both marine and terrestrial environments. For example, satellite tracking of female hawksbill turtles in the ROPME Sea Area indicates that this species is likely to remain within this body of water for breeding and foraging. A genetic study of the same species has also now confirmed that it does not mix with its Indian Ocean counterparts, and needs to be managed as one stock within the ROPME Sea Area. Similarly, a recent study focusing on the population genetics of four commercially important shark species suggests that these species are shared stocks between the Red Sea, Arabian Sea and ROPME Sea Area and need to be considered as one management unit. This has many implications in terms of conservation and is an opportunity for countries in the region to collaborate and develop comprehensive strategies for the protection of threatened or vulnerable species.

Ecosystem restoration and habitat remediation

Reforestation and afforestation activities used to be well developed in the Mashriq countries. However, with the emergence of conflict and social unrest and their consequences on neighbouring countries, these projects have slowed down or been curtailed. Habitat remediation is well developed for the coastal, marine and terrestrial environments of West Asia. For example, in the UAE, large expanses have been converted into new productive intertidal mangrove ecosystems. In Kuwait, new intertidal islands with mangroves, saltmarsh and terrestrial halophytes have been established within residential developments, and in Saudi Arabia millions of mangroves have been planted along the Gulf coast to restore this productive and threatened habitat. Habitat remediation is not limited to government action: in both Kuwait and Saudi Arabia private enterprise is driving restoration. Large coastal and offshore oil- and gas-field developments have embraced habitat remediation as part of their overall operations, and environmental stewardship is now a business objective for many. There is growing recognition that coastal landscaping utilizing saline water irrigation and local halophytic plant species ranging from microalgae to larger vascular plants, such as saltmarsh and mangroves, is key to sustainable coastal development, and can help build natural blue carbon sinks to sequester and store carbon over the long term.

Techniques to deliver saline water for irrigation of halophytes within terrestrial coastal environments are a major advance, saving precious freshwater resources for irrigation, and protecting terrestrial soils from salinization. This technology also has huge potential for the production of forage crops for livestock in either coastal desert areas or inland areas where groundwater is saline.

Environmental education and public awareness

Incorporating environmental education and awareness into various sectors of society is an opportunity to involve the public, governmental organizations, schools, the media and various institutions in the conservation of biodiversity. This can be done by raising public awareness on broad environmental issues, for example through the media, or by using targeted campaigns or educational efforts focused on a specific issue or sector. This in turn leads to increased social responsibility, not only in terms of behaviour and participation in environmental matters, but also in the context of enforcing regulations. For example, the Ministry of Environment and Water in the UAE recently launched its 2015–2021 Environmental Education and Awareness Strategy to reorient current education and awareness programmes to include environmental dimensions and to ensure that basic environmental education is available in schools across the country. The aim is to ensure that younger generations grow up with a better understanding of environmental issues and want to participate in biodiversity conservation.

2.5 Air

Key messages: Air

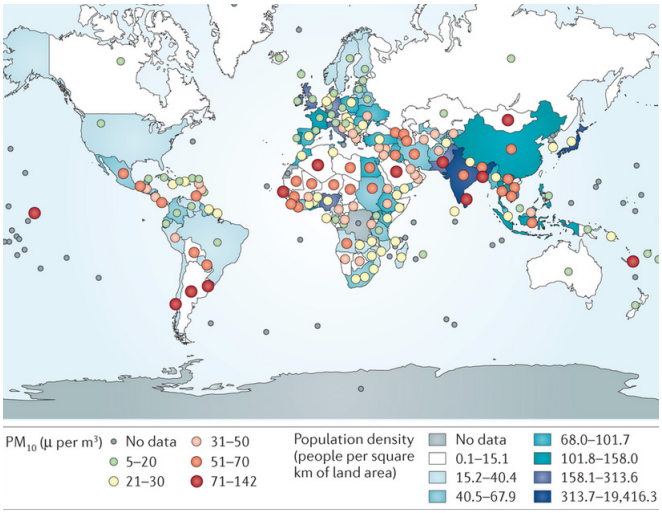
- West Asia has been recognised as one of the major regions where sand and dust storms originate causing environmental, social and economic impacts.
- The level of air pollutants in West Asia has increased progressively over the past two decades.
- Efforts have been made by West Asian countries to reduce the level of air pollutants but further controls are required. Long-term monitoring of major and minor pollutants should be set up in all West Asian countries. Concurrently, cleaner fuels and the installation of pollution-reducing technologies should be introduced.

2.5.1 Air quality in West Asia region

The level of particulate matter (PM_{10}) in West Asian countries is considered very high (**Figure 2.5.1**) and this is a concern for public health. Particulate matter can penetrate the lungs and cause several cardio-respiratory diseases leading to increases in mortality or morbidity. Exposure to other criteria air pollutants like ground-level ozone, nitrogen, and sulphur dioxides also has detrimental impacts on public health (WHO 2016).

In both 2004 and 2008, the highest mortality rates among children under five years attributable to ambient air pollution were in Iraq and Yemen (**Table 2.5.1**). Such findings indicate that appropriate measures are required to alleviate deaths attributable to ambient air pollution.

Figure 2.5.1: Global population density and concentrations of particulate matter



Source: WHO 2016

2.5.2 Pressures on air quality

The West Asia region has natural sources of air pollution, such as dust storms, and man-made sources, such as power and water production, industry, transportation and construction.

Frequent dust storms

West Asia has been recognised as one of the major regions where dust originates (Prospero *et al.* 2002; Boloorani *et al.* 2013; WMO and UNEP 2013). Generally, dust is present throughout the year, increasing in March and April, reaching a maximum in June and July and decreasing in the winter

Table 2.5.1 West Asia deaths attributable to ambient air pollution, 2004 and 2008

Country	Number of deaths			
	per 100'000 children under 5 years		in children under 5 years	
	2004	2008	2004	2008
Bahrain	0	0	0	0
Iraq	45	12	1 945	555
Jordan	2	3	11	26
Kuwait	1	1	2	1
Lebanon	1	1	4	2
Oman	1	1	3	2
OPT	n/a	n/a	n/a	n/a
Qatar	0	1	0	1
Saudi Arabia	2	2	55	65
Syrian Arab Republic	1	2	30	44
UAE	0	1	1	2
Yemen	5	5	178	184

months. The low intensity of dust in winter is probably due to the lack of thunderstorm activity, high-pressure conditions, and a lack of strong winds. In summer months, increased dust activity is ascribed to several factors including increases in wind velocity, thunderstorm activity and strong heating of the landmass, which induces unstable conditions and convective low-pressure systems.

Despite the lack of precise aggregate data on falling dust in West Asia, individual country data can give a feeling of its intensity. Along the coastal area of Kuwait, the annual amount of dust fall-out can reach 1 000 tonnes per square kilometre with an overall mean concentration of 200 micrograms per cubic metre (Khalaf *et al.* 1980) Dust can contains various substances, including hydrocarbons, trace elements, heavy metals, sulphates and nitrates. In one study in Kuwait's Shuwaikh city (Al-Harbi 2015), falling dust was composed of soluble matter (nitrates, sulphates, and chloride), with sulphates the highest inorganic component at an average of approximately 2.37 tonnes per square kilometre per month. The major insoluble matter measured comprised ash, silica, combustible matter and tar, with ash accounting for 58.46 per cent of total dust.

Storms carry fine sand and dust over long distances, with negative impacts including substantial reduction of visibility that hinders various activities and causes increased traffic accidents, and may increase the occurrence of vertigo in aircraft pilots (Hagen and Woodruff 1973; Morales 1979; Middleton and Chaudhary1988; Dayan *et al.* 1991; Yong-Seung and Ma-Beong 1996). Furthermore, dust storms are known to have various adverse impacts on human health and entire ecosystems; they are associated with the prevalance of asthma and a range of allergic and non-allergic respiratory alliments in West Asia. West Asian countries have realized that international cooperation and joint research are important in tackling sand and dust storms (**More...14**).

Man-made sources of air pollution

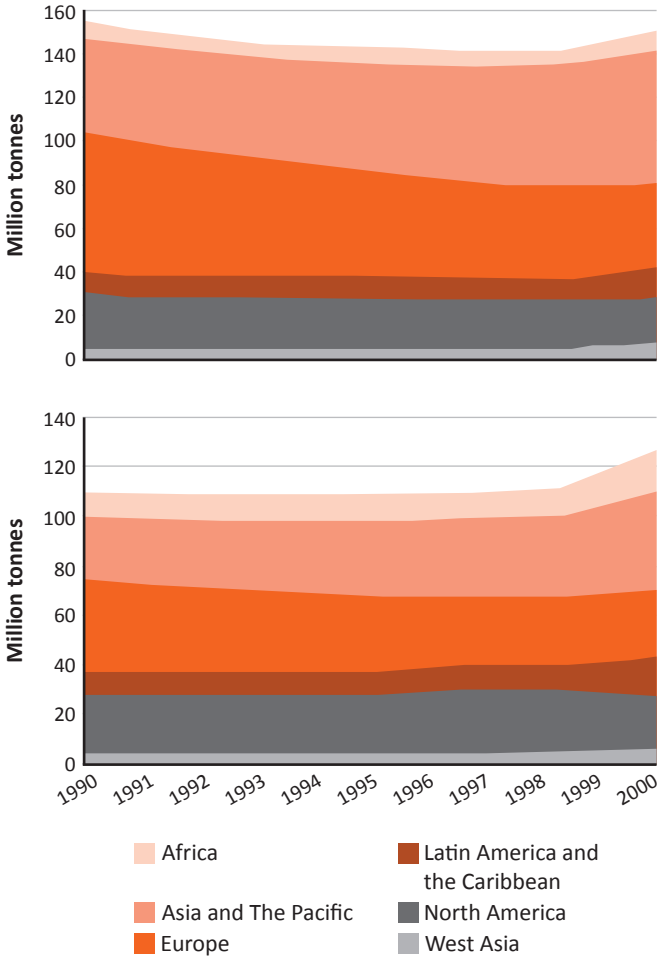
Although West Asian countries have low levels of industrialisation compared to other industrialised regions, there is a well-established oil and petrochemical industrial sector. Furthermore, the region's population is growing fast, resulting in intense construction activity and an increase in transportation-related activities, thus producing air pollution hotspots.

The level of air pollutants in West Asia has increased progressively over the past two decades. **Figure 2.5.2** shows the trends in emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x) for the period of 1990–2000.

From 2000 onward, there are no aggregated emissions data for West Asia, and the more recent trends in emissions of sulphur dioxide and nitrogen dioxide, shown in **Figure 2.5.3** & **Figure 2.5.4,** are based on simulated trends.

It is evident that West Asia's emissions of sulphur dioxide and nitrogen oxides are increasing relative to 1970 levels. In

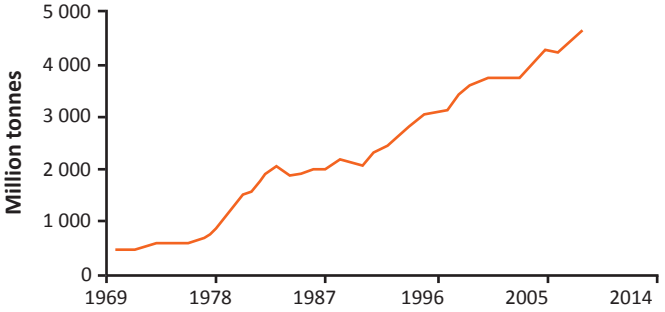
Figure 2.5.2: Global emissions of (a) sulphur dioxide and (b) nitrogen oxides by region, 1979–2000



Source: UNEP 2012

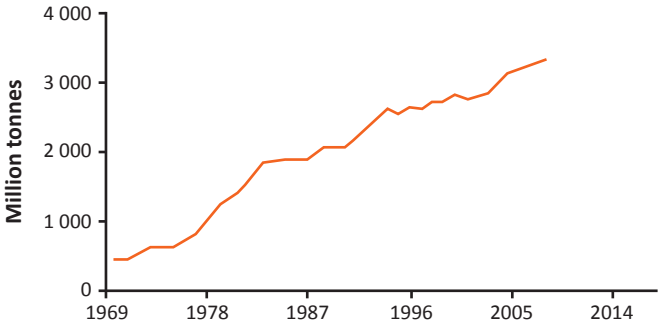
2008, sulphur dioxide emissions rose to 4.62 million tonnes, which is an increase of about 18.7 per cent compared to 2000. Similarly, nitrogen dioxide emissions had increased by 15 per cent in 2008 relative to 2000, rising from 2.8 million tonnes to more than 3.3 million tonnes.

Figure 2.5.3: West Asia sulphur dioxide emissions, million tonnes, 1970–2008



Source: UNEP 2015

Figure 2.5.4: West Asia nitrogen dioxide emissions, million tonnes, 1970–2008



Source: UNEP 2015

2.5.3 Policy responses for air quality management

Although most West Asian countries have ambient air quality and air pollutant emission standards, particulate matter concentrations in the atmosphere still exceed legal standards and the more stringent WHO guidelines for protecting human health and ecosystems. Efforts are in place to improve air quality monitoring and reporting capabilities.

Managing air quality is challenging due to the high share of air pollutant contributions from natural and long-range sources. Initial efforts are being made to reduce exposure to air pollutants through the establishment of dust storm early warning and information systems. As in other regions of the globe, regional cooperation is essential to address transboundary air pollution.

Efforts have been made by West Asian countries to reduce the level of air pollutants but further controls are required. Long-term monitoring of major and minor pollutants should be set up in all West Asian countries. Concurrently, cleaner fuels and the installation of pollution-reducing technologies should be introduced.

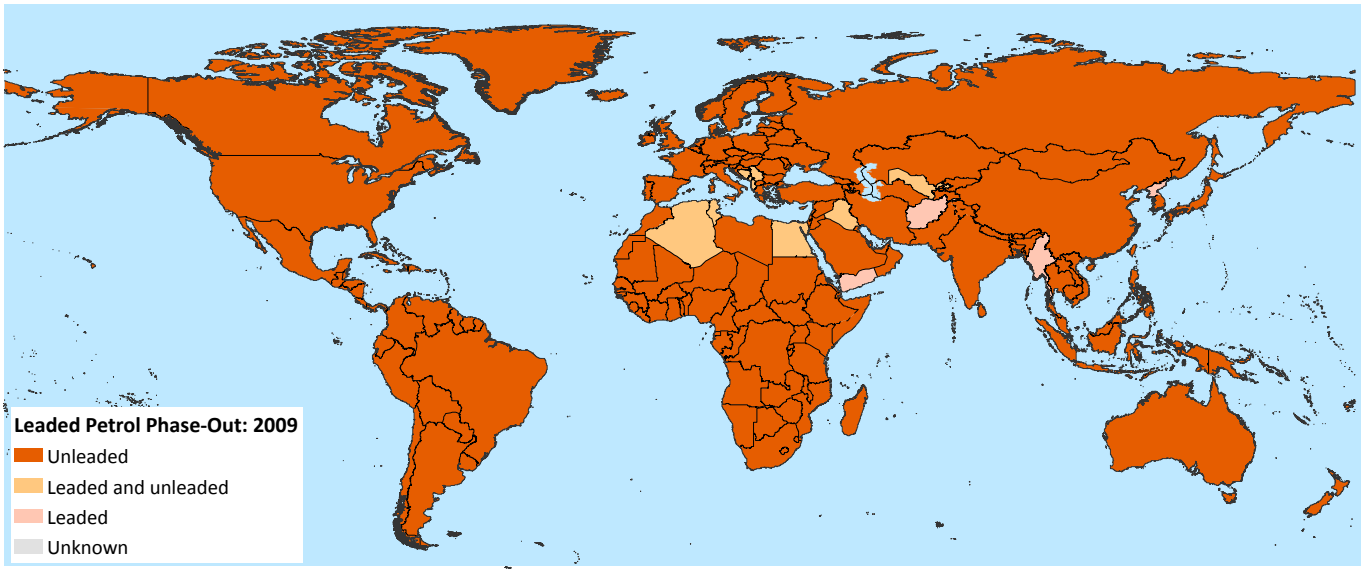
Progress on internationally agreed goals

The main two international examples in West Asia of making considerable progress in solving environmental challenges and accomplishing targets are the removal of lead from petrol and the protection of the stratospheric ozone layer.

Removal of lead from petrol

The 2002 Johannesburg Plan of Implementation provided a range of recommendations, including that human exposure to lead should be reduced. Lead poisoning and exposure can originate from various sources including cosmetics and toys, electronic waste, pigments and paints, and even contaminated food and drinking water. However, the predominant source of lead exposure and poisoning is lead in petrol, which has been identified as the prevailing reason for global environmental lead contamination (WHO 2010). Substantial progress has been made in most of the world's countries in the banning of leaded petrol, although it is still sold in a few countries (**Figure 2.5.5**).

Figure 2.5.5: Global status of leaded gasoline phase-out, January 2015



Source: UNEP 2015

Stratospheric ozone layer

The depletion of the stratospheric ozone layer due to increased anthropogenic activities is one of the key atmospheric issues in the Arctic and Antarctic. The recovery of the stratospheric ozone layer in the polar regions relies mainly on execution of the Montreal Protocol on substances that deplete the ozone layer. Consequently, the integrated efforts of regions to phase-out the use of ozone-depleting substances are of great importance (UNEP 2000). However, despite the success of national efforts in assuring implementation of the Protocol (WMO 2011; UNEP 2010b) regarding the use of ozone-depleting substances, their capture from old equipment and the destruction of collected or stockpiled appliances are still challenging issues.



2.6 Climate change

Key messages: Climate change

- The West Asia region has seen an increase in CO_2 emissions over recent decades as a result of growing total energy consumption. This is linked to population size and economic activity, but is also heavily influenced by the energy fuel mix and the efficiency of water and electricity use.
- Energy use per person is currently rising in West Asia, highlighting the need for increasing efforts to promote energy.
- Mitigation processes include the review of policies and policy instruments to build a low-carbon economy, such as through the promotion of the efficient use of water and energy, increasing the share of renewable sources in the energy mix, and the use of public transport and cleaner vehicles and fuels.
- There is a strong need to develop regional and national adaptation strategies which consider the cumulative impacts of multiple stressors, rather than considering the potential impacts from climate change alone.

2.6.1 Climate change in West Asia

In West Asia, atmospheric temperatures can vary greatly geographically and with seasons and time of day. In the Rub Al Khali desert, the climate is hyper-arid and temperatures can reach 51°C during the day in summer. Annual rainfall can be as low as 40 millimetres per year, evaporation rates vary from 2 to 3 metres per year and localised groundwater recharge is very low in some areas.

The sea area covered by the Regional Organization for the Protection of the Marine Environment (ROPME) has some of the world's hottest waters, with monthly summer sea surface temperatures regularly exceeding 34°C (Riegl *et al.* 2011). The ROPME Sea Area has large coastal extensions less than 20 metres deep, resulting in high evaporation rates. This in turn results in high salinity levels of around 40 kilograms of salts per cubic metre of water near the coastline, compounded by low rates of freshwater inflow (MAF/ICBA 2012).

Climate change is already being felt in the region, with higher temperatures and lower precipitation levels. Over the Arabian Peninsula, from 1979 to 2009, observed annual mean rainfall declined by 47.8 millimetres each decade, while temperatures increased by 0.71°C (maximum), 0.6°C (mean), and 0.48°C (minimum) (Almazroui *et al.* 2012) (**Figure 2.6.1 & Figure 2.6.2**).

