Arab Region: Atlas of Our Changing Environment

HIGHLIGHTS

INTRODUCTION

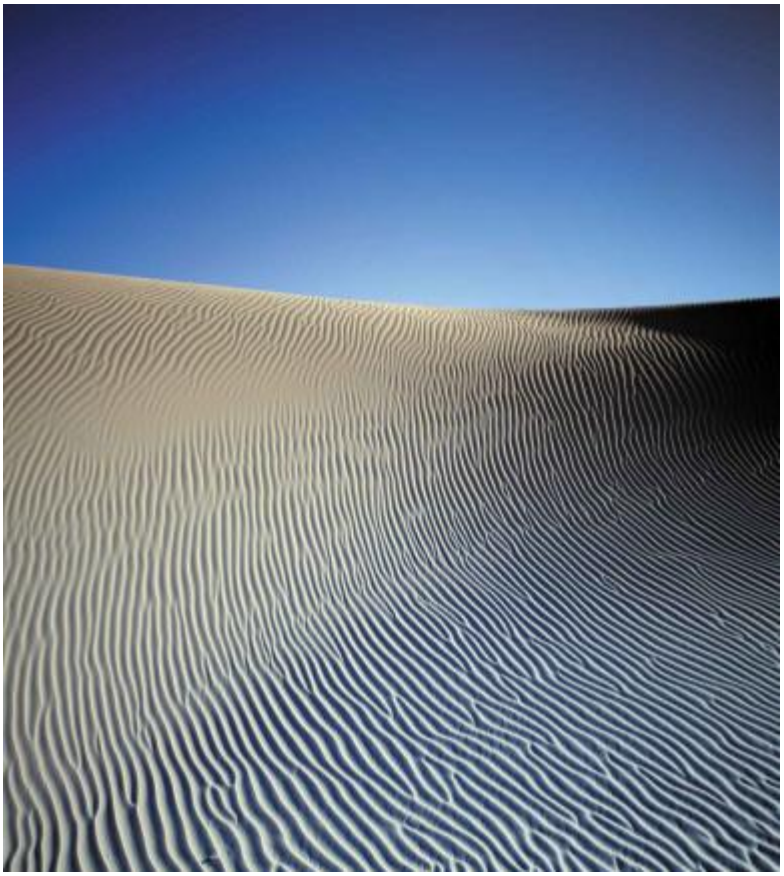
[Photo: Man in desert, p.x]
Source: felinebird/Flickr.com

Environmental change of our planet is a reality. The components of the physical environment are constantly changing as a result of both natural processes and human action. The Arab region is no exception, but the pace of change could be even faster than in other areas as a result of the fast pace of development in the region. Hardly any element of the environment - vegetation, soils, wildlife, surface and underground waters or the coastline - has escaped the purposeful or unintended effects of human action.

The Arab Region Atlas of Our Changing Environment is a unique publication that documents environmental change in the Arab region over the past several decades. This atlas uses state-of-the-art space borne and aerial images, maps, graphics, and photographs along with informative narratives to illustrate how humans have altered their surroundings and continue to make observable and measurable changes to the environment. It aims to provide scientific evidence of rapid environmental changes taking place around the region to inform and raise awareness among both the general public and policy makers, and bring local level changes to the attention of global audiences.

CHAPTER 1: THE ARAB REGION

[Photo: p.1]
Sand Dunes, Algerian Sahara
Source: Dennis Stauffer/Flickr.com



Throughout this atlas, the similarities within the Arab region are emphasized along with the features that are distinct to the individual countries. Chapter 1 describes the physical features that characterize this unique part of the world, highlighting the geography, geology, climate, natural resources and biodiversity. The social and economic character of the region is also presented and provides the necessary backdrop for identifying the environmental challenges as well as opportunities that the Arab region faces in the 21st century. This chapter concludes with an exposé of the programs and earth observation technologies that are being applied in the Arab region to advance research and development and allow for more effective monitoring and forecasting of environmental change.

1. GEOGRAPHY

[Map: p.2-3]
Source: Cross-blended Hypsometric, Natural Earth 2011

The Arab region covers an area of about 14 000 000 km2, including over 30 000 km of coastline, and boasts some of the Earth's most unique geographical features, including: the massive Sahara Desert, which covers most of North Africa; the Nile River, the longest river in the world, with its imposing Aswan Dam; the Dead Sea, which is the lowest elevation on the Earth's dryland surface and one of the world's most saline bodies of water; and the Rub Al Khali Desert on the Arabian Peninsula, which is one of the largest sand deserts in the world that also contains the largest oil fields.

This region also includes the northernmost tropical sea (the Red Sea), and the Socotra archipelago, a group of islands in the Indian Ocean that has one of the highest rates of plant endemism in the world. The geographical biomes and rich biodiversity represented in the region are vitally important to each country's heritage and economic and social well-being. These marine and land resources are increasingly under threat due to population growth, urbanisation, desertification, overexploitation and climate change.

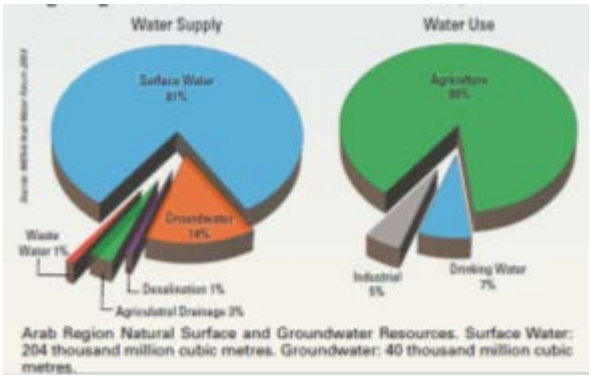
[Photos: p.5]
Arid Desert climate
Source: Cernavoda/Flickr.com

Warm Temperate climate
Source: GanMed64/Flickr.com

Snow climate
Source: Abouid/Flickr.com

Notwithstanding the diversity of landscapes in the region, from the snow-capped peaks of the Atlas Mountains to the sand desert of the Arabian Peninsula, most of the region suffers from resource deficits, most critically, water. Most of the Arab region is categorized as hyper-arid to arid and many of the countries are water scarce (with yearly per capita water availability falling below 1 000 m3), whereby the lack of water hampers economic development and human health and well-being. The very low and highly variable annual rainfall makes the region especially vulnerable to climate change impacts—per capita water availability in the region is expected to fall by half by 2050. These decreases in precipitation coupled with increases in temperature will intensify pressures on natural and physical systems. Given the extreme aridity, most of the agriculture in the region is irrigated- approximately 80 per cent of the available water supplies are used by the agricultural sector. Future water deficits will make food systems in many of these countries more vulnerable. Water scarcity is addressed throughout this atlas and is presented in Chapter 2 as a prominent transboundary issue—it is also featured in Chapter 3 under the country profiles, illustrating both the unique challenges and the shared concerns the region faces with respect to its water resources.

[Pie Chart: p.14]
Arab Region Natural Surface and Groundwater Resources. Surface Water: 204 thousand million cubic metres. Groundwater: 40 thousand million cubic metres.
Source: MENA/Arab Water Forum 2009

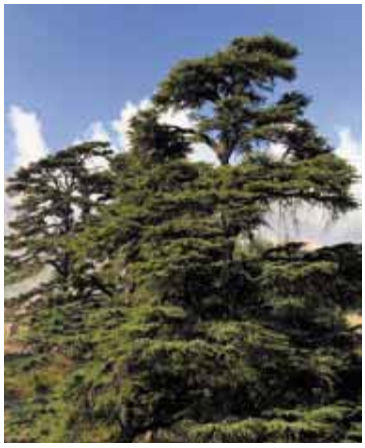


The region incorporates the flora and fauna of the Arabian Peninsula, Africa, Asia and Europe and contains rich biological diversity. Countless locally and regionally endemic species are also represented. The rich biodiversity in the region has exceptional value when considering the variability of ecological, chemical and genetic characteristics. Preservation of these biological resources through designation of marine and terrestrial protected areas has had varied success in the region — over 300 internationally recognized protected areas have been designated and include national parks, marine reserves, grazing reserves and game sanctuaries. Though governments recognize the need for additional protected areas, referred to as 'hema' in Arabic, and the need to conserve and wisely use scarce renewable resources, the number and the extent of protection varies greatly. The North African countries tend to have a higher number of protected areas; for example, Algeria has an extensive protected area system, with 11 national parks, five nature reserves, 42 Ramsar Wetland Sites of International Importance and 6 biosphere reserves. However, protection of these areas is still hampered by a variety of factors such as lack of technical and financial resources, low participation among local populations and poverty. Moreover, they are under threat by civil unrest, enroachment and the introduction and spread of invasive species. There is a clear need for regional approaches to biodiversity conservation and sustainable resource use to protect each country's natural heritage.

[3 Photos: p.11]
The Arab region includes unique types of pasture, agriculture, desert and forest landscapes
Source: Rosino/Flickr.com

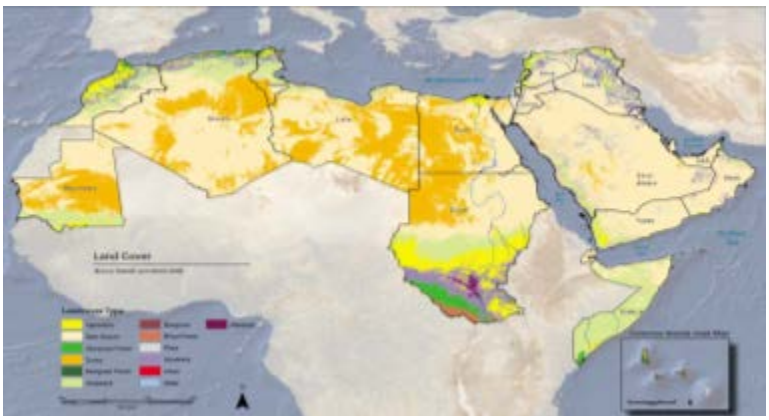
Source: Argenberg/Flickr.com

Source: Charles Fred Flickr.com



Land resources are crucial to development and human well-being. Changes in land resources are driven by environmental, technological and socio-economic factors. The major trends affecting land resources in the Arab region over the past 30 years include: an increase in agricultural lands; a decrease in forest cover, especially in North Africa; an increase in heavily degraded lands resulting from desertification, climate change, chemical pollution from industry and agriculture, and armed conflict; an increase in urban and infrastructural development; and diversification in the use of land resources (primarily tourism and mining).

[Map: p.10]
Land Cover
Source: Tateishi and others 2003

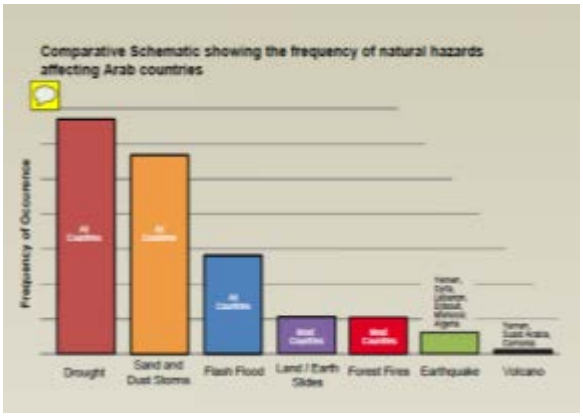


The hazards associated with natural disasters are attracting more attention worldwide. The 2004 Indian Ocean tsunami alerted the world to the extensive devastation that natural disasters can inflict. The Arab region is subject to a variety of natural hazards—the arid to hyper-arid climate lends itself to frequent drought, which is the entire region's most pressing natural hazard (Al-Madhari and Elberier 1996). Between 1980 and 2008, droughts, earthquakes, floods and storms affected more than 37 million people in the region and caused damage estimated at US$20 thousand million (UN-ISDR 2009a). The Arab region has faced 276 disaster events in the past 25 years and more than 40 per cent of these natural disasters occurred in the past five years. An urgent need for disaster prevention and management has been identified for the region, especially in light of climate change and the increased frequency and intensity of natural disasters (UN-ISDR 2009a).

[Pie Chart: p.17]

Comparative Schematic showing the frequency of natural hazards affecting Arab countries

Source: Al-Madhari and Elberier 1996



[Photo: p.17]
Dust storm rolling into Salmiya, Kuwait.
Source: Jemma Copley/Flickr.com

2. ECONOMICS, POPULATION, CULTURAL RICHNESS

[Photo: p.19]
Yemeni gentleman in Sana'a
Source: yeowatzup/Flickr.com

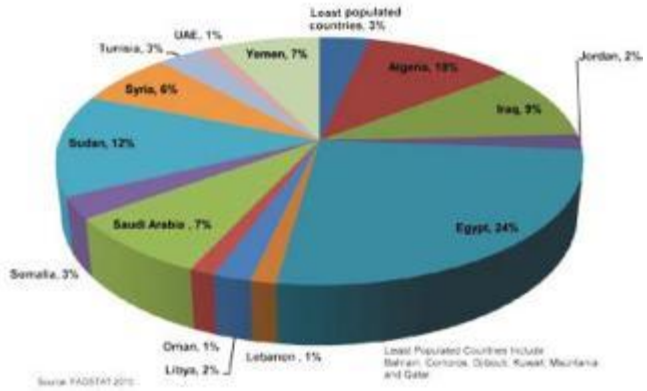
At the crossroads of Asia, Europe and Africa, the Arab region is one of the cradles of civilization. Archaeological evidence shows that some of the earliest human settlement in the world occurred in the Mediterranean region 12 000 years ago. The Eastern Mediterranean is also where the first languages were developed, with evidence of the first writing in present day Egypt, and the first commonly used alphabet on the coast of present day Syria and Lebanon. The Aramaic alphabet evolved from the Phoenicians in the 7th century BCE, and it is believed that most modern alphabets in Asia, including Arabic, can be traced back to Aramaic. With the advent of Islam in the Arabian Peninsula in the 7th century, Arabic, the language of the Qur'an, became the dominant language in the Arab countries of North Africa and Western Asia.

Population Character
If the Arab region were one country, it would be the third most populous in the world after China and India. Egypt is the most populous Arab nation (82.9 million), followed by Sudan (42.3 million) and Algeria (34.9 million). The least populous countries include Bahrain, Qatar, Comoros and Djibouti, with the latter two each having populations under one million.

With a 2.3 per cent population growth rate, the Arab region is distinguished by having one of the highest rates of growth in the world (ESCWA 2003). In the past six decades, the Arab population grew from around 72 million to approximately 352 million (2009), which accounts for about 5 per cent of the total world population. The total population is expected to reach 395 million or 5.5 per cent of the world's population by 2015 (ESCWA 2003).

High population growth rates, especially in the GCC countries, can be partly attributed to the massive influx of foreign workers. Between 1980 and 2002, the United Arab Emirates had the highest population growth rate (4.8 per cent), followed by Qatar (4.4 per cent) and Saudi Arabia (4.1 per cent). The lowest growth rate was in Tunisia (1.9 per cent), Somalia (1.7 per cent) and Lebanon (1.4 per cent) (ESCWA 2003).

[Pie Chart: p.21]
Country Population as a Percentage of Total Population of the Arab Region
Source: FAOSTAT 2010



Beyond Literacy: Education in the Arab Region

The Arab region today has one of the lowest literacy rates in the world. The average rate of adult literacy in the Arab region is 66 per cent, however, there are discrepancies within the region. Jordan, Lebanon, the Occupied Palestinian Territories and Syria have literacy rates of over 90 per cent, while Yemen, Mauritania and Djibouti stand at less than 50 per cent. There is also a major gender discrepancy with two thirds of illiterate adults being women. Literacy has been increasing steadily among the region's youth in recent years; literacy rates for the 15 to 24 year old range increased from 35 per cent in 1970 to 83 per cent in 2006.

Education is integral to escaping poverty through employment. In the Arab region, the quality of education has dropped due to lack of investment. The increasing emphasis toward English-language education among the elite is resulting in wide gaps between them and the Arabic educated population. Today, most Arabs who have the choice tend to study in the West or at Western-founded schools and universities in the region. With increasingly wide gaps between the rich and poor, the main emphasis of governments and development organizations has been on grade-school education.

[Graph: p.21]
Adult Literacy Rates in Arab Region
Source: WHO 2009

Urban Population and Social Vulnerability

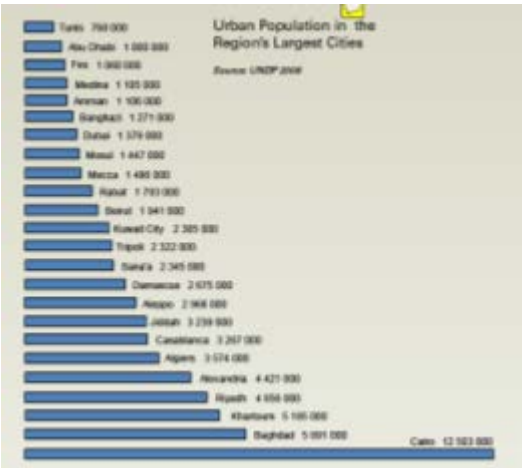
Mayo, Sudan - situated a few kilometres outside Khartoum. The UN estimates at least 2 million people live in camps or slums surrounding the capital city.
Source: sidelife/Flickr.com

The Arab region has become highly urban, with 66 per cent of the population living in cities, an increase from 44 per cent in 1980 (UNFPA 2007). By the year 2030, the region's proportion of city dwellers is expected to reach approximately 78 per cent. Levels of urbanization vary in the region: they are highest in Kuwait (98 per cent), Qatar (96 per cent) and Bahrain (89 per cent); and lowest in Comoros (28 per cent), Yemen (32 per cent) and Somalia (37 per cent). Rapid urbanization has created poverty in the region's cities, putting excessive strain on services, health care, sewage and sanitation systems. In many of the Arab region's largest and oldest cities, basic environmental services such as water, electricity, waste disposal and sewage are inadequate or unavailable. Many of these older cities, such as Cairo, were designed to support much smaller populations, and their expansion occurred rapidly and with little planning.

Chapter 3 of this atlas highlights change in many urban areas in the Arab region, and addresses the specific impacts of rapid urbanization. The agglomeration of people in urban areas has also put stress on rural areas, which are increasingly producing food for the cities, and often using poor agricultural practices that pose risks to the environment and human health. As a result, Arab cities rank low in terms of quality of living. The highest ranked Arab city in Mercer's (2009) quality of living survey was Dubai

(ranked 77 worldwide). The ancient Arab cities of Cairo and Sana'a fell far behind; the lowest-ranked Arab city was Baghdad, at 215. The study cited security concerns for the low score. However, the cities of the oil-rich Gulf States continue to witness improvements in their living standards, especially in education, the economy and housing (Mercer 2009).

