ARAB REGION

Atlas of Our Changing Environment

UNEP

AGEDI

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Arab Region

Atlas of Our Changing Environment

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Arab Region

Atlas of Our Changing Environment

Erg Chebbi, Morocco

After a rainfall in March, a small lake rises near the Erg Chebbi sand dunes in the Sahara

Source: Alex Lichtenberger/Flickr.com

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The Arab region, a group of 22 member countries of the League of Arab States sharing a common language, culture and religion, is divided into three contiguous clusters falling in two continents, two hemispheres, and borders on five oceans and seas. Covering around 14 million square kilometres, the region covers 9 per cent of the Earth's total land area, with a population of over 350 million, of which 56% is urbanised.

The deserts, mountains, dunes, grasslands, forests, and marine areas that typify the region are occupied by thousands of species of plants and animals. This varied landscape contains numerous natural wonders and a wealth of resources and is also home to the vast majority of cities that claim to be the longest continuously inhabited cities in the world.

Over the last few decades, the Arab region has experienced dramatic population and economic growth. This accelerated pace of development has been a major factor in fuelling increased demands on resources and has contributed to rapidly changing land use patterns and environmental change. Although the countries of the region share common concerns about a number of critical environmental and sustainability issues, they also face tremendous differences in their challenges.

In order to better understand the unique environmental trends, concerns and challenges in a region that is witnessing such rapid development, there is demand for a dynamic and credible information base. Data and information is critical to the documentation and quantification of the environmental changes that are taking place on land, in the water, and in the air.

The United Arab Emirates (UAE) envisioned this need, and in 2002 launched the Abu Dhabi Global Environmental Data Initiative (AGEDI), a partnership between Environment Agency – Abu Dhabi (EAD) and the United Nations Environment Programme (UNEP). Since then, this collaboration has included the Environment Outlook for the Arab Region, GEO-4, GEO-5, West Asia GEO Portal, West Asia Map Server, and the Eye on Earth Summit, the first global summit devoted exclusively to the issue of environmental and societal data access.

AGEDI is now pleased to introduce the Arab Region: Atlas of Our Changing Environment, an evidence-based publication and the first of its kind in the region. Through the use of striking satellite imagery and informative descriptions, the Atlas tells a story of prominent environmental change across 22 Arab countries over the last 50 years. It contributes to the knowledge and understanding of our unique environment that is essential for ensuring sustainable development, and it is our hope that it will support the demands for up-to-date information to inform policy at the local, regional, and international levels. It should also be of immense value to all those who want to know more about the Arab region and who care about its future.

Many experts from around the region contributed to making this publication possible, and several consultations with many stakeholders took place through meetings or by remote communications. It is of note that countries and institutions of the region contributed to the selection of the sites for analysis, prepared content and reviewed the country profiles. We would like to commend all contributors, reviewers and others who made this Atlas possible.

We are proud to lend our support to this important publication and may it inspire positive environmental action, spur further research and foster insight into this part of the world.

Razan Khalifa Al Mubarak
Secretary General,
Environment Agency – Abu Dhabi (EAD)

Von Karman Vortices

Von Karman vortices form as air flows around an object in its path, causing it to separate and create eddies in its wake.The clockwise and counterclckwise spirals in this image were created as wind blowing from the north over the Atlantic was disturbed by the Canary Island archipelago, 95 km from the Moroccan coastline (right). This is an Envisat image from 6 June 2010.

Source: European Space Agency (ESA)

Environmental change on 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 due to the rapid pace of development in the region. Hardly any element of the Arab environment - vegetation, soils, wildlife, surface and underground waters or the coastline - has been untouched by the purposeful or unintended effects of human activities. The Arab Region: Atlas of Our Changing Environment is a unique and powerful publication which brings to light stories of environmental change at more than 80 locations across the Arab region. Using a combination of ground photographs, current and historical satellite images, and narrative based on extensive scientific evidence, the atlas illustrates how humans have altered their surroundings and continue to make observable and measurable changes to the Arab region and its environment.

The images presented provide visual evidence of changes taking place in the land, water and atmosphere, and also cover transboundary issues such as river basins, transboundary conservation areas and pollutants. One of the most prominent features of this atlas is the use of paired satellite images to show site specific change over time. These "before-and-after" studies clearly demonstrate the pace of development in the region, offering compelling examples of wide-ranging environmental change, including land use change, urban growth, degradation of marine and coastal areas, altered hydrology and shrinking water bodies, loss of habitats and impacts of climate change.

In a region already confronted by extreme climate, limited natural resources, economic conditions and conflict, these images serve to highlight the distinctive environmental circumstances and challenges faced in the Arab region and the vulnerability of many Arab settlements to environmental risks and natural disasters.

Although the challenges depicted are striking, the atlas examines the opportunities that these challenges present, as well as some of the innovative responses that are being implemented in the region. The atlas also spotlights the unique environmental issues faced by each country, and tracks the individual progress each is making towards achieving the goal of ensuring environmental sustainability as part of the United Nations Millennium Development Goals (MDG 7).

The Arab Region: Atlas of Our Changing Environment is the latest addition to a series of atlases coordinated by UNEP that began in 2005 with the launch of a global atlas - "One Planet, Many People." This new atlas is an important addition to the growing suite of UNEP atlases able to not only fascinate and intrigue readers, but also contribute to a better understanding of the dynamics of environmental change in the Arab region in support of improved decision-making towards a more sustainable future.

UNEP would like to thank the Ministry of Environment and Water, United Arab Emirates; the Abu Dhabi Global Environmental Data Initiative (AGEDI) and the many experts and reviewers from the Arab Region for their invaluable support, expertise and collaboration on this publication.

Source: UNEP

Achim Steiner
UN Under-Secretary General and
UNEP Executive Director

Today we find ourselves faced with the imminent end of the era of cheap oil, the prospect of steadily rising commodity prices, the degradation of forests, lakes and soils, conflicts over land use, water quality, fishing rights and the momentous challenge of stabilising concentrations of carbon in the global atmosphere... In these circumstances, a return to business as usual is not an option.

- Sustainable Development Commission 'Prosperity Without Growth' (March 2008)

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 highlight natural and human-caused landscape changes in the 22 League of Arab States member countries. Earth observation (EO) technologies, which include airborne and satellite sensing systems, are playing an increasingly important role in the assessment and management of natural resources. Advances in EO technologies have improved our ability to detect, evaluate, map and monitor change at the land surface, and have become an essential element for assessing, predicting and adapting to climate change. The hundreds of visually compelling images in this atlas clearly depict landscape-level changes over time and highlight the challenges facing the region. The ability to observe large-scale phenomena to detect gradual environmental change enables us to assess the global impact of human activity and develop methods to ensure a more sustainable future.

The Arab Region: An Introduction

Throughout the ages, societies of the (Arab) region have been under constant pressure to adapt to water scarcity and heat, and have developed ... solutions and institutional mechanisms to deal with these environmental constraints.

- Inger Andersen, World Bank (2010)

Environmental change is chronicled in the 22 member countries of the League of Arab States, which is an association of independent Arab states formed in 1945 to strengthen relations in the region. The Arab region straddles the continents of Africa and Asia, with ten of the countries occurring in Africa (including the island nation of the Comoros), and the remaining in West Asia, mostly along the Mediterranean Sea and on the Arabian Peninsula. The atlas was produced before South Sudan was created, thus Sudan is discussed in pre-separation terms throughout, with exception of Chapter 3 country profile and change pairs. Arab sub-regions often referred to in this publication include the Gulf Cooperation Council (GCC) (which consists of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates), the Maghreb countries (Algeria, Libya, Morocco, Tunisia and Mauritania) and the Mashreq countries (Iraq, Jordan, Lebanon, Occupied Palestinian Territories and Syria). Arabian Peninsula is also used to refer to GCC countries and Yemen. The League of Arab States nations each exhibit unique geographical and ethnic characteristics; at the same time they share historical, cultural and religious ties and are predominantly Arabic-speaking and majority Muslim. These Arab countries are also united by the environmental challenges they face as populations in the region surge, water shortages become more acute and changes in climate exacerbate land degradation and desertification. This atlas demonstrates the ecological challenges the region as a whole faces and also provides specific examples of methods and policies being implemented as well as the opportunities these challenges present.

Chapter 1 begins with a detailed discussion and accompanying illustrations of the region's natural characteristics. The Arab region covers an area of about 14 000 000 km^2, 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.

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, encroachment 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.

The Arab region further 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.

Source: Nwardez/Flickr.com

Village well in Morocco

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 m^3), 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.

Land degradation resulting from human activities and natural environmental factors is acute in many areas of the Arab region. Drought coupled with overgrazing, uncontrolled cultivation, fuelwood gathering, wind-blown erosion, inefficient and inappropriate use of irrigation water, sprawling urbanisation, and sand encroachment all contribute to the process of land degradation. The already limited fertile land is also being lost to alternative land uses. The region's population is expected to grow to 385 million by 2015, up from the current figure of about 352 million—as stated by Mr Hafedh Chekir, the Arab Office Director for the UN Population Fund, 'strategic thinking and planning among Arab governments is needed to avert future hardships'; or as Ms Amat al Alim Alsoswa, UNDP Regional Director, Bureau of Arab States warns: 'urgent action is needed to put the region on a development path which is… sustainable'.

Transboundary Issues and Challenges

Chapter 2 describes the changing nature of transboundary environmental issues in the Arab region and provides specific examples of issues that transcend national borders. The most prominent transboundary issues involve water resources, land, migrating animals and people and pollutants. The impacts of climate change are also addressed that consider the effects of sea level rise, increased temperatures and decreased precipitation in the region. Several images display the effects on the Nile Delta under different sea level rise scenarios; the challenges of a changing climate to island nations such as the Comoros are also highlighted. Other case studies are examined in this chapter that highlight emerging issues as well as opportunities for cooperation and management in a region that includes almost 50 shared borders (Arab and non-Arab states).

Though as a whole, the Arab region contributes only 4.7 per cent (EOAR 2010) 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 oil and gas producing countries contributing a larger proportion of GHG emissions. 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.

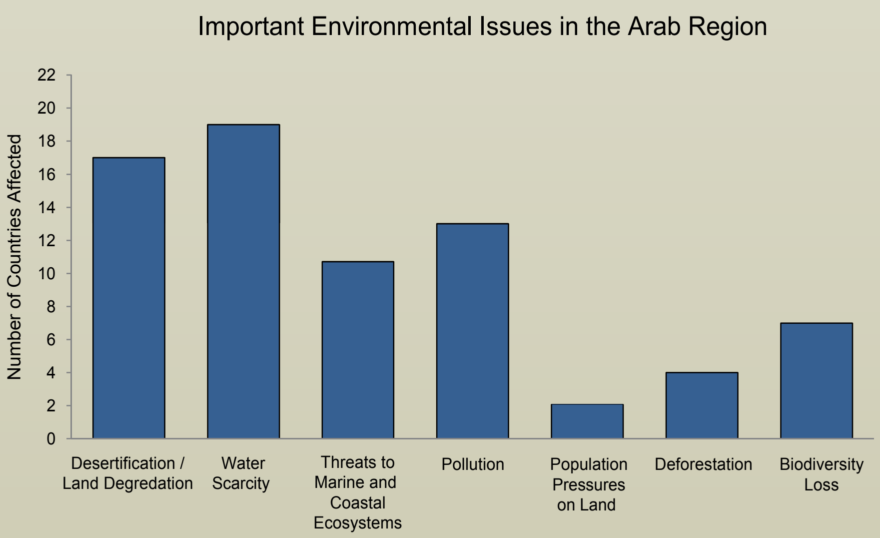
Tracking Progress Towards Environmental Sustainability

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 (Tripoli, Libya; Cairo, Egypt; Aqaba, Jordan, 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 interest readers of this atlas but also promote their understanding of the challenges faced by the Arab region.

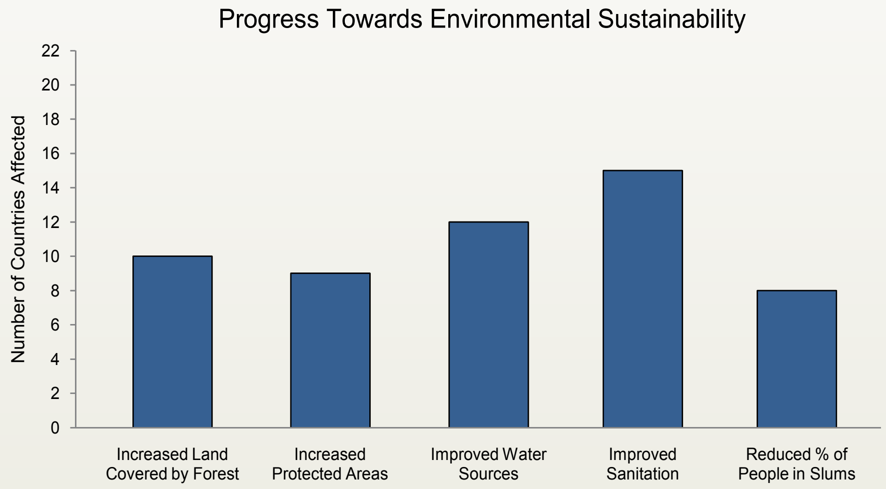
The measures of progress towards meeting environmental sustainability under MDG 7 are tracked from 1990 to present using five indicators: proportion of forested lands, number of urban slum dwellers, access to improved water sources, access to improved sanitation and proportion of protected areas. Though 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.

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 increasing protected areas and increasing land covered by forest, while half of the Arab countries showed progress in 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.

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.



Note: the Atlas identifies the issue in question as one of the top three priorities for each country, though most of these categories are environmental issues across the region.



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

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. The development of countless mega-cities in the Arab region is one of the most striking impressions these images provide—Cairo, Algiers, Beirut, Casablanca, Amman, Sana'a, Riyadh, Baghdad, Mogadishu and Nouakchott have all experienced extensive and rapid development of their urban areas. Associated with this urban expansion is the increase in unauthorized settlements at the cities' fringes with little to no basic services, inadequate waste disposal, intense air pollution, and contamination of soil and groundwater resources, to name but a few impacts.

Alongside the challenges portrayed herein, some of the change pairs also present evidence of innovative responses around the region to a changing climate, water shortages, population pressures and shifts in the economy. The greening of the desert shown in images of Al Ain(UAE) and the Kuwait-Iraq Separation Border displaying Kuwait's conservation and resource protection are testament to efforts in the region to improve environmental conditions and conserve water resources.

The centre-pivot irrigation systems appear as verdant points in the desert landscape—though most of the irrigation water relies on limited groundwater supplies, some countries are using alternative water sources, including reused wastewater and desalinated water, to supplement the mostly non-renewable groundwater resources. Wafra Farms in Kuwait has expanded their food production to include aquaculture of Nile tilapia in order to supplement the fish industry, and has established greenhouses to improve crop production. Greenhouse agriculture has been implemented at a large scale in Syria—the growth of this controlled agriculture was catapulted by recurring drought, the need to improve agricultural efficiency and to meet increased demands for food production internally and abroad. Construction of water conveyance and storage systems across the region has also fueled the growth in agriculture, providing irrigation waters for agricultural production in countries such as Morocco, Tunisia, Sudan, and Mauritania.

The development of the tourism industry in the region as a means to diversify the economies of many of the countries bordering the Regional Organisation for the Protection of the Marine Environment (ROPME) Sea Area and the Mediterranean are evident in many of these satellite images. The opulent development of artificial island complexes to provide luxury residential and tourist resorts has transformed the coastlines of the UAE, Bahrain and Qatar. Coastal developments such as Mesaieed Industrial City (Qatar), Aden (Yemen), and Qatif and Tarut Islands (Saudi Arabia), have transformed the coastal and marine environments, with, at times, grave consequences (oil pollution, destruction of coral reefs, mangroves and seagrass ecosystems, to name a few). On the other hand, images of a converted landfill along the coastline of Tunisia show the benefits of transforming an urban wasteland into a green area that provides both recreation opportunities and habitat. The Taparura Project in Sfax, Tunisia, is a poignant example of projects that are being launched in the region to revive urban areas and reintegrate their coastlines.

Important Environmental Issues in Arab Countries

Algeria	•Desertification •Water Scarcity •Pollution
Bahrain	•Water Quantity and Water Quality •Degradation of Coastal and Marine Ecosystems •Threats to Biodiversity
Comoros	•Threats to Coastal and Marine Resources •Deforestation and Soil Erosion •Threats to Biodiversity
Djibouti	•Water Scarcity •Desertification and Land Availability •Marine Resources and Pollution
Egypt	•Water Scarcity and Pollution of the Nile River •Solid Waste •Loss of Biodiversity
Iraq	•Conflict-related Contamination and Pollution •Ecosystem Degradation •Destruction of Mesopotamian Marshlands
Jordan	•Water Scarcity •Desertification and Land Degradation •Threats to Biodiversity
Kuwait	•Water scarcity and Groundwater Salinity •Land Degradation and Desertification •Pollution and Impacts of the Gulf War
Lebanon	•Deforestation •Management of Urban Environment •Coastal and Marine Pollution
Libya	•Water Scarcity •Arable Land Availability and Desertification •Oil Development and Pollution
Mauritania	•Desertification •Water Scarcity in Nouakchott •Overfishing of Coastal Waters
Morocco	•Desertification and Land Degradation •Water Scarcity and Drought •Pollution of Freshwater and Marine Environments
Occupied Palestinian Territories	•Water Scarcity •Environmental Pollution-Air and Water •Population Pressures on Land
Oman	•Water Scarcity and Water Use •Soil and Groundwater Salinity •Threats to Coastal Areas and Marine Biodiversity
Qatar	•Water Scarcity •Desertification and Land Degradation •Threats to Marine and Coastal Ecosystems
Saudi Arabia	•Water Scarcity and Water Demand •Desertification and Land Degradation •Oil Contamination of Coastal Zones
Somalia	•Water Scarcity and Drought •Desertification, Overgrazing and Deforestation •Threats to Biodiversity
Sudan	•Land Degradation and Soil Erosion •Water Scarcity and Desertification •Loss of Biodiversity
Syria	•Water Scarcity and Water Quality •Land Degradation and Desertification •Deforestation
Tunisia	•Water Scarcity •Air and Water Pollution •Land Degradation and Desertification
United Arab Emirates	•Water Demand and Water Scarcity •Land Degradation and Desertification •Threats to Coastal and Marine Ecosystems
Yemen	•Water Scarcity and Water Quality •Population and Pressure on Land •Soil, Water and Wind Erosion

Finally, conflict is not new to this region—the images from the Jiyeh Power Plant bombing by the Israeli Air Force in 2006 and its resultant oil spill in Lebanon and the oil fires in Kuwait as a result of the 1990 invasion by Iraqi forces, vividly show the environmental impacts of conflict. Though not evident from these images, conflict has other indirect effects, causing displacement and migration, which leads to population pressures in localized areas and abandonment of farmlands and contamination of soils that can interrupt or halt agricultural production. The development and expansion of Israeli colonies in the West Bank is borne out of decades of conflict and is forcing the Palestinians to reside on more marginal lands, impacting their access to rangelands and affecting their water availability.

Perhaps the most compelling story of environmental change is the revitalization of the Mesopotamian Marshlands, which suffered a tragic loss of wetlands from 1950 through 1990. The images in Chapter 3 show the decrease in the extent of wetlands from 1984 to 2000—beginning in 2003, however, the marshlands began to fill again with water as impoundments were lifted and floodgates opened, and by 2006, 58 per cent of the marshlands had been inundated. The ongoing success in rehabilitating the Arab region's most vital wetlands is largely due to involvement by local communities and support of governments and international organizations.

Other striking images that show visible and at times large-scale landscape change are the fire scars in Latakia, Syria spurred by drought and high temperatures; the seismic grid lines from oil surveying in the Libyan desert; and the drying of lakes, seas and marshes due to diversions, draining and reclamation activities in Iraq, Egypt and the West Bank. The impacts of overgrazing in Jonglei, Sudan, flooding in Yemen in 2008 caused by Tropical Cyclone 3B, and phytoplankton blooms off the coast of Algeria due to urban runoff and heavy nutrient loads, are also revealed. All of these images tell a story of change and the accompanying narratives provide the necessary background and details to understand the trends that are visually evident in the Arab region.

The Future

Societies have adjusted to change for millennia. The material, social and cultural life of the Arab region must adapt to the environmental conditions that exist in order to ensure a sustainable future. This atlas, through the use of striking images and summaries, presents a case of rapid change to the Arab landscape that has numerous implications to the region's biodiversity, air and terrestrial and marine environments. It also offers examples of policies that are being enacted in the Arab region and programmes that are being implemented at local and regional scales to address challenges that climate change, population pressures and changing demographics are presenting. The region's progress in meeting the United Nations Millennium Development Goals can also be gauged in these pages to determine the strides that countries are making in providing an adequate quality of life and assuring a more sustainable future.

This publication carries a realistic message about the changes and challenges that the Arab region faces. The most durable asset of this region is its natural ecosystems. This atlas offers readers an awareness of these most vital life-sustaining resources so that mechanisms can be established to better manage and conserve these systems. New approaches to natural resource management and energy production, collaboration, economic efficiency, poverty reduction, enforcement of environmental regulations, and institutional changes are just some of the ways the Arab League nations are responding to challenges. Strengthening technical and financial cooperation among the Arab countries is also critically needed. The Arab region will benefit by collectively approaching these shared challenges, and empowering local communities to take ownership in the protection of life-sustaining natural resources and important ecosystems and habitats. The leaders of the Arab region must seize this opportunity by offering effective leadership for the 21st century that emphasizes coordination and collaboration within the region and prioritizes environmental stewardship and conservation.

[The Arab region] ...is a region rich in its natural resources [oil, gas, and minerals], but more importantly in history, culture, and human potential. It is a region that can – and should – play a larger role in the global economy. This is necessary if the Arab World is to offer greater opportunities to its own citizens – especially young people. But it is also necessary if international partners are to make progress on shared challenges, from assisting fragile and post-conflict states, to promoting peace, to addressing climate change.

- Robert B. Zoellick, World Bank Group President, 2009

Source: Nwardez/Flickr.com

Sand Dunes, Algerian Sahara

Source: Dennis Stauffer/Flickr.com

Chapter 1

The Arab Region

Throughout this atlas, 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.

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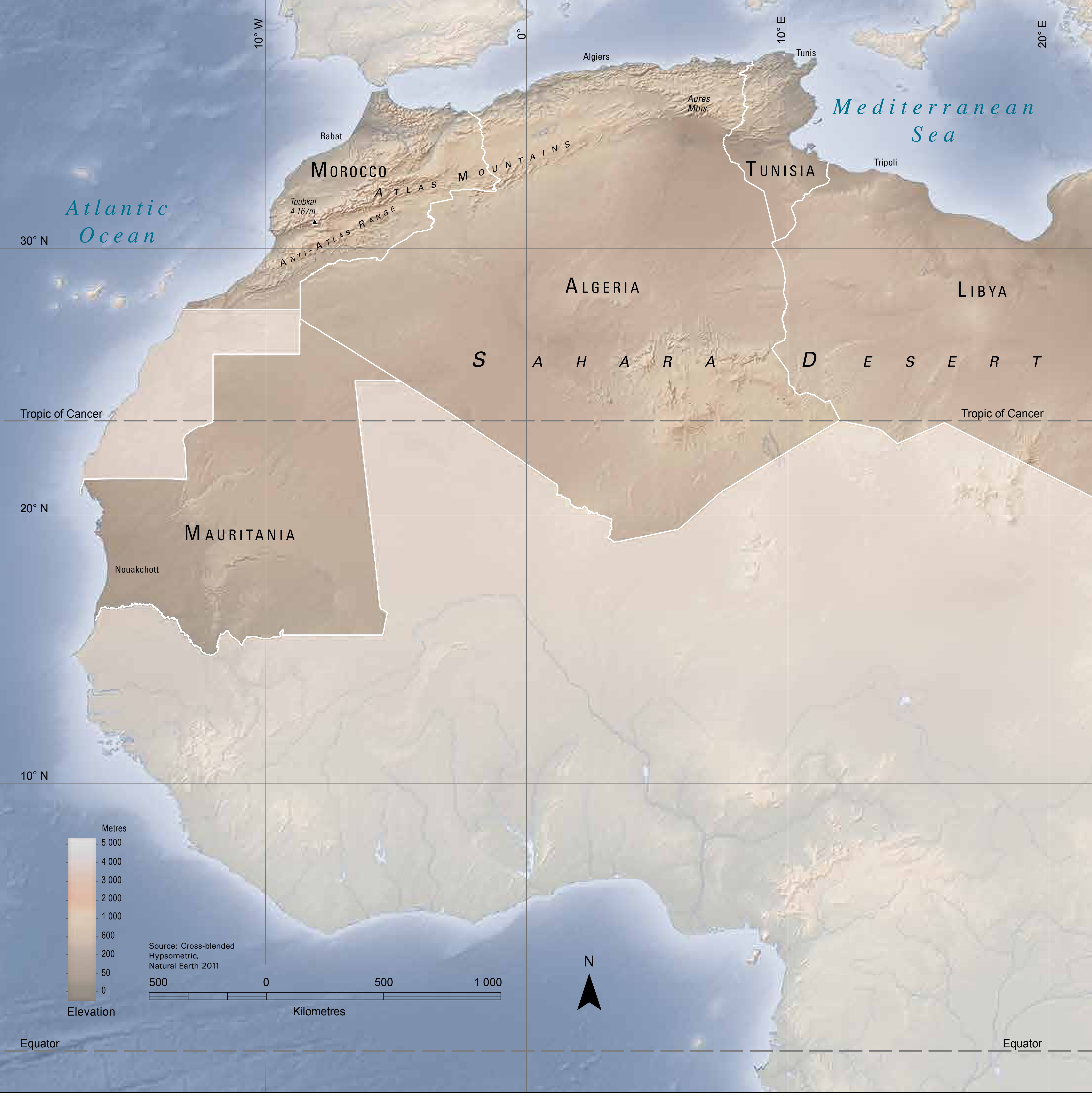
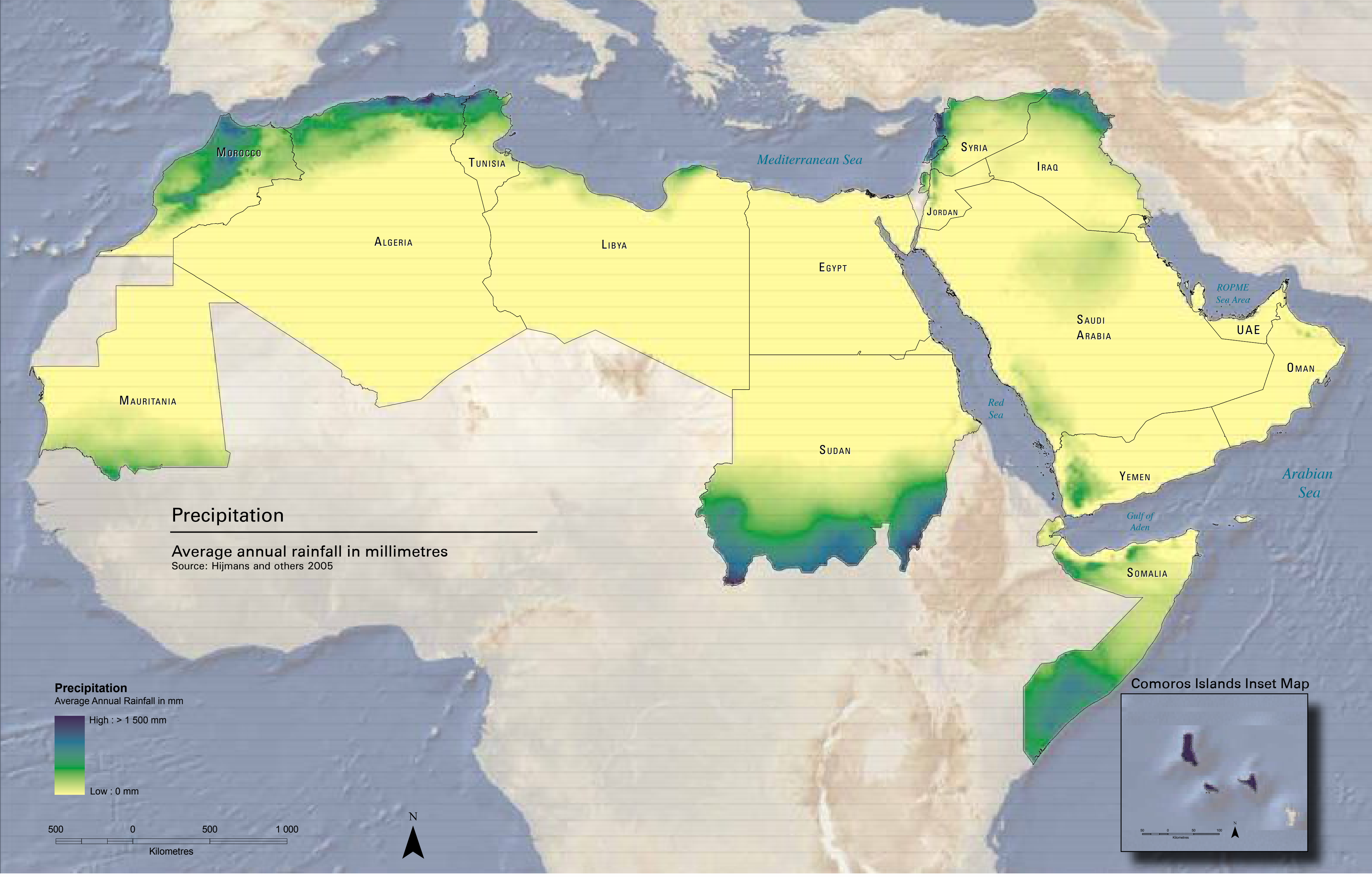


1.1 Geography

The Arab Region has undergone tremendous change in the past half century. The population now exceeds 352 million and is concentrated in urban areas (UN 2009). Pressures on natural systems in the region to provide for the burgeoning population are beyond the systems' ability to regenerate, causing unsustainable use of vital resources. Given the aridity of the climate, this is most poignant in the region's scarce water resources. As long as human activities continue at levels above the regenerative capacity of the natural environment, the result will be a decline in the quality of life. Governmental and non-governmental entities in the region are progressing with efforts to address conservation of the region's natural resources, which will become more challenging under the pressures of population growth, economic development polices, and various climate change scenarios.

The Arab region contains some abundant natural resources, and though many perceive the entire region to be rich in oil and gas resources, major hydrocarbon production is limited to the countries of Saudi Arabia, United Arab Emirates, Kuwait, Algeria, Iraq, Libya and Qatar. These oil-producing countries contain a vast proportion of the world's hydrocarbon reserves, holding almost 60 per cent of the world's proven oil reserves and nearly 30 per cent of proven natural gas reserves (Oil & Gas Journal 2008). The region also has many other resources such as iron-ore, lead, phosphate, cobalt and manganese. Though limited, fertile lands are a resource with parts of southern Sudan, also referred to as the 'food basket of the Arab world', containing some of the most fertile lands in the world. The flora, fauna and marine biodiversity are also a vital part of the region's natural resources and are integral to the fast-growing tourism industry. With a large imbalance in the amount of available resources and the amount of people in the region, the need for more strategic and sustainable development is clear. The priceless services of nature's resources such as the availability of clean water, clean air, fertile soil, and rich biodiversity must be preserved in order to maintain an adequate quality of life for current and future generations.



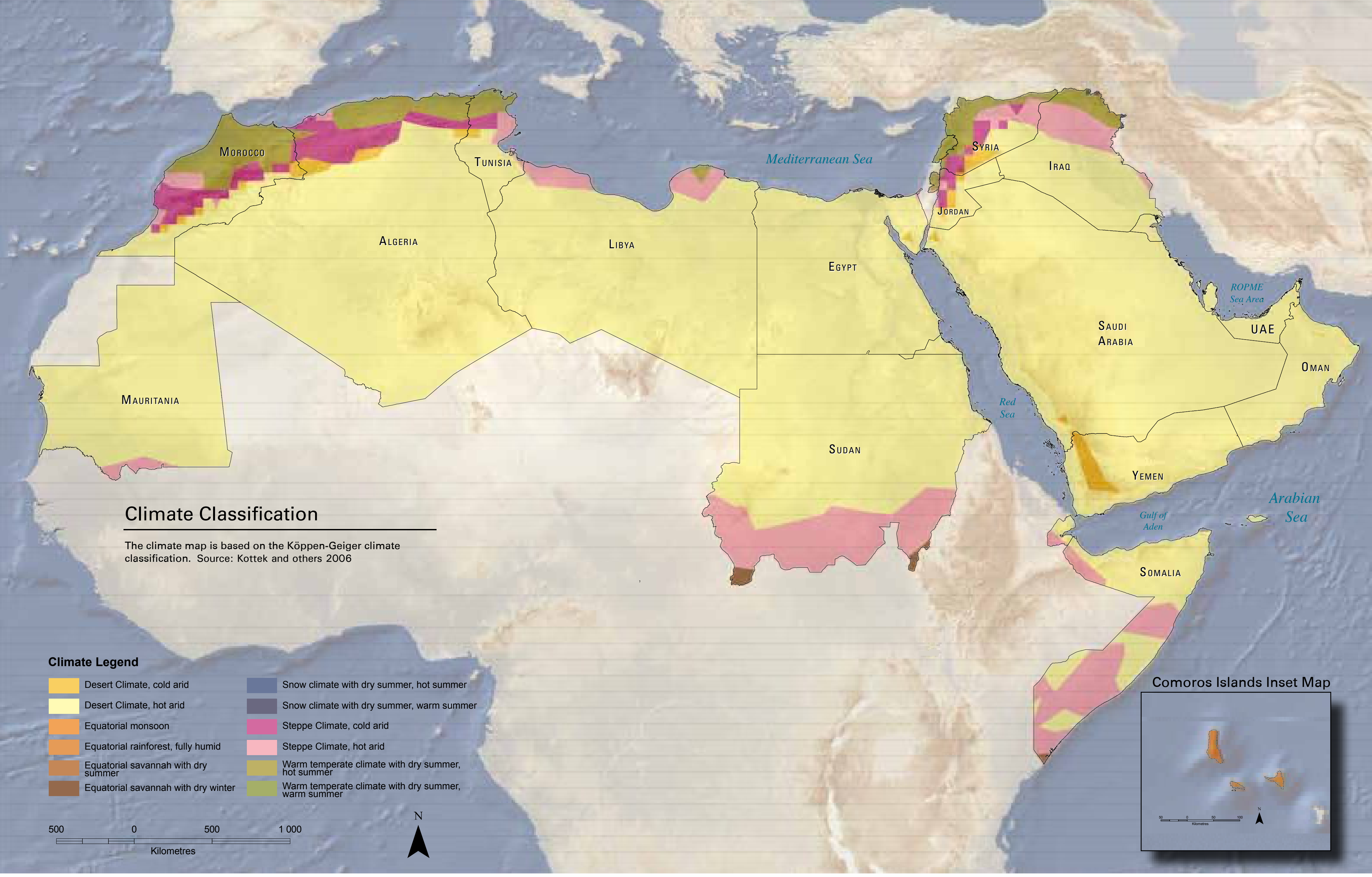
Climate

The climate of North Africa and West Asia is generally characterized as hot and arid. Desert zones dominate this region, with the Sahara Desert comprising 90 per cent of North Africa (AFED 2009). The Sahara Desert has one of the harshest climates in the world, with daytime temperatures reaching up to 57°C, and scant precipitation (below 25 mm annually) (AFED 2009). The Atlas Mountains, which occur in Morocco, northern Algeria and Tunisia, provide relief from the dry desert in terms of elevation, cooler temperatures and higher precipitation. Mediterranean climates dominate here and in northern Libya and Egypt as well as the countries in West Asia that border the eastern Mediterranean (Lebanon, Occupied Palestinian Territories and Syria). The Mediterranean climate is characterized by mostly mild to cool, wet winters with hot, dry summers. The interior of West Asia and the Arabian Peninsula is arid to hyper-arid with low annual precipitation (averages less than 150 mm) and average temperatures ranging from 40 to 50°C in summer and 5 to 15°C in winter; daily variations are extremely high (AFED 2009; FAO 2008). Some exceptions to these climatic conditions exist in the coastal areas and highlands, such as in Yemen's western mountains, which experience heavier precipitation due to the seasonal monsoon.

The precipitation map shows that the majority of the Arab region is subject to hyper-arid conditions, indicating that mean annual potential evapotranspiration exceeds mean annual precipitation. This indicates that the region is vulnerable to the impacts of climate change with even hotter and drier conditions projected in the future. For the region as a whole, average annual rainfall varies between 0 and 900 mm, while the average evaporation rate is more than 2 000 mm per year (AFED 2009; FAO 2008). This moisture deficiency affects the type of land use in the region and makes the area highly vulnerable to impacts from climate change.

The Köppen Climate Classification System, commonly used to classify the world's climates based upon annual and monthly averages of temperature and precipitation, recognizes several climate types: Equatorial, Arid (Desert and Steppe), Warm Temperate, Snow, and Polar climates. The map to the upper right shows the Desert (arid) climate type dominating the region, with limited areas of Equatorial and Warm Temperate climates.

Under this system, most of the Arab region's climate is classified as Arid, which is characterized by little rain and significant variations in daily temperatures. This desert climate covers 12 per cent of the Earth's land surface; temperatures range from 16 to 45° C and annual precipitation for all months is less than 25 mm (AFED 2009; Shaffner 2010). Winds are consistent, which allows for the evaporation of moisture in the intense heat. Winds generally flow downward so the area is seldom penetrated by air masses that produce rain, which makes for very dry heat.



The Equatorial climate type occurs to a limited extent in the Arab region, extending northward and southward from the equator to about 15 to 25° of latitude, and including southern Somalia. This climate is characterized by high year-round temperatures and heavy precipitation; all twelve months of the year have average temperatures of 18°C or higher, annual precipitation greater than 1 500 mm, and humidity that ranges between 77 and 88 per cent (Shaffner 2010). Southern Sudan falls within the Equatorial savannah minor climate type and has an extended dry season during winter; precipitation occurs between April and November; temperatures are typically above 25°C (SSCCSE 2006; UN 2011).

The Warm Temperate climates are affected by tropical air masses during summer and polar air masses in the winter. This climate type generally has warm and dry summers and mild, wet winters. Annual average temperatures range from 7 to 25°C and annual precipitation is 520 mm. In the Arab countries, this mild climate type can be found in the coastal North Africa and the eastern Mediterranean countries. The Arid Steppe climate with cold winters occurs in Morocco, Algeria and Tunisia, and the interior part of Syria, Jordan and Iraq.

Snow climate types do not apply to the Arab region except to the limited alpine environments of Lebanon, Syria, Iraq, Yemen, Morocco and Algeria. These high elevation areas, with temperature ranges from -18 to 10°C, are important to mid-latitude biomes as they provide water storage areas, supplying water during spring and early summer through snowmelt (Shaffner 2010).

Arid Desert climate

Arid climates, the dominant climate in the Arab region, are characterized by little rain, huge daily temperature ranges, low relative humidity and high evaporation; the northern Sahara desert typifies this climate and is shown here.

Warm Temperate climate

The Warm Temperate climates in the Arab region are restricted to narrow coastal belts along the Mediterranean Sea (shown here), and generally have hot, dry summers and mild, wet winters.

Snow climate

Snow climates, shown here in the Lebanon Mountains, are limited in the Arab region, but play a crucial role in replenishing underground aquifers and providing surface water.

Geomorphology

The morphological features of North Africa and West Asia have been shaped by millions of years of tectonic faulting and volcanism, erosion and deposition. Though much of the Arab region is covered by desert, diversity is expressed through contrasting topography and unique landforms. The Sahara Desert of North Africa consists of elevations that range from 30 m below sea level to peaks in the Ahaggar Mountains in southern Algeria and the Tibesti Mountains in southern Libya that exceed 3 000 m. The Sahara Desert has areas of rocky plains, rolling sand dunes and sand seas known as ergs, which are relatively flat and covered with windswept sand with little to no vegetation cover. Ergs also occur on the Arabian Peninsula. The Atlas Mountains, which peak at an elevation of 4 167 m in western Morocco, affect the regional climate by providing a barrier from the hot, dry Sahara Desert to the south. The mountains extend from southwestern Morocco along the coast of the Mediterranean to the eastern edge of Tunisia. Somalia, in the Horn of Africa, contains the Karkaar Mountains along the Gulf of Aden, which provides topographic relief to a landscape that is dominated by plateaus, plains and highlands.

The Great Rift Valley provides dramatic relief to the region, extending almost 6 400 km from East Africa north to Lebanon, where the rift forms the Beqaa Valley, which separates the Western and Eastern Lebanon Mountain ranges. The divergent plate boundary created the Ethiopian Highlands and other distinctive topographic features such as mountain ridges, rugged valleys and deep lakes. Other distinct surface features are the extensive volcanic exposures of basaltic lava (harrats) covering vast areas in southern Algeria, central and southern Libya, Djibouti, western Saudi Arabia, Yemen, and the Hauran-Hammad plateau from Syria south to Saudi Arabia.

Water bodies in the region (not including the seas and oceans), consist mostly of fringing lagoons, lakes and marshes along North Africa's Mediterranean coast (Morocco, Tunisia and Egypt). In West Asia, the Dead Sea, which lies in the Jordan Rift Valley and is fed by the Jordan River, is the most prominent salt lake in the region. Djibouti's Lake Assal, located in the Horn of Africa, is a huge crater lake 155 m below sea level—it is one of the most saline lakes in the world. Other areas of depression that extend below sea level along the coastal areas of North Africa and the Arabian Peninsula on the ROPME Sea create saline or "bitter" lakes. Similar to these depressed plains and bitter lakes are the extensive levelled *sabkhas*, or salt flats that form along the arid coasts, but can also be found inland.

The dominant river systems of the Arab region include the Nile in Africa (with its enormous Delta), the Tigris, Euphrates, and Jordan rivers in West Asia - these vital sources of freshwater are discussed in detail in Chapter 2.

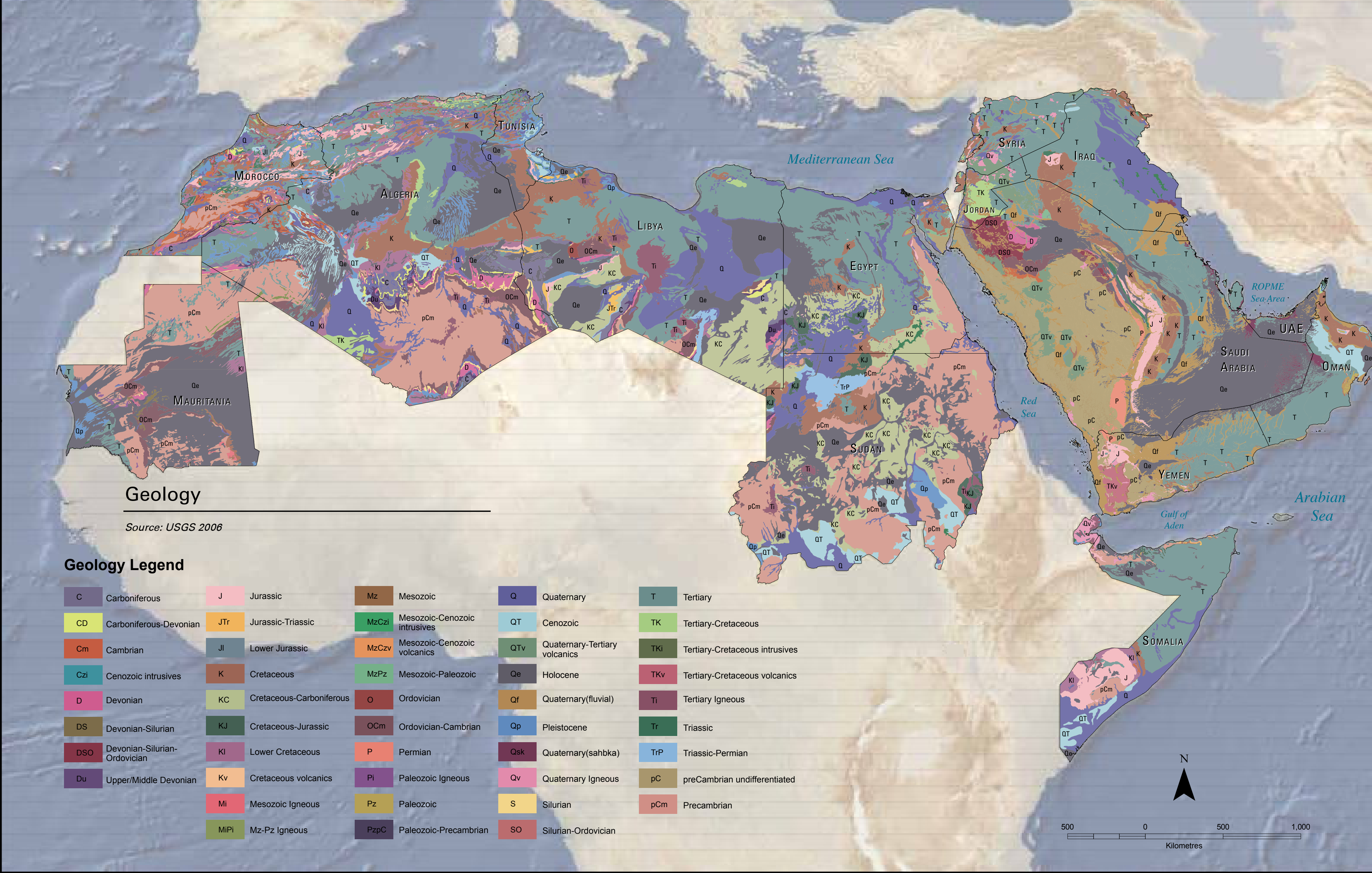
Desert landscapes cover much of West Asia. The Arabian Desert consists of the Rub Al Khali or Empty Quarter, the largest sand desert in the world, which covers most of southern Saudi Arabia; the An Nafud Desert of western Saudi Arabia, with sand dunes that reach over 30 m high; and the Al Dhana Desert, in the east. The Syrian Desert covers portions of Syria, Iraq, Jordan and Saudi Arabia; its varied landscape, which includes numerous oases, was shaped by ancient lava flows.

The Sinai Peninsula, the portion of Egypt that lies in West Asia between the Mediterranean Sea to the north and the Red Sea to the south, is largely desert with mountainous topography. The Asir and Hejaz Mountains extend along Saudi Arabia's Red Sea coastline, reaching heights of 2 130 m. Other mountains on the Arabian Peninsula include the Hadramawt in Yemen and the Al Hajar in northeastern Oman and eastern UAE, which impact the monsoonal wind and rain patterns of the Indian Ocean within the Arabian Peninsula. The steep, snow-capped peaks of the Western Lebanon Mountains, which extend for more than 800 km from the Occupied Palestinian Territories north to Syria, reach 3 088 m in Lebanon, and provide a striking contrast in winter to the low-lying coastal plains and valleys. The Eastern Lebanon Mountains run parallel to these mountains and are separated by the great Bekaa Valley, Lebanon's largest agricultural area.

The Arab region consists of mostly levelled land, which encompasses the enormous stretches of desert across both continents, and the highlands concentrated generally along the margins of the great land masses. The region does include the Taurus and the Zagros mountains, which are huge mountain chains that mark the northern and northeastern boundary of the Arabian Peninsula. They extend for thousands of kilometres and provide a barrier to the movement of cold air masses from the north. The strategic marine areas that provide access to the region include the 13 km-wide Strait of Gibraltar, which separates Morocco from Spain and controls access to the Mediterranean Sea; the 32 km-wide Mandab Strait separating Djibouti from Yemen and controlling access to the Red Sea from the Indian Ocean; the Suez Canal, a 192 km-long man-made throughway that provides access to the Mediterranean from the Red Sea; and the Strait of Hormuz, a 54 km-wide waterway between Oman and Iran, which provides access to the ROPME Sea Area, the site of the heaviest oil tanker traffic in the world.


Harrat Khaybar, Saudi Arabia

Source: Michael Fenton/USGS (courtesy of Earth Science World)



Harrat Khaybar, Saudi Arabia. The western half of the Arabian Peninsula contains large expanses of sand and gravel and extensive lava fields known as harrats. One such field is the 14 000 km^2 Harrat Khaybar, located approximately 137 km to the northeast of the city of Medina. According to scientists, the volcanic field was formed by eruptions along a 100 km-long north-south linear vent system over the past 5 million years; the most recent recorded eruption took place between 600 to 700 A.D. Harrat Khaybar contains a wide range of volcanic rock types and spectacular landforms, several of which are represented in this image (above). The presence of tuff cones, together with other volcanic features indicative of water in the Harrat Khaybar, suggest that the local climate was much wetter during some periods of volcanic activity. Today, however, the regional climate is hyper-arid with little to no precipitation, leading to an almost total lack of vegetation. This NASA image (above) was photographed by an Expedition 16 crewmember on the International Space Station.

Geology

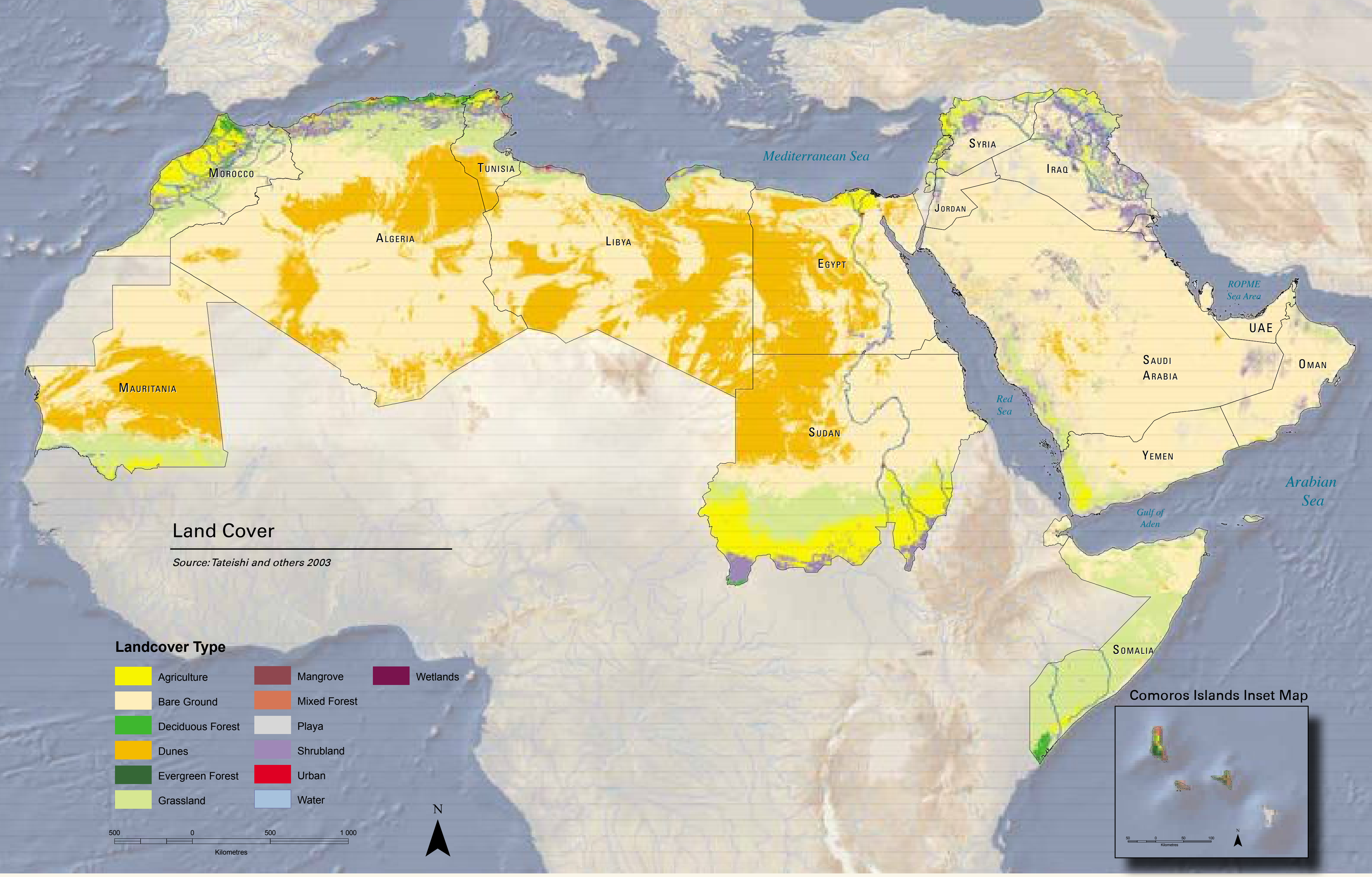
Powerful and gradual geologic processes have shaped the Arab region over hundreds of millions of years and continue to influence the region today. Dynamic tectonic forces associated with fault zones, rifts and ridges are at work in the geologically similar regions of West Asia and North Africa. The countries of the Arabian Peninsula and Iraq lie on the Arabian Plate, which is bordered to the south by the African Plate, to the east by the Indian Plate, and to the west by the Dead Sea Transform Fault (see the next page for a map of regional landforms) (Coffin and others 1998). A divergent boundary known as the Red Sea Rift runs the length of the Red Sea. The Arabian, African and Indian plates are moving northward, colliding with the massive Eurasian Plate and causing uplift of the Taurus and Zagros Mountains in the north and northeast. The Great Rift Valley, the most prominent geological feature in Africa, is also a result of large-scale earth movements, and is responsible for creating several of the largest lakes in East Africa. The junction of the African and Arabian plates where the African continent separates from the Sinai Peninsula is considered the most prolific oil province rift basin in Africa and West Asia, with excellent hydrocarbon potential. The Arabian Plate contains almost 60 and 30 per cent of the world's recoverable oil and gas reserves, most of which are located along the Arabian shelf margin stretching from Iraq to Oman (Beydoun 1998). The surface geology of the region is dominated by 600 million year-old Precambrian rocks that consist of sedimentary, metamorphic and igneous types, and thick deposits of Phanerozoic rock that overlie uncomfortably throughout the region (Kusky 2010). Of the mineral resources present in the region, only oil has been developed on a large scale.


Strait of Gilbraltar
Morocco
Algeria
Tunisia
Mediterranean Sea
Libya
Egypt
Sudan
African Plate
Bathymetry
-6,530 m
-65 m
Eurasian Plate
Caspian Sea
Black Sea
Main Zagros Fault
Mediterranean Sea
Arabian Plate
Red Sea Rift
Gulf of Aden
Arabian Sea
African Plate
Indian Ocean
Atlantic Ocean
Mid-Atlantic Ridge

Tectonic Plate Boundaries and Fault Lines

The major tectonic plates (African, Arabian and Indian) are moving northward and colliding with the Eurasian Plate, causing uplift and seismic activity. Some of the historically active volcanoes concentrate on the Red Sea, the East African Rift, and the Afar Triangle - a triple junction where three plates are pulling away from one another: the Arabian Plate, and the two parts of the African Plate, splitting along the East African Rift Zone.

Source: Coffin and others 1998



Land Use and Land Cover

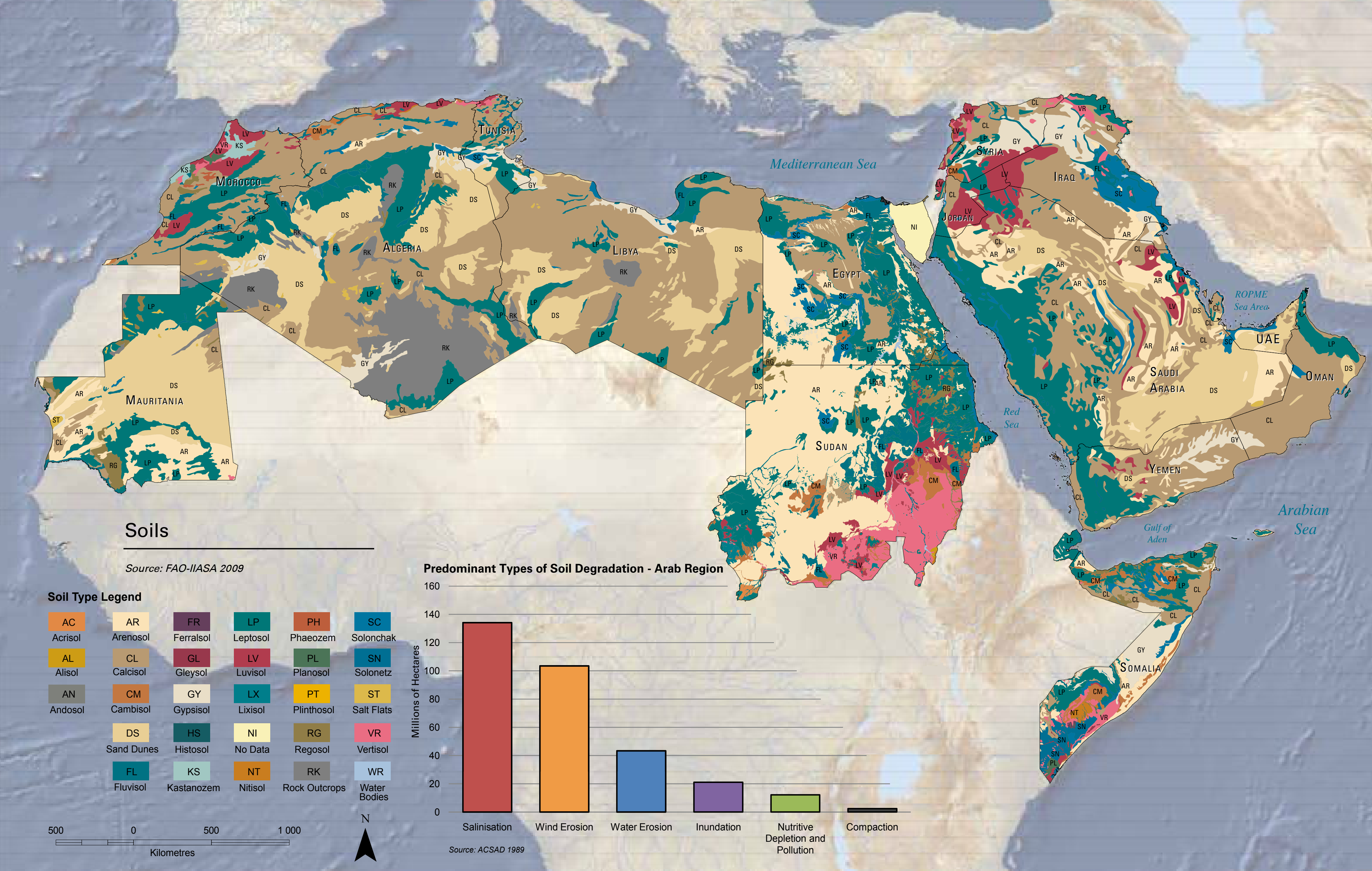
Land resources are crucial to development and human well-being. Changes in land resources are driven by environmental, technological and socio-economic factors. The major trends affecting land resources in the Arab region over the past 30 years include: an increase in agricultural lands; a decrease in 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).

Land Cover

The Arab region faces enormous challenges in safeguarding its natural resources and converting these challenges into opportunities for development. Of the total land area of 14.1 million km^2, 89.3 per cent are arid or hyper-arid lands and 14.5 per cent are agricultural lands, of which only 4.2 per cent are cultivated (AOAD 2009). A huge portion of the region is desertified and highly vulnerable to desertification. For example, the GCC countries are 89.6 per cent desertified and the remaining lands are vulnerable to desertification. The countries in the Mashreq sub-region are the least desertified (35.6 per cent), but a large proportion of the total land area in that region is vulnerable to desertification (48.6 per cent) (ACSAD 2004). Though dryland deserts dominate the region, a variety of ecosystems are found in the Arab region that provide essential habitat and ecosystem services—these include Mediterranean forests, plains, rangelands, savannahs, oases, mountains, rivers, mudflats, springs, marshes, and swamps. Rangelands in the region are a significant land type and cover more than 33 per cent of total area of Arab countries and constitute 13.5 per cent of global rangelands (FAO 2011).

Forests

The climate in the region limits the amount of forest cover—only 6.7 per cent of the total land area in the Arab region is forest. Sudan has by far the greatest amount of forest cover (61 627 000 ha), followed by Somalia (7 515 000 ha), Morocco and Algeria; however deforestation (to clear lands for human settlement and agricultural activities, and for charcoal production) has drastically reduced forest cover, exacerbating desertification in these areas (UNEP 2006). In North Africa, forests occupy about 8.6 per cent of the total land area and occur primarily on the coast of the western Mediterranean countries (UNEP 2007), in the Atlas Mountains, and in southern Sudan and Somalia; other wooded areas occur as natural desert vegetation in wadis (dry riverbeds) and depressions. From 1972 to 1992, the area of natural forest in North Africa was reduced by 53.3 per cent. Widespread tree planting programs implemented in the 1990s have attempted to offset the huge losses in forest cover; between 1990 and 2000, 1 693 000 ha of trees were planted. In West Asia, forests and woodlands occupy only 1.34 per cent of the total land area (UNEP 2007). Much of these woodlands are confined to areas along the coast of the Arabian Peninsula (mangrove forests, *Juniperus* spp. and *Acacia* spp. stands), and across the mountains and hills of northern Iraq, Jordan, Lebanon, the Occupied Palestinian Territories, and Syria.



Protected Areas

The establishment of land and marine protected areas in the region has been recognized as vital to preserving key sites of biological productivity that constitute the majority of the region's flora and fauna. The protected area network includes, but is not limited to, a variety of refuges, national parks, biosphere reserves, bird sanctuaries, and marine reserves. In West Asia, 242 protected areas have been designated—Saudi Arabia leads the other West Asian countries in the number of designated areas (128), followed by Jordan (22) and Kuwait (19). In 2006, the amount of protected areas in West Asia amounted to 87 863 902 ha, or less than 10 per cent of the total land area (UNEP 2007). West Asia lags behind the world average in proportion of protected areas but is expanding efforts to increase the amount of lands under protection to reach 10 to 15 per cent of overall land cover by 2020 (UNEP 2010). The number of designated protected areas amounts to 287 in North Africa. To ensure biodiversity conservation, continued commitment and effective management of the protected areas system must be ensured. A map in Chapter 2 illustrates the protected areas of the Arab region.

The Arab region includes unique types of pasture, agriculture, desert and forest landscapes

Soils

Flood irrigated fields in the Nile Delta often lead to soil and land degradation in Egypt

Soil development in the Arab countries is generally poor due to the arid climate. Common characteristics of soils in the region include: thin soil profiles, reduced organic matter, reduced clay materials (except in river floodplain areas and deltas), low nutrient content, high sandy and stony contents, moderate to high salinity, alkalinity and carbonates. The soils map shows most of the region covered by desert-type soils typical of arid environments as well as thin ribbons of well-developed soils along coastal areas (especially along the Mediterranean) and river systems.

Land degradation brought about by human and natural causes (chemical, wind and water erosion) affects millions of hectares worldwide. Desertification is the most prominent form of land degradation in North Africa and West Asia. Soils are the most important indicator of land health and productivity; degradation of soils in the Arab countries has serious environmental, economic and social consequences that can negatively impact stability in the region. The type of soil degradation and the number of hectares impacted in the Arab region are displayed in the graph (above).

Hydrocarbon Resources (Oil and Gas)

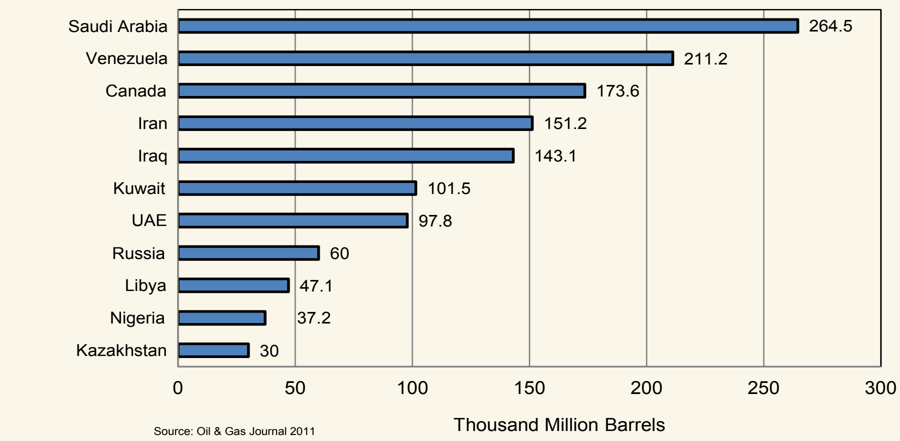
The geology of the region lends itself to significant and accessible oil and gas reserves. Continual sinking of the Arabian Plate has allowed the accumulation of deep layers of sediments where oil and gas resources form and are trapped. Improved technologies have facilitated the oil exploration and extraction processes and provided more cost-effective methods for exploiting these vital resources (the environmental aspects involved in this industry are discussed in Chapters 2 and 3). Oil and gas production have been the mainstay of many Arab countries' economies since production began in the 1960s. Over half of the Organization of the Petroleum Exporting Countries (OPEC) members, established in 1960 to coordinate petroleum policies among member countries, hail from the Arab region (Saudi Arabia, Iraq, Kuwait, Qatar, Libya, UAE, and Algeria). Of the 11 countries that contain the largest proven oil reserves in the world, 5 are Arab nations, led by Saudi Arabia, whose proven oil reserves far surpass the other countries (266.7 thousand million barrels). Saudi Arabia is also the world's top producer of crude oil, with 10.8 million barrels produced per day (Oil & Gas Journal 2008). Gas hydrocarbon reserves, however, are not as plentiful in the region, but remain significant—Qatar contains the third largest reserve of natural gas in the world.

Some Arab countries face challenges in developing their hydrocarbon resources, due to ongoing conflict or aging of the oil fields. In Iraq, natural gas production has risen since 2003, but oil production remains below its pre-war capacity. The Sudan conflict in the central and south-central regions of the country (which ended in 2011 with the formation of an independent South Sudan), has also interfered with oil development and exploration - heavy infrastructure damage has also limited development. In Kuwait, some of the major producing oil fields are over 60 years old, and productivity, especially in the Greater Burgan area (one of the fields set on fire during the Iraq invasion of Kuwait), has been greatly diminished. The need to develop other reserves is critical to maintaining oil production capacity in that country.

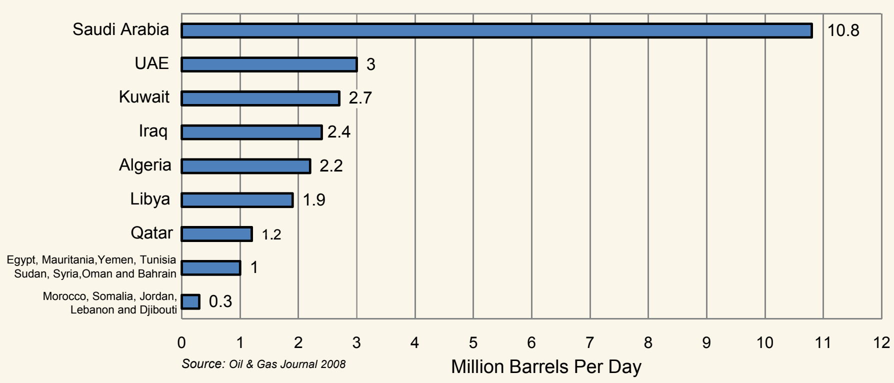
The recent global financial crisis adversely affected the energy sector, decreasing demand for oil. The slow economic growth spurred by this crisis underlined the need for more diversification of the region's economy, and many Arab countries have invested in developing tourism, ports and services facilities and human capital. In addition, oil-producing Arab countries, which used to export only crude oil, have improved refining and distillation processes and are producing liquid petroleum gas, gasoline, jet fuels, kerosene, liquefied natural gas, urea, propane, and butane, adding value to the GNP of those countries. Global energy demands will continue to increase, and though they will be met increasingly with renewable energy such as solar and hydropower, fossil fuels will continue to meet a large proportion of the global energy demand for the near future.

Oil and natural gas are found onshore and underwater in offshore fields. Offshore installations are widespread in the region, especially in the ROPME Sea Area, and carry many pollution risks.

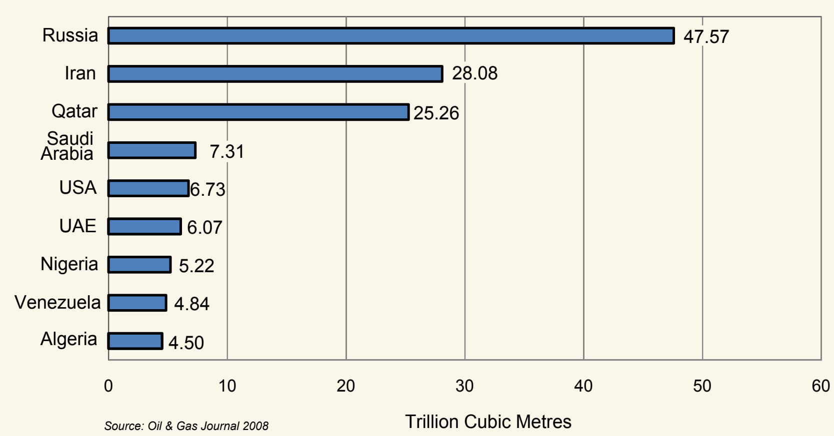
Top Proven World Oil Reserves



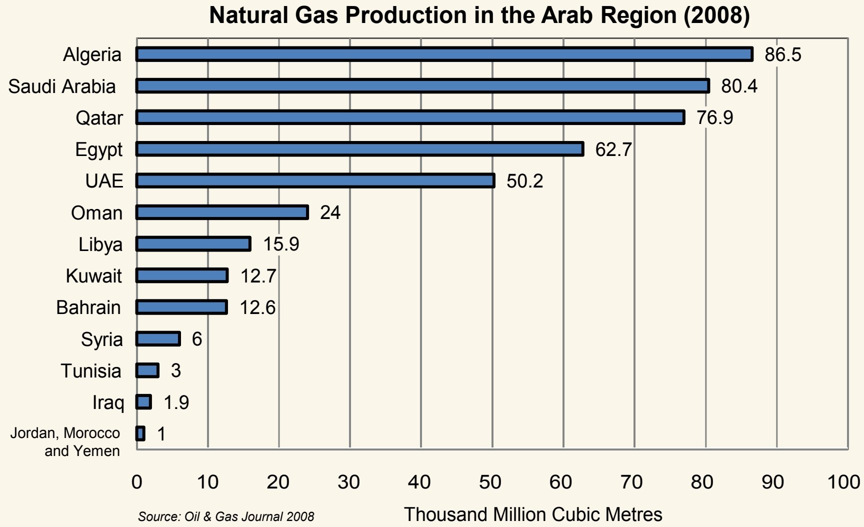
Oil Production in the Arab Region (2008)



Top Proven World Natural Gas Reserves



Natural Gas Production in the Arab Region (2008)



Oil and Gas Producers in the Arab Region

Saudi Arabia is the largest oil producer of the Organization of the Petroleum Exporting Countries (OPEC). With approximately one-fifth of the world's proven oil reserves and some of the lowest production costs, Saudi Arabia is expected to remain the world's largest net oil exporter in the near and long-term. Saudi Arabia also maintains the world's largest oil production capacity. For more than a decade, Saudi Aramco, the world's ninth largest natural gas producer, has aggressively explored for additional reserves to meet growing demand, although success has been limited.

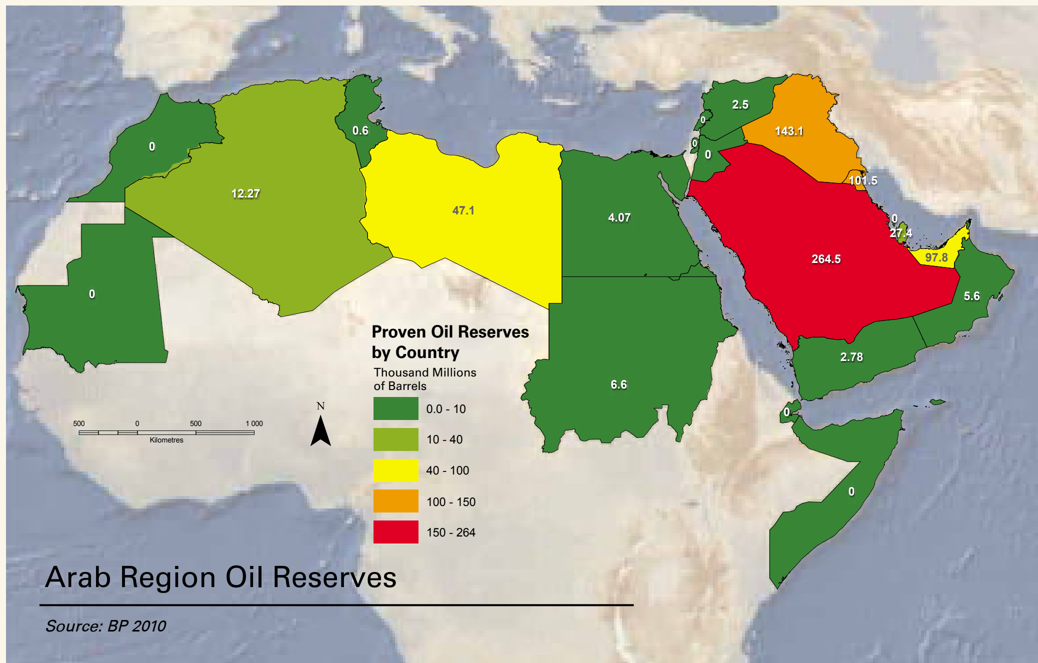
The UAE holds the seventh largest proven oil reserves and the sixth largest proven natural gas reserves in the world. The UAE has ambitious plans to further increase its oil production capacity over the next several years. It is a major producer of natural gas but rising domestic consumption caused the UAE to go from being a net gas exporter to a net gas importer in 2007. The Abu Dhabi Emirate contains the Khuff Reservoir, one of the single largest gas reservoirs in the world that lies beneath the offshore oil fields of Umm Shaif and Abu al-Bukhoosh.

Algeria's hydrocarbon sector accounts for 97 per cent of export revenues. Algeria is a net oil exporting country and is a significant producer of natural gas and liquefied natural gas (natural gas that has been converted temporarily to liquid form, mostly for ease of storage or transport).

Egypt is a significant oil producer and a rapidly growing natural gas producer. The country's first liquefied natural gas export terminal began operating in 2005. The Suez Canal and Suez-Mediterranean Pipeline (SUMED) are strategic routes for oil shipments in the ROPME Sea Area, making Egypt an important transit corridor. Egypt's crude oil production has continued to decline from its 1996 peak of 922 000 barrels per day. Due to major recent discoveries, natural gas is likely to be the primary growth engine of Egypt's energy sector for the foreseeable future.

Libya's economy relies heavily on oil exports. Libya has the largest proven oil reserves in Africa but the country remains largely underexplored. Libyan natural gas production and exports have increased considerably since the opening in 2004 of the Greenstream pipeline, a 540 km-long natural gas submarine pipeline from Libya to Italy.

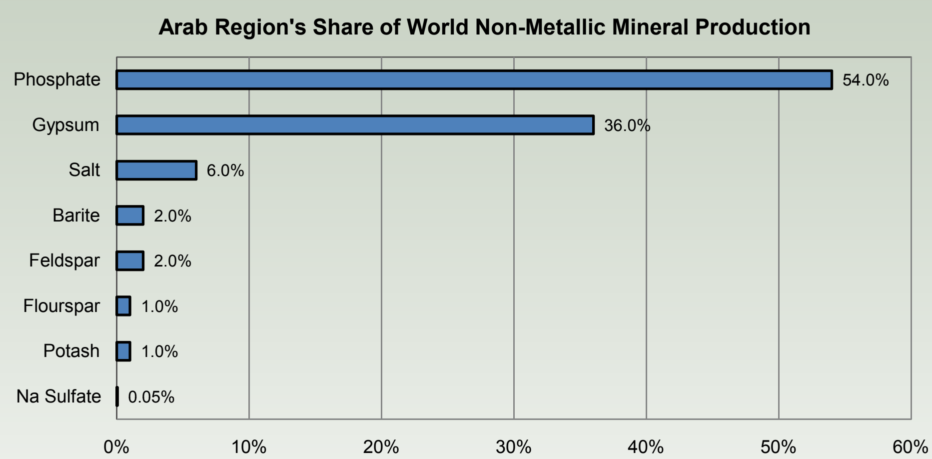
Qatar contains the largest natural gas field in the world (South Pars/ Asalouyeh), which it shares with Iran. It holds the world's third largest natural gas reserves and is the largest supplier of liquefied natural gas. Qatar is currently diversifying its energy sector and encouraging foreign investment to expand its electricity generating capacity. With 27.4 thousand million barrels of proven oil reserves, Qatar is a significant oil producer.



Mineral Resources

Though most of the Arab countries are diversifying their mineral industries, much of the mineral resources of the Arab region remain underexploited. Out of the major 81 mineral commodities being exchanged today in the world market, only 21 are contributed by Arab countries. The lag in mineral development is attributed mainly to financial limitations, political instability, and the focus on hydrocarbons.

The Arab region's metallic mineral resources include gold, silver, aluminium, iron ore, copper, steel, cobalt, and zinc, while non-metallic minerals include phosphate, bromine, feldspar, gypsum, salt, silica sand, potash and limestone (USGS 2010). Mineral fuels, which comprise a major part of the minerals industry, include natural gas, petroleum and coal—helium, ammonia and sulphur, which result from the processing of hydrocarbon fuels, are also significant mineral commodities in the Arab region. While many of the GCC countries are known for their hydrocarbon resources, the North African and Mashreq countries have rich and varied mineral deposits; Algeria, Morocco, Tunisia, Jordan and Syria account for about one-third of the world's phosphate production—Morocco alone is one of the world's top producers of phosphate, and has more than 30 per cent of the world's phosphate reserves. Mauritania ranked seventh in the world in iron ore exports in 2008 and Jordan was the world's fifth leading producer of phosphate rock and the world's sixth leading producer of potash in 2003 (USGS 2010). Governments are promoting growth of their non-fuels mineral sector and expanding their gold, granite, marble and phosphate rock industries.



Source: USGS 2007

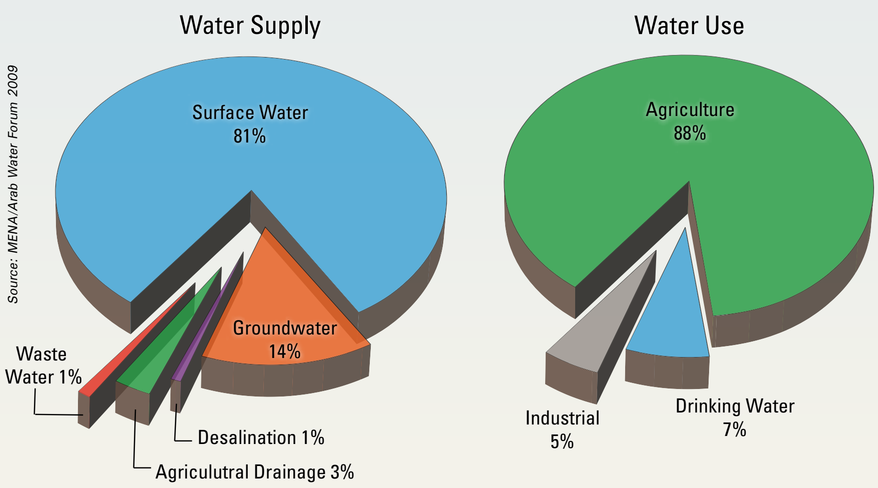
Water Resources

The Dublin Statement on Water and Sustainable Development was adopted in Dublin, Ireland in 1992, providing new perspectives on water and water management. The international participants, in recognizing the critical state of global water resources, adopted four guiding principles to address the need to reverse trends of water overconsumption, pollution and rising threats from drought and floods. Two decades later, these guiding principles carry an urgent relevance to the Arab region, which suffers a severe lack of water security. The Arab region is one of the most water-scarce regions in the world. The extremely arid climate coupled with effects of climate change, lack of water use efficiency, high per capita water consumption and inadequate water policy and planning escalate the water crisis.

Water Availability

Water availability is determined by demand, which is influenced by population growth and urbanization, and supply, which is affected by climatic conditions, drainage systems and hydrogeological features. The availability of water is limited and the Arab region faces severe water shortages. The region contains a scant 1.1 per cent of the global renewable freshwater resources, and is home to about 5 per cent of the world's population (UN 2003). Of the total 244 thousand million m^3 of freshwater resources in the region, surface waters comprise 204 thousand million m^3, while groundwater comprises 40 thousand million m^3 (AFED 2009). With the total water demand in the region nearly equaling the total volume available, it is easy to envision the water shortages the region will face in coming years. The amount of per capita water resources in the Arab region is very low, with Kuwait, the Occupied Palestinian Territories, UAE, Qatar, Libya, Saudi Arabia and Jordan among the nations with the lowest available freshwater per capita in the world. The water scarcity map shows most of the region to be "physically water-scarce", indicating that water resources development has exceeded sustainable limits.

By 2025, most countries in the region will be classified as having absolute water scarcity. This scarcity is complicated by the fact that over 60 per cent of the surface waters originate outside the region, mainly in Turkey and the Ethiopian Plateau. Some countries such as Egypt, Mauritania, Iraq and Syria are almost entirely dependent upon water sources originating outside their borders. In the case of Mauritania, the waters of the Senegal River, which originate in the Futa Jallon mountain region of Guinea, provide that country with most of their freshwater resources; the river valley also contains the only arable land in the country (FAO 1997). Transboundary water issues are discussed in greater detail in Chapter 2 and addressed in specific country profiles in Chapter 3.

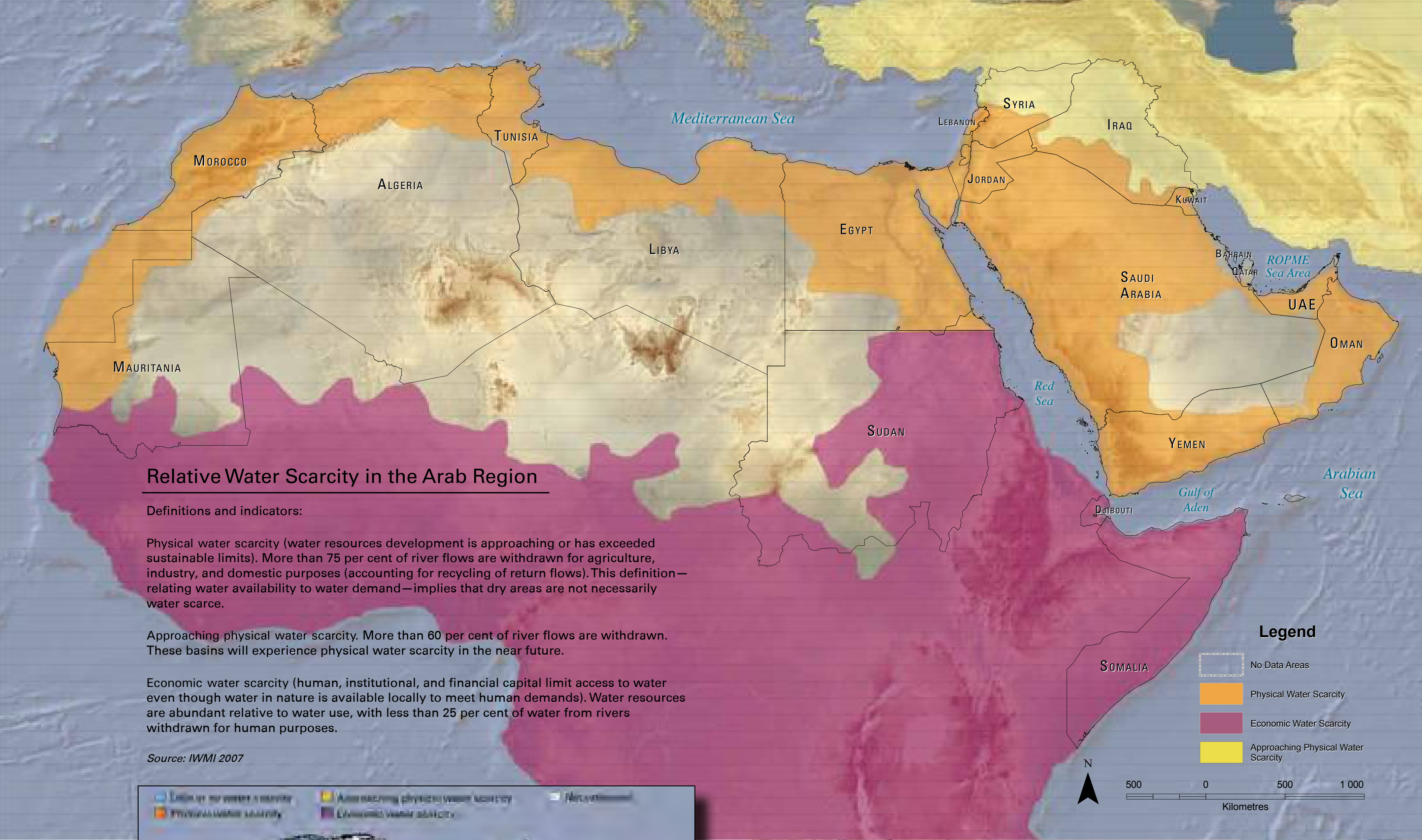


Arab Region Natural Surface and Groundwater Resources. Surface Water: 204 thousand million cubic metres. Groundwater: 40 thousand million cubic metres.

> Water is such a critical and essential resource for human life that it could ultimately define the limits of sustainable development at both national and global levels (UN 2003)

Water supplies are also provided by groundwater, which originate in aquifers that experience little recharge. Groundwater supplies about 14 per cent of the water needs in the region, most (88 per cent) of which is used for agricultural purposes. Despite being significantly less than surface water in terms of volume, groundwater remains an important source of water, and for some countries, such as Bahrain, Kuwait, the Occupied Palestinian Territories and Qatar, it is the only conventional source of freshwater. Aquifer systems in the region are being depleted at a rapid rate; in West Asia alone, with the exception of Iraq, Lebanon and Syria, abstraction of aquifers exceeds recharge (ESCWA 2007a).

Desalination and wastewater recycling also provide supplementary supplies of water, especially in the oil-rich GCC countries where supplies are lowest. Saudi Arabia, UAE and Kuwait are some of the top producers of desalinated water in the world (see Chapter 2). The countries along the Mediterranean have also been expanding their desalination capacity to meet increasing water demands. Approximately 60 per cent of the desalinated water in the world is produced in the region; production is expected to increase from 21 million m^3 of water per day in 2007 to nearly 110 million m^3 per day by 2030 (IEA 2005). This increased production will be facilitated by the use of effective technologies that include reverse osmosis (filtering system to remove salts from seawater) and thermal desalination techniques (heats seawater into steam and condenses it into freshwater). Desalination plants will increasingly be relied upon to meet the region's freshwater needs; however, the adverse environmental impacts associated with this non-conventional water source must also be addressed. Water re-use technologies are gaining momentum in the Arab region, but the region lags behind the world in terms of the volumes of wastewater collected and treated. About 43 per cent of the wastewater generated in the Arab region is treated (Qadir and others 2009). Overall, the region lacks adequate collection and wastewater treatment systems, though disparities exist among countries and within countries (rural versus urban areas). Capital expenditures on advanced water re-use are expected to increase significantly worldwide—countries in the Arab region need to expand their wastewater treatment infrastructure and increase their re-use capacity to accommodate economic growth and address water shortages. Though most of the recycled wastewater is currently being used in irrigation of fodder and food crops, uses are being expanded to all sectors (including recharging of aquifers) to meet growing demands in the region.



Relative Water Scarcity in the Arab Region

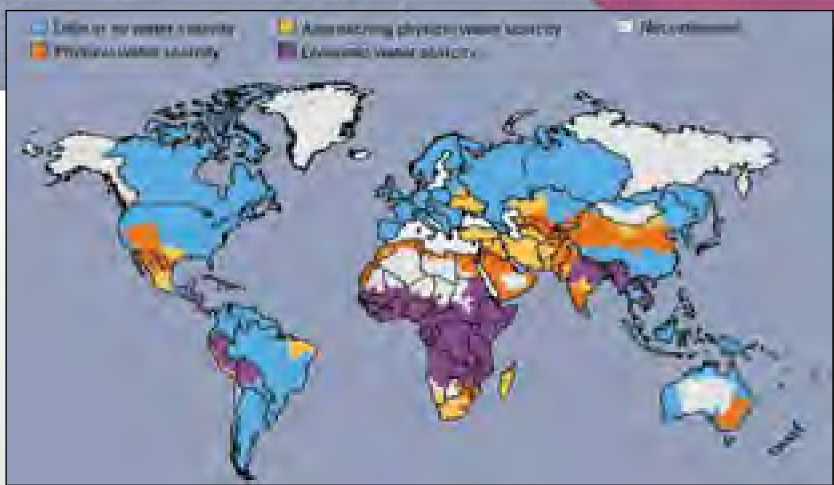
Definitions and indicators:

Physical water scarcity (water resources development is approaching or has exceeded sustainable limits). More than 75 per cent of river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.

Approaching physical water scarcity. More than 60 per cent of river flows are withdrawn. These basins will experience physical water scarcity in the near future.

Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25 per cent of water from rivers withdrawn for human purposes.

Source: IWMI 2007



Source: IWMI 2007

Water Quality

Water quality is a key factor in determining water serviceability. In most of the Arab region, water quality is poor and increases the water stress in the region. Surface and groundwaters are compromised by increased levels of agricultural pollutants, domestic and industrial wastes, untreated effluents, and seawater intrusion (in coastal aquifers as a result of overpumping). High levels of nitrates, ammonia, faecal coliform, and total dissolved solids have been detected in aquifers throughout the region (ESCWA 2002). Major irrigation schemes and industrial and domestic wastewater facilities along the four major river systems in the region (Nile, Tigris, Euphrates, and Jordan rivers) are sources of pollution in those waterways. Higher water temperatures associated with persistent drought and lower flow volumes in the rivers also adversely impacts water quality. The impacts of climate change on water quality are a growing concern, especially as they relate to groundwater contamination by seawater intrusion of coastal aquifers, which could affect potable water supplies for millions of people in the region. Chapter 2 contains a more detailed water quality discussion specific to the Tigris River, Euphrates River, Asi-Orontes River Basin, and the Nile as well as for the Nubian Sandstone and North Sahara aquifer systems.

Source: Water for Sudan/Flickr.com

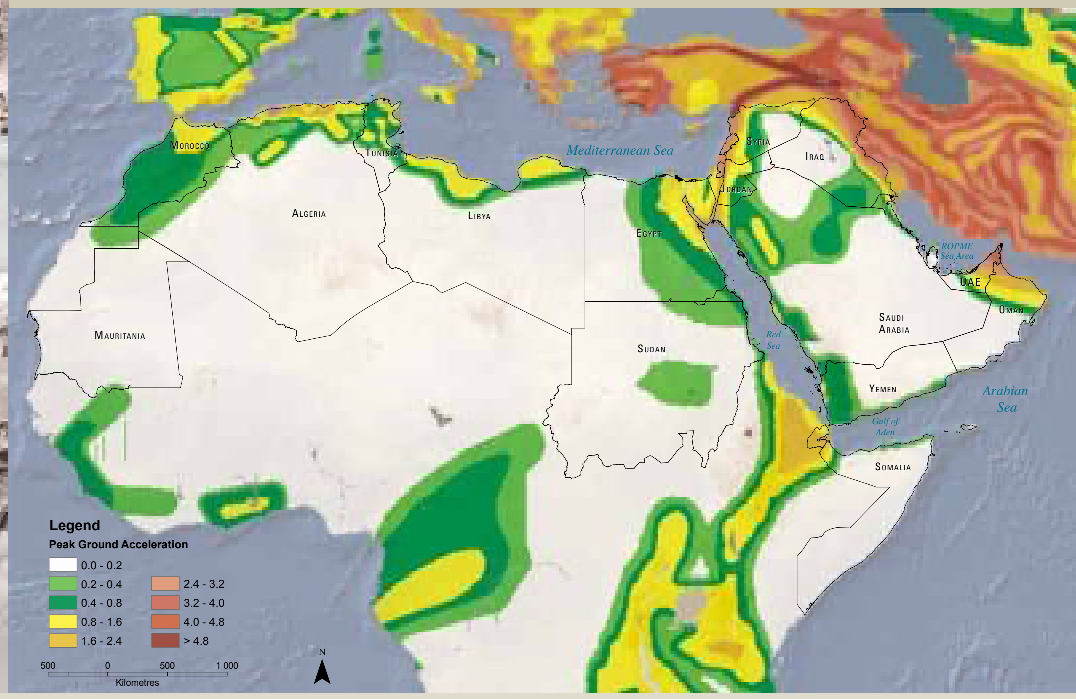
Drinking water pump in southern Sudan. If groundwater is available, wells often provide people in the Arab region with uncontaminated drinking water.

Source: Sara.Scara/Flickr.com

Fault at Ras Mohammed on the Sinai Peninsula, Egypt (photo left). The Ras Mohammed peninsula marks the nexus of the shallow Gulf of Suez and the deep intercontinental chasm of the Gulf of Aqaba, itself a small portion of the Great Rift Valley that stretches deep into Africa. In the past, seismic activity and tremendous eruptive phenomena defined the Sinai and left faults like these. The region was formed as a result of tectonic plate movement: the African, Arabian and Mediterranean shields pulling away from each other, creating a great rift in the land.

Seismic Hazard Zones

In the map below the cooler colours represent lower seismic hazard while the warmer colours represent higher hazard. Specifically, white and green correspond to low hazard (0 - 8% g, where g equals the acceleration of gravity; 9.80665 m/s^2); yellow and orange correspond to moderate hazard (8 - 24% g); pink and red correspond to high hazard (24 - 40% g); and dark red and brown correspond to very high hazard (> 40% g). In general, the highest seismic hazard values in the world occur in areas that have been, or are likely to be, the sites of the largest plate boundary earthquakes (Giardini and others 2000).



Natural Hazards

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). Desertification, earthquakes, flooding, extreme temperatures, wildfires, cyclones, sandstorms and dust storms are also prevalent in the region. Earthquakes in Algeria, Lebanon and the geologically active Great Rift Valley, along with cyclones in the Arabian Sea and the Indian Ocean, landslides in Egypt and Morocco, volcanism in Yemen and Comoros, and sandstorms that originate from the Sahara Desert, are natural events that negatively impact people's lives and livelihoods.

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).

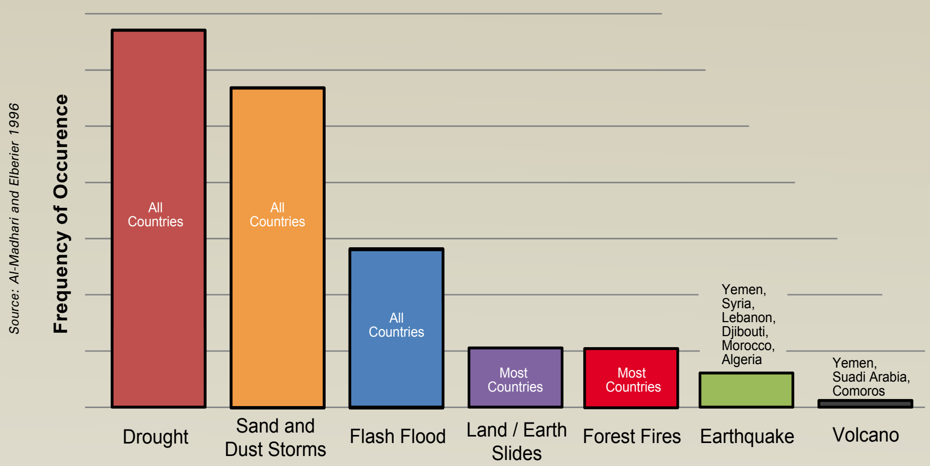
The graph (opposite page) shows the comparative extent of the hazards that affect the Arab countries. Drought is the most extensive and prevalent, impacting communities across North Africa and West Asia and causing the greatest loss of life (Al-Madhari and Elberier 1996). In addition to loss of life, drought can dry up water supplies, cause crops to fail and livestock to perish, and cause widespread malnutrition—almost all of the Arab countries are vulnerable to drought. In addition to drought, earthquakes and floods inflict terrible damage in human and economic terms. The Seismic Intensity Zones map (above) shows the earthquake prevalence and peak ground acceleration. Algeria is the most vulnerable to disastrous earthquakes; other "hot zones" include Djibouti, the Occupied Palestinian Territories, Lebanon and Syria.

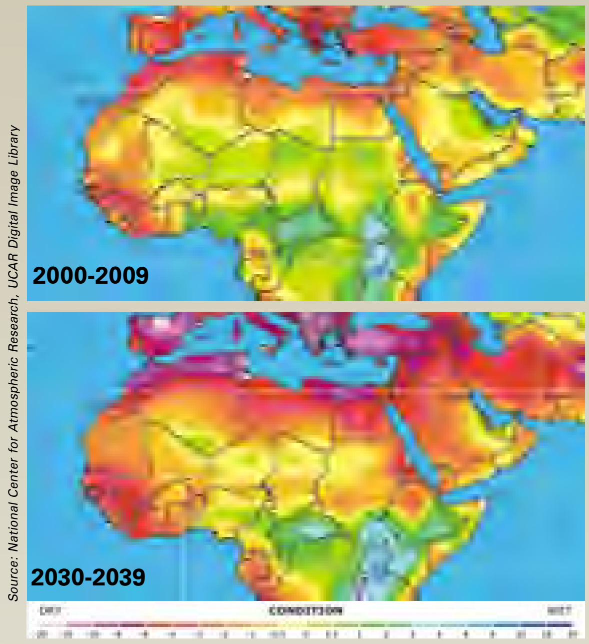
Cyclone Gonu, the strongest tropical cyclone on record in the Arabian Sea, struck Oman in June 2007, causing loss of life and widespread damage. Chapter 3 features images of the devastation brought by the cyclone to the eastern tip of Oman. Tropical Cyclone Three B made landfall in eastern Yemen in October 2008, causing extensive flooding that left many dead and thousands more displaced. The floods caused US$1.7 thousand million in damage and increased the poverty rate in Yemen from 28 to 51 per cent (UN-ISDR 2009b). Images of this destructive storm are displayed in Chapter 3.

Sandstorms and dust storms that originate from the Sahara due to high winds associated with extreme heat occur with frequency in the region and cause reduced visibility and impacts to human health, and promote soil loss, which reduces agricultural productivity. These events occur mostly from December to April; their impacts are far-reaching, extending into the Arabian Peninsula, Jordan and Syria.

Dust storm rolling into Salmiya, Kuwait. Dust storms arise when a strong gust front blows loose sand and dust from dry surfaces. Particles are transported by saltation and suspension, causing soil erosion from one place and deposition in another. The Sahara and drylands around the Arabian Peninsula are the main source of airborne dust, with some contributions from Iran, Pakistan and India into the Arabian Sea. Often poor management of drylands, such as neglecting the fallow system, are increasing dust storms from desert margins and changing both the local and global climate, and impacting local economies.

Comparative Schematic showing the frequency of natural hazards affecting Arab countries





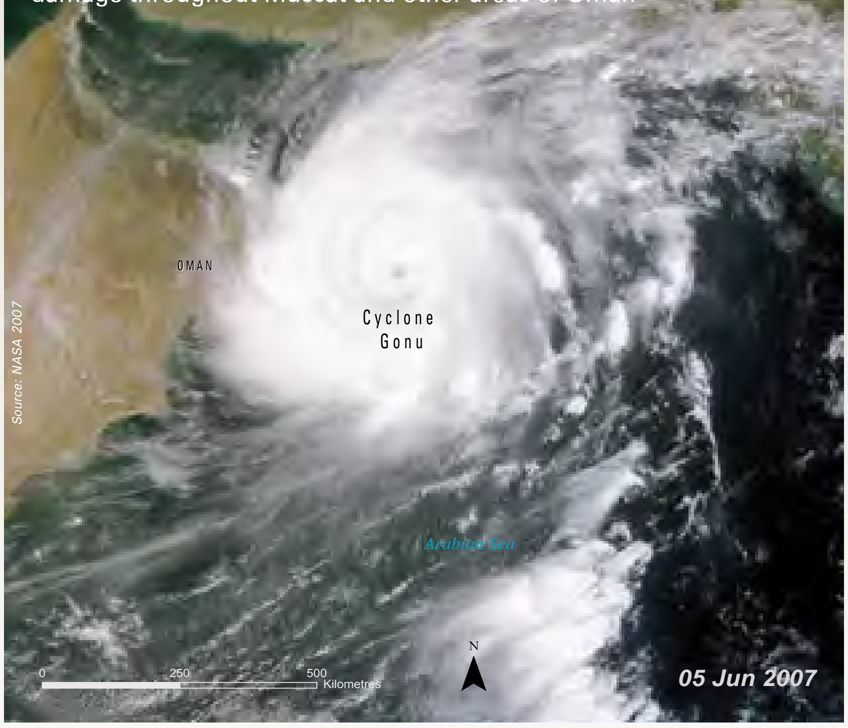
Drought Vulnerability

The two maps use a common drought measure, the Palmer Drought Severity Index (PDSI). The maps display a relatively current condition and a future scenario of drought vulnerability in the region. A reading of -4 or below is considered extreme drought. Regions that are in the red and purple spectrum could face more unusually extreme drought conditions into the future.

Disaster loss is compounded in the Arab region by unplanned urbanization, development in high-risk zones, environmental degradation, and climate change. Flooding and sea-level rise, which are discussed in Chapter 2, will further test the Arab region's preparedness and disaster response.

In an effort to more adequately respond to natural hazards, 168 governments adopted a 10-year plan (Hyogo Framework for Action) at the UN's 2005 World Conference on Disaster Reduction in Kobe, Japan, with the goal of substantially reducing losses from natural hazards by 2015. Losses in life and property can be averted with early warning systems, adequate building codes, resilient infrastructure and government crisis response plans. The Arab League States are actively promoting the integration of disaster risk reduction in key regional policies on climate change, environment and disaster management. Though Arab countries have made progress, the commitments have not translated, in many cases, to operational capacities and commitments of resources. Progress has also been weak with respect to education and public awareness, and data collection and availability. Increased regional coordination and information exchange is needed to ensure that risks from disasters are adequately addressed (UN-ISDR 2009a).

In June of 2007 Tropical Cyclone Gonu made landfall on the Arabian Peninsula causing widespread flooding and damage throughout Muscat and other areas of Oman



Yemen's Al-Tair Volcano erupted in 2007 on the island of Jabal Al-Tair, causing the deaths of eight people.

This ancient souk in Allepo, Syria is an animated Arab bazaar where the old traditions and practices of everyday life do not seem all that remote. The souk still works according to the conventions of commercial life unbroken for generations. The souk markets, traditionally a centre of commerce, remain an important and vibrant part of Arab life.

Source: seier + seier/Flickr.com

1.2 Population, Economics, Cultural Richness

Source: yeowatzu/ Flickr.com

Crossing Dubai Creek. Dubai, UAE

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.

Paradoxically, this same 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, Kuwait, Lebanon, the Occupied Palestinian Territories and Qatar have literacy rates of over 90 per cent, while Mauritania, Morocco, Sudan, Somalia and Yemen stand at less than 60 per cent (WHO 2009) 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. 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 (UN 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).

Source: yeowatzup/Flickr.com

Yemeni gentleman in Sana'a

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 include Bahrain, Qatar, Djibouti and Comoros, with the latter two each having populations under one million.

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).

Despite these high population growth rates, fertility rates in the Arab countries have actually declined since the 1980s. In the period 1980 to 1985, the total fertility rate was 6.2 children per woman; this rate dropped to 4.1 in the period 2000 to 2005. In the oil-rich GCC States, birth rates have fallen significantly as their economies grew following the 1970s oil boom. For example, Qatar's fertility rate was about 7 in the 1970s, and fell to 2.52 children per women in the 1990s. Government policies in the GCC States aimed at increasing fertility have led to higher birth rates in recent years (ESCWA 2003). The Arab region's poorest countries, including Yemen, Mauritania and Egypt, tend to have higher fertility rates; however, they are in decline, and in Egypt, the fertility rate currently stands at 2.9 children per woman, down from 6.2 in 1970 (ESCWA 2003); while Yemen and Mauritania have dropped by approximately 3 per cent and 2 per cent respectively between the time periods of 1970-1975 and 2005-2010.

The demographics of the population are shifting, most notably in the number of youths in the Arab region. The population in the 12 to 24 age range exceeds 66 million in the Arab countries, amounting to more than 20 per cent of the total population (Chabaan 2007). Youths make up 30 per cent of the population in the GCC States, 20 per cent in North Africa, and 11 per cent of the population in the Mashreq countries. This surge in the youth population has contributed to overcrowding in urban areas as they seek employment in the larger cities. One in three working age people in the Arab region are currently unemployed (Chabaan 2007). Youth unemployment rates are high, especially in the poorer Arab countries, reaching 43.4 per cent in Algeria and 39.8 per cent in the Occupied Palestinian Territories.

Most of the Arab region's population is increasingly concentrated in urban areas. Fuelled by high fertility rates, rural-urban migration, international labour migration, conflict, lack of reliable water resources and the concentration of economic activity in urban areas, cities are experiencing unprecedented growth. Greater Cairo, the largest city in the Arab region, is home to an astounding 16.25 million people, an increase from 4.6 million people in 1965.

Population and urbanization are major drivers of environmental degradation in this region, which is characterized by aridity and water scarcity. The levels of renewable water resources in the Arab region are far below the levels of other major regions in the world; the average annual available water per capita in the Arab countries is below 1 000 m^3 (the UN water scarcity threshold) and is expected to decrease to 460 m^3 by 2023, placing most of the Arab countries in the category of "severe water stress". Increasing populations put further stress on limited freshwater resources. Increasing urbanization concentrates the demand for water in large cities that often have poor infrastructure, inadequate waste disposal systems and poor air quality and other pollution problems. Unemployment, specifically among youth, is strongly connected to poverty, which is associated with resource exploitation and loss of biodiversity. As the Arab region's population continues to increase, so will the need to find sustainable solutions.

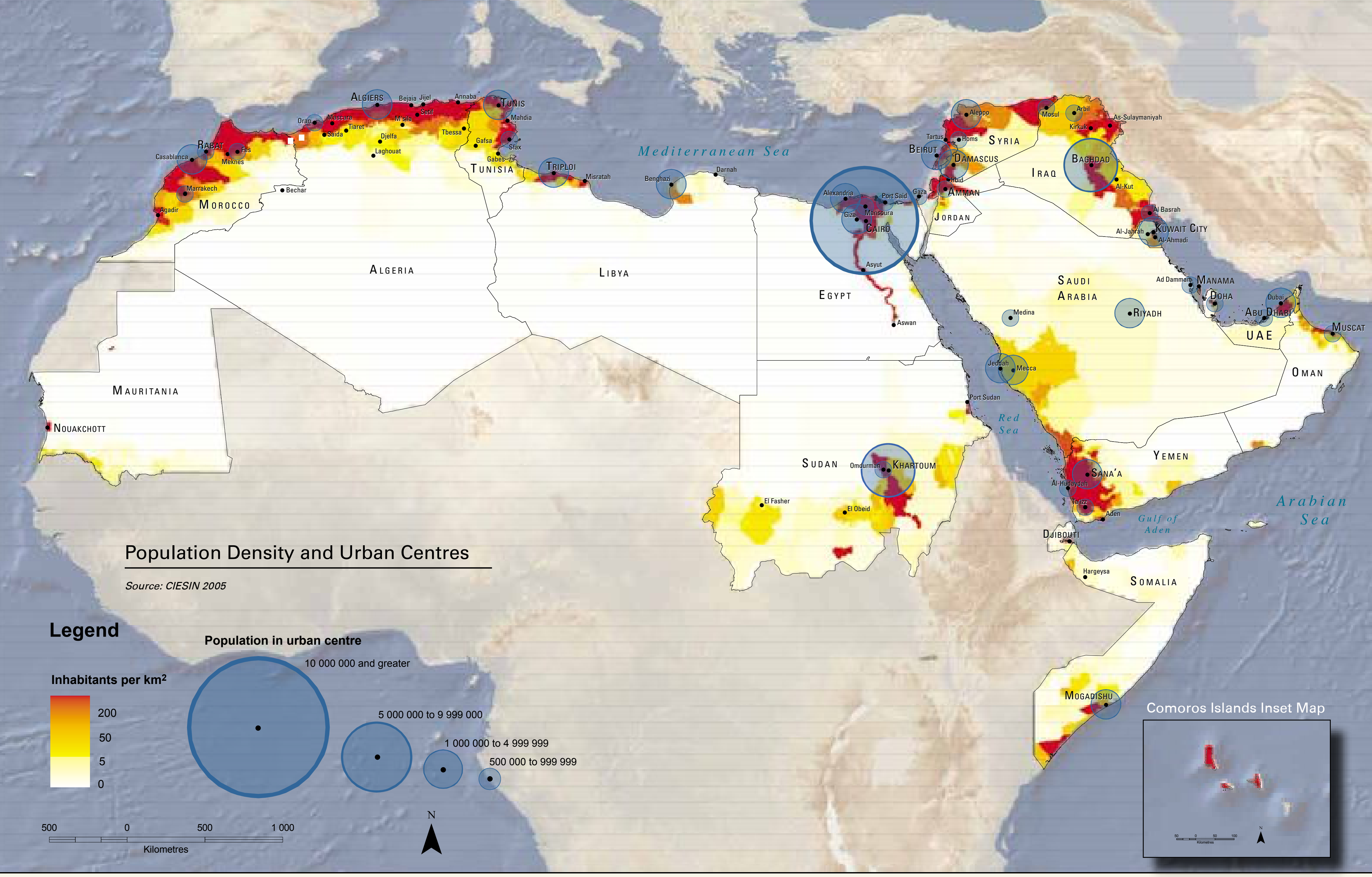
Beyond literacy:

Education in the Arab Region

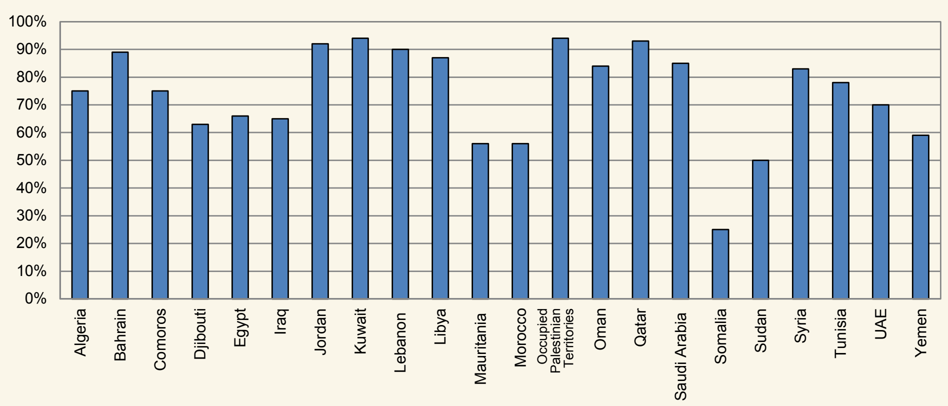
Education is integral to escaping poverty through employment. In the Arab region, the quality of education has dropped due to lack of investment. The increasing emphasis toward English-language education among the elite is resulting in wide gaps between them and the Arabic-educated population. Today, 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.

Poverty affects children's attendance at elementary school and decreases the likelihood of continuing their education. In countries with conflict, the situation is worse; however, education levels in some of the poor countries that enjoy relative stability are also a cause for concern. The proportion of children attending school drops precipitously in the intermediate and secondary levels. In Egypt, the percentage of poor children attending elementary school is 7 per cent lower than that of better-off children, 12 per cent lower at intermediate levels, and 24 per cent lower at secondary levels. In Morocco, about a quarter of children aged 10 to 15 do not complete elementary school because of poverty. Many poor children leave school to work and help support their families. In all cases, low school completion rates perpetuate poverty (UNDP 2009).

In addition, the public education system in the region has not fully responded to the needs of the present generation (ESCWA 2004). This has caused a loss of motivation among young Arabs, who face high levels of unemployment in their home countries. In fact, the poor state of education in the region is seen as a major factor in the Arab region's employment slump, as many schools and universities do not stress the vocational skills that are in demand (UNDP 2009). This is in spite of the fact that the university system in the Arab region has expanded dramatically in the past 50 years. The number of universities in the Arab region has increased from 10 in 1949 to 470 in 2000, and university enrolment per million inhabitants was higher than in China or India (Zahlan 2007; UNESCO 2009a).

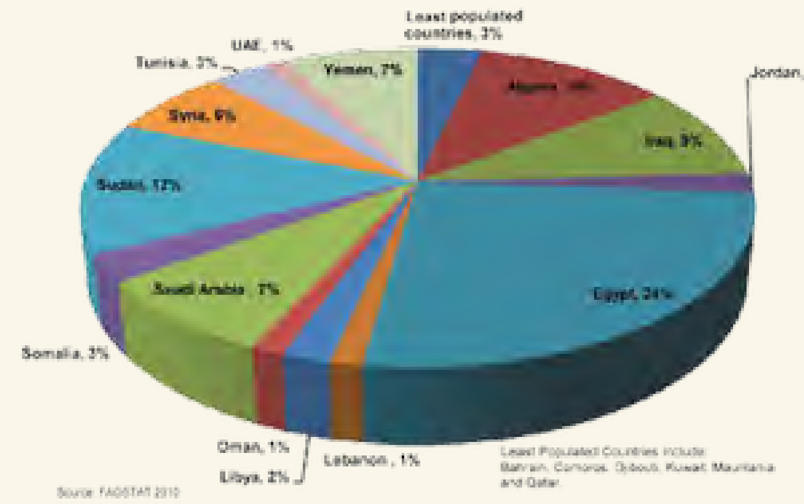


Adult Literacy Rates in Arab Region



Source: WHO 2009

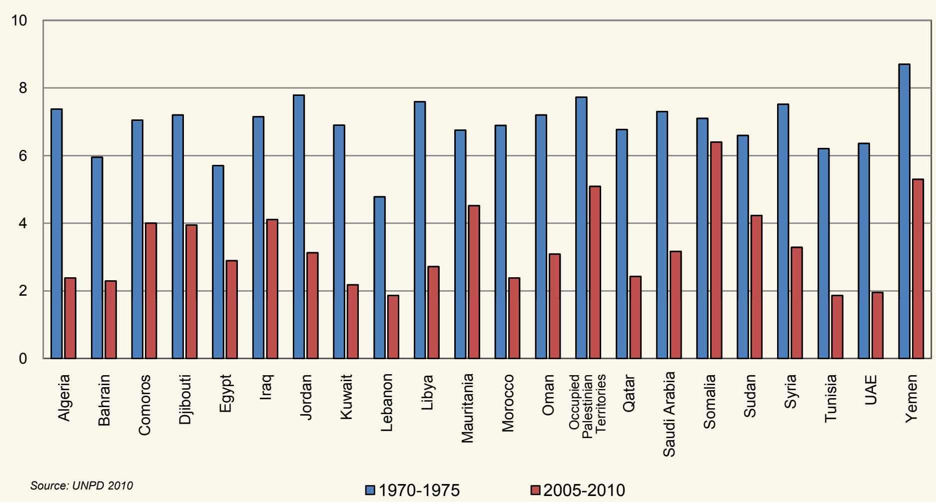
Country Population as a Percentage of Total Population of the Arab Region



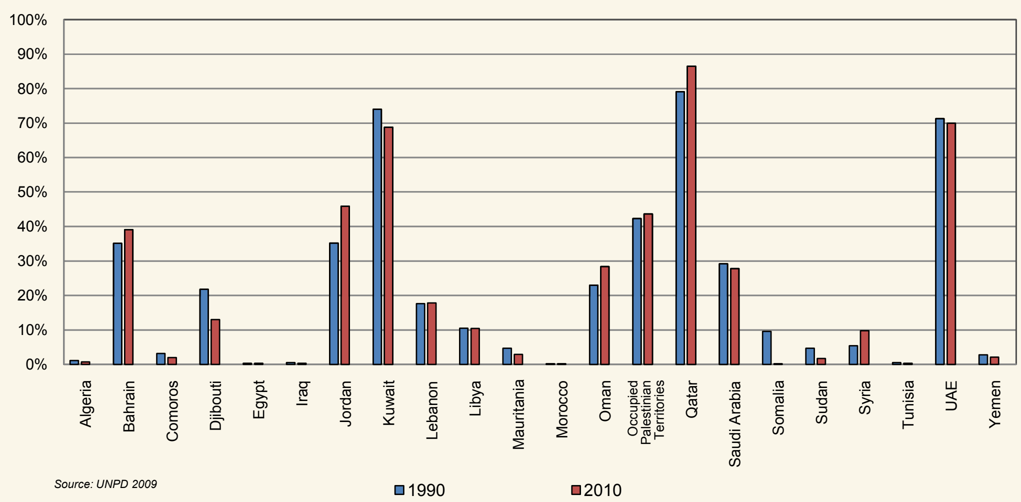
Migrants as a Percentage of Total Population by Country

Migrants as a percentage of total population also showed significant increases between 1990 and 2010 in the Mashreq countries of Jordan and Syria, with the latter's migrant population doubling from 5 to 10 per cent

Fertility Rate in Arab Region



Source: UNPD 2010



Source: UNPD 2009

Urban Population and Social Vulnerability

As one of the cradles of civilization, Western Asia has also been a centre of urban culture. Long before cities in Europe were established, urban centres in the region were flourishing, with the most advanced architecture, roads and infrastructure, waterways, universities and medicine of their time. Today, the cities of the Arab region suffer from some of the world's worst poverty due to environmental degradation, overcrowding and poor planning.

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.

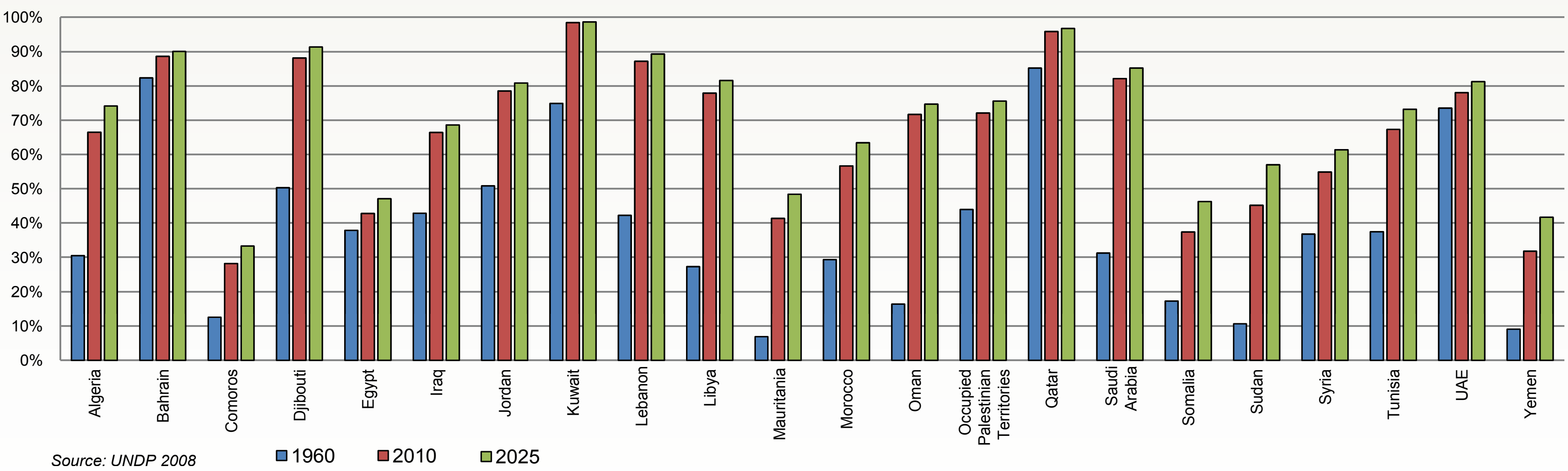
Chapter 3 of this atlas highlights change in many urban areas in the Arab region, and addresses the specific impacts of rapid urbanization. The agglomeration of people in urban areas has also put stress on rural areas, which are increasingly producing food for the cities, and often using poor agricultural 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).

The problem of water scarcity is acute in the Arab region. Aridity, combined with drought, population growth and economic development, are the roots of the water shortage problem in the region. Water scarcity is defined as having less than 1 000 m³ per year of renewable internal freshwater resources available per capita; the global average is about 7 000 m³ per capita (EOAR 2010). Yemen only has 200 m³ per capita, and 33 per cent of the population is without access to safe water, the second highest percentage in the region after Comoros (IRIN 2009).

Rapidly growing urban areas place heavy pressures on water resources. Arab cities suffer from severe water scarcity as the need to meet higher water consumption demands increases. One city where this is a pressing problem is Amman, Jordan, once a quiet desert city that is now a bustling metropolis (see Chapter 3). Similarly, the Yemeni capital Sana'a is facing serious water issues as the aquifer underlying the city is being depleted due to rapid expansion and poor water management (see Chapter 3). Another water-scarce urban area is Dubai; it, however, has been able to meet its population's water requirements due to its capital-intensive sophisticated infrastructure and advanced desalination programmes. Even water-rich countries are not spared: in the Lebanese capital of Beirut, named after the city's hundreds of water wells since pre-Roman times, excessive pumping of the coastal aquifers is causing seawater intrusion into the groundwater. This has made much of the city's wells unusable. Drastic measures are being used to address the problem of decreasing water supplies, exemplified by Libya's Great Man-made River Project, an ambitious project that transports groundwater from inland aquifers to Libya's coastal cities (see Chapter 3 for more information).

Poverty and slums are common themes in the Arab region's urban centres, where already limited resources are needed to support increasing concentrations of people. Traditionally a slum referred to '…housing areas that were once respectable – even desirable – but which deteriorated after the original dwellers moved on to new and better parts of the city' (UN-HABITAT 2007a). Today, slums include the vast informal settlements that are quickly becoming the most visible manifestation of urban poverty. Approximately one thousand million people are slum dwellers, mainly in the developing world, and that number is likely to double in the next 30 years, as the world experiences unprecedented urban growth in the face of increasing poverty and social inequality. The locus of poverty is moving from the countryside to cities, in a process now recognized as the "urbanization of poverty." The absolute number of poor and undernourished in urban areas is increasing, along with the numbers of urban poor who suffer from malnutrition (UN-HABITAT 2007b).

Urban population graph representing per cent of countries total population in urban areas for 1960, 2010 and 2025 (estimated)



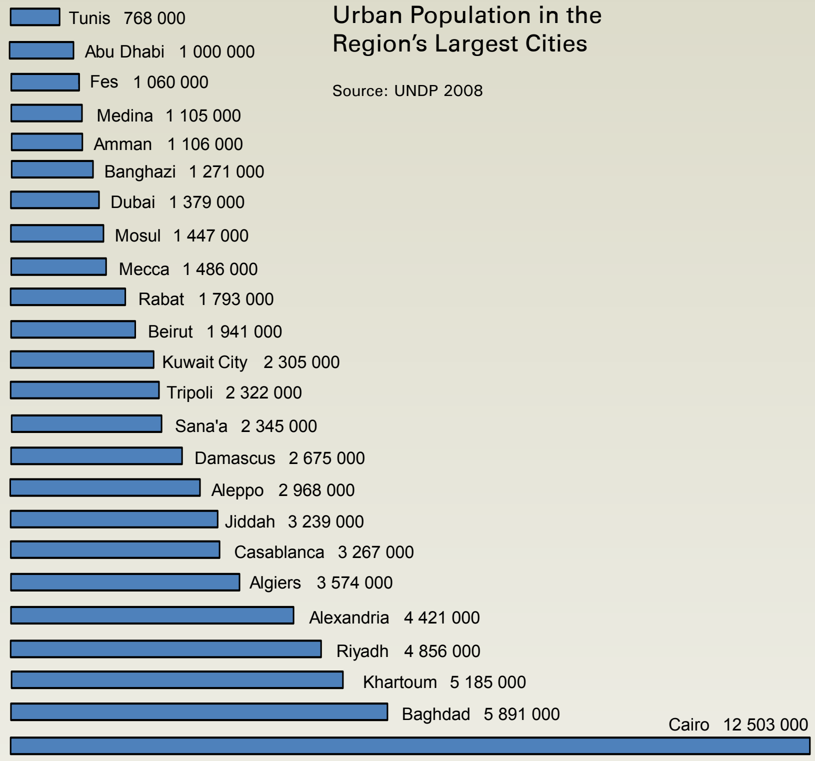
Source: UNDP 2008

Some of the largest slums occur in the Arab region, and include Sadr City in Iraq (1.5 million people), Gaza (1.3 million), Imbaba and Ezbet Al-Haggana (both with populations of 1 million, and both on the outskirts of Cairo), and La Cite des Morts (800 000), also part of Greater Cairo (UN-HABITAT 2007b). Though Egypt has some of the biggest slums in the Arab region, it reduced the number of slum dwellers by 3 million from 1990 to 2005. In contrast, Sudan's slum dwellers increased during this same period. As the Arab regions' slums continue to grow, so do the proportion of vulnerable communities, and the need for increased health care and social management. Chapter 3 country profiles show the change in the number of slum dwellers for each country. Annex 1 shows the proportion of the population by country and sub-region that are slum dwellers.

In recent years, both the international community and Arab governments have identified some of the region's basic health care needs, and they are currently working to meet them. In Yemen, where some 46 per cent of children are underweight and one-fifth of infants suffer low birth weight, joint UNICEF and governmental actions to address children's heath problems are starting to bear fruit (UNICEF 2008a). For the entire region, as part of the Millennium Development Goals (MDG) , efforts are underway to reduce child mortality and improve maternal health. The oil-rich Gulf States are on track to meet most of the MDG; investments in primary health-care infrastructure have improved child survival rates, though approximately 10 per cent of children under five are underweight region-wide. Maternal mortality rates are low, and most deliveries are attended by medical professionals. The prevalence of diseases such as HIV/AIDS remains low, however, there is a need to further educate the region's population about how these diseases are spread (UNICEF 2008b).


Slum dwellings in Cairo

Source: mshamma/Flickr.com



Urban Population in the Region's Largest Cities

Source: UNDP 2008


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

Policy Dimensions for Human Security

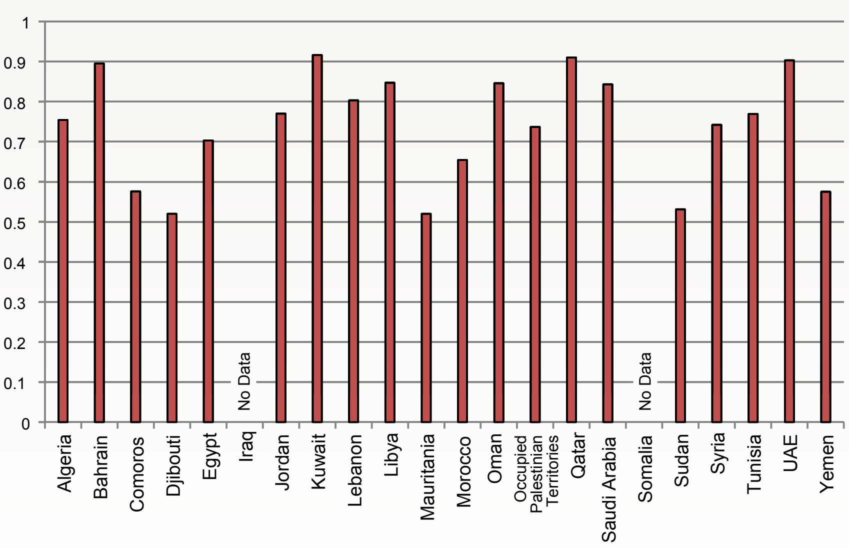
The UNDP defines human security as ‘the liberation of human beings from those intense, extensive, prolonged, and comprehensive threats to which their lives and freedom are vulnerable’, and identifies seven forms of security: economic, food, health, environmental, personal, community and political (UNDP 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 Djibouti and Mauritania have 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).

One of the worst examples of human insecurity, caused by both conflict and the absence of safety nets can be found among Palestinians. Many of these refugees afflicted by violence may also become exposed to both disease and mental health problems. This may undermine their chances of maintaining a normal family structure even during relatively stable periods. The dislocation caused by conflict fragments families and adds to increased violence. Under these conditions, Palestinians face the possibility of separation from family and their extended social network, lack of access to critical health and social services and obstacles to educational and vocational training (UNRWA 2004).

Human Development Index (HDI) for Arab Countries

Source: UNDP 2009



In the more stable Arab states, there have been successful efforts to provide various forms of social security, something that much of the world lacks. Access to an adequate level of social protection is considered a basic right, and is recognized in the Universal Declaration of Human Rights and the International Covenant on Economic Social and Cultural Rights (ILO 2010). Some Arab countries have been pioneers in social security programs. In 1950, Iraq established a social security program, the first of its kind in the region, followed by Syria, Saudi Arabia and Kuwait in 1959, 1962, and 1976 respectively. Bahrain began its program in 1976 and Yemen and Oman began their plans in 1991. Since the establishment of these security plans, no major reforms have been introduced. Key problems include schemes that are large and unaffordable, financially unsustainable, and structures that don’t ensure funds are managed in the best interest of members (Robalino and others 2005).