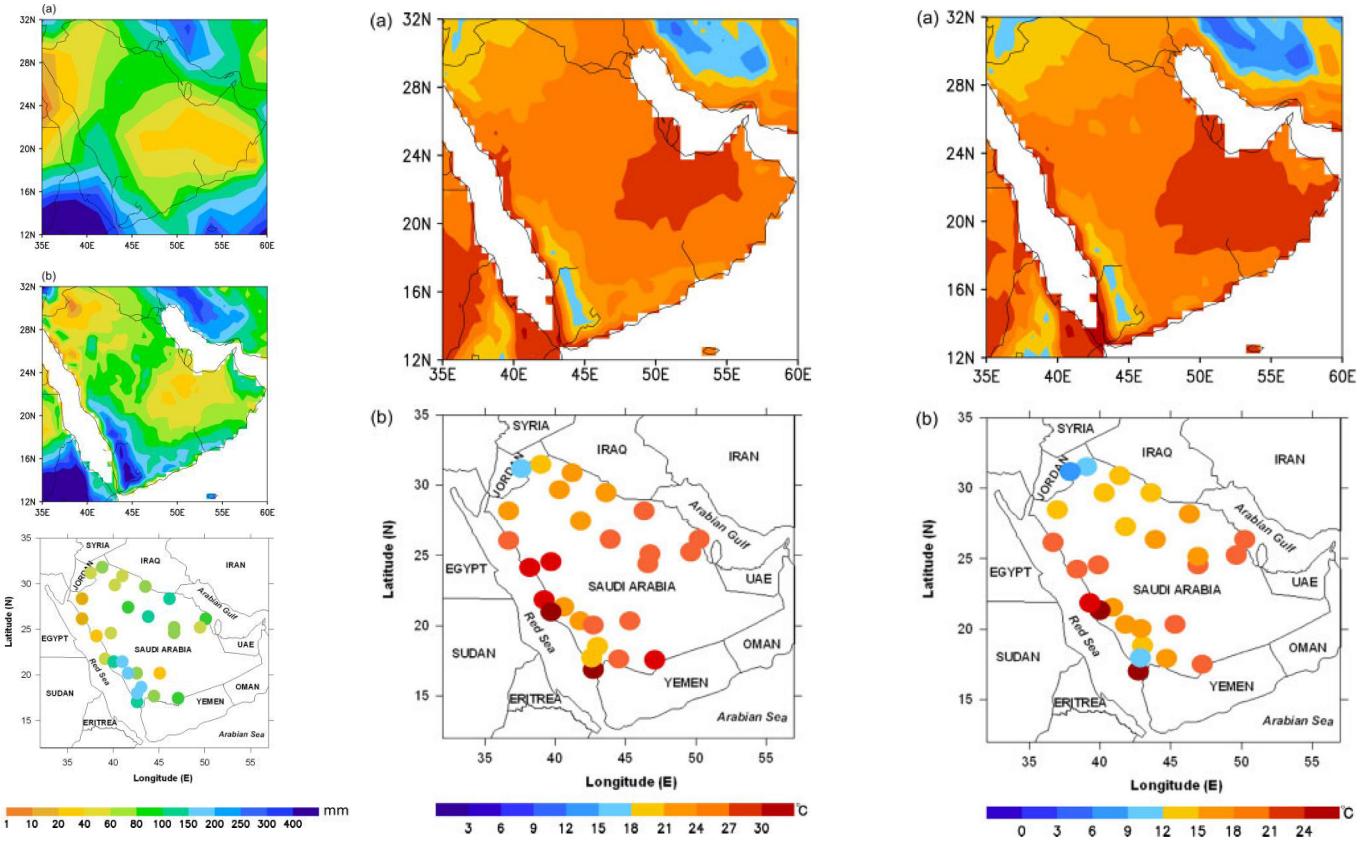
Sea surface temperatures in the ROPME Sea Area, except the Gulf of Oman waters, have risen on average by 0.2°C per decade over the past 50 years, but this rate accelerated to 0.45°C per decade in the past 20 years (Sheppard and Loughland 2002). In some areas the rate of heating is projected to occur much more rapidly as a result of the combined effects of global climate change and local stressors such as desalination – Kuwait Bay has already shown substantial sea surface temperature increases of 0.6°C per decade between 1985 and 2002 , three times the global average (Al-Rashidi *et al.* 2009). Such increases threaten thermally sensitive marine organisms. Projections show that sea temperatures in the Arabian Gulf are likely to increase by 2°C this century, with the consequence that mass coral mortality events are predicted to have a 50 per cent probability of occurrence annually within 50 years (Sheppard 2003).

Projections of future climate in the Arabian Peninsula for 2060–2079 under RCP 8.5[3] indicate that atmospheric temperatures would increase by 2–3°C over land areas but decrease over

3 RCP 8.5 is the Representative Concentration Pathway defined in the IPCC's 5th Assessment Report that corresponds to a high emission scenario and radiative forcing reaching 8.5 watts per square metre near 2100.

◄ Credit: Shutterstock/ Ahmad A Atwah

Figure 2.6.1: Mean annual rainfall, temperature and annual minimum temperature for the Arabian Peninsula, 1979–2009. The lowest mean annual rainfall (< 80 mm) occurred over Rub Al-Khali and the sand desert area to the west of the Arabian Peninsula. The wettest region is the southwest of the Arabian Peninsula (>150 mm). Mean temperatures in the Arabian Peninsula varied from 21ºC-27ºC, with the highest temperatures (>27ºC) occurring over the Rub Al-Khali. Mean annual minimum temperatures were as low as 6ºC-16ºC in the north western and southwestern regions of the Arabian Peninsula.

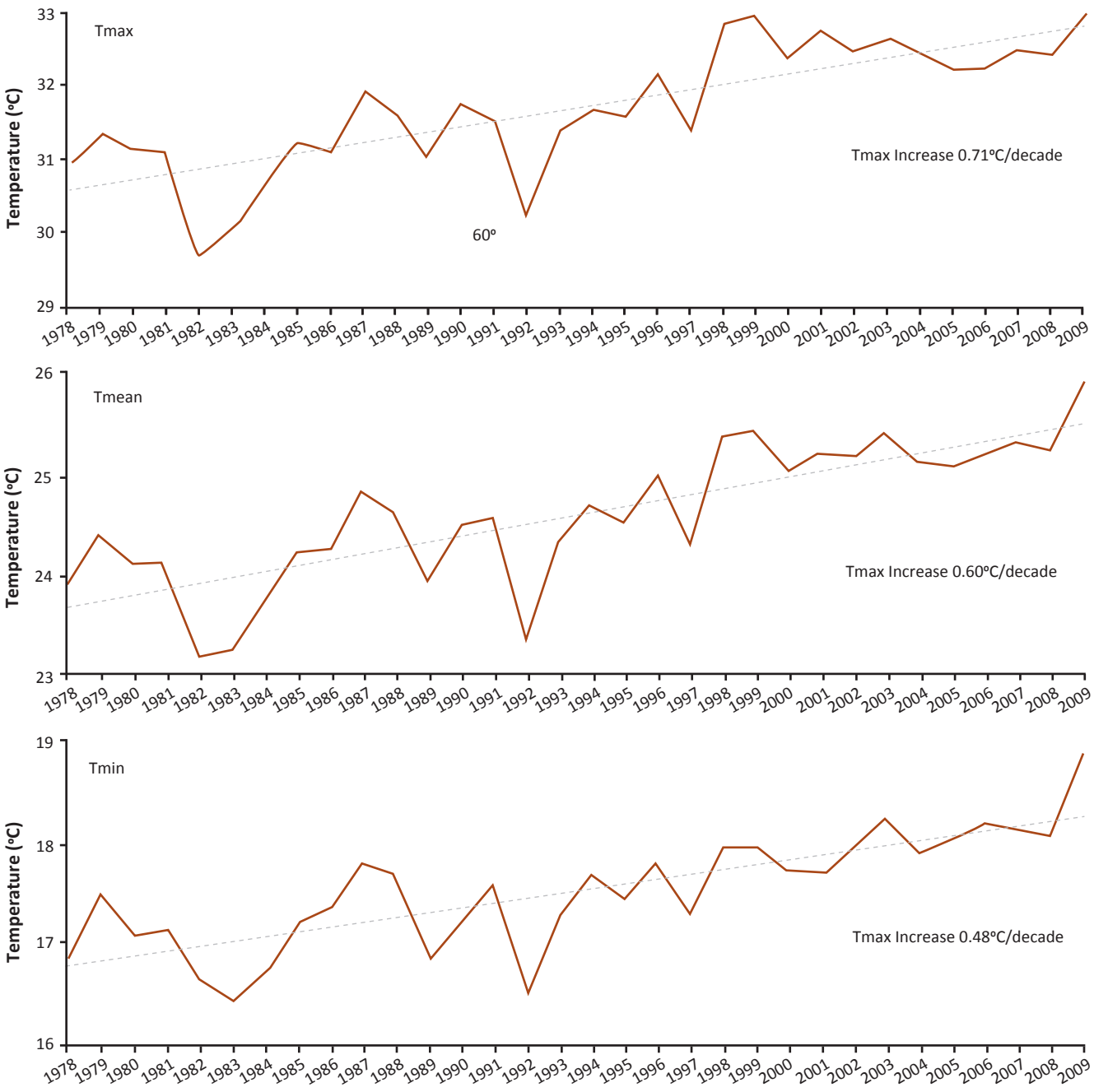


Sources: (left) CMAP; (entre) CRU; and (right) observed datasets, averages over 1979–2009; Almazroui 2012; Almazroui *et al.* 2012

coastal areas relative to 1986–2005 levels. Precipitation would increase over much of the United Arab Emirates (UAE), the Hajar Mountains, Qatar and the ROPME Sea Area. Oman and eastern Saudi Arabia are projected to see a decrease in rainfall. Projections also show that much of the precipitation would occur in heavier but fewer rainfall events (AGEDI 2015).

Projections of temperature and rainfall distribution up to 2100 have also been made for the Arab region. Average atmospheric temperatures for 2081–2100 are projected to increase by 1–3°C in the medium emissions scenario (RCP 4.5) and by 2–5°C in the highest emissions scenario (RCP 8.5).

Figure 2.6.2: Saudi Arabia, time sequences for observed maximum, mean and minimum temperatures, 1978–2009



Source: Almazroui 2012

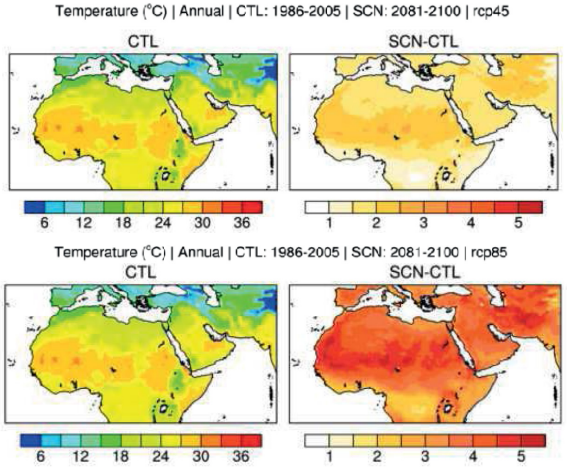
The areas showing a higher increase are in the Saharan area of North Africa and central areas of the Arabian Peninsula (**Figure 2.6.3**) (Pal and Eltahir 2015).

For extreme temperature indices, projections show increasing trends in hot summer days – the annual number of days when the maximum temperature (Tmax) is greater than 35°C – by the end of the century throughout the entire Arab region (**Figure 2.6.4**).

Projections for 2081–2100 show that precipitation will exhibit larger variability than temperature (**Figure 2.6.5**). In general, there is a reduction in average monthly precipitation, particularly for the upper Euphrates and Tigris river catchment.

Predictions of dry-bulb maximum temperatures and wet-bulb maximum temperatures in southwest Asia according to the RCP 4.5 and RCP 8.5 scenarios **(Figure 1.2.9)** suggest that the region should push global mitigation efforts to achieve the RCP 4.5 scenario and avoid the business-as-usual scenario that will most likely lead to exceeding the survival threshold around the ROPME Sea Area and affect its human habitability.

Figure 2.6.3: West Asia – temperature (°C), medium (top) and high (bottom) climate change scenarios for 2081–2100, showing additional °C compared to observed temperatures, 1986–2005



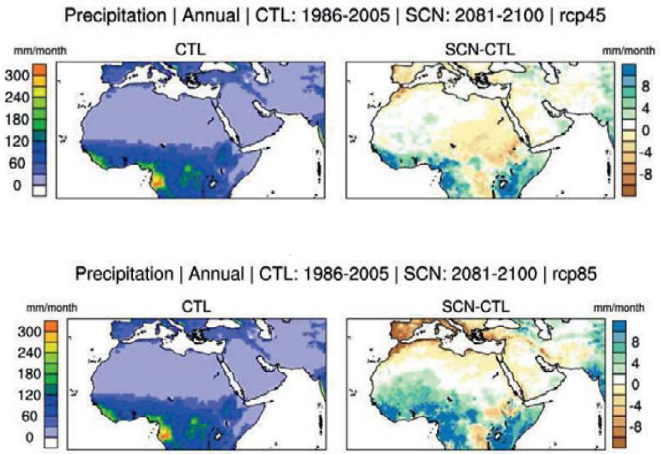
Source: UNESCWA 2015

Vulnerability to climate change impacts

There is a need to improve the understanding of climate change in the region, as well as the vulnerability of society, the economy and the environment to its impacts. Climate change will potentially affect coastal areas due to sea level rise, and lead to increased erosion and accretion due to changes in currents and storm surges. Impacts on public health may also be felt, with changes in the incidence of respiratory disease and heat stroke, and the potential introduction of vector-borne diseases like malaria and dengue fever.

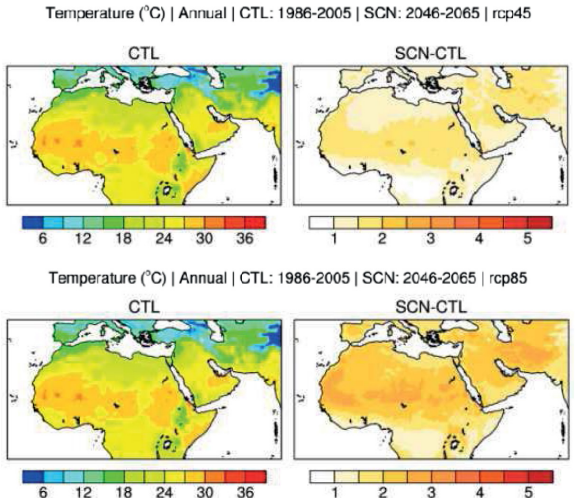
The availability of freshwater could also be affected, although the region is already facing high levels of freshwater scarcity. The expectation is that reliance on desalination of seawater will increase as conventional sources become further depleted. Food security could continue to be an issue of concern, with countries relying on regions that are vulnerable to the impacts of climate change.

Figure 2.6.4: West Asia – temperature (35 °C), medium (top) and high (bottom) climate change scenarios for 2081–2100, showing annual additional number of days above 35 °C, compared to observed numbers in 1986–2005



Source: UNESCWA 2015b

Figure 2.6.5: West Asia – precipitation, medium (top) and high (bottom) climate change scenarios for 2081–2100, showing changes in precipitation compared to observed amounts in 1986–2005



Source: UNESCWA 2015

Sea level rise associated with climate change will impact parts of West Asia's coastal lands, mostly in Bahrain, Kuwait, Iraq, Qatar, Saudi Arabia and UAE (UNEP 2013) (**Figure 2.6.6**). Climate change scenarios that take into account increased human activities in coastal areas call for the adaption of coastal management regulations and the use of remote sensing technologies to monitor changes in coastal areas.

Terrestrial and marine ecosystems are highly specialised to withstand the region's climate conditions and are therefore highly vulnerable to climate change impacts in the region. Ecosystems are already under stress from the encroachment of human infrastructure and activities that accompany rapid growth and economic development. Even small long-term variations in atmospheric temperature, precipitation and the physical and chemical conditions of the ROPME Sea Area could adversely affect ecosystems.

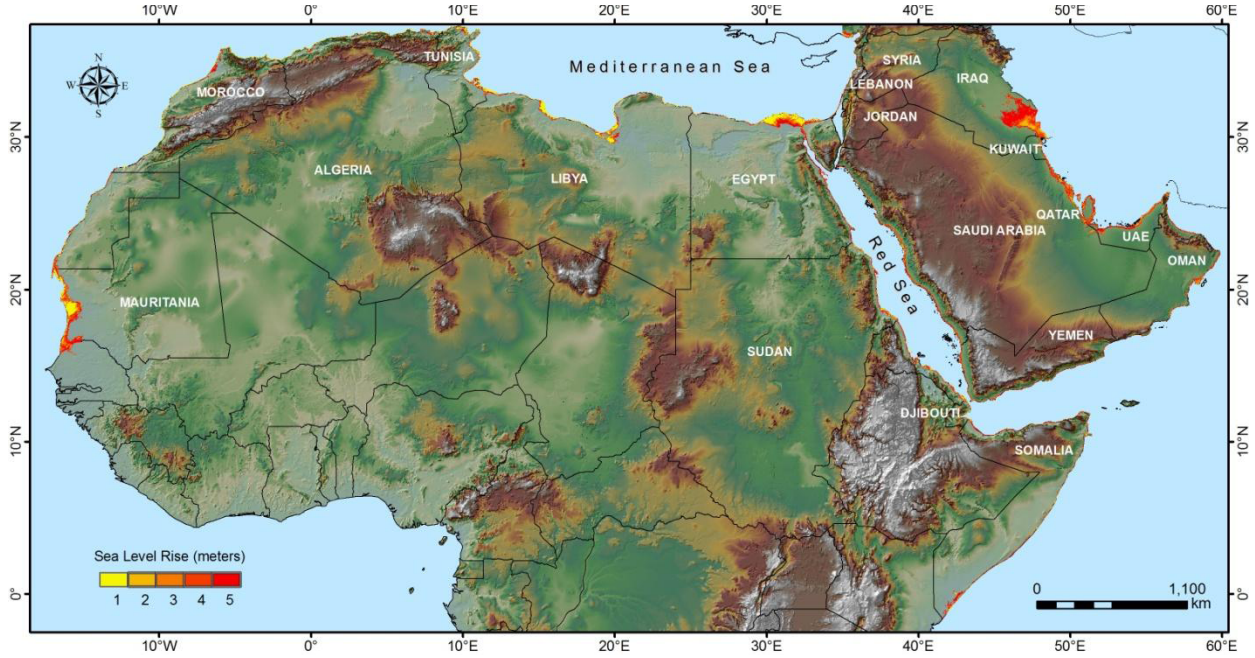
Fisheries and tourism may also be affected by changes in marine habitats and species. A diverse array of marine species has adapted to the extreme conditions found in the ROPME Sea Area, able to survive at temperatures that would be lethal to populations elsewhere. These organisms, however, are living at the upper limits of their thermal tolerance and increased temperatures associated with climate change are likely to push many of them beyond this threshold, resulting in widespread mortality (Tolba and Saab 2009). For example, in 1996 a thermal anomaly resulted in sea surface temperatures increasing by 2 °C above the normal summer maxima, and resulted in widespread and substantial mortality, above 90 per cent, of corals across the entire southern basin of the ROPME Sea Area (excluding the Gulf of Oman). Given that this increase matches the projection of sea surface temperature rise by the end of the century, it is likely that temperature changes will have significant repercussions for the many marine species already living at their thermal tolerance limit.

The fishing industry provides more than USD500 million in goods and services to national economies in the region, in addition to employment for tens of thousands of individuals directly and indirectly supporting fishing activities. It is the largest natural resource sector outside oil and gas. Future climate change is likely to have substantial direct and indirect effects on these fisheries. High temperatures in Arabian waters have been shown to result in fish that are smaller, mature more quickly and die younger than individuals living in more benign environments in the region (Tolba and Saab 2009).

Increases in sea surface temperatures, therefore, have the potential to reduce the overall fish biomass available for exploitation. In addition, because smaller fish produce exponentially fewer eggs, climate change may reduce the ability of fish populations to replace individuals that have been harvested (Tolba and Saab 2009).

Climate change is also likely to affect fisheries indirectly through the loss of critical habitat. Seagrass meadows and coral reefs represent important nursery and/or foraging habitats for a variety of commercially important fish species,

Figure 2.6.6: Overview of the coastal areas of the Arab region most vulnerable to sea level rise



Tolba and Saab 2009

but these ecosystems are considered to be highly vulnerable to the shifts in temperature that are projected under future climate change, particularly in the thermal extremes of the ROPME Sea Area (Tolba and Saab 2009).

2.6.2 Greenhouse gas emissions from West Asia

In 2011, West Asia was responsible for 3.5 per cent of global CO_2 emissions, a small share when compared to contributions from other regions (World Bank 2015), but the region is home to only 2.1 per cent of the world population (UNDESA 2015). Saudi Arabia had the highest total annual greenhouse gas emissions in the region, but it also has the largest economy, the second largest population and the highest energy use (World Bank 2015) (**Figure 2.6.7**).

West Asia's hyper-arid, arid and semi-arid climates, coupled with sub-optimal use of energy resources, results in some countries having higher CO_2 emissions per person compared to the world average of 4.98 tonnes.

Emissions per person vary greatly across the region – in 2011, Qatar led the region with 43.89 tonnes of CO_2 emissions per person, while the West Bank and Gaza (OPT) emitted only 0.57 tonnes of CO_2 per person (World Bank 2015) (**Figure 2.6.8**).

The West Asia region has seen an increase in CO_2 emissions over recent decades as a result of growing total energy consumption. This is linked to population size and economic activity, but is also heavily influenced by the energy fuel mix and the efficiency of water and electricity use. Interestingly, energy use per person has generally stayed at the same

level and only increased in some countries, probably due to efforts to improve efficiency of production and consumption (**Figure 2.6.10**).

West Asia's population has grown steadily, reaching 144.78 million inhabitants in 2013, and estimated at 154.21 million in 2015 on the basis of the population growth rates (World Bank 2015). Gross domestic product (GDP) in the region has for the most part increased over the past four decades. Average GDP per person per year in West Asia varies significantly by country. Qatar had the highest, followed by Kuwait, the UAE and Saudi Arabia (World Bank 2015).