[Graph: p.23]
Urban Population in the Region's Largest Cities
Source: UNDP 2008

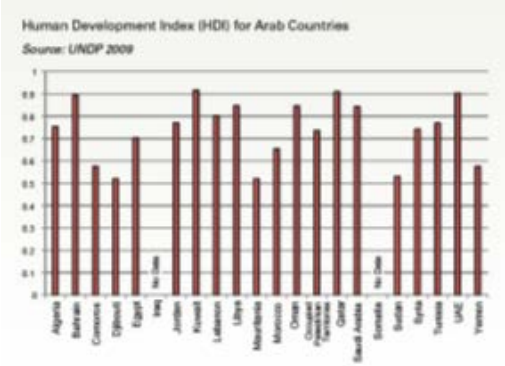


Policy Dimensions for Human Security

The UNDP defines human security as 'the liberation of human beings from those intense, extensive, prolonged, and comprehensive threats to which their lives and freedom are vulnerable', and identifies seven forms of human security: economic, food, health, environmental, personal, community and political (UNDP 1994). In the Arab region, though variations exist, human insecurity remains a fact of daily life in most countries. Although some Arab countries show a decent degree of human development, few Arab countries can claim to have a genuinely democratic political system where authority is held by institutions represented by citizens (Chourou 2005). The GCC countries, characterized by a relatively small population and high natural resource wealth, have significantly higher Human Development Index (HDI) ratings than the Mashreq and Maghreb regions. Kuwait rates the highest of the Arab countries, while Mauritania has the lowest HDI rating for the region (excluding Somalia and Iraq which were not ranked).

Human insecurity in the region impedes development. It affects one-fifth of the people in some Arab countries, and more than half in others. In the worst cases, it is found in the conflicts in Iraq, Sudan, Somalia and the Occupied Palestinian Territories. Human insecurity also appears in Arab countries that enjoy relative stability where the security forces hold wide sway in curtailing citizens' rights. As of 2008, six Arab countries (the Occupied Palestinian Territories, Sudan, Iraq, Algeria, Egypt and Syria) are under a state of emergency, indicating that the state is able to exercise unspecified control beyond the stated law (UNDP 2009).

[Graph: p.24]
Human Development Index (HDI) for Arab Countries
Source: UNDP 2009

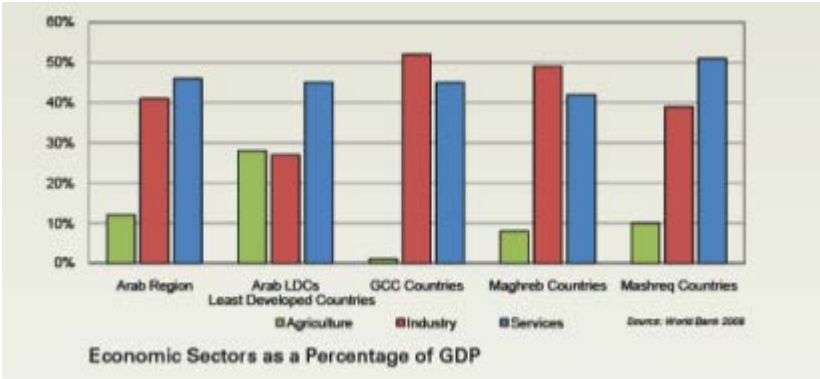


Economic Context

The Arab region represents an economically diverse region that includes the oil-rich economies of the GCC countries and the more resource-scarce countries (in relation to population) such as Yemen, Egypt and Morocco. Oil wealth has catapulted the standard of living in many of these countries and spurred increased resource consumption, exerting greater pressures on natural resources. Though the hydrocarbon sector continues to serve as the backbone of many of the countries' economies (especially the GCC countries and some of the North African countries), these nations are attracting foreign and domestic investments outside the energy sector and investing heavily in developing other sectors—the tourism industry is now the fastest growing sector in the region.

As the Arab economies grow, so too does their reach into the international markets. This has resulted in more liberal economic policies, with both positive and negative outcomes. As of 2011, there are 12 Arab member countries in the World Trade Organization (WTO): Bahrain, Djibouti, Egypt, Jordan, Kuwait, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and the UAE. Those with observer status include Algeria, Comoros, Syria, Yemen, Iraq, Lebanon, Libya and Sudan (WTO 2008, WTO 2011).

[Graphs: p.27]
Economic Sectors as a Percentage of GDP,
Source: World Bank 2009



Consumption Character and GDP

[Photo: p.28]
The Business Bay Executive Towers in Dubai, UAE
Source: Mohamed Somji/Flickr.com

For the past 40 years, the wealth created by high oil revenues in the Gulf States has increased consumption of goods at local levels. This has allowed some Arab countries to enjoy a high standard of living, but has also raised concerns about the long-term sustainability of high levels of consumption in an arid region experiencing a population explosion. Like most parts of the world, the pace of consumption in the Arab region is outstripping the availability of renewable resources. The most affected environmental resources are water, terrestrial and marine ecosystems. The new consumptive society has increased gaps between rich and poor, particularly between rural and urban populations and local and migrant workers.

In 2007, the Economic and Social Commission for Western Asia (ESCWA 2007c) region reported its fifth consecutive year of high growth following a continuous increase in oil prices due to high global demand. For the region as a whole, real GDP growth was approximately 5.4 per cent in 2007, significantly above the world average of 3.7 per cent, though below the projected average of 6.9 per cent for developing countries (ESCWA 2007c).

Human and Cultural Richness

[Photo: p.28]
Source: Joelle Nebbe-Mornod/Flickr.com

The Arab region is home to some of the oldest, richest and most diverse cultures and traditions in the world, from the early Ugarit alphabet (the birthplace of the three monotheistic faiths) to the oldest learning institutions and architecture. It is home to the longest continuously operating universities in the world, and during the times of the Middle Ages the region was a centre for learning. The League of Arab States is working with UNESCO to educate and preserve cultural traditions of the Arab region. However,

despite successful efforts made by both organizations, the shifts from traditional to modern ways of life have often come at the expense of historical preservation.

While many Arab artists have made names for themselves, the region is much better known for its heritage sites, considered some of the most important in the world. These include the ancient pyramids of Egypt, the hanging gardens of Babylon in Iraq, the Roman city of Palmyra in Syria, the Roman ruins of Baalbek in Lebanon and the Nabatian city of Petra in Jordan. The Arab region boasts 65 UNESCO World Heritage sites, most of which can be found in the Eastern Mediterranean countries of Egypt, the Occupied Palestinian Territories, Lebanon and Syria (UNESCO 2010). Although laws aimed at preserving ancient sites have had a measure of success, the region's rapid urbanization remains an ongoing threat that is placing tremendous stress on these priceless monuments.

[Photo: p.29]
The Giza Necropolis - a UNESCO World Heritage site - stands on the Giza Plateau, on the outskirts of Cairo, Egypt.
Source: Steven Wagner/Flickr.com

3. BIODIVERSITY

The Arab region is a meeting place and a transitional area between various phytogeographic and zoogeographic regions of the world. Floristic elements of five floral provinces exist in the region representing the Mediterranean, Irano-Turanian, Saharo-Sindian, and the Sudano-Deccanian (Zohary 1973). The spectacular terrain and various climatic conditions that prevail in the Arab region, along with the diverse biogeographic origins of the species, contribute to the diversity of flora and fauna at the species level, particularly to the endemism of these taxa. The number of plant species varies among the sub-regions of the Arab region, reaching up to 4 000 species in some countries. Morocco, Tunisia, Iraq and Algeria have the highest number of known vascular plant species, while Kuwait, Bahrain, Qatar, and the UAE have the lowest. A large number of endemic taxa also occur in the region; the total number of known endemic flora is about 3 397 (Boulos and others 1994; Ghabbour 1997).

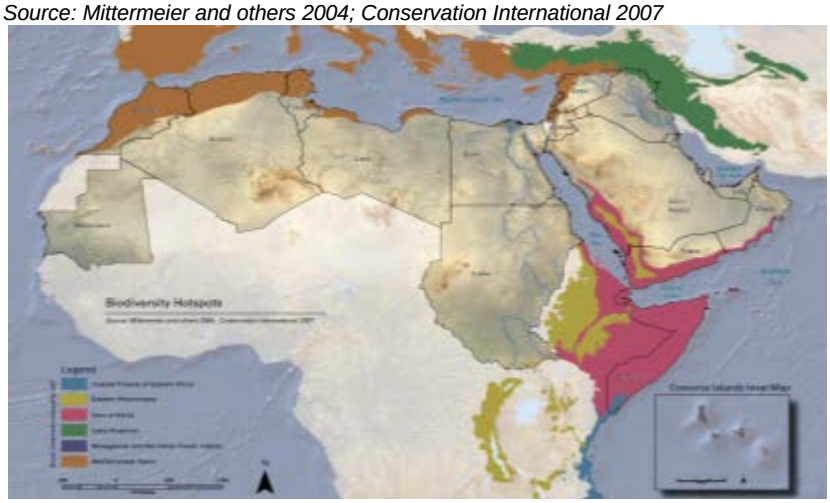
[Photo: p.30]
Dugong (Dugong dugon)
Source: Julien Willem/Flickr.com

Of the six major faunal realms, three are represented in the region: the Palaearctic, the Ethiopian and the Oriental (Ghabbour 1997). There are approximately 1 700 mammals, of which 39 (or 3 per cent) are endemic (WRI 2002; Animal Info. database 2005; SCBD 2010). In addition, 30 species of birds are endemic to the region along with 132 species of reptiles and eight amphibians (FAO 1997; WRI 2002; SCBD 2010). Endemism is highly exceptional in some localities like Socotra archipelago where more than 30 per cent of the biota is endemic. For the Arab region, mammal species diversity is fairly low and ranges from 0.002 to 0.005 km2 (Mackay 2009).

[Photo: p.32]
The Hamadryas baboon (*Papio hamadryas*)
Source: Geofe Wilson/Flickr.com

There are 34 internationally recognized biodiversity hotspots in the world representing various habitats (Conservation International 2007). By definition, these hotspots are home to at least 1 500 species of endemic vascular plants and have lost at least 70 per cent of their original natural vegetation (Conservation International 2007). These hotspots represent some of the most remarkable places on Earth, yet they are also the most threatened —as reservoirs of some of the richest plant and animal life on Earth, their conservation is essential. The Arab region has six biodiversity hotspots: Irano-Anatolian Hotspot**,** Mediterranean Basin Hotspot**,** Coastal Forests of Eastern Africa, The Horn of Africa, and Madagascar and the Indian Ocean Islands.

[Map: p.32]
Biodiversity Hotspots
Source: Mittermeier and others 2004; Conservation International 2007

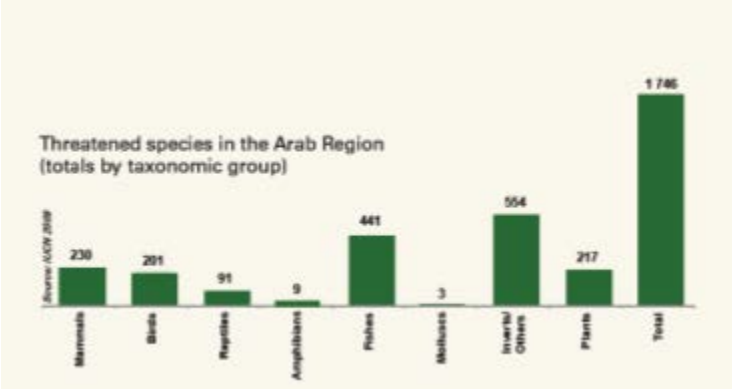


Biodiversity Threats and Conservation

Biodiversity is declining across the Arab region due to habitat degradation and loss, and associated species decline. Species populations, especially of large mammals, have declined in the last 100 years as a result of habitat degradation and over-hunting. The total number of known threatened species in the Arab region is 1 746, 13 per cent of which are mammals, 12 per cent birds, 5 per cent reptiles, 0.5 per cent amphibians, 25 per cent fish, and 12 per cent plants (IUCN 2009). A majority of these species are critically endangered (69 per cent of animals and 39 per cent of plants). The number of birds and reptiles threatened with extinction in the region doubled between 2002 and 2006, and the number of threatened fish species increased 14 times over this same period (UN/LAS 2007; IUCN 2009). In the Mediterranean, out of the nine species groups (amphibians, birds, cartilaginous fish, cetaceans, crabs and crayfish, endemic freshwater fish, mammals, dragonflies and reptiles) one-fifth are threatened with extinction - 5 per cent are critically endangered, 7 per cent endangered and 7 per cent vulnerable (Cuttelod and others 2008).

[Photo: p.36]
Scimitar-horned oryx (Oryx dammah) is now extinct in the wild throughout its range
Source: shanidov/Flickr.com

[Graph: p.36]
Threatened species in the Arab Region (totals by taxonomic group)
Source: IUCN 2009



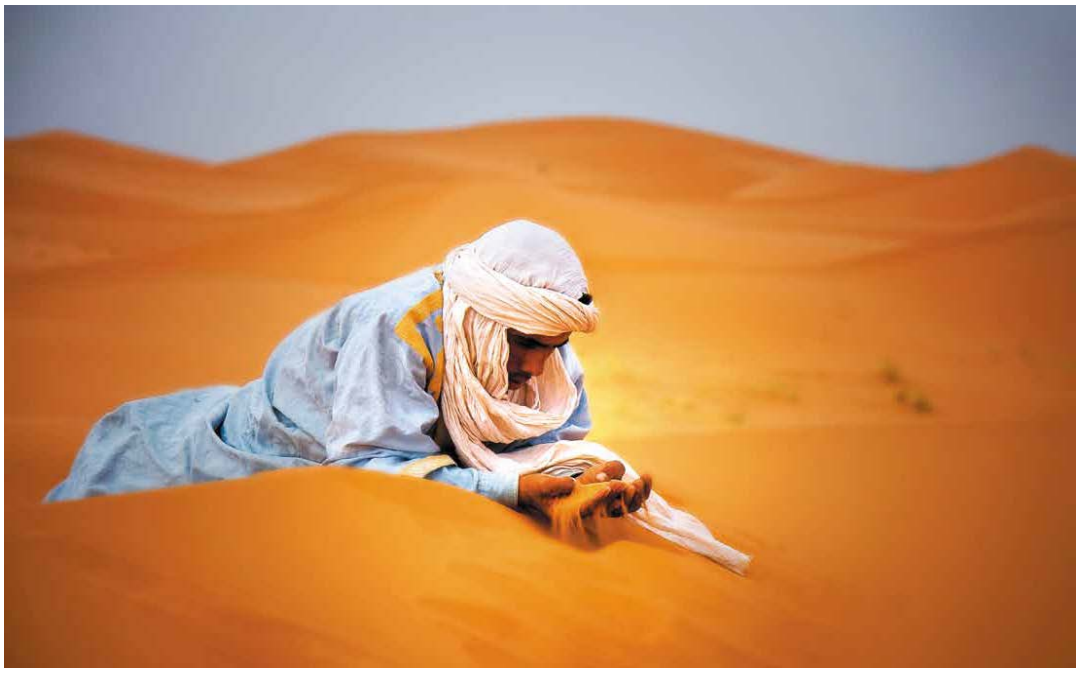
The driving forces and pressures of this biodiversity loss can be attributed to urban, agricultural and industrial development, specifically, overgrazing by domestic animals, over-utilization of land and water resources, commercial exploitation of biodiversity resources and overpopulation. Invasive alien species are another threat to biodiversity and native fauna and flora. Alien species are species, sub-species, or lower taxon occurring outside of their natural range and dispersal potential, and includes any part, gametes or propagule of such species that might survive and subsequently reproduce (IUCN 2000). A total of 554 invasive species have been reported in the Arab region. Thirty-six per cent of them are classified as aliens, whereas 51 per cent are native and the bio-status of 75 species is yet to be determined. Nearly 15 per cent of reported invasive species are marine species introduced mostly by migration and ballast water from ships (GISD n.d.).

Conservation

Captive breeding programmes for threatened species began in the region in the 1980s, with the Arabian oryx, houbara bustard and some gazelle species in Jordan, Oman, Saudi Arabia and Syria (GCEP 2000). Efforts at establishing protected areas are underway - as of 2004 the total areas that have been officially declared as protected remain less than 4 per cent of the total land area of the Arab region, which is three times below the world average (12 per cent) for the same year (SCBD 2004; UNEP-WCMC 2006; UN/LAS 2007). The number of Ramsar protected sites in the region is 109 with a total area of 12 410 436 ha, 66 per cent of which are in North African countries (Ramsar 2007); the number of World Heritage Sites totals 65 and covers an area of 1 063 259 (8 per cent) in the Arab region (also see Chapter 2) (UNESCO 2010). On the marine side, the protected and managed areas in the Mediterranean are 4 per cent of its total area (Abdulla and others 2008); by contrast, the amount of protected area in the Red Sea is 12 per cent (Wood 2007).

4. CHALLENGES AND OPPORTUNITIES

[Photo: p.41]
Morocco – Sahara
Source: Nwardez/Flickr.com



The Arab region is facing distinctive environmental circumstances and challenges. Although this region is endowed with some unique and rich natural resources, it is also scarce in renewable natural resources, such as water and land resources. Moreover, the environmental agenda has not been given adequate attention due to policy, social and economic factors, and development plans have yet to consider the environment as an integral component of development. Today, the state of the environment in the Arab region is at a pivotal crossroads, with numerous environmental challenges that are currently affecting the region or are threatening in the near future. At the same time, awareness of these issues, in addition to political and social willingness to act, provide hope for timely intervention.

Challenges

Arab countries are faced with a variety of challenges that threaten environmental sustainability, including:

• Limited freshwater resources, overexploitation of ground and surface waters and contamination by industrial, agricultural and domestic wastes;

• Rapid urbanization resulting from high population growth rates and the influx of migrants from rural areas and outside the region, which has led to environmental degradation and pollution;

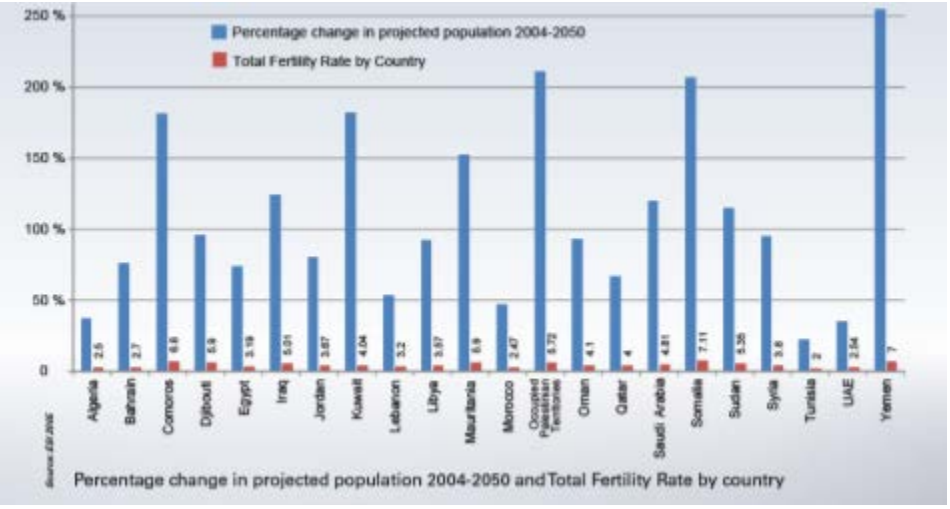
• The depletion of natural resources and encroachment of agricultural lands as a result of the need to maintain economic growth and satisfy the needs of expanding populations;

• The vulnerability of many Arab settlements to environmental risks and natural disasters, including the impacts of climate change, such as heat waves, floods, sea-level rise, the loss of biodiversity, drought and desertification.