Other examples of programs include a maternity protection scheme in Jordan proposed for workers in the private sector that would be jointly financed by employers and the government. In 2006, Bahrain introduced an unemployment insurance plan, which provides temporary income replacement in case of unemployment and access to training to ensure a quick re-integration into the labour market (ILO 2010).

Overall, however, efforts to integrate social security across the Arab region have been very limited. The Arab League has published a number of position papers and declarations on the issue, and has also fostered a few research projects such as the Arab Project for Family Health. Probably the best example of a social safety net in the Arab region has come from the Gulf Cooperation Council (GCC), the six-member group of countries, including Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, established in 1981 to improve regional economic cooperation. Today, the organization can be credited with creating and facilitating social safety nets for its citizens. Many citizens of the oil-rich Arab states enjoy subsidized healthcare, government pension plans, free university education and other social benefits.

Much of the success that the GCC has experienced over the past two decades can be attributed to oil and gas resources, which has left them vulnerable to foreign intervention and resulted in a lack of economic diversification. The challenge among these oil-rich nations will be to sustain these programs beyond the oil era. And while many GCC countries have published their 2030 visions, it is noteworthy that the notion of “social security” has been displaced in most of them by the broader notion of “human security”.

Additionally, in many Arab countries, and especially in the GCC countries, foreign workers are excluded from national social security plans. As a result, only a small proportion of the work force has access to coverage. In the year 2000, only 21 per cent of the workforce was covered in Saudi Arabia, while 23 per cent were covered in Kuwait (ILO 2010). In contrast, Jordan and Yemen afford the same types of coverage to their migrant workers as they do their own citizens.

Economic Context

The Mediterranean basin and the Arabian Peninsula have some of the oldest economies in the world. With the establishment of the first farms, cities and markets came the heart of the spice and incense roads, a bustling network of trade routes.

Today, the economies of the Middle East and North Africa are best known for producing and exporting oil. The old cities that were once centres of trade are now tourist attractions, several of which are designated as UNESCO World Heritage sites, and which have contributed to the region's emerging services sector. While the Arab region's modern day economies are far different from the early days, there is still a strong tradition of entrepreneurial spirit that persists in the region – from the network of Lebanese businessmen who send remittances back home, to the sovereign wealth funds in the Gulf being used as a way to diversify their oil economies. Even as regional conflicts persist in parts of the region, so do the economies as they enter the age of globalization.

For the past 50 years, the extraction of oil and natural gas has been the main stimulus for the economies of the Arab countries, most notably Saudi Arabia, Libya, Algeria, Sudan, Oman, Bahrain, Qatar, the United Arab Emirates, Iraq and Kuwait. By the end of 2005, the region held 56 per cent of the known world oil reserves and 30 per cent of the gas reserves, and accounted for 32 per cent of total oil production and 12 per cent of gas production (BP 2010). This has helped oil producing countries create sophisticated infrastructure and health and education systems.

However, as mentioned above, not all oil-rich states or citizens can claim that their biggest natural resource has served them well. In some countries, oil wealth has been the cause of foreign occupation or domestic political unrest. In any case, it is the resource that links all of the region's countries and sectors, for better or for worse – from the price of food to remittances sent to the Mashreq countries to the growing services-based economies of West Asia and North Africa.

The dependency of Arab economies on oil and gas exports has profound implications on economic stability. This was demonstrated by the economic regression that accompanied the slump in oil prices in the late 1980s and early 1990s, and which resulted in rising debts and unemployment rates. The recent increases in oil prices contributed to the reduction of inflation and of public and foreign deficits. However, much of the economic achievements were eroded by population growth, particularly in countries such as Egypt and Yemen. Nevertheless, some oil-producing countries, such as the GCC states were able to utilize oil revenues in order to modernize infrastructure and improve services.

Oil and gas are not the only extractable resources of the Arab region. As noted earlier in this chapter, several Arab nations are rich in mineral and metal ores, especially iron (Mauritania, Algeria and Libya), phosphate (Egypt, Syria, Tunisia, Morocco and Jordan) and potash (Jordan). The extracting industry is a significant source of foreign currency in these countries, where it represents between 6 and 12 per cent of the total extracting industries output.

Moving Away from Oil Dependency: The UAE

The UAE has been working to move away from its reliance on oil as a primary source of income. It launched the region's first light rail network in 2009 and is in the process of building the world's largest airport, scheduled for completion in 2020. With continued emphasis on non-oil projects, it is considered the most diversified economy on the Arabian Peninsula.

By the end of 2030, it is expected that about 64 per cent of real GDP in Abu Dhabi will come from non-oil sources. It intends to achieve a zero non-oil trade balance by 2028. While bolstering the non-oil export sector further, the emirate plans to use the revenues generated from oil as a core component of the economy, providing a stimulus when necessary. It is hoped that this combination of economic diversification, with the oil revenues as a safety net will reduce the potential for volatility in the economy, pave the way for more stable growth and be a model for other oil-rich states looking to diversify their economies (Abu Dhabi DED 2009)

But the emirate is not new to careful planning and long-term investment. With US$627 thousand million in assets dating back to 1976, Abu Dhabi ranks number one in the world for sovereign wealth funds, followed by Norway, which holds US$445 thousand million, and Saudi Arabia, with US$431 thousand million in assets (Sovereign Wealth Fund Institute 2010)

Abu Dhabi, UAE

Source: Shenli Leong/Flickr.com

Economic context (continued)

Agriculture is the most basic and essential component of any economy. This is why after years of neglect the sector is now getting much-needed attention from policy makers – as food prices take up a higher proportion of people's incomes and rural development is being prioritized. Agriculture now contributes to only small proportions of the countries' GDPs, except for Sudan, Somalia and the Comoros, where it accounts for up to 40 per cent of GDP, and where up to 70 per cent of the economically active population of the country works in agriculture (UN 2006). Labour shortages, lack of financial incentives and investment have led to agriculture's generally unhealthy state in the region. However, the inherent climatic variability that characterizes the region makes agriculture a highly risky enterprise and poses a constant threat to food security. For example, recent recurring droughts have contributed to the decline of the agricultural sector in Syria, although self-sufficiency had been achieved in producing cereals and exportable surpluses had been produced in some products in the past 10 years.

Many Arab countries have begun devoting more of their attention to the services sector, in particular, the tourism industry. These include Lebanon, Syria, Egypt and Morocco. Some oil-rich states, such as the UAE, have also been trying to expand their tourism and services sectors in an effort to diversify their economies. Some 28.5 per cent of total investment in Dubai in 2005 went into the tourism sector (ESCWA 2007b). From 2004 to 2005, the Arab countries' share of world tourism revenues rose from 4.2 to 5.2 per cent as a result of an increase in tourist numbers (from 39.4 million to 54 million) (ESCWA 2007b).

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). The rapid accession into global markets has come at a price for some. In Jordan, membership in the WTO has resulted in poor patients having less access to cheaper generic drugs. Jordan was required to make this compromise, leading to a drastic increase in the price of medicine (due to the complex Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement implemented by the WTO as a condition of membership) (Oxfam 2007).

High population growth, over-reliance on the performance of oil-producing countries and a low rate of technical progress has impeded the ability of many Arab countries to integrate into the world economy. As a result, their ratio of trade to GDP either remained flat or declined (ESCWA 2002). Arab economies' share of total global GDP is still around 3 per cent. Additionally, the trade balances of Arab states remain in chronic deficit. However, as Arab countries move towards economic diversification and integration, they may be able to capture the comparative advantages of individual countries while promoting regional economic growth.

Arab economic diversification: Clothing and textile

One sector that has shown some promise for diversifying away from oil and creating sustainable development is the clothing and textile industry. This industry is a major employer in the Arab countries, especially of female workers. It has contributed significantly to total manufacturing value added and to exports. The Arab Federation for Textile Industries is trying to increase the awareness of the importance of this sector in order to help countries reach their development goals. This has led to a regional study in collaboration with the UNDP's regional Arab Trade and Development Program (ATDP) to foster policy dialogue through regional forums and publications. Seven country studies –of Tunisia, Egypt, Morocco, Jordan, Syria, Saudi Arabia and Lebanon have already been completed (IDRC 2009).

Arab Agriculture: Egypt

Since ancient times, Egypt has been considered the 'Gift of the Nile'. The water from the river created the largest oasis in the world, making the banks of the Nile rich in agricultural cultivation. Today, approximately one-third of the Egyptian workforce is directly engaged in farming, and many more work indirectly with the sector through processing or trading agricultural products, despite the fact that some of the country's most fertile lands are being lost to erosion and salinization.

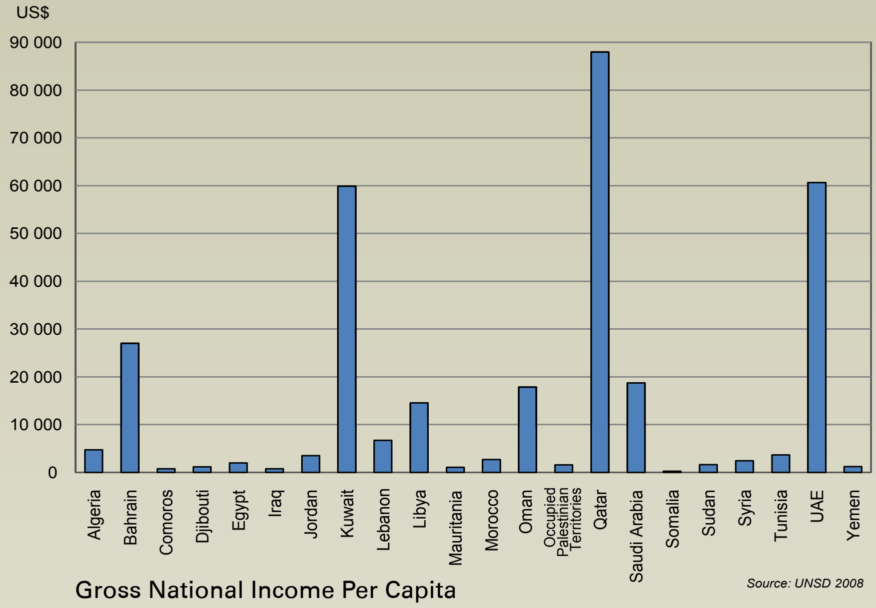
This has led to increased poverty, as the country's population, 97 per cent of whom live in the Nile Delta area, increases and more Egyptians move from rural to urban areas looking for work. Egypt has about 10.7 million poor people, and 70 per cent of them live in rural areas. Most of them live in Upper Egypt and depend on agriculture for their livelihoods and alternative employment is limited (IFAD 2008).

Economies in conflict: Occupied Palestinian Territories

While the past several years have seen a boom in construction, tourism and free trade in many Arab countries, those that suffer from conflict, such as Iraq, the Occupied Palestinian Territories, Somalia and Sudan, have been left behind. In the Occupied Palestinian Territories, more than six decades after occupation, restrictive measures, violence, war and restrictions on movement continue to dominate economic prospects of the Palestinians. Today, the following challenges face Palestinian development efforts: adverse conditions of conflict; intensified, systematic mobility restrictions; lack of national sovereignty; an ambitious, if not unrealistically large-scale reform agenda; and limited policy space available to the Palestinian Authority to manage the economy, and its now systemic dependence on foreign aid. Between 1999 and 2004, the economy contracted with a 15 per cent loss in GDP. The welfare impact is more serious: real per capita gross national income (GNI) dropped by more than 33 per cent from 1997 to 2004. As a result, 63 per cent of the population lives below the poverty line of US$2.3 per person per day, and 16 per cent lives in extreme poverty (below US$1.6 per person per day), with the inability to meet their basic needs (UNCTAD 2006).

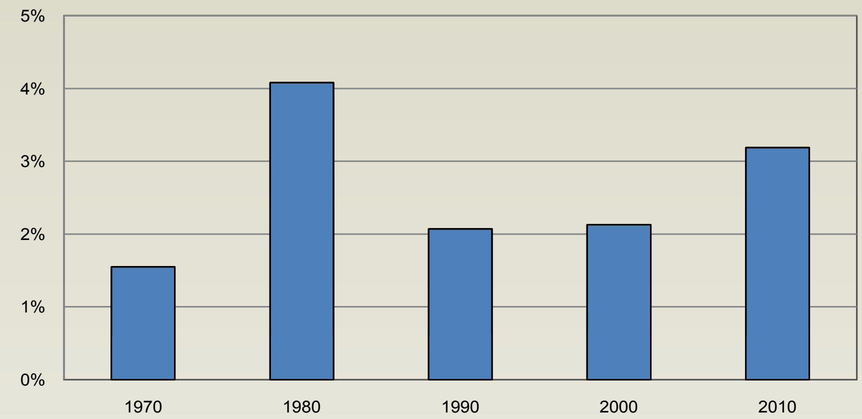
Economic Impacts of oil dependency

In the past, sharp declines in oil prices have adversely affected the livelihoods of people in West Asia and North Africa. One sign of the vulnerability of Arab economic growth is its high volatility tied to oil markets. The high growth in the 1970s to stagnation through the 1980s and back to significant growth in the early 2000s reflect the unpredictable cycles of the oil market. Steep drops in oil income in the 1980s affected oil producing countries such as Saudi Arabia, which saw its GDP halved between 1981 and 1987 (in current prices). Other countries experienced negative economic growth. The hardest hit was Kuwait, where GDP declined by nearly 20 per cent in 1981 and 1982. These shocks were also felt in non-oil Arab economies, which depend on remittances. For nearly two and a half decades after 1980, the entire region witnessed limited economic growth. World Bank data show that real GDP per capita in the Arab countries grew by a mere 6.4 per cent from 1980 to 2004 (i.e. by less than 0.5 per cent annually). This has led many Arab countries to turn toward the services sector, at the expense of agriculture and manufacturing. While this boosted their economies and GDPs, it also created a consumer society in a less industrialized region (UNDP 2009).



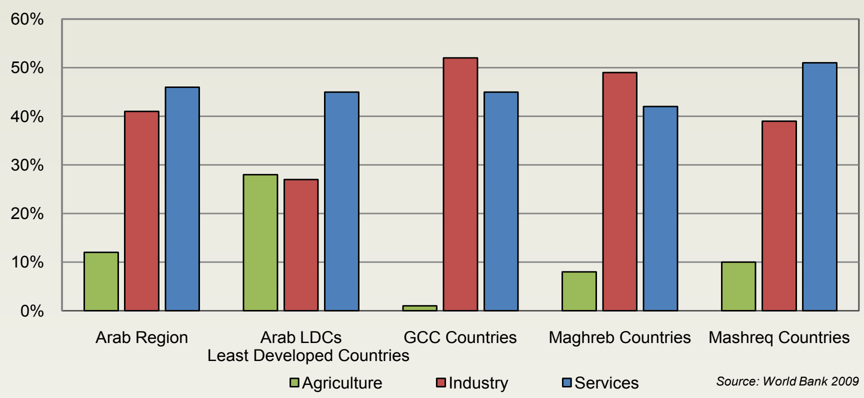
Gross National Income Per Capita

Source: UNSD 2008



Arab Region GDP as a Percentage of World GDP

Source: World Bank 2009; and IMF 2010



Source: World Bank 2009

Economic Sectors as a Percentage of GDP

Traffic in Cairo, Egypt

Source: vagabondblogger/Flickr.com

Hunger in the Arab Region

Probably the most important indication of poverty, more so than GDP or consumption, is hunger. In some Arab countries, more than half of the population lives with hunger. Fluctuations in global food prices in recent years have sent even more people into poverty and malnutrition. Despite its rich resources, the Arab region is experiencing an increase in hunger and malnutrition, and the region is falling behind in this Millennium Development Goal. It is one of two regions (the other is sub-Saharan Africa), where the number of undernourished has risen since the 1990s —from about 19.8 million in 1990 to 1992 to 25.5 million in 2002 to 2004 (UNDP 2009). The countries that have been most effective in lowering malnourishment between 1990 and 2004 are Djibouti, Kuwait and Mauritania. Sudan has also made progress, but still experiences serious hunger prevalence. Saudi Arabia, Egypt, Lebanon, Jordan, Somalia, Morocco and Yemen, on the other hand, recorded increases in both the absolute numbers and prevalence of undernourishment, while Syria and Algeria achieved very small reductions in prevalence, but none in numbers. The region's low self sufficiency rate in staple foods is one of its most serious development gaps (UNDP 2009).

Young Yemeni children in Mazrak camp in northwest Yemen. Over half Mazrak camp's residents are children under 18 years old, many of them are severely malnourished.

Source: IRIN Photos/Flickr.com

Source: IRIN Photos/Flickr.com


Source: Mohamed Somji/Flickr.com

The Business Bay Executive Towers in Dubai, UAE

Consumption Character and GDP

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).

While the Arab region was not as severely impacted by the 2008 food and financial crisis as other regions (overall GDP growth slowed to 2.9 per cent in 2009), this period was telling with regard to the dangers of depending on oil. Meanwhile, GDP gains for the oil importers (diversified economies) faltered by almost two percentage points in the year, from a strong 6.6 per cent outturn in 2008 (powered by growth of more than 7 per cent in Egypt) to 4.7 per cent in 2009.The World Bank estimates that GDP growth for developing oil exporters should reach 3.1 and 3.7 per cent, respectively, in 2010 and 2011. GDP for the high-income GCC economies is anticipated to increase by 3.2 per cent in 2010 and 4.1 per cent in 2011, as oil production firms and a higher average oil price help to restore revenues, albeit in more moderate increments (World Bank 2010).

Despite the Arab region's economic dependence on oil, the ratio of the states' consumption to GDP and of their revenues to GDP is greater than that of their developing world counterparts. This is mainly due to their high oil revenues and thus, high rates of personal consumption. This gives Arab countries control over economic life that is unmatched in most developing countries. In 2005 this ratio reached 25.6 per cent in the Arab region, while in low-income countries it was 13 per cent; in 1995, the average for the Arab countries was 26.1 per cent, while it was 13.3 per cent for low-income developing countries, and 17.2 per cent for the middle-income developing nations. This ratio reached a peak in 2005 among the OPEC-member Arab states, with 68.04 per cent in Libya; 48.62 per cent in Saudi Arabia; around 40 per cent or less in Algeria, Oman, Qatar, and Kuwait; and between one-third and less than one-fifth in the other Arab states. The lowest rate was in Sudan where it reached 17.84 per cent (UNDP 2009). While this has provided a certain degree of economic comfort and security for some Arab countries, in the long-term this could delay political and environmental reform in the region.

In spite of some high levels of economic development, governments of the region are increasingly challenged to provide the basic needs for their growing populations and to narrow the employment gap between genders and between rich and poor. In addition, due to high population momentum, savings and investment are low, and in some countries 85 per cent of the national income was spent on consumption during the 1990s. To meet job demand for its youthful working-age population, Arab countries need more investment in human resources, including literacy and technical training. To achieve sustained economic growth through technical progress, Arab countries must sharply increase their savings and investment rates.

Human and cultural richness

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. In 1859, the University of Al-Kairawan was founded in Fez, Al-Azhar University was founded in 970 in Cairo, and Mustansiriya University was founded in Baghdad in 1233. Students studied math, science and philosophy centuries before universities in the West opened their doors. Throughout its history, the region has been a crossroad of civilizations, attracting some of the world's largest empires, with merchants from as far as China travelling through and leaving their mark. The ancient empires of what is now the Arab region go as far back as 2000 B.C., when the Sumerians ruled the area.

Islamic architecture is highly influenced by geometric patterns, which has developed over the centuries. These designs have evolved into beautiful complex geometrical patterns that are still used for modern day mosques.


Source: Joelle Nebbe-Mornod/Flickr.com

The Arab region is very ethnically diverse and includes many tribal minorities and smaller linguistic and religious groups. The majority of people in the Arab region, or 80 per cent, speak Arabic as their first language, while the remaining 20 per cent speak Arabic as their second language (Holt and others 2000). The vast majority of the Arab region's inhabitants are Sunni Muslims, followed by Shiite Muslims, Christians and Jews, with different sects within these faiths.

Historians, writers and artists from the Arab region have made a significant contribution to the region's cultural heritage. Probably the most prominent and popular modern-day Arab historian is Palestinian-American Edward Said. Best known for his work *Orientalism*, Said's revised approach to the history of West Asia has changed the way the subject has been taught in universities. There are a number of eminent writers from the Arab region. Lebanese-American poet Khalil Gibran, whose 1923 book *The Prophet*, gained him international acclaim, is considered the world's third most-read poet after Shakespeare and Lao-Tzu. Palestinian poet Mahmoud Darwish is also one of the most influential poets of his time. His poems have been translated into 35 languages and his work has been considered the voice of the Palestinian people. Though she has never had the popular following of Gibran or Darwish, Algerian writer Assia Djebar broke new ground when she was selected to become part of the French Academy in 2005, making her the first North African writer to earn such a distinction. Her work addresses colonialism, feminism and human rights (Rogers 2005). In 1988, the Nobel Prize in literature was awarded to the Egyptian novelist and social critic Naguib Mahfouz.

Art from the Arab region, both visual and performing, has been a profound source of expression for those addressing foreign occupying powers and internal domestic policies. One of the Arab region's most iconic visual artists is Naji al Ali, a Palestinian born in the 1930s. Although he was also a prolific writer, it was his cartoons of a simple Palestinian boy in rags named Handala that became a symbol of the Palestinian struggle. Probably the most iconic performing artist in the Arab region is Lebanese singer Fayrouz, who has managed to achieve legendary status during her own lifetime. Born in the 1930s, her songs about Palestine and others taken from Arab poems have become classics, and their messages resonate throughout the Arab region, spanning generational divides.

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.

In 1954, in response to the proposed Aswan Dam in Egypt, UNESCO launched a cultural heritage safeguarding campaign to protect the treasures of ancient Egypt, such as the Abu Simbel temples. The Abu Simbel and Philae temples were taken apart, moved to a higher location, and put back together. This led to further campaigns to preserve cultural heritage sites throughout the world. 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).

UNESCO believes that it is important to foster worldwide understanding of Arab culture, which, throughout history has developed enriching contacts with the rest of the world. For example, Arab scholars such as the traveler Ibn Batuta, the scientist Ibn Sina and the philosopher Ibn Khaldun have expanded humankind's knowledge in the fields of geography, medicine and astronomy. Even relatively new cities in the Gulf, with their global influence, continue to spread Arab culture today (Matsuura 2003). 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.

The notable museums in the region help to preserve the rich culture and history of the Arab region. These include the Egyptian Museum in Cairo, which has a vast collection of ancient pharaoh artwork; the National Museum in Damascus, which houses artefact spanning nearly 10 000 years (including the Duro Europos synagogue from eastern Syria); and the Baghdad museum, which holds important relics from the Mesopotamian era. The Arab region is increasingly gaining a reputation as a major contributor of modern and contemporary art. Dubai has emerged as a regional hub for auction houses and art galleries, and Arab artists are gaining worldwide recognition. In addition, Beirut and Damascus are seeing contemporary art galleries emerge in what many have called a cultural renaissance.

In the future, the biggest threat to the Arab region's cultural history could be environmental degradation. With population pressures, rapid economic development and the impacts of climate change, the challenges to the conservation and management of World Heritage sites are formidable. This is particularly true for developing countries with weak institutions, policies and management (UNESCO 2009). 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.

The Giza Necropolis - a UNESCO World Heritage site - stands on the Giza Plateau, on the outskirts of Cairo, Egypt. This complex of ancient monuments includes the three pyramids known as the Great Pyramids.

Source: Steven Wagner/Flickr.com

Source: Julien Willem/Flickr.com

Dugong (*Dugong dugon*)

Found in warm, coastal waters from the ROPME Sea Area to Australia (including the Red Sea, Indian Ocean, and Pacific Ocean), the dugong or sea cow is one of the most unique and globally endangered sea mammals in the world. It resembles a cross between a seal and a whale and feeds on seagrass. Although the dugong is considered vulnerable to extinction globally, populations in the ROPME Sea Area, which hosts the second largest population of dugong in the world, are stable due to effective conservation and protection measures. Marine biodiversity is also described with more information in Chapter 2, Regional Seas.

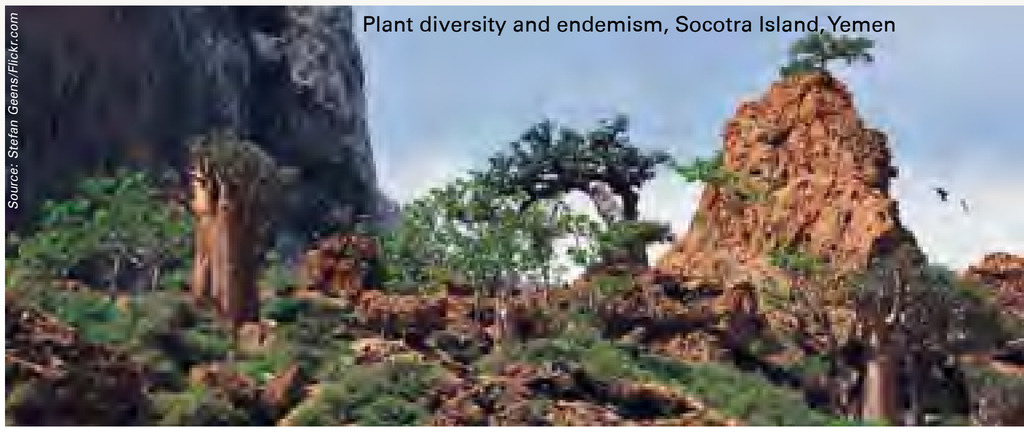
Ecosystems, Species, Threats and Conservation

The biosphere, the relatively thin layer of Earth where all life occurs, is a mosaic of living communities of species interacting with their environment; a mosaic of ecosystems. Biodiversity (or biological diversity) is the term given to the variety of life on Earth and the natural patterns it forms, encompassing the full range of species, genetic variation, and ecosystems in a given place. These ecosystems occur over a broad range of scales. The biosphere can be divided into biomes: large-scale ecosystems characterized by vegetation type and climatic characteristics, including deserts, forests, mountains, and grasslands. Tropical forests, coral reefs, and Mediterranean heathlands are the most species-rich ecosystems (UNEP 2002). Approximately 1.75 million species have been identified, mostly small invertebrates; estimates suggest that there may be as many as 14 million species (UNEP 2002).

Terrestrial Biodiversity

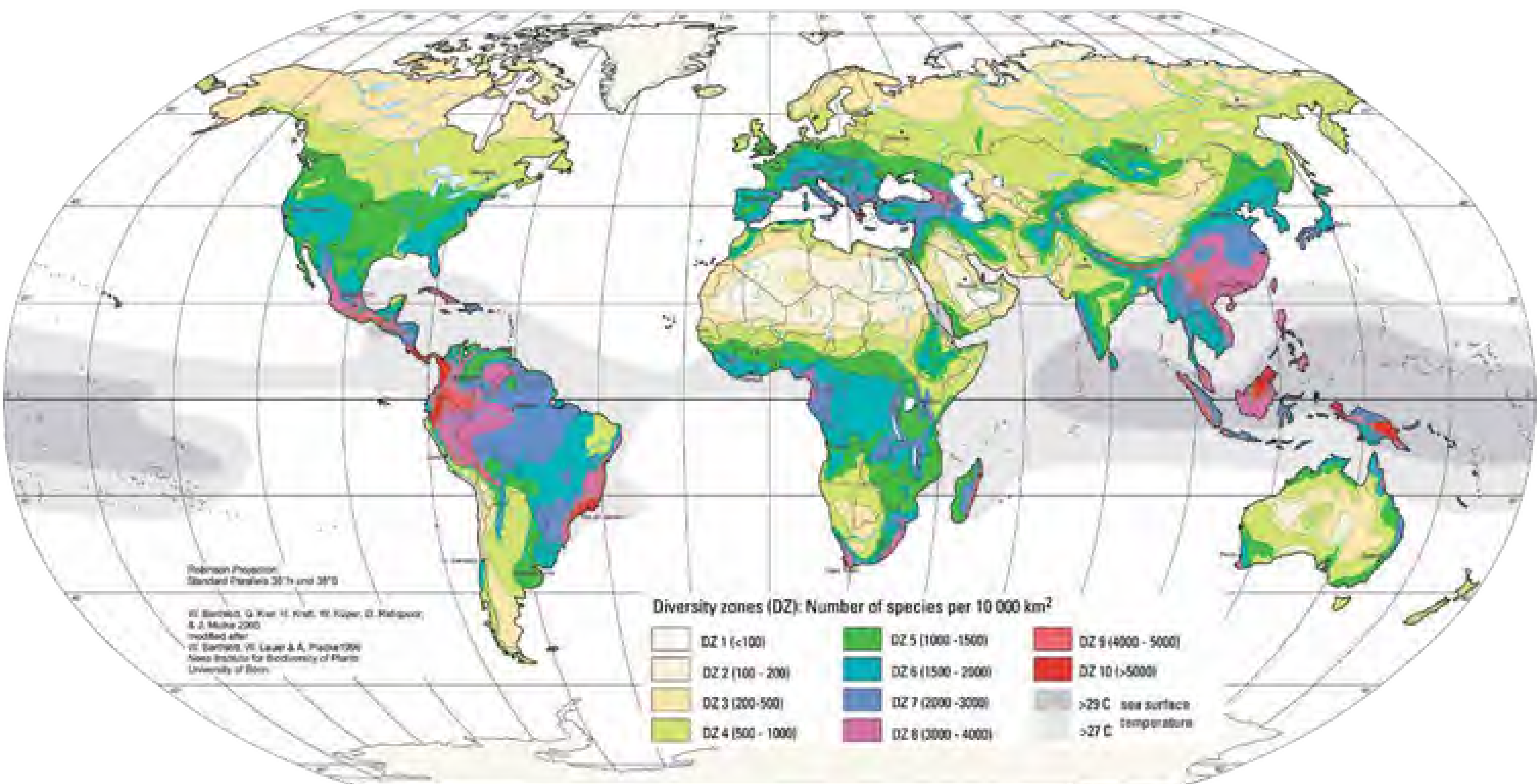
The Arab region is a meeting place and a transitional area between various phytogeographic and zoogeographic regions of the world. Floristic elements of five floral provinces exist in the region representing the Mediterranean, Irano-Turanian, Saharo-Sindian, and the Sudano-Deccanian (Zohary 1973). The 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).

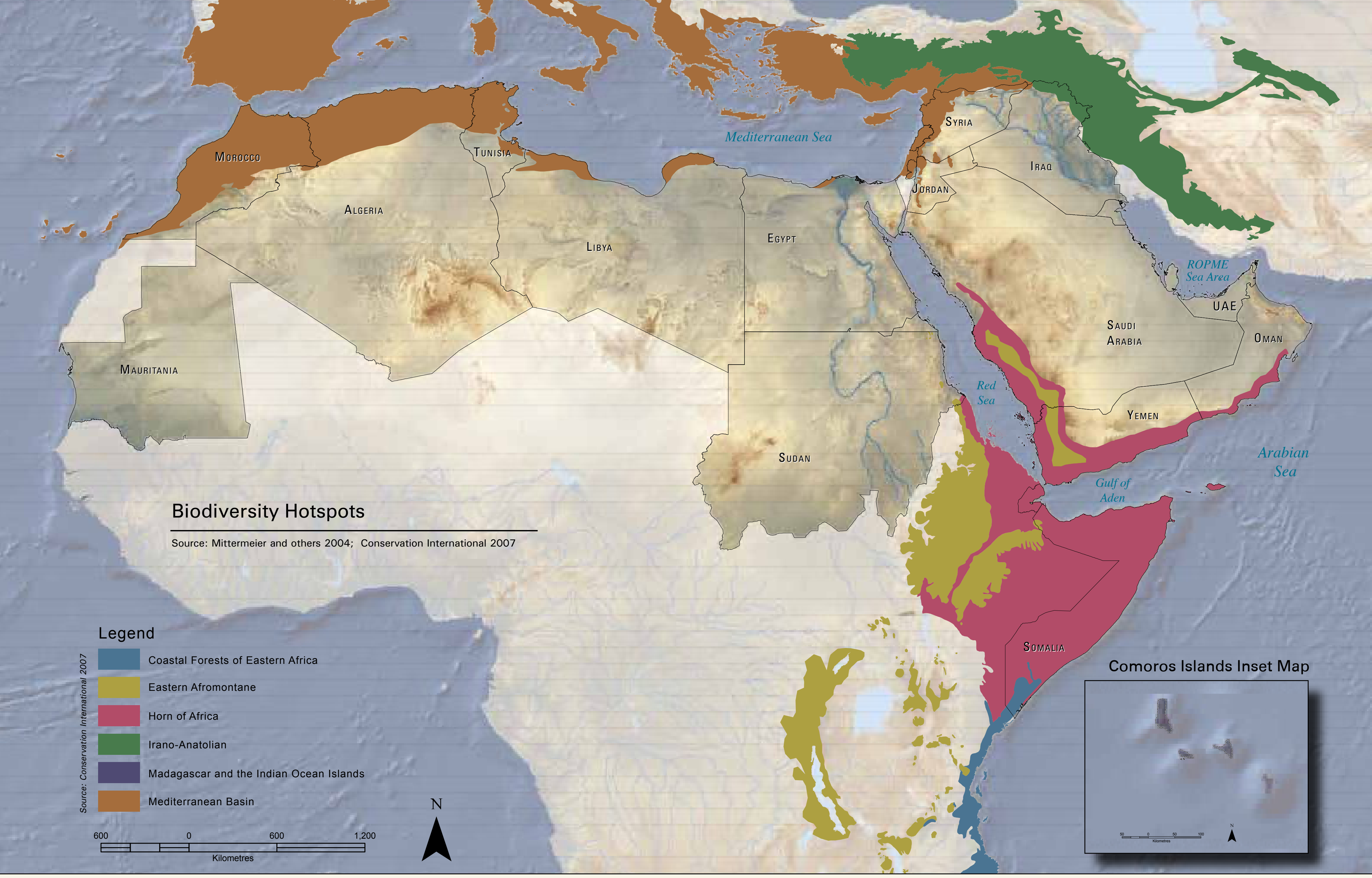
Of the six major faunal realms, three are represented in the region: the Palaearctic, the Ethiopian and the Oriental (Ghabbour 1997). There are approximately 1 700 mammals, of which 39 (or 3 per cent) are endemic (WRI 2002; Animal Info. database 2005; SCBD 2010). In addition, 30 species of birds are 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 km^2 (Mackay 2009).


Plant diversity and endemism, Socotra Island, Yemen

Source: Stefan Geens/Flickr.com

Global Biodiversity: Number of Vascular Plant Species





Biodiversity Hotspots

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 Hamadryas baboon (Papio hamadryas) is a species of baboon from the Old World monkey family. It is the northernmost of all the baboons; being native to the Horn of Africa and the southwestern tip of the Arabian Peninsula.

Arab Region Biodiversity Hotspots

Irano-Anatolian Hotspot- Located in part of the mountains of northern Iraq, southeast Turkey, northwest Iran, and northeast Syria, the climate is continental with an annual rainfall ranging from less than 100 to over 1 000 mm. With many centres of local endemism, the region's vegetation consists of 2 500 endemic plant species. The ecosystem type consists of forest steppe, which supports oak-dominant deciduous forests on the southwestern slopes of the Anatolia and Zagros mountains. This hotspot includes four endemic and threatened species of vipers (*Vipera* sp.).

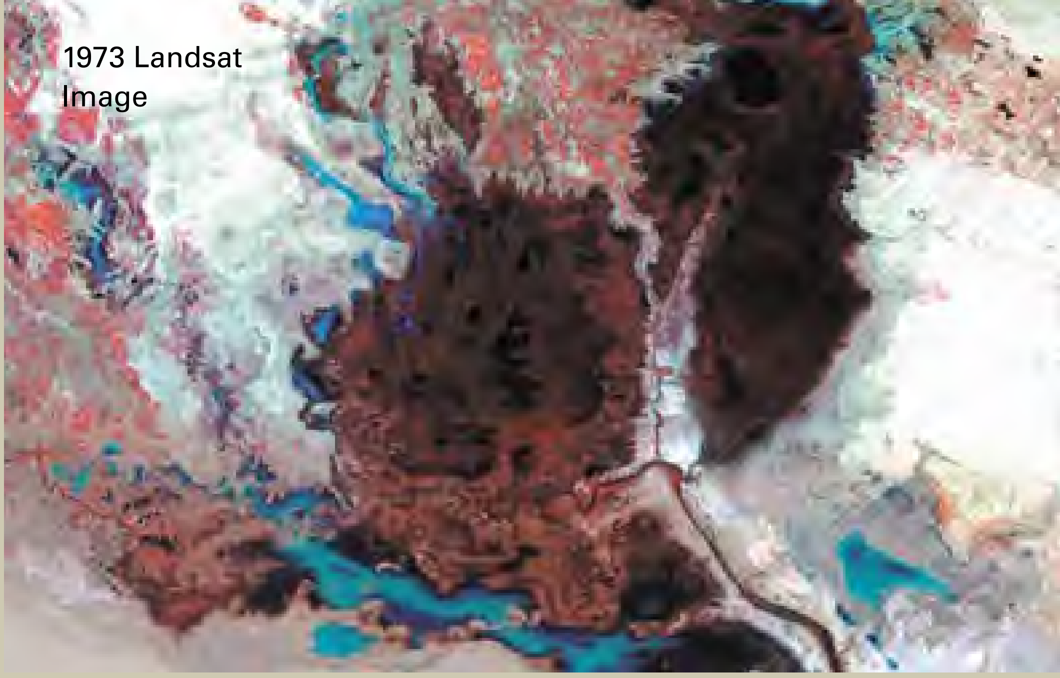
Mediterranean Basin Hotspot- This hotspot stretches over 2 085 292 km² and includes parts of European Mediterranean countries, Turkey, the Mashreq and Maghreb countries of the Arab Region, as well as around five thousand islands scattered throughout the Mediterranean Sea. It includes 15 000 to 25 000 plant species, 60 per cent of which are endemic. About one-third of its fauna is endemic and includes: 62 per cent of amphibian species, 50 per cent of the crabs and crayfish, 48 per cent of reptiles, 26 per cent of mammals, 14 per cent of dragonflies, and 6 per cent of sharks and rays (IUCN 2008). The region supports diverse forms of vegetation "ecoregions", most notably: Eastern Mediterranean conifer-sclerophyllous-broadleaf forests, Mediterranean acacia-argania dry woodlands and succulent thickets, Mediterranean dry woodlands and steppe, and the true Mediterranean woodlands and forests (WWF 2001). Major threats include coastal development, which fragments habitat.

Mesopotamia Wetlands

"The demise and Revival of an ecosystem"

With an original area that covered 15 000 to 20 000 km^2, the Mesopotamian marshlands complex, centred at the confluence of the Tigris and Euphrates rivers in southern Iraq, was the largest wetland in the Mashreq sub-region of the Arab region. Aside from their importance to the Arab Marsh people who settled there, the marshlands are home to many resident and migratory birds. Upstream dam building coupled with water diversion and land reclamation projects in southern Iraq reduced water inflow into these swamps, which have reduced their surface area significantly, converting them to bare land and salt crusts (UNEP 2001). Less than 7 per cent of their original extent remained in 2002 (UNEP 2004).

By 2004, with re-flooding efforts, nearly 40 per cent of the marshlands were inundated (The Eden Again Project 2004). A UNEP assessment of the marshlands restoration in 2006 concluded that about 58 per cent of the marsh areas are present, though there is fragmentation of the wetland areas. Signs of biodiversity were documented in terms of the abundance of vegetation and the number of bird species; however, frequent droughts and demand for irrigation water are still the main threats to this marshland ecosystem. In 2007, Haur Al-Hawizeh, an area of 137 700 ha of marshland in the Mesopotamian complex, was declared a Wetland of International Importance (Ramsar 2009). The imagery provided in the Iraq Country Profile in Chapter 3 documents the striking changes that have occurred in this vital freshwater ecosystem.


1973 Landsat Image


2000 Landsat Image

A drastic reduction in marshland water and vegetation can be seen from 1973 and 2000. The red and dark brown hues indicate vegetated land and blue hues indicate areas of open water.

Coastal Forests of Eastern Africa-
This hotspot contains the forests of southeastern Somalia. The climate is tropical to subtropical with complex vegetation composed mainly of moist and dry forests, coastal thickets, fire-climax savannah woodlands, seasonal and permanent swamps, and littoral habitats that include mangrove vegetation along parts of the coast. This hotspot is home to a variety of primate species. The major threat in this region is agricultural expansion.

The Horn of Africa- This hotspot includes the southern coastal parts of the Arabian Peninsula, most of Somalia, Djibouti, Yemen (including Socotra archipelago), Oman and a small part of far-eastern Sudan as well as the tiny islands in the Red Sea. The region is entirely arid and a home to a number of endemic and threatened antelopes and reptiles. Other distinctive endemics include the Somali wild ass and the sacred baboon. The area contains 2 750 endemic plant species (Conservation International 2007). With only about 5 per cent of its original habitats remaining, this is the most degraded hotspot in the world. Mangroves, acacia and *Prosopis* sp. grow in this region. Major threats include overgrazing, fuelwood cutting and political instability.

Madagascar and the Indian Ocean Islands- This hotspot consists of a number of islands in the Indian Ocean, including the Comoros Islands. Rainfall is heavy (up to 6 000 mm/yr) and gives rise to diverse vegetation, ranging from tropical dense rainforests to dry deciduous forests and thorny vegetation. This hotspot contains a unique assemblage of species with high levels of endemism. Threats here include deforestation, hunting, expansion of agriculture, mining and invasive species.

Socotra Archipelago, Yemen

A World Heritage Site -"Galápagos of the Indian Ocean"

Belonging to the Horn of Africa's biodiversity hotspot, Socotra archipelago, in the northwest Indian Ocean near the Gulf of Aden, is 250 km-long and comprises four islands and two rocky islets. The site (410 460 km^2) is of universal importance due to its rich biota. Thirty-seven per cent of Socotra's 825 plant species, 90 per cent of its reptiles and 95 per cent of its land snails are endemic (IUCN n.d.; UNESCO 2011). Locally, endangered tree species include *Maerua angolensis, Metaporana obtusa* and *Cephalocroton socotranus*. With over 22 Important Bird Areas (IBAs), the islands support 192 bird species (44 resident and 85 migratory bird species), most of which are globally important. The marine life of Socotra is also very diverse, with 253 species of reef-building corals, 730 species of coastal fish and 300 species of crab, lobster and shrimp.

Haghier massif and Diskum plateau, Socotra Archipelago, Yemen. The Dragon Blood's tree are one of many species found only on Socotra.


Source: Stefan Geens/Flickr.com

Mangrove Ecosystems

Of particular ecological interest are the patchy mangrove forests (*Avicennia marina* [Forssk]) that grow along the coasts of the GCC countries and the Red Sea. Ecologically, mangrove communities attenuate wave action, halt coastal erosion and shelter native species of flora and fauna, especially avifauna. Nearly 45 species of waterfowl were recorded in mangrove areas of Bahrain, including: Grey Heron (*Ardea cinerea*), Ruddy Turnstone (*Arenaria interpres*), Little Stint (*Calidris minuta*), Kentish Plover (*Charadrius alexandrines*), Ringed Plover (*C. hiaticula*), Lesser Sand Plover (*C. mongolus*), Little Egret (*Egretta garzetta*), Common Moorhen (*Gallinula chloropus*), and Black-winged Stilt (*Himantopus himantopus*) (Mohammed 1994). Common associated species in mangrove habitats include halophytes or salt-tolerant plants such as *Salicornia* sp., *Suaeda* sp., *Tamarix* sp. and *Hammada* sp. Other hydrophilic or water-loving plants such as *Phragmites australis* and *Juncus* sp. are present along drains and water courses.

Mangroves entrap sediments and nutrients, reducing seawater turbidity. Mangrove forests along the coasts of the ROPME Sea Area and the Red Sea are experiencing pressures due to the combined effects of grazing and cutting, commercial shrimp farming, pollution and large-scale development along the coasts of Arabia and Egypt (PERSGA 2004). The coastal zone in Bahrain was increased by 40 km^2 in less than 20 years due to reclamation projects (see Bahrain's profile in Chapter 3) (UNEP 2004). In Saudi Arabia, more than 40 per cent of the ROPME Sea Area coastline was reclaimed and almost 50 per cent of the mangroves were lost (Sheppard and others 1992). Similarly, the Palm Islands on the coast of Dubai (UAE) will increase Dubai's shoreline by 120 km (see UAE's country profile in Chapter 3 for more information). This trend is affecting pristine areas and disturbing critical habitats.

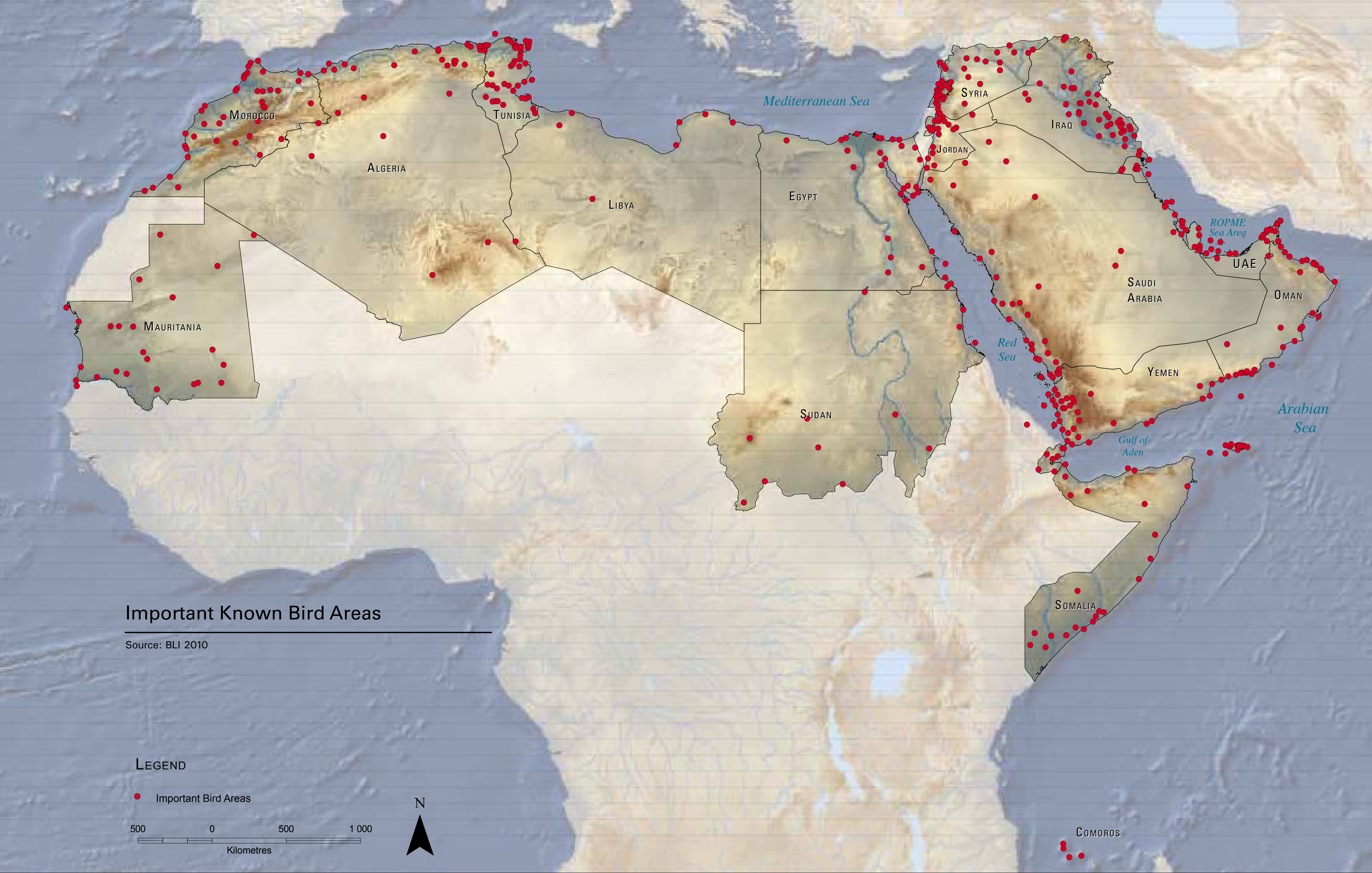
Important Bird Areas

A total of 391 sites covering more than 300 000 km^2, or about 5 per cent of the land area of West Asia (including Iran and Afghanistan), has been identified as Important Bird Areas (IBAs) (BLI 2008). Half of these areas are wetlands, 30 per cent of which are coastal and marine habitats. Over 20 per cent of these are under high to moderate threat (Evans 1994, BLI 2008).

In North Africa, IBAs are concentrated in Egypt, Tunisia, Algeria and Morocco, mostly along the coasts and major rivers. IBAs host important populations of birds and are found in seven main habitat-types, including: woodland, bush land, grassland, agricultural, desert, wetland and marine habitats. Unfortunately, most IBAs are not protected by law and are threatened by degradation and destruction (Evans 1994).

Source: Flickr.com

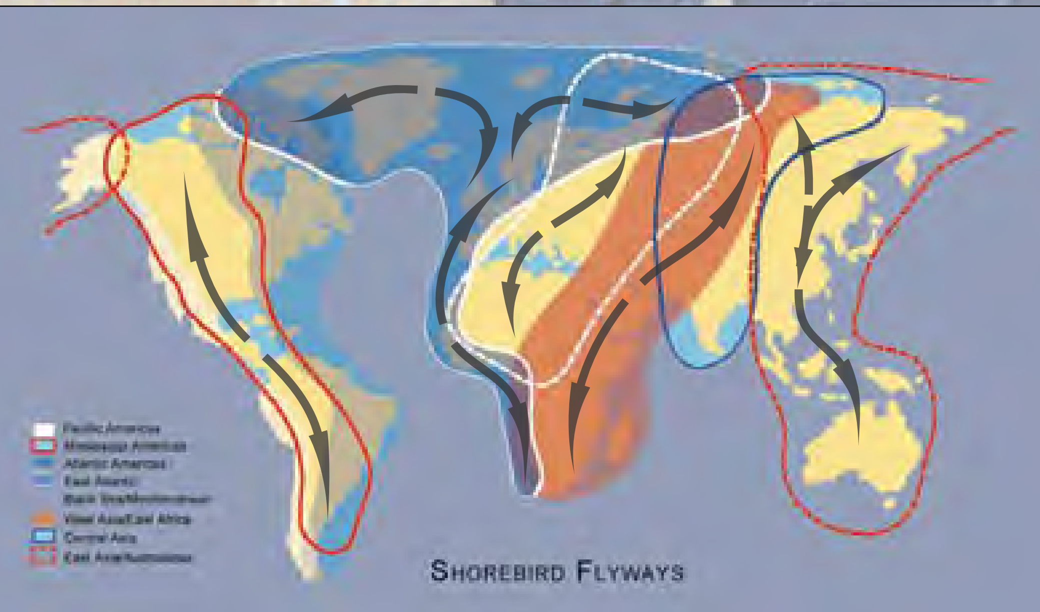
Mangrove ecosystem



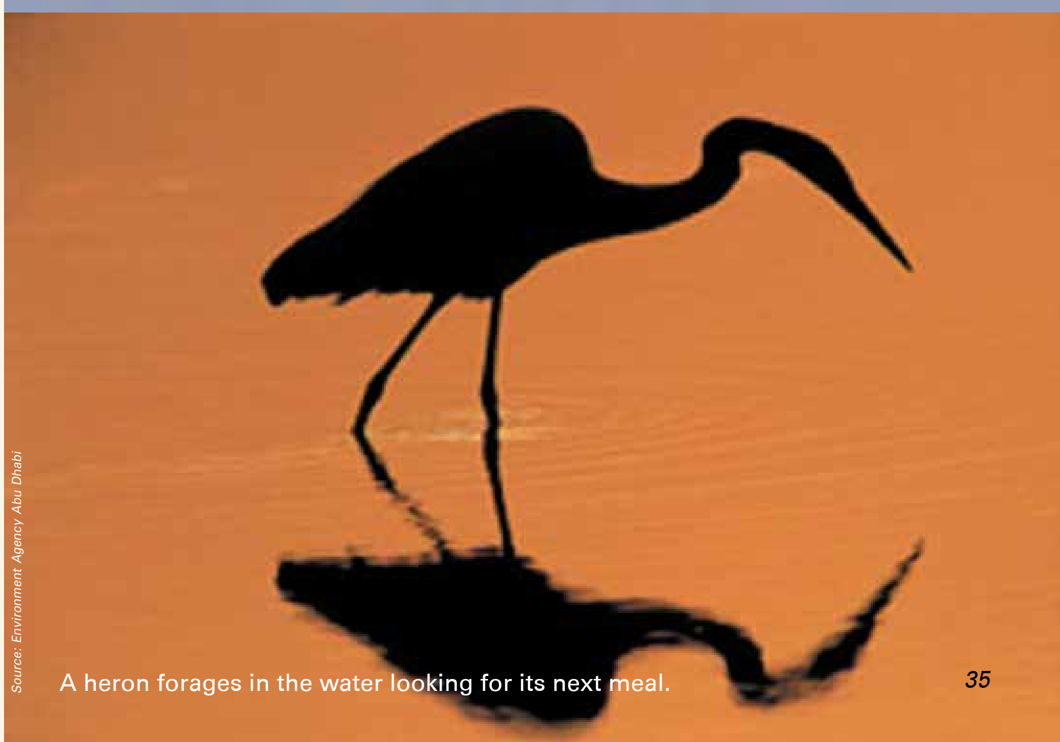
Migratory Birds

The coastlines of the ROPME Sea Area and Red Sea provide ideal habitat for seabirds and support large concentrations of internationally important birds. The Red Sea is a flyway for many bird species that seasonally migrate between Europe and Africa. The Arab region sits at the intersection of several flyways of waders/shorebirds, including: the West Asia/East Africa Flyway, the Mediterranean/Black Sea Flyway and the East Atlantic Flyway. The islands of the southern Red Sea, specifically the Farasan Islands, are used by many hundreds of thousands of birds during their spring and autumn migrations. Islands in the northern Egyptian Red Sea support a number of rare bird species; the islands near Hurghada at the Gulf of the Suez mouth, support significant breeding seabird populations and are migration stopover points (PERSGA 2003). Thirty-three breeding colonial waterbird species are found along the Mediterranean coastline - 9 of these species are under threat from wetland loss and habitat degradation (UNEP/MAP/MEDPOL 2005)

Beginning in 2010, the UN MDG report profiled the degree to which IBAs are protected worldwide, in recognition that IBAs are critical sites for the conservation of the world's birds and other biodiversity. The degree to which IBAs are protected will continue to be tracked as part of meeting MDG 7, to ensure environmental sustainability. The report indicates that over two-thirds of IBA sites are unprotected or only partially protected (UN 2010).



Source: Boere and others 2007



Source: Environment Agency Abu Dhabi

A heron forages in the water looking for its next meal.

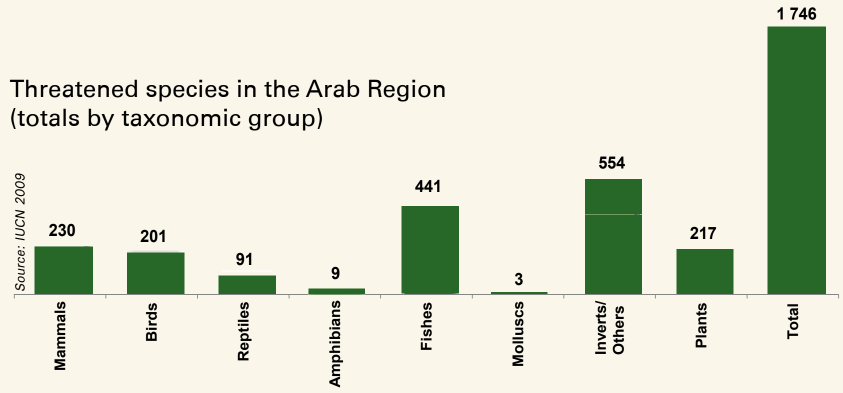
Biodiversity Threats and Conservation

Threats

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 Queen of Sheba's gazelle (*Gazella bilkis*), the Asian lion (*Panthera leo persicus*) and the Ostrich (*Struthio camelus syriacus*) became extinct in the wild in the last century (IUCN 2009). Presently, pressures on species are still mounting, endangering some species survival and restricting others to smaller areas. Scimitar-horned oryx (*Oryx dammah*) is now extinct in the wild over all its range in the Maghreb sub-region; other species such as the Arabian tahr (*Hemitragus jayakari*), Rhim (*Gazella leptoceros*), Cuvier's gazelle (*Gazella cuvieri*) and Mesopotamian fallow deer (*Dama mesopotamica*) are considered endangered (IUCN 2009). Northern Bald Ibis (*Geronticus eremita*) is a critically endangered bird (IUCN 2009) and the Mediterranean monk seal (*Monachus monachus*) and sea cow (*Dugong dugon*) are two critically endangered sea mammals in the Mediterranean Sea and ROPME Sea Area (IUCN 2009). Others such as cheetah (*Acinonyx jubatus*), wild goat (*Capra aegagrus*), mountain gazelle (*Gazella gazella*), dorcas gazelle (*Gazella dorcas*), and Reem gazelle (*Gazella subgutturosa*) are vulnerable throughout their natural range in the Arab region (IUCN 2009).

Other animals are restricted to limited areas of their original range. Striped hyenas (*Hyaena hyaena*) are being driven out of their natural range and are now near threatened (IUCN 2009). The Arabian leopard (*Panthera pardus*), formerly widespread, persists now in a few isolated areas in the mountains of the Arabian Peninsula (IUCN 2009). Similarly, houbara bustards (*Chlamydotis undulata*) now winter in much reduced numbers in Arabia and are considered vulnerable (IUCN 2009). Other species like the Arabian oryx (*Oryx leucoryx*) became extinct in the wild but have been successfully re-introduced using captive stock.

The total number of known threatened species in the Arab region is 1 746,



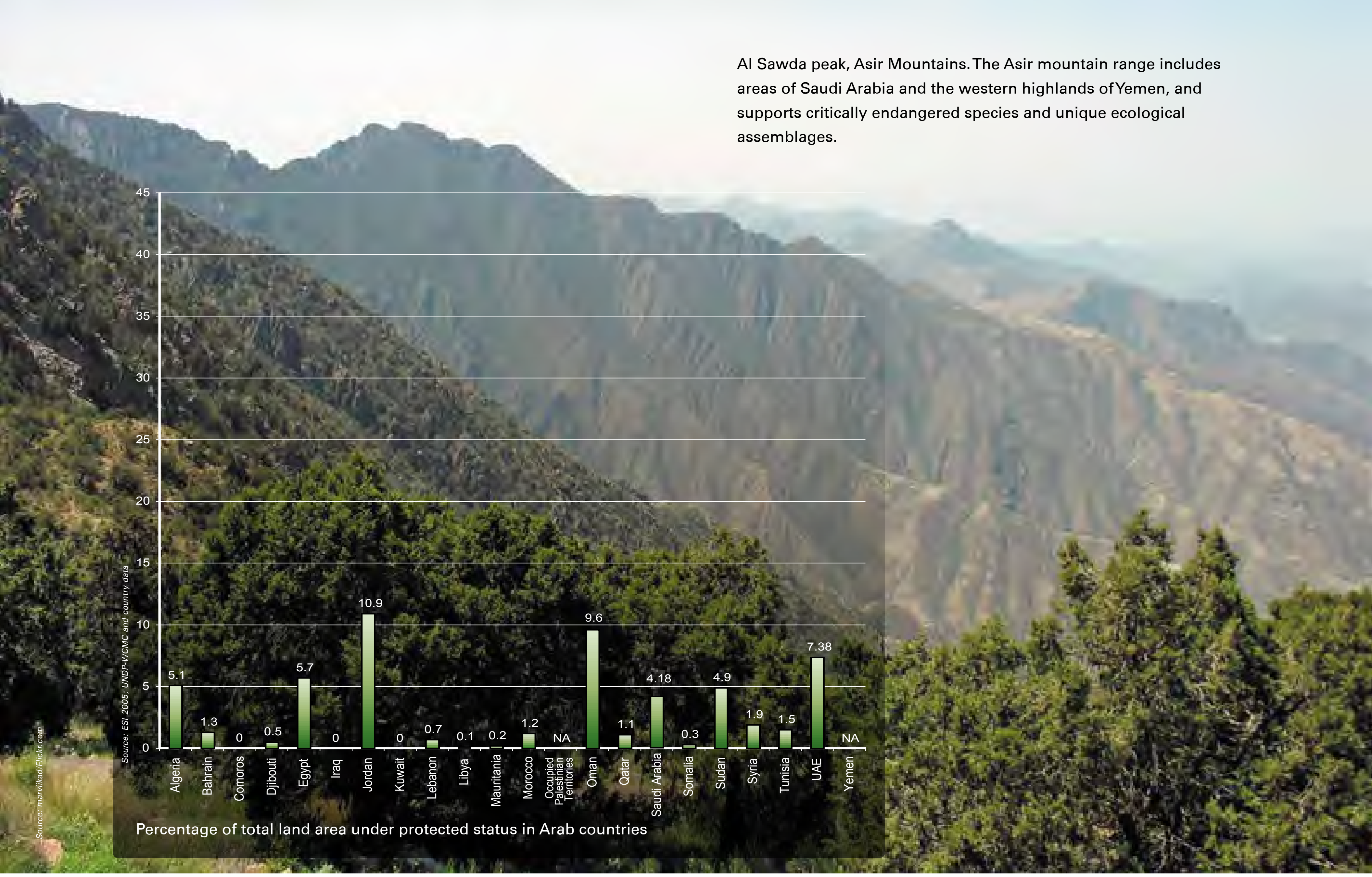
13 per cent of which are mammals, 12 per cent birds, 5 per cent reptiles, 0.5 per cent amphibians, 25 per cent fish, and 12 per cent plants (IUCN 2009). A majority of these species are critically endangered (69 per cent of animals and 39 per cent of plants). The number of birds and reptiles threatened 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).

The driving forces and pressures of this biodiversity loss can be attributed to urban, agricultural and industrial development, specifically, over-grazing 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.).

Scimitar-horned oryx (*Oryx dammah*) is now extinct in the wild throughout its range

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).



Al Sawda peak, Asir Mountains. The Asir mountain range includes areas of Saudi Arabia and the western highlands of Yemen, and supports critically endangered species and unique ecological assemblages.

Percentage of total land area under protected status in Arab countries

Southwestern Arabia

A Case of ecosystem decline

Rising to about 3 760 m, the southern part of the Asir Mountains of Saudi Arabia and most of the western highlands of Yemen host a mosaic of vegetation types. Coniferous communities are dominated by *Juniperus procera*, found at elevations above 2 500 m, whereas evergreen forest and scrub vegetation of *Olea chrysophylla* and *Tarchonanthus camphoratus* dominate the zone between 2 000 and 2 500 m. At lower elevations, deciduous communities of *Acacia* spp., *Commiphora* spp., *Grewia* spp. and other succulents prevail (Miller 1994; Hegazy and others 1998). This region supports over 2 000 vascular plant species of which 8.5 per cent are endemic (Miller 1994). The woodlands and surrounding habitats are rich in animal life, sheltering approximately 34 mammal species, 245 bird species, 41 reptile species and 7 amphibian species (Jennings and others 1988; Newton and Newton 1996). The Asir Mountains are home to the critically endangered Arabian leopard (*Panthera pardus* ssp. nimr), the Arabian wolf (*Canis lupus* ssp. arabs), caracal (*Caracal caracal* ssp. schmitzi), the rock hyrax (*Procavia capensis* ssp. jayakari) and the striped hyena (*Hyaena hyaena*) (Nader 1996; Baillie and Groombridge 1996; WWF 2001; IUCN 2009). The Asir Mountains are also home to large herds of baboons and several species of gazelle. The Arabian mountain gazelle (*Gazella gazella cora*) is a slender gazelle with a long neck and legs that was once distributed widely across the Arabian Peninsula, Egypt, Jordan, Lebanon and Syria. Populations remain along the Red Sea coast, the Asir Mountains and other localized areas on the Arabian Peninsula. Habitat loss across its range, along with hunting, are the gazelle's primary threats.

Juniper forests have been a substantial and an important ecosystem in the Asir Mountains. Coupled with human disturbance, spells of drought are blamed for the die-back of juniper forests, especially those at lower altitudes (Gardner and Fisher 1996). In Saudi Arabia, extensive decline (450 000 hectares) has been reported in the last two decades in Asir National Park and the Raidah National Park (900 hectares) (Miller 1994; Fisher 1997; NCWCD 2003; Yoshikawa and Yamamoto 2005).

Juniperus procera in the Asir Mountains of Saudi Arabia and Yemen

Threatened Species

Threatened species include any species that are vulnerable to extinction in the near future. Three categories are used to describe the degree to which a species or population are at risk, and include: vulnerable, endangered and critically endangered.


Arabian Leopard

The Arabian Leopard (Nimr) (*Panthera pardus*)

The total population of the Arabian leopard is less than 200 individuals, found basically in three subpopulations in the mountains of the Arabian Peninsula and surrounding areas. The largest recorded population (17 individuals) is in Jabal Samhan Nature Reserve in the Dhofar Mountains of southern Oman. Though not confirmed, a subpopulation may also occur in the western Sarawat and Hijaz mountains of Saudi Arabia. A subpopulation was recorded north of Sana'a in Yemen. The Arabian leopard, which is critically endangered, is threatened by habitat loss, degradation, fragmentation and hunting. A number of wild leopards were live-captured in Yemen in the early 1990s and sold to zoos; some have been placed in conservation breeding centres in the UAE and Saudi Arabia.

The Arabian Oryx (*Oryx leucoryx*)

The Arabian oryx's home range covers most of the Arabian Peninsula and north to Kuwait and Iraq. Their range dwindled by the 20th century and the last wild individuals were most likely shot in 1972 in Oman. Populations were also under pressure from: poaching, degradation of habitat and frequent drought (IUCN 2009). After being released into enclosures in 1972, the first herd of oryx was re-introduced into the wild in Oman at Jiddat-al-Harasis in 1982. Re-introduction efforts continue in Bahrain, Jordan, Saudi Arabia, Qatar, the UAE and Syria where large herds are held captive in enclosures (about 6 000 to 7 000 oryx). Wild populations are estimated at 1 100; the largest herds occur in Saudi Arabia (950 individuals), and Oman. In 2011 the oryx was classified as vulnerable.


Arabian Oryx

Source: Jonathan Molina/Flickr.com


Dorcas Gazelle

Dorcas Gazelle (*Gazella dorcas*)

The Dorcas gazelle's home range includes the entire Sahelo-Saharan region, which extends from the Mediterranean Sea to the southern Sahel and from the Atlantic Ocean to the Red Sea. The Dorcas gazelle is classified as vulnerable as the population has declined by more than 30 per cent between 1988 and 2006 due to hunting and degradation of habitat (IUCN 2009). Little information on the status of the species in the Arab region is available; however, an estimated 800 to 2 000 individuals were recorded in the wild in Morocco.


Northern Bald Ibis

Source: Wikicommons

Northern Bald Ibis (*Geronticus eremite*)

The Northern Bald Ibis is a critically endangered species due to the continuing declines in its population within its natural range due to chick predation, hunting, urbanization and agricultural practices (IUCN 2010). In 2002, a small migratory colony (5 to 7 birds) was recorded at Palmyra, Syria. The largest population (500 to 600 birds) is found in Morocco at Souss-Massa National Park.


Dugong

Source: Julien Willem/Flickr.com

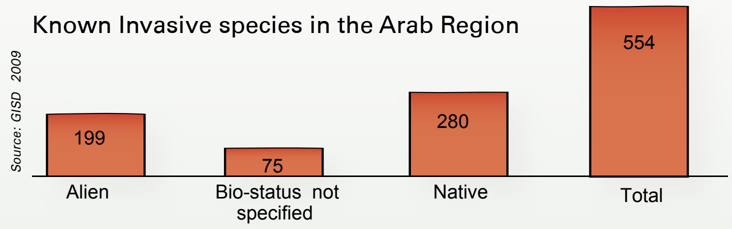
Dugong (*Dugong dugon*)

The dugong, vulnerable throughout its range, is declining or extinct in at least one-third of its range; its status is unknown in half of its range and considered stable in the remainder on the remote coasts of Australia. Australian waters are estimated to support upwards of 85 000 dugong, while the ROPME Sea Area supports a population of about 5 800 sea cows (Preen 2004). Population declines are attributed to the loss of seagrass habitat, marine pollution, gill netting and hunting. In the ROPME Sea Area, dugong have been heavily impacted by marine construction activities that have destroyed much of the seagrass beds on which they feed (UNEP 2010).

Mediterranean Monk Seal (*Monachus monachus*)

With a total worldwide population of 350 to 450 animals, the Mediterranean monk seal is critically endangered due to its small and widespread subpopulations and its declining numbers. Main subpopulations (250 to 300 individuals) are found in the Mediterranean along the coasts of Greece and western Turkey as well as Tunisia and Algeria. Main threats to the Mediterranean monk seal include: red tides, habitat destruction, oil pollution, illegal dynamite fishing and deliberate killing by fishermen (Aguilar and Lowry 2008; IUCN 2009).

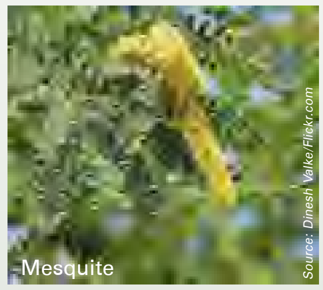

Monk Seal



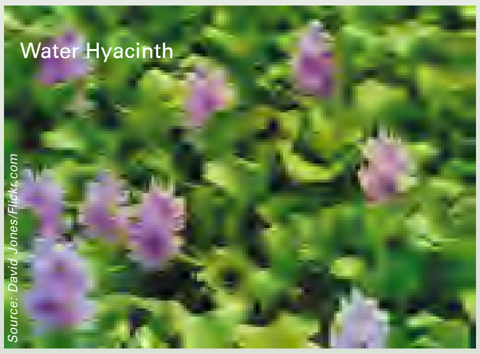
Invasive Species

Invasive species are non-native, non-indigenous or alien species to that ecosystem, or native species, which adversely affect the habitats and bioregions they invade, threatening native biodiversity.

Mesquite (*Prosopis juliflora*)


Mesquite
Source: Dinesh Valke/Flickr.com

Mesquite is a perennial evergreen that reaches 10 m high. It is native to the Americas and established itself in agricultural fields and rangelands in many Arab countries after it was introduced as a source of fuelwood, fodder and landscaping. Mesquite has spread in agricultural fields and rangelands, lowering their usability. Its seeds are spread by livestock when they consume mesquite pods and the seeds pass through their intestines.


Water Hyacinth
Source: David Jones/Flickr.com

Water hyacinth (*Eichhornia crassipes*)

Water hyacinth is a floating plant of tropical origin. It is fast growing and reproduces sexually and vegetatively with populations known to double in two weeks. It is considered an invasive species in a number of Arab countries, including Egypt, Sudan and Syria. It clogs waterways, reduces biodiversity and transpires water. The total infested area is estimated to be 487 km^2, and covers most of the drainage and irrigation canals in different governorates of Egypt, and about 151 km^2 of lakes (Fayad and others 2001).

The Indian house crow (*Corvus splendens*)


Indian House Crow
Source: kibuyu/Flickr.com

The house crow is an aggressive alien species of Asian origin. It preys on a wide range of animals and plants, including chicks and eggs of other birds, and poses a risk to native bird species. It has established itself in the GCC countries, Yemen, Djibouti, Egypt and Morocco. It mainly thrives in coastal cities.


Red Palm Weevil
Source: Flickr.com

Red palm weevil (*Rhynchophorous ferrugineus Olivier*)

The red palm weevil is a very aggressive invasive pest that thrives on date palm trees. The insect originated from tropical Asia and poses a threat to thousands of date palm trees in the Arabian Peninsula; in Egypt alone, the red weevil caused the death of more than 10 million palm trees (EEAA 2009).

The wild common carp (*Cyprinus carpio*)

The wild common carp was introduced in many countries of the world for food purposes. It is raised commercially at natural and man-made water impoundments in many Arab countries. The common carp is omnivorous, feeding principally on aquatic plants. While feeding, the carp destroys aquatic vegetation and stirs up substrates, making the water unclear and destroying natural habitats for other species. Due to its high fecundity, fast growth rate and its wide ecological tolerance, this species has spread and now thrives in many habitats—it has the distinction of being one of the 100 "World's Worst invaders".


Common Carp
Source: Wikicommons.

Threatened species richness in the Mediterranean

The Mediterranean Sea constitutes less than 1 per cent of the world's surface area and 0.32 per cent in volume as compared to the world's oceans; nevertheless, it contains 7 per cent of the world's marine species. Twenty-seven per cent of the world's known cetacean species (or mammals that include whales, dolphins and porpoises) occur in the Mediterranean and Black seas; nine species are year-round residents of the Mediterranean (Cuttelod and others 2008).

The Mediterranean Monk Seal (*Monachus monachus*), the world's most endangered pinniped, sharks, rays and chimaeras also occur in the Mediterranean, with 71 species living and breeding in the Sea. Forty-two per cent of the Mediterranean shark species are threatened.

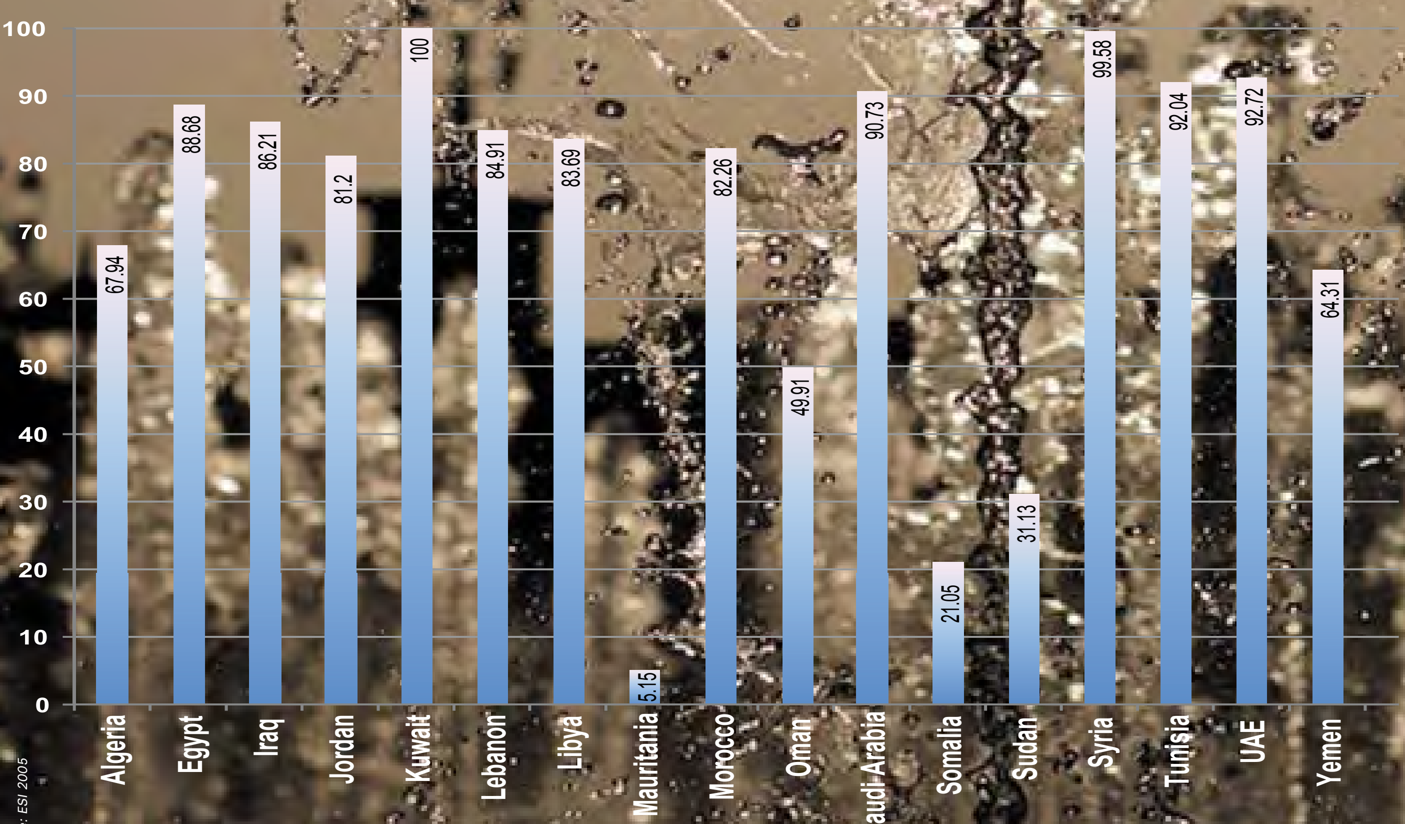

Giant Devilray (*Mobula mobular*)
Source: Sarah Faulwetter/Flickr.com

The most significant threats for Mediterranean species (by order of importance)

Source: IUCN 2009

- Habitat loss and degradation
- Pollution
- Over-exploitation (harvesting, fishing, hunting)
- Natural disasters
- Invasive species
- Human disturbance
- By-catch

Freshwater resources in the Arab region represent only 1 per cent of global water resources although the region accounts for approximately 5 per cent of the world's population and 10 per cent of world land (IFAD 2009). The average renewable water resources in the Arab region are well below 1 000 m^3 per year per capita (the world average is 7 000 m^3) (EOAR 2010).



Source: ESI 2005

Water stress in Arab countries (per cent)

Source: Stephen Barber/Flickr.com

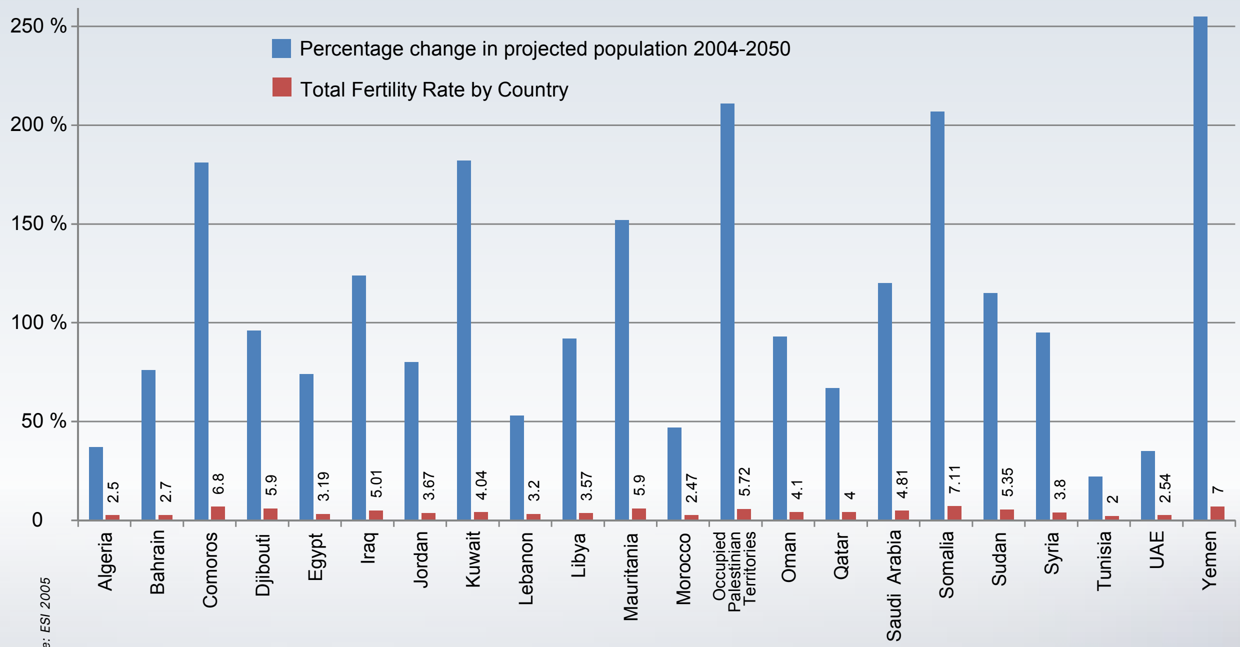
1.4 Challenges and Opportunities

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, over-exploitation 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.



Source: ESI 2005

Percentage change in projected population 2004-2050 and Total Fertility Rate by country

Source: Nwardez/Flickr.com

Morocco - Sahara

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.

Slow economic growth explains why poverty persists in this part of the world where the population growth rate dwarfs the pace of economic growth. Economic growth in many Arab countries is a direct result of the exports of raw materials and cash crops. Embargoes imposed on some Arab countries and the inability to participate in world trade contributes to slow growth. Arab Least Developed Countries (LDCs) account for only 3 per cent of the region's total trade volume, which explains the inability to finance environmental management at large. Poor governance, excessive regulation of the business environment and the lack of mechanisms for re-distributing wealth are also factors that contribute to poverty in the region (Martin and Artadi 2003).

The Arab region is also the scene of numerous conflicts and occupations, which negatively affect the pace of economic growth and development. Conflict destroys a country's productive capacity and deters investment. Natural resources are intricately linked to human conflict; the scarcity, and in some cases, abundance of natural resources contributes to conflict, and warfare itself exacts a toll on natural resources. A resource of particular concern in the Arab region that is also likely to be a source of major conflict is water; the nature of this transboundary resource coupled with high demands and limited supplies lends itself to conflict. Conflict in the Arab region also requires substantial military expenditure, which for many countries, exceeds expenditures for health and education.

Management of resources in the Arab region is a major issue. The Arab region possesses significant reserves of oil and natural gas. Arab countries invest most of the profits from oil and natural gas sales in American and European companies (El-Naggar 2005). For example, in 2000, oil-producing Arab countries invested an estimated US$1.4 trillion outside the region, despite the fact that economic and social development initiatives in the region are desperately seeking funding. Many Arab oil-producing countries depend on foreign labour, which often means that earnings are transferred outside the Arab region in the form of remittances rather than reinvested locally (El-Naggar 2005).


The Arab region is witness to ongoing, major international conflicts as well as several internal conflicts and conflagrations. There has been limited progress in recognizing and addressing the complex environmental dimensions and impacts these conflicts cause.

Source: Flickr.com


Slum settlement outside of Baghdad, Iraq.

Source: Dave Malkoff/Flickr.com

Improving environmental conditions in the region is a means for bettering living standards. Also, investing in human resources can augment deficiency in natural resources and enhance environmental management by boosting people's willingness and the affordability of enhancements. Arab countries have worked on improving their health systems to increase the general level of health of the population and the living conditions for all social segments. Overall, the percentage of people in Arab countries with access to good sewage systems exceeded 60 per cent in 2008 (UN MDGs, Chapter 3). Also, the spread of infectious diseases, such as HIV/AIDS is relatively low in the Arab region. Despite general improvements in human well-being, there is still a need to exert additional efforts and allocate additional resources to reach the targets of the Millennium Development Goals (MDGs), which are discussed in greater detail in Chapter 3. The Arab Human Development Report (UNDP 2009) states the need to pay special attention to the status of women in the Arab region. Improving the status of women is central to the overall development of the Arab countries.

The transfer of available technologies to the Arab region is critical to advancing living standards, but faces several challenges. Adult illiteracy is a major hindrance to the transfer of technology in many Arab countries. Expenditures on education in the region are one of the lowest in the world (as a percentage of GDP); however, some countries have made substantial investments in education. For example, Saudi Arabia's education expenditures increased from 5 per cent of GDP in 1990 to 9.5 per cent in 2001, ranking first in the world (UNESCO 2003); and Qatar provided US$2.6 thousand million toward research and education. According to the Arab Human Development Reports (UNDP 2003-2005), the capacities of many Arab countries to generate adaptive technologies conducive to their sustainability are limited. Not all Arab countries can afford to import the technology necessary to transform their production systems. The inability to access technological advances or develop these technologies locally is a challenge to the sustainable development of the Arab region.

Socotra archipelago is part of Yemen and is recognised as an UNESCO World Natural Heritage Site. The Dragon Blood's tree are one of many species found only on Socotra. The island is very isolated and a third of the plant life is found nowhere else on the planet. Protecting these unique and vital ecosystems is part of a growing trend in the Arab region.

Source: Alexandre Baron/flickr.com

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.

Alexandria, Egypt May 06 1968. This high resolution black and white image is one of more than 860 000 images of the Earth's surface collected between 1960 and 1972 as part of the CORONA program. This declassified military intelligence imagery acquired by the first generation of United States photo-reconnaissance satellites, allows for unprecedented examination of the Earth's landscape from four and even five decades ago. Nearly all of the imagery from the CORONA program was collected using black and white film. The declassified imagery was acquired by satellite-borne camera systems. The satellites were designed to deorbit a film capsule from space with mid-air recovery of the returning capsule by a specially equipped aircraft. The typical spatial resolution of the imagery is sub two metre, allowing the imagery to have effective application today as a way of illustrating landscape and environmental change compared with today's satellite imagery. The CORONA imagery is utilized in many of the change pairs illustrated in Chapter 3.

1.5 Earth Observations

Environmental Monitoring and Modern Technology


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.

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.

Source: NASA/MODIS

Two images of the Earth centred over Europe and the Arab region display a change pair of day and night. The stunning images visually depict the urbanization extent visible by city lights at night in this part of the globe. The images represent state of the art in utilising remote sensed imagery platforms to give illuminating detail of our Earth and the impact or changes we have induced. The images were made from a combination of AVHRR, NDVI, Seawifs, MODIS, NCEP, DMSP and Sky2000 catalog data.

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).

The UAE is a leader in the region with regard to space-based technologies, and is forging ahead with the development of a national space industry that will house the Gulf Earth Observation Satellite Centre (4C GEOC). The facility will have the capability to acquire, process, analyze and distribute high-resolution data from optical and Synthetic Aperture Radar (SAR) Earth observation satellites - the data will be acquired under the company's Gulf Satellites Programme, an earth observation system (EOS) consisting of four high-resolution SAR satellites (GULF SAR 1, 2, 3 and 4) and two high-resolution optical satellites. The centre will focus on defence applications, civilian security and surveillance, emergency risk management, maritime management, environmental protection, geology, forestry and hydrology, cartography and planning.

The Emirates Institution for Advanced Science and Technology (EIAST), based in Dubai, successfully launched a satellite (DubaiSat-1) into orbit in 2009. The remote-sensing satellite was designed for a minimum lifetime of 5 years in-orbit operation and will provide the UAE with a valuable source of information to support the country's development plans. Its data will be used for infrastructural development, long-term urban planning, the management of natural disasters, scientific and space research and development.

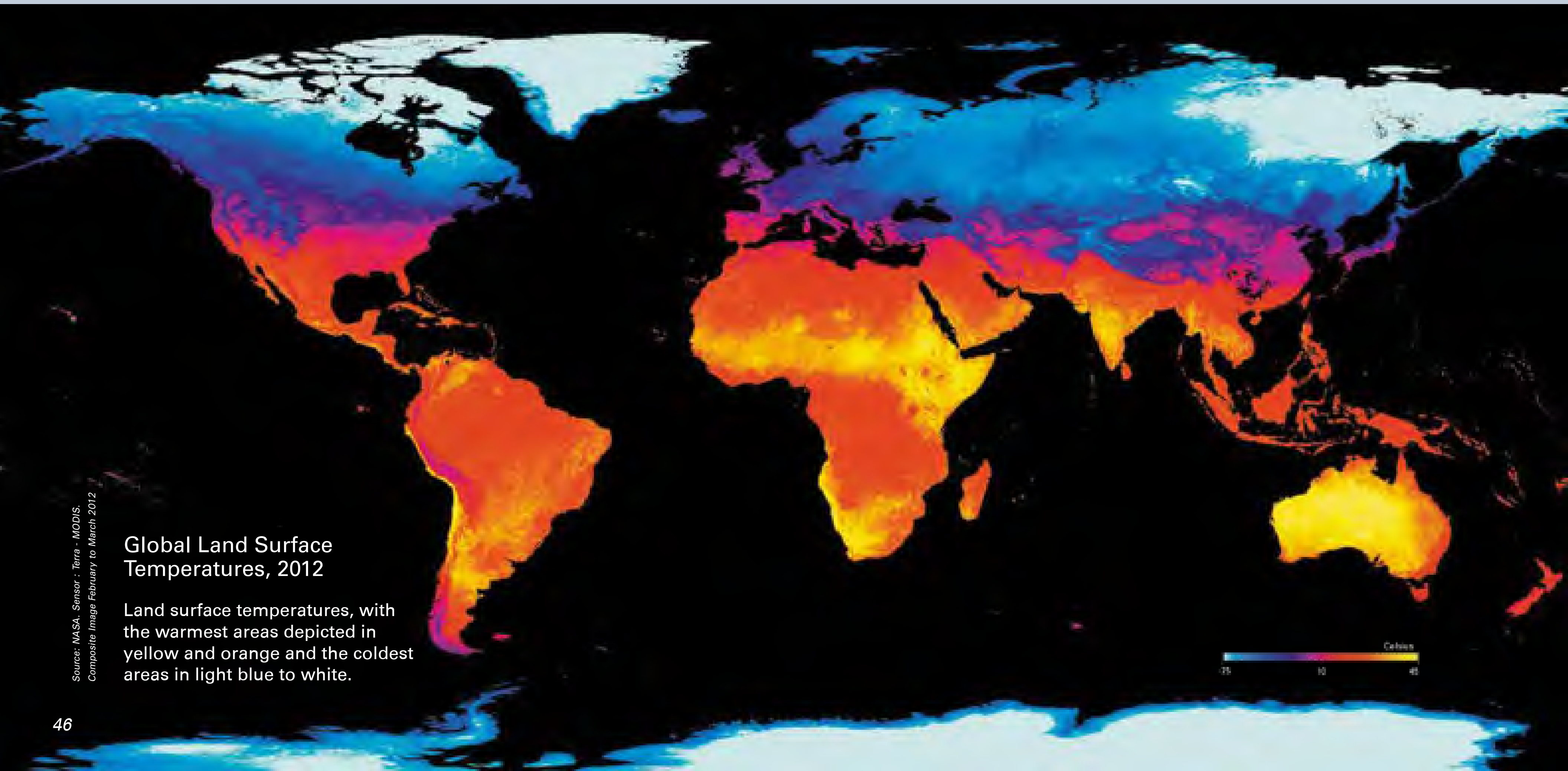
Egypt is a pioneer in the Arab region with the first remote sensing centre established in 1976. Saudi Arabia has invested considerable resources in creating a remote-sensing infrastructure; the Saudi Centre for Remote Sensing, established in 1983, has advanced data analysis capabilities (Johnson and Levite 2003). Saudi Arabia has been in the satellite field for years with its SaudiSat micro-satellite programme. Saudisat 1A and 1B were developed by the Saudi Institute for Space Research at KACST (King Abdulaziz City for Science and Technology), Riyadh.

The Algerian National Space Technology Centre (CNTS) luanched ALSAT -1 in 2002 and is developing the ALSAT-2 system, which consists of two optical observation satellites. The ALSAT-2 system will enable Algeria to obtain high quality images for use in a wide variety of applications, including cartography, management of agriculture, forestry, water, mineral and oil resources, crop protection, management of natural disasters and land planning.

The Arab region, in recognition of the overall socio-economic benefits and environmental applications provided by these remote sensing technologies, will likely continue investing and developing this key industry.

Global Land Surface Temperature

The Arab region, covered by vast deserts, has some of the highest land surface temperatures in the world. Land surface temperatures are monitored using satellite remote sensing because they influence global weather and climate patterns, and are a good indicator of seasonal climatic fluctuations (Dall'olmo and Karnieli 2002). Most pertinent to the Arab region are the impacts of rising land surface temperatures on the availability of water resources (Arab Water Council 2009). Satellite data are also used to determine how rising land surface temperatures affect glaciers, ice sheets, permafrost and vegetation and to determine the effects of increased atmospheric greenhouse gases on land surface temperatures (NOAA 2010a). Global land surface temperatures from March 2010 are displayed in the image below. Worldwide, the average land surface temperatures for March were the fourth warmest on record (NOAA 2010a). Temperatures range from -25°C, which appear as light blue, to 45°C, which are yellow.



Global Land Surface Temperatures, 2012

Land surface temperatures, with the warmest areas depicted in yellow and orange and the coldest areas in light blue to white.

Source: NASA. Sensor : Terra - MODIS.
Composite Image February to March 2012

Global Sea Surface Temperature

The temperature of the sea surface has a large influence on global climate and weather patterns; every three to seven years, the equatorial waters in the Pacific warm by 2 to 3°C, driving the El Niño climate pattern, which affects rainfall around the world. At more localized scales, ocean temperatures influence the development of tropical cyclones, which develop in the Indian Ocean and impact the Arab Gulf States (such as the case with Cyclone Gonu [2007] and the recent Cyclone Phet [2010]). The satellite image below, which displays the temperatures of the top millimetre of the ocean surface, is useful in: monitoring global temperature anomalies, determining impacts of temperature changes on primary production, and informing how air-sea interactions drive changes in weather and climate patterns. At 16.44°C, the global ocean surface temperature for February 2010 was the second warmest on record. Globally, the ocean surface temperature for April 2010 was 0.57°C above the 20th century average of 16.0°C - the warmest temperatures were recorded in the equatorial portions of the major oceans, and particularly in the Atlantic Ocean (NASA 2010b).

Remote Sensing in Oil and Groundwater Exploration

Remote sensing technologies are used in the exploration of oil, gas and minerals. Remote sensing systems are used extensively to search for surface indicators of "leaking" subsurface oil and gas, or to conduct structural geologic analysis to detect subsurface traps where oil and gas accumulate. Remote sensing can also be used to identify oil leaks, spills and seepages and to observe and monitor environmental damage associated with drilling, pumping, pipeline transfer, and refining of hydrocarbons (Short 2007). Many countries in the Arab region (especially the GCC countries, Algeria and Libya), due to their significant oil and gas reserves, have adopted the use of remote sensing technologies, not only for exploration purposes but also for oil spill planning and response.

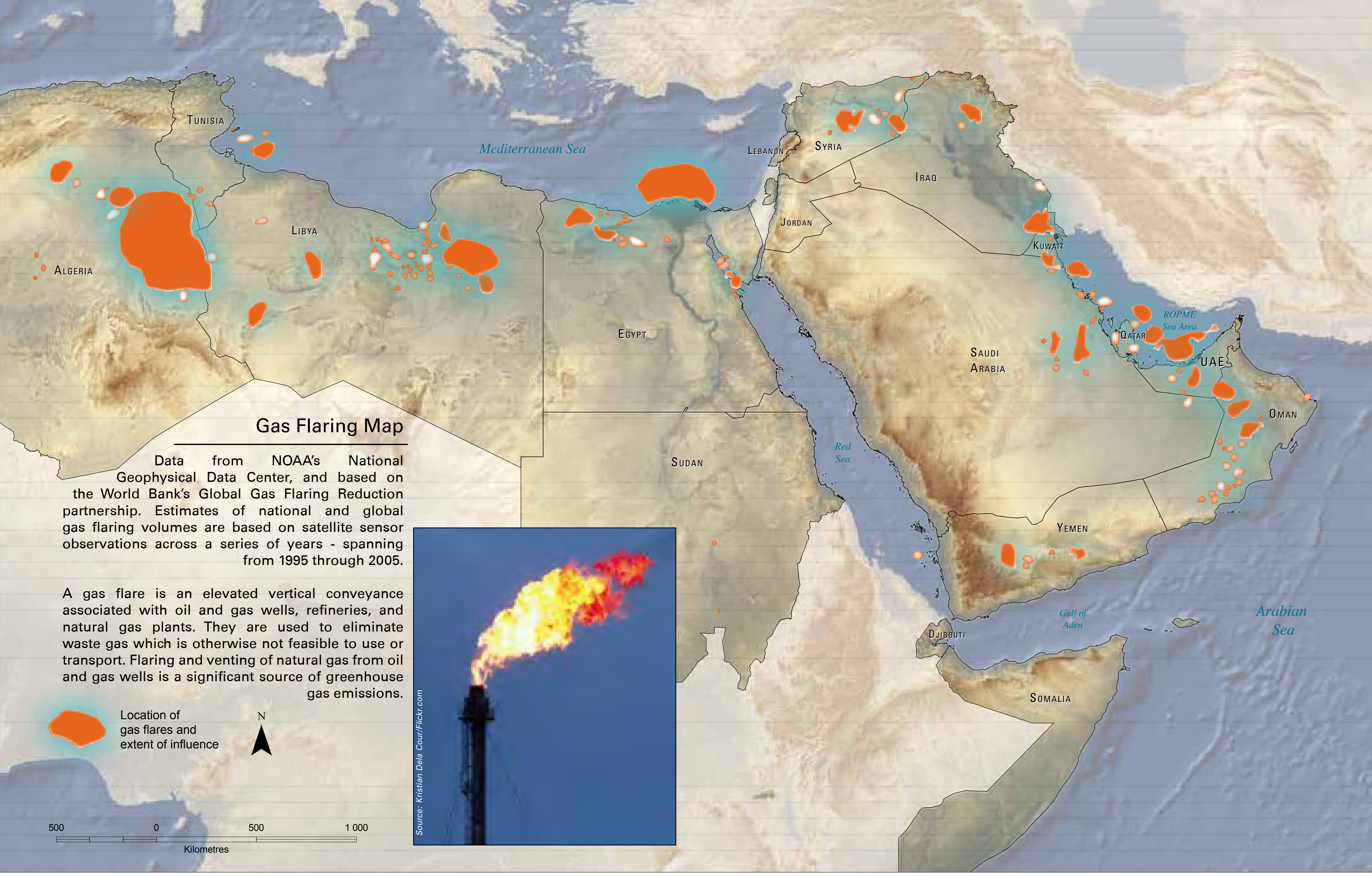
Remote sensing has also played a valuable role in advancing the exploration of groundwater resources. Different types of imagery (Panchromatic, multispectral, thermal and radar) are analysed to identify geological features such as faults and drainage patterns (both active and those filled with runoff water) that may contain groundwater (El-Baz 2000). In Oman, the UAE and Egypt, these technologies have been successfully used to identify groundwater occurrences. The "1 000 Wells for Darfur" project in western Sudan, is using space image data to exploit groundwater resources by selecting the most appropriate well sites, with the aim of establishing peace and economic security in northwestern Sudan (IRC 2007). The Arab Land Data Assimilation System (LDAS), a collaborative project between NASA, the World Bank, the Arab Water Council and others, uses satellite and data assimilating model technology to monitor the water cycle in the West Asia/North Africa region for use in water resource assessments and to monitor changes in surface and groundwater availability (NASA 2009).

Global Sea Surface Temperatures, 2012

Temperatures of the sea surface, with cooler waters appearing in hues of blue and purple and warmer waters in hues of pink to light yellow.

Monitoring Land Use Change in Coastal Areas

In the last few decades, dynamic changes have occurred along the world's coastlines. As of 2003, three thousand million people—or half of the world's population—lived within 200 km of a coastline; by 2025 that figure is likely to double (Creel 2003). As the 'earth at night' imagery displays (shown at the beginning of this section), much of the population of the Arab region is confined to these coastal areas, mostly due to the extensive desert that covers much of the region. Coastal areas along the Mediterranean, Red Sea and ROPME Sea Area are experiencing heavy pressures from population growth and urbanization. Socio-economics play a significant driving role in putting pressure on the coastal zone, for example part of the Nile delta coast is completely re-shaped due to socio-economic and market trends in the last two decades (Abou El-Magd and Hermas 2010) Sea level rise associated with climate change will impact huge areas of Arab coastal lands—in fact, a one-metre rise in sea level is expected to directly affect 41 500 km^2 of coastal area, mostly in Egypt, Tunisia, Morocco, Algeria, Kuwait, Qatar, Bahrain and the UAE (AFED 2009). These climate change scenarios, coupled with increased development of coastal areas, have forged the need to adapt land use regulations and apply remote sensing technologies to monitor coastal land use changes. Time-series satellite imagery and GIS models are being used in urban planning; for example, Oman used satellite imagery from 1991 to 2003 to analyze the extent of urban growth along a narrow strip of coastline (Al-Awadhi and Azaz 2003). These technologies are also being used to monitor mangrove habitat and seagrass beds in the emirate of Abu Dhabi, UAE (Howari and others 2009).



Gas Flaring Map

Data from NOAA's National Geophysical Data Center, and based on the World Bank's Global Gas Flaring Reduction partnership. Estimates of national and global gas flaring volumes are based on satellite sensor observations across a series of years - spanning from 1995 through 2005.

A gas flare is an elevated vertical conveyance associated with oil and gas wells, refineries, and natural gas plants. They are used to eliminate waste gas which is otherwise not feasible to use or transport. Flaring and venting of natural gas from oil and gas wells is a significant source of greenhouse gas emissions.

Source: Kristian Dela Cour/Flickr.com

Remote Sensing in Monitoring Desertification

Desertification threatens over one-third of the Earth's land surface. In 2004, more than one thousand million people worldwide were affected by drought and desertification, and since the 1950s, an estimated US$26 thousand million in agricultural production has been lost to land degradation (UNCCD 2004). The Arabian Peninsula has the highest ratio of desert to total land area in the world (nine-tenths or 90 per cent), followed by North Africa, with over three-fourths of the land, or 78 per cent; and desertification threatens one-fifth of the total area of the Arab countries (2.87 million km^2). Earth observation satellites have provided significant contributions to desertification assessment and monitoring. Many Arab countries are currently using satellite remote sensing and Geographic Information System (GIS) technologies to monitor land cover and vegetation changes and determine rates and types of desertification (vegetation cover degradation, wind erosion, water erosion and soil salinization) (El Hassan 2004). Biogeographic zones of transition between desert and grassland/savanna, such as the Sahel (to the south of the Sahara Desert), provide key points of observation. The Arab Centre for Studies of Arid Zones and Dry Lands (ACSAD) is a regional organization that promotes the dissemination of appropriate technologies, specifically remote sensing and GIS, to monitor and combat desertification.

Gas Flaring

With over 30 per cent of the world's proven natural gas reserves and low production levels, the Arab region will account for some of the largest increases in natural gas production in the coming decades. Natural gas, which is the cleanest fossil fuel, is increasingly comprising a larger proportion of world energy consumption; in 2007, natural gas contributed 21 per cent of global electricity generation, up from 12 per cent in 1973 (IEA 2009).

When crude oil is brought to the surface during the extraction and production process, the associated gas also surfaces and may be used at the installation as fuel, transported elsewhere, or injected into the ground; where there is a lack of gas infrastructure, this associated gas is usually released into the atmosphere by flaring or venting. For years, gas flaring has been an accepted practice in the industry; however, today it is considered to be wasteful and harmful to the environment. Though gas flaring declined by more than 13 per cent between 2005 and 2008, globally it remains a significant issue with over 140 thousand million m^3 of natural gas flared annually, which is equivalent to the combined gas consumption of Central and South America (World Bank 2010). Gas flaring has a global impact on climate change by adding about 363 million tonnes of CO_2 (or around 1 per cent of total anthropogenic CO_2 emissions) in annual emissions. Satellite data are being used to estimate global gas flaring volumes to determine the effectiveness of efforts to reduce gas flaring over time and to improve spatially explicit estimates of anthropogenic carbon emissions into the atmosphere (NOAA 2010c) — the top gas flaring countries in the world identified using satellite data from 2005 to 2008 are: Russia, Nigeria, Iran, Iraq and Algeria (World Bank 2010). Future reductions in gas flaring will lessen the waste of this valuable energy resource and reduce the amount of carbon dioxide emitted into the atmosphere.

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The mountain oasis of Chebika,
southwest Tunisia.

Source: Lansbricae/Flickr.com

Chapter 2

Transboundary Environmental Issues

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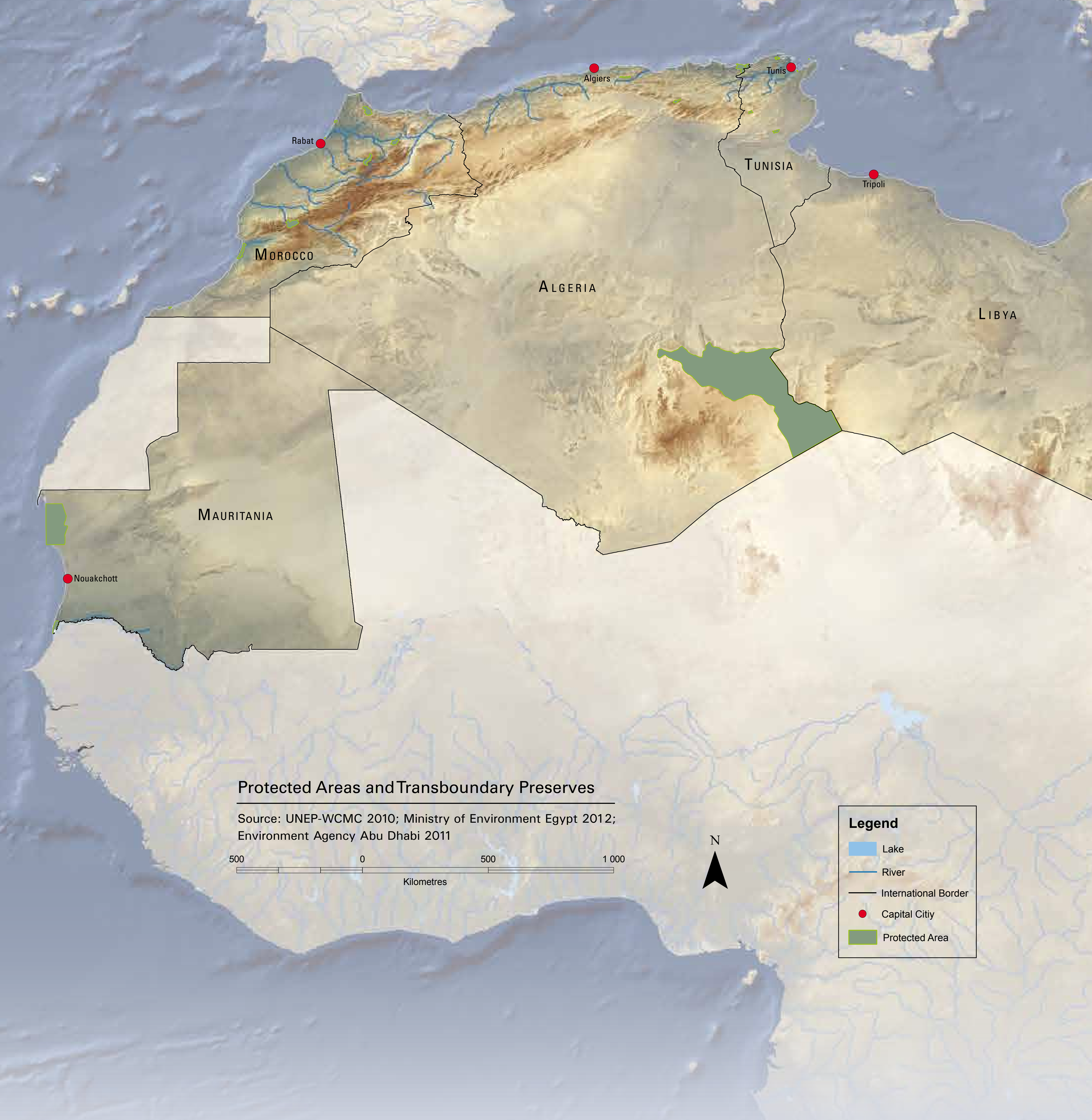
Though the nature of regional or transboundary environmental issues has changed in recent years, transboundary issues are not new to the Arab region. Disputes over resources such as water and land have been a source of local and regional conflict for centuries. The term transboundary refers to the movement 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.

The most pressing transboundary environmental issue in the Arab region is shared water resources. The major shared water basins in the region include the Jordan River, Nile River and the Tigris-Euphrates. 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. 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.

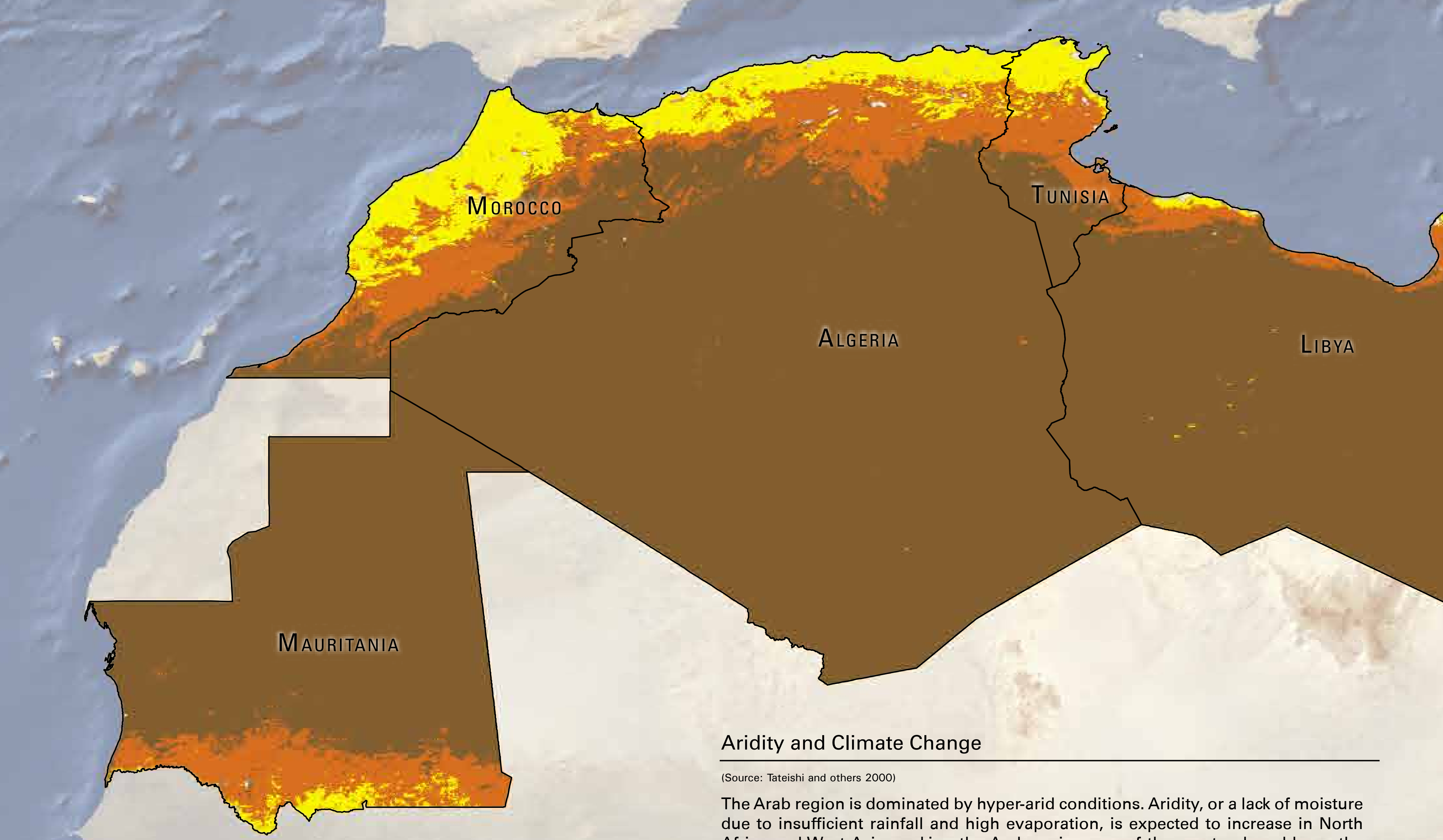
Though some countries in the region have invested in developing alternative water sources such as desalination and reclaimed wastewater, they are not sufficient to meet expected demand. Nations without the means to invest in these alternative water sources are especially vulnerable to depleting groundwater resources, and the conservation of these water resources is vital to their economic and social well-being.



Organizations such as 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.

Human migration in response to environmental degradation or conflict puts

added pressure on the receiving community or country. Foremost among these populations are the Palestinian refugees from 1948 and 1967, Gulf War returnees from Kuwait in 1991, refugees from Lebanon's civil war, and more recently, from Iraq. The League of Arab States recognizes that a unified approach to many of the scarcity and security issues is needed; during the recent 22nd League of Arab States Summit (March 2010), countries reiterated their commitment to protecting pan-Arab national security and adopting active policies for addressing climate change and preserving the environment. A unified approach to addressing resources scarcity and environmental deteriorations is crucial as they can lead to economic decline, decreased agricultural production, movements of people across borders, and threaten the security and sovereignty of a nation. Though these conditions can lead to conflict, they also provide opportunities among countries for cooperation and management. Recognition of the need for instituting formal agreements and developing an integrated approach to natural resources sustainable use and management among Arab governments is the first step toward addressing transboundary environmental challenges.



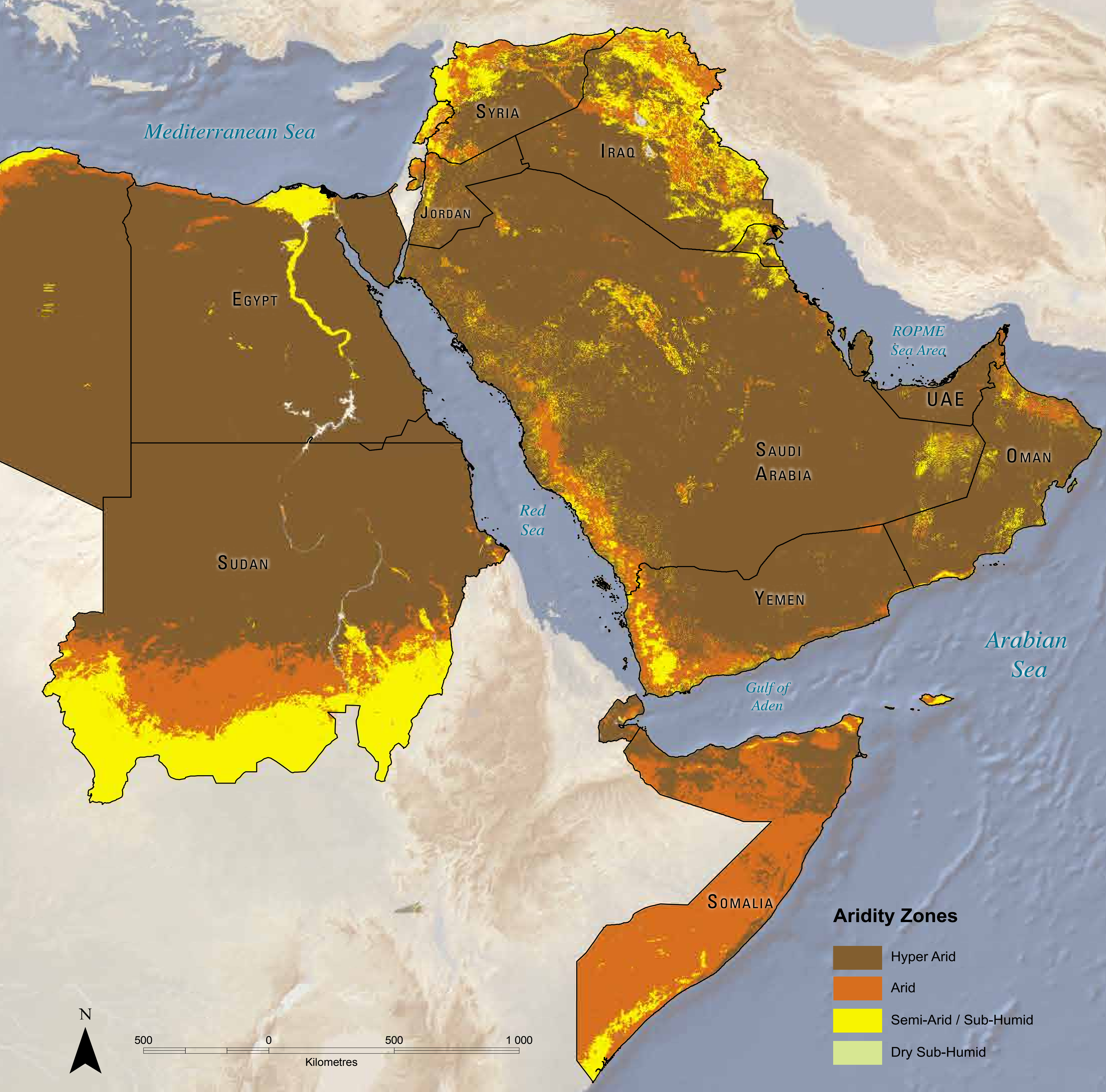
Aridity and Climate Change

(Source: Tateishi and others 2000)

The Arab region is dominated by hyper-arid conditions. Aridity, or a lack of moisture due to insufficient rainfall and high evaporation, is expected to increase in North Africa and West Asia, making the Arab region one of the most vulnerable on the planet to the impacts of climate change. Summers are expected to be drier and hotter, while winters will be shorter and rainfall more erratic. Heat waves will increase in frequency along with extreme weather events. These climatic changes will have significant environmental, ecological and economic impacts that are addressed in this section and throughout Chapter 3.

Source: Allan Donque/Flickr.com

Desert landscape, United Arab Emirates



…today, climate change is already responsible for forcing some fifty million additional people to go hungry and driving over ten million additional people into extreme poverty (Global Humanitarian Forum 2009)

2.1 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.

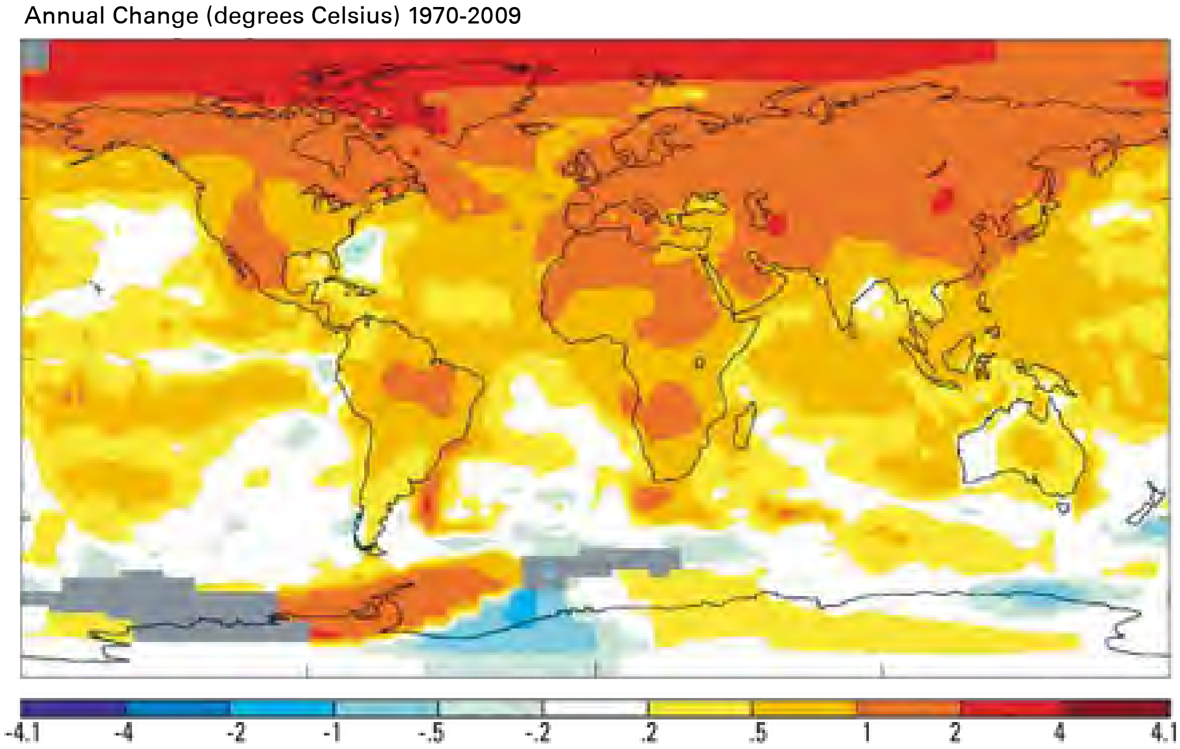
The region's biodiversity is expected to be another casualty of global warming—a 2°C increase in temperature could cause up to 40 per cent of all species in Arab countries to become extinct (AFED 2009). Natural ecosystems especially at risk due to climate change include the coastal mountain ranges of the Red Sea, the cedar forests of Lebanon and Syria, mangroves in the ROPME Sea Area, reed marshes in Iraq, the mountain ranges in Yemen and Oman and all the major river systems (AFED 2009). These areas provide niche habitats and contain unique species assemblages that are restricted in scope and are already at the margin of their ecological tolerances. Rainfall patterns are also predicted to shift with global climate change with a projected decrease in the Arab region of between 0 and 20 per cent. Reduced rainfall coupled with higher temperatures may decrease water flows in the Euphrates and Jordan rivers by 30 and 80 per cent, respectively, by the end of this century (IPCC 2007) - the Fertile Crescent lands (Iraq, Syria, Lebanon, Jordan and the Occupied Palestinian Territories), which depend upon these vital surface waters, will lose fertility due to lack of water and soil erosion. Most of the Arab region's freshwater resources are used for irrigation - lowered precipitation and higher temperatures will exacerbate the pressures on food and animal production in the region.

Higher temperatures will also cause sea level rise of between 0.5 to 4 m, resulting in huge losses in coastal zones that support many of the population centres, agricultural areas and economic centres. A one metre sea level rise could cause the loss of 12 to 15 per cent of agricultural lands in the Nile Delta region alone, and reduce agricultural productivity of the entire Arab region by 20 per cent. The most serious impacts of sea level rise are expected in Egypt, Tunisia, Morocco, Djibouti, Algeria, Kuwait, Qatar, Bahrain and the UAE - even at the optimistic low sea level rise scenario of 0.5 m, low-lying areas will be inundated and inhabitants in cities such as Alexandria, Egypt will be displaced. Djibouti's population is already regularly buffeted by tropical storms from the Indian Ocean, which are expected to increase in frequency and intensity. With 7 per cent of the population living less than 5 m above sea level, Djibouti will be increasingly vulnerable to inland flooding. Qatar, on the ROPME Sea Area, is also extremely vulnerable to rises in sea level, with 18 per cent of its land area and 14 per cent of its population less than 5 m above sea level. Similarly, 10 per cent of Bahrain, or 74 km^2 of the small 741 km^2 island nation may be inundated (Al-Jeneid and others 2007).

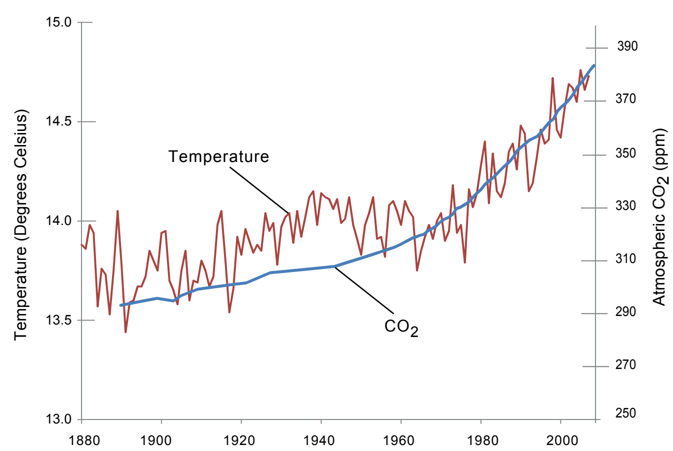
Climate change will increase competition for many resources within and across borders, and cause displacement of populations, increasing the risk of conflict in the region. Though most Arab nations have ratified relevant conventions and signed significant protocols on climate change, urgent measures need to be implemented that include information acquisition, public awareness, and defining impacts that can be developed into effective policies (AFED 2009). Increasing the Arab region's preparedness through activation of the United Nations Framework Convention on Climate Change (UNFCCC) 'Adaptation Fund' is one of several approaches that governments are taking, using funds to implement adaptation projects and programs. Yemen is implementing the Pilot Program for Climate Resilience (PPCR) as part of a World Bank program to fund developing countries to prepare national-level strategic programs for climate resilience and build capacity for implementing them.

Examples of extreme weather conditions related to climate change: forest fires in Lebanon and flooding in Oman.

Annual Change (degrees Celsius) 1970-2009



Map sources and parameters: NASA GISS 2007; GHCN_GISS_HR2SST_1200km_Trnd1212_1970_2009



Average Global Temperature and Atmospheric Carbon Dioxide Concentrations, 1880-2007. The relationship between global temperature and atmospheric carbon dioxide concentrations since the beginning of the Industrial Revolution in 1880 until 2007. As CO_2 levels rise, temperatures also increase. The accumulation of CO_2 and other Green House Gases (GHG) contribute to global warming.

Source: NASA GISS 2007; NOAA/ESRL 2010

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.

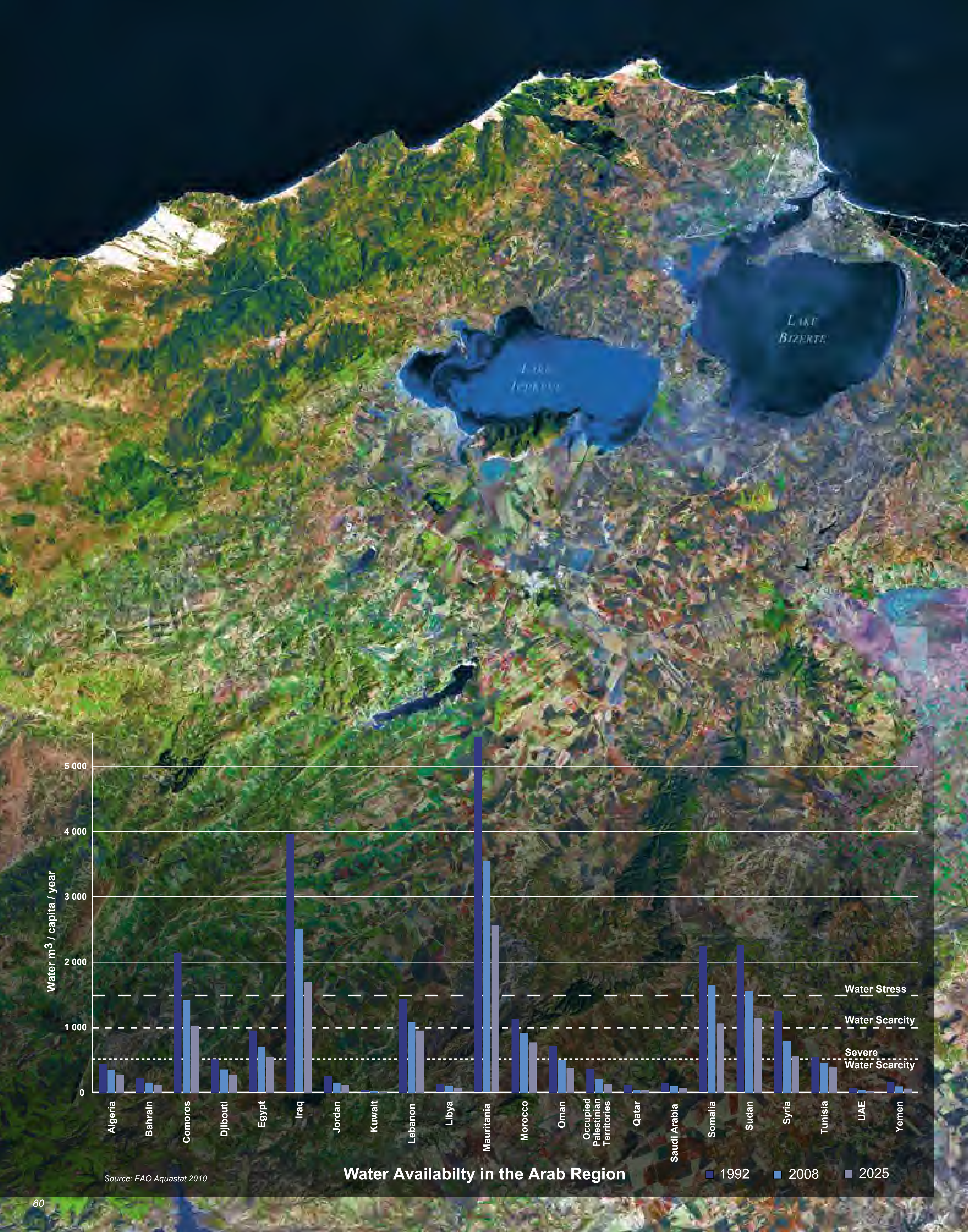
Small Island Developing States- The Case of the Comoros

More than one-third of the world's population (2.8 thousand million) is physically vulnerable to climate change, and inhabit areas of the world that are prone to floods, storms, droughts and sea-level rise (Maplecroft 2009). Small Island Developing States (SIDS) are among the most vulnerable to climate change—the Comoros Islands, situated between Mozambique and Madagascar in the Indian Ocean, are no exception. In the Comoros, pressures on natural resources are already high and there is limited capacity to adapt to the impacts of changes in climate due to poor land quality, low crop production, low yields, water stress and a growing population. Beaches on the Comoros Islands are eroding due to increased wave intensity and abnormal tidal ranges (UNEP 2005a). A 1 m rise in sea-level in the Comoros would cause 7.34 km^2 of low-lying coastal areas to be flooded (UNFCCC 2002). Sea-level rise will also result in migration and displacement of inhabitants along the coastal zones (home to over 40 per cent of the country's population), loss of livelihoods, increased water-related diseases, and loss of coastal lands, agricultural areas, groundwater resources (due to seawater intrusion into groundwater systems) and biodiversity (UNFCCC 2005).

