Chapter 3

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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).

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.

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	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)**
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	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**
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)	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
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	**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".

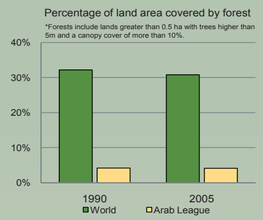
[a]For monitoring country poverty trends, indicators based on national poverty lines should be used, where available.

[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, using the five indicators for sustainability (proportion of forested lands, slum dwellers, access to improved water sources and improved sanitation, and protected areas).

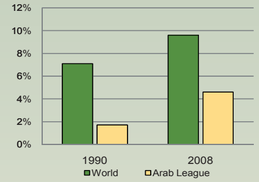
Proportion of land area covered by forest

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).



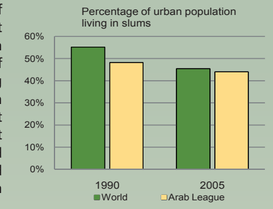
Proportion of protected areas

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.



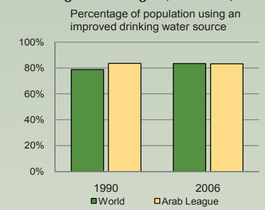
Proportion of urban population living in slums

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).



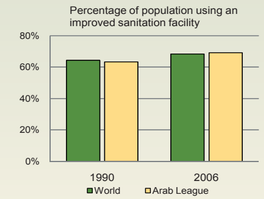
Population using an improved drinking water source

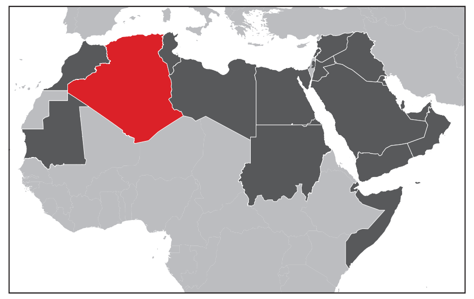
In 2007, approximately 86 per cent of the Arab region's population had access to safe water. Although this percentage rivals that of the world's, many of the Arab countries are far behind the target of halving the proportion of people without sustainable access to safe drinking water by 2015. In Somalia, 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 km²

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

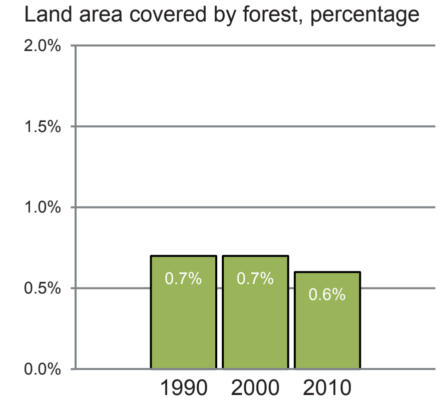
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

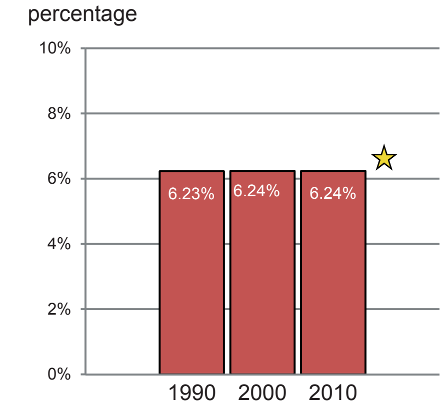
Algeria faces many challenges in its pursuit of environmental sustainability. Water shortages, desertification, and natural disasters are some of the most pressing issues, all of which are compounded by climate change. Reforestation and afforestation efforts have resulted in significant gains in forest 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

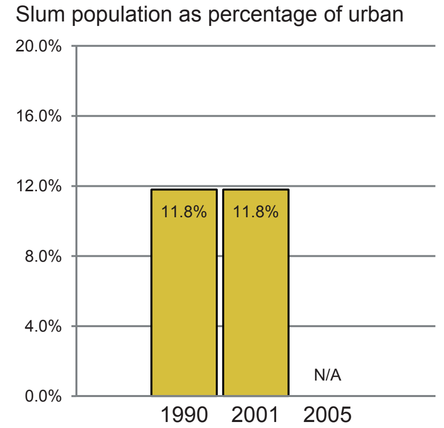
Land area covered by forest, percentage



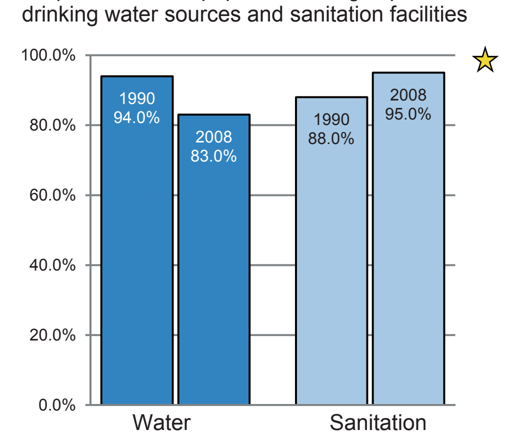
Protected area to total surface area, percentage



Slum population as percentage of urban



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

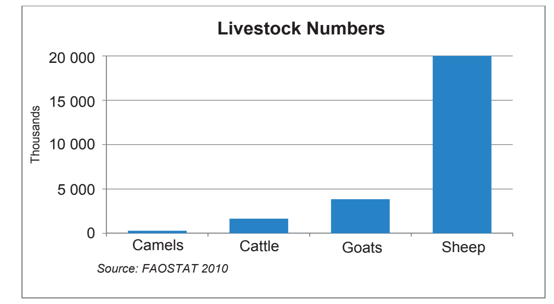


The Hamma Desalination Plant, which began purifying up to 200 000 m³ of seawater per day in 2008 provides up to two million residents of Algiers with a reliable and drought-proof supply of fresh water

Source: GE 2010

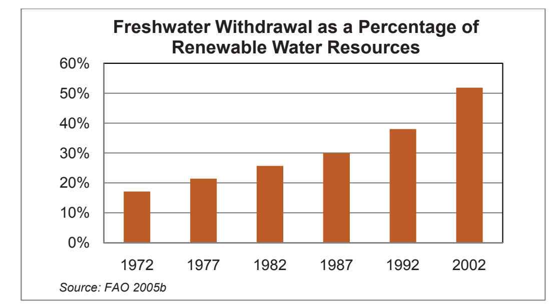
Desertification

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 m³) is considerably lower than the international water scarcity threshold of 1 000 m³ (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).

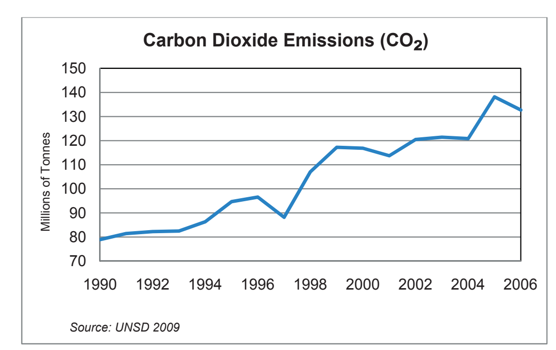


Forty-two Wetlands of International Importance covering almost 3 million ha have been designated in Algeria, representing an array of unique wetland types

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 m³ 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.



Bab el Oued, Algiers, Algeria
Source: mamminigton.Flickr.com

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.

Mediterranean Sea

ALGIERS

A L G E R I A

0 10 20 40 Kilometres

N

10 Aug 2003

Mediterranean Sea

ALGIERS

A L G E R I A

0 10 20 40 Kilometres

N

11 Aug 2003

Mediterranean Sea

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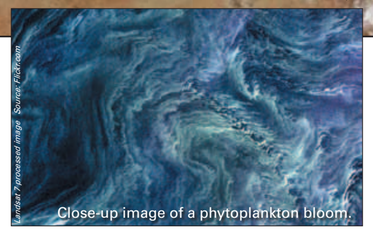


Landsat 7 processed image. Source: Flickr.com

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.

El Ouloudj

ALGERIA

Mechtet el Kita

Skikda Province

Mechta Bin el Ouidane

'Ain Kechera

Oumm Toub

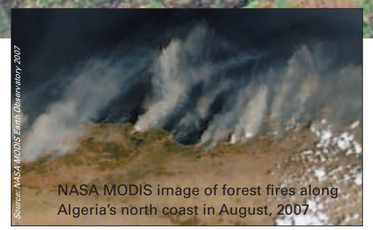
Arago

Mechtet el Ouadia

N

0 4 8 Kilometres

7 Jun 1987



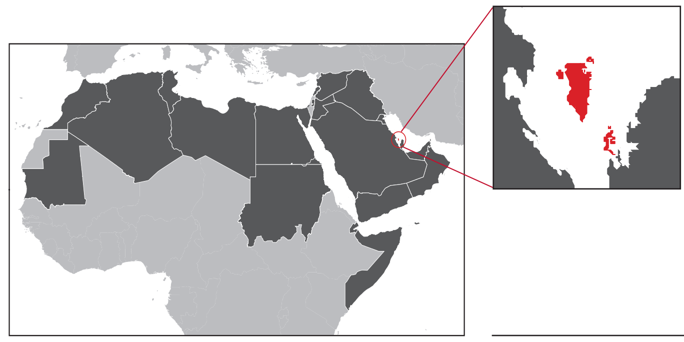
Source: NASA MODIS Earth Observatory 2007

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.

6 Aug 2009



Kingdom of Bahrain

Total Surface Area: 741 km²

Estimated Population in 2010: 1 262 000

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

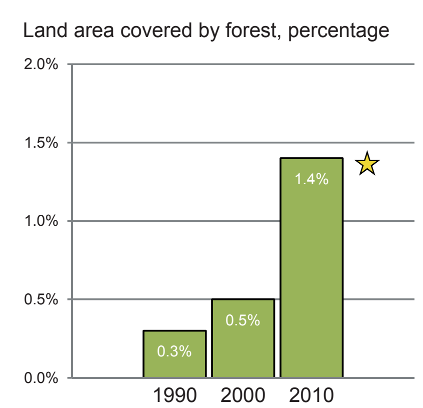
- Water Quantity and Water Quality
- Degradation of Coastal and Marine Ecosystems
- Threats to Biodiversity

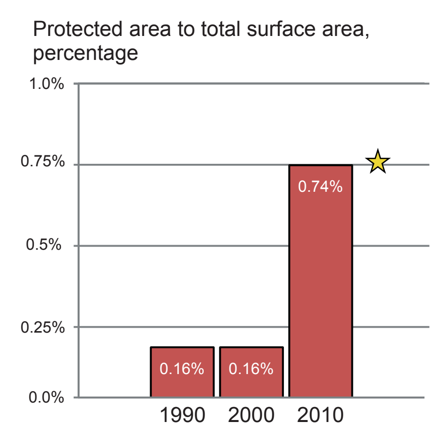
Progress Toward Environmental Sustainability

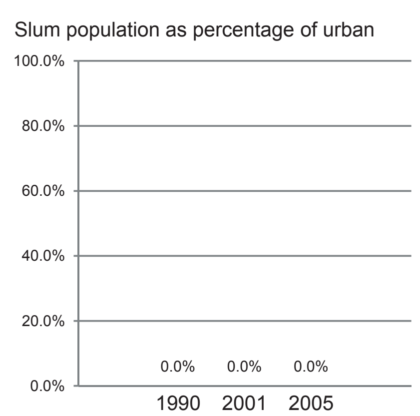
As defined by the United Nations Millennium Development Goal 7 Indicators

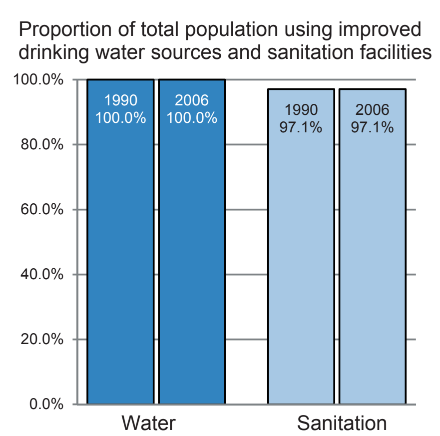
Rapid population growth, urbanization and industrialization are major challenges to Bahrain's future environmental sustainability. Almost all of the population has access to improved water sources (100 per cent) and sanitation facilities (97.1 per cent), which contributes substantially to the high standard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

☆ Indicates Progress







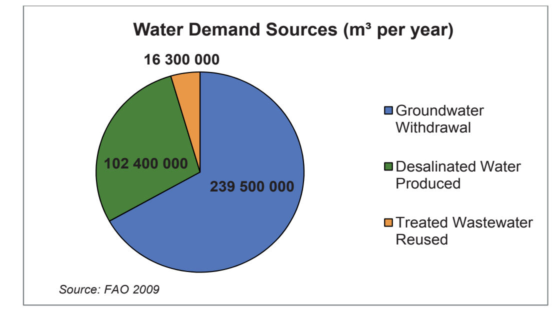


The King Fahd Causeway, completed in 1986, connects Bahrain to the Saudi Arabian mainland; hailed as a spectacular construction project, the causeway has brought economic benefits to both countries, but also increased traffic and air pollution

Source: KFCA n.d.

Water Quantity and Water Quality

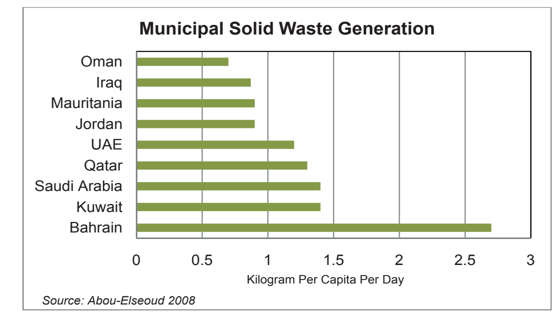
With average annual rainfall of only 76 mm per year, no permanent surface waters, diminishing groundwater levels, and a high population growth rate, Bahrain faces severe water scarcity. Until recently, Bahrain relied upon its many freshwater springs, which supported tree plantations and agriculture and 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.



Source: FAO 2009

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 km² in 1981 to 741 km² 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).

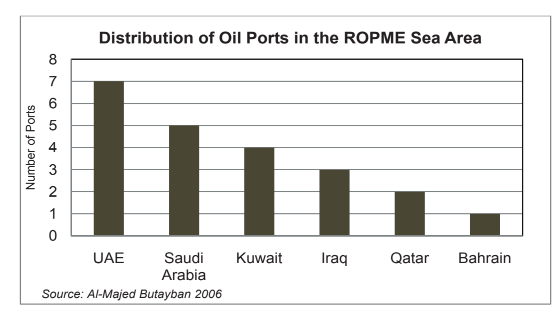


Source: Abou-Elseoud 2008

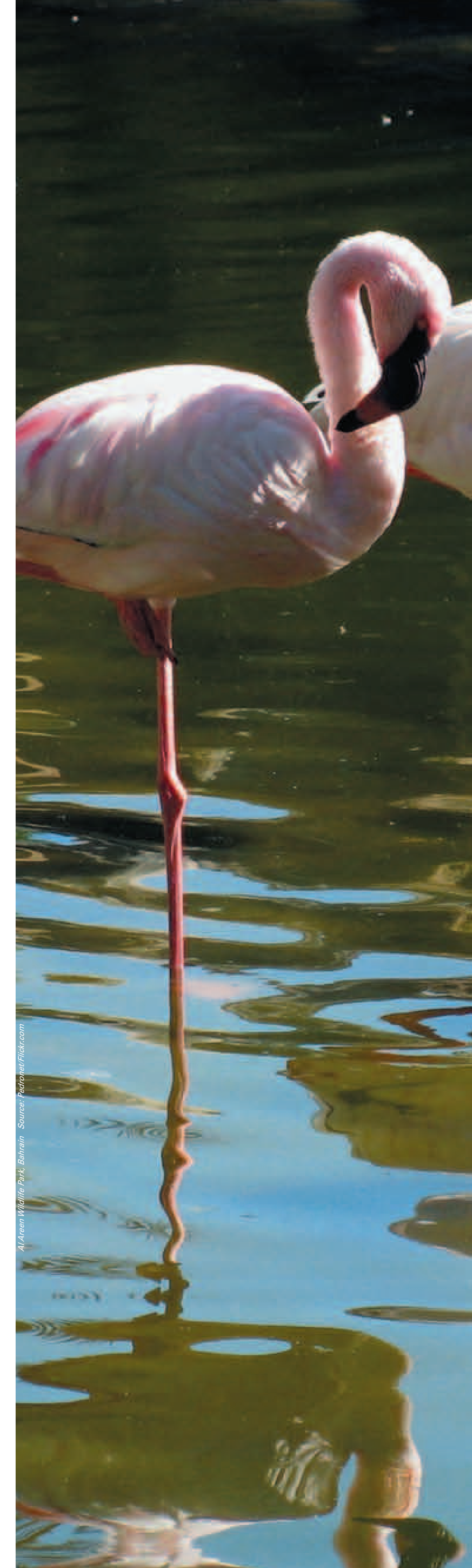
Manama, Bahrain Source: Graeme/Flickr.com

Threats to Biodiversity

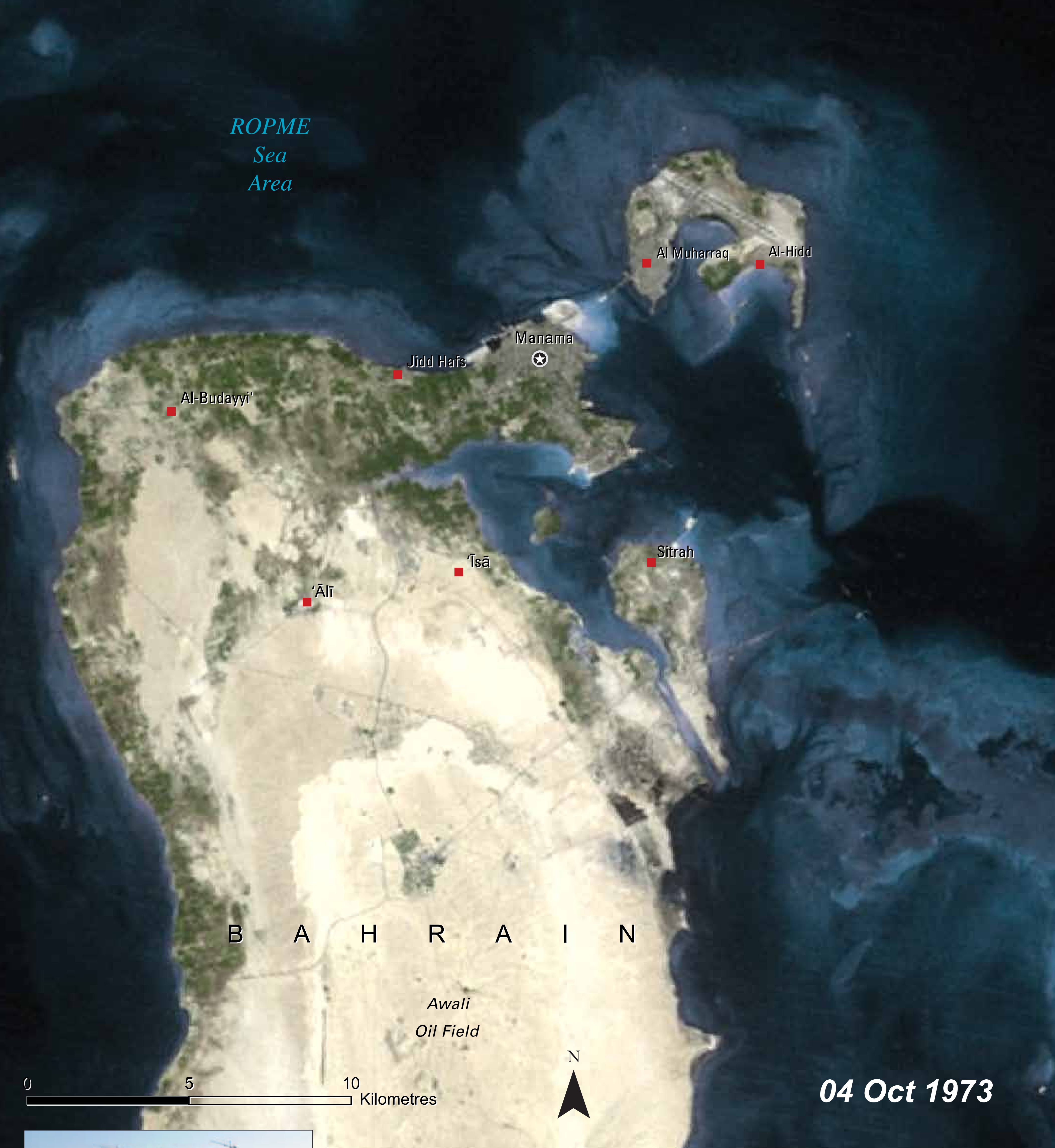
Bahrain is rich in biodiversity, and possesses hundreds of species of flora and birdlife. Coastal areas, wetlands, and small islands provide habitat for over 300 bird species (Mohamed 1993). The principal wetlands in Bahrain are coastal mudflats that occur around many of the islands. Tubli Bay, on Bahrain 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.

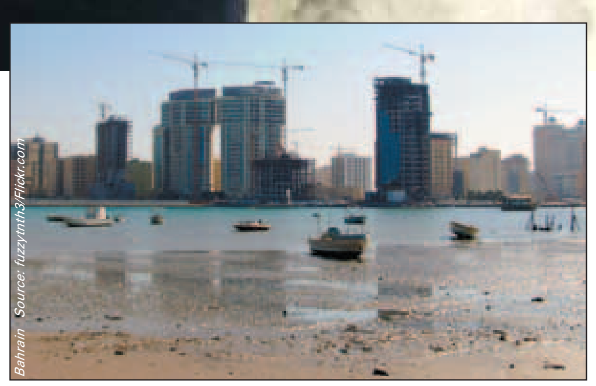


Source: Al-Majed Butayban 2006



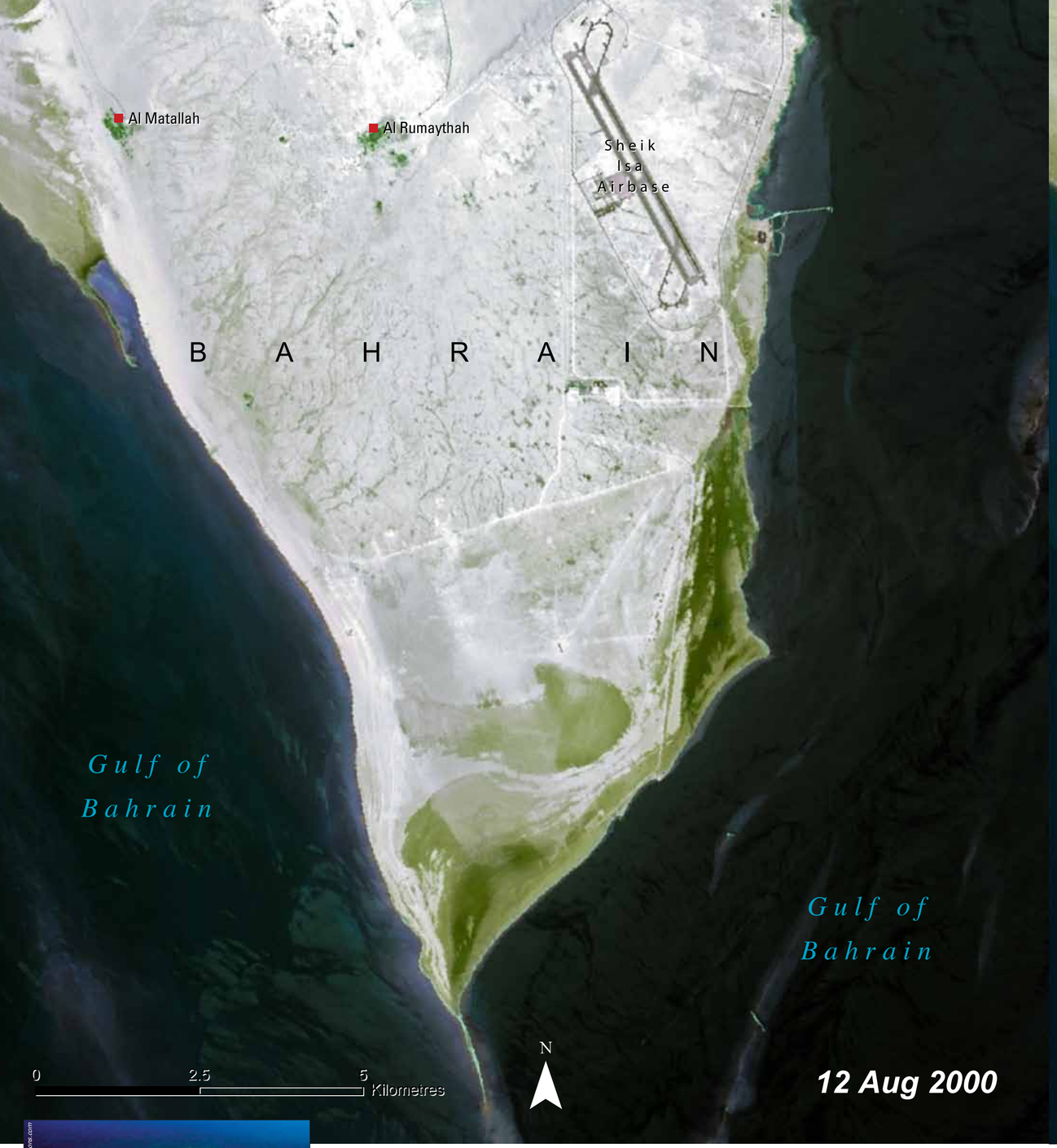
Al Areen Wildlife Park, Bahrain Source: Pedronet/Flickr.com

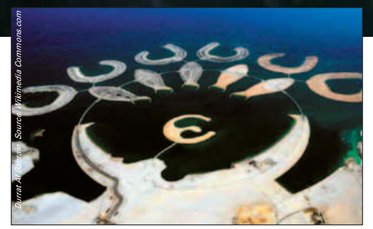




Manama and Northern Bahrain

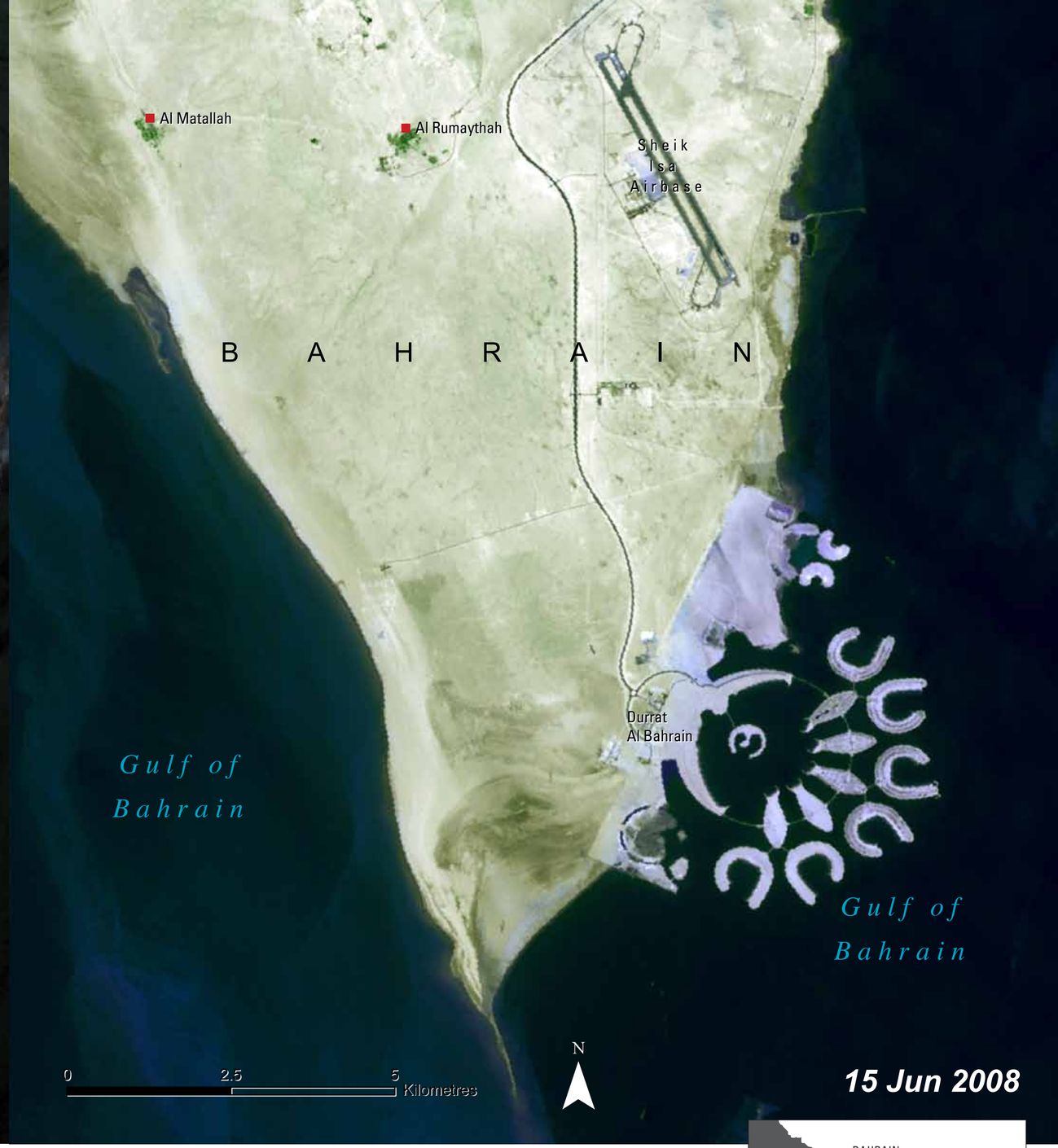
Bahrain consists of five governorates: Capital, Northern, Muharraq, Central and Southern. Although the Southern Governorate contains the largest land area, it is the northern third of the island that is home to the majority of Bahrain's population. Urbanization and rapid development are the principal 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 km^2 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.




Durrat Al Bahrain. Source: Wikipedia Commons.com

Durrat Al Bahrain

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.

ROPME
Sea Area

B A H R A I N

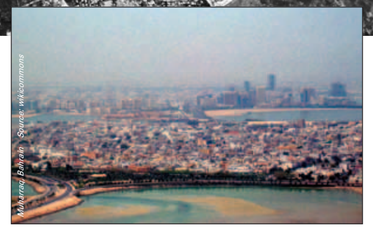
Al Muharraq

Al-Hidd

Manama

0 1 2 Kilometres

27 Sep 1969



Muharraq, Bahrain. Source: wikicommons

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).

ROPME
Sea Area

B A H R A I N

Diyar Al Muharraq

Amwaj Islands

Muharraq Island shoreline 1969

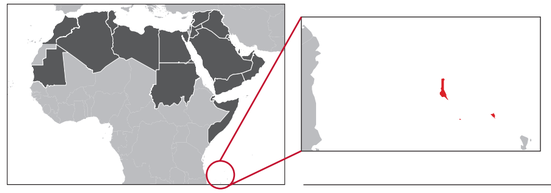
Al Muharraq

Al-Hidd

Manama

0 1 2 Kilometres

20 Oct 2009

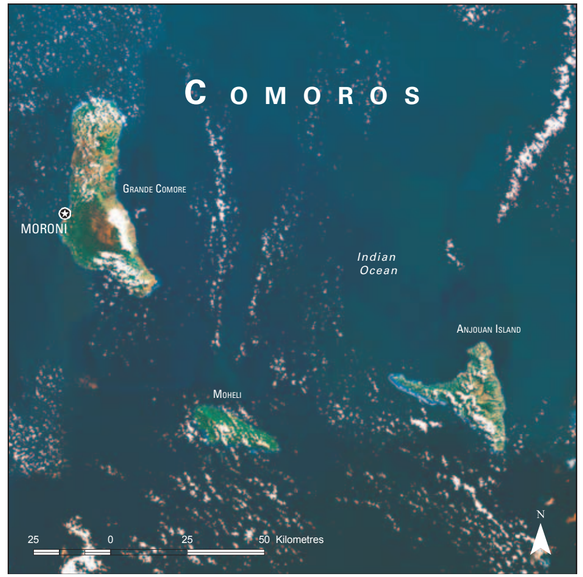


Union of the Comoros

Total Surface Area: 2 235 km^2

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 km^2.



Important environmental issues

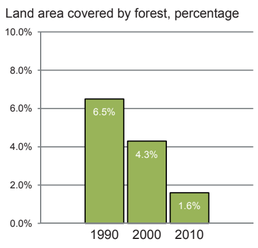
- Threats to Coastal and Marine Resources
- Deforestation and Soil Erosion
- Threats to Biodiversity

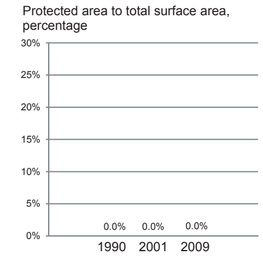
Progress Toward Environmental Sustainability

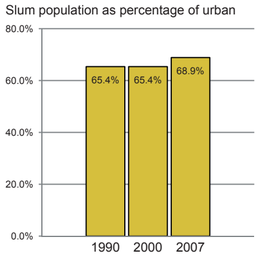
As defined by the United Nations Millennium Development Goal 7 Indicators

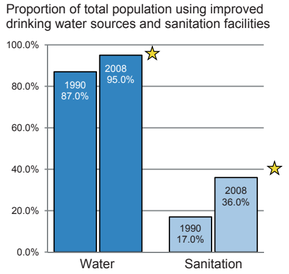
Over the past 25 years the population of Comoros has nearly doubled (FAOSTAT 2009). Heavy population pressures combined with intensive farming practices and uncontrolled deforestation have caused serious soil erosion. Environmental degradation is compounded by the effects of climate change (heavy rains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

☆ Indicates Progress







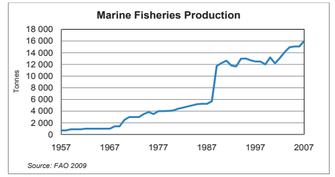


Source: UNDP 2012

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.