Internal renewable water resources vary significantly in the region, with most countries feeling absolute water scarcity with less than 500 cubic metres per person per year. Iraq and Lebanon are the only two countries in the region with more than 500 cubic metres per person per year.

Due to the scarcity of renewable natural freshwater resources, the region relies significantly on unconventional freshwater sources such as desalination, which is highly energy intensive. As a result, the power and water sector in the region is a large emitter of greenhouse gas emissions. In addition, desalination has other impacts on the environment that result from the intake of seawater, the discharge of warm brine into the aquatic environment and the emission of other air pollutants.

2.6.3 Policy responses for climate change mitigation and adaptation

Mitigation measures

Greenhouse gas emissions (GHG) can be reduced as a co-benefit of improving resource efficiency and productivity, with additional benefits for economic competitiveness and improvements in public health. Responses include the review of policies and policy instruments to build a low-carbon economy, such as through the promotion of the efficient use of water and energy, increasing the share of renewable sources in the energy mix, and the use of public transport and cleaner vehicles and fuels. Energy use per person is currently rising, highlighting the need for increasing efforts to promote energy efficiency. The share of alternative and nuclear energy sources as a percentage of total energy use has fluctuated widely since 1971, having seen a recent increase of 2 per cent since 2009.

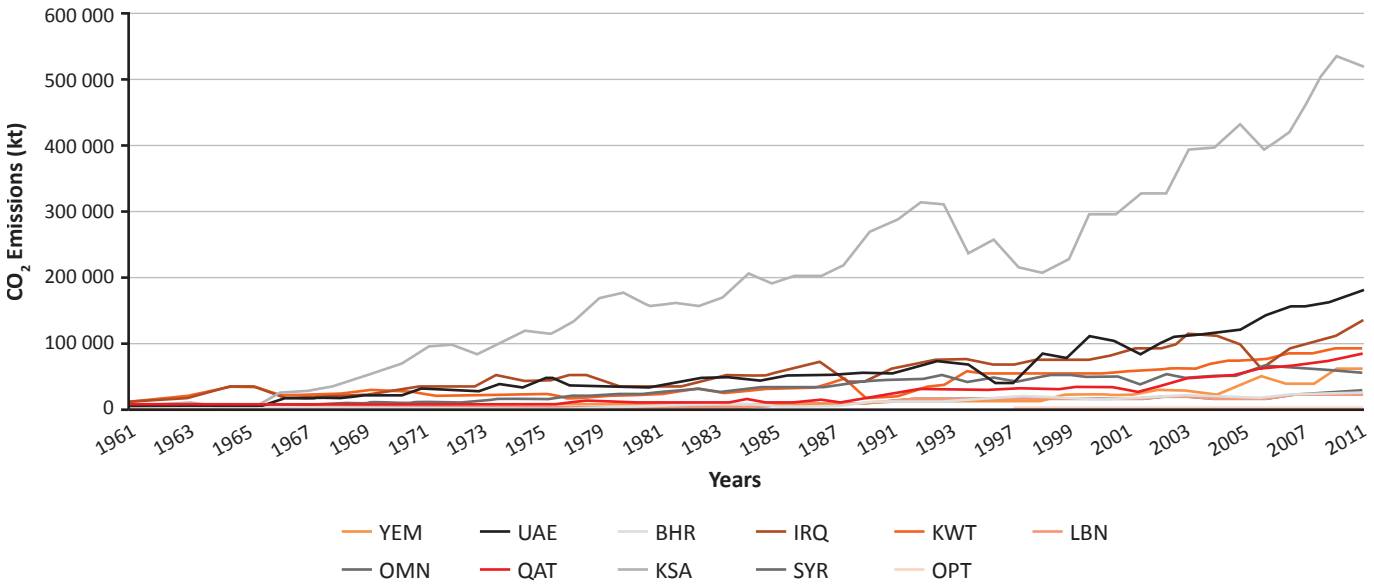
At the same time, actions aimed explicitly at mitigating GHG emissions are becoming more prominent. With the exception of Syria, all West Asian countries have presented an Intended Nationally-Determined Contribution (INDC) as part of the UNFCCC process that produced a new climate treaty in December 2015. While the INDCs vary in detail and ambition, they represent a commitment on the part of each country to periodically enhance and report actions to limit emissions.

The actions most commonly presented include renewable energy and energy efficiency measures. Most set targets of reducing GHG emissions against business-as-usual scenarios rather than absolute goals. For instance, Jordan aims to reduce emissions by 12.5% by 2030 conditional on receiving appropriate international support. Saudi Arabia's INDC aims to achieve mitigation co-benefits of up to 130 million tonnes of CO_2 equivalent annually by 2030. Others have set sectoral targets, such as the UAE's national goal of having clean energy (defined as both renewable and nuclear) contributing 24 per cent of the national mix by 2021. Most list sets of projects or policies that they will use to pursue these targets.

Mitigation action in the region will be facilitated by two important trends. First, renewable energy prices, particularly solar photovoltaic (PV), have fallen dramatically in recent years to the point that PV is now the cheapest option for new generation capacity in West Asia. Although price declines in 2014-15 have made natural gas more competitive, PV prices are well under 6 US cents per kWh of electricity produced and still falling.

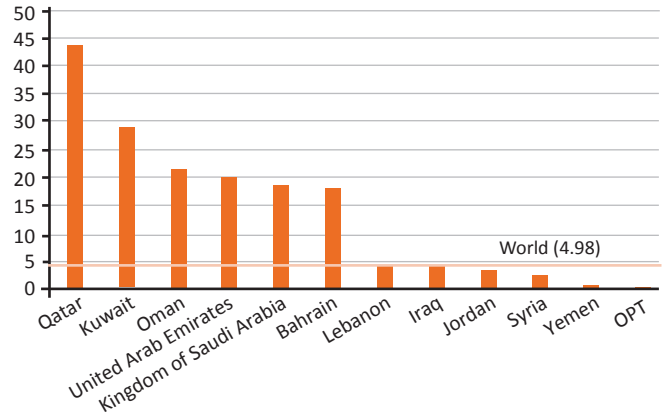
The second is that budgetary pressures in many oil-producing countries have led to a reduction of fossil fuel subsidies. The UAE phased out transport fuel subsidies in 2015 and has steadily reduced subsidies in the utilities sector. Saudi Arabia and others are following suit. This is likely to support efforts to increase energy efficiency.

Figure 2.6.7: West Asia, total carbon dioxide emissions, '000 tonnes, 1961–2011



Source: World Bank 2015

Figure 2.6.8: West Asia, carbon dioxide emissions per person (tonnes) by country, 2011



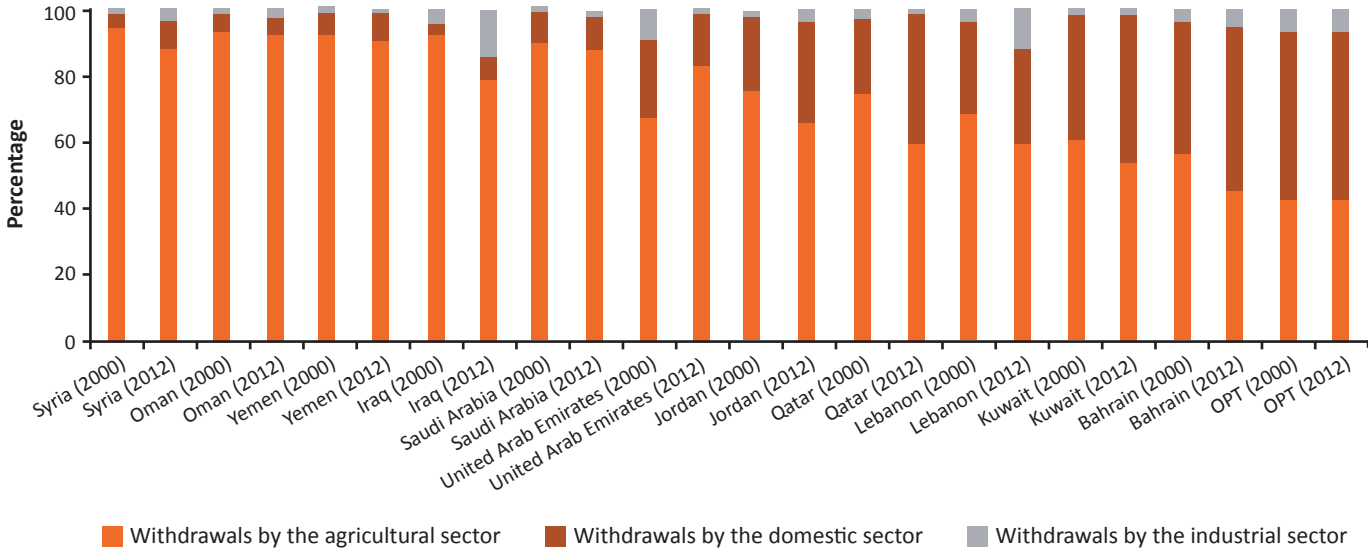
Source: World Bank 2015

Finally, coastal and marine ecosystems are being recognised for their contribution as carbon sinks, with mangrove ecosystems being considered significant blue carbon sites that actively sequester and store carbon over the long term. The loss of natural mangrove ecosystems in the region has accelerated with increased coastal development and land reclamation for residential and tourism developments. Coastal seagrass ecosystems have also declined due to increased dredging activity for shipping channels and to provide reclamation material for coastal development, particularly industry, ports and real estate. Efforts to establish and restore mangrove habitats through extensive planting programmes have been successful in several Gulf countries.

Adaptation measures

While climate change represents a major threat to ecosystems in the region, it is not an isolated threat. Climate change impacts

Figure 2.6.9: West Asia, energy use per person by country, kilograms of oil equivalent, 1971–2011



Source: World Bank 2015

are likely to have additive or synergetic interactions with other ecosystem stressors, magnifying potential effects. For example, discharge from the growing number of desalination facilities in the Arabian region will result in thermal plumes with elevated temperatures and high levels of chlorates and other anti-scaling chemicals. In the increasingly warm and acidic marine environment projected to occur with climate change, impacts from these stressors may be enhanced.

In addition to direct impacts in the region, West Asian countries will face risks from the global effects of climate change. In particular, many of the region's countries depend heavily on food imports. Damage to major food exporters around the world may quickly give rise to challenges as world food supplies possibly decline, affecting access and international food prices.

Countries are investing in research to improve understanding of climate change impacts in the region and to assess the vulnerability of natural and man-made systems. This work will inform the identification and selection of effective and cost-efficient climate change adaptation measures in various activity sectors and segments of society. Especial attention is required for the identification of and support for vulnerable communities.

Initial efforts are ongoing to introduce consideration of climate change and its impacts in sector planning. As an example, Abu Dhabi's Urban Planning Council developed a plan for the capital region that considers implications from potential sea-level rise. Collaboration between the public and private sectors and effective engagement of civil society are vital to build adaptive capacity in strategic planning and to build the resilience of communities.

Finally, there is a strong need to develop adaptation strategies which consider the cumulative impacts of multiple stressors, rather than considering the potential impacts from climate change alone.

2.7 Waste management

Key messages: Waste management

- Regional municipal solid waste generation is increasing at about 3 per cent per year (median). More than 50 per cent of the municipal solid waste in the region comprises food waste, with organic solids ranging from 22.4 to 34.4 per cent.
- Countries in the West Asia region can aspire to build a circular economy. Integrated management of waste provides a significant opportunity for the whole of West Asia; however, different approaches are required across the region. Notably, socio-economic circumstances, current conflicts and human displacement have a major impact on the waste sector.

2.7.1 Waste generation in West Asia

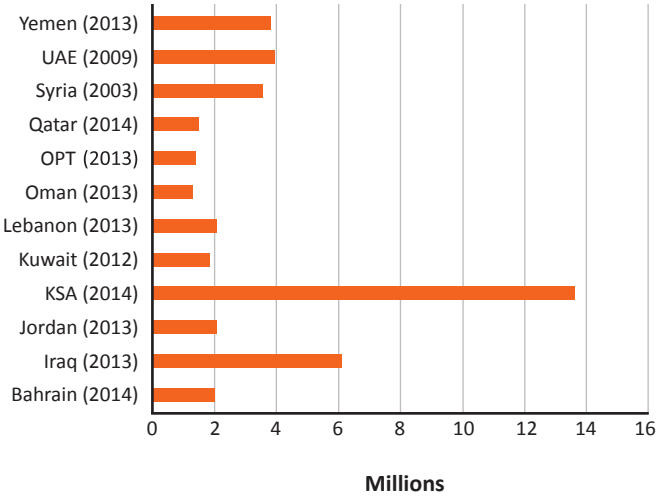
The total annual quantity of solid waste generated for the 12 West Asian Countries is between 130–150 million tonnes. In 2015, more than 156 million people living in West Asia generated an estimated 45.9 million tonnes of municipal solid waste, as shown in **Figure 2.7.1**.

Regional municipal solid waste generation is increasing at about 3 per cent per year (median). More than 50 per cent of the municipal solid waste in the region comprises food waste, with organic solids ranging from 22.4 to 34.4 per cent (**Figure 2.7.2**). The percentage share of national greenhouse gas emissions (GHG) from municipal solid waste ranges from 0.54 (Qatar) to 12.49 (Jordan) and amounted to 30 160 gigagrammes CO_2 equivalent (UNFCCC 2015). West Asia is yet to experience significant activity in the waste-to-energy sector (**More...15**)

The wastewater generation rate in the Middle East is estimated at 80–200 litres per day per person, with sewage sludge and septic tank collections sent to landfill.

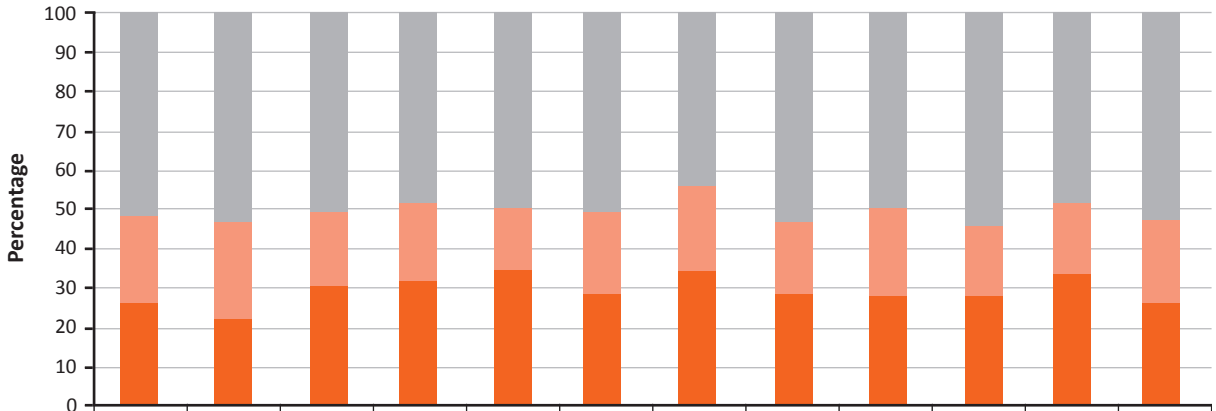
Solid waste generation and composition is influenced by economic conditions, living standards, urbanisation, and demographic, social and political change, all of which require the development of more waste management infrastructure to handle the increased amount of waste generated annually.

Figure 2.7.1: West Asia, municipal solid waste generation, tonnes, latest year



Source: CATEC Tadweer (2014)

Figure 2.7.2: West Asia, composition of municipal solid waste, per cent, latest year



	Bahrain (2010)	Iraq (2007)	Jordan (2013)	KSA (2007)	Kuwait (2012)	Lebanon (2013)	Oman (2010)	OPT (2013)	Qatar (2009)	Syria (2002)	UAE (2009)	Yemen (2012)
Moisture content, %	51.7	53.5	50.9	48.6	49.6	51.2	44.1	52.9	49.5	54.4	48.2	52.6
Inert solids, %	22.6	24.1	18.5	19.3	16.2	20.5	21.4	18.4	22.5	17.5	18.0	21.6
Organic solids, %	25.7	22.4	30.6	32.1	34.3	28.3	34.4	28.7	28.0	28.1	33.8	25.8

Source: Dumble 2015

The West Asia region is undergoing a period of social and political change affecting many of its countries, with conflict and human displacement disrupting the waste management sector. Conflicts cause uncertainty and insecurity, with population groups displaced or mobilised as refugees. Refugees in Lebanon create 889 tonnes of waste per day, or about 15.7 per cent of the country's total municipal solid waste (**Figure 1.2.9**). At the start of July 2015 there were an estimated 2.97 million refugees in Lebanon, Jordan, Yemen and Iraq, generating an estimated total of about 1 440 tonnes per day or 0.48 kilograms per refugee per day.

2.7.2 Waste management in the region

The development of governance at a regional level is underway to support integrated waste management across the West Asia region. In 2013 the Secretariat General of the GCC produced guidelines for the management of municipal solid waste for the GCC countries with the aim of establishing a unified information base of waste quantities in preparation for a unified management and disposal guide. In 2002, they also put forward the Common System for the Management of Hazardous Chemicals, which established minimum legislation for the member states in dealing with hazardous chemicals (**Box 2.7.1**).

Waste management policy and legal framework

Most West Asian countries have developed waste management policies and issued legislation. Countries including Kuwait, Jordan, Lebanon, OPT, Qatar, Syria, UAE and Yemen have developed national strategies, master plans or frameworks with varying degrees of consistency and effectiveness.

Many existing strategies, master and implementation plans, including for Lebanon, Saudi Arabia, Syria and UAE, represent realistic efforts and are proportionate to the development of integrated waste management systems and

Box 2.7.1: e-Waste

Presently, there is no regional policy regarding the management of e-waste. The bulk of it is being disposed of in dumpsites, with 5 per cent being exported to Asia, Africa and South America for recycling by the private sector. Saudi Arabia is one of the largest e-waste generators, producing more than 3 million tonnes per year. Qatar has e-waste management regulation. Legal frameworks are being prepared in UAE, Jordan and Bahrain.

infrastructure. But in each of these countries there has been either a long delay or a period of frustrated procurement and development in advancing these plans. Many lack appropriate infrastructure developments on the ground supported by the necessary resources, clearly defined roles and responsibilities, or links to strategic objectives, all of which hinders the progress of their policies.

Waste Collection and Segregation

Municipal solid waste collection coverage is generally good in West Asia's high- and upper-middle-income countries (World Bank 2015) such as Kuwait, the United Arab Emirates (UAE) and Lebanon. Syria and Yemen have the lowest coverage rates of waste collection and segregation (**Table 2.7.1**) (Sweepnet 2014; UNSD 2015).

Waste collection in some countries in the region is affected by regional conflict, with refugees adding 15.7 per cent to municipal solid waste generation in Lebanon at a rate of 0.484 kilograms per refugee per day. There is little source segregation and wastes are collected from communal containers of typically 1.2 cubic metres placed in the street, and often overfilled. In Lebanon, containers do not have lids as a security measure. Industrial, medical and hazardous streams are usually but not always collected separately (El-Khoury and Partners 2015).

Poor regulation control and planning in the region mean that fly tipping[4] and littering are a major problem. Monitoring in Abu Dhabi over a three month period in 2009–2010 revealed that almost 10 000 incidents of contract non-compliances in waste collection and street cleaning occurred. Investigations undertaken over a two-week period in two collection rounds (March 2010) identified 68 927 cubic metres of illegally tipped waste. The consequence of illegal tipping and littering is an additional burden, requiring waste workers to collect and remove the waste to authorised waste management facilities.

The regional waste sector employs tens of thousands of workers, mainly as unskilled labourers who carry out street cleaning, waste collection and sorting. Concerns have been raised over the lack of documentation kept by employers in GCCs on waste workers' health. According to regulations, as expatriates entering the country, waste sorters employed to manually segregate the waste collected in communal containers are subject to pre-employment medical examination. However, if their occupation is not correctly registered they are likely to miss the proper medical examination and follow-up.

Segregation of materials for reuse and recycling is mainly carried out by the informal sector. At the regional level, about 10 per cent of total municipal solid waste – or about 6.3 million tonnes – was recovered this way in 2015. National amounts were estimated at around 12 per cent in Lebanon, 7 per cent in Jordan, 10 per cent in Saudi Arabia, and 10 per cent in UAE.