Source: UNEP/GRID and others 2000

Impact of sea level rise in the Nile Delta, Egypt

The Nile Delta is formed where the Nile River empties into the eastern Mediterranean Sea. It is the most important agricultural region of Egypt and is also one of the most densely populated places on Earth, with 50 million people and a density of 1 545 inhabitants per square kilometre. The delta's 270 km-long coastline lies only 0 to 1 m above sea-level in places and is lined with lagoons and sand belts. The 1 to 10 km-wide coastal sand belts, shaped by discharge of the Rosetta and Damietta branches of the Nile, are eroding and will be further compromised by sea-level rise. These belts provide essential protection of lagoons and low-lying reclaimed lands. Rising sea-levels will inundate large areas of valuable agricultural lands in the delta—a sea-level rise of 0.5 m will inundate the coastal cities of Alexandria, Damietta and Port Said, and a rise of only a few metres will threaten El Mansura, El Mahalla el Kubra, Damanhur, Tanta, Kafr el-Sheikh, Shirbin, Burg el Arab and El Qantara Shark. Important industry and shipping facilities in the delta will also be threatened. Sea-level rise will also impact water quality and affect fisheries in the lagoons, which comprise one-third of Egypt's fish catches. Groundwater salination and impacts to recreational tourism along Egypt's coasts are also expected. These maps show areas of the Nile Delta that would be inundated under different sea-level rise scenarios (0.5 and 1.0 m) and the effects.



Water Availabilty in the Arab Region

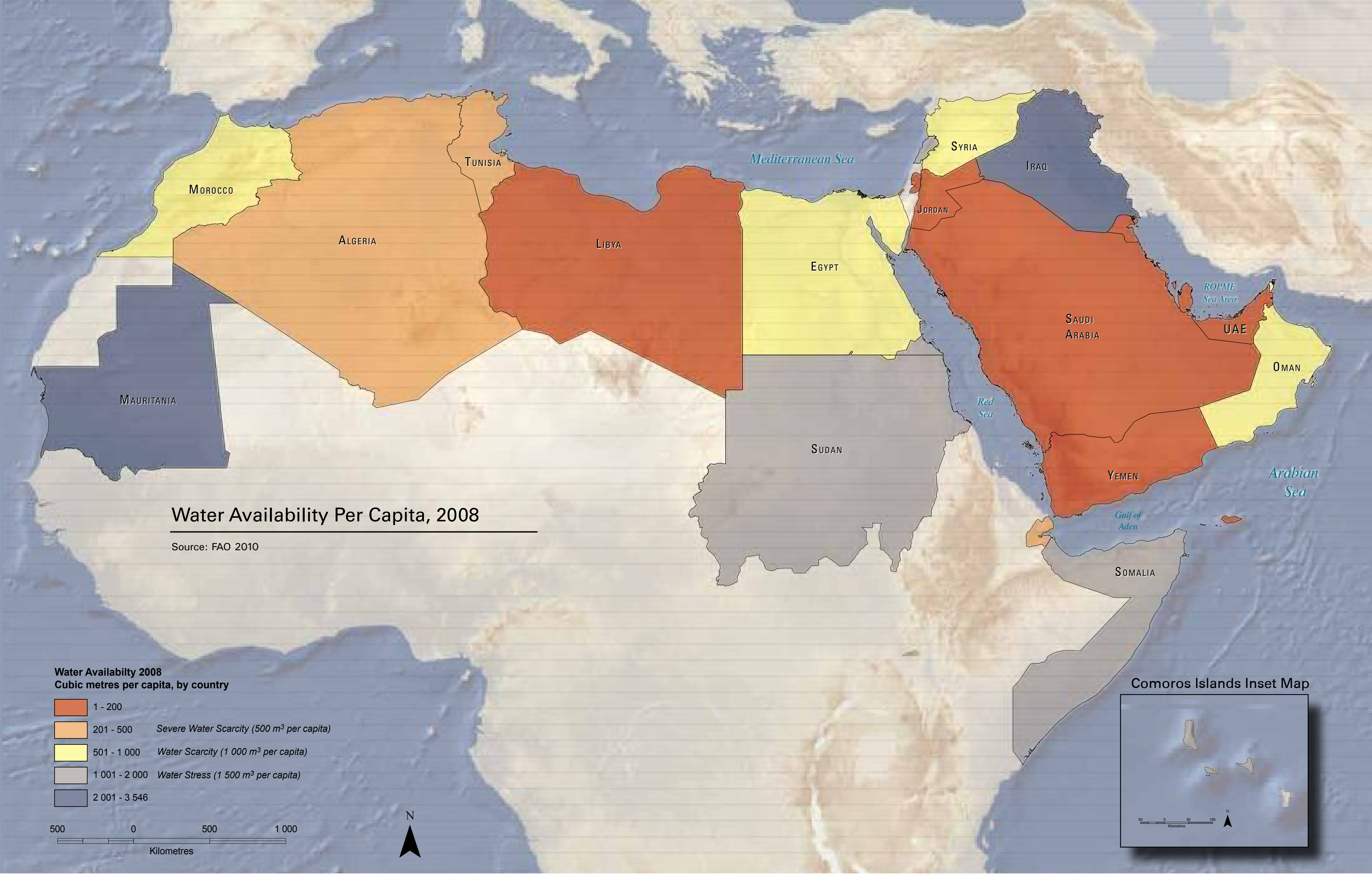
Source: Landsat TM Mosaic

2.2 Water

Water Resources and Pollution

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 below 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. 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.

This vivid Landsat satellite image, derived from data collected over several months in 2001, uses a collection of approximately 7 461 high-quality images to create a seamless mosaic that centres on the North African country of Tunisia. The image focuses specifically on Tunisia's northern coastal plains along the Mediterranean Sea and the country's capital city of Tunis. This data set was derived from a NASA remote-sensing device. Surface observations were collected and combined every eight days (to compensate for clouds that can block the sensor's view) to produce a high-resolution image of the Earth's surface. This image displays extensive agricultural lands in the northern valleys around Lake Ichkeul and Lake Bizerte and around Tunis (shown in different shades of green), where the Medjerda River flows out of the Atlas Mountains. Northern Tunisia and the Medjerda River Basin produce almost all of the country's agriculture, which is dominated by livestock, trees (olive, almond, and fig), vegetables and cereals; this region is experiencing an intensification of agriculture and the amount of irrigated area is increasing rapidly (Bouraoui and others 2005). The Medjerda River, a vital water source for the entire country, is being contaminated with industrial and agricultural pollutants as well as heavy metals and arsenic from mining activities in northwest Tunisia and mining districts in Algeria (Jdid and others 1999). Lake Ichkeul, a freshwater lake that provides important habitat for many migrating birds, is threatened by dams on rivers that feed the lake, increased salinity and agricultural encroachment of its marshlands.



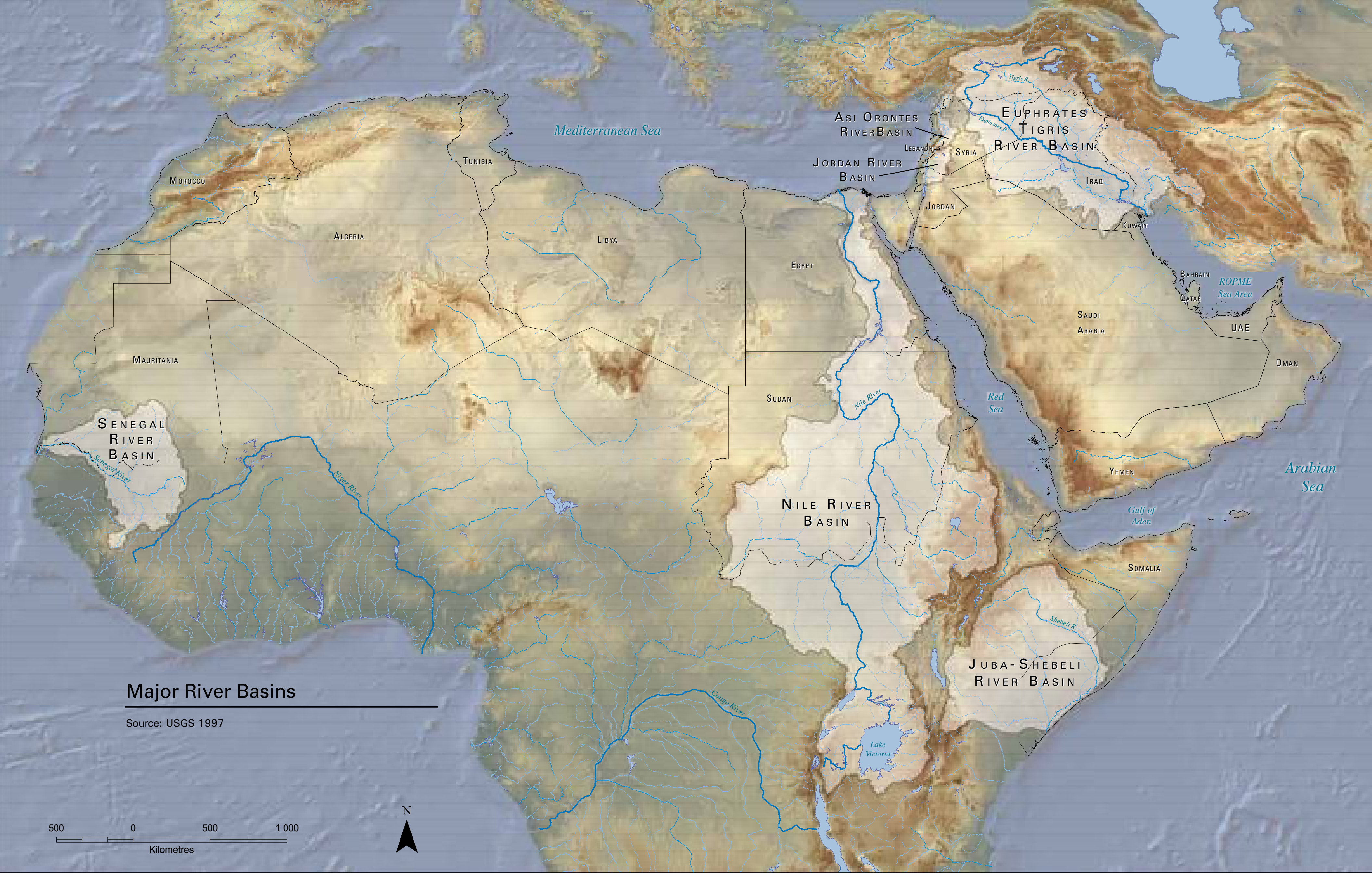
Water Resources

The Arab region encompasses six major river basins that originate outside of the region; the Jordan, Nile, Euphrates and Tigris, Juba-Shebeli, Senegal and the Asi-Orontes. The overall water resources of these rivers constitute about 66 per cent of the total freshwater resources in the Arab region (ACSAD 2008)—the dependency ratio of renewable freshwater originating from outside Syria, Mauritania, Iraq and Egypt is above 70 per cent (UNEP/GRID 2009). (The dependency ratio is a good indicator of where tension and conflict over water-sharing and use can occur; generally, the higher the dependency ratio, the higher the potential for conflict.) Syria, Iraq and Egypt, which are the main agricultural producers in the Arab region, depend heavily on waters from the Euphrates, Tigris and Nile rivers. In Syria, the major irrigated areas are located within the shared river basins of the Asi-Orontes, Euphrates and Nahr el Kabir Janoubi. Any future conflict that interrupts the free flow of these rivers could severely undermine the livelihood of farmers as well as the economic stability of these countries.

The five river basins that are shared among Arab countries include: the Asi-Orontes, Nahr El Kabir Janoubi, Yarmouk (a tributary of the Jordan), Jordan and Medjerda rivers (Tunisia). A majority (82 per cent) of total surface water resources in the Arab region are shared (ACSAD 2008). With respect to groundwater, almost all the major aquifers are shared between the Arab countries and with neighbouring countries. The major aquifers in the region are displayed in the following pages. The sharing of water resources is further complicated by regional disputes, contested borders and land occupation. Foremost among these is the Israeli/Palestinian dispute over West Bank aquifers, and the Syrian/Israeli conflict over the Golan Heights (Israel withdraws about 30 per cent of its water needs from the Golan Heights). Another threat to shared water resources is the overall deterioration in water quality due to lack of adequate sanitation systems and treatment plants, which constitute a threat to human health—almost all the rivers in the region are used as sewage systems without adequate treatment.

Growing water scarcity and the heavy reliance of Arab countries on surface water that originates outside the region, coupled with the lack of treaties for almost all the river basins and groundwater aquifers, presents a significant social, economic and environmental threat to the region. There is a pressing need to finalize treaties and implement integrated approaches to water resources management and planning. Transboundary water disputes are extremely complex and involve issues of sovereignty, individual and collective rights, economic growth and power. Consequently, transboundary water resources management requires an enabling environment that encourages cooperation between affected nations rather than entering into conflict. Strengthening integrated water resources management and improving water governance at the national level would facilitate more effective and efficient water resources management.

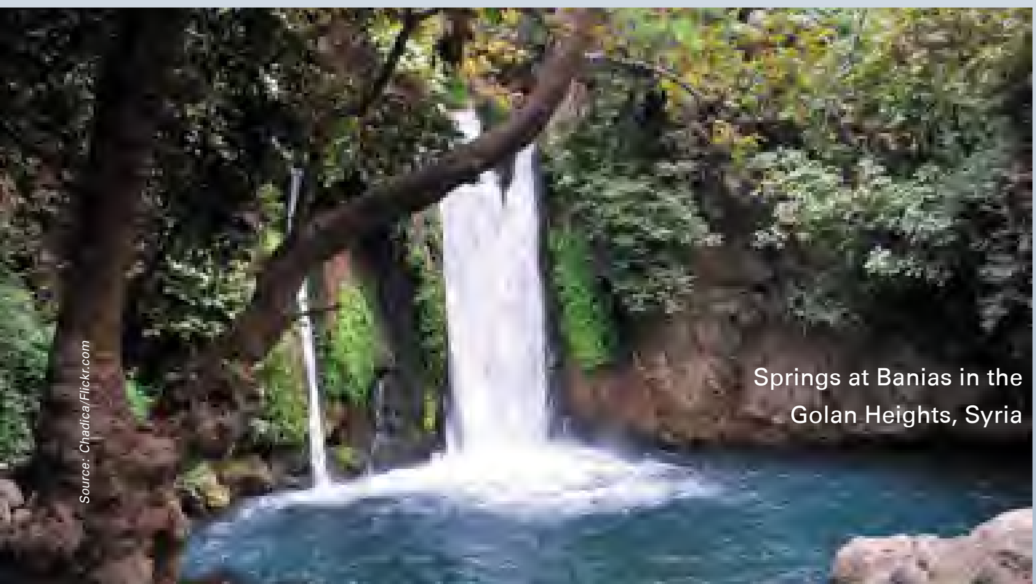
In 1995, the former World Bank Vice President Ismail Serageldin claimed



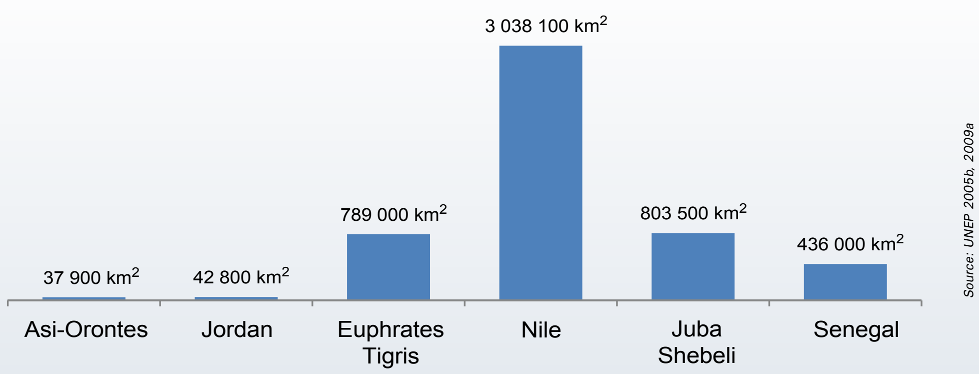
Major River Basins

Source: USGS 1997

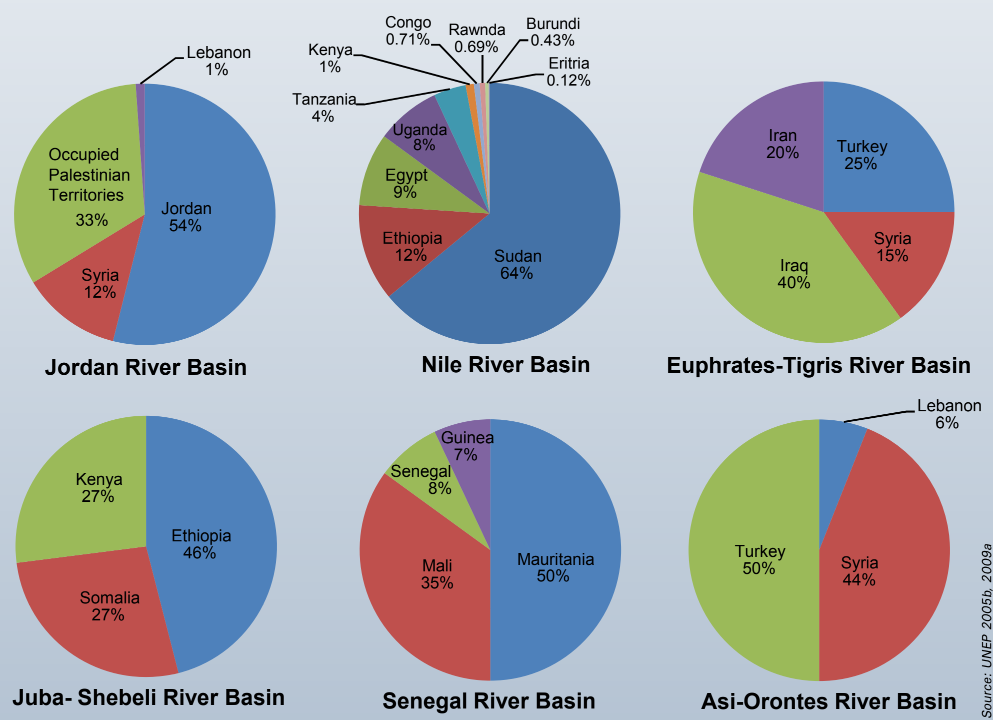
that "the wars of the next century will be about water". Though there are cases where conflicts have arisen over water resources, the need for cooperation among riparian nations to jointly manage their shared water resources provides an opportunity to build trust and prevent conflict. In fact, a 2003 study found that of the international water incidences in transboundary basins, a majority favoured cooperation (1 228), while 507 resulted in conflict (Wolf and others 2003). Within nations, the potential for conflict by water users can also arise—nowhere is this more apparent than in Yemen, where recent clashes over water shortages have resulted in a number of deaths. Seventy to eighty per cent of rural conflicts in Yemen are attributed to water and less than half of the rural population has access to an adequate supply of water (Kasinof 2009). With limited rainfall, quickly depleting underground water supplies, continued drought and inefficient agricultural practices, the civil unrest associated with water shortages can be expected to continue in Yemen.



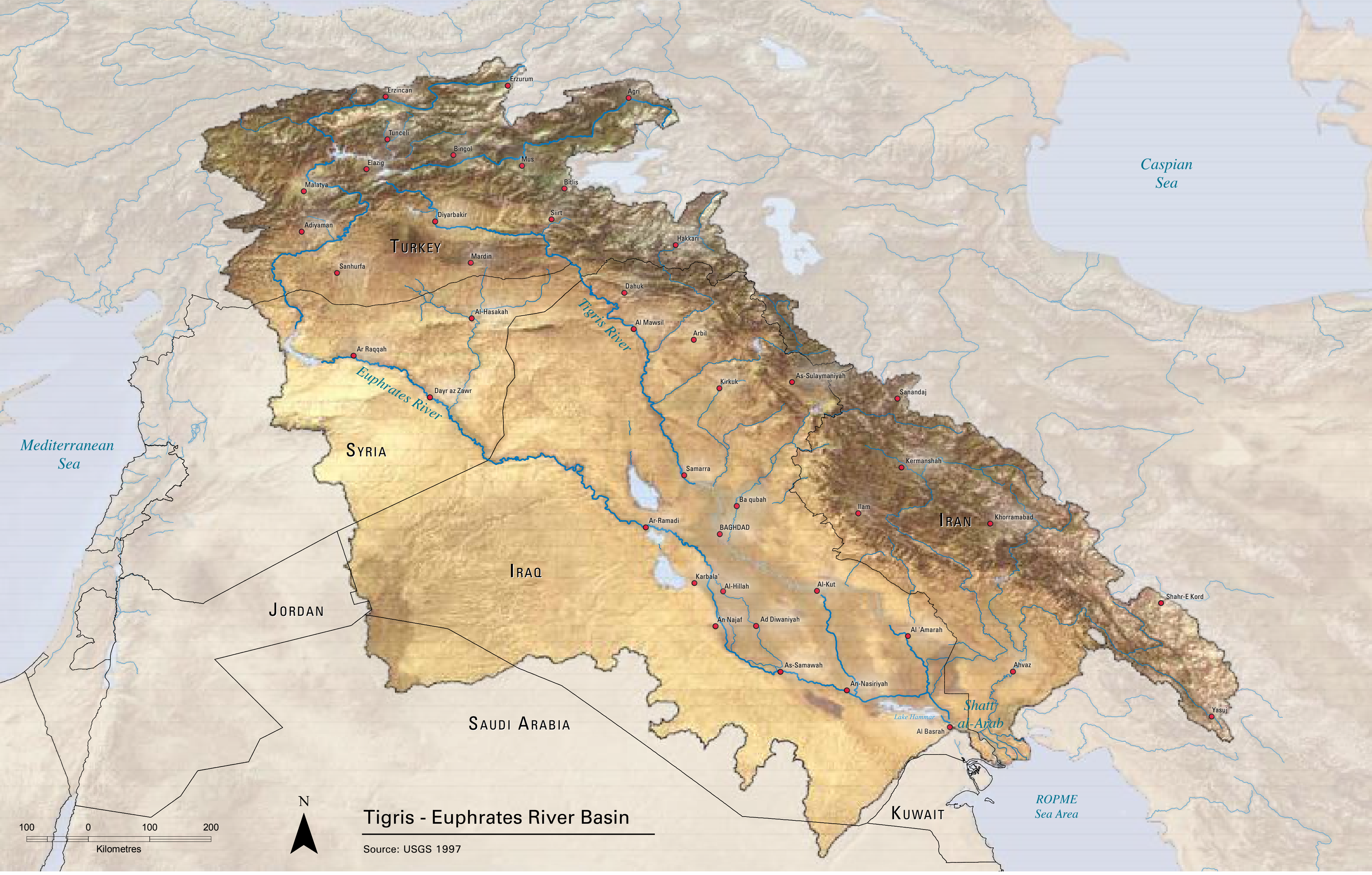
Springs at Banias in the Golan Heights, Syria



Comparison of total area (sq. km) of the six major river basins in the Arab region



Percentage of river basin area within countries for the six major river basins in the Arab region. Significant area of the river basins originate outside of Arab countries.



Euphrates River Basin

With a length of 2 700 km, the Euphrates River is the longest river in southwest Asia, running through Turkey, Syria and Iraq. Turkey contributes almost 98 per cent of the water carried by the Euphrates River. The two Syrian tributaries, the Khabur and the Balikh, also have their catchments in Turkey. The average annual flow across the Turkish-Syrian border is about 29.8 BCM (UNEP 2009a). No other tributaries flow into the Euphrates after the Khabur, except in Iraq, where some of the Tigris' waters are added to the Euphrates. After entering Iraq, the river runs to the city of Hit and travels 753 km to the delta in the ROPME Sea Area. The Euphrates loses a major portion of its waters to irrigation canals and to Lake Hammar (in Iraq). The Euphrates River catchment area covers about 444 000 km^2 (ACSAD-UNEP 2001).

As a major supplier of surface water for Turkey, Syria and Iraq, the Euphrates River has been a source of continuing conflict among these three countries—the risk of water shortages constitute one of the most strategically important security issues of these nations. Increased damming of the Euphrates for agriculture, hydroelectric power and industrial needs, has significantly reduced the amount of water that flows downstream. Syria and Iraq depend heavily on these waters; Syria obtains approximately 85 per cent of its renewable water supply from the Euphrates-Tigris river systems, while Iraq obtains 100 per cent. Turkey's implementation of the GAP Project, also called the Southeastern Anatolia Project, is the most contentious issue with respect to water-sharing in the basin. The GAP Project is a massive US$32 thousand million hydroelectric and irrigation project that includes the construction of 22 dams and 19 hydroelectric power plants on the Euphrates and Tigris rivers and their tributaries—the scheduled completion has been delayed until 2047. Syria and Iraq are concerned about the substantial reduction in downstream river flows; according to Iraq's Water Resources Ministry, the Ilisu part of the GAP project will reduce the Tigris River waters by 47 per cent per year, depriving the Iraqi city of Mosul of about 50 per cent of its summer water requirements (Daly 2008). Full implementation of the GAP project is expected to withdraw up to 70 per cent of the Euphrates' natural flow. Lack of flow in the Euphrates River will also compromise Syria's ability to irrigate its agricultural lands and produce hydroelectricity (Syria relies on high water levels in Assad Lake to sustain hydroelectric production). The Protocol of 1987 was the first bilateral agreement between Turkey and Syria. In the agreement, Turkey committed to releasing a yearly average base flow of approximately 16 BCM over the Syrian border. Syria and Iraq reached a water-sharing agreement soon thereafter in which 58 per cent of the waters were allocated to Iraq and 42 per cent to Syria. In several instances, Turkey has limited these flows of water, bringing Syria and Turkey to the brink of war. Water quality was not considered in the bilateral agreements, and has become a major concern for Syria and Iraq. Water salinity is increasing, especially along the Syrian-Iraqi border, where it exceeds 1.0 g/l, due largely to irrigation waters. Pollution from upstream pesticide and fertilizer use is also compromising the water quality in the basin (Guner 1997).


Source: Shay Haas/Flickr.com

Euphrates River

Climate change has emerged as an increasingly challenging threat to water availability in the river basin. Expected global climate change scenarios indicate that catchment areas in Turkey will face a reduction in precipitation of about 20 per cent, an increase in temperature and an increase in evaporation rates (IPCC 2007). These changes will have numerous adverse impacts, particularly on agriculture and water management in the basin.

Tigris River Basin

The Tigris River originates in southeastern Turkey only about 30 km from the headwaters of the Euphrates. The river drains an area of 471 606 km^2 that is shared by four countries (Turkey, Syria, Iraq and Iran). The Tigris flows for 523 km through Turkey before it enters Syria for 44 km, forming the northeastern part of the border between Syria and Turkey, and then flows for 1 418 km in Iraq. The Tigris has four main tributaries: the Upper Zab, which originates in Turkey; the Lower Zab, which originates in Iran; the Diyala, which flows from Iran and Iraq; and Adhaim, which also originates in Iraq. The Adhaim joins the Tigris River about 80 km north of Baghdad, while the Diyala River meets the main stem in Baghdad. The Upper and Lower Zab join the main stem of the river south of Mosul in Iraq (ACSAD-UNEP 2001). The discharge of the Upper and Lower Zab tributaries make up about 50 per cent of the discharge of the Tigris at Baghdad (Beaumont 1998). The majority of the total catchment area of the Tigris River occurs in Iraq (ACSAD-UNEP 2001). The Tigris joins the Euphrates River in southeastern Iraq, where it forms the Shatt al-Arab (the catchment is about 19 000 km^2, and continues 180 km until it empties into the ROPME Sea Area) (Murakami 1995).

Turkey contributes around 52 per cent of the Tigris' flow, with Iraq contributing 48 per cent and Syria contributing none of the flow (Asit 1994). The period of greatest discharge for the Tigris system is from March through May—minimum flow conditions are experienced from August through October. Flow is also variable from year to year. Some of the waters of the Tigris River have been diverted to the Euphrates River through an artificial canal, El Tharthar, and the irregular water flow from the tributaries makes the Tigris a very unstable and unreliable river in terms of annual flow and floods (Kor 1997).

The Tigris has been heavily dammed by Iraq; one of the larger operational dams is the Mosul Dam, which is used in hydropower production, irrigation and flood control. Turkey plans to build extensive hydroelectric projects along the river, as described under the Euphrates River section. The government of Syria is currently evaluating water supply projects. A recent agreement has been signed by Syria and Turkey (and supported by Iraq) that permits Syria to irrigate about 150 000 ha by pumping about 50 m^3 per second from the Tigris River. No agreements have been reached, to date, with Iran for sharing waters that originate in the Lower Zab tributary. With most of the water extracted from the Tigris River being used for irrigation, there is a potentially serious problem with regard to the quality of the irrigation return waters. In general, about 20 per cent of the water that is applied for use in irrigation, drains off the fields and makes its way into adjacent water courses or percolates into the groundwater. These waters carry a variety of chemicals, including pesticides, herbicides and petroleum products.


Source: jmcfall/Flickr.com

Tigris River


Source: Shay Haas/Flickr.com

Euphrates River

Nile River Basin

The Nile River is the longest river in the world with a length of 6 850 km and a catchment area of 3 007 000 km^2, which covers approximately 10 per cent of the African continent. The water of the Nile comes principally from two sources: the Equatorial Plateau and the Ethiopian Highlands, both of which receive large amounts of rain. The Nile River Basin is shared by ten riparian countries and consists of two sub-basins: the White Nile and the Blue Nile, which converge in Sudan and feed into Egypt as a single river. Almost 200 km before discharging into the Mediterranean Sea, the river bifurcates and its branches encompass the Nile Delta, where the majority of Egypt's population and agricultural lands are located (see the Egypt section in Chapter 3).

Egypt and Sudan are extremely dependent upon waters from the Nile and have the highest dependency ratios of all Nile Basin countries, at 97 per cent and 77 per cent respectively. Given that most of their water resources originate outside of their borders, Egypt and Sudan are extremely vulnerable to any upstream changes in water management and use. The Nile provides the basis of agricultural development for Egypt and northern Sudan, as such, the Nile River is integral to those populations' livelihoods and food security. Egypt's construction of the Aswan High Dam, completed in 1970, impounded a reservoir, Lake Nasser, which has a gross capacity of 169 BCM and yields waters for irrigation and power generation. The dam also impounds floodwaters to the Nile Delta, which has resulted in the gradual decrease in the fertility of these agricultural lands. To compensate, Egypt applies an estimated 1 million tons of artificial fertilizers to substitute for the 40 million tons of silt that were formerly deposited annually by the enriching floodwaters of the Nile. Other impacts to water quality in the Nile are discussed in Chapter 3 and include increased salinity downstream and heavy inputs of untreated wastewater and industrial wastes (Brown and others 2003).

Basin-wide cooperation among the riparian countries began in the 1950s. A 1959 treaty between Egypt and Sudan secured 55.5 BCM of water per year for Egypt (at the Sudanese border), and 18 BCM per year for Sudan, along with 10 BCM annually for seepage and evaporation. Cooperation among riparian countries is crucial as the region faces continued drought, growing populations, desertification and land degradation, pollution increases, and the effects of climate change. These factors will intensify the reliance and competition for the Nile's resources. The Nile Basin Initiative (NBI) was established in 1999 by the ten riparian countries to achieve sustainable socio-economic development through the equitable utilization of the Nile Basin waters—many cooperative projects have been undertaken in the past 20 years in recognition of the need to adequately and efficiently manage the water resources of the Nile River.

Nile River Basin

Source: USGS 1997

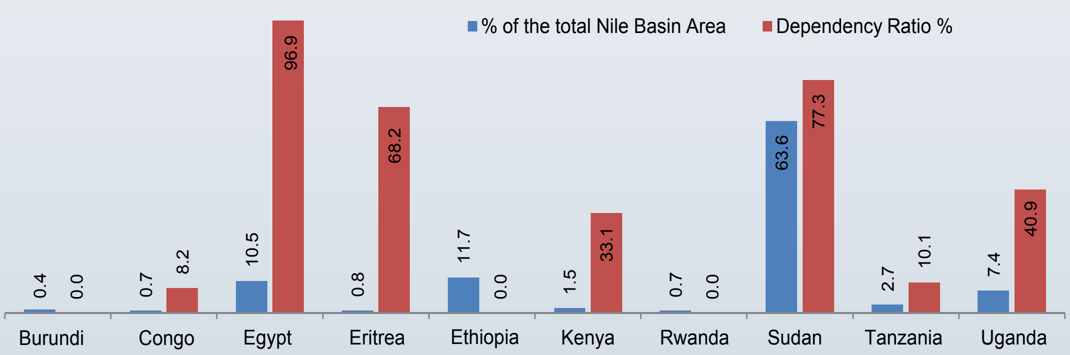
ASI-ORONTES RIVER BASIN

The Asi-Orontes River Basin is shared among Lebanon, Syria and Turkey and covers approximately 37 900 km^2 (Wolf and others 1999) of which 6 per cent is in Lebanon, 44 per cent is in Syria and 50 per cent is in Turkey (UNEP 2009a). The Orontes River originates in Lebanon, and then courses through Syria from south to north and then into Turkey where its empties into the Mediterranean Sea. The Orontes River and its tributaries collect runoff from the highlands and plateaus located on both sides of the rift valley. The average annual flow is estimated at 2 400 MCM, equivalent to about 80 m^3/s with a minimum and maximum discharge of 10 and 400 m^3/s respectively (FAO 2006a).

A 1994 bilateral treaty between Lebanon and Syria allocates water use and provides for the construction of a dam on the Orontes in Lebanon that allocates 80 MCM to Lebanon (provided the flow of the river does not drop below 400 MCM) to irrigate 6 600 ha. If the water flow drops below 400 MCM, the Lebanese share is reduced by 20 per cent; essentially the risk of drought is borne by Lebanon (ESCWA 2001). Water quality is managed by a joint technical committee. On the lower parts of the river, concentrations of ammonia, suspended solids and biological oxygen demand (BOD) exceed allowable limits, likely due to heavy inputs of chemical fertilizers and insecticides as well as solid waste. An agreement between Syria and Turkey was finalized in 2001 to cooperate on technical issues and identify joint future projects. Recently, the two countries agreed to construct a dam to share water and hydropower.

Asi-Orontes River Basin

Source: USGS 1997



Country Area Percentage of the Nile River Basin and Water Dependency Ratios

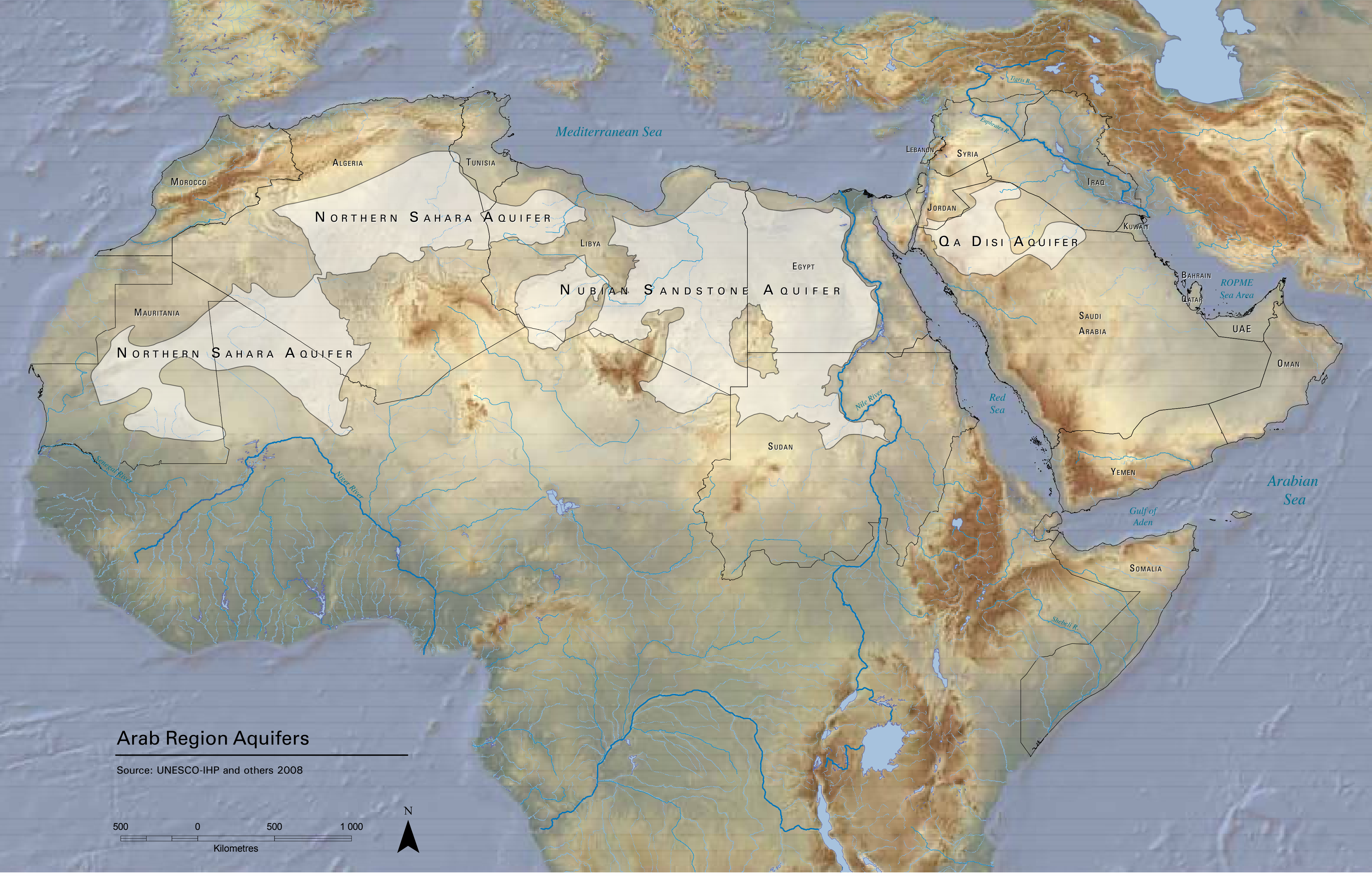
Source: FAO 1995 and 1997 in UNEP/GRID 2000

Source: Hovic/Flickr.com

Asi-Orontes River, Syria

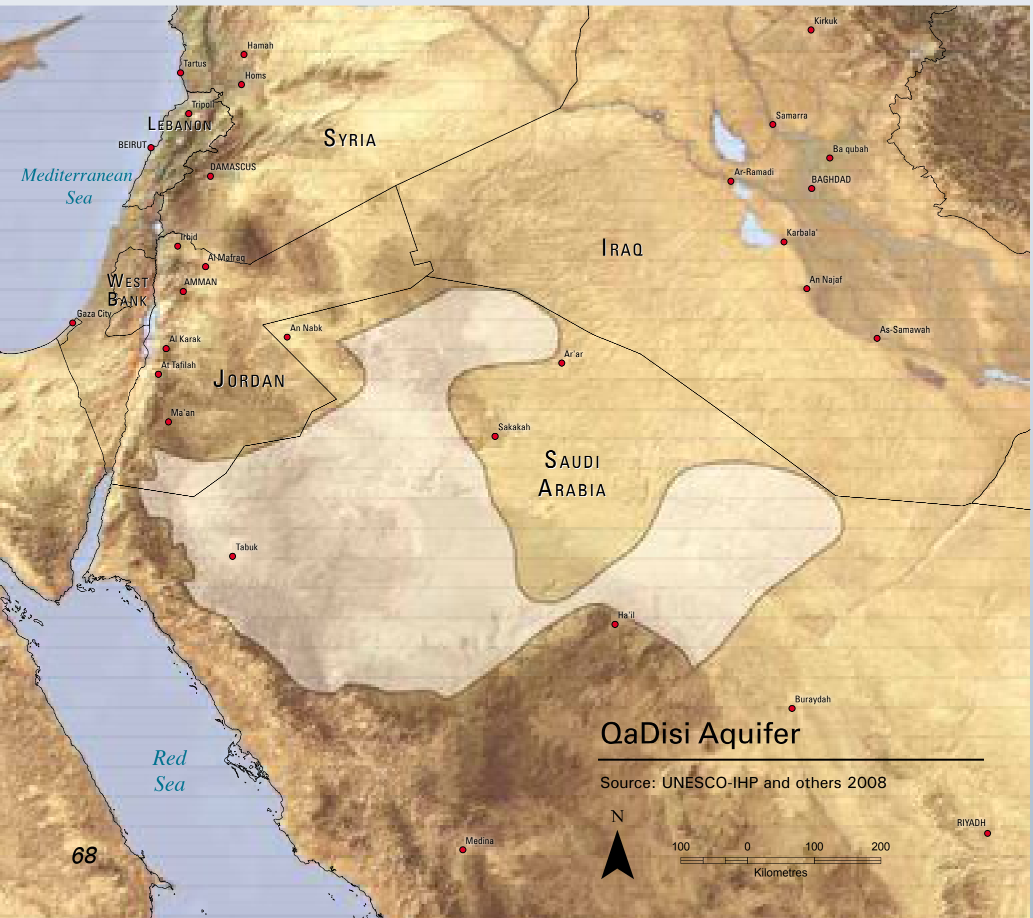
Source: Michael Gwyther-Jones/Flickr.com

Nile River, Egypt



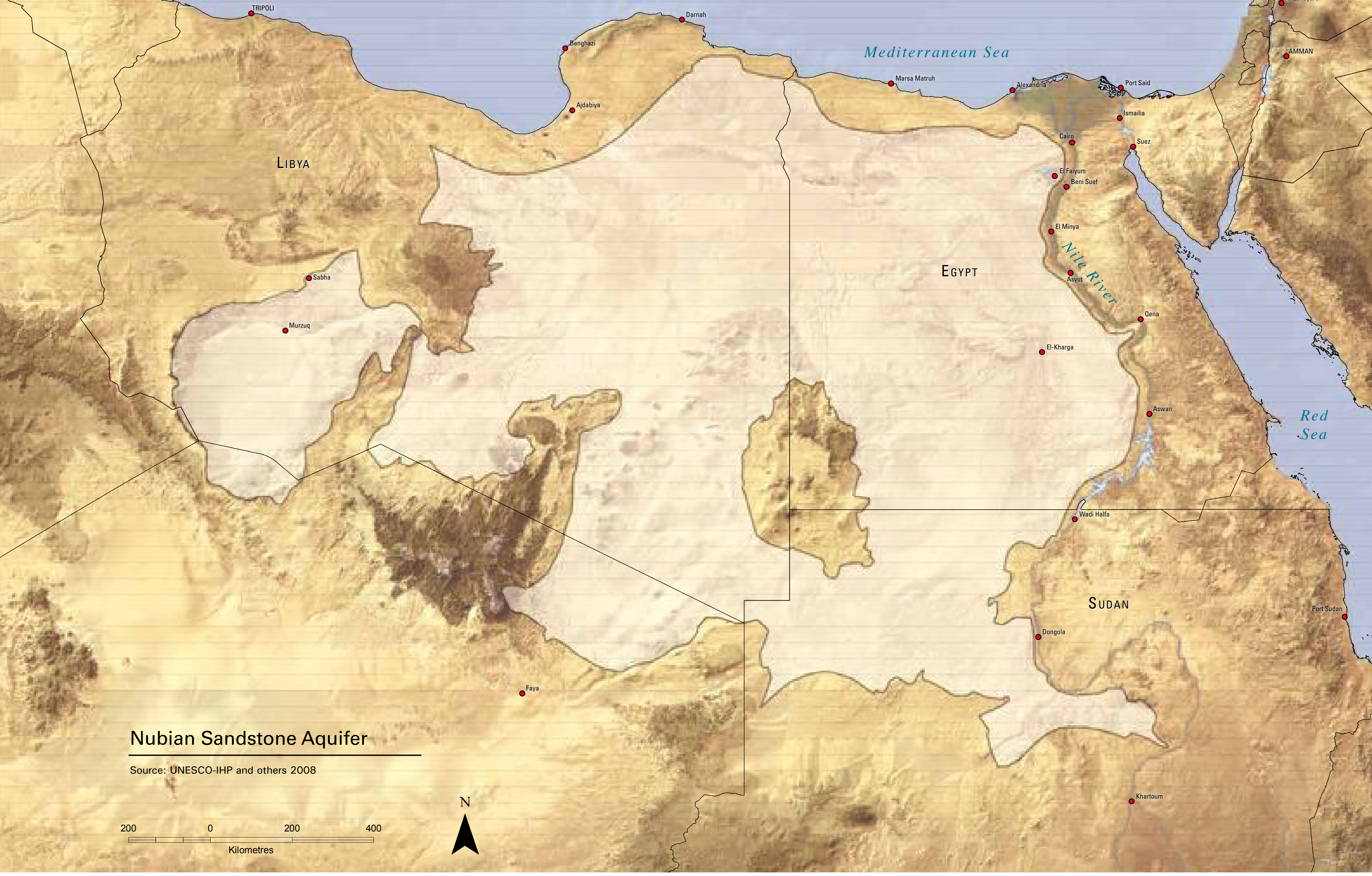
Aquifers in the Arab Region

Underground reserves of water are a life-supporting resource for the Arab region, which has little rainfall and limited surface waters. A number of transboundary aquifers underlie the region that provide vital freshwater for agriculture, industry and domestic uses. Globally, aquifers contain almost 96 per cent of the Earth's freshwater. Most of this water is used for irrigation (65 per cent), while 25 per cent supplies drinking water needs and 10 per cent is for industry. In the Arab region, groundwater supplies are relied upon heavily—the GCC countries, as well as the Occupied Palestinian Territories and Jordan rely on groundwater for the bulk of their water needs. To meet growing demands for water, wells continue to be dug and groundwater extracted, depleting these mostly non-renewable resources. The importance of shared water governance to prevent pollution and over-exploitation of aquifers is being recognized in the Arab region, which contains some of the largest transboundary aquifers in the world.



QaDisi Aquifer

The QaDisi Aquifer is a large aquifer underlying southern Jordan and northern Saudi Arabia. Water from the aquifer is abstracted by both countries; however, Saudi Arabia uses substantially more water (650 MCM per year), mostly for irrigation purposes. Jordan abstracts approximately 75 MCM per year for irrigation and to supply the coastal town of Aqaba. Plans to convey groundwater to Jordan's capital of Amman 300 km away have further complicated the relationship between the two countries over use of the fossil water, and sparked fears of a "pumping race" between the countries. The tension over allocations of groundwater from the QaDisi Aquifer is a prime example of the need for bi-lateral cooperation in the region.



Nubian Sandstone Aquifer

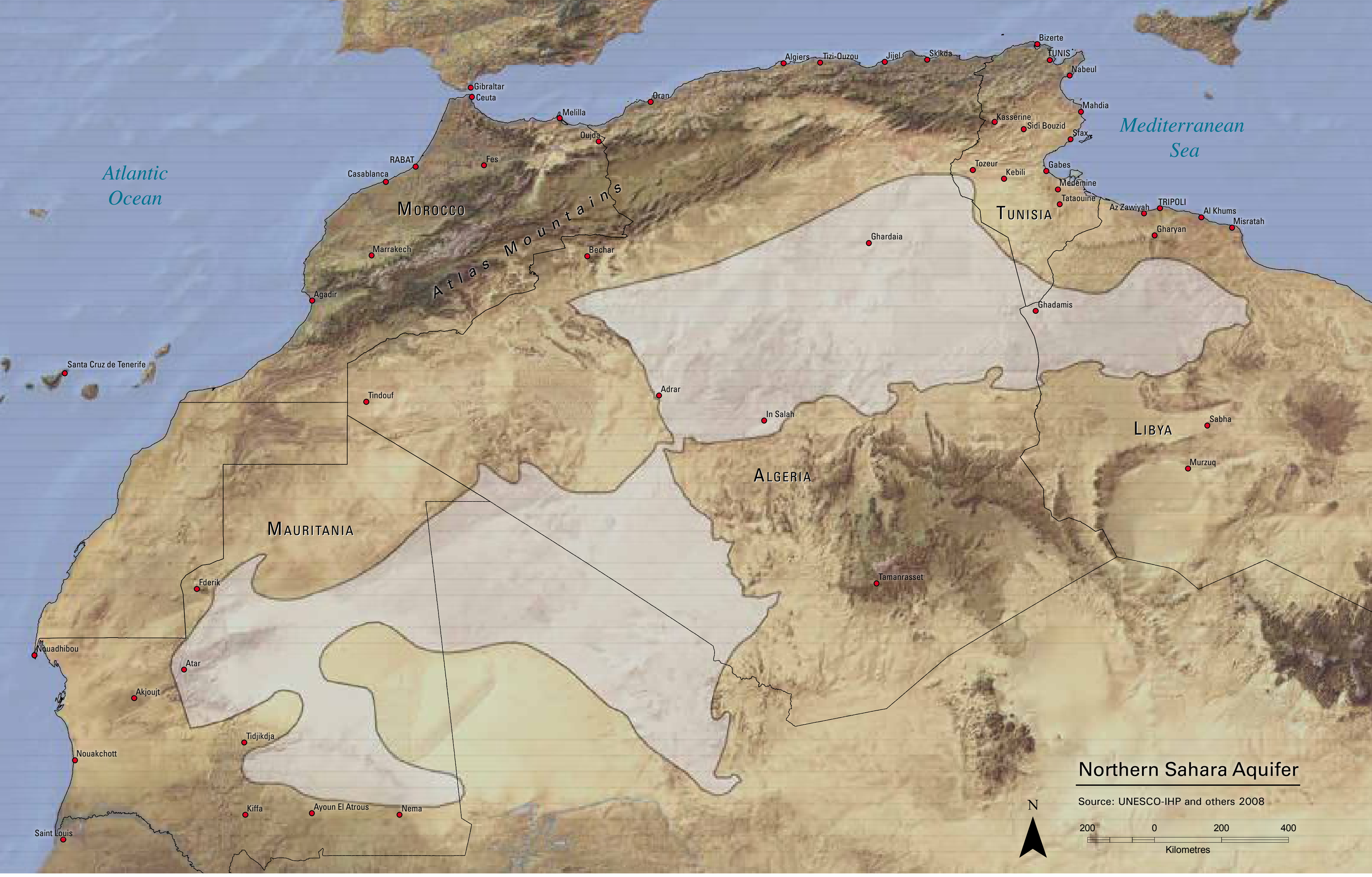
The Nubian Sandstone Aquifer System is a transboundary aquifer that underlies Chad, Egypt, Libya and Sudan. It covers approximately 2.2 million km^2 and contains fossil water that is estimated to be 35 000 years old. The demands on the use of this non-renewable groundwater are considerable and continue to increase with population growth, food demands and economic growth; in some areas, such as the Dakhla Oasis in the Western Desert of Egypt, the aquifer water is the only available water resource. Over-exploitation of the aquifer is occurring at a large scale and continues to increase every year. In the past 40 years, over 40 BCM of water has been extracted from the system in Libya and Egypt. This has produced a maximum drawdown of about 60 m. Most of the groundwater is used for agriculture in Libya and Egypt (UNESCO 2006). To more effectively manage the use of this groundwater over time (the life of the aquifer is estimated to be between 20 and 200 years), it is important to assess the aquifer storage capacity and to calculate the amount of groundwater that can be used by the four sharing countries (UNESCO 2006; CEDARE 2002).

Cooperation among Chad, Egypt, Libya and Sudan began in the 1970s when a regional project was initiated by UNESCO –UNDP to study the aquifer. The most comprehensive project to date was implemented by the Center for Environment and Development for the Arab Region and Europe (CEDARE), whereby a joint committee from the four countries cooperatively supervises the management of the groundwater system. In response to the growing pressures on the Nubian aquifer, the IAEA/UNDP/GEF Nubian Project was launched in July 2006. This project developed a new regional model of the Nubian aquifer to provide a greater understanding of the groundwater system and the transboundary issues and impacts. The model is three-dimensional and treats the entire aquifer system as a single homogenous unit but allows future modification as more data become available. This regional model provides the ability to forecast future scenarios and forms the basis on which shared data collection and decision-making strategies can be devised across the four Nubian countries.

One of the major projects based on the exploitation of this non-renewable aquifer is the Great Man-Made River Project in the southern desert of Libya. It is touted as the largest water project in the world, with more than 4 000 km of pipe to convey over 6 MCM/day or 2 100 million MCM/yr of water for agricultural purposes to meet domestic demands in Libya's coastal cities. Additional information about this massive project is provided in the Libya section of Chapter 3.


Source: Vyacheslav Argenberg Flickr.com

Dakhla Oasis, Egypt is one of the seven oases of the Western Desert of Egypt and is 100 per cent reliant on groundwater. Dakhla Oasis is located 350 km from the Nile Valley.



North Sahara Aquifer System

The Northern Sahara Aquifer System contains a considerable amount of non-renewable water reserves that are shared by Algeria, Libya and Tunisia. The aquifer covers an area of more than one million square kilometres, 69 per cent of which is in Algeria, 23 per cent in Libya and 8 per cent in Tunisia. During the past 50 years, the total annual abstraction rate from the Northern Sahara Aquifer increased from 0.6 MCM to 2.5 BCM. Much of the water use occurs in Algeria with 1.3 BCM per year; Tunisia and Libya abstract 0.55 and 0.33 respectively. Increased reliance on the aquifer to meet growing demands has created a deterioration of the water quality (high salinity), decreased artesian flow, and drying up of wells.

Groundwater mismanagement and overuse, mostly for irrigation purposes, has also led to the deterioration of the fragile oasis ecosystems in the region due to soil salinization and lowered groundwater levels. In 1999, Algeria, Libya and Tunisia began joint studies that were implemented by the Sahara and Sahel Observatory to improve the hydrogeological knowledge of the aquifer, develop an information system and mathematical model and initiate a mechanism for consultation. As a result of this project, there is now 50 years (1950 to 2000) worth of historical data on groundwater levels, water salinity and exploitation. The main output of this project includes the ability to predict the capacity of the system to supply appreciable quantities of water while minimizing risks to the water resource. It is crucial that this resource be jointly managed and that data and information be exchanged among the three countries in order to formulate common policies and strategies.

Pumping groundwater from a well in the Northern Sahara

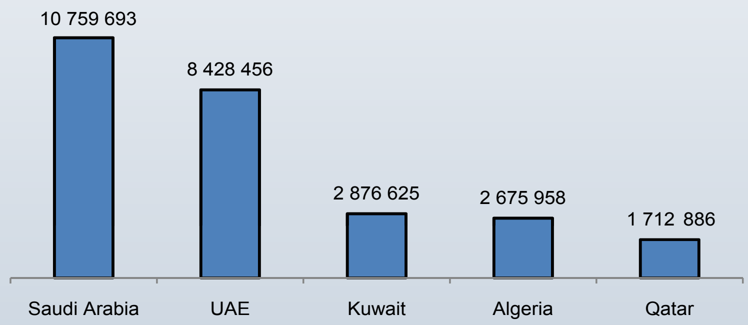
Azzizia Desalination Plant, Saudi Arabia

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).

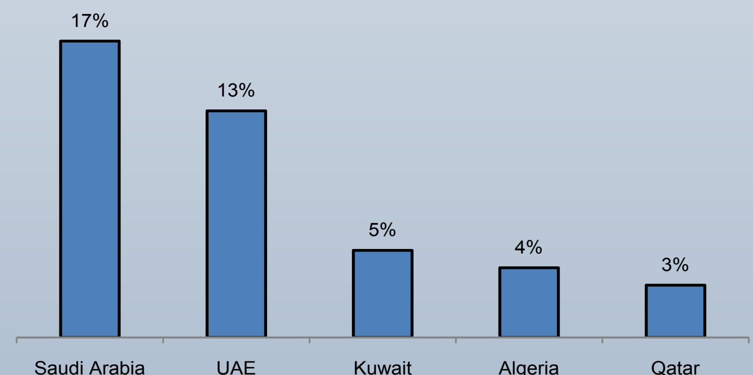
Desalination capacity has increased substantially in the past few decades; in 1999 capacity in the Arab region stood at over 12.5 MCM per day, of which 90 per cent was in the GCC countries. The environmental impacts associated with desalination have not been thoroughly studied to date; however, the widespread 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.

Desalinated water production m^3/day

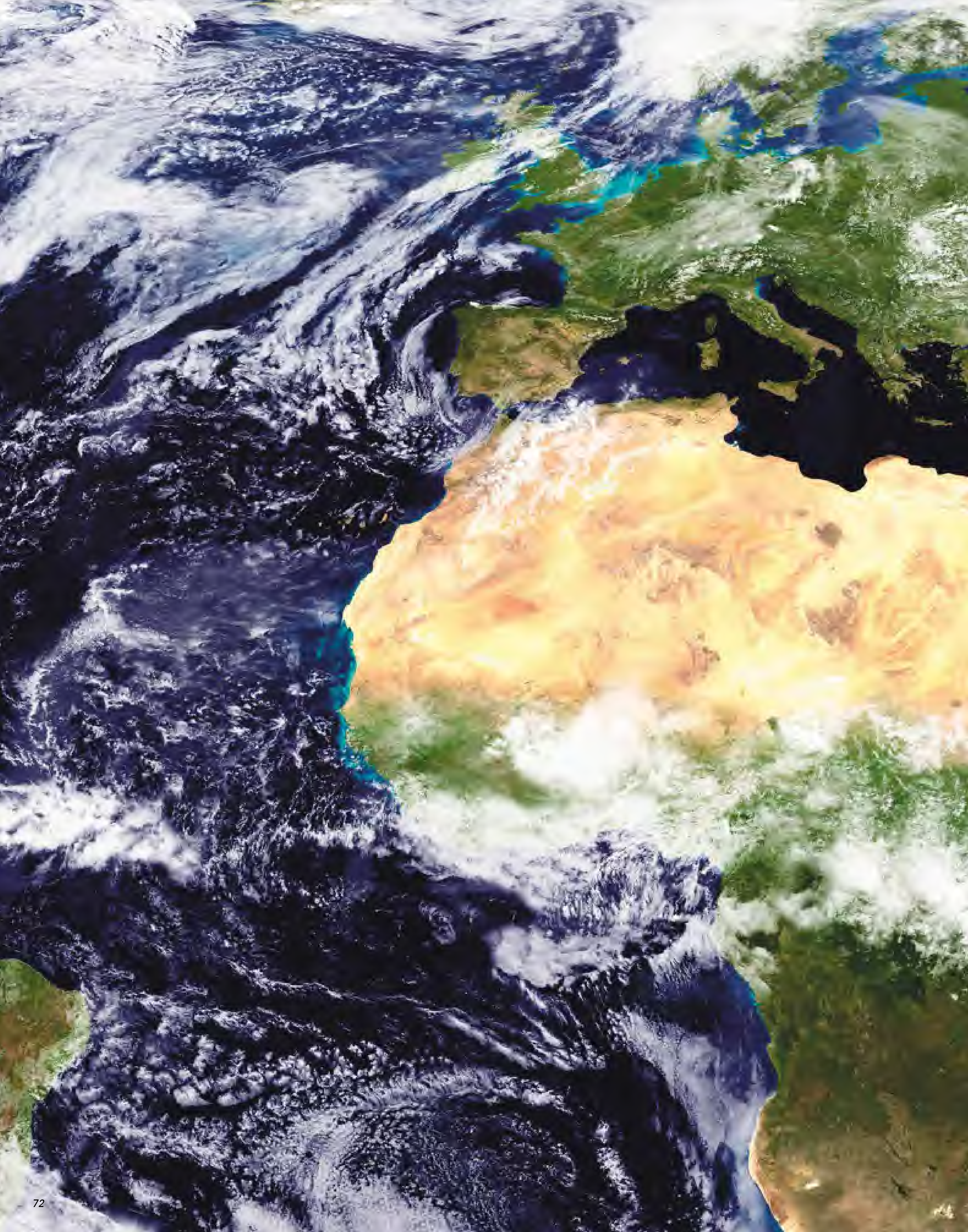


Source: Global Water Intelligence 2008

Per cent of Global Desalination Capacity



Source: Global Water Intelligence 2008

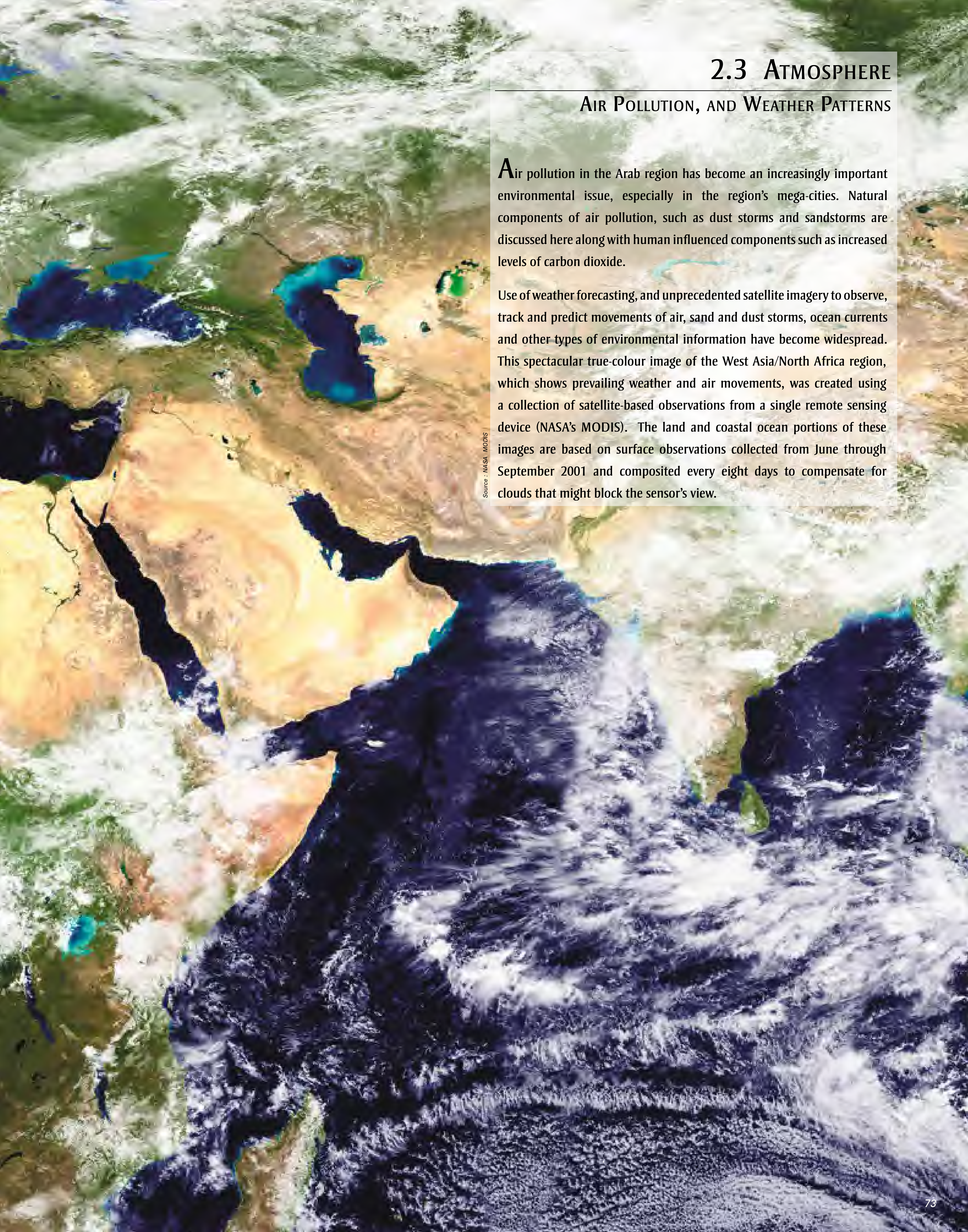


2.3 Atmosphere

Air Pollution, and Weather Patterns

Air pollution in the Arab region has become an increasingly important environmental issue, especially in the region's mega-cities. Natural components of air pollution, such as dust storms and sandstorms are discussed here along with human influenced components such as increased levels of carbon dioxide.

Use of weather forecasting, and unprecedented satellite imagery to observe, track and predict movements of air, sand and dust storms, ocean currents and other types of environmental information have become widespread. This spectacular true-colour image of the West Asia/North Africa region, which shows prevailing weather and air movements, was created using a collection of satellite-based observations from a single remote sensing device (NASA's MODIS). The land and coastal ocean portions of these images are based on surface observations collected from June through September 2001 and composited every eight days to compensate for clouds that might block the sensor's view.



Source : NASA MODIS

The Nile River in Cairo, Egypt

Air pollution is of concern in major cities, like Cairo

Air Pollution

Air pollutants of concern are those found in the troposphere, the lowest layer of the Earth's atmosphere that extends up to 17 km above the Earth's surface. Major air pollutants include particulate matter (PM), oxides of sulphur (SO_X), oxides of nitrogen (NO_X), carbon monoxide (CO), carbon dioxide (CO_2), volatile organic compounds (VOC) and lead. Some of these primary pollutants react together or with water in the atmosphere to produce secondary pollutants such as ground level ozone, acid rain, fog, and smog that have harmful health effects and impact regional temperatures, precipitation and agriculture (UNEP 2002b).

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. Given the ability of harmful pollutants to travel great distances, transboundary air pollution is also becoming an increasing concern, forcing nations to engage in cooperative actions to increase understanding about the impacts of transboundary air pollution and develop effective pollution control strategies. Harmful air pollutants such as soot particles and nitrogen oxides from vehicle exhaust, agricultural pesticides, mercury from coal-fired power plants, as well as dust blown off deserts and eroded croplands may drift aloft for up to several months and are the main transboundary pollutants of concern (NRC 2009).

Cities such as Sana'a, Dubai, Cairo, Beirut, Baghdad and Manama suffer from high concentrations of air pollutants that far exceed World Health Organization (WHO) guidelines (UNEP-GEO 2006; WHO 2009). Urban air pollution is mostly attributed to energy and industrial production and vehicular emissions—most of the air pollution in urban centres is due to poor vehicle maintenance, aged cars, low quality fuel and poor traffic management (Selim 2004). In fact, 90 per cent of total emissions of carbon monoxide in Arab countries are due to transportation activities (ESCWA 2006). Many Arab countries have phased out the use of lead, lowered sulphur levels in fuels (though they remain high compared to other regions) and adopted cleaner vehicle technologies; however, Algeria, Egypt, Tunisia, Iraq and Yemen still use both leaded and unleaded fuel for their motor fleets (UNEP 2010). Many Arab countries are working with the UNEP's "Partnership for Clean Fuels and Vehicles" program, which aims to alleviate the growing scale of urban air pollution in Arab cities caused by vehicles. In Bahrain, for example, a diesel retrofit program was implemented to reduce emissions from diesel engines (specifically sulphur dioxides), one of the major sources of pollution in Manama.

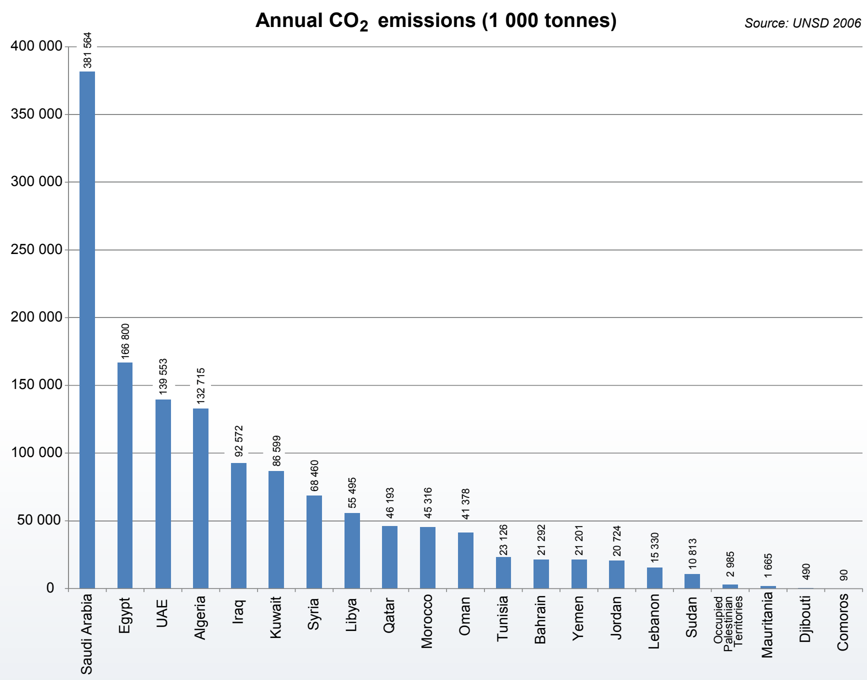
Some cities (Kuwait City, Abu Dhabi) have adopted the Air Quality Index (AQI) to report daily air quality, focusing specifically on concentrations of ground-level ozone, particulate matter, carbon monoxide, sulphur dioxide and nitrogen dioxide, which pose some of the greatest threats to human health.

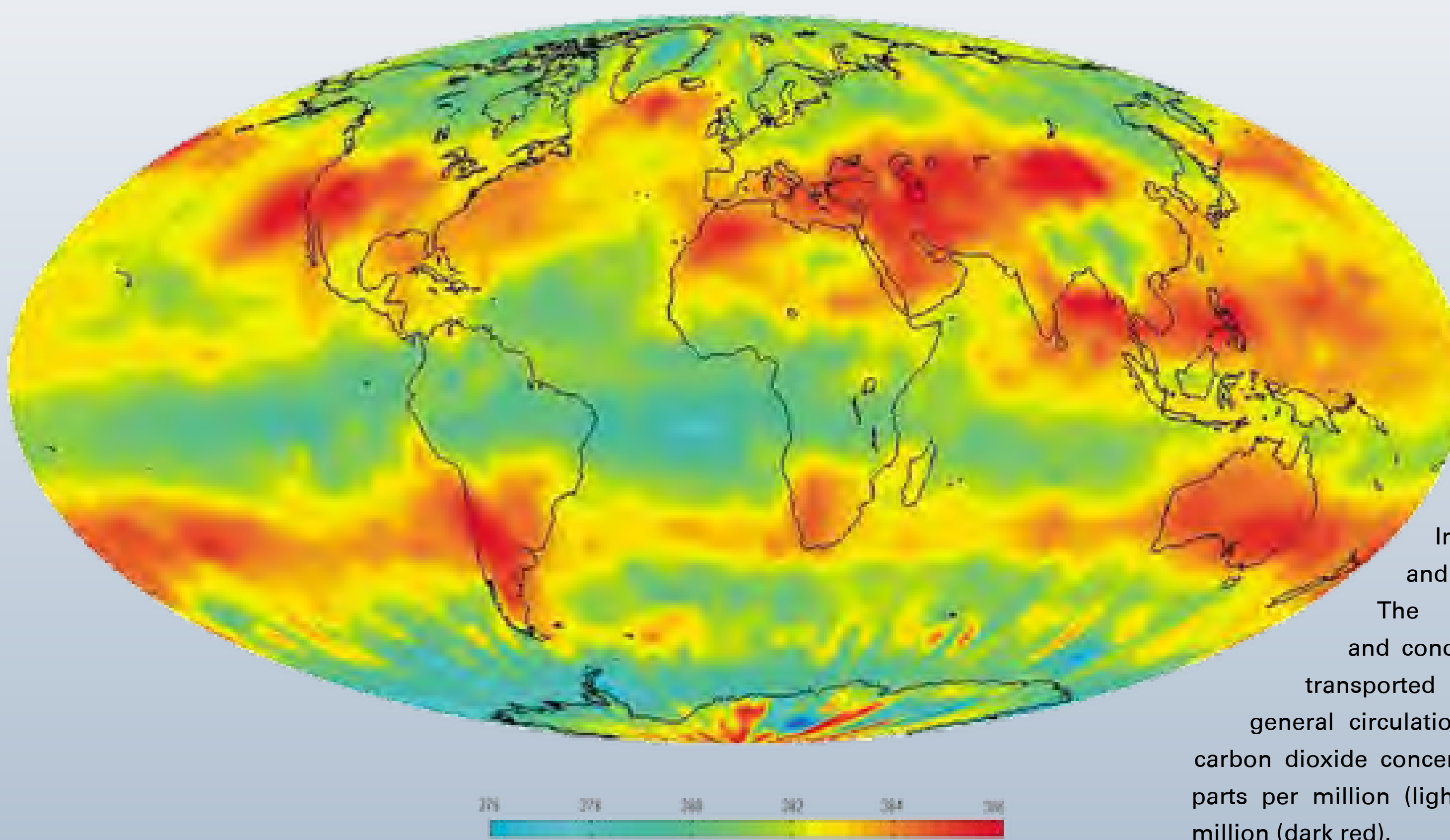
Other technologies such as remote sensing are also being used, though to a limited extent, to monitor and quantify transboundary air pollution, detect and track sand and dust storms and forest fires. Use of new technologies in the industrial sector are adding filters to the smokestack of plants to reduce emitting of air pollutants. In the UAE, the city of Dubai initiated an on-the-road vehicle emission measurement survey using remote sensing as a way to formulate strategies to control vehicle emissions (Dubai Municipality 2010).

Forest fires also contribute significantly to poor air quality in the region. The incidence of forest fires, which are mostly human-caused, has increased markedly, especially in countries bordering the Mediterranean. These fires turn large areas into degraded scrubland, cause widespread erosion and loss of human life and property, and cause atmospheric disturbances, emitting large amounts of PM, CO, VOC and NO_x into the atmosphere. These pollutants impact air quality and contribute to global warming.

A majority of CO_2 emissions in the region are generated as a by-product of the combustion of fossil fuels (oil, coal and natural gas) for energy production and transport. All fossil fuels are made up of hydrocarbons that release carbon dioxide when burned. CO_2, a greenhouse gas, contributes to global warming—the top CO_2 emitters in the world (annual emissions) are China, the United States, Russia, India and Japan (UNSD 2006). The contribution of the Arab region to global CO_2 emissions is low (4.7 per cent) (EOAR 2010); however, oil and gas producing countries contribute a larger proportion of emissions than other countries in the region. Pollution levels in many urbanized areas in the Arab region frequently violate particulate standards. Air quality in Greater Cairo is a major concern to the Government of Egypt, particularly with regards to adverse health impacts (EEAA 2011). The Egyptian government is monitoring ambient concentrations of lead and fine particulate matter through a network of monitoring stations throughout the city. The monitoring network has been operational since 1998. Air quality measures a number of parameters, such as PM10, sulphur dioxide, and carbon monoxide. With more than one million vehicles on the streets, mobile emissions are one of the major sources of air pollution in Greater Cairo. Vehicle emissions of fine particulate matter and other pollutants are significant, and the government is currently working towards a tighter control over vehicle emissions (EEAA 2011).

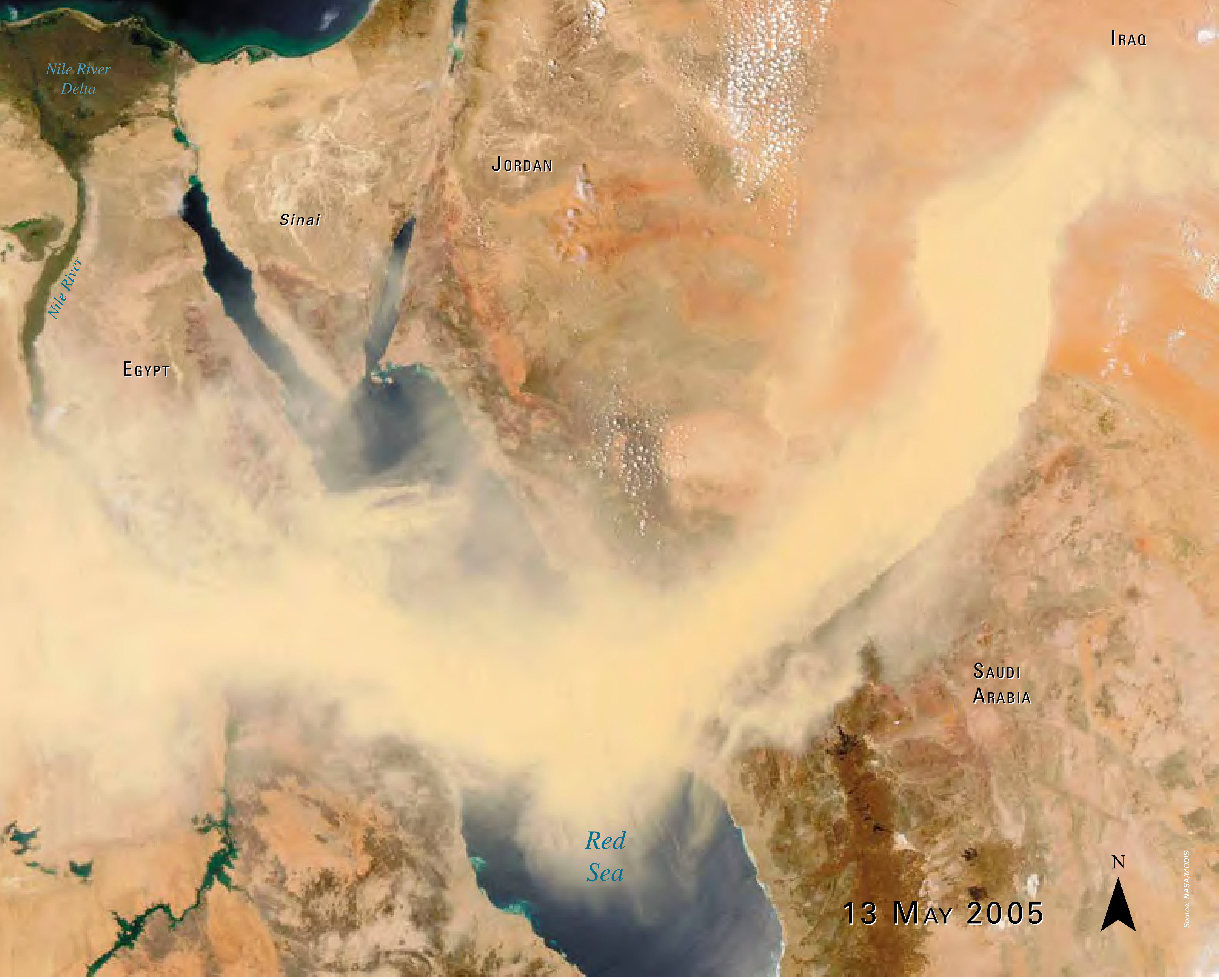
In Syria, daily concentrations of PM10 varied between 115 and 600 $\mu g/m^3$ for most cities—in Damascus, PM10 concentrations were as high as 749 $\mu g/m^3$ in highly congested traffic areas and 333 $\mu g/m^3$ in residential zones (Haffar 2004). Beirut's PM10 concentrations average 166 $\mu g/m^3$ and SO_2 levels of 300 $\mu g/m^3$ have been recorded near major cement factories and power plants; levels of ozone and smog in Beirut also regularly exceed WHO air quality guidelines (Chaaban and Chedid 2003). Algiers, Rabat and Abu Dhabi also experience high levels of PM10, SO_2 and nitrogen dioxide (NO_2), all of which have serious health risks.





Global Carbon Dioxide

This image of global CO_2, from July 2008, was created with data acquired by the Atmospheric Infrared Sounder (AIRS) and produced by JPL/NASA. The image displays patterns and concentrations of CO_2 that are transported around the Earth by the general circulation of the atmosphere. The carbon dioxide concentrations range from 368.2 parts per million (light blue) to 386.2 parts per million (dark red).

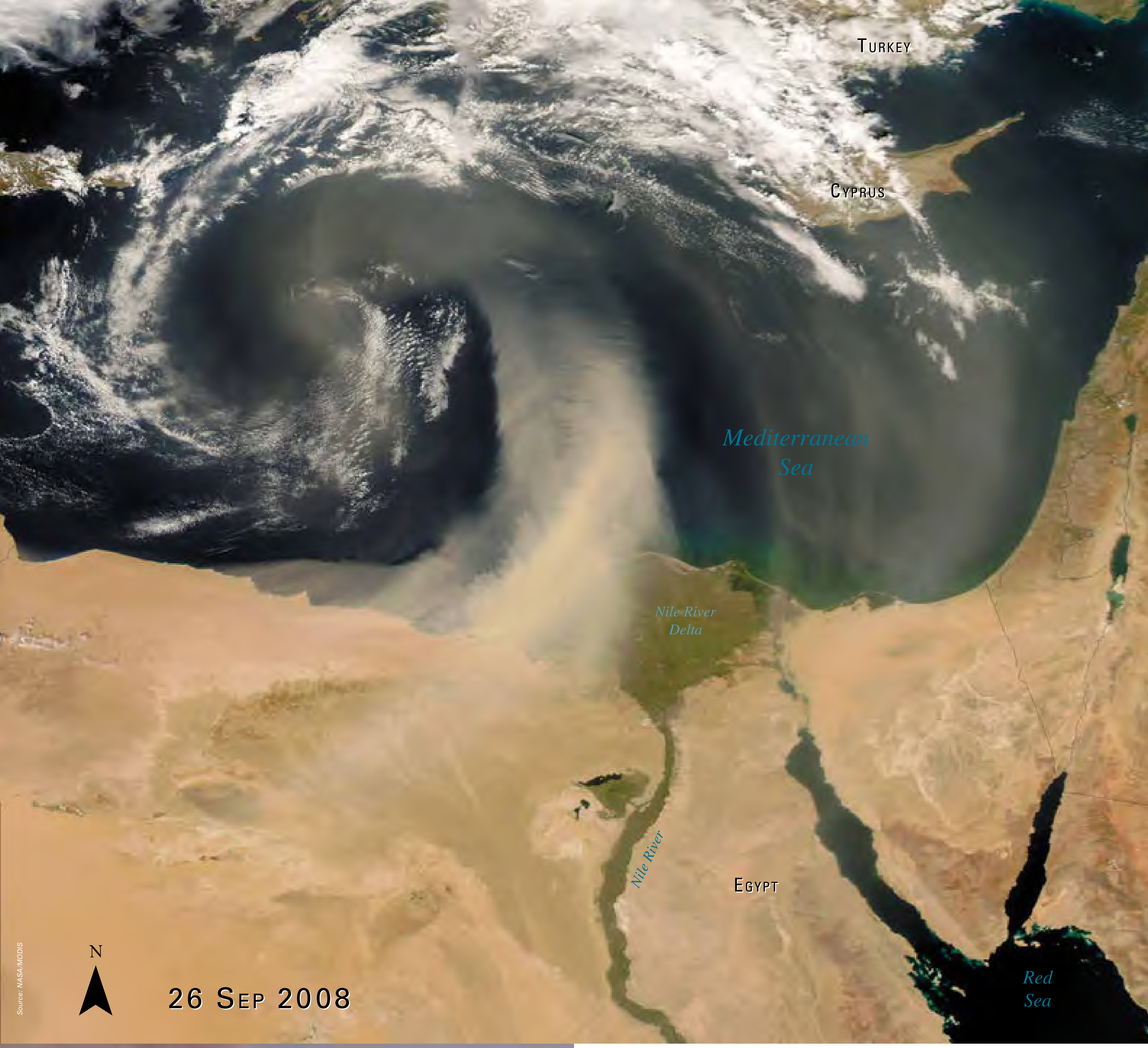


Dust and Sand Storms

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. The Environment Agency-Abu Dhabi recently expanded its air quality monitoring program to include the measuring of PM2.5 levels (dust and chemicals that are capable of penetrating deep into the lungs); PM2.5 levels are also being assessed to determine how much of the particulates are naturally occurring versus human-caused (EAD 2010b).

Dust and Sand Storms Originating in Iraq

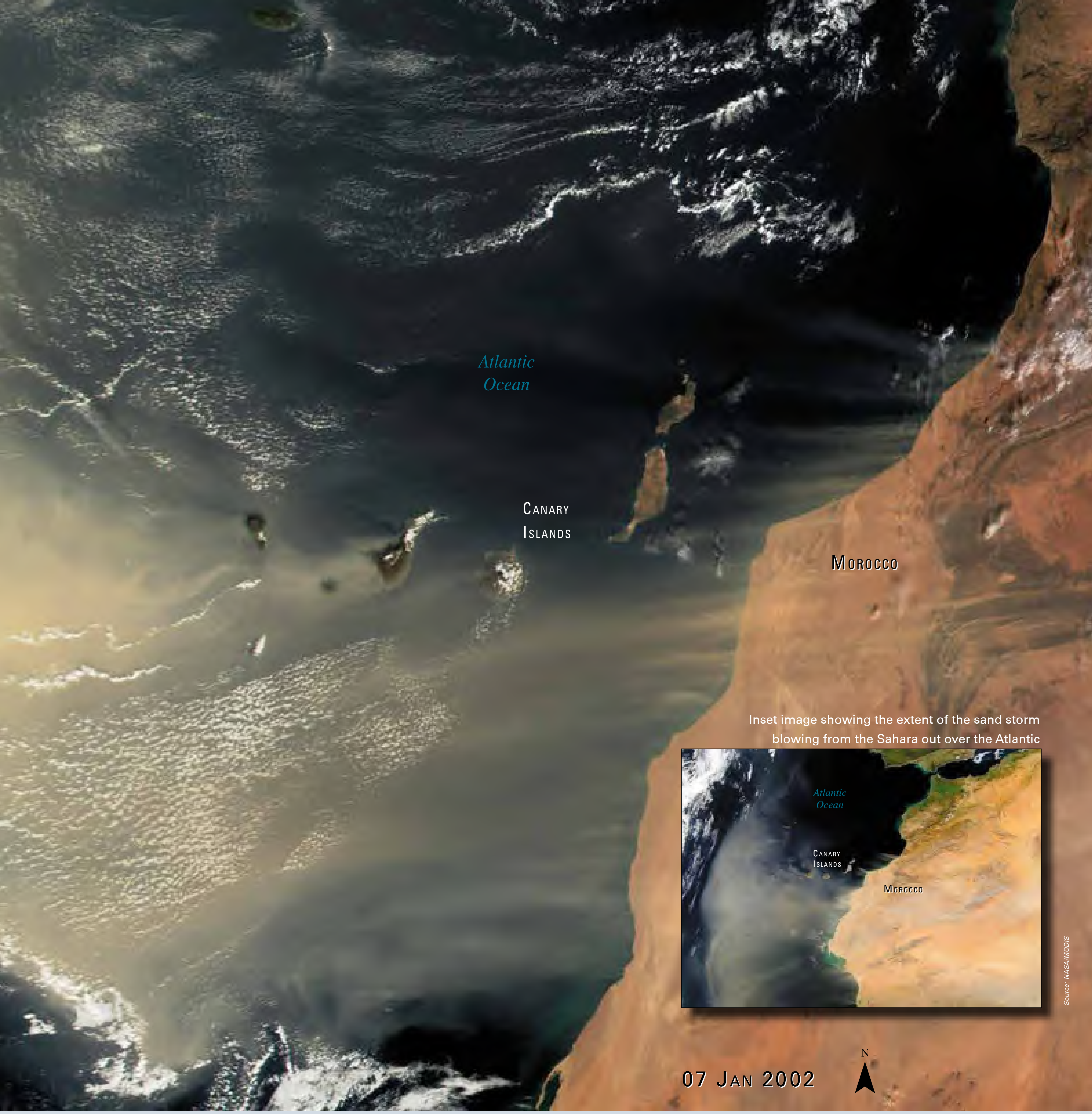
In Iraqi cities, DSS that completely cover populated neighbourhoods are a common occurrence. Land degradation associated with conflict and poor agricultural practices and management has transformed much of the arable land into desert; even the slightest wind movements can pick up dust that can remain airborne for days (ESCWA 2006). This image shows a thick band of dust snaking across the Red Sea between Egypt and Saudi Arabia on 13 May 2005 that originated in Jordan and northern Iraq. The dust impaired visibility, caused health complications and prevented planes from taking off and landing at local airports. These DSS that originate in Jordan and Iraq can extend into Iran, Syria, Saudi Arabia and affect countries to the south, blowing over the Red Sea and into northeast Sudan, southern Egypt, Eritrea and northern Ethiopia. The Nile River (upper left of image) is a ribbon of green with the water flowing northward into a fan-shaped delta before emptying into the Mediterranean Sea (NASA 2005). A ground photo illustrating the immense size of a dust storm in Iraq is shown to the right.



DSS in Al Asad, Iraq on 26 April 2005

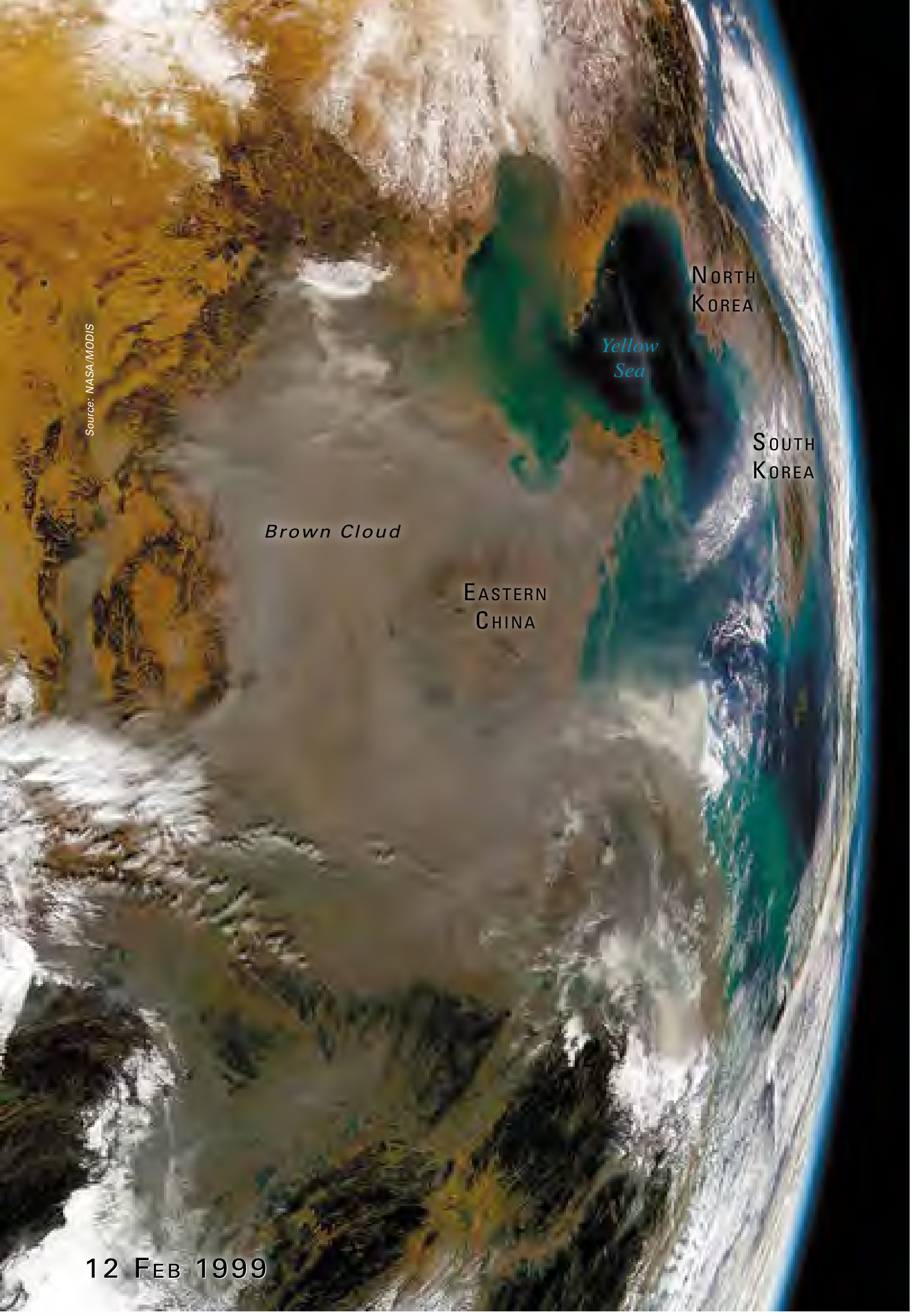
Dust and Sand Storms from North Africa to Southern Europe

Frontal wind directions, as shown in the image above, clearly indicate transboundary wind movements from the Arab region to northern Mediterranean countries such as Turkey, Greece, and Italy. These fronts carry dust from the Sahara Desert in Libya and Egypt over thousands of kilometres by convection currents, which form when warmer, lighter air rises and colder, heavier air sinks. The 'simoon' is the dust and sand-laden desert wind of North Africa and Arabia that contributes largely to the atmospheric dust over Europe; evidence of the dust from simoon winds has also been found on the seafloor at considerable distances from shore and as far north as Sweden (Hassan 2004).



Dust Storms from the Northern African Coast to the Canary Islands

The 'Calima' is an oppressive dust and sand-laden wind that blows from an area of high pressure usually over North Africa and the Sahara Desert. It is driven by south-easterly winds west into the Atlantic and over the Canary Islands, and brings with it extremely hot temperatures, poor visibility and poor air quality that can last from several hours to a week. The Sahara dust is exported across the Atlantic Ocean during these storms, and can blanket areas with dense clouds of dust and sand that extend as far as the Caribbean. The dust carries bacteria and fungi that can harm Caribbean corals but also provides essential soil-building properties for plant growth on the islands. Saharan dust is also believed to play a role in mitigating the Atlantic hurricane season (NASA 2007). This image shows a dust storm from the western regions of Morocco travelling west towards the Canary Islands. A thick pall of sand and dust blew out from the Sahara Desert over the Atlantic Ocean on 7 January 2002, engulfing the Canary Islands in what was one of the worst sand storms ever recorded for the country.



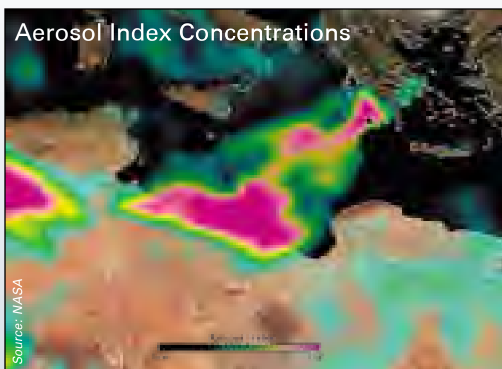
Asian Brown Cloud

The Asian Brown Cloud is a 3 km thick layer of soot and other anthropogenic particles and emissions that is formed during the dry winter monsoon each year between January and April, and stretches from China and the western Pacific Ocean to the Arabian Peninsula. The pollutants are a result of the combustion of fossil fuels, biomass burning and industrial emissions. The cloud is typically composed of sulphates, organic compounds, soot, mineral dust, ammonium, fly ash, and other minor constituents such as potassium and nitrates (UNEP 2002b). The cloud has strong sunlight absorbing capabilities due to its high soot content, which can impact the radiative heating of the atmosphere and land surfaces during January to April, affecting regional temperatures, precipitation, agriculture and health. Reduced heating of the ocean decreases evaporation and precipitation locally or in regions far from the source of the pollution. This brown cloud phenomenon, first observed in 1999 (image at left), epitomizes the effects of transboundary air pollution problems, whereby air pollutants extend beyond their source regions, affecting areas around the world. The brown cloud, which extends up to 3 km in altitude, can disperse rapidly around the globe (Ramanthan and others 2001).

Thirteen mega-cities, including Bangkok, Beijing, Cairo, Dhaka, New Delhi, Tehran, Mumbai and Seoul have been identified as brown cloud hotspots. These hotspots experience surface cooling due to reduced sunlight, which disrupts the hydrological cycle (increasing problems of water stress) and reduces agricultural productivity (by acid deposition and subsequent plant damage, and reduced photosynthesis). In addition, the impacts to human health are far-reaching, with high incidences of respiratory illness. Other effects include an increase in the frequency and strength of the thermal inversion caused by the cloud that can trap more pollution, exacerbating the air quality problems in these locales.

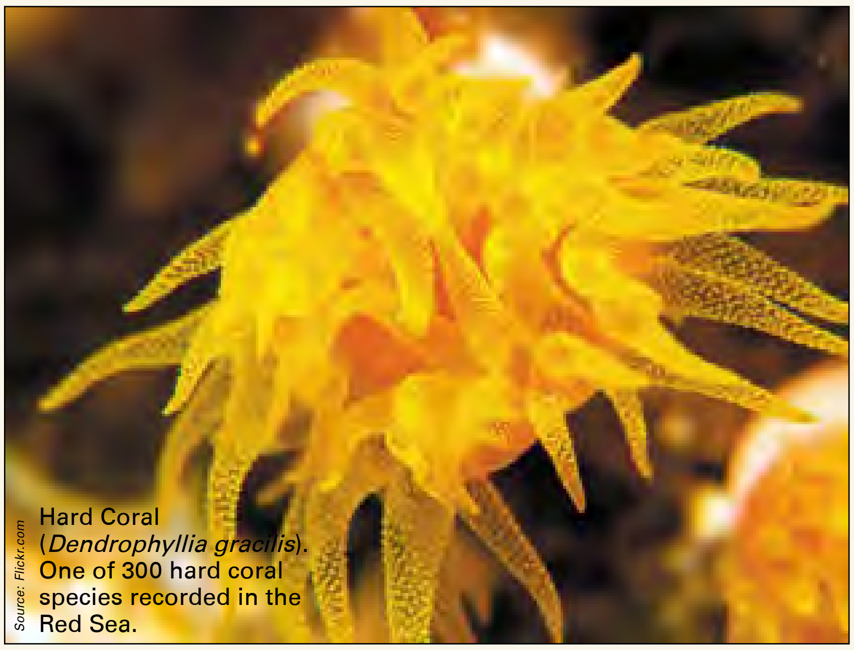
Smoke and Aerosol Concentrations from wildfires originating in Greece

In late August 2007, deadly wildfires in southern Greece sent thick plumes of smoke and aerosols south over the Mediterranean Sea to the Libyan and Tunisian coasts (image at right). These fires, a result of scorching heat waves, destroyed thousands of acres of forest, olive groves and farmland in Greece. In these images, the active forest fires are red and the smoke plumes are shown extending west—the aerosol index images show the highest aerosol concentrations in pink over Libya, Tunisia and Algeria and lower concentrations are shown in yellow and green (see inset map) (NASA 2007). These wildfire emissions cause an increase in average particulate matter concentrations, organic aerosol mass, and gaseous concentrations of carbon monoxide, nitrogen dioxide and ammonia.



The deep blue waters of the Red Sea stand out among the surrounding desert in this true-colour Aqua MODIS image from September 2004. Located in the Great Rift Valley between Africa and Asia, the Red Sea is bounded by the countries of Egypt, Israel, Jordan, Saudi Arabia, Sudan, Yemen, Eritrea, Djibouti, and Somalia. The northern end of the Red Sea is bifurcated by the Sinai Peninsula, creating the Gulf of Suez to the west and the Gulf of Aqaba to the east. At the southern end of the Red Sea, the Dahlak Archipelago is evident, displaying green shallow waters dotted with small islands. Further south, the sea narrows where Yemen on the Arabian Peninsula and Djibouti in the Horn of Africa lie only 30 km apart, connecting the Red Sea to the Gulf of Aden and the Arabian Sea. The Nile River flows north through Egypt and Sudan in the upper left portion of the image.

Red Sea, Mediterranean and ROPME Sea Area



Source: Flickr.com

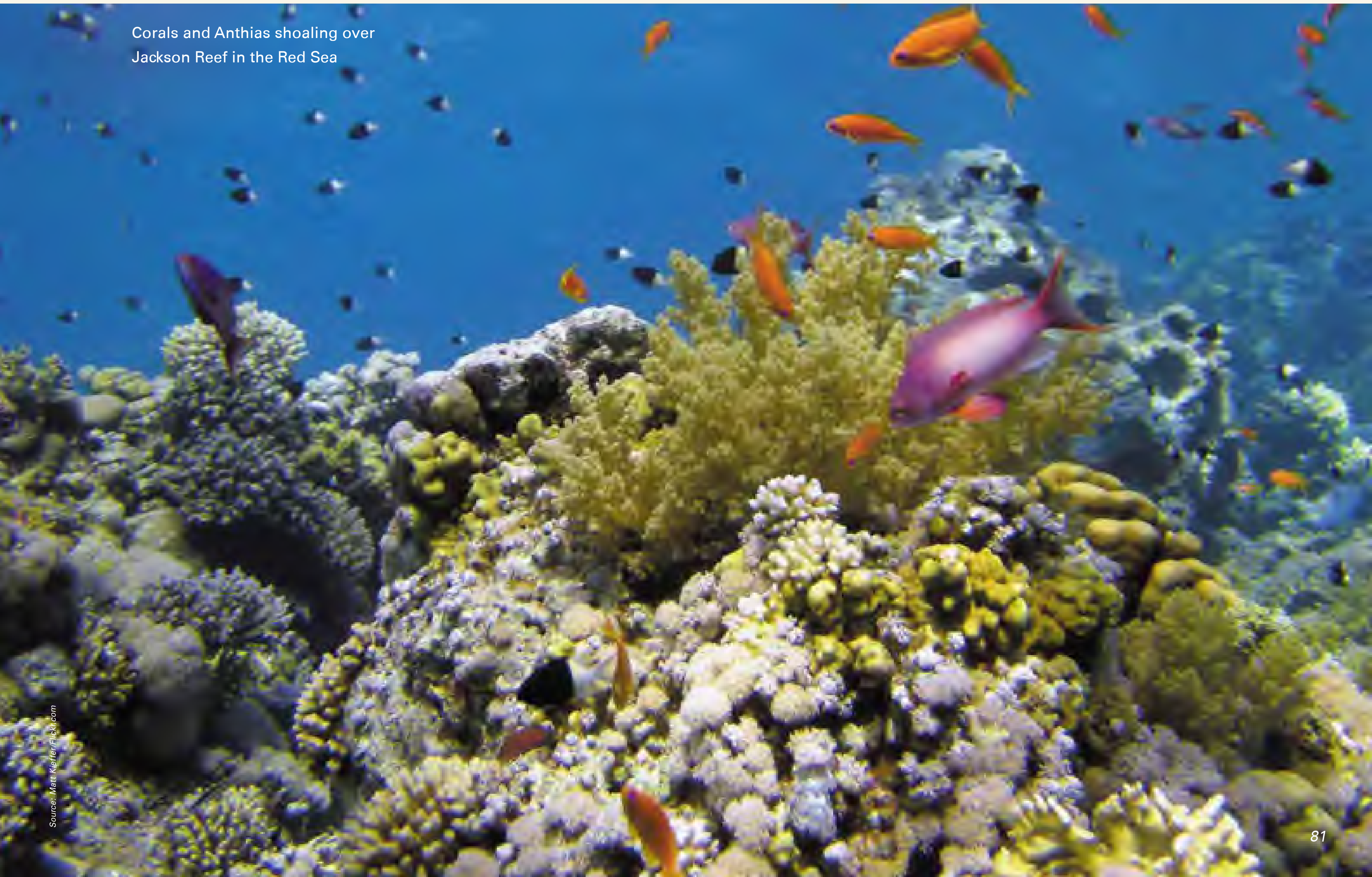
Hard Coral (*Dendrophyllia gracilis*). One of 300 hard coral species recorded in the Red Sea.

Despite their remarkable size and resilience, the Earth's oceans and coastal areas face a number of unprecedented threats to their integrity and sustainability. Chief among these are land and sea pollution, over-utilization of marine resources, loss of marine and coastal habitats, and introduction of invasive aquatic species (UNDP/GEF 2004).

Twenty of the 22 League of Arab States countries encompass five 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.

Transboundary Issues and Analysis

Transboundary issues often present challenges that can lead to conflict but can also promote cooperation. In recent years, environmental and resource issues have become the most prominent transboundary issues (Lonergan and others 1997). 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).



Corals and Anthias shoaling over Jackson Reef in the Red Sea

Source: Matt Kieffer/Flickr.com

TDA is a scientific and technical assessment of an international waters area that prioritizes and quantifies the environmental issues and establishes their immediate, intermediate and fundamental (root) causes (UNEP/MAP/MED POL 2005). The process of formulating a TDA and a Strategic Action Programme (SAP) has provided an integrated approach and structured framework for the coastal countries bordering these two regions.

Shared TDA issues of the Marine Environment of the Arab Region

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 land-based 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.


Source: Flickr.com

Overfishing

The Mediterranean Region

The yield of fisheries is generally low in the Mediterranean Sea compared to other Seas and oceans, probably due to lower primary productivity. Approximately 1.5 million tonnes of fish are caught in the Mediterranean Sea each year (WWF 2004); the catch for the Mashreq countries during 2000 was 80 915 tonnes (Benoit and Comeau 2005). Fisheries resources in the Mediterranean have long been overexploited and there are clear indications that catch size and quality have declined, often dramatically; some species have disappeared entirely from commercial catches. Overfishing, driven by demand and rising prices, is increasing competition for the same fish resources and stocks and destroying their natural habitats. Destructive fishing practices have also contributed to reduced fish stocks; between 1980 and 1992, the number of trawl nets increased by 137 and 170 per cent in Algeria and Morocco, respectively (Benoit and Comeau 2005).

The Red Sea and Gulf of Aden

The Red Sea and Gulf of Aden are recognized globally for their great diversity of marine environments and the abundance of unique species. The status of fisheries in some nations of the Red Sea and Gulf of Aden region is unknown due to lack of stock assessments and incomplete fisheries statistics. However, it is known that the fisheries resources in the Red Sea and Gulf of Aden are exploited locally and by foreign fleets. In addition, illegal fishing in the region by vessels operating outside their natural waters is commonplace. Overfishing has caused declines in catches of finfish, lobster and scombrids, and cuttlefish stocks have completely collapsed (PERSGA 2009). The shark resources in the region are heavily fished (much of it used to fuel the shark fin markets of East Asia), especially in Sudan, Djibouti, Yemen and Somalia (PERSGA 2004). Fisheries are also overexploited in Egypt, Sudan and Yemen.

The ROPME Sea Area

Fish species diversity is generally lower in the ROPME Sea Area, and the fisheries sector only plays a minor role in the economies of bordering countries (Bahrain, Iraq, Kuwait, Qatar, Oman and UAE). The ROPME Sea Area is suffering the impacts of haphazard coastal developments, physical alterations, destruction of habitats, sedimentation, high salinity and extremes of temperature that are impacting the fisheries. These activities eliminate the nursery areas for commercially important species of fin and shellfish. Bottom trawling has severely destroyed benthic communities and substantially reduced commercial fish populations over the past 10 to 20 years. Kuwait's total fish landings in 2007 were less than half their peak 1995 level. Probable reasons include overfishing, nursery ground destruction, and reduced discharge of the Shatt Al-Arab River (Sheppard and others 2010).

Fisheries transboundary aspects

Fisheries issues are transboundary because of the presence of highly migratory stocks and extensive shared stocks; the environmental impacts and other socio-economic aspects are also transboundary. For example, the fragmentation of the Mediterranean area by so many Exclusive Economic Zones (EEZ) bordering each other virtually assures that many stocks are transboundary and/or shared. Fisheries activities cause mortality of endangered species (such as sea turtles and some dolphins), destroy benthic habitats due to dredging (such as seagrass beds and possible coralline hard bottoms), and have ecologically-harmful by-catch (UNEP/MAP/MED POL 2005). International cooperation, compromise, consensus and concerted action are needed for the sustainable exploitation of marine resources and protection of the vulnerable Mediterranean environment.


Source: Paul Fenwick/Flickr.com

Shark laid out for sale at market. Overexploitation of some marine species is causing significant ecosystem changes.

Segrass habitats are vital to many marine species, and are a threatened habitat globally.

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.

Coral Reefs

Coral reefs occur in shallow tropical waters where sunlight can reach reef-building corals on solid surfaces and stable sediments. Of the 284 300 km^2 of reef area in the world, 18 660 km^2, or about 7 per cent, occur in waters of 13 Arab countries (none are in the Mediterranean Sea) (Spalding and others 2001). Saudi Arabia and Egypt's Red Sea waters have the highest reef area in the Arab region, with 6 660 and 3 800 km^2, respectively. The Socotra archipelago of Yemen, however, boasts the richest site for reefs in the region, with 253 stony coral species. Coral reefs are highly vulnerable to anthropogenic stresses and a changing climate - 60 per cent of these habitats were assessed as at risk primarily due to coastal development, overfishing and the threat of oil spills (WRI 1998).

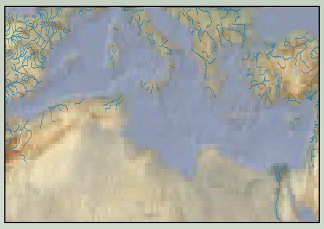
Seagrass Communities

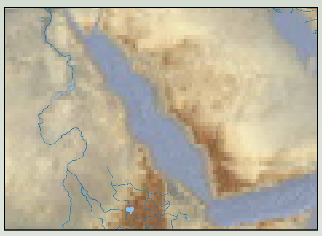
Seagrasses consist of submerged aquatic vegetation whose biomass provides food, habitat and nursery areas for many marine species. In the Mediterranean, seagrass meadows produce more than 80 per cent of the annual fish yield in the sea; they also stabilize the seashore and maintain water quality, mostly through oxygen production (WWF n.d.). Seagrasses abound in the ROPME Sea Area and provide the main diet of the endangered dugong. In the Red Sea, seagrasses are fairly widespread along the coast, especially in the shallow waters of the southern coast.

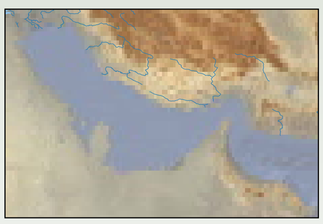
Mangrove Forests

Mangroves grow in waterlogged and saline soils of the intertidal zone. They play an important ecological role in coastal areas, preventing soil erosion and providing habitat for fish, crustaceans and birds. They are scattered along the Red Sea coast and ROPME Sea Area.

Information on the Coastal and Marine Environment of the Arab States







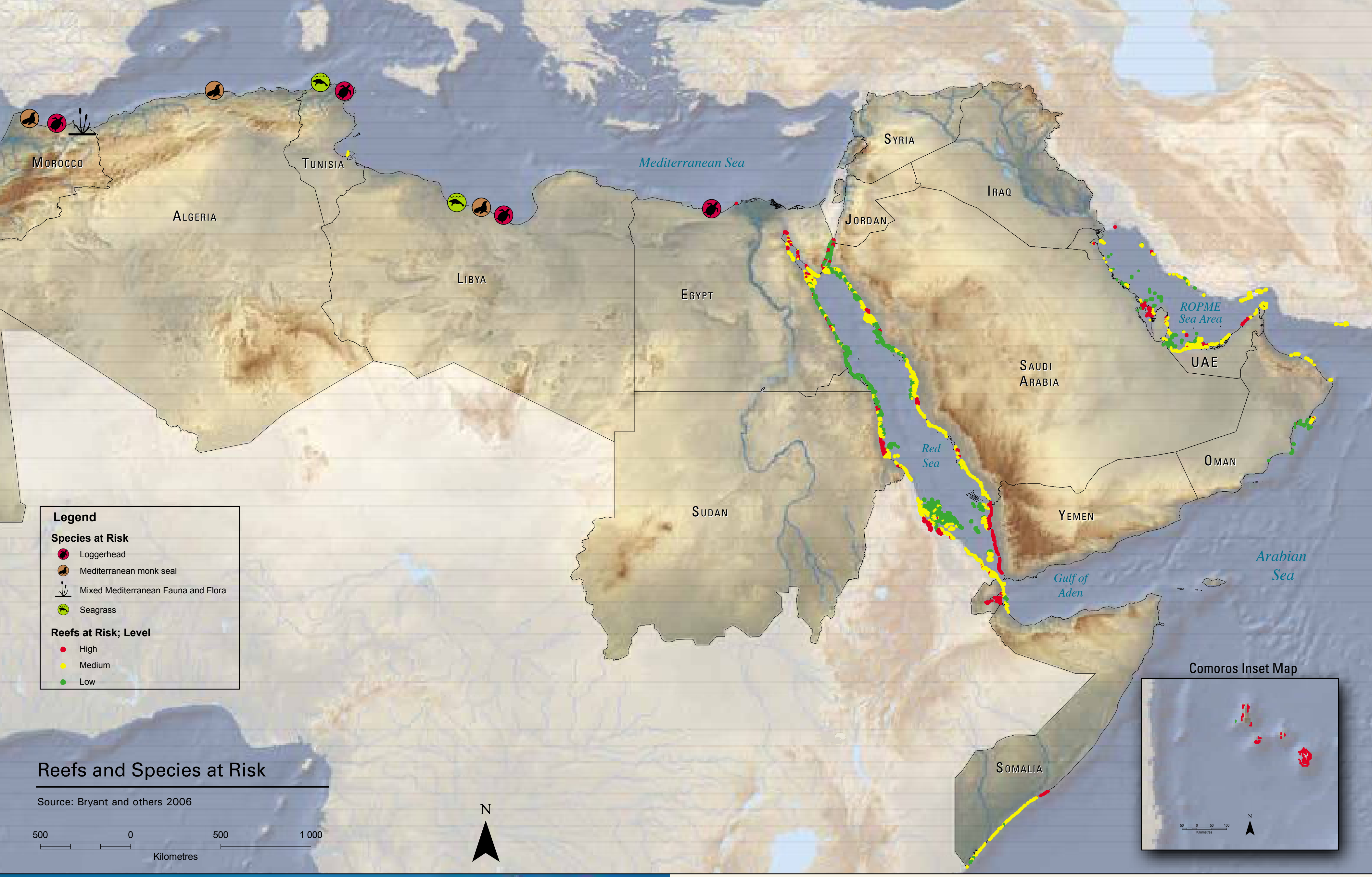
Region	Countries	Coastal & Shelf Extension & Area		
		Coastline km	Cont. shelf km^2	Territorial Sea km^2
MED Region	Algeria	1 557+	9 688	27 863
	Egypt	2 450+	50 060 (Med+RS)	82 048 (Med+RS)
	Lebanon	294+	1 169	4 702
	Lybia	2 025+	63 595	38 131
	Morocco	2 008+	70 365	37 481
	Syria	212+	852	3 866
	Tunisia	1 927+	65 347	36 773
PERSGA Red Sea & Gulf of Aden Region	Djibouti	443**	3 406	4 853
	Egypt	1 800**	X	X
	Jordan	27**	82	87
	Saudi Arabia	1 840**	95 580 (RS+G)	95 580 (RS+G)
	Somalia	3 898**	40 392	68 849
	Sudan	2 245**	15 861	32 645
	Yemen	3 149**	65 341	82 359
ROPME Sea Area (Data for Arab Countries of the ROPME Sea Area)	Bahrain	255***	7 967	4 006
	Iraq	105***	1 034	716
	Kuwait	756***	6 526	5 362
	Oman	3 165***	46 670	51 821
	Qatar	909***	31 156	11 373
	Saudi Arabia	790***	95 580 (RS+G)	95 580 (RS+G)
	UAE	735***	51 394	30 962
Other Regions	Mauritania	1 268	28 370	19 455
	Comoros	469	1 426	12 684

Source: El-Sayed (2008) X - No Data Available

Main source: World Resource Institute. Earth trends: The Environmental Information Portal (2006)

*EEAA (2006) **PERSGA (1998) *** ROPME (2003)

Blue fish shoaling over Bedouin Moon, Red Sea



Reefs and Species at Risk

Source: Bryant and others 2006

Lost and discarded fishing nets entangle live coral and tear them away from their bases

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 sub-regions of the sea (Saudi Arabia, Bahrain and Kuwait) (Sheppard and others 2010).

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 map above shows areas of risk for those species along the southern coast.

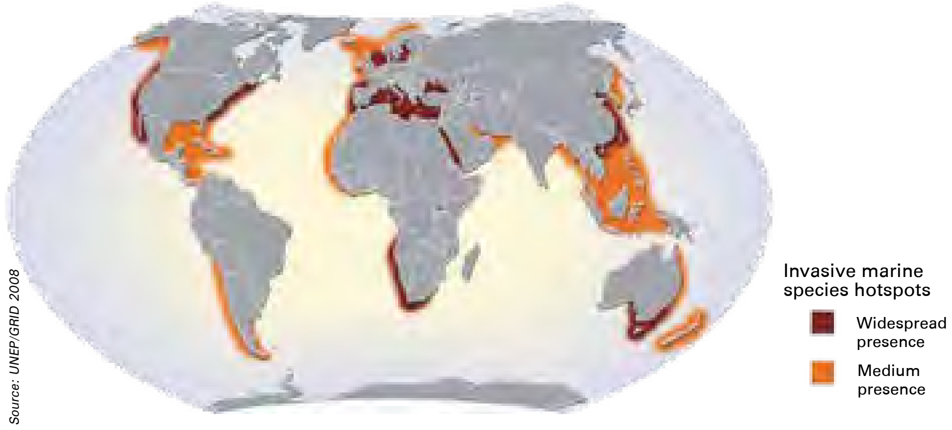
The Red Sea and Gulf of Aden

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

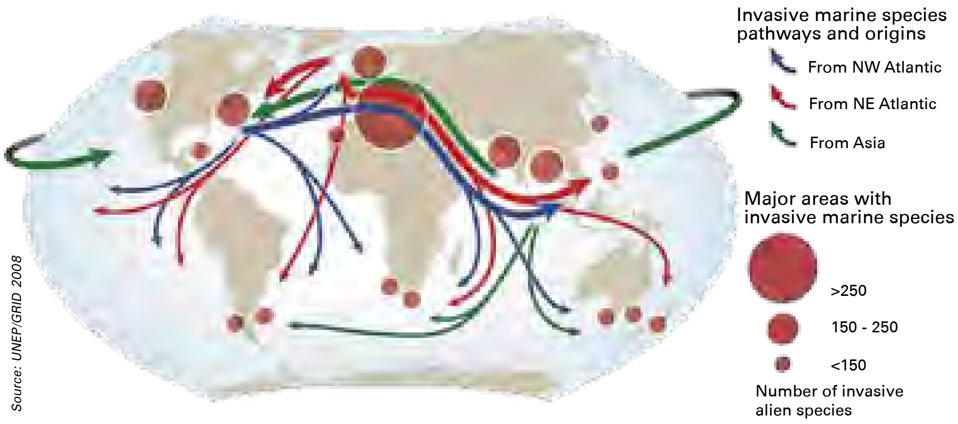
Loss of Ecosystem & Biodiversity - Transboundary Aspects

Transboundary issues regarding the degradation of coastal habitats and decline of biodiversity arise because of combinations of the following:

- Marine living resources are often migratory;
- Coastal habitats provide nursery and feeding grounds for migratory species;
- Degradation of coastal habitats contributes to overall decline of regional and global biodiversity; and
- Ecosystems are inherently transboundary in nature (UNEP/MAP/MED POL 2005)



The locations of major problem areas for invasive species infestations or occurrence of exotic species in the marine environment. The impacted areas are subject to high levels of pollution, intensive fishing and bottom trawling, and major shipping routes.



The major pathways and origins of invasive or exotic species infestations in the marine environment. These patterns are concurrent with major shipping routes.

Infestation of Crown of Thorns (*Acanthaster planci*) on a coral reef

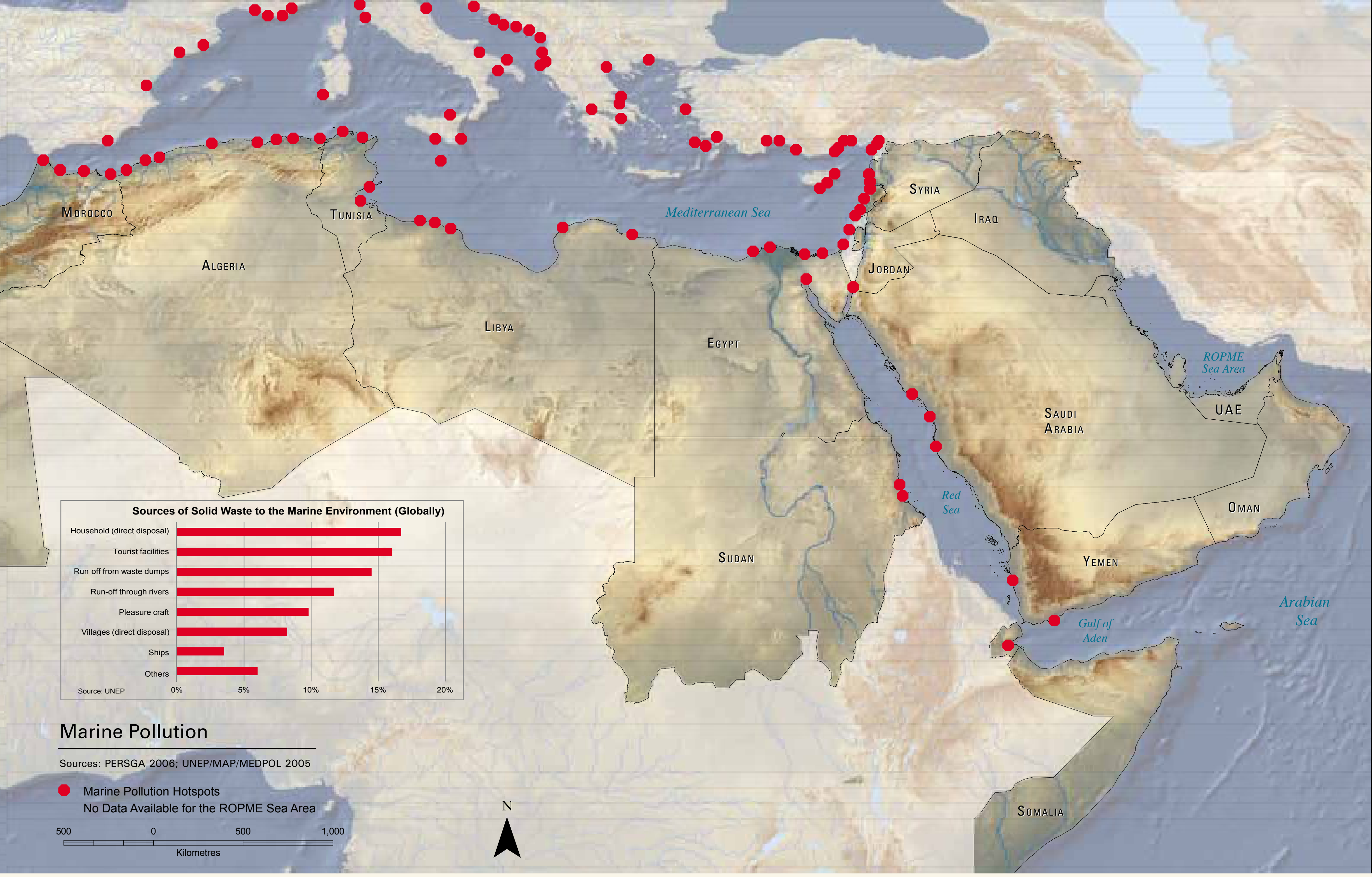
Invasive species

Since the opening of the Suez Canal in 1869, invasive species from the Red Sea (Lessepsian species, either alien or alien invasive species) have become a major component of the Mediterranean ecosystem and have tremendous impacts on the ecology, endangering many local and endemic species. About 300 tropical Indo-Pacific species have become established in the waters of the eastern Mediterranean; more than 70 per cent of the non-indigenous decapods and about 63 per cent of the exotic fish occurring in the Mediterranean are of Indo-Pacific origin introduced into the Mediterranean through the Suez Canal. The Mediterranean region has developed an action plan to address invasive species, and has implemented coordinated measures and efforts to prevent, control and monitor the effects of infestations. The ROPME Sea Area is also vulnerable to invasive species, many of which are introduced by the enormous volume of ballast water from tankers (Sheppard and others 2010). Over 60 Red Sea fish species have entered the eastern Mediterranean via the Suez Canal and are either established or undergoing rapid colonization (Golani 1993; Goren and Galil 2005). These alien fish invasions impact community structure and alter food webs (Goren and Galil 2005). The interactions of invasive species with other stressors, such as global climate change, have long been a concern. A poignant example of how small changes in water temperature can influence invasiveness is the colonization by the lizardfish (*Saurida undosquamis*). After being introduced into the Mediterranean via the Suez Canal, the lizardfish population increased rapidly in the 1950s; its rapid increase was attributed to a rise of 1 to 1.5°C in sea temperature during the winter months of 1955 (Galil 2007). It formed thriving populations in a short amount of time in the eastern Mediterranean, displacing the native hake (*Merluccius merluccius*) and became so abundant that it constituted more than one-fifth of the total fish landings along areas of the Mediterranean coast (Galil 2007).

Invasive species - transboundary aspects

Biotic invasion is one of the five top drivers for global biodiversity loss. The number and severity of outbreaks and infestations of invasive species (species purposefully or accidentally introduced in non-native environments) is growing worldwide, and invasions of marine habitats are now occurring at an alarming rate. Invasive species can change the functions of entire ecosystems. Exotic and invasive species have been identified as a major threat to marine ecosystems, with dramatic effects on biodiversity, biological productivity, habitat structure and fisheries (UNEP-GRID 2008).

Lessepsian species invasion. This brushtooth lizardfish (*Saurida undosquamis*), introduced into the Mediterranean through the Suez Canal, has driven out native fish, become a considerable commercial fish catch and a top predator (Yousif 2003).



Marine Pollution and Hotspots

The Mediterranean Region

An estimated 150 million people are concentrated along the Mediterranean coastline, 54 million of whom inhabit coastal zones in the eight Arab countries bordering the Mediterranean Sea. Many millions more people descend on the Mediterranean annually as part of a thriving tourism industry. The Mediterranean coastline is also heavily industrialized with hundreds of petrochemical industries, energy installations and chemical and chlorine plants that discharge effluent directly into the sea. Contamination sources in the Mediterranean are largely land-based, consisting mostly of untreated sewage discharge from urban centres, agricultural run-off containing pesticides, nitrates and phosphates, and industrial effluents. The map above displays pollution 'hotspots' or areas where pollution is discharged from domestic, municipal or industrial sources to the marine environment, causing impacts to public health, ecosystems and biodiversity.

Though much of the marine contamination sources are land-based, there is increased oil tanker and other shipping traffic in the Mediterranean. An estimated 220 000 vessels cross the Mediterranean Sea each year – about one-third of the world's total merchant shipping. The Mediterranean is a major route for transporting crude oil — approximately 370 million tonnes of oil are transported annually in the Mediterranean Sea, with around 250 to 300 oil tankers crossing the sea every day. The most important oil traffic lane (90 per cent of total oil tanker traffic) connects the Suez Canal and the Sidi Kerir terminal of the SUMED pipeline in Egypt with Gibraltar (REMPEC 2002). The Mediterranean receives approximately 18 per cent of global marine oil pollution, which is minor compared to the ROPME Sea Area and the Red Sea (UNEP-GEO 2000); however, the control of transboundary pollutants and management of waste in the Mediterranean is in need of urgent attention. Mediterranean border countries are applying integrated approaches to coastal zone management to address transboundary pollution reduction and coastal biodiversity conservation priorities in hot spots and sensitive areas.

Pollution transboundary aspects

Pollutants often travel great distances through air, sea currents and rivers before their effects can be traced. Environmental pollution can produce adverse impacts locally (or in proximity to the source of the pollution), regionally, nationally and, in certain cases, globally. Air masses and ocean currents follow circulation patterns that can disperse pollutants and contaminants even to the most remote and pristine environments on the planet.

Oil spills are one of the greatest threats to marine environments in these regions. The effects of oil pollution can be far-reaching and pose a threat to the health of ecosystems. Offshore marine life as well as coastal ecosystems, marine birds that feed at sea, and mariculture are all exposed to risk from oil spillages mainly from offshore oil extraction and oil transport.

The Red Sea and Gulf of Aden

Hotspots and main land-based sources of pollution in the Red Sea and Gulf of Aden Region are shown in the map to the left. Although approximately 7 per cent of the world's sea-borne oil is transported through the region, there have been no major spills (>5 000 tonnes) resulting from shipping accidents. Most spills in this region have been the result of operational discharges, equipment failures and groundings (ITOPF 2003).

In addition to routine operational leaks and spills from oil exploration and production, pollution by oil from tank washing and discharges from passing ships is the most significant form in the Red Sea. Chronic oil pollution, in the form of tar balls arriving on the shorelines, has already been observed in the immediate vicinity of some major Red Sea ports and coastal areas. The coast of Saudi Arabia between Jeddah and Yemen is heavily tarred in places, along with the Gulf of Aden coastline of Yemen, the coasts of Djibouti and the coast near the offshore oil fields of the Gulf of Suez (GIWA 2006).

There are 25 000 to 30 000 ship transits annually through the Red Sea. Oil tankers and other ships constitute another significant source of oil pollution in the southern entrance to the Gulf of Suez (GIWA 2006). Major shipping routes run close to the coral reefs near the ports of Djibouti and Port Sudan, and ships often discharge oily wastes and sewage. Ships also cause physical damage when collisions within the reefs occur.