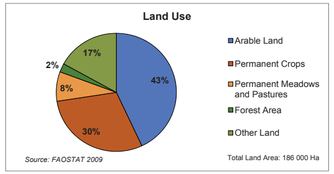
Threats to Coastal and Marine Resources

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.



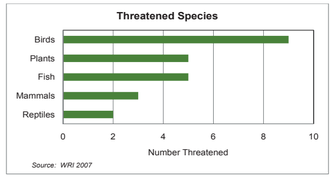
Found in the forests of Anjouan and Mohéli islands, populations of mongoose lemur (*Eulemur mongoz*) are estimated at between 1 000 and 10 000. Forest clearing for agriculture, timber and charcoal production are the greatest threats to this endangered mammal

Mongoose Lemur Source: Norman Farrow

Source: Sacramento Zoological Society 2003

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.



Mosque, Grande Comore Source: Woodfin Photo

C O M O R O S

0 0.5 1 Kilometres

N

04 Aug 2002


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.

C O M O R O S

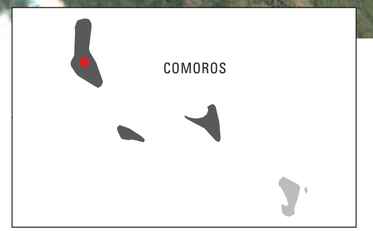
MODIS NASA image of the volcano during the eruption in 2005

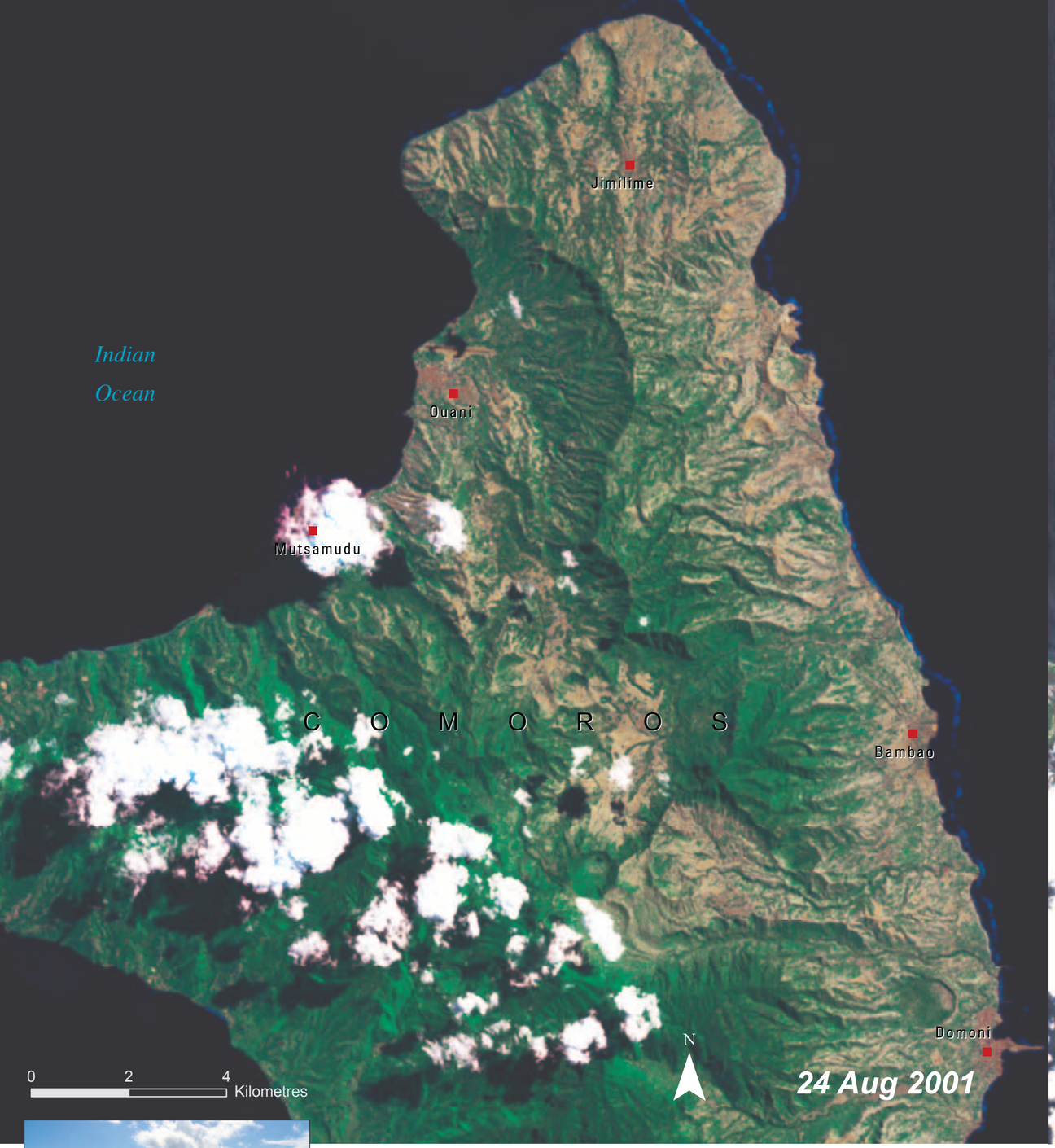
0 0.5 1 Kilometres

N

19 Apr 2005

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).

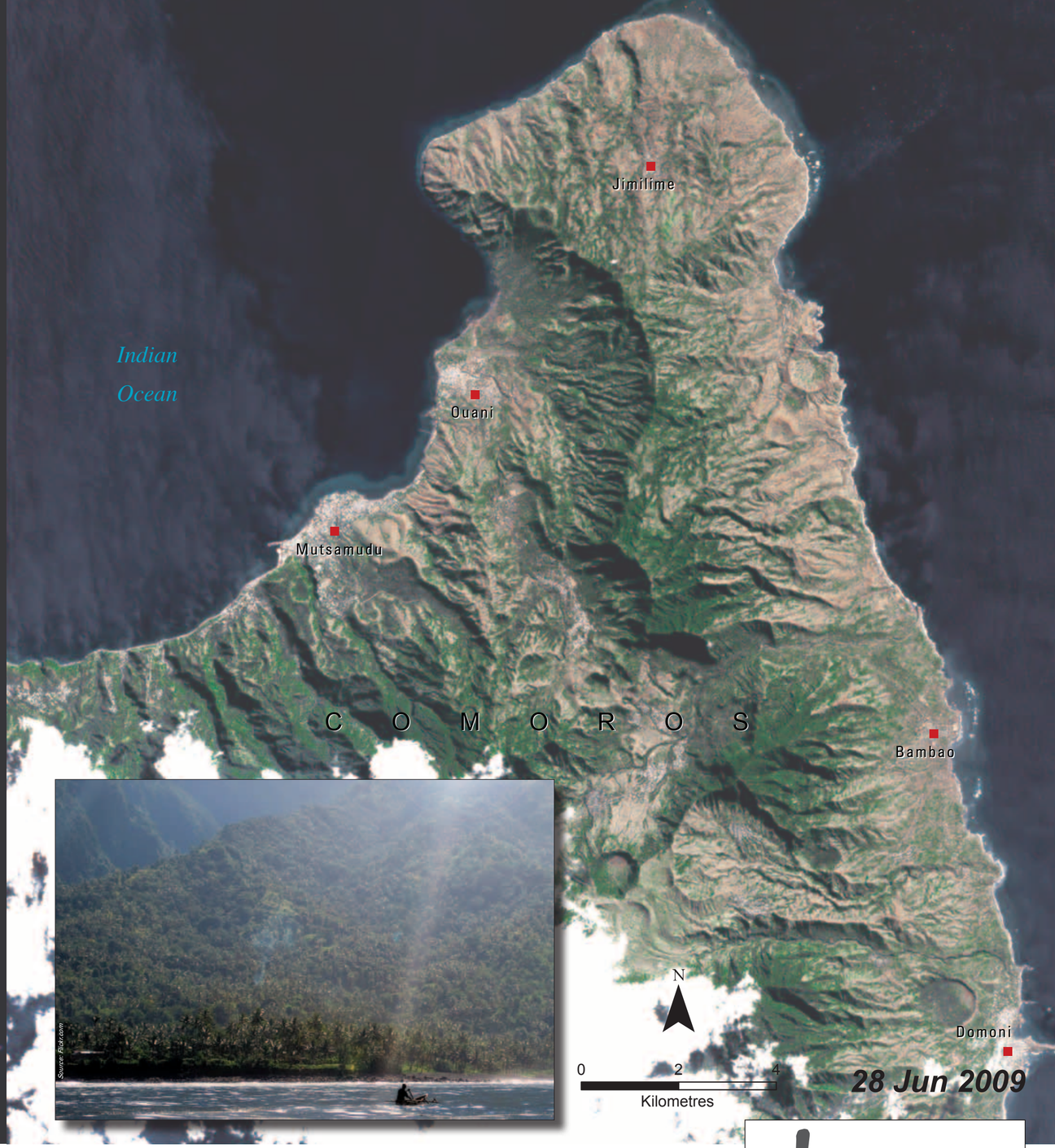





Source: mwiri Flickr.com

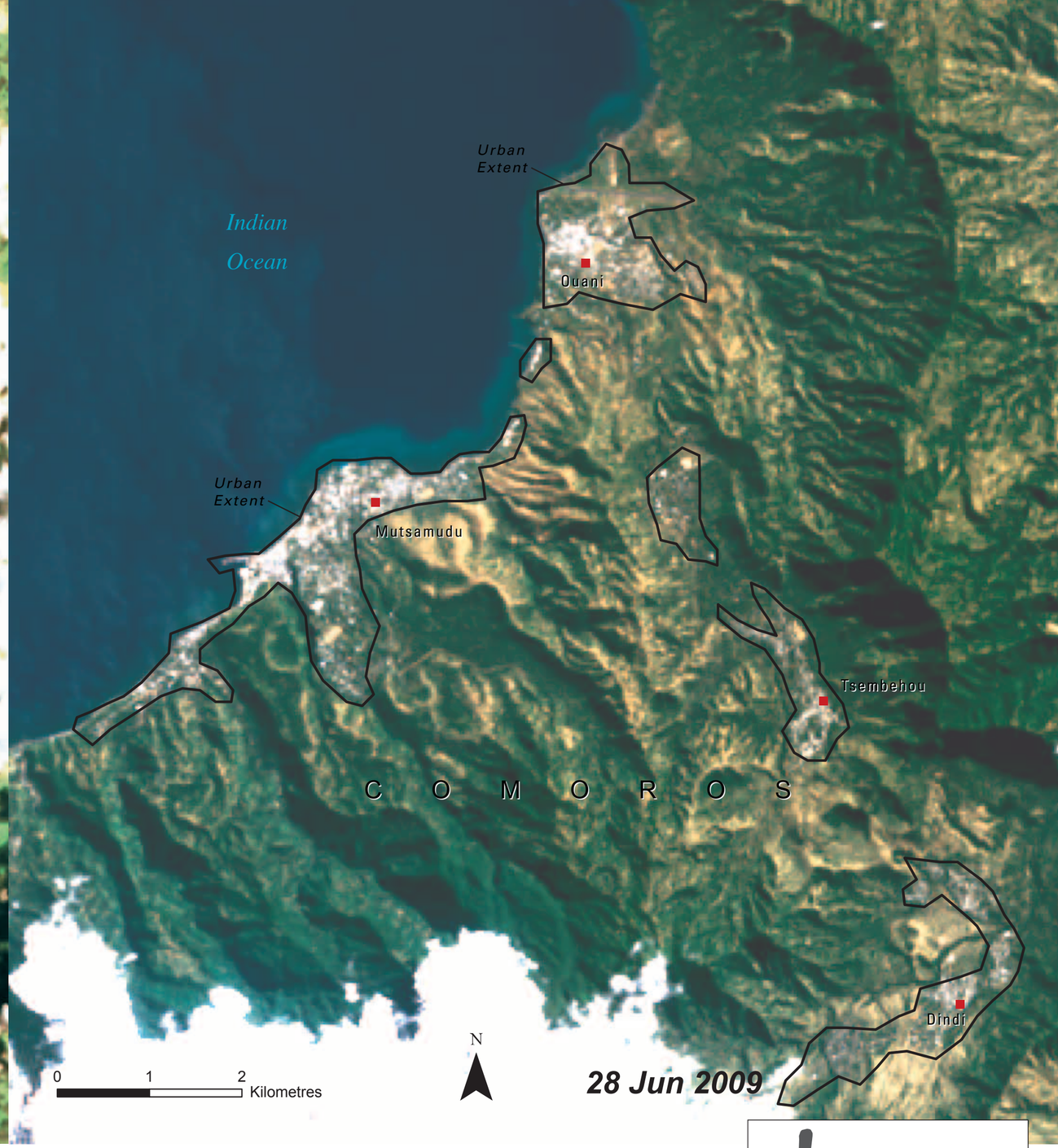
Deforestation in Anjouan, Comoros

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.



Source: Flickr.com

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: Woodbus 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 km2

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 32ºC. 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

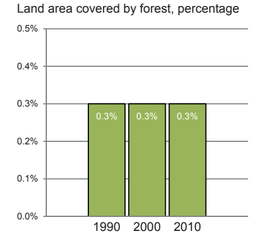
- Water Scarcity
- Desertification and Land Availability
- Marine Resources and Pollution

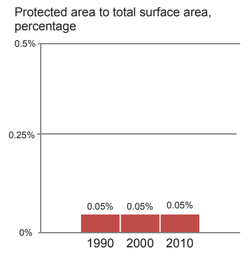
Progress Toward Environmental Sustainability

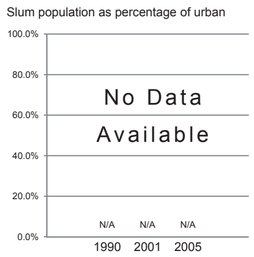
As defined by the United Nations Millennium Development Goal 7 Indicators

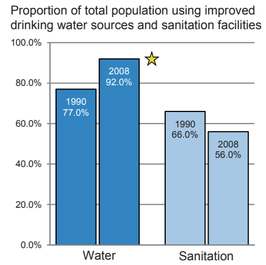
Djibouti's population is concentrated in the city of Djibouti, the only major urban centre in the country. The city contains endemic poverty, widespread unemployment, and a growing refugee population. In 2002, the extreme poverty rate was 42.2 per cent and the unemployment rate was 59 per cent (African 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).

☆ Indicates Progress







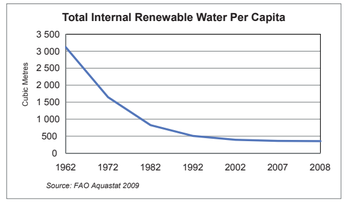


Persistent drought and marginal agricultural opportunities throughout Djibouti induces food shortages and forces heavy reliance on food imports. A consequence is that 24 per cent of the Djibouti population is undernourished

Source: WFP 2009

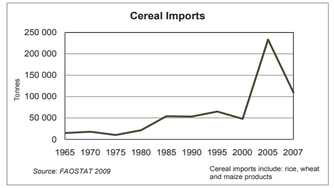
Water Scarcity

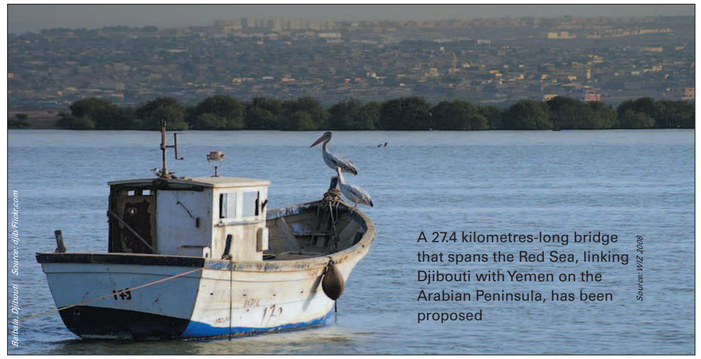
Djibouti is facing severe water shortages, and is well below the international water scarcity threshold (1 000 m^3/per capita/per year) with only 353 m^3 available per person per year. Marked declines in the amount of renewable water threaten food security and rural livelihoods. With no permanent rivers 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).





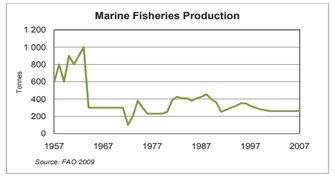
Bridge, Djibouti Source: djib.Flickr.com

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

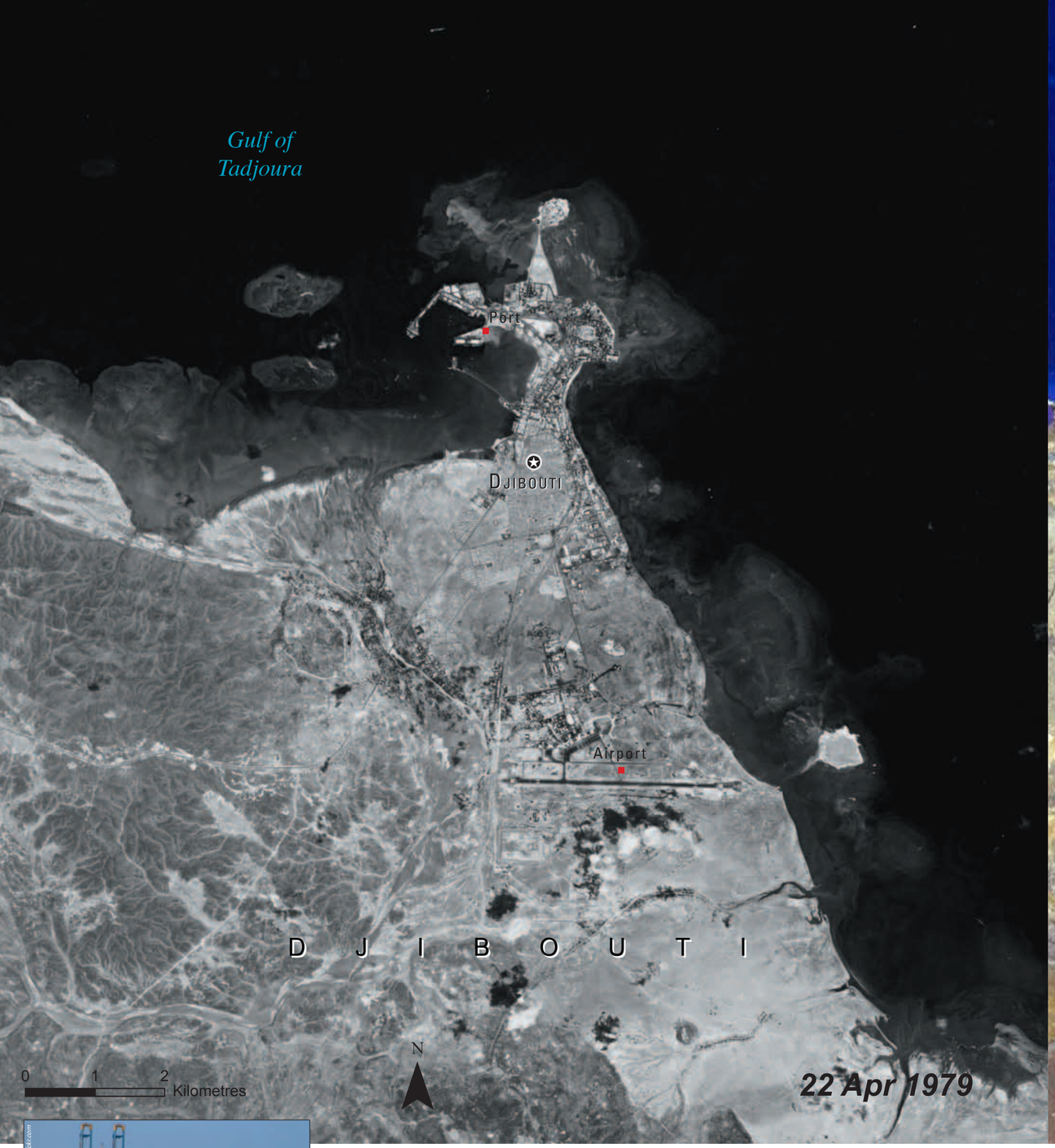
Source: WHZ 2008

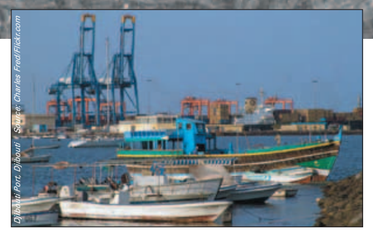
Threats to Coastal and Marine Resources

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: canoboo33.Flickr.com

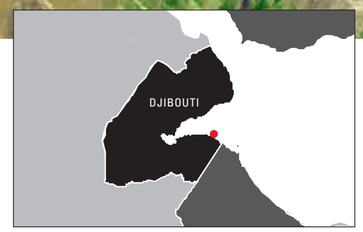


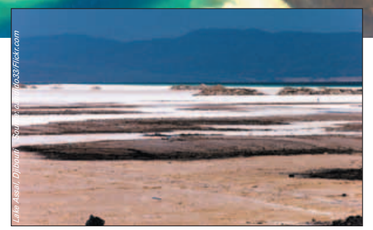

Djibouti Port, Djibouti | Source: Charles Fred/flickr.com

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.

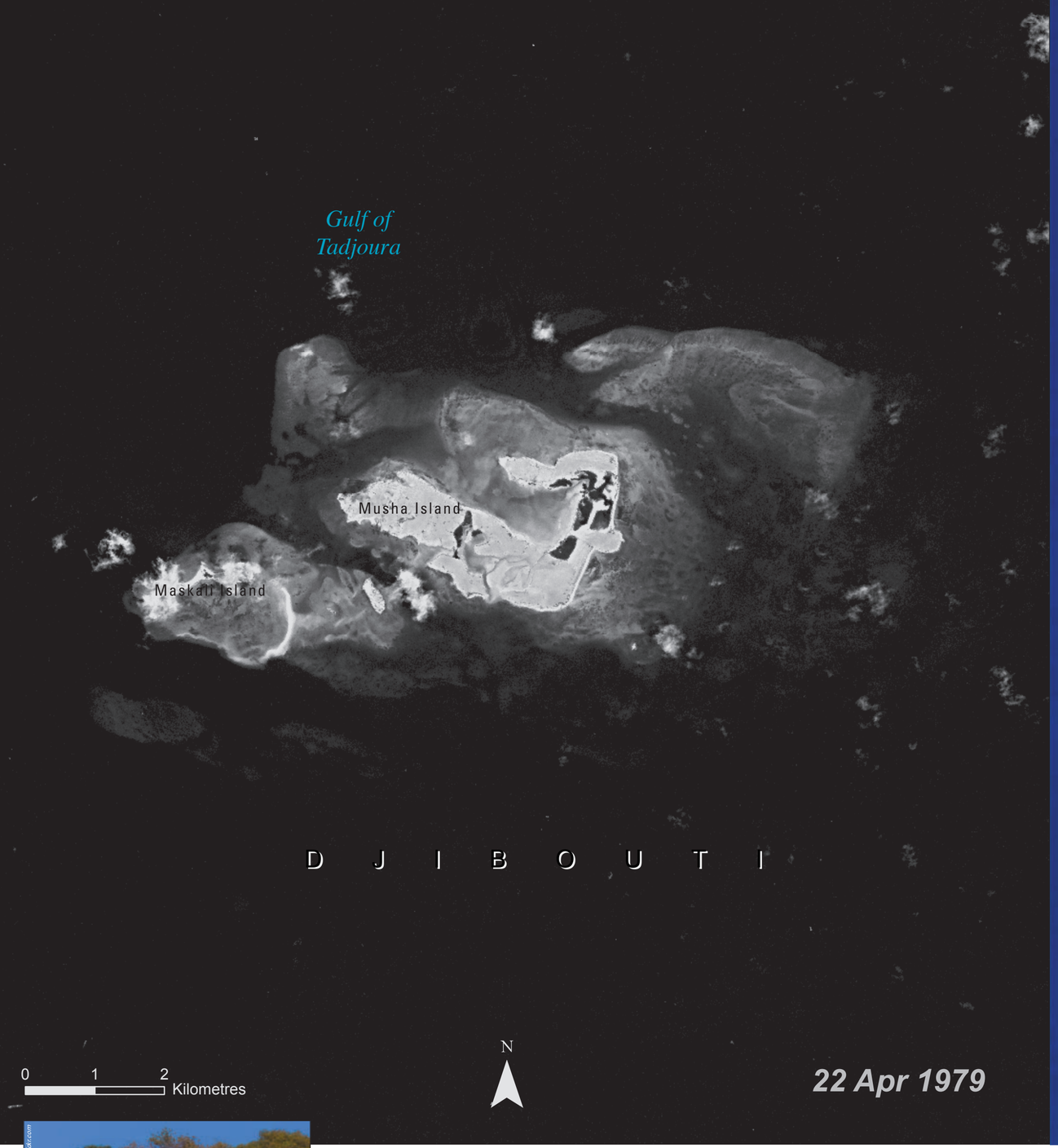


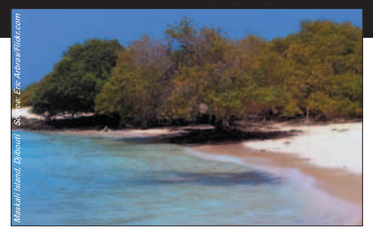


Lake Assal, Djibouti

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.

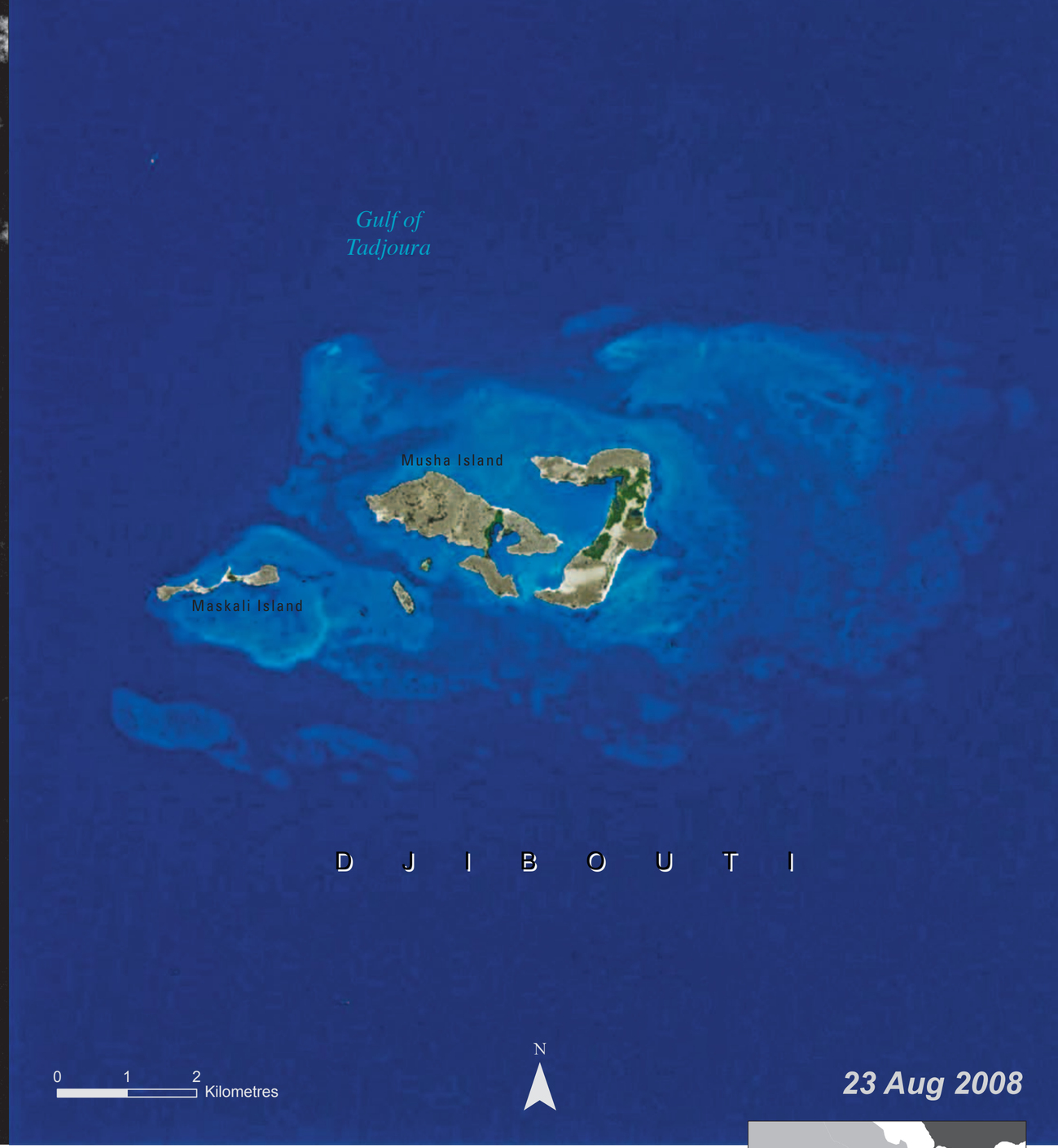
The water of Lake Assal is ten times more saline than seawater, and is the most saline body of water in the world. The extreme salinity and inhospitable climate makes the lake mostly uninhabitable. As shown in these images, the water levels fluctuate greatly with occasional inputs from rainwater, seawater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

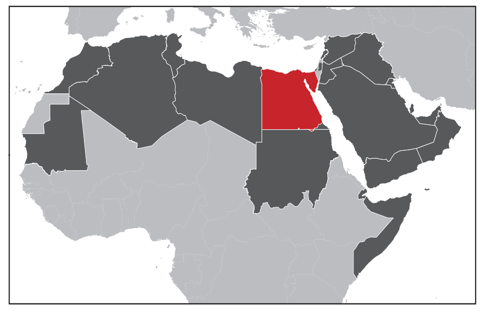



Maskali Island, Djibouti Source: Eric Alonso-Flickr.com

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 km²
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

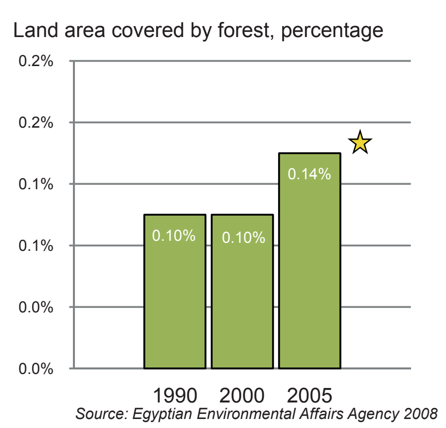
- Water Scarcity and Pollution of the Nile River
- Solid Waste
- Loss of Biodiversity

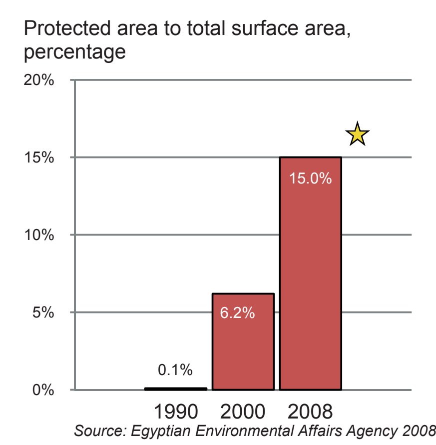
Progress Toward Environmental Sustainability

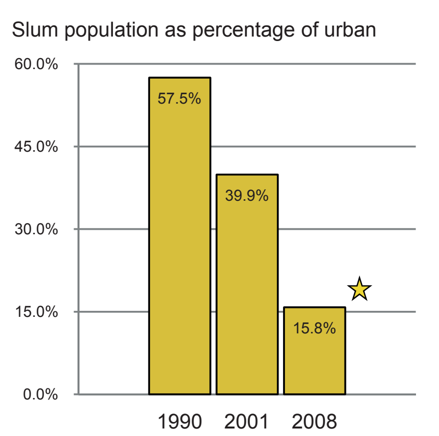
As defined by the United Nations Millennium Development Goal 7 Indicators

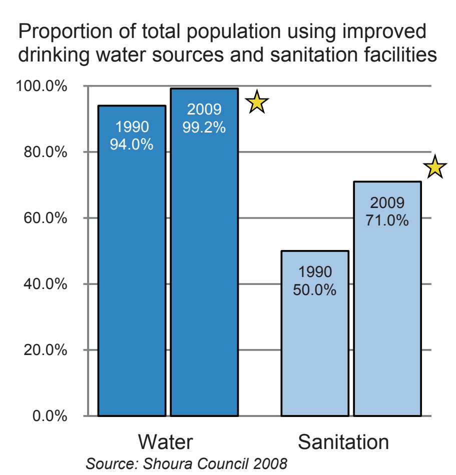
Ensuring environmental sustainability in the Arab League's most populous nation remains a challenge with rapid population growth and expansion of industrial, agricultural and tourism activities. Progress has been made in increasing the amount of protected areas and forest areas, improving access to clean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

☆ Indicates Progress







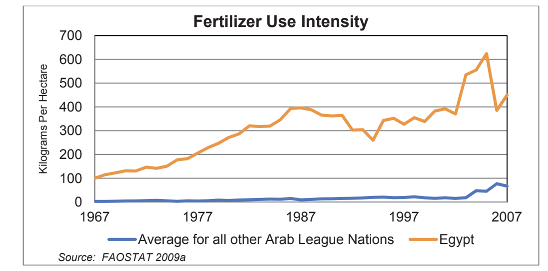


In March 2008, Egypt signed an agreement with Russia to assist in building Egypt's first nuclear power plant

Source: EIA 2008

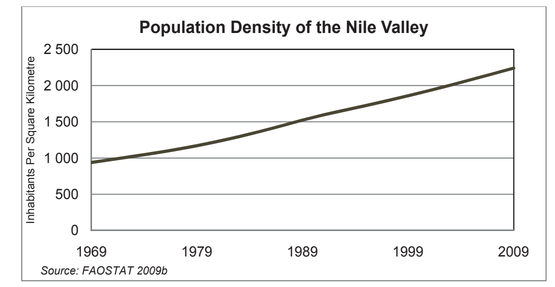
Water Scarcity and Pollution of the Nile River

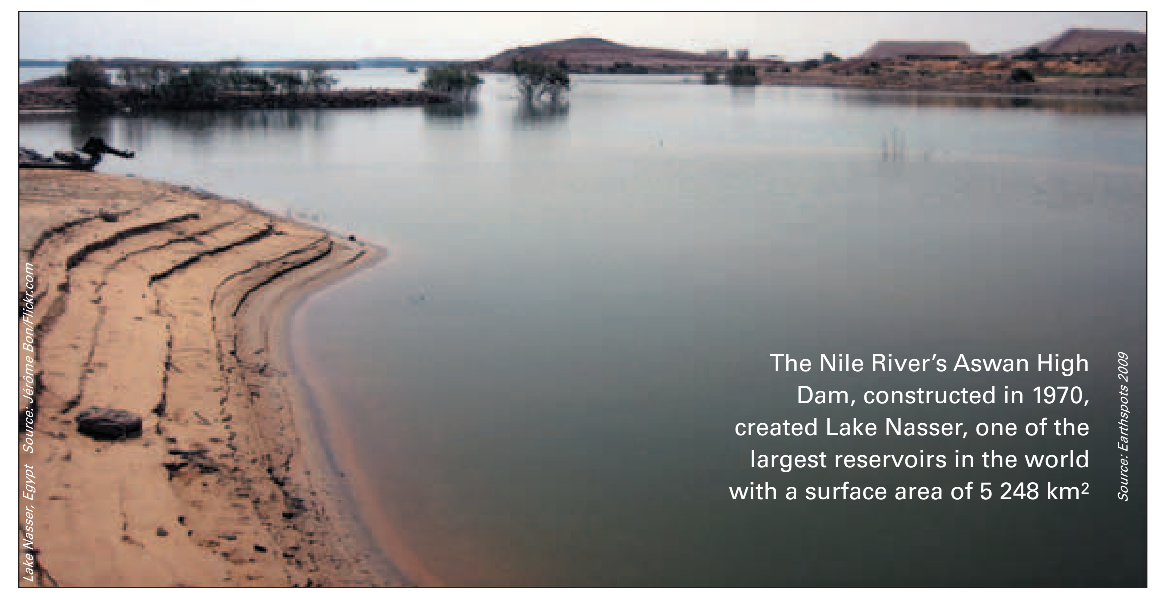
Egypt's population of 80 million doubled in the past 30 years, placing immense stress on the country's water resources. Egypt ranks among the world's water scarce countries—the per capita water availability is expected to fall to 545 m³ per year by 2025 (FAO 2010). Impacts from climate change are also 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.