These challenges are exacerbated by a number of issues, including poverty. The Arab region has poverty levels that are significantly lower than those of countries with similar levels of income, mostly due to effective safety nets. Rates of poverty decreased substantially from 1970 to 1980 (the proportion of the population living with less than one dollar a day in the region went from 11 to 2.4 per cent). Poverty rates

again decreased substantially during the periods 1990 to 1995 and 2000 to 2004 (UNDP 2005). Access to basic human amenities, however, are lacking in many Arab countries, particularly the non-oil producing nations such as Yemen, Somalia and the Sudan.

[Graph: p.41]
Percentage change in projected population 2004-2050 and Total Fertility Rate by Country
Source: ESI 2005



Opportunities

Many Arab countries have established special institutions for environmental management and sustainable development. The sensible management and use of natural resources, however, requires capacities that many Arab countries lack. In collaboration with the UNDP and UNEP, Arab countries initiated a number of National Capacity Self Assessments (NCSA) to encourage institutional development conducive to sustainable development. To date, almost half of the Arab countries have developed national plans identifying development actions to strengthen their capacity to manage priority environmental issues and contribute to global environmental benefits.

General economic improvements have a positive impact on natural resources, human resources and overall quality of life. The Council of the Arab Economic Unity (CAEU), which has been in effect for decades, will promote inter-Arab trade and prepare for establishing the Arab Common Market during 2017-19. CAEU has also prepared a strategy for Arab economic integration from 2000 to 2020. This strategy is meant to serve as an investment map for Arab countries and includes a mechanism for developing investments in the Arab region and promoting greater intra-Arab regional trade.

Many Arab countries have experienced improvements in health and education, yet there is a need for additional improvements. Peace and security are essential for the sustainable development of the Arab region. Research should also harness information and communication technologies conducive to the sustainable development of the Arab region.

Regional cooperation and integration provide a great opportunity for efficient and sustainable use of natural resources, caring for the environment and progressing social and economic development using human and financial resources of the countries of the region.

5. EARTH OBSERVATIONS

Environmental Monitoring and Modern Technology

[Photo: p.45]
Source: NASA

Earth observation data derived from satellite remote sensing, aerial surveys, and land and ocean-based monitoring systems provide useful information on Earth trends that can be used by decision-makers at many levels. Integrating these data sets with other data sources, such as field surveys, is a critical challenge not only at a regional scale, but at the global level. Programmes such as the intergovernmental Group on Earth Observations (GEO) (six of the Arab countries, mostly in North Africa, are members), UNEP's Global Environmental Outlook Data Portal, and the International Geosphere-Biosphere Programme (IGBP) are promoting efforts to integrate data collected using different earth observation technologies. These robust technologies allow for more effective monitoring and forecasting of changes in the global environment and can be used for a number of environmental, economic and social benefits, including protecting biodiversity, improving climate observations, supporting disaster management, managing water resources and forecasting weather.

Though the Arab region as a whole has been slow to adopt many of these technologies, regional programmes and partnerships are rapidly developing to encourage innovative technologies and research and development. Some governments in the region have established ministries to promote innovation policies and guide technological development. The Institute for Arid Regions, based in Tunisia, operates a geographical information and remote sensing laboratory that uses remote sensing for natural resource management, including the study of desertification in West Asia and Africa. The UAE-based Arab Science and Technology Foundation, whose main interest is water and energy, is a pan-Arab organization that promotes the advancement of science and technology in the Arab region, and is engaged in projects that range from water desalination to sponsoring satellite navigation projects. The Arab Scientific Research and Education Network (ASREN), launched in early 2010 by the Global Alliance for Information and Communication Technology and Development (GAID) of the UN, is a regional network that will enable collaborative scientific research through remote access to computing services, instrumentation and resources.

[Photo: p.45]
Two images of the Earth centred over Europe and the Arab region display a change pair of day and night.
Source: NASA/MODIS

The Earth images shown here display the Arab region and Europe. Most striking in the Earth at night image is the contrast between the distribution and density of lights in the Arab region versus the European countries. The lights are confined mostly to coastal areas in the Arab region, as the interior deserts are mostly uninhabited. Europe, by contrast has population centres distributed evenly throughout the continent.

Satellite capabilities are becoming more widespread in the Arab region and plans for a pan-Arab space agency are being submitted to governments around the region. There are currently about 20 emerging space projects in the Arab region (UAE Interact 2009).

CHAPTER 2: TRANSBOUNDARY ENVIRONMENTAL ISSUES

[Photo: p.52]
The mountain oasis of Chebika, southwest Tunisia
Source: Lansbricae/Flickr.com

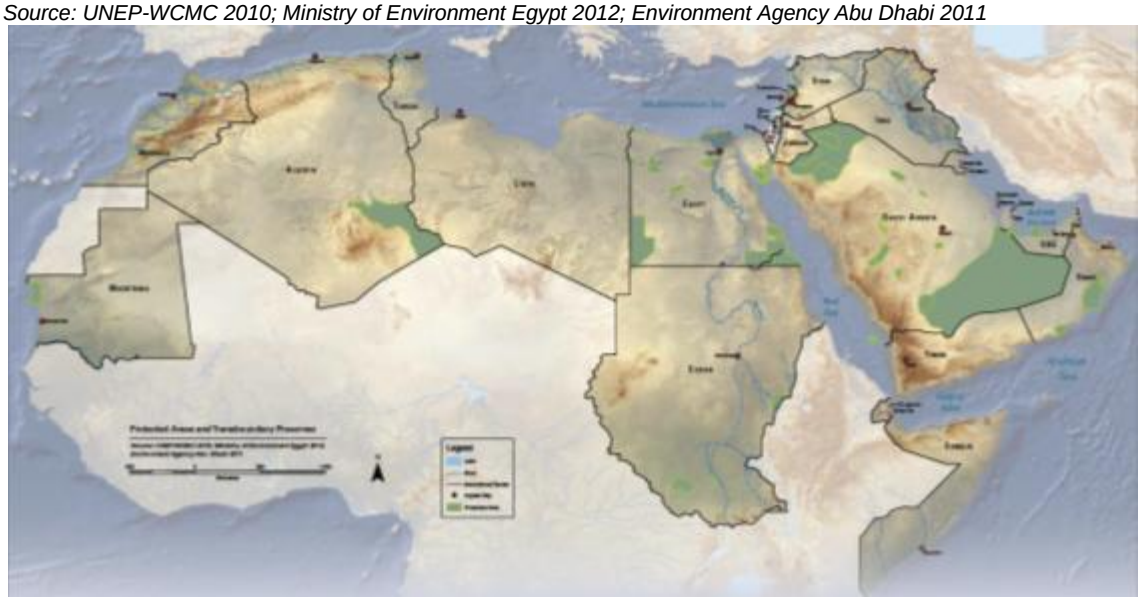
Chapter 2 describes the changing nature of transboundary environmental issues in the Arab region and provides specific examples of issues that transcend national borders.

Though the nature of regional or transboundary environmental issues has changed in recent years, transboundary issues are not new to the Arab region. Disputes over resources such as water and land have been a source of local and regional conflict for centuries. The term transboundary refers to the movement of physical and biological resources, or of impacts associated with these resources, across political borders. With almost fifty shared borders among Arab and non-Arab countries, the potential for transboundary movements and impacts is high. To complicate matters, some of these countries have not agreed on the demarcated boundary lines of their land and marine borders.

Organizations like UNESCO have launched programs such as the Internationally Shared (Transboundary) Aquifer Resources Management Project (2000) in order to improve existing knowledge on aquifer systems and formulate common principles for transboundary management of aquifers. Improved data and knowledge about these shared resources will provide governments in the Arab region with the ability to develop common strategies for the sustainable use of this resource. Though water shortages are the driving force for security concerns in the region, other transboundary issues are considered in this chapter and include: deteriorating water quality, coastal and marine pollution, air pollution, human migration due to land and water degradations and scarcity, desertification, environmental deteriorations and associated conflicts. Increased desertification and land degradation in the Arab region places already limited arable lands in the region at further risk (only 14.5 per cent of the total land area is arable and only 29 per cent of

this land is cultivated), which transfers across borders in the form of food insecurity and human migration.

[Map: p.54-55]
Protected Areas and Transboundary Preserves
Source: UNEP-WCMC 2010; Ministry of Environment Egypt 2012; Environment Agency Abu Dhabi 2011

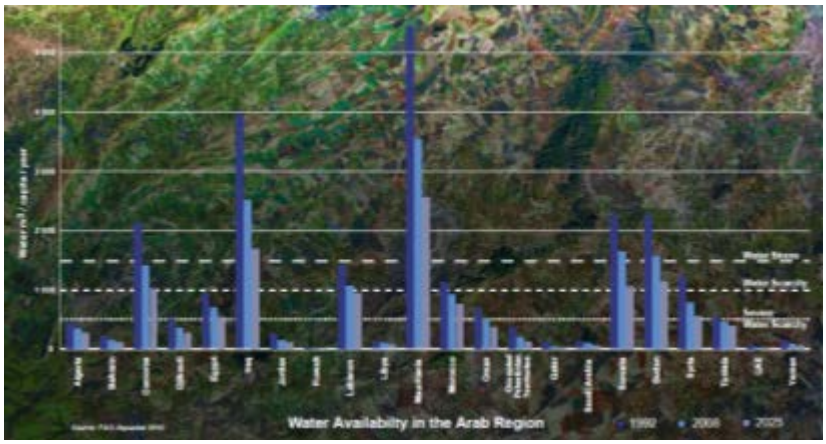


1. WATER

Water Resources

The most pressing transboundary environmental issue in the Arab region is shared water resources. The Arab region is one of the most water scarce regions of the world; of the 22 Arab League nations, 8 have the lowest water availability per capita in the world. The water availability graph shows the extent of water stress and water scarcity in the region; for all countries, the amount of available water per capita is decreasing. By 2025, Mauritania and Iraq will be the only countries in the Arab region that are not water stressed or water scarce. Increased demands for water have been driven largely by the explosive growth in population in the Arab region and increases in food production; in 1980, the population of the Arab region was 172 million—by 2015, the population is expected to reach 385 million. Other factors such as improved living standards and climate change exacerbate the water scarcity in the region.

[Graph: p.60]
Water Availabilty in the Arab Region
Source: FAO Aquastat 2010



[Photo: p.67]
Nile River, Egypt
Source: Michael Gwyther-Jones/Flickr.com

Water scarcity in the region is exacerbated by high water demand; the water-poor GCC countries have some of the higher per capita water use in the world. Access to shared freshwater resources has historically been a source of conflict in the region but has also provided opportunities for cooperation. The major shared water basins in the region include the Jordan River, Nile River and the Tigris-Euphrates. In this semi-arid to arid environment, water requirements are met mostly by groundwater, the majority of which are mined from non-renewable aquifers. The annual extraction of groundwater is far in excess of natural replenishment; continued exploitation of the major aquifer systems (Nubian Sandstone, North Western Sahara, Saq Aquifer, and Qa Disi Aquifer) has important transboundary implications as the groundwater basins underlie multiple countries.

[Photo: p.70]
Pumping groundwater from a well in the Northern Sahara
Source: Catherine Murray/Flickr.com

Desalination

The severe limitations on water resources availability in the Arab region has forced many countries to seek non-conventional water resources in the form of desalinated water and to a lesser extent, treated wastewater. Though these sources overall cover only a small portion of the domestic and industrial water demand, they provide essential supplies of water. Desalination, or the process of converting seawater into freshwater, is practiced widely in the Arab region; the West Asia countries use about 70 per cent of worldwide desalinated water capacity, while North Africa (mainly Libya and Algeria) uses about 6 per cent. Saudi Arabia, the UAE, Kuwait, Algeria and Qatar are the top producers of desalinated water in the region; Saudi Arabia has 17 per cent of the world's desalination capacity, UAE has 13 per cent and Kuwait has 5 per cent (Global Water Intelligence 2008).

[Photo: p.71]
Azzizia Desalination Plant, Saudi Arabia
Source: Waleed Alzuhair/Flickr.com

Desalination capacity has increased substantially in the past few decades; in 1999 capacity in the Arab region stood at over 12.5 MCM per day, of which 90 per cent was in the GCC countries. The environmental impacts associated with desalination have not been thoroughly studied to date; however, the widespread practice of disposing the salt concentrate that remains after desalination into rivers or the sea has transboundary implications. Nowhere is this more apparent than in the ROPME Sea Area where desalination plants are a major source of pollution, discharging about 1 000 m^3 per second of wastewater into the sea. The wastewater elevates the salinity levels and temperatures in the sea, and also contains chemical pollutants that impact the marine environment (Lattemann and Hopner 2008). A recent study suggests that desalination capacity in the Arab region will need to increase by 2.7 MCM per day every

year to meet the rising demand for water in the region (FSRS 2009). The by-products of producing this alternative water resource have transboundary environmental implications that require joint planning, coordination and management.

2. Global Challenges

Climate Change

The ramifications of climate change on the Arab region will be severe given the region's already arid climate and scarce water resources. The major impacts of climate change on Arab countries will be rising temperatures, lowered precipitation and sea-level rise. Global temperatures rose during the 20th century by 0.74°C and surface temperatures are projected to increase an additional 1.4 to 5.8°C by 2100 (IPCC 2007). Temperatures in the Arab region are expected to face an increase of 2.0 to 4.4°C by the end of this century. Higher temperatures will exacerbate desertification, increase the incidence and intensity of droughts, heat waves and forest fires, and increase weather variability, causing extreme weather events. Higher temperatures will also increase water scarcity in the region, with per capita water availability predicted to fall by half by 2050, causing acute water shortages.

[Photo: p.71]
Examples of extreme weather conditions related to climate change: forest fires in Lebanon and flooding in Oman.

Source: jcookfisher/Flickr.com

Source: Qusai Al Shidi/Flickr.com

In 2007, the Council of Arab Ministers Responsible for the Environment adopted the Arab Ministerial Declaration on Climate Change in recognition of the region's vulnerability and need to include climate issues in all sectors of sustainable development policy as well as adopt national and regional climate action plans (Hamid 2009). The region's most urgent issue is water management and the need to improve efficiency and implement sustainable practices - water reform that is planned as part of a more holistic set

of economic changes that include agriculture, industrial development, tourism, accountability and public finance, will be more effective (World Bank 2007). The mitigation measures and adaptation that will be necessary as we collectively face changed conditions on the planet can be turned into opportunities--managing scarce natural resources, developing renewable energy, managing coastal areas, preventing air and water pollution, and ensuring efficient use of water and energy and sustainable food production. The World Bank, United Nations and regional organizations such as the Arab Forum for Environment and Development (AFED) are developing strategies and approaches for addressing the impacts of climate change on Arab countries and encouraging concrete action, mitigation and adaptation to enhance the region's resilience to climate change.

3. ATMOSPHERE

Air Pollution and Weather Patterns

[Photo: p.74]
The Nile River in Cairo, Egypt
Source: Flickr.com

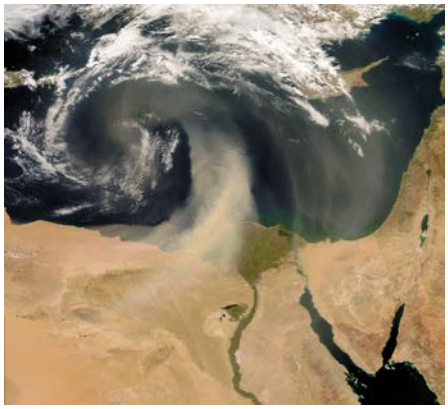
Air pollution is of concern in major cities, like Cairo

Air quality and atmospheric pollution have become increasingly important environmental issues, particularly in urban areas, in the Arab region. Emissions associated with oil and gas (exploration, processing, reformulating and shipping), the transportation sector, and energy-intensive industries (power generation, water desalination, petrochemicals, fertilizers, steel, aluminium and cement) are of particular concern. Vehicular emissions are the main source of air pollution in the Arab region; air quality is also aggravated by seasonal sand and dust storms, which are capable of carrying pollutants long distances (ESCWA 2006).

Data on air quality and emissions in the Arab region are lacking and either do not exist in some countries or are in the process of being developed, such as in the UAE, Egypt, Tunisia and Lebanon (AFED 2008). The health-related and environmental costs of poor air quality are prompting governments in the region to adopt policies and enact legislation to reduce emissions. The role of CO_2 emissions as a major contributor to global climate change has also become a principal concern, especially given the high per-capita CO_2 emissions among Arab countries. Though as a whole, the Arab region contributes only 4.2 per cent of total global Green House Gas (GHG) emissions (North America and Europe each contribute 23 per cent of total GHG emissions), there are large discrepancies in the region, with the GCC countries contributing a larger proportion of GHG emissions due to oil and gas industries. These same countries are also making large investments in solar power and other green technologies to tackle climate change and transfer to a lower carbon sustainable economy that is more secure and tenable.