The informal sector focuses its recycling efforts on the most valuable materials, including 57 per cent iron and ferrous

4 Fly tipping is the illegal deposit of waste on land

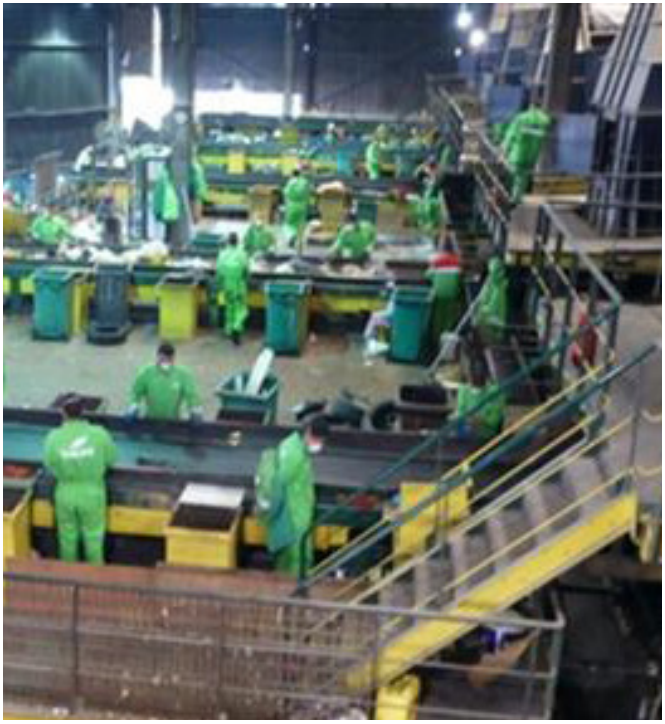
tin as well as significant quantities of non-ferrous metals, 15 per cent cardboard and 13 per cent plastics. The scale of this indicates an informal sector valuation in excess of USD1 billion as a regional industry. Informal-sector collection and recycling are based on market conditions, with no regulation, price guarantees or support from the government. Moreover, the market price of recyclables is affected by increased competition and fluctuating oil prices. Shortcomings facing the informal sector include safety, hygiene and health issues, often alongside a lack of medical insurance or employment benefits.

Waste Treatment and Disposal

There is significant ongoing reliance on the use of dumpsites and unlined landfill sites across the region. Of the region's total municipal solid waste, 87.7 per cent is dumped or put into landfill, with a small proportion of about 2.9 per cent incinerated. Some countries also conduct waste recycling and composting.

Dumpsites are in evidence around many communities including refugee camps, often located near countries experiencing conflict. Many of the landfills are unlined. The need to maintain a safe and healthy environment has been threatened by the disposal of waste in streets and at dumps located outside towns and villages. Dumpsites accross the region are polluting land and groundwater in a region where water stress and scarcity are crutial issues (WRI 2015). Emissions of GHGs and fires at dumpsites

Manual picking lines at sorting plant in Lebanon



Source: CQA International 2015

Table 2.7.1: West Asia, municipal solid waste collection coverage

West Asia MSW Waste Collection Coverage					
Country*	Urban%	Rural%	Total	Year	Source
Jordan	90.0	70.0		2013	(2) SWEEP-Net Jordan,2014
Kuwait			100.0	2009	(3) UNSD, 2015
Lebanon	100.0	99.0		2013	(2) SWEEP-Net Lebanon,2014
Palestine	93.0	88.0		2013	(2) SWEEP-Net Palestine ,2014
Syria			74.00	2003	(3) UNSD, 2015
Yemen	65.0	5.0		2012	(2) SWEEP-Net Jordan,2014

Note: * Country data found by assessment team

produce particulates from the combustion of flamable gases (Cointreau 2006) and sequestered carbon sources.

At the country level, the proportion of incinerated waste varies from about 22 per cent in Qatar in 2014 (QDB 2015), through 12.5 per cent in Iraq in 2005, to 5.3 per cent in Syria in 2003 (UNSD 2015). The residual quantity recycled regionally is about 6.6 per cent with about 3.0 per cent composted (Sweepnet 2014; UNSD 2015; QDB 2015). (Video: Composting in Dubai).

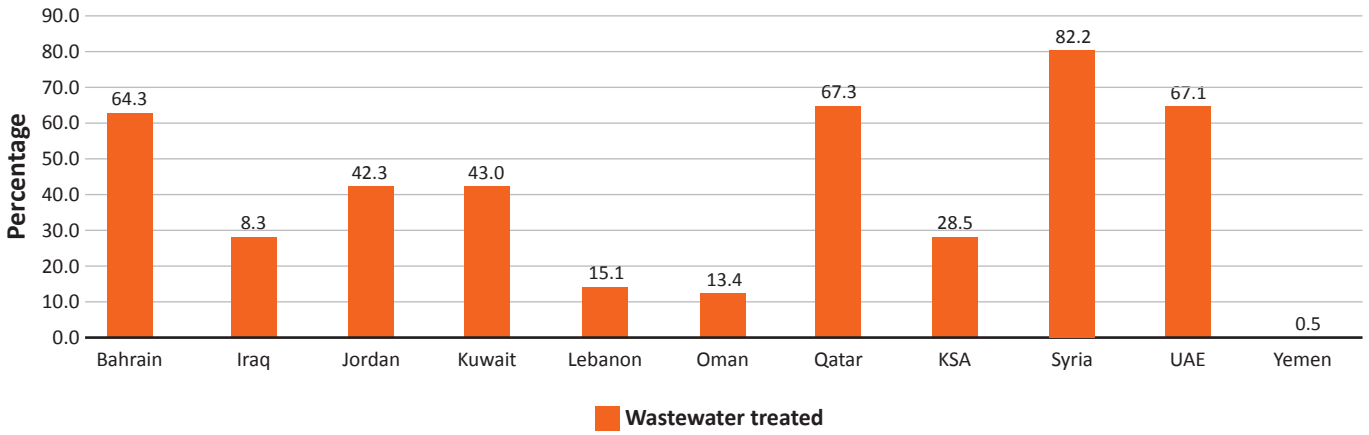
There have been several promising initiatives in the past few years, especially in Jordan, Qatar and UAE, but more effort is required to make waste-to-energy a by-line for sustainable development. An example of integrated waste management in the region is the treatment facility in Qatar combining recycling, composting and incineration with energy recovery. When the Qatar National Development Strategy 2011–2016 was considered, the solid waste management facility plant at Mesaieed was an appropriate solution, but its capacity was overwhelmed by the time the project was completed. Qatar needs a handful of such centres to tackle the growing garbage disposal problem (**More...15**).

In oil-producing high-income countries, industrial sludge, drilling wastes, and medical and hazardous wastes including radioactive materials, are usually dealt with by the authority set up to manage activities in the oil sector, such as ADNOC in Abu Dhabi, Oman PDO, Aramco in Saudi Arabia and KOC in Kuwait. In Jeddah, 500 000 cubic metres of raw sewage are discharged daily into Buraiman Lake (Zafar 2015). Recent wastewater treatment levels are shown in **Figure 2.7.3**.

The key developing markets for recycling in the region are for construction and demolition waste, metal waste, plastics, paper and cardboard, and glass. Estimates from waste characterization and generation data indicate that about 17.3 million tonnes of dry solids from municipal solid waste are currently dumped or put in landfill (Dumble 2015) (**Table 2.7.2**).

Materials recovered from sorting and composting plants are at low levels across the region and of generally poor quality due to high moisture content and a lack of source-segregated collection. The number and capacity of secondary smelters across West Asia (Pawlek 2015) indicates under-capacity, for example in Lebanon, Iraq and Qatar.

Figure 2.7.3: West Asia, wastewater treatment rates, 2014



Source: Waste Management World 2015

Table 2.7.2: West Asia, estimated dry solids in residual municipal solid waste

	Organic waste	Wood	Paper and cardboard	Rubber	Plastic	Textile	Diaper	Metal	Glass	Other
Total Dry solids/ tonne	6,159,268	130,372	2,850,922	141,672	3,370,104	806,566	207,177	1,017,639	1,223,978	1,356,946

Note: Dumble 2015

2.7.3 Policy responses for waste management

Integrated management of waste provides a significant opportunity for the whole of West Asia; however, different approaches are required across the region. Notably, socio-economic circumstances, conflict and human displacement have a major impact on the waste sector. The development of integrated waste management (IWM) in West Asia needs to be approached in a comprehensive manner, with the engagement of communities and government entities in supporting the initiatives of designated waste management authorities.

Stakeholder engagement and extended producer responsibility

Waste management is a community-driven process sometimes supported by non-governmental organisations but with limited success. An example of active participation of private business in promoting plastics conservation and recycling initiatives – Clean Up the Gulf – was launched in 2013 across six GCC cities (Abu Dhabi, Dubai, Riyadh, Rabigh, Al-Jubail, and Kuwait).

Extended producer responsibility (EPR) can be a strong policy principle in waste management measures, supporting supply-chain recycling and the 4Rs (Reduce, Reuse, Recycle and Recover) (Hoornweg *et al.* 2012), and engaging businesses and communities in sustainable best practice providing economic development opportunities from the growing circular economy, promoting the transformation from waste to resource management (Al-Hajj *et al.* 2012) and targeting net zero or lower emissions from the sector. However, EPR is not well known in the region and law-makers need to consider appropriate policy and economic measures.

Modernization of waste management data systems

Up-to-date waste management data for the region are poor, making effective waste management and control difficult, and progress in integrated waste management has also been limited by indecision in setting up the necessary infrastructure **(Box 2.7.2)**.

Innovation in financial mechanisms

Cohesive community resources must be used efficiently and sustainably, since waste management funding at the regional level has been difficult for both governments and private-sector providers. Many schemes have failed, including those funded by the UN.

Building the confidence of external funding sources to support public- and private-sector procurement processes is necessary for developing integrated waste management infrastructure and to secure realistic levels of funding. Further market confidence can be improved if governments share liabilities and risks with private-sector partners in a fair and equitable manner, and adopt regulations and standards to remove market barriers that are preventing the reuse and remanufacture of recyclable waste streams **(Box 2.7.3)**.

Box 2.7.2: Modernization of waste management data systems in UAE and Kuwait

Abu Dhabi, UAE – Integrated Data Management

The Nadafa Programme in Abu Dhabi (UAE) is a first step in applying modern data management based on global information system (GIS) technology. The Programme has established a system of live data management and vehicle tracking that effectively controls the collection and movement of wastes, reducing illegal dumping by 95 per cent.

Kuwait Data Collection – waste composition and characterization study

A study on waste composition and characterization in Kuwait was conducted in 2014 by an international consulting firm for Kuwait Municipality. The aim of the study was to determine Kuwait's current and future municipal solid waste quantities and composition. The study calculated waste generation quantities for the year 2013 and estimated future quantities for the years up to 2040. The study was executed in three stages over a period of six months to ensure that any seasonal variations were captured. The results and conclusions of this study are fundamental to ensuring proper design of a proposed waste-to-energy facility as well as future waste recycling measures and treatment of organic fractions.

Box 2.7.3: Jordan Waste-to-Energy coordinated planning approach

Jordan is to develop its first landfill gas-to-energy recovery system with capacity for 2 000 tonnes a day. Jordan's Greater Amman Municipality will use a USD13 million loan from the European Bank for Reconstruction and Development (EBRD). The EBRD is co-financing the loan with USD5 million from the Bank's Green Energy Special Fund (GESF). The government of Austria is providing resources to ensure appropriate supervision of engineering and support project implementation.

Waste tariffs can be found in Jordan, Oman and the UAE. Low waste tariffs and fees such as in Jordan do not significantly contribute to the high costs of waste handling, treatment and disposal. In Abu Dhabi, only 28 per cent of waste management costs are recovered by the existing tariff scheme. Waste producers' ability to pay for services is very limited in some West Asian countries, and their willingness to pay for the services is not high.

The Nadafa Programme in Abu Dhabi (UAE) imposes a waste tariff paid by all commercial businesses based on the wastes they produce and the size of the company. In the first year of implementation (2011), the tariff collected about AED181 million (USD50 million) over a 10-month period, which at the time represented about 30 per cent of the annual waste management budget, excluding pest control services.

The activities of the informal sector are perceived as a threat to the commercial viability of public-private partnership contracts in Lebanon (**Figure 2.7.4**) and Saudi Arabia, and to opportunities for improved management (Dumble 2012).

Procurement systems and implementation

Procurement plagued by inconsistencies in planning needs to be supported by commitments to realistic levels of funding with appropriate support from external funding organisations. Internal measures such as realising value from recyclable materials and the introduction of waste tariffs helps to improve financial confidence.

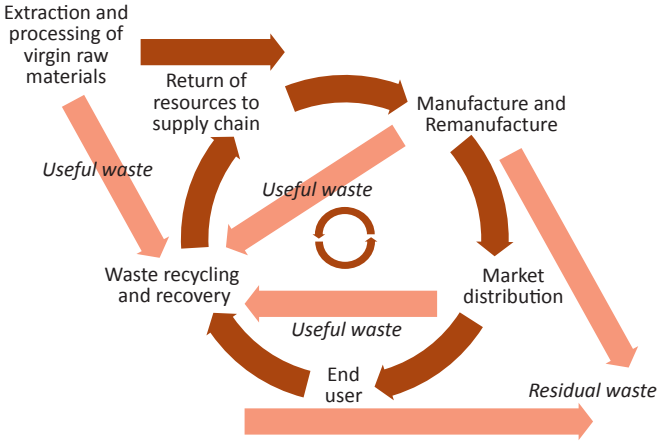
Once contracts are signed, local planning issues such as delays in the provision of 'no objection' letters by other government entities can effectively stop any further progress. Implementation of procurement decisions based on integrated waste management policy interventions can be frustrated by lack of confidence among political partners, stakeholder and entity opposition or concerns, conflict, and community planning issues. Such issues do little to create confidence and attract private funding.

Building the circular economy

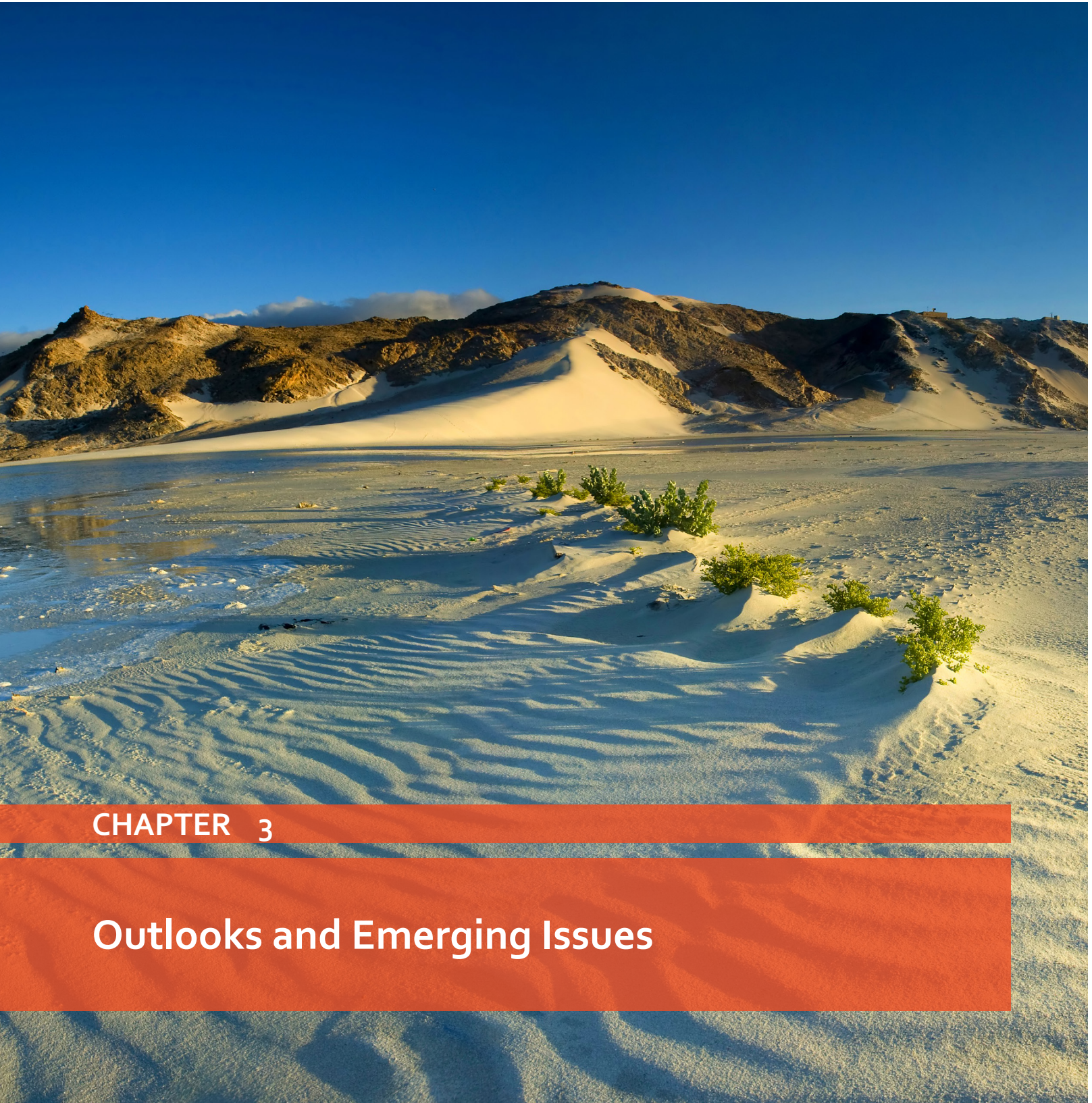
Countries in the West Asia region can aspire to build a circular economy, a concept gaining momentum internationally, in particular in Europe. Building an effective circular economy in West Asia would help to drive down waste management costs while providing goods and services to the economy. This would require addressing the barriers preventing the use the recycled and secondary materials. There are many areas where composite or mixed solid wastes could be used for roads, footpaths and general hard core, but such applications are hindered by the adoption of criteria often intended for high-specification work. There are a number of innovative manufacturing processes that can make use of mixed solid waste streams if they are clean. Thermoplastic recyclables need to be segregated, washed and converted to the specifications required by supply-chain users to maximize added value, as indicated in the mechanical heat treatment options in **Figure 2.7.4**.

See references for Chapter 2

Figure 2.7.4: Infographic of circular economy



Source: Barczak, P. 2015



CHAPTER 3

Outlooks and Emerging Issues

3.1 Introduction

As with other DPSIR assessments, this Outlooks chapter offers a vision of a future under a set of policy measures designed to achieve sustainable development. The vision has been arrived at by using the Sustainable Development Goals (SDG) as guidelines for achieving national and regional goals. It analyses the policy pathways that could lead to achieve SDG targets either in terms of their impacts on existing policies or how they enable particular scenarios to unfold. It provides the basis for how the West Asia region might look after successful implementation of measures to attain the SDG milestones. The vision presented here is not a prediction of how the future will evolve but rather an optimistic view of what it could be. The section also explores the challenges of implementing global environmental pathways, and provides insights into the scope of the course of action that West Asian governments could take.

Sections 3.2 to 3.4 identify the major drivers behind the changes that are currently underway, including the impact of population growth rates as well as current economic growth. An exploration of global megatrends and teleconnections with other regions addresses regional and local conflicts, fluctuations in oil supply and demand, and how the use of technology could shape the future. Current emerging environmental issues and how they might play a role in determining the environmental agenda of the region are also investigated.

Section 3.5 explores sustainability challenges in the context of the environmental dimension of the SDGs, highlighting those identified by the West Asia region as pertinent to their own conditions and requirements, and matching them to the five broad environmental themes addressed in this report.

Section 3.6 introduces the Oryx Scenario, an optimistic vision of the future for the next 25 years based on the goals of regional sustainability. The Oryx Scenario assumes fulfilment of core West Asia priorities, namely: improving the level of peace and security; reducing current trends in water scarcity,and coping with the impacts of climate change.

Section 3.7 returns to a vision of the future, 40 years (10 years after the adoption of SDGs), arranging the major themes and requirements of sustainability in supporting the SDGs.

3.2 Current regional drivers of change

The regional drivers can be seen as the cause of environmental challenges and they can also be seen as possible tools for change. The first identified drivers are population growth rates and urban development and the next driver of change is economic growth and the way it can help make the transition to cleaner living.

3.2.1 Population and urban growth

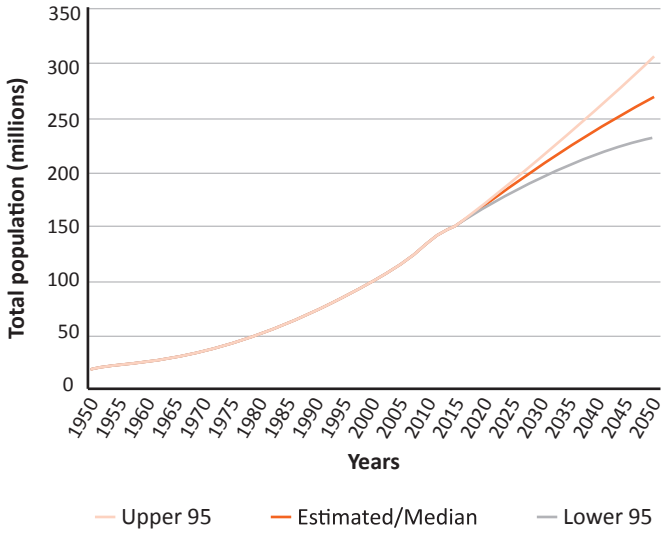
In pre-modern times the bulk of West Asia's population was concentrated in the fertile areas of Iraq, Syria and Yemen. The rest of the region supported thinly distributed populations, mostly engaged in rain-fed agriculture, fishing and pastoralism. Much of the habitat was not touched by human development.