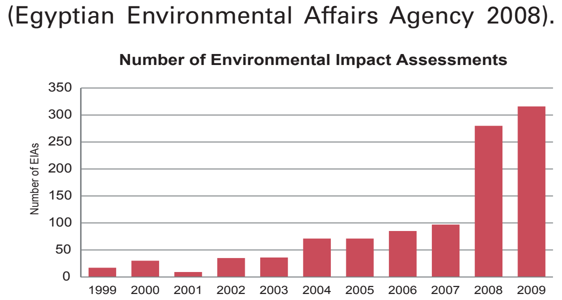


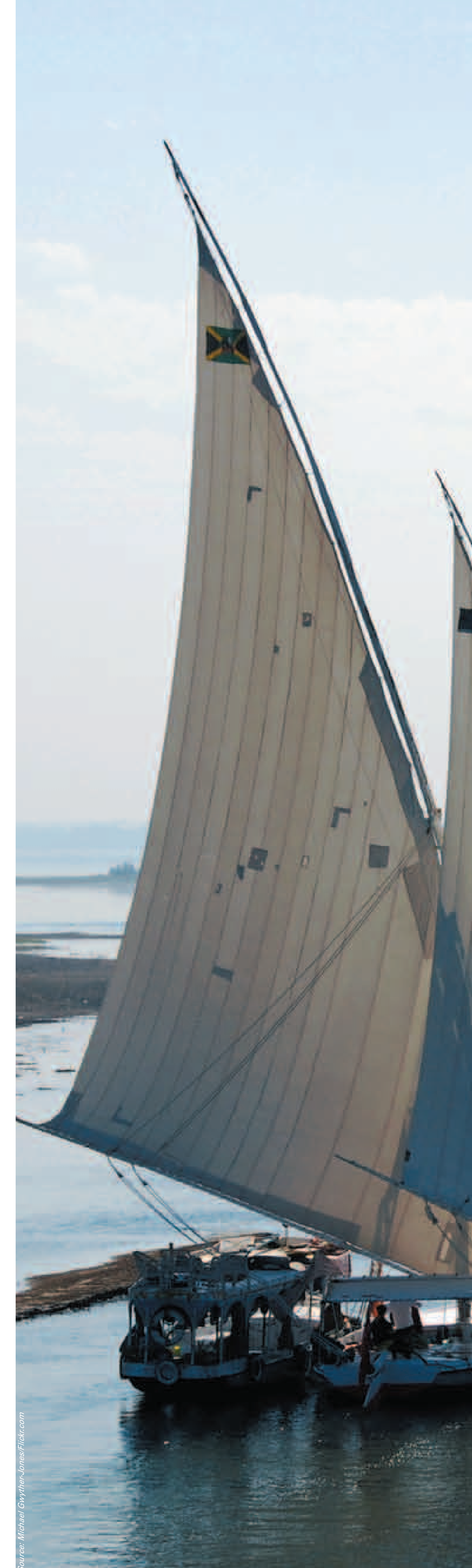


The Nile River's Aswan High Dam, constructed in 1970, created Lake Nasser, one of the largest reservoirs in the world with a surface area of 5 248 km²

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

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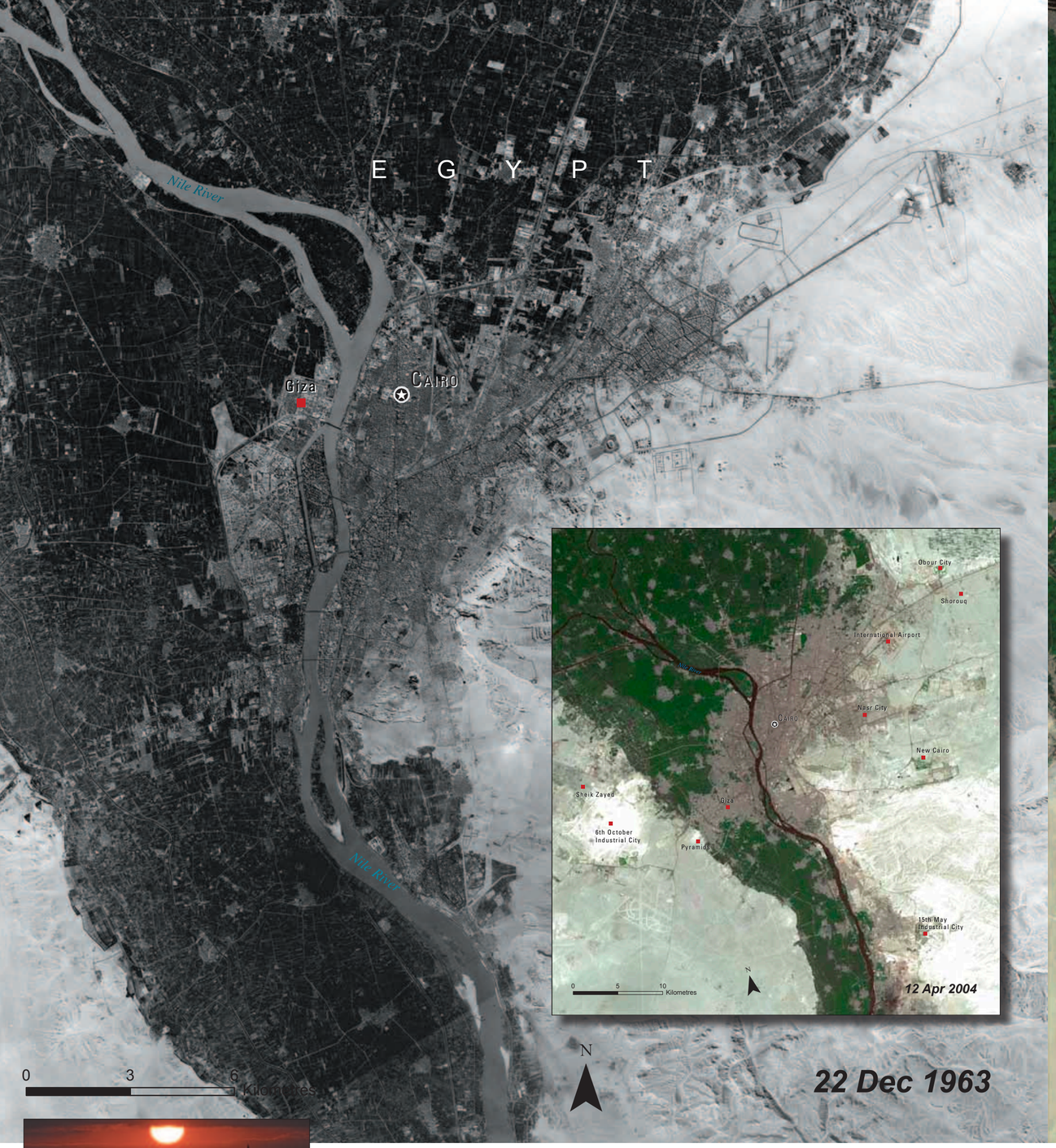
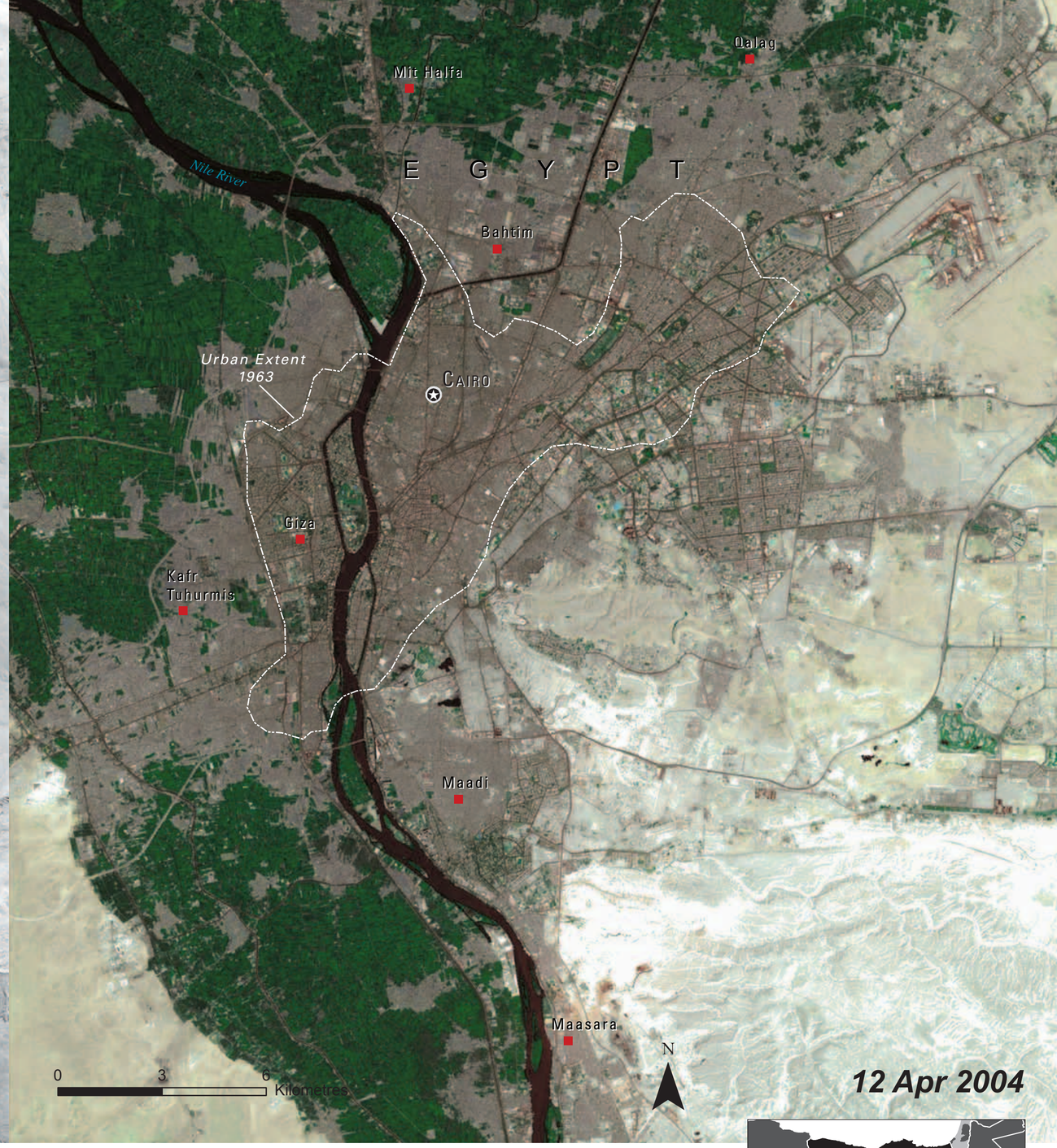
1984 to1990 Mosaic



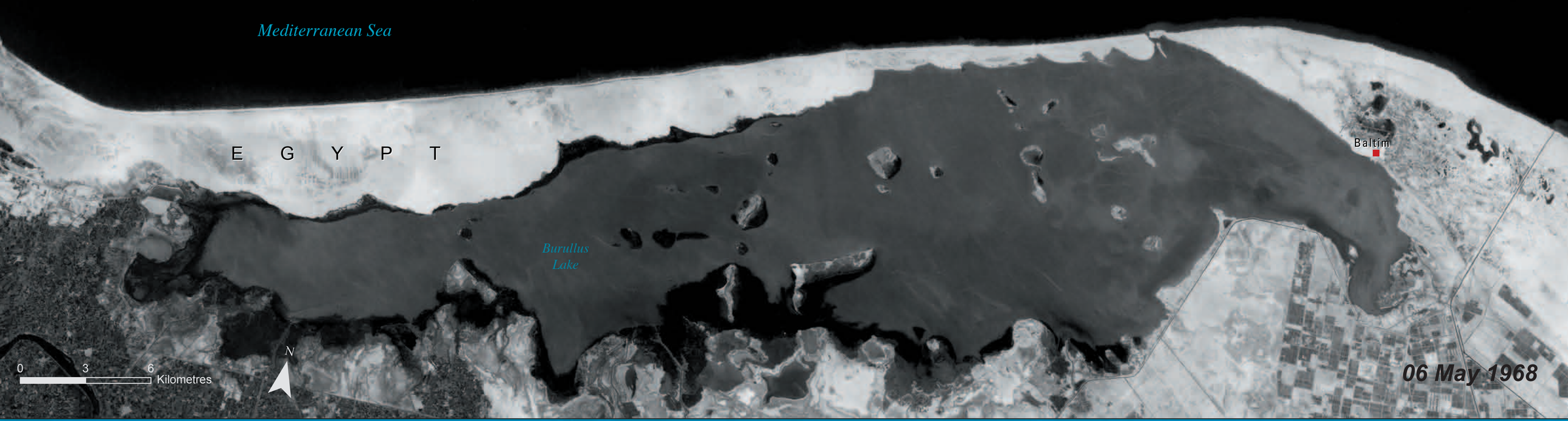


Nile River, Egypt
Source: Michael Gwyther-Jones/Flickr.com

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).

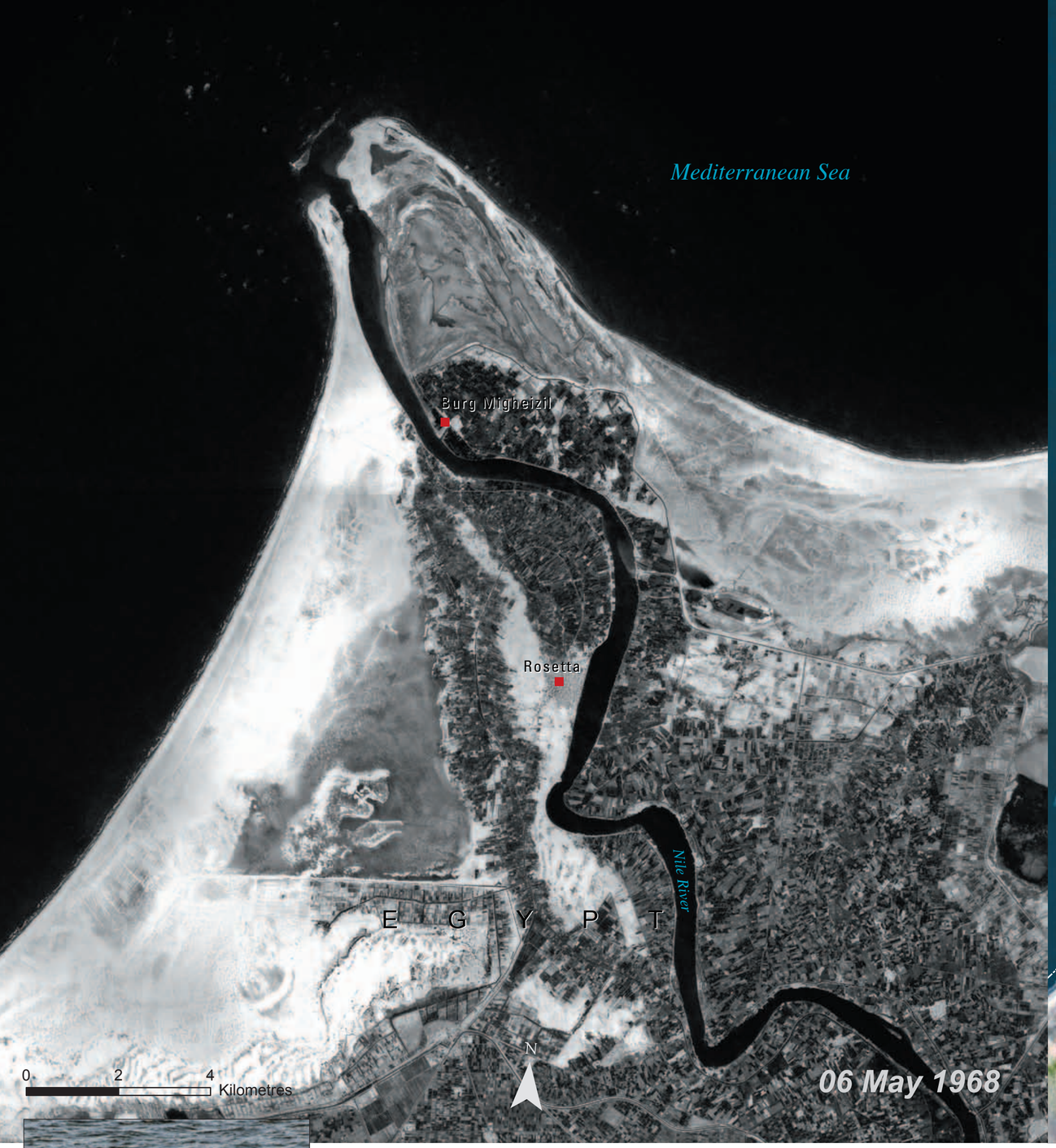



Lake Burullus Source: Flickr.com

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.

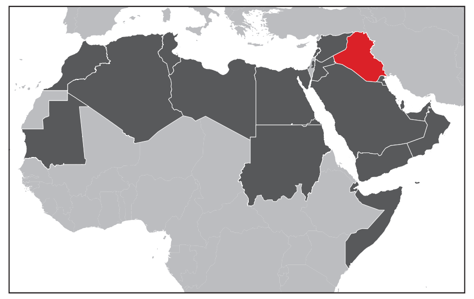
Burulllus Lake has lost 37 per cent of open water and 85 per cent of marsh area in the past 40 years as a result of ongoing drainage and reclamation activities (BLI 2009). Impoundment of Nile sediments in upstream dams has caused severe coastal erosion, which continues to reduce the size of these coastal 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.

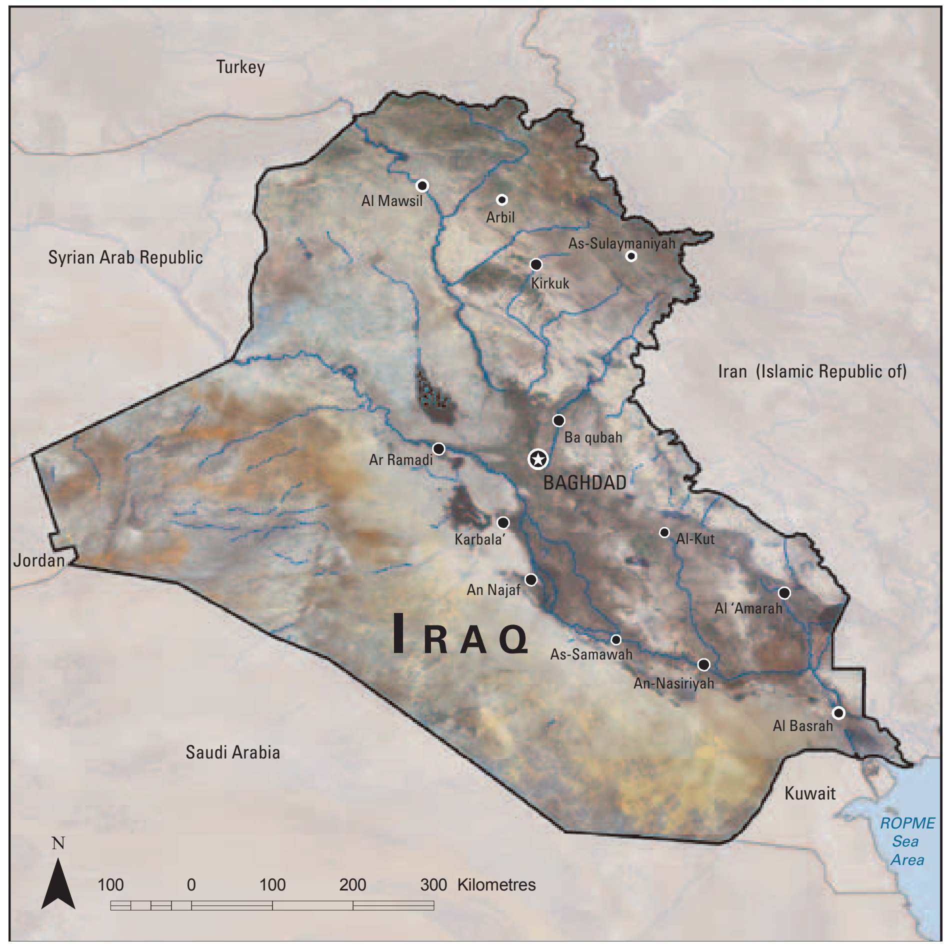
Revetments were constructed between 1986 and 1991 on the western and eastern parts of the promontory to prevent further erosion; however, they were not efficient in stopping the erosion (Elsayed and others 2005). Coastal erosion along this shoreline is the net result of reduced flows in the Nile River (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

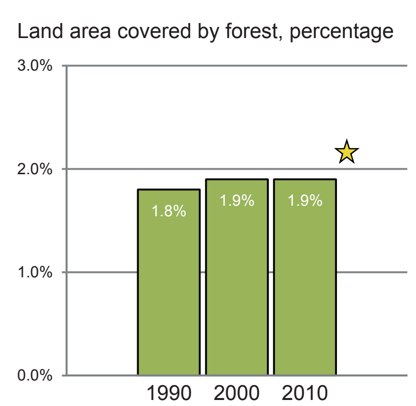
- Conflict-related Contamination and Pollution
- Ecosystem Degradation
- Destruction of the Mesopotamian Marshlands

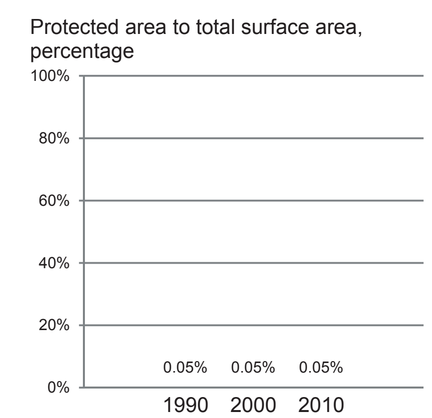
Progress Toward Environmental Sustainability

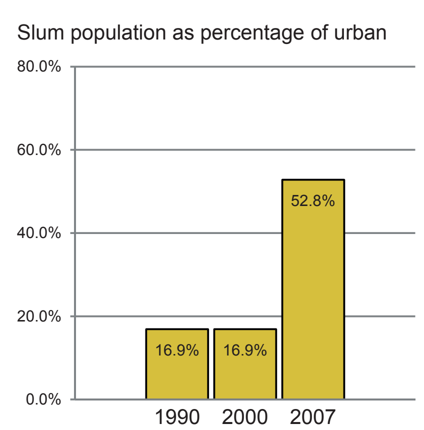
As defined by the United Nations Millennium Development Goal 7 Indicators

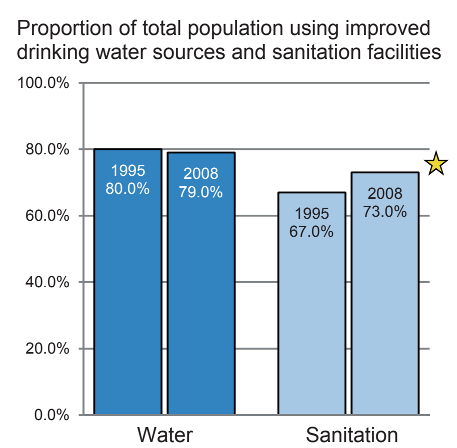
Iraq has been embroiled in conflict for the past three decades, challenging its efforts to confront its environmental and social issues. Since 1995 the proportion of the population using improved drinking water sources has decreased slightly, making the population more susceptible to water-borne diseases. 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







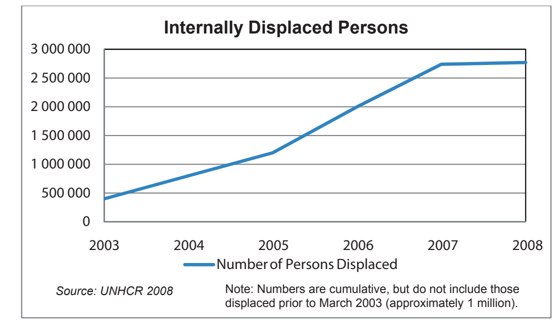


From 1988 to 2002, cancer rates in the heavily bombed city of Basra increased more than tenfold; the increase is believed to be caused in part by depleted uranium in weaponry

Source: IRIN 2004

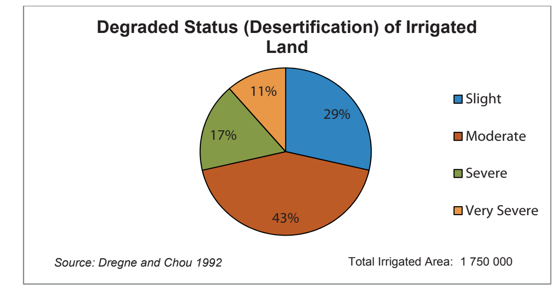
Conflict-related Contamination and Pollution

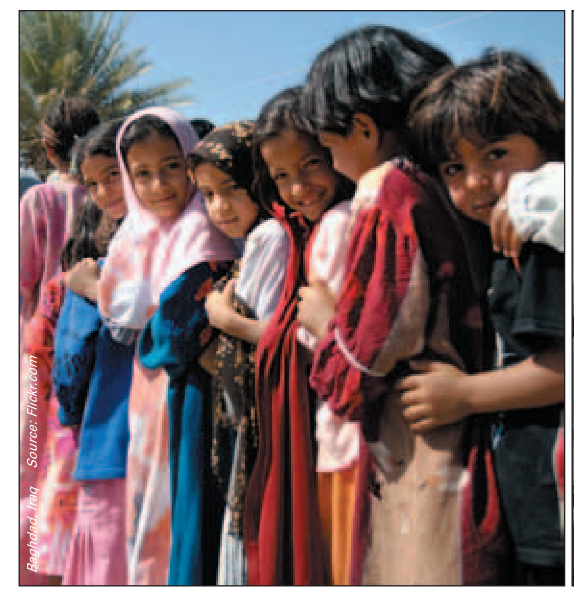
On-going conflicts since 1980 have exacerbated the environmental stresses in Iraq as well as the number of internally displaced persons. Decades of conflict have caused social and environmental upheaval across the country. Huge quantities of military debris (spent cartridges, shells) and unexploded land 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.




Baghdad, Iraq Source: Flickr.com

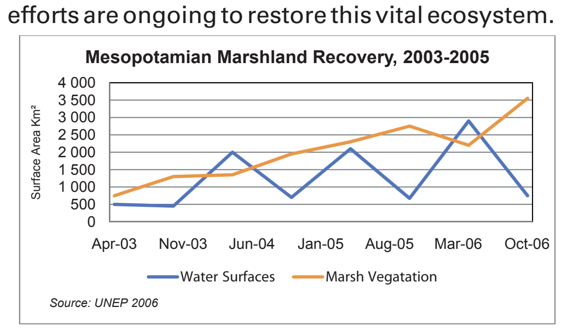

The destruction of the Mesopotamian marshlands forced 100 000 Marsh Arabs to flee Iraq in the early 1990s, and left hundreds of thousands of marshland peoples internally displaced within Iraq

Source: UNEP 2003b

Euphrates River. Source: Jayel Aheram/Flickr.com

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.




Near Baghdad, Operation Desert Storm Source: Lietmotiv/Flickr.com

Baghdad, Iraq, Source Wikimedia

Baghdad, Iraq

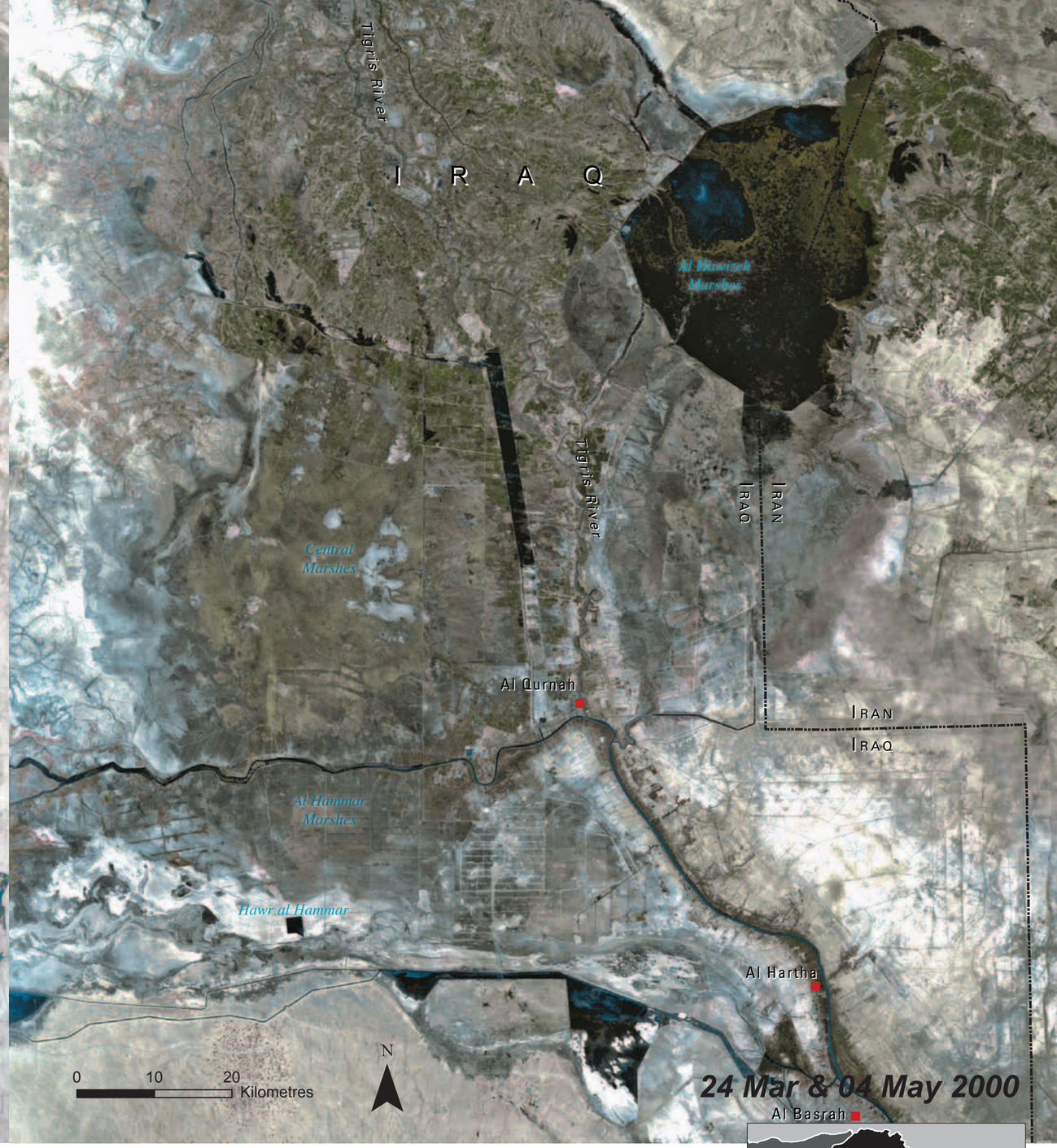
The ancient city of Baghdad was founded on the shores of the Tigris River in a broad alluvial floodplain known as the 'Fertile Crescent', due to its high quality soils. The city has always been intricately tied to the Tigris, which bisects the city in two. Baghdad's population increased from 500 000 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.