Dust and Sand Storms

[Sat. Image: p.77]
Dust and Sand Storms from North Africa to Southern Europe
Source: NASA/MODIS



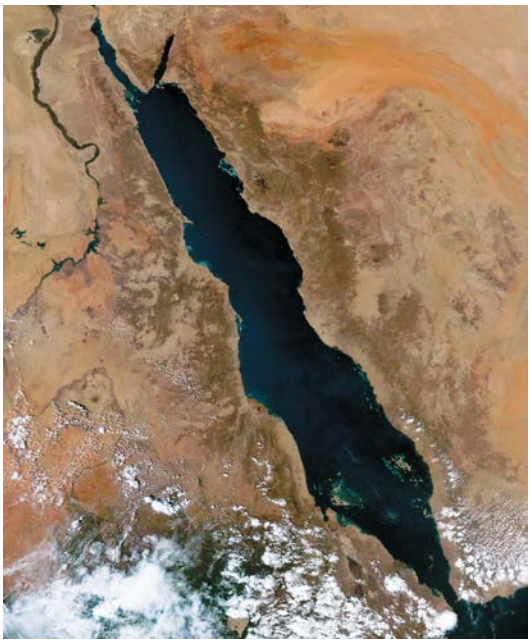
Dust and Sand Storms (DSS) are common in arid and semi-arid regions, and arise when wind gusts blow loose sand and dust from a dry surface. The Sahara Desert and the Arabian Peninsula are the main sources of airborne dust and particulates, which can be transported across the entire region and even across the Mediterranean and Atlantic (NASA 2005). The minerals carried by DSS are the main source of nutrients for phytoplankton, the basic food upon which marine life depends; however, they are also hazardous in terms of air quality and can damage vegetation and infrastructure. Those particles, also known as aerosols, can alter the physics of cloud formation and reduce rainfall in the polluted region. Increases in temperature associated with climate change will increase soil fragility, making sand and dust particles more mobile with winds, which are also expected to increase in frequency and severity.

4. SEAS

Red Sea, Mediterranean and ROPME Sea Area

Twenty of the 22 League of Arab States countries encompass 5 of the UNEP Regional Seas Programme areas: the Mediterranean Region, the Red Sea and Gulf of Aden Region, Eastern Africa Region, the ROPME Sea Area and Western Africa Region. These regional seas are experiencing impacts from rapid coastal development and degradation of the marine and coastal environments. The UNEP Regional Seas Programme was created to conserve marine and coastal environments through organizing regional activities and initiatives. Some of the Arab League countries share more than one region; for example, Egypt's coastlines include the Mediterranean and the Red seas, and Saudi Arabia's coastlines extend along the Red Sea and the ROPME Sea Area.

[Photo: p.80]
The Red Sea
Source: NASA/MODIS



Transboundary issues often present challenges that can lead to conflict but can also promote cooperation. Most of the Arab countries recognize the nature and challenges of transboundary marine issues and have considered the Transboundary Diagnostic Analysis (TDA) approach within a regional context (for example the Mediterranean, Red Sea and Gulf of Aden regions). The major transboundary coastal and marine issues in the Mediterranean, Red Sea and Gulf of Aden, and ROPME Sea Areas include: overfishing, loss of biodiversity and ecosystems, invasive species, sea and landbased pollution (including oil spills) and eutrophication. Data on the transboundary movements of hazardous wastes and other pollutants in and through these regions are scattered and often lacking.

Marine Ecosystem Types

Marine ecosystems cover 70 per cent of the Earth's surface and are home to a variety of habitats that range from productive coastal areas to deep ocean floor. The predominant marine ecosystems of the Arab region include tropical communities that consist of coral reefs and mangrove forests, as well as seagrasses and intertidal systems (rocky, sandy and muddy shores). These marine ecosystems are some of the most biologically productive and diverse in the world and are essential to human survival and well-being.

[Photo: p.83]
Segrass habitats are vital to many marine species, and are a threatened habitat globally.
Souorce:Jayhem/Flickr.com

Loss of Ecosystems and Biodiversity

The Mediterranean Region

The Mediterranean Sea contains 8 to 9 per cent of the world's known marine species in an area that constitutes less than 1 per cent of the world's oceans. Due to the threats posed (as described in Chapter 1), the Mediterranean Sea remains a global biodiversity hotspot. Species at risk in the Mediterranean include the Loggerhead turtle and monk seal.

The Red Sea and Gulf of Aden

The Red Sea and Gulf of Aden contain only about 8 per cent of the world's mapped coral reefs, almost two-thirds of which are at risk because of pollution and activities associated with coral reef areas (UNEP GEO 2000). Intertidal and nearshore subtidal habitats (including coral reefs) have been lost or degraded as a result of coastal and industrial development. Mangroves have been harvested for use in construction and for firewood; mangroves are also degraded due to grazing by camels in Yemen, Sudan, Djibouti and Somalia.

The ROPME Sea Area

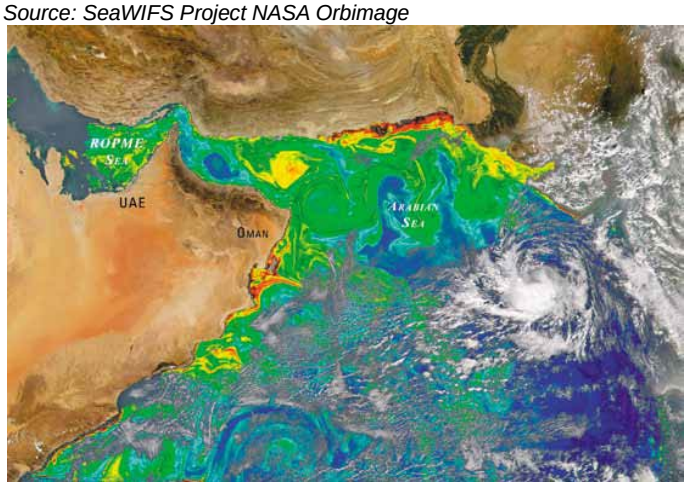
Although the ROPME Sea Area is a stressed environment with high temperatures and low species richness, it contains a high level of biodiversity. As an example, the taxonomic distinctness of algae is exceptionally high in the ROPME Sea Area, at least for certain subregions of the sea (Saudi Arabia, Bahrain and Kuwait) (Sheppard and others 2010).

[Photo: p.84]
Lost and discarded fishing nets entangle live coral and tear them away from their bases
Source: Tim Sheerman-Chase/Flickr.com

Chlorophyll: Key indicator of phytoplankton biomass and eutrophication

Chlorophyll-a, a ubiquitous photosynthetic pigment often associated with other pigments in freshwater and coastal marine phytoplankton, serves as a useful indicator for both the photosynthetic potential and biomass of phytoplankton (Flemer 1969a; Flemer 1969b). Eutrophication occurs when the amount of phytoplankton biomass increases due to the enrichment of waters with nutrients (nitrogen and phosphorus), causing excessive algae blooms – most oxygen from the water system is then used to decompose the algae. Though nutrient enrichment may, in some cases, lead to increased production in commercial fisheries, most of the effects of nutrient enrichment are negative, and result in 'coastal dead zones', which are areas of oxygen deprivation and devoid of life. Currently there are 146 coastal dead zones worldwide—this number has doubled every decade since 1960 (Larsen 2004); agricultural runoff and municipal wastewater associated with rapid urbanization and growth in populations along the coasts are increasingly to blame. Nutrient over-enrichment interacts synergistically with other human activities, contributing to ever increasing ecosystem degradation (UNEP 2006a).

Chlorophyll concentrations, an index of phytoplankton biomass, in the Arabian Sea, 6 October 2004
[Sat. Image: p.88]
Source: SeaWIFS Project NASA Orbimage



5. CONFLICT

Contention Strife and Human Migration

The Arab region, which is home to 5 per cent of the global population, exhibits some of the highest migration rates in the world. Continued conflict and growing scarcity of resources, coupled with climate change, will likely increase the rate of migration. Countries in the Horn of Africa are among those most affected due to poverty, conflict and limited access to resources such as fertile land and water (UNHCR 2010a). Much of the conflict is centred in the arid and semi-arid regions of the Horn of Africa, where pastoralists and agriculturalists have to share resources under deteriorating climatic conditions and resource capacities.

[Photo: p.91]
Refugees in west Darfur, Sudan
Source: Nite Owl/Flickr.com

Displacement in the countries of West Asia is mostly fueled by armed conflict, such as in Iraq, the Occupied Palestinian Territories and Yemen. For example, out of a population of 4 million in Lebanon, 400 000 are Palestinian refugees (UNRWA 2008); Syria's population of 18 million includes 1.2 million Iraqi refugees and 560 000 Palestinian refugees (UNHCR 2009a). Jordan is an extreme example of an Arab country affected by mass migration due to regional conflicts - migrants account for more than half of the country's population of 5.7 million, with approximately two million registered Palestinians and an estimated half million Iraqis (UNHCR 2009b). The case of Jordan is all the more acute because it has one of the lowest annual per capita water resources in the world at 153 m3 (UNDP 2009).

[Photo: p.92]
A Lebanese boy who lost his house in Harat Houreyk (a southern suburb of Beirut) as a result of conflict in the country.
Source: Farfahinne/Flickr.com

Armed conflict is not only political in nature; in the past 60 years, at least 40 per cent of intra-state conflicts were linked to natural resources (UNEP 2009b). Although environmental factors are rarely the sole source of conflict, potential for violence, and thus displacement, is expected to rise with demographic pressures, economic hardship, growing demand for resources, and climate change. Extreme weather events such as storms, droughts and floods have significantly increased in the past 30 years, causing the displacement of 20 million people in 2008; during that same year, 4.6 million people were internally displaced due to conflict and violence (IOM 2010). The Arab region generates and hosts a large number of refugees and displaced people, estimated at 9.6 million (UNHCR 2010a). As the world's increasing population puts further pressure on already strained resources, environmental migrants are becoming

more commonplace. It is estimated that by 2050, 25 to 1 000 million persons will be displaced internally or across borders due to climate change (IOM 2010). These refugees, in turn, place an additional burden on existing resources, causing further environmental degradation and bolstering a vicious cycle of conflict-displacement-and environmental degradation.

[Photo: p.93]
Iraq war refugees
Source: codepinkhq/Flickr.com

CHAPTER 3: TRACKING PROGRESS TOWARDS ENVIRONMENTAL SUSTAINABILITY

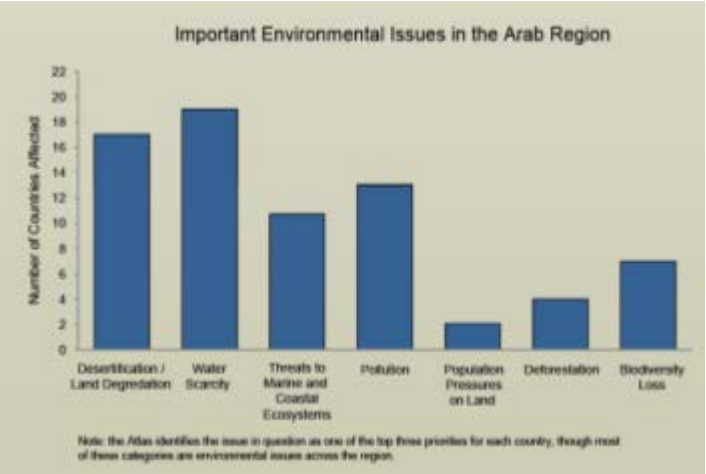
[Photo: p.102-103]
An abstract landscape - clusters of traditional homes and paddocks surround a small village in northern Somalia.

Chapter 3 includes visually compelling graphics and descriptive narratives that highlight environmental changes in each of the 22 Arab League nations. For each country, maps and brief country descriptions are provided, followed by a summary of the three most pressing environmental issues. Progress towards ensuring environmental sustainability (UN Millennium Development Goal [MDG] 7) is also tracked and summarized using data over a twenty-year time period. For each of the Arab countries, satellite images are used to showcase change over time—the changes depicted may have occurred rapidly in response to a localized event (for example, the impacts of Cyclone Gonu in Oman or the eruption of the Karthala Volcano in the Comoros), or the change may have occurred more gradually, such as urbanisation (Manama, Bahrain; Casablanca, Morocco, for example), the shrinking of the Azraq wetland in Jordan, or the erosion of the Rosetta Promontory at the mouth of the Nile Delta in Egypt. These images provide visual confirmation of the rapid development this region has undergone in just a few decades—the subsequent imprint on the landscape will not only intrigue readers of this atlas but also promote their understanding of the challenges faced by the Arab region.

The most pressing environmental issues faced by each of the Arab countries were identified using peer reviewed reports and public information and confirmed by official representatives of each country. Those identified include: water scarcity, desertification and land degradation, threats to marine and coastal ecosystems, pollution, population pressures on the land, deforestation and biodiversity loss. Water scarcity is a key environmental issue in 19 of the 22 countries, followed by desertification and land degradation, which afflicts 17 of the countries; pollution is another key issue in 13 Arab nations.

Many of these major issues are interrelated and most are a direct consequence of increasing populations and environmental conditions associated with climate change.

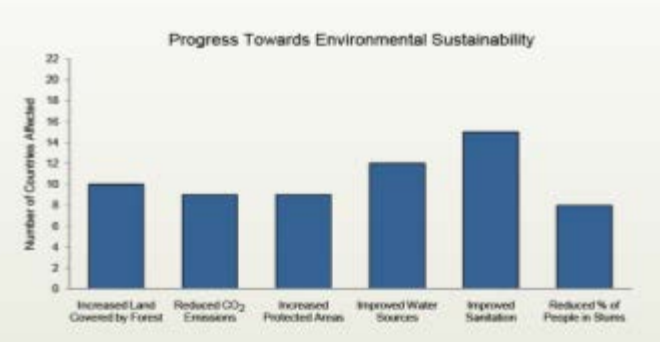
[Graph: p.xiii)
Important Environmental Issues in the Arab Region



1. MILLENNIUM DEVELOPMENT GOALS

The measures of progress towards meeting environmental sustainability under MDG 7 are tracked from 1990 to present using six indicators: proportion of forested lands, number of urban slum dwellers, access to improved water sources, access to improved sanitation, proportion of protected areas, and amount of CO2 emissions. Though progress has been made towards meeting targets for some of these indicators, it has been slow and uneven across the Arab countries. Obstacles to meeting targets include shortcomings in aid or assistance, the current global economic crisis, local environmental conditions brought about by climate change and lack of effective governance.

[Graph: p.xiii]
Progress Towards Environmental Sustainability



Most of the countries focused on improving those elements of the environment that have direct consequences to human health such as improved sanitation and access to improved water sources. The indicator with the highest number of countries showing progress is improved sanitation, with 15 of the 22 indicating positive change from 1990 to present. In contrast, the number of countries that showed progress in reducing the proportion of urban slum dwellers was only 8 of 22; less than half of the Arab countries showed progress in reducing CO2 emissions, increasing protected areas, increasing land covered by forest, and improving water sources. Challenges to reducing the number of people residing in

urban slums are a direct result of recurring drought in the region or migrations due to conflict. Chapter 3 includes more detailed information on meeting targets for these indicators and provides a measure of how the region is doing as a whole relative to the global community.

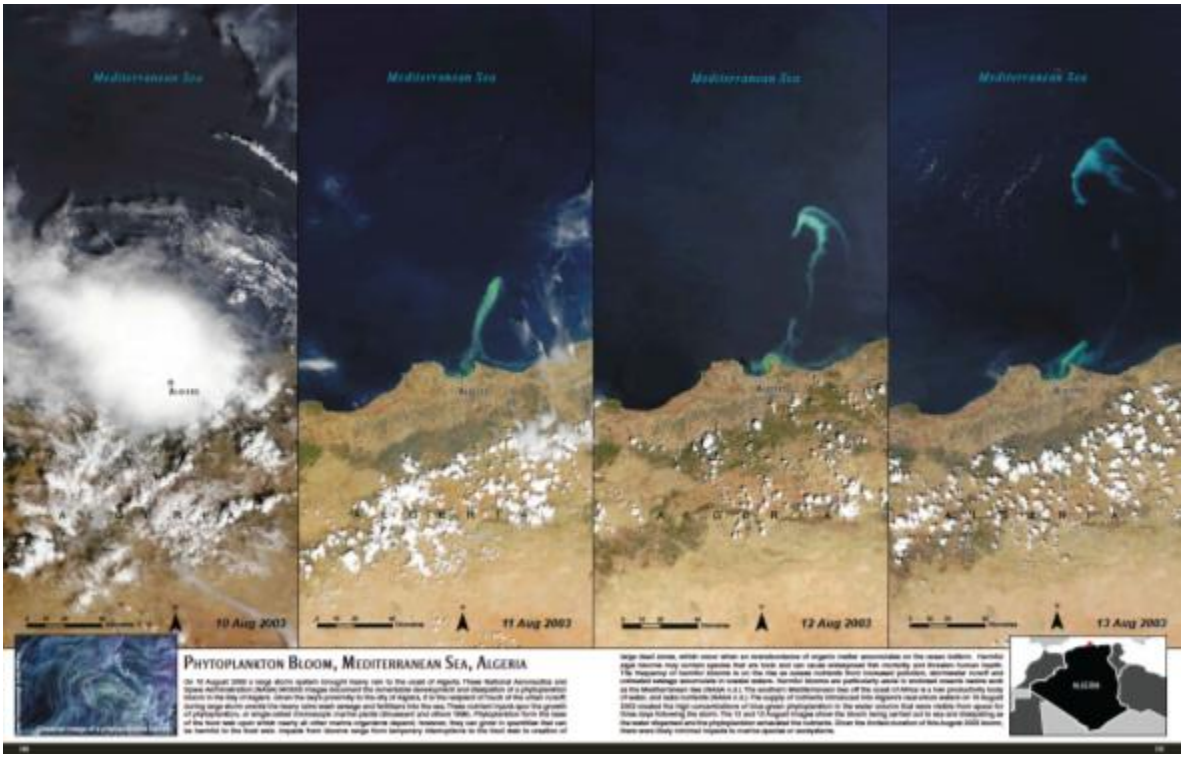
2. IMAGES OF A CHANGING ENVIRONMENT

With nearly 140 paired satellite images showing change over time (change pairs) in each of the Arab countries, this Atlas provides visual evidence of sometimes drastic change occurring in the region over a relatively short span of years. Landscape changes that are noteworthy and common to many of the countries include: the greening of the desert from increased irrigated agriculture; expansion of oil fields; deforestation and vegetation loss due to fires, insect infestations or harvesting for fuelwood; unbounded urbanisation, development of coastal areas and impacts from severe weather events.