The situation changed considerably following independence, the discovery of oil, and rising wealth and education. These changes have brought about a phenomenal growth in population and living standards. West Asia's population is projected to continue to grow in the next few decades, albeit at increasingly lower rates. It is expected to increase from just over 150 million (2.1 per cent of global population) in 2015 to about 205 million (2.4 per cent of global population) in 2030 (**Figure 3.2.1**) (UNDESA 2015a). A large proportion of the population, 52 per cent, is under the age of 18. With the notable exception of Yemen and to a lesser extent Syria, West Asia's population is also highly urbanized. These high rates of population growth and urbanization, coupled with current consumption patterns, compound the pressures on the region's limited land and water resources (UNEP 2010b).

Due to its aridity and water scarcity, given the state of technology, the region has already surpassed its natural capacity to meet its own food and water demand; the increasing gap between the region's ecological footprint

◄ Credit: Shutterstock/ Ozphotoguy

Figure 3.2.1: West Asia, population growth, 1950–2050



Source: UNDESA 2015a

and its biocapacity is demonstrated in **Figure 3.2.2** (AFED 2012). Increasing water demand has further exacerbated the region's serious water scarcity and exerted pressure on groundwater extractions rates. Most of the countries in the region rely on imports to meet food demand, making them highly vulnerable to market forces. Energy requirements have largely been met through fossil fuel power generation that further increase the region's carbon footprint.

West Asia's population is youthful, presenting both challenges and opportunities. As job demand has outstripped the region's capacity to generate employment, many young people have looked for work elsewhere, particularly in Europe and North America. This process has accelerated considerably with the conflicts in Iraq and Syria, which have forced hundreds of thousands of refugees to flee by dangerous routes to Europe. The younger generations also have increased overall levels of consumption and expectations.

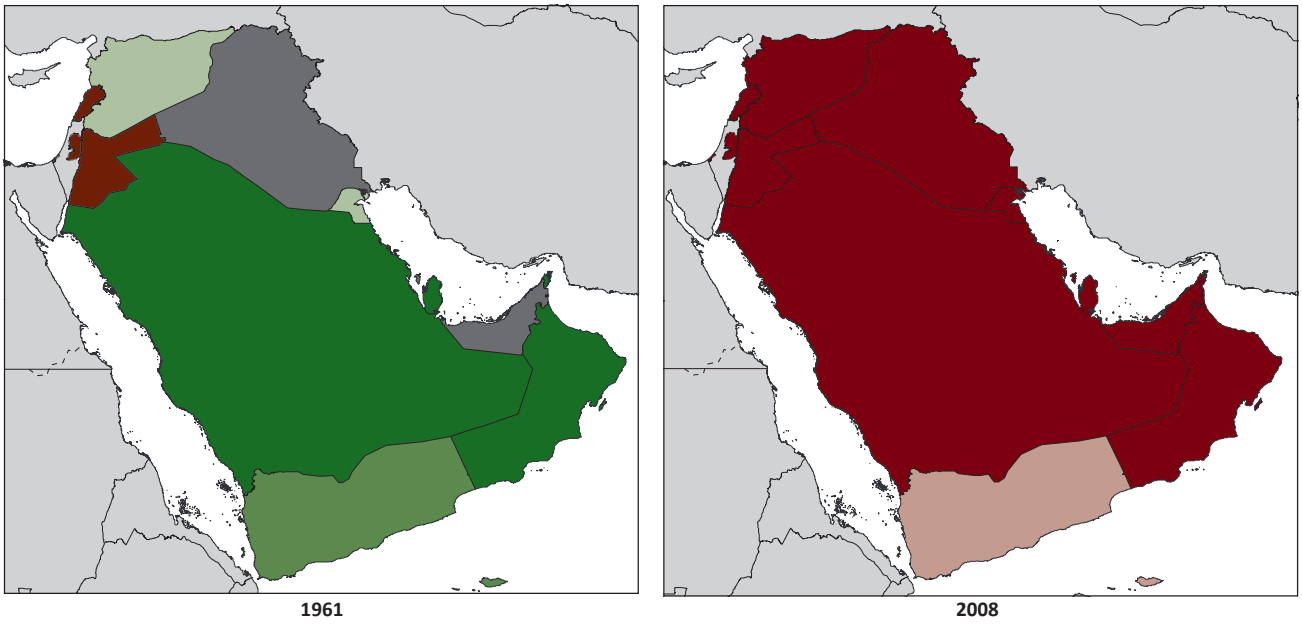
At the same time, however, youth is more open to adopting new lifestyles, including those that emphasize sustainability and conservation of ecological systems and natural resources. Sustainable campus and education initiatives in the United Arab Emirates (UAE) have raised awareness among school and higher education students of the importance of sustainability, water and energy conservation, and waste reduction and reuse (EAD 2015).

3.2.2 Economic check

There are significant disparities in West Asia's economic landscape. While some of the region's countries, particularly those in the GGCs sub region, are among the world's highest-income countries, with a large gross domestic product (GDP), others, such as Yemen, are among the lowest and have stagnant economies. Civil war and conflict have ravaged some economies, causing substantial damage to infrastructure, supply chains and other monetary institutions. Currently, the conflict in Iraq resulted in negative growth rate which is a contraction in Gross Domestic Product (GDP) and this is partly attributed to the destruction of economic infrastructure. Despite growth in crude oil production in 2014, the fall in oil prices since 2014 has considerably reduced revenues for the Iraqi government. In contrast, Jordan and Lebanon have maintained moderate expansion of domestic demand; improved balance-of-payments contributed to historic highs in the foreign reserves of both countries in 2014 (UNESCWA).

The region holds 52.2 per cent of world oil reserves and 24.6 per cent of world gas resources (OAPEC 2009). Oil and gas exports along with petrochemicals are the main sources of income in the GCCs sub region. With the current slump in oil prices, efforts to diversify the economies of oil-producing countries are intensified. Political emphasize on economic diversification has fluctuated inversely with the varied revenue from oil and gas. However, low oil prices have spurred strong political emphasis on diversification (Hvidt 2013). On the other hand, in the Mashriq sub-region and Yemen, the agricultural sector is the main source of economic activity, contributing 30 per cent of GDP and employing more than

Figure 3.2.2: West Asia, the growing gap between ecological footprint and biocapacity, 1961–2008



Source: AFED 2012

40 per cent of the workforce (UNESCWA 2002), although there are also some extractive industries in countries such as Jordan and Syria.

3.3 Megatrends and teleconnections

Megatrends reflect the impact of current regional trends and their interplay in the West Asia countries' reality. They include conflict and refugee exodus, the fluctuation of oil prices and the move to use technology and data sharing. Megatrends provide a description of the status of current trends and how these factors may shape the future.

3.3.1 Conflict and refugee exodus

The Arab Spring felt in West Asia and the Arab region has developed into full-scale violent conflicts in Iraq and Syria, leading to a massive exodus of millions of refugees, first to neighbouring countries and more recently to Europe by illegal and dangerous routes. The thrust of this refugee crisis

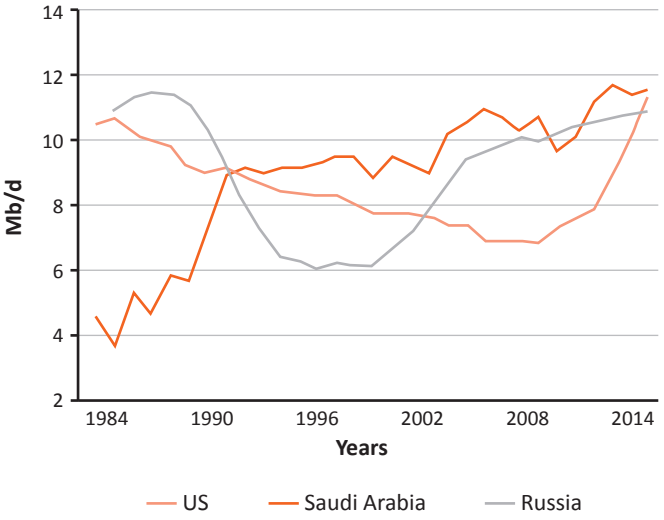
is not only testing Europe's religious and ethnic tolerance and its human rights tradition, but, as some European countries start to raise border controls, is also threatening the European Union's open-border policy and potentially its very integrity. The ramifications of the current upheaval in West Asia reach across continents and oceans and cannot therefore be isolated from the rest of the world.

A protracted violent conflict brings not only loss of life, injury and human misery, but also uprooting of communities and devastation of homes, infrastructure and agricultural land. The majority of refugees from the conflicts in Iraq and Syria will not be able to return home without clearance of mines and unexploded ordnance. Experience shows that the clearing of mines and rebuilding of infrastructure might take decades. West Asia will face a daunting task to remove the debris of war and reconstruct whole new cities and towns.

3.3.2 The fluctuation of global oil supply and demand

The discovery of oil has brought great wealth not only to the GCC countries where most of the oil is found, but also to other countries in Western Asia that rely to varying degrees on remittances from their nationals working in all economic sectors of the GCC countries. Consequently, West Asia has been greatly influenced by global oil prices that reflect a balance of global demand and supply. Oil prices diminished by more than 60 to 70 per cent during the second first half of 2015, placing tremendous pressure on oil-producing countries; the largest oil exporter Saudi Arabia ran a budget deficit in 2015. Although slower growth in China has contributed to the recent slump in oil prices, it is mainly attributed to the dramatic rise of US oil-shale production, which may eventually make it the largest global oil producer–ahead of Russia and Saudi Arabia (**Figure 3.3.1**) (Dale 2015). Consequently, the US shale revolution has a dramatic impact on the West Asian economy.

Figure 3.3.1: The world's largest oil producers, million barrels per day, 1984–2014



Source: Dale 2015

3.3.3 Use of technology in monitoring and data sharing

Following a trend in developed nations, some countries in West Asia are adopting state-of-the-art technology to monitor water and electricity consumption. The Dubai Electricity and Water Authority (DEWA) installed 120 000 smart meters at the beginning of 2015 and is planning to expand their use (Malek 2015). Smart meters can monitor electricity consumption on a real-time basis, facilitate better service and reduce down-time. The smart meters are a component of smart networks that can connect households to renewable energy sources such as solar panels. Moreover, West Asia is also witnessing an increased interest in basic research. Recently, the King Abdullah University of Science and Technology (KAUST) in Saudi Arabia installed Shaheen II, the seventh most powerful supercomputer in the world. The computer is being used for a wide range of research projects including climate modelling and the development of renewable energy grids.

3.4 Emerging issues

Emerging issues is about anticipating scenarios which are not a current trend but probable events and outcomes that might determine the status of the environmental agenda of the region.

3.4.1 Extreme events and natural disasters

Recent natural disasters in West Asia indicate that countries of the region are not well prepared to mitigate and respond to these events. The flooding in Jeddah, Saudi Arabia, in November 2009 resulted in more than 150 fatalities and significant economic damage. Although the episode was triggered by an unprecedented downpour over a very short period, the inadequacy of drainage systems and poor emergency preparedness contributed significantly to the number of fatalities and the amount of damage (Assaf 2010).

3.4.2 Increased coastal urbanization

The extensive coasts of West Asia have been open to global trade throughout history, encouraging the growth of urban centres on the Mediterranean Sea, the Red Sea and the GCC sub region. However, these urban communities have grown considerably over the past few decades, particularly in the ROPME Sea Area[5] through which a significant share of the world's oil passes. In the UAE, artificial islands have been built to accommodate an exponential growth in real estate that only slowed in 2008 following the global recession. However, coastal development is projected to continue over the coming decades. This coastal urbanization process has adversely affected the marine environment due to the release of wastewater and brine from desalination plants, as well as debris from construction sites. The deterioration of the marine environment is expected to continue unless measures are taken to control this development and its impacts. This includes eliminating the release of untreated waste – both liquid and solid – into the marine environment and developing a sustainable management approach to coastal development.

3.4.3 Proliferation of invasive species

Several countries in West Asia are witnessing uncontrolled growth in populations of invasive alien species. For example, the mesquite tree Prosopisjuliflora, native to South and Central America, has spread throughout Oman where it is known as Ghafbahri. In addition to causing sickness in grazing animals, the tree is known to transfer toxic chemicals into soil that hamper the growth of other plants including trees (Oman Coast 2015).

3.5 Sustainability pathways

This section explores sustainability challenges in the context of the SDGs and their targets, highlighting those identified by the West Asia region as pertinent to their own conditions and requirements, and matching them to the five broad environmental themes addressed in this report.

3.5.1 Sustainable Development Goals and targets

The SDGs are major constituents of the future environmental setting at the global level. West Asia is no exception and it needs to clarify how future planning regarding the SDGs should unfold. Bahrain, Jordan through its 2025 vision, Qatar in its 2030 vision and UAE in its vision 2021 have taken steps towards integrating the principles and objectives of the SDGs into their national development plans and strategies. Saudi Arabia has also considered achieving the SDGs in its 10th development plan.

The SDGs represent a major departure from their predecessors the Millennium Development Goals (MDGs), in that they expand the spectrum of main issues to those reflecting the priorities of developing countries. The SDGs, however, have 17 Goals and 169 targets, thus running the risk of splintering the focus on critical issues that pertain to a specific country or region. And there is also the formidable task of devising methods of measuring progress on these

5 ROPME Sea Area (referred to as the Kuwait Action Plan Region in the past) is the sea area surrounded by the eight Member States of ROPME: Bahrain, I.R. Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

targets. The SDG targets were reviewed and a set of SDG targets (presented in **Table 3.5.1**) were selected to reflect the regional priority areas that were identified in the West Asia Regional Environmental Information Network (REIN) Conference that was held in Amman in May 2015. The selected SDGs are discussed below (this is not an inclusive list but given information and time constraints, the below table presents identified SDGs that overarch priority areas:

- SDG target 16.1 tops the list as it captures the main concern of a region with three of its most populous countries – Iraq, Syria, and Yemen – witnessing civil wars and unrest accompanied by a massive exodus of refugees. Without active intervention at regional and global levels, these violent events may continue for years to come and threaten to spill over to neighbouring countries. As indicated previously, refugees have overwhelmed the main host countries and are triggering a major global crisis as many travel across dangerous routes to Europe. West Asian countries have underscored peace and security as a prerequisite for achieving the SDGs. Jordan, Qatar and Iraq also emphasized the important role of the UN, particularly support from the specialized agencies, in addressing national and transnational challenges such as those of refugees and displaced people as well as education.

Table 3.5.1: Sustainable Development Goal targets particularly relevant to the West Asia region

#	Description of selected SDG target
1	**SDG target 16.1:** significantly reduce all forms of violence and related death rates everywhere.
2	**SDG target 6.4:** by 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity.
3	**SDG target 6.5:** by 2030 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate.
4	**SDG target 6.3:** by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.
5	**SDG target 2.4:** by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality.
6	**SDG target 11.4:** strengthen efforts to protect and safeguard the world's cultural and natural heritage.
7	**SDG target 13.3:** improve education, awareness raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction, and early warning.
8	**SDG target 11.6:** by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality, municipal and other waste management.
9	**SDG target 12.5:** by 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse.
10	**SDG target 9.5:** enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, particularly developing countries, including by 2030 encouraging innovation and substantially increasing the number of R&D workers per one million people and public and private R&D spending.

- SDG target 6.4 calls for improving water-use efficiency to moderate the severe water scarcity that grips most of West Asia. Most of the region's countries have emphasized water-use efficiency in their national development plans. However, wasteful use of water is still rampant in the region, particularly in the agricultural sector.
- SDG target 6.5 calls for adopting integrated water resource management for addressing water issues. It particularly draws attention to transboundary cooperation, a central issue for West Asia since most of its renewable water originates in Turkey and Iran. An equally challenging situation is facing the OPT, as most of their sources of water are under Israeli control.
- Water scarcity in West Asia is compounded by deterioration in water quality as a result of widespread pollution of water resources by industrial, agricultural and urban uses.
- SDG target 6.3 points to effective measures that would significantly reduce water pollution. Investment in wastewater treatment and reuse has already yielded great benefits to many West Asian countries including Jordan and the GCC countries. Other countries in the region could follow suit.
- SDG target 2.4 addresses the major issues facing agriculture in West Asia. The sector is already under severe stress from chronic scarcity of water and land resources, compounded by competition for these resources with rapidly growing urban populations. Climate change is projected to severely decrease precipitation and increase the duration of dry periods.
- One of the pressing issues that has arisen from the recent conflict and is addressed by SDG target 11.4 is the need to take a proactive approach to safeguard the archaeological monuments of the region – some dating back to the earliest human civilisations. Several sites designated by the United Nations Educational Scientific and Cultural Organization (UNESCO) as World Heritage Sites, have been deliberately destroyed by fanatical militant groups, with looted antiquities from Iraq and Syria smuggled out of the region and sold to illegal traders.
- West Asia is expected to be one of the regions most affected by climate change. As indicated earlier, climate change is expected to dramatically reduce precipitation levels in the region and increase evapotranspiration levels, which will further reduce renewable water resources. SDG target 13.3 emphasizes the use of education, awareness raising and governance in addressing climate change.
- Air quality is becoming a main concern in several West Asian cities as a result of the rapid rise in car ownership and poor public transport. SDG target 11.6 calls for reducing the adverse impacts of air pollution. Section 3.6.2 addresses air quality issues in the region.
- The issue of waste management is addressed by SDG target 12.5. This explicitly calls for the adoption of integrated waste management principles that emphasize prevention, reduction, reuse and recycling. This is discussed in more detail in Section 3.6.6.
- SDG target 9.5 highlights the serious deficiency in scientific research and innovation in developing countries including those of West Asia. The region has one of the world's lowest expenditures on research and development per unit of GDP.

3.5.2 Air

There is evidence that air quality in some areas of West Asia is deteriorating rapidly, being under continuous anthropogenic pressure from increasing population, urbanization, energy production and other polluting industries (UNEP *et al.* 2010). The ambitious economic development in West Asia has been a driver of environmental degradation, including air pollution. However, there are also natural driving forces that contribute to the problem, namely dust and sandstorms (UNEP *et al.* 2010). The decreased quality of air causes a number of serious respiratory diseases that can lead to premature death (UNEP *et al.* 2010). Efforts to monitor air pollution appeared as early as the 1980s in West Asia with Kuwait establishing eight air-monitoring stations in 1984 (UNEP *et al.* 2010). In addition, National Cleaner Production Centres have been established in several West Asian countries, for example Lebanon and some GCC countries, to try and reduce the negative impact

of industrial activities, which contribute up to 49.5 per cent of West Asia's GDP (EOAR 2010; LAS 2007).

3.5.3 Land

Geography, and consequently climate, have modified the environment of West Asia to produce arid to semi-arid conditions across most of the region, reducing its capacity in terms of freshwater, food production and economic growth. Cultivated land and forests make up only 4.8 per cent and 1.4 per cent respectively of the land area. Rangelands have deteriorated through overgrazing and wind erosion of cultivated marginal lands, which has led to increased desertification and dust storms. In addition, the high rates of population growth and urbanization as well as continuous conflicts and wars for more than 70 years, associated with population displacement and migration as well as bad governance, have all widened the gap between supply and demand and led to high levels of land depletion, and poverty, making the future bleak for land and people alike. Local indigenous scientific research is crippled throughout West Asia and must be encouraged and supported to help solve such issues.

3.5.4 Biodiversity

Biodiversity underpins the essence of life and the roots of culture in West Asia. The Strategic Plan for Biodiversity 2011–2020 provides the region with numerous opportunities to conserve and restore its biodiversity before it is too late. Results from the scoping done by West Asian countries during preparation of their fifth national reports to the CBD have shown that biodiversity across the region is witnessing a rapid decline in both habitat cover and species populations, despite many efforts to protect and conserve them. Moreover, there is an urgent need to improve institutional, systemic and individual capacities to ensure a basis for good governance of biodiversity conservation. Many countries are also seen to lack the necessary tools and policy instruments to implement various international agreements such as the Nagoya and Cartegena Protocols. On a more positive note, progress has been noted in the region with countries showcasing increased commitment in the implementation of the CBD and their contributions towards achieving the Aichi Targets, in addition to embracing the ecosystem-based approach and encouraging stakeholder engagement. Under business-as-usual conditions it is expected that unsustainable development will continue accompanied by exponential population growth that exceeds the environment's carrying capacity, uncontrolled human consumption resulting in an increase in waste production, and illegal hunting and trade along with other negative practices such as overgrazing and land-use change. All these contribute further to degrading the region's habitats and driving species towards extinction.