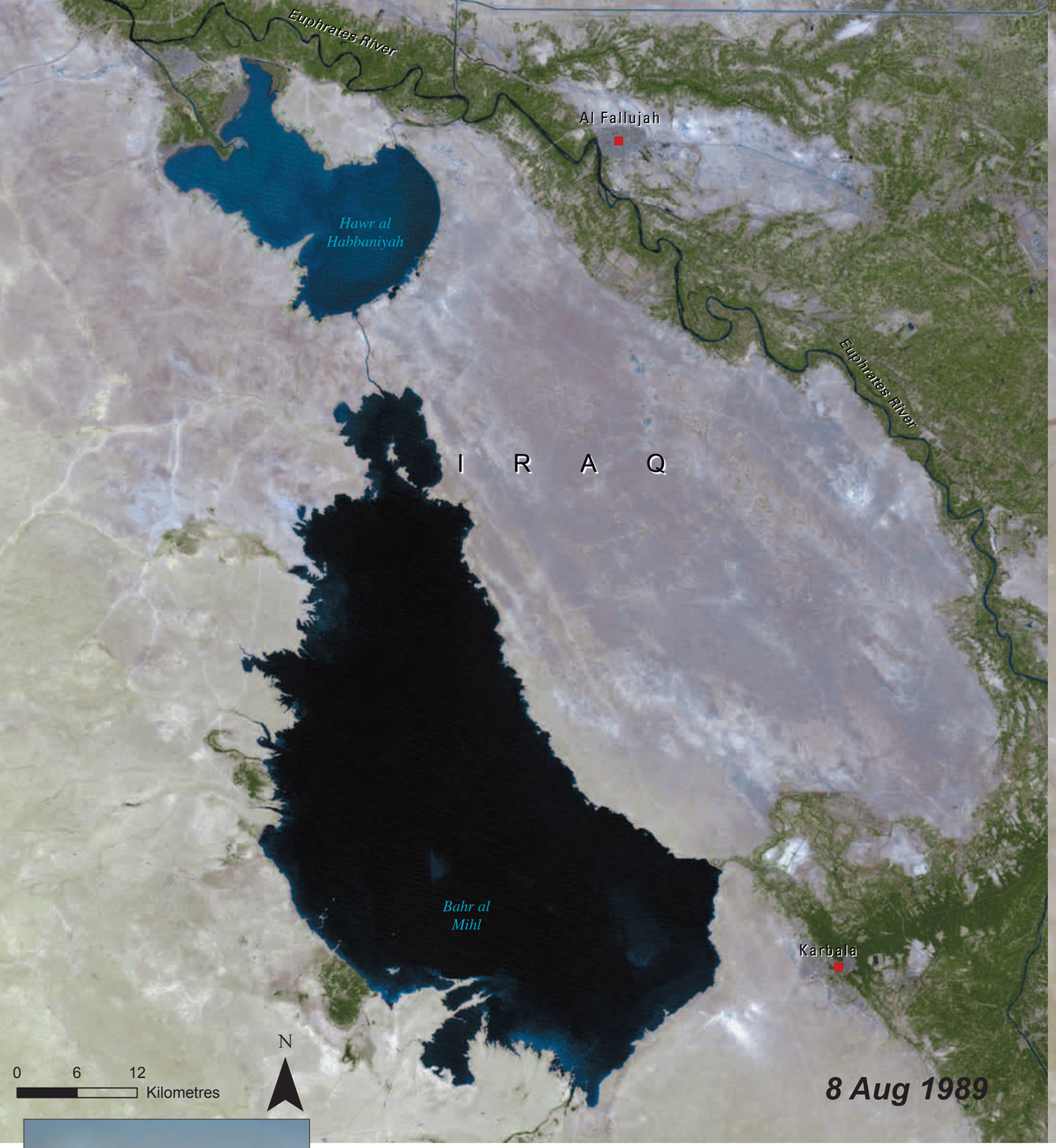
Marshlands (Iraq). Source: Wikicommons

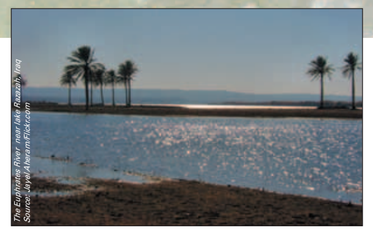
Mesopotamian Marshlands, Iraq

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).



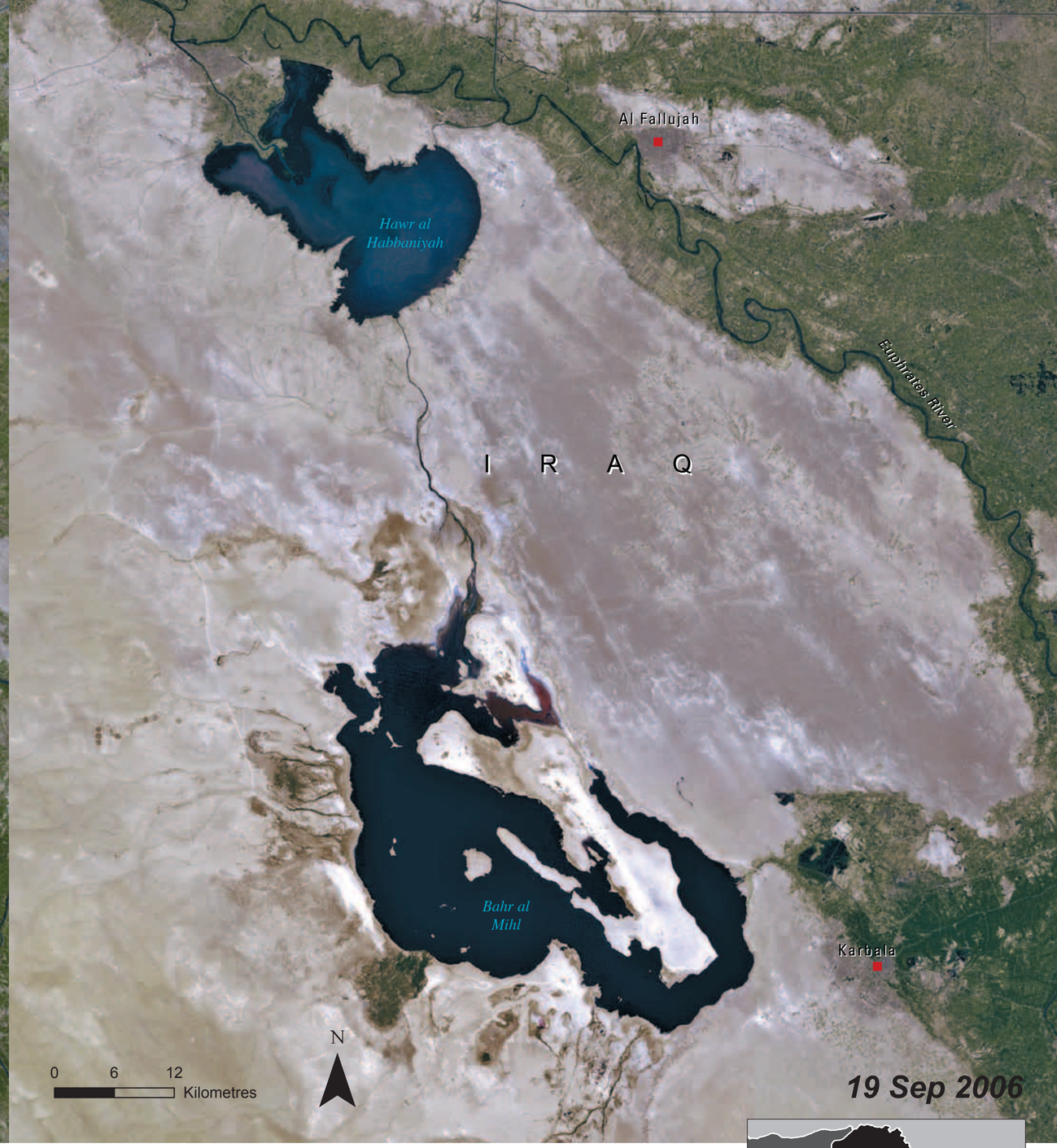
Beginning in the 1950s more than 30 large dams were built upstream of the marshlands, causing reduced annual and seasonal flows into the system. Following a period of dramatic channelization and modification in the late 1980s and early 1990s, the Central and Al Hammar marshlands were reduced by 97 and 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: Joyce Ahrens 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

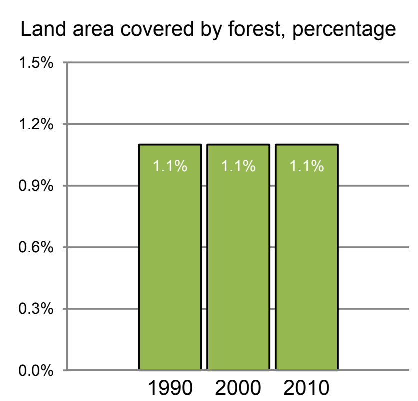
- Water Scarcity
- Desertification and Land Degradation
- Threats to Biodiversity

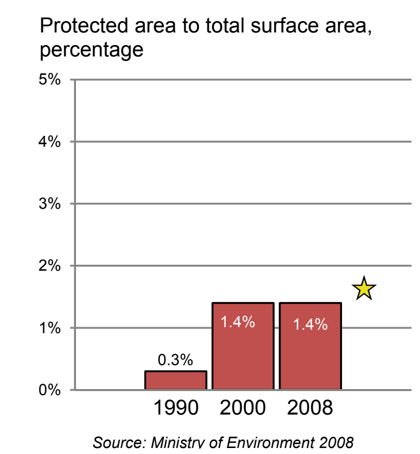
Progress Toward Environmental Sustainability

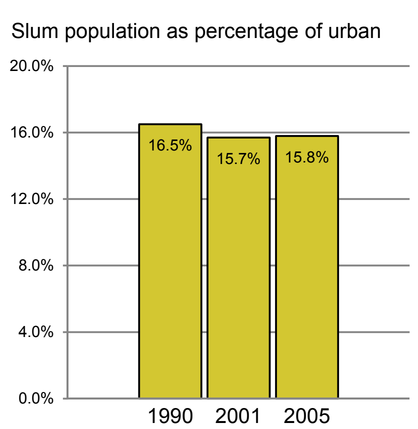
As defined by the United Nations Millennium Development Goal 7 Indicators

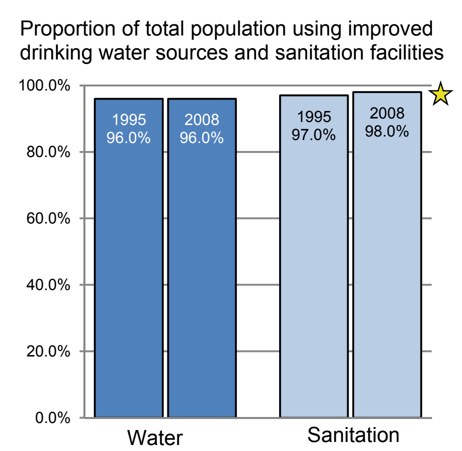
Given Jordan's limited natural resources, arid climate, persistent drought and expanding population, the country has been proactive in addressing its environmental issues, and it has made notable progress in achieving environmental sustainability. Since the establishment of the first nature reserve in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

☆ Indicates Progress







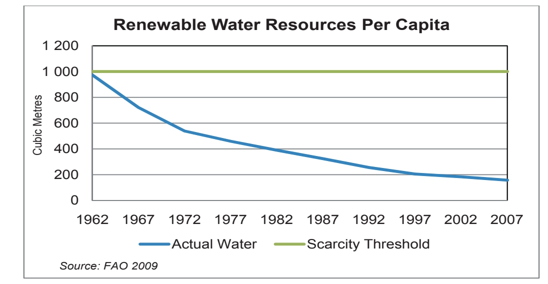


The Red Sea- Dead Sea Conveyance Program proposes to construct a canal to deliver 850 million m³ of water per year from the Gulf of Aqaba to the Dead Sea to address acute water shortages in Jordan and neighbouring countries

Source: World Bank 2009

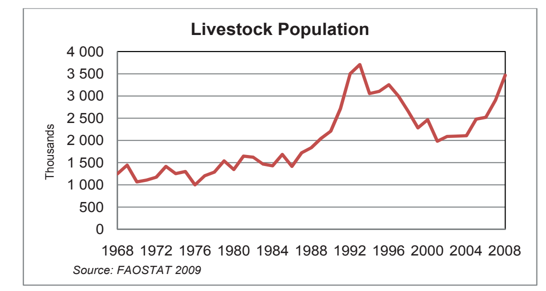
Water Scarcity

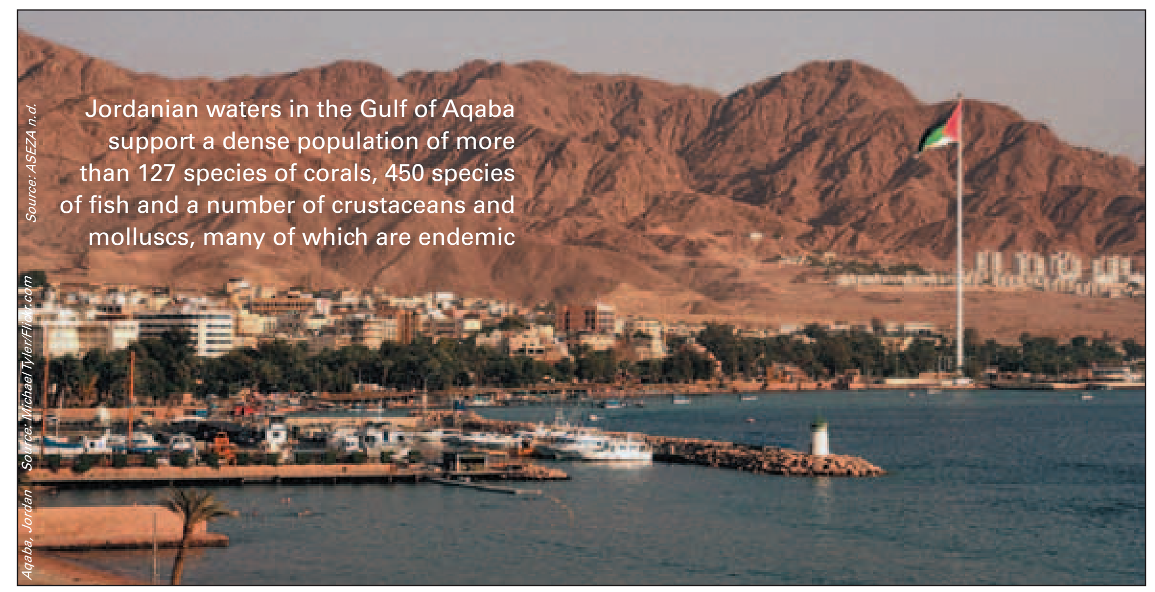
The scarcity of water is Jordan's greatest environmental challenge. Aridity, persistent drought, and high rates of natural population growth, along with large periodic influxes of refugees, have contributed to Jordan's chronic water shortages. Jordan has some of the lowest per capita water availability in the world at 153 m³ 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 m³ 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).

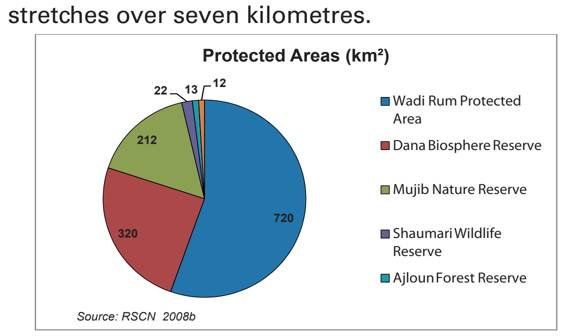


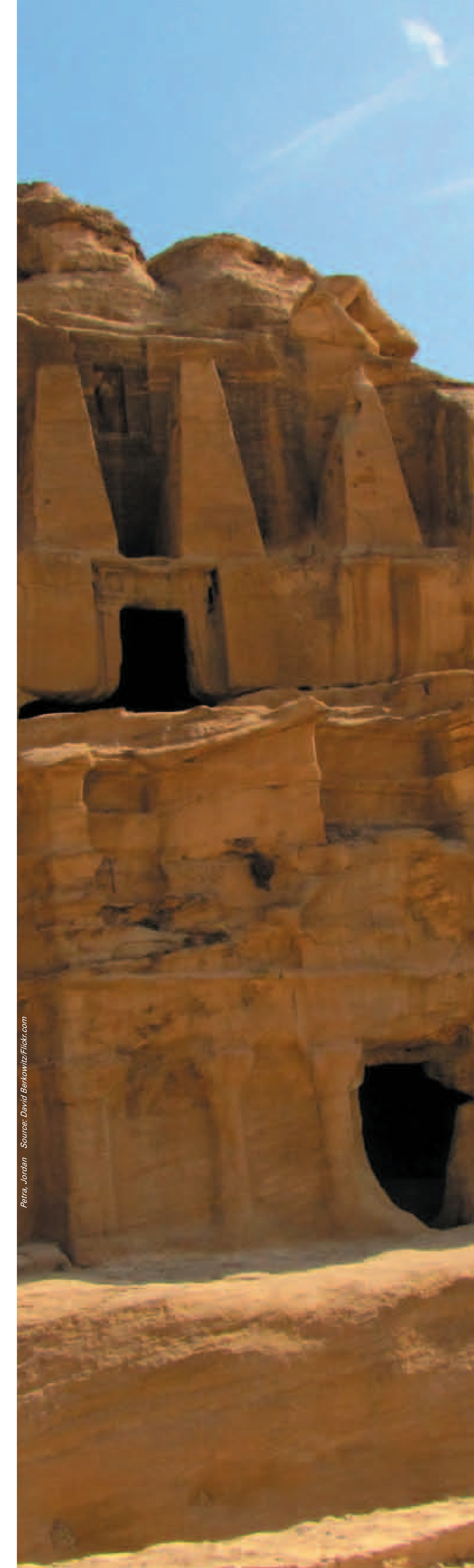


Aqaba, Jordan Source: Michael Tyler/Flickr.com

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.





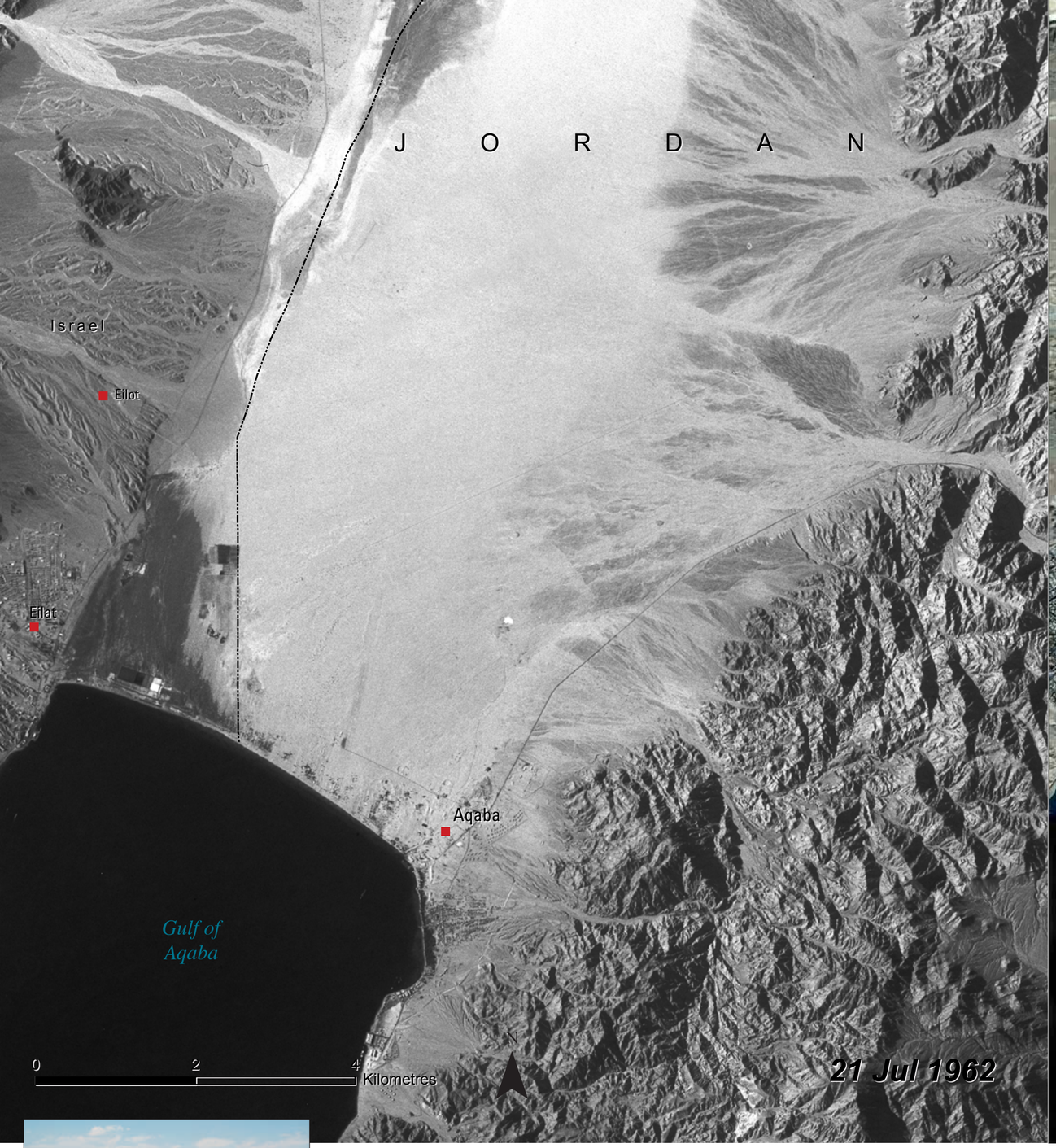
Petra, Jordan Source: David Berkowitz/Flickr.com

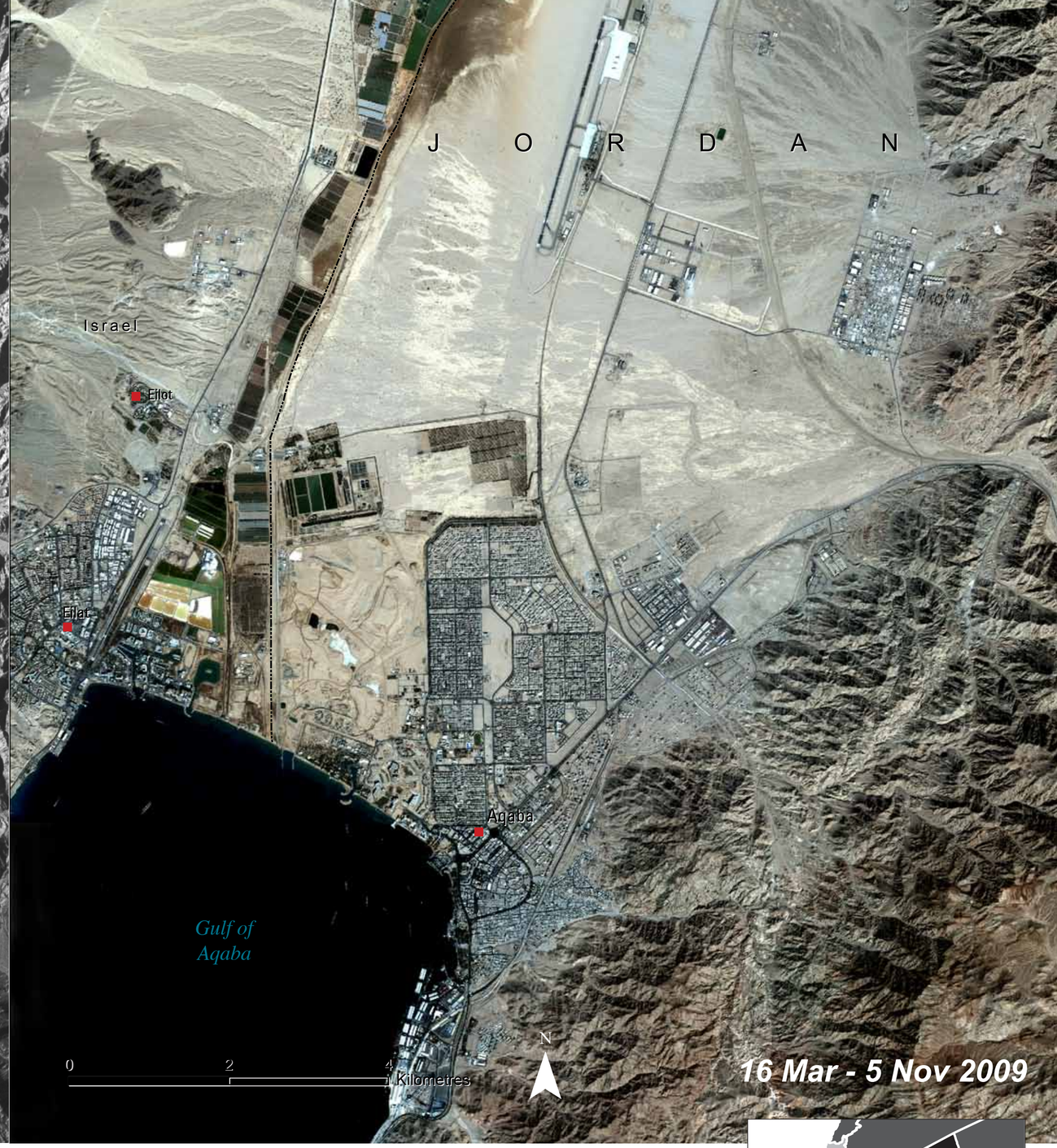

Amman, Jordan. Source: Jonrawlinson Flickr.com

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).



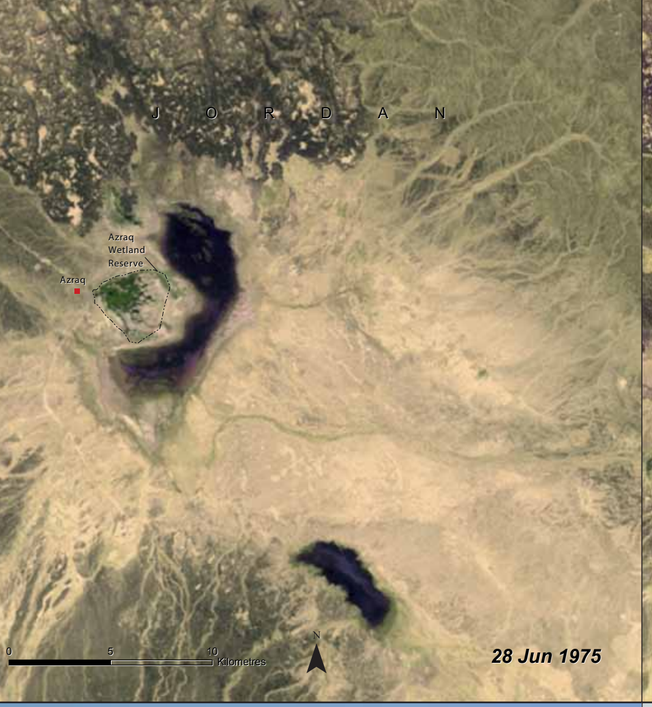


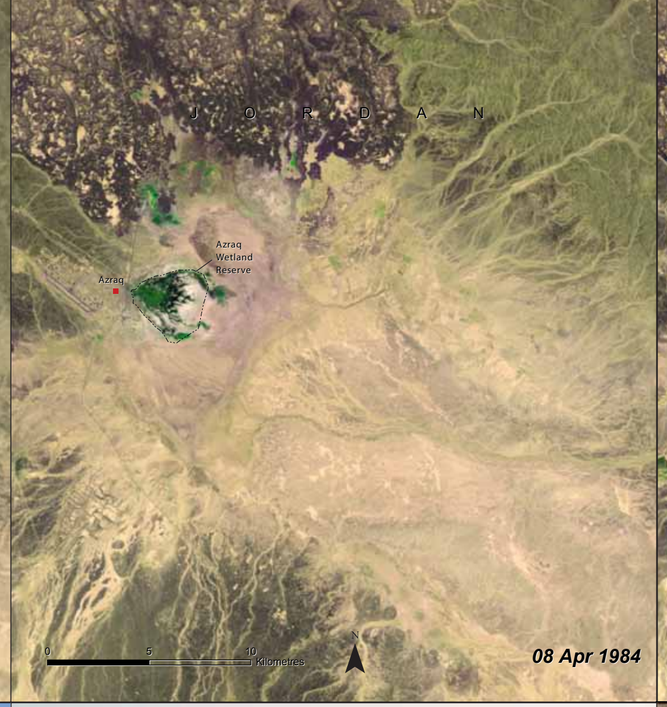

Aqaba Marina. Source: Josh Dvir/Flickr.com

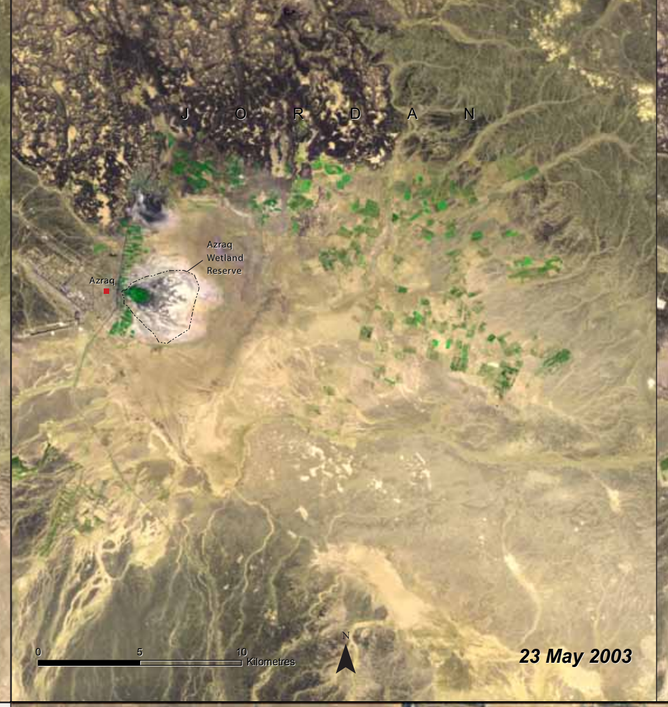
Aqaba, Jordan

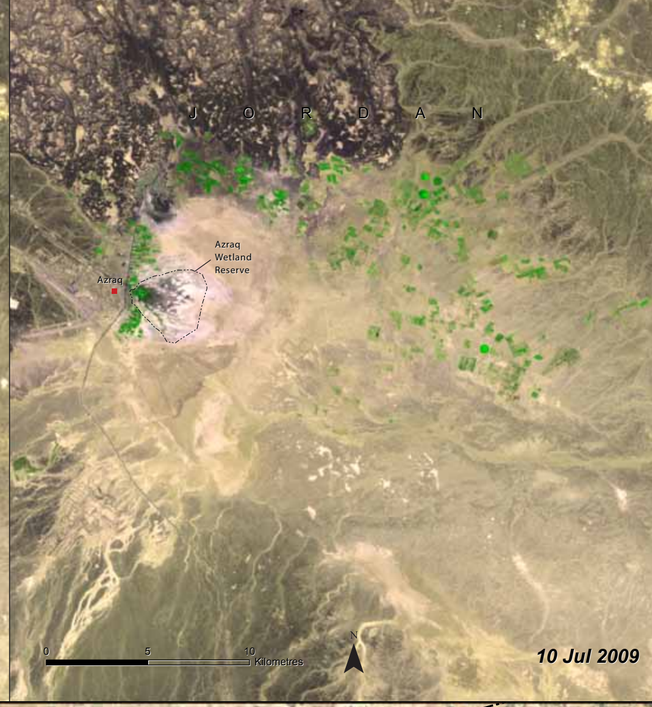
Aqaba, strategically located at the head of the Gulf of Aqaba, is a rapidly expanding urban, industrial, transport and tourism centre. As Jordan's only seaport, Aqaba's port facilities are vital to the country's commercial livelihood; cargo capacity increased from 54 431 tonnes in 1952 to over 19 million 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: Jordan Country Focal Point


Azraq Wetlands Palm Trees 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 km² Azraq Wetland Reserve was established.