ALGERIA

(Images: p.110-111)

PHYTOPLANKTON BLOOM, MEDITERRANEAN SEA, ALGERIA

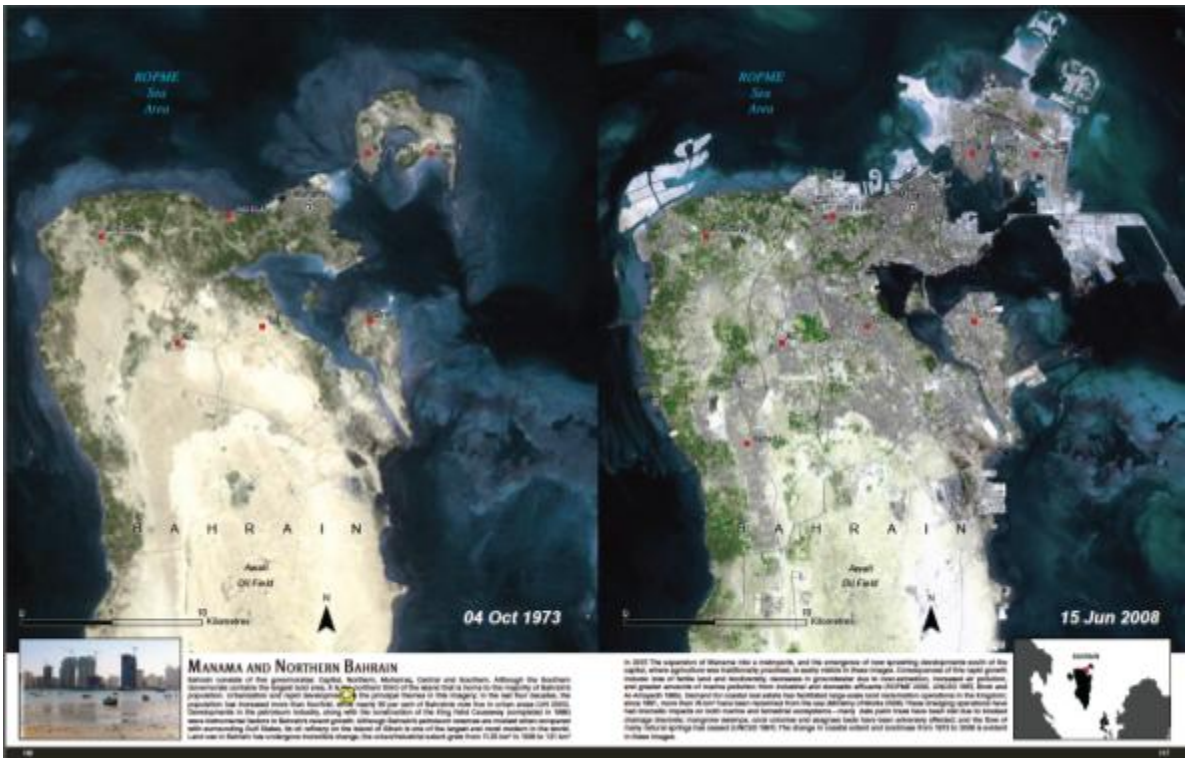


On 10 August 2003 a large storm system brought heavy rain to the coast of Algeria. These National Aeronautics and Space Administration (NASA) MODIS images document the remarkable development and dissipation of a phytoplankton bloom in the Bay of Algiers. Given the bay's proximity to the city of Algiers, it is the recipient of much of the urban runoff; during large storm events the heavy rains wash sewage and fertilizers into the sea. These nutrient inputs spur the growth of phytoplankton, or single-celled microscopic marine plants (Brussaard and others 1996). Phytoplankton form the base of the food web upon which nearly all other marine organisms depend; however, they can grow in quantities that can be harmful to the food web.

BAHRAIN

(Images: p.116-117)

MANAMA AND NORTHERN BAHRAIN

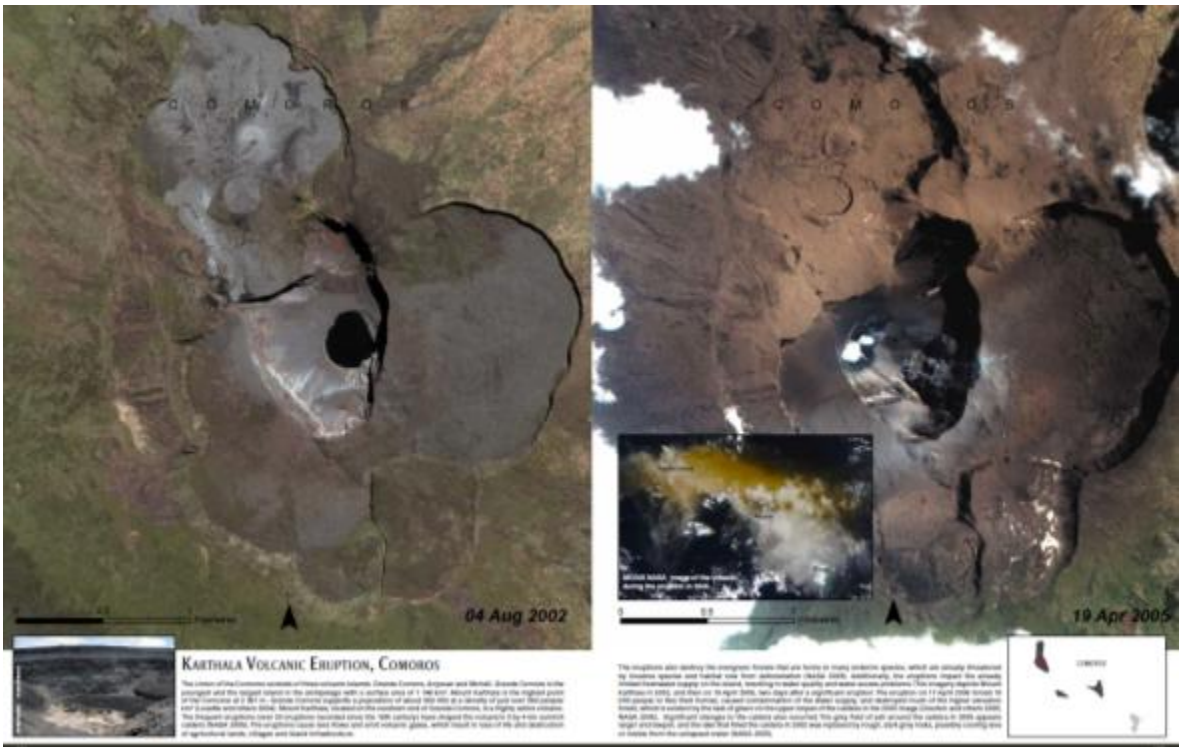


Urbanization and rapid development are the principal themes in this imagery; in the last four decades, the population has increased more than fourfold, with nearly 90 per cent of Bahrainis now living in urban areas (UN 2002). Developments in the petroleum industry, along with the construction of the King Fahd Causeway (completed in 1986) were instrumental factors in Bahrain's recent growth. Land use in Bahrain has undergone incredible change; the urban/industrial extent grew from 11.35 km² in 1939 to 131 km² in 2007. The expansion of Manama into a metropolis, and the emergence of new sprawling developments south of the capital, where agriculture was traditionally practiced, is easily visible in these images. Consequences of this rapid growth include: loss of fertile land and biodiversity, decreases in groundwater due to over-extraction, increased air pollution, and greater amounts of marine pollution from industrial and domestic effluents (ROPME 2003, UNCSD 1997, Birch and Al-Arrayedh 1985).

COMOROS

(Images: p.124-125)

KARTHALA VOLCANIC ERUPTION, COMOROS



The Union of the Comoros consists of three volcanic islands: Grande Comore, Anjouan and Mohéli. Mount Karthala, located on the southern end of Grande Comore, is a highly active volcano. The frequent eruptions (over 20 eruptions recorded since the 19th century) have shaped the volcano's 3 by 4 km summit caldera (NASA 2005). This imagery depicts Mount Karthala in 2002, and then on 19 April 2005, two days after a significant eruption. The eruption on 17 April 2005 forced 10 000 people to flee their homes, caused contamination of the water supply, and destroyed much of the higher elevation forest, which is evident by the lack of green on the upper slopes of the caldera in the 2005 image (Doulton and others 2005; NASA 2005). Significant changes to the caldera also occurred. The grey field of ash around the caldera in 2005 appears larger and deeper, and the lake that filled the caldera in 2002 was replaced by rough, dark grey rocks, possibly cooling lava or rubble from the collapsed crater (NASA 2005).

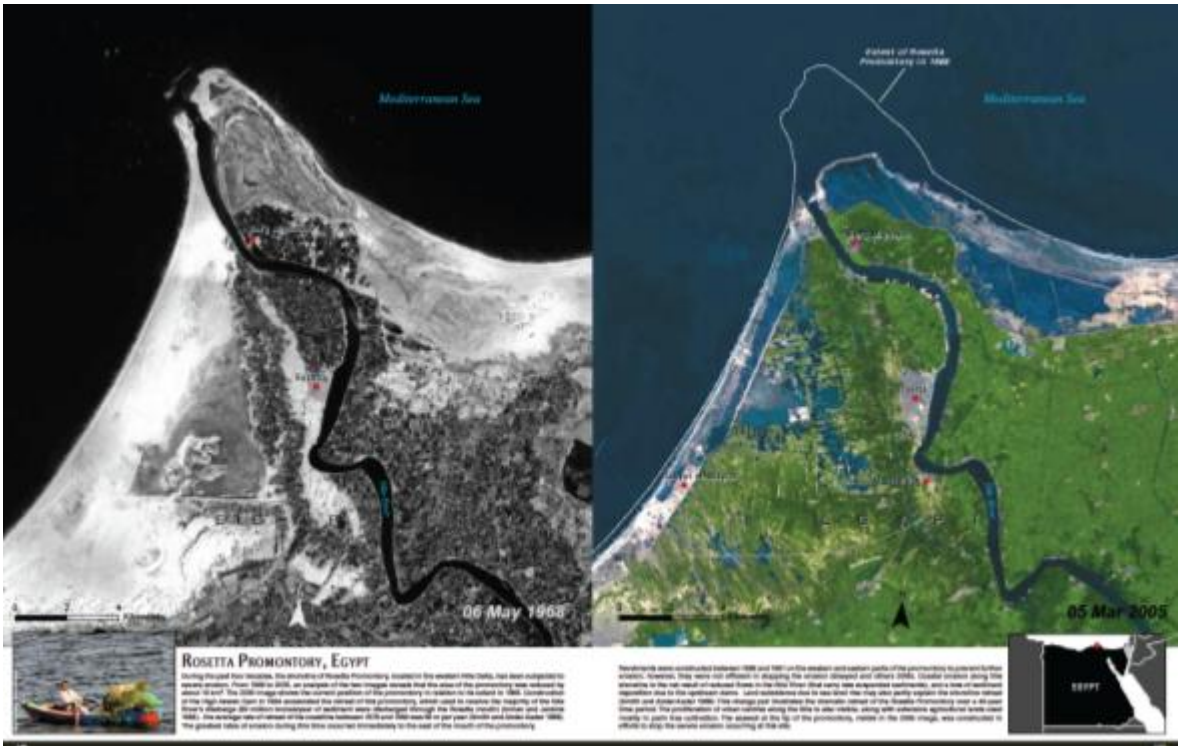
DJIBOUTI
(Images: p.134-135)

LAKE ASSAL, DJIBOUTI

At 155 metres below sea level, Lake Assal is the second lowest terrestrial surface in the world and the lowest point in Africa (Lynch 2009). Lake Assal sits in the Afar depression, which is formed by the diverging Indian, African and Arabian plates. This positioning gives the lake a unique geological profile. Volcanic flows have created natural barriers around the lake that usually prevent marine waters from filling the depression. With no outlet, and a desert climate characterized by strong dry summer winds and temperatures that can reach 52°C, Lake Assal has very high evaporation rates. The water of Lake Assal is ten times more saline than seawater, and is the most saline body of water in the world. The extreme salinity and inhospitable climate makes the lake mostly uninhabitable. As shown in these images, the water levels fluctuate greatly with occasional inputs from rainwater, seawater and groundwater. Receding lake levels reveal expansive salt pans, shown as white in these images. These salt pans represent the largest undeveloped salt reserve in the world (ECP 2008), and have provided an important source of income for the Afar Sudanese people, who harvest the salt for distribution to neighbouring countries. In 2008, plans for a large-scale mining operation on Lake Assal were unveiled; estimates indicate that 3.6 million tonnes of salt per year could be produced and exported by 2012 (ECP 2008).

EGYPT
(Images: p.146-147)

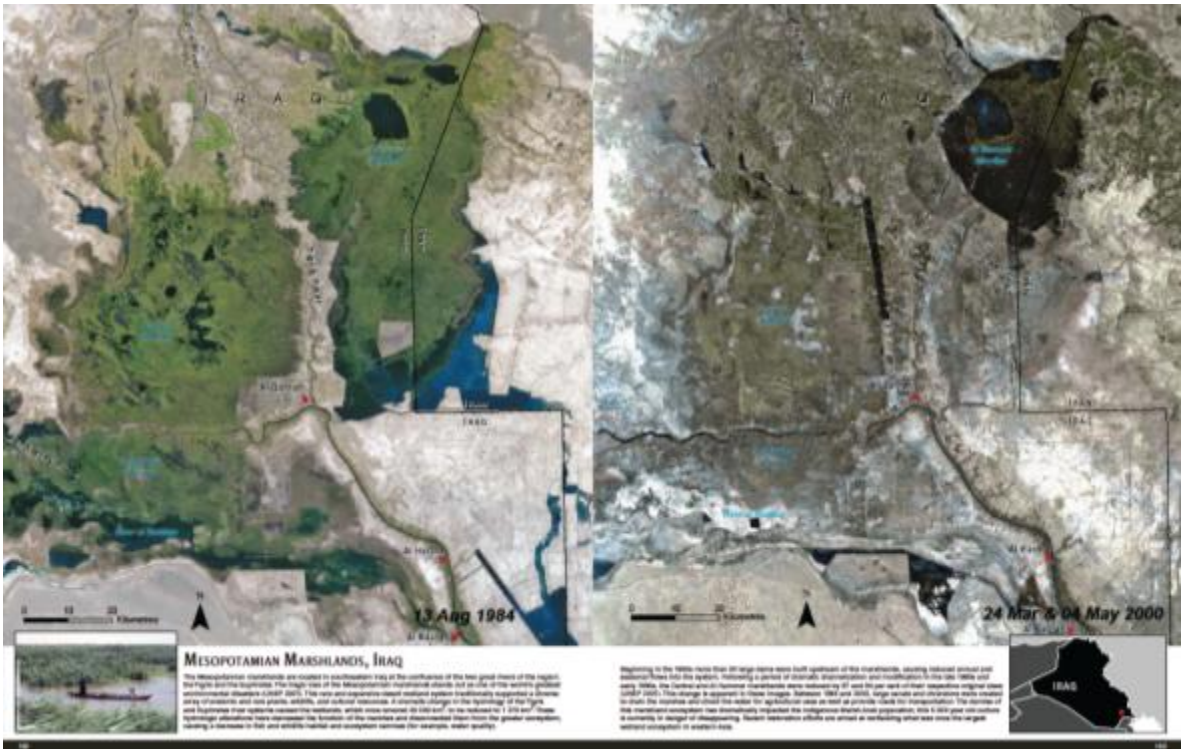
ROSETTA PROMONTORY, EGYPT



During the past four decades, the shoreline of Rosetta Promontory, located in the western Nile Delta, has been subjected to severe erosion. From 1968 to 2005, an analysis of the two images reveals that the area of the promontory was reduced by about 16 km2. The 2005 image shows the current position of the promontory in relation to its extent in 1968. Coastal erosion along this shoreline is the net result of reduced flows in the Nile River (that carry less suspended sediments), and a loss of sediment deposition due to the upstream dams. Land subsidence due to sea level rise may also partly explain the shoreline retreat (Smith and Abdel-Kader 1988). The proliferation of urban centres along the Nile is also visible, along with extensive agricultural lands used mostly in palm tree cultivation. The seawall at the tip of the promontory, visible in the 2005 image, was constructed in efforts to stop the severe erosion occurring at this site.

IRAQ
(Images: p.152-153)

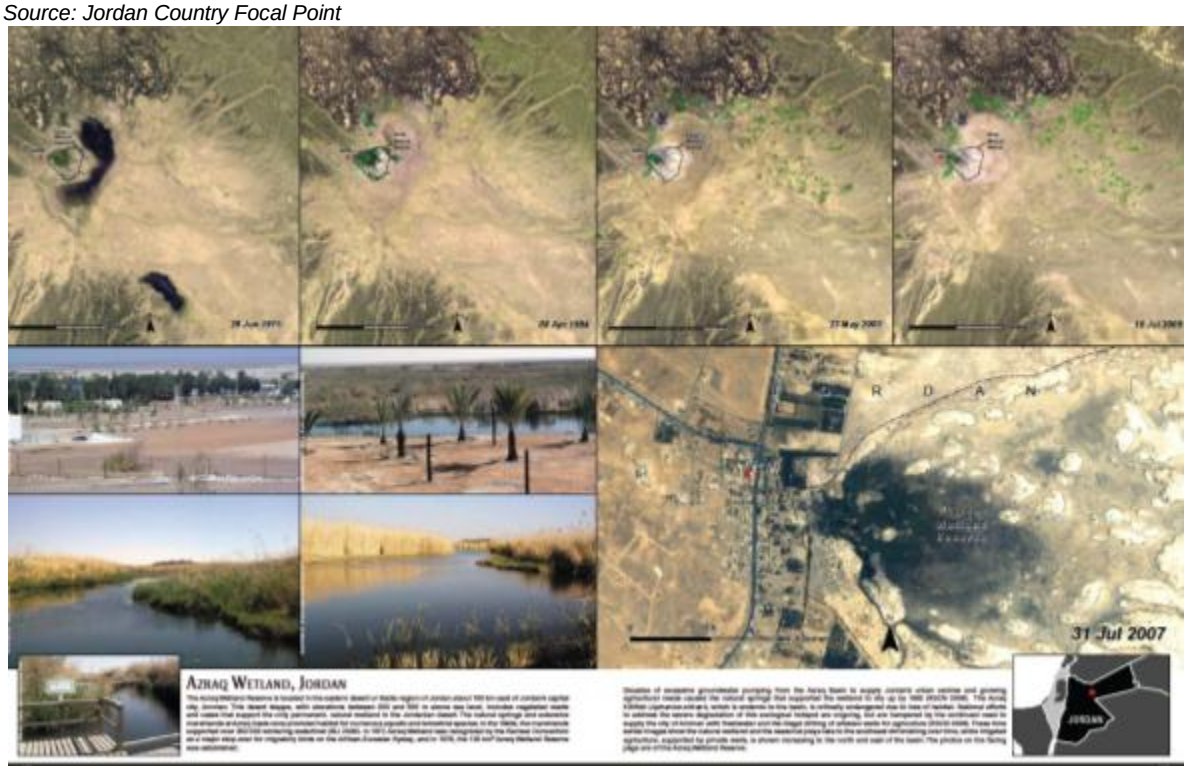
MESOPOTAMIAN MARSHLANDS, IRAQ



The Mesopotamian marshlands are located in southeastern Iraq at the confluence of the two great rivers of the region: the Tigris and the Euphrates. The tragic loss of the Mesopotamian marshlands stands out as one of the world's greatest environmental disasters (UNEP 2001). This rare and expansive desert wetland system traditionally supported a diverse array of endemic and rare plants, wildlife, and cultural resources. A dramatic change in the hydrology of the Tigris and Euphrates river systems caused the wetlands, which once covered 20 000 km2, to be reduced to 1 270 km2. These hydrologic alterations have decreased the function of the marshes and disconnected them from the greater ecosystem, causing a decrease in fish and wildlife habitat and ecosystem services (for example, water quality). This change is apparent in these images. Between 1984 and 2000, large canals and diversions were created to drain the marshes and divert the water for agricultural uses as well as provide roads for transportation. The demise of this marshland ecosystem has dramatically impacted the indigenous Marsh Arab population; this 5 000 year old culture is currently in danger of disappearing. Recent restoration efforts are aimed at revitalizing what was once the largest wetland ecosystem in western Asia.