The ROPME Sea Area

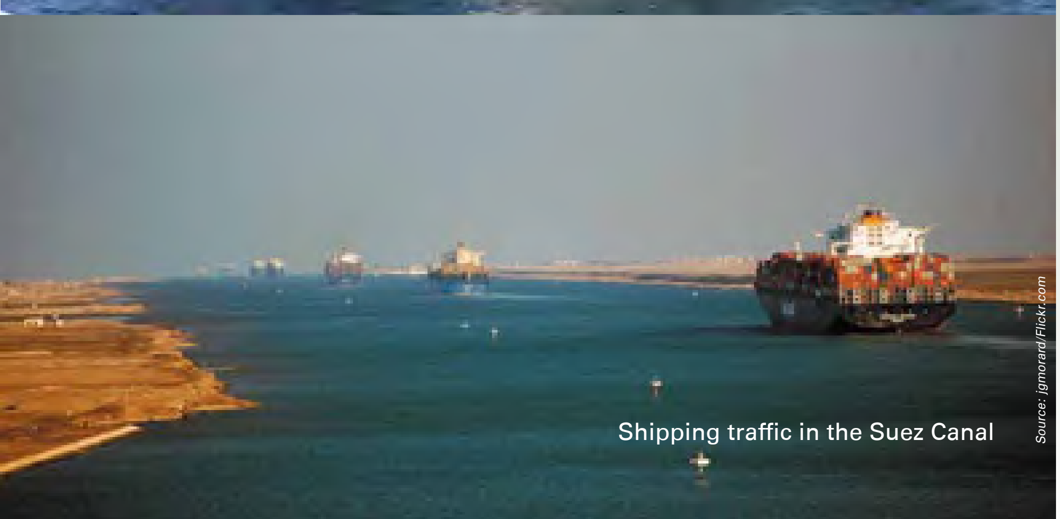
The ROPME Sea Area has some of the greatest pollution risks in the world due to the large number of tanker loading terminals, offshore installations and the high volume of oil tanker traffic. Of the 20 biggest oil spills (greater than 34 000 tonnes) worldwide, 6 were in the ROPME Sea Area (OSIR 2004). The impacts of industrial effluents from petroleum refineries and the petrochemical industry are significant. An estimated two million barrels of oil are spilled annually from ballast discharges, tanker slops and oil and gas platforms (GESAMP 2001). Oil pollution from incidents such as submarine pipeline ruptures also pose a risk to marine ecosystems. In addition, the power plants cause thermal pollution, and the desalination plants, common along the coast of the ROPME Sea Area, release chlorine, brine and thermal loads into the seawater (ROPME 2003).

The ROPME Sea Area has the heaviest traffic of oil tankers. About 25 000 tanker movements sail in and out of the Strait of Hormuz annually and transport about 60 per cent of all the oil carried by ships throughout the world (Sheppard and others 2010). On average, every day about 14 to 15 million barrels of oil loaded on super tankers are transported through the narrow Strait of Hormuz.

Impacts associated with oil traffic include shores heavily contaminated with oil residues and tar balls. About 2 million barrels of oil are spilled annually from the routine discharge of dirty ballast waters and tank washing, partly due to the lack of shore reception facilities. During the Gulf War, over 20 per cent of mangroves on the eastern coast of Saudi Arabia and about 50 per cent of the coral reefs were affected by oil contamination. Hundreds of square kilometres of seagrass beds as well as tidal mud flats were inundated with heavy petroleum products (Sheppard and others 2010).

In 1981, on a voyage from Aqaba to Suez the Loullia ran onto Gordon Reef in the Straits of Tiran, Red Sea

Source: Alex Polezhaev/Flickr.com

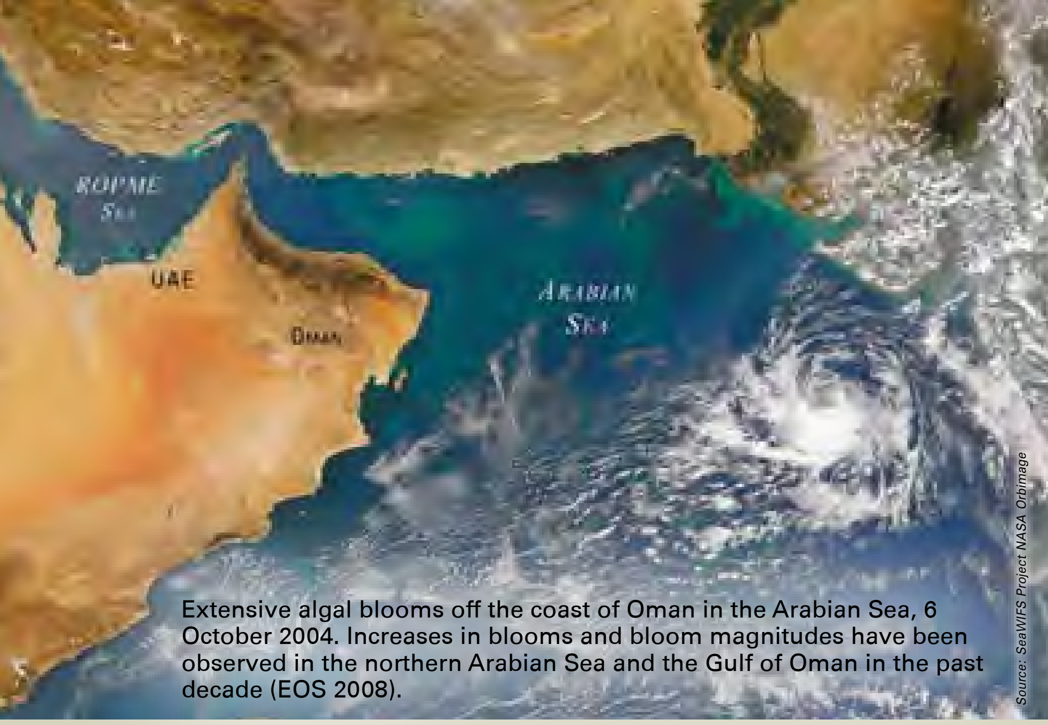


Shipping traffic in the Suez Canal

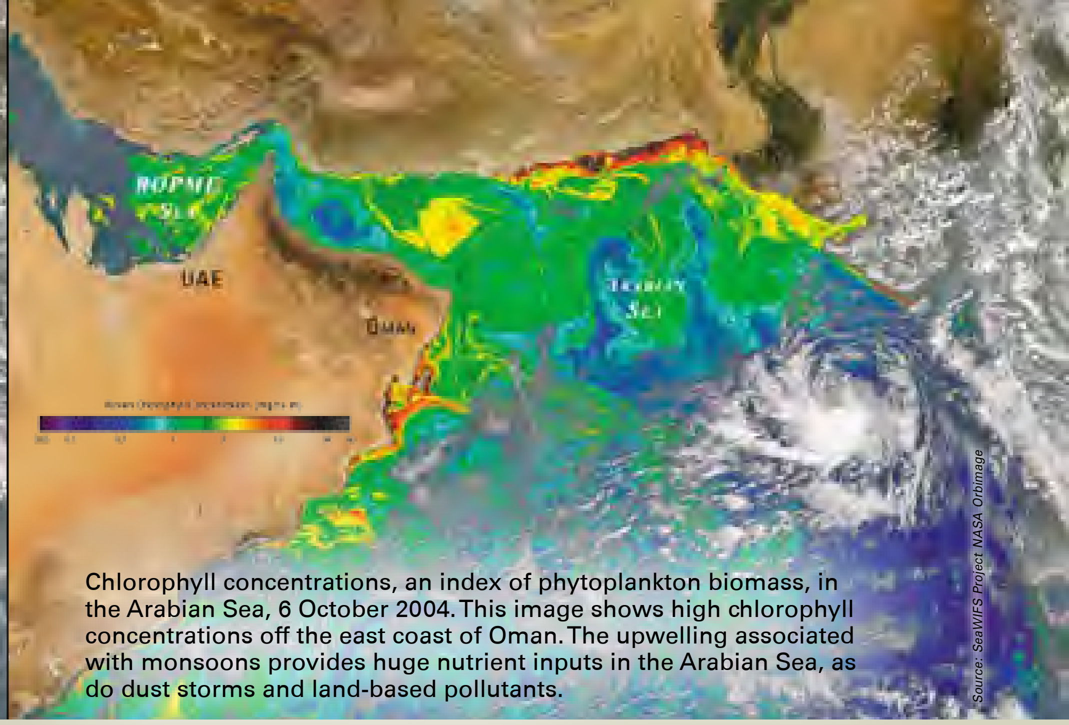
Source: jgmorard/Flickr.com

Navigation Risks in the Red Sea

The Red Sea and Gulf of Aden form part of a major world shipping route that transports about 7 per cent of the global sea-borne oil (PERSGA 2004). Much of the world's crude and refined oil cargoes pass through this region, making it one of the most heavily polluted marine environments. Insufficient and poorly maintained navigational aids and unregulated maritime traffic in many areas of the Red Sea have created high risk zones. These high risk areas include: the southern Red Sea at Bab-al-Mandab and Huneish Archipelago; northern loading points for the Yanbu Petroline in Saudi Arabia; the SUMED pipeline at Ain Sukhna in Egypt; the entrance to the Gulf of Suez and the Suez Canal; and the Straits of Tiran at the entrance to the Gulf of Aqaba. Though no major oil spills (>5 000 tonnes) have occurred to date, a major accident would inflict significant damage to what is considered one of the world's most important marine habitats and species communities. Component 2 of the Regional Organisation for the Conservation of the Environment of the Red Sea and Gulf of Aden's (PERSGA) Strategic Action Programme (SAP) (2004) was designed to promote safety of international shipping and to introduce measures to reduce the impacts of marine pollution. Some of the measures include re-schemed charts of the southern Red Sea to provide better navigational coverage, oil spill prevention and management, traffic separation schemes, and vessel traffic systems.



Extensive algal blooms off the coast of Oman in the Arabian Sea, 6 October 2004. Increases in blooms and bloom magnitudes have been observed in the northern Arabian Sea and the Gulf of Oman in the past decade (EOS 2008).



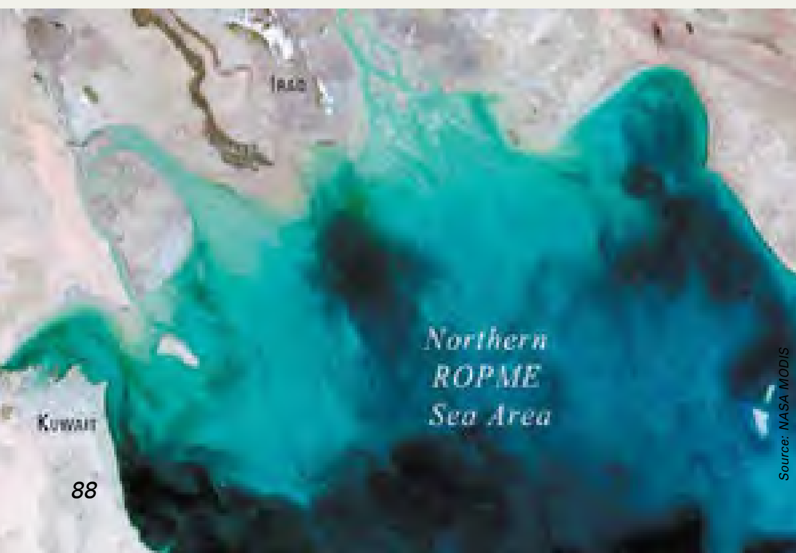
Chlorophyll concentrations, an index of phytoplankton biomass, in the Arabian Sea, 6 October 2004. This image shows high chlorophyll concentrations off the east coast of Oman. The upwelling associated with monsoons provides huge nutrient inputs in the Arabian Sea, as do dust storms and land-based pollutants.

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 wordlwide - 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).

The Mediterranean Region

Nutrient discharge and eutrophication have been identified as a serious source of environmental degradation in Mediterranean ecosystems due to untreated or partially treated discharges of urban sewage into the sea and leaching from fertilized agricultural areas. An estimated 53 per cent of wastewater discharged remains untreated (UNEP 2004). Areas that are especially impacted include the shallow waters near the Nile Delta and major urban areas such as Sfax, Tunisia (UNEP/MAP/MEDPOL 2005).



Increases in nutrient concentrations and sediments at the outfall of the Shatt-Al-Arab River (at centre) in the northern end of ROPME Sea Area cause phytoplankton blooms- this bloom occurred 29 November 2002. Inputs from untreated sewage, industrial pollutants and oils into Kuwait Bay also increase the seawater nutrient levels.

Eutrophication - transboundary aspects

The transboundary aspects of eutrophication relate primarily to its effects on biodiversity. An excess of nutrients in the water gives rise to a complex chain of reactions that disrupt aquatic ecosystems. Under eutrophication, long-living (and slow growing) plants that are important for biodiversity (and support diverse fauna) tend to be outcompeted by fast growing opportunistic species. Among the most serious consequences of eutrophication for biodiversity are algal blooms or red tides. These red tides, caused by several species of microscopic plant-like cells or phytoplankton that produce potent chemical toxins, result in fish kills and contamination of shellfish, and also pose a threat to public health. Bivalve shellfish can accumulate so many toxins that they become toxic to humans. Fish exposed to lower (sublethal) concentrations are also vulnerable to red tides, as they may accumulate toxins in their body.

The Red Sea and Gulf of Aden

Some areas, particularly on the west coast of the Red Sea south of Suez, still receive a considerable load of nutrients and biological oxygen demand (BOD) discharges from domestic sewage. This contributes to eutrophication of the coastal waters around selected population centres, major ports and tourist facilities (Gerges 2002). Oxygen depletion is further exacerbated by dredging and infilling associated with urban expansion, tourism and industrial development, which causes excess sedimentation, which in turn leads to suffocation of benthic communities and ecosystem damage (GESAMP 2001 in UNEP 2006a).

The ROPME Sea Area

Discharges of industrial waste and untreated or partially treated sewage contributes to eutrophication in the ROPME Sea Area. Sewage treatment plants exist in all the countries that border the sea, but the level of treatment varies and the capacity is not sufficient to deal with existing loads. Moderate measurements of chlorophyll-a, ranging from 0.2 to 0.86 mg/m^3, have been reported in the ambient marine environment of the inner ROPME Sea Area (Sheppard and others 2010); values around 0.5 mg/m^3 and greater have been reported from the outer ROPME Sea Area waters. Signs of eutrophication including red tides were observed in Kuwait Bay and in the coastal waters of Muscat (Oman), Dhahran (Saudi Arabia), Abu Dhabi (UAE) and Bahrain (ROPME 2003).

The Dead Sea

The Dead Sea, about 400 m below sea level, is a hypersaline landlocked lake located in the Jordan Rift Valley. The Jordan River is the only major water source flowing into the Dead Sea, although there are small perennial springs that also feed into the sea. The Dead Sea's distinctive chemical composition and fresh/salt water interface have created a unique ecology of international importance. This body of water is rapidly changing, and water levels are dropping due to sharp decreases in inflow from the Jordan River. Excessive abstraction of the river water to meet increased demand in surrounding countries has caused a significant decrease in the Dead Sea's water level. The water level has decreased from 394 m below sea level in the 1960s to 418 m below sea level as of 2006. These levels continue to drop at an alarming pace of 0.8 to 1 m/yr, and the surface area is shrinking accordingly—the Dead Sea's surface area has been reduced by one-third, and currently covers 637 km^2 (World Bank 2009). The impacts of this declining water level and surface area include loss of freshwater springs, river bed erosion, and creation of thousands of sinkholes, or underground craters.

Infrastructural, institutional and demand management solutions have been proposed to prevent continued degradation of the Dead Sea and develop additional water resources. Foremost among these is the Red Sea-Dead Sea Water Conveyance Concept; this would convey seawater in a canal from the Red Sea into the Dead Sea while generating hydroelectric power for use in desalination. This would arrest the rapidly declining water levels in the sea and allow water to accumulate over time to feasible levels (World Bank 2009). Opponents of the canal propose that allowing the Jordan River to flow unimpeded into the Dead Sea would be a more effective restoration tool; other concerns related to the conveyance project include the changes to the Dead Sea's unique water chemistry due to inputs of Red Sea water, the introduction of invasive species, and the disproportionate benefits to certain riparian countries due to already established border and water rights. Addressing the problem of overexploitation of ground and surface waters is essential to curbing the tremendous ecological damage to this internationally significant site. The need for effective water governance for the Jordan River and Dead Sea basin has been recognized. The countries of Israel, Jordan and the Occupied Palestinian Territories are promoting the canal project to coordinate efforts to recharge the Dead Sea; however, addressing water demand in the region is an essential part of a comprehensive conservation strategy. These images show the dramatic decrease in surface area of the Dead Sea from 1973 to 2009, as well as extensive development of salt evaporation ponds at the south end of the sea. These ponds produce sodium chloride and potassium salts.

Source Jonas Hansel/Flickr.com

Hebron, West Bank. Protective wire mesh protects shoppers in the alleyways of the bazaar from rocks, bottles and trash being thrown down from settlements above.

The once flourishing bazaars of central Hebron, one of the West Bank's largest cities, are now blocked with barbed wire or mesh fencing. Since establishment of a Jewish settlement in the heart of the city in 1979, the economy of this dynamic urban centre has been in decline. To protect the hundreds of settlers, the Israeli military enforces drastic security measures that severely restrict Palestinian movement in areas surrounding the settlement and have driven Palestinians out of their home (UNISPAL 2007).

2.5 Conflict

Contention, Strife and Human Migration

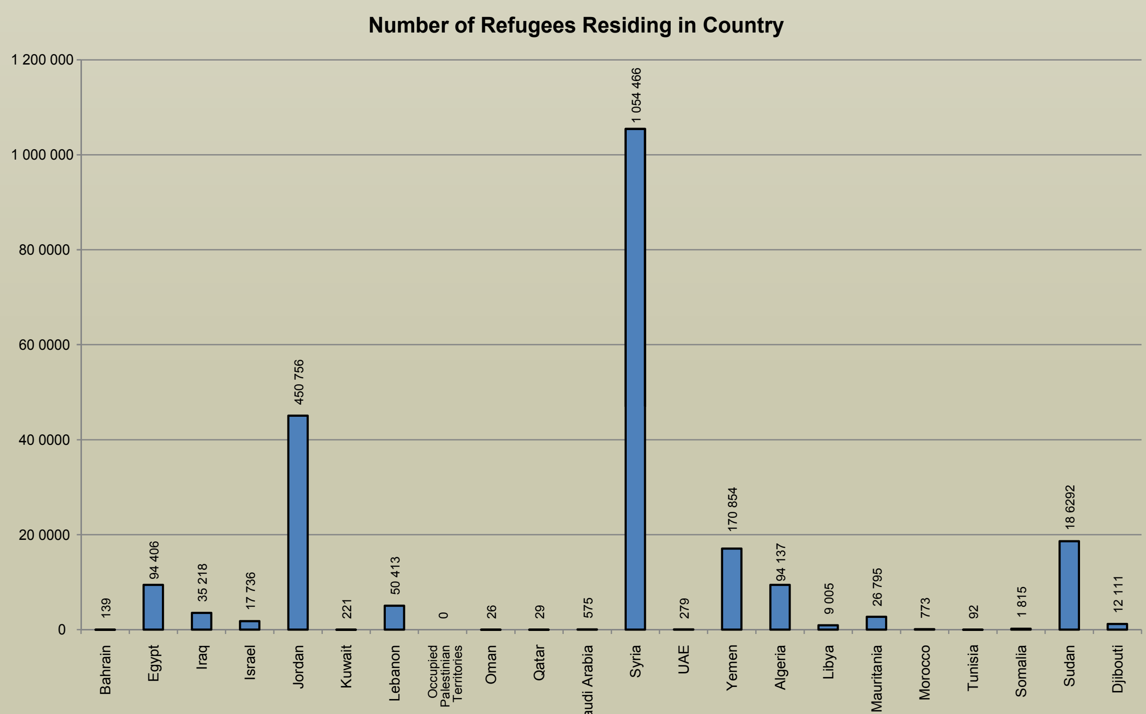
Migration is one of the defining global issues of the early 21st century, with more people on the move today than at any other point in human history—almost 214 million people live outside their birthplace today, which is equivalent to about 3 per cent of the world population. Sixteen million of these migrants are refugees (UN 2009). The current annual growth rate of international migrants worldwide is about 2.9 per cent (International Organization for Migration [IOM] 2010), which is substantial when compared to the world population growth rate of 1.2 per cent in 2009 (PRB 2009). Human migration can be internal (Internally Displaced Persons [IDPs]) or external (refugees and labour migrants), and can be triggered by armed conflict, environmental degradation, or the need to better economic opportunities.

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 in the region, 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.

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 m^3 (UNDP 2009).

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.

Ongoing conflict in Western Sahara, along with desertification, are prompting migrations of the local population. Once composed primarily of grasslands, the Sahel is facing increased desertification due to extreme weather conditions such as drought and flooding. Communities are heavily dependent on natural resources, which renders them highly vulnerable to environmental changes (IOM 2008). As of 2009, 125 000 people in the western part of Morocco were receiving food rations from the World Food Program (WFP 2009).



Source: UNHCR 2010a


Source: Nite Owl/Flickr.com

Refugees in west Darfur, Sudan

Photo: Yesil Sevenler/Flickr.com

Photo: Yesil Sevenler/Flickr.com

As a result of the Israeli bombing of the Jiyyeh power plant in Lebanon on 27 July 2006 a massive oil spill near Jbeil is evident, causing widespread environmental consequences. The coastline of Lebanon was heavily polluted by oil as a result of the bombing.

Conflict and displacement: Lebanon

Continuous conflict in Lebanon (1975 to 1990 civil war, Israel's 18-year occupation of southern Lebanon, July 2006 Israeli war on Lebanon and the 2007 Nahr el Bared conflict and consequent destruction of the Palestinian refugee camp) has left hundreds of thousands of people dead and over a million displaced. Conflict has also caused mass emigration out of the country. An estimated 28 per cent of the population was displaced due to the civil war and 949 villages were affected, of which 174 were totally or partially destroyed. The vast majority – over 85 per cent –were displaced from Mount Lebanon or the southern region. Subsequent Israeli conflicts left approximately 200 000 Lebanese displaced. Palestinian refugees, already displaced from their home country, were further uprooted during the "War of the Camps" in 1985.

Although most of the displacement was temporary, many people resettled indefinitely in Dahia, the southern suburbs of Beirut. As of 2006, nearly 17 000 Lebanese were still displaced by the civil war. The 2006 Israeli conflict destroyed and damaged civilian infrastructure, and forced an estimated one million people to flee their homes (90 per cent had returned home within less than a week of the ceasefire) (UNEP 2007a). Environmental impacts of the 2006 conflict were widespread. Oil contamination from bombings was one of the more severe environmental consequences of the conflict. According to the UNEP Post-Conflict Environmental Assessment "The environmental impact of the conflict was brought to the fore by the bombing of fuel storage tanks at the Jiyeh thermal power plant ... which resulted in some 10 000 to 15 000 tons of heavy fuel oil spilling into the sea, affecting approximately 150 km of Lebanese coastline, as well as part of Syria's coast" (UNEP 2007a).

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

Source: United Nations Photo Flickr.com

Above, a Lebanese woman, who has lived through years of conflict, speaks about the cluster bombs that hit no more than 10 m from her family's home.

In this photo, ravaged skeletons of buildings litter urban areas of Lebanon from years of conflict.

Source: Patrick Abi Salloum/Flickr.com

Source: NASA / MODIS Images

Mesopotamian Marshes 2002, just prior to re-flooding of the marshlands

Mesopotamian Marshes 2007, after re-flooding. Note the expansion of the Al-Hawizeh, Al-Hammar, and Central marshes

Source: icodeplanet/Flickr.com

Iraq war refugees

Iraq

The war in Iraq has caused massive internal and external displacement since 2003. By January 2009, 2.7 million Iraqis were internally displaced and about 2 million others were refugees in neighbouring countries such as Jordan and Syria (UNHCR 2010a). In the past, years of sanctions also caused a severe brain drain - beginning in 2003, where an estimated 40 per cent of Iraq's professionals fled the country and many others were persecuted or killed by militias. Between 2005 and 2007, school enrolment dropped by 45 per cent due to lack of teachers and fear of kidnapping (UN News Centre 2007).

Although the overall security situation is somewhat improving, mass returns have not taken place yet due to continued violence; in 2009, only 6 per cent or 167 000 IDPs returned to their homes, while only 37 000 refugees returned to Iraq (UNHCR 2010b). Also, Iraqis remaining in their place of origin are vulnerable due to the ongoing violence and continue to face a deteriorating standard of living, lack of infrastructure, movement restrictions, high unemployment and loss of work opportunities (UNHCR 2010a).

Mesopotamian Marshes

The Mesopotamian marshlands of southern Iraq, which consist of wetlands, open water, tall reedbeds, desert shrubs and grasses as well as inundated mudflats (UNEP 2003), have sustained the way of life of the Marsh Arabs for thousands of years. These marsh peoples live in reed dwellings floating on water and make their living out of raising buffalo, fishing, agriculture, and manufacturing reed baskets and furniture. Almost 90 per cent of the marsh area was lost due to upstream damming and massive drainage works in southern Iraq by the previous Iraqi regime during the 1990s (UNEP 2003)—the surface area shrunk from an estimated 20 000 km^2 to 400 km^2 in 2000 (UNEP 2007b). The demise of the marshlands, and the forced expulsion of the indigenous population in the 1980s, caused the displacement of up to 300 000 Marsh Arabs inside and outside Iraq (Reliefweb 2003). In 2003, a mere 40 000 of the once 500 000 marsh inhabitants remained, or 8 per cent of the original population (Reliefweb 2003).

After the collapse of the Saddam regime in 2003, local communities started to open floodgates and destroy earthen dikes and dams, releasing water back into the marshes. By March 2004, almost 20 per cent of the original marshland area had been restored (UNEP 2007b). In July 2004, UNEP launched the first phase of a long-term project to restore the marshlands, provide clean drinking water and sanitation for 22 000 Marsh Arabs and train Iraqis in wetland management and restoration (UNEP 2004). According to the Iraqi Marshlands Observation System (IMOS), 58 per cent of the marshlands have recovered to their original extent (UNEP 2006b). Timely and adequate water flows must be maintained to ensure the recovery of this dynamic and unique ecosystem, which requires coordinated basin-wide management of the Tigris and Euphrates rivers.

Source: Salim Virji/Flickr.com

Iraqi Marsh Arab


Source: Gytis Cibulskis/Flickr.com

Conflict and Environmental Degradation: Iraq

In an area north of the city of Al-Basrah, Iraq, which borders Iran, marshlands were drained and walled off. This strategic place has been used as a staging area for military exercises and battles, and is littered with minefields and gun emplacements.

The image on the left is from 13 August 1984 and displays the Tigris river, palm plantations and agriculture along the river, areas of open water and marshlands. Some landscape impacts are evident in the staging area in the 1984 image.

The image on the right was acquired by Landsat 7's Enhanced Thematic Mapper plus (ETM+) sensor on 24 January 2001. This is a false-color composite image made using near-infrared, red, and green wavelengths. The image has also been sharpened using the sensor's panchromatic band. This image displays the vast impacts from military operation and conflicts, and the total environmental devastation of the area. Marshlands and open water are completely drained and the agricultural zones are fallow. The landscape has been shattered by use as a conflict zone.

Source: DVIDSHUB/Flickr.com

New green plant cover within fenced protection area near Al Abdaly Farms in the north of Kuwait

New vegetation in Al-Jahra Protected Area

Kuwait-Iraq and Kuwait-Saudi Arabia Green Borders:

Remarkable Environmental Change and Enhancement

The most apparent and visible evidence of desertification is the loss of vegetation cover and its insufficient protection against soil erosion. Loss of plant cover entails loss of biodiversity and the failure to withstand habitat deterioration or desertification. Successfully stemming the spread of desertification can be achieved through national policies that allow resource conservation to be an integral part of national endeavours that protect and utilize natural resources sustainably. The Kuwait-Iraq Separation Border Zone (a demilitarized zone), imposed by the UN Security Council in 1991 after the Iraq war, runs 190 km along the border and extends 10 km into Iraq and 5 km into Kuwait. Comparing the image pairs shows that within this fenced and protected area, the change in green cover is clearly evident. Similarly, the fenced border areas between Kuwait and Saudi Arabia, and the fenced oil fields in Kuwait have also shown a remarkable increase

New vegetation in Sabah Al-Ahmad Nature Reserve

in green plant cover and demonstrate the power of land use protection from grazing and anthropogenic pressures. Removal of the perturbations has contributed positively to the growth of plant cover and resource conservation. In the past twenty years, the Government of Kuwait has adopted and established twelve protected areas and nature reserves around the country. Another ten protected areas have been proposed, in addition to over eight restricted areas for specific reasons, which includes fenced oil fields and buffer regions around international borders. The 5 km-wide fenced area along Kuwait's northern and north-western borders (established in 1991) was later declared by the Government of Kuwait as a nature reserve to protect wildlife and biodiversity. The combined area (12 adopted protected areas plus 8 fenced areas) in Kuwait is 26.76 per cent of the total country area; over 4 769 square kilometres. These change pair images clearly demonstrate the positive effects that restriction and resource protection have on the landscape by capturing the dramatic increase of green vegetation cover.

Waterhole in Sabah Al-Ahmad Nature Reserve

Israel's separation wall has become the most visible manifestation of the Israeli military occupation in Palestine

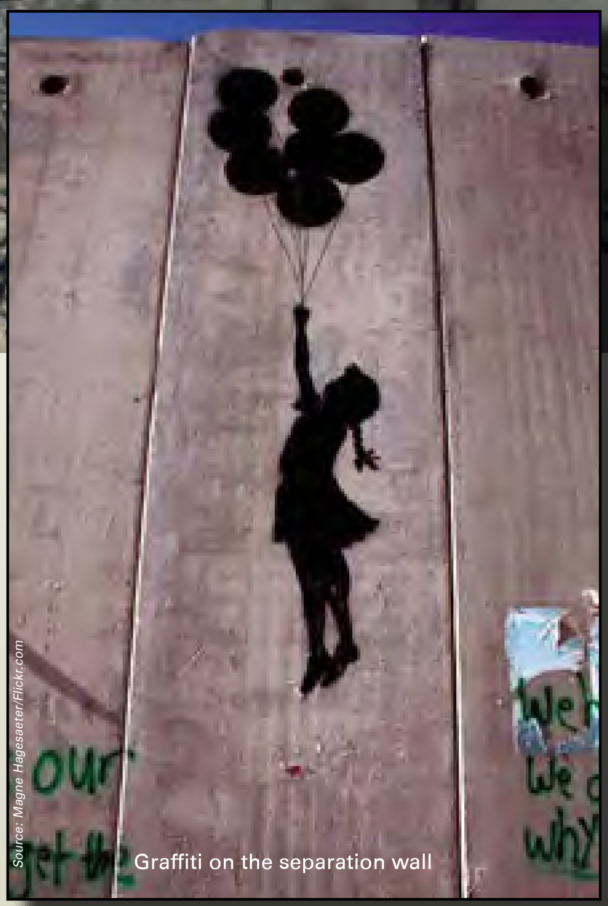
Source: John Jobby Flickr.com

Separation Wall

Occupied Palestinian Territory

In November 1947, the UN General Assembly partitioned historical Palestine into Arab and Jewish states. In the war that followed, more than 700 000 people lost their homes. In 1976, the war between Israel, Egypt, Jordan and Syria resulted in the occupation of the West Bank, Gaza, and the Golan Heights, which also displaced hundreds of thousands of people. Today, almost 1.4 million Palestinian refugees, more than one-third of the total Palestinian population, live in 58 camps in the Occupied Palestinian Territories, Lebanon, Syria and Jordan (UNRWA 2009).

In June 2002, Israel began building a "separation wall" within the West Bank as an asserted security measure. The wall, with a planned length of over 700 km (almost half of which was complete by 2010) separates the West Bank from Israel. It restricts freedom of movement and access of Palestinians, often making it difficult for inhabitants to conduct their daily routines. The wall has also interrupted agricultural activities in the Occupied Palestinian Territories, which contribute 12 per cent of the GDP (World Bank 2009). Agriculture, which uses two-thirds of water resources in the Occupied Palestinian Territories, has been gradually deteriorating since the start of the occupation due to over-extraction of groundwater resources and deteriorated water networks; construction of the wall has isolated 10 per cent of agricultural lands in the West Bank (World Bank 2009), and further restricted Palestinian access to their lands (especially olive groves), a large part of which fall outside the wall extent (Negotiations Affairs Department 2004). The wall has also cut off farmers from their domestic and agricultural wells, further limiting access to water resources. As a result, Palestinian abstractions from the three aquifers in the West Bank have declined from 138 MCM in 1999 to 113 MCM in 2007 (World Bank 2009).



Graffiti on the separation wall

Source: Magne Hagesaeter/Flickr.com

Israeli control over resources also impacts water quality; over-extraction of Israeli wells has alarmingly decreased the water table in Palestinian wells, thus increasing salinity (World Bank 2009). Water quality is further exacerbated by land pollution sources, specifically solid waste dumpsites and wastewater treatment plants operating beyond their design capacity. In 2007, a collapsed sewage pond in northern Gaza (Beit Lahia) flooded an entire village and killed four Palestinians – the pond and treatment plant were designed to serve 50 000 people but instead serve 190 000 (UNEP 2009b).

Internally displaced women carrying water in Sudan

Source: Rita Willaert/Flickr.com

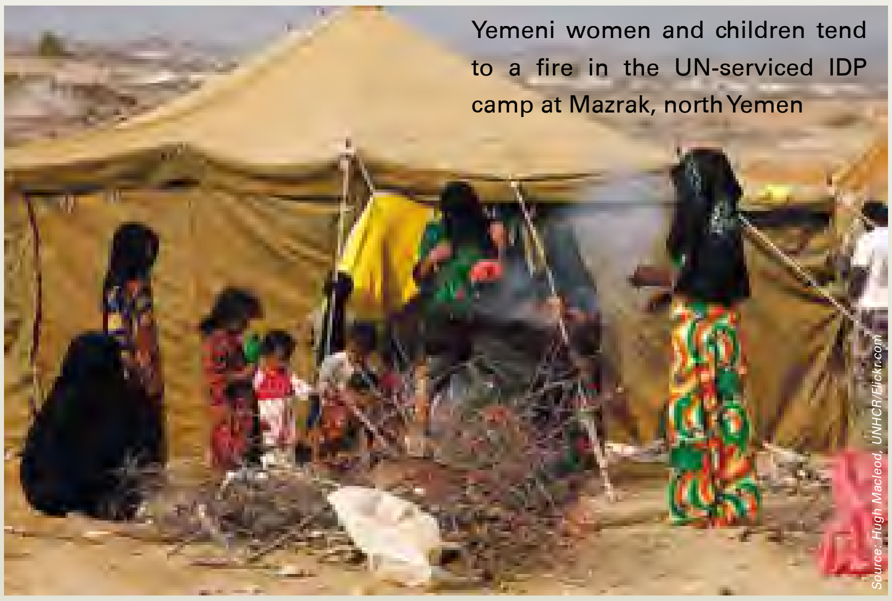
Conflict and displacement: Sudan

Sudan has the largest number of IDPs and international refugees in the world, partly due to long-term violent conflicts that include: the first civil war between the north and south (1955-1972); the oil-fueled second civil war (1983-2005), mostly in the south; and the Darfur conflict (1970-1994), which resumed in 2003. The Darfur conflict alone has caused the displacement of upwards of 2.6 million people, and an influx of 250 000 refugees into Chad, which has transboundary environmental consequences (UNHCR 2010a).

Conflict between the north and south in Sudan is largely due to competition over oil reserves, water and agricultural lands (UNEP 2007c). These areas of the country exhibit extreme differences in terms of climate and natural resources—the south is equatorial, has more water and is more fertile, while the north is mostly desert. Deforestation and a decline in precipitation over the past 30 years has caused nomads and pastoralists in North Darfur to move south, leading to violent competition with the residing farming communities over scarce water resources and agricultural land (UNEP 2007c).

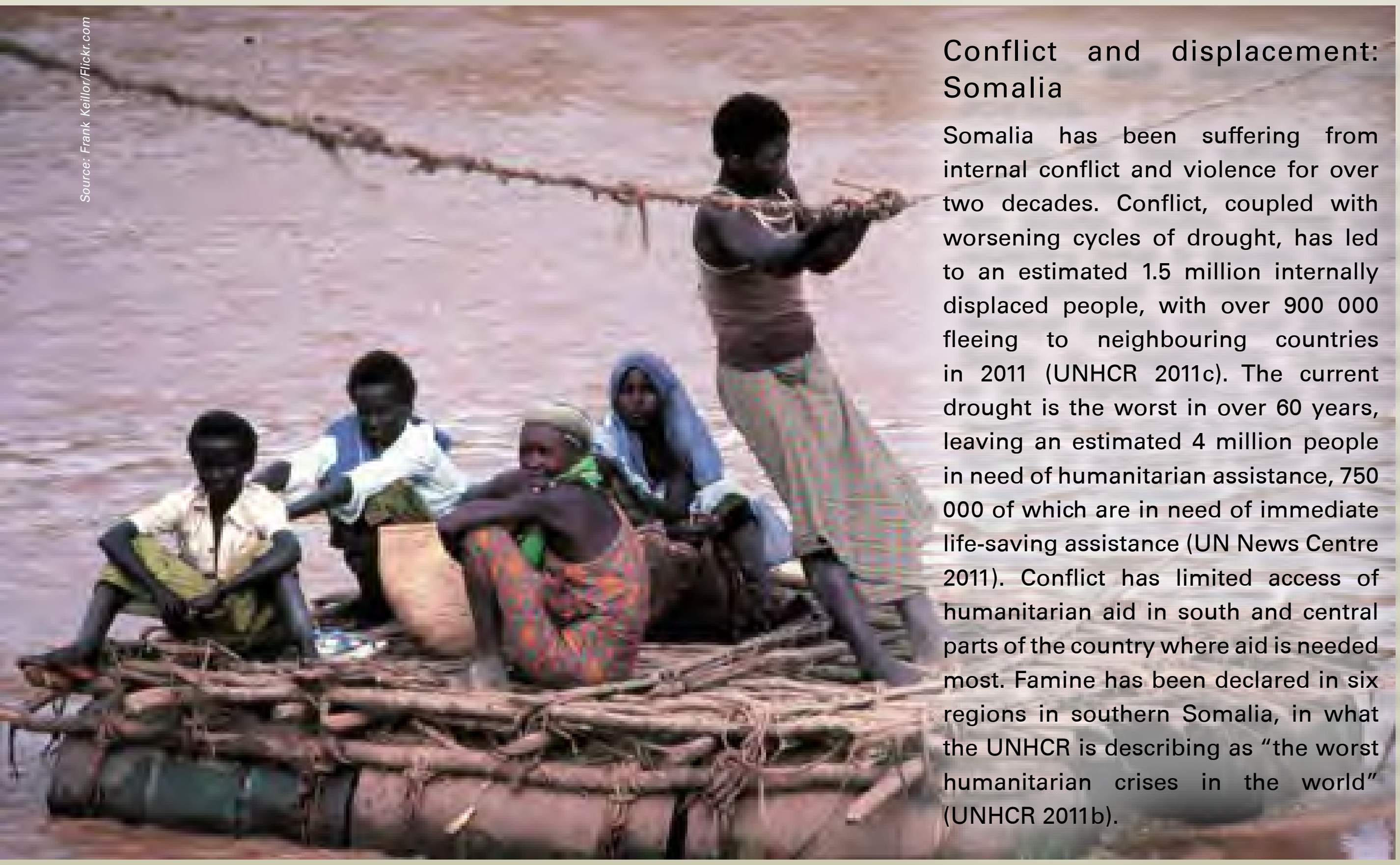
Conflict and displacement: Yemen

Yemen is one of the poorest countries in the world, with high unemployment, severe droughts and food shortages. Ongoing conflict in the country over the past several years has caused massive displacement, particularly along the border with Saudi Arabia where over 150 000 people have been displaced from the Sa'ada governorate since the start of the latest conflict in 2009 (UNHCR 2010a). As of January 2009, the number of IDPs in Yemen was estimated at 100 000, while up to 800 000 people are indirectly affected by the conflict, including communities hosting the refugees. The country also hosts more than 140 000 migrants (as of January 2009), mainly from Somalia, but also from Iraq and Ethiopia (UNHCR 2010a). Abandonment of farmlands in the north due to conflict and drought has led to widespread land degradation.



Yemeni women and children tend to a fire in the UN-serviced IDP camp at Mazrak, north Yemen

Source: Hugh Macleod, UNHCR/Flickr.com



Source: Frank Keillor/Flickr.com

Conflict and displacement: Somalia

Somalia has been suffering from internal conflict and violence for over two decades. Conflict, coupled with worsening cycles of drought, has led to an estimated 1.5 million internally displaced people, with over 900 000 fleeing to neighbouring countries in 2011 (UNHCR 2011c). The current drought is the worst in over 60 years, leaving an estimated 4 million people in need of humanitarian assistance, 750 000 of which are in need of immediate life-saving assistance (UN News Centre 2011). Conflict has limited access of humanitarian aid in south and central parts of the country where aid is needed most. Famine has been declared in six regions in southern Somalia, in what the UNHCR is describing as "the worst humanitarian crises in the world" (UNHCR 2011b).

Somali children at a feeding centre in southern Somalia

Source: Frank Keillor/Flickr.com

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An abstract landscape - clusters of traditional homes and paddocks surround a small village in northern Somalia. Pastoral grazing is the centre of culture and resources for the people of this remote village. The repetitive crescent shapes are erosion control devices built into the slopes to try and control soil loss due to lack of vegetation from heavy grazing pressures.

Chapter 3

Authors: Zach Hill, Tim Maguire , Derek Risso, Aditya Agrawal, Bruce Pengra, Shannon Campbell

Tracking Progress Towards Environmental Sustainability

In 2000, 189 nations and 23 international organizations committed to achieving eight Millennium Development Goals (MDGs) to reduce poverty, hunger and disease and improve quality of life in the developing countries by the year 2015. These development targets were derived from the United Nations Millennium Declaration of 2000 and specifically include: eradicating poverty and hunger, achieving universal primary education, promoting gender equality and empowering women, reducing child mortality, improving maternal health, combating diseases, ensuring environmental sustainability, and developing a global partnership for development. Progress toward reaching these targets is tracked and measured using different indicators, which are described in the MDG table listed in this Chapter.

Though progress has been made in meeting these goals, it has been slow and uneven and is impacted by the current global economic crisis, local environmental conditions brought about by climate change and by shortcomings in aid or assistance. Another obstacle to advancing targets is the lack of effective governance at the national level. The Millennium Development Goals Report (2009) notes that though important milestones have been reached with fewer people dying of AIDS and more people with access to primary education, progress has been too slow in meeting many of the targets and must be accelerated in order to create a more equitable and sustainable future. An MDG Summit was convened in September 2010 in order to boost progress towards achieving the MDGs. In the Arab countries, the MDGs are effectively being used as a tool for formulating policies, planning and prioritization. Constraints in the region to meeting the MDG goals include weak institutional capacities and lack of effective planning, increasing water scarcity, priorities of human security, climate change constraints, and insufficient data and monitoring (UNDP 2010).

Millennium Development Goals (MDGs)	Effective 15 January 2008
Goals and Targets (from the Millenium Declaration)	**Indicators for monitoring progress**
Goal 1: Eradicate extreme poverty and hunger	
Target 1.A: Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1.1 Proportion of population below US$1 (PPP) per day[a] 1.2 Poverty gap ratio 1.3 Share of poorest quintile in national consumption
Target 1.B: Achieve full and productive employment and decent work for all, including women and young people	1.4 Growth rate of GDP per person employed 1.5 Employment-to-population ratio 1.6 Proportion of employed people living below US$1 (PPP) per day 1.7 Proportion of own-account and contributing family workers in total employment
Target 1.C: Halve, between 1990 and 2015, the proportion of people who suffer from hunger	1.8 Prevalence of underweight children under five years of age 1.9 Proportion of population below minimum level of dietary energy consumption
Goal 2: Achieve universal primary education	
Target 2.A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	2.1 Net enrolment ratio in primary education 2.2 Proportion of pupils starting grade one who reach the last grade of primary school 2.3 Literacy rate of 15-24 year-olds, women and men
Goal 3: Promote gender equality and empower women	
Target 3.A: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	3.1 Ratios of girls to boys in primary, secondary and tertiary education 3.2 Share of women in wage employment in the non-agricultural sector 3.3 Proportion of seats held by women in national parliament
Goal 4: Reduce child mortality	
Target 4.A: Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	4.1 Under-five mortality rate 4.2 Infant mortality rate 4.3 Proportion of one year-old children immunized against measles
Goal 5: Improve maternal health	
Target 5.A: Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	5.1 Maternal mortality ratio 5.2 Proportion of births attended by skilled health personnel
Target 5.B: Achieve, by 2015, universal access to reproductive health	5.3 Contraceptive prevalence rate 5.4 Adolescent birth rate 5.5 Antenatal care coverage (at least one visit and at least four visits) 5.6 Unmet need for family planning
Goal 6: Combat HIV/AIDS, malaria and other diseases	
Target 6.A: Have halted by 2015 and begun to reverse the spread of HIV/AIDS	6.1 HIV prevalence among population aged 15-24 years 6.2 Condom use at last high-risk sex 6.3 Proportion of population aged 15-24 years with comprehensive correct knowledge of HIV/AIDS 6.4 Ratio of school attendance of orphans to school attendance of non-orphans aged 10-14 years
Target 6.B: Achieve, by 2010, universal access to treatment for HIV/AIDS for all who need it	6.5 Proportion of population with advanced HIV infection with access to antiretroviral drugs
Target 6.C: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	6.6 Incidence and death rates associated with malaria 6.7 Proportion of children under five sleeping under insecticide-treated bednets 6.8 Proportion of children under five with fever who are treated with appropriate anti-malarial drugs 6.9 Incidence, prevalence and death rates associated with tuberculosis 6.10 Proportion of tuberculosis cases detected and cured under directly observed treatment short course
Goal 7: Ensure environmental sustainability	
Target 7.A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources	
Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss	7.1 Proportion of land area covered by forest 7.2 CO2 emissions, total, per capita and per US$1 GDP (PPP) 7.3 Consumption of ozone-depleting substances 7.4 Proportion of fish stocks within safe biological limits 7.5 Proportion of total water resources used 7.6 Proportion of terrestrial and marine areas protected 7.7 Proportion of species threatened with extinction
Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation	7.8 Proportion of population using an improved drinking water source 7.9 Proportion of population using an improved sanitation facility
Target 7.D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers	7.10 Proportion of urban population living in slums[b]
Goal 8: Develop a global partnership for development	
Target 8.A: Develop further an open, rule-based, predictable, non-discriminatory trading and financial system Includes a commitment to good governance, development and poverty reduction—both nationally and internationally Target 8.B: Address the special needs of the least developed countries (LDCs) Includes: tariff and quota free access for the LDCs' exports; enhanced programme of debt relief for heavily indebted poor countries (HIPC) and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction Target 8.C: Address the special needs of landlocked developing countries and small island developing states (through the Programme of Action for the Sustainable Development of Small Island Developing states and the outcome of the twenty-second special session of the General Assembly) Target 8.D: Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term	Some of the indicators listed below are monitored separately for the least developed countries (LDCs), Africa, landlocked developing countries and small island developing states **Official development assistance (ODA)** 8.1 Net ODA, total and to the LDCs, as percentage of OECD/DAC donors' gross national income 8.2 Proportion of total bilateral, sector-allocable ODA of OECD/DAC donors to basic social services (basic education, primary health care, nutrition, safe water and sanitation) 8.3 Proportion of bilateral official development assistance of OECD/DAC donors that is untied 8.4 ODA received in landlocked developing countries as a proportion of their gross national incomes 8.5 ODA received in small developing states as a proportion of their gross national incomes **Market Access** 8.6 Proportion of total developed country imports (by value and excluding arms) from developing countries and LDCs, admitted free of duty 8.7 Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries 8.8 Agricultural support estimates for OECD countries as a percentage of their gross domestic product 8.9 Proportion of ODA provided to help build trade capacity **Debt sustainability** 8.10 Total number of countries that have reached their HIPC decision points and number that have reached their HIPC completion points (cumulative) 8.11 Debt relief committed under HIPC and MDRI Initiatives 8.12 Debt service as a percentage of exports of goods and service
Target 8.E: In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries	8.13 Proportion of population with access to affordable essential drugs on a sustainable basis
Target 8.F: In cooperation with the private sector, make available the benefits of new technologies, especially information and communications	8.14 Telephone lines per 100 population 8.15 Cellular subscribers per 100 population 8.16 Internet users per 100 populations

The Millennium Development Goals and targets come from the Millennium Declaration, signed by 189 countries, including 147 heads of state and government, in September 2000 (http://www.un.org/millennium/declaration/ares552e.htm) and from further agreement by member states at the 2005 World Summit (Resolution adopted by the General Assembly—A/RES/60/1, http://www.un.org/Docs/journal/asp/ws.asp?m=A/RES/60/1). The goals and targets are interrelated and should be seen as a whole. They represent a partnership between the developed countries and the developing countries "to create an environment—at the national and global levels alike—which is conducive to development and the elimination of poverty".

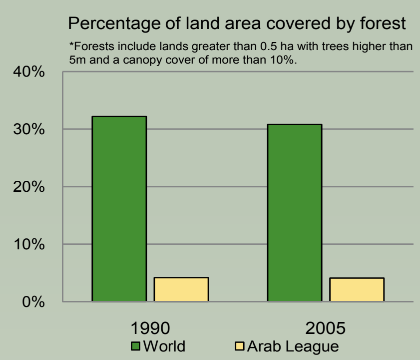
[a] For monitoring country poverty trends, indicators based on national poverty lines should be used, where available.

[b] The actual proportion of people living in slums is measured by a proxy, represented by the urban population living in households with at least one of the four characteristics: (a) lack of access to improved water supply; (b) lack of access to improved sanitation; (c) overcrowding (three or more per room); and (d) dwellings made of non-durable material.

In this chapter, the major environmental issues are identified and described for each Arab country, and relevant land cover changes are vividly depicted over time using airborne and satellite imagery. For each country, the progress towards meeting the goal of ensuring environmental sustainability (MDG 7) is also tracked from 1990 to date (Source: UN MDG database unless otherwise specified), using the five indicators for sustainability (proportion of forested lands, slum dwellers, access to improved water sources and improved sanitation, and protected areas).

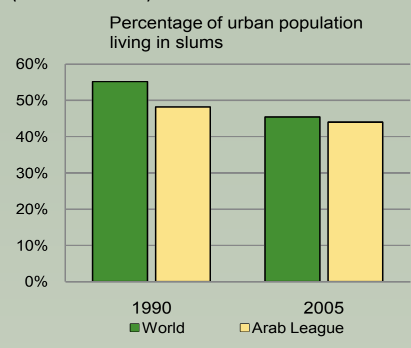
Proportion of land area covered by forest

About 13 million hectares of the world's four thousand million hectares of forest are lost each year to deforestation and degradation caused by demand for fuel and building materials and conversion to agricultural lands (UN 2009). However, since 2000, new planting and natural expansion of existing forests has slowed the rate of forest loss world-wide. Although the Arab League nations as a whole contain only a small proportion of forested area, the mountainous areas along much of the Mediterranean, and to a lesser extent, the Red Sea and ROPME Sea Area, harbour important littoral forests. The North African countries of Somalia and Sudan experienced a decrease in forest area from 2000 to 2005, while Egypt, Algeria, Morocco and Tunisia's forest area increased during that same time period. Many of the countries in West Asia experienced increases in forest area, due mostly to afforestation and reforestation projects (FAO 2006).



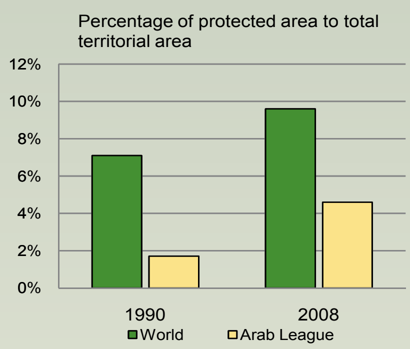
Proportion of urban population living in slums

Today, about half of the world's population lives in an urban setting. Due to rapid population growth and increased urban migration, the number of city dwellers will continue to expand, increasing from 3.5 thousand million people today to nearly 5 thousand million by 2030 (UNFPA 2007). Rapid expansion of urban areas will make it challenging to improve living conditions quickly enough to meet the 2020 target of achieving a significant improvement in the lives of at least 100 million slum dwellers. In 2005, one out of three urban dwellers in developing countries were living in slum conditions, defined as lacking at least one of the basic conditions of decent housing: clean water, improved sanitation, durable housing and adequate living space (UN 2009). In the Arab region, the widening gap in wealth inequality is reflected in the high rates of urban slum dwellers in Arab cities and towns, which amounted to 42 per cent in 2001 (UNEP 2009). Rates of urban slum dwellers are very uneven within the region; in 2005, Sudan had the world's second highest rate at 94 per cent, while Syria had 11 per cent (UNEP 2009).



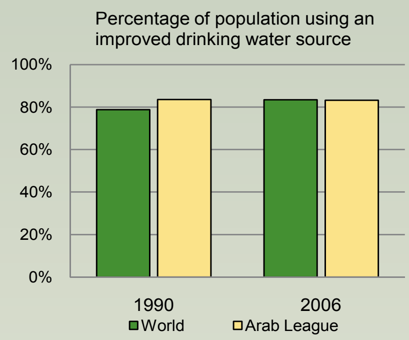
Proportion of protected areas

Worldwide, the amount of land and marine areas under protection in 2008 was over 21 250 000 km² (UNSD 2010) (other estimates include the area to be 25 775 617 km²) (WDPA 2009); in 1990, the estimated amount of protected areas was just over 13 million km² (UNSD 2010). Although the proportion of protected areas has steadily increased in the last several decades, the status of many protected areas is unknown and effective conservation is not consistently applied or enforced. Despite their importance to the sustainability of fish stocks and coastal livelihoods, marine protected areas make up only 15.4 per cent of total protected areas globally (UNSD 2010). Many countries in the Arab region have been increasing efforts to protect their environmental heritage by establishing areas with restricted activities; from 1990 to 2008, the countries of Saudi Arabia, Egypt, Jordan and Bahrain all made notable progress.



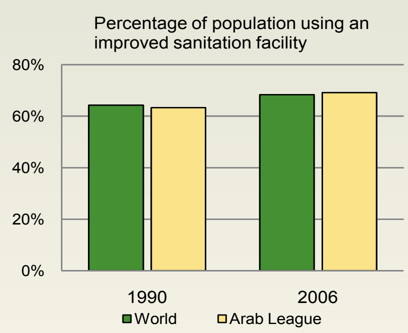
Population using an improved drinking water source

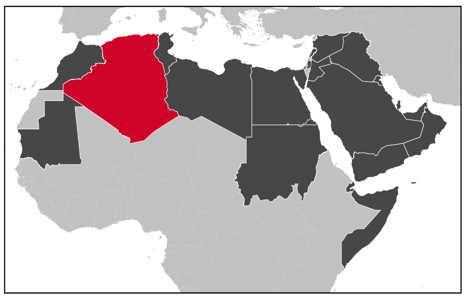
In 2007, approximately 86 per cent of the Arab region's population had access to safe water. Although this percentage rivals that of the world's, many of the Arab countries are far behind the target of halving the proportion of people without sustainable access to safe drinking water by 2015. In Somalia, for example, only 29 per cent of the population has access to safe water; the second lowest in the world (UNSD 2010). Other lesser developed countries in the Arab region (Mauritania, Yemen, and Sudan) also suffer from lack of access to safe drinking water. Due to this lack of progress, many Arab countries (not including the GCC countries) are projected to miss the 2015 target by 27 years, while the world as a whole is ahead of schedule in meeting the drinking water target (UN 2009).



Population using an improved sanitation facility

From 1990 to 2006, 1.1 thousand million people in the developing world gained access to toilets, latrines and other forms of improved sanitation. However, the number of people worldwide without access to improved sanitation services in 2006 remained at 2.5 thousand million; 1.4 thousand million of which would need to gain access to such services if the 2015 target is to be met (UN 2009). While the most recent data show that approximately 70 per cent of the Arab region's population has access to sanitation services, progress within the region has been uneven. In the countries of Comoros, Sudan, Mauritania and Yemen, less than 50 per cent of the people have access to sanitation services (UNEP 2009); in Somalia only 23 per cent have access to such services. In contrast, the average rate of access for Arab countries outside Africa is 80 per cent (UNSD 2010). Without sanitation facilities, people resort to open defecation, which has negative environmental impacts and threatens human health.





People's Democratic Republic of
Algeria

Total Surface Area: 2 381 741 km^2
Estimated Population in 2010: 35 468 000

Algeria, located in northern Africa, borders the Mediterranean Sea between Morocco and Tunisia. It is the second largest country in Africa after Sudan. Eighty seven per cent of the country lies within the bounds of the Sahara Desert. The coastal zone is a narrow mountainous region that has a hospitable Mediterranean climate with warm, dry summers and cold, rainy winters; 96 per cent of the population resides in this fertile region, which makes up less than one-fifth of the country's land (UNCCD 2004). Annual precipitation varies dramatically, ranging from 1 000 mm in the coastal mountains to less than 100 mm in the Sahara Desert. Flash floods regularly occur October to December, causing loss of life, loss of livestock and leaving many homeless.

Important environmental issues

- Desertification
- Water Scarcity
- Pollution

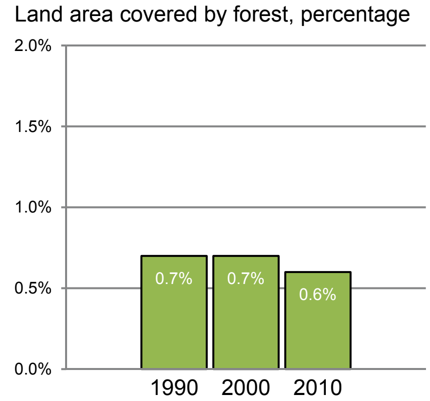
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

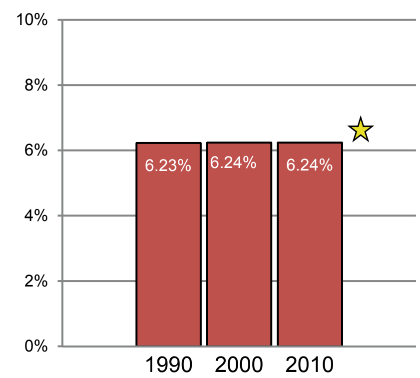
Algeria faces many challenges in its pursuit of environmental sustainability. Water shortages, desertification, and natural disasters are some of the most pressing issues, all of which are compounded by climate change. Reforestation and afforestation efforts have resulted in significant gains in forest cover. As part of its national strategy and sustainable development plan for the preservation of protected areas, Algeria continues to expand its protected area programme—recent initiatives to add marine sanctuaries and reserves are aimed at improving the programme (UNEP n.d.).

☆ Indicates Progress

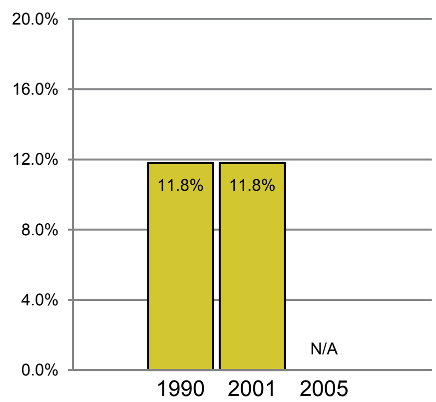
Land area covered by forest, percentage



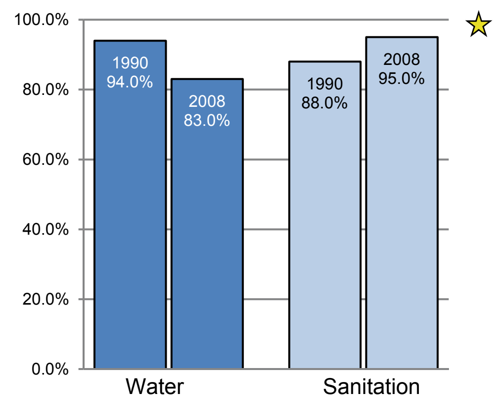
Protected area to total surface area, percentage



Slum population as percentage of urban



Proportion of total population using improved drinking water sources and sanitation facilities

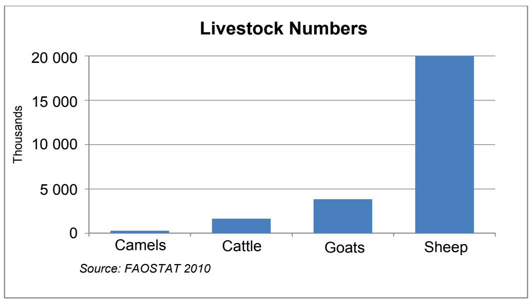


The Hamma Desalination Plant, which began purifying up to 200 000 m^3 of seawater per day in 2008 provides up to two million residents of Algiers with a reliable and drought-proof supply of fresh water

Source: GE 2010

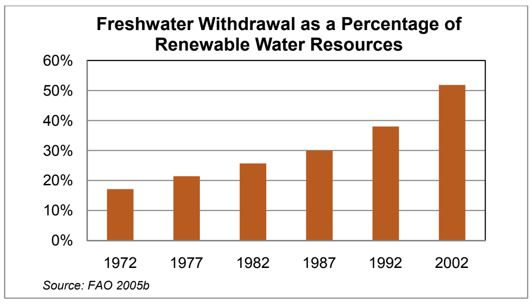
Desertification

Algeria is 90 per cent desert and is at risk of further desertification due to overgrazing, population growth, inappropriate agricultural practices, drought and deforestation. An estimated 40 000 ha of land per year are lost to desertification (Afrol News 2009). Desertification risk is greatest in the north of Algeria where more than 20 million ha of soils are highly exposed and vulnerable to erosion due to overgrazing. Sheep stocks are ten times greater than the carrying capacity of the utilized pasture land, thereby exposing soils to water and wind erosion (Abahussain and others 2002). Deforestation has drastically reduced forest cover, exacerbating desertification. Currently, 1 per cent of Algeria is forested (2 277 000 ha). Between 1990 and 2005, natural recovery and forestry management supported regrowth and Algeria gained 27.2 per cent of its forest cover, or around 487 000 ha (FAO 2005a). Reforestation and afforestation schemes have been initiated by the government along with dune fixation (fencing with dry palms and other materials) (Abada 2004).



Water Scarcity

The amount of water available per person per year in Algeria (350 m^3) is considerably lower than the international water scarcity threshold of 1 000 m^3 (FAO 2007). The majority of the water resources in Algeria are in the north, where over-exploitation of coastal groundwater has resulted in saltwater intrusion. Chronic water shortages due to low average precipitation, drought, increased population, and inefficient irrigation practices are impacting the nation's economy and agricultural sector. Sixty-five per cent of the total water withdrawals in Algeria are for agriculture, 22 per cent for municipal use and 13 per cent for industrial purposes. To maximize scant water resources, the government is building new dams and desalination plants and installing water treatment facilities. A desalination plant was constructed in 2008 to provide water to residents of Algiers, whom previously received water only once every three days (GE 2010).

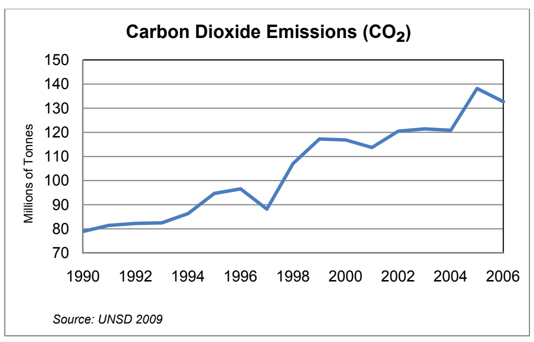


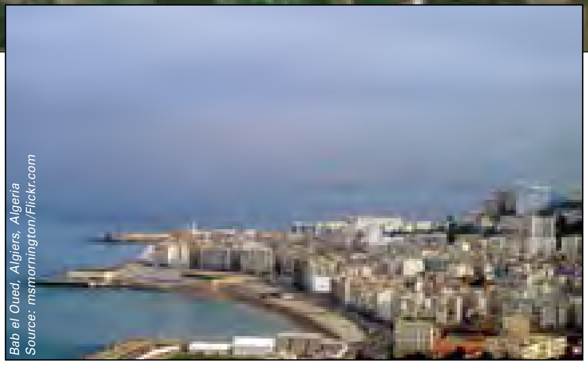
Forty-two Wetlands of International Importance covering almost 3 million ha have been designated in Algeria, representing an array of unique wetland types

Source: Ramsar 2004

Pollution

Pollution of freshwater and the marine environment from the oil industry, fertilizer runoff, raw sewage and industrial effluents is a significant problem in northern Algeria, where the majority of the population resides. Industries discharge roughly 200 million m^3 of effluent per year (Gherras and others 2009). Approximately 97 per cent of solid waste is dumped untreated into rivers and the sea; the west coast of Algeria is the main recipient of this wastewater. Algeria has the fifth-largest reserve of natural gas in the world and is the second largest gas exporter; the hydrocarbon sector accounts for roughly 60 per cent of budget revenues, 30 per cent of GDP and over 95 per cent of export earnings (Tradeport 2002). Petroleum refinery wastes are a major contributor to the increasingly severe pollution of the Mediterranean Sea.

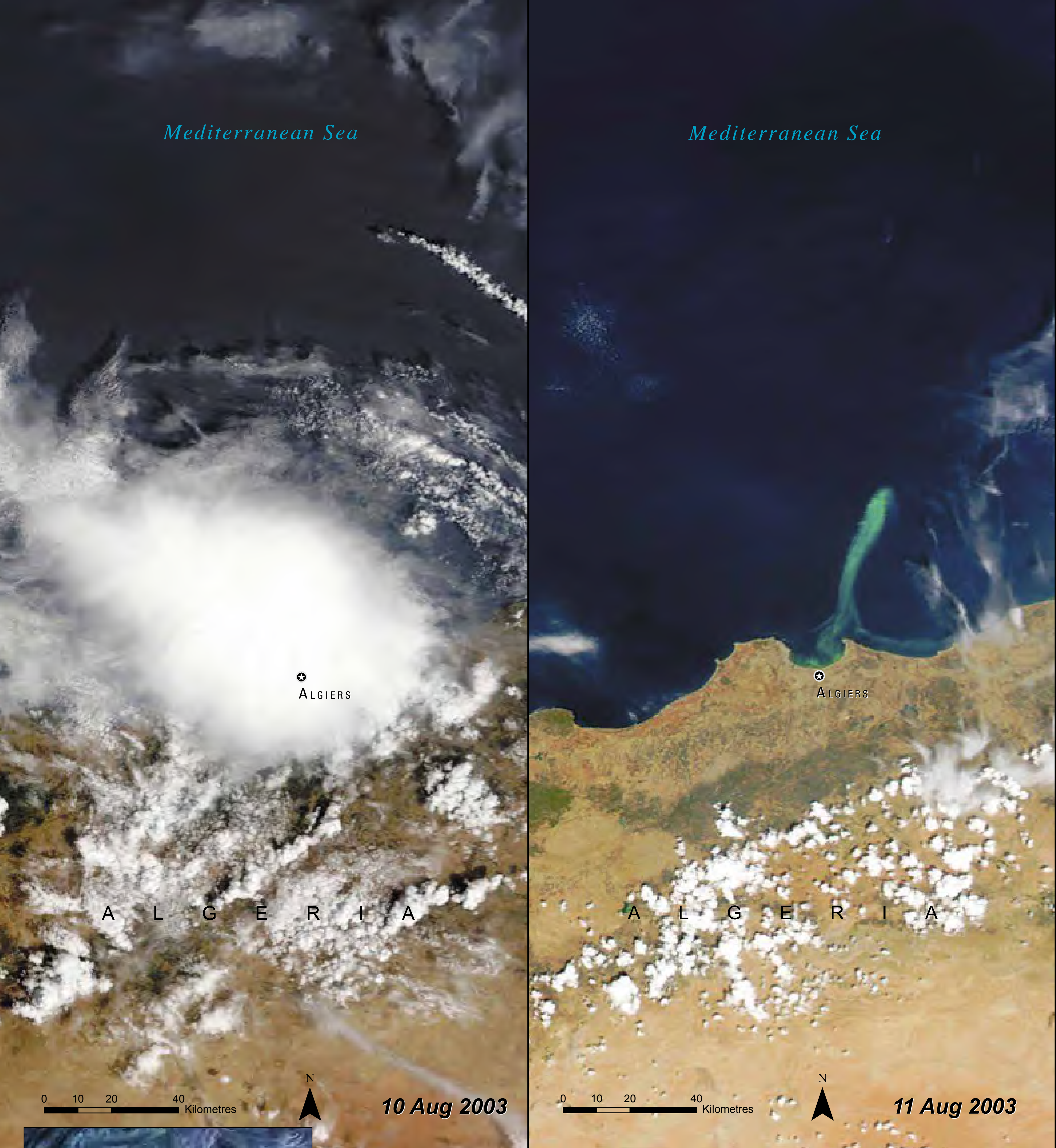


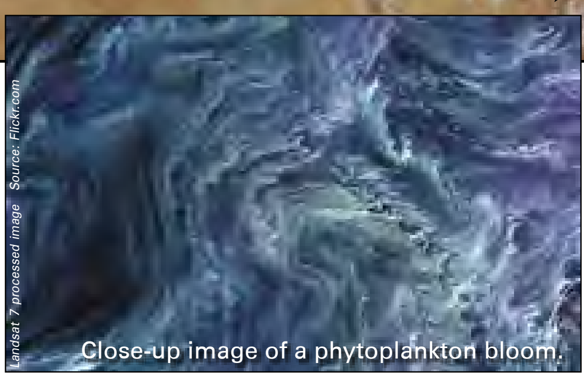


ALGIERS, ALGERIA

Algiers, the capital and main port of Algeria, is situated on the narrow coastal plain between the Atlas Mountains and the Mediterranean Sea. It is a major commercial centre for trade and export of grain, iron, phosphates, wines, citrus fruits and vegetables, as well as oil from central Algeria. The main industries are oil refining, petrochemicals, and metal working. 96 per cent of the population lives along the Mediterranean coast on 13 per cent of the country's total land mass. In the mid-1980s the pace of urbanization had accelerated to an estimated 5.6 per cent per year, prompting the government to implement a program to discourage migration to the cities (Metz 1994). Currently, about 65 per cent of the population is urban (UNdata 2007). The city of Algiers is the recipient of most of the migrants and has experienced

rapid growth - the dramatic growth of the city has also resulted in a dramatic loss of arable lands. Algiers was first settled over 1 000 years ago and has grown into a large thriving city with a metropolitan population of approximately 3.4 million (UNdata 2007). The city is struggling to keep up with rapid growth and increased standards of living, with major strains placed on infrastructure and water supplies. Water shortages and pollution are a chronic problem in the city where untreated wastewater and industrial effluents are dumped into water courses and the Mediterranean Sea. Already scarce water supplies are further threatened by regular droughts. In addition, air pollution from an increased number of vehicles is impacting air quality in the city (Yassaa and others 2001). These images document the incredible growth in and immediately surrounding the city of Algiers. The suburbs are no longer separated from the city in the 2009 image, and extend further south than in 1984. In addition, the amount of irrigated agricultural land in the Mitidja Plain to the south of the city is more extensive in 2009.



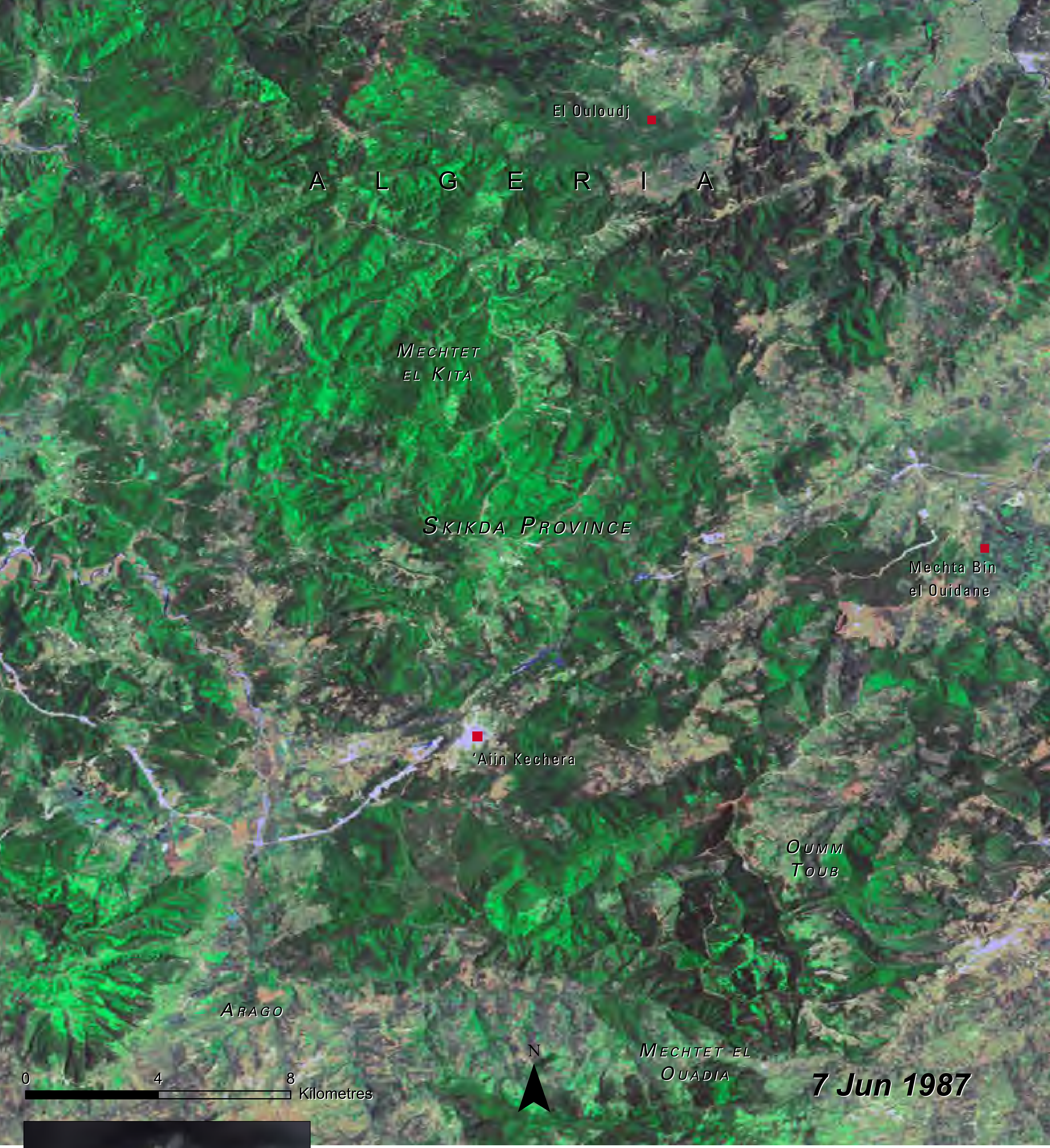


Close-up image of a phytoplankton bloom.

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. Impacts from blooms range from temporary interruptions to the food web to creation of

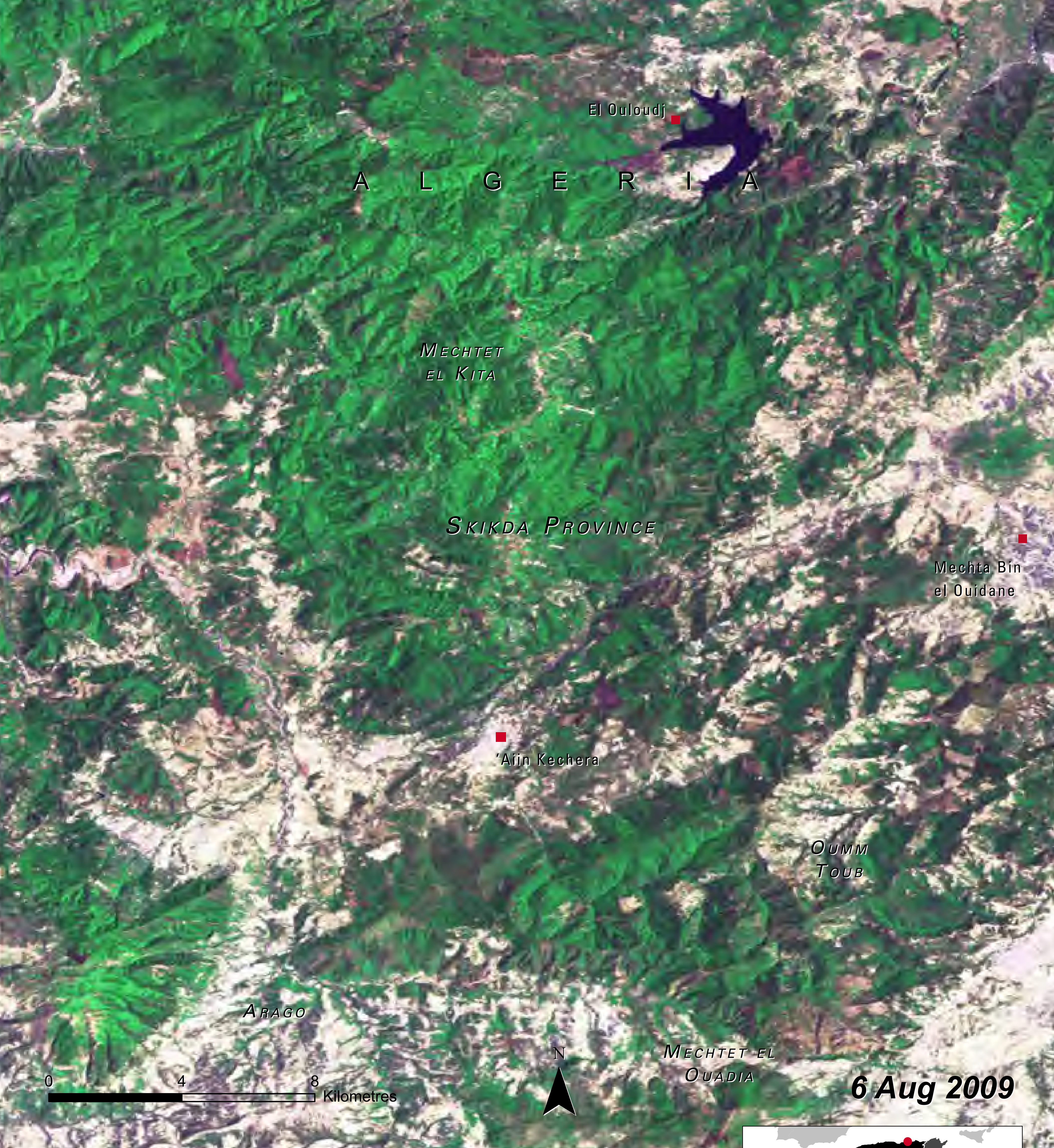
large dead zones, which occur when an overabundance of organic matter accumulates on the ocean bottom. Harmful algal blooms may contain species that are toxic and can cause widespread fish mortality and threaten human health. The frequency of harmful blooms is on the rise as excess nutrients from increased pollution, stormwater runoff and untreated sewage accumulate in coastal waters. Harmful blooms are particularly acute in enclosed oceanic basins such as the Mediterranean Sea (NASA n.d.). The southern Mediterranean Sea off the coast of Africa is a low productivity body of water, and lacks nutrients (NASA n.d.). The supply of nutrients introduced into Algiers's near-shore waters on 10 August 2003 created the high concentrations of blue-green phytoplankton in the water column that were visible from space for three days following the storm. The 12 and 13 August images show the bloom being carried out to sea and dissipating as the water dispersed and the phytoplankton exhausted the nutrients. Given the limited duration of this August 2003 bloom, there were likely minimal impacts to marine species or ecosystems.



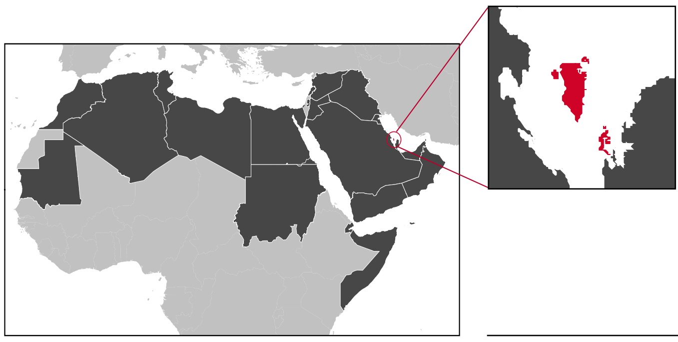
NASA MODIS image of forest fires along Algeria's north coast in August, 2007

Deforestation and Forest Fires, Skikda, Algeria

Skikda is an ancient city in northeastern Algeria located on the Gulf of Stora on the Mediterranean Sea. The city experienced rapid development and growth in the last decades from the oil refining, natural gas and petrochemical industries. It is Algeria's third largest commercial port after Algiers and Oran. The province of Skikda contains some of Algeria's most dense Mediterranean-type forests. Clearing of these forests for agricultural uses and cutting of timber for heating and industrial needs have severely reduced the tree cover in Skikda (Zaimeche 1994). In addition, forest fires burn thousands of hectares of forest lands every year: between 1991 and 2000, 1 739 fires were recorded, which were estimated to affect



54 797 ha of forest per year (FAO 2007). The human impacts on the landscape in Skikda are highlighted in this change pair. The greatest ecological threats are deforestation and burning of scrub vegetation, soil erosion from vegetation cover loss, overgrazing and poor farming practices. The numerous valleys in this region of the Tell Atlas Mountains contain most of Algeria's arable land; widespread erosion affects the productivity of these fertile areas. Though massive afforestation and reforestation efforts have been undertaken by the Algerian government in the past few decades to compensate for the high rates of deforestation, population growth and urbanization continue to exert pressures on needed forest resources. From 1990 to 2007, the amount of forested area in Algeria actually increased from approximately 1.8 million ha to 2.3 million ha (FAOSTAT 2009). However, these change pair images show a marked decrease in forest cover in the Skikda region in 2009 compared to 1987.



KINGDOM OF BAHRAIN

The Kingdom of Bahrain comprises an archipelago of natural and artificial islands situated in the ROPME Sea Area close to the Arabian Peninsula. Bahrain Island is the country's largest island and contains the nation's capital, Manama. The Hawar Islands to the south offer unique habitat for rare birds. The Gulf of Bahrain, a shallow inlet of the ROPME Sea Area, surrounds most of the islands, which together, have 161 km of coastline. Bahrain's climate is arid with mild winters and very hot, humid summers. The terrain is mostly low desert plain. The Kingdom has limited natural resources; the decline in oil reserves has forced the country to diversify its economy and develop its tourism and banking sectors and expand its petroleum processing and refining industries. Dates, almonds, figs and pomegranates are grown in the fertile northwestern region.

Important environmental issues

- Water Quantity and Water Quality
- Degradation of Coastal and Marine Ecosystems
- Threats to Biodiversity

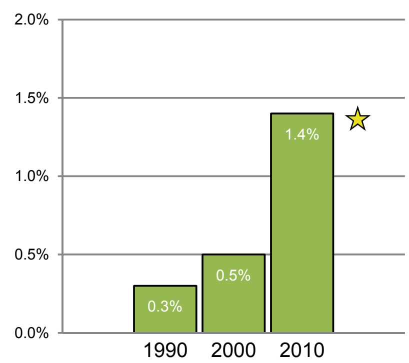
PROGRESS TOWARD ENVIRONMENTAL SUSTAINABILITY

AS DEFINED BY THE UNITED NATIONS MILLENNIUM DEVELOPMENT GOAL 7 INDICATORS

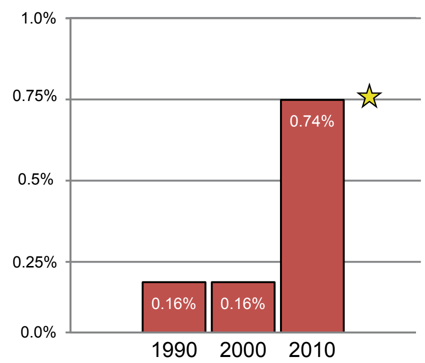
Rapid population growth, urbanization and industrialization are major challenges to Bahrain's future environmental sustainability. Almost all of the population has access to improved water sources (100 per cent) and sanitation facilities (97.1 per cent), which contributes substantially to the high standard of living in Bahrain (UN 2003).

☆ Indicates Progress

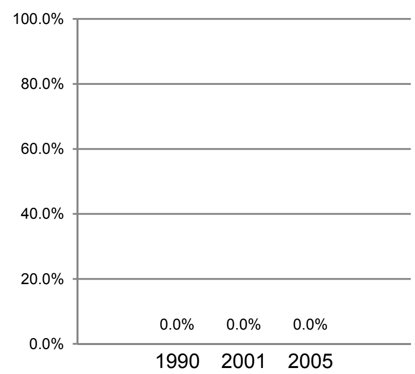
Land area covered by forest, percentage



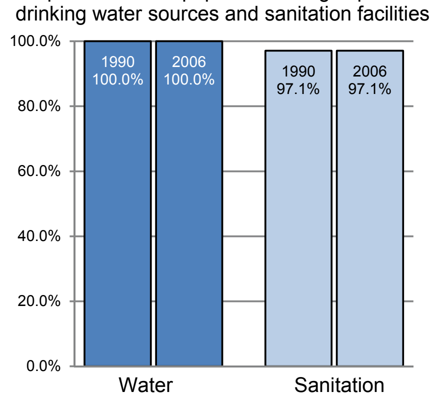
Protected area to total surface area, percentage



Slum population as percentage of urban



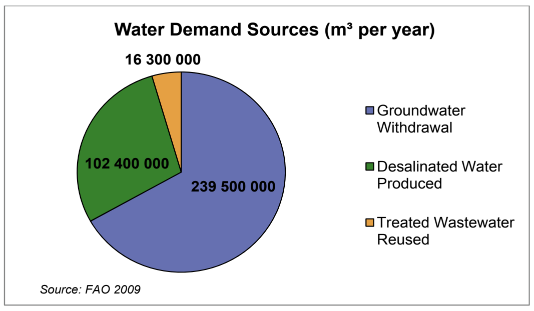
Proportion of total population using improved drinking water sources and sanitation facilities



THE KING FAHD CAUSEWAY, COMPLETED IN 1986, CONNECTS BAHRAIN TO THE SAUDI ARABIAN MAINLAND; HAILED AS A SPECTACULAR CONSTRUCTION PROJECT, THE CAUSEWAY HAS BROUGHT ECONOMIC BENEFITS TO BOTH COUNTRIES, BUT ALSO INCREASED TRAFFIC AND AIR POLLUTION

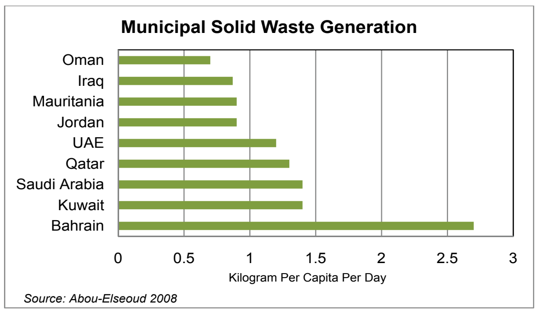
Source: KFCA n.d.

With average annual rainfall of only 76 mm per year, no permanent surface waters, diminishing groundwater levels, and a high population growth rate, Bahrain faces severe water scarcity. Until recently, Bahrain relied upon its many freshwater springs, which supported tree plantations and agriculture and provided habitat for an array of animals and migratory bird species. Over-extraction of groundwater caused a decline in spring flows in the early 1980s and led to the dereliction of many hectares of date gardens and other crops (Birch and Al-Arrayedh 1985). Groundwater quality has been compromised by high salinity levels from over-exploitation and pollution from septic tanks, cesspools and oil fields (Birch and Al-Arrayedh 1985). Desalinated water and treated wastewater are augmenting scarce water supplies in Bahrain, specifically to meet domestic water demands and for landscaping needs. Drip irrigation techniques and a ban on the drilling of new wells are measures being implemented to conserve water in the agricultural sector.



Degradation of Coastal and Marine Ecosystems

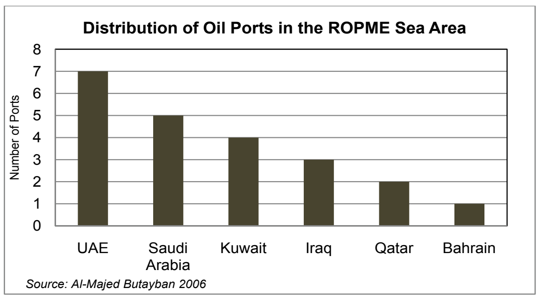
Bahrain's marine ecosystems are vulnerable to pollution by industrial effluents, urban development, irrigation drainage, and secondary treated wastewater. Bahrain's coastal waters receive significant inputs from petroleum refineries and the petrochemical industry, thermal pollution from power plants, and chlorine, brine and thermal inputs from desalination plants (ROPME 2003). A shortage of land in Bahrain prompted the reclamation and dredging of coastal areas—Bahrain's surface area increased from 665.3 km^2 in 1981 to 741 km^2 in 2007, an expansion of 11.4 per cent (Ministry of Works 2008). Sand dredging and reclamation activities have destroyed benthic communities and caused rapid declines in fisheries (FAO 2010).



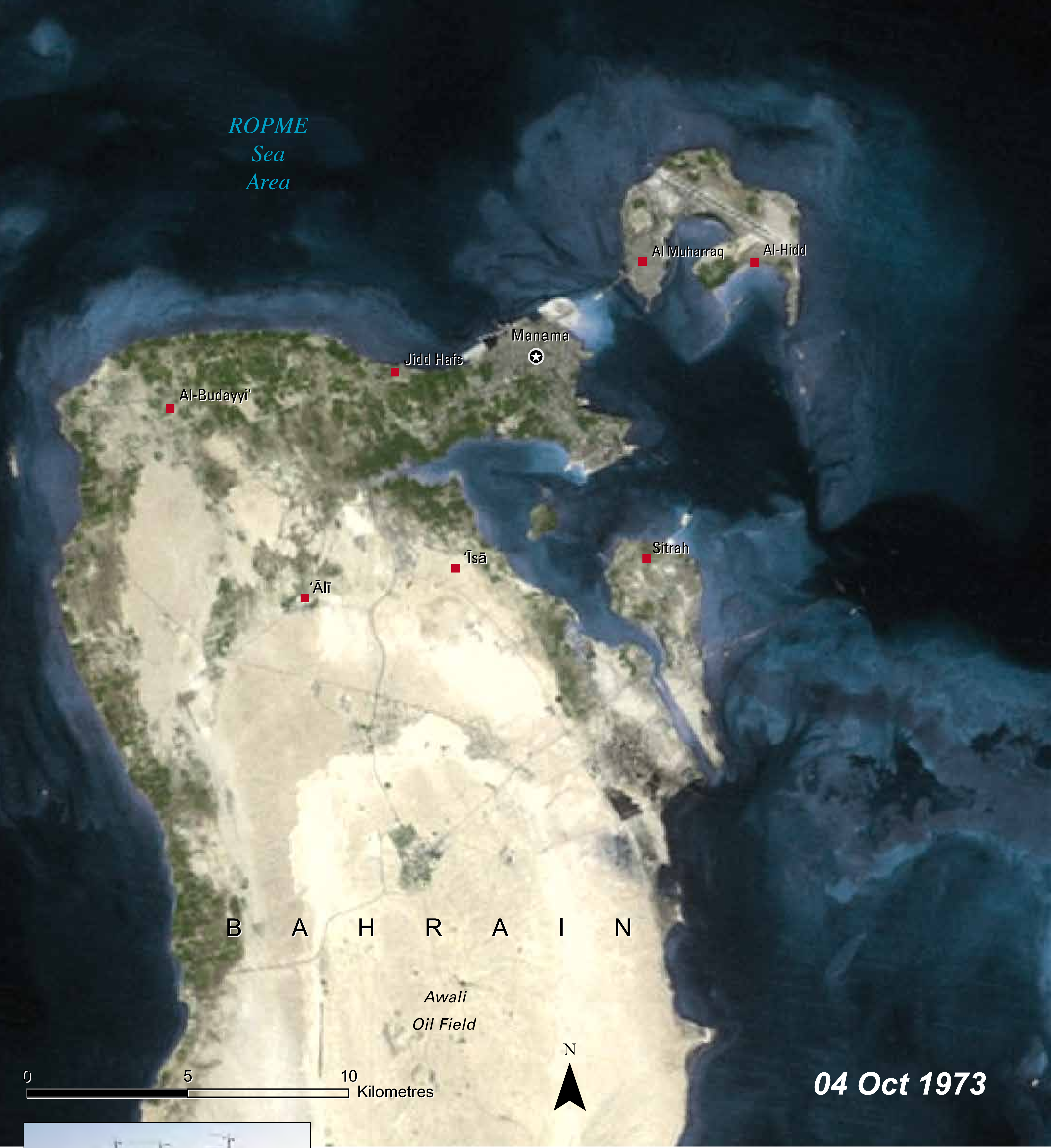
Manama, Bahrain Source: Graeme/Flickr.com

Threats to Biodiversity

Bahrain is rich in biodiversity, and possesses hundreds of species of flora and birdlife. Coastal areas, wetlands, and small islands provide habitat for over 300 bird species (Mohamed 1993). The principal wetlands in Bahrain are coastal mudflats that occur around many of the islands. Tubli Bay, on Bahrain Island, contains one of the last remaining stands of mangroves in Bahrain and is an important nursery ground for shrimp. The Hawar Islands provide valuable habitat for many migratory seabirds and contain the largest breeding colony of Socotra Cormorant in the world. The islands are also the winter home for the Greater Flamingo (Mohamed 1993). Lawzi Lake, the largest inland wetland, provides breeding habitat for the Moorhen and the Black-winged Stilt (Mohamed 1993). Bahrain contains one terrestrial and five marine protected areas to protect wildlife species and prevent further degradation of vulnerable ecosystems (KOB 2006). Coastal and inland wetlands are under threat from development, oil spills, and land reclamation activities.

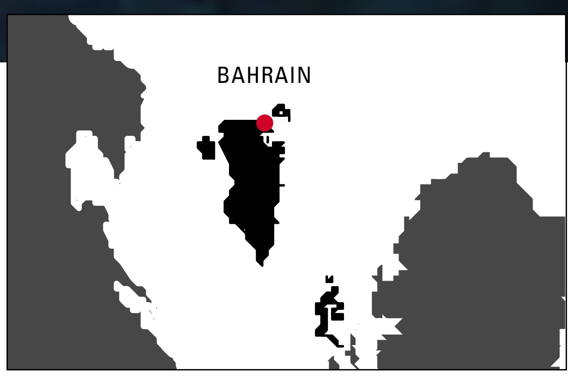



Al Areen Wildlife Park, Bahrain Source: Pedronet/Flickr.com

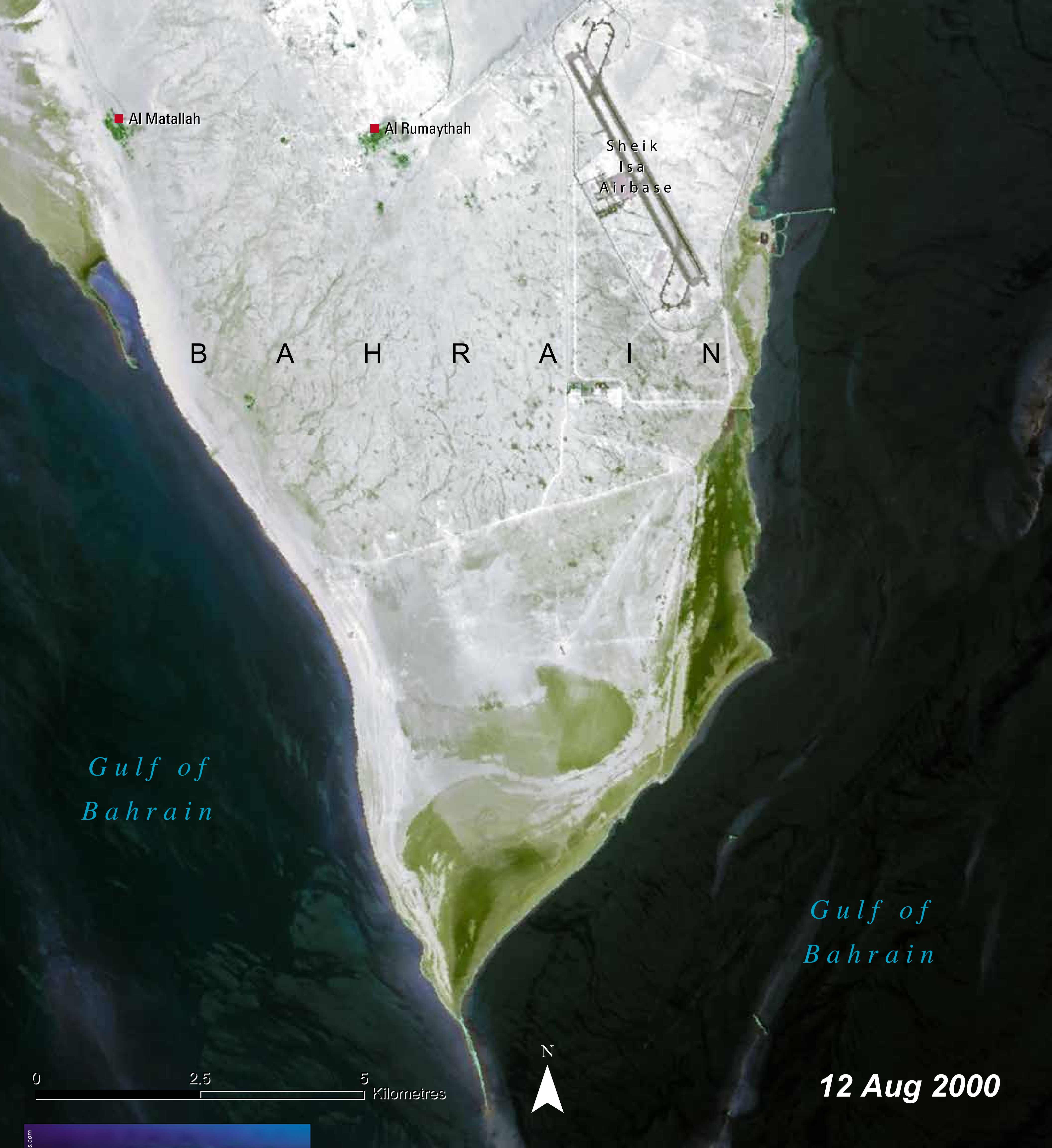


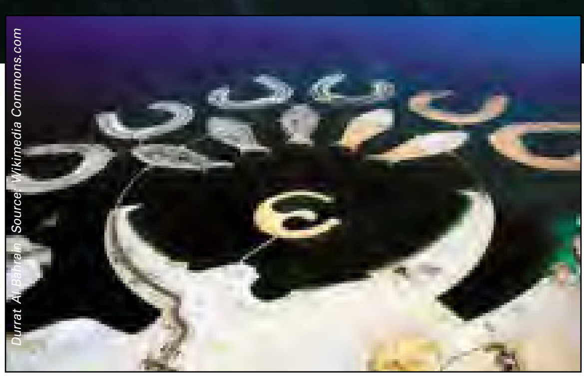
Manama and Northern Bahrain

Bahrain consists of five governorates: Capital, Northern, Muharraq, Central and Southern. Although the Southern Governorate contains the largest land area, it is the northern third of the island that is home to the majority of Bahrain's population. 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. Although Bahrain's petroleum reserves are modest when compared with surrounding Gulf States, its oil refinery on the island of Sitrah is one of the largest and most modern in the world. Land use in Bahrain has undergone incredible change; the urban/industrial extent grew from 11.35 km^2 in 1939 to 131 km^2

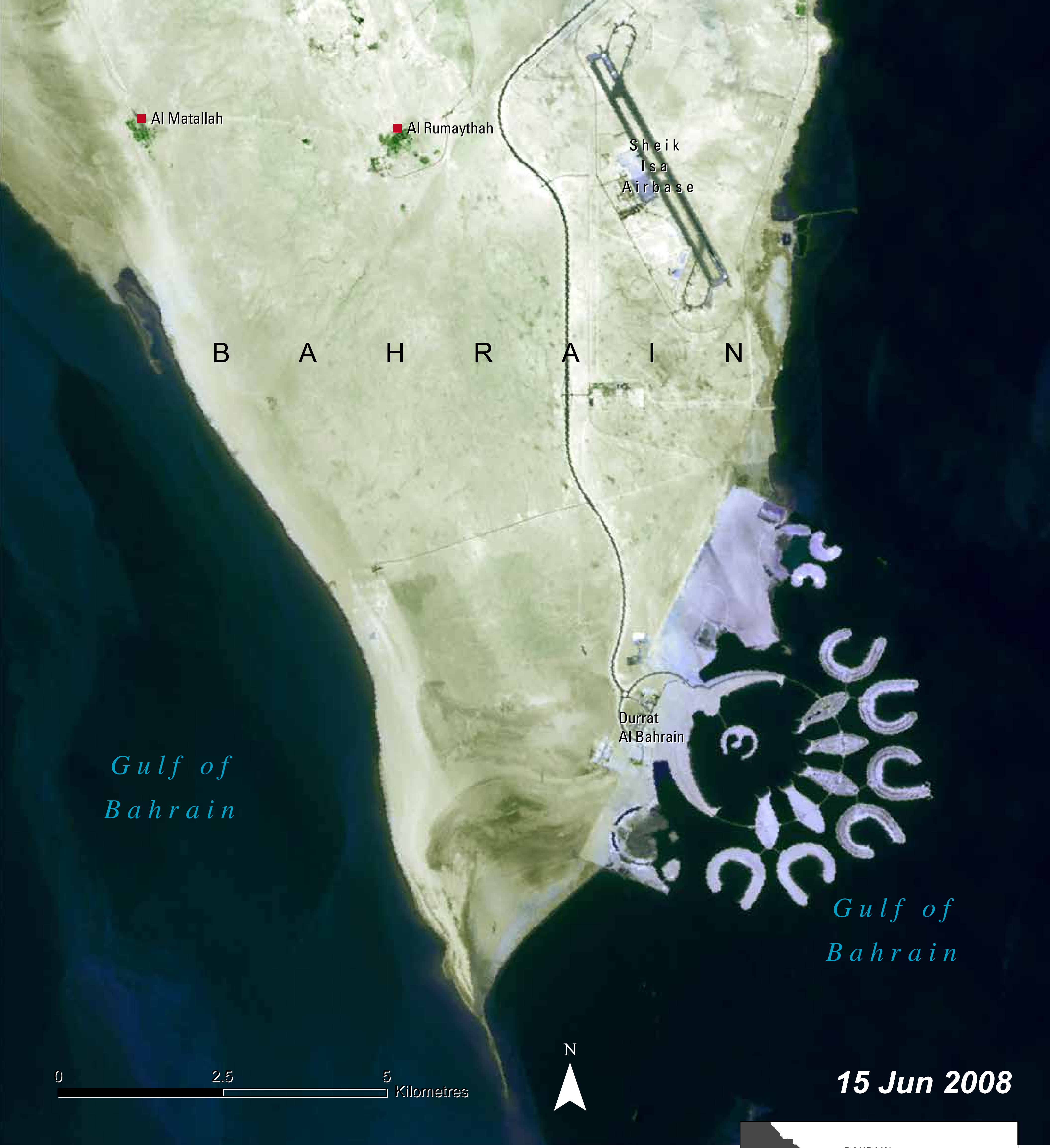


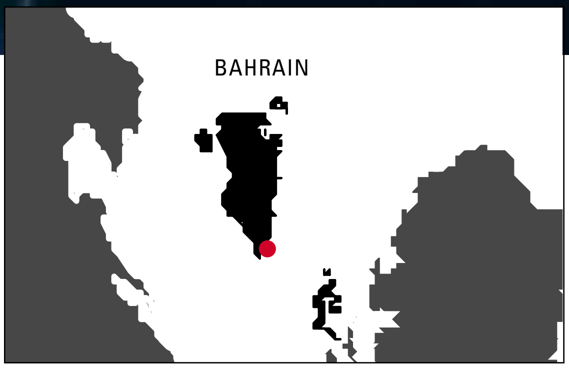
in 2007. The expansion of Manama into a metropolis, and the emergence of new sprawling developments south of the capital, where agriculture was traditionally practiced, is easily visible in these images. Consequences of this rapid growth include: loss of fertile land and biodiversity, decreases in groundwater 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). Demand for coastal real estate has facilitated large-scale land reclamation operations in the Kingdom; since 1981, more than 76 km² have been reclaimed from the sea (Ministry of Works 2008). These dredging operations have had dramatic impacts on both marine and terrestrial ecosystems—many date palm trees have been lost due to blocked drainage channels; mangrove swamps, coral colonies and seagrass beds have been adversely affected; and the flow of many natural springs has ceased (UNCSD 1997). The change in coastal extent and landmass from 1973 to 2008 is evident in these images.



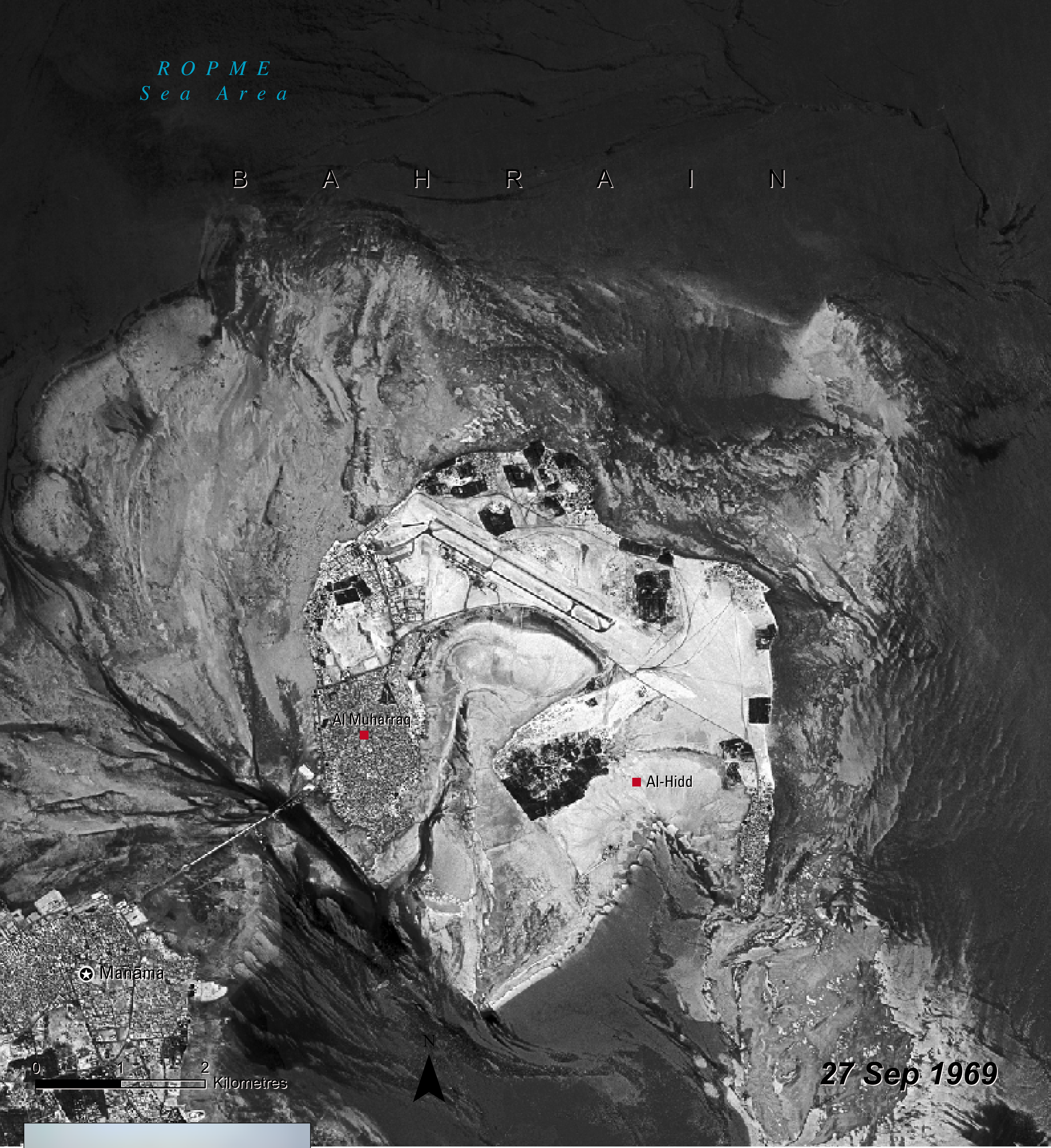


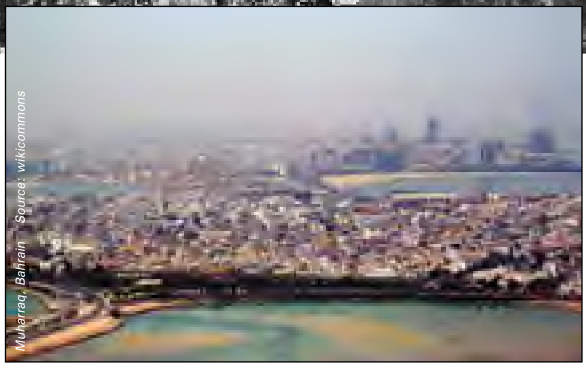
Touted as the Kingdom's largest planned luxury residential, commercial and tourist resort development, Durrat al Bahrain Island is one of several ambitious projects that are transforming the tourism sector in Bahrain. The 11 interconnected islands at Durrat al Bahrain (13 islands are planned) cover 21 km^2 on the south coast of Bahrain, and are arranged in two circular rows of six atolls and five petals. The islands will house luxury villas, commercial areas, recreational facilities and marinas. An 18-hole golf course is planned for the main island of Bahrain adjacent to the off-shore islands. This US$6 thousand million reclamation and development project, jointly owned by the Government of Bahrain and the Kuwait Finance House, is being implemented in phases. When completed, it will accommodate 60 000 residents and up to 4 500 daily visitors. A new 45-km causeway linking Bahrain and Qatar will facilitate access to the artificial island.





The extensive landscaped areas of Durrat Al Bahrain, including the golf course, will require large amounts of water, which is already scarce in the Kingdom. A desalination plant on the mainland will provide over 30 000 m^3 per day of water (Al Bawaba 2008). Dredging operations have introduced siltation, increased turbidity of the seawater, and degraded the coral colonies, mangroves and seagrass beds in Bahrain's near-shore areas (Al-Madany and others 1991). Reclamation operations, along with brine and thermal impacts from desalination plants and increased urban and domestic waste, further stress Bahrain's marine environment, which is already subject to high temperatures, high salinity, sharp temperature fluctuations, and a low nutrient content (Salahuddin 2006). Though the environmental aspects of the project are extensive an environmental impact assessment was completed and incorporates a range of environmental mitigation options as well as establishing long-term coastal and marine monitoring stations for use by the Public Commission for Marine Resources, Environment and Wildlife.

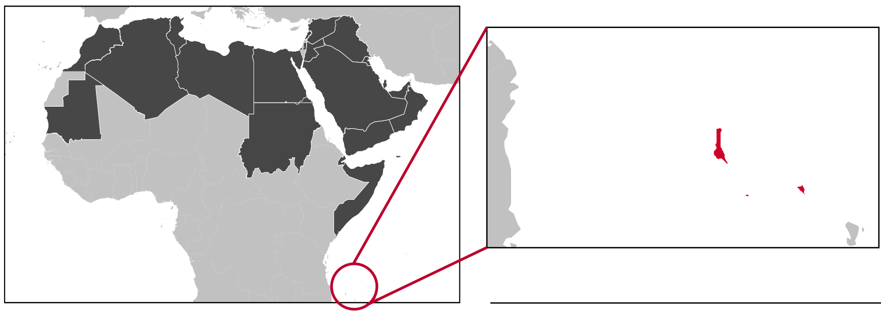




Al Muharraq Island, Bahrain

Al Muharraq Island, located immediately northeast of the island of Bahrain, is connected to the capital city of Manama by three causeways. Al Muharraq, the second largest city in Bahrain, has experienced dramatic growth—from 1991 to 2001, its population more than doubled and the city was home to one-sixth (103 576 people) of the country's population. The island contains the Bahrain International Airport, which is undergoing an expansion that will more than double the terminal area (BIA 2006). As this change pair illustrates, the extent and shape of the island has undergone significant changes. Coastal dredging operations have reclaimed most of the land that can be seen outside the island's 1969 shoreline (marked in

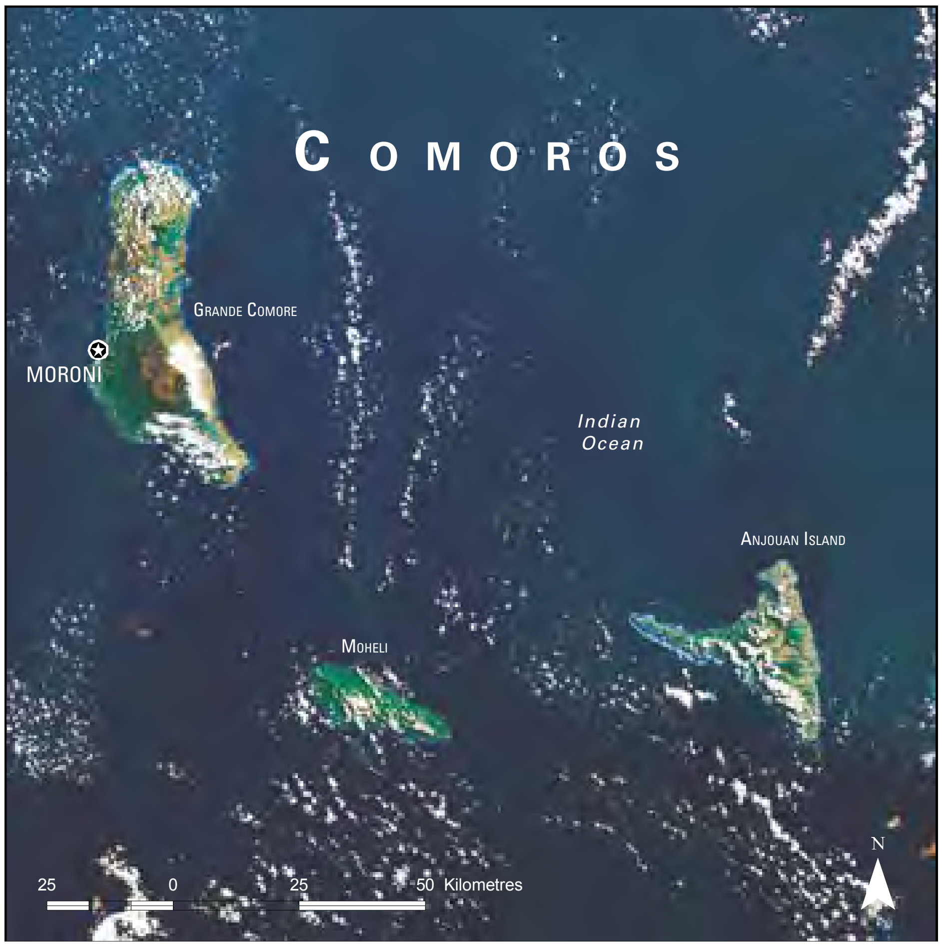
black). The shallow sand and rock that once surrounded the shoreline (visible in the 1969 image) has nearly disappeared, and has largely been used to form Diyar Al Muharraq and the Amwaj Islands to the north. The US$3.2 thousand million project at Diyar Al Muharraq covers 12 km^2 and will house over 100 000 people (Diyar Al Muharraq 2008). The adjacent Amwaj Islands project is another artificial island development that has a beachfront of 9.5 km. When completed, some 80 million m^3 of material will be excavated and placed at Diyar Al Muharraq (GLDD 2007). This displacement of material has severe impacts on marine ecosystems, and is also causing the bay between Manama and Muharraq to narrow, eventually connecting the two landforms (MEST 2007). Of equal concern, is this island nation's vulnerability to sea level rise; a 1.5 m rise in sea level by 2100 would result in the inundation of more than 17 per cent of the Kingdom (Al-Jeneid and others 2007).



Union of the
Comoros

Total Surface Area: 2 235 km²
Estimated Population in 2010: 735 000

Comoros is a small island nation off the eastern coast of Africa in the Indian Ocean. It consists of three main islands and many minor islets. The capital city Moroni is located on Grande Comore, the largest island in the archipelago. The island interiors vary from steep mountains to low hills. Mount Karthala, one of the most active volcanoes in the world, is the highest peak on Grande Comore at 2 361 m and contains some of the largest stands of rainforest in the country. The climate is generally tropical with two distinct seasons and an average of 900 mm of rainfall per year. Cyclones frequently occur during the rainy season from November to May. The population density is high with 377 inhabitants per km².



Important environmental issues

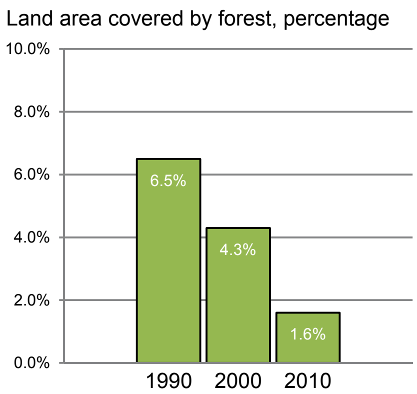
- Threats to Coastal and Marine Resources
- Deforestation and Soil Erosion
- Threats to Biodiversity

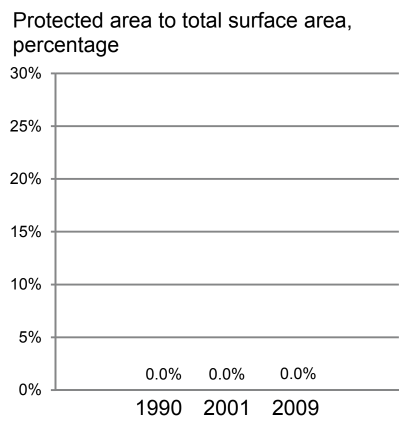
Progress Toward Environmental Sustainability

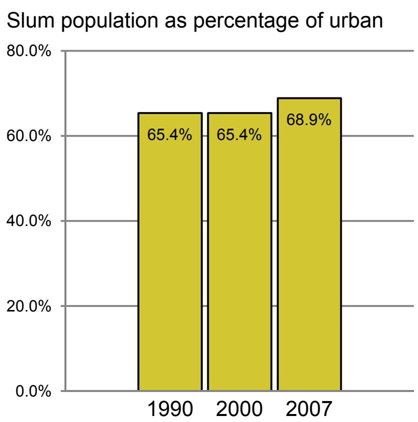
As defined by the United Nations Millennium Development Goal 7 Indicators

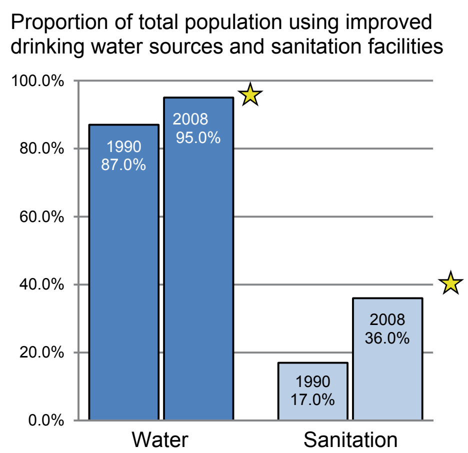
Over the past 25 years the population of Comoros has nearly doubled (FAOSTAT 2009). Heavy population pressures combined with intensive farming practices and uncontrolled deforestation have caused serious soil erosion. Environmental degradation is compounded by the effects of climate change (heavy rains and cyclones, extreme dry seasons and rising surface ocean temperatures), which in turn, exacerbates the poverty issue in Comoros.

☆ Indicates Progress









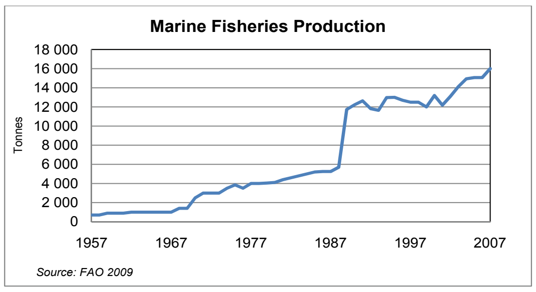
THE LARGEST REMNANT OF COMOROS' ONCE-EXTENSIVE EVERGREEN FOREST IS ON THE SLOPES OF MOUNT KARTHALA ON THE GRANDE COMORE ISLAND; 26 790 HA HAVE BEEN RECOMMENDED FOR PROTECTION.

Source: UNDP 2012

Moroni, Grande Comore, Source: Woodhouse/Flickr.com

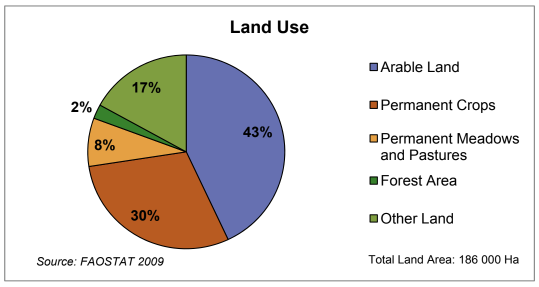
Threats to coastal and marine resources

The Comoros Islands are a biodiversity hotspot with high endemism and diverse tropical marine habitats. Marine and coastal environments are affected by pollution, high fishing pressure, coral and sand mining and dynamite fishing. Coral and sand are mined for construction of buildings and lime production. Sand mining extracts the sand from beaches, leaving them scarred, while reefs are damaged by dredging, mining and heavy sediment loads (Mohammed 1994). Over the past 50 years, inshore fisheries have declined (Granek and Brown 2005) and stresses on species such as green turtles (that use the beaches for nesting), the rare coelacanth, and the endangered dugong have been noted. About 64 per cent of the fisheries resources in the coastal areas are currently exploited (Granek and Brown 2005). Fish catches increased from 6 000 metric tonnes in 1985 to 16 000 metric tonnes in 2004. The government intends to increase fisheries production by over 50 per cent to create jobs and raise the sector's contribution to GDP to over 13 per cent by 2009 (ASCLME Project n.d.).



Deforestation and Soil Erosion

Today, forests cover less than three per cent of Comoros. The rate of forest loss between 2000 and 2005 was 7.4 per cent per year. Comoros lost 58 per cent (7000 ha) of its forest cover between 1990 and 2005 (NASA 2009). Deforestation is due mainly to charcoal production and agricultural encroachment. Once heavily forested, Comoros' denuded slopes and fragile laterite soils are now prone to severe soil erosion. The lack of proper terracing of croplands exacerbates erosion and diminishes the productivity of the soils (NAPA 2006). At present all potentially arable land is already in use, therefore any additional agricultural land that is created for export or to provide for the growing population must be created at the expense of remaining forests (FAO 2003). Though progress is slow, reforestation efforts and subsidies of kerosene to minimize tree cutting for fuel, are being used to prevent further loss of these ecosystems.



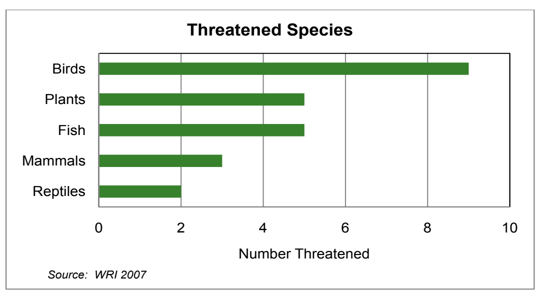
Found in the forests of Anjouan and Mohéli islands, populations of mongoose lemur (*Eulemur mongoz*) are estimated at between 1 000 and 10 000. Forest clearing for agriculture, timber and charcoal production are the greatest threats to this endangered mammal

Source: Sacramento Zoological Society 2003

Mongoose Lemur Source: ... Norman Flickr.com

Threats to Biodiversity

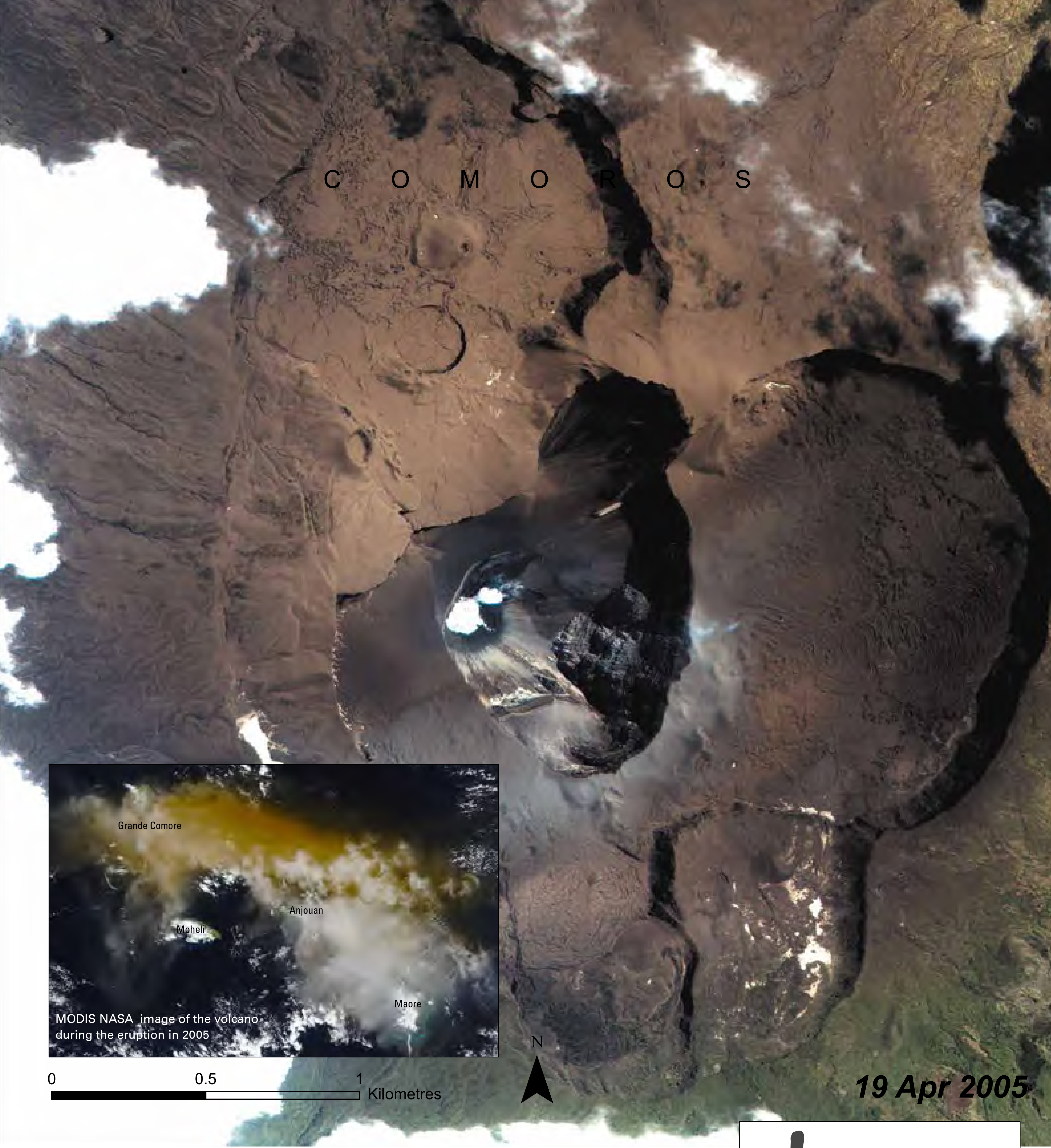
The Comoros abound with mountains, grassy savannahs, evergreen forests, mangroves and coral reefs that provide habitat for a number of rare and endemic species. More than 33 per cent of the indigenous vascular plants and 25 per cent of bird species are endemic (CBD n.d.). The islands contain 138 known species of birds, 935 plant species, 34 reptile species, 14 marine mammals and 8 terrestrial mammals, including lemurs and three types of fruit bats (Kiszka and others 2006; NAPA 2006). Remaining forest tracts on Mohéli provide habitat for the last surviving population of the scops owl (three of the species are classed by BLI as "critically endangered") and the Livingstone's fruit bat (BLI 2009). The islands also harbour the most important egg-laying sites for marine turtles in the Indian Ocean and the tenth most important site in the world (NAPA 2006). Habitat loss and invasive species are serious threats to biodiversity. Mohéli Marine Park, established in 2001, and Lake Dziani Boudouni, a wetland site, are currently the only protected areas in Comoros.