Decades of excessive groundwater pumping from the Azraq Basin to supply Jordan's urban centres and growing agricultural needs caused the natural springs that supported the wetland to dry up by 1992 (RSCN 2008). 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 km²
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 37ºC) and short, cool winters; average minimum temperatures in January fall to 7ºC. 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

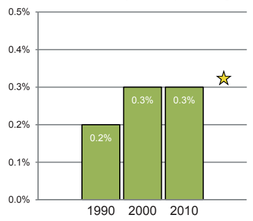
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

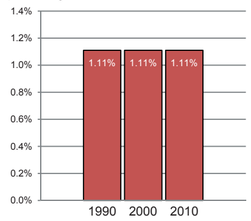
Kuwait has made substantial progress in achieving many of its MDG targets such as eradicating absolute poverty and achieving advances in health and education.

☆ Indicates Progress

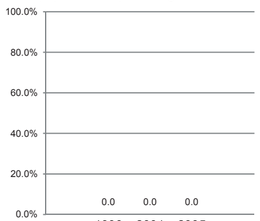
Land area covered by forest, percentage



Protected area to total surface area, percentage

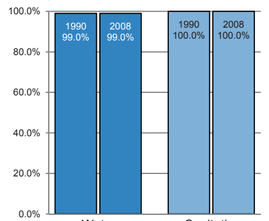


Slum population as percentage of urban



Source: Central Statistic Office 2008

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



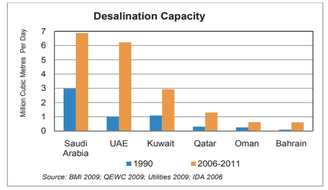
Of the 26 protected areas in Kuwait, the Sabah Al-Ahmad Wildlife Reserve is the largest terrestrial protected area (330 km²) and is a major source of plant genetic diversity in the country

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 m³/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.

Desalination Capacity

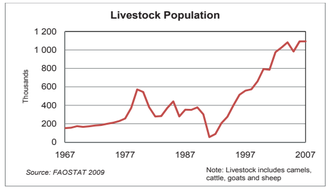


Source: BMI 2009; QEWC 2009; Utilities 2009; IDA 2006

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.).

Livestock Population



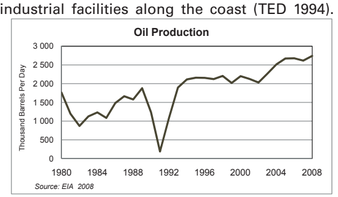
Source: FAOSTAT 2009

Note: Livestock includes camels, cattle, goats and sheep

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).

Oil Production



Source: EIA 2008

Kuwait Bay

KUWAIT CITY

ROPME Sea Area

Kuwait Int'l Airport

K U W A I T

Al Ahmadi

N

0 5 10 Kilometres

01 Aug 1972

Kuwait Bay

KUWAIT CITY

Al Jahra

ROPME Sea Area

Kuwait Int'l Airport

Al Fanaitis

K U W A I T

Al Ahmadi

N

0 5 10 Kilometres

27 Sep 2009

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.

KUWAIT CITY

ROPME Sea Area

K U W A I T

Greater Burgan Oil Field

KUWAIT

SAUDI ARABIA

0 5 10 Kilometres

N

05 Dec 1990

15 Feb 1991

28 Feb 1993

20 Jan 2002

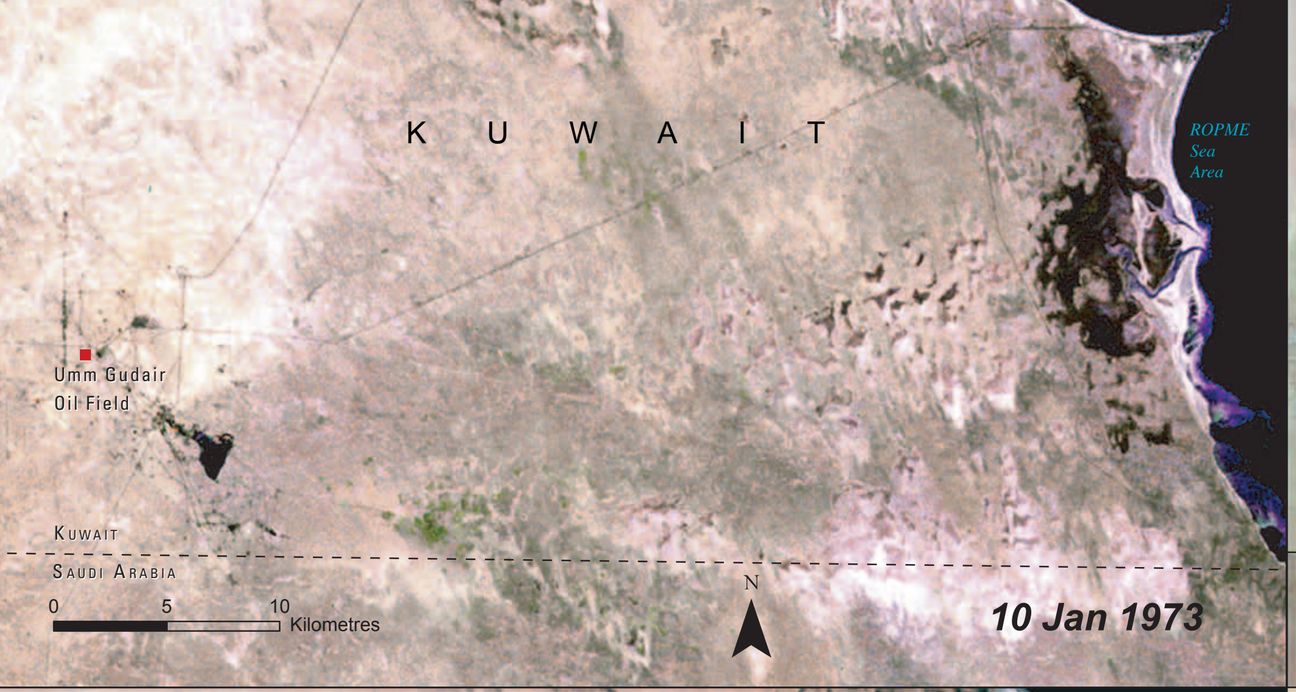
Images from Kuwait Country Contact

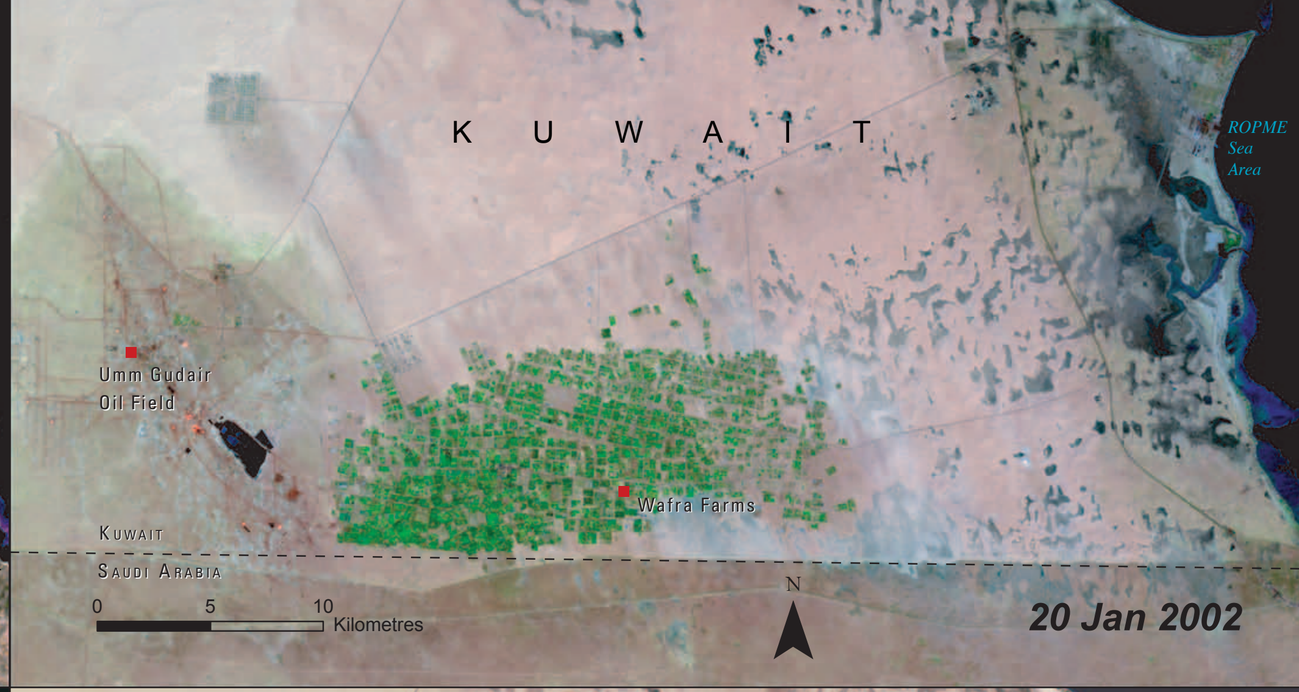
Oil Fires, Kuwait

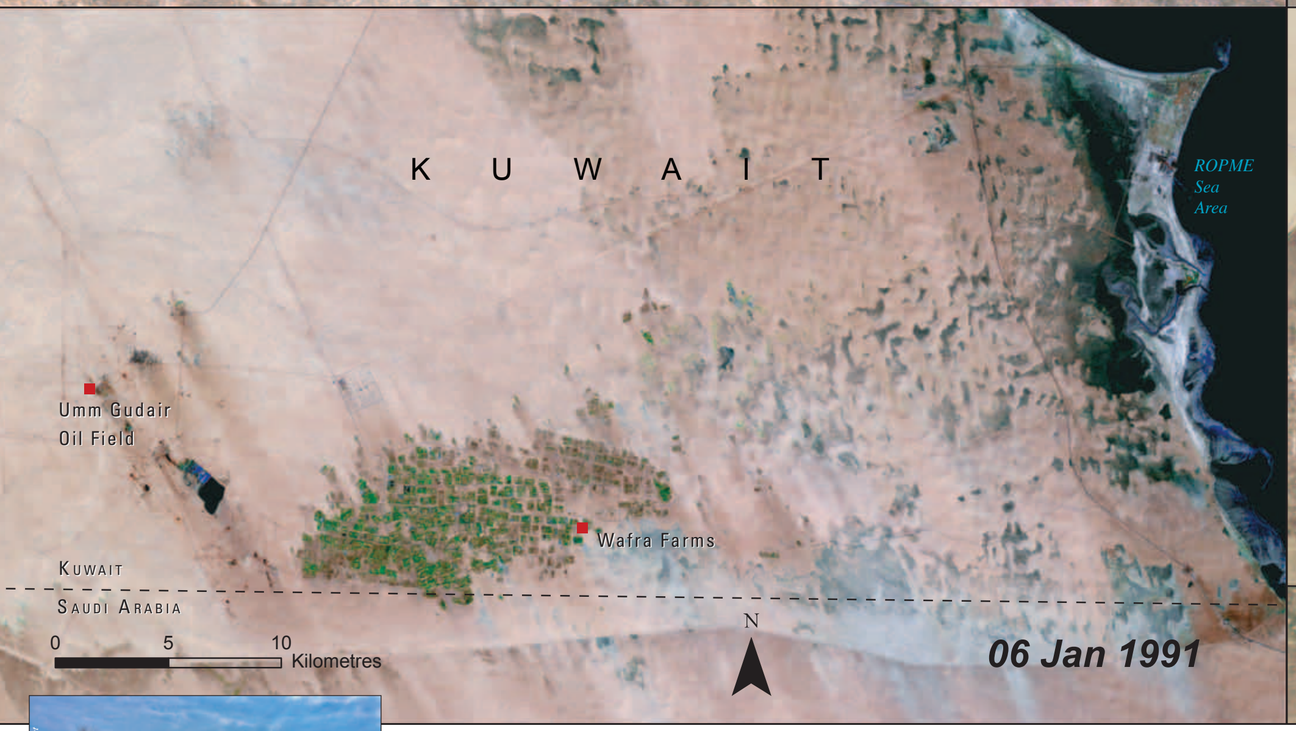
The invasion of Kuwait by Iraqi forces on 2 August 1990 set in motion a series of catastrophic events, which culminated in the setting ablaze of 789 oil wells as the forces began retreating in February 1991 (TED 1994). High subsurface pressure and the littering of land mines around the oil fields complicated 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.

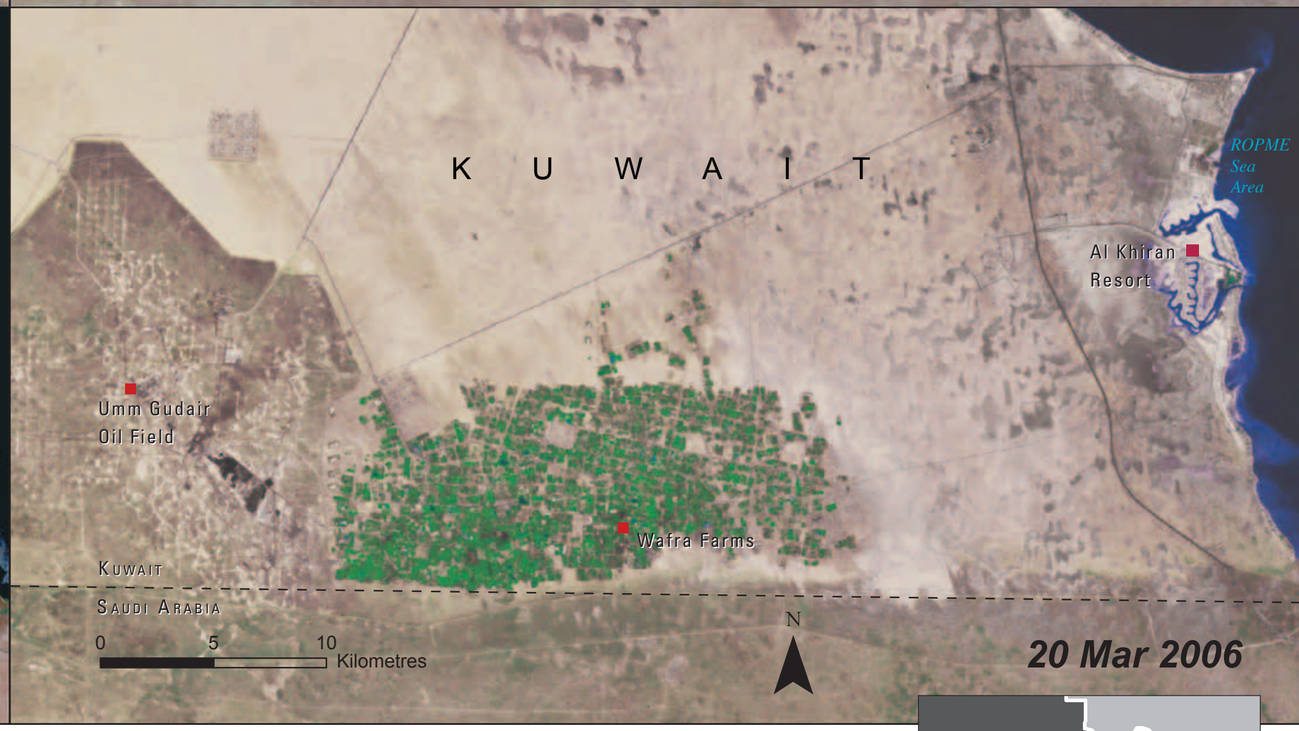
Images from Kuwait Country Contact

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.







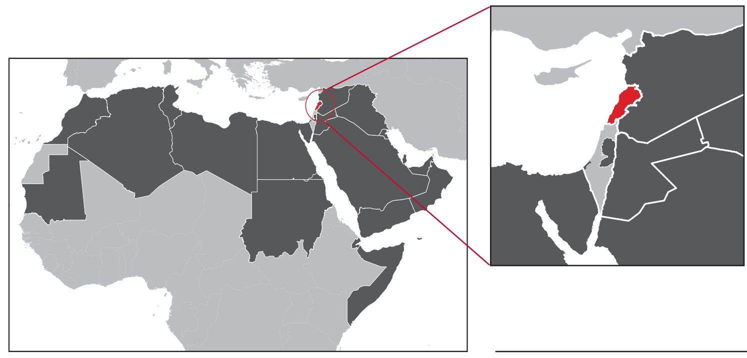


Wafra Farms. From Country Kuwait/Context

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

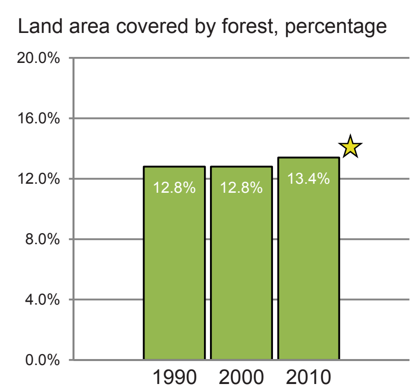
- Deforestation
- Management of Urban Environment
- Coastal and Marine Pollution

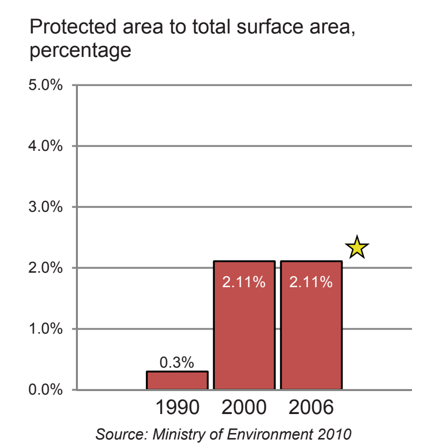
Progress Toward Environmental Sustainability

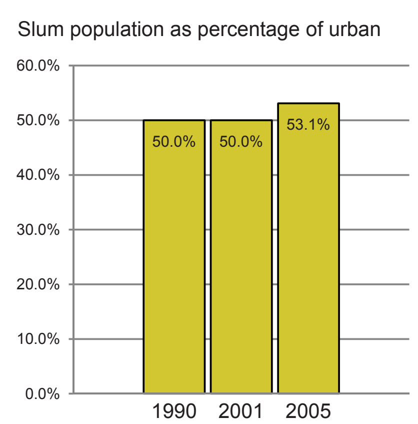
As defined by the United Nations Millennium Development Goal 7 Indicators

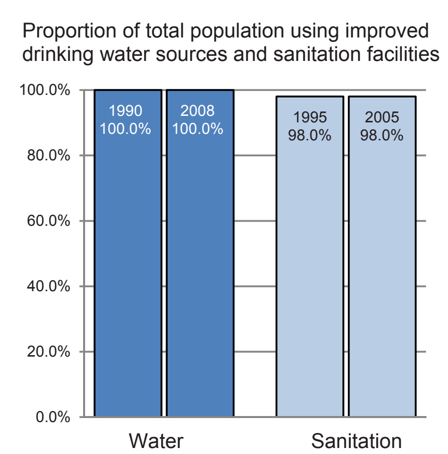
The slum population as a per cent of the urban population is high in Lebanon at over 50 per cent. This is due in large part to the conflicts and wars that Lebanon has endured. The Lebanese civil strife (1975 to 1990) and the regional conflicts with Israel have been particularly destructive with severe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

☆ Indicates Progress







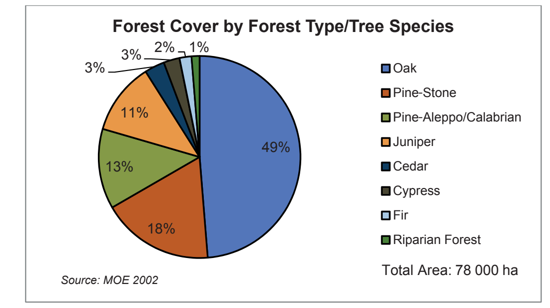


About 48 per cent of the population is distributed in the Beirut and Mount Lebanon region alone, whereas only 13.6 per cent live in the central Bekaa region (the largest governorate in area)

Source: UNHSP 2009

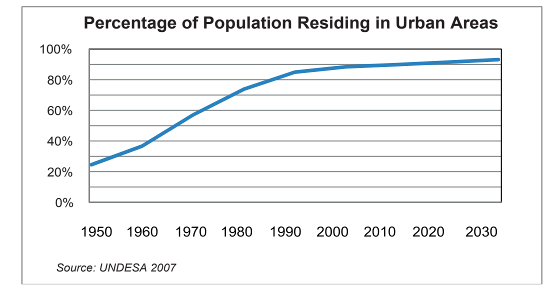
Deforestation

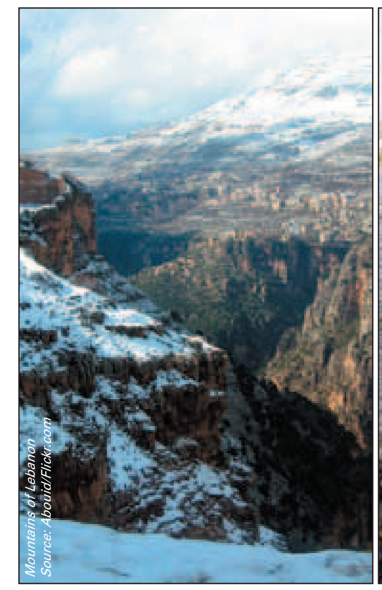
Lebanon's mountainous terrain once supported vast areas of forest. In 1965, forest cover was approximately 18.4 per cent; over the next three decades, forest cover was reduced by 35 per cent (NCSR 2007). Recent estimates place the total forest area in Lebanon at about 136 000 ha or comprising 13.29 per 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

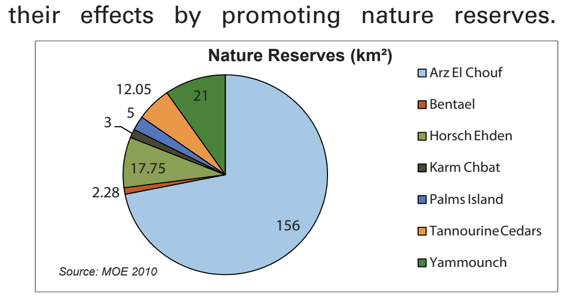
The July 2006 bombing by Israel of the Jiyeh Power Plant resulted in the largest ever oil spill in the Mediterranean

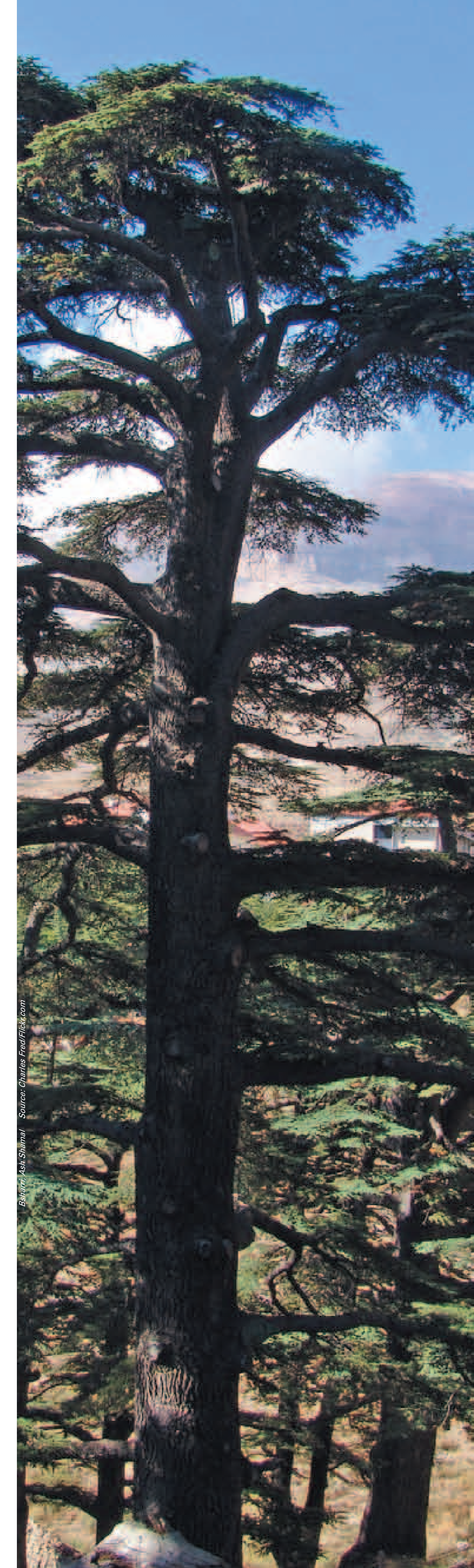
Source: UNEP 2007

Oil spill on the Lebanese coastline after Israeli bombing.
Source: Ministry of Environment, Lebanon.

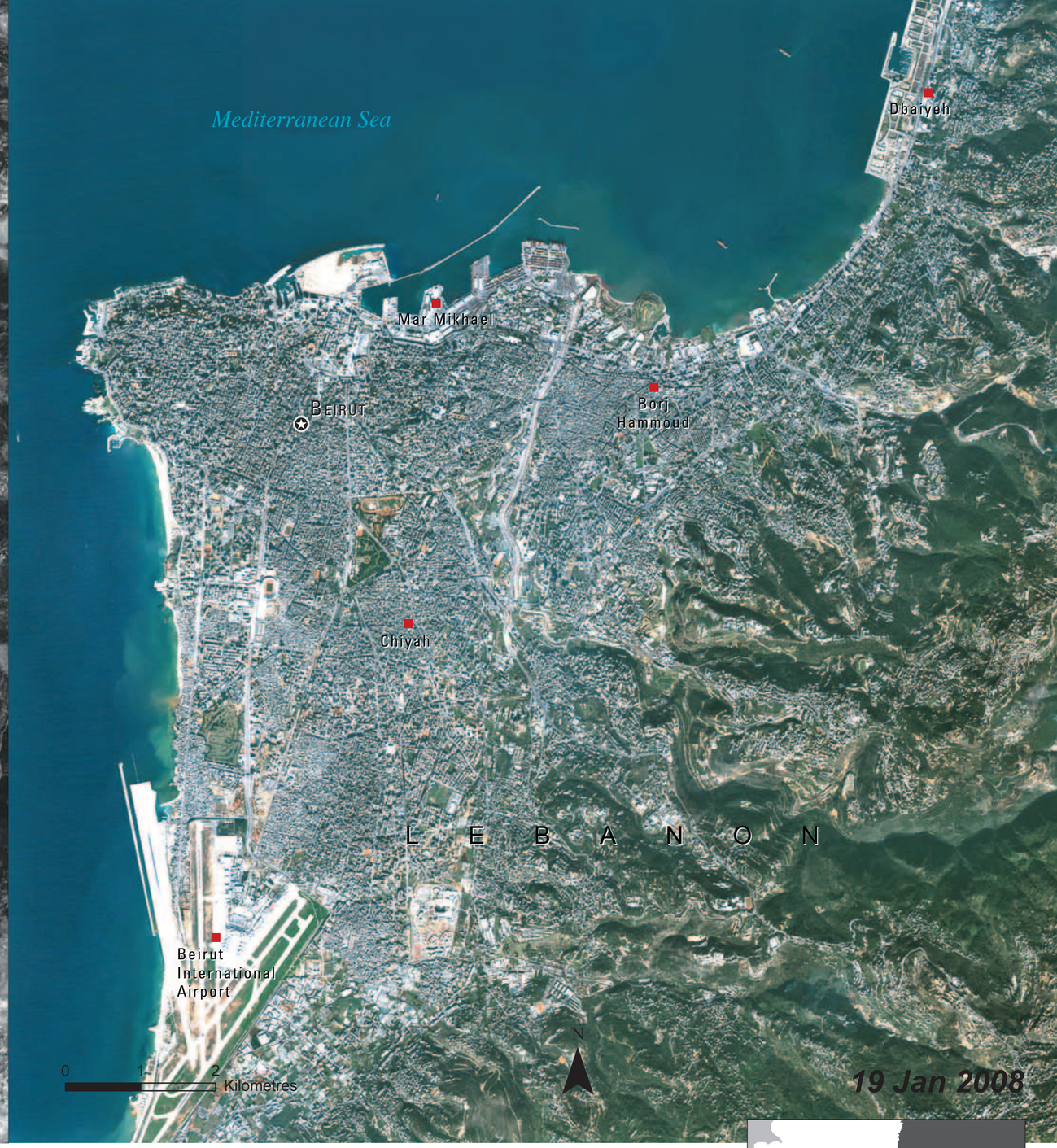
Coastal and Marine Pollution

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, 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).

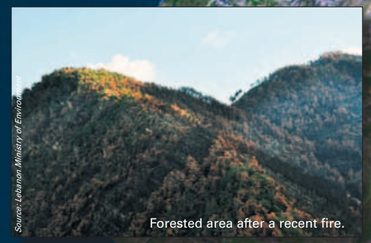
Jiyeh Power Plant Bombing and Oil Spill, Lebanon

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).

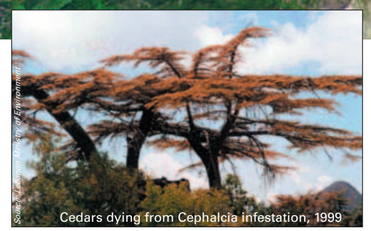
Cephalcia pupae and adult.

Source: Lebanon Ministry of Environment



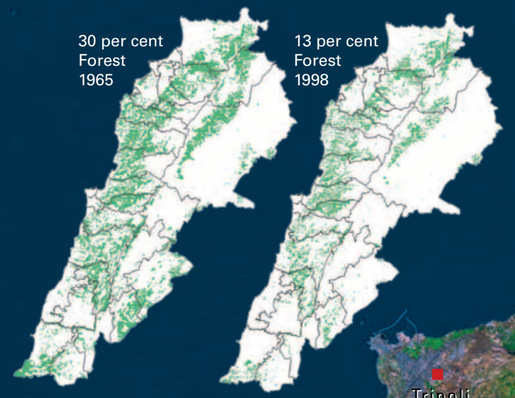
Forested area after a recent fire.

Source: Lebanon Ministry of Environment



Cedars dying from Cephalcia infestation, 1999

Source: Lebanon Ministry of Environment



Lebanon Forest Cover 1965 to 1998

Forest Cover Maps , Source: Lebanon Ministry of Environment 2010

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 km²
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

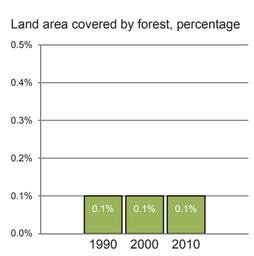
- Water Scarcity
- Arable Land Availability and Desertification
- Oil Development and Pollution

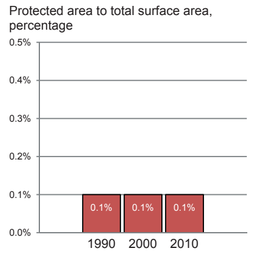
Progress Toward Environmental Sustainability

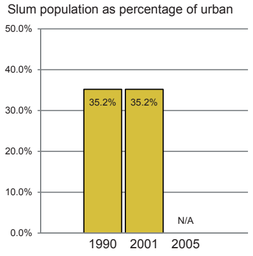
As defined by the United Nations Millennium Development Goal 7 Indicators

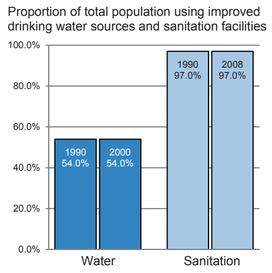
Libya's most pressing environmental issue is water scarcity. The agricultural sector consumes more than 80 per cent of total water supplies, while crop water productivity is exceedingly low (Alghariani n.d.). Depletion of groundwater as a result of agricultural overuse has caused salinization of the 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







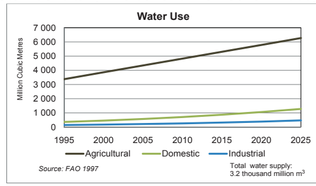


The Great Man-made River Project, driven by Libyan leadership to promote food self-sufficiency, is expected to cost US$33.69 thousand million over 50 years

Source: GWPMED n.d.