JORDAN
(Images: p.162)

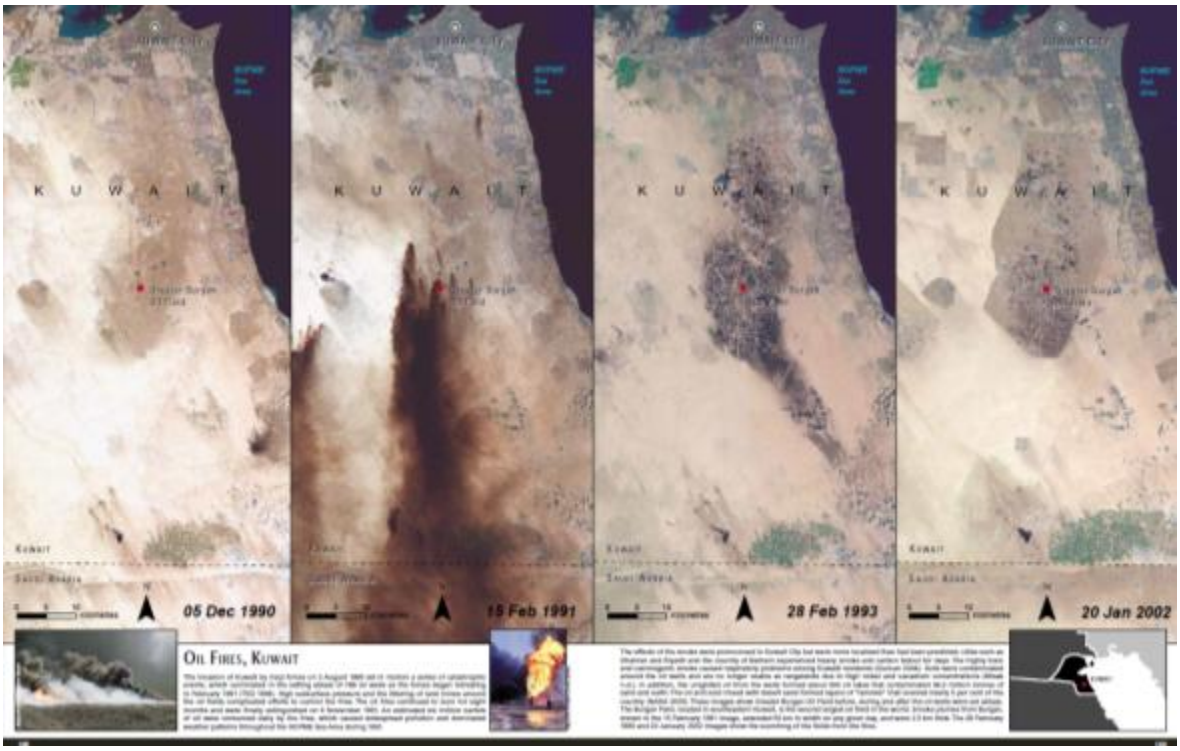
AZRAQ WETLAND, JORDAN
Source: Need Citation
Source: Jordan Country Focal Point
Source: wikicommons
Source: Jordan Country Focal Point



The Azraq Wetland Reserve is located in the eastern desert or Badia region of Jordan about 100 km east of Jordan's capital city, Amman. This desert steppe, with elevations between 600 and 900 m above sea level, includes vegetated wadis and oases that support the only permanent, natural wetland in the Jordanian desert. The natural springs and extensive marshlands at Azraq Oasis once provided habitat for numerous aquatic and terrestrial species; in the 1960s, the marshlands supported over 350 000 wintering waterfowl (BLI 2009). In 1977, Azraq Wetland was recognized by the Ramsar Convention as a major stop-over for migratory birds on the African-Eurasian flyway, and in 1978, the 120 km2 Azraq Wetland Reserve was established. Decades of excessive groundwater pumping from the Azraq Basin to supply Jordan's urban centres and growing agricultural needs caused the natural springs that supported the wetland to dry up by 1992 (RSCN 2008). National efforts to address the severe degradation of this ecological hotspot are ongoing, but are hampered by the continued need to supply the city of Amman with freshwater and the illegal drilling of artesian wells for agriculture (RSCN 2008). These time series images show the natural wetland and the seasonal playa lake to the southeast diminishing over time, while irrigated agriculture, supported by private wells, is shown increasing to the north and east of the basin.

KUWAIT
(Images: p.168-169)

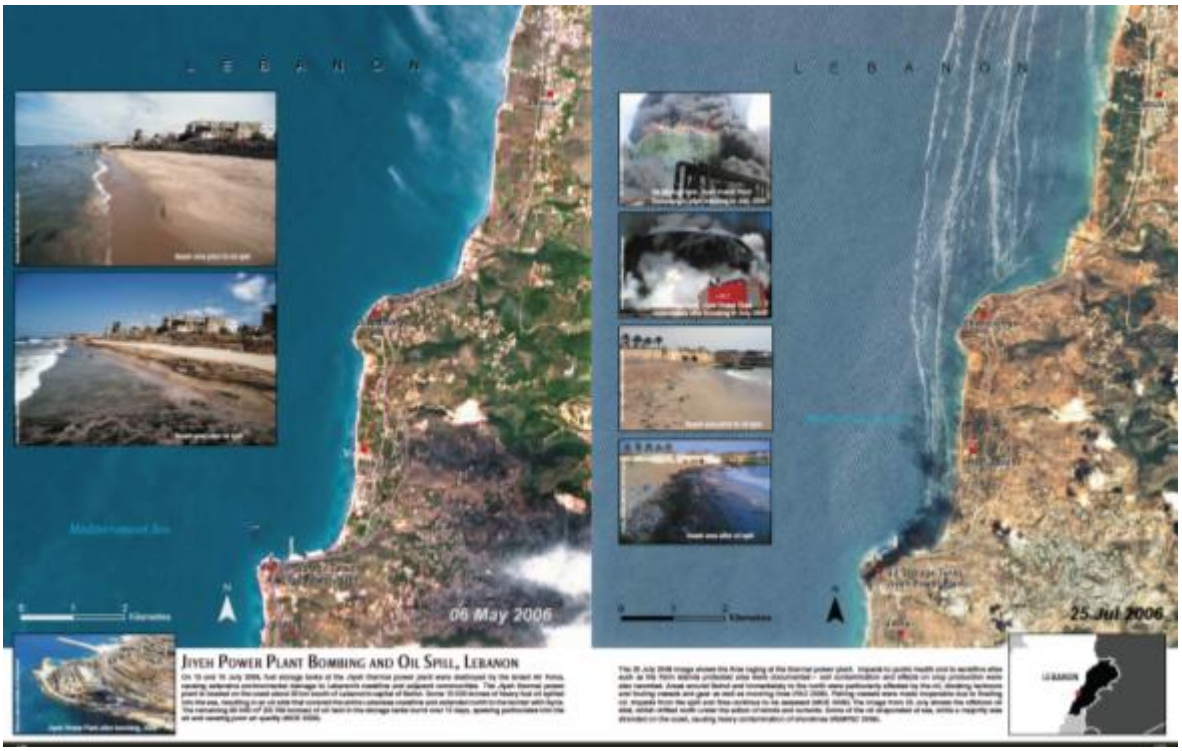
OIL FIRES, KUWAIT



The invasion of Kuwait by Iraqi forces on 2 August 1990 set in motion a series of catastrophic events, which culminated in the setting ablaze of 789 oil wells as the forces began retreating in February 1991 (TED 1994). High subsurface pressure and the littering of land mines around the oil fields complicated efforts to control the fires. The oil fires continued to burn for eight months and were finally extinguished on 6 November 1991. An estimated six million barrels of oil were consumed daily by the fires, which caused widespread pollution and dominated weather patterns throughout the ROPME Sea Area during 1991. The effects of the smoke were pronounced in Kuwait City but were more localized than had been predicted; cities such as Dhahran and Riyadh and the country of Bahrain experienced heavy smoke and carbon fallout for days. The highly toxic and carcinogenic smoke caused respiratory problems among Kuwaiti residents (Duncan 2004). Soils were contaminated around the oil wells and are no longer usable as rangelands due to high nickel and vanadium concentrations (Misak n.d.). In addition, the unignited oil from the wells formed about 300 oil lakes that contaminated 36.3 million tonnes of sand and earth. The oil and soot mixed with desert sand formed layers of “tarcrete” that covered nearly 5 per cent of the country (NASA 2003). These images show Greater Burgan Oil Field before, during and after the oil wells were set ablaze. The Burgan Field, located in southeastern Kuwait, is the second largest oil field in the world. Smoke plumes from Burgan, shown in the 15 February 1991 image, extended 50 km in width on any given day, and were 2.5 km thick. The 28 February 1993 and 20 January 2002 images show the scorching of the fields from the fires.

LEBANON
(Images: p.176-177)

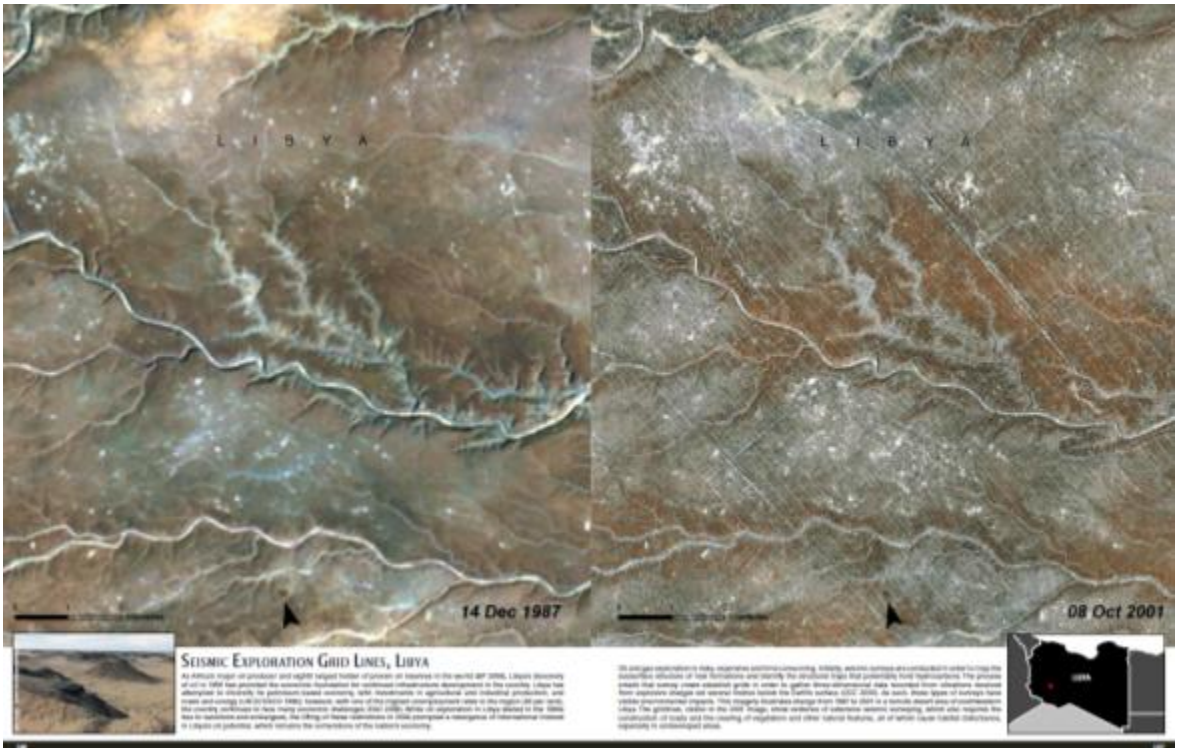
JIYEH POWER PLANT BOMBING AND OIL SPILL, LEBANON



On 13 and 15 July 2006, fuel storage tanks at the Jiyeh thermal power plant were destroyed by the Israeli Air Force, causing extensive environmental damage to Lebanon's coastline and adjacent communities. The Jiyeh thermal power plant is located on the coast about 30 km south of Lebanon's capital of Beirut. Some 15 000 tonnes of heavy fuel oil spilled into the sea, resulting in an oil slick that covered the entire Lebanese coastline and extended north to the border with Syria. The remaining 60 000 m3 (55 764 tonnes) of oil held in the storage tanks burnt over 12 days, spewing particulates into the air and causing poor air quality (MOE 2006). The 25 July 2006 image shows the fires raging at the thermal power plant and the offshore oil slick, which drifted north under the action of winds and currents. Some of the oil evaporated at sea, while a majority was stranded on the coast, causing heavy contamination of shorelines (REMPEC 2006).

LIBYA
(Images: p.186-187)

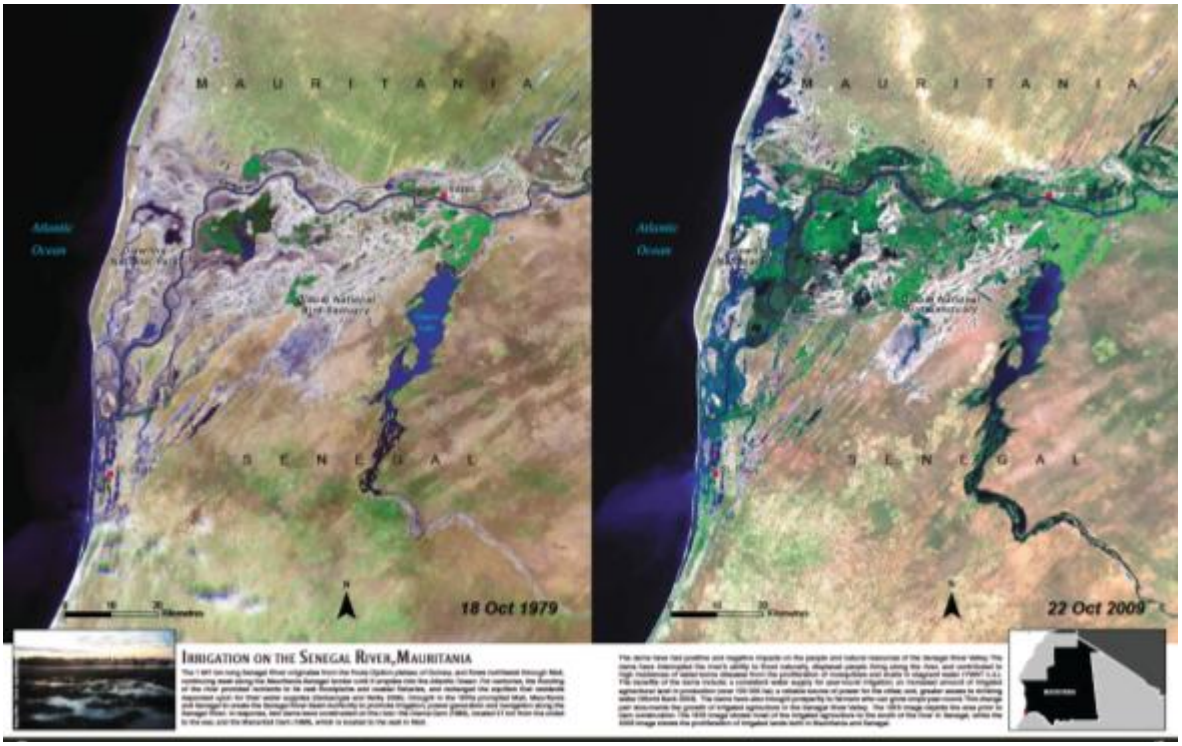
SEISMIC EXPLORATION GRID LINES, LIBYA



While oil exploration in Libya stalled in the 1990s due to sanctions and embargoes, the lifting of these restrictions in 2004 prompted a resurgence of international interest in Libya's oil potential, which remains the cornerstone of the nation's economy. Oil and gas exploration is risky, expensive and time consuming. Initially, seismic surveys are conducted in order to map the subsurface structure of rock formations and identify the structural traps that potentially hold hydrocarbons. The process entails that survey crews establish grids in order to gather three-dimensional data recorded from vibrations received from explosive charges set several metres below the Earth's surface (OCC 2000). As such, these types of surveys have visible environmental impacts. This imagery illustrates change from 1987 to 2001 in a remote desert area of southwestern Libya. The gridlines, visible in the 2001 image, show evidence of extensive seismic surveying, which also requires the construction of roads and the clearing of vegetation and other natural features, all of which cause habitat disturbance, especially in undeveloped areas.

MAURITANIA
(Images: p.194-195)

IRRIGATION ON THE SENEGAL RIVER, MAURITANIA



The 1 641 km-long Senegal River originates from the Fouta Djallon plateau of Guinea, and flows northwest through Mali, continuing west along the Mauritania-Senegal border until it empties into the Atlantic Ocean. For centuries, the flooding of the river provided nutrients to its vast floodplains and coastal fisheries, and recharged the aquifers that residents depended upon for their water supplies (DeGeorges and Reilly 2006). Drought in the 1970s prompted Mali, Mauritania and Senegal to create the Senegal River Basin Authority to promote irrigation, power generation and navigation along the Senegal River. In response, two dams were constructed on the river: the Diama Dam (1986), located 27 km from the outlet to the sea; and the Manantali Dam (1988), which is located to the east in Mali. The dams have had positive and negative impacts on the people and natural resources of the Senegal River Valley. This change pair documents the growth of irrigated agriculture in the Senegal River Valley. The 1979 image depicts the area prior to dam construction. The 1979 image shows most of the irrigated agriculture to the south of the river in Senegal, while the 2009 image shows the proliferation of irrigated lands both in Mauritania and Senegal.