However, holistic and innovative approaches to biodiversity conservation can be embraced at the regional level, inspired by rising environmental consciousness and resulting in shifting attitudes and behaviour among communities. Little or no governance being one of the main causes of biodiversity loss, this approach embraces balance (sustainability) at its core, thereby envisioning a future in which governments, private and civil society organisations work together in partnership to ensure good governance in the region. This results in good biodiversity management and conservation accompanied by social and economic growth.

3.5.5 Water

Given the aridity of West Asia – expected to intensify under climatic change – the region has little prospect of increasing its natural water supplies. However, a combination of demand management and augmentation of supply from treated wastewater and desalination, and effective control of water pollution, can help the region rein in the rapid rise in water poverty, and potentially reverse the trend if population growth decelerates at an increasing rate.

Sustainable resource management is gaining stronger ground in various countries of the West Asia region. Countries in the GCC initiated bold policies and measures in 2015-2016 to enhance water and energy efficiency and put a price tag on environmental services. Voluntary energy and water efficiency programmes were enhanced, and complemented

with fiscal measures, mainly reducing subsidies. The Saudi budget for the fiscal year 2015-2016 highlighted this trend, as stated by a statement from the Ministry of Finance, committing to: "Reviewing government support, including revision of energy, water, and electricity prices gradually over the next five years, in order to achieve efficiency in energy use, conserve natural resources, stop waste and irrational use, and minimize negative effects on low and mid-income citizens and the competitiveness of the business sector."

This was immediately followed by a change in prices to better reflect the cost of the service and control consumption. Other measures to control the production of water-intensive crops, such as wheat and fodder, were implemented across the GCC, to preserve limited groundwater resources. Other countries, including Jordan, had earlier started strict water preservation measures, including metering and water pricing.

The SDGs encourage and expect countries to adopt an integrated approach to managing water resources. Water management should be considered across a wide range of sectors, including agriculture, tourism and industry, in which most of the water is used. Considering that most renewable water resources in West Asia are transnational, it is important to reach agreements between affected countries on the most efficient and fair management of these resources. Although this seems far-fetched during the current protracted violent conflicts in Iraq and Syria, it could become the catalyst for ending these conflicts and maintaining order and peace in the region.

3.5.6 Waste

Nearly 90 per cent of municipal solid waste in West Asia is disposed of in unlined landfill sites and leachate from these is contaminating scarce groundwater resources. Proper integration of municipal solid waste management in West Asia is generally hampered by technical, administrative and financial shortcomings in some countries.

There are, however, great opportunities for utilising waste as a resource, but this requires technical and financial support from high-income countries, promotion of safe recycling, and enacting regulations to promote the use of recyclables as substitute raw materials.

The following key recommendations are offered to assist in the implementation of integrated waste management across West Asia:

- develop regional legislation to stop the dumping of wastes in landfill and phase out the use of all unlined landfill sites by 2025;
- develop accurate and reliable databases based on geographic information system (GIS) location and tracking systems including solid waste generation and composition in all municipalities;
- coordinate integrated waste management policies and regulations across the region;
- establish tariff schemes for all waste producers and build incentives to reduce wastes and recycle;
- engage with local communities to create communal collection points that encourage segregation of wastes;
- establish extended producer responsibility with key industries, importers and their supply chains to reduce waste production, increase resource efficiency and increase utilisation of waste as a resource.

3.6 The Oryx scenario – a vision of environmental sustainability

The Oryx scenario presents visionary outlook where all is well in the West Asia region. It is an optimistic vision of the future for the next 25 years based on the goal of regional sustainability (10 years after the adoption of SDGs). The scenario assumes fulfilment of core West Asia priorities, namely: improving the level of peace and security; reducing current stresses in water scarcity; and coping with the impacts of climate change.

3.6.1 Scenario milieu

The Oryx scenario describes a range of paths that countries in West Asia could follow in their efforts to leap to a better future in the next 25 years. Most of these countries have experienced stormy times in the last few years, which has created an atmosphere of uncertainty and doubt. The new regional priority is to reorient, recover and discover new ways of facing emerging changes and challenges.

Countries are striving to mainstream sustainability in their policies and practices. Developed countries were the earliest countries to contextualise, incorporate and apply these concepts; however, they progressed by trial and error and developed mechanisms to correct for errors. The experience they gained in this respect has superseded that of many other countries and it might be replicated by developing nations, but it requires commitment to change, conviction to modify working rules, and the resources to support different pathways. It involves leapfrogging to environmental, social and economic sustainability.

3.6.2 Scenario assumptions

The Oryx Scenario is a visionary look at the future of the West Asia region, drawing an optimistic picture of the pathways to environmental sustainability as depicted in **Table 3.6.1**.

The scenario assumes that the region will move towards a green economy. Eco-tourism will be the prevailing model of the tourist industry, environmental sustainability will be a core subject in the educational curriculum and regional cooperation will be a national priority issue leading to peace and security. Cross-regional cooperation will play a major role in the management of transboundary environmental issues with sustainable consumption and production as the absolute norm. Increased per-person water availability will be achieved through the successful implementation of integrated water resource management plans and by increased cooperation in the management of transboundary water resources. Environmental matters will be integral to national and regional policies and high on the political agenda of West Asian countries, leading to improved environmental democracy and governance systems. The assumptions are hypothetical and give the reader an imagination of a future outlook that can be manifested with will power. The Oryx Scenario proposes selective outcomes:

- That regional cooperation will prevail, leading to economic stability and increased security and human well-being. It also assumes that young citizens will be the major driving force as entrepreneurs and architects of the future.

- That the region will apply modern desalinization technologies and use integrated water resource management efficiently.

- That countries of the region will apply adaptation and mitigation measures and implement the internationally agreed treaties to manage the impact of climate change, including displacement and sea level rise.

3.6.3 The Oryx scenario unfolds

With economics as the backbone of any country, sustainability is the propeller driving the economy and economics. With countries economically dependent on natural resources and stakeholders aware of the impacts of resource overuse on economies, society and the environment, there has been a shift towards sustainable development paradigms.

Oil-rich West Asian countries, mainly the GCC countries and Iraq, have been using their endowment of hydrocarbons as the main vehicle to build their economic prosperity. However, with the post-oil paradigm looming and slumping revenues from oil, as well as the political manipulation of oil supply and demand, these countries should move towards other avenues on which to base their economies, such as ecotourism, agriculture and fishing.

West Asian countries with limited or no oil resources are in a position to seek sustainable horizons that might expand their economies to meet the increasing demands of growing populations. Institutional development and investment

Table 3.6.1: The Oryx Scenario matrix

Issue	Trend	Rationale
Economic Development	↗	Development ambitions of West Asian countries no longer contradict environmental sustainability. The region's mitigation strategies make it more dependent on renewable energy sources in its path towards greener economies for its countries.
Education and environment	↗	Well educated and environmentally aware youth lead West Asian countries. Environmental issues are national priorities for the region's governments and rank high on their agendas.
Conflicts and displacement	↘	The region is politically stable where regional cooperation addresses extremism effectively improving peace and security. Displacement driven by climate change impacts is well managed through adaptation strategies that include relocation plans. Transboundary resources are managed effectively.
Sustaining natural capital	↗	Awareness of the value of ecosystem services drives consumption patterns. Efficiently –enforced environmental legislations and mitigation policies pave the way for sustainable production methods in West Asia.
Water Scarcity	↘	Population control policies increases the per person share of water for the citizens of West Asian countries. IWRM and water footprint considerations are making water use more efficient. Climate change exacerbated water scarcity is addressed by the agricultural adaptation of the region's countries.
Politics and environment	↗	West Asian countries are rapidly climbing the environmental democracy ranking as political parties integrating environment and sustainability into their mandates and the civil society is more involved in monitoring environmental performance.

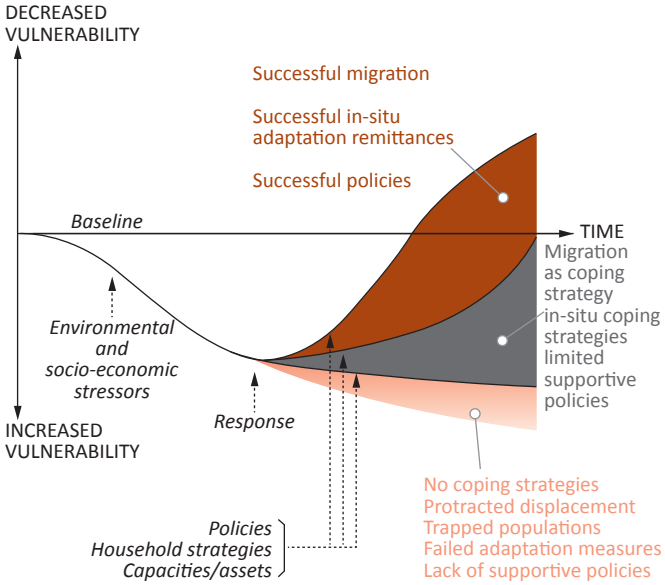
in human resources and capacity building are among the fundamental elements of economic diversification and development, followed by creativity in sustainable use of renewable resources while preserving ecosystem goods and services. This might also be done by diversifying their economies through regional and international cooperation. Investments in manufacturing, trade, commerce and tourism have become major economic avenues with increasing attention being paid to environmental issues.

- Phasing out of an economy based on oil and other minerals ushers countries into a wide new domain, leaping out of the old economic practices developed in the early 1950s into a more spacious and vibrant economy fed by innovation and creativity and overarched by sustainability.
- In this scenario, countries seek new models based on the green economy, taking advantage of their natural capital (Black *et al.* 2011). The thrust towards a green economy entails the creation of a new class of entrepreneurs, mainly young citizens who run small- and medium-sized businesses. This initiative also moves the economy towards the private sector, widening its contribution in the national economy as well as ensuring financial stability and developing the skills of young businessmen. Many of the young entrepreneurs have turned to resource recovery from waste, a multiple-benefit business. On the one hand, waste management practices have improved in areas where these industries are located. On the other, the profit margin is promising enough to attract more young entrepreneurs to the business (Figure 3.6.1).
- The Oryx Scenario coincides with transition to green economy in terms of environmental change. This implies

cross-regional cooperation, legislative reform, and closed-cycle industrial parks. The pioneering experience of Bahrain in establishing one of these parks hosting small, medium and large technology companies in niche markets was one step in furthering the management of the environment-industry nexus as in **Figure 3.6.1**.

- In addition, a capacity-building programme to support consumer groups and improvement of governance in West Asia and a sustained link between social, economic and environmental policies provides an opportunity and a solution to the sustainability challenge in the region. Integration, cooperation and dialogue at national, regional and inter-regional levels replace the tensions and armed conflicts that hindered the sustainable development agenda in past decades.

Figure 3.6.1: Migration and environmental change: vulnerability and resilience scenarios



IOM 2015

3.7 Sustainable outlook

Adopting a positive vision of the future and trusting that West Asia countries are capable of achieving sustainable development, several sustainable development goals are articulated each presenting a dimension of realizing this bright future. Ten goals are explored based on their relevance to the region's main priority areas. Seven SDGs are selected representing the environmentally related goals while the remaining two goals are portraying how the region might be prosperous in light of achieving peace and security, partnerships and regional cooperation.

3.7.1 Healthy people, healthy planet

West Asian countries have exerted remarkable efforts to eliminate environmental risks that cause health issues. Health institutions across the region have adopted measures that have substantially reduced mortality rates and disease burdens from hazardous chemicals and air, water, and soil contamination. Scientific research in the field of environmental health played an important role in this achievement. GCC countries in cooperation with the Mashriq countries and Yemen continue to develop a regional network of air quality monitoring stations, with strict implementation of laws and regulations regarding industries that contribute the most to air pollution, making significant improvements in air quality in the region. The prevailing peace and security in West Asia has helped in improving environmental health as countries have been able to combat water-borne diseases through effective wastewater and sewage treatment. The region's successful implementation of international conventions such as the Basel, Rotterdam and Stockholm conventions related to hazardous chemicals and wastes was vital to promoting health and well-being in the region.

3.7.2 Clean water and good hygiene

West Asian countries are providing access to safe and affordable drinking water through investment in adequate infrastructure, providing sanitation facilities and encouraging hygiene at every level. Through enforced rules and regulations, countries are protecting and restoring

water-related ecosystems such as forests in Lebanon, Syria and Oman, mountains in Yemen and Saudi Arabia, wetlands in Iraq and the UAE and rivers in OPT, Jordan, Syria and Iraq that are essential for the mitigation of water scarcity. Also through international and regional cooperation, West Asian countries are encouraging cooperation in transboundary water resource management. Countries continue their policies to encourage investment in projects, and water systems are being managed under a system of governance and coordination to ensure their sustainability and integrity. The availability and sustainable management of water and sanitation are achieved through a reduction in pollution and elimination of dumping as well as minimisation of hazardous chemicals and materials. Implementing the circular economy and resource efficiency has increased the recycling and safe reuse of wastewater, increased water-use efficiency and reduced water scarcity throughout the region.

3.7.3 Green affordable energy

West Asian countries continue to decrease their reliance on fossil fuels as the main source of energy, having managed to secure affordable and renewable energy sources for their citizens. Effective laws and regulations are enacted to encourage active participation of the private sector in the energy sector. Moreover, there is a notable improvement in energy efficiency by using new technologies to meet the increasing development ambitions and energy demand in the region. The share of renewable energies in the total energy mix has increased significantly making it possible for West Asia countries to meet their international obligations with respect to greenhouse gas emissions targets. The water, food and energy nexus in the Mashriq countries and Yemen is now well balanced as the integrated environmental management of its components is applied.

3.7.4 Responsible consumption and production

Regional and national policies have been designated for the promotion of resource and energy efficiency, sustainable infrastructure and access to basic environmental services, green jobs and an enhanced quality of life for all citizens of the region. Jordan has adopted and implemented its strategies on a green economy and solid waste management. The UAE has also implemented its Green Growth and Innovation Strategy to increase the use of clean energy. Other GCC countries are diversifying their economic activities. The Mashriq countries, through cooperation between various actors operating in the supply chain, are reducing resource use, environmental degradation and industrial pollution, resulting in improved quality of life. Countries have managed to use their natural resources efficiently. The GCC countries, which used to have among the highest ecological footprints in the world, are now categorised among the non-ecological deficit countries. Yemen and the OPT continue to have some of the world's smallest footprints, achieved by reducing food losses, applying environmentally sound management of chemicals and all wastes, and promoting public procurement practices. The West Asia region, which used to be one of the most water-stressed in the world, has managed to control per-person water consumption and regulate both municipal and domestic water demands. Depending on the structure of their economies, countries are no longer subsidising the inefficient use of fossil-fuels, thereby minimising wasteful consumption and eliminating market disorders.

3.7.5 Tackling climate change

West Asian countries now incorporate the climate change dimension in the national policies and planning processes of all relevant sectors. The region's policies in the energy sector, coupled with sustainable consumption and production, are satisfactorily fulfilling its climate change mitigation targets. At the global level, GCC countries are now contributing to climate funds that support mitigation actions in the least developed countries. Regarding adaptation, Mashriq governments continue to strengthen resilience to natural disasters and extreme events. With the region regarding sea level rise as one of the biggest threats of climate change, governments are implementing various adaptation strategies ranging from coastal defences to economic diversification for the affected communities. While West Asian countries had formulated their adaptation strategies on the basis of a potential 1-metre rise in global mean

sea level, the 0.4-metre rise projected by the IPCC (2013) under the least emissions scenario (RCP 2.6) has not been exceeded. Seawater intrusion in the GCC countries and Yemen has been minimised by coastal protection measures and sustainable management of groundwater resources. Communities whose livelihoods are sensitive to climatic changes, such as small-scale agriculture, have been made more resilient through income-diversification and capacity-building programmes. The continuous development of innovative technologies in early warning and risk assessment has increased the adaptive capacity of the region. Countries are cooperating to control climate-induced migration and secure livelihoods for displaced people. Jordan, UAE, Qatar and Yemen have contributed to global efforts to reach a binding agreement on the basis of common but differentiated responsibilities.

3.7.6 Life below water

Countries in West Asia continue to place high priority on the conservation and sustainable use of marine resources in the ROPME Sea Area, Red Sea and eastern Mediterranean. Marine life that has suffered from the various conflicts is now fully conserved. The GCC countries increasingly rely on clean modern technologies in desalinising water to meet their demand. Agreement between countries has been ratified to transfer water through a marine pipeline across the ROPME Sea Area. Iraq, Kuwait, Oman, Saudi Arabia and the UAE are implementing the joint programme for the protection of marine resources. Bahrain has a state-of-the-art marine and biodiversity research centre. Qatar continues to reaffirm its commitment to the Global Alliance for Drylands to Combat Desertification and Drought. West Asian governments have agreed on a framework to sustainably manage and protect marine and coastal ecosystems from land-based pollution, as well as to address the impacts of ocean acidification. Sustainable use of marine resources is now implemented through enforcing agreed international laws and regulations. As a result, the region has succeeded in protecting the life cycle of marine habitats that was previously disrupted. Countries are now continuously regulating harvesting to end overfishing and illegal, unreported and unregulated fishing in the ROPME Sea Area, Red Sea and eastern Mediterranean.

3.7.7 Life on land

West Asian countries are effectively implementing laws and regulations to conserve and restore the use of terrestrial ecosystems such as forests, wetlands, drylands and mountains, particularly after the devastating effects of armed conflict – now resolved – that occurred in the region and led to massive destruction of habitats and high rates of biodiversity loss. Iraq, Oman, the UAE and Yemen have established a programme for protecting and fostering terrestrial ecosystems. Combating desertification and restoring degraded land and soil, including land affected by desertification, drought and flood, are also high on countries' priority agenda and are reinforced through land-use laws. The mobilisation and increase in financial resources as well as involvement of the private sector are effectively ensuring the conservation and sustainable use of biodiversity and ecosystems. Many countries encourage the private sector to achieve zero net deforestation in agricultural commodity supply chains, resulting in the reduction of natural forest loss.

3.7.8 Peace, justice and strong institutions

Promoting just, peaceful and inclusive societies is now the overarching priority of all West Asian countries. The region managed to significantly reduce earlier death rates resulting from domestic and armed conflicts and violence. Peace and security prevail in the entire region as a result of peace agreements and bilateral and multi-lateral cooperation. Institutions are functioning efficiently to assess and monitor the state of the environment and keep it under review. Governments give full public access to environmental information and civil society groups are playing a major role in monitoring environmental change. Freedom for all citizens is maintained according to national cultures and legislation. Citizens are now participating in the environmental decision-making process at all levels. The prevailing equal access to

justice and democracy has led to reductions in all forms of domestic unrest. This has also substantially reduced the rate of corruption and bribery in the region.

3.7.9 Partnerships for the goals

West Asian countries have endeavoured to revitalize global partnerships for sustainable development by strengthening the means of implementation. Improved revenue collection systems, technology transfer and knowledge sharing, capacity building for implementing goals and restructuring policy frameworks were the core elements that enhanced the implementation process for achieving sustainable development practices. With regard to revenue collection, the Mashriq countries and Yemen are now working on strengthening domestic resource mobilisation to improve domestic capacity through environmental taxes and revenue collection such as pollution penalties and fines. Governments use the revenues to increase institutional capacity for maintaining the sustainable development goals and national future visions that have been achieved. The public sector and all stakeholders are involved in formulating capacity-building programmes to support national plans to implement all sustainable development goals. Countries have come together to form a West Asian environmental information network that aims to enhance data sharing and the exchange of knowledge and environmentally sound technologies, based on cross-regional cooperation, agreements and multi-stakeholder partnerships. Countries have taken serious steps towards global partnerships involving different sectors (public, private and civil society), creating national and regional information hubs and portals that integrate timely environmental information, enhancing the availability and accessibility of environmental information and technological innovation.

The Mashriq countries, which called for regional data-sharing mechanisms, have worked on creating partnerships and increasing their market capacity to include global information technology companies. The GCC countries continue to enhance regional capacity building to increase significantly the availability of disaggregated high-quality, timely and reliable data and support statistical development. West Asian countries have strong partnerships and international cooperation. The public and private sectors are now major players in the development process, with overseas development assistance (ODA) acting as a critical means of implementation.

Jordan has a coordinated partnership between national governments, donors, multilateral institutions, the private sector and civil society. The region has a dedicated programme for capacity building with respect to project preparation, policy guidance and effective technical assistance to help countries build economic resilience and meet their individual responsibilities for financing their development needs.