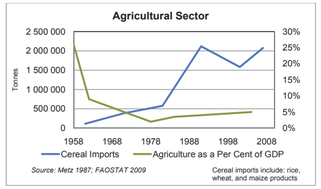
Water Scarcity

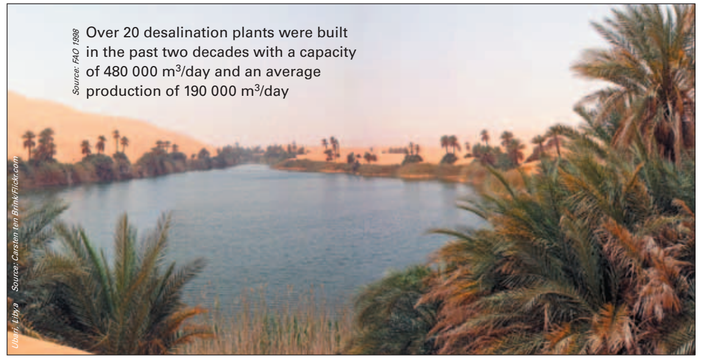
Libya's water scarcity, with only 104 m³ available per person per year, is exacerbated by low rainfall and a rapidly increasing population. With no perennial rivers or streams, the main water source is groundwater, which is being exploited beyond annual replenishment and becoming more saline (Swain 1998). 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

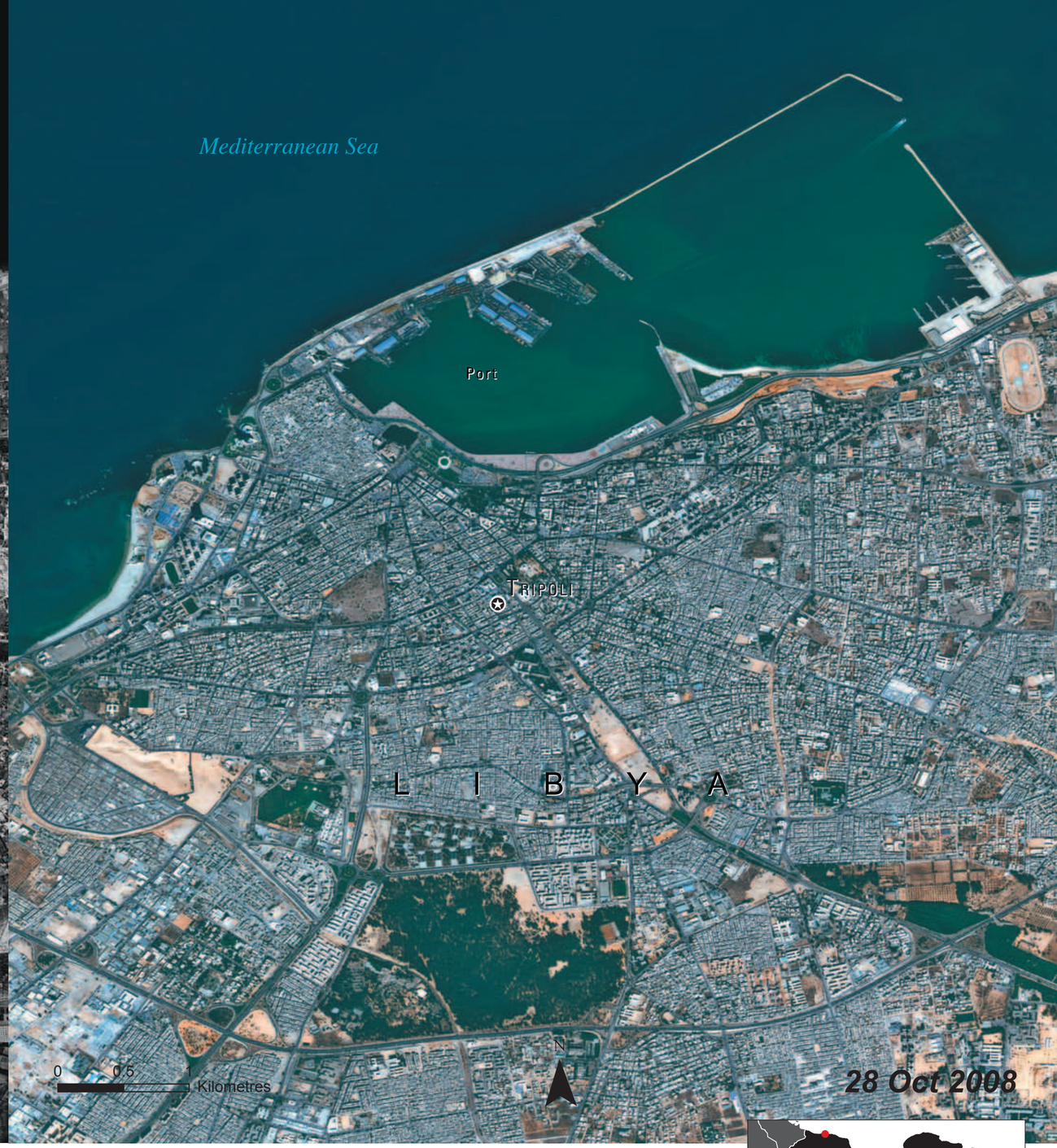
Less than 2 per cent of Libyan land is arable, and approximately 8 per cent is pastureland suitable for livestock grazing. Arable lands, which are almost all currently being cultivated, are concentrated on a narrow coastal strip between Tripoli and Benghazi, where the majority of the population resides. 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.).





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.

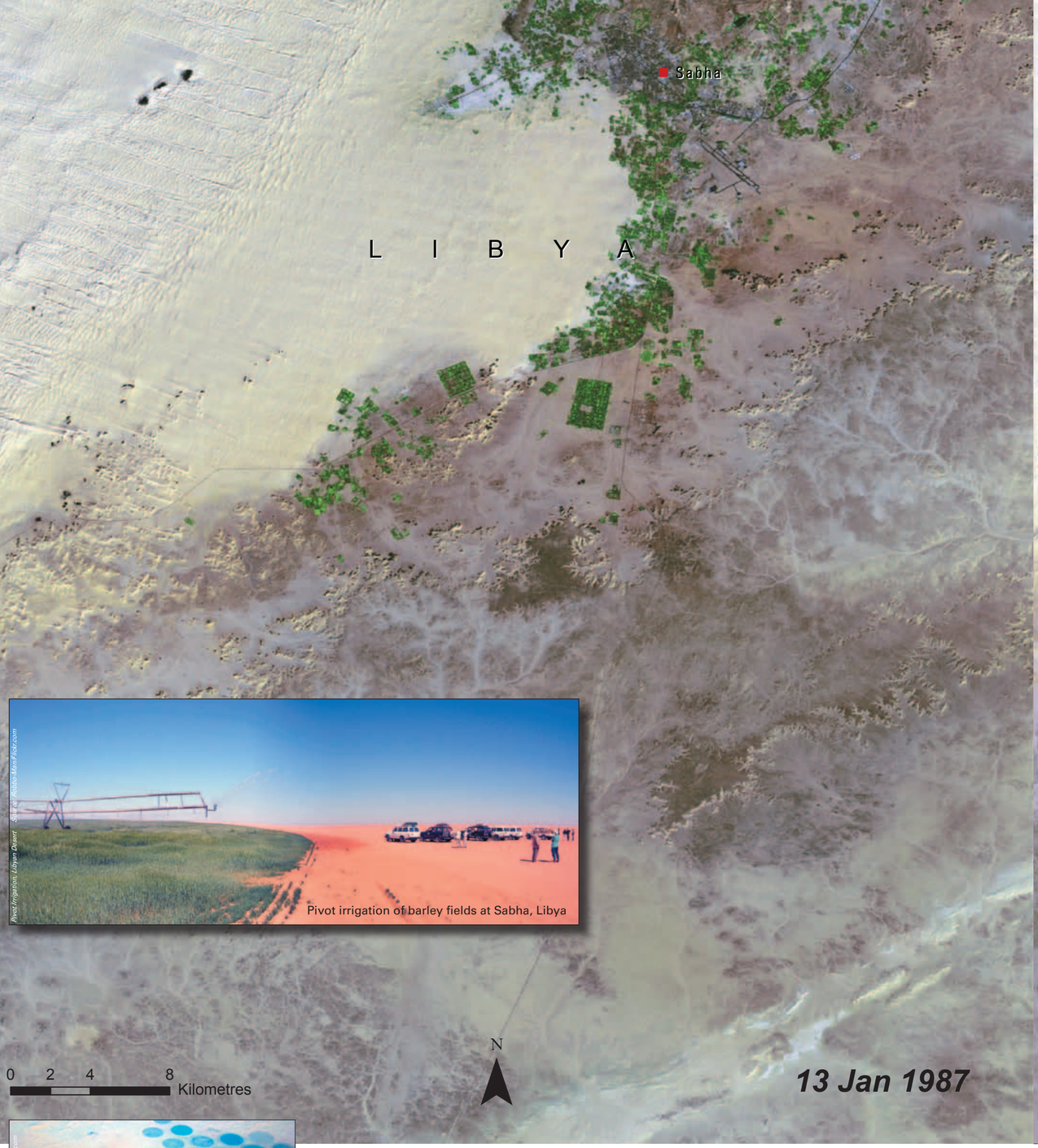


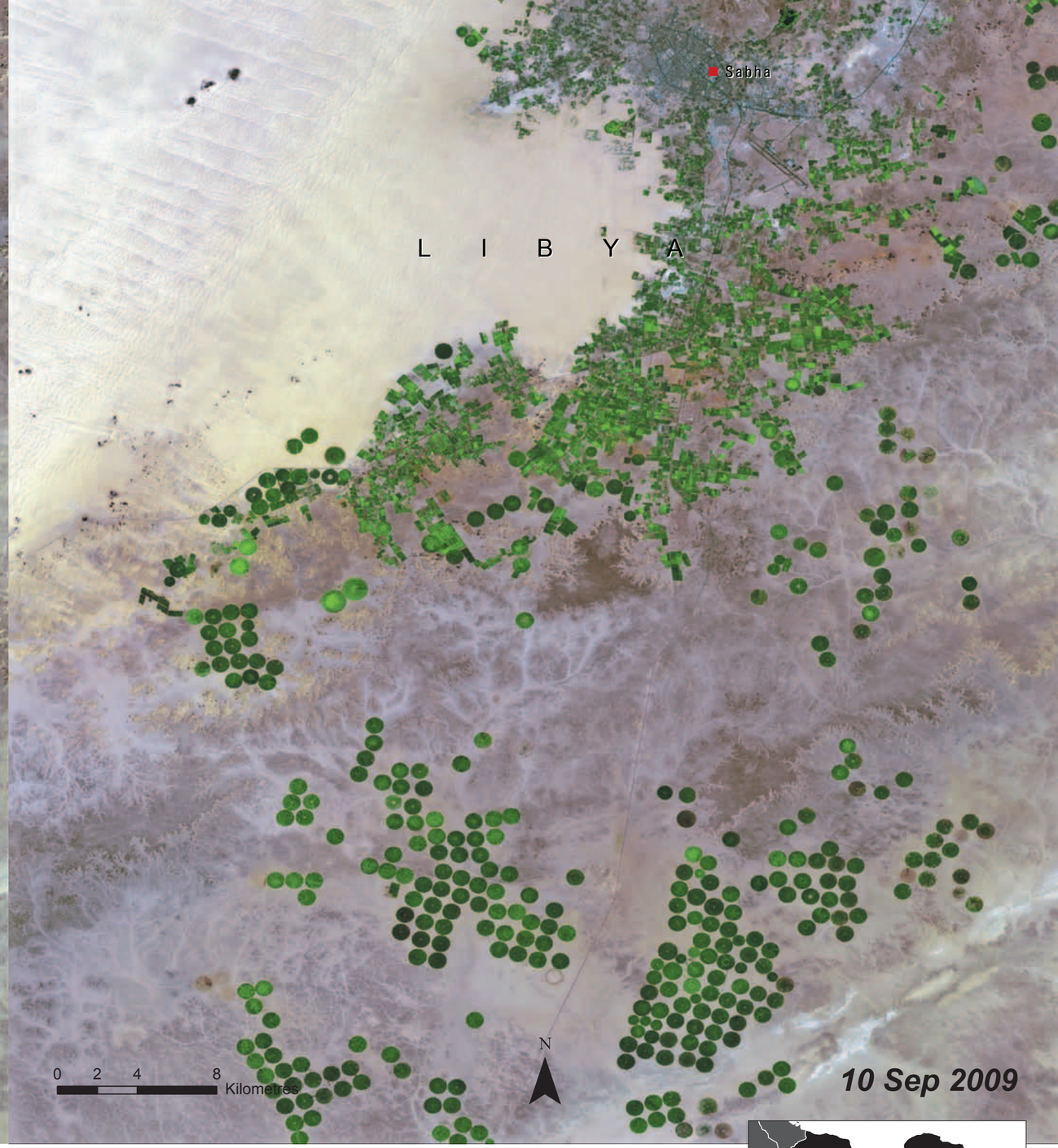

Tripoli, Libya Source: © Robert Harding

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).

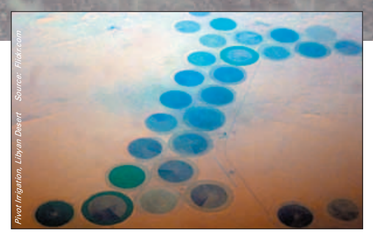
The city of Tripoli is under threat from: oil industry pollutants, which impact groundwater quality and marine ecosystems; outfall from desalination plants, which have proliferated along the nation's coastline to meet growing demands for water; compromised groundwater quality due to saltwater intrusion 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

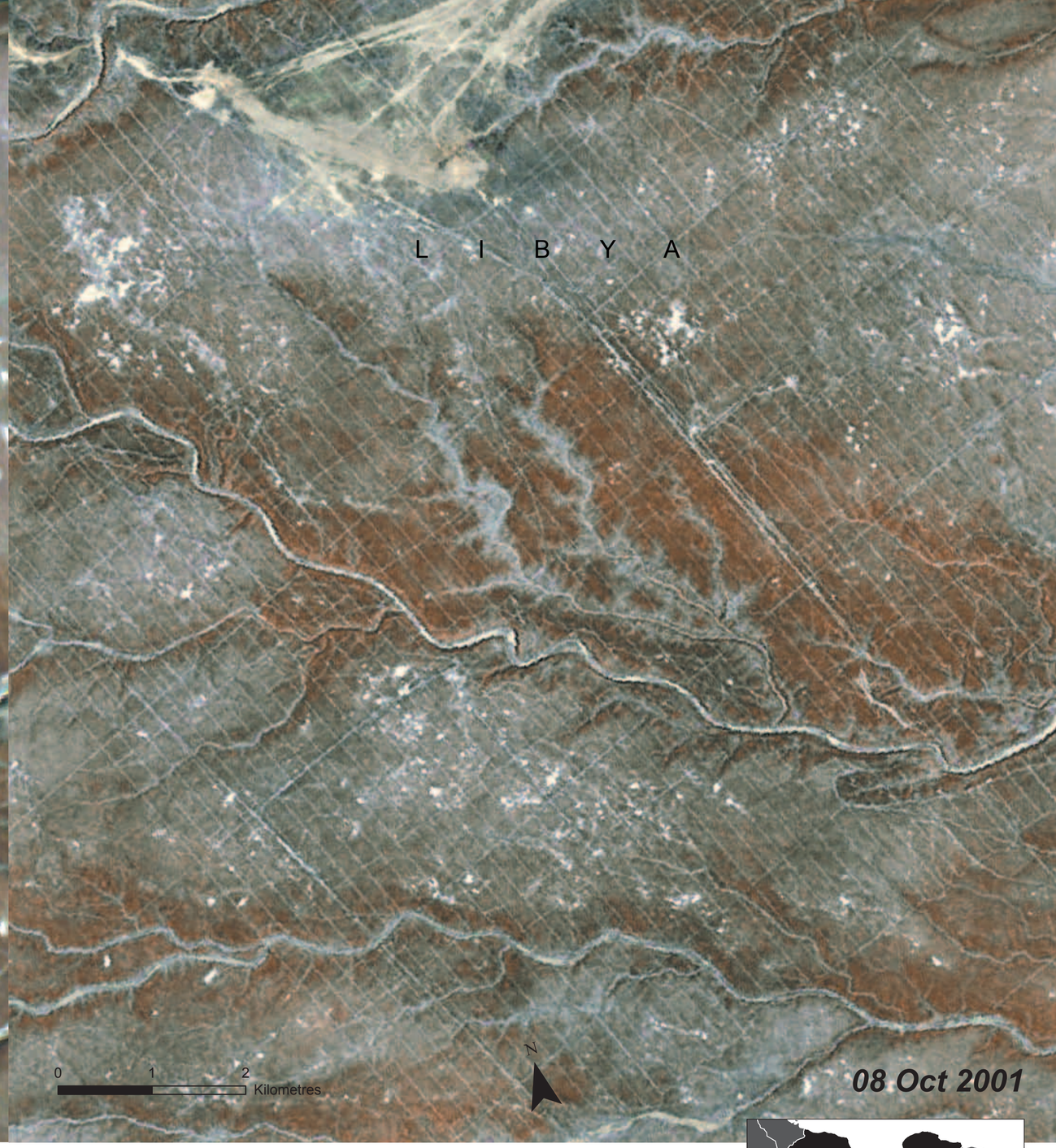
Pivot Irrigation, Libyan Desert Source: Flickr.com


Pivot Irrigation, Libyan Desert Source: Flickr.com

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.




Libya mud hills Source: Rudolf Baumann Photo

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 km²
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

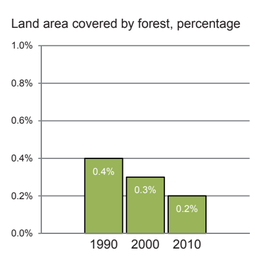
- Desertification
- Water Scarcity in Nouakchott
- Overfishing of Coastal Waters

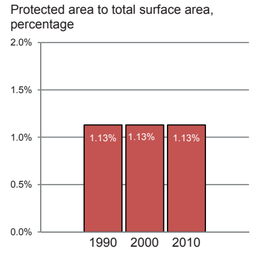
Progress Toward Environmental Sustainability

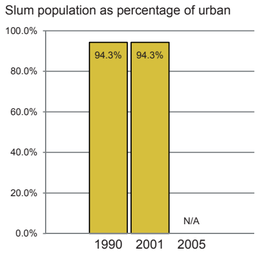
As defined by the United Nations Millennium Development Goal 7 Indicators

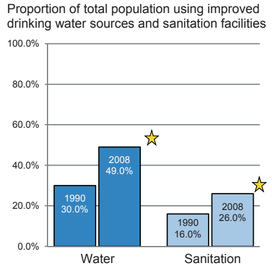
Slum dwellers make up the majority of Mauritania's urban population. Nouakchott, Mauritania's capital city, has a slum population of approximately 450 000 (Robelus n.d.) Due to poor water quality, slum dwellers are at an increased risk of contracting water-borne diseases such as cholera. In 2003, the 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







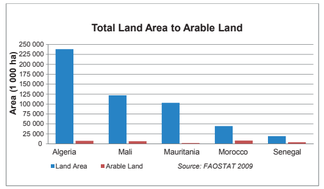


The Banc d'Arguin National Park, a 12 000 km² coastal wetland, is home to the critically endangered monk seal and over two million migratory waterbirds

Source: UNEP-WCMC n.d.

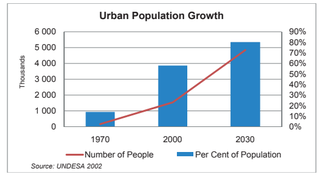
Desertification

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.

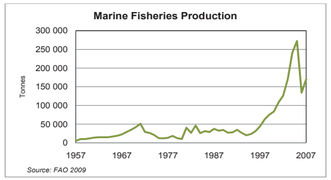


Improvements in irrigation led to a rise in rice production from 22 680 tonnes in 1985 to 93 803 tonnes in 2000 Source: FAO 2002

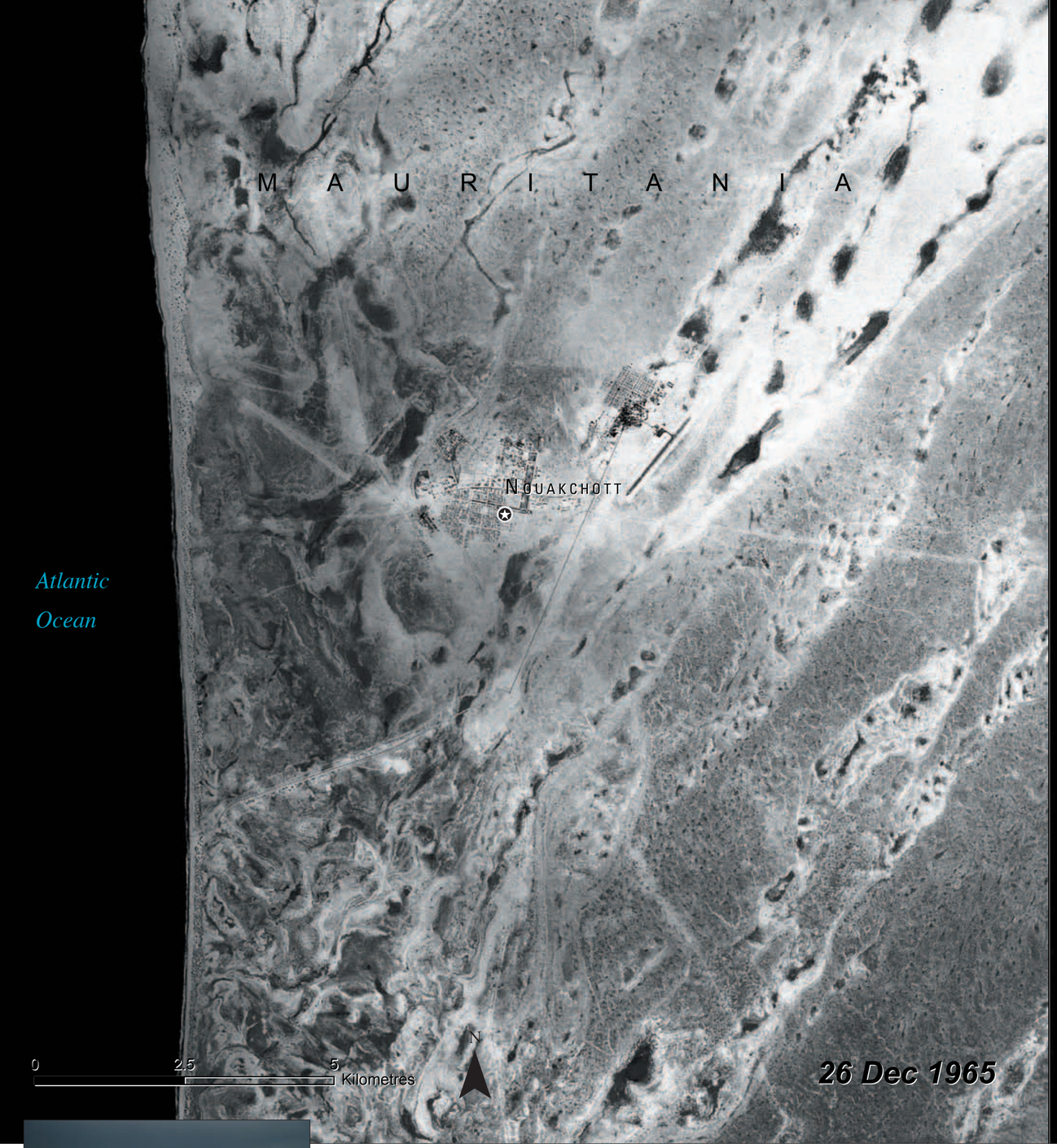
Oualata, Mauritania Source: Hajjaw Flickr.com

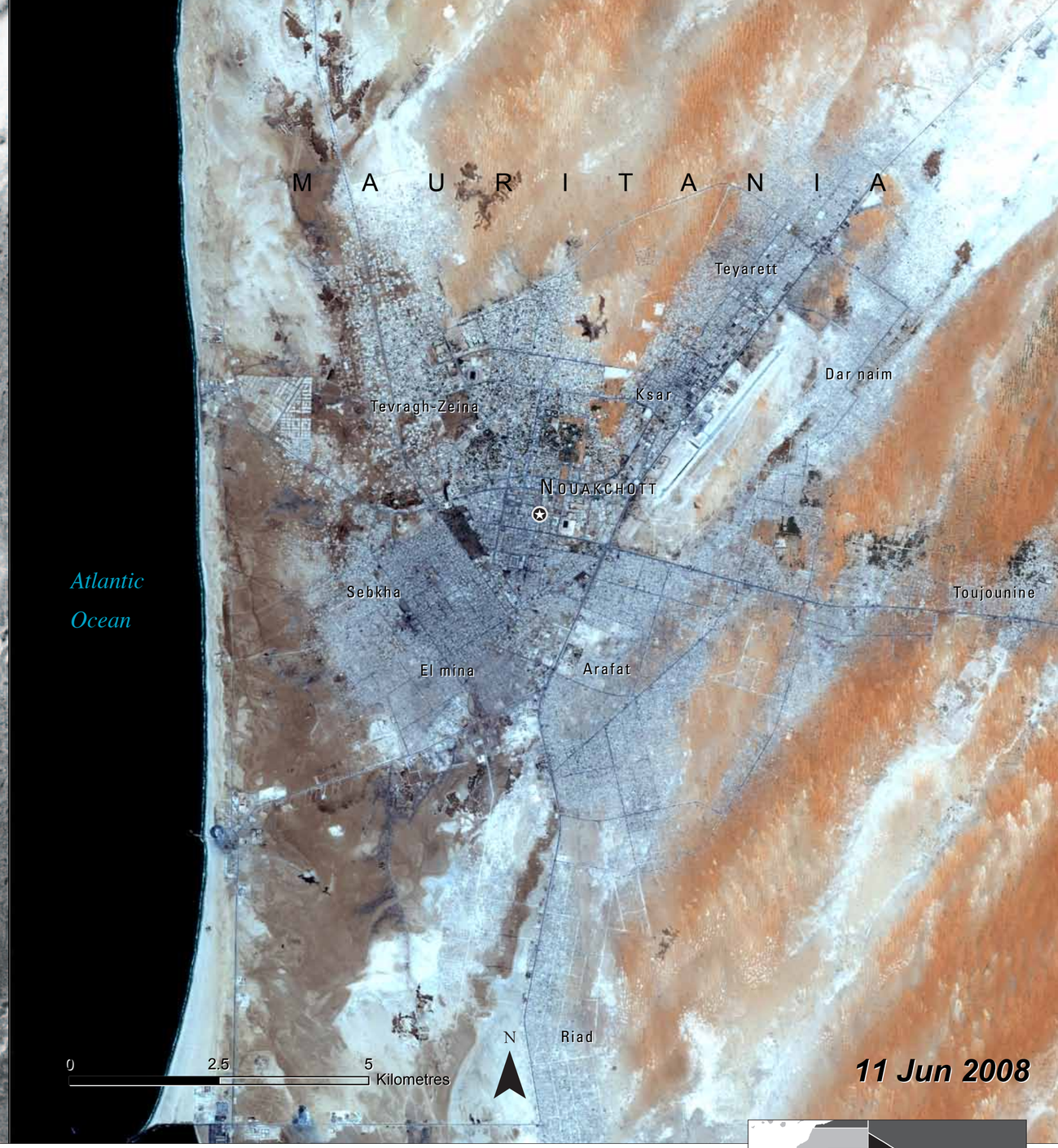
Overfishing of Coastal Waters

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 Source: Perihania Flickr.com






Source: Ferdinand Reus Flickr.com

NOUAKCHOTT, MAURITANIA

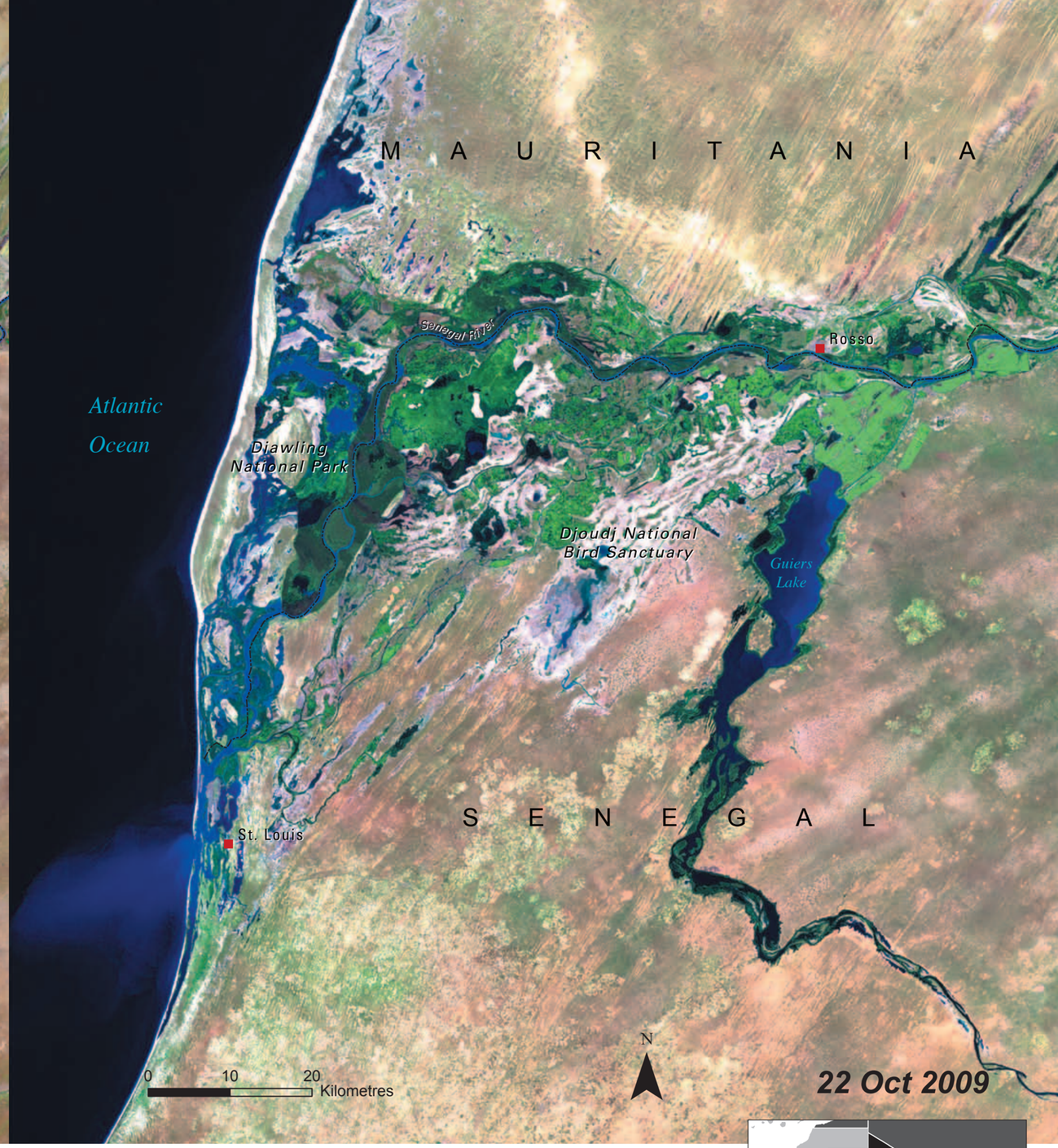
Nouakchott, the capital of Mauritania, is located on the Atlantic coast. The city is the largest in Mauritania and contains approximately one-fourth of the country's population (Lekweiry and others 2009). In 1961, when Mauritania gained independence from France, most of the population was nomadic; by 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 - http://www.panoramio.com

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.

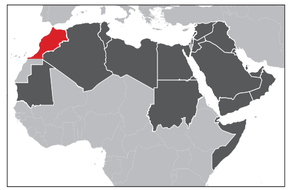


Senegal River Source: Jurgen Ziska.com

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

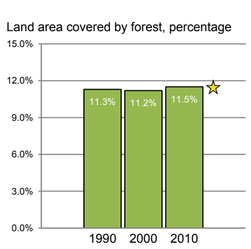
- Desertification and Land Degradation
- Water Scarcity and Drought
- Pollution of Freshwater and Marine Environments

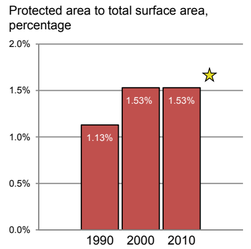
Progress Toward Environmental Sustainability

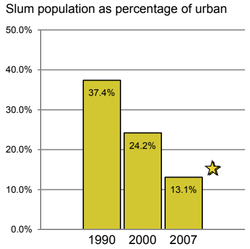
As defined by the United Nations Millennium Development Goal 7 Indicators

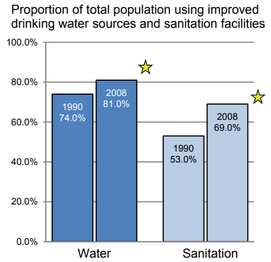
The volume of wastewater produced in Morocco from 1992 to 2002 nearly tripled; currently 600 million m³ of wastewater is produced each year in Morocco, 13 per cent of which is treated. The proportion of the urban population served by wastewater treatment plants is less than 8 per cent (FAO 2009). The 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







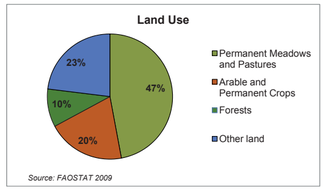


Morocco's 'Vision 2010' was launched by Moroccan King Mohammed VI with the aim of attracting 10 million international visitors to the Kingdom by 2010

Source: Ministry of Tourism 2005

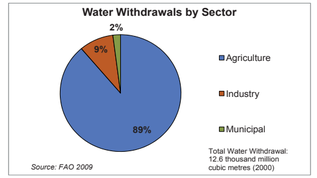
Desertification and Land Degradation

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).



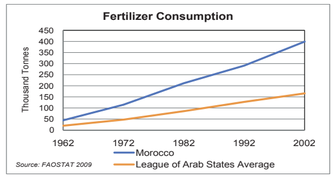
Water Scarcity and Drought

Morocco is under severe water stress—in the past decade water availability per capita (730 m³/year) dropped below the international water scarcity threshold of 1 000 m³ 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 m³ 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).