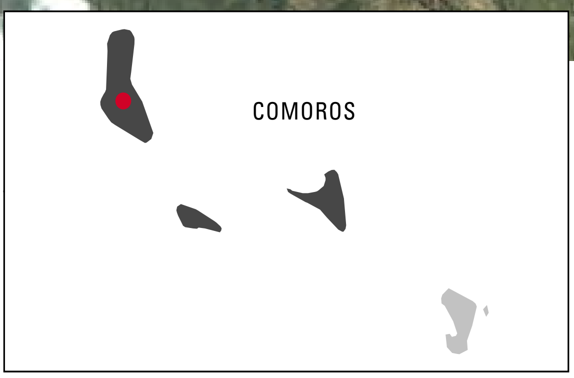


Karthala caldera Source: Flickr.com

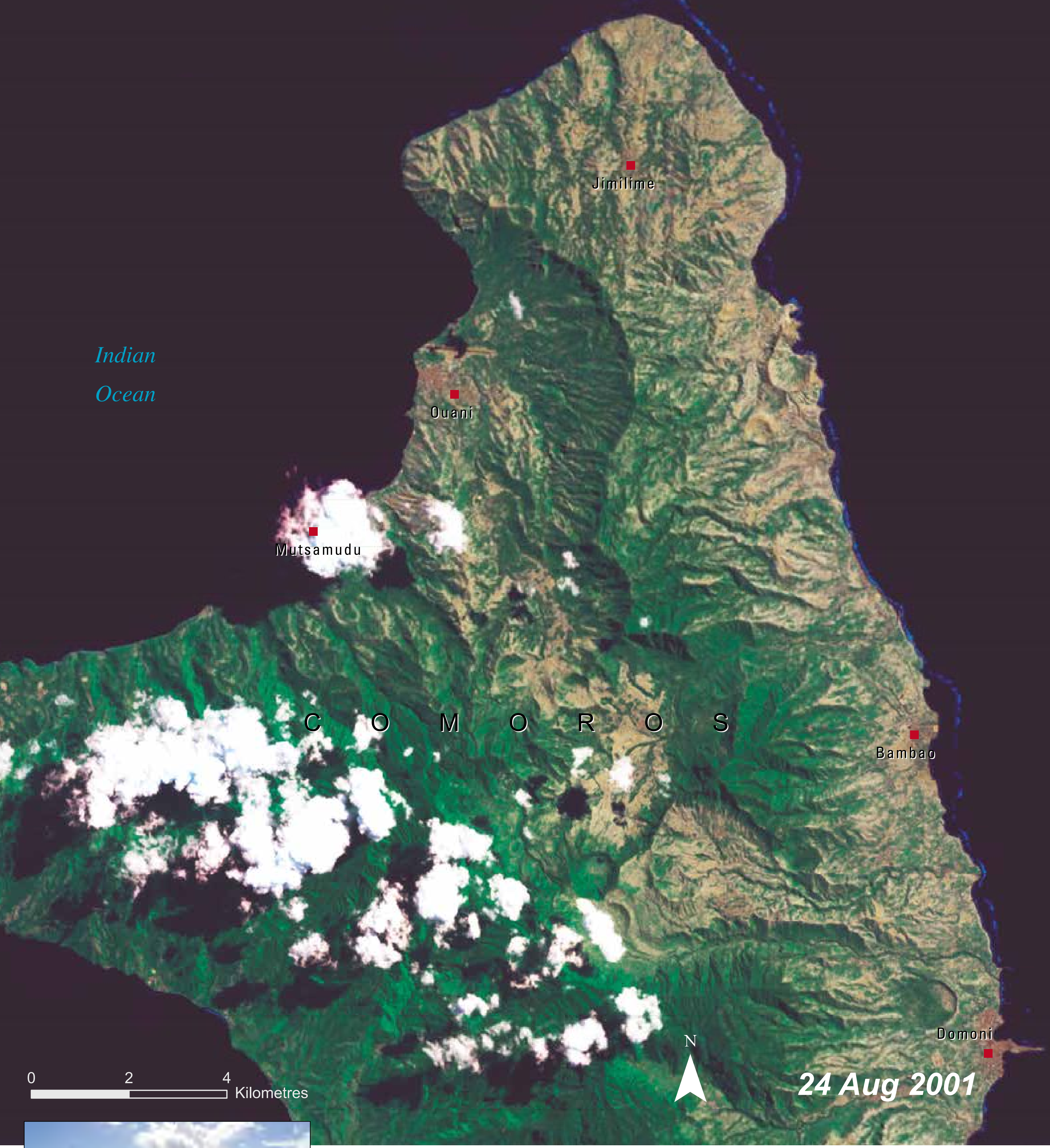
Karthala Volcanic Eruption, Comoros

The Union of the Comoros consists of three volcanic islands: Grande Comore, Anjouan and Mohéli. Grande Comore is the youngest and the largest island in the archipelago with a surface area of 1 148 km². Mount Karthala is the highest point of the Comoros at 2 361 m. Grande Comore supports a population of about 300 000 at a density of just over 260 people/km² (Louette and others 2004). 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). The eruptions cause lava flows and emit volcanic gases, which result in loss of life and destruction of agricultural lands, villages and island infrastructure.



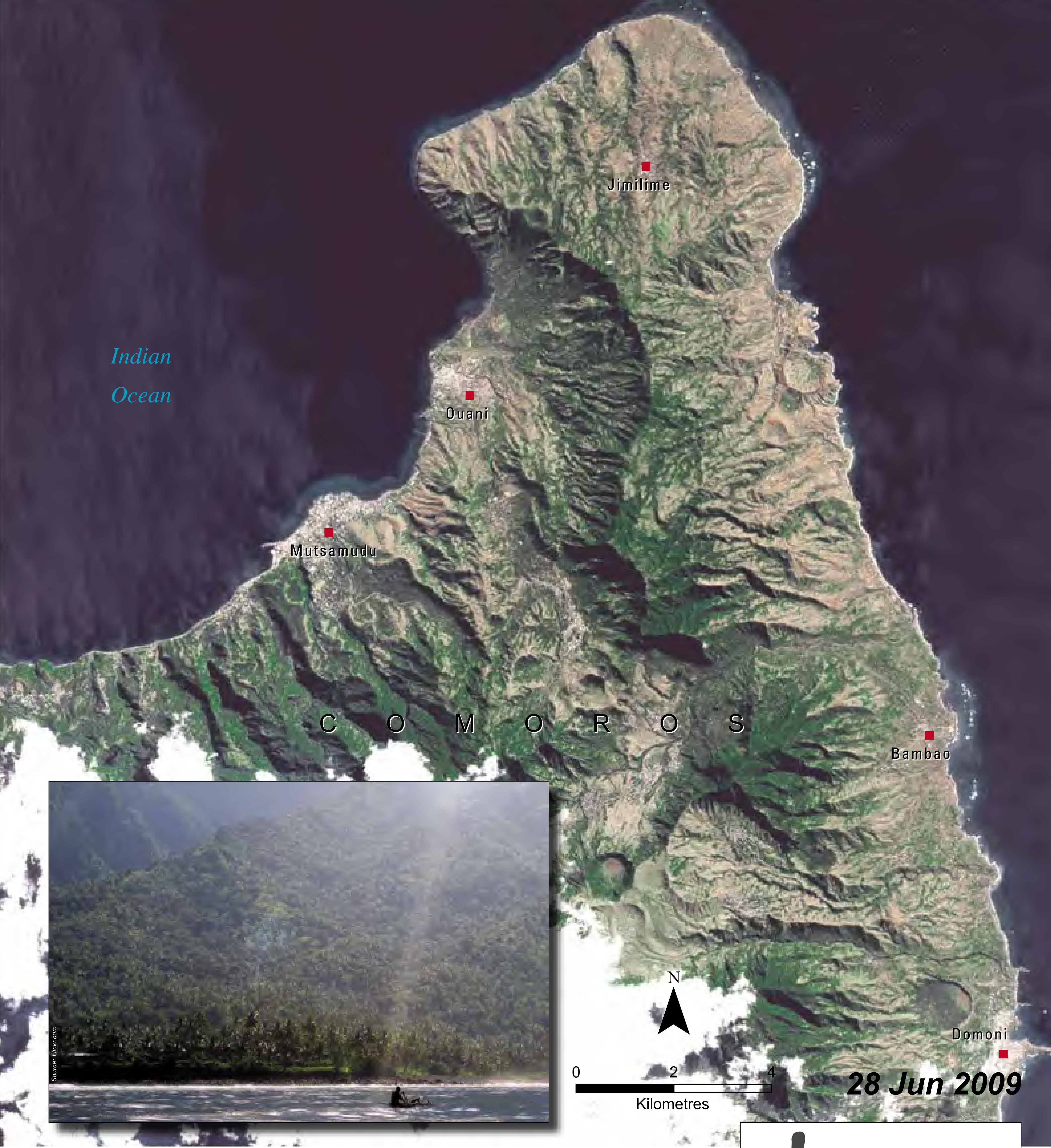


The eruptions also destroy the evergreen forests that are home to many endemic species, which are already threatened by invasive species and habitat loss from deforestation (NASA 2009). Additionally, the eruptions impact the already limited freshwater supply on the island, resulting in water quality and water access problems. 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).



Deforestation in Anjouan, Comoros

Anjouan, located southeast of Grande Comore, is the second largest island in the Union of the Comoros, encompassing roughly 424 km². Anjouan contains steep mountain slopes that reach elevations over 1 550 metres above sea level. Rainfall on Anjouan is heavy and ranges from 1 400 mm on the southeast coast to 2 700 mm on the southwest coast. These environmental conditions allow for the presence of productive moist forests, which support high biodiversity and contain a high concentration of endemic fauna and flora (Myers and others 2000). The human population density on Anjouan is twice that of Grande Comore, placing severe pressure on the island's limited natural resources (Louette and others 2004). Deforestation is widespread on all of the islands of the Comoros. On Anjouan, the problem is particularly acute.



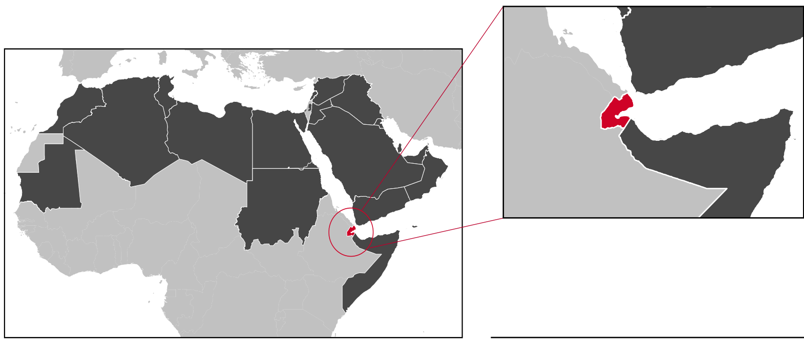
Anjouan once had the most extensive forests of all the islands; large tracts of forest have been cleared by the local population who are dependent upon rainforest lands for subsistence cultivation and fuelwood. The Comoros forests have been cleared over time; however, between 2000 and 2005, the rate of deforestation was 7.4 per cent, the highest rate in Africa for that time period (UN 2007). Population pressures and widespread poverty are the main causes of increased deforestation on the islands. The absence of appropriate land management measures and protections exacerbates the problem on Anjouan (NASA 2009). Anjouan has the smallest remaining area of primary forest among the islands of the Comoros. Much of the remaining forests on Anjouan are degraded as they support plantations or occur on overexploited and unproductive soils (Doulton and others 2005). These images document the loss of forest cover on Anjouan between 2001 and 2009. Most notable is the loss of forest cover on mountain slopes; remaining forests are restricted to inaccessible steep high elevation slopes (Doulton and others 2005).

Moroni, Grande Comore
Source: Woodlouse/Flickr.com

Mutsamudu, Comoros

The Union of the Comoros is one of the poorest countries in the world with limited natural resources and a high population growth rate. The Comoros has an estimated population of 735 000 (2010) and a 2.5 per cent population growth rate (UNDESA 2005; IRIN 2007). Rapid population growth in the archipelago is a major constraint to social and economic development and stresses already limited natural resources (GECC 2009). Mutsamudu, the administrative capital of Anjouan Island and the largest city on the island, has a population of 30 900 (2003). It is the second largest island in the Union of the Comoros, and has a population density that is double that of Grande Comore (Louette and others 2004). The Comoran population has become increasingly urbanized in recent years.

In 1991, the proportion of Comorans residing in cities and towns of more than 5 000 inhabitants was roughly 30 per cent, up from 23 per cent in 1980. More recent estimates put the number of Comorans living in urban areas at 34 per cent (UNDESA 2005). The 1995 and 2009 images demonstrate the extent of urban growth in and around the city of Mutsamudu. The 1995 image shows the urban area of Mutsamudu confined mainly to the coastline of Anjouan. The town of Ouani, which is located north of Mutsamudu and contains the Ouani airport, is apparent in both images; however, in the 2009 image, the extent of Mutsamudu and Ouani are much larger, with the two urban centres almost merging. The 2009 image also shows growth southwest of Mutsamudu along the coast and into the higher elevation slopes south of the city. The towns east of Mutsamudu in the interior of the island have also increased in size. The effects of urbanization, including the loss of agricultural lands and deforestation, are apparent in the 2009 image.



Republic of Djibouti

Total Surface Area: 23 200 km^2
Estimated Population in 2010: 889 000

Djibouti is a small desert country in northeast Africa bordered by the Red Sea and the countries of Somalia, Ethiopia and Eritrea. It is a narrow strip of land that borders the Gulf of Tadjoura, varying in width from 20 km to 90 km. Its 300 km of coastline consists of sandy beaches, while inland areas are semi-desert and desert with minor mountain ranges. Djibouti receives little precipitation, with average annual rainfall of less than 220 mm. It is one of the hottest places on earth, with an average annual temperature of 32°C. Djibouti is strategically located at the junction of the Red Sea and the Gulf of Aden, which is a gateway for international shipping and close to many of the region's oil fields. The capital,Djibouti City, is the main port.

Important environmental issues

- Water Scarcity
- Desertification and Land Availability
- Marine Resources and Pollution

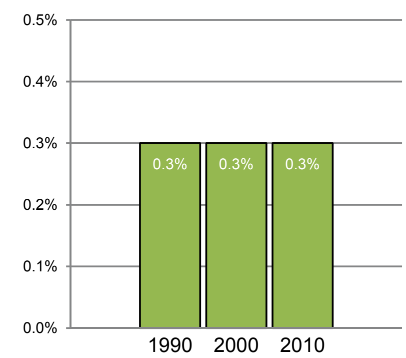
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

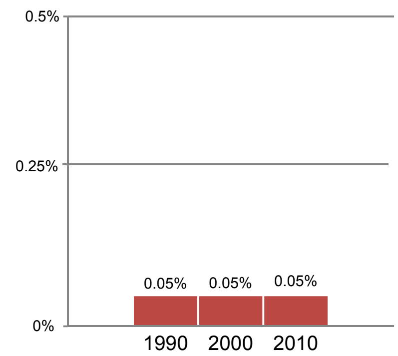
☆ Indicates Progress

Djibouti's population is concentrated in the city of Djibouti, the only major urban centre in the country. The city contains endemic poverty, widespread unemployment, and a growing refugee population. In 2002, the extreme poverty rate was 42.2 per cent and the unemployment rate was 59 per cent (African Economic Outlook 2009). Overall, improvements have been made in living conditions and human development indicators. A water supply project initiated in 2007 by UNICEF, the European Union and Djibouti's Ministry of Agriculture is providing 25 000 rural residents and their livestock with access to clean drinking water close to their homes (UNICEF 2007).

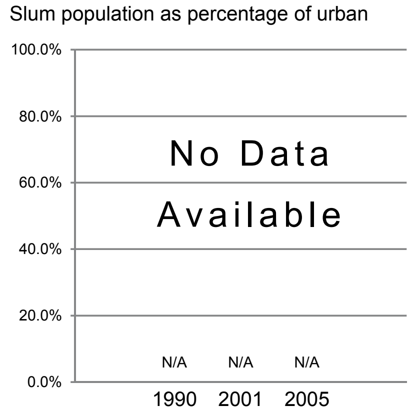
Land area covered by forest, percentage



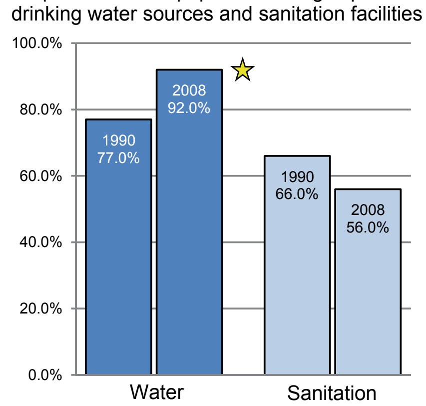
Protected area to total surface area, percentage



Slum population as percentage of urban



Proportion of total population using improved drinking water sources and sanitation facilities

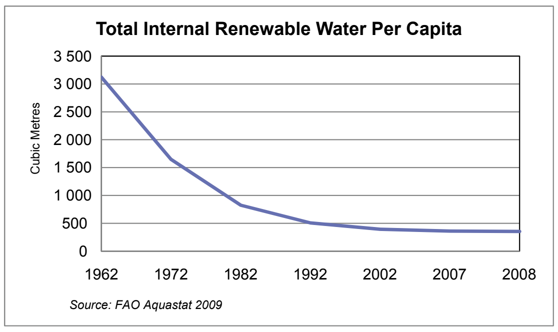


Persistent drought and marginal agricultural opportunities throughout Djibouti induces food shortages and forces heavy reliance on food imports. A consequence is that 24 per cent of the Djibouti population is undernourished

Source: WFP 2009

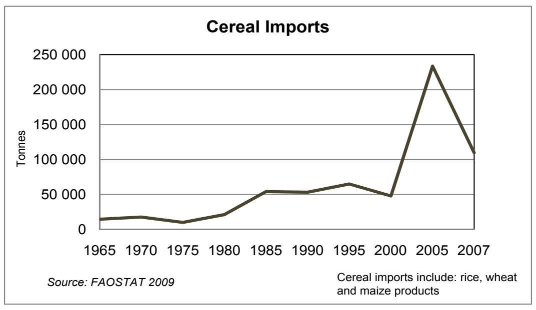
Water Scarcity

Djibouti is facing severe water shortages, and is well below the international water scarcity threshold (1 000 m^3/per capita/per year) with only 353 m^3 available per person per year. Marked declines in the amount of renewable water threaten food security and rural livelihoods. With no permanent rivers or streams and little precipitation, groundwater represents 98 per cent of all water used in Djibouti (Jalludin and Razack 2004). Over-exploitation of groundwater resources is causing salinization (salt water intrusion) and impacting water quality. Almost 50 per cent of rural inhabitants do not have ready access to developed sources of drinking water (UNICEF 2007). A series of droughts since 2001 have further limited water availability for human consumption, agriculture and livestock, making it difficult to sustain the pastoralist lifestyle (WFP 2007). Increases in population, measured at 1.75 per cent annually (World Bank 2009) are placing further stress on limited water resources in Djibouti.



Desertification and Land Availability

About 96 per cent of Djibouti is desertified and the remaining 4 per cent is vulnerable to desertification. Only 0.04 per cent or 900 ha of the land is arable. More than one-third of the total land area is covered by permanent pasture and the dominant land use is livestock grazing (FAO 2005). Rangelands have little ground cover due to overgrazing and poor water supplies. Persistent drought has prevented the sufficient regeneration of pasture, leading many of Djibouti's pastoralists, who constitute 75 per cent of the total labour force (FAOSTAT 2007), to become highly food insecure (IRIN 2008). Drought has also contributed to high rates of livestock mortality. The absence of agriculture in Djibouti forces heavy dependence on food imports; the global rise in food prices has had a disastrous effect on the poor. Acute malnutrition has increased, especially in areas surrounding the city of Djibouti and in the northwest pastoral zone (IRIN 2009).



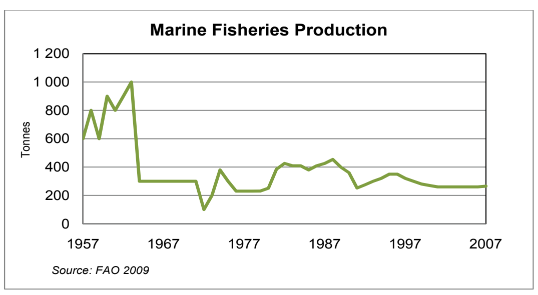
A 27.4 kilometres-long bridge that spans the Red Sea, linking Djibouti with Yemen on the Arabian Peninsula, has been proposed

Source: WIZ 2008

Babala, Djibouti Source: djib/Flickr.com

Threats to Coastal and Marine Resources

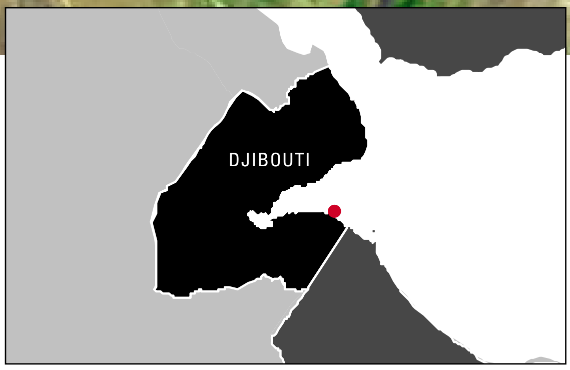
The unique and diverse marine life of Djibouti's coastal waters can be attributed to the oceanographic influences of the Indian Ocean, Red Sea and Arabian Sea. These productive waters are threatened by high levels of sedimentation, urban wastewater, industrial effluents, and oil pollution. Reefs are particularly susceptible to sedimentation; 90 per cent of the coral reefs in the South Maskali Islands Reserve have been adversely impacted by sediment (Djibril 1998). Areas around ports, which receive heavy shipping traffic, are also susceptible to high rates of pollution. Djibouti's reefs are also vulnerable to the collection of coral and shells, spearfishing, dredging and anchor damage from fishing and tourist boats (Djibril 1998). The fisheries sector, which is currently underutilized, is expanding to meet domestic and export market needs. Currently, the total catch is 350 tonnes per year, while the maximum sustainable yield is estimated at 5 000 tonnes of fish annually (FAO n.d.).



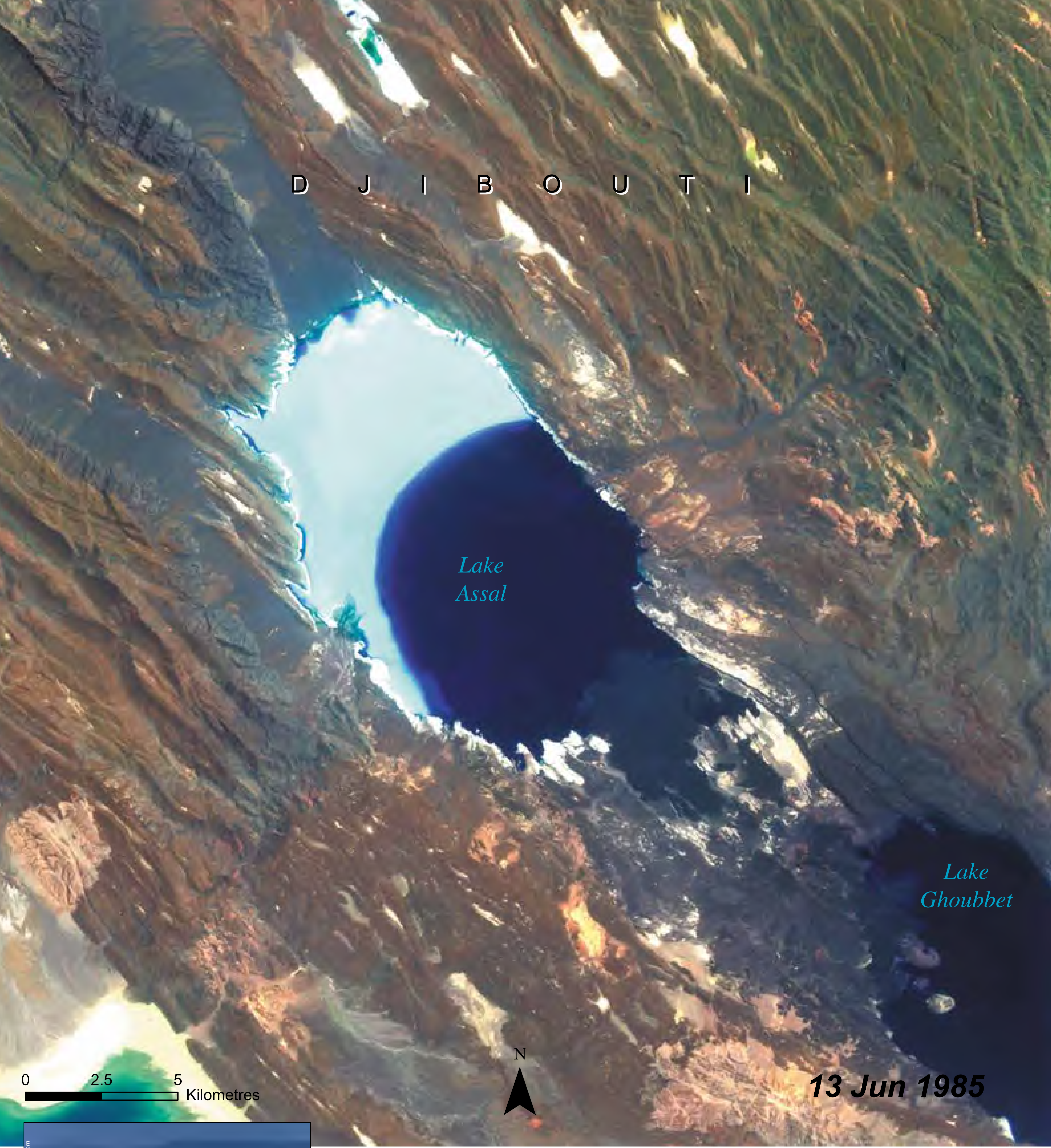
Maskali Island, Djibouti Source: Candido33/Flickr.com

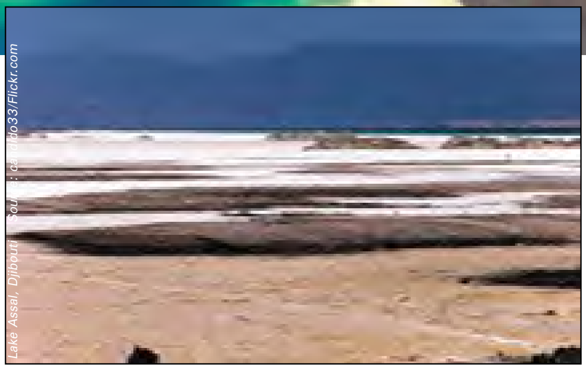
Djibouti City, Djibouti

With 65 per cent of the total population, Djibouti City is the capital and largest urban area in the country (WFP 2010). The city was built on a small peninsula located on the Horn of Africa at the mouth of the Red Sea, and is strategically important due to its large natural harbour, which provides essential port services to neighbouring landlocked countries (IRIN 2010). Originally a French colony, the city was established in 1886 with the intention of linking the Red Sea coast to the Ethiopian plateau. In 1917, a railroad was built linking Djibouti City to Addis Ababa, Ethiopia (Ali Moeman n.d.). This railway link spurred an era of rapid and unregulated population growth and urban development. Poor infrastructure in the city prompted the government in the 1950s to institute a series of urbanization regulations, including construction standards.



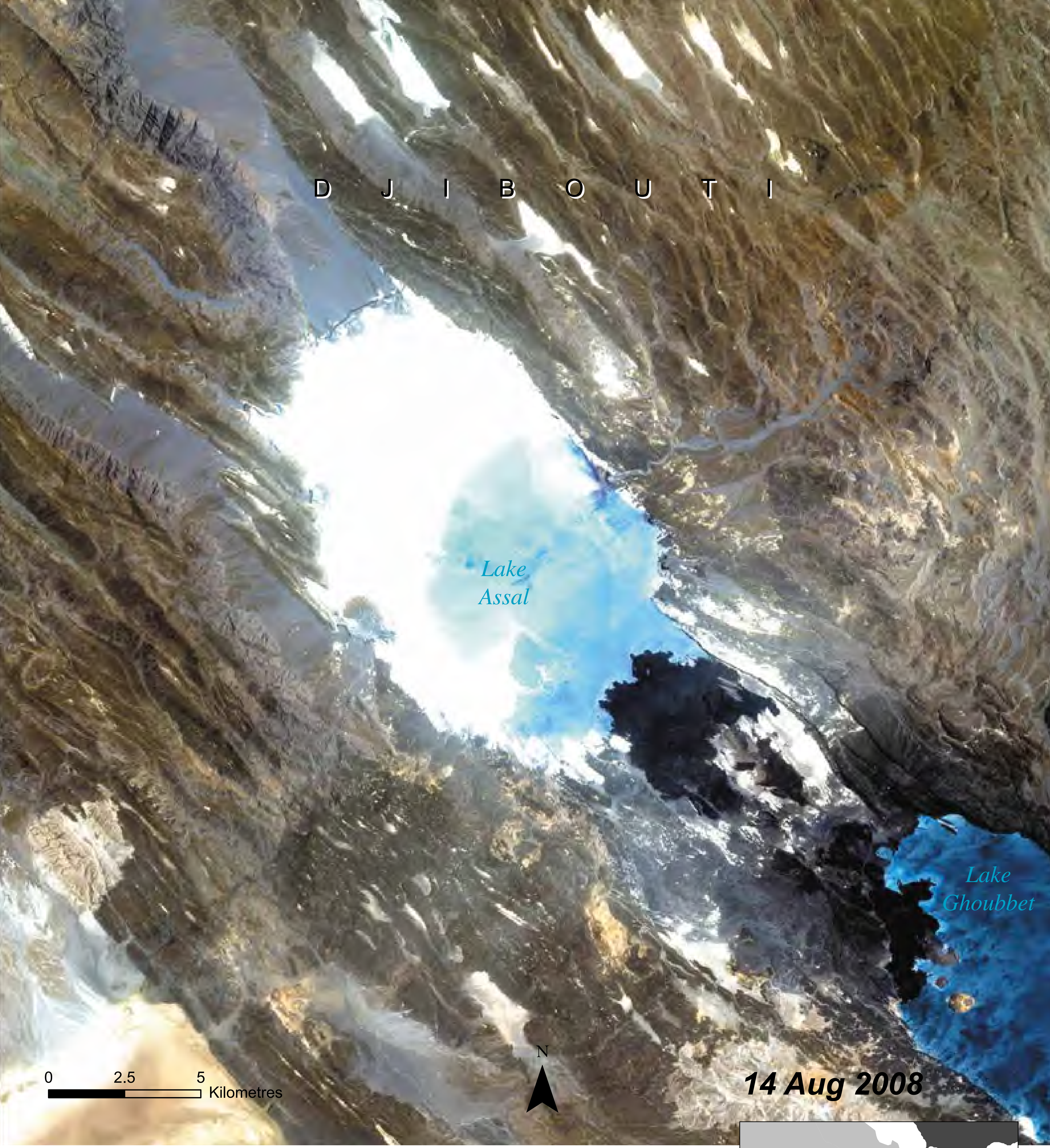
More recently, informal settlements have been established in the Balbala district to the west, avoiding the restrictions put in place by the government. Balbala is the fastest growing district in the city and is home to 35 per cent of its population. This poor infrastructure development and rapid growth exacerbates the city's water supply and sanitation problems; out of 30 districts in Djibouti City, only 13 are connected to the sewage network. Much of the wastewater flows untreated into the sea (Ali Moeman n.d.). The marine environment surrounding the peninsula is also subject to oil spills where refueling facilities are located. In 2002, a significant leak of chromate copper arsenate (CCA) contaminated the harbour water at Djibouti Port (TAD 2009). These images show the expansion and change in land use in and around Djibouti City from 1979 to 2008. The earlier image shows little to moderate settlement outside of the peninsula. The 2008 image, in contrast, reveals the amount of urbanization that has occurred in the Balbala district and south of the peninsula. The port facilities west of the cape have also been expanded.



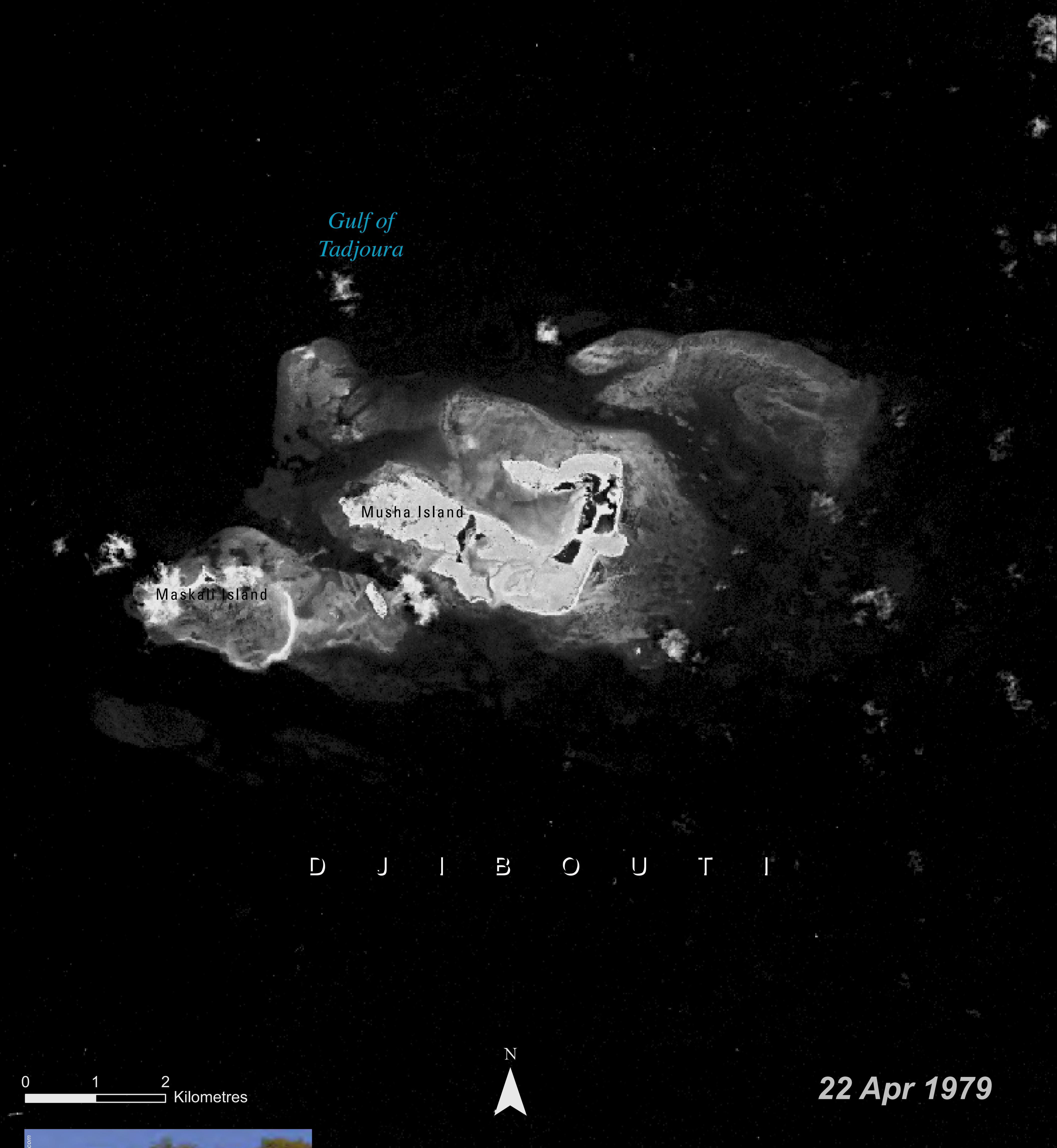


Lake Assal, Djibouti

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). The lake is located in the Danakil Desert at the terminus of the Gulf of Tadjoura, which lies on the western end of the Gulf of Aden. 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.



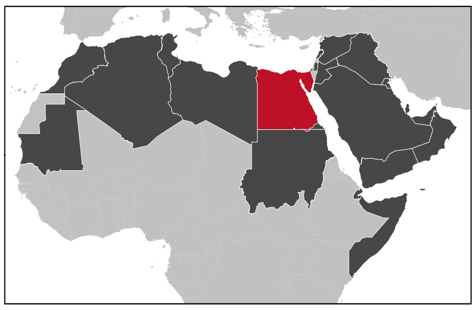
The water of Lake Assal is ten times more saline than seawater, and is the most saline body of water in the world. The extreme salinity and inhospitable climate makes the lake mostly uninhabitable. As shown in these images, the water levels fluctuate greatly with occasional inputs from rainwater, seawater 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).



Musha and Maskali Islands, Djibouti

The bodies of water surrounding the Horn of Africa and the ROPME Sea Area are home to 8 per cent of the world's total coral reefs; almost 60 per cent of these habitats are considered to be at risk due to coastal development, overfishing, and the threat of oil spills by heavy tanker traffic (WRI n.d.). Djibouti's marine biodiversity is high given its location at the confluence of two major biogeographic provinces and one smaller sub-regional zone (Obura 1998). Its coastline of 372 km is fringed by a network of discontinuous coral reefs (Pilcher and Abdi 2000). The principal coral growth areas include: the north coast and Sept Freres archipelago (which faces the Strait of Bab al-Mandab); and the Gulf of Tadjoura, which includes the Musha and Maskali Islands. It appears in these two change pairs as though the islands themselves have shrunk in size, but it is only shallow waters and sand bars causing this apparition. The Corona image on the left looks as though there

is more land, but this is shallow sand bars under the water that appear as light blue in the right image. In 1991, of the 24 individual reefs in Djibouti, only 9 were considered to be in satisfactory condition; 3 were in medium condition; 4 were bad, and 8 were considered disastrous (WRI 2006). Coral cover in Djibouti's reef system ranges from 5 to 90 per cent, with an average of 56 per cent (Wilkinson 2000). There are several threats to the coral reefs in Djibouti, both anthropogenic and natural. Direct human threats include: land-filling and dredging, anchor damage from fishing and tourist boats, oil and wastewater discharges, overfishing and the unsustainable collection of corals and shells. The degradation of the Musha and Maskali reefs are a direct result of high levels of tourism, while reefs on the coast of Djibouti City are threatened by sewage and petroleum pollution. Other threats to these ecologically vital marine areas include: coral bleaching caused by abnormally high surface temperatures; high levels of turbidity from excessive nutrient inputs; and predation of coral species by the Crown of Thorns starfish.



Arab Republic of Egypt

Total Surface Area: 1 001 449 km^2

Estimated Population in 2011: 79 602 000

Egypt is located in north-eastern Africa and is bordered by the Mediterranean Sea to the north, Israel, the Occupied Palestinian Territories and the Red Sea to the east, Sudan to the south, and Libya to the west. Egypt controls the Suez Canal, which is a strategic sea link between the Red Sea, Indian Ocean and the Mediterranean Sea. Egypt has four major physical regions that include the Nile Valley and Delta, the Western Desert, Eastern Desert and the Sinai Peninsula. It is predominantly desert and the climate is generally arid with an average of 51 mm of rainfall per year. The arable regions occur in the Nile Valley and Delta, which is home to almost all of the country's population. The Nile River, the longest river in the world, traverses 1 600 km through Egypt, and contains the most extensive oasis on earth.

Important environmental issues

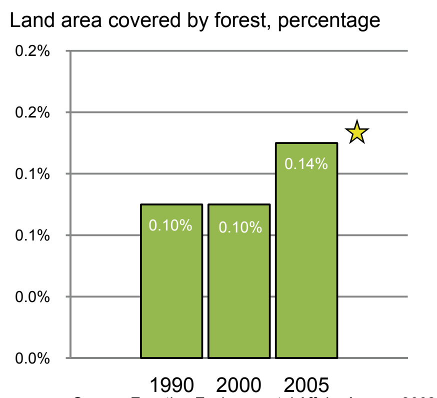
- Water Scarcity and Pollution of the Nile River
- Solid Waste
- Loss of Biodiversity

Progress Toward Environmental Sustainability

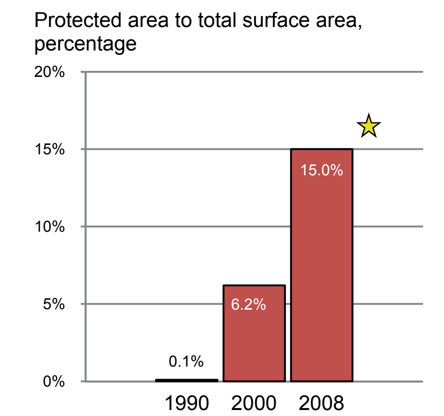
As defined by the United Nations Millennium Development Goal 7 Indicators

Ensuring environmental sustainability in the Arab League's most populous nation remains a challenge with rapid population growth and expansion of industrial, agricultural and tourism activities. Progress has been made in increasing the amount of protected areas and forest areas, improving access to clean water sources and sanitation facilities and decreasing the proportion of the urban population living in slums (Egyptian Environmental Affairs Agency 2009).

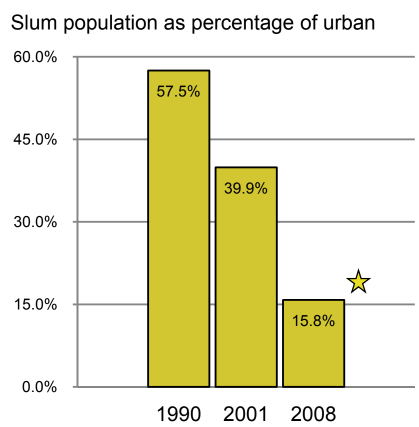
☆ Indicates Progress



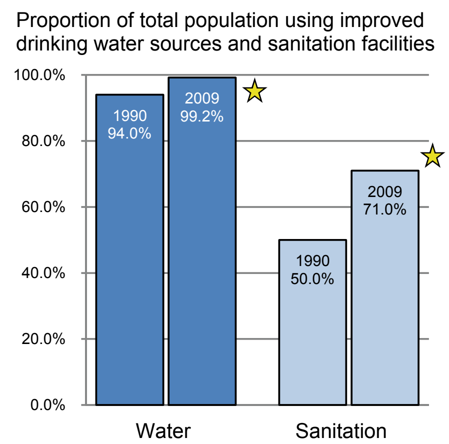
Source: Egyptian Environmental Affairs Agency 2008



Source: Egyptian Environmental Affairs Agency 2008



Source: Shoura Council 2008



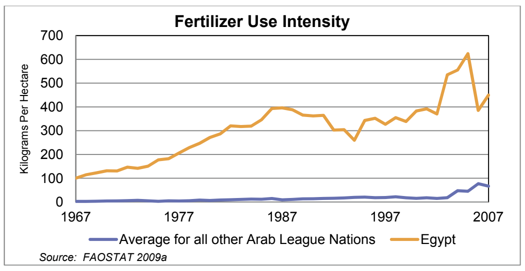
Source: Shoura Council 2008

In March 2008, Egypt signed an agreement with Russia to assist in building Egypt's first nuclear power plant

Source: EIA 2008

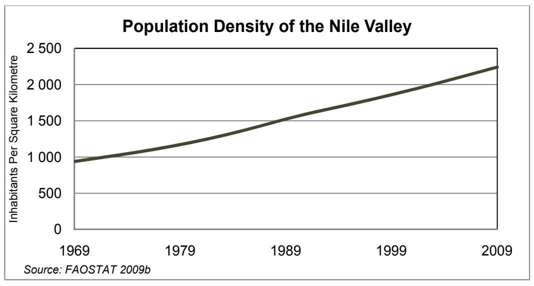
Water Scarcity and Pollution of the Nile River

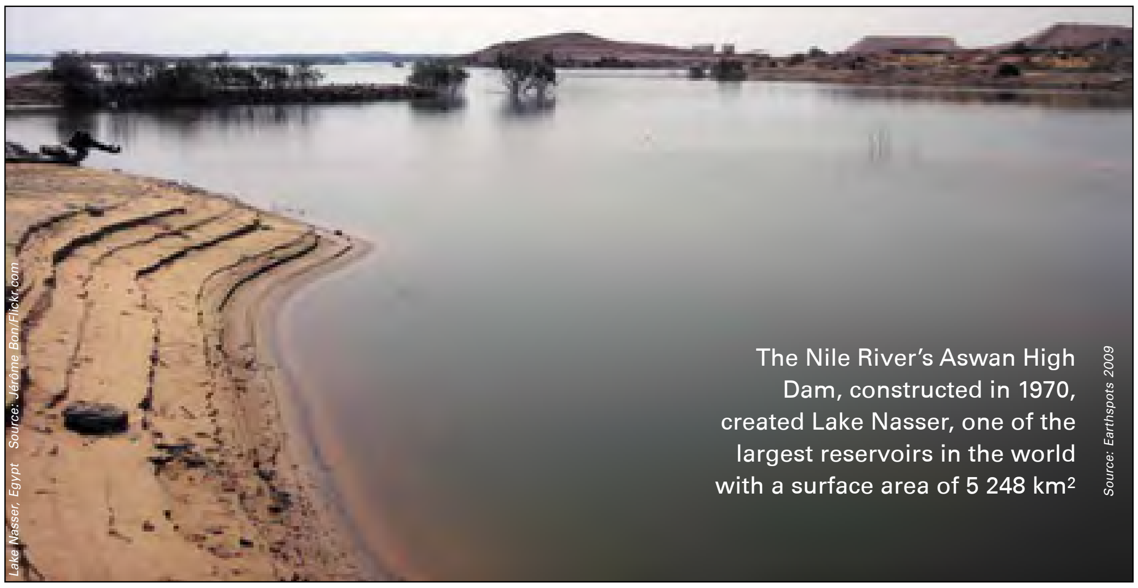
Egypt's population of 80 million doubled in the past 30 years, placing immense stress on the country's water resources. Egypt ranks among the world's water scarce countries—the per capita water availability is expected to fall to 545 m³ per year by 2025 (FAO 2010). Impacts from climate change are also expected to reduce rainfall in parts of Egypt by 20 to 25 per cent by 2050 (Ragab and Prudhomme 2002). Programmes to re-use wastewater, desalinate seawater and harvest rainwater have been implemented. The Nile River, Egypt's main water source, is depended upon for irrigation, drinking water, electricity and transportation. About 99 per cent of Egypt's population resides along the river valley and Delta (Egyptian Environmental Affairs Agency 2009). It has been heavily impacted by urban and industrial effluents and agriculture. Programmes to improve water quality have been successful—of the 102 industrial facilities discharging effluents directly into the river, 75 have stopped, and the remaining are in the process of complying (Egyptian Environmental Affairs Agency 2009).



Solid Waste

Inadequate solid waste management rates as one of Egypt's most pressing urban environmental concerns. Solid municipal waste or trash generated from households and other sources represent 60 per cent of the total solid waste in Egypt, while industry produces the remainder. Expansion of industry to include chemicals, pharmaceuticals, leather products, and fertilizers has exacerbated the solid waste problem. The total quantity of municipal solid waste per capita increased during the last decade due largely to increases in standards of living. The total generated amount of solid waste reached 66 million tonnes in 2008. In Greater Cairo, in spite of the growing numbers of inhabitants, waste amounts have decreased as a result of state efforts (Egyptian Environmental Affairs Agency 2009). Waste collection and disposal systems still lag, with only 65 per cent of municipal waste collected on average in Cairo. Inadequate disposal and illegal dumping contributes to air pollution problems and impacts human health.

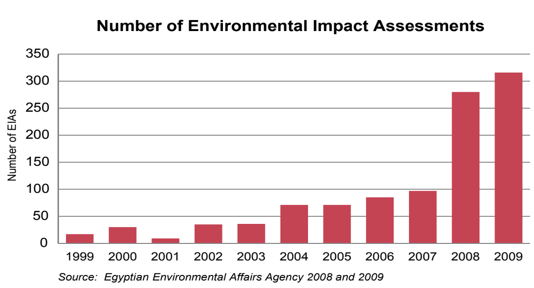




The Nile River's Aswan High Dam, constructed in 1970, created Lake Nasser, one of the largest reservoirs in the world with a surface area of 5 248 km²

Loss of Biodiversity

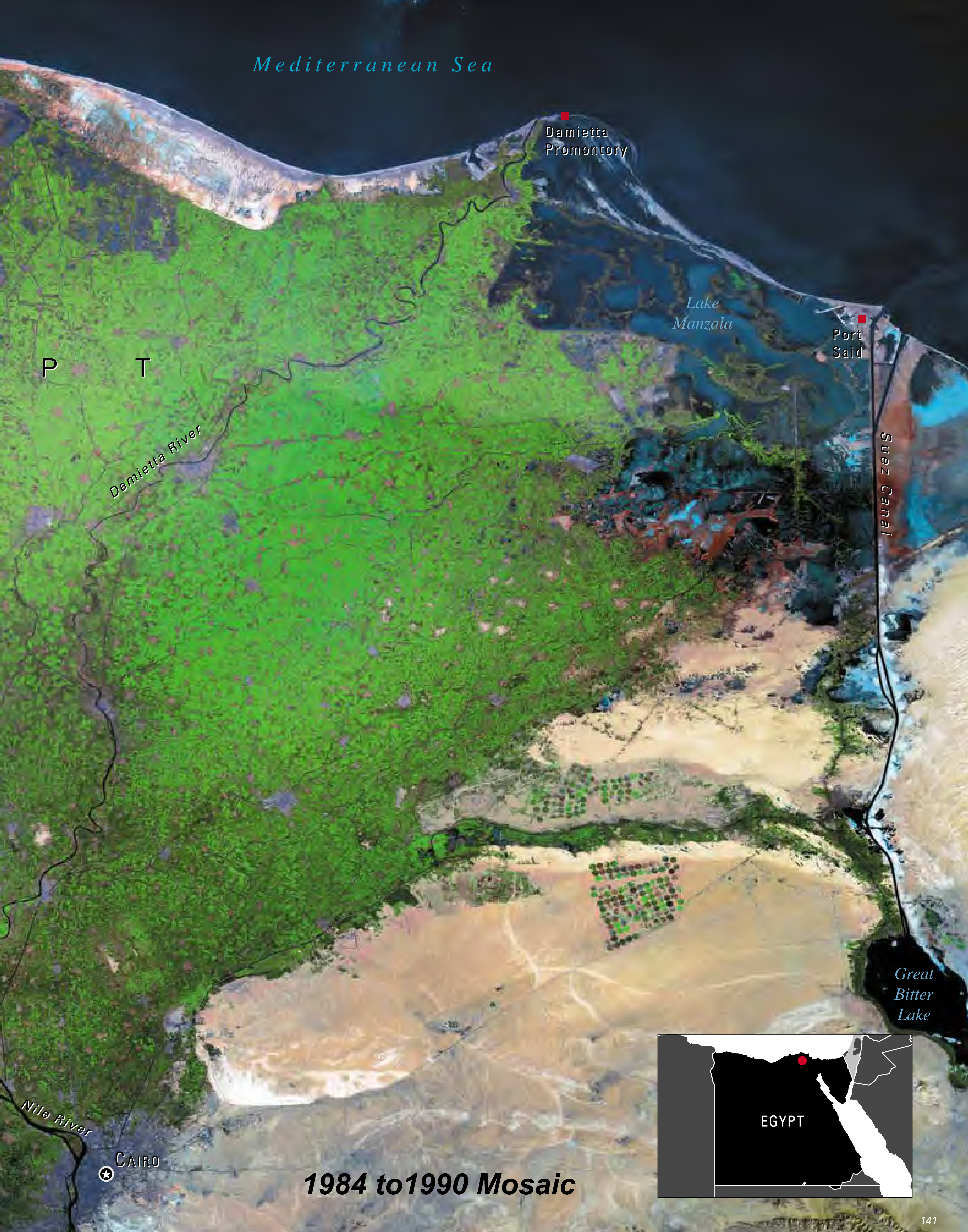
The deserts, mountains, Nile Valley, oases, wetlands and marine environments are home to at least 3 000 plant species, 116 mammal species, 447 bird species, 109 reptile species, 9 amphibian and more than 1 000 fish species (Egyptian Environmental Affairs Agency 2008). Habitat destruction is the greatest threat to Egypt's biodiversity. Economic development and population densities in the Nile Valley and Delta, rapid development of coastal areas, grazing, tree-cutting, pollution and invasive species negatively impact Egypt's plant and animal life (Winer 1999). Oil pollution is threatening beaches and marine habitats. Over-exploitation of fish resources also contributes to biodiversity loss. Introduction of the Nile perch has severely reduced diversity of the Nile system (Kitchell and others 1997). Legislation for protected areas, conservation and rehabilitation programmes, monitoring, biodiversity assessments, and increased law enforcement have had positive results with increases recorded in populations of threatened gazelle, ibex, turtles and birds (Egyptian Environmental Affairs Agency 2008).



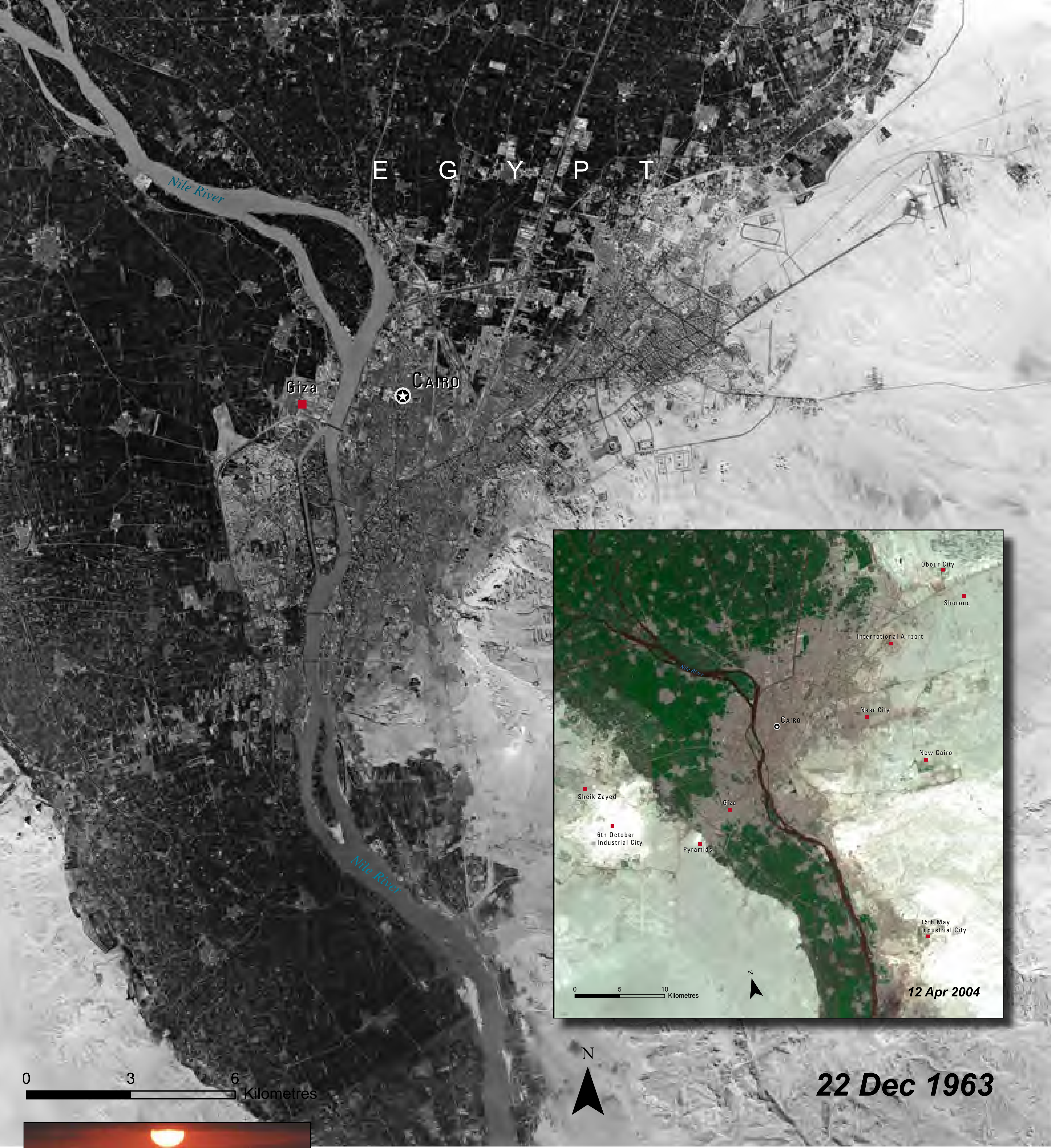
The Nile Delta, Egypt

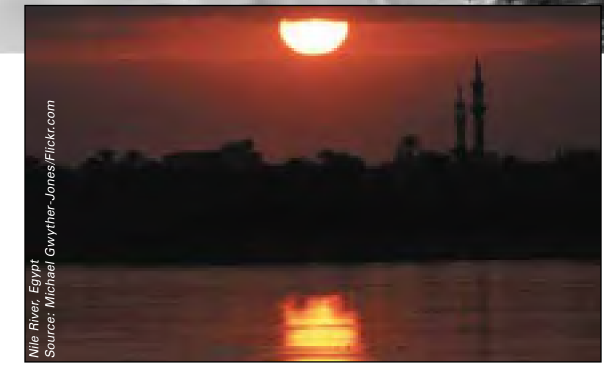
The Nile Delta, one of the world's largest deltas, forms a wide arc along Egypt's Mediterranean coast from Alexandria in the west to Port Said in the east, and extends south almost 160 km to Egypt's capital, Cairo. The Nile Delta's 270 km-long coastline, only 0 to 1 m above sea level in places, is lined with lagoons and sand spits. The largest of the deltaic lakes is Lake Manzala; other coastal lagoons include Lake Burullus, Lake Idku and Lake Maryut. The 25 000 km^2 delta contains most of Egypt's farmlands, which are fed by branches of the Nile (Rosetta and Damietta rivers are the major tributaries). The Nile Delta is one of the most densely populated places on Earth, with 1 545 people per km^2 and a total of 50 million inhabitants (FAO 2010). This region has undergone dramatic ecological changes as a result of rapid population growth, urbanization, and industrial and agricultural development. Reduced nutrient and sediment deposits in the delta due to the construction of the Aswan Dams in the 20th century, and reduced water flow to the delta to meet upstream demand are impacting water quality and soil salinity and decreasing the productivity of Egypt's 'breadbasket'. These problems are expected to worsen; the amount of Nile water reaching farmlands in the delta is expected to drop by 70 per cent in the next 50 years due to increased evaporation (caused by higher temperatures associated with climate change) and heavier demands on water use (Shenker 2009). Erosion of coastal areas and urban encroachment onto productive lands are reducing the amount of land available for cultivation; coastal erosion is already occurring at an astonishing rate of up to 60 m per year (Frihy and Komar 1991). This image shows areas around the peripheries of the delta that are being developed for agriculture in response to reduced availability of land and high salinity in the delta.


Nile Delta, Egypt – Source: Christopher Rose/Flickr.com



1984 to1990 Mosaic

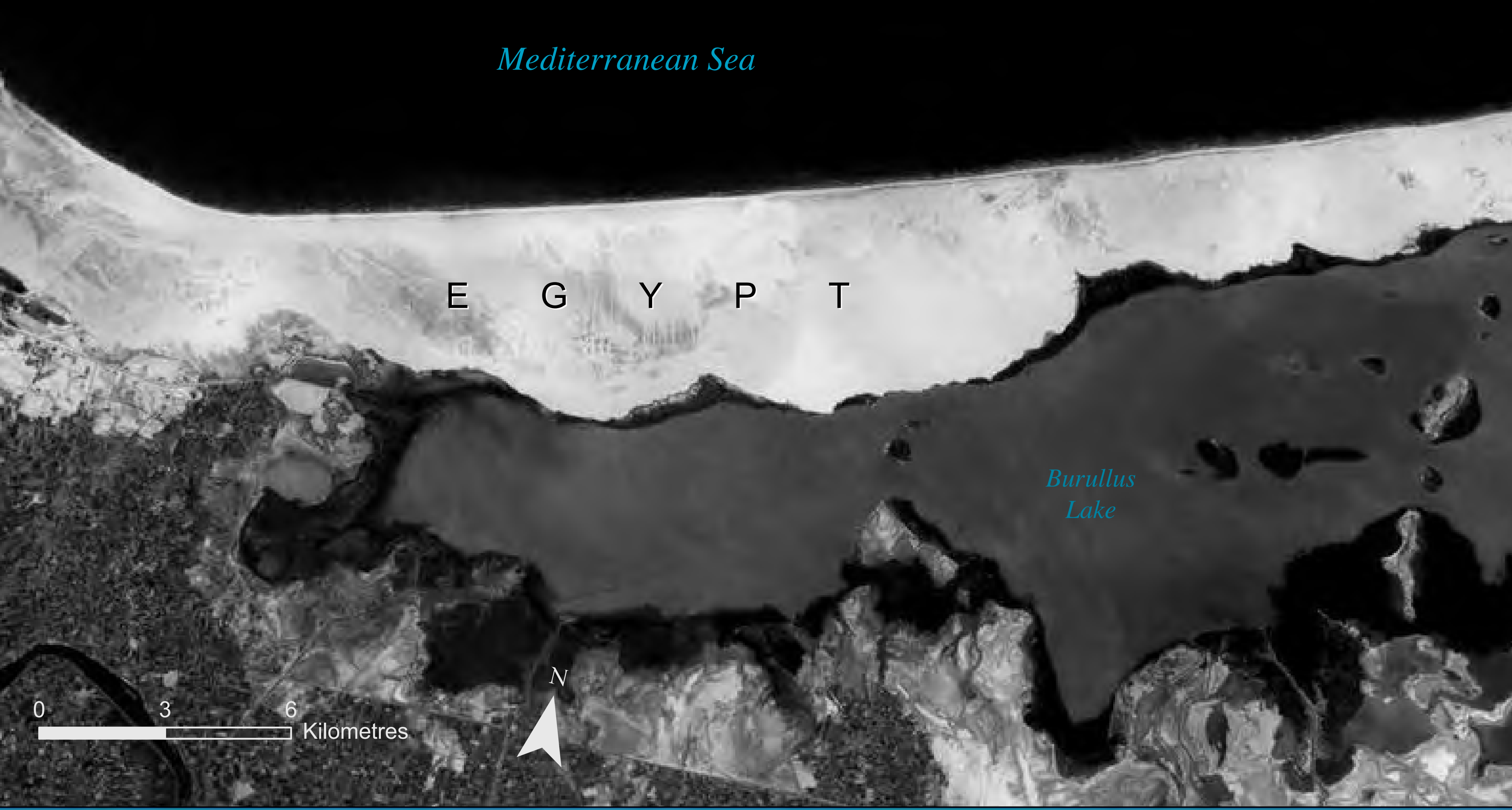


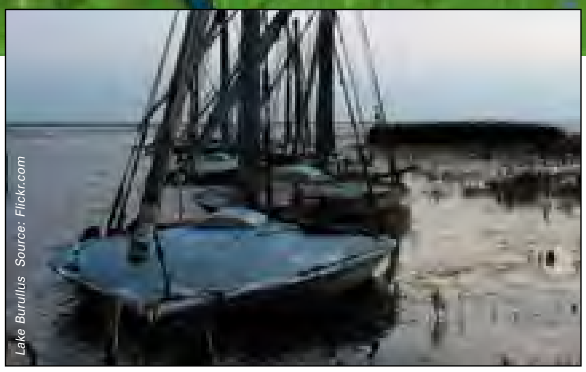


Cairo, Egypt

For over one thousand years, Egypt's capital city, Cairo, has served as the country's political and economic centre. With its strategic location at the foot of the Nile River Delta, Cairo has experienced steady and dynamic growth. After gaining independence from Britain in 1952, government policies directed at industrialization of Greater Cairo were implemented, along with massive housing projects (Yousry and Atta 1997); a period of rapid population growth ensued. From 1971 to 2006, the population of Greater Cairo almost tripled, increasing from 6.7 million to 18.4 million (CAPMAS 1976, 2006). The growth in Greater Cairo's urban area was equally dramatic, increasing from 160 km^2 in 1971 to 1 269 km^2 in 2006. The images in this change pair reveal this astounding growth. The white outline shown in the 2004 image delineates the 1963 urban extent, highlighting the expansion of the districts and cities over that 40-year time period.

There are many consequences to this rapid population growth and urbanization. Informal housing, in the form of illegal subdivisions, results in unplanned, high-density, and low-quality developments that are often deprived of basic services and infrastructure (Yousry and Atta 1997). Some planned cities in Greater Cairo are absorbing populations from overcrowded adjacent areas to improve quality of life in this mega-city. The concentration of industry, including textile manufacturing, chemical and petroleum plants, and cement and steel factories in and around the city (constituting 50 to 64 per cent of Egypt's industry), are leading to air pollution problems and impacting human health (Robaa 2003). These industries also pollute the waters of the Nile River, which are already subject to inputs of mostly untreated domestic, agricultural and industrial wastewater from upstream sources. The expansion of water supply networks without construction of sewerage systems, or the rehabilitation of existing systems, has compounded these water quality problems (Myllyla 1995).





Lake Burullus Source: Flickr.com

Lake Burullus, Egypt

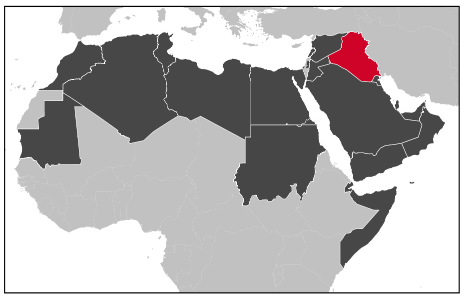
Considered the second largest natural lake in Egypt, Lake Burullus is a shallow, brackish coastal lagoon that lies between the two Nile branches forming the delta. The lake is separated from the sea by a broad, dune-covered sandbar that is 5 km at its widest in the west; the only connection with the sea is a narrow channel to the northeast of the lake at the village of El Burg. The lake is approximately 65 km long and 6 to 16 km wide - the average water depth is 0.8 m (BLI 2009). Lake Burullus provides recreation and tourism opportunities, has a productive fishery, and is a water source for industry; its many islands provide habitat for numerous waterbirds.

Burulllus Lake has lost 37 per cent of open water and 85 per cent of marsh area in the past 40 years as a result of ongoing drainage and reclamation activities (BLI 2009). Impoundment of Nile sediments in upstream dams has caused severe coastal erosion, which continues to reduce the size of these coastal wetlands by encouraging the landward migration of coastal sandbars. Discharge of agricultural, industrial and domestic wastewater into the lake, along with erosion and siltation, affect the water quality; heavy fertilizer and pesticide loads are causing eutrophication of the lake (Saad 2003). Increased development, including a highway that runs along the sandbar north of the lake (visible in the 2005 image), increases accessibility and places added pressure on this last 'wilderness' of the delta. The 2005 image highlights the reclamation and development that has occurred on the lake's periphery, especially to the south, and shows the extent to which open water has decreased since 1968.

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 km^2. The 2005 image shows the current position of the promontory in relation to its extent in 1968. Construction of the High Aswan Dam in 1964 accelerated the retreat of this promontory, which used to receive the majority of the Nile River's discharge (80 million tonnes/year of sediment were discharged through the Rosetta mouth) (Inman and Jenkins 1984) - the average rate of retreat of the coastline between 1978 and 1984 was 90 m per year (Smith and Abdel-Kader 1988). The greatest rates of erosion during this time occurred immediately to the east of the mouth of the promontory.

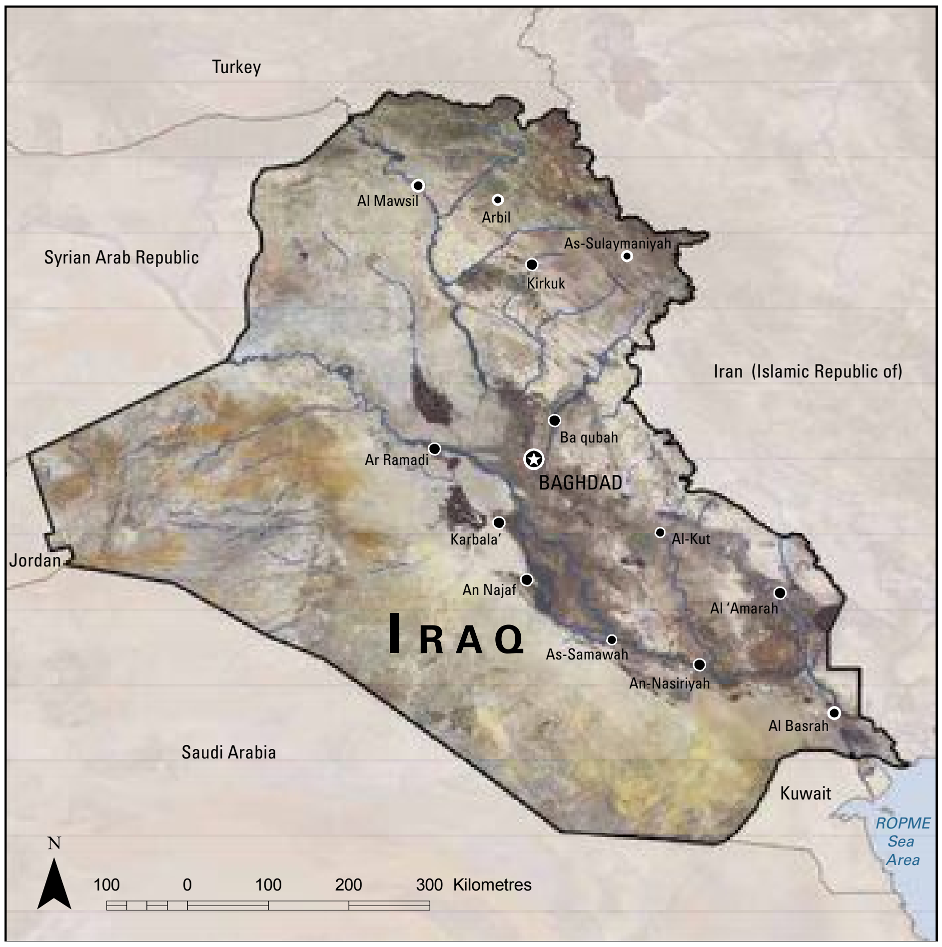
Revetments were constructed between 1986 and 1991 on the western and eastern parts of the promontory to prevent further erosion; however, they were not efficient in stopping the erosion (Elsayed and others 2005). Coastal erosion along this shoreline is the net result of reduced flows in the Nile River (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). This change pair illustrates the dramatic retreat of the Rosetta Promontory over a 40-year time period. 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

Total Surface Area: 438 317 km2
Estimated Population in 2010: 31 672 000

Iraq is bordered by Iran, Jordan, Kuwait, Saudi Arabia, Syria, and Turkey - the longest border is shared with Iran (1 458 km), while the ROPME Sea Area coastline is just 58 km in length. Geographical regions in Iraq consist of: desert plateau west of the Euphrates River; northeastern highlands, upland desert in the northwest between the Tigris and the Euphrates rivers; and alluvial plains formed by the combined deltas of the Tigris and Euphrates rivers. Iraq receives an average of 156 mm of rainfall per year, most of which falls in January and February. Summers are mostly dry and hot and the winters are mild and cool; the mountain areas experience cold winters with occasional heavy snows that cause extensive flooding by early spring in central and southern Iraq.



Important environmental issues

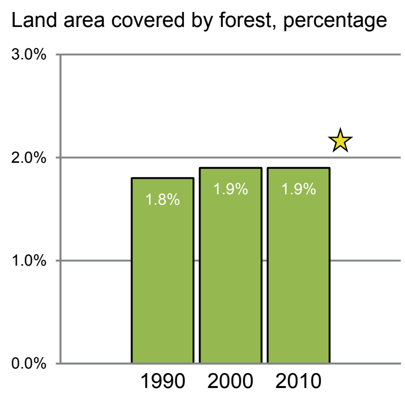
- Conflict-related Contamination and Pollution
- Ecosystem Degradation
- Destruction of the Mesopotamian Marshlands

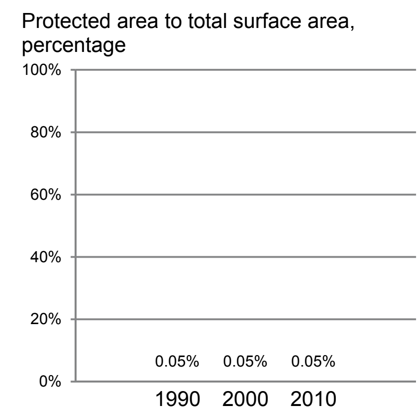
Progress Toward Environmental Sustainability

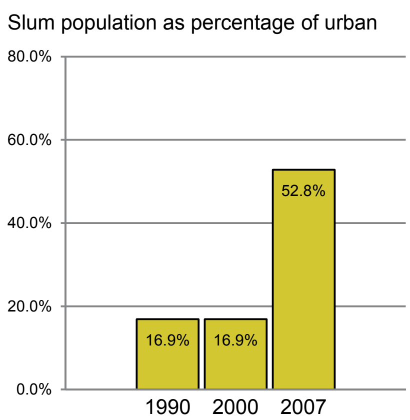
As defined by the United Nations Millennium Development Goal 7 Indicators

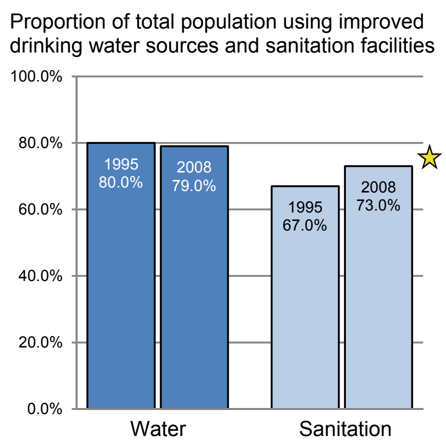
Iraq has been embroiled in conflict for the past three decades, challenging its efforts to confront its environmental and social issues. Since 1995 the proportion of the population using improved drinking water sources has decreased slightly, making the population more susceptible to water-borne diseases. Unsafe water and disrupted water services are also to blame for increased rates of acute malnutrition among Iraqi children (UNICEF 2003). However, access and use of improved sanitation facilities has increased for the total population.

☆ Indicates Progress







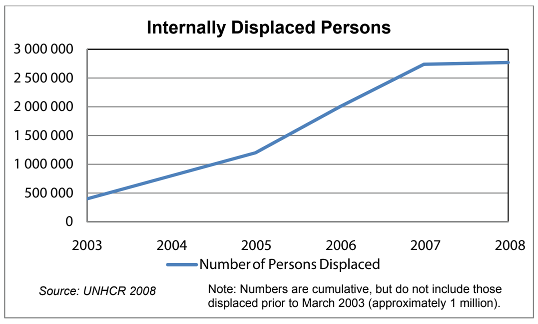


From 1988 to 2002, cancer rates in the heavily bombed city of Basra increased more than tenfold; the increase is believed to be caused in part by depleted uranium in weaponry

Source: IRIN 2004

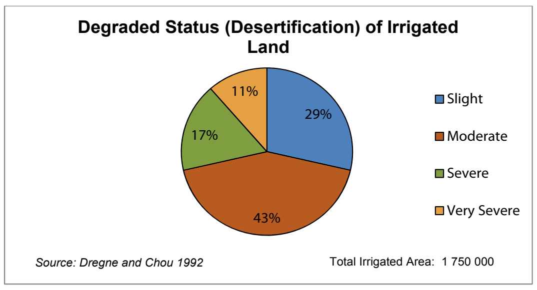
Conflict-related Contamination and Pollution

On-going conflicts since 1980 have exacerbated the environmental stresses in Iraq as well as the number of internally displaced persons. Decades of conflict have caused social and environmental upheaval across the country. Huge quantities of military debris (spent cartridges, shells) and unexploded land mines litter the landscape, contaminating soil and water. Radioactive and toxic gases from chemical weapons and depleted uranium from bombs and missiles contaminate food and water supplies, impacting human health - the rate of leukemia among children in Basrah increased by 60 per cent from 1990 to 1997 (Yaqoub and others 1998). Destruction of the waste disposal system has resulted in raw sewage discharge into the Tigris River, Baghdad's only source of water (UNEP 2003a). Targeting of the oil industry infrastructure resulted in massive oil fires and spills; in 1991, an estimated 11 million barrels of oil were intentionally released into the ROPME Sea Area, impacting 800 miles of coastline and killing seabirds and marine turtles (Sadiq and McCain 1993).



Ecosystem Degradation

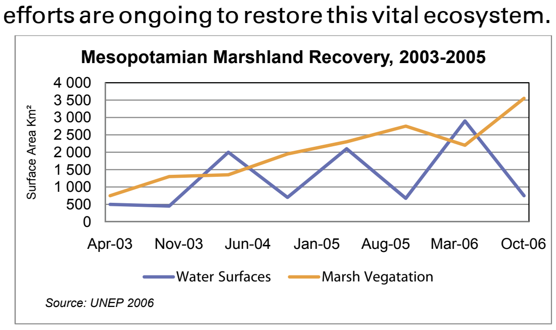
Desertification due to water shortages, drought, urbanization and poor land management practices afflicts 38.1 per cent of land in Iraq, while 54.30 per cent of the land is vulnerable to desertification (Attia and others 1999). Salinization and water logging of the soil due to poor irrigation practices degraded half of the irrigated areas in central and southern Iraq by 1970. By 1989, 700 000 ha had been rehabilitated; however, three-quarters of Iraq's irrigated land continues to suffer from elevated salinity, impacting food security and sustainable development (UNEP 2003a). Extensive deforestation has reduced the forest cover to areas in the northeast and along the Euphrates and Tigris rivers; forest cover is estimated at 799 400 ha, a reduction from 1.8 million ha in 1970 (UNEP 2003a). Population growth (3.6 per cent growth rate from 1980 to 1990) and urbanization (75 per cent of the population resides in urban areas) are placing additional pressures on Iraq's limited natural resources.

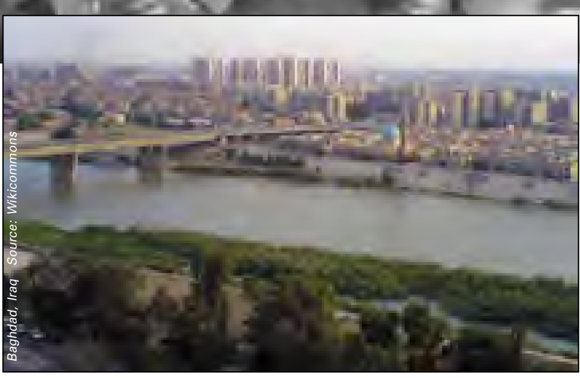


The destruction of the Mesopotamian marshlands forced 100 000 Marsh Arabs to flee Iraq in the early 1990s, and left hundreds of thousands of marshland peoples internally displaced within Iraq

Destruction of the Mesopotamian Marshlands

The Mesopotamian marshlands, the largest wetland in western Asia located in southern Iraq, originally covered 20 000 km². It supported a diverse array of aquatic species, mammals and endemic fish and was home to human communities for millennia. By 2003, drainage schemes, damming and conflict had reduced the marshlands to less than 7 per cent of their 1973 extent (UNEP 2003b). The impacts to migratory birds, aquatic species and coastal fisheries in the northern ROPME Sea Area that use the marshlands for nursery and spawning habitat, are devastating. The displacement of the Marsh Arab population is a major humanitarian crisis. In 2003, drainage structures were dismantled and dykes were breached, allowing re-flooding of part of the marshlands. In 2005, 41 per cent of the original marshland area was re-flooded. Emergent wetland vegetation, which provides important habitat for aquatic species, is rapidly re-establishing (UNEP 2006). Collaborative efforts are ongoing to restore this vital ecosystem.





Baghdad, Iraq Source: Wikicommons

BAGHDAD, IRAQ

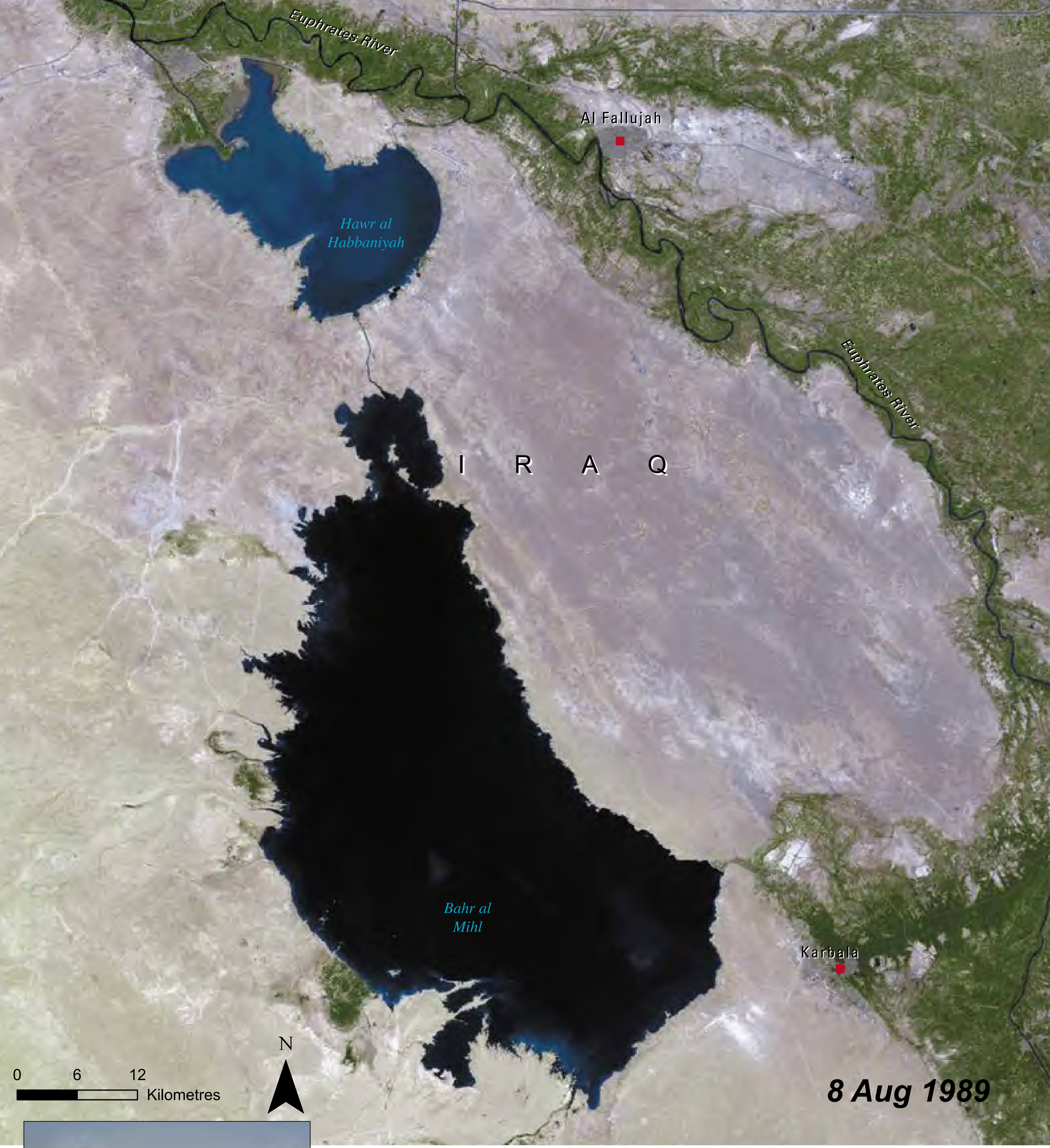
The ancient city of Baghdad was founded on the shores of the Tigris River in a broad alluvial floodplain known as the 'Fertile Crescent', due to its high quality soils. The city has always been intricately tied to the Tigris, which bisects the city in two. Baghdad's population increased from 500 000 in 1958 to over 6.5 million in 2004 (Burnham and others 2006), resulting in rapid expansion of the urban zone. Baghdad's many environmental problems are a direct result of conflict, urbanization, land use change and drought. The development of dikes and canals along the Tigris River has occurred for centuries. As a result, the river has been channelized, straightened, and narrowed.

Mid-river islands have been diked off; side channels have been drained; and canals and diversions have been built and expanded, increasing the risk of flooding and reducing habitat for fisheries and wildlife. Rapid population growth has stressed the city's water supply and outpaced its water treatment capacity. In addition, the footprint of the urban centre has expanded into the agricultural areas, decreasing the amount of land under cultivation. These images show Baghdad's astounding growth over a 46-year time period. Agricultural lands are almost absent in the greater Baghdad area in the 2009 image. The 2009 image also shows additional bridges spanning the Tigris River, which connect the area east of the river (Risafa) with areas to the west of the river (Karkh). The inset image overlays the 1963 greater Baghdad area onto the 2009 image, highlighting the profound change along the banks of the Tigris River.

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 km^2, to be reduced to 1 270 km^2. 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).

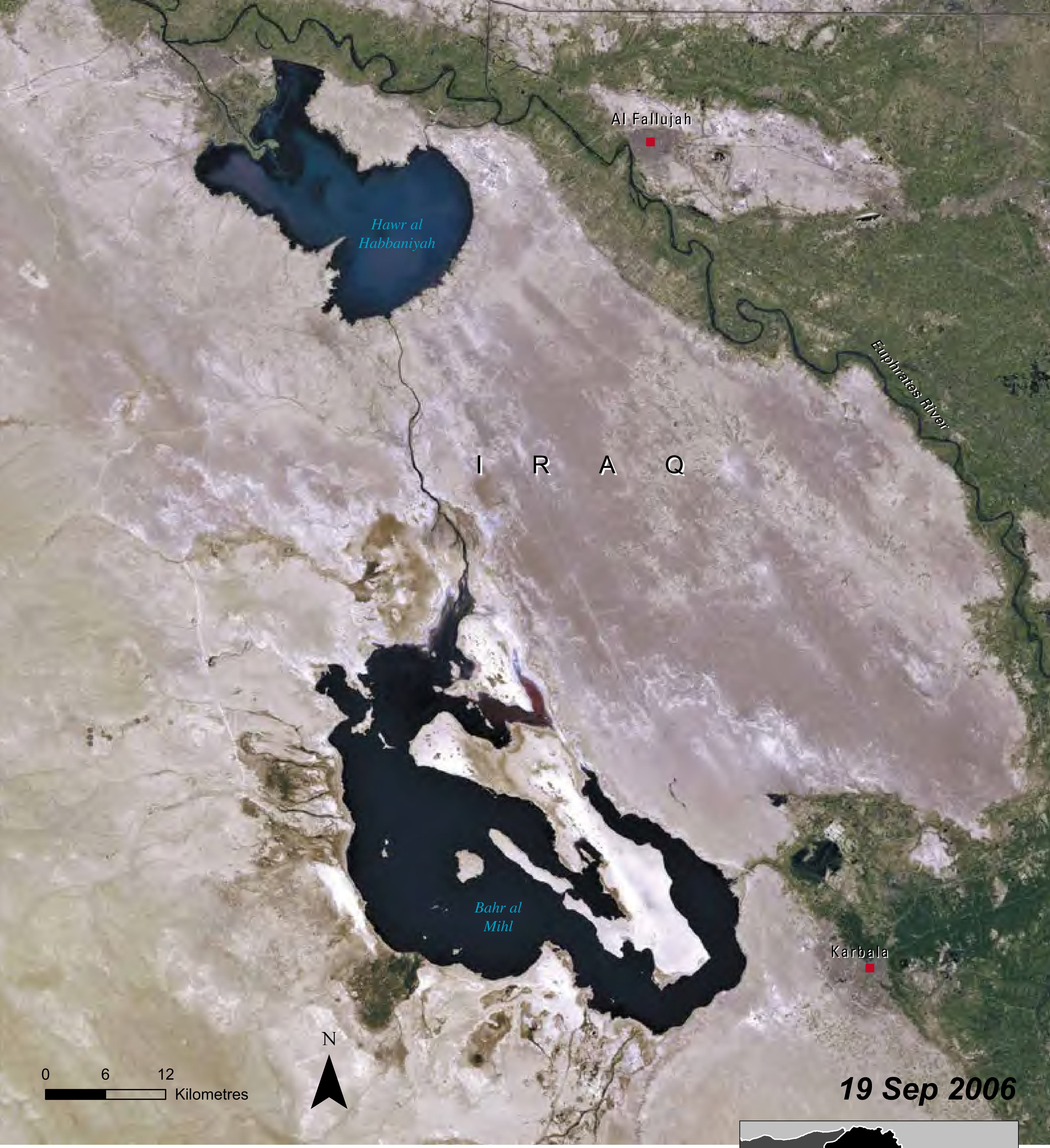
Beginning in the 1950s more than 30 large dams were built upstream of the marshlands, causing reduced annual and seasonal flows into the system. Following a period of dramatic channelization and modification in the late 1980s and early 1990s, the Central and Al Hammar marshlands were reduced by 97 and 94 per cent of their respective original sizes (UNEP 2001). 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.



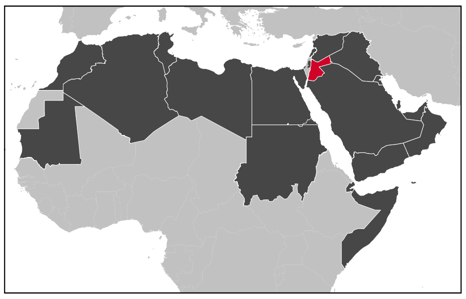

The Euphrates River near lake Razazah, Iraq
Source: Jayel Aheram/Flickr.com

Lake Razazah, Iraq

Lake Razazah is a man-made lake located 100 km southwest of Baghdad in the desert plateau region of Iraq on the edge of the Syrian Desert. The lake was created in 1969 by diverting waters from the Euphrates during flood pulses. Originally about 60 km long and 40 km wide, Lake Razazah was created to provide additional water storage for irrigation purposes, taking excess waters from Lake Hawr al Habbaniya, which lies directly north of the lake. Lake Razazah has been identified as a Wetland of International Importance and is a designated Important Bird Area (BLI 2009). The construction in 1990 of the large Ataturk Dam in Turkey removed the large flood pulses that filled and maintained the lake.



Because the lake fills two large saline depressions (Bahr al Milh and Hau Abu Dibis), the lake water has always been brackish; however, in recent years, the salinity has been steadily increasing (Scott 1995). The lake has lost more than one-third of its depth, become more saline due to evaporation, and the fishery has collapsed. The images presented show the lake's decline in extent from 1989 to 2006. As the lake becomes shallower, the shape of the lake is changed, revealing a number of islands and creating an irregularly shaped shoreline. Satellite images taken at different intervals over the past twenty years reveal that the lake's extent has fluctuated greatly, experiencing notable declines in some years and gains in others.



Hashemite Kingdom of Jordan

Total Surface Area: 89 342 km2

Estimated Population in 2010: 6 187 000

Jordan is bordered by Syria, Iraq, Israel, the West Bank and Saudi Arabia. More than 70 per cent of the country is high desert plateau that is divided by valleys, gorges and mountainous areas. The Jordan Valley is a deep rift valley lying largely below sea level that contains the Jordan River and the Dead Sea. The rainy season brings precipitation from November to April; the rest of the year is very dry with precipitation ranging from less than 50 mm in the eastern deserts to 600 mm per year in the high plateaus of North Jordan. Jordan's natural resources include minerals such as phosphate, potash, limestone, oil shale and others. Jordan is landlocked except for its 26 km of shoreline along the Gulf of Aqaba. Major rivers include the Jordan, Yarmuk and Az Zarqa.

Important environmental issues

- Water Scarcity
- Desertification and Land Degradation
- Threats to Biodiversity

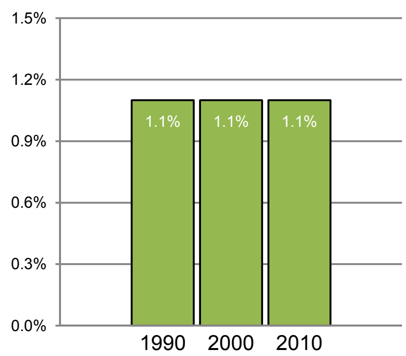
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

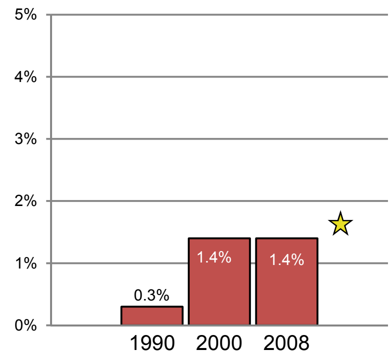
Given Jordan's limited natural resources, arid climate, persistent drought and expanding population, the country has been proactive in addressing its environmental issues, and it has made notable progress in achieving environmental sustainability. Since the establishment of the first nature reserve in 1975, a total of seven have been designated to protect the nation's vital resources (RSCN 2008a).

☆ Indicates Progress

Land area covered by forest, percentage

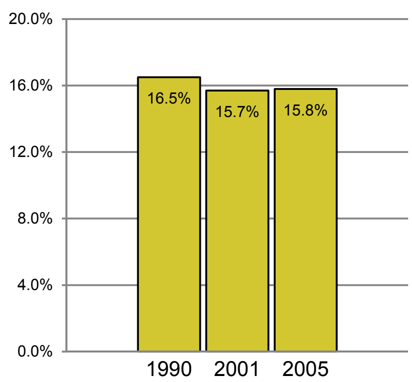


Protected area to total surface area, percentage

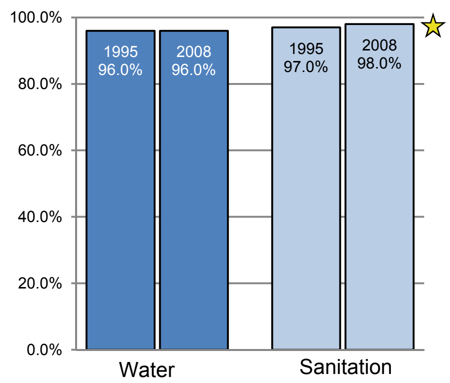


Source: Ministry of Environment 2008

Slum population as percentage of urban



Proportion of total population using improved drinking water sources and sanitation facilities

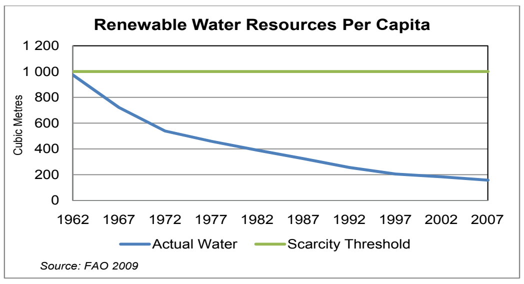


The Red Sea- Dead Sea Conveyance Program proposes to construct a canal to deliver 850 million m3 of water per year from the Gulf of Aqaba to the Dead Sea to address acute water shortages in Jordan and neighbouring countries

Source: World Bank 2009

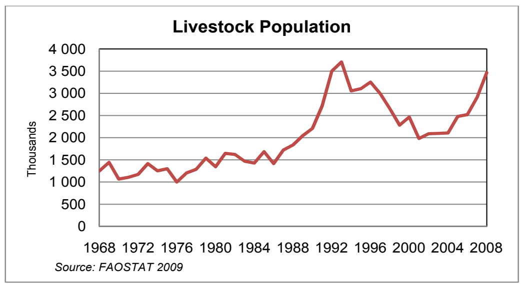
Water Scarcity

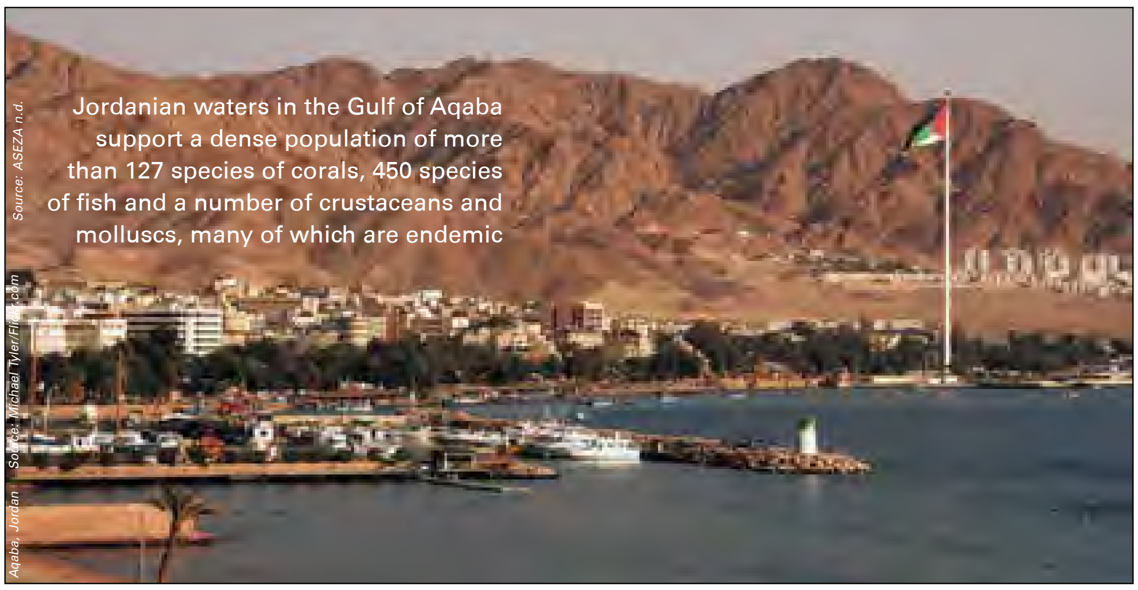
The scarcity of water is Jordan's greatest environmental challenge. Aridity, persistent drought, and high rates of natural population growth, along with large periodic influxes of refugees, have contributed to Jordan's chronic water shortages. Jordan has some of the lowest per capita water availability in the world at 153 m^3 per year (UNDP 2008). Increasing population and climate change threaten to widen the gap significantly between water supply and demand. By 2025, if current trends continue, per capita water availability will fall to 91 m^3 per year, putting Jordan in the category of having an absolute water shortage. Jordan shares waters from the Jordan River and its tributaries with neighbouring countries, whose control has partially limited Jordan's water availability. The share of water used for agriculture (64 per cent), is expected to decrease in order to provide more water for the domestic sector. Projects such as the Red Sea-Dead Sea Conveyance Program are being proposed to address water shortages.



Desertification and Land Degradation

About 80 per cent of Jordan is desertified and 11 per cent is vulnerable to desertification (Abahussain and others 2002). Leading causes of land degradation in Jordan are population growth, poor farming practices, overgrazing, deforestation, the conversion of rangelands to croplands in marginal areas, and uncontrolled urbanization (Khresat 2006). Deforestation resulting from wood and crop cultivation decreases soil stability, making it prone to erosion. To date, climate change has caused a 30 per cent reduction in the Kingdom's surface water resources (MDG-F 2009), and rainfall is expected to decrease, making Jordan's arid and semi-arid lands more vulnerable to desertification. Rangelands are deteriorating due to widespread overgrazing, uncontrolled herd movements, firewood collection and persistent drought. The encroachment of urban areas into agricultural lands in the highlands is reducing the traditional production areas of food crops such as wheat and barley (Abu-Sharar 2006).





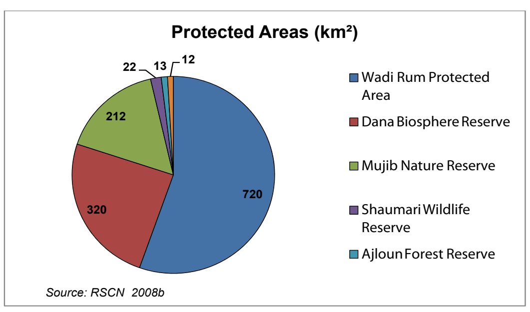
Jordanian waters in the Gulf of Aqaba support a dense population of more than 127 species of corals, 450 species of fish and a number of crustaceans and molluscs, many of which are endemic

Source: ASEZA n.d.

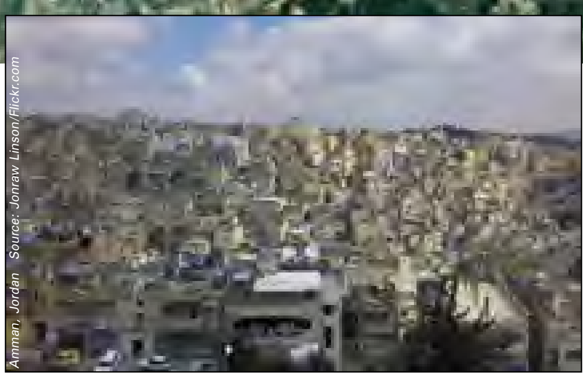
Aqaba, Jordan Source: Michael Tyler/Flickr.com

Threats to Biodiversity

Jordan's remarkable biodiversity is threatened by habitat loss, overhunting, pollution, and the introduction of exotic species. Jordan has 47 globally threatened species. Of the 78 mammals in Jordan, 12 are considered globally threatened, such as the Arabian oryx and the Nubian ibex (RSCN 2008b). Livestock grazing and uncontrolled hunting between 1930 and 1960 led to the disappearance in Jordan of the Arabian oryx, onager and Asiatic lion. Hunting enforcement and captive breeding programs in nature reserves have brought the oryx and ibex back from the brink of extinction. Fifteen globally threatened bird species occur in Jordan, the most well-known of which is the Houbara Bustard, which still faces threats from hunting in Jordan and neighbouring countries. The Saker Falcon is also threatened, and is used in falconry mostly to hunt Houbara Bustards. Marine species are also under threat; the Gulf of Aqaba Marine Park was established to protect a coral reef strip that stretches over seven kilometres.



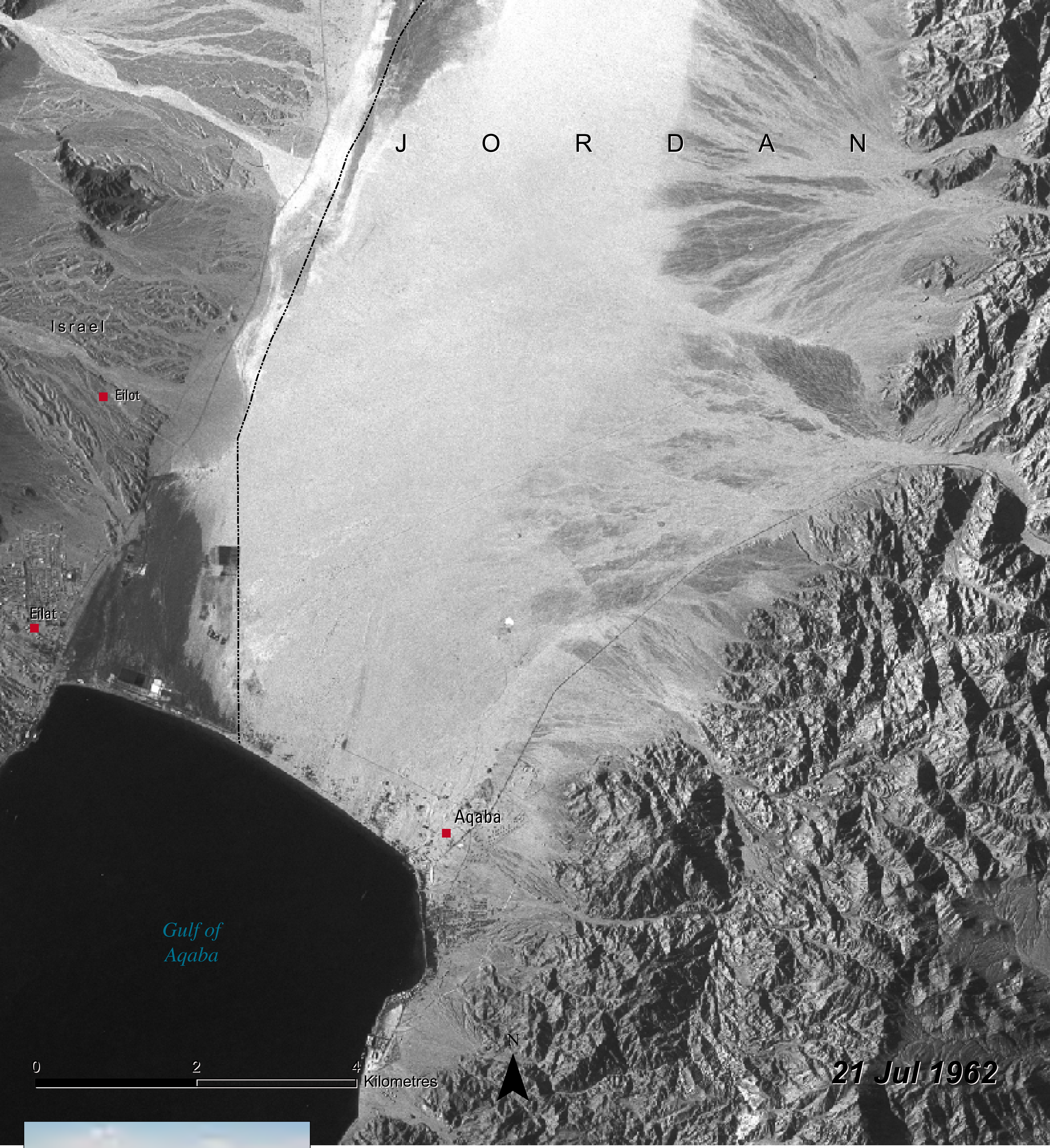
Petra, Jordan Source: David Berkowitz/Flickr.com

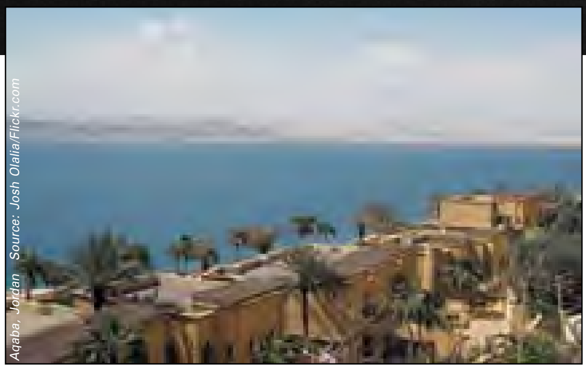


Amman, Jordan

Jordan's capital city of Amman has experienced phenomenal growth in the past century. Amman, which once consisted of a handful of dwellings with no more than 2 000 to 3 000 people, has become a major regional city with more than 2.17 million people (Hashemite Kingdom of Jordan 2006). From 1918 to 2002, the urban area increased by 162 km^2 (Al Rawashdeh and Saleh 2006). The city, located in northwest Jordan on an undulating plateau with steep hills and narrow valleys, originally occupied seven hills around the Wadi Ras el Ain - it now spans 19 hills.

Rural-urban migration, along with the influx of refugees from various regional conflicts, displaced persons from the West Bank, and returning emigrants from the gulf countries during the Gulf War, contributed to Amman's uncontrolled growth (Potter and others 2007). The refugee camps of Baqa and Marka, some of the larger Palestinian refugee camps, were originally sited outside of the city; the 2009 image shows the camps now forming part of Amman's extended metropolitan area. This change pair reveals the physical growth of the city from 1984 to 2009; the rapid growth in all directions is apparent, especially into the northeastern industrial town of Zarqa. To the northwest of the city, wealthy residential districts have spread into the mountainsides. This prosperous city faces water supply problems (water is rationed), a poor water distribution network, and traffic congestion problems (the city currently lacks an integrated public transport system)(Potter and others 2007; Al-Dakhlallah and Jadaan 2005).



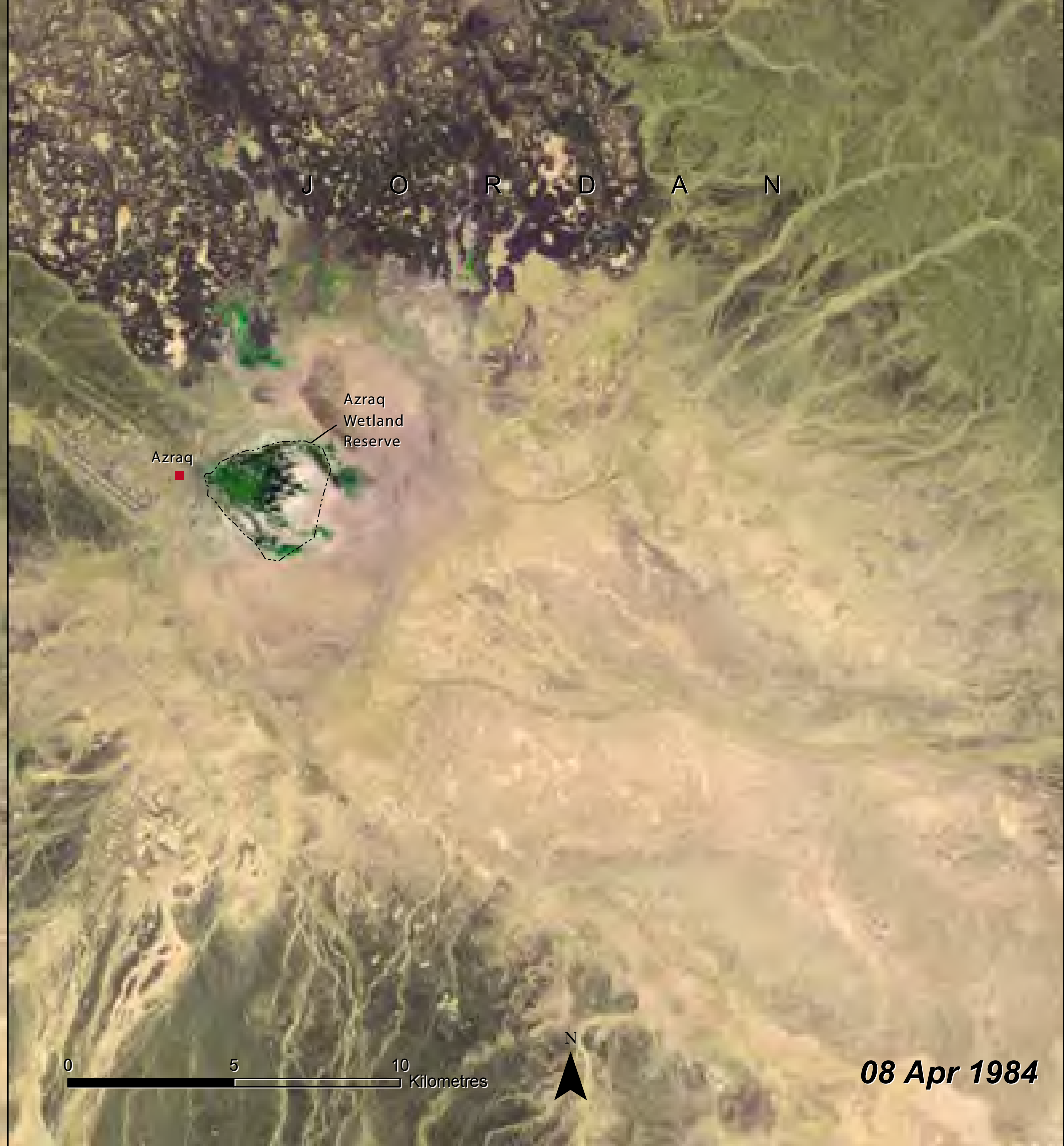


Aqaba, Jordan Source: Josh Olalia/Flickr.com

Aqaba, Jordan

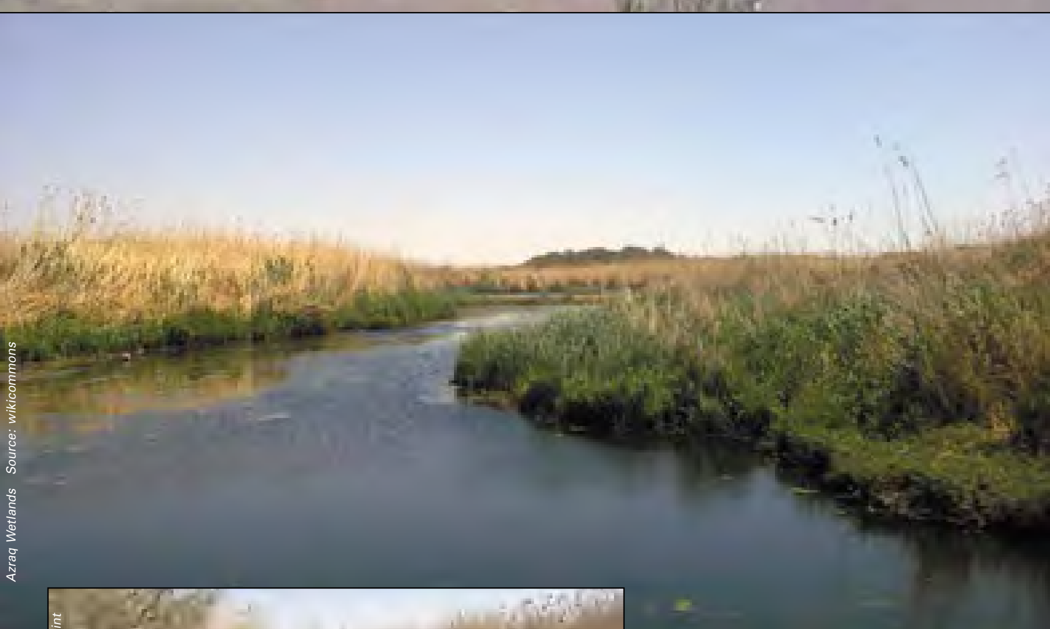
Aqaba, strategically located at the head of the Gulf of Aqaba, is a rapidly expanding urban, industrial, transport and tourism centre. As Jordan's only seaport, Aqaba's port facilities are vital to the country's commercial livelihood; cargo capacity increased from 54 431 tonnes in 1952 to over 19 million tonnes in 2004 (WPS 2010). During the 1980-1988 Iran/Iraq War, Aqaba became a crucial part of Iraq's supply line; however, United Nations sanctions against Iraq during subsequent conflicts curtailed Aqaba's utility as a regional seaport (Kardoosh 2005). The peace process between Israel and Jordan helped to revitalize the seaport and accelerate tourism development.

The Aqaba Special Economic Zone Authority (ASEZA), created in 2001 to manage and develop the region's economy, has been instrumental in modernizing the city, which now has an international airport, a booming tourism industry, a growing industrial sector, and a contemporary road network (Kardoosh 2005). The astounding growth of the city of Aqaba, which has a population of 98 400, is illustrated in these images. The rich biodiversity of the Gulf of Aqaba faces threats from municipal sewage, industrial pollutants (phosphate, potash and bromide industries), higher water temperatures (power generation and fertilizer production), and oil spills (Aqaba handles between 18 to 27 million tonnes of oil per year) (Obeidi 1996). The impacts associated with the tourism industry (spearfishing, marine litter, coral damage by swimmers and divers, and collection of corals, shells and other marine animals), also contribute to the degradation of the Gulf of Aqaba's highly sensitive reef system (Obeidi 1996).




Azraq, Jordan Source: Need Citation


Azraq Wetlands Palm Plantations Source: Jordan Country Focal Point

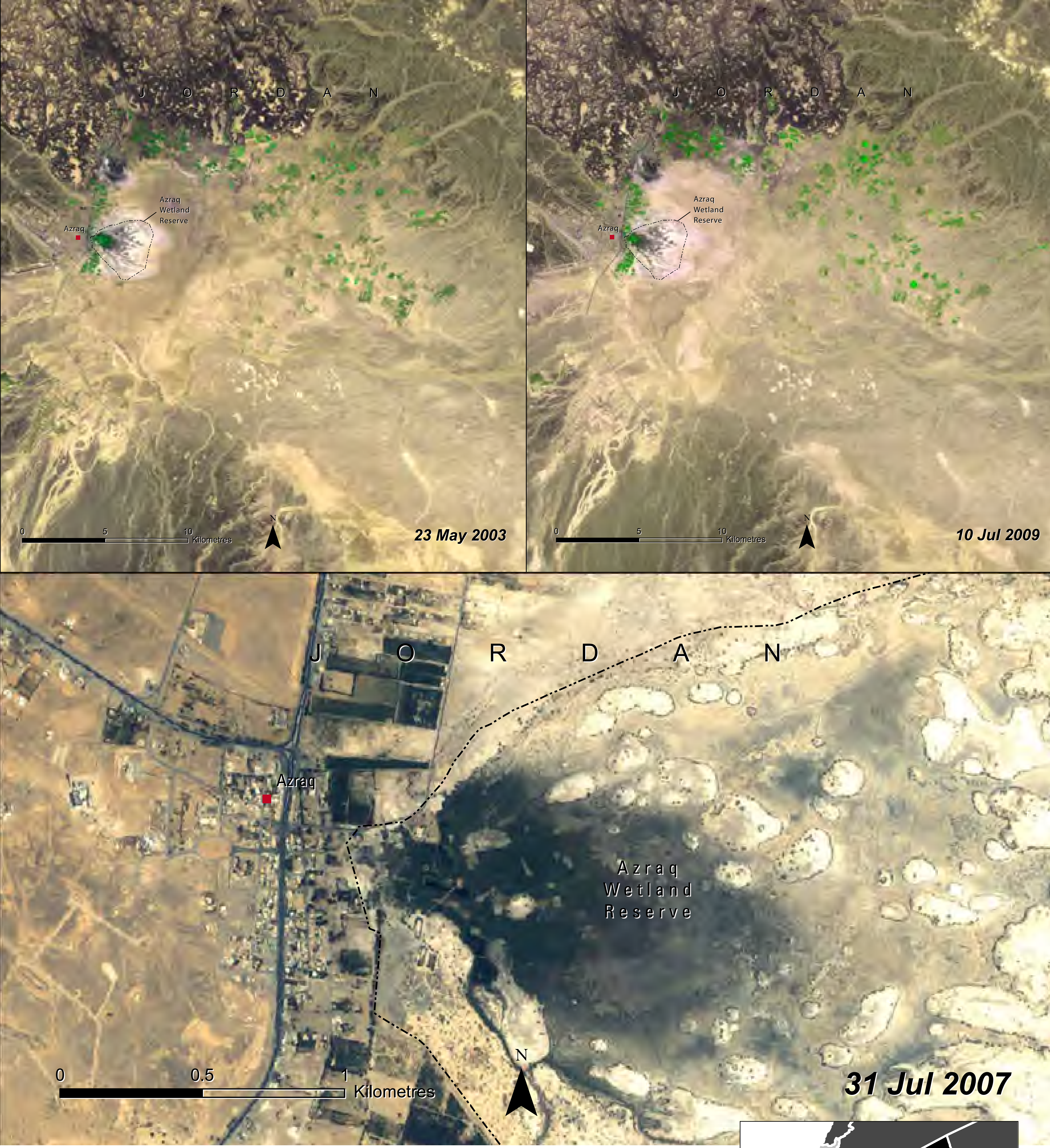

Azraq Wetlands Source: wikicommons


Azraq Wetlands Source: Jordan Country Focal Point

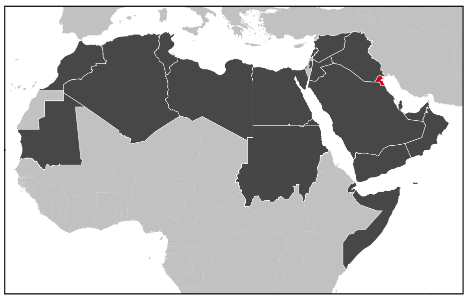

Azraq Wetlands Source: Jordan Country Focal Point

Azraq Wetland, Jordan

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 km^2 Azraq Wetland Reserve was established.



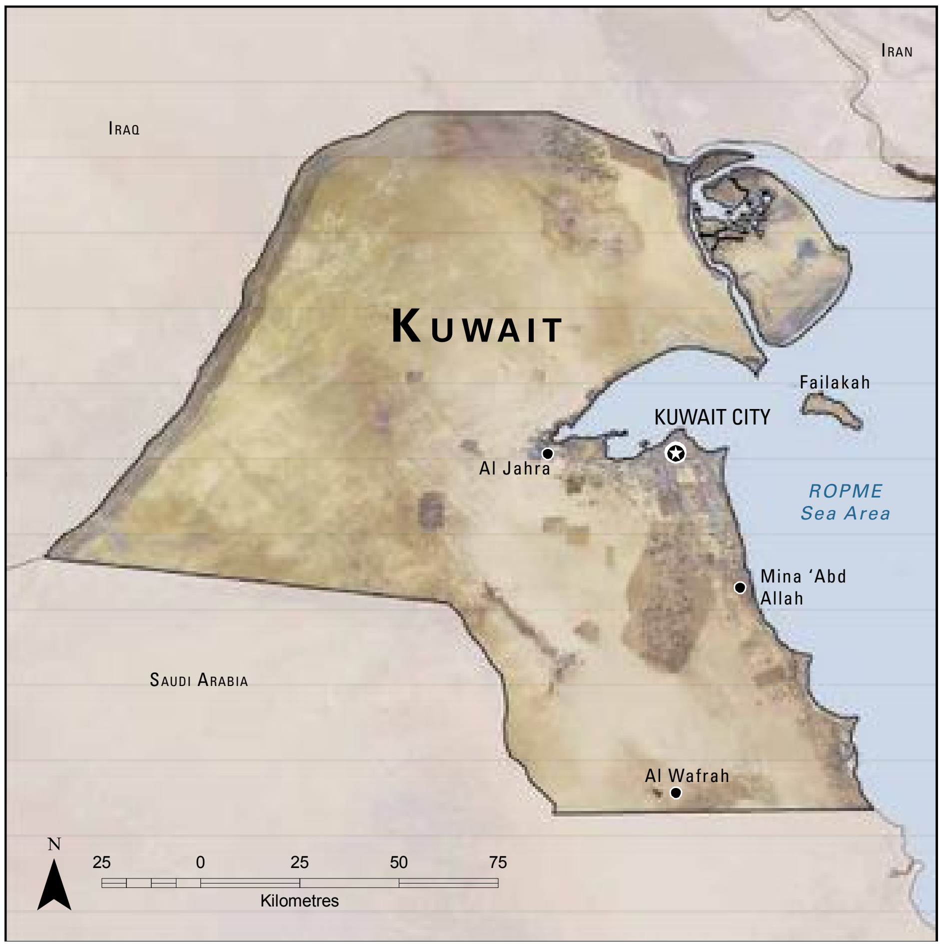
Decades of excessive groundwater pumping from the Azraq Basin to supply Jordan's urban centres and growing agricultural needs caused the natural springs that supported the wetland to dry up by 1992 (RSCN 2008). The Azraq Killifish (*Aphanius sirhani*), which is endemic to the basin, is critically endangered due to loss of habitat. 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. The photos on the facing page are of the Azraq Wetland Reserve.



State of
Kuwait

Total Surface Area: 17 818 km^2
Estimated Population in 2010: 2 737 000

Kuwait is a small country situated at the northwestern corner of the ROPME Sea Area between Iraq and Saudi Arabia. Kuwait consists mostly of desert plains covered by loose mobile sediments that are continually transported by the wind. Kuwait has 499 km of coastline and a number of small, mostly uninhabited islands in the ROPME Sea Area. Kuwait has no permanent lakes or rivers, forcing heavy reliance on groundwater resources, desalinated water and recycled water. Precipitation is scant, averaging 105 mm per year. The climate is dry with intensely hot summers (mean temperature of 37°C) and short, cool winters; average minimum temperatures in January fall to 7°C. Kuwait experiences the *shamal*, a north wind that blows from Iraq primarily during the spring, leaving the country with a coating of fine dust.



Important environmental issues

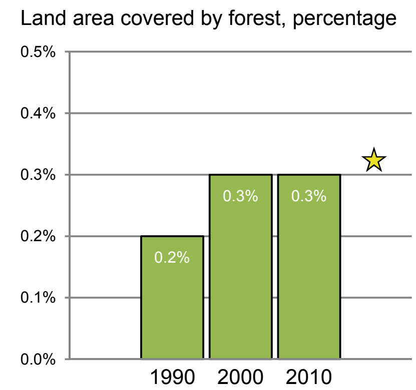
- Water Scarcity and Groundwater Salinity
- Land Degradation and Desertification
- Pollution and Impacts of the Gulf War

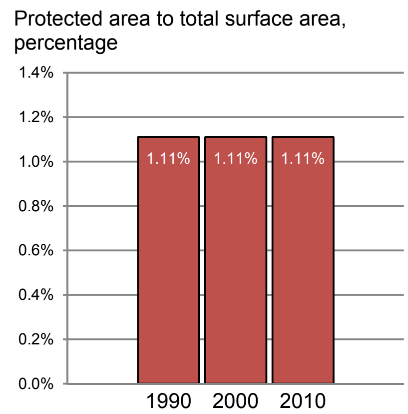
Progress Toward Environmental Sustainability

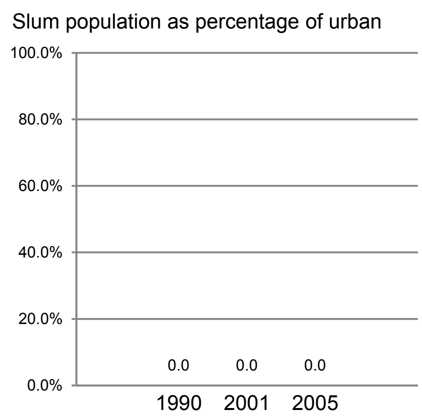
As defined by the United Nations Millennium Development Goal 7 Indicators

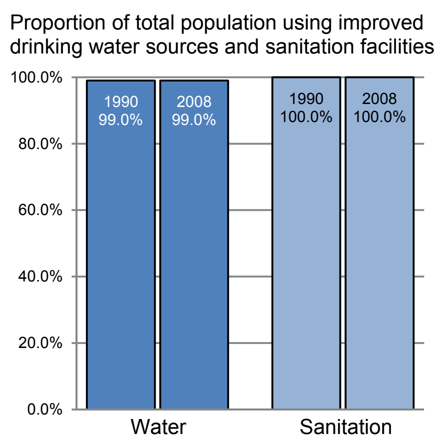
Kuwait has made substantial progress in achieving many of its MDG targets such as eradicating absolute poverty and achieving advances in health and education.

☆ Indicates Progress









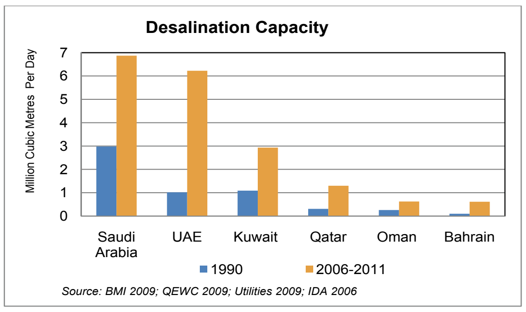
Source: Central Statistic Office 2008

Of the 26 protected areas in Kuwait, the Sabah Al-Ahmad Wildlife Reserve is the largest terrestrial protected area (330 km ^{2}) and is a major source of plant genetic diversity in the country

Source: Al-Tamimi n.d.

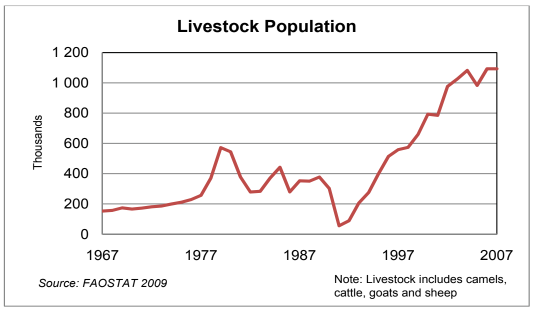
Water Scarcity and Groundwater Salinity

With scant rainfall and no permanent surface water flows, Kuwait has minimal renewable water resources. Groundwater inflow has been estimated at 20 million m^3/year through lateral underflow from Saudi Arabia. Groundwater extraction rates are 12 times more than this annual inflow, resulting in deteriorating groundwater quality and quantity (FAO 2008). Eighty-five per cent of the wells in the southern Al Wafra agricultural region recorded salinity levels higher than 7 500 ppm in 2002; 90 per cent of the wells in Al Abdali in the north recorded these same high salinity levels. Rapid population growth along with increased urbanization and agriculture have increased demand for water in Kuwait (Al-Humoud and others 2003). Per capita water consumption in Kuwait is high; 44 per cent of water withdrawn is used for municipal purposes while 54 per cent is for agriculture and 2 per cent is for industrial uses. Desalinated seawater is the primary source of fresh water for drinking and domestic purposes.



Land Degradation and Desertification

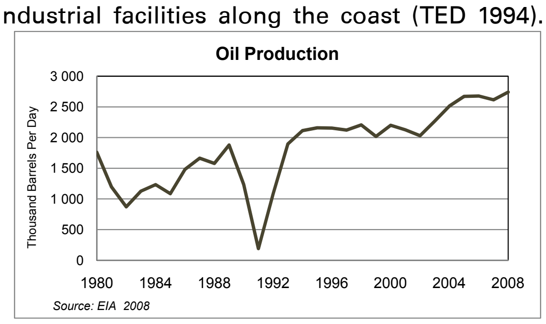
Desertification in Kuwait is severe and is exacerbated by fragile ecological conditions, drought, overgrazing, intensive human activities and the consequences of the Gulf War. Almost 100 per cent of Kuwait is desertified. Sand encroachment is especially severe in northwestern Kuwait (Al-Dousari 2005). Land degradation in the form of wind and water erosion, soil compaction and sealing occurs in open desert areas where livestock grazing is the main land use (Al-Dousari and others 1999). The productivity of soils in agricultural areas is being depleted, and water logging, salinization and sand encroachment occur on almost all irrigated lands (Al-Awadhi and others 2003); 86 per cent of irrigated lands in Kuwait are estimated to be salinized by irrigation (FAO 1997). During the war, agricultural lands were littered with mines and unexploded ordnances, contaminating soils and water. The Kuwaiti oil fields suffer from acute soil contamination from crude oil spills (Misak n.d).