With regard to policy frameworks, countries have taken serious steps towards policy implementation in order to maintain their success in achieving the SDG targets. This has been executed through the involvement of civil society and the public and private sectors in the policy- and decision-making process, building on the experience and resourcing strategies of partnerships.

3.8 Conclusion

With respect to the SDGs and the 2030 agenda, the West Asia regional assessment report provides useful analysis for countries to increase their understanding of the linked national and regional environmental challenges. This analysis can feed into regional dialogue for cooperation and collaboration to build resilience to secure future needs and attain sustainable development goals. In order to make the leap to the Oryx scenario outcomes there will need to be systemic adjustments to existing policies in order to steer environmental, social and economic development to meet the challenges identified in this assessment report.

The two regional themes identified in this assessment: peace, security and the environment, and the water, energy and food nexus, cannot be addressed in isolation. The interdependencies of different aspects of the two

narratives impose a binding scope to address challenges in a holistic way. As established in this assessment report, the two narratives, along with their aligned priorities, ask policy makers to assess the impacts of their policy options in relation to other priorities. For example, exploring options for water security, one cannot dismiss the negative impacts on biodiversity from water desalination, and consequently, one cannot disregard the indirect social and economic impacts of reduced fish catch. In the same vein, in planning for long-term water security in the region, one has to assess current groundwater extraction rates and their impacts on the agriculture sector as well as the indirect impacts on food security. The fact there are trade-offs (short, medium and long term) as well as benefits and costs, oblige policy makers to carry out holistic assessment of policy options in order to understand, with high confidence, the aggregate impacts and to be able to map contingency plans. This is the advantage of developing policy enabled by science.

Therefore, in order to link challenges across priority areas and in order to find viable solutions that may have (direct and indirect) impacts across priorities, a preferred mechanism is to adopt an integrated assessment platform that includes all affected sectors and constituencies. In this manner, not only are priorities linked with associated impacts, but the environmental, social and economic impacts on different sectors are understood and planned for. This can be done through a Policy Impact Assessment Framework, a Regulatory Impact Assessment Framework, or a Strategic Impact Assessment Framework. The adopted framework should capture potential synergies among different priorities, policies, and practices; it therefore requires that priorities are not treated in isolation.

Institutionalizing integrated environmental assessment paves the way to investigate different aspects of social and economic development that are affected by environmental impacts. The impact assessments can therefore be linked, directly or indirectly, to social and economic development targets and goals. Some of the adjustments need not be radical and may not have high associated cost; however the benefits can be captured in ripple effects across different sectors and lead to greater well-being of societies. More significant adjustments may require substantial investment in order to make rooted changes and these can be informed by the anticipated outcomes of the impact assessment studies.

See references for Chapter 3

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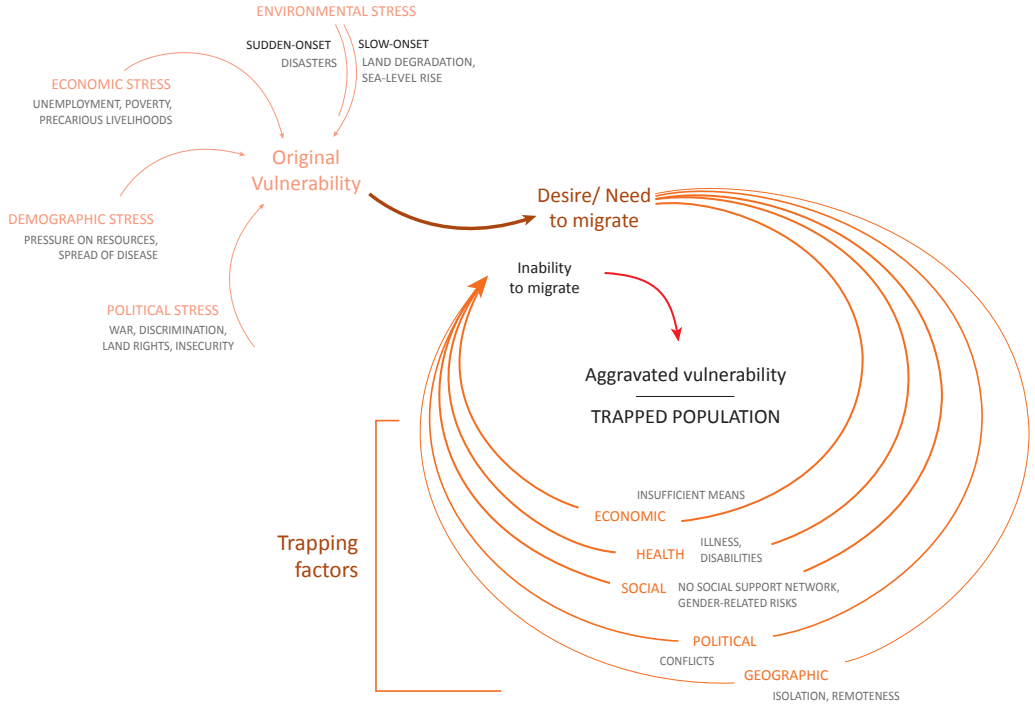
Supplementary Information

Additional information and to read **More...**:

1. Peace, security and the environment

The complex relationships between peace, security and the environment are both interdependent and mutually reinforcing. Just as conflict results in environmental degradation, the environment has been the source of conflicts in the quest for security, achievable only through access to natural resources. This vicious cycle is exacerbated by oppression, mainly of minorities and women, as well as the existence of power struggles. Inequalities hinder sustainable development and trigger clashes, which in turn tend to amplify marginalization and disparity (Spring 2001). Peace and security being closely tied to environmental security, they must be addressed simultaneously (Khagram *et al.* 2013). As long as social structures do not secure sustainable livelihoods for all, struggles to protect the environment from conflicts will fail, just as a disregard of life-supporting systems will not allow human development. In addition, political, demographic, economic and environmental stresses might result in the displacement of the vulnerable populations. People might not be able to migrate due to political conflicts alongside other economic, health, social and geographic reasons as shown in the Figure below. The vulnerability of these trapped communities tends to increase with time (Black et al., 2011).

Trapped populations



Source: IOM 2015

◄ Credit: Shutterstock/ Zeljkodan

2. The Iraq-Iran war

The Iraq–Iran war (1980–1988), the region's longest war in the 20th century, which resulted in 600 000 Iranian and 400 000 Iraqi deaths (UNEP 2003) has left the Shatt al-Arab estuary and the Mesopotamian marshlands, two extremely ecologically important areas, severely mined and damaged by chemical weapons. Marshlands dried out due to construction of defensive infrastructure and causeways, while palm plantations and millions of trees around the Shatt al-Arab estuary were destroyed. Moreover, towards the end of the war, up to 4 000 Kurdish villages were devastated, leading to the displacement of their populations and the destruction of orchards and cropland (AFED 2008). Marine ecosystem degradation was intensive, especially due to the targeting of oil installations leading to the spilling of approximately 2 million barrels of oil and the destruction of more than 500 commercial vessels, which still affects marine life to date. Most of these issues have never been addressed, as among the war's indirect impacts was the loss of functioning institutions, notably the failure of the Environment Department of the Ministry of Health to re-establish its pre-war functions (AFED 2008). In 1990, during Iraq's occupation of Kuwait, military and civil infrastructure was bombed, damaging sewage systems, water supply plants, power stations, oil refineries, petrochemical industries and biological and chemical weapons facilities.

During the First Gulf War, up to 5 million people were forced to leave their homes, resulting in the greatest displacement of people in the shortest time period ever recorded (Arkin et al. 1991). Notably, the largest oil spill in history, known as the world's worst ecological disaster, was caused by the release of 6–8 million barrels into the Regional Organization for the Protection of the Marine Environment (ROPME) Sea Area. A toxic micro-layer formed and temperatures dropped suddenly, affecting birds and marine life. As the ROPME Sea Area is enclosed and shallow, contaminants tend to accumulate rapidly and settle. The region also nestles among the most important habitats for marine turtles, and the life cycle of these important species was disrupted (AFED 2008; Dixon and Fitz-Gibbon 2003; Poonian 2003). A popular uprising followed the end of the war, an event which led to a governmental campaign to drain the second largest wetland in the region as a punishment. The scheme entailed diverting the waters away from opponents who had taken refuge in the Mesopotamian marshlands. This led to the elimination of 93 per cent of the marshlands by 2002, the displacement of hundreds of thousands of Marsh Arabs, and subsequent desertification (AFED 2008; Poonian 2003).

The invasion and occupation of Iraq by the US, which lasted almost 10 years (Dewachi et al. 2014), resulted in oil fires that suffocated people, poisoned ecosystems and led to acid rain, fallout of soot and chemical pollution (Mayell 2003). This burning released approximately 500 million tonnes of carbon dioxide, an amount which is considered to have contributed to the progression of climate change. Furthermore, marine habitats were significantly polluted by burning oil, aggravating the degradation caused by previous conflicts. Additional to the burning oil was the pollution from bombing, which reached neighbouring countries and contaminated groundwater and surface water resources. More specifically, the targeting of industrial sites, as well as armament factories, caused acute pollution episodes. These events have led to the damage of numerous freshwater ecosystems, the loss of wetlands, and to the further degradation of the Mesopotamian marshes. Although information regarding particular species is lacking, the destruction of habitats is enough to assume very high rates of biodiversity loss (Dixon and Fitz-Gibbon 2003; McLaren and Willmore 2003). Other environmental impacts include the significant increase in phytoplankton productivity in the waters at the mouth of the Tigris and Euphrates due to a rise in nutrient levels caused by raw sewage and wastewater. Moreover, large amounts of waste, garbage and toxic material were dumped and burnt in desert ecosystems (Mayell 2003). Finally, a by-product of the war has been the extremely high amounts of fuel required for planes, boats and tanks to maintain the occupation (Dixon and Fitz-Gibbon 2003).

Recently, the aggression of radical groups that began in June 2014 has further aggravated the environmental situation in Iraq. The intensive fighting near the Baiji oil refinery has caused an increase in levels of hazardous substances in

groundwater and soil. Furthermore, conflicts around Kirkuk's oil fields have the potential to lead to further contamination and health-related impacts. These consequences might once again put strong environmental pressure on Iraq (Zwijnenburg 2015).

3. Loss of biodiversity due to the Palestinian-Israeli conflict

Due to the ongoing conflict, approximately 300 plant species have been listed on the International Union for Conservation of Nature's (IUCN) Red List of Endangered Species, posing significant risks to ecosystem balance. Furthermore, several species of aquatic birds, among which a large proportion nests and breeds in Wadi Gaza, have also been labelled as threatened (UNEP 2005).

4. Impacts of conflict in Syria

Armed conflict in Syria led to an escalation of environmental problems and severe toxic footprint. Almost five years into the Syrian conflict, the environmental and health impacts resulting from military activities are beginning to appear. Alongside this, poverty is on the rise, aggravated by displacement of people and the destruction of public service infrastructure such as schools and hospitals. A significant portion of the population has fled to neighbouring countries and Europe, while even larger numbers have been internally displaced. By July 2015, the number of refugees in neighboring countries exceeded 4 million, while the number of internally displaced reached 7.6 million (UNHCR 2015; UNDP/UNRWA 2013). Furthermore, 7.9 million people's livelihoods sank below the poverty line, of whom today more than 50 per cent live in extreme poverty. Poverty has been exacerbated by unemployment rates, still on the rise and reaching 48.6 per cent (UNDP/UNRWA/SCPR 2013). In this context, environmental pressures have been exerted both by armed conflicts and by their socio-economic consequences. These impacts are not limited to Syria, but also affect neighboring countries, chiefly Jordan, Turkey, andLebanon (Carrion 2015; Mencütek 2015). Additionally, the availability of water per person has decreased to one third of pre-crisis levels, from 75 to 25 litres per day, further impacting health (UNICEF 2013). The deterioration of health and educational systems and shrinking gross domestic product (GDP) reflect the regression of Syria's Human Development Index (HDI) rating, which by 2013 had decreased by 20.6 per cent on its 2010 value (UNDP/UNRWA/SCPR 2013). Once covering 3.3 per cent of the country, large areas of Syrian forests have been destroyed either by fire as a result of shelling or by excessive wood cutting for cooking and heating purposes due to fuel shortages. Several protected areas and wildlife reserves, as well as World Heritage Sites including Palmyra, have been burnt or destroyed.

5. Impact of conflict in Lebanon

After several years of civil war, Lebanon is still subject to continuous international and civil conflicts, and the country's natural environment is suffering from severe stresses. Direct damage of the civil war include the destruction of infrastructure and agricultural lands, depletion of natural resources, and pollution of soil and groundwater. High numbers of displaced people, estimated at more than 70 000, have put further pressure on natural resources in specific regions and led to the abandonment of farmlands (AFED 2008). Among the most adverse effects of the 2006 were 1 200 fatalities, 4 000 injuries and up to 1 million displaced people, together with more than 10 000 tonnes of oil that leaked into the coastal waters, contaminating two thirds of Lebanon's 225-kilometre coastline. The most affected habitats were harbours, caves and natural bays, where the oil was trapped, posing serious threats to biodiversity. In addition, ecologically important areas such as Palm Islands were contaminated, reversing conservation efforts. Along with sea contamination, the oil spill led to air pollution through evaporation and the release of toxic sprays (Heinrich Böll Foundation 2006).All this, along with the destruction of plantations and orchards, severely affected farming communities, with many impacts lasting to this day (UNEP 2007; Heinrich Böll Foundation 2006). Since 2011, due to the absence of proper governmental response plans, wastewater pollution has increased by one third and air pollution by 20 per cent. Furthermore, water quality has deteriorated and

urban population density increased from 400 to 520 people per square kilometre. With various intersecting regional tensions and wars, the potential for future international and civil conflicts threatens to push environmental strain in Lebanon to new heights. (Kadi, 2015). Additionally, as Lebanon looks to exploit its off-shore natural gas reserves, it becomes crucially pressing for key political, economic, and social changes to be made.

6. Impacts of conflict in Yemen

Listed among the world's least developed countries (LDC), Yemen suffers from rapid population growth and rural-to-urban migration, lack of economic development, increasing pressure on natural resources, and widespread health concerns. Instability in Yemen is increasingly impacting the country's environment, once ecologically important and rich in biodiversity. Rapid population growth and urbanization add to the challenges and raise serious questions about the severity of future environmental change. Not only is water scarcity a challenge, but water quality is deteriorating due to pollution and contamination of aquifers, predominantly in cities (World Bank 2000). Moreover, although 90 per cent of water is used for agriculture, most of the wheat and rice consumed in Yemen is imported (BTI 2014). By October 2015, and as a result of the ongoing war, the World Health Organization (WHO) reported 5 462 deaths and 26 447 injuries (Howeidy 2015). Occurring at a time of water scarcity and more specifically during an important cropping season, 11 million people are now severely food insecure, of which 4.8 million are living in emergency conditions. Up to 850 000 children are malnourished and approximately 16 million people, more than half of the total population, are in need of emergency aid and access to safe drinking water. The conflict is not only impacting markets and trading, but also hindering agricultural production. Since farmers, fishers and other food producers are those most affected by the violence, food insecurity and poverty will continue to rise (FAO 2015).

7. Future measures

With the absence of participatory conflict resolution plans and action at the international, regional and national levels, peace and security will probably deteriorate, leading to further environmental degradation in the region. The impacts of climate change will have major effects on West Asia's ecosystems and natural resources.

International resolutions, as well as economic, political and social changes will be required to secure the well-being of people living in West Asia. Environmental assessments and recovery plans will have to be implemented, as significant degradation has resulted from past and ongoing conflicts. In this framework, the relationships between peace, security and the environment will have to be further considered in the future. Urgent action is needed, including for the restoration of environmental damage and a reduction of its health impacts. This set of measures will pave the way to sustainable development and ecologically healthy potential future scenarios.

8. Water quality

The challenge of water quality deterioration across West Asia is eclipsed by concerns over quantity. However, increasing levels of pollution and salinity of both surface and groundwater resources is increasingly affecting the ability to use the region's scarce water resources, and is heightening tension between riparian countries. The deterioration of groundwater quality in GCC Council countries due to over-abstraction from the non-renewable aquifers during the last 20 years is an example. There is, however, a need for minimal environmental water flows to maintain ecosystems, a fact that is rarely incorporated in national water management planning and strategies within the region. As an arid and semi-arid region, water scarcity in West Asia has led to a supply management approach that seeks to utilize all available water resources and that prioritizes quantitative water allocation. The deterioration of conventional water resources has led to investment in non-conventional water resources such as desalination in the GCC countries. Domestic and industrial wastewater and agricultural drainage water

are discharged into the region's rivers and streams causing the degradation in water quality.

9. Integrated Water Resource Management (IWRM) for economic development

Without integrated and smart management of water resources, increased economic activity in the region will demand more freshwater and create more pollution, breaking the boundaries of sustainable water resource use. This will be aggravated by the impacts of climate change that are already affecting some of the region's vulnerable rivers and ecosystems. At the same time, improved quality of life will increase the water demand. Cities should be willing to create more investment to attract residents and businesses, yet this will exacerbate the need for more water resources. Whether the region faces water quality, scarcity or variability issues, the anticipation of and response to water challenges will define its capacity for growth in the future. Through the integrated, sustainable and smart management and development of its limited freshwater, the region could overcome these challenges and enjoy environmental, economic and social benefits – indeed, accessibility to safe and clean water is considered a building block for the region's economic and social growth. Rapid urbanization, however, could hinder the development of adequate water-supply and sanitation infrastructure. With the increase in population and urbanization, the annual per-person share of renewable freshwater resources in the region will fall from 850 cubic metres in 2015 to 650 in 2025 and 425 in 2050 (UNEP 2012)

10. Transboundary shared water resources

One of the biggest challenges facing the water sector in West Asia is coping with shared water resources, either surface water basins or groundwater aquifers. The region's shared surface water basins are well known. Most of them have been subject to discussion and negotiation between riparian countries, and some, most notably the Jordan River Basin, have been overshadowed by sustained political conflict. There are seven shared rivers in West Asia. Surface water resources, mainly from river flows, are estimated at 93.1 billion cubic metres, concentrated mainly in the Mashriq sub-region, with 80.1 billion cubic metres available from the major shared rivers and the remaining 13 billion from smaller rivers, springs and intermittent wadi flows (UN-UNESCWA 2007). The Mashriq countries, including Iraq, Lebanon and Syria, rely on river flows supplemented by limited groundwater sources, while the remaining countries rely on flood water and shallow and deep groundwater sources. Total annual internal renewable water resources account for only 6.3 per cent of their average annual precipitation, against a world average of 40.6 per cent, due to the high rate of evaporation. The Arabian Peninsula is characterized by an arid climate with annual rainfall of less than 100 millimetres a year, with no surface water bodies, and depends mainly on non-renewable groundwater aquifers and desalinated water to meet its increasing water demand (UN-UNESCWA 2013).

Renewable groundwater in West Asia generally takes the form of shallow alluvial aquifers recharged by the main rivers and wadi flow, especially during major flooding events, and directly from rainfall in aquifer outcrop areas. Renewable groundwater, or the annual amount of groundwater recharge, is estimated at 15 500 million cubic metres (UN-UNESCWA 2005). In the Mashriq sub-region, the amount and frequency of recharge is much greater than on the Arabian Peninsula due to the higher volume and frequency of rainfall. The degree of groundwater exploitation in most countries of West Asia is much higher than the amount of recharge, leading to continuous and sharp declines in groundwater levels, extensive depletion of groundwater reserves and increased salinity.

There are extensive groundwater reserves of varying quality available in shared deep non-renewable aquifers covering most countries of the Arabian Peninsula, Jordan and Syria. The major shared deep groundwater sources are the Eastern Arabian Aquifers, Um Err Raduma, Dammam and Wajeed, located in the Arabian Peninsula; the Shaq aquifer between Saudi Arabia and Jordan, and the Basalt aquifer between Jordan and Syria. There are 18 shared groundwater aquifer systems within the region.

Shared water remains a sensitive topic in West Asia and data sharing between riparian countries is very limited. As a result, there is no common understanding of the state and development of water availability, use and trends. On a national level, data is often lacking, incomplete or inaccessible, particularly when it comes to water use, which is rarely measured. Regionally, data from different countries can be contradictory, often because there are no unified standards for measuring hydrological changes. The fact that cooperation between riparian countries is limited further impedes the development of a common vision on shared water resource management. Existing bilateral agreements centre on water allocation, with an emphasis on infrastructure development and use. Water quality is not addressed in these agreements. While there are no river basin associations in place, bilateral cooperation over surface water does take place through technical committees and local projects.