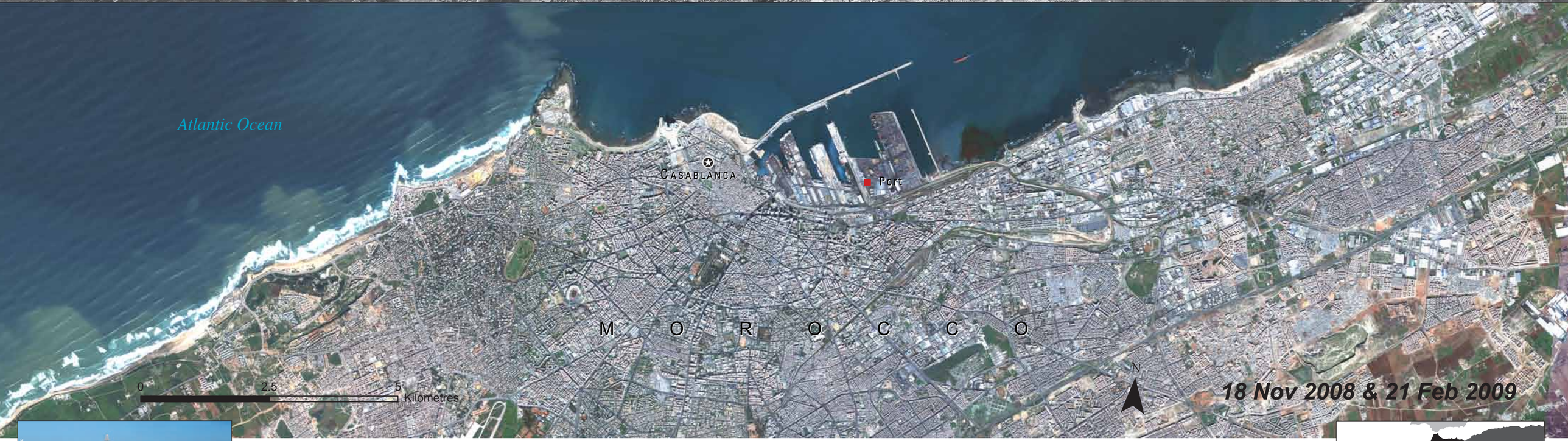


Pollution of Freshwater and Marine Environments

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).



Ouzoud Falls, Morocco Source: YzalFlickr.com




Casablanca, Morocco. Source: UggBoy♥UggGirl.com

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 km² in 1907 to 210 km² 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 km² (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.

M O R O C C O

Ouergha River

0 5 10 Kilometres

N

07 May 1987

Al Wahda Reservoir, Morocco
Source: dmidd Flickr.com

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.

M O R O C C O

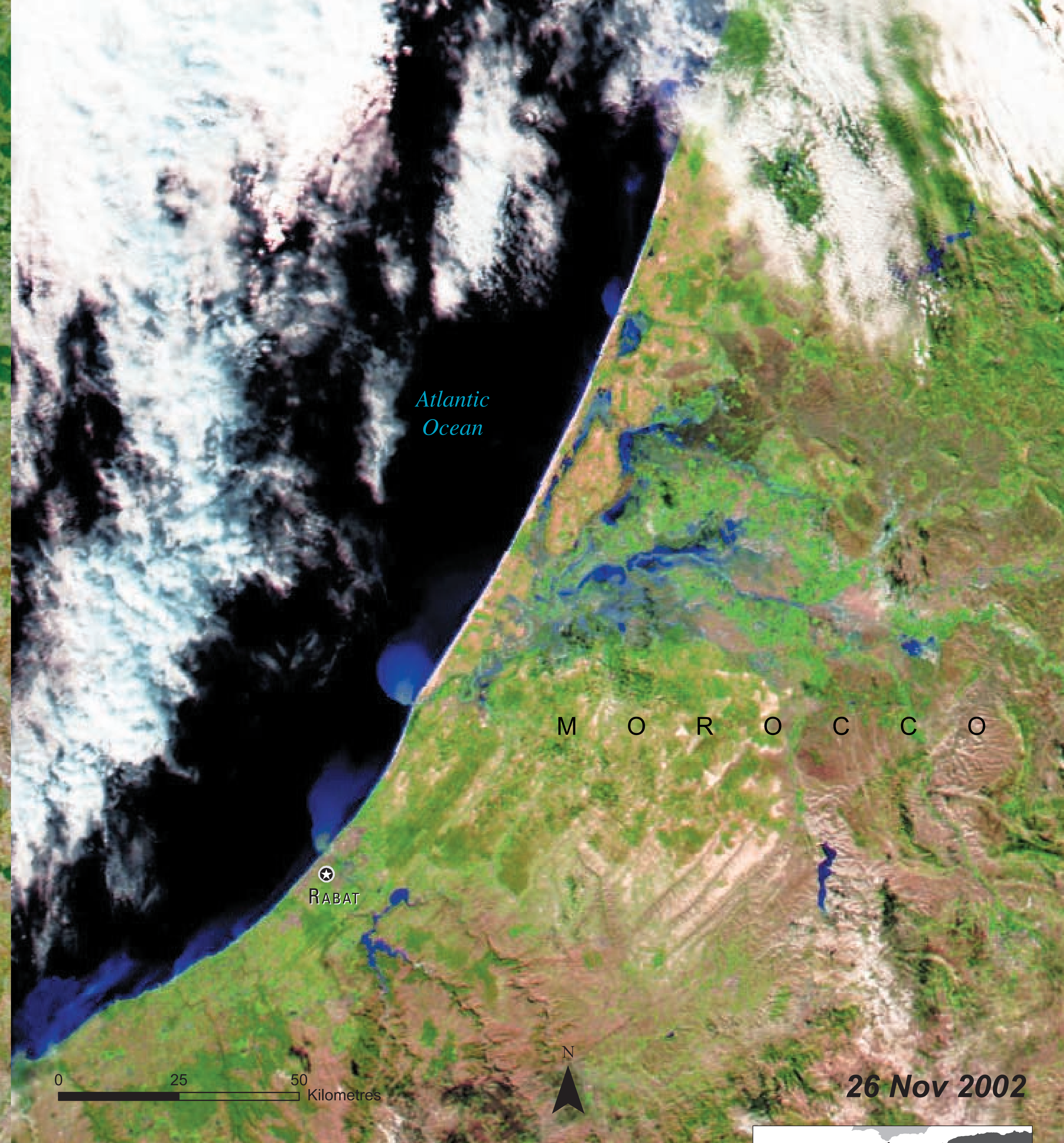
Lake
Al
Wahda

0 5 10 Kilometres

N

29 Dec 2006

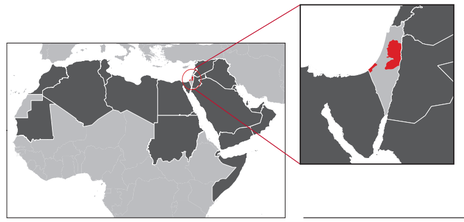
However, natural and human-caused erosion is filling the reservoir with silt, threatening the dam's long-term operation. It is estimated that the reservoir loses 60 million m^3 of capacity each year due to siltation. In addition, these sediments trapped in the reservoir are no longer reaching coastal 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.



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 km²
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

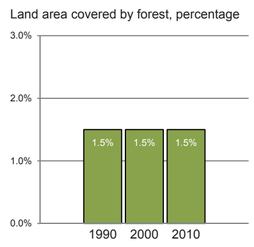
- Water Scarcity
- Environmental Pollution-Air and Water
- Population Pressures on Land

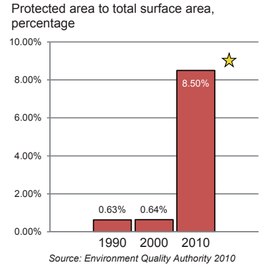
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

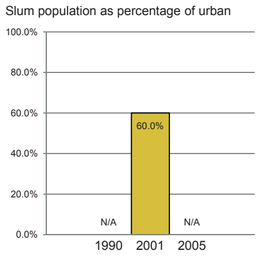
Sixty-three per cent of the Palestinian population lives in the West Bank and 37 per cent in the Gaza Strip (UN ESOSOC 2007). Approximately half of all Palestinian households are dependent on international food assistance (Commission of the European Communities 2009). Food insecurity is widespread in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

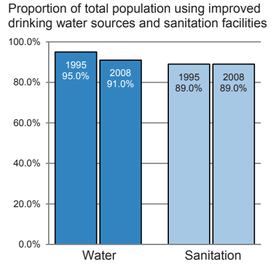
☆ Indicates Progress





Source: Environment Quality Authority 2010



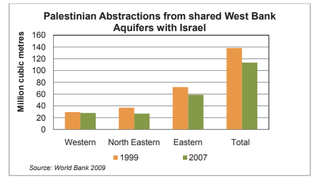


The 750 km-long (proposed and mostly built) separation wall by Israel will impact 50 per cent of the West Bank population through loss of land (including agricultural fields), loss of water resources, separation of communities and isolation areas

Source: HDP 2003

Water Scarcity

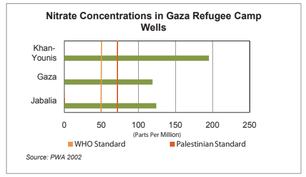
The Occupied Palestinian Territories is among the countries with the scarcest annual renewable water resources per capita (125 m^3 in the Gaza Strip, and 75 m^3 in the West Bank). Demand for water was 554 million m^3 in 2005, and is projected to increase to 785 million m^3 by 2020 (PNA 2005). The principal 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.



Source: World Bank 2009

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.



Source: PWA 2002

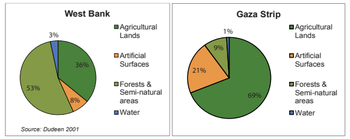

The West Bank has 19 refugee camps and 875 000 refugees; the Gaza Strip has eight refugee camps and 1 218 000 refugees. The Beach Refugee Camp in Gaza, which is less than 1 km², houses 87 000 refugees

Source: UNHHA 2012a, 2012b

Photo Credit: Ryan Rodrick Beiler

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.



Source: Dudeen 2001


Wadi Qilt in the Judean mountains near Jericho Source: EvolvementRadar.com

OCCUPIED PALESTINIAN TERRITORIES

Uja A-Tahta

Jordan River

Jericho

JORDAN

WEST BANK

Dead Sea

N

0 2.5 5 Kilometres

29 Jul 1963

OCCUPIED PALESTINIAN TERRITORIES

Uja A-Tahta

Jordan River

Jericho

JORDAN

WEST BANK

Dead Sea Shoreline 1963

Dead Sea

N

0 2.5 5 Kilometres

07 Aug 2000

Farmers gather tomatoes in the West Bank
Source: James Emery © Creative Commons

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).

OCCUPIED PALESTINIAN TERRITORIES

The Old City

JERUSALEM

0 1 2 Kilometres

N

19 Jul 1963

OCCUPIED PALESTINIAN TERRITORIES

1949 Armistice Line

ISRAEL

WEST BANK

The Old City

Ma'ale Adumim

JERUSALEM

0 0.5 1 2 Kilometres

N

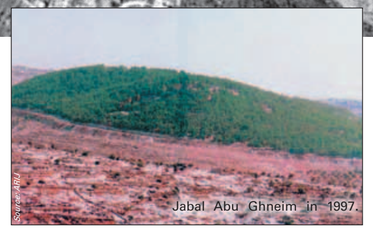
06 Aug 2009

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.

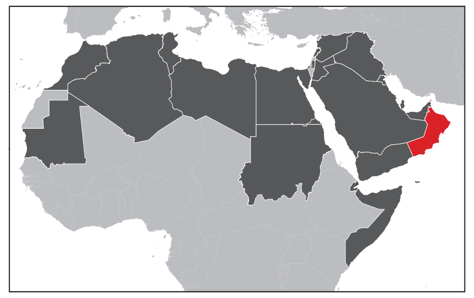
The colony consists of residential neighbourhoods and industrial areas. The highway connecting the settlement to Jerusalem (visible on the 2009 image) was completed in 2003, allowing quick commuter access to the city. The colony is located in a region known as the Eastern Slopes, which are considered 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, 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).

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

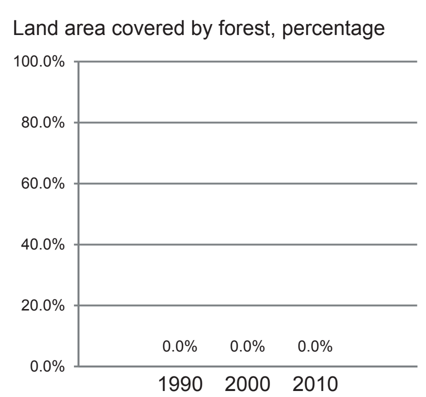
- Water Scarcity and Water Use
- Soil and Groundwater Salinity
- Threats to Coastal Areas and Marine Biodiversity

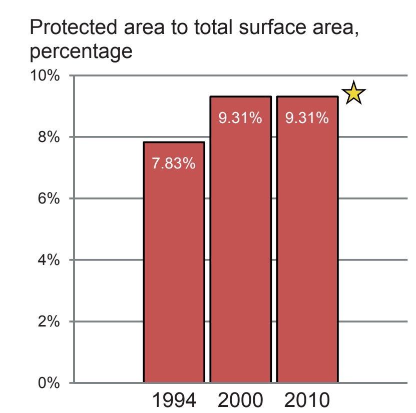
Progress Toward Environmental Sustainability

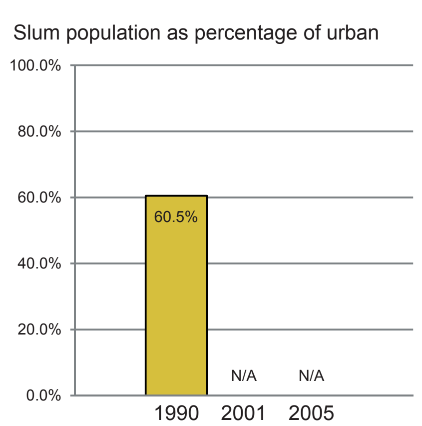
As defined by the United Nations Millennium Development Goal 7 Indicators

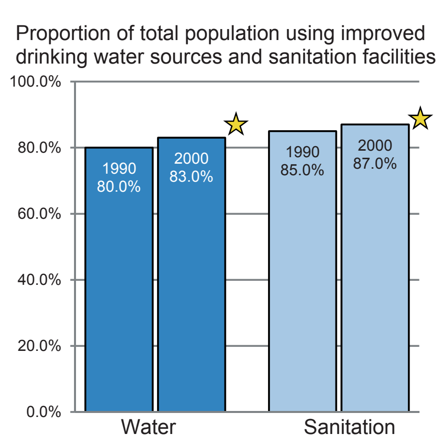
Oman's economic reliance on the oil sector began with its first commercial oil exports in 1967. However, a slump in oil prices in 1998-99 forced the Sultanate to start to diversify its economy. By 2020, the crude oil sector's share of GDP is expected to drop to 9 per cent of Oman's GDP, down from 41 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







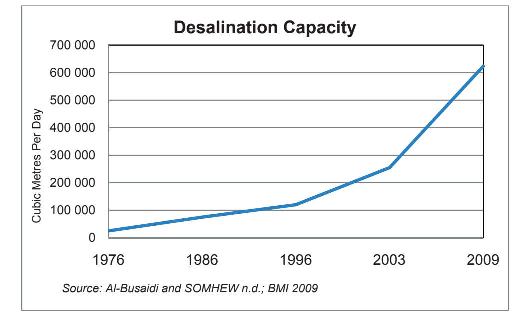


In the more populated regions of Oman, demand for desalinated water is expected to increase by 15 per cent per year from 2007 to 2014

Source: OPWP 2007 in Al-Barwani 2008

Water Scarcity and Water Use

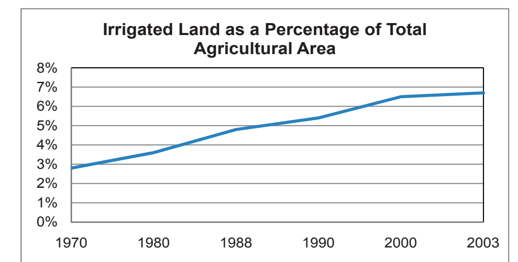
Oman receives an average annual rainfall of less than 40 mm in the deserts and coastal areas, and reaches 300 mm per year in the mountains. Groundwater accounts for 70 per cent of the water use in the Sultanate (Ministry of Regional Municipalities and Water Resources 2005). 91 per cent of water used 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 m³ in 1971 to 34 068 706 m³ 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 m³) exceeded actual per capita renewable water resources (337 m³) (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.



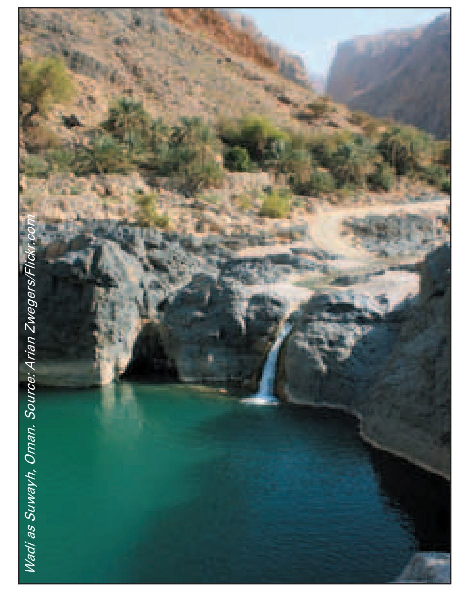
Source: Al-Busaidi and SOMHEW n.d.; BMI 2009

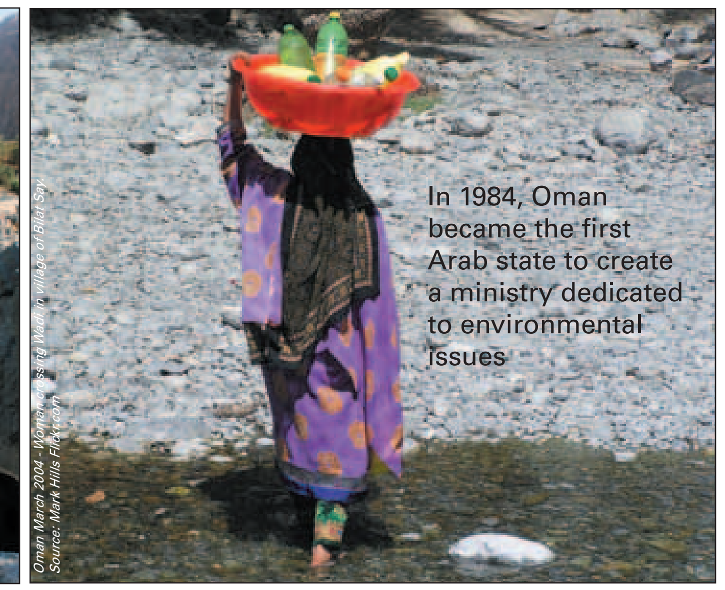
Soil and Groundwater Salinity

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).



Source: FAOSTAT 2006

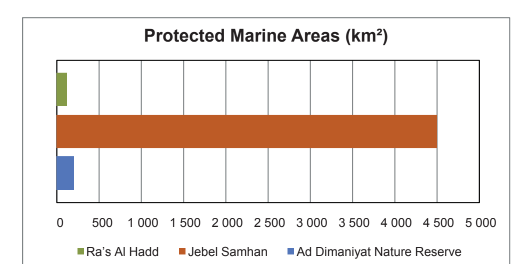

Wadi as Suwayh, Oman. Source: Arian Zwegers/Flickr.com



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

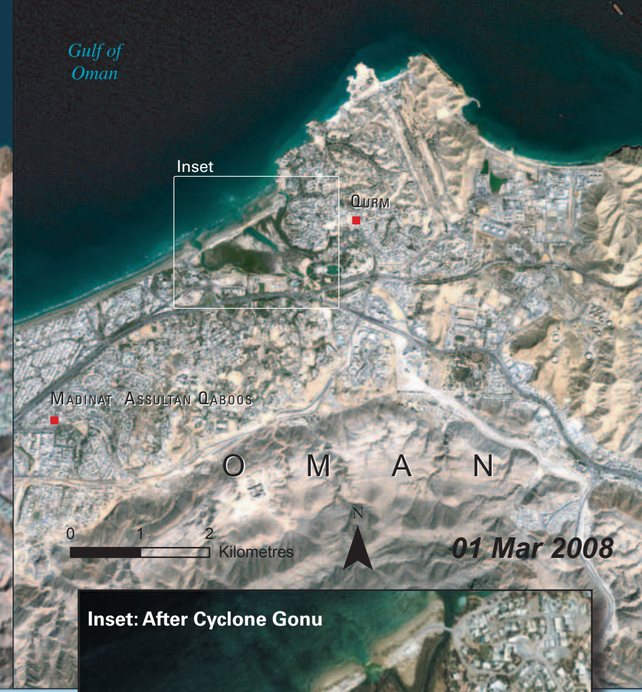
Threats to Coastal Areas and Marine Biodiversity

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).



Source: Wood 2007


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




Corniche, Muscat, Oman. Source: Zhu

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: Rastapopulaire Flickr.com

O M A N

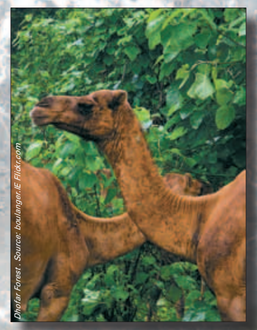
Dhofar Mountains

Arabian Sea

0 5 10 Kilometres

N

18 Oct 1973



Dhofar Forest . Source: bourgoint.E Flickr.com

O M A N

Dhofar Mountains

Salalah

Arabian Sea

0 5 10 Kilometres

N

20 Oct 2006

Dhofar Forest . Source: Nawal Al-Hosni

Dhofar, Oman

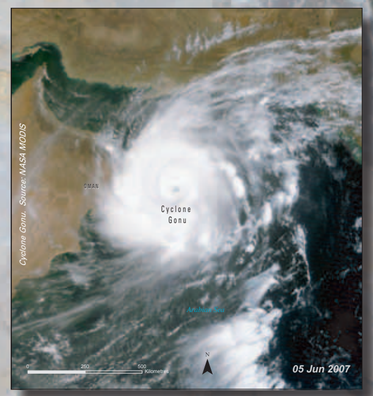
The Dhofar Governorate of the Sultanate of Oman is located in the southern part of the country bordering Yemen. The Dhofar region is dominated by the Dhofar Mountains, which is a rugged coastal mountain range that enjoys a mild tropical climate throughout the year. The Dhofar Mountains stretch for 400 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.

Inset

Gulf of Oman

O M A N



0 1 2 Kilometres

N

03 Jul 2005


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.

Inset

Gulf of Oman

O M A N


Inset: before Cyclone Gonu

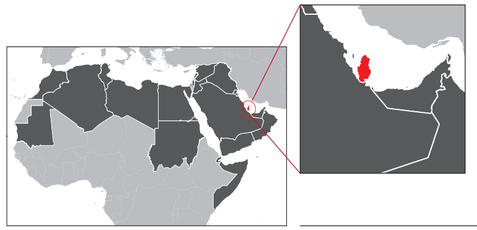

Inset: after Cyclone Gonu

0 0.5 1 2 Kilometres

N

16 Nov 2007

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

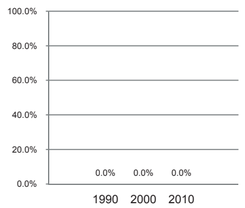
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

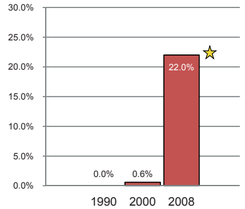
☆ Indicates Progress

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.

Land area covered by forest, percentage

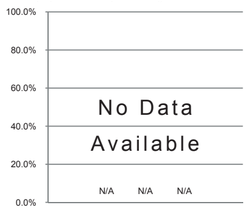


Protected area to total surface area, percentage

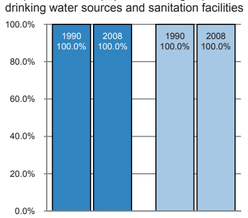


Source: Ministry of Environment 2008

Slum population as percentage of urban



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

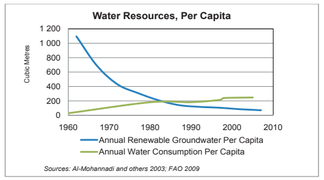


Qatar was the first country in the Arab region to breed the Arabian oryx (oryx leucoryx), Qatar's national animal, in captivity. The Arabian oryx was listed as endangered in 1996

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).

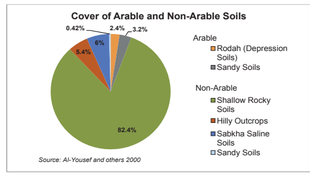


Photo: gazelle. Source: Arkivpicturesarchive.com

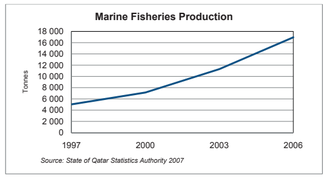
More than 4 in every 5 people in Qatar are immigrants; this amounts to 1 357 000 foreign nationals, which represents 80.5 per cent of the total population

Source: UNDP 2009

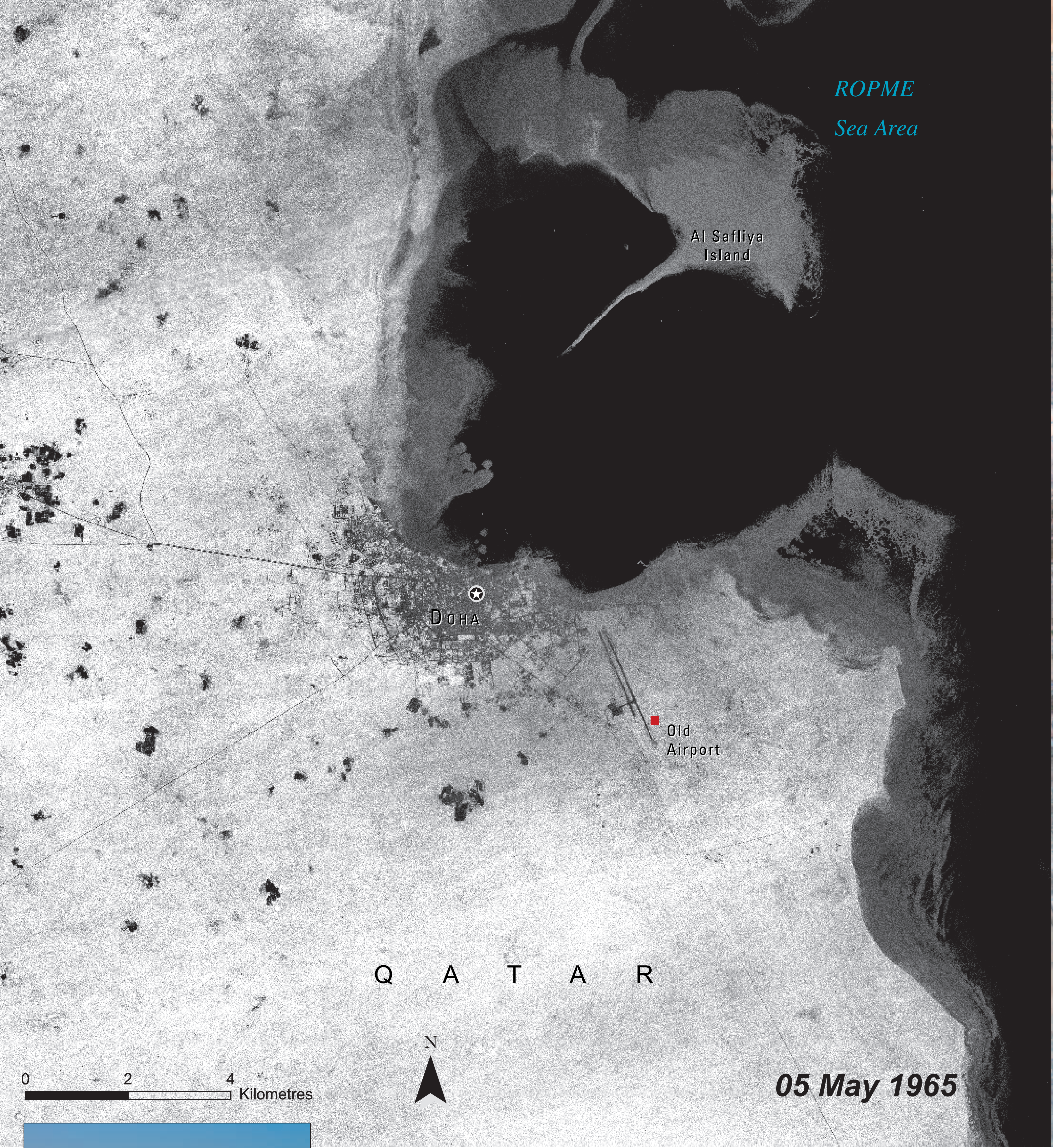
Photo: Qatar. Source: M. Lubinski Photo.com

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).



Al Reyam, Qatar. Source: Petroleum Museum



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.

Q A T A R

Al Aaliya Island

ROPME Sea Area

Onaiza

Al Safliya Island

0 1 2 Kilometres

N

06 Jun 1990

Lusail City

Q A T A R

Al Aaliya Island

ROPME Sea Area

West Bay Lagoon

The Pearl

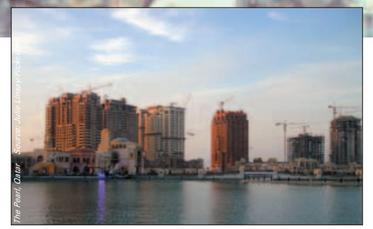
Onaiza

Al Safliya Island

0 1 2 Kilometres

N

02 Jun 2009

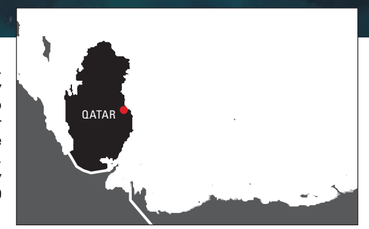


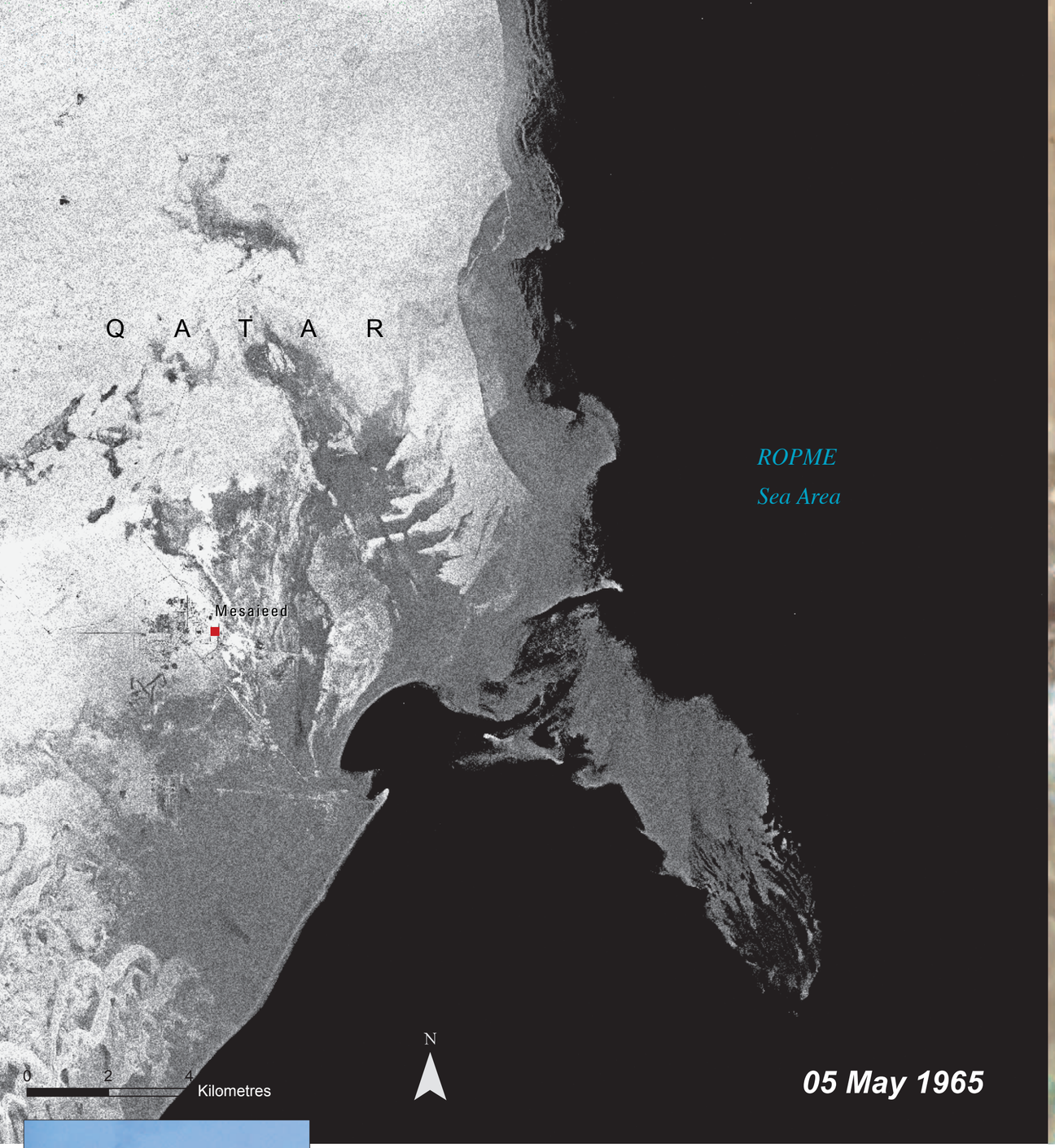
The Pearl, Qatar

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.