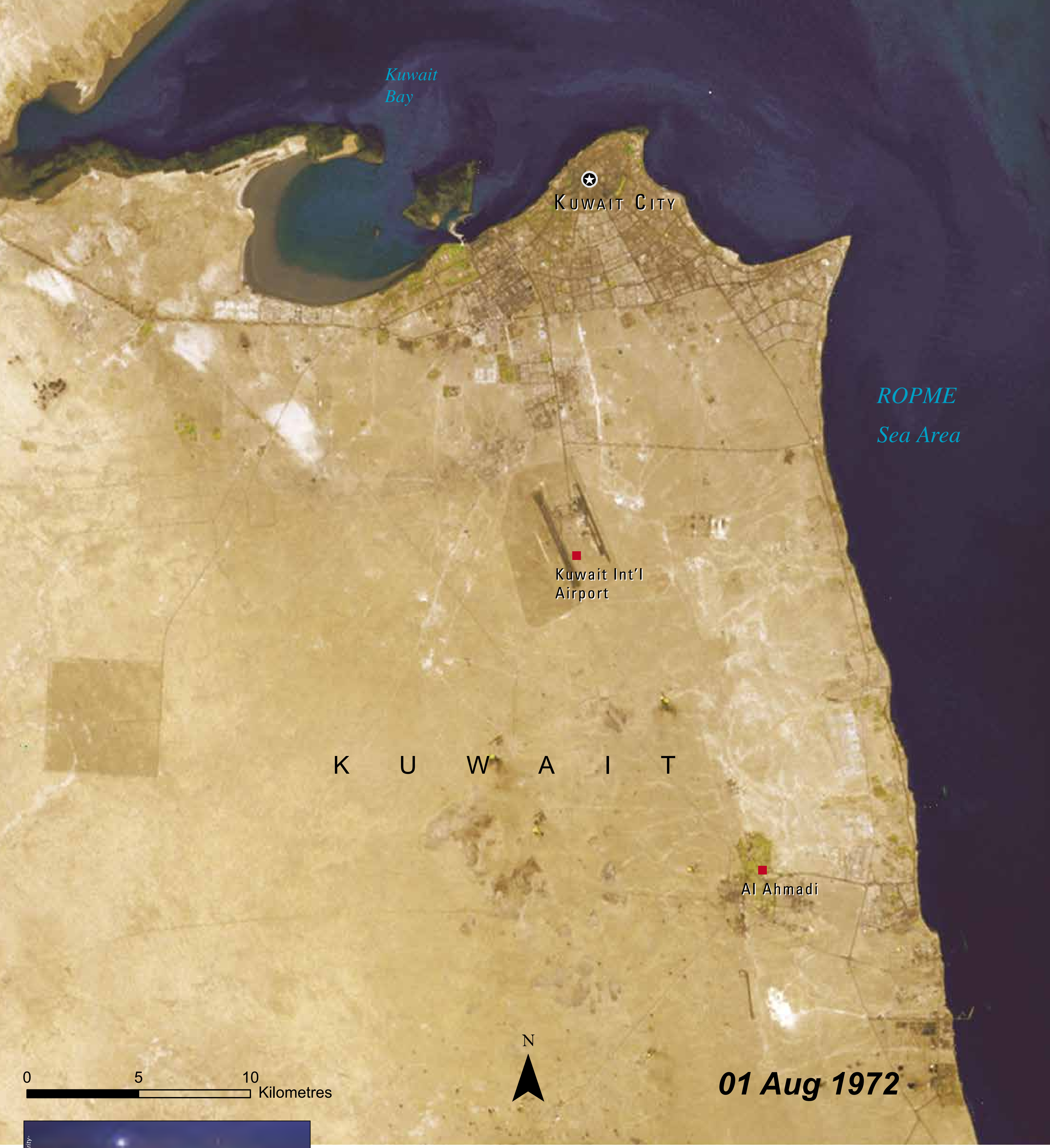
Kuwait City. Source: Environment Public Authority-Kuwait

Pollution and Impacts of the Gulf War

The transport sector and oil industry are the main contributors of air pollution in Kuwait. Air pollution from high vehicle use often results in excessive levels of nitrogen oxide and carbon monoxide in Kuwait City (Elkarim and others 1991). The 789 oil wells set ablaze during the Gulf War released large quantities of airborne particulate matter, soot, and organic carbons, polluting the air and causing irrevocable ecological damage to Kuwait and the ROPME Sea Area (TED 1994; Al-Mutairi and Koushki 2009). About 500 million barrels of oil were dumped into the ROPME Sea Area, threatening fragile marine ecosystems and impacting the fishing industry. An estimated 1.03 million tonnes of oil enters the ROPME Sea Area each year due to oil spills and tanker traffic. In addition to impacting marine and coastal ecosystems, these oil spills disrupt the operation of desalination plants, power plants, and industrial facilities along the coast (TED 1994).




Kuwait City. Source: Environment Public Authority-Kuwait

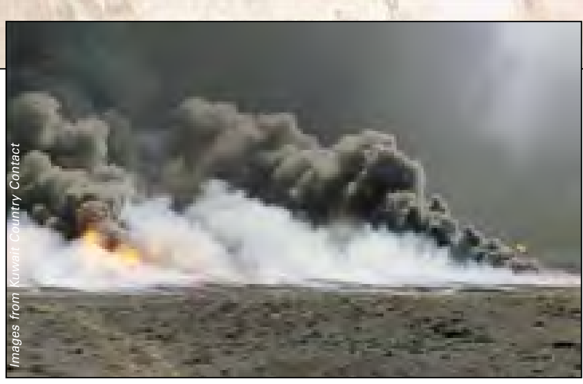


Kuwait City Source: Environment Public Authority-Kuwait

Kuwait City, Kuwait

Kuwait City is Kuwait's political, cultural and economic centre. The city is located on Kuwait Bay, a natural harbour on the ROPME Sea Area. Kuwait City is a vast metropolitan area that extends 25 km or more from east to west and 12 km from north to south. The city has experienced a rapid rate of development since the discovery of oil in the late 1930s, transforming the once nomadic port town into a thriving metropolis. From 1975 to 2005 the population grew from 682 000 to 1 810 000 (UNDESA 2003; UNDESA 2005). Over 90 per cent of the country's population resides within a 500 km^2 area surrounding Kuwait City and its harbour.

Massive infrastructure development, including construction of highways, urban settlements and industrial plants have caused degradation to the inland, coastal, and marine ecosystems. Kuwait Bay receives untreated wastewater from the city, as well as industrial effluent from desalination and power plants. Significant increases in seawater temperatures in the bay can be attributed to climate change and increased human activities along the coast (Al Rashidi and others 2009). These images document the explosive growth of Kuwait City's urban area from 1972 to 2009. The 1972 image shows the city primarily restricted to the bay area and extending inland about five km. In contrast, the 2009 image shows the urban area extending west to Al Jahra and then south along the coast with no break between the various districts of Al Fanaitis and Al Ahmadi.



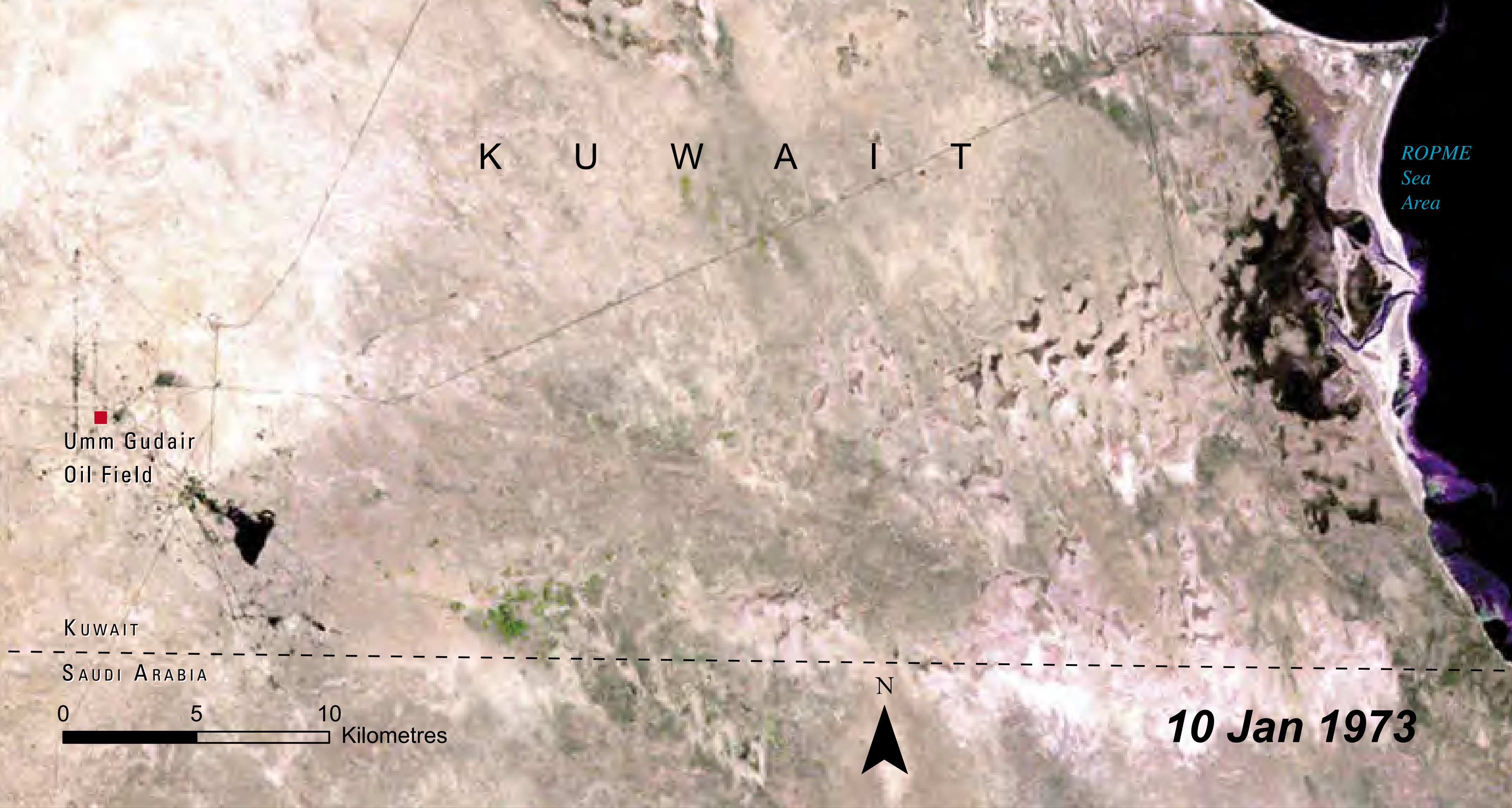
Images from Kuwait Country Contact

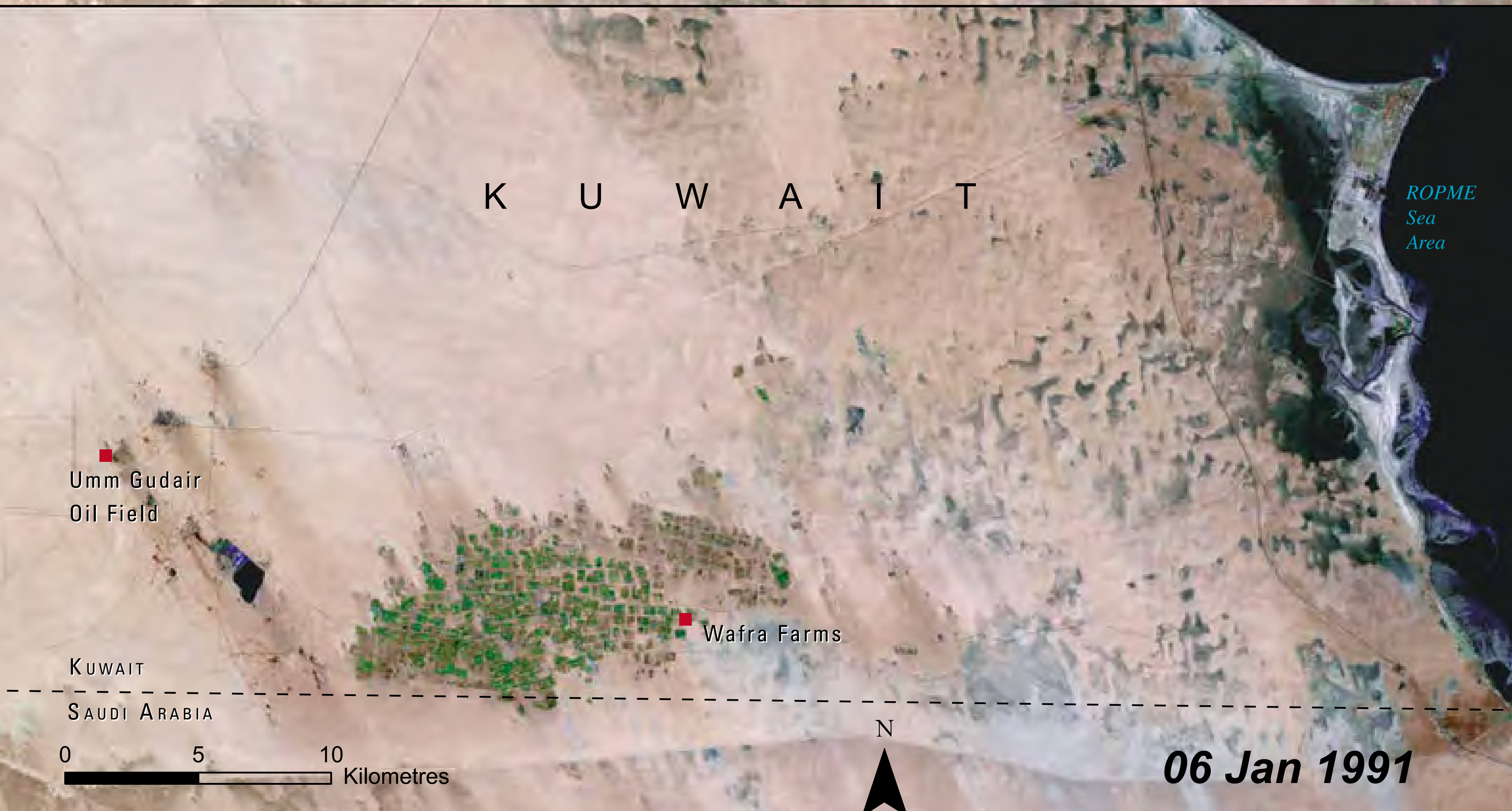
Oil Fires, Kuwait

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.

Images from Kuwait Country Contact

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.

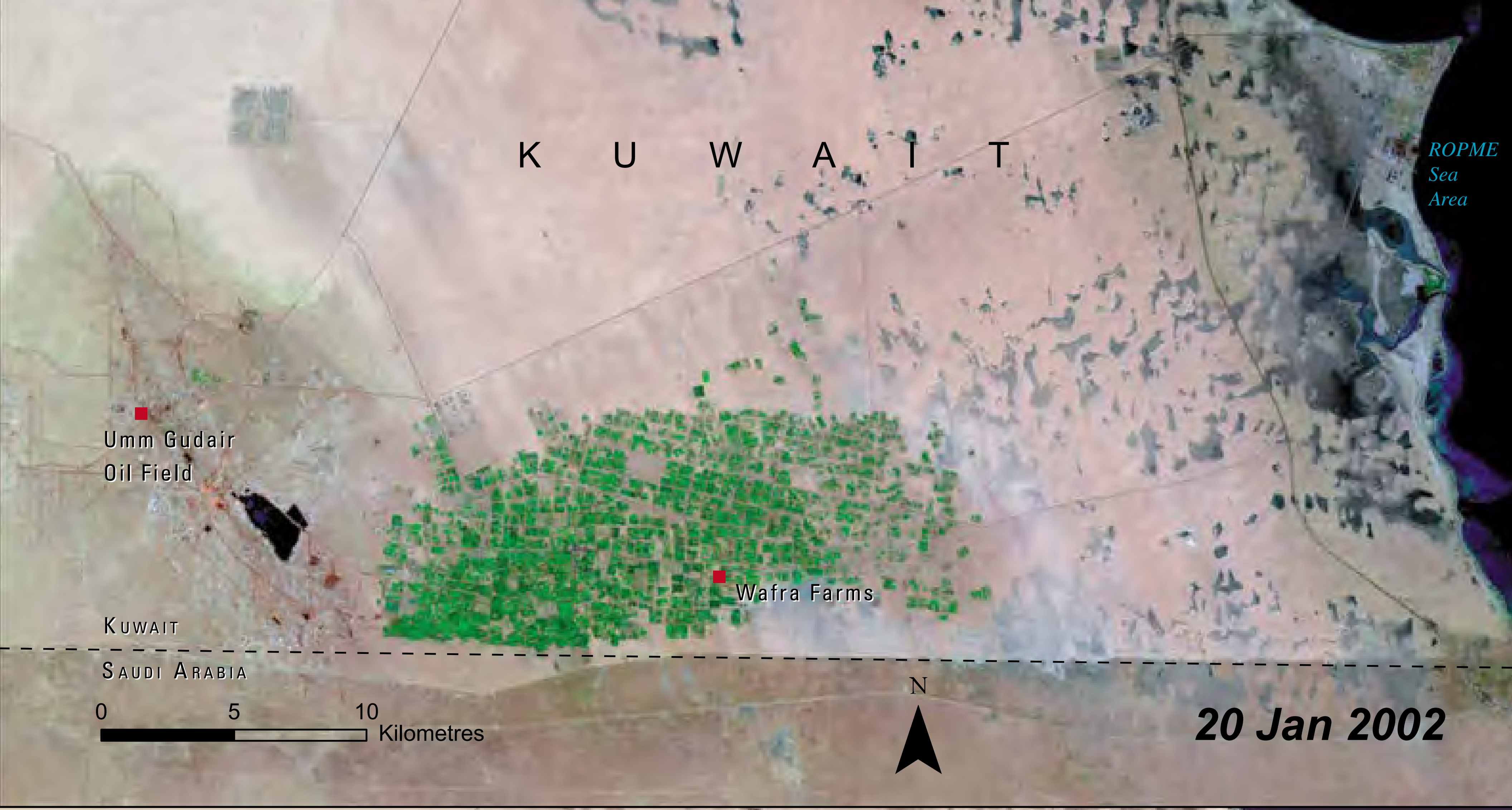


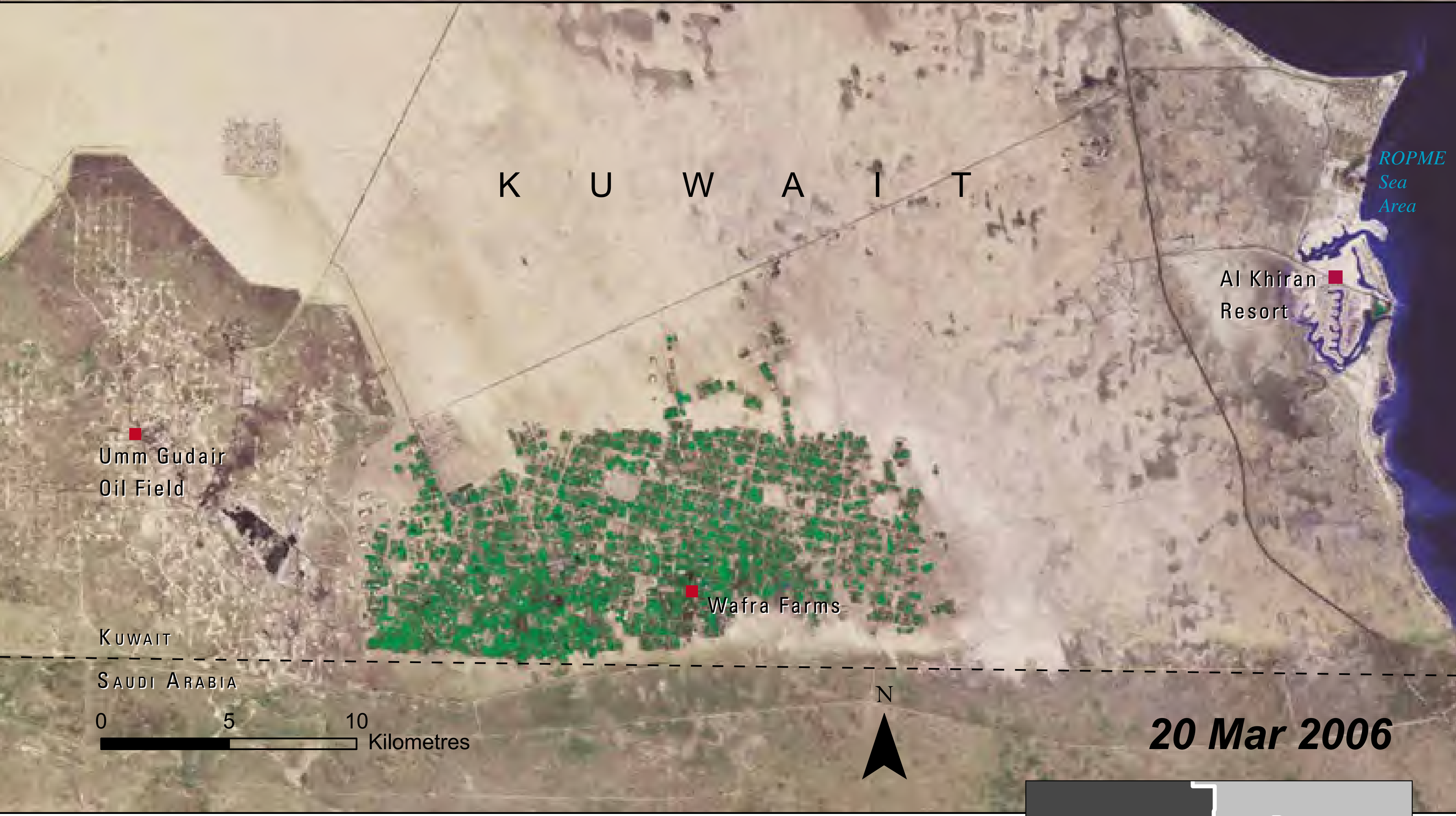



Wafra Farms. From Country Focal Point/Contact

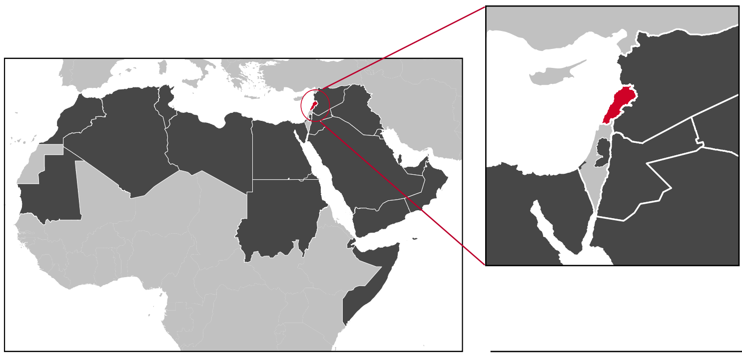
Wafra Farms, Kuwait

Wafra Farms is an agricultural area located in southeastern Kuwait on the border with Saudi Arabia. It is one of two major agricultural regions in Kuwait; the other is the Al Abdali region in the north. Given Kuwait's hyper-arid climate, scarce water resources and poor quality land resources, the farms at Wafra were developed in the 1970s to increase food production. Over the next 30 years, the agricultural area expanded to 1 495 farms that cover 10 000 ha (FAO 2008). The 1980s saw a huge expansion in irrigated area at Wafra at the behest of the Kuwaiti government; however, production was interrupted by damage incurred from the Gulf War. Sand encroachment from the surrounding desert and increased soil salinity from overexploited groundwater are impacting agricultural productivity (Omar and others 1998).





The proportion of the area that is currently uncultivated is increasing. Greenhouse agriculture is also practiced at Wafra Farms, and is becoming an important agribusiness in Kuwait (Al Nasser and Bhat n.d.). However, this type of agriculture is also subject to the same limiting conditions that are threatening conventional agriculture. In 1997, Wafra Farms began aquaculture for Nile tilapia using brackish groundwaters that are drained to irrigate crops. The aquaculture industry is being expanded in Kuwait to supplement local landings from capture fisheries (FAO 2006). These innovative production schemes at Wafra are an attempt by Kuwait to achieve greater self-sufficiency in food production, despite its limited resources. These images show the progression of agricultural development at Wafra Farms from 1973 to 2006. Note the expansion over time of the Umm Gudair Oil Field to the west and the coastal development at Al Khiran Resort.



Lebanon

Total Surface Area: 10 452 km2
Estimated Population in 2010: 4 228 000

Lebanon is a small and mountainous country, sharing most of its border to the north and east with Syria. It contains 210 km of coastline along the Mediterranean Sea. The physiographic regions consist of fertile coastal plain, the Lebanon Western Mountain Series, the Beqaa Valley (Lebanon's chief agricultural area), and the Lebanon Eastern Mountain Series, which form the eastern border with Syria. Lebanon contains many rivers and streams, most of which have their origin in springs. The climate is generally Mediterranean with hot, dry summers and cool, rainy winters. Average annual rainfall is estimated at 840 mm; most of the precipitation falls between November and March. The highest mountain peaks are covered in snow for most of the year.

Important environmental issues

- Deforestation
- Management of Urban Environment
- Coastal and Marine Pollution

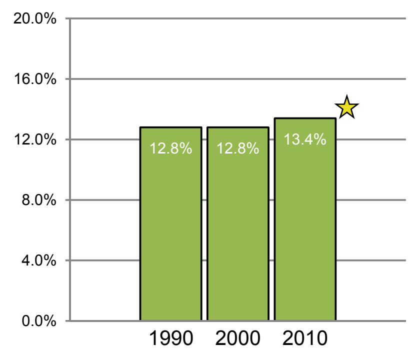
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

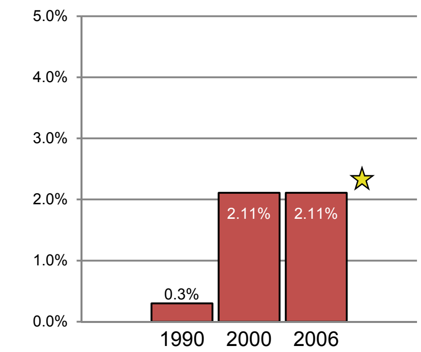
The slum population as a per cent of the urban population is high in Lebanon at over 50 per cent. This is due in large part to the conflicts and wars that Lebanon has endured. The Lebanese civil strife (1975 to 1990) and the regional conflicts with Israel have been particularly destructive with severe impacts to the country's infrastructure, social, economic and environmental development (Fawaz and Peillen 2003).

☆ Indicates Progress

Land area covered by forest, percentage

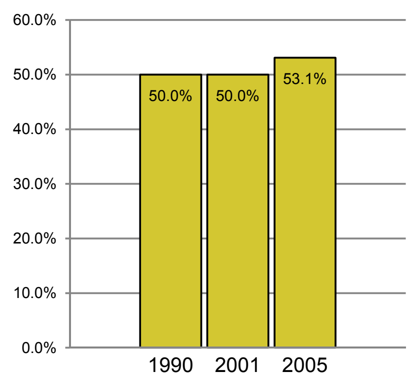


Protected area to total surface area, percentage

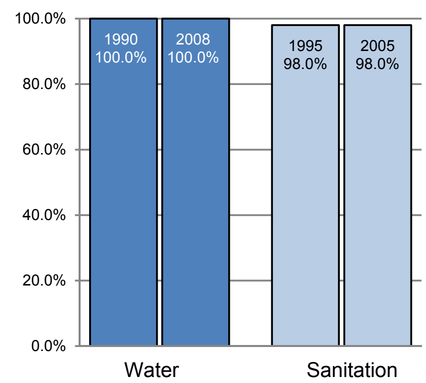


Source: Ministry of Environment 2010

Slum population as percentage of urban



Proportion of total population using improved drinking water sources and sanitation facilities

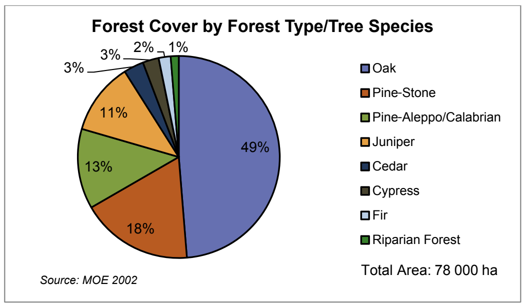


About 48 per cent of the population is distributed in the Beirut and Mount Lebanon region alone, whereas only 13.6 per cent live in the central Bekaa region (the largest governorate in area)

Source: UNHSP 2009

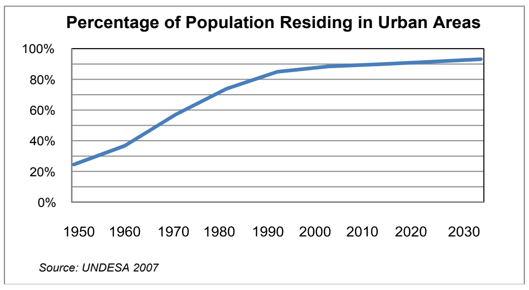
Deforestation

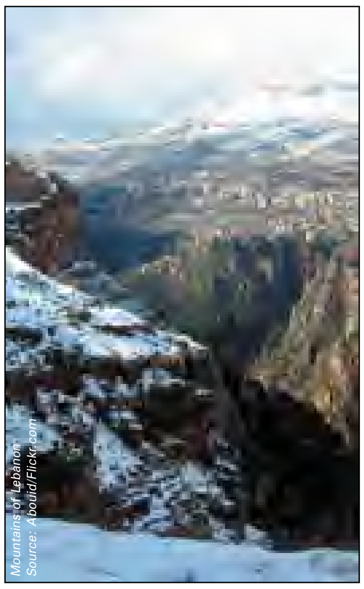
Lebanon's mountainous terrain once supported vast areas of forest. In 1965, forest cover was approximately 18.4 per cent; over the next three decades, forest cover was reduced by 35 per cent (NCSR 2007). Recent estimates place the total forest area in Lebanon at about 136 000 ha or comprising 13.29 per cent of the country's total land area (FAO 2005). The main threats to Lebanon's forests include urban sprawl, disease from insects, fires, overgrazing, quarries and war. Annually, an area of 1 500 to 2 000 ha is burnt mostly by human-caused fires (AFDC 2007). Deforestation degrades air quality, destroys habitat for flora and fauna and accelerates erosion, especially on the eastern slopes of the Lebanese Mountains and the western slopes of the Lebanon Eastern Mountain Series. Despite the conflict-ridden conditions in Lebanon since 1990, reforestation and afforestation efforts have increased the forest cover area—from 1990 to 2005, Lebanon gained 12.4 per cent (15 000 ha) of forest cover.



Management of Urban Environment

Rapid population growth in Lebanon has drastically impacted air, soil, and water quality, and the rate of growth has outstripped the provision of necessary infrastructure. Inadequately treated solid waste and municipal wastewater is dumped into the sea, rivers, irrigation channels and valleys. In the past 20 years, urbanization has reduced cultivated land area by 7 per cent, and irrigated lands by 15 per cent (METAP 1995). In Tripoli, from 1985 to 1998, the urban area increased 35 per cent, and cultivated land decreased 38 per cent (Masri and others 2002). The population in Lebanon increased by 32 per cent between 1970 and 1980, and then decreased during the civil strife (1980 to 1990); it is expected to rise 59 per cent by 2020 (FAO 2005). Urban growth in the coastal and mountainous zones is forcing development of marginal lands that are susceptible to landslides, floods and other hazards, increasing the risks to human safety (Masri and others 2002).

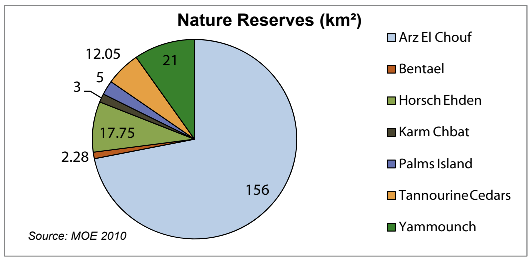



Mountains of Lebanon
Source: Abouid/Flickr.com

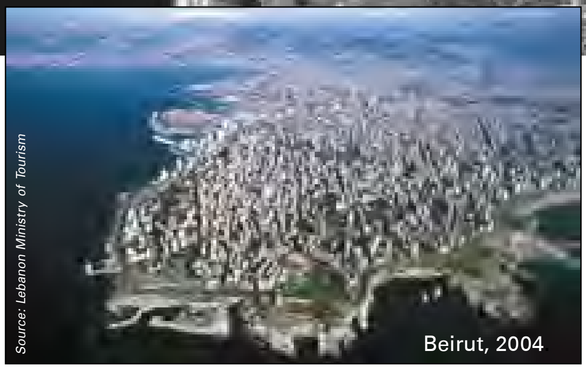

The July 2006 bombing by Israel of the Jiyeh Power Plant resulted in the largest ever oil spill in the Mediterranean
Source: UNEP 2007
Oil spill on the Lebanese coastline after Israeli bombing.
Source: Ministry of Environment, Lebanon.

Coastal and Marine Pollution

Urban encroachment along Lebanon's 210 km coastline has had major negative impacts on the marine environment. Untreated wastewater is released into the Mediterranean, resulting in high levels of organic pollutants and human pathogens (UNEP 2007). About 71.2 million tonnes of wastewater is disposed of annually into the sea from the major urban areas along the coast (Pathan 1977); in 2004, 68 million tonnes of wastewater alone was estimated to enter Beirut's coastal waters (MOE 2010). The unregulated use of fertilizers and pesticides and the haphazard discharge of industrial and solid wastes are also causing high levels of mercury, copper, cadmium and polychlorinated biphenyl (PCB) in Lebanon's coastal waters. Traces of mercury and pesticides such as DDT have been found in measurable concentrations in fish offshore. Discharge and disposal of ballast waters, dredging, and petroleum pollution from accidental tanker spills also increases pollutants around port areas (UNEP 2007). As part of its strategy, Lebanon is working to combat these issues and offset their effects by promoting nature reserves.



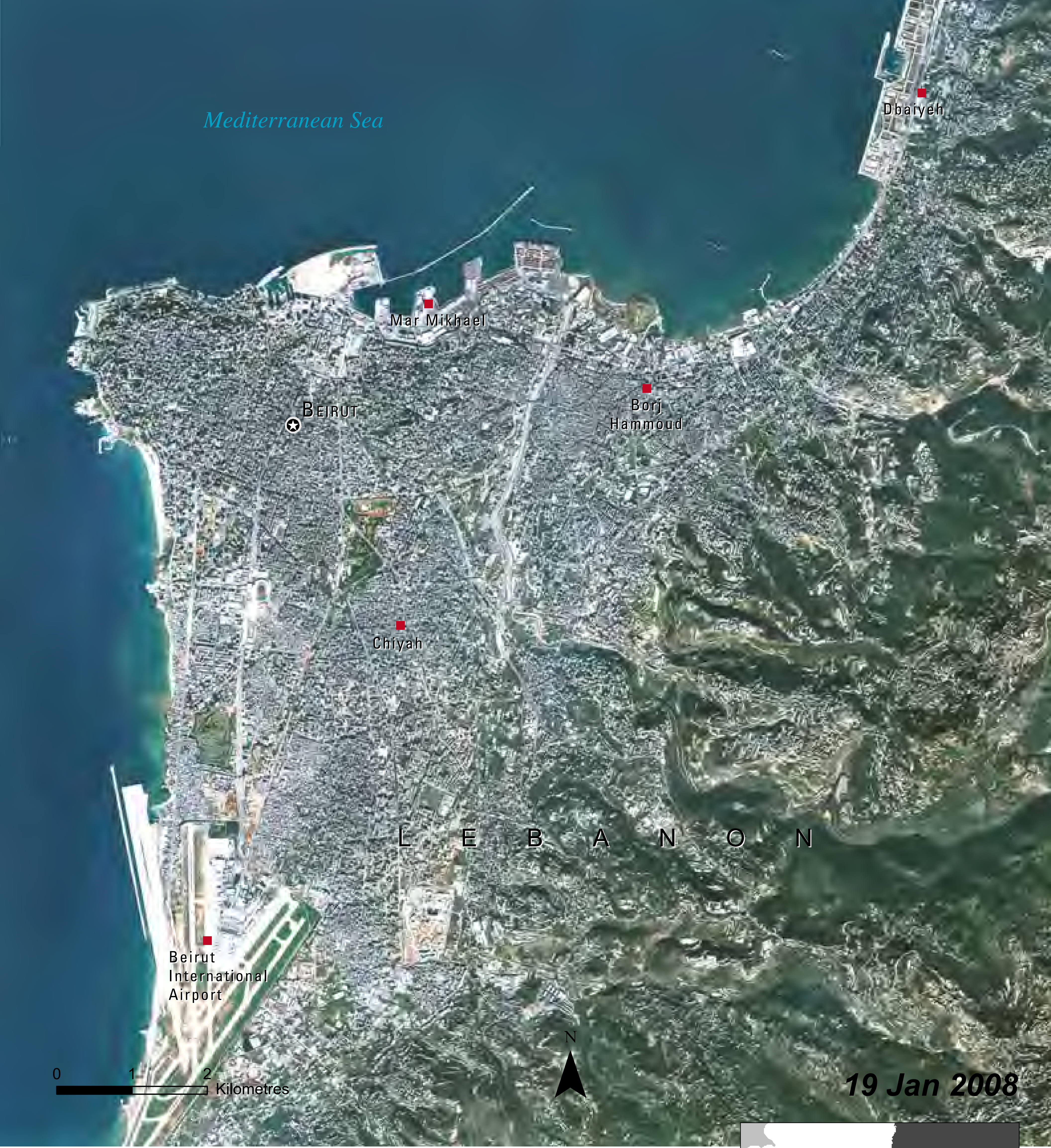

Bsharri, Ash Shamal Source: Charles Fred/Flickr.com



Beirut, 2004

BEIRUT, LEBANON

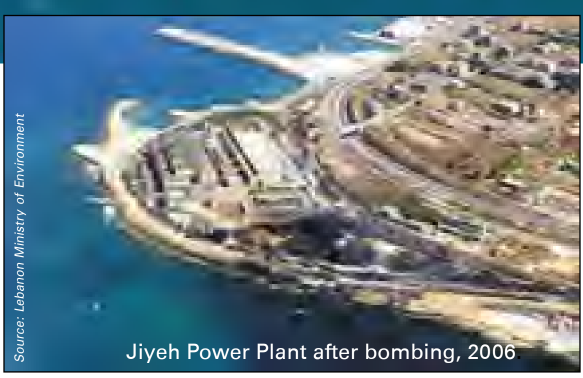
Lebanon's 15-year civil war led to the massive displacement of civilians who took refuge mainly in and around Beirut as well as other coastal cities such as Saida, Tyre, Tripoli, Jounieh and Jbeil. This spurred an era of rapid urban growth. In 1963, urban areas in Lebanon covered 254 km^2 compared to 650 km^2 in 1998 (CDR-SDATL 2002). Almost 87 per cent of the population currently lives in urban areas, a marked increase from 44 per cent in 1961 (FAOSTAT 2009). About one-third of the total population of Lebanon resides in Beirut and its suburbs. The surface area of Beirut in 1998 was 20 km^2; the suburbs of Beirut comprise an additional 68 km^2 (CDR-SDATL 2002). Lebanon has one of the highest population densities in the world, with 391 inhabitants per km^2; municipal Beirut has an astounding 19 000 inhabitants per km^2 (CDR-SDATL



2002). This rapid urban growth and population density poses major challenges, including: the diminished physical and aesthetic qualities of the urban landscape due to unplanned construction; reduced agricultural lands and green spaces; increased air pollution; and inadequate treatment of domestic and industrial effluents that flow untreated into the sea (MOE 2006). The environmental impacts from the 2006 bombing by Israel resulted in heavy oil contamination of Beirut's shoreline, air pollution from burning oil, and extensive destruction of the city's infrastructure. This change pair shows the astonishing growth of Beirut City and its periphery from 1963 to 2008. Urban settlements are shown extending in all directions, including the foothills of Mount Lebanon. Extensive areas of reclaimed land are visible in the 2008 image along Beirut's coast around Mar Mikhael, Dbaiyeh and the Beirut International Airport, whose expanded runway sits on 204 000 m^2 of reclaimed land (HCAG 2000).

Beach area prior to oil spill

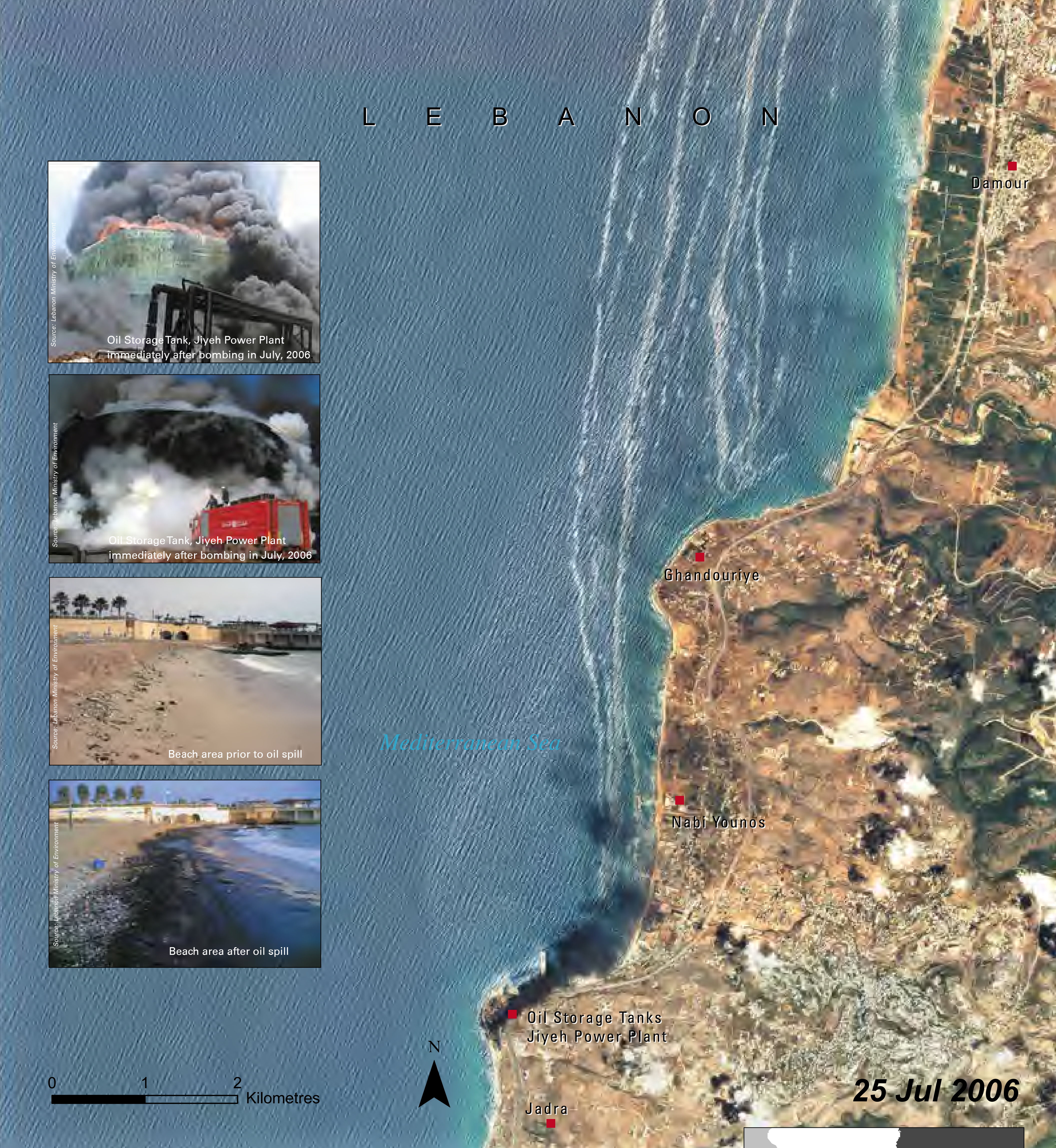
Beach area after oil spill



Jiyeh Power Plant after bombing, 2006

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 m^3 (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. Impacts to public health and to sensitive sites such as the Palm Islands protected area were documented— soil contamination and effects on crop production were also recorded. Areas around Beirut and immediately to the north were particularly affected by the oil, blocking harbours and fouling vessels and gear as well as mooring lines (FAO 2006). Fishing vessels were made inoperable due to floating oil. Impacts from the spill and fires continue to be assessed (MOE 2006). The image from 25 July shows 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).

Cephalcia pupae and adult.

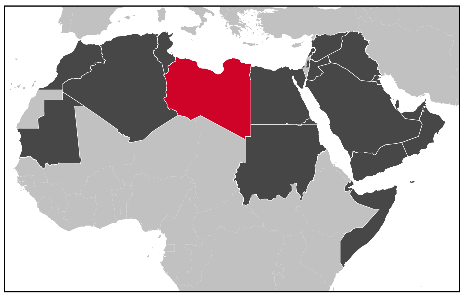
Forested area after a recent fire.

Cedars dying from Cephalcia infestation, 1999

Forest Degradation, Loss and Change, Lebanon

Lebanon's forests cover about 139 376 ha of the total land area, a reduction from 192 960 ha in 1965 (see inset maps). Forest types include broadleaf (which constitutes over 50 per cent of the forest types), coniferous, and mixed forest. Despite strict legislation regulating any form of wood extraction, Lebanon's forests continue to be exploited. Almost all forest lands in Lebanon are classified as disturbed (85 per cent)(FAO 2005), mainly as a result of tree cutting for fuelwood, fires (mostly human-caused), urbanization, overgrazing, quarrying and insect infestations. These images show the change in forest area from 1972 to 2009. The 2009 image highlights areas of insect infestation, fires, and forest fragmentation and loss.

Infestations of the cedar web-spinning sawfly (*Cephalcia tannourinensis*), which first appeared in 1996 in the southern Tannourine-Hadath El Jebbe cedar forest, caused extensive defoliation of over 600 ha of forest. Defoliation of the needles reduces the tree's growth rate and makes it susceptible to secondary insect pests. A 1999 infestation of the sawfly prompted a national emergency to be declared; subsequent studies financed by GEF have attributed these pest outbreaks to higher soil humidity and temperatures brought about by changes in climate (MOE 2006). Forest fragmentation, especially on the eastern slopes of Mount Lebanon (shown in the 2009 image), has led to severe landscape degradation, increased the risk of desertification, and reduced biodiversity (Jomaa and others 2007). Fires, many of which are believed to be deliberately set by real estate promoters or charcoal producers, consume over 1 000 ha of natural forest each year in Lebanon (UNCCD 2003). Urbanization is exerting its toll on Lebanon's forested areas—increases of over 10 km^2 per year of urban areas are occurring at the expense of natural and agricultural lands (CDR-SDATL 2002).



Socialist People's Libyan Arab Jamahiriya

Total Surface Area: 1 759 540 km^2
Estimated Population in 2010: 6 355 000

Libya is situated on the North African coast, stretching 1 800 km along the Mediterranean Sea between Tunisia and Egypt. It is also bordered by Algeria, Niger and Chad. More than 90 per cent of Libya is desert or semi-desert; rainfall in this interior region is less than 100 mm per year. The coastal plains are home to the majority of Libya's population and contain the country's only arable land, which amounts to under 2 per cent of the total land area. Rainfall is over 300 mm per year in the northern Tripoli region (Jabal Nafusah and Jifarah Plain) and in the northern Benghazi region (Jabal al Akhdar). The climate is Mediterranean along the coast, and transitions abruptly to the south, where desert temperatures are hot and rainfall is rare and irregular.

Important environmental issues

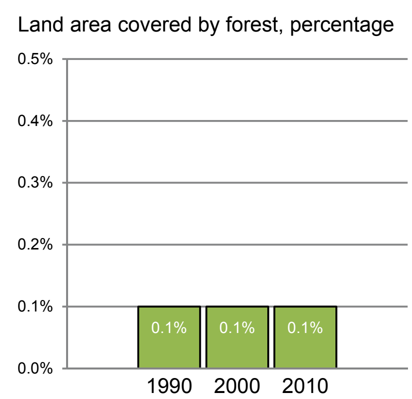
- Water Scarcity
- Arable Land Availability and Desertification
- Oil Development and Pollution

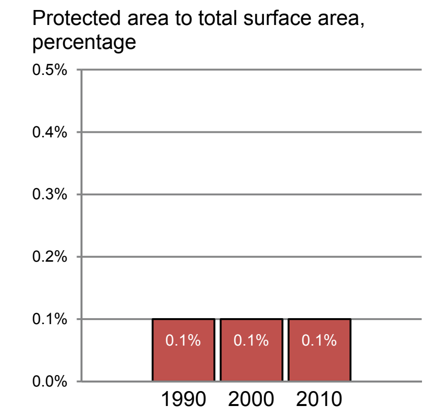
Progress Toward Environmental Sustainability

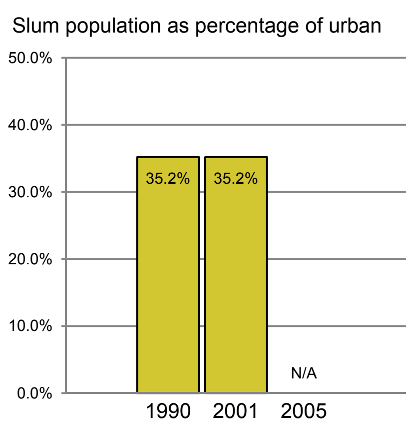
As defined by the United Nations Millennium Development Goal 7 Indicators

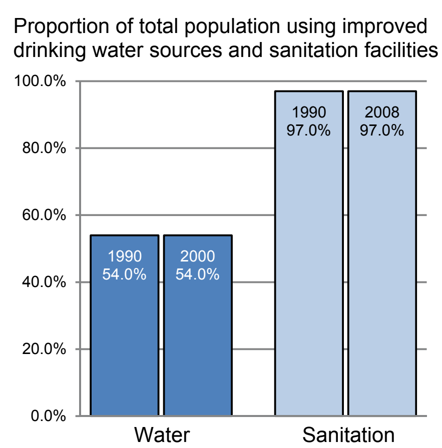
Libya's most pressing environmental issue is water scarcity. The agricultural sector consumes more than 80 per cent of total water supplies, while crop water productivity is exceedingly low (Alghariani n.d.). Depletion of groundwater as a result of agricultural overuse has caused salinization of the coastal aquifers. The proportion of the population using improved drinking water sources was stagnant from 1990 to 2000, however, access to reliable sanitation facilities for the population continues to be very high.

☆ Indicates Progress







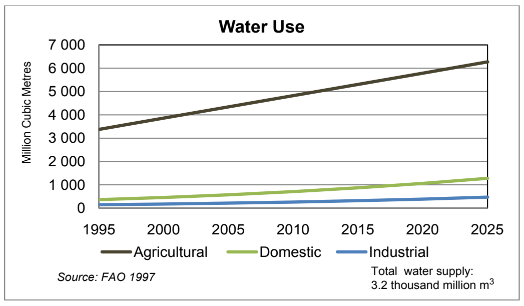


The Great Man-made River Project, driven by Libyan leadership to promote food self-sufficiency, is expected to cost US$33.69 thousand million over 50 years

Source: GWPMED n.d.

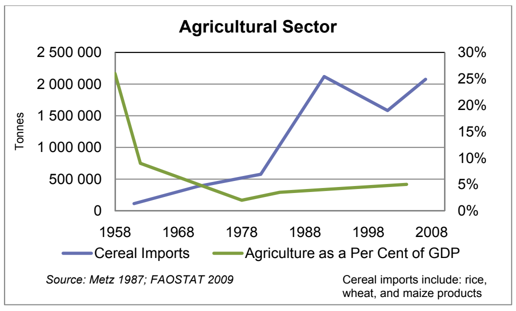
Water Scarcity

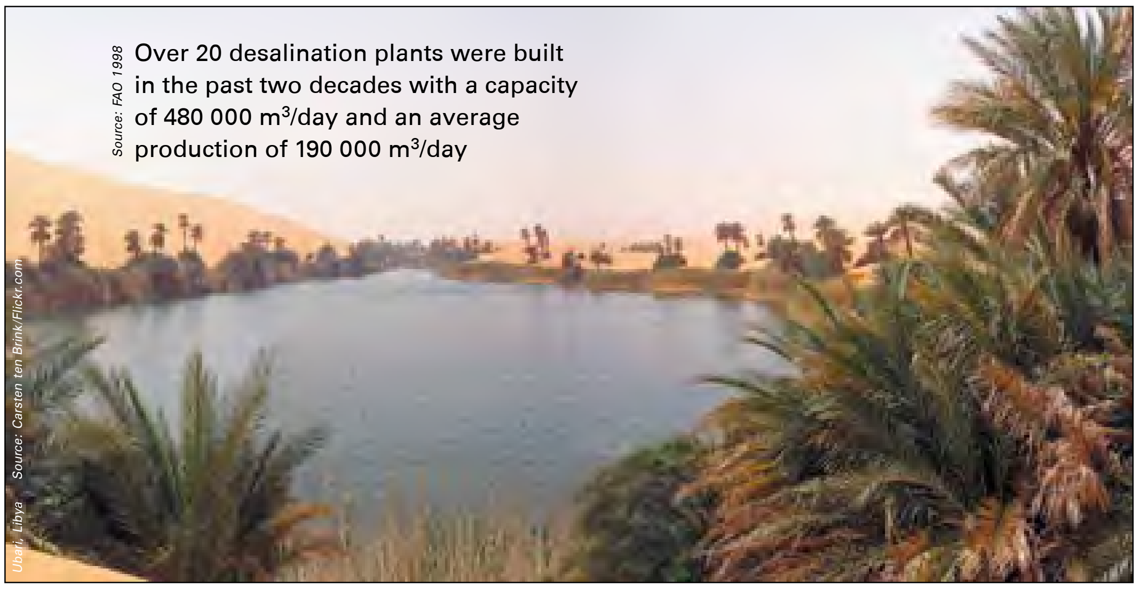
Libya's water scarcity, with only 104 m³ available per person per year, is exacerbated by low rainfall and a rapidly increasing population. With no perennial rivers or streams, the main water source is groundwater, which is being exploited beyond annual replenishment and becoming more saline (Swain 1998). Aquifers in the deserts of southern Libya have become a significant water source for the country. The Great Man-made River Project, initiated in 1984, taps the aquifers of the Al Kufrah, Sarir, and Sahba oases and transports the water through a series of pipes to the northern coast for domestic, agricultural and industrial uses. Once all phases are complete, the project will extract 6.5 million m³ of water daily. Initially, the project aimed to irrigate 500 000 ha of new farm land; however, water is instead being used to meet domestic needs in Libya's urban centres (USDA 2004). Development of alternative sustainable sources of water is needed to avoid severe future water deficits (Wheida and Verhoeven 2006).



Arable Land Availability and Desertification

Less than 2 per cent of Libyan land is arable, and approximately 8 per cent is pastureland suitable for livestock grazing. Arable lands, which are almost all currently being cultivated, are concentrated on a narrow coastal strip between Tripoli and Benghazi, where the majority of the population resides. Libya has a growth rate of 2.17 per cent and it is estimated that the urban population will expand by 50 per cent over the next 25 years (UN Habitat 2007). At this rate, urban expansion is anticipated to claim almost half of the country's most fertile lands by 2025 (UNCCD 1999). As a consequence, agricultural production systems continue to increase in intensity, and are more vulnerable to degradation. In an effort to increase agricultural production and to stem rapid migration to the major coastal cities, the Libyan government has put forth various subsidy and land grant schemes (Anima n.d.).



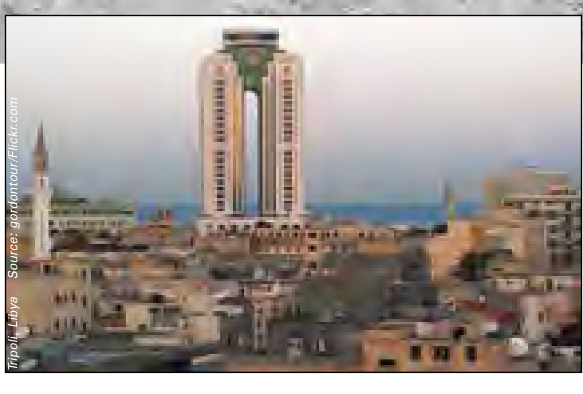


Ubari, Libya Source: Carsten ten Brink/Flickr.com

Oil Development and Pollution

Libya has huge reserves of hydrocarbons with total proven oil reserves of 39.1 thousand million barrels and 1.5 trillion m³ of natural gas reserves (2005). This amounts to 3 per cent of world reserves and 40 per cent of African reserves (Anima n.d.). Libya's hydrocarbon potential is determined to be largely unexplored, and the likelihood of discovering new oil reserves is high. From 2000 to 2005, hydrocarbons accounted for 56 per cent of GDP, 97 per cent of Libya's exports, and 80 per cent of revenue (Anima n.d.). The oil industry has been state-owned since the 1970s, but is seeking foreign investment to help increase oil production capacity to two million barrels per day (bpd) by 2008-2010 and three million bpd by 2015 (USDOE 2005). Libya's oil refineries emit carbon dioxide and other forms of air and water pollution that adversely impact the environment.

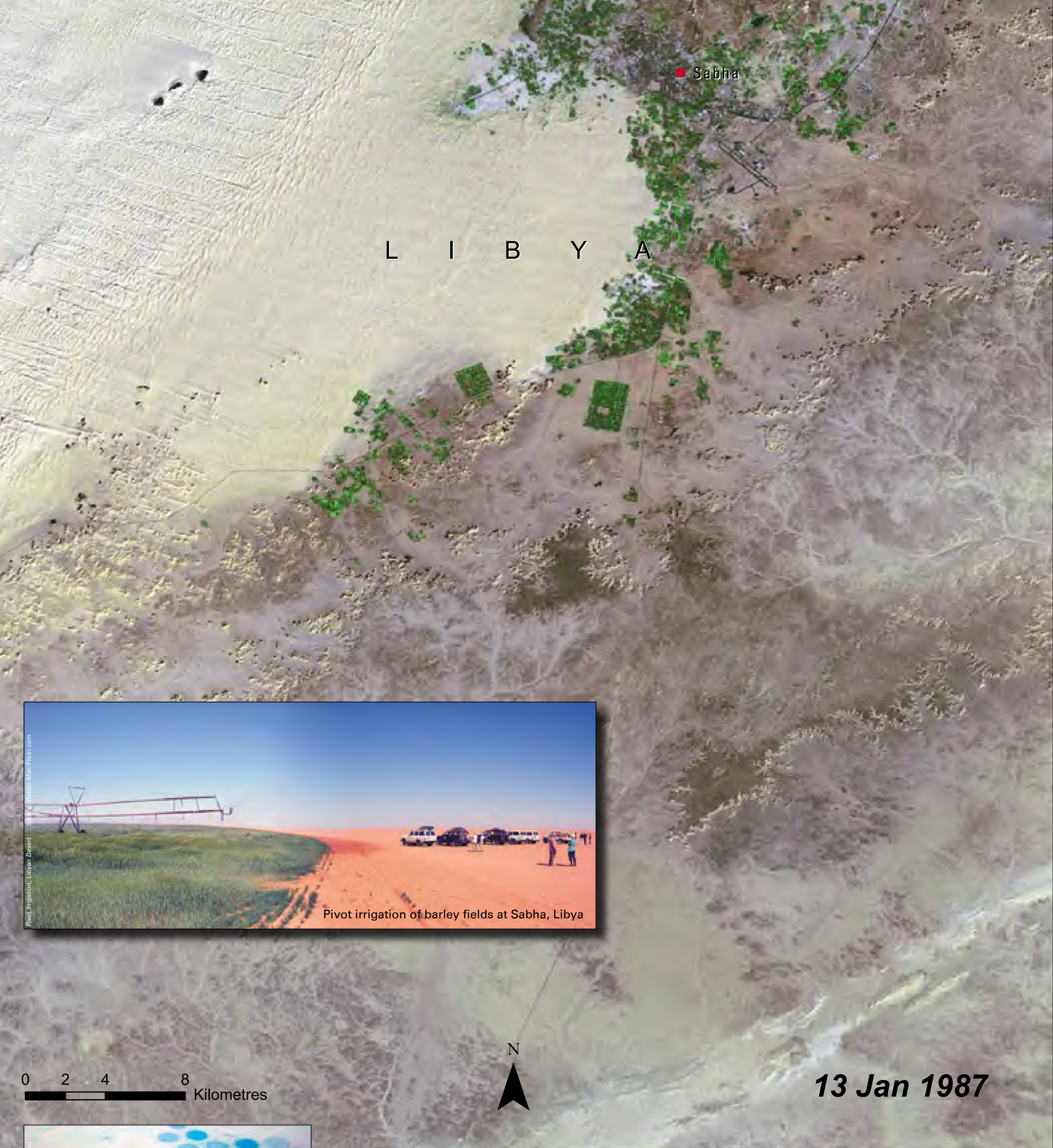
Darnah, Libya Source: Naji/Flickr.com



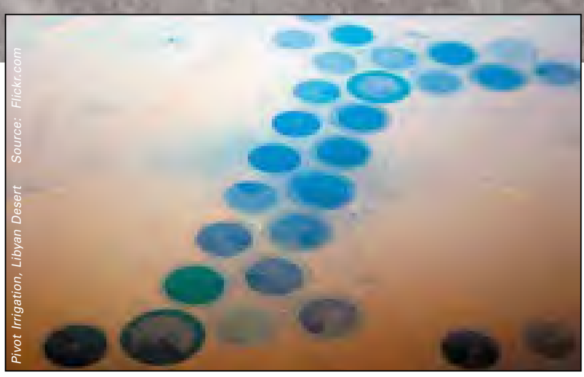
Tripoli, Libya

Tripoli is the capital and largest city of the Libyan Arab Jamahiriya. It contains the country's main sea port and is the commercial and manufacturing centre of the country. Located on the Mediterranean coast along a narrow band of fertile lowlands that quickly give way to a vast interior of arid, rocky plains and the sands of the Sahara Desert, Tripoli has seen dramatic urban growth over the past several decades. The imagery illustrates Tripoli's growth from 1963 to 2008, during which the urban extent has nearly quadrupled in size. In 2008, Tripoli supported 1.7 million or 30 per cent of Libya's total population (Elbenadak 2008) The discovery of oil in 1959 fuelled rapid economic growth and development in Libya (Elbenadak 2008); it is currently Africa's largest holder of oil reserves (BP 2009).

The city of Tripoli is under threat from: oil industry pollutants, which impact groundwater quality and marine ecosystems; outfall from desalination plants, which have proliferated along the nation's coastline to meet growing demands for water; compromised groundwater quality due to saltwater intrusion from over-extraction of fossil waters; loss of arable lands, which increases dependence on food imports; and air pollution from the petroleum and power generation industries, open municipal dumps and the use of leaded gasoline - creating significant risk to human health (Oman and Karlberg 2007). The recent lifting of sanctions against Libya in 2004 has initiated further development in Tripoli and other parts of the country. This change pair illustrates the growth of Tripoli's urban area over a 45-year time period. Development of the city's infrastructure is apparent, with added highways and expansion of the city's main port; conversion of agricultural lands to urban uses is also evident.

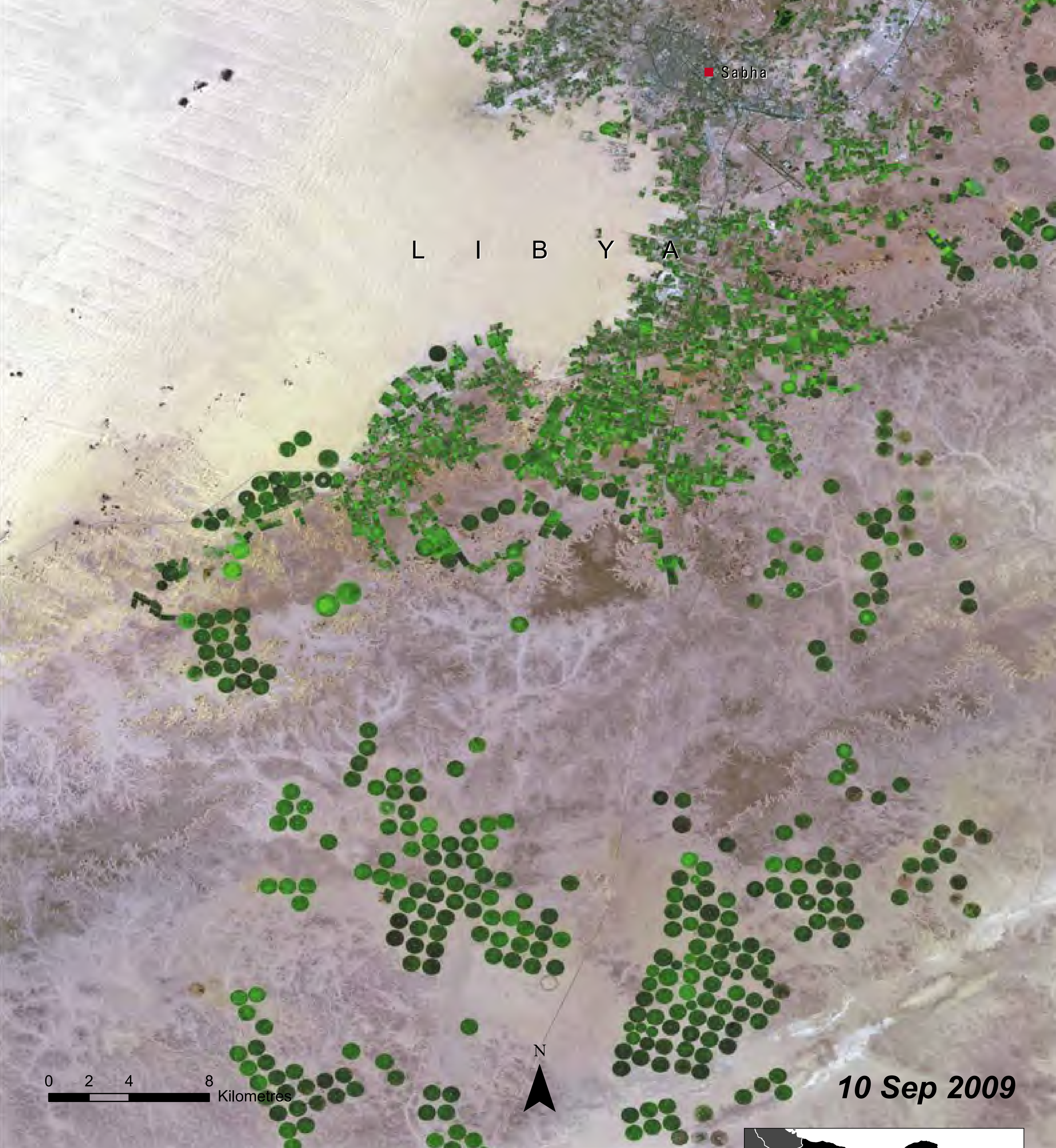


Pivot irrigation of barley fields at Sabha, Libya



Sabha, Libya

The Nubian sandstone aquifer system is one of the largest regional aquifer resources in the world, extending over 2 million km^2 in the eastern part of Libya, Egypt, Chad and Sudan. The fossil groundwater found in the numerous laterally or vertically connected aquifers of the Nubian system is estimated to be more than 40 000 years old. These water resources were discovered in the 1950s as part of Libya's oil exploration activities. Under the direction of Libya's former leader, Muammar Gaddafi, an ambitious plan was developed to tap the fossil water in order to meet the country's growing water demands. In 1984, construction of the Great Man-made River (GMMR) began, which is considered the largest water development scheme ever undertaken.

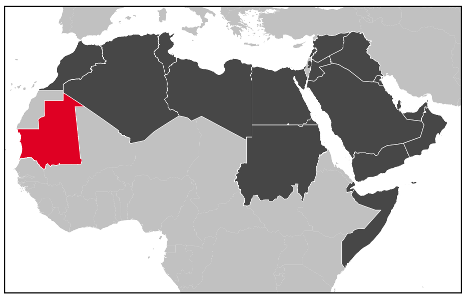


Consisting of over 1 300 wells up to 500 m deep and over 2 000 km of pipeline, the GMMR, once complete, will provide 6.5 million m^3 of water per day to Libya's populated coastal areas for domestic and agricultural uses (GMRA 2008). Though the GMMR is Libya's primary agricultural water resource, much of the water delivered via the GMMR is being used to meet increased domestic needs (USDA 2004). This imagery illustrates the transformation from 1987 to 2009 of oasis-based agriculture in the region directly south of Sabha, to extensive centre-pivot irrigated agriculture. Most of these centre-pivot irrigation lines run continuously to provide water for grain production. Excessive groundwater extraction has lowered water tables in the region and dried up some of the oasis lakes (UN General Assembly 2004). Given the limited recharge of the Nubian sandstone aquifer system, and increased demands for water in the region, sustainable use of this resource must be emphasized by the four countries that share this ancient water reserve.

Seismic Exploration Grid Lines, Libya

As Africa's major oil producer and eighth largest holder of proven oil reserves in the world (BP 2009), Libya's discovery of oil in 1959 has provided the economic foundation for continued infrastructure development in the country. Libya has attempted to diversify its petroleum-based economy, with investments in agricultural and industrial production, and roads and energy (UN ECOSCO 1996); however, with one of the highest unemployment rates in the region (30 per cent), the country continues to face many economic challenges (FAO 2008). 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.



Islamic Republic of Mauritania

Total Surface Area: 1 025 520 km^2
Estimated Population in 2010: 3 460 000

Mauritania is situated in the northwest region of Africa, with Algeria to the east, and a coastline on the Atlantic Ocean. The Senegal River, to the south, is Mauritania's only source of perennial surface water. Mauritania consists mainly of arid desert and semi-arid grassland, and with an average of 92 mm of rainfall per year, it is one of the driest countries in Africa (FAO 2007). There is little topographic variation and the terrain consists mainly of flat, barren plains of the Sahara Desert. The population resides mostly in the cities of Nouakchott and Nouadhibou and along the Senegal River in the southern part of the country. Iron mines centred around Nouadhibou and Zouerat exploit the country's rich iron ore resources.

Important environmental issues

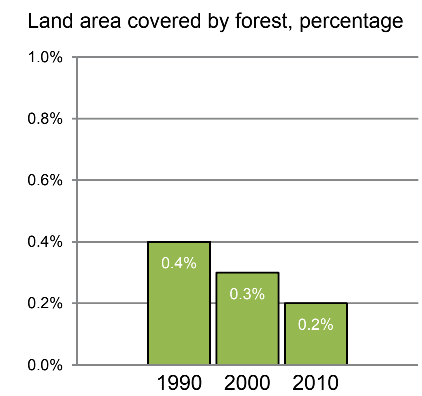
- Desertification
- Water Scarcity in Nouakchott
- Overfishing of Coastal Waters

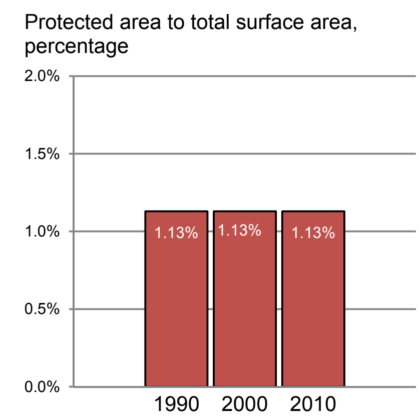
Progress Toward Environmental Sustainability

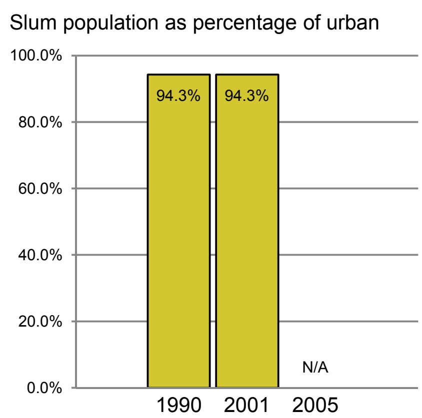
As defined by the United Nations Millennium Development Goal 7 Indicators

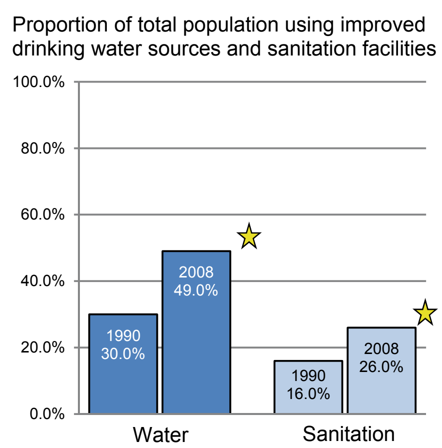
Slum dwellers make up the majority of Mauritania's urban population. Nouakchott, Mauritania's capital city, has a slum population of approximately 450 000 (Robelus n.d.) Due to poor water quality, slum dwellers are at an increased risk of contracting water-borne diseases such as cholera. In 2003, the government proposed a project to pipe water from the Senegal River to Nouakchott; however water disputes between Mauritania and Senegal are delaying its implementation.

☆ Indicates Progress







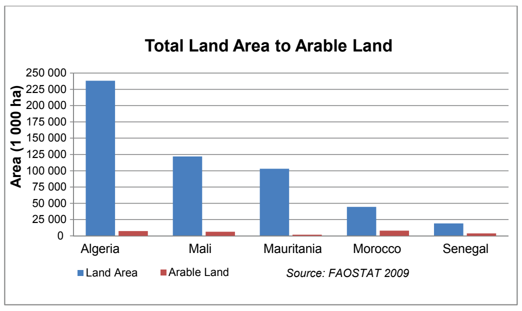


The Banc d'Arguin National Park, a 12 000 km ^{2} coastal wetland, is home to the critically endangered monk seal and over two million migratory waterbirds

Source: UNEP -WCMC n.d.

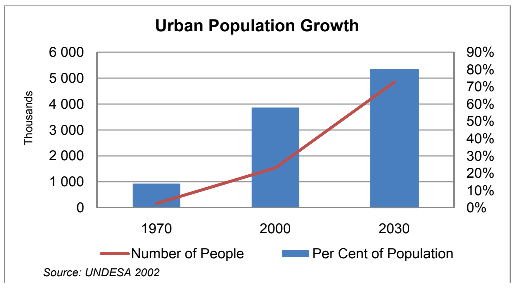
Desertification

The southward creep of the Sahara Desert into urban areas and agricultural lands in Mauritania is having devastating environmental and economic impacts. Prolonged drought combined with overgrazing, deforestation, poor farming methods and increased population are accelerating desertification, threatening the capital of Nouakchott and the fragile agricultural belt along the Senegal River. In response, the government constructed dams on the Senegal River and its tributaries to increase the amount of cultivatable acreage; however, arable land remains scarce, comprising less than 1 per cent of Mauritania's total surface area (World Bank 2007). Deforestation due to drought and excessive fuelwood cutting resulted in a loss of 148 000 ha (35.7 per cent) of forest cover between 1990 and 2005 (FAO 2005). The remaining forests provide an important buffer against the advancing desert, but are threatened by the growing demand for fuelwood and agricultural land.



Water Scarcity in Nouakchott

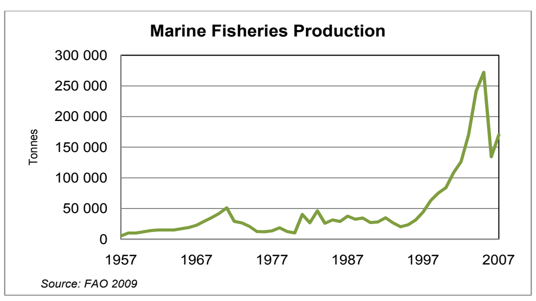
Though the average annual renewable water resources (4 029 m^3/capita/year) (WRI 2002) are above the 1 000 m^3/capita/year threshold for water scarcity, the urban population in Mauritania is facing dire water shortages. Lake Trerza, the aquifer that supplies water to the capital city of Nouakchott, is rapidly drying up. Nouakchott receives an average of only 159 mm of rainfall per year. Years of drought have forced much of the nomadic population to abandon cattle raising and move to urban centres. Nouakchott's population, currently estimated at over 740 000, has increased tenfold over a 30-year period; many of the inhabitants reside in the outskirts of the city where there is no water supply (UNEP 2009). A mere 10 per cent of the population in Nouakchott is served by the water supply system; others are forced to get their water from unreliable water carts or trucks.

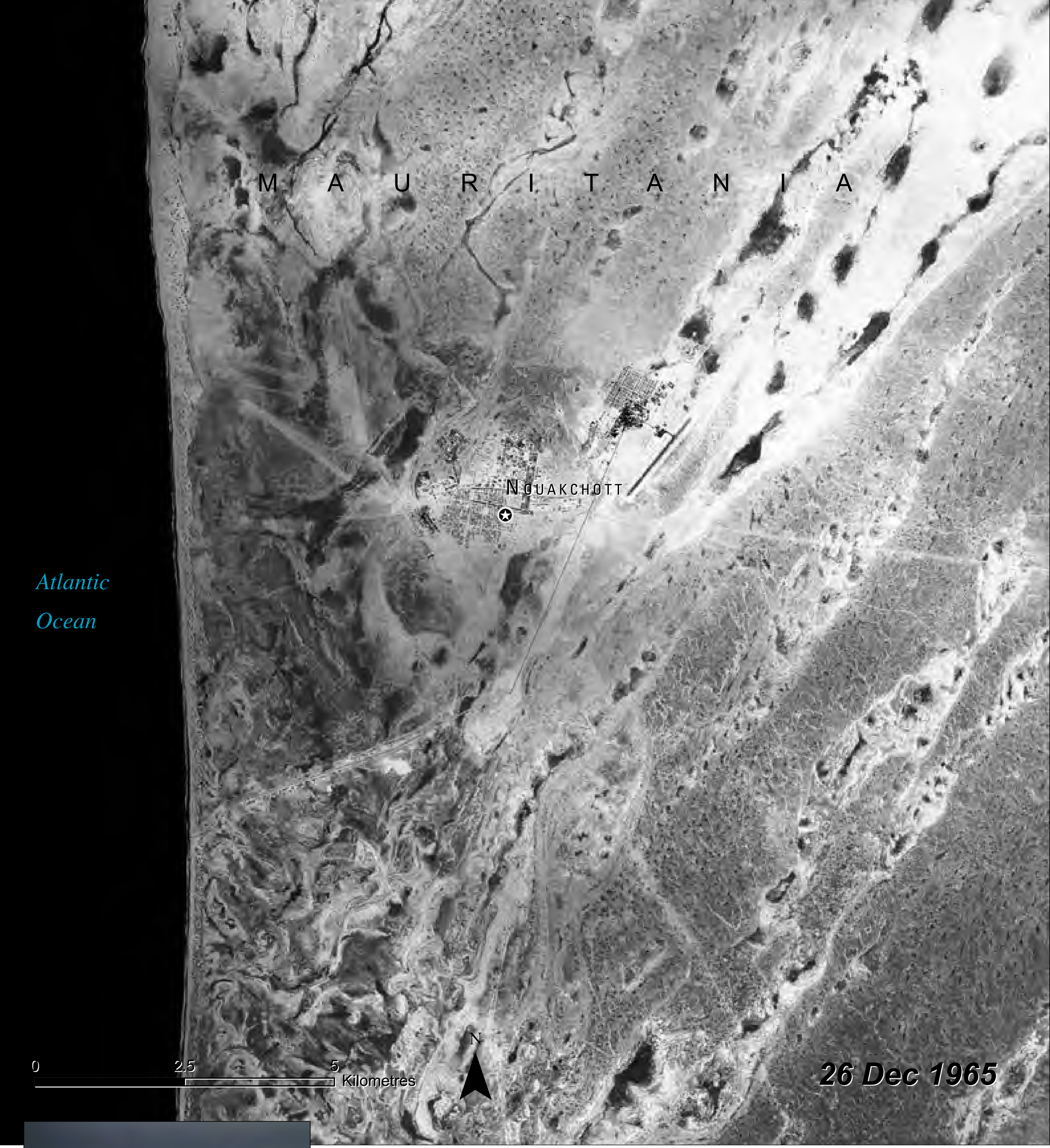


Improvements in irrigation led to a rise in rice production from 22 680 tonnes in 1985 to 93 803 tonnes in 2000

Overfishing of Coastal Waters

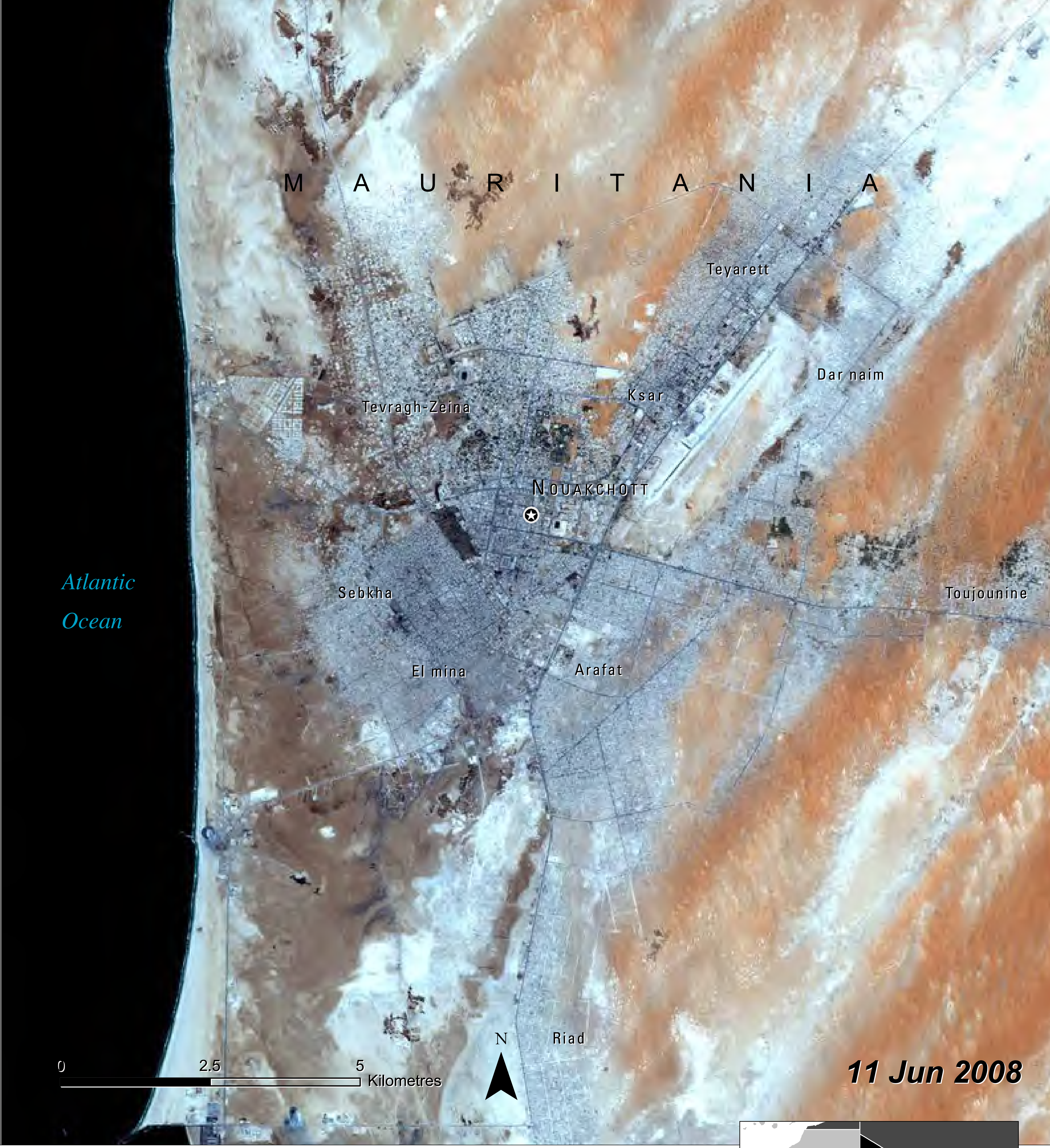
The waters off the 754 km-long coast of Mauritania are among the richest fishing grounds in the world. In 1983, exports of fish overtook iron ore exports as Mauritania's most important foreign exchange earner (Handloff 1988). The fisheries sector employs about 39 000 people, or 4 per cent of the active workforce in Mauritania. This sector accounts for 12 per cent of the gross domestic product, but overfishing by foreign industrial fleets, which represents 90 per cent of all production, is a growing concern. A ban on fish exports was imposed in 2008 to try to meet domestic needs and reduce fishing pressures; the ban covers sea bream and two species of grouper, which together account for almost 80 per cent of fish exported from Mauritania. Fishing zones and seasonal fishing bans to protect species during their peak reproductive season are loosely enforced and managed (Murison 2003).



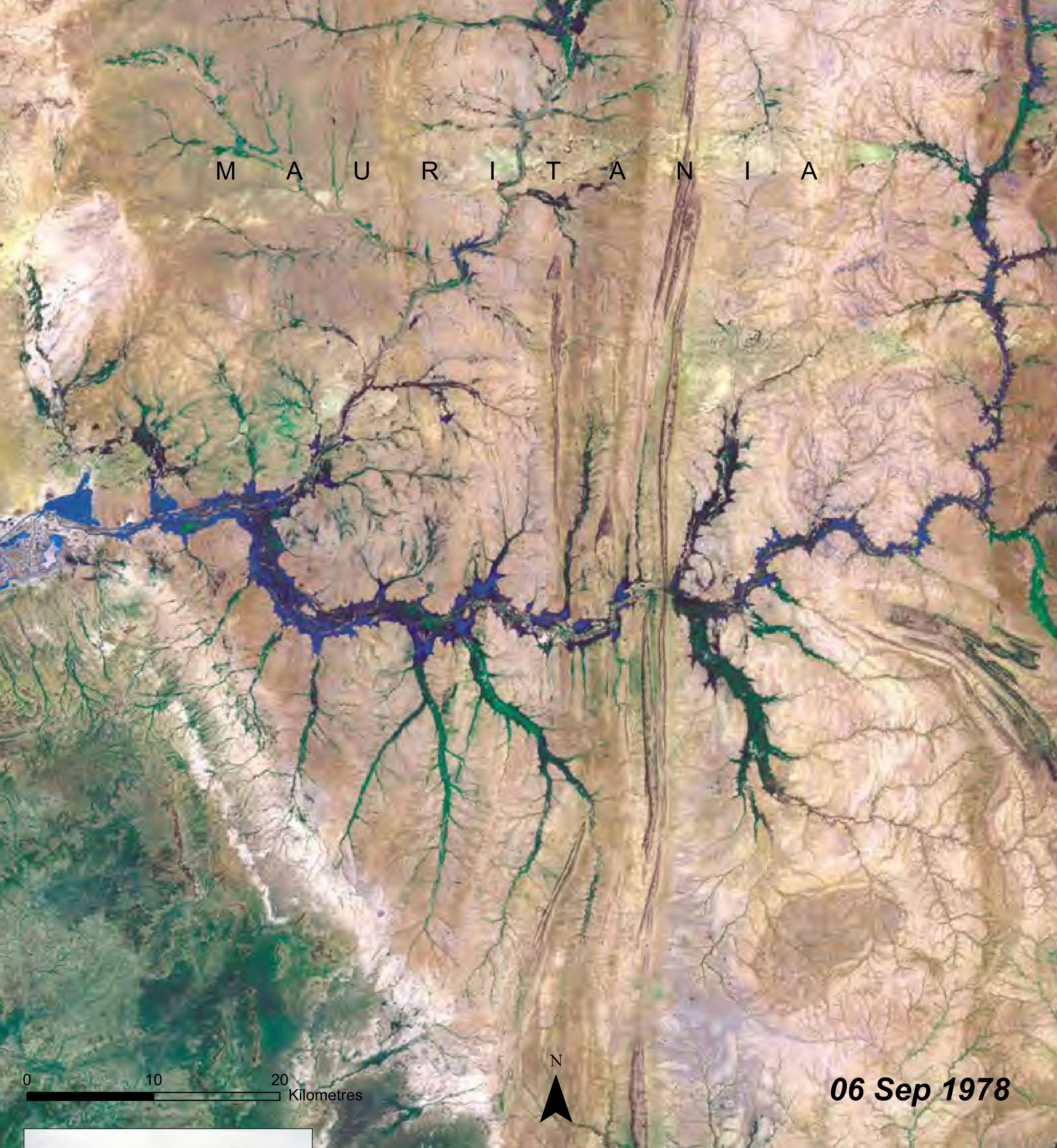


Nouakchott, Mauritania

Nouakchott, the capital of Mauritania, is located on the Atlantic coast. The city is the largest in Mauritania and contains approximately one-fourth of the country's population (Lekweiry and others 2009). In 1961, when Mauritania gained independence from France, most of the population was nomadic; by the mid-1980s, less than 15 per cent of the population was still nomadic or semi-nomadic, and the proportion that was urban grew to 30 per cent (Handloff 1988). Rapid urbanization fuelled by drought, rural poverty and employment opportunities transformed Nouakchott from a small fishing village to a burgeoning capital city that is now home to approximately 740 000 inhabitants. Nouakchott's rapid and uncontrolled urbanization has outpaced the city's ability to provide basic services to its inhabitants.

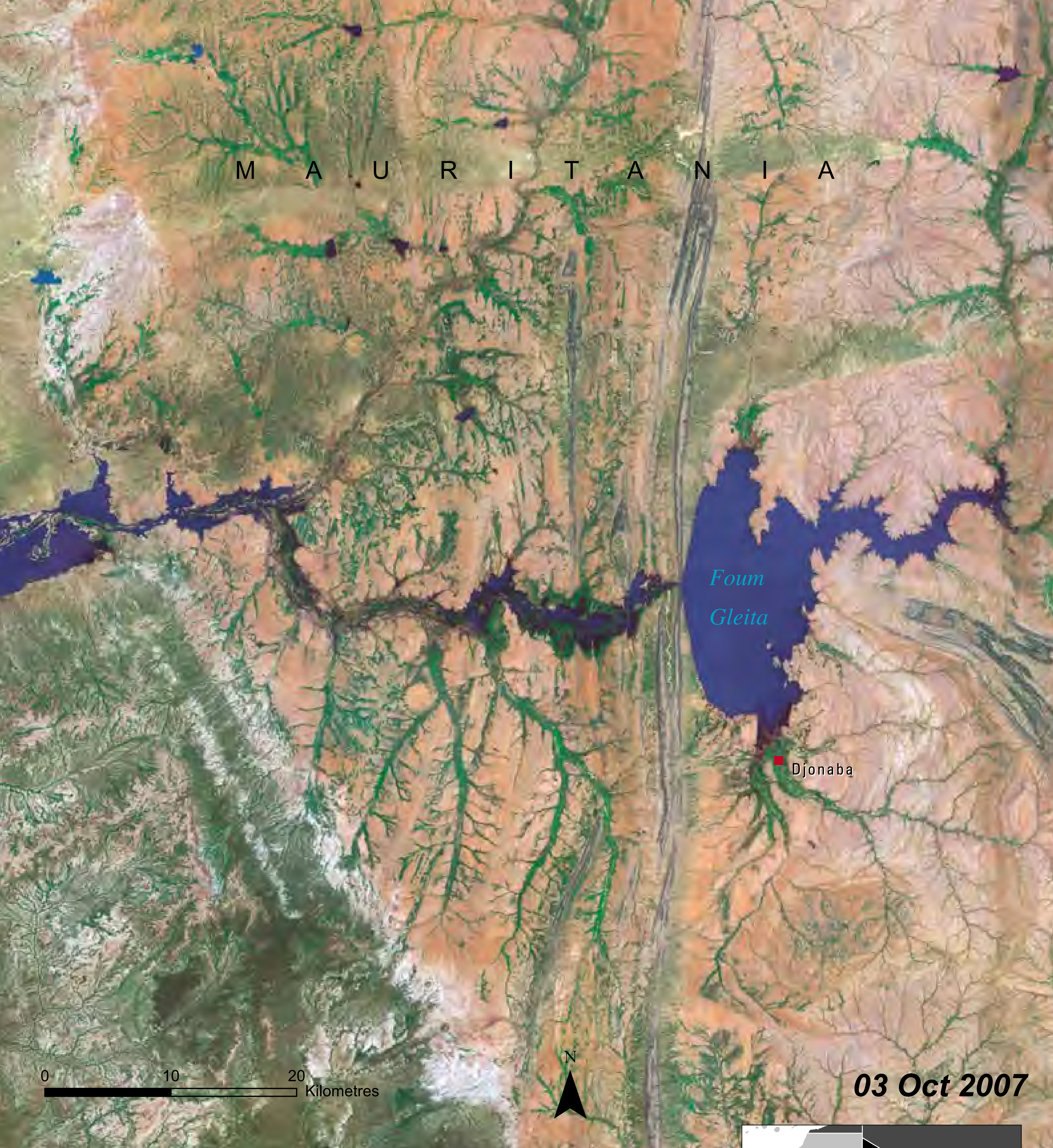


The majority of the population lives in shantytowns or kébés in the outskirts of the city where there is no water supply or electricity (Medilinks 2004). Water scarcity and rationing as well as housing shortages in the city are rampant, and disease from lack of sanitation and access to clean water is widespread. In addition, Trarza Lake, the aquifer upon which the population relies for its freshwater, is quickly being depleted (Medilinks 2004). Nouakchott is also threatened by desertification from encroaching sands of the Sahara Desert. The change pair above documents Nouakchott's explosive growth from 1965 to 2008. Also visible in the imagery are the sand dune formations (which appear as ripples) and lack of vegetation cover in 2008 as compared to 1965. Overgrazing and drought have significantly reduced vegetation cover in the desert surrounding the city, exacerbating the erosion and land degradation problems in and around this coastal capital (UNEP n.d.).

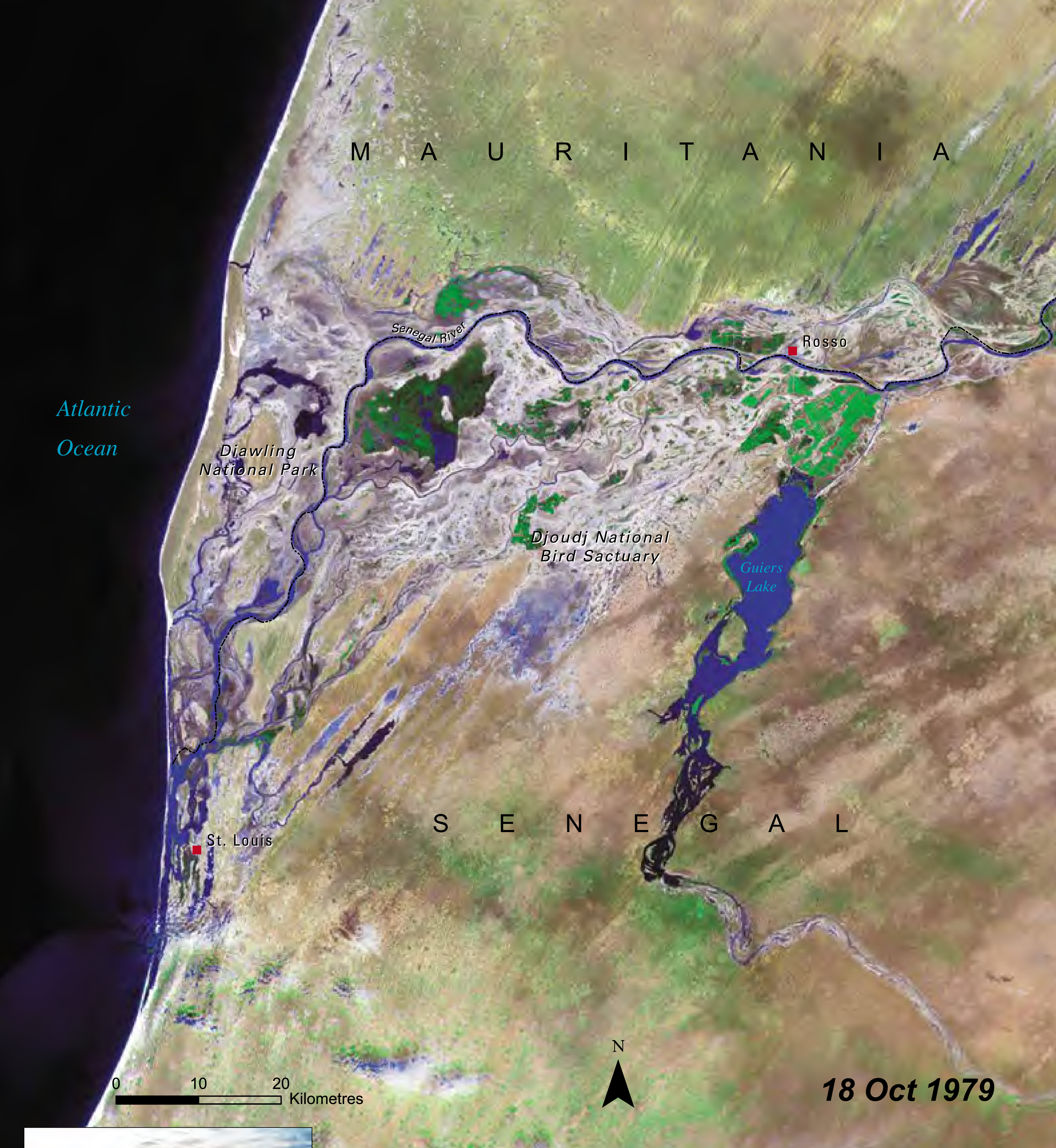


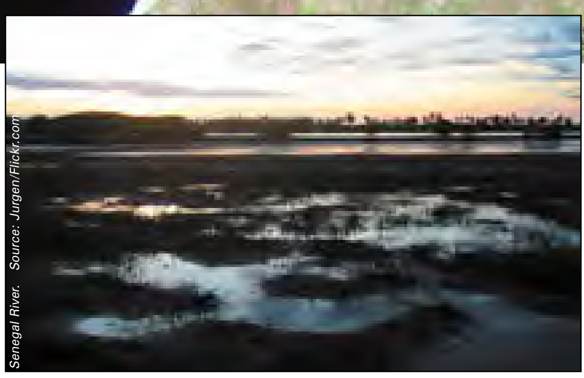
Foum Gleita Barrage, Mauritania

The Gorgol River, located in southern Mauritania, is a tributary to the Senegal River, which forms the border between Mauritania and Senegal. Between 1985 and 1989, a large irrigation dam known as the Foum Gleita was constructed on the Gorgol River. Irrigation schemes for rice cropping were introduced on a large scale in the Sahel region in response to the severe droughts of the 1970s and 1980s (Van Asten 2003). Construction of the Foum Gleita dam inundated thousands of hectares of previously arable land along the floodplain of the Gorgol River, creating a large lake with a water retention capacity of about 500 million m^3. By 1989, the lake provided irrigation for 1 950 ha of land used mostly for rice cropping. Initially, the rice yields were good (4.6 to 5.2 t/ha), but over time, they began to decline rapidly (2.7 to 4.6 t/ha) (WARDA



1999). By 1993, about 240 ha of land had been abandoned by farmers due to low productivity attributed to high levels of salt from the underlying bedrock. Most of the abandoned lands occur outside the floodplain of the Gorgol River, where soils are more shallow, and therefore contact with the underlying bedrock is greater. Floodplain soils, in contrast, are deep and not impacted by the salinity of the bedrock. While the dam provides a more reliable source of water, the removal of prime agricultural land from production has serious implications for food security and economic growth. The 2007 image shows the lake and inundation of the floodplain to the east and west along the Gorgol River. The irrigated areas immediately surrounding the lake are more pronounced in the 2007 image than the 1973 image. Increased soil salinity and subsequent farm abandonment is jeopardizing the continued production of rice in this region.

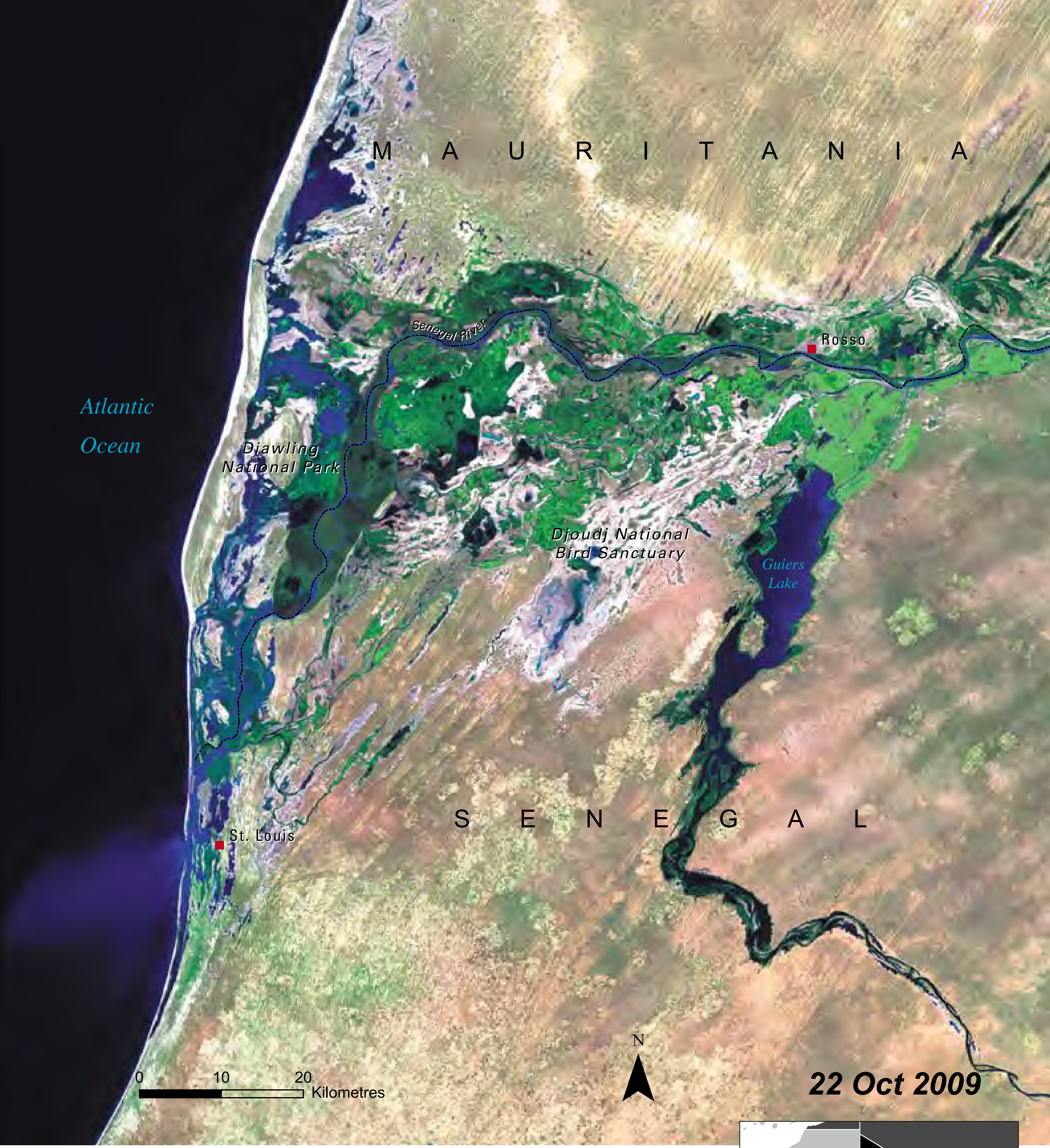




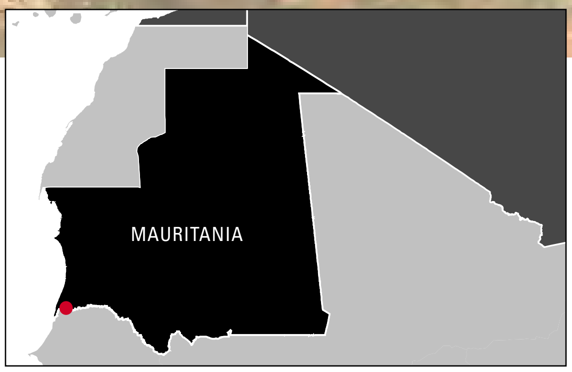
Senegal River. Source: Jurgen/Flickr.com

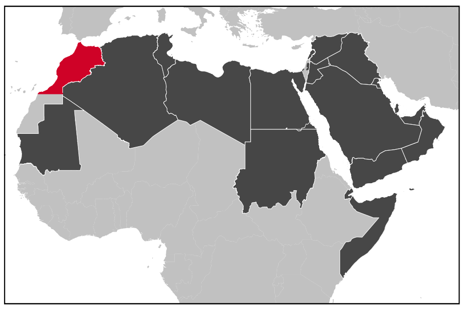
Irrigation on the Senegal River, Mauritania

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. The dams have interrupted the river's ability to flood naturally, displaced people living along the river, and contributed to high incidences of water-borne diseases from the proliferation of mosquitoes and snails in stagnant water (YWAT n.d.). The benefits of the dams include: a consistent water supply for year-round irrigation; an increased amount of irrigated agricultural land in production (over 100 000 ha); a reliable source of power for the cities; and, greater access to drinking water (World Bank 2004). The dams have also brought prosperity to farmers who can grow crops year-round. 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.





Kingdom of Morocco

Total Surface Area: 446 550 km2

Estimated Population in 2010: 31 951 000

Morocco borders the North Atlantic Ocean and the Mediterranean Sea in northern Africa. Algeria lies to the east and Mauritania to the south. Principal cities include Rabat, Morocco's capital, Casablanca, Marrakech, Tangier, and Fes. The northern coast and interior are mountainous with large areas of bordering plateaus, valleys and rich coastal plains that support a rich diversity of flora and fauna. Rainfall varies from 600 to 1 200 mm per year in the northeast along the Mediterranean to 100 to 200 mm per year in the southeastern desert. Over 90 per cent of the country is classified as arid or semi-arid, and the population is concentrated primarily in the fertile coastal plains in the north. The Atlas Mountains, rising to 4 167 m in Jebel Toubkal in the southwest, are some of the highest in Africa.

Important environmental issues

- Desertification and Land Degradation
- Water Scarcity and Drought
- Pollution of Freshwater and Marine Environments

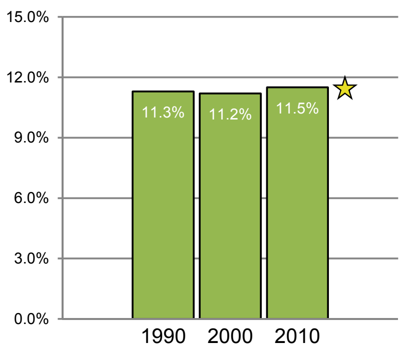
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

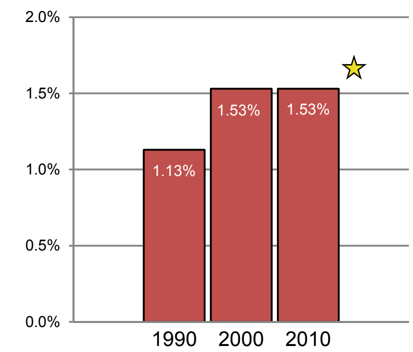
The volume of wastewater produced in Morocco from 1992 to 2002 nearly tripled; currently 600 million m^3 of wastewater is produced each year in Morocco, 13 per cent of which is treated. The proportion of the urban population served by wastewater treatment plants is less than 8 per cent (FAO 2009). The National Plan for Sewerage and Wastewater Treatment aims to connect 80 per cent of the population to the network by 2020. Notable improvements in access to drinking water among Morocco's rural population have been made, increasing from 15 per cent in 1994 (World Bank 2009) to 85 per cent in 2007 (Department of Water and Environment 2009).

☆ Indicates Progress

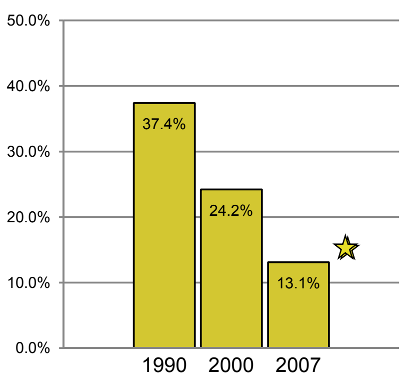
Land area covered by forest, percentage



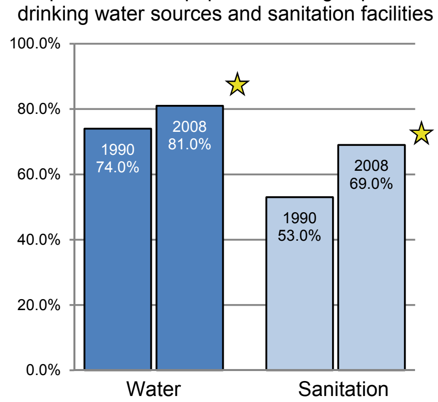
Protected area to total surface area, percentage



Slum population as percentage of urban



Proportion of total population using improved drinking water sources and sanitation facilities

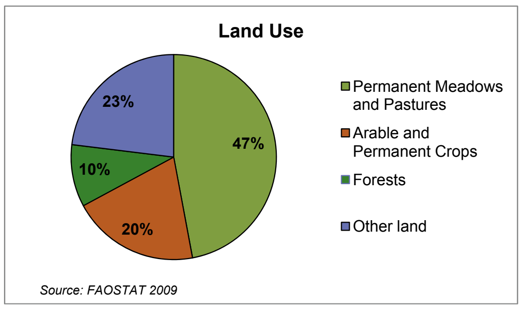


Morocco's 'Vision 2010' was launched by Moroccan King Mohammed VI with the aim of attracting 10 million international visitors to the Kingdom by 2010

Source: Ministry of Tourism 2005

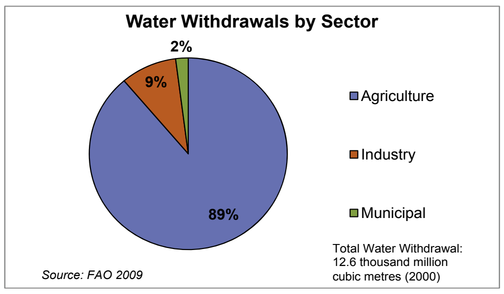
Desertification and Land Degradation

In Morocco, 93 per cent of land is affected by desertification processes (GM-UNCCD 2008). Recurrent drought, lowered precipitation associated with climate change, population pressures, deforestation, high incidence of bush fires and overgrazing are accelerating desertification and land degradation in Morocco. Morocco's proportion of arable land is remarkably high (19.61 per cent) (AOAD 2007); however, the productivity of some of the land has declined by 50 per cent due to soil erosion and salinization, and the pace at which usable land is being lost is accelerating. Droughts can reduce crop production by as much as 85 per cent, resulting in extreme annual variation in cereal yields (Karrou n.d.). While forests area has grown from 10 to 11.5 per cent of the total area (UNSD 2011), excessive firewood harvesting, land clearing to convert to other land uses and fires consume 31 000 ha of forested area each year, exacerbating desertification (El Bagouri 2006).



Water Scarcity and Drought

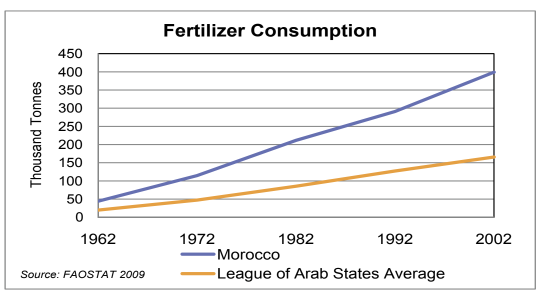
Morocco is under severe water stress—in the past decade water availability per capita (730 m^3/year) dropped below the international water scarcity threshold of 1 000 m^3 per person per year (Department of Water and Environment 2009). Surface water is unevenly distributed throughout Morocco, and although groundwater is more universally available, exploitation in several basins has surpassed natural replacement rates. By 2020, groundwater exploitation at the national level will exceed recharge of groundwater reserves by 20 per cent (FAO 2005). Large dams currently provide 500 million m^3 of water for household, industrial, and irrigation uses. Siltation of Morocco's reservoirs is significantly reducing the amount of available water. New reservoirs are being constructed to try to maintain levels of water storage in Morocco. Actions to promote water conservation, improve water systems efficiency and eliminate wasteful consumption are also being implemented (Biad 2001).

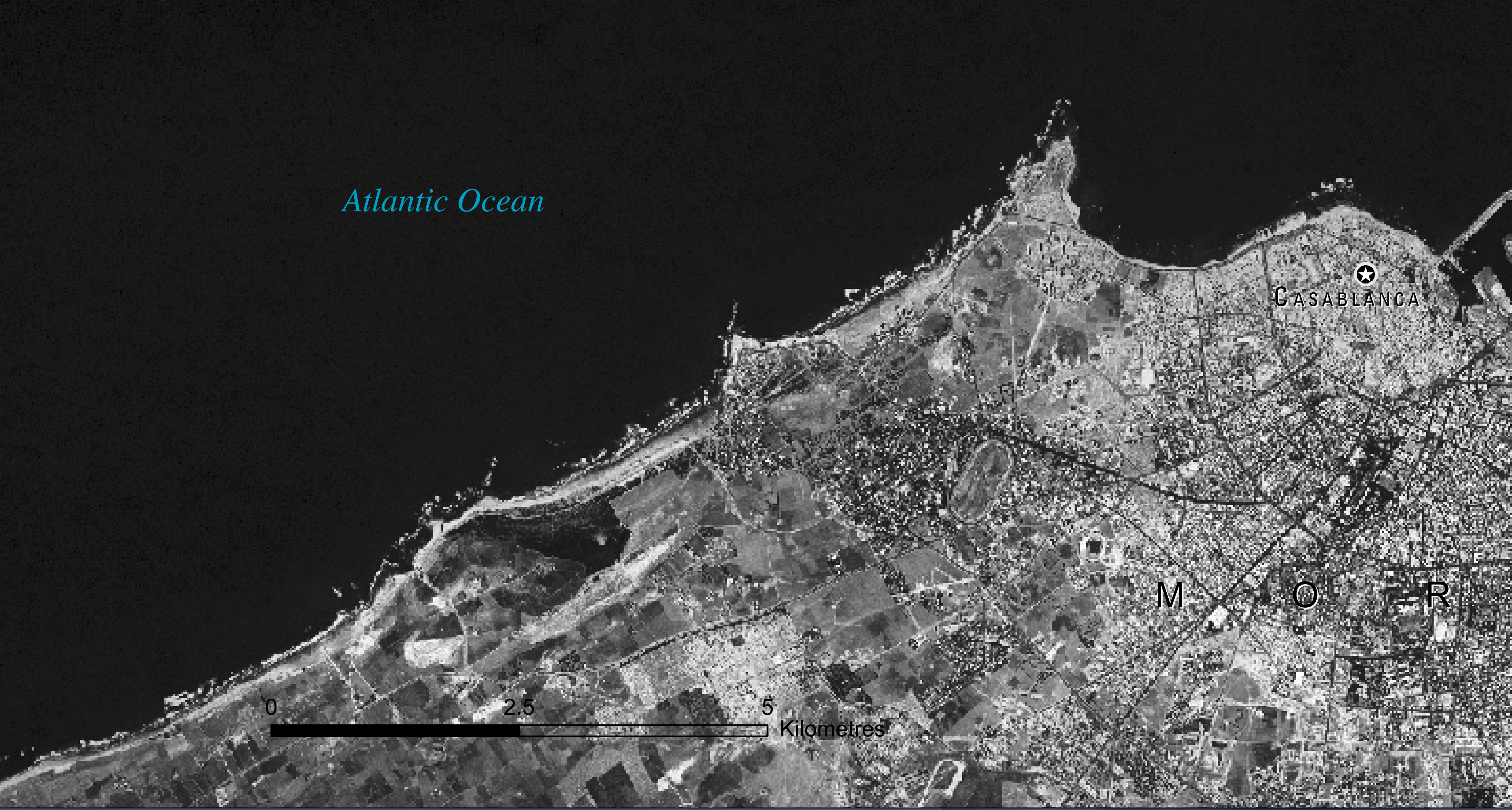


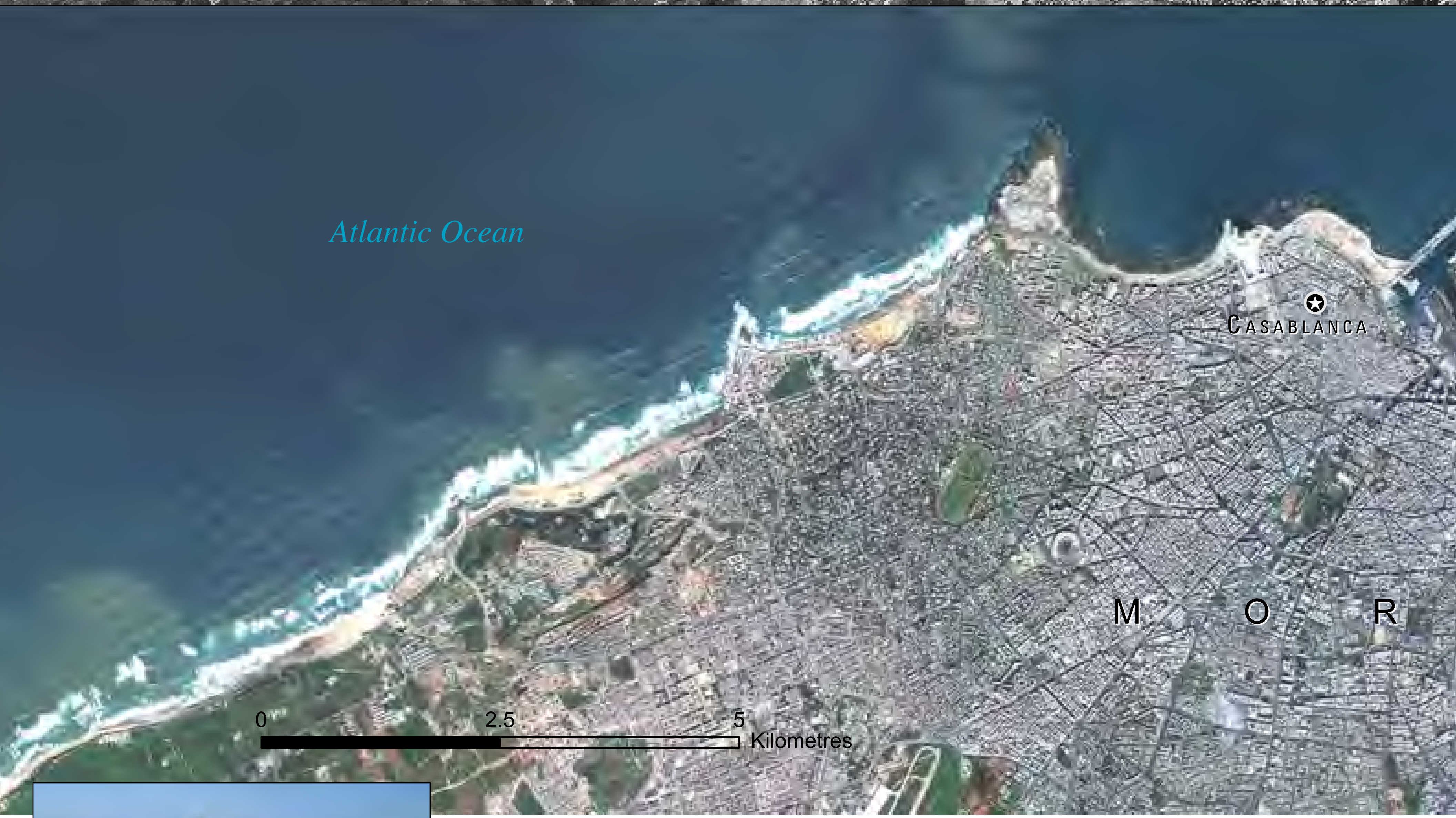
Olive production accounted for 230 000 ha in 1970; today about 500 000 ha of cultivated lands are devoted to olive production, a figure the government seeks to double by 2010

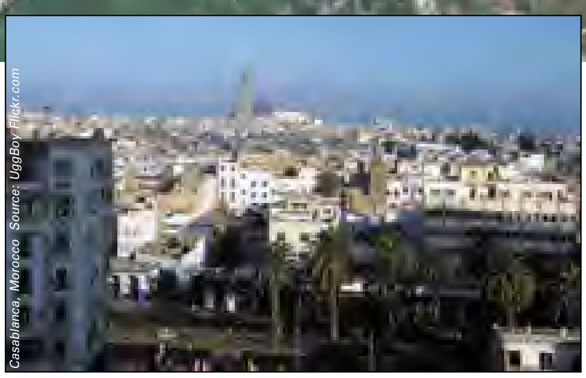
Pollution of Freshwater and Marine Environments

Morocco's river basins, including the Sebou River Basin, which accounts for 45 per cent of Morocco's water resources, are heavily impacted by metallic and organic pollutants from untreated industrial and municipal waste and agricultural runoff. Pesticide and fertilizer runoff; industrial wastes from paper mills, sugar plants, tanneries, wool mills and chemical plants; and urban sewage are the major sources of pollutants (Thieme and others 2005). Fertilizer use in Morocco's agriculture sector has risen steadily since 1965, impacting groundwater resources (FAO 2002). Soil erosion, sedimentation, and salinization are additional sources of contamination. Morocco's cities alone produce 5 million tonnes of solid waste annually, most of which is discharged directly into the ocean/sea. Contamination of the drinking water supply has increased the incidence of water-borne diseases. A programme to treat waste was developed in 2008 that will equip 350 urban areas with controlled waste sites (Department of Water and Environment 2009).









Casablanca, Morocco

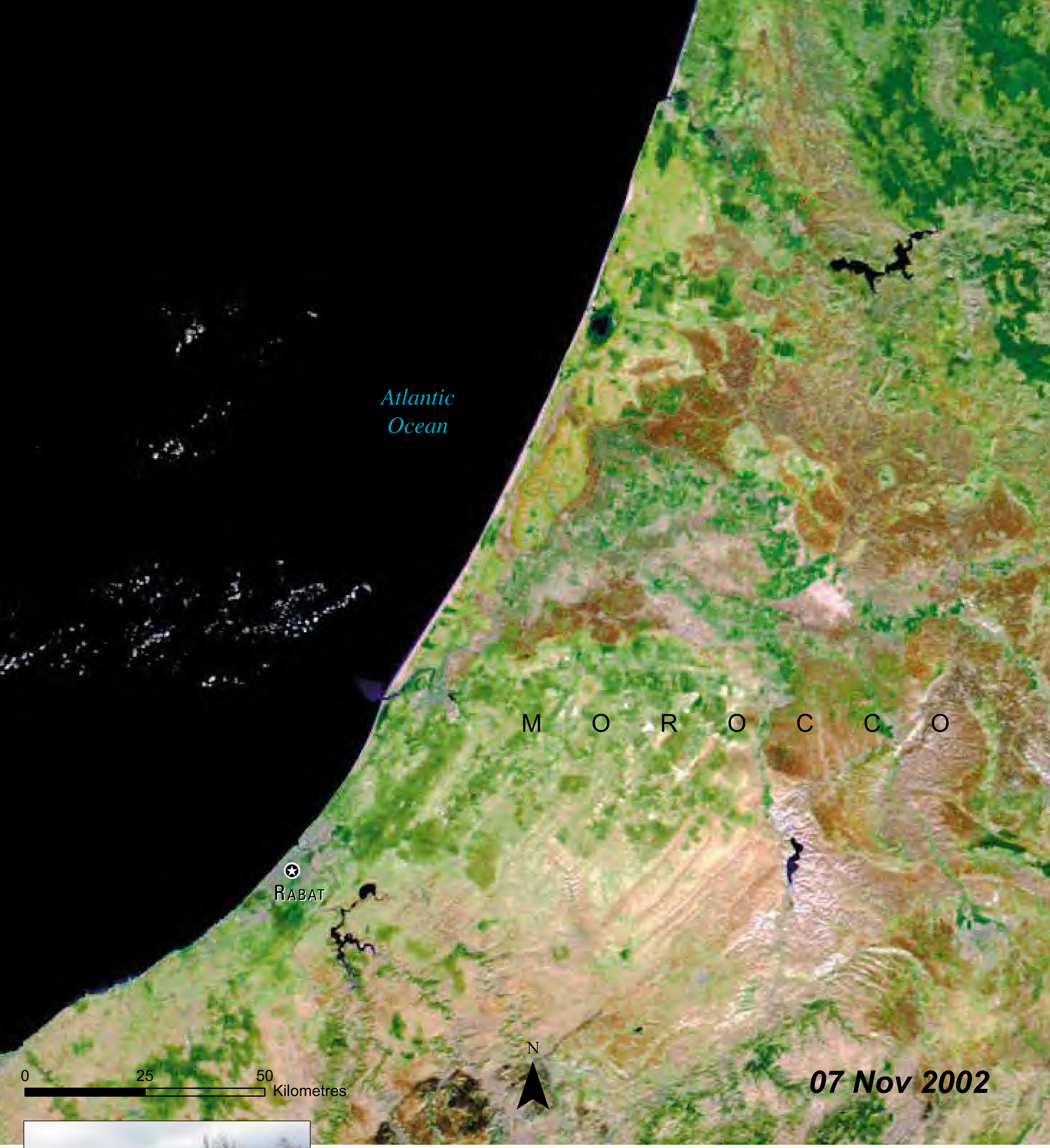
Casablanca, located in western Morocco on the Atlantic coast, is the country's largest city. With its heavy infrastructure, including two harbours, airport, and road and rail networks connecting the city to the rest of the country, Casablanca serves as the financial and industrial centre of Morocco; some 60 per cent of Moroccan industry is concentrated in the city (Ouassani 2009). As a metropolitan region, Casablanca's land area has increased greatly, expanding from 0.5 km^2 in 1907 to 210 km^2 in 2000. In 1996, land reform led to the inclusion of surrounding communities, and a region coined "Greater Casablanca" was created, with an area of 869 km^2 (FMER n.d.). 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.

Al Wahda Reservoir, Morocco

Al Wahda Dam, located on the Ouergha River in northern Morocco, was completed in 1996 to develop the area's water supply for irrigation, reduce devastating flooding along the river and generate hydroelectricity. With a capacity of 3.8 thousand million m^3, it is the largest of the 110 dams in Morocco and the second largest in Africa (FAO 2010). Since completion of the dam, flooding has decreased by 90 per cent, potential irrigation areas have increased by about 110 000 ha, and hydroelectricity production has reached approximately 400 GW per year, providing about one-third of Morocco's electrical supply. The electricity produced by the dam allows the Moroccan government to avoid burning 140 000 tonnes of fossil fuels per year, thereby reducing greenhouse gases released into the atmosphere.

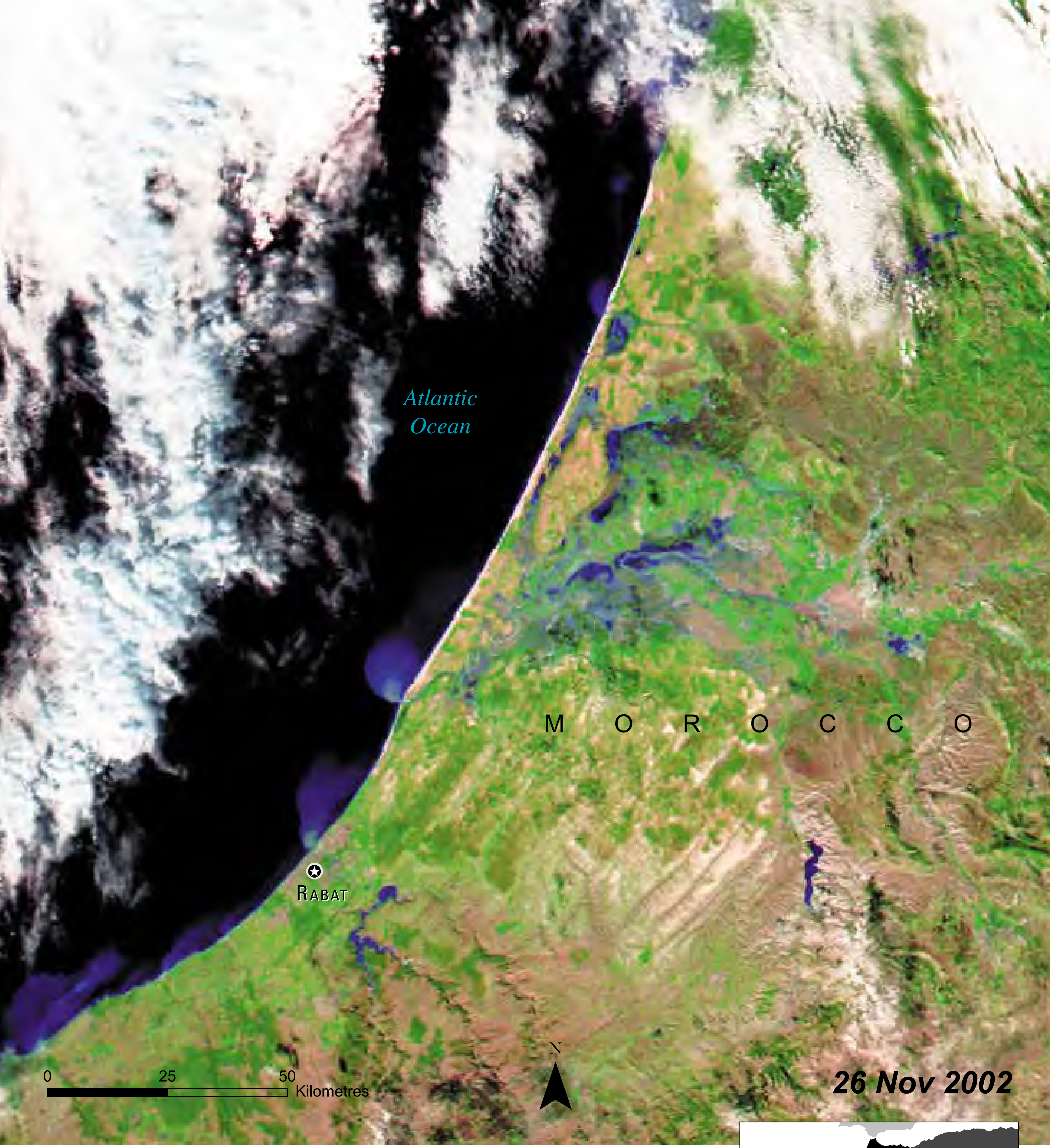
However, natural and human-caused erosion is filling the reservoir with silt, threatening the dam's long-term operation. It is estimated that the reservoir loses 60 million m^3 of capacity each year due to siltation. In addition, these sediments trapped in the reservoir are no longer reaching coastal zones, significantly altering the coastal sedimentary budget and the physical environment of coastal ecosystems (Snoussi and others 2002). Another potential threat to the dam's future viability is suggested by climate and hydrological modelling, which predict that a 1°C increase in average air temperature between 2000 and 2020 might reduce runoff to the Al Wahda Dam by 10 per cent (Agoumi 2003). These images illustrate the change in land cover before and after construction of the Al Wahda Dam.