11. Demand –side management of water

One of the most important tools for integrated and sustainable management of scarce water resources in the region is through demand-side management. This could be done in many ways such as improving farm water management, which could have the greatest impact on irrigation water use. However, it is a complex matter and also involves social, economic, legal, organizational, technical and policy issues. At present, although water is an extremely valuable and vital resource, it is generally supplied for free or at a very low and highly subsidized price. Cost recovery and water pricing policy could help to improve and increase water-use efficiency and ensure better investment in water-sector projects. New innovative technologies could also help to improve the efficiency of water use and increase the productivity of both water and food sectors. Many technologies are available such as precision irrigation, trickle and sprinkler systems, laser levelling and hydroponic agriculture. All could contribute to substantial improvement in water application and distribution efficiency in the agricultural sector.

12. Water transfers and investment

The development and management of the water sector is largely funded by government budgets, which in turn are influenced by the magnitude of a country's gross domestic product (GDP). Annual budget allocation to the water sector varies across the region, with higher allocation rates in the GCC countries; while some countries, mostly in the Mashriq, depend on Arab and international lending institutions to finance their water supply and sanitation sector. Achievements vary between countries based on their policies and priorities among the various sectors, namely water supply and sanitation coverage, increases in food production, allocation of sufficient funds to invest in infrastructure, and the provision of financial support to increase agricultural and industrial productivity. Water transfers between water basins or across national borders have been studied and discussed in the region over the last two decades, one example being the agreement between Iran and Kuwait to transfer water through a marine pipeline across the Gulf. The studies done on this project indicate that it is more feasible than desalinating Gulf water, but, due to geopolitical and technical issues, this agreement was never implemented (Dawoud 2011).

13. Marine Invasive species

The number of invasive species found in the Mediterranean is about 1 000, including molluscs, fishes, benthic plants and crustaceans (UNEP-MAP RAC/SPA 2010). About eight species of the coastal rocky fish community in Lebanon are considered Red Sea migrants (Harmelin-Vivien et al. 2005). Four Lessepsian fish species have been reported in Syrian coastal waters (Hassan and Ahmed 2012). At least 12 species of jellyfish have invaded the Mediterranean, some of which have significant impacts on fishing and other industries (Brotz and Pauly 2012).

Biodiversity in Syria

With a total land area of 185 000 square kilometres, Syria is considered one of the most biodiverse Mediterranean countries. The Mediterranean climate and various

topographic forms – mountains, hills, plains and vast desert areas – have contributed to the creation of distinct ecosystems with rich fauna and flora. There are nearly 4 000 species of flowering plants in the country, of which 22 are Ptyeridophytes, 10 are Gymnosperms and the remainder are Angiosperms. About 300 of the country's plant species are endemic. There are 2 500 species of animals, of which 62 per cent are insects, 15 per cent birds, 6 per cent reptiles and amphibians, and 5 per cent mammals; and there are 641 species of fungus, 55 bacteria, and 754 algae. About 354 bird species have been recorded in Syria, of which 161–194 species breed in the country and 156 are migratory. Marine flora is estimated at 660 species of algae from 7 phyla, and 4 species of marine plants belonging to the phylum Spermatophyta. Marine fauna include 1 027 species from a range of different animal phyla (single celled, Spongia, Cnidaria, Ctenaria, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata, Chaetognatha, Tunicata, and Vertebrata).

Source: The National Study on Biological Diversity (1998); (Saad 2009)

Biodiversity in Jordan

Jordan has an extraordinary fauna and flora species composition due to its location at the cross-border of three main continents – the African, Oriental and Palearctic. There is a total of 13 vegetation types in Jordan, where 2 622 plant species have been recorded so far. More than 100 species are considered endemic, including Iris nigricans, Origanum petraeum and Crocus moabticus. In addition, several rare orchid and other iris species have been recorded.

The fauna of Jordan is represented by more than 644 animal species, excluding invertebrates. This includes 83 species of mammals including globally threatened species such as *Capra nubiana, Gazella dorcus, Gazella subgutturosa, Gazella gazelle* and *Oryx leucoryx.* Avifauna composition is especially rich in Jordan with 436 species recorded so far. The richness in birds is due to Jordan's geographic location associated with the Great Rift Valley and because it lies on a major bird migration route. Freshwater diversity is also high, with 15 species of fish recorded, including the endemic *Aphanius sirhani.* Further, Jordan hosts 110 species of herpeto-fauna including three species of amphibian and 107 species of reptile: 37 snakes, one tortoise, one terrapin and 68 species of lizard including the flagship species Uromastyx aegyptia and *Varanus griseus.*

Source: Al Eisawi 1996

14. Application of ecosystem approach to the management of the world heritage site in Bahrain (Pearling, Testimony of the Island):

Pearls of Bahrain have been regarded since antiquity as the best in the world due to their great beauty and remarkable purity. A project aimed at improving the environmental, cultural and socio-economic management of global cultural heritage pearling areas in Bahrain through the application of ecosystem-based management approach was carried out during the period 2012 to 2014. The project was implemented as collaboration between the Supreme Council for Environment, the Ministry of Culture of the Kingdom of Bahrain and the United Nations Environment Program-Regional Office for West Asia (UNEP-ROWA). The project , which is considered the first of its kind in the region, centered on the application of ecosystem-based management approach to enhance environmental protection of oyster beds that were declared as a World Cultural Heritage Site in 2012. Several national workshops were organized with the participation of a wide range of national stakeholders, including governmental and academic institutions, and representatives of private sector and civil society. Specialized studies including ecological and socio-economic characterizations for the oyster beds areas were conducted. These studies helped in developing the strategic, ecological and operational objectives for the protection and specifying target indicators and monitoring programs.

Source (Supreme Council for Environment, Bahrain 2015)

Dust and sand storms

Dust storms are increasing in frequency in the Arabian Peninsula. They are generated in regions where soil cover is

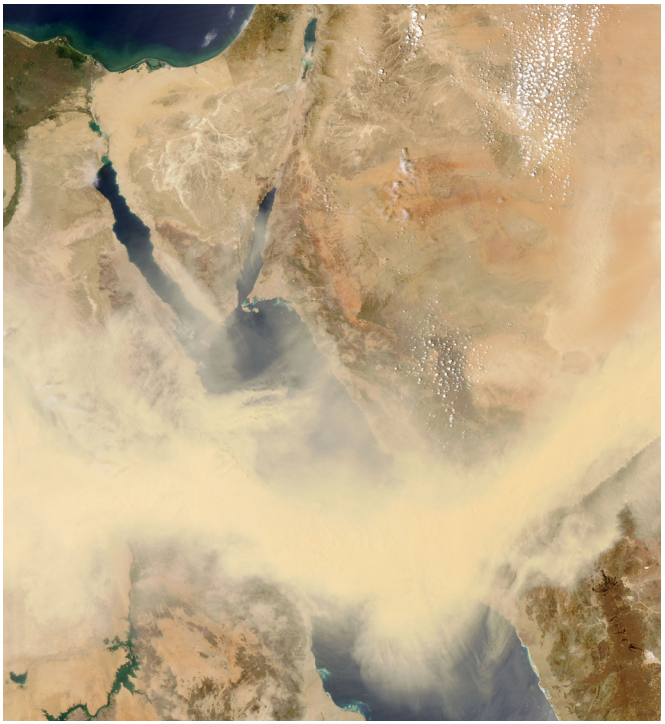
being loosened by livestock grazing and road development. Dust storms known as khamaseen blow from the North African Sahara across Egypt and then to the Eastern Mediterranean, carrying substantial amounts of dust in each event during March–May each year (Abed et al. 2009). Dust storms can also blow in the opposite direction, depending on atmospheric pressure, such as the 2005 dust storm which originated in Iraq and travelled southwest across the Red Sea. Monitoring of 70 dust storms between 2001 and 2012 indicated that Syria and Iraq are the most productive sites for dust storm generation in West Asia (Moridnejad et al. 2015).

15. Mangroves plantation in Abu Dubai, UAE

Mangrove forests cover thousands of hectares along the UAE shorelines. These forests provide a rich natural habitat and safe breeding grounds for several fish species, turtles and commercially important shrimps. They also prevent the coastline erosion, and play an important role in reducing carbon emissions, thereby moderating the impacts of climate change. Abu Dhabi accounting for more than 75% of the total mangrove forest area in the UAE. Excessive human activities in some locations have adversely affected the mangrove ecosystem. Therefore, The Environmental Agency-Abu Dhabi initiated large-scale cultivation programs to rehabilitate the affected areas. For instance, around 750,000 of mangroves have been planted in Saadiyat Island, which is currently being developed as a cultural hub of Abu Dhabi. This initiative was aimed at mitigating the environmental damages caused by the massive development on the island.

To provide more relevant estimates of emissions and to help assess technology options, clean development mechanism (CDM), Intergovernmental Panel on Climate Change (IPPC) and WRATE (Waste and Resources Assessment Tool for the Environment) life-cycle analysis methodologies were applied to waste characterization and generation data (Dumble 2015; UNFCCC 2015; RTI International 2010; Dumble et al. 2011; Papageorgiou 2009; Intergovernmental Panel on Climate Change 2006). The datasets, which cover the emissions and costs of waste transport, processing and disposal, provide an overview of all waste management

Dust storm generated in Iraq crossing the Red Sea in 2005



Source: NASA Earth Observation 2005

activities (Dumble 2015) and a good indication of the relative emissions of each technology option (subject to future validation and confirmation). The technology scenarios are applied to three recycling and composting scenarios:

1. no recycling and composting;
2. 9.6 per cent recycling and composting – the current situation;
3. 48.3 per cent recycling and composting – the future.

The recycling and composting interventions can be applied at the dirty material recycling facility stage of management, or as source-segregation options for clean recycling, depending on the collection services available.

There are three main residual treatment technologies:

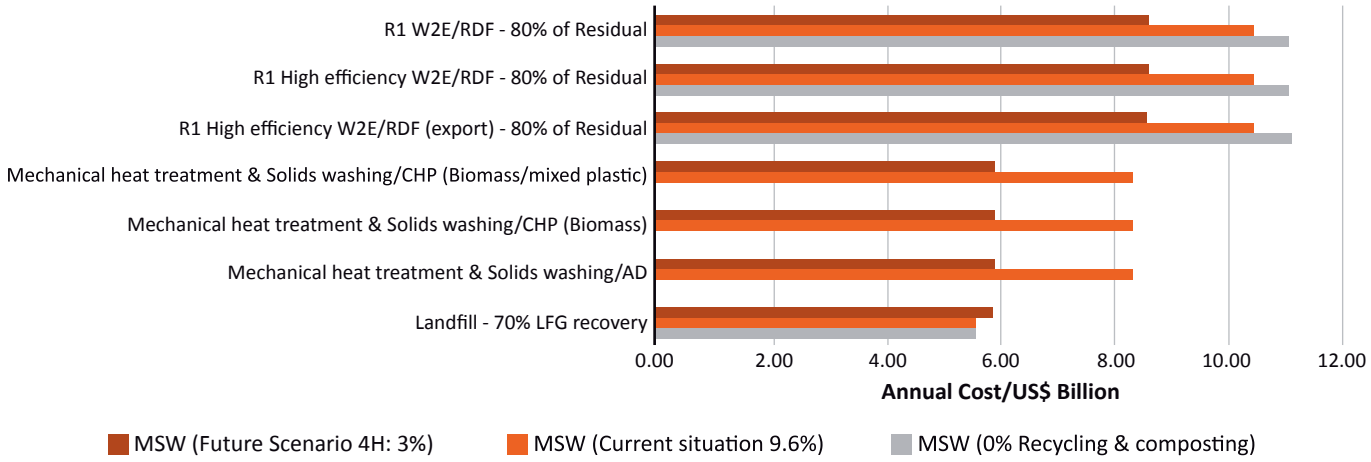
1. landfill with landfill gas recovery;
2. waste-to-energy by incineration under the R1 waste-to-energy efficiency classification, for energy recovery as combined heat and power and electricity only;
3. mechanical heat treatment (at temperatures of 80–1500C to ensure sterilization of wastes), with power created from the natural organic fraction (anaerobic digestion, thermal treatment with combined heat and power).

The purpose of option 3 is to achieve the best possible recovery rates for high-value solids that can be returned to the supply chain. The data indicate that total regional emissions from the collection, treatment and disposal of 45.9 million tonnes of municipal solid waste in 2015 amounted to 67 447 gigagrammes of carbon dioxide equivalent. The regional increase in waste in 2013 was about 3.0 per cent, just slightly ahead of population growth at 2.4 per cent (Dumble 2015).

Based on country trends in waste generation, the regional amount is expected to reach 75.9 million tonnes by 2030, with the higher- and upper-middle-income countries generating most of the projected increase.

The results show the relative impacts on emissions of 24 potential technology interventions or options across the region, with current regional municipal solid waste emissions including processing and collection, estimated at 68 164 gigagrammes of carbon dioxide equivalent (Dumble 2015). The total costs, at 2015 prices, of the different collection, treatment and disposal options per unit of emission reduction show that the optimum cost of achieving net zero emissions in the region's waste sector is in the region of US$81,087 to 57,420 per gigagramme of carbon dioxide equivalent avoided for high added-value recyclables, with near net zero emissions under the incineration option indicating a higher cost ranging from USD 98,081 to 84,107 per gigagramme of carbon dioxide equivalent avoided (Dumble 2015). This work support the application IWM and the UNEP Waste and Climate Change Framework (UNEP 2010b) as practical means of sector GHG reduction.

West Asia, estimated annual costs of integrated management technology options

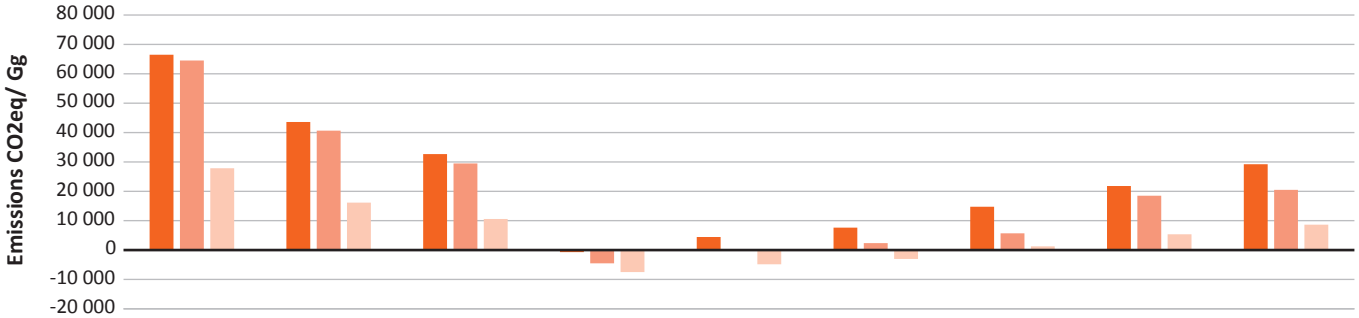


Source: Dumble 2015

The total regional cost of achieving zero emissions from collection, treatment and disposal interventions is estimated to be in the range of USD4,2–7,1 billion per year . Current annual regional spending on collection and treatment is estimated to be about of USD2.6 billion based on 5–10-year waste collection contracts (Dumble 2015).

Source (Abu Dhabi E-government 2014)

West Asia, municipal solid waste emission reduction scenarios under a range of technological options, 2015



	MSW Dumpsite	Landfill - 50% LFG Recovery	Landfill - 70% LFG Recovery	MHT & Solids Washing/ AD	MHT & Solids Washing/ CHP (Biomass)	MHT & Solids Washing/ CHP (Biomass/ mixed plastic)	High Efficiency (55%)W2E - 80% of Residual	High Efficiency (55%) W2E/RDF (export) - 80% of Residual	Electric-ity only (20%) W2E - 80% of Residual
MSW (0% Recycling & composting)	66,491	43,578	32,681	-703	4,437	7,628	14,753	21,815	29,222
MSW (Current situation 9.6%)	64,509	40,641	29,491	-4,505	346	2,349	5,698	18,491	20,504
MSW (Future Scenario 48.3%)	27,856	16,157	10,593	-7,505	-4,829	-3,034	1,252	5,356	8,640

Source: Dumble 2015

Note: LFG = landfill gas; AD = anaerobic digestion; R1 is a European classification for a waste-to-energy plant; CHP = combined heat and power (can include cooling); W2E = waste to energy; RDF = refuse-derived fuel.

Acronyms and Abbreviations

4Rs	reduce, reuse, recycle and re-think
ACSAD	Arab Center for Studies of Arid Zones and Dry Lands
ADFEC	Abu Dhabi Future Energy Company
AEWA	African-Eurasian Migratory Waterbird Agreement
AFED	Arab Forum for Environment and Development
AOAD	Arab Organization for Agricultural Development
AWC	Arab Water Council
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe
CAMRE	Council of Arab Ministers Responsible for the Environment
CBD	Convention on Biological Diversity (UN)
CDC	Centers for Disease Control and Prevention (United States)
CEDARE	Center for Environment and Development for the Arab Region and Europe
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CO	carbon monoxide
CO_2	carbon dioxide
COP	Community of Practice
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
CSO	civil society organisation
DALY	disability adjusted life year
DPSIR	drivers, pressures, state, impacts, responses
EBA	ecosystem based adaptation
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EEA	European Environment Agency
EU	European Union
EIA	environmental impact assessment
EPA	Environmental Protection Agency (United States)
EPR	Extended producer responibility
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FCNL	Friends Committee on National Legislation
GCC	Gulf Cooperation Council
GDP	gross domestic product
GEF	Global Environment Facility
GEMS	Global Environmental Monitoring System
GEO	Global Environment Outlook
GESAMP	Group of Experts on Scientific Aspects of Marine Environmental Protection

GESF	Green Energy Special Fund
GHG	greenhouse gas
GIS	geographical information systems
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
ICT	information and communication technology
ICZM	integrated coastal zone management
IFAD	International Fund for Agricultural Development
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission of UNESCO
IRIS	Indicator and Reporting Information System
IRP	integrated resource planning
IUCN	International Union for Conservation of Nature
IWM	integrated waste management
IWRM	integrated water resources management
JRC	European Commission Joint Research Centre
LAS	League of Arab States
LDC	Least developed country
LDCF	Least Developed Countries Trust Fund
LME	large marine ecosystem
LPG	liquefied petroleum gas
MA	Millennium Ecosystem Assessment
MAP	Mediterranean Action Plan for the Barcelona Convention
MARPOL	International Convention for the Prevention of Pollution From Ships
MDG	Millennium Development Goal
MEA	multilateral environmental agreement
MPA	marine protected area
MSW	municipal solid waste
N_2O	nitrous oxide
NAMA	nationally appropriate mitigation actions
NASA	National Aeronautics Space Administration (United States)
NBI	Nile Basin Initiative
NBSAP	national biodiversity strategies and action plans
NGO	non-governmental organization
NH_3	ammonia
NH_X	ammonia and ammonium
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NMVOCs	non-methane volatile organic compounds
O_3	ozone
OCHA	Office for the Coordination of Humanitarian Affairs
ODA	official development assistance

ODS	ozone-depleting substance
OECD	Organisation for Economic Co-operation and Development
OPT	Occupied Palestinian Territories
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAH	polycyclic aromatic hydrocarbons
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyls
PCT	polychlorinated terphenyls
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter of 2.5 micrometres (0.0025 millimetre) or less
PM_{10}	particulate matter with a diameter of 10 micrometres (0.01 millimetre) or less
POPs	persistent organic pollutants
REDD	Reducing Emissions from Deforestation and Forest Degradation
REIN	Regional Environmental Information Network
ROPME	Regional Organization for the Protection of the Marine Environment of the sea area surrounded by Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates
SADC	Southern African Development Community
SAICM	Strategic Approach to International Chemicals Management
SAP	Scientific Advisory Panel
SDG	Sustainable Development Goals
SEA	strategic environmental assessment
SEEA	System of Environmental-Economic Accounting
SIDS	small island developing states
SLCF	short-lived climate forcer
SLE	Special Lead Editors
SoE	state of the environment
SOER	State of the Environment Report of the EEA
SO_X	sulphur oxides sulphur
SO_2	dioxide sustainability
SST	sea surface temperature
TEEB	The Economics of Ecosystems and Biodiversity
TRIPs	trade-related aspects of international property rights
UAE	United Arab Emirates
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEA	United Nations Environment Assembly
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme

UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-UNESCWA	United Nations Economic and Social Commission for West Asia
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	The United Nations Refugee Agency
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Research
UNSD	United Nations Statistics Division
UNU	United Nations University
UNWTO	United Nations World Tourism Organization
USA	United States of America
UV	ultraviolet
VOC	volatile organic compound
WA	West Asia
WCRP	World Climate Research Programme
WFP	World Food Programme (United Nations)
WHO	World Health Organization
WIO	Western Indian Ocean
WMO	World Meteorological Organization
WRI	World Resources Institute
WTO	World Trade Organization
WWAP	World Water Assessment Programme
WWF	World Wide Fund for Nature

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