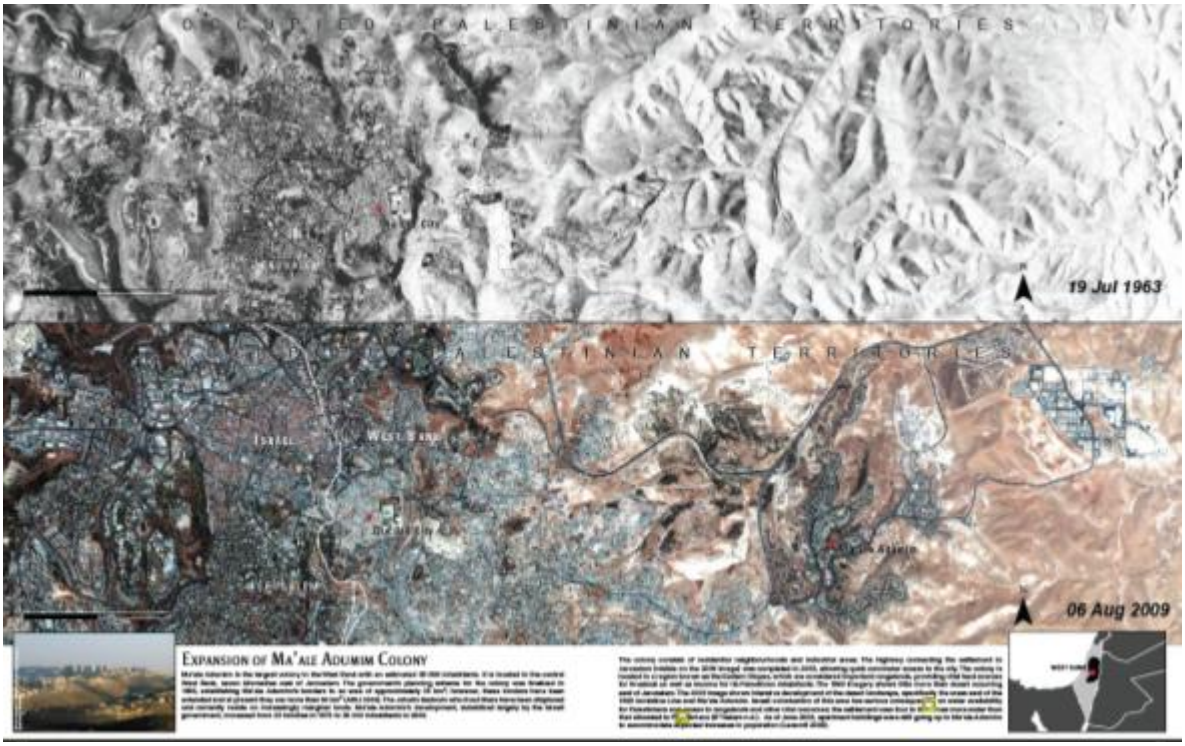
MOROCCO
(Images: P.198-199)

CASABLANCA, MOROCCO

Casablanca, located in western Morocco on the Atlantic coast, is the country's largest city. Since 1950, the population of Casablanca has increased sevenfold; 11 per cent of the country's population (3.2 million) now resides in Casablanca (Mongabay n.d.). Rapid urbanization and industrialization of this mega-city have given rise to significant environmental and social problems, including: urban poverty; land degradation stemming from loss of permeable soils and destruction of vegetation; poor air quality from vehicle traffic and industrial pollution; and contamination of water supplies and coastal waters from industrial effluent and untreated domestic wastewater (UNEP n.d.). These images detail the dramatic change that has taken place in Casablanca from 1967 to 2009. Population density throughout the city has steadily increased, while the agricultural lands, visible around the periphery of the 1967 image, are nearly absent in the 2009 image. There is also a notable difference in the extent of Casablanca's port, now one of the largest in Africa.

OCCUPIED PALESTINIAN TERRITORIES
(Images: P.208-209)

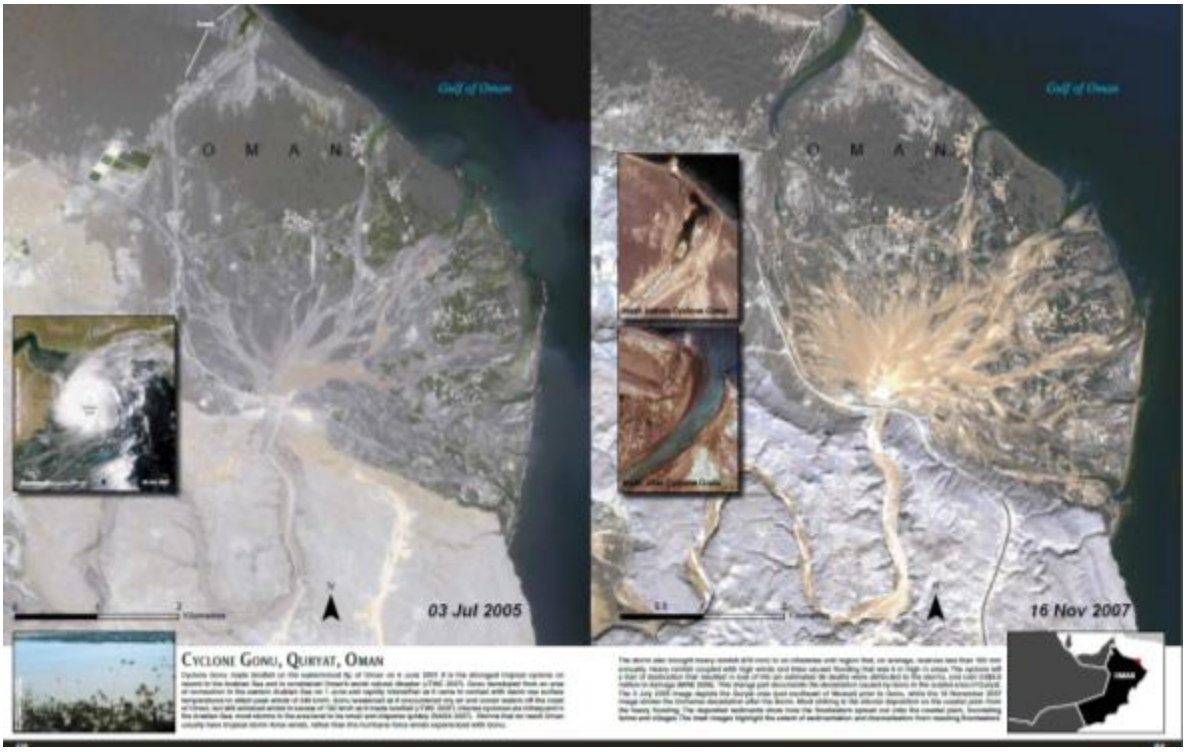
EXPANSION OF MA'ALE ADUMIM COLONY



Ma'ale Adumim is the largest colony in the West Bank with an estimated 35 000 inhabitants. It is located in the central West Bank, seven kilometres east of Jerusalem. Ma'ale Adumim's development, subsidized largely by the Israeli government, increased from 23 families in 1975 to 35 000 inhabitants in 2008. The colony consists of residential neighbourhoods and industrial areas. The Jahalin Bedouin who lived there have been displaced and currently reside on increasingly marginal lands. The colony is located in a region known as the Eastern Slopes, which are considered important rangelands, providing vital feed sources for livestock as well as income for its Palestinian inhabitants. The 1963 imagery shows little more than desert occurring east of Jerusalem. The 2009 image shows intensive development of the desert landscape, specifically the areas east of the 1949 Armistice Line and Ma'ale Adumim. Israeli colonization of this area has serious consequences on water availability for Palestinians and access to rangelands and other vital resources; the settlement uses four to five times more water than that allocated to Palestinians (B'Tselem n.d.). As of June 2009, apartment buildings were still being constructed in Ma'ale Adumim to accommodate additional residents (Lazaroff 2009).

OMAN
(Images: P.218-219)

CYCLONE GONU, QURYAT, OMAN



Cyclone Gonu made landfall on the easternmost tip of Oman on 6 June 2007. It is the strongest tropical cyclone on record in the Arabian Sea and is considered Oman's worst natural disaster (JTWC 2007). The storm brought heavy rainfall (610 mm) to an otherwise arid region that, on average, receives less than 100 mm annually. Heavy rainfall coupled with high winds and tides caused flooding that was 6 m high in areas. The cyclone left a trail of destruction that resulted in loss of life (an estimated 56 deaths were attributed to the storm), and cost US$3.9 million in damage (MNE 2006). This change pair documents the devastation caused by Gonu in the coastal area of Quryat. Most striking is the alluvial deposition on the coastal plain from the heavy flooding. The deposited sediments show how the floodwaters spread out onto the coastal plain, inundating farms and villages. The inset images highlight the extent of sedimentation and channelization from receding floodwaters.

QATAR
(Images: P.218-219)

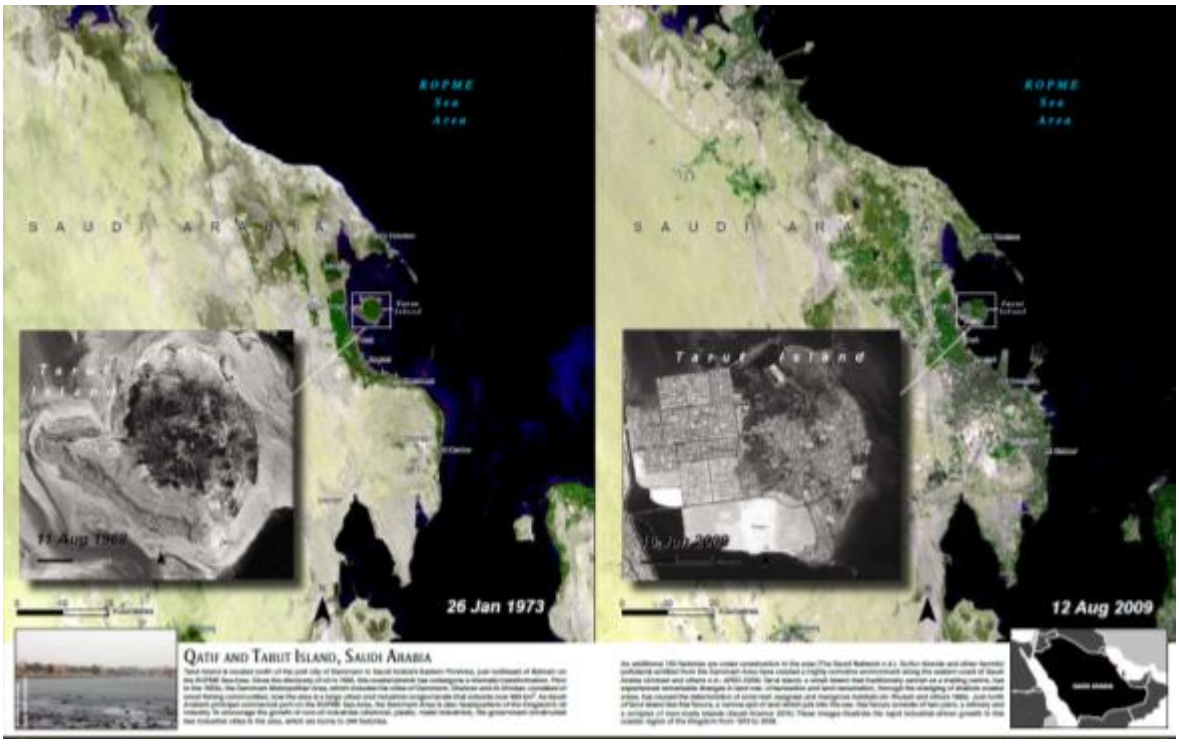
THE PEARL AND LUSAIL CITY, QATAR

The Pearl and Lusail City are new waterfront developments located on the ROPME Sea Area just north of the capital city of Doha. The Pearl, initiated in 2004, is an artificial island complex built on a reclaimed pearl diving reef. The Pearl City will accommodate 41 000 residents and include over 40 km of new coastline (UDC 2011). Lusail City, which consists of reclaimed land and dredged canals, will be built to accommodate 250 000 residents and is intended to be the biggest domestic real estate development in the country, covering more than 3 500 ha (Lusail 2011). Together, these mega projects will provide luxury residential and commercial properties, entertainment, and education and research facilities. However, along with these luxury developments comes the threat of dramatic population growth and urban expansion. Massive desalination and power plant projects are being proposed in Qatar to meet the country's burgeoning power and water demands (FAO 2008); however, these plants emit gases, hot brine effluent and chemicals that pose a threat to already sensitive marine ecosystems in the ROPME Sea Area (Richer 2008). These images show the dramatic change in north Doha from 1990 to 2009. The alteration from what was once largely undeveloped land to an area modified by man-made canals and reclaimed island properties is clearly evident.

SAUDI ARABIA

(Images: P.234-235)

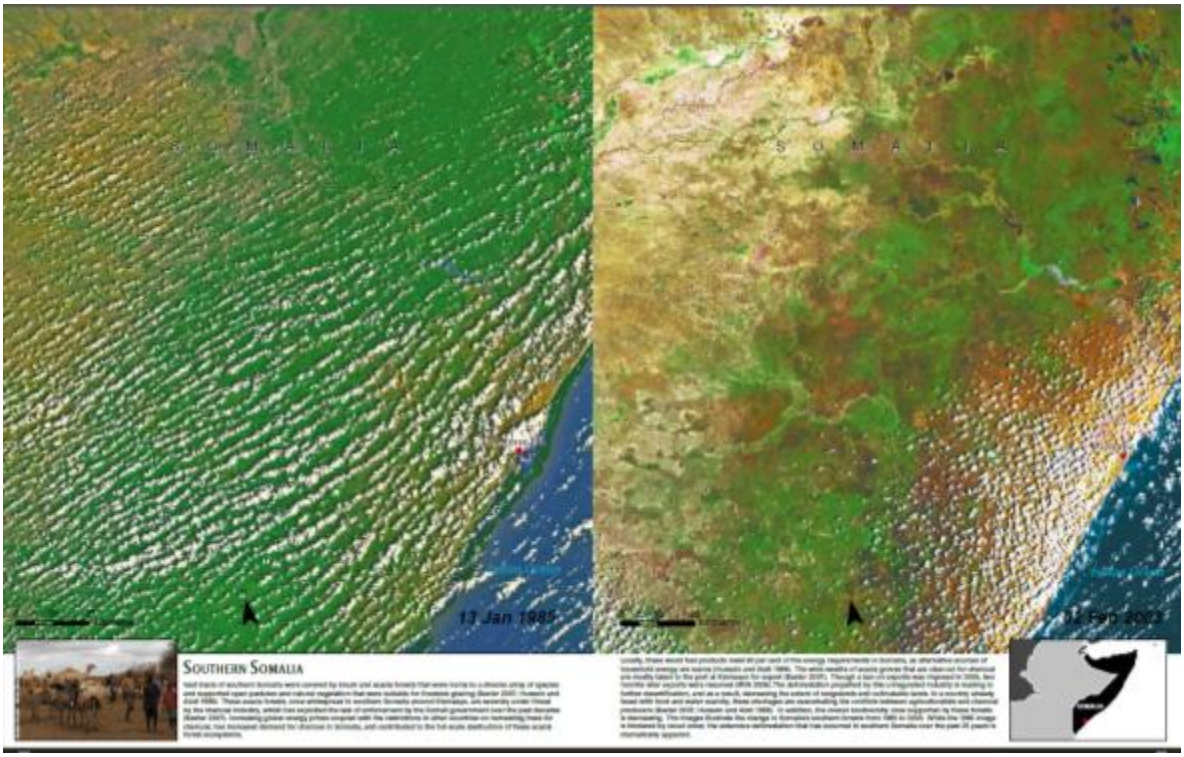
QATIF AND TARUT ISLAND, SAUDI ARABIA



Tarut Island is located north of the port city of Dammam in Saudi Arabia's Eastern Province, just northeast of Bahrain on the ROPME Sea Area. Since the discovery of oil in 1936, this coastal stretch has undergone a dramatic transformation. Prior to the 1930s, the Dammam Metropolitan Area, which includes the cities of Dammam, Dhahran and Al-Khobar, consisted of small fishing communities; now the area is a large urban and industrial conglomerate that extends over 483 km2. To encourage the growth of non-oil industries (chemical, plastic, metal industries), the government constructed two industrial cities in the area, which are home to 244 factories. An additional 160 factories are under construction in the area (The Saudi Network n.d.). Tarut Island, a small island that traditionally served as a trading centre, has experienced remarkable changes in land use. Urbanization and land reclamation, through the dredging of shallow coastal areas, has caused the deterioration of coral reef, seagrass and mangrove habitats (Al-Thukair and others 1995). These images illustrate the rapid industrial-driven growth in this coastal region of the Kingdom from 1973 to 2009.

SOMALIA
(Images: P.242-243)

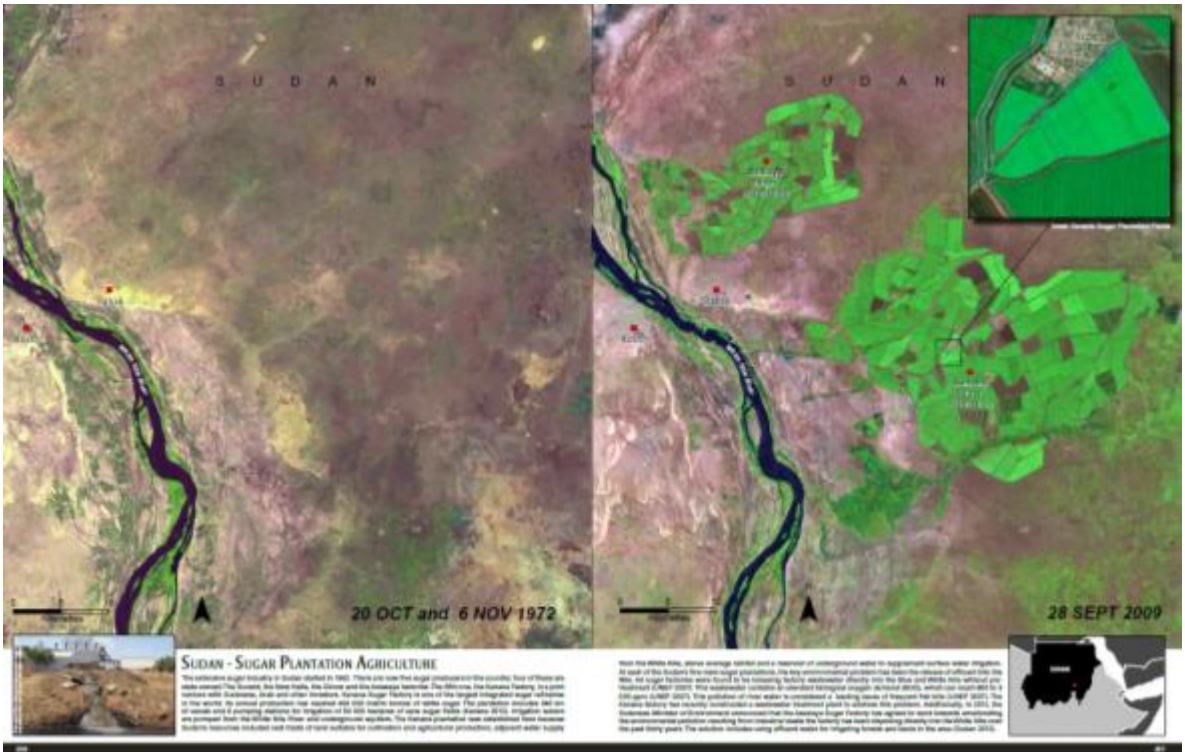
SOUTHERN SOMALIA



Vast tracts of southern Somalia were covered by brush and acacia forests that were home to a diverse array of species and supported open pastures and natural vegetation that were suitable for livestock grazing (Baxter 2007; Hussein and Abdi 1998). These acacia forests, once widespread in southern Somalia around Kismaayo, are severely under threat by the charcoal industry, which has exploited the lack of enforcement by the Somali government over the past decades (Baxter 2007). Increasing global energy prices coupled with the restrictions in other countries on harvesting trees for charcoal, has increased demand for charcoal in Somalia, and contributed to the full-scale destruction of these acacia forest ecosystems. The deforestation propelled by this unregulated industry is leading to further desertification, and as a result, decreasing the extent of rangelands and cultivatable lands. In a country already faced with food and water scarcity, these shortages are exacerbating the conflicts between agriculturalists and charcoal producers (Baxter 2007; Hussein and Abdi 1998). The images illustrate the extensive deforestation that has occurred in southern Somalia over the past 25 years.