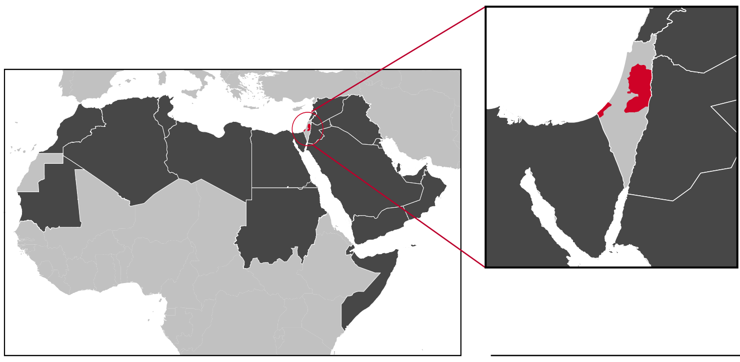

Floods of Oued Fliflа in El Jadida (1996)
Source: L. Mahin/wikicommons.com

FLOODING, MOROCCO

On 17 and 18 November 2002, a powerful cold front hit North Africa, bringing unusually heavy rains to northern Morocco. These heavy rains caused devastating flooding in the country, claiming 89 lives and impacting upwards of 100 000 people. Villages that were built in floodplains were destroyed and houses were swept away by swollen rivers; agricultural lands were flooded; hundreds of cattle were killed; and there was extensive damage to infrastructure along Morocco's coast (IFRC 2003). The floods also forced the closure of parts of the rail system and destroyed an oil refinery between Rabat and Casablanca.



These images display the before and after effects of flood waters as they washed into the Atlantic Ocean in the vicinity of Rabat, Morocco's capital city. The water from the flash floods, which appears as solid blue in the 26 November image, scoured drainages and emptied into riverbeds and lakebeds. The worst of the flooding occurred just north of Rabat along the coast. The floodwaters carried loose sediment from the surrounding countryside and deposited them into the Atlantic. These floodwaters, heavy with material runoff, formed the sediment plumes that appear along the coast. In these false colour images, land is green and tan, clouds are white and light blue, and water is dark blue and black. Under normal conditions, there is little standing water in Morocco, as is visible in the 7 November 2002 imagery.



Occupied Palestinian Territories

Total Surface Area: 6 020 km^2
Estimated Population in 2010: 4 039 000

The Occupied Palestinian Territories, one of the smallest countries in the region, contains two geographical regions: the Gaza Strip and West Bank, which are separated by the State of Israel. Neighbouring countries include Jordan and Egypt. The West Bank topography consists of central highlands, semi-arid rocky slopes, an arid rift valley and fertile plains in the north and west. The Dead Sea, the lowest point in the world at 410 m below sea level, is located in the southeast corner of the West Bank. The Gaza Strip is a narrow, low-lying stretch of sand dunes along the eastern Mediterranean Sea. The climate in the West Bank is hot and dry during the summer and cool and wet in winter, while the climate in Gaza is more temperate.

Important environmental issues

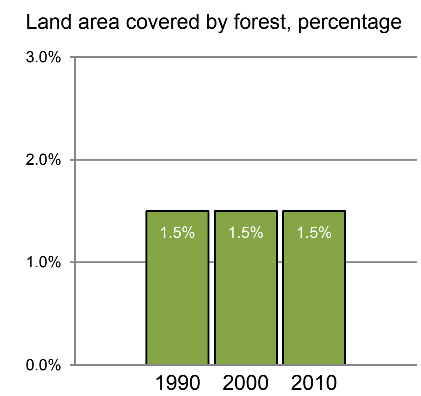
- Water Scarcity
- Environmental Pollution-Air and Water
- Population Pressures on Land

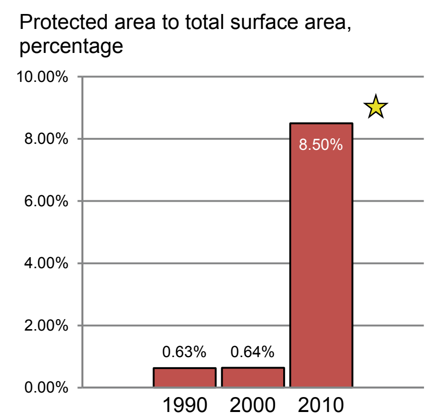
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

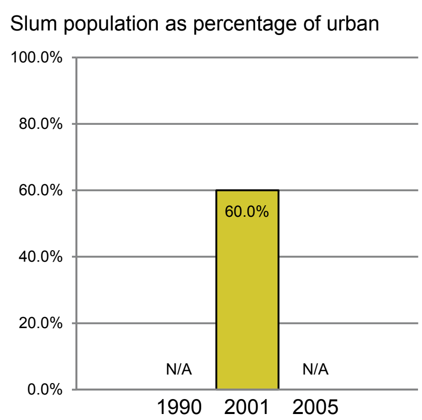
Sixty-three per cent of the Palestinian population lives in the West Bank and 37 per cent in the Gaza Strip (UN ESOSOC 2007). Approximately half of all Palestinian households are dependent on international food assistance (Commission of the European Communities 2009). Food insecurity is widespread in the West Bank and Gaza Strip with 38.7 per cent and 41.6 per cent, of the population, respectively, considered food insecure (FAO 2004).

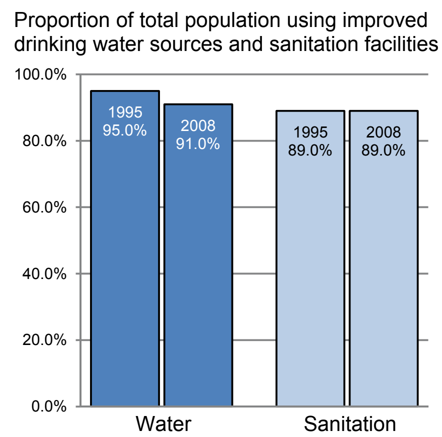
☆ Indicates Progress





Source: Environment Quality Authority 2010



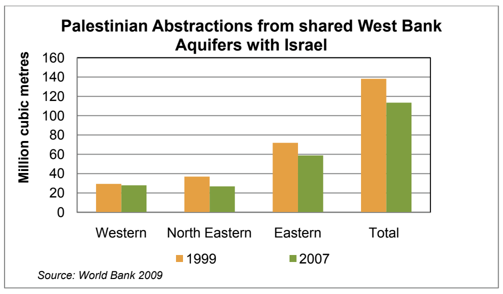


The 750 km-long (proposed and mostly built) separation wall by Israel will impact 50 per cent of the West Bank population through loss of land (including agricultural fields), loss of water resources, separation of communities and isolation areas

Source: HDIP 2003

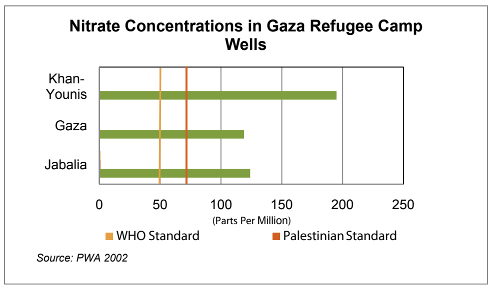
Water Scarcity

The Occupied Palestinian Territories is among the countries with the scarcest annual renewable water resources per capita (125 m^3 in the Gaza Strip, and 75 m^3 in the West Bank). Demand for water was 554 million m^3 in 2005, and is projected to increase to 785 million m^3 by 2020 (PNA 2005). The principal water source is groundwater followed by springs and harvested rainwater. Palestinians lost access to valuable surface waters from the Jordan River following the 1967 Israeli occupation. Palestinians have access to one-fifth of the resources of the Mountain Aquifer, and overall, abstract about 20 per cent of the estimated potential of the aquifers that underlie the region. Overdraws of aquifers underlying the West Bank by Israelis is limiting the availability of water to Palestinians in the West Bank (World Bank 2009). In the Gaza Strip, salt water intrusion of the shallow coastal aquifer due to declining groundwater levels is increasing the groundwater salinity.



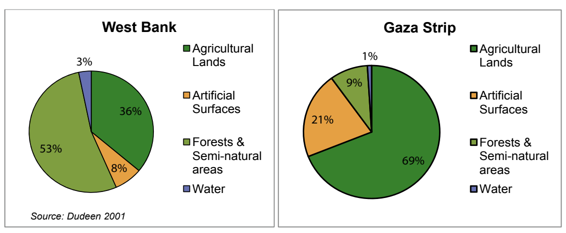
Environmental Pollution- Air and Water

Air pollution is caused by vehicle emissions, burning of solid waste, and industrial activities - cross-border Israeli factories also contribute to poor air quality. Lead pollution levels in urban areas from vehicle emissions are six times higher than the WHO annual average of lead concentrations (0.5μg/m^3) (El-Ghussain n.d.). Water quality has deteriorated such that only 7 per cent of the water supplied for domestic use in the Gaza Strip meets WHO standards (El-Ghussain n.d.). Groundwater and spring water are contaminated by industrial and municipal waste, and unregulated and excessive pesticide and herbicide use. High levels of pollution in Gaza are impacting human health. The lack of proper sewage collection and treatment systems means that most domestic wastewater is dumped untreated into the sea, wadis, and areas adjacent to agricultural lands and urban centres.

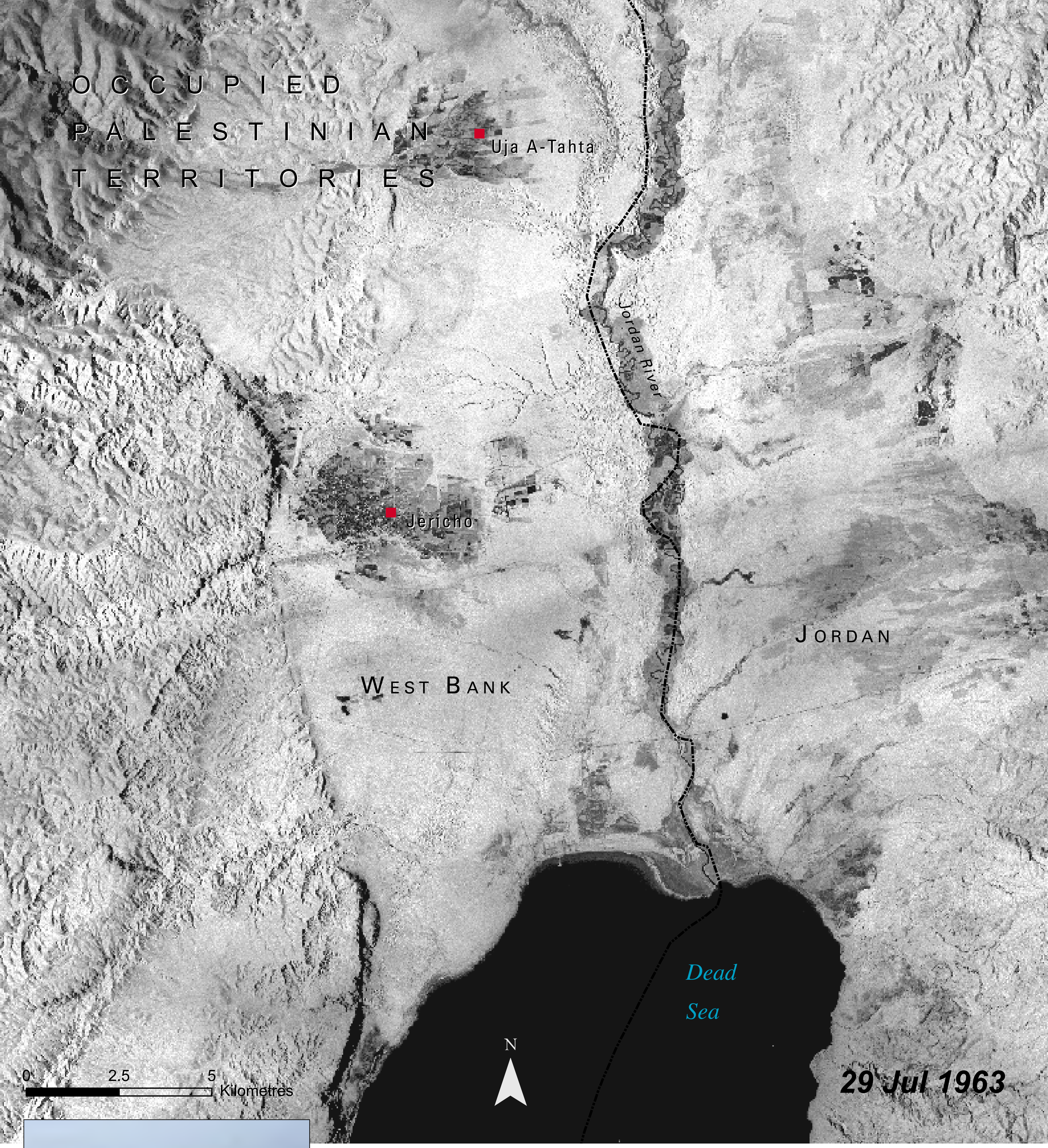


Population Pressures on Land

The population surged in the past decade from 2.89 million to 3.76 million. The Gaza Strip has one of the highest overall population growth rates (3.42 per cent) and population densities in the world (4 311 persons per km^2); the West Bank population growth rate was 2.23 per cent in 2008 with a density of 255 persons per km^2. The Israeli settler population grew from 379 099 in 2000 to approximately 500 000 in 2012 (includes East Jerusalem) (UN OCHA 2012). There are 122 Israeli colonies in the West Bank (none occur in Gaza since 2005). Population pressures, changing lifestyles, increased food demand, and expanded colonization have hastened land degradation. Deforestation in the West Bank decreased the forest cover by 23 per cent from 1971 to 1999 (Mahassneh 2008). Rangelands are severely overgrazed and access to grazing lands in the West Bank has been limited by military installations, colonies, bypass roads and the annexation and separation wall.




Wadi Qilt, In the Judean mountains near Jericho Source: Exothermic/Flickr.com



Farmers gather tomatoes in the West Bank
Source: James Emery/Flickr.com

Jordan Valley - Northern Dead Sea

The Dead Sea is a hypersaline lake that is bound by Jordan to the east and the West Bank and Israel to the west. It lies in the narrow Jordan Rift Valley and its surface and shores are 410 m below sea level, the lowest elevation on the Earth's surface. The Dead Sea is 378 m deep, 67 km long and 18 km wide at its widest point. Its main tributary and only major water source is the Jordan River. The Dead Sea has undergone dramatic changes over the past 30 years. Most notable in the 2000 image, as compared to the 1963 image, is the receding shoreline of the lake. The Dead Sea has lost about one-third of its surface area as a result of the unsustainable exploitation of water and mineral resources (UNEP 2002).

Since 1970, the water levels have been dropping at a rate of 80 cm to 1 m per year (IMOE 2002). As much as 95 per cent of the flow of the Jordan River has been diverted by Jordan and Israel for agricultural and domestic uses. The Palestinians lost access to Jordan water flows and valuable agricultural lands following the 1967 occupation by Israel. Water quality in the lake is decreasing due to industrial wastewater and sewage, which enters the Dead Sea via the Wadi Al Nar. Large sinkholes are emerging on the western shores of the lake. These sinkholes are a result of dropping groundwater levels (Abelson and others 2006), and are affecting the productivity of agricultural lands surrounding the lake. In an effort to stem the declining lake levels and provide additional water for agricultural production, ambitious plans to convey seawater from the Red Sea to the Dead Sea are underway (World Bank 2009).


Ma'ale Adumim - Source: Environment Quality Authority - Palestine

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. The government's planning scheme for the colony was finalized in 1983, establishing Ma'ale Adumim's borders to an area of approximately 35 km^2; however, these borders have been extended and at present they are more than 50 km^2 (ARIJ 2006). The Jahalin Bedouin who lived there have been displaced and currently reside on increasingly marginal lands. 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 highway connecting the settlement to Jerusalem (visible on the 2009 image) was completed in 2003, allowing quick commuter access to the city. 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).

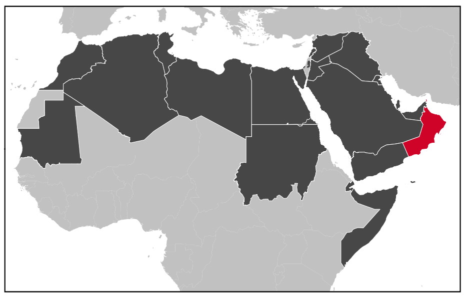
Jabal Abu Ghneim in 1997.

Jabal Abu Ghneim, Occupied Palestinian Territories

Jabal Abu Ghneim, located just south of Occupied East Jerusalem and the 1949 Armistice Line, is an approximately two square km area that was once a forested hillside planted by the Jordanians prior to 1967. It functioned as an ecological reserve with the aim of protecting the deteriorating environment against increasing desertification. The abundant pine trees of Abu Ghneim provided an oasis for several species of animals and plants. For many years, Abu Ghneim and its surrounding areas were designated by the Israeli Jerusalem Municipality as 'an area in which development is restricted so that the beauty of its landscape, as well as ecological diversity might be preserved'. This policy continued until 1991, when the Israeli government approved the construction of a new settlement in Jabal Abu Ghneim (UN 1997).

Jabal Abu Ghneim in 2009

In March 1997, the Israeli government began building 6 500 housing units in Jabal Abu Ghneim to accommodate more than 30 000 settlers (UN 1997). The forest area was cleared, with more than 125 hectares of pine trees cut down (UN 1997). These images show marked development of the entire area from 1963 to 2009, including widespread settlement activity in Jabal Abu Ghneim.



Sultanate of Oman

Total Surface Area: 309 500 km2
Estimated Population in 2010: 2 782 000

Oman, the third largest country on the Arabian Peninsula after Saudi Arabia and Yemen, is surrounded by three seas: the ROPME Sea Area, the Gulf of Oman, and the Arabian Sea. It contains mountain ranges, wadis, and plains, but consists mostly of sand desert. Large, isolated populations of Ghaf (*Prosopsis cineraria)* trees line the margins of Oman's central desert, providing habitat for a number of wildlife species. The southern part of the country experiences heavy monsoon rains that fall between June and October. The interior of the country gets strong summer winds that raise large sandstorms and dust storms that impact infrastructure, affect visibility and air quality and disrupt communications (Attia and others 1999).

Important environmental issues

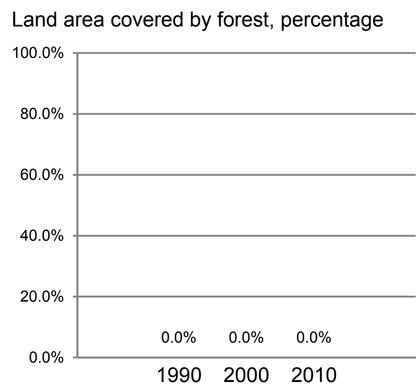
- Water Scarcity and Water Use
- Soil and Groundwater Salinity
- Threats to Coastal Areas and Marine Biodiversity

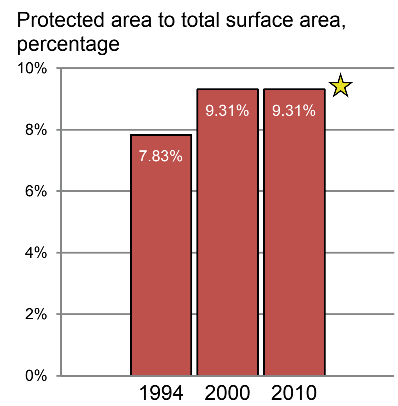
Progress Toward Environmental Sustainability

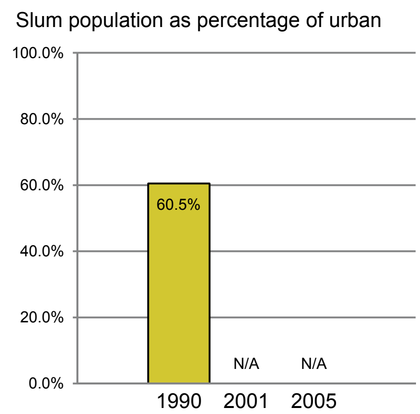
As defined by the United Nations Millennium Development Goal 7 Indicators

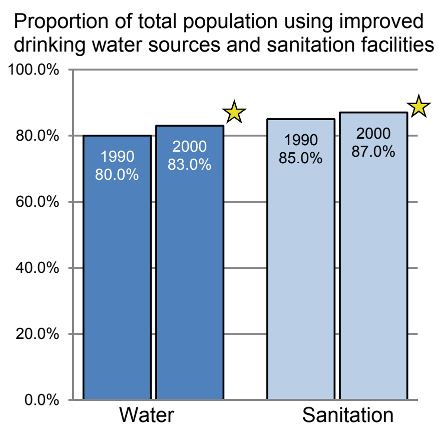
Oman's economic reliance on the oil sector began with its first commercial oil exports in 1967. However, a slump in oil prices in 1998-99 forced the Sultanate to start to diversify its economy. By 2020, the crude oil sector's share of GDP is expected to drop to 9 per cent of Oman's GDP, down from 41 per cent in 1996; natural gas is expected to account for 10 per cent, up from 1 per cent in 1996; and non-oil sectors are expected to contribute nearly four times their 1996 amount (WHO 2006).

☆ Indicates Progress







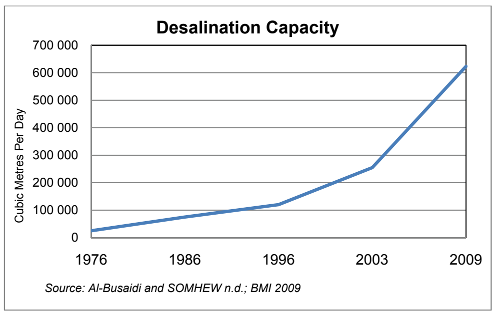


In the more populated regions of Oman, demand for desalinated water is expected to increase by 15 per cent per year from 2007 to 2014

Source: OPWP 2007 in Al-Barwani 2008

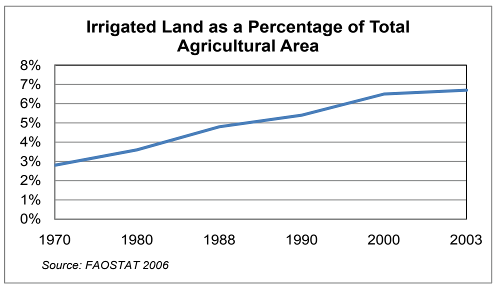
Water Scarcity and Water Use

Oman receives an average annual rainfall of less than 40 mm in the deserts and coastal areas, and reaches 300 mm per year in the mountains. Groundwater accounts for 70 per cent of the water use in the Sultanate (Ministry of Regional Municipalities and Water Resources 2005). 91 per cent of water used is for agriculture, while industry and domestic uses constitute 2 and 7 per cent, respectively (FAOSTAT 2005). Domestic water consumption in the Muscat area increased from 238 481 m^3 in 1971 to 34 068 706 m^3 in 1989. Rapid industrialization coupled with an average annual population growth of 2.9 per cent (2000 to 2005) is also placing pressure on limited water supplies. In 2000, per capita annual water withdrawals (518 m^3) exceeded actual per capita renewable water resources (337 m^3) (FAOSTAT 2005). Desalination of water began in 1976 to supplement scarce water supplies and now provides a large portion of water used in urban areas (Al-Barwani 2008). Al-aflaj are the main source of irrigation water in Oman beside wells and natural springs.



Soil and Groundwater Salinity

Increasing soil and groundwater salinity throughout the Sultanate is threatening soil productivity and impacting agriculture. The main causes of increased salinity in Oman are high temperatures and low precipitation, and proximity to the sea (salt water intrusion, salt water sprays, and saline water floods). The salinization of irrigated soils by groundwater has become a major process of soil salinization in many areas of the Sultanate, particularly in coastal areas (MAF 1993; Hussain and others 2006). Salt affected areas cover 44.2 per cent of Oman (MAF 1993). The coastal plains of Batinah in northern Oman have been severely impacted by salinization, and many farmers have had to abandon their crops due to low productivity; the estimated annual losses from soil and water salinity in Oman are US$49 million (Hussain and others 2006). Efforts are underway to formulate a national strategy for Oman to combat salinity and protect water resources from pollution (ICBA 2009).



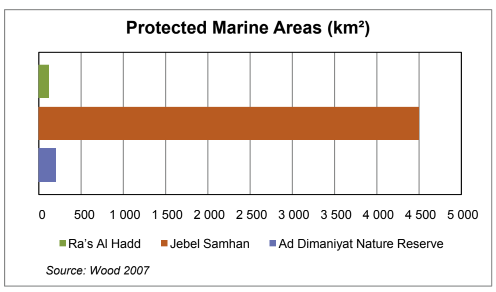
Wadi as Suwayh, Oman. Source: Arian Zwegers/Flickr.com

Oman March 2004 - Woman crossing Wadi in village of Bilat Say. Source: Mark Hills Flickr.com

In 1984, Oman became the first Arab state to create a ministry dedicated to environmental issues

Threats to coastal areas and marine biodiversity

Oman's marine environment is rich in biodiversity, and contains numerous species of whales, dolphins, and sea turtles, many of which are under threat. The coastal and island habitats provide breeding beaches for turtles as well as migrating shorebirds. Coral reef systems, which provide important habitat for fish, lobster and cuttlefish, are threatened off the Oman coast as a result of sediment accumulations from coastal construction projects (especially around Muscat), increased tourism, fishing activities (abandoned nets, traps and anchor damage) and oil pollution from heavy tanker traffic. Oman's long coastline makes it especially vulnerable to oil pollution from tanker operations and accidental spills; the oil leaves beaches covered in heavy petroleum particulate residues (Badawy and Al-Harthy 1991). Protected areas have been established to conserve these threatened coastal and marine ecosystems; as of 2004, the Sultanate had three marine protected areas (FAOSTAT 2005).



Oman – Wadi Bani Khalid. Source: Andries3/Flickr.com


Corniche, Muscat, Oman. Source: Z.Hill

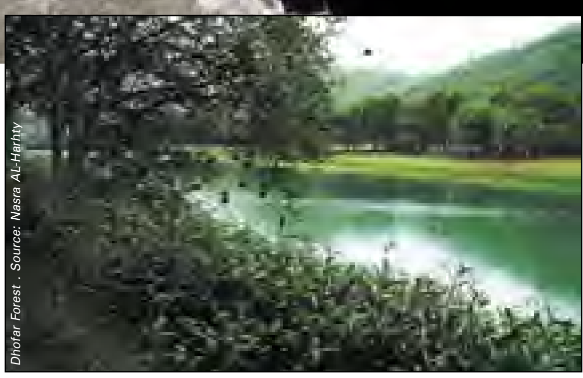
MUSCAT, OMAN

Muscat is the capital and largest city in Oman. It is located in the northeast of the country on the Gulf of Oman. Its strategic location on the coast along with its natural harbours has made it an important trading port for thousands of years (MNE 2006). The urban landscape of Muscat is typified by low-lying white buildings, while the surrounding area is dominated by the peaks of the Western Hajar Mountains, the highest mountain range of the eastern Arabian Peninsula. Muscat experienced rapid infrastructure development beginning in the 1970s. The first five-year plan was launched in 1976 with the intent of making Muscat the centre of government and the largest city in the country (Peterson 2004). Muscat's explosive growth is evident in this change pair.

Mangrove Natural Reserve in Muscat.
Source: Ministry of Information

The 1972 image depicts Muscat prior to implementation of Oman's 'Renaissance' of modernization. The 2005 image shows the result of development, with Muscat burgeoning into the economic and cultural heart of Oman. Rapid urbanization and industrialization in and around Muscat coupled with population growth is putting a strain on already limited natural resources and on freshwater supplies in particular. The Muscat Governorate has 834 760 inhabitants (29 per cent of Oman's population) (MNE 2008). Muscat is vulnerable to large storm systems given its location on the coast. The inset images of Qurm depict infrastructural damage from the 2007 Cyclone Gonu, which overwhelmed the drainage systems in Muscat, and caused heavy flooding. The city's lush palm forests and eucalyptus groves were downed by the high winds and the streets were covered in mud carried by the floodwaters (NDD 2007). The effect of the floodwaters on the Mangrove Nature Reserve at the centre of these images is evident, with heavy channelization and deposition.

Dhofar Forest . Source: Rastapopoulose Flickr.com

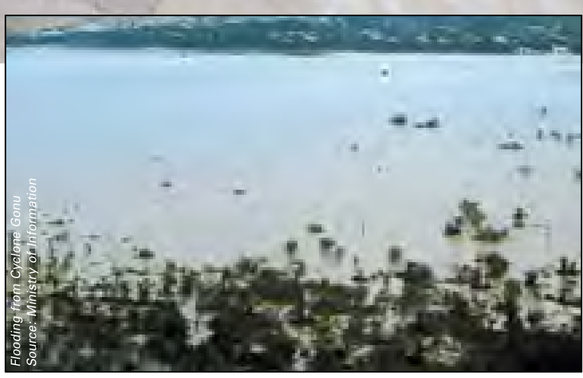

Dhofar Forest . Source: Nasra AL-Harthy

Dhofar, Oman

The Dhofar Governorate of the Sultanate of Oman is located in the southern part of the country bordering Yemen. The Dhofar region is dominated by the Dhofar Mountains, which is a rugged coastal mountain range that enjoys a mild tropical climate throughout the year. The Dhofar Mountains stretch for 400 km from east to west along the southern coast of Oman, reaching peaks of 1 800 m. They are subject to the Khareef, or southwest monsoons that occur in late June to early September (MOI 2009). The rains brought by the monsoon support a variety of lush vegetation and supply springs with water for year-round use. The coastal forests support more than 750 terrestrial plant species, 50 of which are endemic (Shammas 2007a). The Dhofar Mountains are ideal for cattle grazing and livestock rearing, as the area supports an abundance of vegetation.

Excessive grazing by camels and cattle over the past three decades has reduced overall vegetation cover and put more than half of the Dhofar indigenous species at risk of extinction (Shammas 2007a). Loss of vegetation cover also has detrimental effects on water supplies. The vegetation in the cloud forests of the Dhofar Mountains collects fogwater from mist that forms there. Studies have shown that fogwater contributes 60 to 80 per cent of the annual natural recharge of the Salalah coastal plain aquifer, upon which much of the local population relies (Shammas 2007b). This change pair documents the loss of vegetation in the Dhofar Mountains from 18 October 1973 to 20 October 2006. In the 2006 image, the reduction in vegetation is highly pronounced to the north of the mountains and in the valleys, where roads have provided easy access for livestock grazing. In contrast, the 1973 image shows roads confined to the area immediately surrounding Salalah, and shows more extensive vegetation.

Cyclone Gonu. Source: NASA MODIS

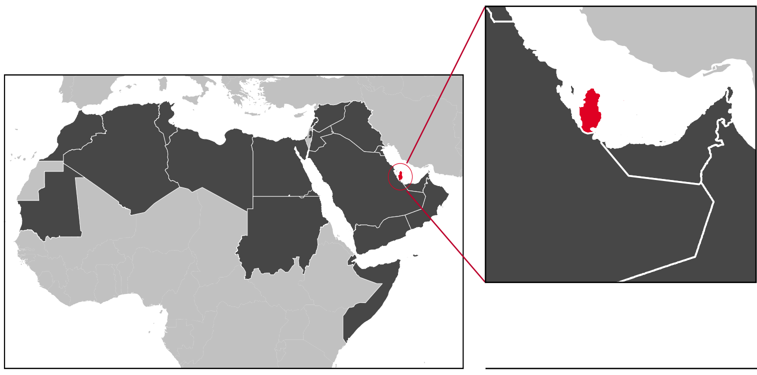


Flooding from Cyclone Gonu
Source: Ministry of Information

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). Gonu developed from an area of convection in the eastern Arabian Sea on 1 June and rapidly intensified as it came in contact with warm sea surface temperatures to attain peak winds of 240 km/h. Gonu weakened as it encountered dry air and cooler waters off the coast of Oman, but still achieved winds in excess of 150 km/h as it made landfall (JTWC 2007). Intense cyclones are infrequent in the Arabian Sea; most storms in the area tend to be small and disperse quickly (NASA 2007). Storms that do reach Oman usually have tropical storm-force winds, rather than the hurricane-force winds experienced with Gonu.

The storm also 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. The 3 July 2005 image depicts the Quryat area (just southeast of Muscat) prior to Gonu, while the 16 November 2007 image shows the immense devastation after the storm. 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.



State of Qatar

Total Surface Area: 11 586 km²
Estimated Population in 2009: 1 696 563

The State of Qatar is located on a peninsula that is surrounded by the ROPME Sea Area, and shares a land border with Saudi Arabia to the south. The land is desert or semi-desert, and receives an annual average rainfall of 75 mm. It has no rivers or lakes and the primary sources of water are rainfall and groundwater. The main landscape features are sand dunes, *sabkhas* (salt flat), depressions and wadis. About 80 per cent of Qatar's population is urban, most of whom reside in the capital city of Doha. Exploitation of oil and gas reserves since 1949 has resulted in significant changes in demographics and diversification of the economy with establishment of the steel, iron, fertilizer, chemical, cement, and petrochemical industries (UNCSD 1997; IMF 2011).

Important environmental issues

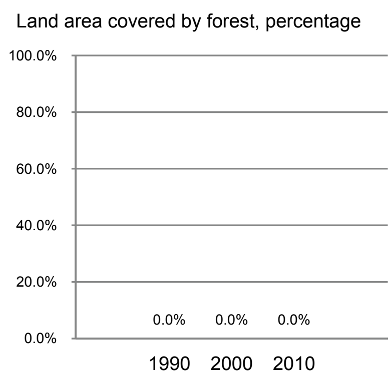
- Water Scarcity
- Desertification and Land Degradation
- Threats to Marine and Coastal Ecosystems

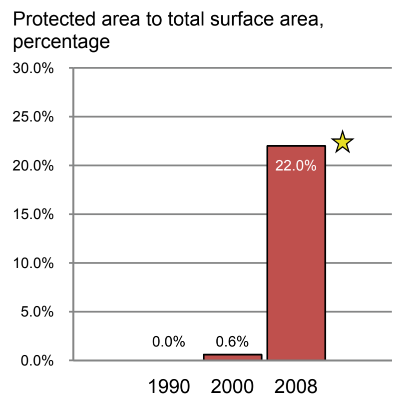
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

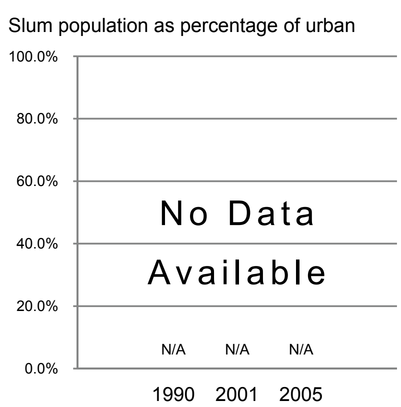
☆ Indicates Progress

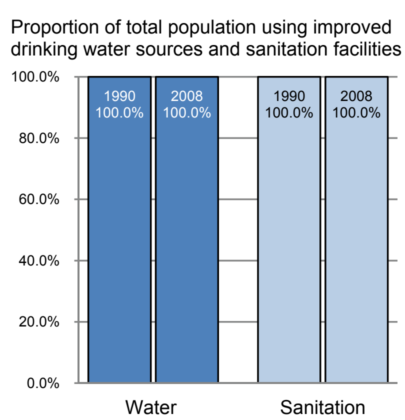
Though Qatar is a water-deficient nation, the per capita water consumption is one of the highest in the world (PPC 2008). High consumption rates are largely due to substantial improvements in the standard of living from oil and gas revenues, government subsidies and lack of tariffs. Qatar's annual production of oil and gas represents 700 barrels of oil equivalent (boe) per head, while in Saudi Arabia the figure is 150 boe (GCC 2008). This high boe per capita is a major contributing factor in Qatar's lead global standing in terms of GDP per capita.





Source: Ministry of Environment 2008



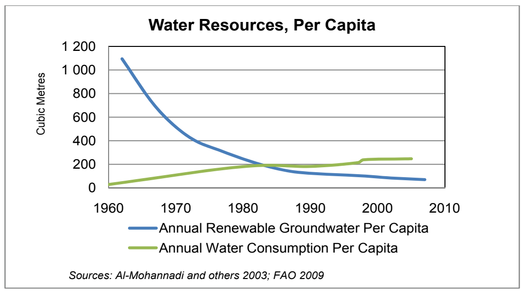


Qatar was the first country in the Arab region to breed the Arabian oryx (Oryx leucoryx), Qatar's national animal, in captivity. The Arabian oryx was listed as endangered in 1996

Source: IUCN 2009

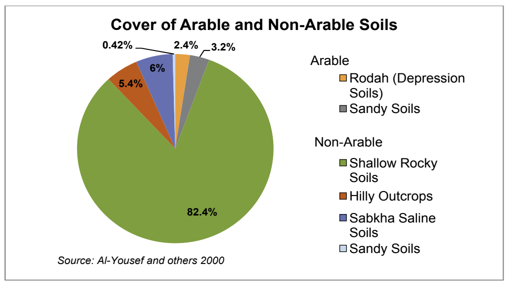
Water Scarcity

Qatar's unprecedented population growth (10.65 per cent per year from 2005 to 2010), coupled with rapid industrialization and urbanization has placed heavy demands on limited water resources. In a country with limited rainfall and no permanent surface water supplies, groundwater provides 49.7 per cent of the total water use. A bulk of this groundwater (83.5 per cent) is used for agriculture; overall, agricultural uses constitute 74 per cent of total water withdrawals, while 23 per cent is for domestic use and 3 per cent for industry (FAO 2008). Desalinated seawater and tertiary treated sewage water represent 40.6 and 9.7 per cent, respectively, of the total water withdrawals. The annual renewable groundwater per capita is about 71 m^3, while the rate of extraction per capita is far higher at 390 m^3 per year (Amer and Al-Mahmoud 2003). Drawdown of these vital underground aquifers due to overexploitation and lack of recharge is causing groundwater salinity levels to increase, which results in infertile soils and low crop yields.



Desertification and Land Degradation

Desertification and land degradation in Qatar can be attributed to precipitous declines in groundwater levels, increased salinity of the groundwater, and encroachment of sand on agricultural lands (UNCCD 2000). In Qatar, overgrazing of already marginal lands removes vegetation that prevents soil erosion; vegetation cover has been reduced from 10 per cent of total land cover to 1 per cent (Kanady 2009). Removal of the topsoil from wind and water erosion leads to a loss of agricultural production and of biodiversity. The total area affected by wind erosion in Qatar was estimated at 191 000 ha; with 21 000 ha of agricultural lands being lost to wind desertification (FAO 1992). Encroachment of sand dunes on agricultural and rangelands is especially prominent in the southern regions where the rate of sand dune movement is estimated at 8 km per year (UN 2002). Moderate to severe land degradation affects more than 90 per cent of rangelands (Harahash and Tateishi 2000).



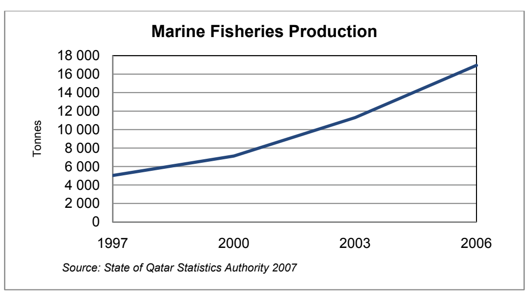

Rheem gazelle. Source: Animalpicturesarchive.com

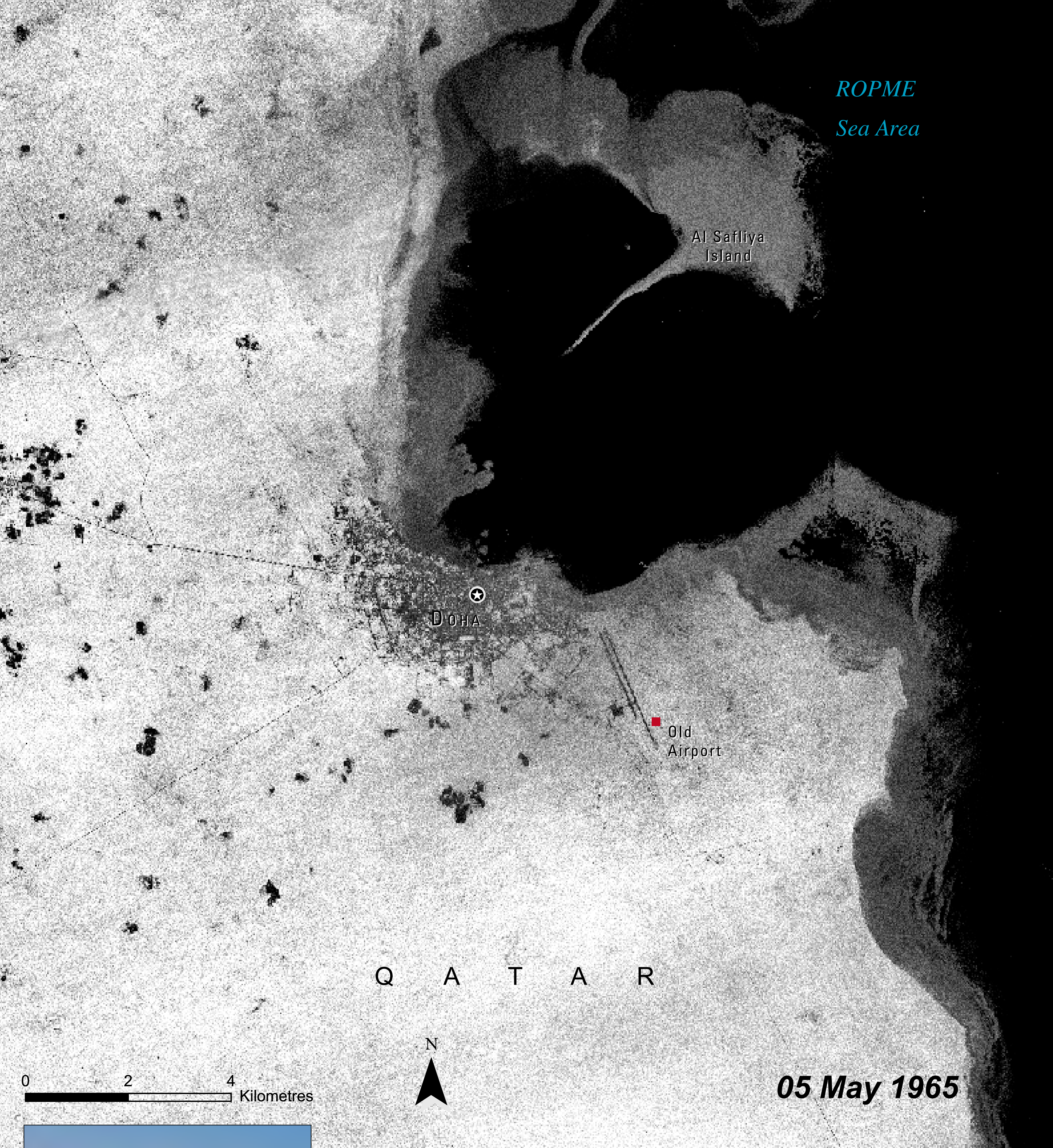
Doha, Qatar. Source: M. Lubinski/Flickr.com


Al Rayyan, Qatarr. Source: Pedroner/Flickr.com

Threats to marine and Coastal Ecosystems

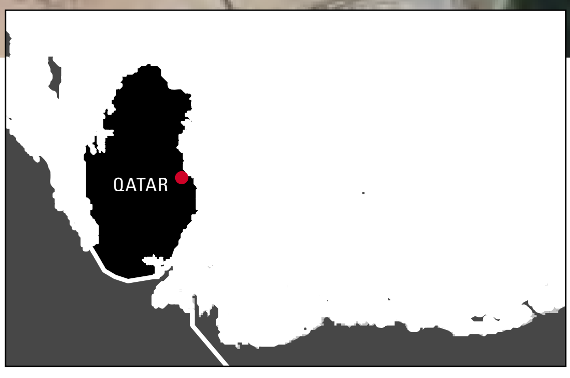
The coastline of Qatar and its numerous offshore islands extend for more than 900 km. The coastal zone supports a number of environmentally sensitive areas such as mangrove forests, coral reefs, and seagrasses, which provide feeding and spawning grounds for many different species. The marine environment, a source of national pride that supports 955 known species, is under threat due to increased tourism, dredging and reclamation, rising salinity and destruction and bleaching of coral reefs due to construction activities and climate change (PPC 2008). Pollutants from oil spills are the greatest contamination source in coastal waters; other sources are from untreated industrial effluents, sewage and waste (UNCSD 1997). The over exploitation of fish stocks is a common threat to marine ecosystems throughout the Arabian Gulf. The total local catch of fish in Qatar increased from 4 271.3 tonnes in 1995 to 7 139.6 tonnes in 2000 for an increase of approximately 67% since 1995 (Qatar 2000).



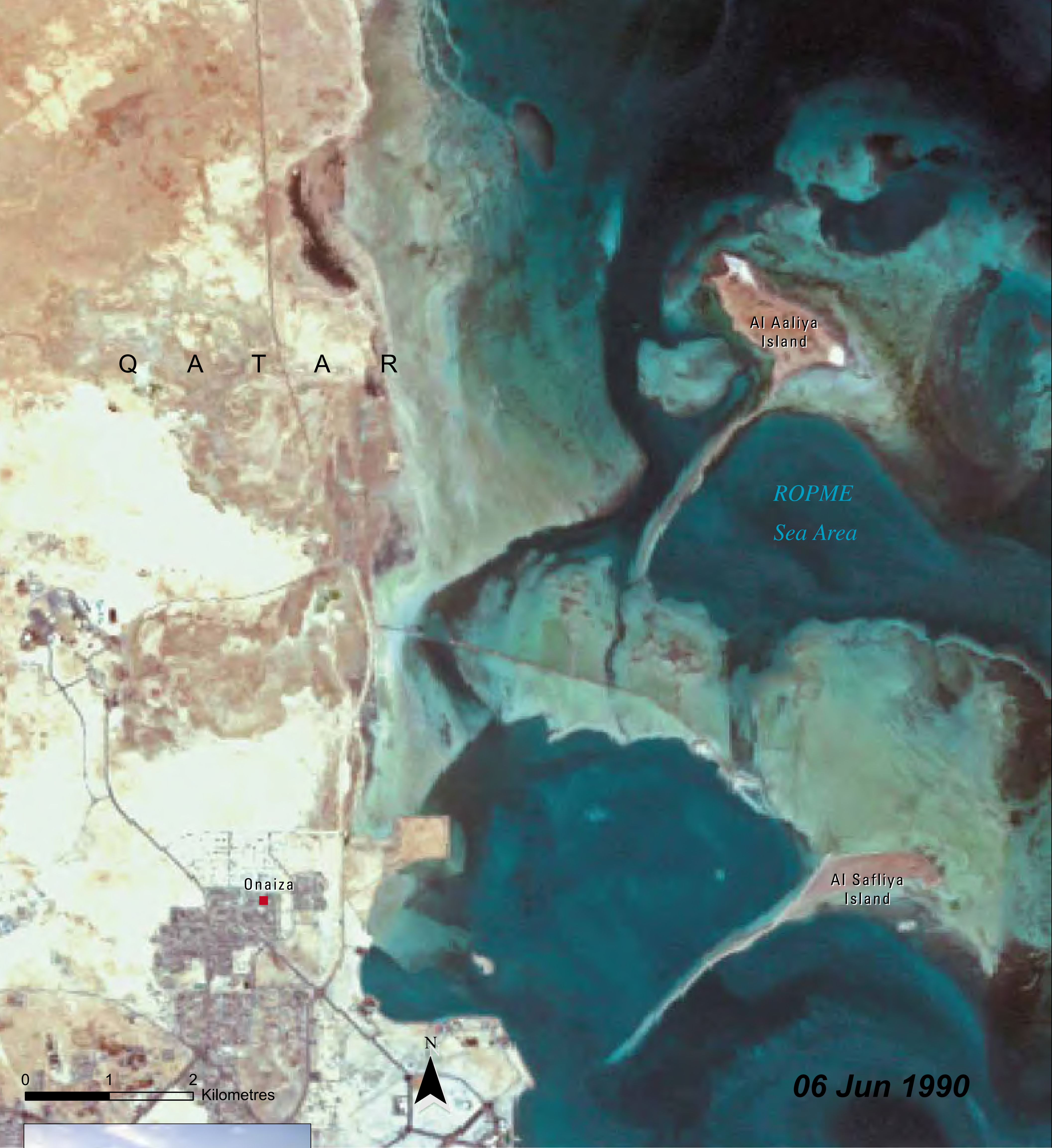


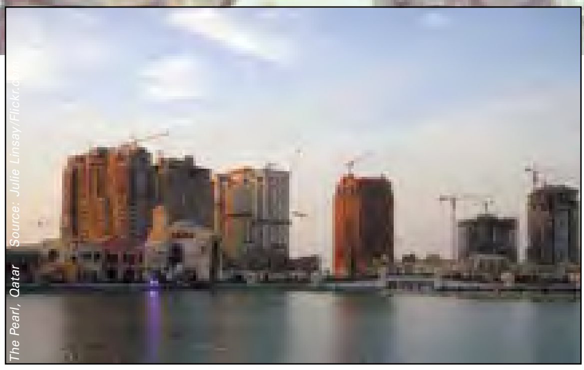
Doha, Qatar

Doha, the capital and largest city in Qatar, is located on the eastern central coast along the ROPME Sea Area. Doha serves as Qatar's economic, governmental and cultural centre and supports almost half of the country's population, which grew from 20 000 in 1950 to 776 000 in 2005. The population in Doha is currently estimated at 1 357 000 (UNDESA 2010). During the early 20th century, Qatar's economy depended exclusively on the fishing and pearling industry. After the introduction of cultured pearls by the Japanese in the 1930s, Qatar experienced a major economic downturn. This was quickly reversed when Qatar began exporting oil in 1949— Qatar now produces over 800 000 barrels of oil per day and is one of the richest countries in the world (Richer 2008). Revenues from the oil industry are responsible for transforming Doha into the modern metropolis it is today.



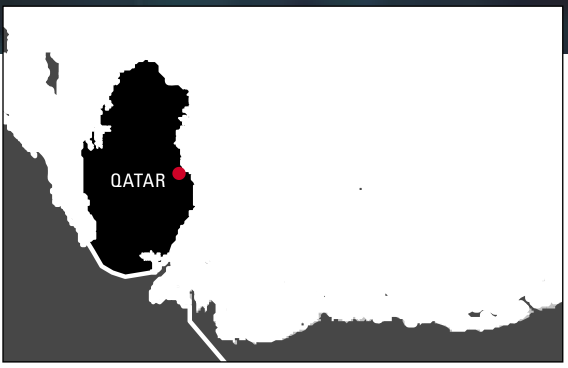
Doha's dramatic growth from 1965 to 2009 is clearly evident from these images. While the extent of the city has grown significantly in the past 30 years, the coastline has also experienced considerable alteration through land reclamation projects and the development of artificial islands. Extensive reclamation areas have occurred at the Doha Port and the New Doha International Airport. This growth has been at the expense of fragile intertidal and shallow tidal ecosystems, where increased turbidity due to sediment loads stress fish stocks by damaging nursery and feeding grounds. The increased population in Doha has placed greater demands on land for housing and recreation, waste disposal and sewage treatment facilities (Richer 2008). The increased demand for scarce water supplies has been met by producing more desalinated water and recycled wastewater. Due to decades of overexploitation, groundwater is no longer sufficient or reliable, especially in coastal areas such as Doha, where the aquifers underlying the city have experienced high rates of saltwater intrusion.



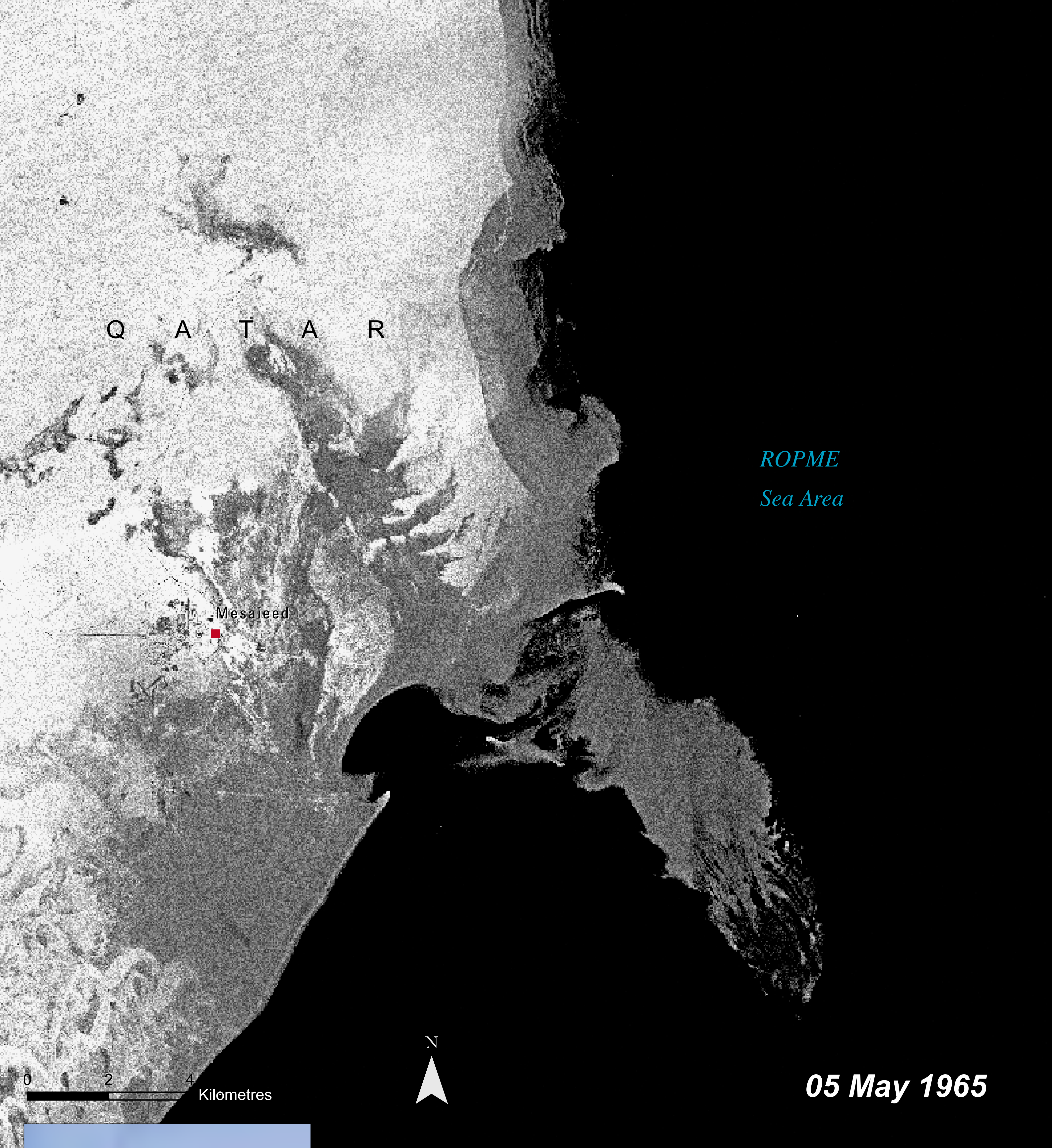


The Pearl and Lusail City, Qatar

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 400 ha island complex is shaped like a string of pearls and diamonds that are linked to the mainland by a four-lane highway (UDC 2011). 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.



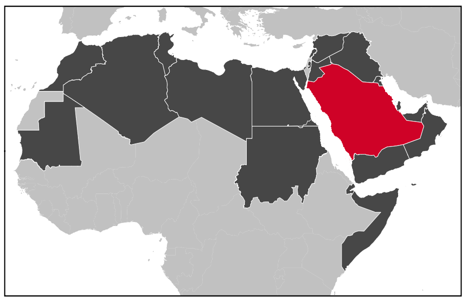
However, along with these luxury developments comes the threat of dramatic population growth and urban expansion. Water consumption and demand have risen sharply, with a 300 per cent increase in drinking water production (mainly from desalination) and storage since 2000 (UN 2009). From 2008 to 2013, the demand for water in Qatar is expected to increase by 11 per cent annually (QEW 2008). 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. In the 2009 image, The Pearl City appears nearly completed while the initial stages of Lusail City are evident just to the north.



MESAIEED INDUSTRIAL CITY, QATAR

Mesaieed Industrial City (MIC), located approximately 40 km south of Doha on the ROPME Sea Area, was one of the first industrial cities built in Qatar in 1949. MIC initially functioned as a tanker terminal for Qatar Petroleum and now hosts a variety of petroleum-based industries including refineries, petrochemical plants and steel plants. Currently, it includes an expanding residential community that is home to 13 000 residents; by 2015 the population is expected to reach 25 000 (SGS n.d.). About 60 per cent of Qatar's GDP is generated through operations at MIC, with over 2 200 ships passing through its port each year (RasGas 2008). While the economic and strategic importance of MIC cannot be disputed, the environmental costs of heavy shipping traffic and concentrated industrial activities along the coastline are negatively impacting coastal and marine ecosystems.

Cooling waters used for industrial activities generate thermal plumes that increase temperatures in waters where aquatic species are already at their thermal limit. Decreases in marine diversity and impacts to zooplankton populations have been documented in waters adjacent to MIC (Nour El-Din 2004); species such as corals are particularly at risk as they are immobile. Coral bleaching, which occurs as a result of high temperatures, has reduced live coral cover to as little as 1 per cent in Qatar's shallow coastal waters, causing significant decreases in fish stocks and species richness (Riegl 2002). Pollution of coastal waters from oil tanker exhaust, leaks, ballast exchange and spills puts marine ecosystems at further risk of degradation. These images illustrate the transformation of the coastline in the MIC area from May 1965 to June 2008.



KINGDOM OF
SAUDI ARABIA

TOTAL SURFACE AREA: 2 149 690 KM²
ESTIMATED POPULATION IN 2010: 27 448 000

The Kingdom of Saudi Arabia occupies the bulk of the Arabian Peninsula and is composed primarily of desert. It is bordered by eight Arab countries. The ROPME Sea Area lies to the northeast and the Red Sea to the west. Temperatures are generally very hot; midday temperatures from June through August can soar to 50°C and humidity in the coastal regions approaches 100 per cent. The terrain is varied but generally barren desert with salt flats, gravel plains and sand dunes; mountains in the south west rise to 2 700 m. The southern part of the country contains the Rub Al-Khali (Empty Quarter), the largest sand desert in the world. Saudi Arabia's capital Riyadh, located in the Eastern Province, is the site of some of the largest oil fields in the world.

Important environmental issues

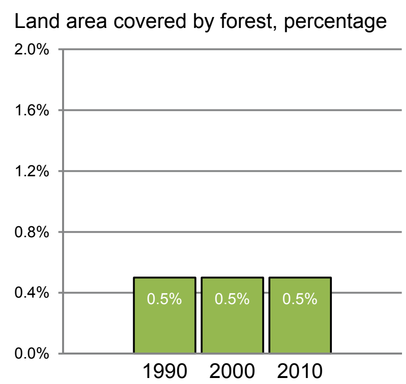
- Water Scarcity and Water Demand
- Desertification and Land Degradation
- Oil Contamination of Coastal Zones

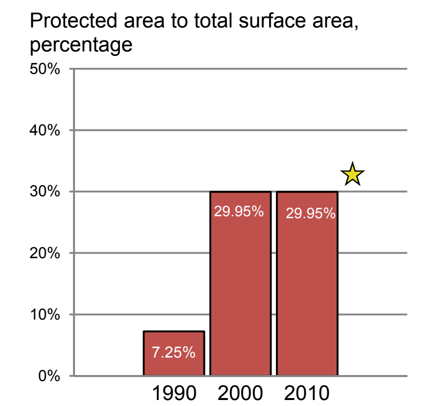
PROGRESS TOWARD ENVIRONMENTAL SUSTAINABILITY

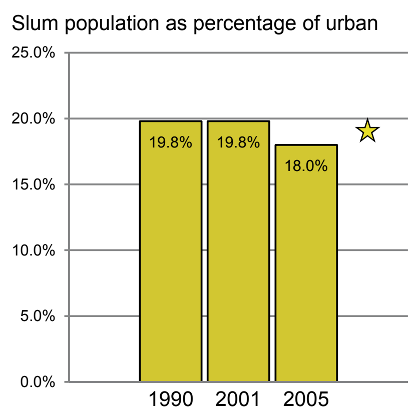
AS DEFINED BY THE UNITED NATIONS MILLENNIUM DEVELOPMENT GOAL 7 INDICATORS

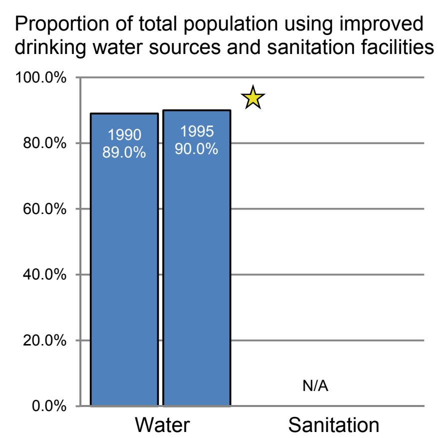
During the 1970s, the Kingdom began implementing five year plans for developing Saudi Arabia's infrastructure, health, education, social services, and industry. In line with the Kingdom's MDG commitments, the 2005-2009 development plan emphasized protection of the environment and conservation of natural resources. To promote sustainable development, Saudi Arabia is investing US$300 million in research and development in carbon capture and storage technologies (Raouf 2008).

☆ Indicates Progress







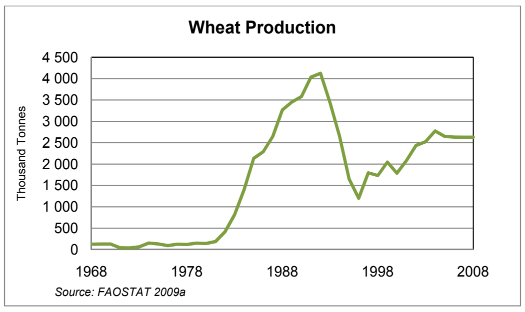


SAUDI ARABIA IS THE LARGEST PRODUCER OF DESALINATED WATER IN THE WORLD: IN 2004, THE VOLUME OF WATER SUPPLIED BY THE COUNTRY'S 30 GOVERNMENT-OPERATED DESALINATION PLANTS REACHED 1.1 THOUSAND MILLION M³

Source: World Bank 2007

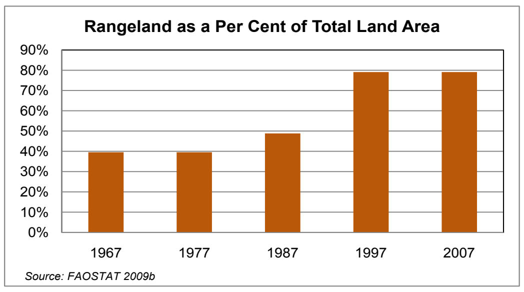
Water Scarcity and Water Demand

Saudi Arabia faces severe water challenges, balancing supply and demand while facing aridity and water scarcity, non-renewable supplies, poor groundwater quality, saltwater intrusion, and overdrafting and contamination of aquifers (Mohorjy and Grigg 1995). Chronic water shortages and rising population forced the Kingdom to invest heavily in seawater desalination, which now supplies 70 per cent of the country's drinking water. Saudi Arabia's population is expected to exceed 29 million by 2010 and increase to 36.4 million by 2020—the resulting demand for water will increase from over 3 000 m^3/year in 2010 to approximately 4 000 m^3/year by 2020 (Dagbah and Abderrahman 1997). Saudi Arabia is the world's largest producer of desalinated water; desalinated water supplies the major inland urban and industrial centres through a network of water pipes that run for more than 3 700 km. Policies to reduce water demand have been implemented and include limits on consumption and reductions in intensive agricultural practices like wheat production.



Desertification and Land Degradation

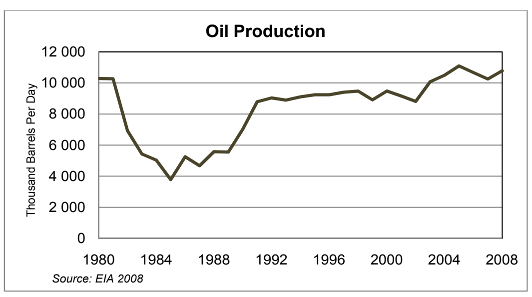
Saudi Arabia consists mostly of arid or semi-arid lands, with uninhabitable desert covering nearly half of the country; only 1.67 per cent of Saudi land is arable (Vincent 2008). Desertification and land degradation from wind erosion, overgrazing, deforestation, inefficient irrigation practices and drought are primary causes of degradation that lead to soil erosion, salinization and solidification, decreased land productivity and reduced vegetation cover. Rapid social and economic changes associated with the development of the oil industry over the past century have accelerated land degradation. Poor irrigation practices contribute to water logging and salinization, which affects about 63 per cent of irrigated lands. Overgrazing is a key factor in the desertification of rangelands, which cover 75 per cent of the total land area of Saudi Arabia; 60 per cent of these rangelands are estimated to be seriously degraded (Vincent 2008). Overstocking of rangelands by some 40 per cent is the main cause of degradation (Vincent 2008).

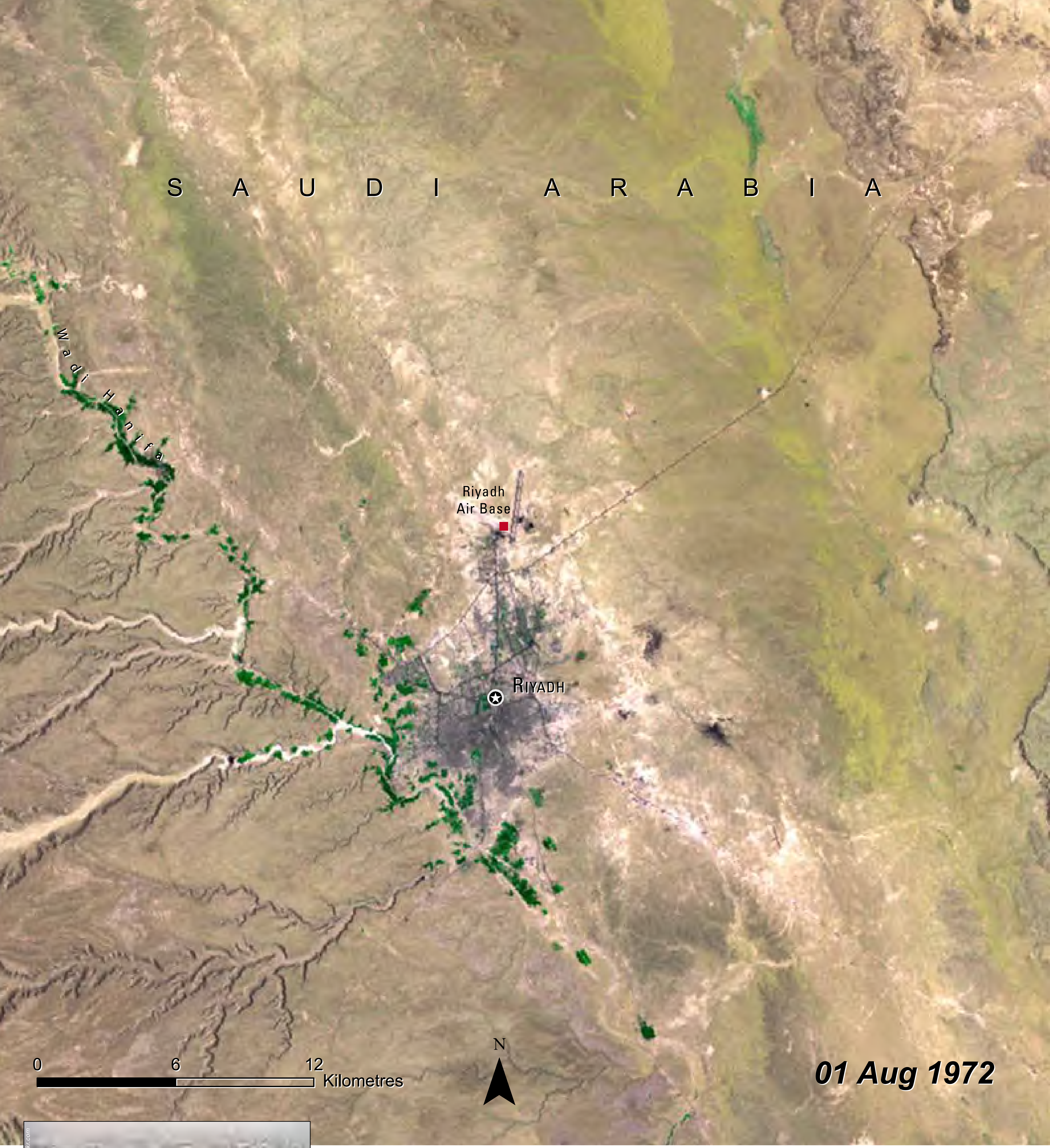


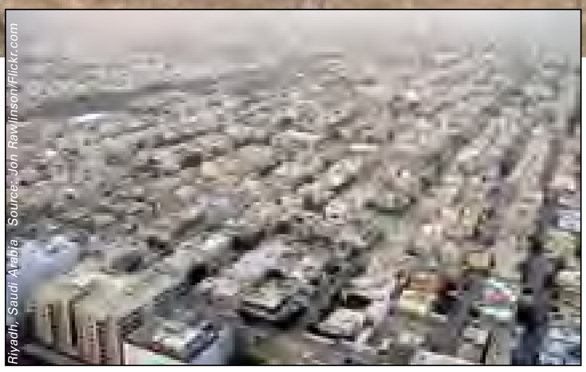
A 30-year programme initiated in the early 1970s to increase wheat production in Saudi Arabia is being phased out by the government due to scarce water supplies; by 2016, the Kingdom will rely entirely on wheat imports

Oil Contamination of Coastal Zones

The Kingdom's long coastline and extensive marine resources are sensitive to environmental pressures from urban, industrial, agricultural, recreational and fishing activities, desalination plants, ports and oil drilling. Oil spills are a major threat to the Red Sea and the ROPME Sea Area. The ROPME Sea Area has experienced a number of moderate-to-large oil spills over the past 20 years. During the 1980 to 1988 Iran-Iraq war, oil tankers in the ROPME Sea Area were attacked, resulting in the spill of thousands of barrels of oil (Vincent 2008). In 1991, an additional six million barrels of oil were pumped deliberately into the sea during Iraq's occupation of Kuwait. The counter-clockwise currents transported the oil slicks south and the winds kept the slicks close to shore, severely contaminating some 650 km of the Saudi Arabian coastline with oil (UN n.d.). Marine reserves have been created in the ROPME Sea Area and the Red Sea to protect Saudi Arabia's marine life and reduce disturbance to coastal ecosystems.

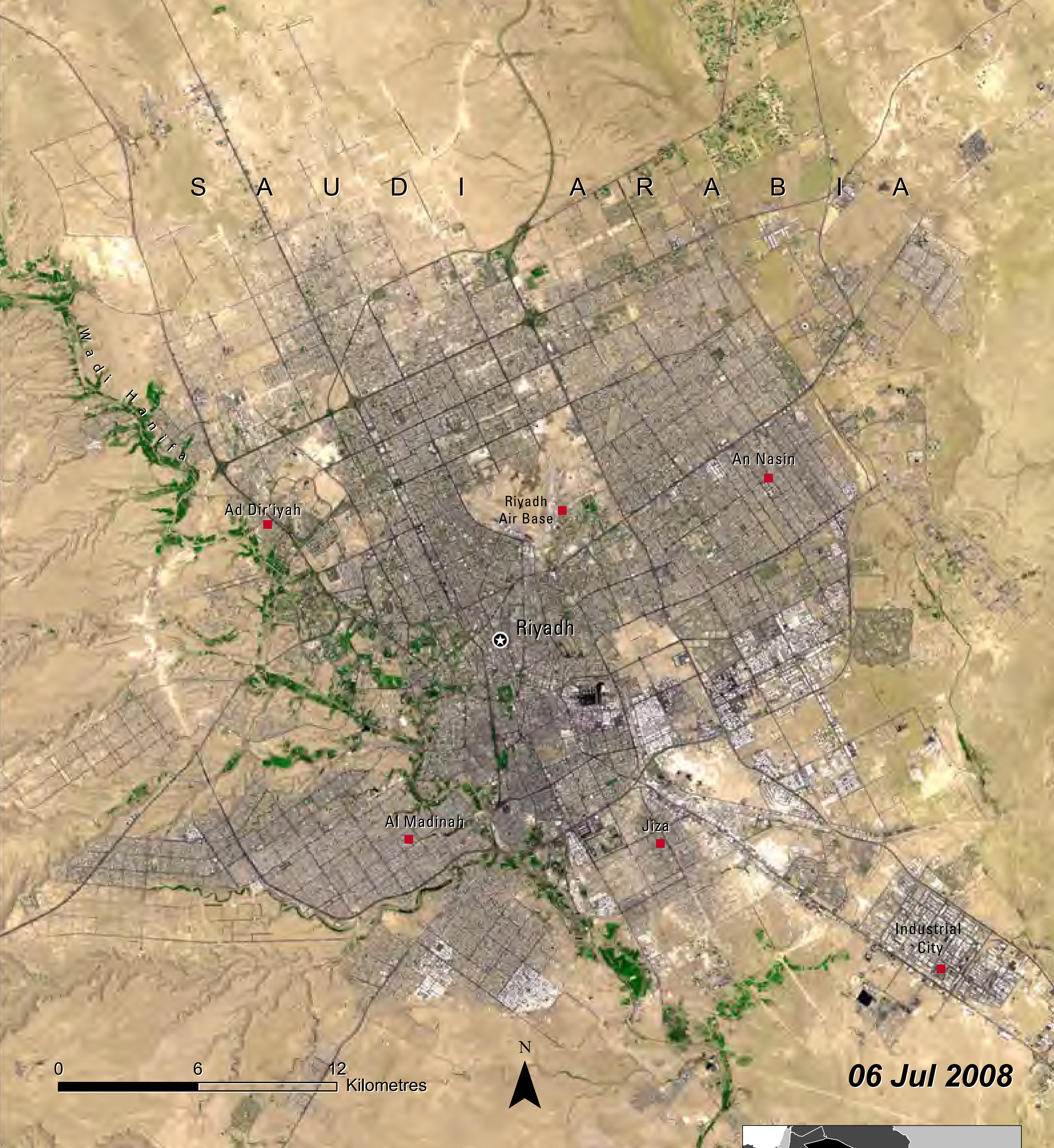




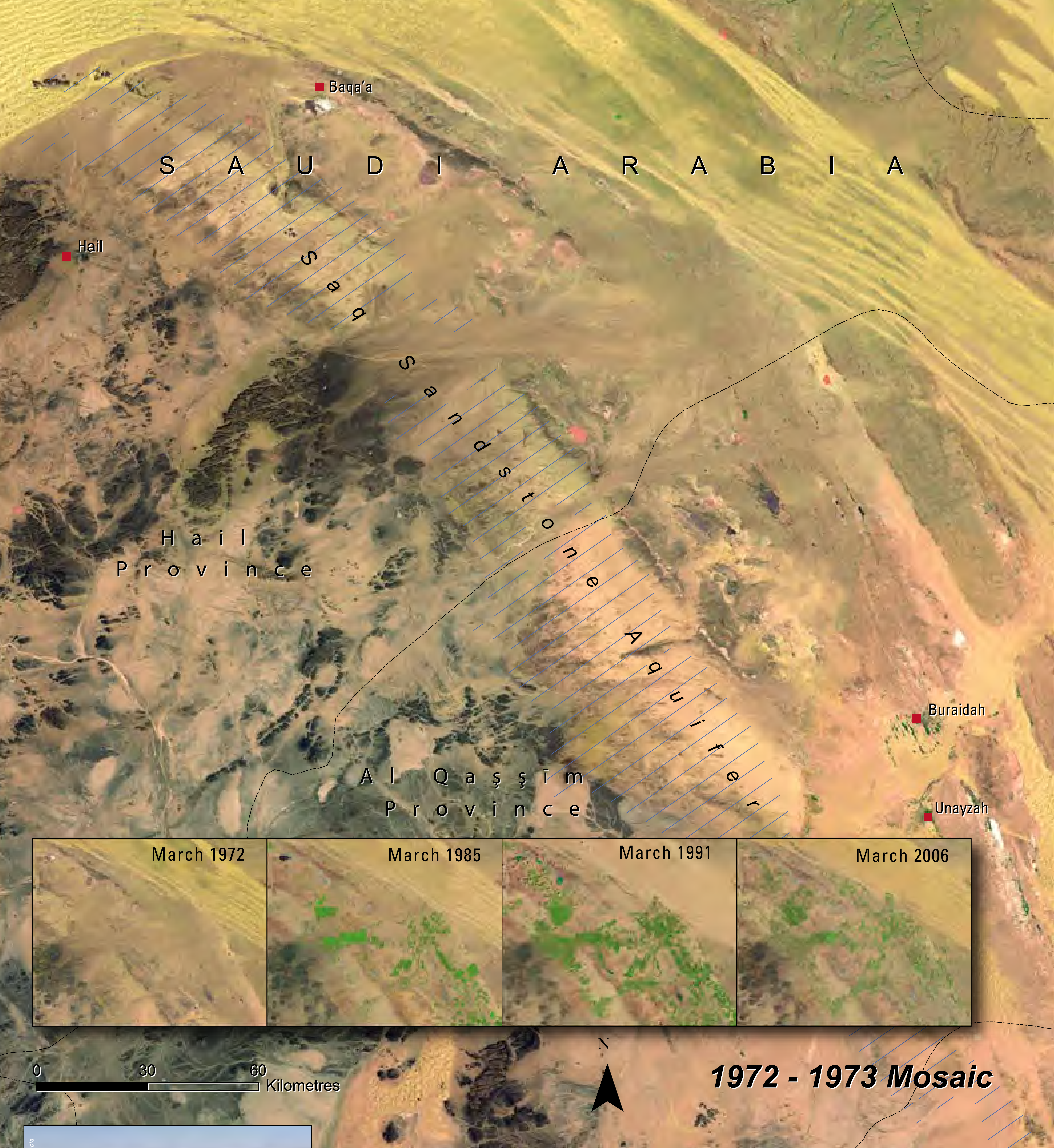

Riyadh, Saudi Arabia. Source: Jon Rawlinson/Flickr.com

Riyadh, Saudi Arabia

Once a tribal enclave that covered an area of less than 1 km^2, Riyadh, Saudi Arabia's capital and largest city, now occupies an area of 1 600 km^2 and is one of the fastest growing cities in West Asia. It is the Kingdom's legislative, financial, administrative, diplomatic and commercial centre. Riyadh is located in the heart of the Arabian Peninsula and was originally established in 1746 around several small oases. The discovery of oil in the Eastern Province in 1938 and the subsequent oil boom spurred explosive growth in Riyadh from 1968 to present (Oteibi and others 1993). This large ultramodern city, which was home to 350 000 people in 1970, now has a population of 4.8 million and is expected to reach 11 million by 2020 (Alkhedheiri 2002).

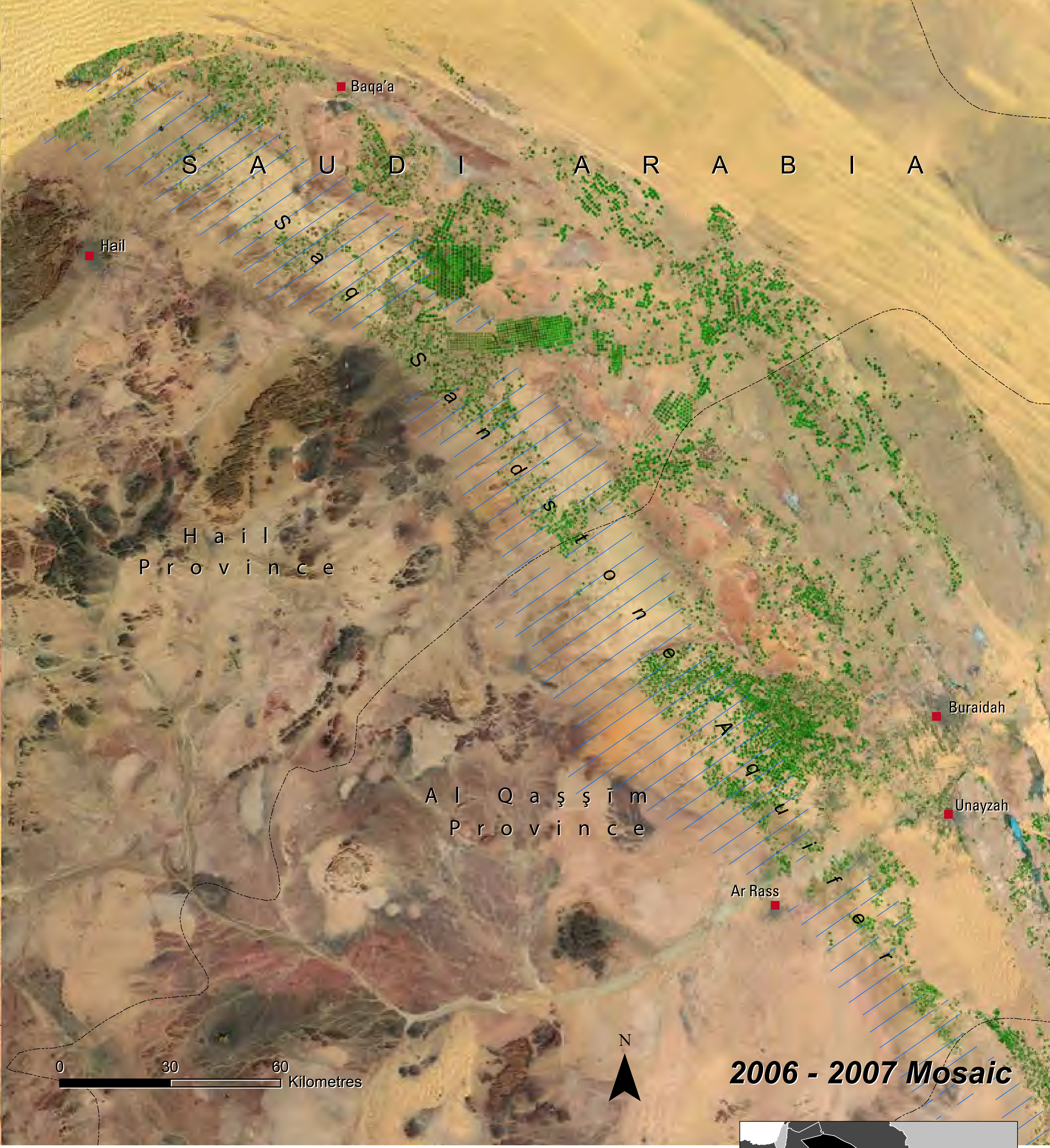


The impact of this growth threatens the sustainability of the city. Only one-third of the city has fully developed infrastructure that includes water supply, electricity, sewerage, drainage and roads (Garba n.d.). Desalinated water transported over 460 km is mixed with groundwater from eight well fields to provide water to the city. Water production and supply has lagged behind demand since 1991 and groundwater levels are rapidly declining (HCDR 1997). Air pollution from industrial areas (especially in the southeast of the city), automobile emissions and construction dust, is increasing (Al Rajhi and others 1996). These images document the significant growth of the Kingdom's capital city from 1972 to 2008. The green that is shown coursing through the city is Wadi Hanifa and its tributaries. The wadi, which has been an agricultural centre for centuries, is being overrun by residential developments and is impacted by discharge of polluted effluents, garbage dumping and stone quarrying (Al-Asad 2004).

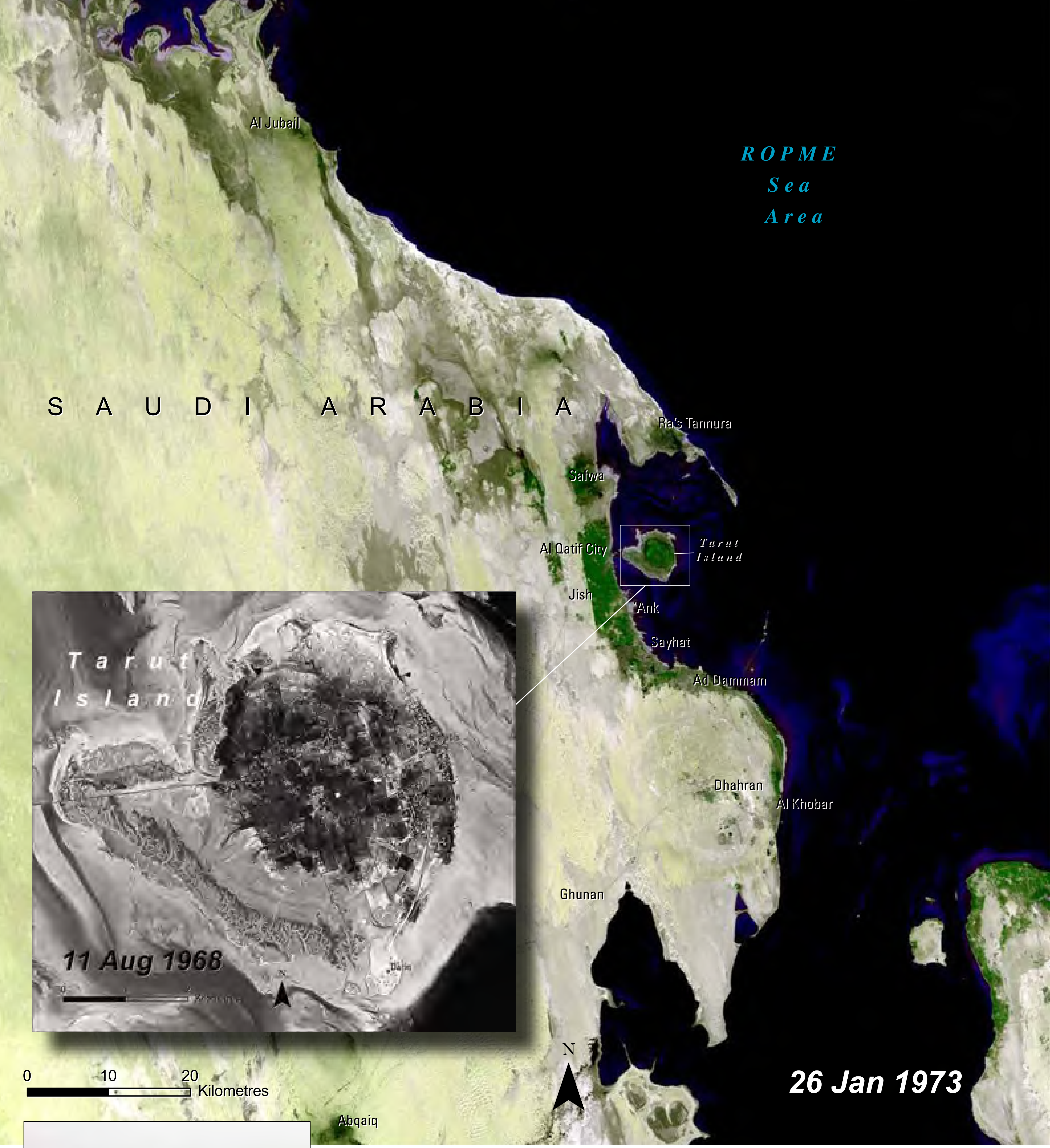


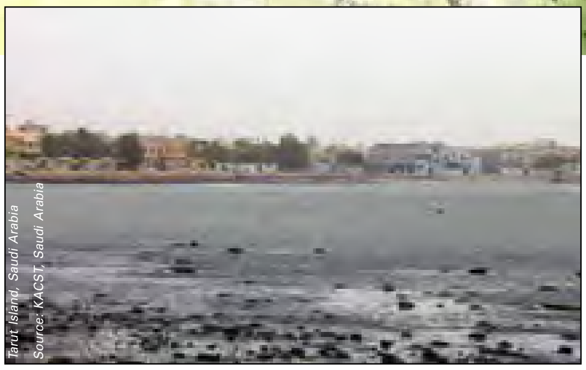
Hail - Qassim, Saudi Arabia

The provinces of Al Qassim and Hail are located in the centre of the Arabian Peninsula to the northwest of Riyadh. Underlying this rocky plateau interspersed with sand desert and isolated mountain groups is the Saq Sandstone Aquifer, the most important groundwater reservoir on the Arabian Peninsula (Al-Ahmadi 2008). This aquifer extends over 1 200 km in Saudi Arabia and north into Jordan. Groundwater from the Saq aquifer supplies the many agricultural projects in the region and has facilitated the rapid urbanization and agricultural development here since the early 1950s. Studies indicate that this major aquifer contains a significant amount of fossil water (estimated at 280 000 MCM) that is 22 000 to 28 000 years old (Segar 1988; Lloyd and Pim 1990; Edgell 1997).



With little present-day recharge, the extensive pumping of fossil water has decreased the groundwater levels. Since 1999, groundwater levels have dropped at an average rate of 2.3 to 10.5 m per year (Al Ahmadi 2008). Groundwater salinity levels have also increased and are higher just to the east and west of Al Qassim Province (Sharaf and Hussein 1996). The time series images above depict the agricultural development that occurred in this region from 1972/1973 to 2006/2007. The amount of cultivated area (shown as green circles that represent centre-pivot irrigation systems) peaked in the 1990s with the help of government subsidies, and then experienced a sharp decline in the late 1990s. This decline is attributed to the lack of continued subsidization and promotion by the government, decreased water levels from overpumping of wells and contamination of soils.

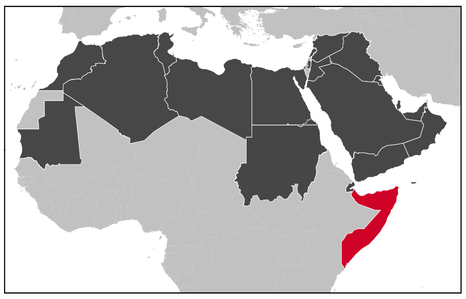



Tarut Island, Saudi Arabia
Source: KACST, Saudi Arabia

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 km^2. As Saudi Arabia's principal commercial port on the ROPME Sea Area, the Dammam Area is also headquarters of the Kingdom's oil industry. 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.). Sulfur dioxide and other harmful pollutants emitted from the Dammam Area have created a highly corrosive environment along the eastern coast of Saudi Arabia (Ahmad and others n.d.; AFED 2009). 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). Just north of Tarut Island lies Ras Tanura, a narrow spit of land which juts into the sea. Ras Tanura consists of two piers, a refinery and a complex of man-made islands (Saudi Aramco 2010). These images illustrate the rapid industrial-driven growth in this coastal region of the Kingdom from 1973 to 2009.



Somali Republic

Total Surface Area: 637 657 km^2
Estimated Population in 2010: 9 331 000

Somalia is located in East Africa and borders Ethiopia, Kenya and Djibouti. Its coastline (3 898 km) is the longest in Africa and borders the Gulf of Aden to the north and the Indian Ocean to the east. Except for some forested lands, the land is mostly desert with flat to undulating plateaus rising to hills in the north. The climate is hot and dry with considerable seasonal temperature variations. Mean temperatures range from 21ºC to 30ºC in the lowlands to 9ºC to 21ºC in the mountains. Average annual rainfall is less than 280 mm. Somalia is subject to recurrent drought and occasional tsunamis and floods; the December 2004 tsunami impacted 650 km of Somalia's coastline and killed more than 300 people.

Important environmental issues

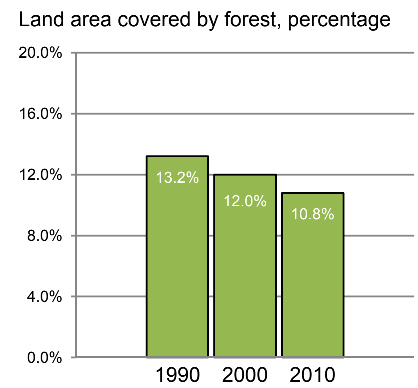
- Water Scarcity and Drought
- Desertification, Overgrazing and Deforestation
- Threats to Biodiversity

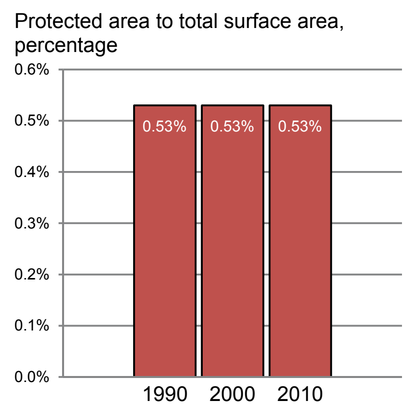
Progress Toward Environmental Sustainability

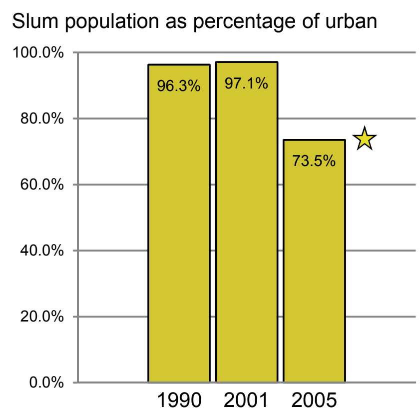
As defined by the United Nations Millennium Development Goal 7 Indicators

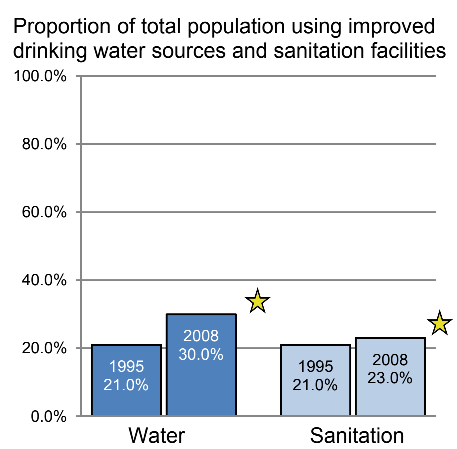
☆ Indicates Progress

Somalia is plagued by civil war and grinding poverty. It is the site of the world's worst humanitarian crisis, with drought leading to the death of tens of thousands of Somalis, half of those children, over a period of only four months (UN 2011). 1.5 million Somalis are internally displaced, and over 900 000 have fled to neighbouring countries Kenya, Ethiopia and Djibouti to escape drought and violence (UNCHR 2011). The drought has left 4 million Somalis, more than 50 per cent of the population, in need of humanitarian assistance, with an estimated one in three children acutely malnourished (UN News Centre 2011).







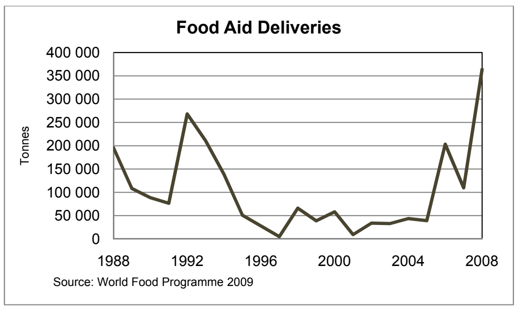


The area to the west of Mogadishu that lies between Somalia's two permanently flowing rivers (Jubba and Shabeelle) is the most fertile region in the country and home to remnant populations of hippopotamus (Hippopotamus amphibius)

Source: IUCN 2010

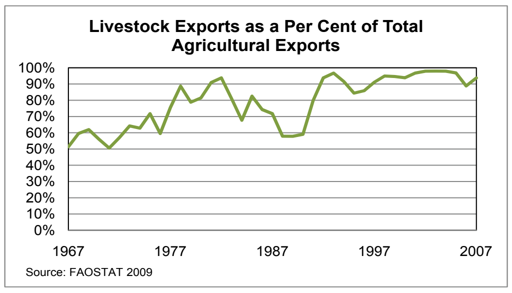
Water Scarcity and Drought

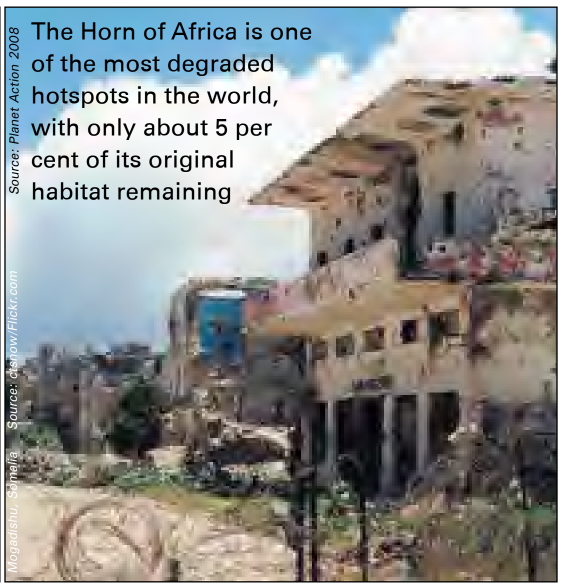
Somalia's scant water resources come from sporadic rainfall (50-500 mm per year), surface waters (Jubba and Shabeelle rivers in the south) and groundwater in the north and east. Ninety-seven per cent of Somalia's water resources are used for agriculture, while 3 per cent is for urban and domestic uses. Due to prolonged civil conflict, lack of water management and erratic rainfall, only 30 per cent of the population has access to safe drinking water (UN 2011b). Recurring drought has exacerbated the water crisis in Somalia and compounded the food insecurity problem, leading to increased rates of malnutrition. By November 2011, the United Nations had declared a famine in six regions in southern Somalia as the country suffers the worst drought in over 60 years (UN New Centre 2011). Water shortages are forcing pastoralists, estimated at 60 per cent of the population, to abandon their way of life.



Desertification, Overgrazing and Deforestation

Due to high aridity and drought frequency, all of Somalia's land area is at high risk of desertification (FAO 2003). Rapid and widespread exploitation of Somalia's natural resources is occurring throughout the country. Somalia's forest cover has been reduced by 1 151 000 ha since 1990 (FAO 2005). Trees are harvested and forests burnt to supply the charcoal industry (much of it for the export market), destroying habitat and degrading soils. Hundreds of square kilometres of forest continue to be cleared monthly, even as a 2006 ban on charcoal exports was implemented to curb uncontrolled deforestation of acacia forests. Overgrazing results in reduced productivity of pasturelands, which account for nearly 70 per cent of Somalia's total land area (FAOSTAT 2007). Virtually all pasturelands and almost all the water resources have disappeared from Somalia's southern region of Gedo (IRIN 2006a).



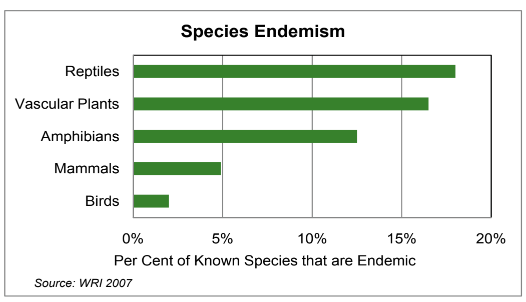


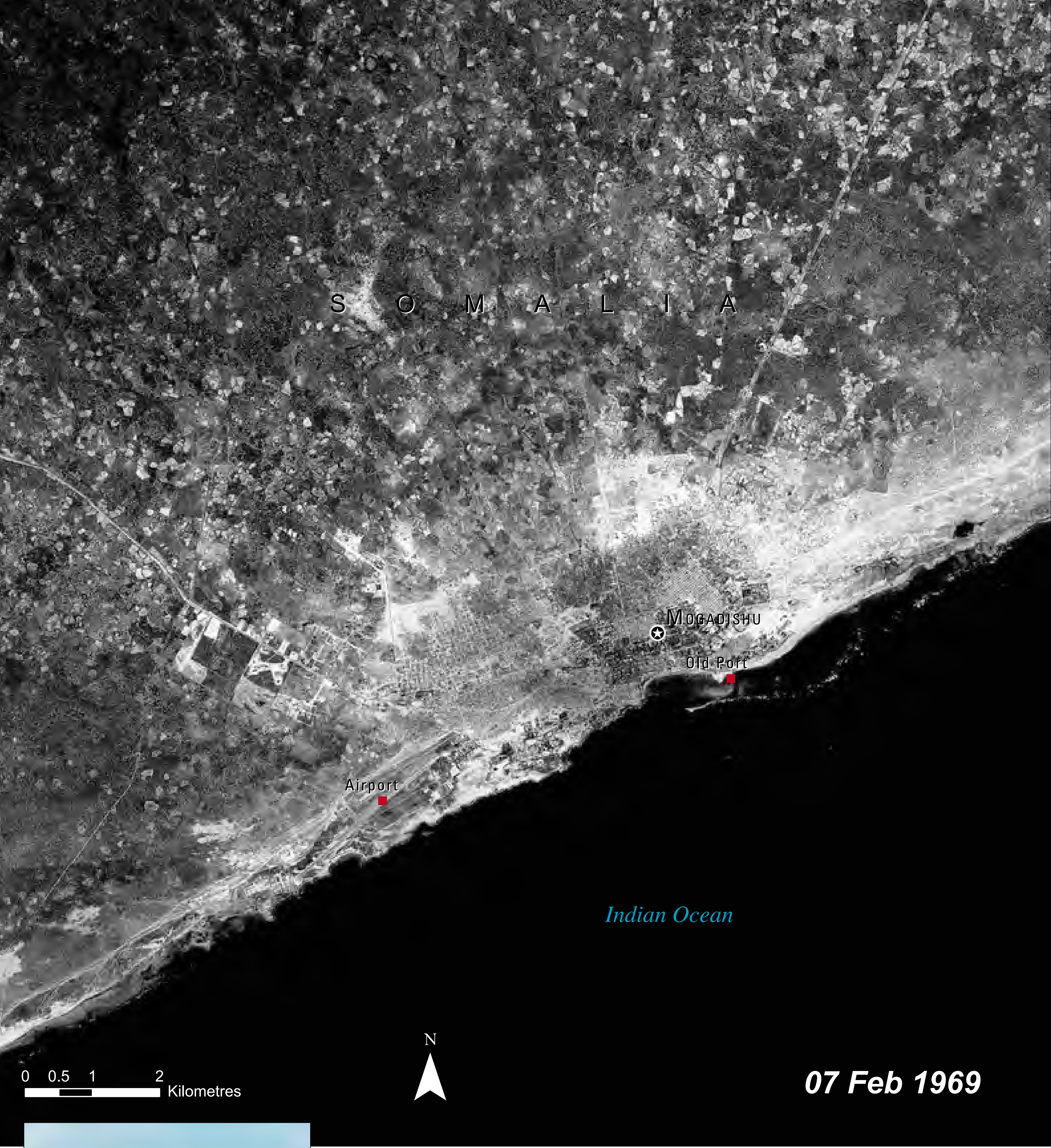
The Horn of Africa is one of the most degraded hotspots in the world, with only about 5 per cent of its original habitat remaining

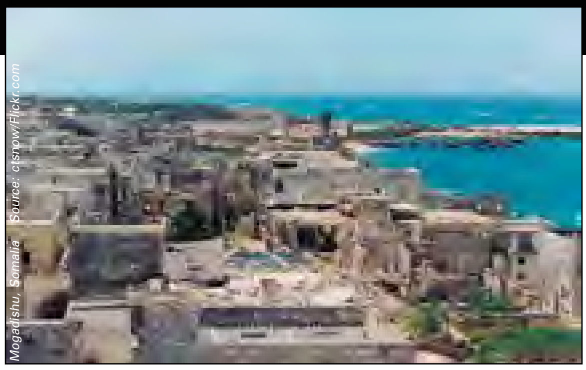
Source: Planet Action 2008

Threats to Biodiversity

Somalia's dry bushlands, grasslands and deciduous shrublands, along with juniper forests and riverine forest patches, provide habitat for a number of species, including a large proportion of endemic species (UNEP 2005). Somalia's extensive coastline consists of coral reefs, seagrass beds, mangrove forests, seabird colonies and turtle nesting beaches, which are currently unprotected and heavily exploited. Although the state of most fish stocks is unknown, some species such as sharks and lobsters are thought to be over-fished. Marine resources are also under threat by illegal fishing from foreign fleets (IRIN 2006b). The greatest threats to biodiversity are the uncontrolled production of charcoal, agricultural schemes along Somalia's rivers, severe wildlife poaching, lack of governance and political instability (CI 2007). Remaining populations of elephants and lions in Somalia are estimated at 200 and 500-750, respectively (Emslie and Brooks 1999; Stoddard 2006).



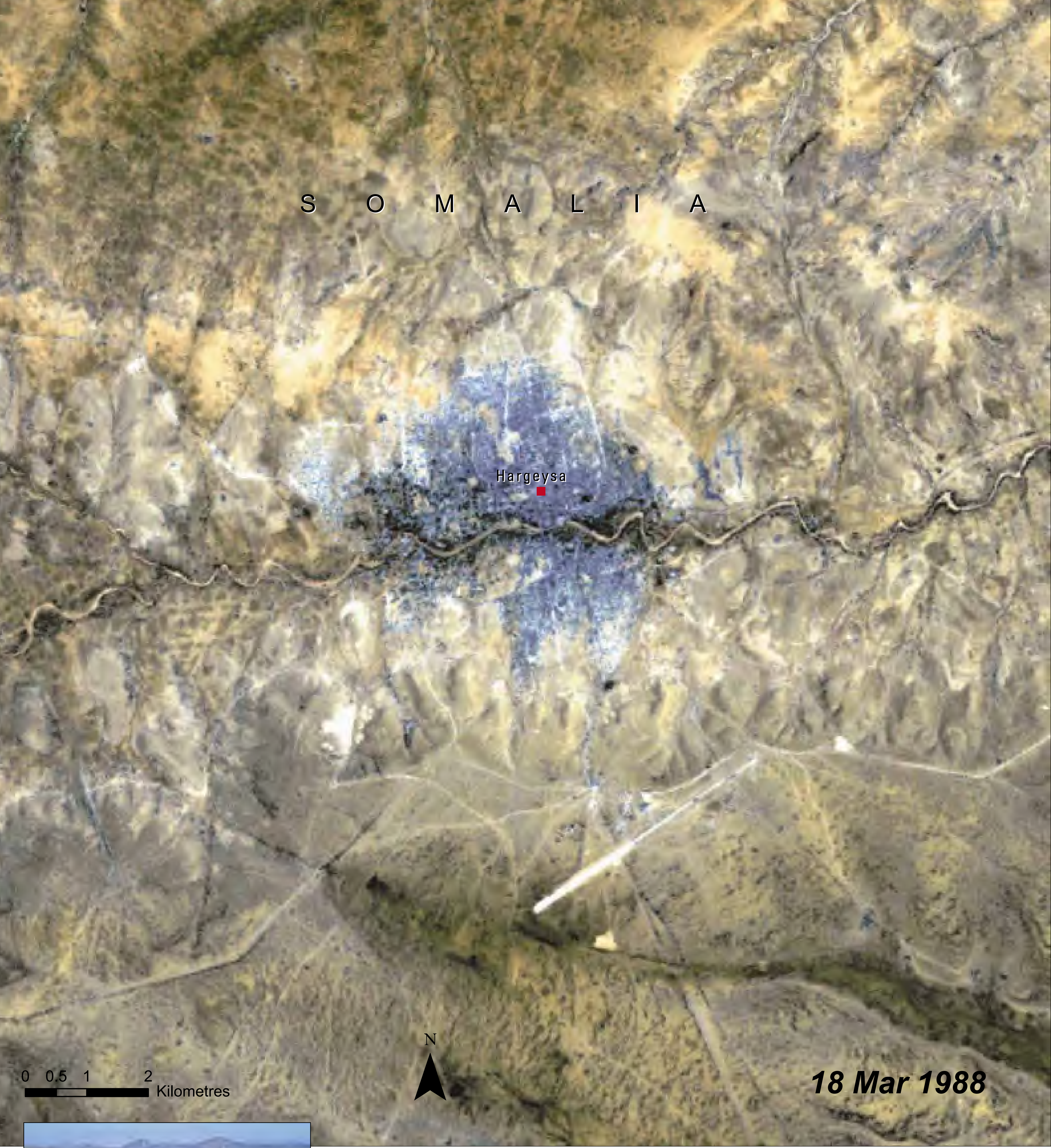




Mogadishu, Somalia

Mogadishu, Somalia's capital city, is located in the Banadir region on the country's southern coast. Since the pre-WWII colonial times, Mogadishu has played a central role in Somali politics, economy and society. The city has a long and turbulent history, characterized by political insecurity stemming from deep clan-based divisions. In 1991, civil war caused the destruction of much of Mogadishu's infrastructure; this violence and instability, coupled with a lack of centralized government, has kept Mogadishu from developing sustainable social, economic and environmental institutions and policies. The country's instability has been exacerbated by persistent drought in the region, which has deteriorated rangelands and contributed to widespread famine among the urban and rural poor (UNCHR 2011).

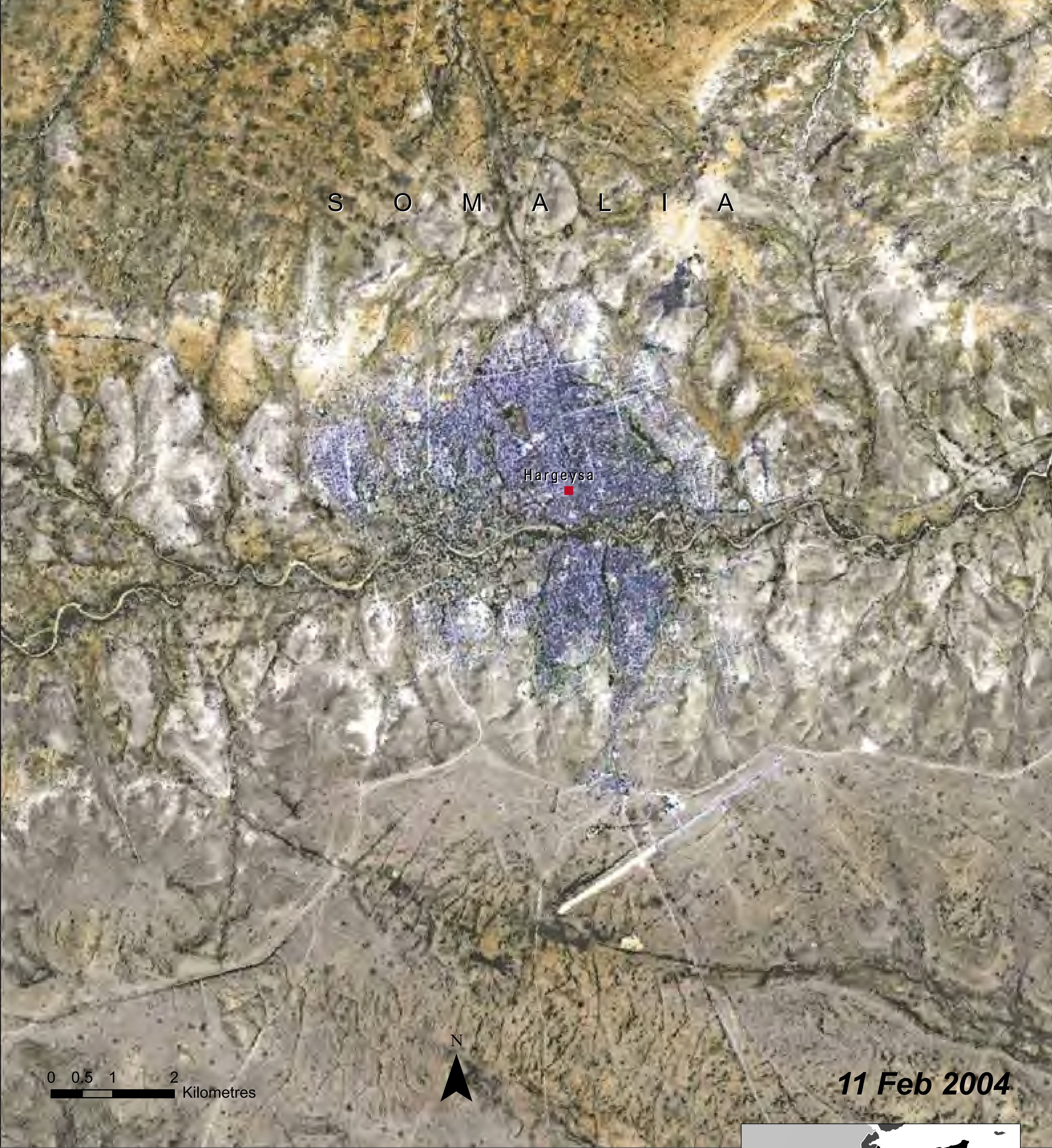
For the past two decades, Mogadishu's population has been in constant flux as a result of fighting and drought; in 2007, of the 401 000 who fled, only 123 000 returned to the capital (UN News Centre 2007). Notwithstanding this volatility, these images clearly show the trend of urban expansion in Mogadishu from 1969 to 2009. The farmland that can be seen on the city's perimeter in the earlier image has now been usurped by sprawling suburban development. The airport and port facilities have also been expanded. Much of this coastal infrastructure was damaged during the 2004 tsunami (MPA n.d.). Urban development is a major cause of environmental degradation in Somalia, with domestic waste, pollution, and demands for fuelwood and charcoal on the rise; urban demands continue to increase as Somalis displaced by conflict seek refuge in Somalia's growing capital city (IUCN 2006).



Mountains of Somaliland, Northern Somalia
Source: najeeb/Flickr.com

Hargeysa, Somalia

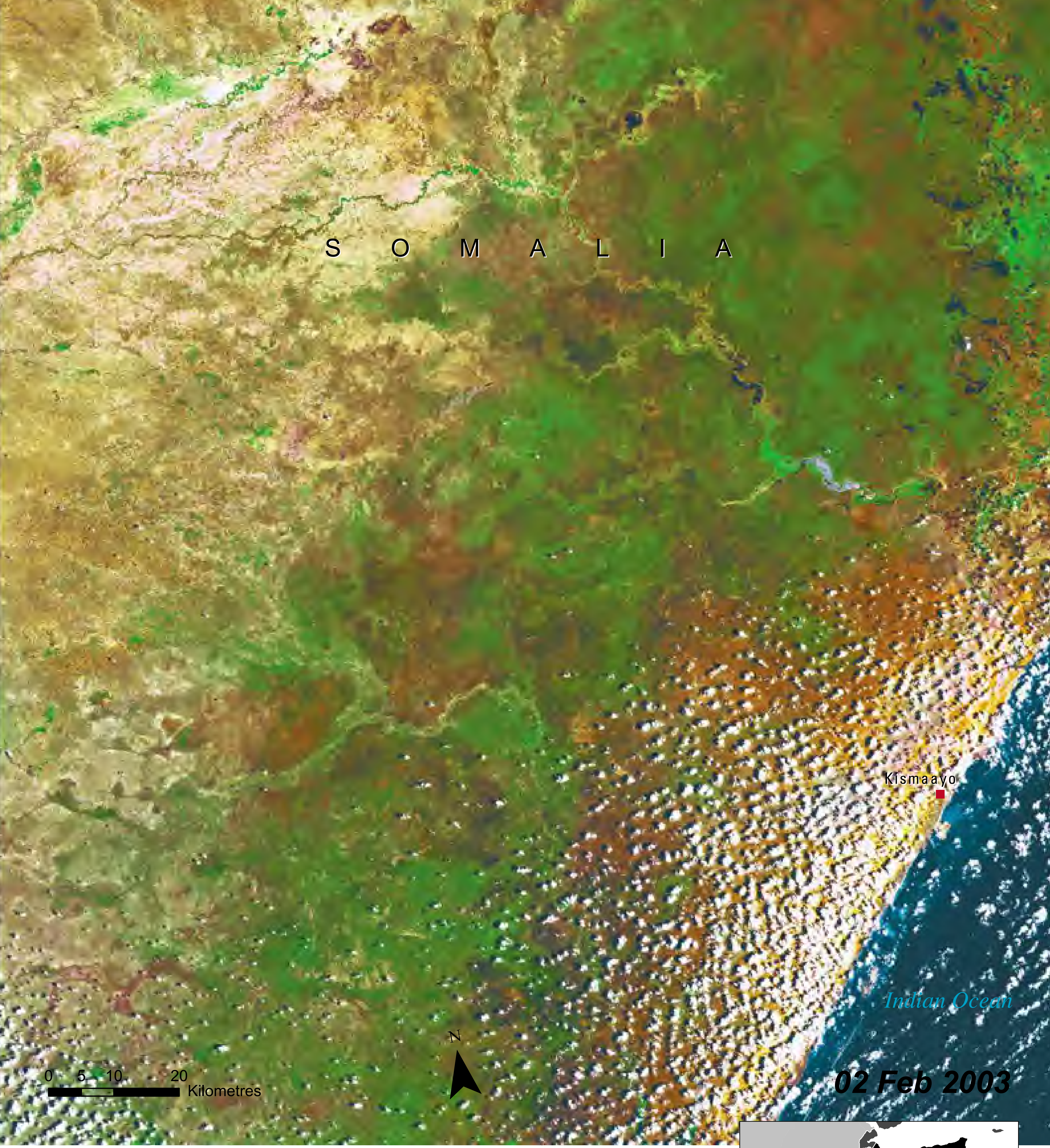
Hargeysa, the largest city in northern Somalia, is located in the western part of the country at an elevation of 1 334 m. It is a financial centre and a construction and food processing hub. Since 1991, Hargeysa has undergone a remarkable and rapid transformation, reconstructing its residential and commercial centres devastated during the civil war. The city has remained relatively free of the continued violence that plagues Somalia's southern city of Mogadishu. Hargeysa's economy has grown substantially in the past decade, along with its population: the number of inhabitants is estimated at 650 000 (Somaliland Government 2009).



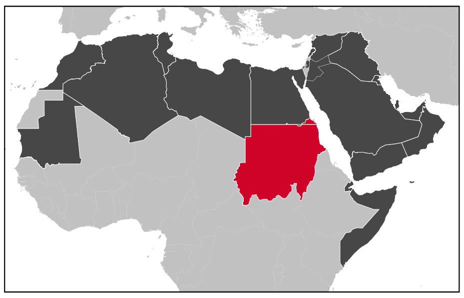
Hargeysa's population increase can be partly attributed to the influx of internally displaced persons (from the south and mixed migrants from throughout Somalia as well as Ethiopia) and pastoralists, who are abandoning their livelihoods due to acute water shortages. These population influxes are placing enormous strain on Hargeysa's urban economy and infrastructure (UN OCHA 2009). Foremost among the city's environmental challenges is the lack of adequate water and sanitation infrastructure. Inhabitants of Hargeysa also depend heavily on charcoal fuel, which contributes to unsustainable tree harvests in surrounding areas; more than two million bags of charcoal are consumed each year in the region's urban centres, the equivalent of 2 to 2.5 million trees (APD 2006). These images illustrate urban growth in this mountainous region of Somaliland from 1988 to 2004.

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.



Locally, these wood fuel products meet 90 per cent of the energy requirements in Somalia, as alternative sources of household energy are scarce (Hussein and Abdi 1998). The wide swaths of acacia groves that are clear-cut for charcoal are mostly taken to the port at Kismaayo for export (Baxter 2007). Though a ban on exports was imposed in 2006, two months later exports were resumed (IRIN 2006). 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). In addition, the overall biodiversity once supported by these forests is decreasing. The images illustrate the change in Somalia's southern forests from 1985 to 2003. While the 1985 image is hindered by cloud cover, the extensive deforestation that has occurred in southern Somalia over the past 25 years is dramatically apparent.



Republic of the Sudan

Total Surface Area: 1 886 068 km^2
Estimated Population in 2011: 33 419 000

Sudan is located in northern Africa and is dominated by the Nile River and its tributaries. It is bordered by seven other countries and has 853 km of coastline along the Red Sea. The climate is primarily arid desert in the north and central regions and tropical along the southern border; rainfall increases towards the south. In the north there is the very dry Nubian Desert; in the south there are swamps and rainforest. Much of the terrain is flat plains and desert; mountains occur in northeast and west. Agriculture is the basis of Sudan's economy, with modest amounts of oil reserves, natural gas and mineral deposits. The majority of Sudan's population is concentrated along the fertile riverine areas in the central area of the country.

Important environmental issues

- Land Degradation and Soil Erosion
- Water Scarcity and Desertification
- Loss of Biodiversity

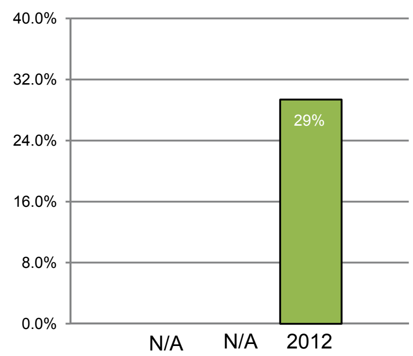
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

☆ Indicates Progress

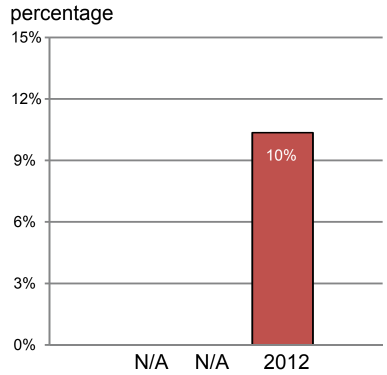
Sudan holds a large and diversified natural resource base including fertile land, forests, fresh water, wild and domestic animal stock, marine ecosystems, mineral and soil resources. However, the country is confronted by numerous environmental problems including: desertification and land degradation, water pollution, deforestation, soil erosion and deterioration in biodiversity (UNDP 2012). Deterioration in biodiversity and pressures on habitats are growing with more areas opened to development and resources extraction (UNDP 2012). South Sudan seceded from Sudan to become an independent state on 9 July 2011. Consequently, some of the statistical data for the new territorial boundary of Sudan are not yet available.

Land area covered by forest, percentage



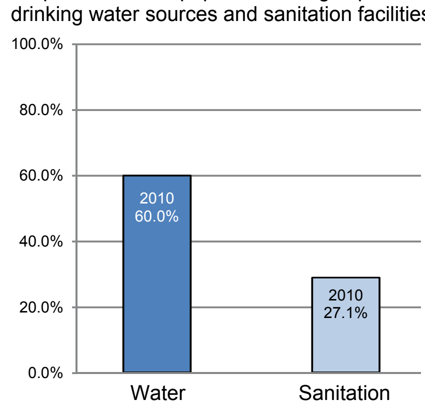
Source: FAO 2012

Protected area to total surface area, percentage



Slum population as percentage of urban

Proportion of total population using improved drinking water sources and sanitation facilities

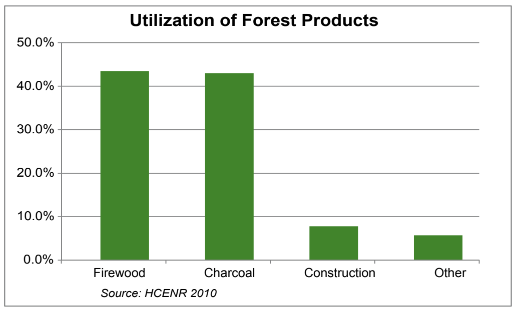


In recent years, major population migrations have occurred in response to conflict, climate change and desertification. Sudan has over four million Internally Displaced Persons.

Source: UNFPA 2012

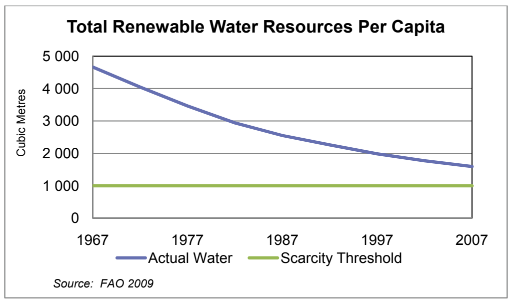
Land Degradation and Soil Erosion

Deforestation, agricultural expansion and overgrazing are leading to severe erosion and watershed degradation in the Nile riverine area (UNEP 2007). Agriculture, Sudan's largest economic sector, is subject to severe degradation due to soil erosion, weed infestation, pesticide mismanagement and water pollution. The agriculture sector plays an important role in the Sudan's growth, industrialization, exports and environment, and contributes more than 39 percent to GDP (FAO 2012). Agricultural activities and livestock rearing are the main sources of livelihood for an estimated 60 to 80 percent of the population (FAO 2012). Widespread degradation of rangelands is attributed to frequent drought and the explosive growth in livestock numbers. Sudan has the largest livestock herd in Africa and animal production is an important means of livelihood (FAO 2012). Grazing lands cover approximately half of Sudan's total land area (UNEP 2007). 29 percent of the Sudan's land area is covered by forests (FAO 2012). Forest resources account for 71 percent of energy consumption and more than 30 percent of livestock feed (FAO 2012). Clearing of forests for these needs has resulted in substantial loss to Sudan's forest cover over the last several decades; this and grazing pressure are leading to significant soil erosion throughout the county.

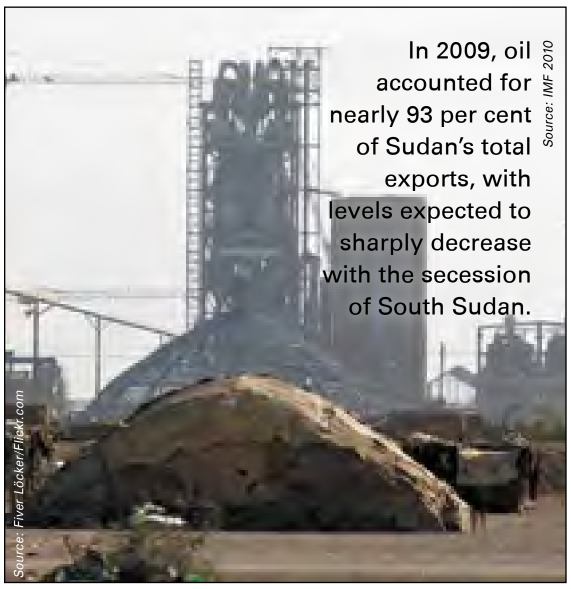


Water Scarcity and Desertification

Sudan's water resources derive almost exclusively from the Nile River system, followed by groundwater and rainwater resources (Ahmed 2007; UNEP 2007). Sudan is primarily desert and semi-desert; the Sahara Desert spans the northern part of the country where temperatures can reach up to 52°C with rainfall less than 25 mm per year (Ahmed 2007). Periodic, persistent drought has impacted agricultural productivity and food security and led to displacement and conflict, particularly in the Darfur and Kordofan regions (UNEP 2007; FAO 2012). Shortages of potable water inhibit agriculture, animal husbandry, and human settlement, and speed up the desertification process (Aba Hussain et al. 2002). Since the 1930s, there has been an estimated 50 km to 200 km southward shift of the boundary between semi-desert and desert in Sudan; climate change, population pressures and drought place Sudan at considerable risk of further desertification (UNEP 2007).



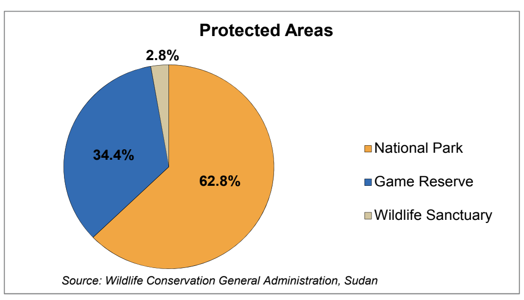

Source: United Nations Photo/Flickr.com



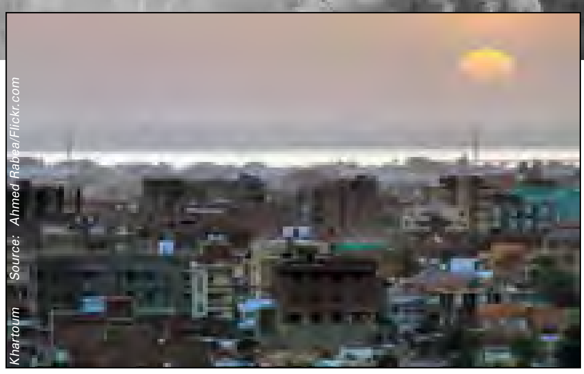
Source: Fiver Locker/Flickr.com

Loss of biodiversity

Sudan is rich in its diversity of ecosystems, habitats and species; it includes six actual or proposed marine protected sites with a total area of approximately 1 900 km^2, and twenty-six actual or proposed terrestrial and freshwater protected sites with a total area of approximately 157 000 km^2 (Suad Badri-USAID 2012). Several species which occur in Sudan and have declined to critical levels, as reported by the Sudan Wild Life Forces and the IUCN, including: Hippopotamus, cheetah, African lion, and Soemmerring's gazelle. Decades of civil war have facilitated illegal poaching, increased subsistence hunting, and thwarted meaningful conservation measures. Wildlife authorities report consistent problems with protected area management, ranging from poaching to livestock encroachment and land degradation(Suad Badri-USAID 2012).




Makniyah, Nahr an Nil, Sudan. Source: Dia Khalil/Flickr.com


Khartoum Source: Ahmed Rabea/Flickr.com

KHARTOUM, SUDAN

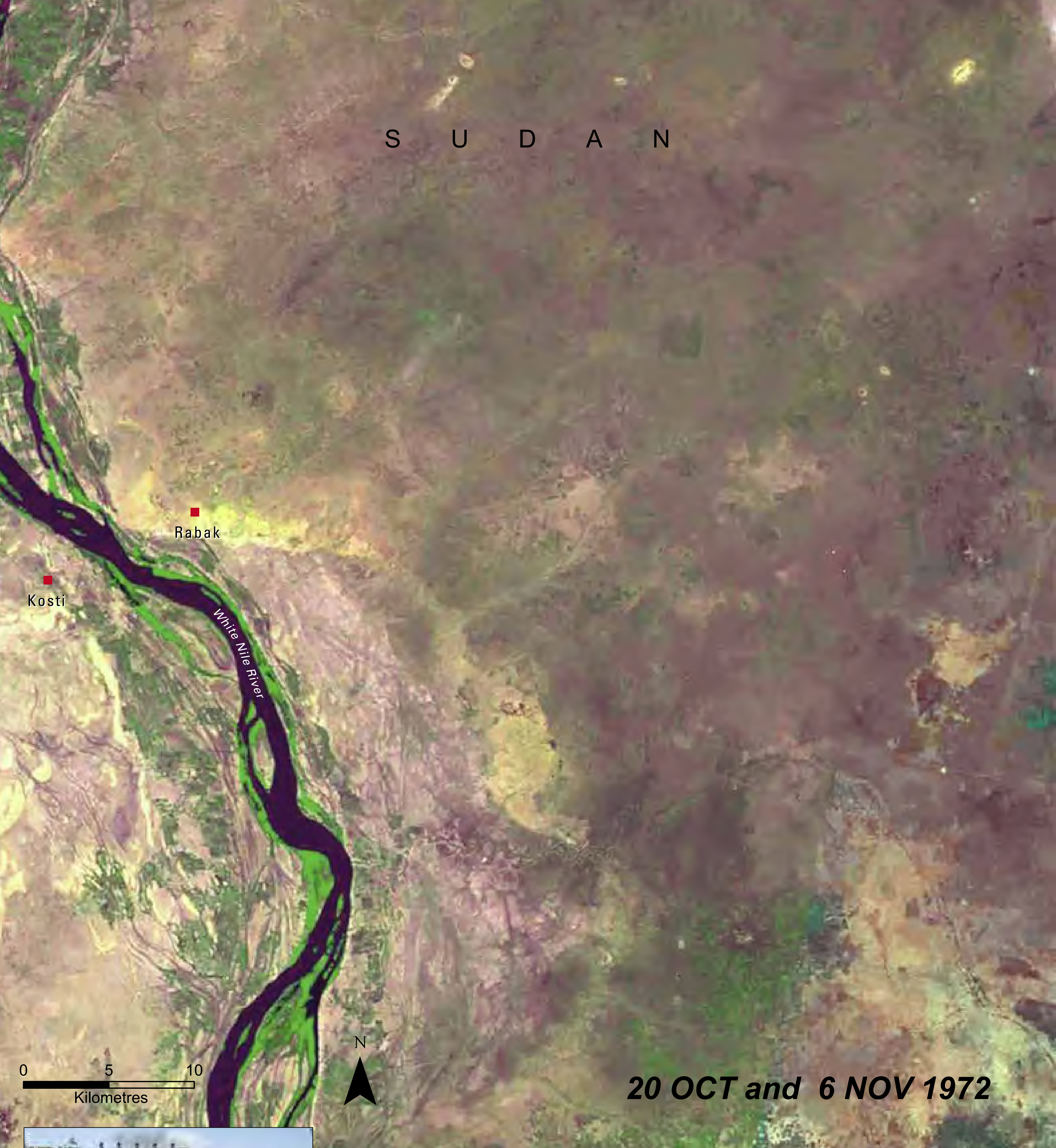
Located at the confluence of the White Nile and the Blue Nile, Khartoum is the capital of Sudan and Khartoum state. The climate is hot and arid; daily temperatures reach 32°C throughout the year, and can rise to 48°C, while rainfall averages only 155 mm annually. Metropolitan Khartoum has an area of 802.5 km² and is comprised of Khartoum, North Khartoum, and Omdurman. Khartoum lies close to the rich, irrigated cotton-growing Gezira area to the south and much of its trade is based on Nile river traffic. Khartoum has long served as a major communications centre between the Arab countries of North Africa and central African countries. A strategically important oil pipeline links the city with Port Sudan on the Red Sea.

The greater Khartoum area has experienced explosive growth, increasing from approximately 250 000 inhabitants in the 1950s to over 5 million today (UNEP 2007). The two images illustrate the rapid growth of Khartoum's urban area between 1965 and 2009. The sprawl of Omdurman, the development on Tuti Island following completion of the bridge in 2007, the channelization of the three rivers and the growth of downtown Khartoum are clearly visible. The 2009 image also shows expanded agriculture on the city's fringe, and conversion of former agricultural areas to urban landscapes (especially in North Khartoum); numerous infrastructure projects have modified the fertile Nile floodplain. Increased industrial and domestic wastes affecting the Nile's water quality (Ahmend and Digna 2007), leaky septic tanks in residential areas polluting wells (Alraheem 2000), and increased air pollution from the industrial and transportation sectors are impacts of this rapid urbanization. Unauthorized settlements on the outskirts of the city lack sufficient water, sanitation and solid waste facilities and pose significant environmental health problems (UNEP 2007).

Merowe Dam, Sudan

Merowe Dam is the largest contemporary hydropower project in Africa. Located in northern Sudan 350 km north of Khartoum, the dam reservoir and ten generating units became operational in 2009. The dam has a width of 9 km and a crest height of up to 67 m. The reservoir is 170 km long with a total storage capacity of roughly 12.5 BCM, or about 20 per cent of the Nile's annual flow. The reservoir has displaced about 55 000 residents, inundating the narrow strip of fertile Nile floodplain farmland, including date palm plantations (Teodoru and others 2006). In the new resettlement areas both the quantity and quality of social services such as education, health, water and energy supply have improved. Agricultural areas have also increased substantially, though poor soil productivity has been reported at relocated sites.

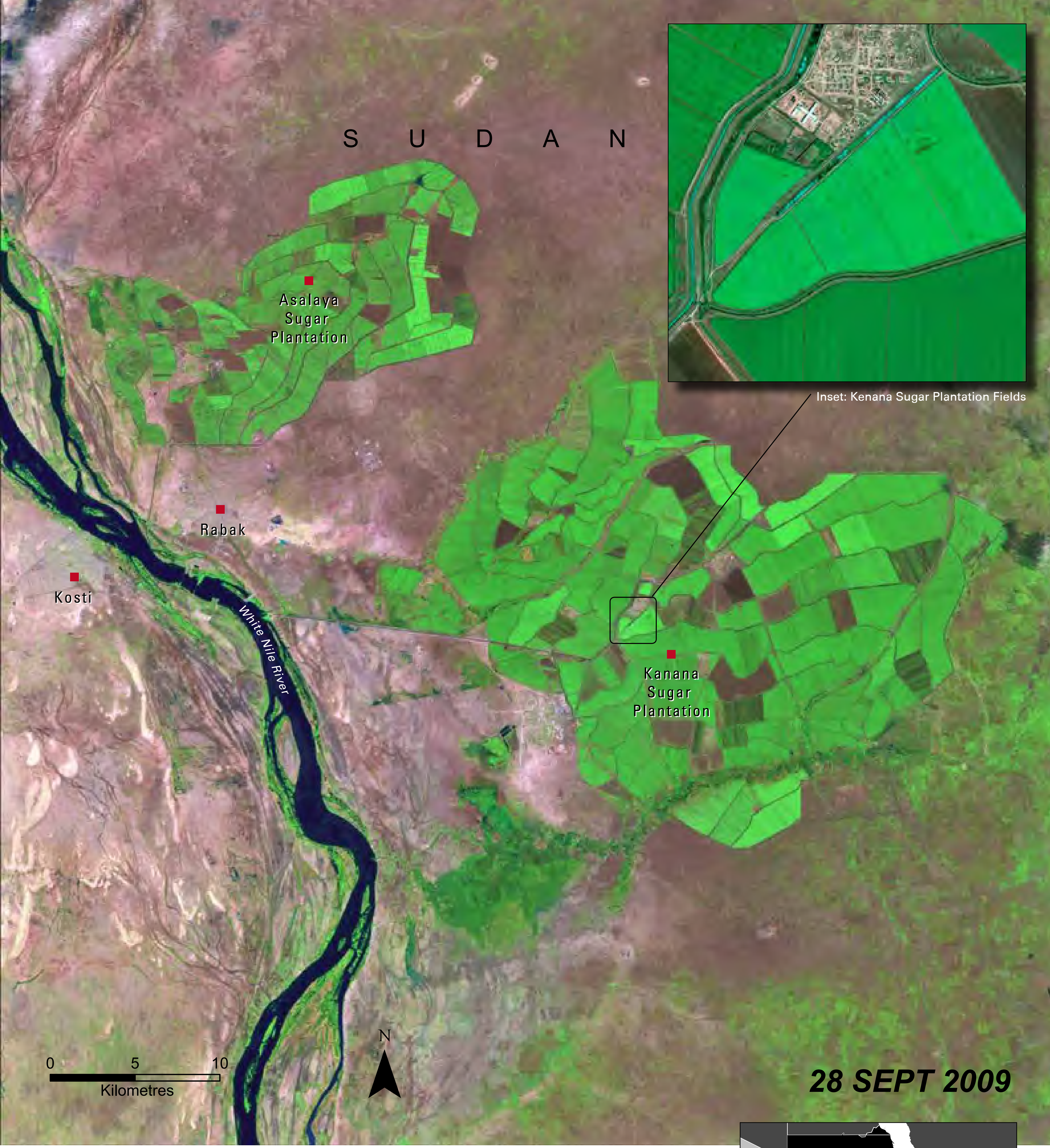
The dam will act as a sediment trap, reducing its capacity in the future; the construction of deep sluices along with two proposed irrigation canals that will siphon water from the reservoir will help to ameliorate the siltation problems. The decrease in fertile silt will negatively affect flood recession farmland downstream, but reduce sedimentation in Egypt's Aswan High Dam. Other impacts include downstream riverbank erosion and reduced river valley groundwater recharge (UNEP 2006). Merowe currently contributes 900 MW to the Sudan energy grid with a projected completed capacity of 1 250 MW, or between 50 to 70 per cent of the country's total capacity. This dam project has led to other infrastructure upgrades, including grid capacity improvements (new power lines), highways and access roads, bridges, a railway and an airport (Merowe Dam Project 2010). The 2003 image was taken before the dam was constructed. The February 2009 image shows the newly inundated reservoir which is almost at full capacity.



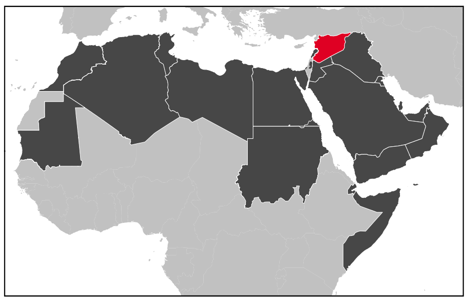
Untreated effluent flows from the Assalaya sugar factory to the White Nile, 2007. Source: UNEP/Post-Conflict

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. The plantation includes 340 km of canals and 6 pumping stations for irrigation of 50 000 hectares of cane sugar fields (Kenana 2012). Irrigation waters are pumped from the White Nile River and underground aquifers. The Kenana plantation was established here because Sudan's resources included vast tracts of land suitable for cultivation and agricultural production, adjacent water supply



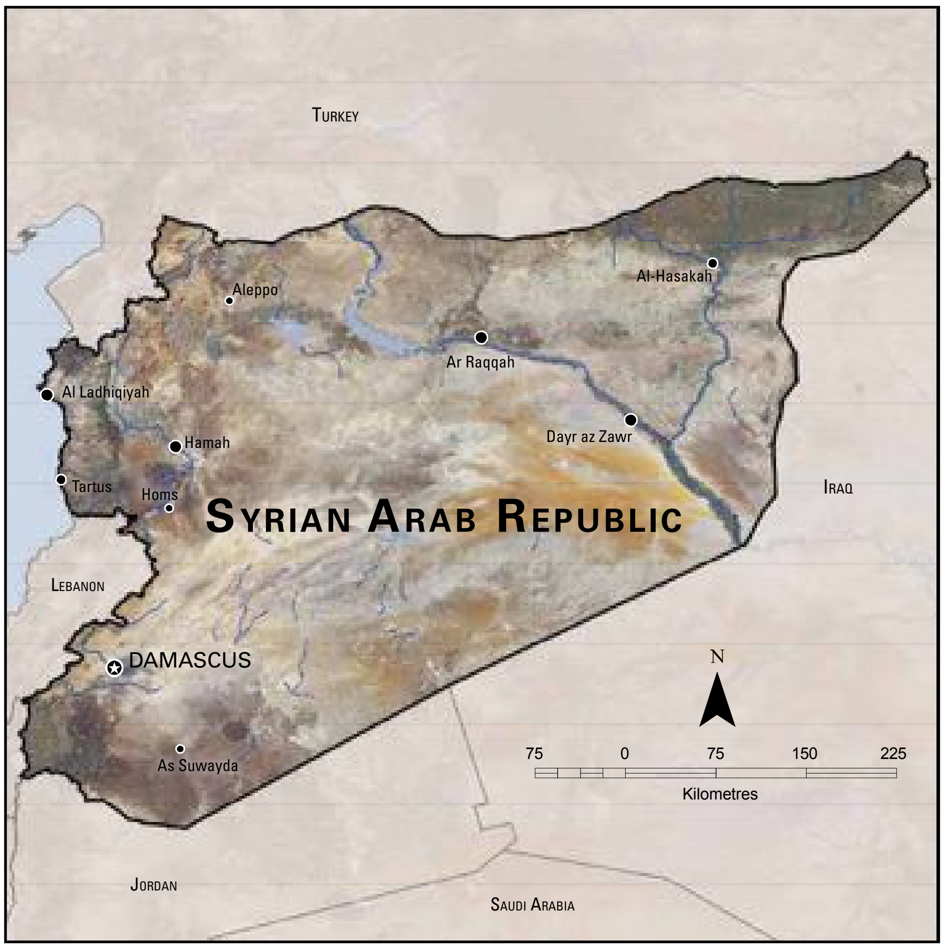
from the White Nile, above average rainfall and a reservoir of underground water to supplement surface water irrigation. At each of the Sudan's five main sugar plantations, the key environmental problem has been the release of effluent into the Nile. All sugar factories were found to be releasing factory wastewater directly into the Blue and White Nile without pre-treatment (UNEP 2007). This wastewater contains an elevated biological oxygen demand (BOD), which can reach 800 to 3 000 ppm (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 factory has been disposing directly into the White Nile over the past thirty years. The solution includes using effluent water for irrigating forests and lands in the area (Sudan 2012).



Syrian Arab Republic

Total Surface Area: 185 180 km^2

Estimated Population in 2010: 20 411 000



The Syrian Arab Republic lies on the eastern coast of the Mediterranean Sea and shares its longest borders with Turkey and Iraq. Syria contains four distinct geographic regions: fertile coastal plains, mountains that parallel the Mediterranean Sea, interior semi-arid plains, and desert, which occupies much of the southeastern part of the country. The northeastern and southern parts of the country are important agricultural areas where grain and cotton is cultivated. The Euphrates River, which is Syria's longest river, provides vital irrigation waters to eastern Syria. Average annual precipitation varies, ranging from 1 500 mm in the humid coastal mountains to less than 100 mm in the deserts of the southeast. Most of Syria's population is concentrated in the western part of the country.

Important environmental issues

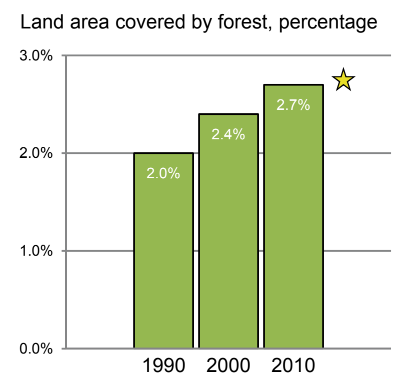
- Water Scarcity and Water Quality
- Land Degradation and Desertification
- Deforestation

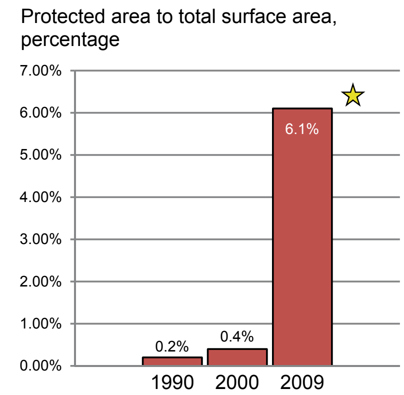
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

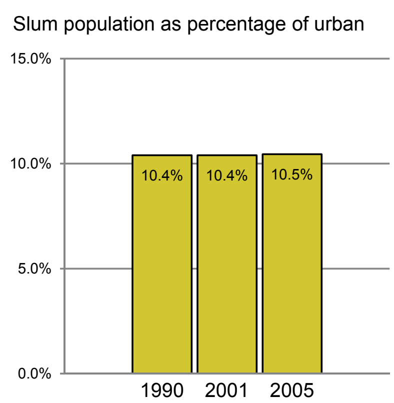
Although Syria has lost much of its forest cover, in recent times that trend has been reversed. Between 1995 and 2005, Syria regained 21.2 per cent of its forest cover, or around 105 000 ha (MAAR 2006). Syria is home to an increasing population that features one of the largest growth rates in the world (3.50 per cent in 1985 and 2.54 per cent from 1995 to 2000) (FAO-MAAR 2001). Syria has shown progress since 1990 in populations using both improved drinking water sources and improved sanitation facilities..

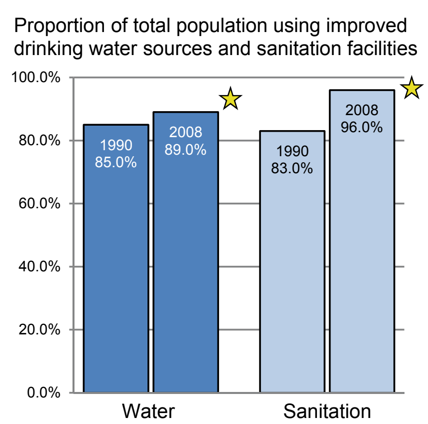
☆ Indicates Progress





Source: Ministry of State for Environmental Affairs 2009

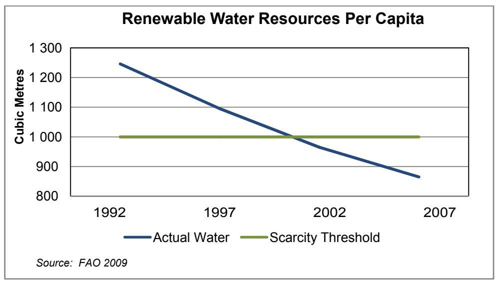




The Sabkhat al-Jabbul Nature Reserve, a 37 500 hectare permanent saline lake in northern Syria, is one of the region's largest protected wetlands

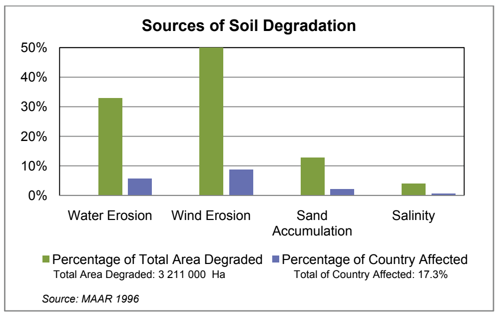
Water Scarcity and Water Quality

The Syrian Arab Republic is below the international water scarcity threshold (1 000 m^3 person/year) with only 840 m^3 available per person annually, ranking Syria among countries with moderate water stress (FAO 2006). With continued population growth, drought, inefficient irrigation practices, and decreased availability of surface and groundwater resources, Syria is facing severe water stress in the near future. Increased salinity of coastal aquifers as well as industrial and urban pollution is a further threat to Syria's freshwater resources and to human health. Agriculture accounts for 85 per cent of water use; the total irrigated area increased from 650 000 ha in 1985 to 1.3 million ha in 2002 (Salman 2002). Decreased water availability places severe constraints on the agricultural sector, which contributes about 32 per cent to the country's GDP and employs nearly 31 per cent of the work force. Several projects are underway to address this issue, including water transportation projects, and improving the water infrastructure.



Land Degradation and Desertification

Much of Syria is semi-arid and occupied by desert; only 32 per cent of the total land area is arable, while steppes and pasturelands make up 45 per cent of the total land area—all of which are threatened by desertification. Fifty-nine per cent of Syria's lands are vulnerable to desertification caused by overgrazing, deforestation, urbanization and recurring drought (Abdelgawad 1997). Seventeen per cent of Syria's land area suffers from soil degradation, which limits the productive capacity of the land. The main causes of land degradation in Syria are intense cultivation, overgrazing, deforestation, soil erosion, soil salinity, and impacts from forest fires (UNCCD 2005). About 90 per cent of the pasturelands in Syria are degraded due to overgrazing and mismanagement—this lowers livestock growth and survival and leads to loss of income and people's nutritional input (ACSAD and GSLAS 2000).

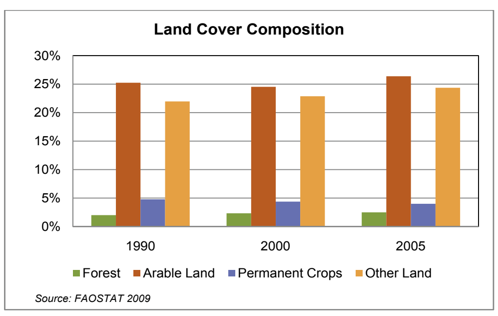


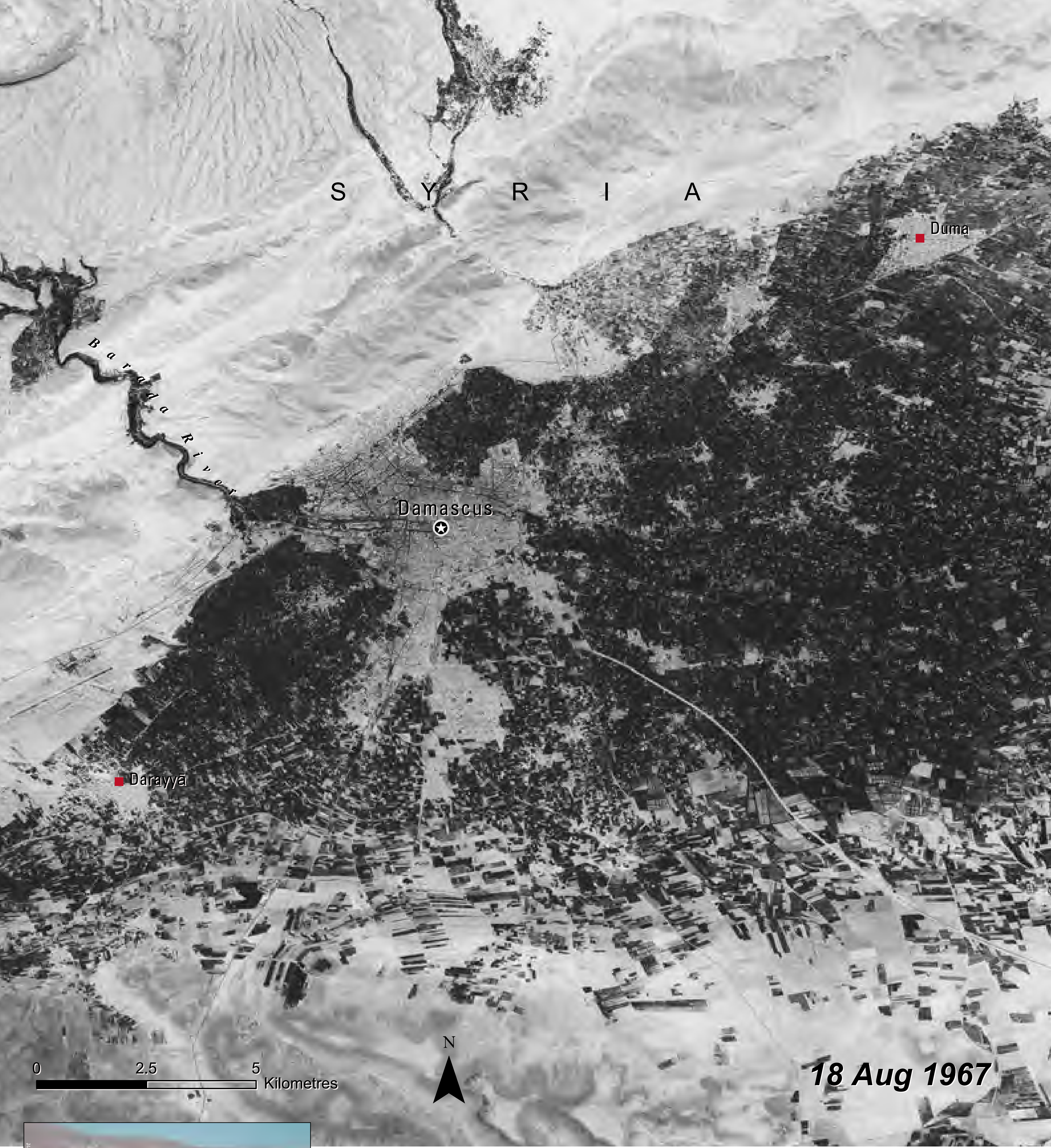
Based on current rates of depletion, it is estimated that Syria may soon experience water deficits in three of its major river basins

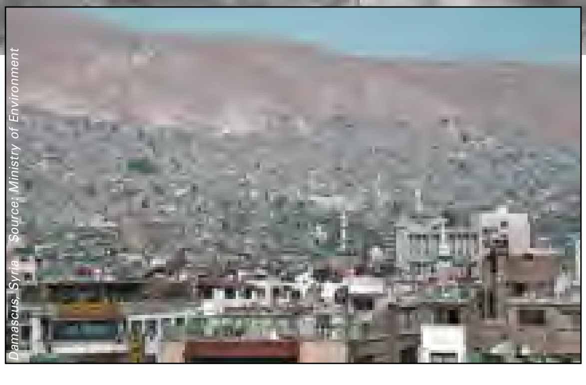
Source: FAOSTAT 2009

Deforestation

Forests once covered the coastal mountains and river valleys. The nation's forests are felled at a rate of 2.2 per cent (1990 to 1996) each year to clear land for agriculture, human settlement, and livestock production, and supply the commercial logging industry. Forest cover in Syria has been reduced to 3 per cent of the total land area over the past century (FAO 2010). These mostly oak, pine, juniper and cedar forests, which currently cover about 232 840 ha, are also under threat from exotic and invasive species, insect infestations and wildfires (see the Latakia Deforestation section). Fragmentation and loss of these natural areas poses serious threats to Syria's biodiversity. Syria has expanded its protected area system in order to conserve its genetic resources, and support development of its tourism sector and scientific research- by 2015, the Syrian Arab Republic aims to have 10 per cent of its total land area in a protected status (MAAR 2009).







Damascus, Syria

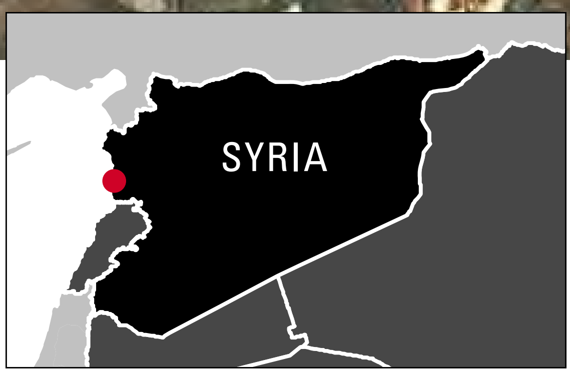
Syria's capital city, Damascus, is one of the oldest continuously inhabited cities in the world. Located 80 km inland from the Mediterranean Sea in southwestern Syria, this crowded metropolis of 4 million people is the country's manufacturing, trading and cultural centre. The metropolitan area of Damascus, which includes the cities of Duma, Darayya, Harasta, Al-Tall and Jaramana, experienced rapid growth beginning in the late 1950s, mostly as a result of rural-urban migration. The oil boom of 1973, coupled with a new era of political stability and changes in economic policy, accelerated industrial development in the region (Wincler 1999). Influxes of Palestinian and Iraqi refugees over the past few decades (over half a million refugees live in the metropolitan area) have contributed to the city's overcrowding and infrastructure problems.

Severe housing shortages in Damascus, beginning in the 1970s, led to the development of informal housing areas; these random and informal settlements continue to spring up on the fringes of the city, contributing to the urban sprawl. The 2009 image shows extensive sprawl to the south of the main city and on the northeastern edge of the city, where many of the informal settlements occur. These settlements lack basic vital services, which pose human health risks; they have also become a serious obstacle to current development planning in the city. Other impacts of urbanization in Damascus include: pollution of the Barada River from heavy industrial and domestic waste (MOE 2003); increased concentrations of heavy metals in the air, water and soil due to vehicle emissions (Moller and others 2005); the drying up of the Ghouta oasis, which once surrounded the city, due to increased urban water demands; uncontrolled waste dumping; and the loss of important heritage sites (Cyark 2009). This change pair shows drastic growth of the Damascus metropolitan area from 1967 to 2009.

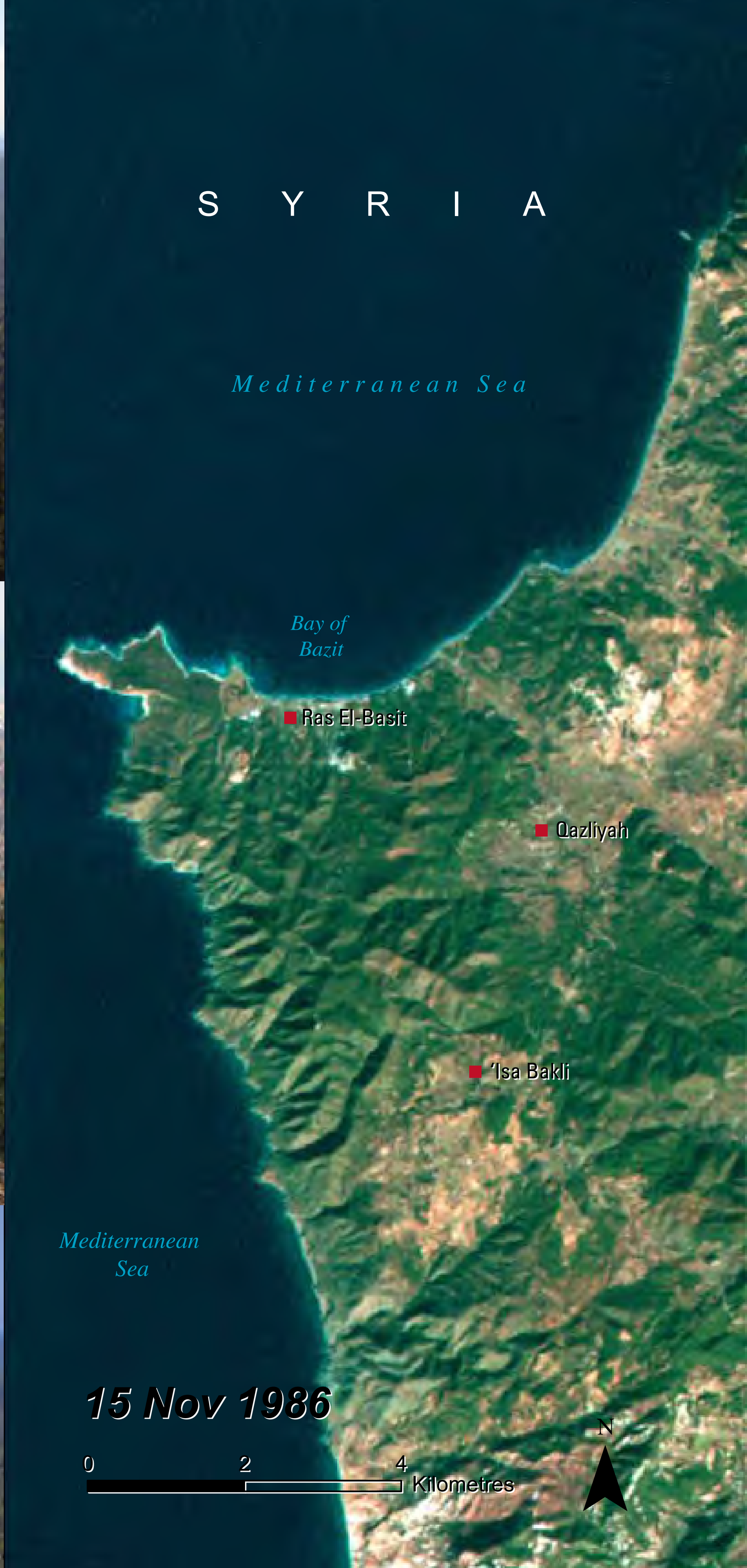
Greenhouses along the Tartus coastline, Syria
Source: Ministry of Environment

Greenhouse Agriculture - Tartus, Syria

Located on the Mediterranean coast just north of the border with Lebanon, Tartus Province, an area of about 1 890 km^2, 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 (98 per cent of citrus, 42 per cent of olives, 55 per cent of tomatoes and 56 per cent of tobacco production) (IFAD 2001). Greenhouse production has been practiced for decades in the Mediterranean region.

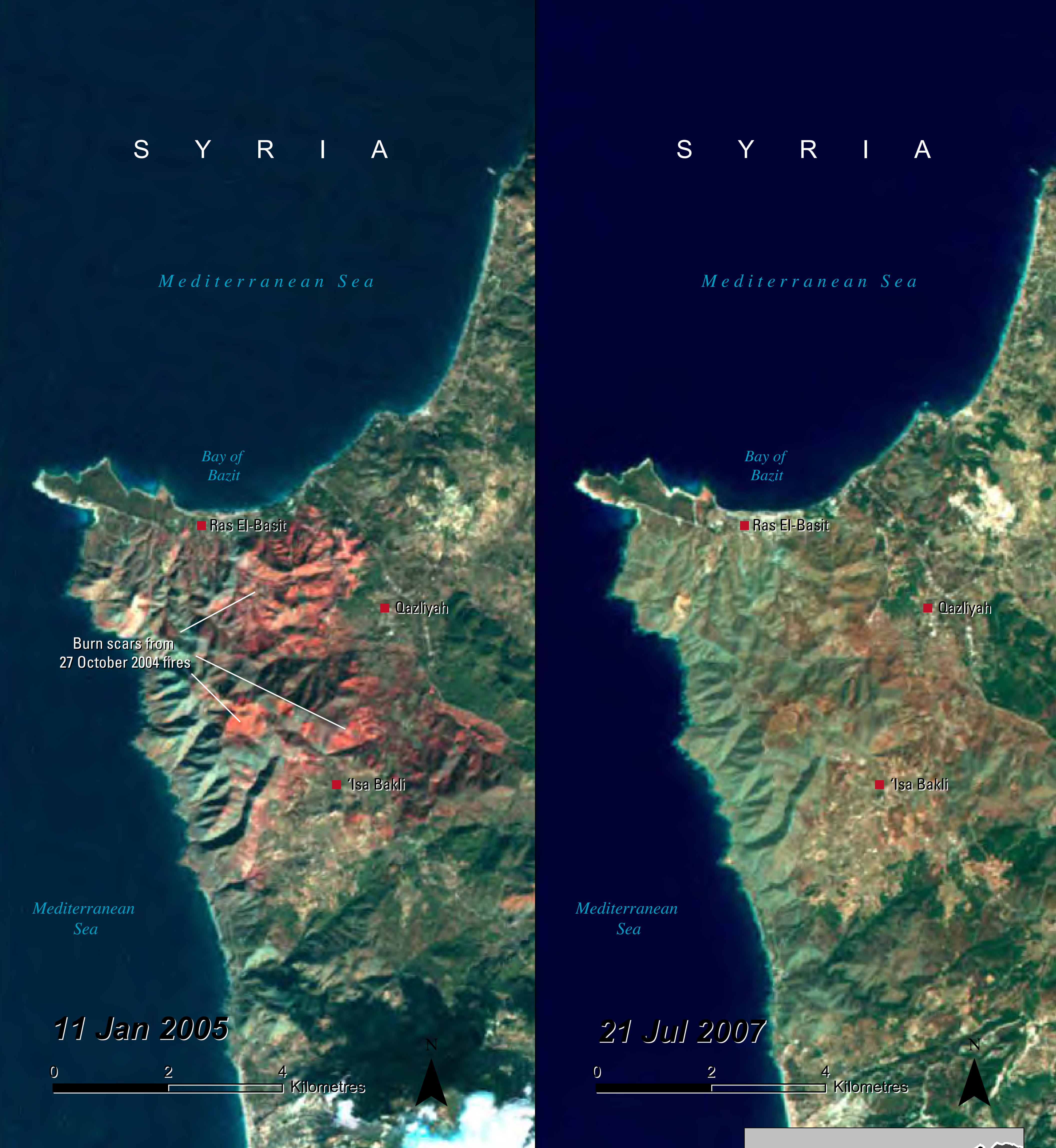


The growth of controlled agriculture in Syria in particular has been facilitated by the favourable climate along the coast, the increase in international demands for out-of-season vegetables, the development of low-cost plastics and simple technologies, and the government's efforts to improve food security in the country (IFAD 2001). 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). The number of greenhouses in Tartus increased from 10 in 1979 to 107 813 in 2009 (MAAR 2009). 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).

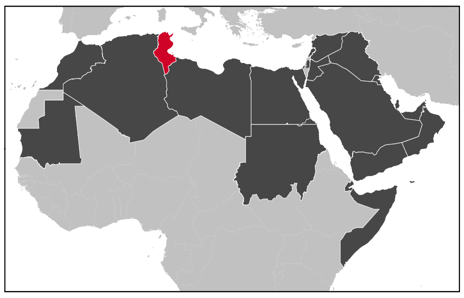


Deforestation - Latakia, Syria

The province of Latakia on Syria's northern coast is one of the country's richest in terms of vegetative cover. These woodlands (85 000 ha), composed mostly of pine and oak, make up some of Syria's largest remaining forest stands (MAAR 2009). Woodcutting, practiced for centuries in Syria, culminated in the large-scale destruction of Syria's forest lands during the two world wars in the past century - trees were cut down for the Baghdad and Hejaz railways, fires were deliberately set as a protest against the foreign regime, and trees were cleared for the tobacco-curing industry (FAO 1963).



More recently, in Latakia, high unemployment, inflation and drought have attracted farmers to the more lucrative charcoal industry, causing abandonment of farmlands and the harvesting of oak trees to produce the charcoal (Asia Times 2009). Fires also lead to the degradation of forests in this region—about 1 000 ha of forests were destroyed by fire in recent years (ACSAD 2003). This change pair shows the impacts from fires that ravaged the area in 2004 over a two-day period, consuming over 2 000 ha of pine forest and orchards and destroying several homes (BBC 2004). Drought, high winds and unseasonably high temperatures contributed to the fire. The more recent images show little recovery of the area, possibly a result of land use changes that are preventing tree re-establishment. The loss of vegetative cover from fires and deforestation in this mountainous coastal region is causing large-scale soil erosion and loss of soil fertility. Failure to maintain the mountain terraces for agriculture is also increasing soil erosion in Latakia Province's northern mountain slopes (ACSAD 2003).



TUNISIA

TOTAL SURFACE AREA: 163 610 KM^2

ESTIMATED POPULATION IN 2010: 10 481 000

Tunisia, the northernmost country on the African continent, borders the Mediterranean Sea between Libya and Algeria. The terrain is mountainous in the north where the Atlas range continues from Algeria, reaching altitudes of 1 500 m. The coastal regions and the northern mountains have a typically Mediterranean climate with moderate winter rainfall. In early summer and autumn, rain can take the form of heavy downpours. The semi-arid central region merges into the Sahara Desert at the southern tip of the country, where rainfall is scant and temperatures can reach 50°C during the sirocco wind spells. The Madjerda is Tunisia's only perennial river, and is critical to the region's agriculture. A series of salt lakes or chotts lie at the northern edge of the Sahara.

Important environmental issues

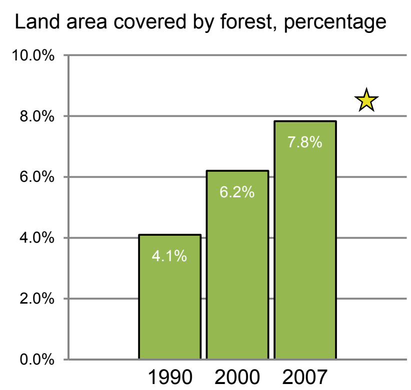
- Water Scarcity
- Air and Water Pollution
- Land Degradation and Desertification

PROGRESS TOWARD ENVIRONMENTAL SUSTAINABILITY

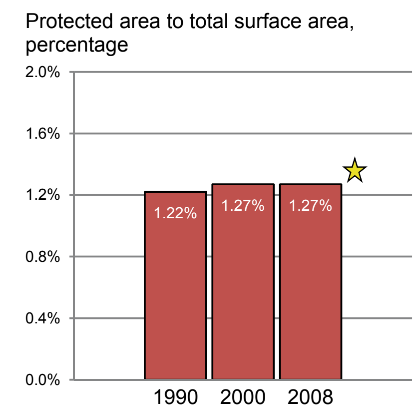
AS DEFINED BY THE UNITED NATIONS MILLENNIUM DEVELOPMENT GOAL 7 INDICATORS

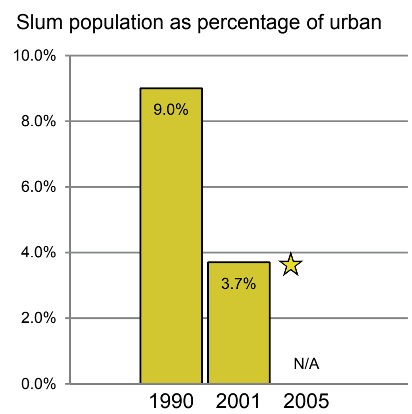
Tunisia has achieved high access rates to water supply and sanitation services; both important public health issues. Tunisia's mobilized water resources increased from 2.755 BCM in 1990 to 4.1 BCM in 2005 by improving water conservation, rationing water use and reusing treated wastewater. These achievements have enabled Tunisia to assure food security and improve the quality of life for its inhabitants.

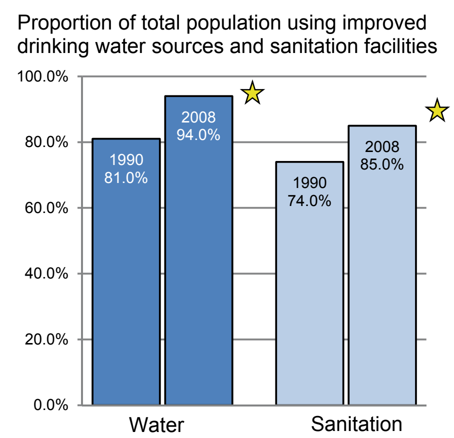
☆ Indicates Progress



Source: Ministry of Environment 2007







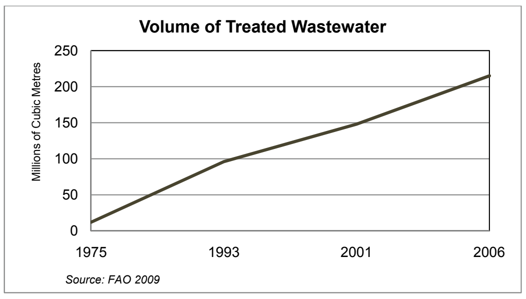
THE SCIMITAR-HORNED ORYX (ORYX DAMMAH), LISTED AS EXTINCT IN THE WILD, WAS REINTRODUCED IN TUNISIA'S DGHOUMES NATIONAL PARK IN 2007

Source: Gilbert and Woodfine 2008

Sousse, Tunisia   Source: b+c+c+f/Flickr.com

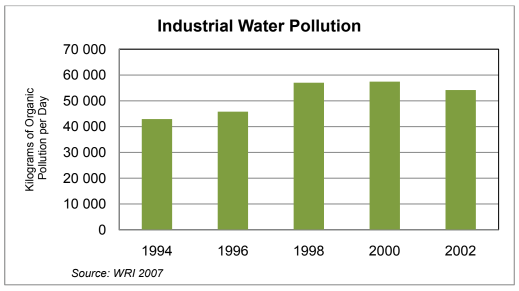
Water Scarcity

Tunisia is severely water-scarce with only 458 m³ available per person per year (FAO 2007). Tunisia receives scant rainfall (average of 1 520 mm per year) and is quickly depleting its groundwater reserves. Persistent drought, population growth, rising living standards, and accelerated urbanization pose a threat to the sustainability of water abstractions and agricultural activities. Overexploitation of groundwater, which provides 43 per cent of Tunisia's water resources, is resulting in high levels of salinity (between 0.5 and 3.5 mg/m³) and severely impacting water quality (ONAS 2008). Eighteen existing dams, 21 planned dams and 235 hillside dams are expected to augment available water supplies. In addition, seawater desalination and re-use of wastewater are major parts of Tunisia's strategy to meet increased water demands and improve the quality of drinking water. Four desalination plants produce nearly 4 per cent ofTunisia's total water resources (GHEF 2008); 29 per cent of treated wastewater is re-used for irrigation of agricultural lands.



Air and Water Pollution

Tunisia's seaboard has undergone rapid urbanization in recent decades. Tunis, Tunisia's capital city, grew by 3 per cent a year from 1970 to 1995 (Planbleu n.d.). Air pollution from motor vehicles is a growing problem in Tunis. Energy generation and the transport sector are major contributors to air pollution; the transport sector is the top contributor of CO2 and lead emissions. CO2 emissions account for 92 per cent of the total greenhouse gas emissions ofTunisia (UNEP 2008). Tunisia produces about two million tonnes of solid waste; dumping of raw sewage along with toxic and hazardous materials poses health risks and threatens water sources. In industrial cities, fertilizer manufacturing is a major source of water pollution. Phosphate extraction and mine tailings add heavy metals and arsenic into the Madjerda River, Tunisia's only major perennial river (Jdid and others 1999). Heavy oil tanker traffic in the Mediterranean contributes to oil pollution.



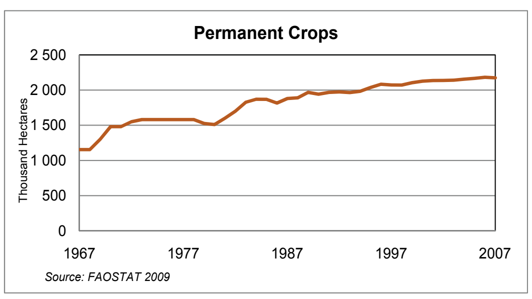
Tunisia is the world's top producer of deglet nour dates, and possesses 50 per cent of the worlds' deglet nour palm trees

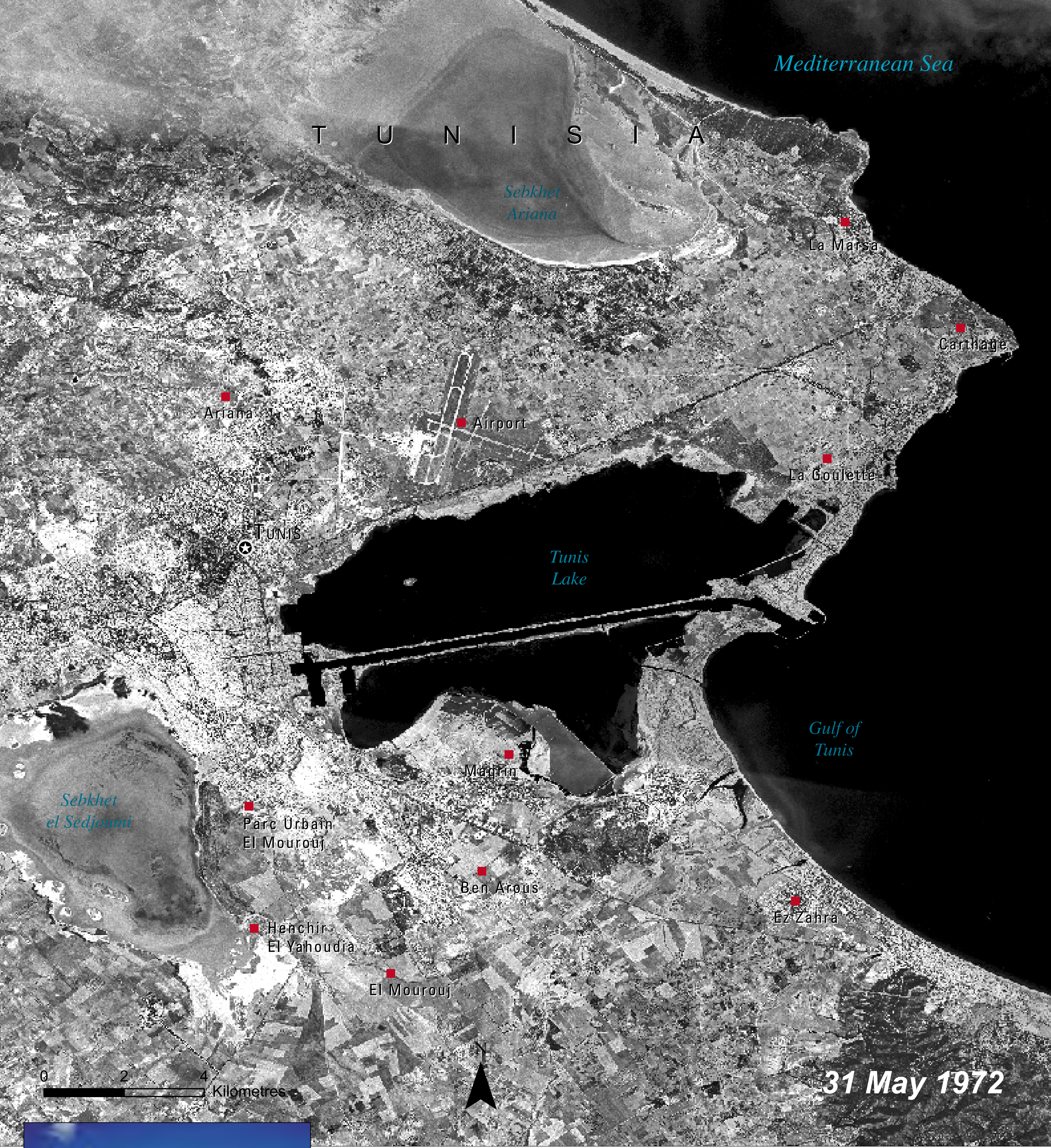
Source: UNIDO n.d.

Tamerza, Tunisia   Source: Delirante Bestiole/Flickr.com

Land Degradation and Desertification

About 66 per cent of Tunisia is subject to wind erosion, with annual transport of sand in select areas estimated at 50 to 200 tonnes per hectare. At least 8 000 ha of land are lost annually to the encroaching Sahara, costing an estimated US$100 million per year (IUCN and WWF 2003). Areas in southern Tunisia and particularly the depressions of Chott El-Garsaa are strongly threatened by desertification amplified by overgrazing and urbanization. About one-fifth of Tunisia's land north of the Sahara is affected by salinization, reducing agricultural productivity and forcing farmers onto rangelands and other marginal soils prone to desertification (Mtimet 2004). Tunisia's forested lands, which cover approximately 7 per cent (1 226 000 ha) of the country, provide an important buffer to desertification. Between 1990 and 2005, forest cover increased from 4.14 per cent to 6.8 per cent (World Bank 2005). These increases can be attributed to ambitious plantation programmes (Merlo and Croitoru 2005).





Tunis, Tunisia Source: Ashley Good/Flickr.com

Tunis, Tunisia

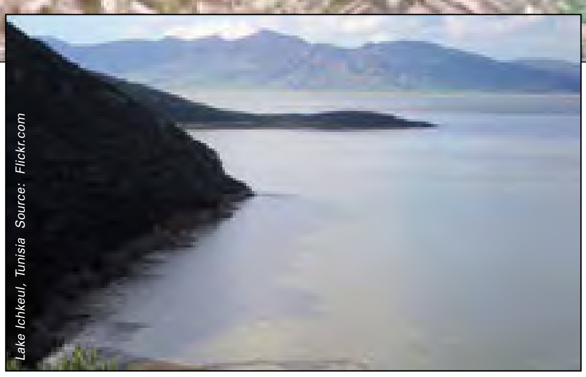
As the capital and largest city, Tunis serves as the commercial, industrial and administrative centre of Tunisia. Situated among rolling hills, lagoons and lakes, Tunis and its surrounding communities have experienced rapid modernization and economic growth in the past decades. This growth, coupled with increasing population (995 000 not including outlying areas), has resulted in environmental degradation in and around the city. Prior to the 1990s, waste disposal in Tunisia was largely unregulated, causing contamination of the soil and groundwater (Yoshida and others 2008). Henchir El Yahoudia, located adjacent to Sebkhet el Sedjoumi, was once the largest landfill in Tunisia (approximately 150 ha).

The landfill contained domestic, industrial and medical waste, which posed a threat to the surrounding areas. It was closed in 1999 and rehabilitated, and is now an urban park (World Bank 2004). The imagery illustrates the growth of Tunis from 1972 to 2008. From Tunis Lake, the urban area has expanded in all directions. To the northeast is Sebkhet Ariana, an evaporating saline lake. Sebkhet el Sedjoumi, to the southwest, is a key wetland, providing habitat for a number of bird species, including the Greater Flamingo (BLI 2009). Rehabilitation of these lakes has been achieved through development of purging stations for household and industrial wastewater and by the closure of the landfill. An expressway divides Lake Tunis, connecting the city to the harbour at La Goulette. With little water circulation and heavy nutrient inputs from wastewater, Lake Tunis experiences eutrophication and occasional fish kills (NASA 2008). Plans are underway to develop the southern shore of the lake into a new commercial, residential and touristic centre.

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; this was the site of a massive stockpiling of phosphor gypsum, which reached a height of six metres and covered a surface area of 50 ha (Callaert and others 2008). The landfill was a primary source of pollution for the city.

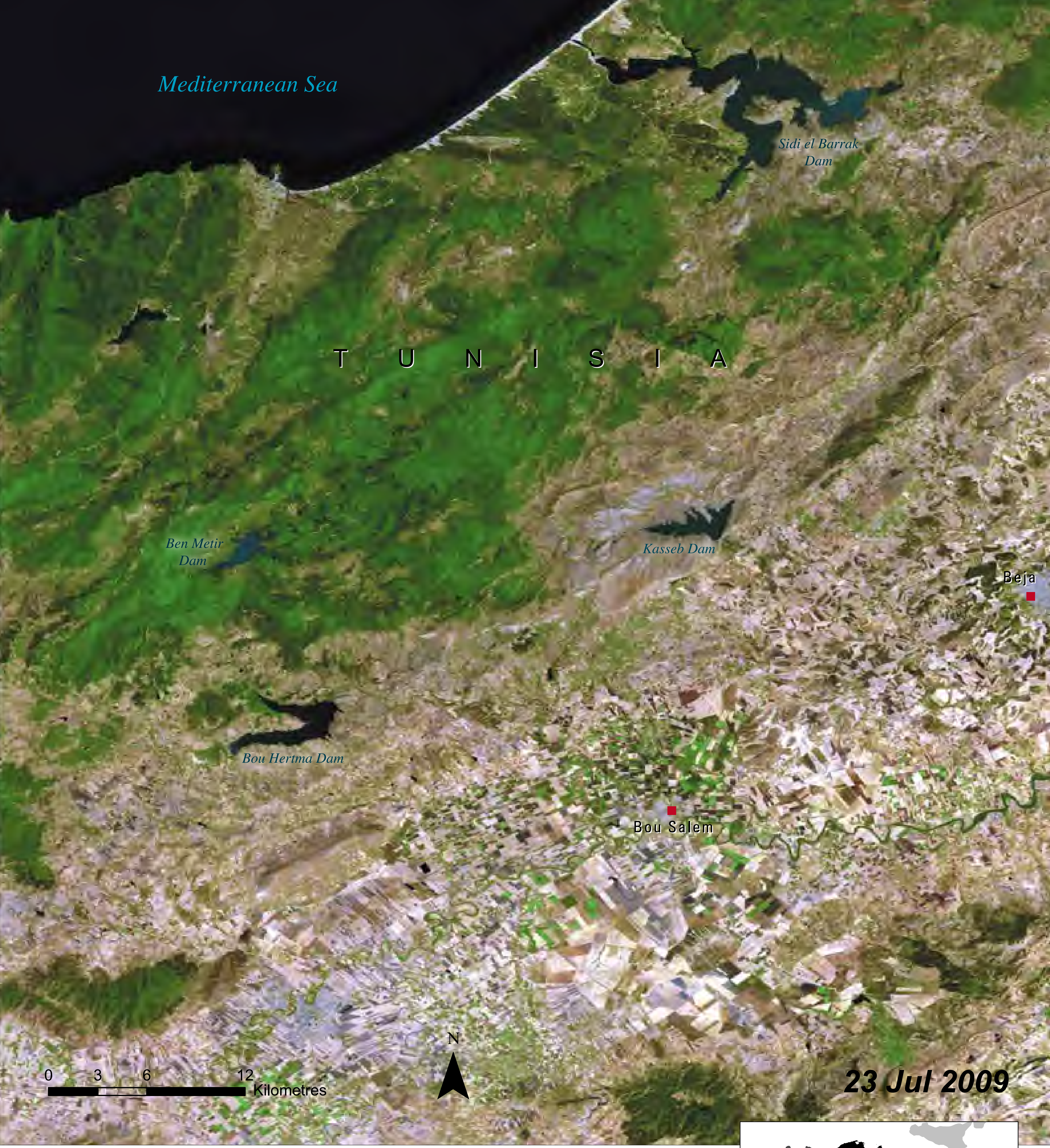
To improve the overall environment and revive the city, the Taparura Project was initiated in 2006. In addition to decontaminating and rehabilitating the former landfill site, the project aims to transform the northern coast of Sfax into a thriving urban area and reintegrate Sfax with its coastline through 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. This image also displays the drastic growth of Sfax's urban area since 1984.



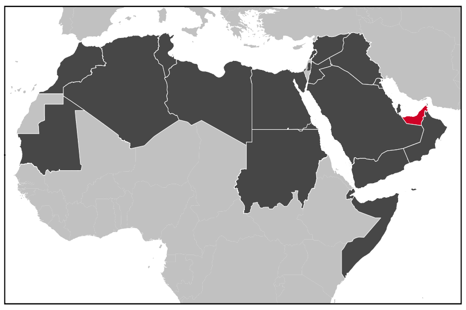
Lake Ichkeul, Tunisia Source: Flickr.com

Bou Hertma Dam, Tunisia

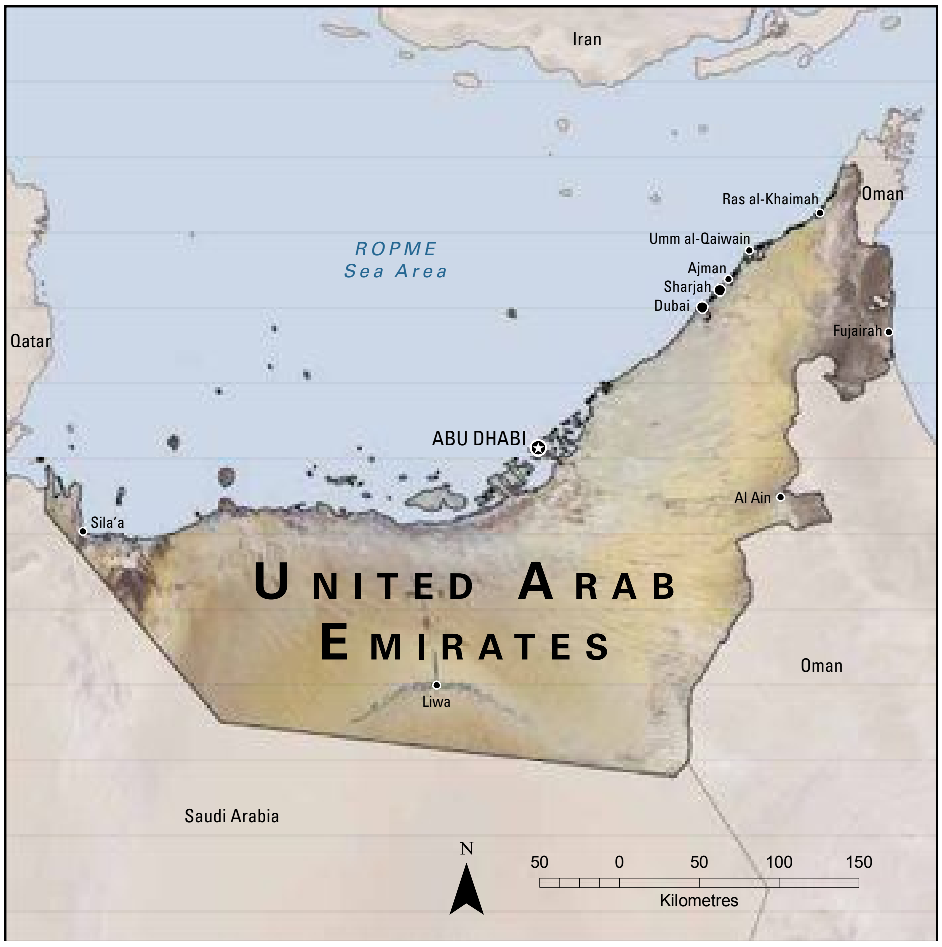
Tunisia is mostly arid to semi-arid with Mediterranean influences along the coast. With scarce rainfall and a negative water balance, water harvesting and storage techniques are playing an important role in water supplementation, flood prevention, water table recharge and erosion control (Ouessar and others 2002). The Bou Hertma Dam, constructed in 1976, is located in northwest Tunisia in a relatively productive area due to moderate amounts of rainfall (400 to 800 mm/yr). The dam is one of over 200 dams constructed in Tunisia as part of a plan to support increasing agriculture as a result of population pressures (MELUP 2001). These images illustrate changes from 1972 to 2009, the most notable of which is increased agricultural production.



In addition to the Bou Hertma reservoir that has an approximate volume of 117 million m^3, newly developed reservoirs are also visible in the 2009 image, which together allow the storage of 2 200 million m^3 of water and represent 88 per cent of total runoff in northern Tunisia (MAERH 2007). The Sidi el Barrak Dam, visible in the 2009 image, was constructed in 2002 to provide irrigation water and supply drinking water for Tunis and other cities. Irrigated agricultural areas supplied by these systems amount to 405 000 ha (of which 83 per cent are equipped with water saving devices)—and are expected to increase to 420 000 by 2011. The agricultural sector in Tunisia is playing a larger role in the economy, and represents 9.4 per cent of total exports. Tunisia is mitigating environmental impacts by implementing land, water and soil conservation strategies and decreasing fertilizer use (MELUP 2001).



United Arab Emirates



Total Surface Area: 83 600 km²

Estimated Population in 2010: 8 264 070

The United Arab Emirates (UAE) borders the Oman Sea and the ROPME Sea Area between Saudi Arabia and Oman. The UAE is a federation of seven emirates, the largest of which is Abu Dhabi. The terrain is largely desert with flat, barren coastal plains that merge into rolling desert sand dunes. The Hajar Mountains in the east rise over 2 000 m in places and provide habitat for a number of endemic species. Coastal areas contain extensive *sabkhas*, or salt pans, that extend far inland. The climate is hot and dry; average maximum temperatures in the summer reach above 48ºC in coastal areas and average annual rainfall is less than 120 mm. The mountainous areas are cooler and receive greater amounts of rainfall (up to 350 mm per year).

Important environmental issues

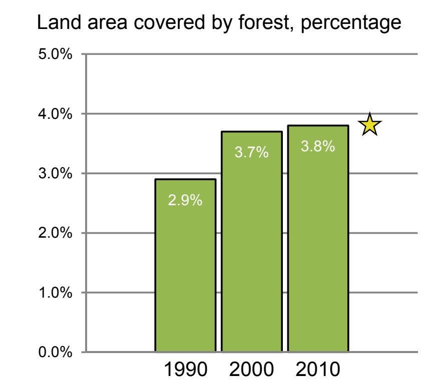
- Water Demand and Water Scarcity
- Land Degradation and Desertification
- Threats to Marine and Coastal Ecosystems

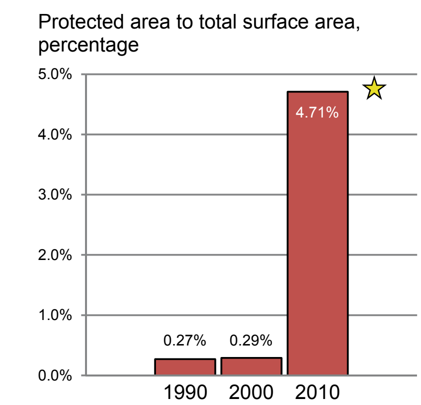
Progress Toward Environmental Sustainability

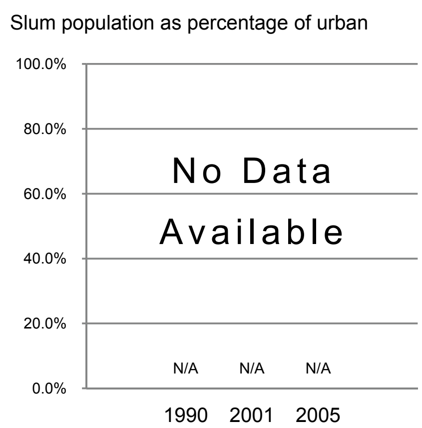
As defined by the United Nations Millennium Development Goal 7 Indicators

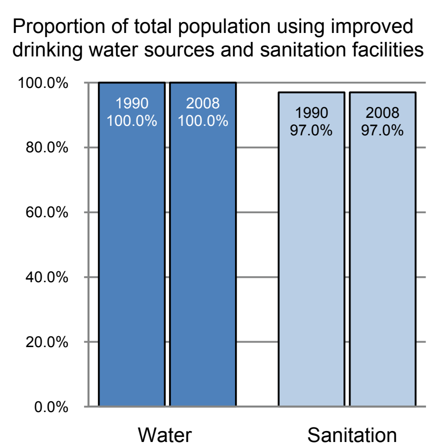
The discovery of oil and gas in the 1950s in the UAE rapidly transformed the country into a booming economy, providing income for infrastructure development and expansion of social services. With a gross national income of US$55 028 per capita in 2008, the UAE ranks as "high income" among industrialized nations (IMF 2009). This rapid economic expansion, coupled with population growth that is fueled by the influx of expatriates (77.5 per cent of the population is non-national), presents significant environmental challenges (Shah 2006).

☆ Indicates Progress







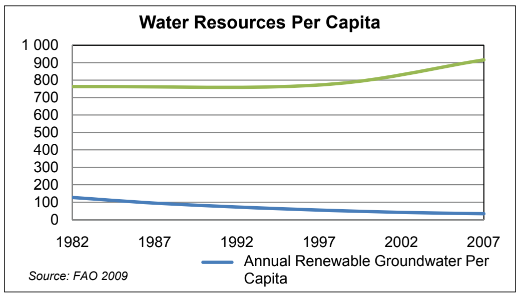


With a capacity of 9 000 000 m³/day the UAE is the second largest producer of desalinated water after Saudi Arabia - by 2015, the UAE's desalination capacity is expected to increase to over 11 000 000 m³/day

Source: UN 2009

Water Demand and Water Scarcity

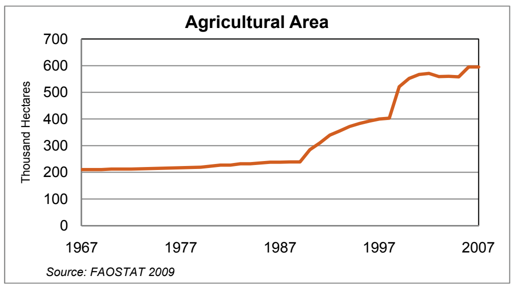
The UAE is below the international water scarcity threshold with only 916 m^3 available per capita per year (EAD 2006). Lack of surface water and rainfall and rapidly diminishing groundwater resources have forced the UAE to rely on desalinated seawater and recycled wastewater. Groundwater continues to provide the bulk of water used (71.2 per cent), followed by desalinated water (24 per cent), and treated wastewater (4.8 per cent) (EAD 2006). Approximately 62 per cent of water withdrawals are for irrigation, 32 per cent are for domestic uses and 6 per cent are for industrial and commercial uses (EAD 2012). Total consumption of groundwater resources in the Abu Dhabi Emirate exceeds natural recharge capacity by 24 times. Despite the lack of water, the UAE is the third largest per capita water consumer in the world. By 2025, water demand in the UAE is expected to increase by 44 per cent to 3.2 thousand million m^3 (UNU 1997). Advances in the standard of living, rapid economic growth and increases in population contribute to high water use.



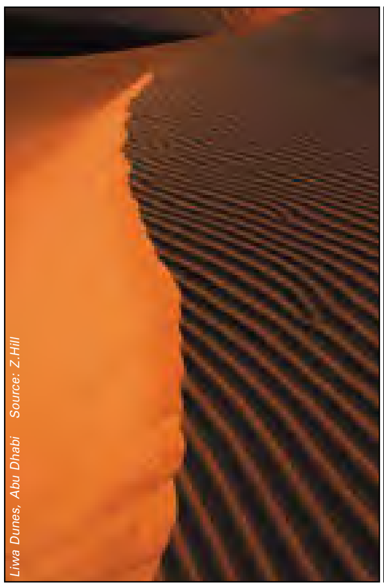
Source: FAO 2009

Land Degradation and Desertification

Due to overall aridity in the UAE, nearly 100 per cent of land is desertified (Abahussain and others 2002). Wind erosion is the major cause of land degradation in the UAE where dry sandy soils, poor vegetation cover and hyper-arid conditions prevail. Soil salinization of irrigated lands as a result of saline groundwater and lack of precipitation to leach salts from the soil profile, has resulted in highly saline soils. The resulting waterlogging of the soils decreases productivity of agricultural lands. Despite land degradation problems, the agricultural area in the UAE increased from 210 000 ha in 1967 to 595 000 ha in 2007 (FAOSTAT 2009). Crops are grown in sands that are highly irrigated and fertilized, which impacts the quality of groundwater resources. Overgrazing decreases vegetation cover of rangelands, making them more susceptible to wind erosion and desertification. Aggressive efforts are being made to combat desertification through legislation and establishment of natural reserves and greenbelts.



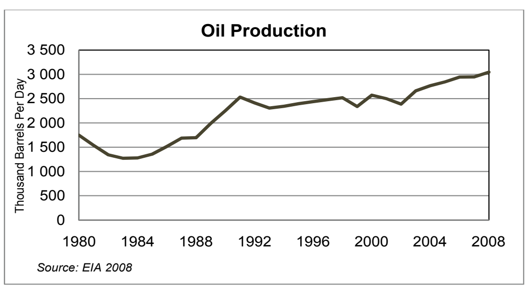
Source: FAOSTAT 2009


Liwa Dunes, Abu Dhabi   Source: Z Hill

Date Palms   Source: Jema Smith/Flickr.com

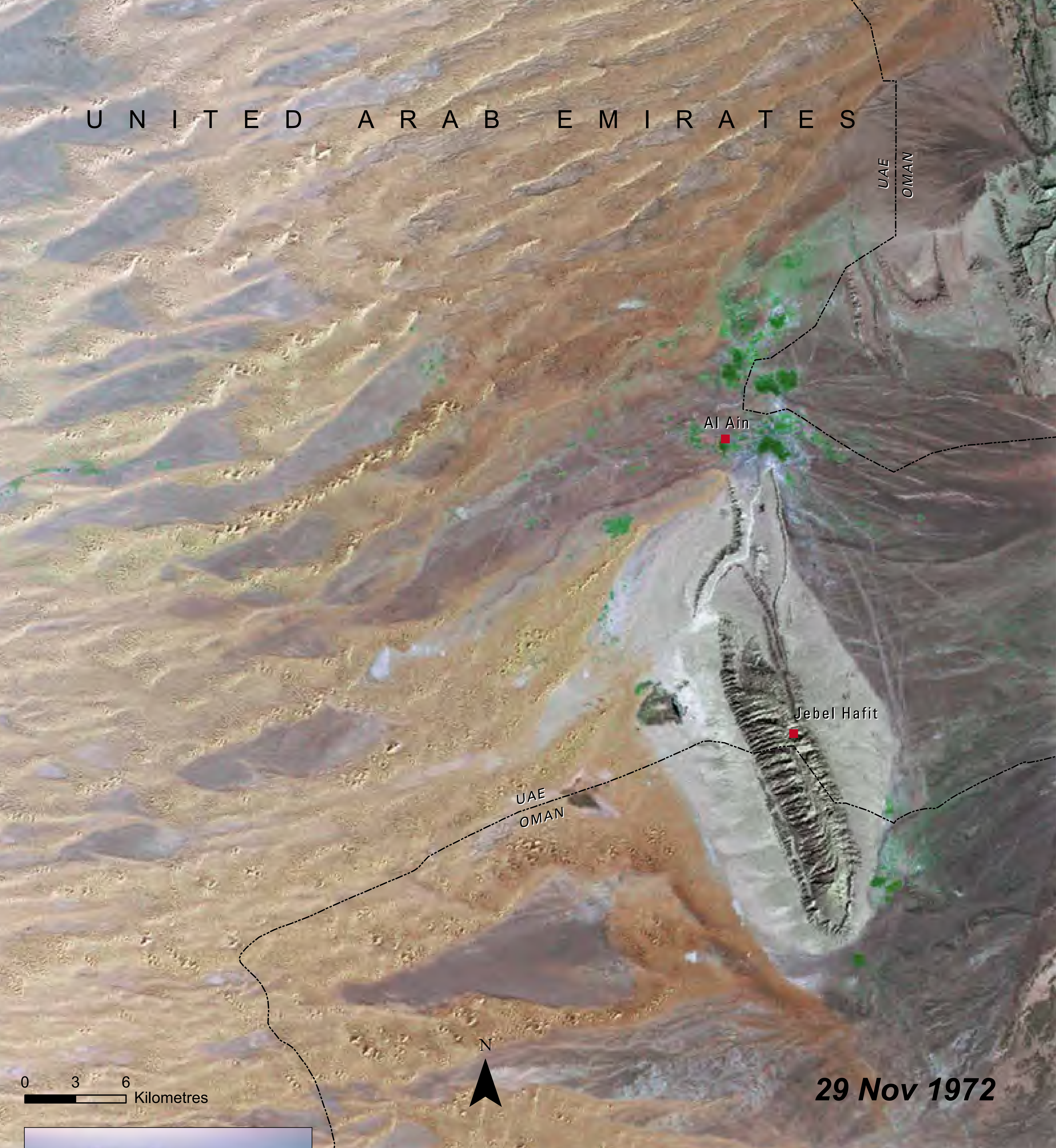
Threats to Marine and Coastal Ecosystems

During the past three decades, rapid development of industry (oil and gas), recreation, transportation and tourism sectors has occurred in UAE's coastal and marine environments. Coastal and marine ecosystems are under threat from pollution due to the large number of offshore oil and gas installations, tanker loading terminals and the high volume and density of tanker traffic (AFED 2009). It is estimated that two million barrels of oil are spilt annually into the ROPME Sea Area. Major declines in fish stocks have been documented due to fishing pressure, habitat degradation (pollution, dredging, land reclamation and channelling of the seabed) and environmental changes (AGEDI 2008). Uncontrolled development and land reclamation programmes have destroyed or damaged significant portions of coral reefs, mangroves, salt marsh habitats and inter-tidal flats along the coast (EAD 2008). Dunes and beaches are mined for sand or graded to make way for residences, hotels and other recreational facilities, resulting in habitat loss and biodiversity loss (Al Abdessalaam 2005).



Source: EIA 2008

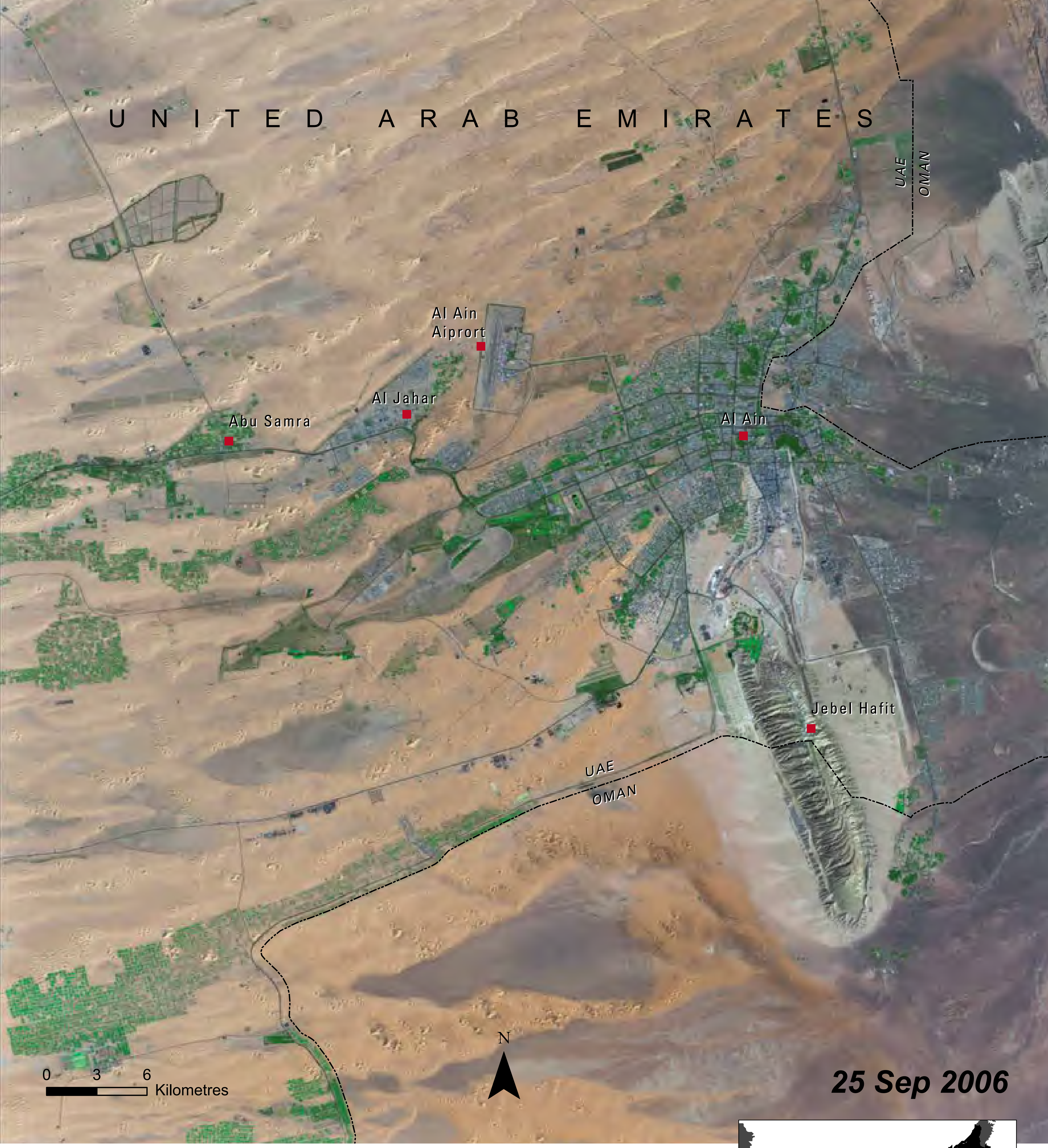

Source: Environmental Agency Abu Dhabi




Jebel Hafit, UAE Source: EAD Abu Dhabi

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. Jebel Hafit is the most westerly outlier of the Hajar Mountain range and forms an isolated rocky island that is 17 km long and 1 300 m high. 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. Date palms are grown here in addition to salad crops such as tomatoes and cucumbers.



Much of the vegetation is watered using a combination of groundwater, re-used wastewater and desalinated seawater. The population growth in Al Ain over the past 30 years has been dramatic, increasing from 120 000 in 1980 to 374 000 in 2009. 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).

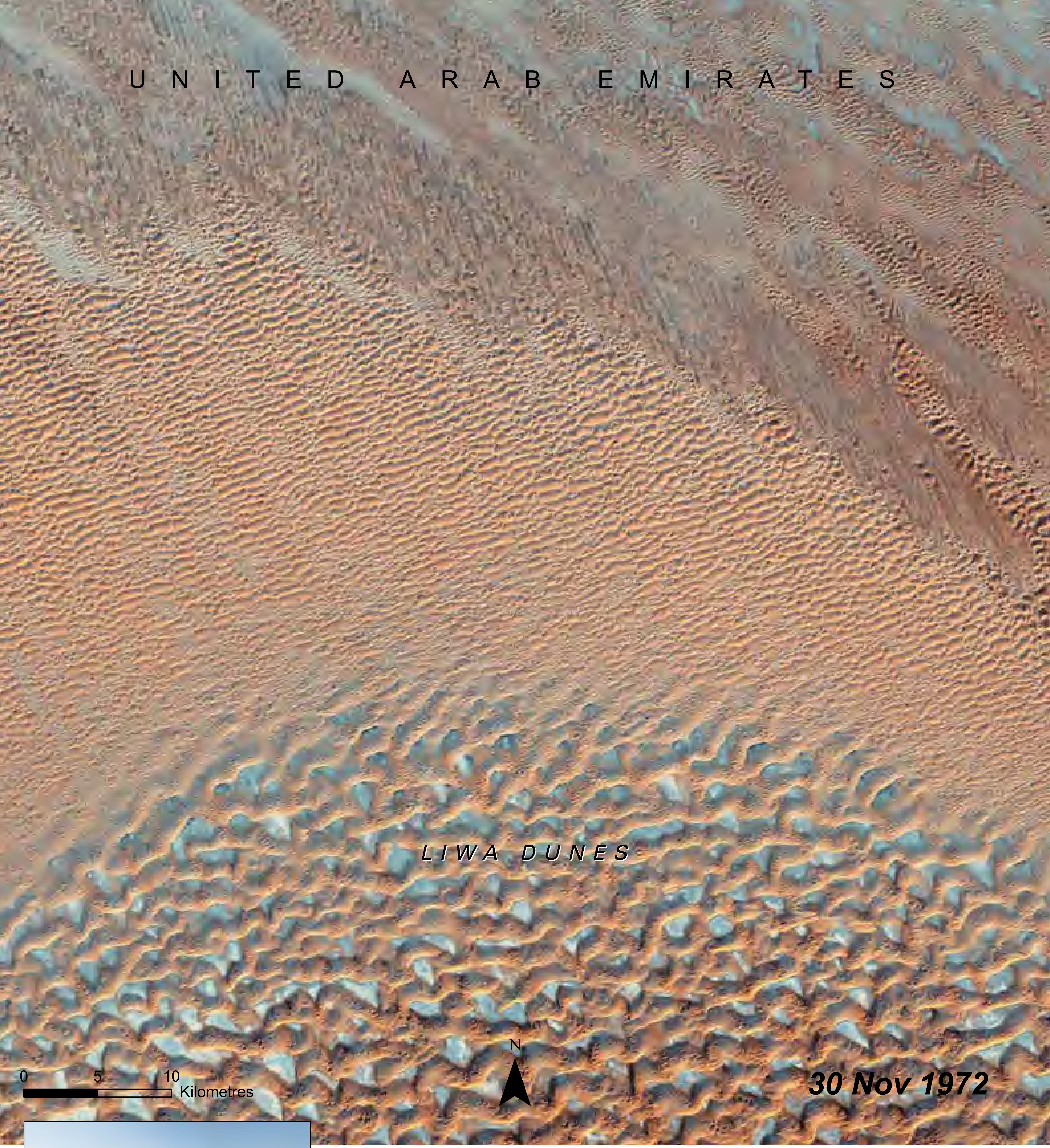
Dubai, UAE Source: Brirrob Flickr.com

Dubai Coastline, UAE

Major development of Dubai's coastline began in the late 1970s with the construction of the Jebel Ali Port and the Dubai dry docks. Minor modifications were made during the following 20 years, with construction of fishing ports and the development of the Burj Al Arab Island in 1998, an artificial island 280 m from Jumeirah beach. In 2002, construction commenced on a series of large-scale artificial coastal islands, significantly altering the natural coastline of the Emirate.

This development has negatively impacted the Jebel Ali reef, the largest coral reef along the Emirate's coast. Much of the coral habitat has been buried or heavily impacted by sedimentation from dredging and changes in water flow. This loss

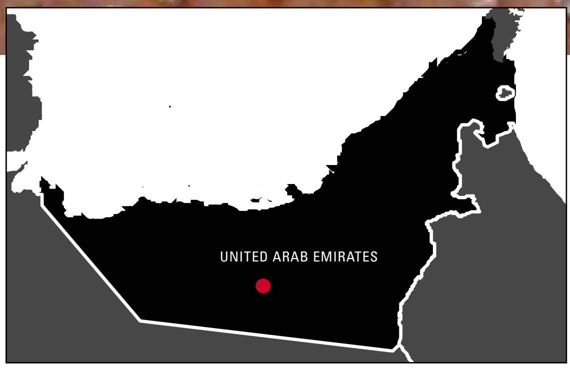
of coral cover and diversity has had a profound impact on the abundance, diversity and composition of coral reef fish communities (Burt 2009). Many of these man-made structures also create new habitats; for example, coral species are recruiting in fairly high abundance on the rocky breakwater structures surrounding the islands (Burt and others 2009). Despite the creation of artificial reef ecosystems, the future of natural reefs are in jeopardy; management and reduction of planned real estate development and desalination facilities are important steps in addressing this issue.



Liwa, UAE

Liwa is located in central Abu Dhabi Emirate on the northern edge of the Rub al Khali or "Empty Quarter" desert. Liwa is the largest oasis in the Arabian Peninsula; the red mega-dunes reach 150 m, providing a stark contrast to the surrounding desert. Between the massive sand dunes are *sabkhas* (salt flats), which form where the underground water table meets the Earth's surface— the *sabkhas* are visible in both images above. Due to the availability of water, this oasis was traditionally settled and continues to support a thriving population. Fifty communities now lie along the Liwa Crescent, which stretches 120 km from east to west.

In an effort to boost the UAE's agricultural sector and achieve food self-sufficiency, this area developed rapidly in the past three decades; this dramatic change is visible in the 2006 image. The UAE increased its agricultural area by 400 000 ha over a 40-year period through massive afforestation schemes, date palm cultivation, and nursery projects (FAOSTAT 2009). Agriculture in Liwa is dominated by date palms and a variety of vegetable and fruit crops. Groundwater is the main source of water for agriculture; however, irrigation expansion, persistent drought and decreased rainfall have led to rapid declines in groundwater levels. Increased salinity and agricultural pollutants are contaminating the groundwater, causing some wells in Liwa to be discontinued (Wood and others 2003). Sound management practices are being implemented to avoid depleting the groundwater resource, which, at current abstraction rates, is projected to be depleted in less than 40 years (USGS 1996).



Republic of Yemen

Total Surface Area: 527 968 km^2
Estimated Population in 2010: 24 053 000

The Republic of Yemen is located on the southwestern corner of the Arabian Peninsula. It shares a land border with Saudi Arabia to the north and Oman to the east. The coastline extends more than 2 000 km along the Red Sea, Gulf of Aden and the Arabian Sea. Yemen has five major geographical areas: the hot and humid coastal Tihama plain along the Red Sea and Gulf of Aden; the highlands parallel to the Red Sea coast; high plateau; the Al-Rub Al-Khali desert interior; and the islands in the Arabian and Red seas. Yemen's coastal and marine ecosystems include extensive mangroves, coral reefs, and seagrass areas, which are of major economic importance for fisheries and tourism.

Important environmental issues

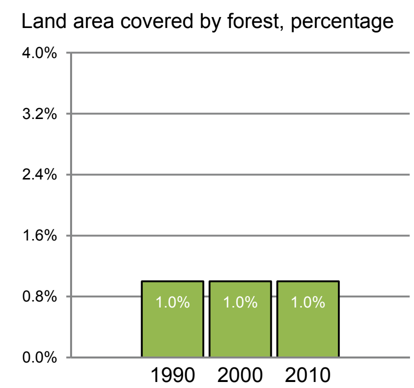
- Water Scarcity and Water Quality
- Population and Pressure on Land
- Soil, Water and Wind Erosion

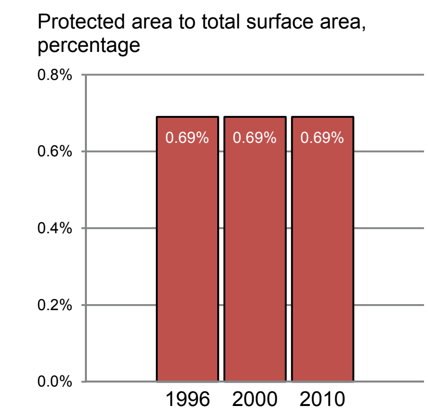
Progress Toward Environmental Sustainability

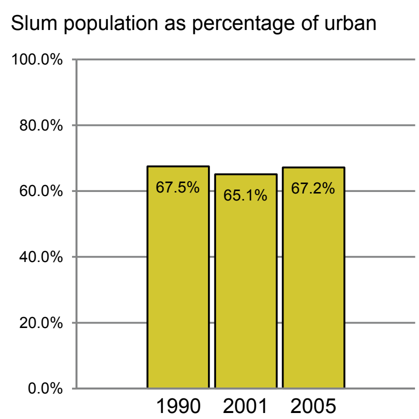
As defined by the United Nations Millennium Development Goal 7 Indicators

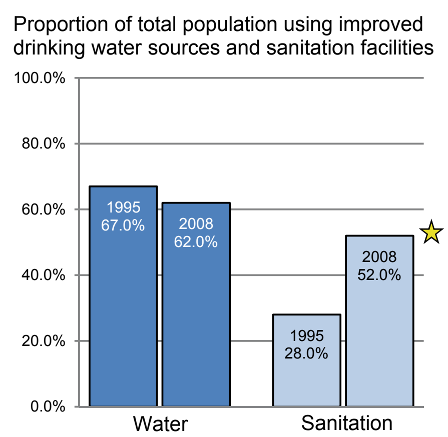
As one of the poorest countries in the Arab region, Yemen is struggling with many social and environmental issues. Yemen suffers from a lack of adequate drinking water and wastewater disposal systems for its urban and rural populations - 40 per cent of urban households are not linked to water mains and two-thirds lack proper sanitation (GTZ 2007).

☆ Indicates Progress







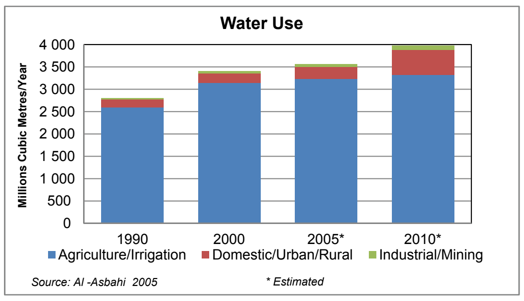


Socotra Island, home of the famous dragon's blood tree, is considered the "jewel" of biodiversity in the region with 900 plant species, 27 reptile species, and 190 different birds, many of which are endemic

Source: Socotra Conservation and Development Programme n.d.

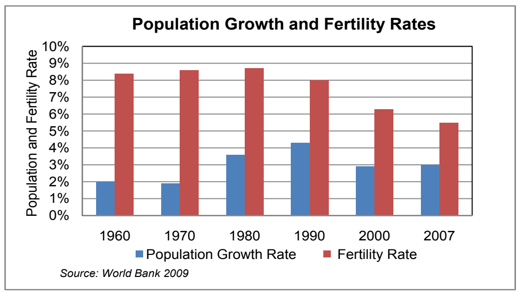
Water Scarcity and Water Quality

Yemen is considered one of the most water scarce regions in the world and suffers from grave water shortages. The country's water supply relies on limited groundwater, which has been heavily overexploited and polluted over the past 20 years (GTZ 2007). Renewable fresh water is very scarce; with an annual recharge of 2 100 million m^3, the availability of water per capita is 130 m^3/year (or 2 per cent of the global average) (Al Sabahi and others 2009).The shallow aquifers, especially in the urban areas, are contaminated by industrial and residential wastes, while coastal aquifers are subject to saline intrusion. Water contamination has led to outbreaks of diseases such as cholera, bacterial dysentery and typhoid (YMWE 1999). Increased rainwater harvesting in the highlands where annual precipitation averages 500 to 800 mm/year, along with establishment of desalination plants in coastal areas, may help alleviate the water shortage issues.



Population and Pressure on Land

One of the major problems facing Yemen is the environmental degradation associated with population growth. In 1975, Yemen's population was only 7 million; in 2007 it was over 22 million and is expected to reach 43 million by 2035. Yemen has one of the highest fertility rates in the world with 5.5 births per woman (UNPD 2007). The urban population is growing at a rate of 4.8 per cent (2005); between 1970 and 2005, the urban population (as per cent of total) rose from 13 to 26 per cent. The increased population is placing pressure on the country's limited resources. Land degradation due to overgrazing, excessive fuelwood harvesting, improper disposal of industrial and municipal wastes, water shortages and overuse of fertilizers and pesticides on agricultural lands is occurring country-wide. Priority actions such as establishing a network of protected areas, expanding resource planning and legislation are needed in order to reverse current environmental trends.

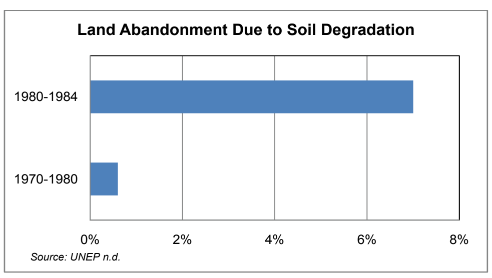


Qat agriculture consumes 30 per cent of Yemen's groundwater; production of this narcotic, Yemen's primary cash crop, is growing by 12 per cent per year

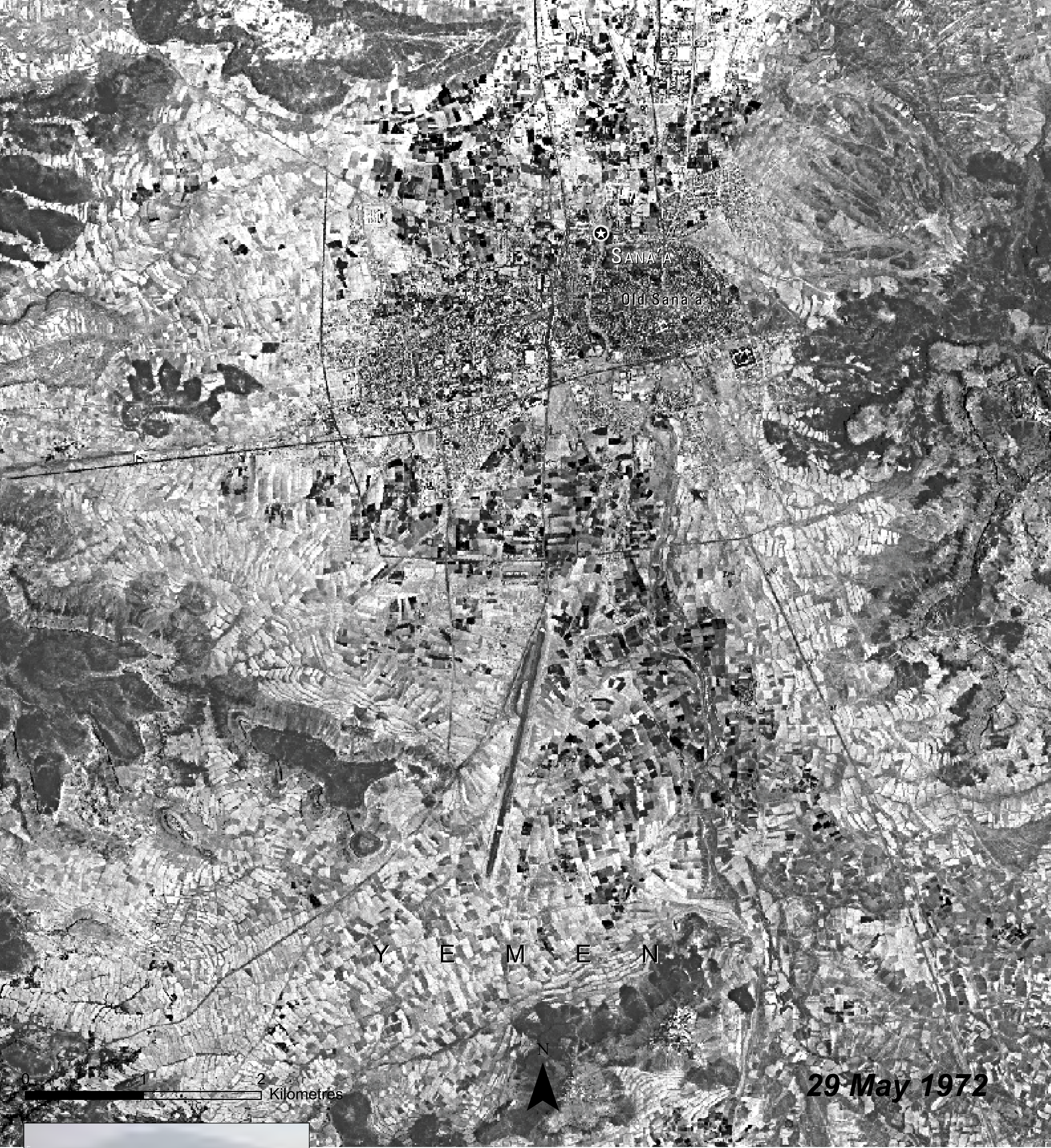
Source: World Bank 2007

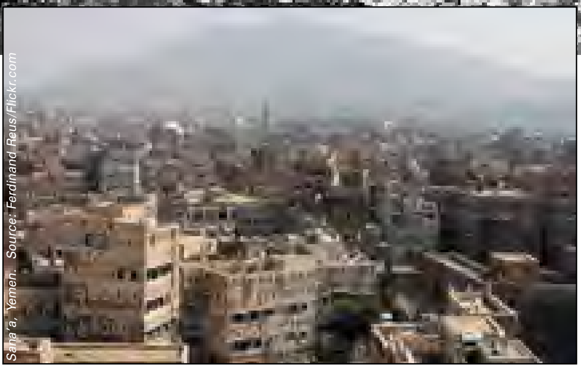
Soil, Water and Wind Erosion

The rate of soil and water erosion has increased in the past 40 years as a result of vegetation removal and unsustainable land use and farming practices. In Yemen, the area affected by water erosion increased from 5.5 million ha in 1992 to 12 million ha in 2000 (MAI 2000); water erosion destroys woody vegetation in the northern highlands and results in significant sedimentation in coastal areas. Mountain terraces, a national heritage of Yemen that constitute 20 to 25 per cent of the total arable land, are subject to increased soil and water erosion due to lack of maintenance and overharvesting of stabilizing vegetation (Al-Hebshi 2005). Wind erosion, which promotes sand encroachment on productive lands, is estimated to affect 6.1 million ha (FAO 1992). Forty per cent of Yemen's total land area is rangeland with some forest cover (about 1 per cent); 76 per cent of these lands have experienced moderate to severe desertification (Abdelgawad 1997; ACSAD and GSLAS 2000). Overall, the rate of desertification is estimated at 3 to 4 per cent (Al-Hebshi 2005).



Sana'a, Yemen. Source: Ferdinand Reus/Flickr.com

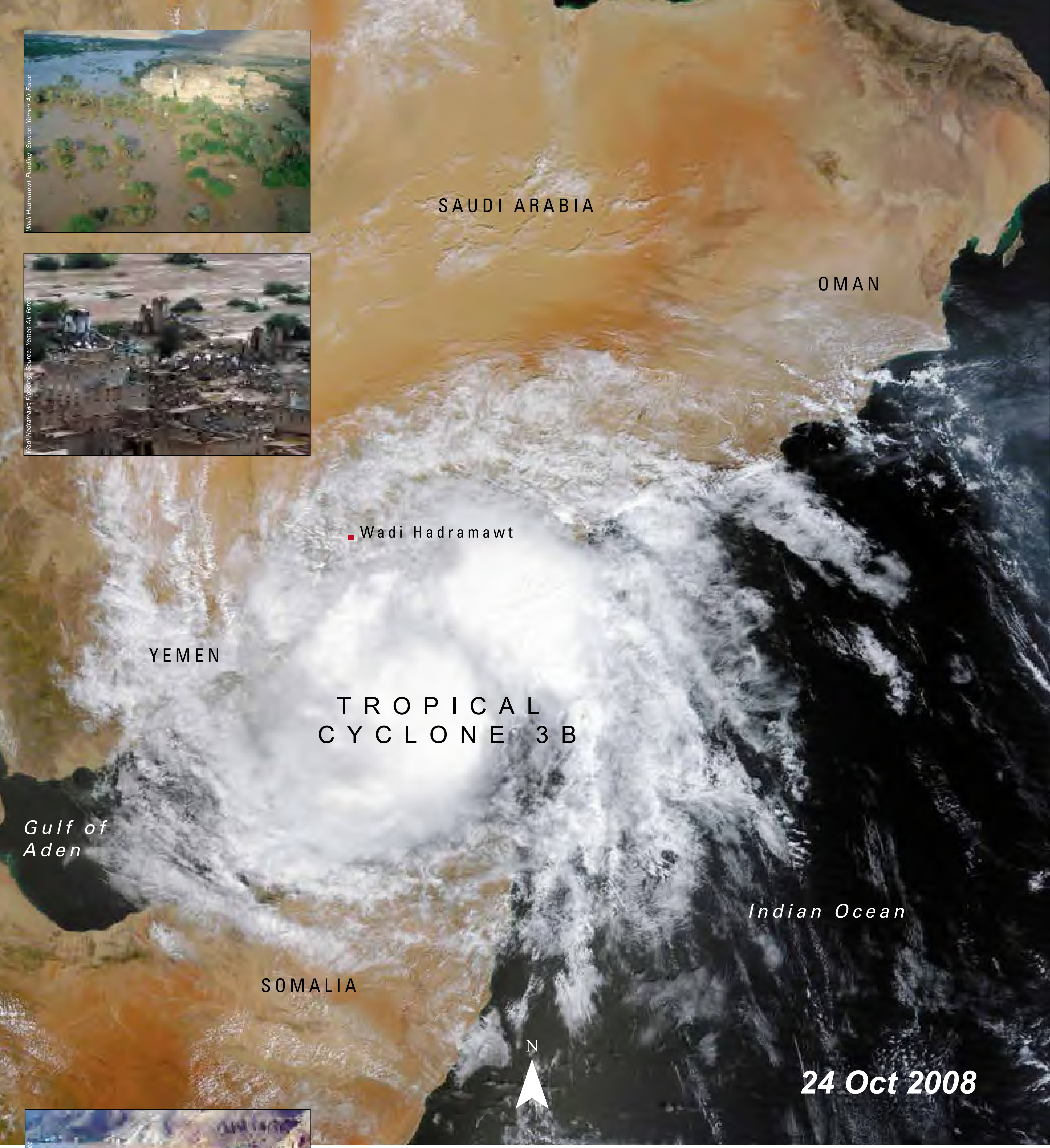



Sana'a, Yemen. Source: Ferdinand Reus/Flickr.com

Sana'a, Yemen

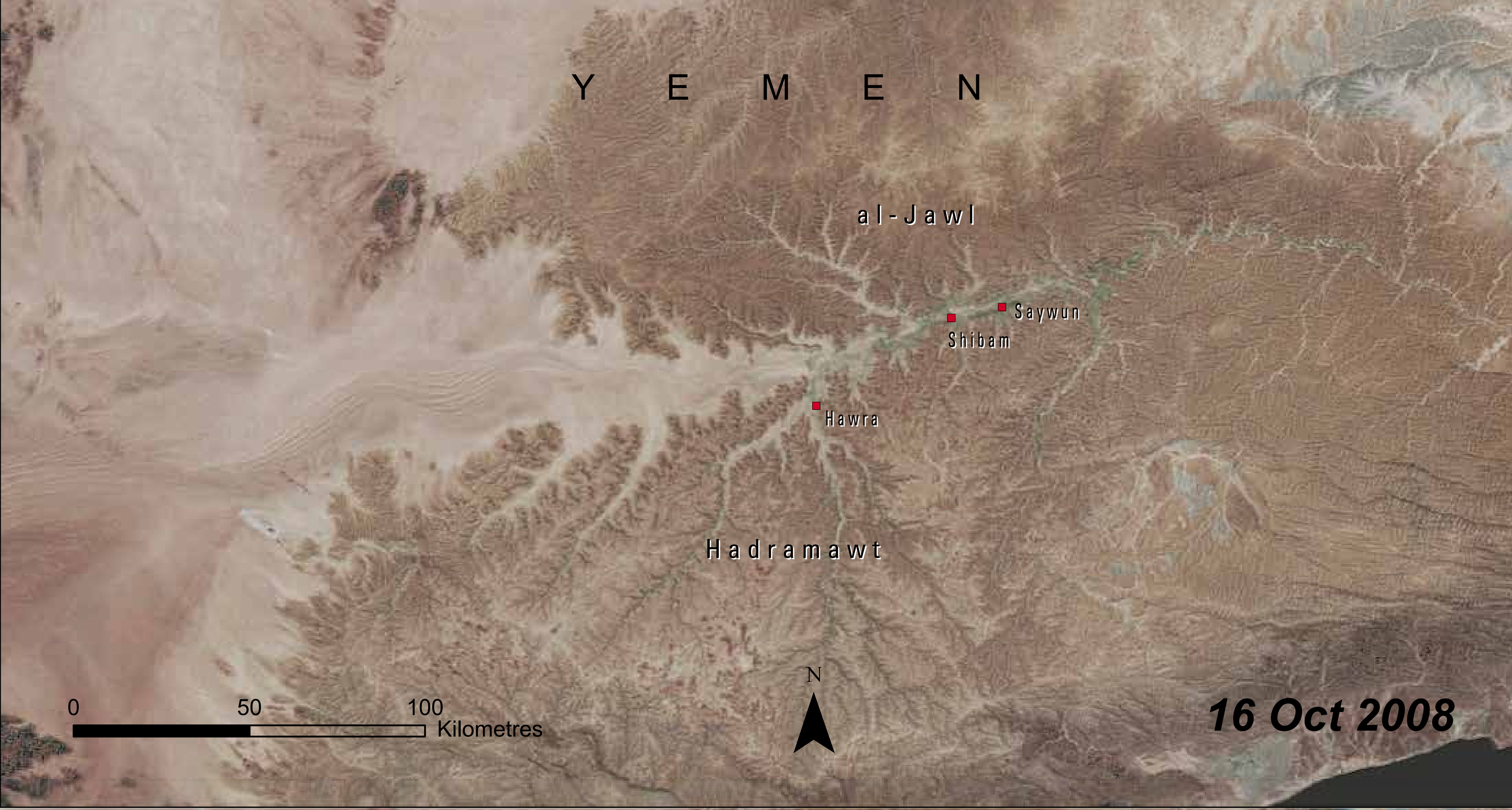
Sana'a, Yemen's capital and largest city, is located in an intermountain plain in the central Yemen Highlands. The plain is 2 200 m above sea level and is flanked by mountains that rise to about 3 000 m above sea level. This region has a temperate climate with mild temperatures and approximately 200 mm of rainfall per year, which mostly occurs during July and August. With an annual growth rate of around 10 per cent, Sana'a has experienced huge increases in population, from 135 000 in 1970 to over 2 million at present. Rapid urbanization has led to water scarcity and water contamination problems. The city relies heavily on groundwater, which is being mined at alarming rates and is subject to contamination by industrial and residential wastes. Groundwater levels in the Sana'a Basin are falling as much as 5 to 6 m per year (MPIC

2003). Lack of access to safe water has resulted in health problems, especially among the urban poor. Inadequate disposal of wastewater and solid waste leads to further deterioration of land and water resources. Deforestation of mountain slopes, overgrazing, and the lack of maintenance of highland agricultural terraces, causes massive soil erosion in the highlands. Inadequate land, along with antiquated services and facilities to accommodate urban growth, are posing significant threats to urban productivity, human health, and natural resources. The 1972 imagery shows extensive hillside terraces surrounding the immediate urban centre. The 2009 imagery shows encroachment of the urban areas into the hillside terraces, where agriculture has traditionally been practised for millennia. Terraced agriculture provides erosion control, helps to recharge shallow aquifers, and is the main source of income for about 60 per cent of the population in the highlands (MPIC 2003). The deterioration and loss of these agricultural lands has severe implications for Yemen's economy and environment.

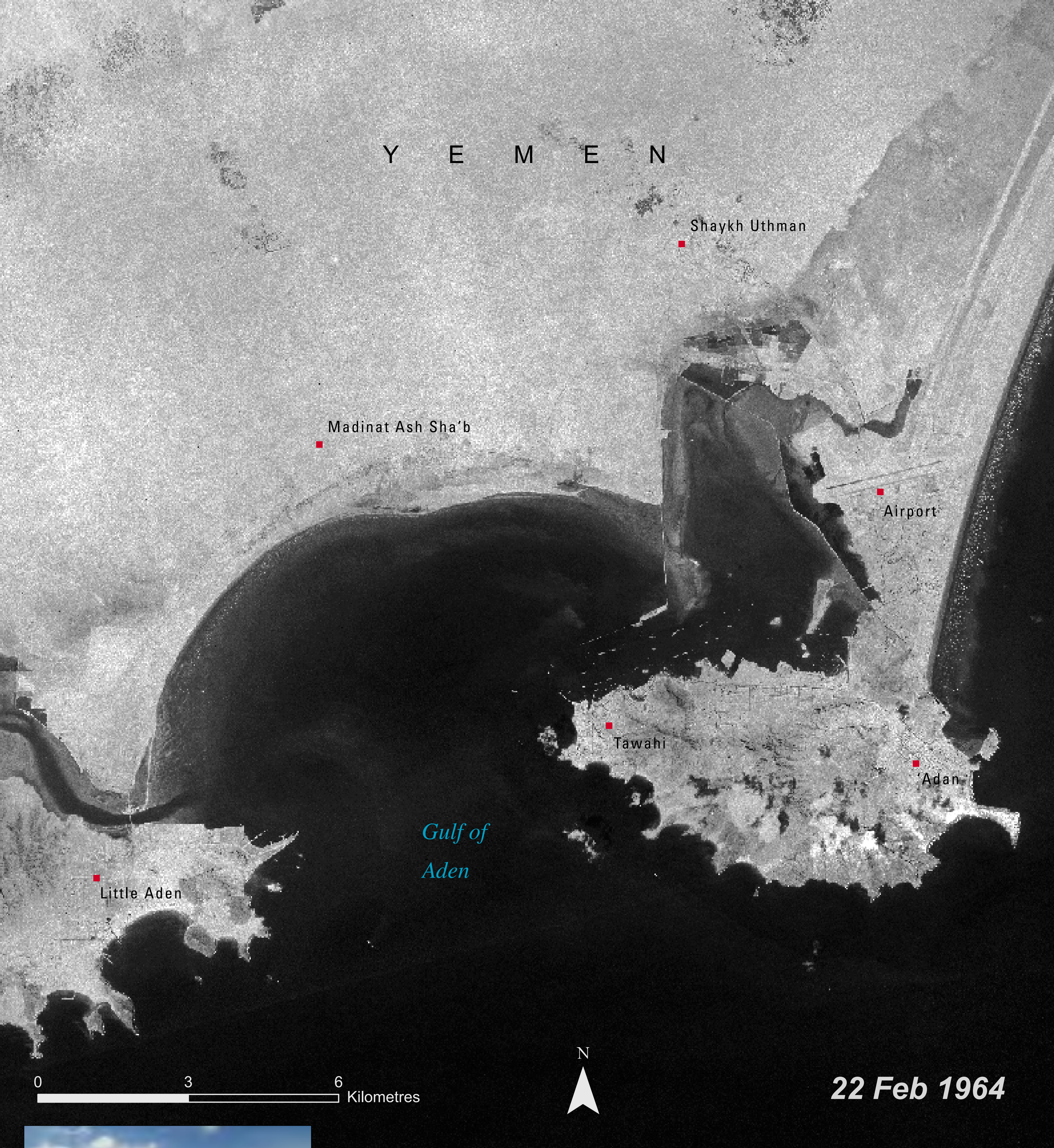


Flooding along the Wadi Hadramawt, Yemen

Wadi Hadramawt is a 640-km-long valley located in eastern Yemen that constitutes one of the country's most agriculturally rich areas. Many types of grain, cotton, qat and a variety of fruits and vegetables are produced here. A sparse network of deeply sunk wadis, or seasonal watercourses, drains the high and arid plateau of eastern Yemen and is at the centre of Hadramawt, a distinct geographic and socio-political region that was a famous trading site in ancient times. Though heavy rain is unusual in Yemen, the country is prone to flooding, particularly during the monsoon season. 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.



Gulf of Aden, Yemen
Source: Raphael Fauveau/Flickr.com

Aden, Yemen

The city of Aden is located on a peninsula in the Gulf of Aden in the Arabian Sea that is joined to the mainland by a low isthmus. The city includes many sub-centres such as Madinat Ash Sha'b on the mainland as well as the volcanic peninsula of Little Aden. The Gulf of Aden is a geologically young body of water, and is an important repository of marine biodiversity with complex systems of coral reefs interspersed with mangroves and seagrass beds (World Bank 2000). The cold, nutrient-rich upwelling waters of the Gulf of Aden give rise to prodigious fisheries production. The most significant threats to marine ecosystems in the Gulf of Aden are increases in the human population in the coastal zone and rapid economic growth. Widespread destruction of coastal ecosystems has taken place through land-filling and dredging.

Critical mangrove habitats are threatened by extensive wood cutting and the disposal of raw sewage and untreated industrial waste, while seagrass vegetation is damaged by bottom-trawling. In addition, heavy fishing activity during the spawning season, and development of industrial scale fisheries, is disrupting ecosystems upon which fish, shrimp, and other marine fauna depend (World Bank 2000). The Gulf of Aden is a vital waterway for shipping traffic and a main transport route for oil tankers, making it vulnerable to major oil spills. These images show extensive development of the coastal zone in and around Aden from 1964 to 2004. Development of port processing facilities on land as well as modifications to approach channels in the Gulf to accommodate the needs of ever larger container ships, is occurring at a rapid rate. Increased industrial sites such as power plants and desalination plants are being established along the coast to provide for Yemen's growing population and serve its urban centres.

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MODIS (Moderate Resolution Imaging Spectroradiometer) sensor on NASA's TERRA satellite. October, 2008.

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MODIS (Moderate Resolution Imaging Spectroradiometer) sensor on NASA's TERRA satellite. October, 2008.

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Source: NASA ISS/Flickr.com

Coastal region of Somalia, south of the capital of Mogadishu, during the wet season.

Rub al Khali - world's largest sand sea,
Arabian Peninsula

Source: NASA ISS/Flickr.com

Epilogue

"There was no water and too much sand..."

- Nofa Hamid, sheep herder from Addami village in Syria (NPR 2010)

Source: Hovic/Flickr.com

Northern Syria

Source: Wikicommons

Yemen

In the drought-stricken village of Addami in northern Syria, villagers such as Nofa Hamid have abandoned their once-fertile lands that have turned to dust in search of work in cities. The massive displacement of 'water refugees' is happening region-wide in response to increasing water scarcity and climate change. Nofa Hamid, who has been tending sheep for almost 50 years said the summer had been 'crazy' and that the sand was 'everywhere'. Sheep herders and farmers who depend on their livestock and farmlands are being forced to seek other livelihoods - many find temporary jobs in urban areas; however, the future for many sheep herders like Nofa Hamid is uncertain given the increased temperatures and significant reductions in annual average rainfall expected in the Arab region as a result of climate change. The effects of water scarcity and displacement of peoples to cities ranges greatly from unchecked sprawl, lack of basic services, increasing food insecurity, and pollution. The environment is also affected by reduced biodiversity and exacerbated soil erosion, which increases desertification. The degradation of the landscape has far reaching consequences, both social and environmental.

Just as oil largely defined the past century for the Arab region, water scarcity and desertification will likely define this century. The drought conditions in the village of Addami and the migrations of people forced to seek other livelihoods, have become commonplace in the Arab region; these conditions will worsen with increases in population, and in some cases, by conflict. Chapter 2 of this atlas describes water availability and supply as a transboundary issue, which highlights the potential for coordination and collaboration among water-sharing countries, but also emphasizes the potential for conflict over an increasingly scarce natural resource. In response, the Arab League nations are investing substantial effort and funds into developing alternative water supplies, adopting water conservation measures, and planting more water efficient crops to mitigate growing water scarcity problems. Some countries are going to extraordinary lengths to increase water supplies, such as the case with Morocco's cloud seeding program in the Central High Atlas Mountains, where silver iodide is used as a seeding agent to increase the precipitation efficiency of cold clouds to produce snowfall and augment the snowmelt runoff in the summer, when the water is needed most. Other Arab countries are implementing extensive wastewater recycling programs and the Arab region boasts some of the largest desalination plants in the world.

With almost 40 per cent of the global population projected by 2015 to be living in countries where it is difficult or impossible to meet basic water needs, and over half of the Arab countries expected to experience severe water scarcity by 2050, these innovative methods are key to ensuring future water supplies. As the UN Committee on Economic, Social and Cultural Rights commented: 'Water is fundamental for life and health. The human right to water is indispensable for leading a healthy life in human dignity. It is a pre-requisite to the realization of all other human rights'. Efficient water management and coordinated approaches to managing increasingly scarce natural resources in the Arab region are fundamental to ensuring a secure future for the people of this region.

Acronyms and Abbreviations

ACSAD	Arab Center for Studies of Arid Zones and Drylands
AFED	Arab Forum for Environment and Development
ATDP	Arab Trade and Development Program
BCE	Before the Common Era
BCM	billion (thousand million) cubic metres
bpd	barrels per day
boe	barrels of oil equivalent
°C	Celsius
CAEU	Council of the Arab Economic Unity
CBD	Convention on Biological Diversity
CEDARE	Center for Environment and Development for the Arab Region and Europe
cm	centimeters
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DAC	Development Assistance Committee
EPA	Environmental Protection Agency
ESCWA	Economic and Social Commission for Western Asia
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GEF	Global Environment Fund
GEO	Group on Earth Observations
GHG	Greenhouse Gases
GIS	Geographic Information System
GNP	Gross National Product
GWh	Gigawatt Hour
ha	hectares
HDI	Human Development Indicator
HIPC	Heavily Indebted Poor Countries
IBAs	Important Bird Areas
IDPs	Internally displaced persons
IGBP	International Geosphere-Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature and Natural Resources
kg	kilograms
km	kilometres
km^2	square kilometres
km^3	cubic kilometres
LDCs	Least Developed Countries
m	metres
m^2	square metres
m^3	cubic metres
m^3/sec	cubic metres per second
Mashreq region	Egypt, Iraq, Jordan, Lebanon, Palestinian and Syria
Maghreb region	African nations of Algeria, Libya, Morocco, Tunisia and Mauritania
MCM	million cubic metres
MDRI	Multilateral Debt Relief Initiative
MDGs	Millennium Development Goals
mm	millimetres
MODIS	Moderate Resolution Imaging Spectoradiometer
MW	Megawatt
n.d.	no date
NO_2	Nitrogen Dioxide
NO_x	nitrogen oxides
N_2O	Nitrous Oxide
NASA	National Aeronautics and Space Administration, United States of America
NCSA	National Capacity Self Assessments
NOAA	National Oceanic and Atmospheric Administration, United States of America
O_3	ozone
OPEC	Organization of the Petroleum Exporting Countries
PCB	Polychlorinated biphenyl
PERSGA	Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden
ppm	parts per million
PM	particulate matter
ROPME	Regional Organisation for the Protection of the Marine Environment
RSA	ROPME Sea Area
RSGA	Red Sea and Gulf of Aden
SIDS	Small Island Developing States
SO_x	sulphur oxides
UAE	United Arab Emirates
µg	microgram
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNSD	United Nations Statistics Division
USAID	United States Agency for International Development
USGS	United States Geological Survey
WFP	World Food Programme
WHO	World Health Organization
WRI	World Resources Institute
WTO	World Trade Organization
WWF	World Wildlife Fund
yr	year

Changes in MDG Goal 7: Environmental Sustainability Indicators	Forested Land as % of Land Area		Protected area to total surface area, percentage		Access to Improved Water source (% of total population)		Access to Improved Sanitation (% of total population)		Slum Population as percentage of urban population	
Country Names	1990	2010	1990	2010	1990	2008	1990	2008	1990	2005
Algeria, People's Democratic Republic of	0.7	0.6	**6.23**	**6.24**	94	83	**88**	**95**	11.8	N/A
Bahrain, Kingdom of	**0**	**1.4**	**0.16**	**0.74**	100	100	97	97	0	0
Comoros, Union of the	6.5	1.6	0	0	**87**	**95**	**17**	**36**	65.4	68.9
Djibouti, Republic of	0.3	0.3	0.05	0.05	**77**	**92**	66	56	N/A	N/A
Egypt, Arab Republic of	**0**	**0.1**	**2.08**	**6.08**	**90**	**99**	**72**	**94**	**50.2**	**17.1**
Iraq	**1.8**	**1.9**	0.05	0.05	81	79	N/A	73	16.9	52.8
Jordan, Hashemite Kingdom of	1.1	1.1	**0.73**	**1.94**	97	96	N/A	98	**16.5**	**15.8**
Kuwait, State of	**0.2**	**0.3**	1.11	1.11	99	99	100	100	N/A	N/A
Lebanon	**12.8**	**13.4**	**0.33**	**0.36**	100	100	N/A	89	50	53.1
Libyan Arab Jamahiriya, Socialist People's	0.1	0.	0.11	0.11	54	54	97	97	35.2	N/A
Mauritania, Islamic Republic of	0.4	0.2	1.13	1.13	**30**	**49**	**16**	**26**	94.3	N/A
Morocco, Kingdom of	**11.3**	**11.5**	**1.13**	**1.53**	**74**	**81**	**53**	**69**	**37.4**	**13.1**
Oman, Sultanate of	0	0	**0**	**9.31**	**80**	**88**	85	N/A	60.5	N/A
Occupied Palestinian Territories	1.5	1.5	**0.63**	**0.64**	95	91	N/A	89	N/A	N/A
Qatar, State of	0	0	**0.89**	**1.39**	100	100	100	100	N/A	N/A
Saudi Arabia, Kingdom of	0.5	0.5	**7.25**	**29.95**	89	89	N/A	N/A	**19.8**	**18**
Somali Republic	13.2	10.8	0.53	0.53	**21**	**30**	N/A	23	**96.3**	**73.5**
Sudan, Republic of the	32.1	29.4	4.18	4.18	65	57	34	34	86.4	94.2
Syrian Arab Republic	**2**	**2.7**	**0.25**	**0.64**	**85**	**89**	**83**	**96**	10.4	10.5
Tunisia	**4.1**	**6.5**	**1.22**	**1.27**	**81**	**94**	**74**	**85**	**9**	**3.7**
United Arab Emirates	**2.9**	**3.8**	**0.27**	**4.71**	100	100	97	97	N/A	N/A
Yemen, Republic of	1	1	**0**	**0.69**	72	62	**18**	**52**	**67.5**	**67.2**

* Improvements are marked in **bold green**

Source used for country names: Permanent Mission to the United Nations, 2008.

Note: Some of the dates may vary along with the data sources- see the country profiles in Chapter 3 for further information

Source: Martin Allen/Flickr.com

About Remote Sensing Images

The field of Remote Sensing has grown considerably since its infancy in the early 1970s when the initial earth-observing satellite of the Landsat program was launched. The Landsat program, jointly managed by NASA and the U.S. Geological Survey, has collected and archived images of the Earth's surface for nearly 40 years. This valuable historical record provides a unique opportunity for identifying and documenting environmental change anywhere on the planet. This atlas relies heavily, although not completely, on the images provided by the Landsat Program to depict environmental change in the Arab region. Since the initial earth-observing satellite of the Landsat Program was launched in the 1970s several new satellites with improved sensors (EO-1, OrbView, IKONOS etc.) collected data at higher resolutions and with an ability to capture different portions of electromagnetic radiation (e.g. radio waves, microwaves, visible light, infrared). The improved imagery from non-Landsat satellites proved invaluable in documenting change in the Arab region. Additionally, this atlas benefited from declassified satellite data, such as the images from the CORONA program, which allowed for documenting change in the Arab region from as early as the 1960s.

Satellites, like Landsat, use "multispectral" sensors to collect reflected electromagnetic energy from the visible range (400 to 700 nanometers), as well as wavelengths that the human eye cannot see (700 to 2 350 nanometers), and thermal energy to create images of the Earth. Multi-spectral sensors divide electromagnetic radiation into a small number of "bands" or ranges of wavelength. For example Landsat-7 collects electromagnetic radiation in eight different bands or ranges of wavelength (see table). Each of these ranges of "light" can tell us something different about the Earth's surface.

Creating usable and understandable images from multi-spectral sensors entails combining three or more of the available bands and displaying them as one of the three colours of standard monitor displays: red, green and blue. Often this yields an image that is not intuitive for the non-specialist to interpret (see the image at left, below). By selecting certain bands and adjusting the distribution of brightness - the overall brightness and the contrast - a more intuitive looking image can be achieved (see the image at right, below). The images in this atlas have been adjusted so that non-expert readers can interpret these images easily. The specific sensors and the band combinations used in Chapter Three can be found in the references at the end of the chapter.

In general, images are displayed so that live vegetation shows as various shades of green. Coniferous forests are generally darker shades of green, as are mangroves. Broadleaf forests are typically depicted as a slightly brighter shade of green. Agricultural fields with actively growing crops are shown as an even brighter shade of green; however this is dependent on the crop and its state of growth. The patterns of brightness are often important clues as to the nature of the vegetation. Senescent or inactive vegetation generally appears as shades of grey and brown.

Water bodies are often blue to black in appearance; however when sediment is present or the water is shallow it will appear lighter, even taking on a pink caste. Areas of bare ground will show as bright, usually almost white, while urban areas and roads generally appear as a shade of pale purple. Clouds, when they cannot be avoided, will appear as bright white.

As mentioned above, data from other sensors, such as ASTER[1] and MODIS[2], as well as the high resolution commercial sensors QuickBird[3] and IKONOS[4], were used in the production of this atlas. Readers will note the number of black and white images in the atlas, which were collected by the declassified satellite CORONA[5]. Corona was the United States first photo reconnaissance satellite system, operating from August 1960 until May 1972. The program was declassified in February 1995.

Landsat-7 ETM+Bands		
Band	Spectral Range (nm)	Description
1	450 to 515 nm	blue-green light
2	525 to 605 nm	green light
3	630 to 690 nm	red light
4	775 to 900 nm	near-infrared radiation
5	1 550 to 1 750 nm	mid-infrared radiation
6	10 400 to 12 500 nm	thermal-infrared radiation
7	2 090 to 2 350 nm	mid-infrared radiation
8	520 to 900 nm	pan-chromatic

Both of these images are from the same ASTER remote sensing image taken over Baghdad, Iraq in August of 2009. On the left, image bands are shown as red, green and blue, with the contrast and brightness determined by the default settings of a standard Geographic Information System software program. On the right, bands are displayed as red, green and blue and the colour balance, contrast and brightness have been adjusted.

1 ASTER (The Advanced Spaceborne Thermal Emission and Reflection Radiometer) is a sensor aboard the TERRA satellite is a joint effort between National Aeronautics and Space Administration (NASA) and Japan's Earth Remote Sensing Data Analysis Center (ERSDAC).
2 MODIS (Moderate Resolution Imaging Spectroradiometer) is a sensor carried on NASA's TERRA and AQUA satellites.
3 QuickBird is a high resolution commercial multispectral sensor aboard the QuickBird satellite, operated by DigitalGlobe.
4 IKONOS is a high resolution commercial multispectral sensor aboard GeoEye's IKONOS satellite.
5 Corona is a U.S. photographic surveillance satellite flown from the 1960s through the 1970s.

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Increasingly, and through satellite images, we see stark evidence of the impact human activities are having on the planet. Viewing the Earth from this remarkable range and scale allows us to better comprehend the environmental changes taking place on land, in the water, and in the air.

This Arab Region Atlas of Our Changing Environment uses evocative imagery and informative descriptions to tell a story of prominent environmental change across 22 Arab countries over the last 50 years. While this atlas documents the commonalities shared by these nations, it also highlights the unique challenges each country faces in the 21st century.

Using current and historical satellite images, maps and photographs, a range of sites have been examined to survey specific environmental changes. In a region already confronted by extreme climate, limited natural resources, economic conditions and conflict, the environmental challenges depicted are striking.

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