SUDAN
(Images: P.250-251)

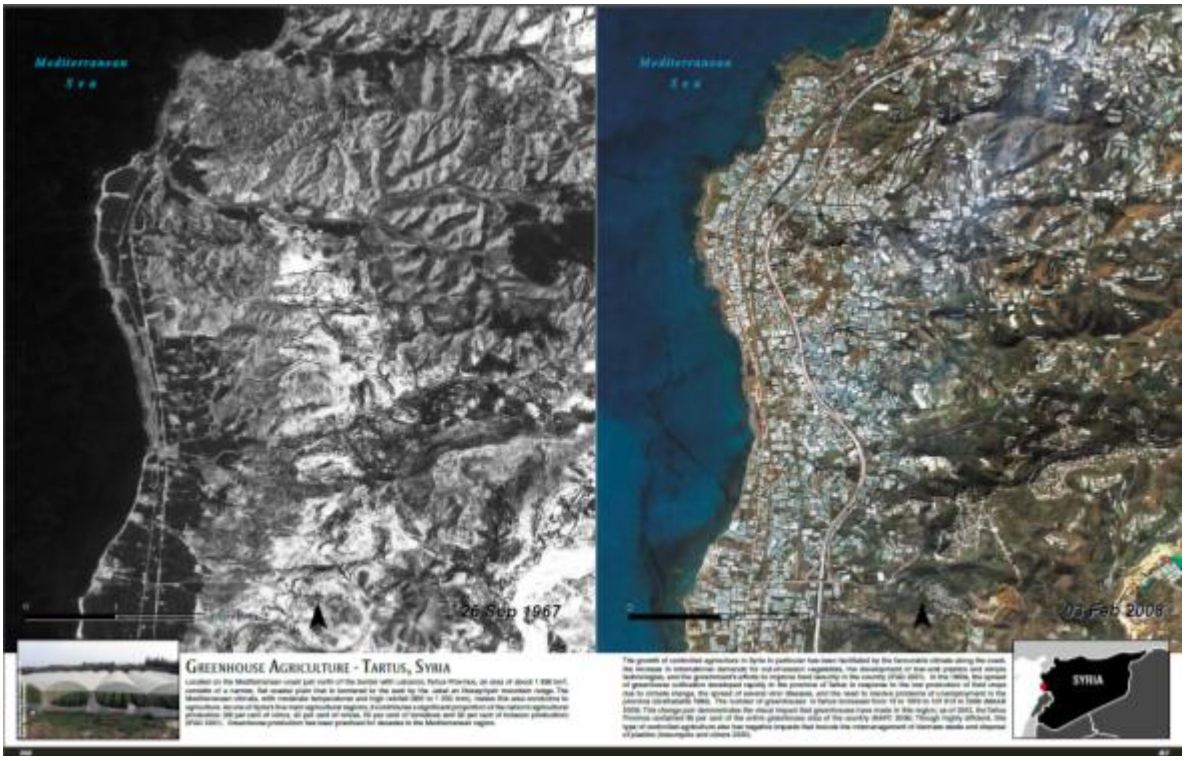
SUDAN - SUGAR PLANTATION AGRICULTURE



The extensive sugar industry in Sudan started in 1962. There are now five sugar producers in the country; four of these are state-owned: The Guneid, the New Halfa, the Sinnar and the Assalaya factories. The fifth one, the Kenana Factory, is a joint venture with Sudanese, Arab and other investors. Kenana Sugar Factory is one of the largest integrated sugar refineries in the world. Its annual production has reached 400 000 metric tonnes of white sugar. At each of the Sudan's five main sugar plantations, the key environmental problem has been the release of effluent into the Nile. All sugar factories were found to be releasing factory wastewater directly into the Blue and White Nile without pretreatment (UNEP 2007). This pollution of river water is considered a leading cause of frequent fish kills (UNEP 2007). The Kenana factory has recently constructed a wastewater treatment plant to address this problem. Additionally, in 2012, the Sudanese Minister of Environment announced that the Assalaya Sugar Factory has agreed to work towards ameliorating the environmental pollution resulting from industrial waste. The solution includes using effluent water for irrigating forests and lands in the area (Sudan 2012).

SYRIA

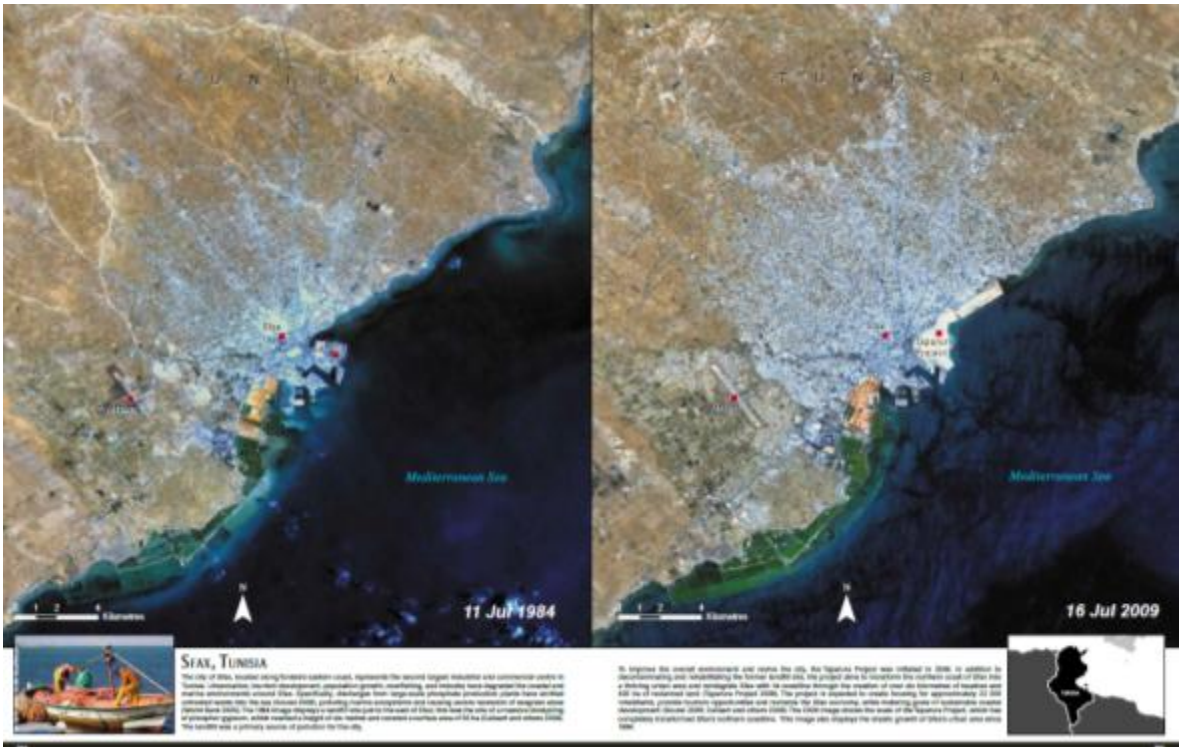
(Images: P.256-257)
GREENHOUSE AGRICULTURE - TARTUS, SYRIA



Located on the Mediterranean coast just north of the border with Lebanon, Tartus Province, an area of about 1 890 km2, consists of a narrow, flat coastal plain that is bordered to the east by the Jabal an Nusayriyah mountain range. The Mediterranean climate, with moderate temperatures and high rainfall (800 to 1 000 mm), makes this area conducive to agriculture. As one of Syria's five main agricultural regions, it contributes a significant proportion of the nation's agricultural production. Greenhouse production has been practiced for decades in the Mediterranean region. In the 1990s, the spread of greenhouse cultivation developed rapidly in the province of Tartus in response to the low production of field crops due to climate change, the spread of several viral diseases, and the need to resolve problems of unemployment in the province (Grafiadellis 1996). This change pair demonstrates the visual impact that greenhouses have made in this region; as of 2002, the Tartus Province contained 85 per cent of the entire greenhouse area of the country (NAPC 2006). Though highly efficient, this type of controlled agriculture also has negative impacts that include the mismanagement of biomass waste and disposal of plastics (Assumpcio and others 2005).

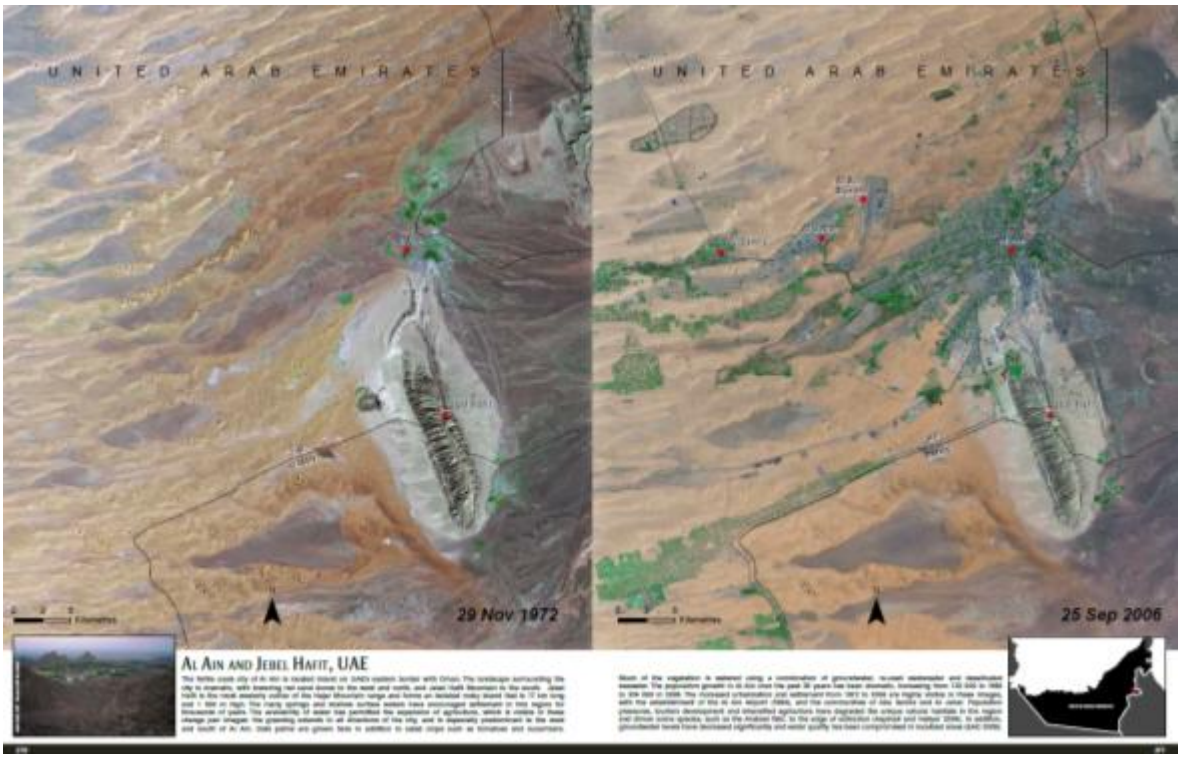
TUNISIA
(Images: P.264-265)

SFAX, TUNISIA



The city of Sfax, located along Tunisia's eastern coast, represents the second largest industrial and commercial centre in Tunisia. Urbanization, tourism development, population growth, overfishing, and industry have degraded the coastal and marine environments around Sfax. Specifically, discharges from large-scale phosphate production plants have emitted untreated waste into the sea (Soussi 2009), polluting marine ecosystems and causing severe recession of seagrass areas (World Bank 2005). The 1984 image displays a landfill site just to the east of Sfax that was a primary source of pollution for the city. To improve the overall environment and revive the city, the Taparura Project was initiated in 2006. In addition to decontaminating and rehabilitating the former landfill site, the project aims to transform the northern coast of Sfax into a thriving urban area and reintegrate Sfax with its coastline through the creation of over six kilometres of beaches and 420 ha of reclaimed land (Taparura Project 2008). The project is expected to create housing for approximately 22 000 inhabitants, provide tourism opportunities and revitalize the Sfax economy, while fostering goals of sustainable coastal development (Soussi 2009; Callaert and others 2008). The 2009 image shows the scale of the Taparura Project, which has completely transformed Sfax's northern coastline.

UNITED ARAB EMIRATES
(Images: P.270-271)
AL AIN AND JEBEL HAFIT, UAE

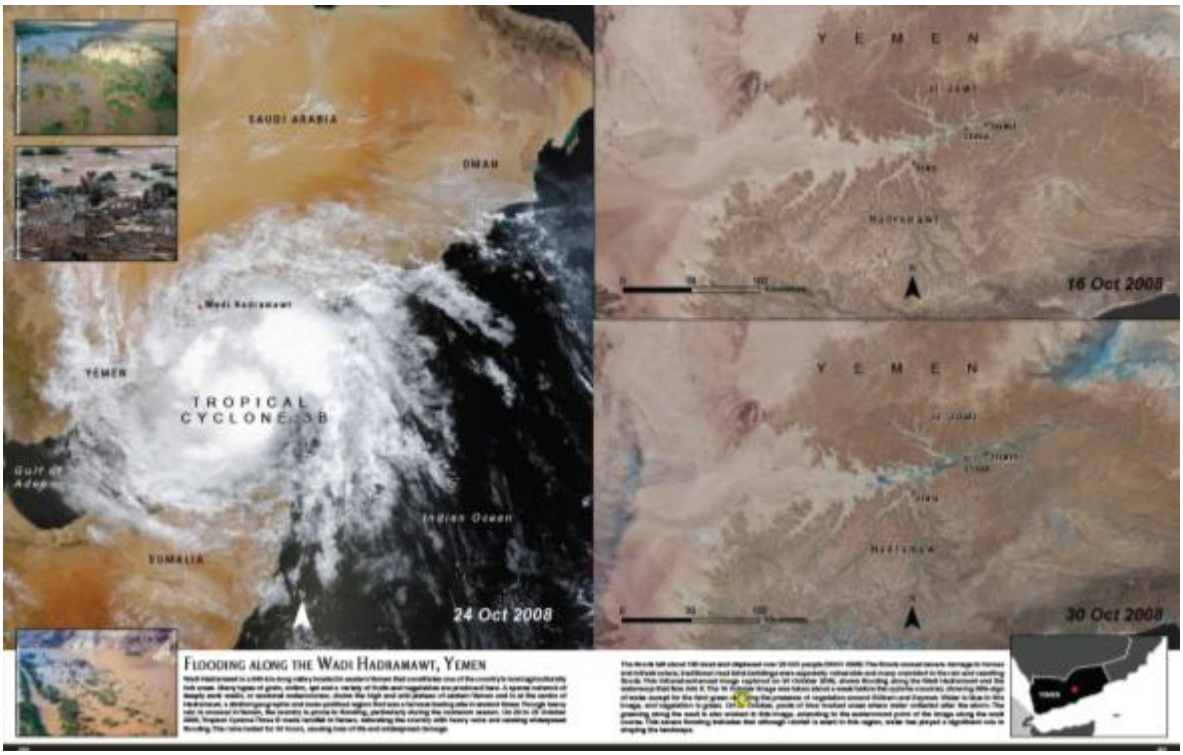


The fertile oasis city of Al Ain is located inland on UAE's eastern border with Oman. The landscape surrounding the city is dramatic, with towering red sand dunes to the west and north, and Jebel Hafit Mountain to the south. The many springs and shallow surface waters have encouraged settlement in this region for thousands of years. The availability of water has permitted the expansion of agriculture, which is visible in these change pair images: the greening extends in all directions of the city, and is especially predominant to the west and south of Al Ain. The increased urbanization and settlement from 1972 to 2006 are highly visible in these images, with the establishment of the Al Ain Airport (1994), and the communities of Abu Samra and Al Jahar. Population pressures, tourism development and intensified agriculture have degraded the unique natural habitats in the region and driven some species, such as the Arabian Tahr, to the edge of extinction (Aspinall and Hellyer 2004). In addition, groundwater levels have decreased significantly and water quality has been compromised in localized areas (EAD 2009).

YEMEN

(Images: P.280-281)

FLOODING ALONG THE WADI HADRAMAWT, YEMEN



On 24 to 25 October 2008, Tropical Cyclone Three B made landfall in Yemen, saturating the country with heavy rains and causing widespread flooding. The rains lasted for 30 hours, causing loss of life and widespread damage. The floods left about 180 dead and displaced over 20 000 people (WHO 2008). The floods caused severe damage to homes and infrastructure; traditional mud-brick buildings were especially vulnerable and many crumbled in the rain and resulting floods. This infrared-enhanced image captured on 30 October 2008, shows flooding along the Wadi Hadramawt and the waterways that flow into it. The 16 October image was taken about a week before the cyclone occurred, showing little sign of water except for the faint green denoting the presence of vegetation around Shibam and Saywun. Water is blue in this image, and vegetation is green. In the 30 October image, pools of blue mark areas where water collected after the storm. The greening along the wadi is also evident in this image, extending to the easternmost point of the image along the wadi course. This severe flooding indicates that although rainfall is scant in this region, water has played a significant role in shaping the landscape.