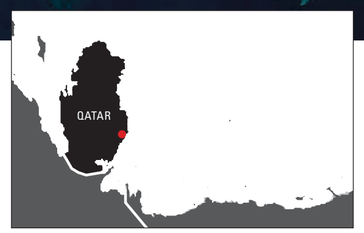




Mesaieed Industrial City, Qatar

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

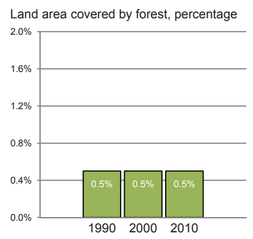
- Water Scarcity and Water Demand
- Desertification and Land Degradation
- Oil Contamination of Coastal Zones

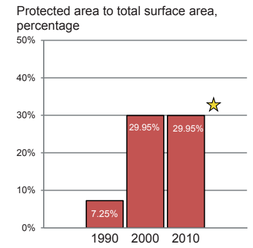
Progress Toward Environmental Sustainability

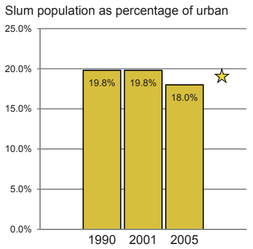
As defined by the United Nations Millennium Development Goal 7 Indicators

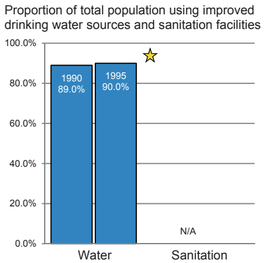
During the 1970s, the Kingdom began implementing five year plans for developing Saudi Arabia's infrastructure, health, education, social services, and industry. In line with the Kingdom's MDG commitments, the 2005-2009 development plan emphasized protection of the environment and conservation of natural 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







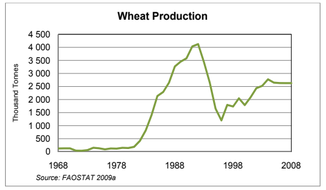


Saudi Arabia is the largest producer of desalinated water in the world: in 2004, the volume of water supplied by the country's 30 government-operated desalination plants reached 1.1 thousand million m³

Source: World Bank 2007

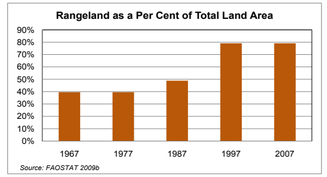
Water Scarcity and Water Demand

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 m³/year in 2010 to approximately 4 000 m³/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).



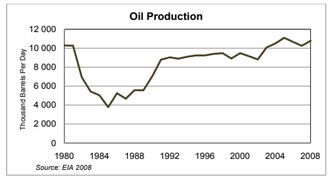

Riyadh, Saudi Arabia Source: Panoramio.com


Farm in Saudi Arabia Source: Al Jazirah Newspaper.com

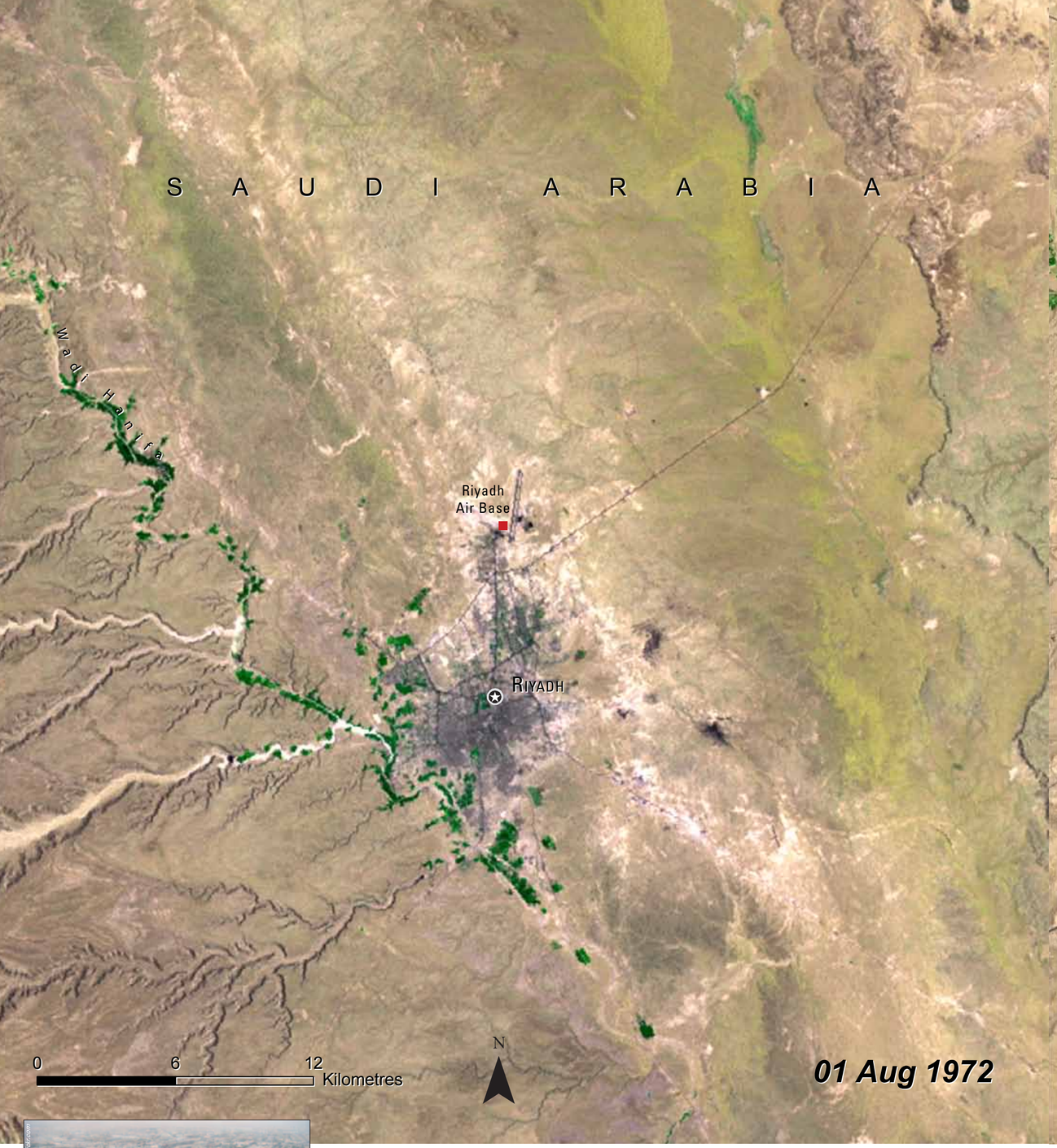
A 30-year programme initiated in the early 1970s to increase wheat production in Saudi Arabia is being phased out by the government due to scarce water supplies; by 2016, the Kingdom will rely entirely on wheat imports Source: UNEP

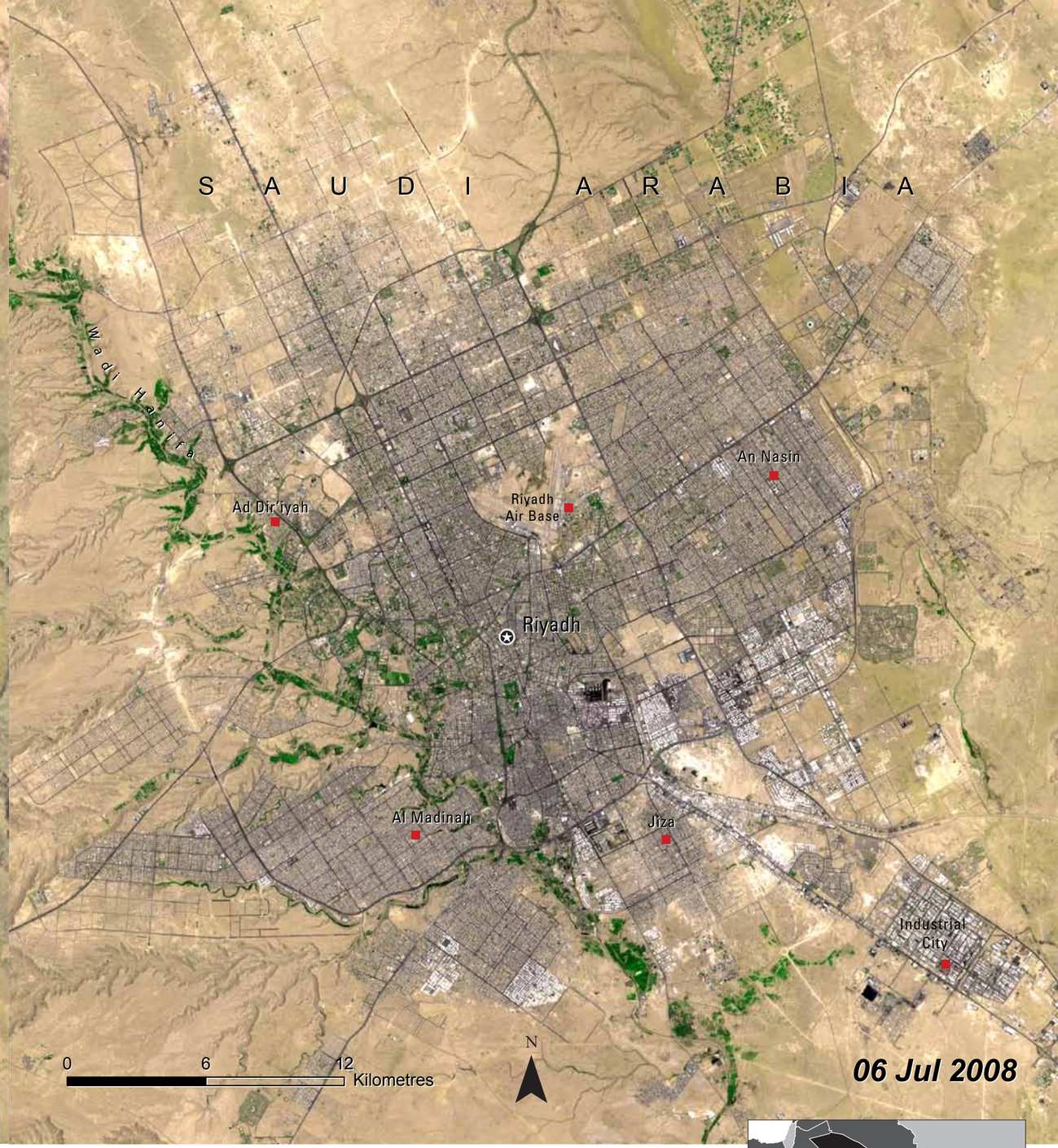
Oil Contamination of Coastal Zones

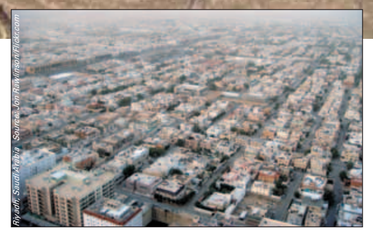
The Kingdom's long coastline and extensive marine resources are sensitive to environmental pressures from urban, industrial, agricultural, recreational and fishing activities, desalination plants, ports and oil drilling. Oil spills are a major threat to the Red Sea and the ROPME Sea Area. The ROPME Sea 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.




The Empowering of Saudi Arabia Source: PetroneedEgypt.com



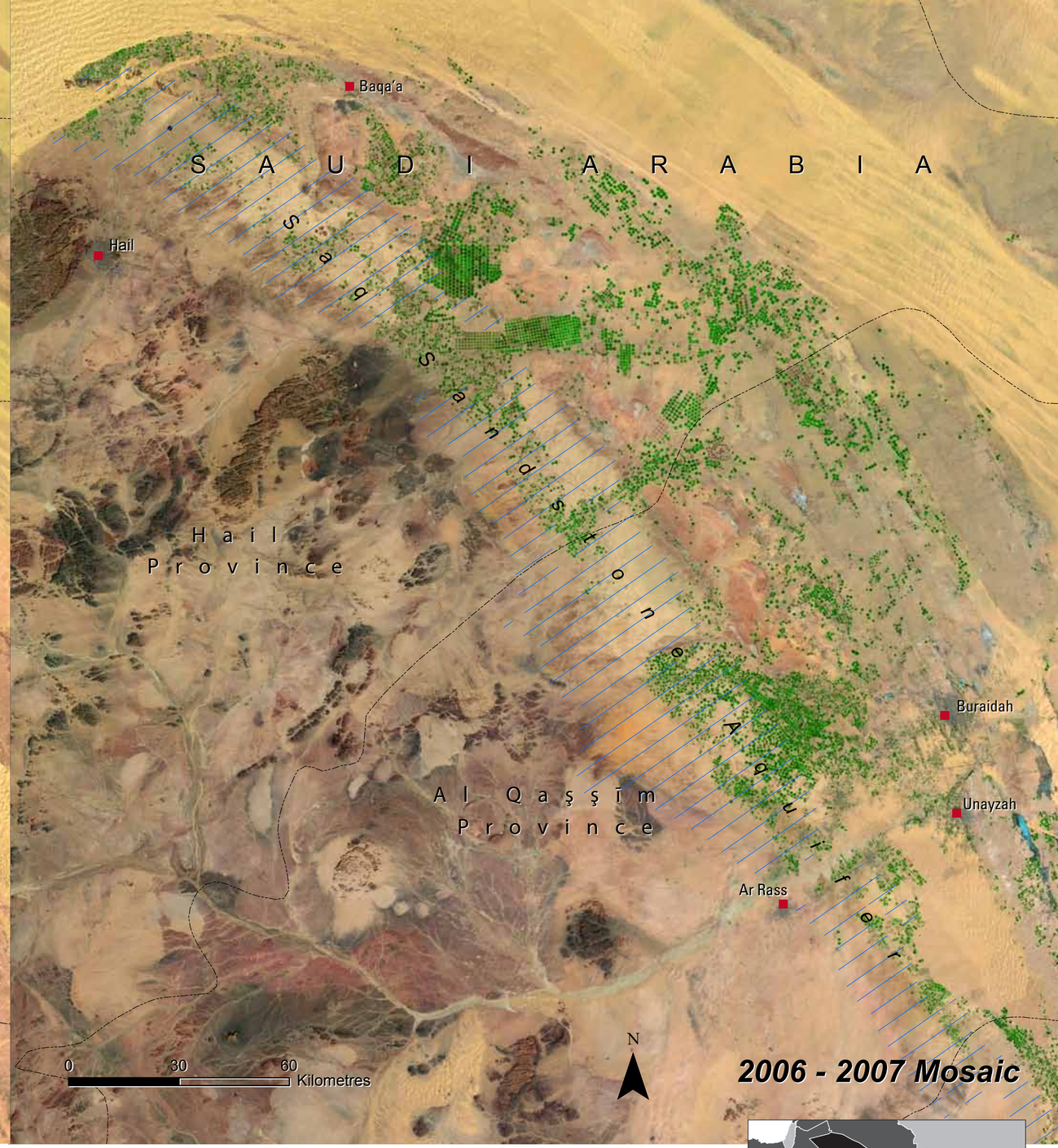




Riyadh, Saudi Arabia

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 City, Saudi Arabia. Source: NASA, Saudi Arabia

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.

Burial Mound, Saudi Arabia
Source: MoCST 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 km²
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

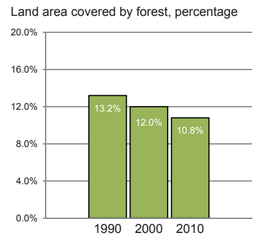
- Water Scarcity and Drought
- Desertification, Overgrazing and Deforestation
- Threats to Biodiversity

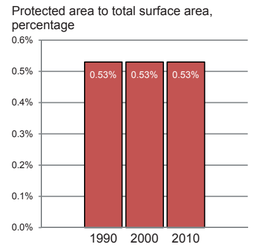
Progress Toward Environmental Sustainability

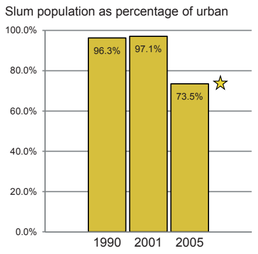
As defined by the United Nations Millennium Development Goal 7 Indicators

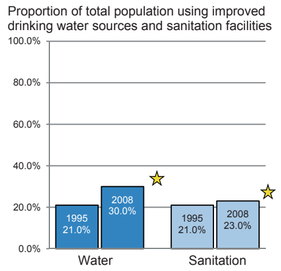
Somalia is plagued by civil war and grinding poverty. It is the site of the world's worst humanitarian crisis, with drought leading to the death of tens of thousands of Somalis, half of those children, over a period of only four months (UN 2011). 1.5 million Somalis are internally displaced, and over 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).

☆ Indicates Progress







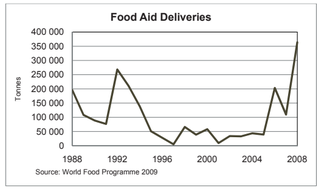


The area to the west of Mogadishu that lies between Somalia's two permanently flowing rivers (Jubba and Shabeelle) is the most fertile region in the country and home to remnant populations of hippopotamus (Hippopotamus amphibius)

Source: IUCN 2010

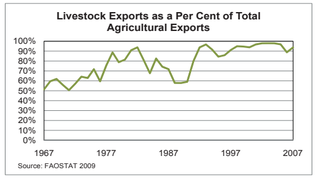
Water Scarcity and Drought

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.

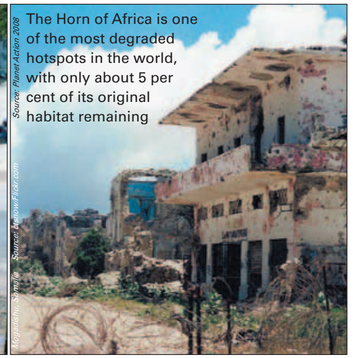


Desertification, Overgrazing and Deforestation

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).



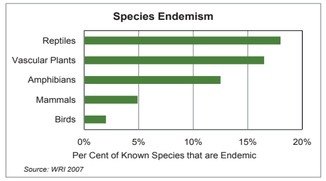

Source: Robert van der Sleen Flickr.com

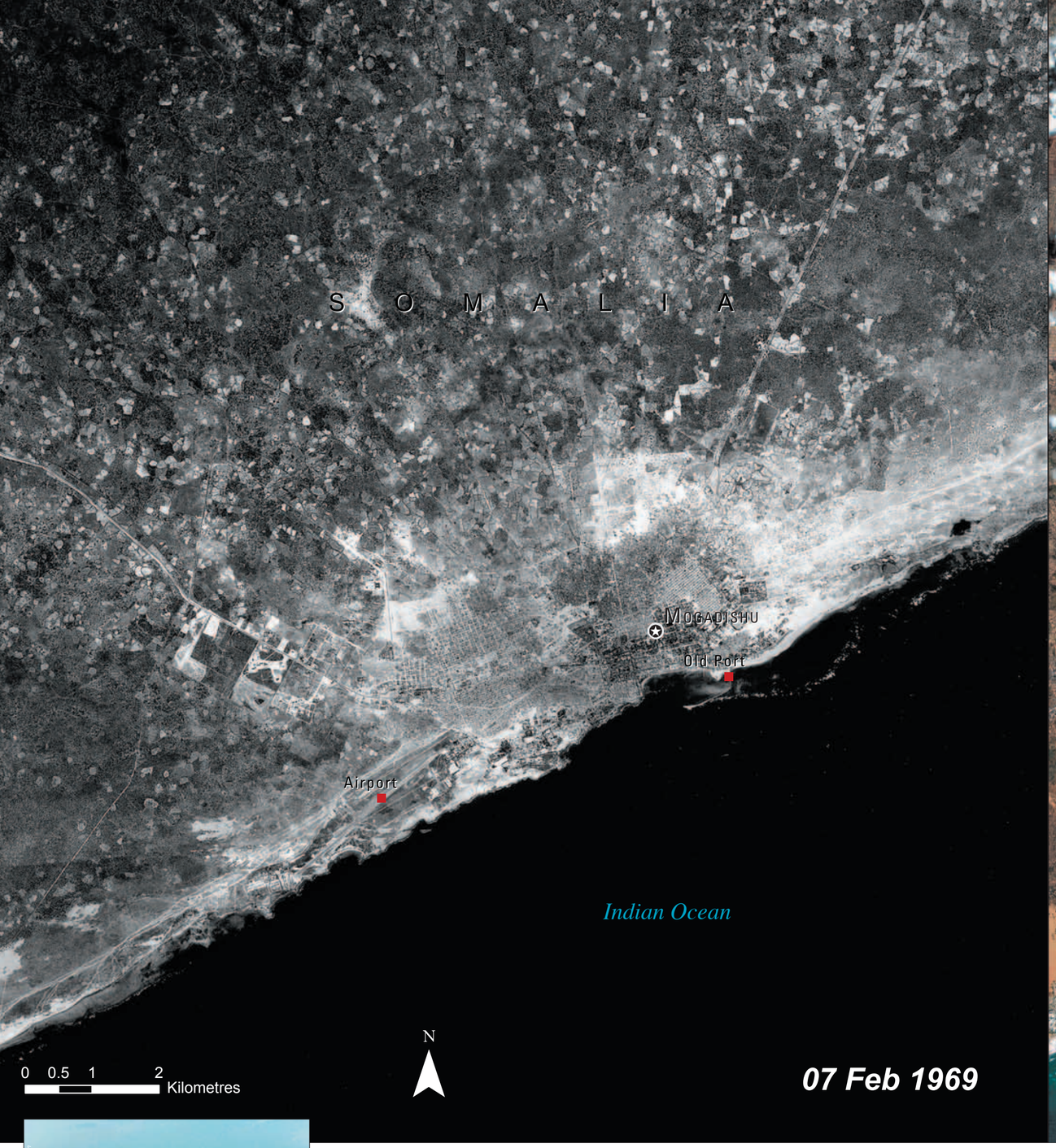

Source: Planet Action 2008

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

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).



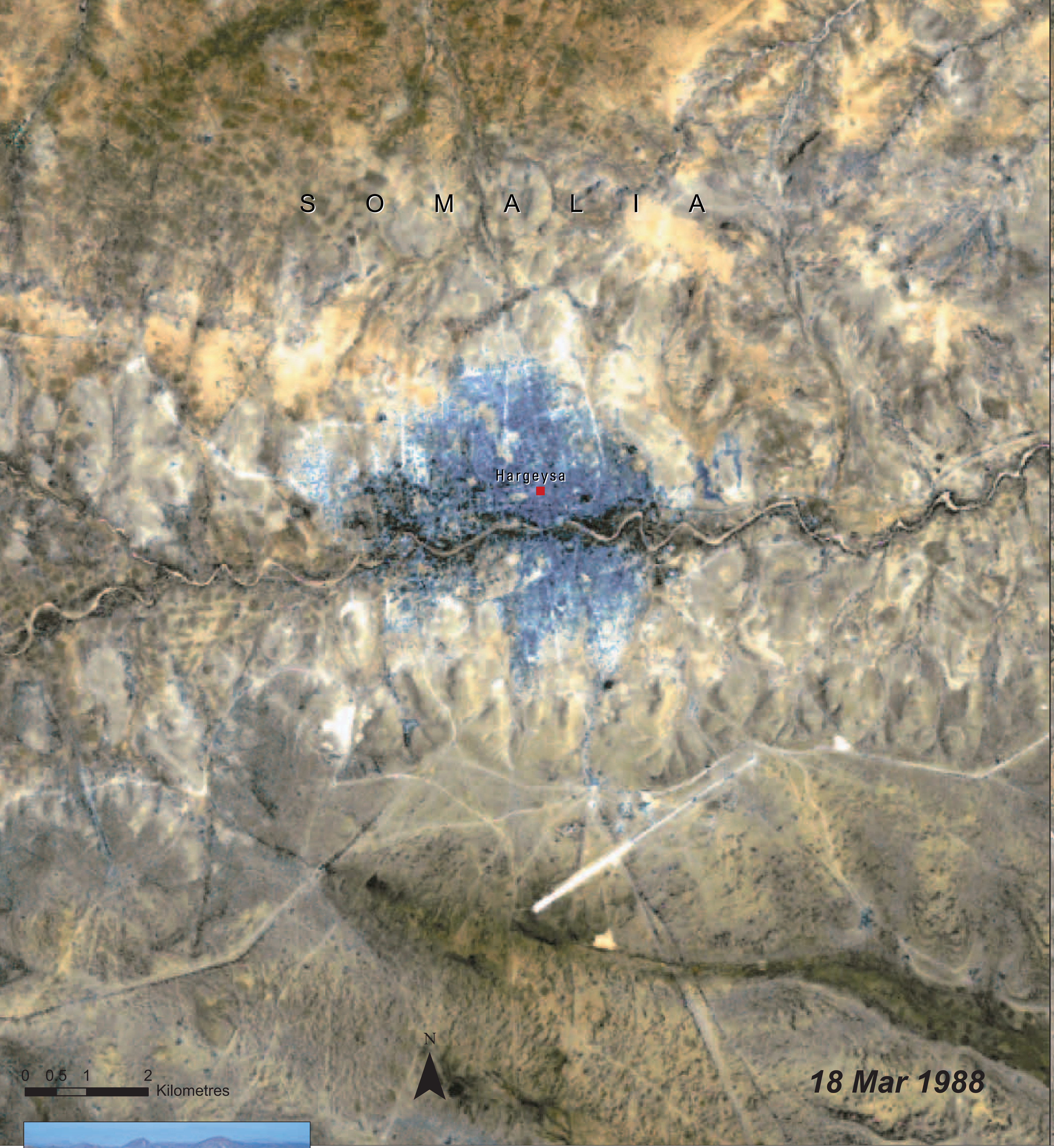


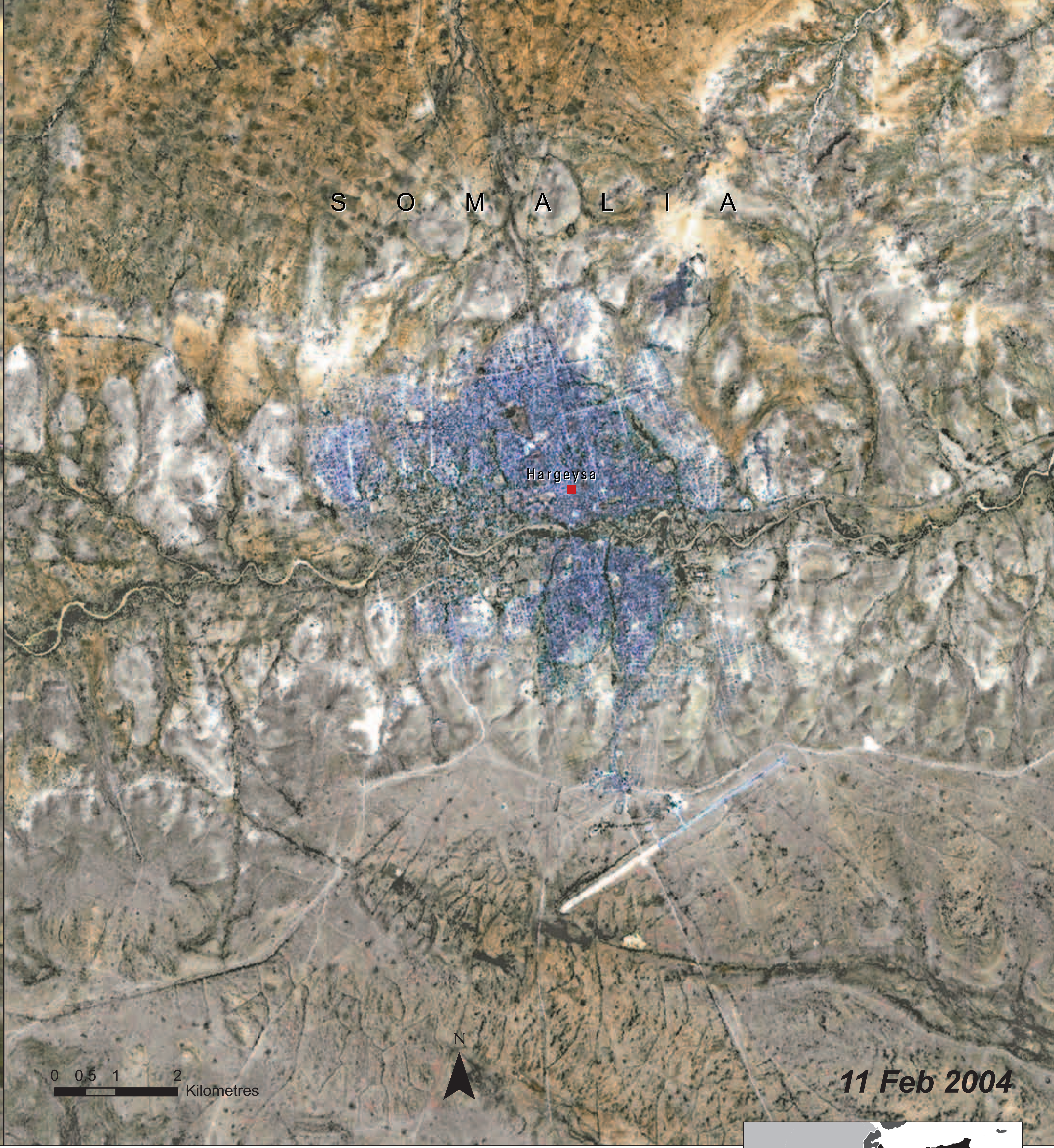

Mogadishu, Somalia (Somali: Xamar) (Wikipedia Commons)

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).

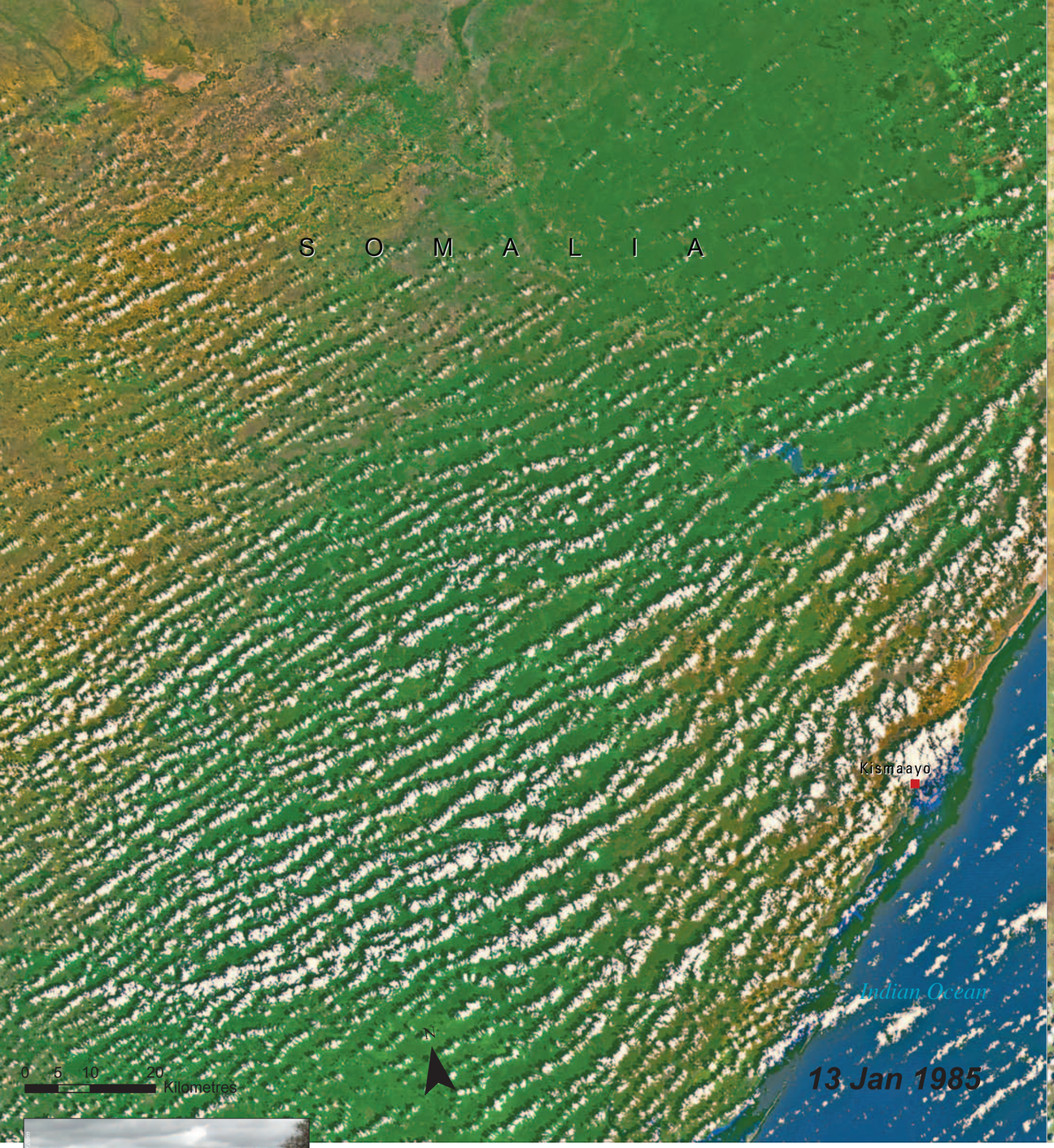


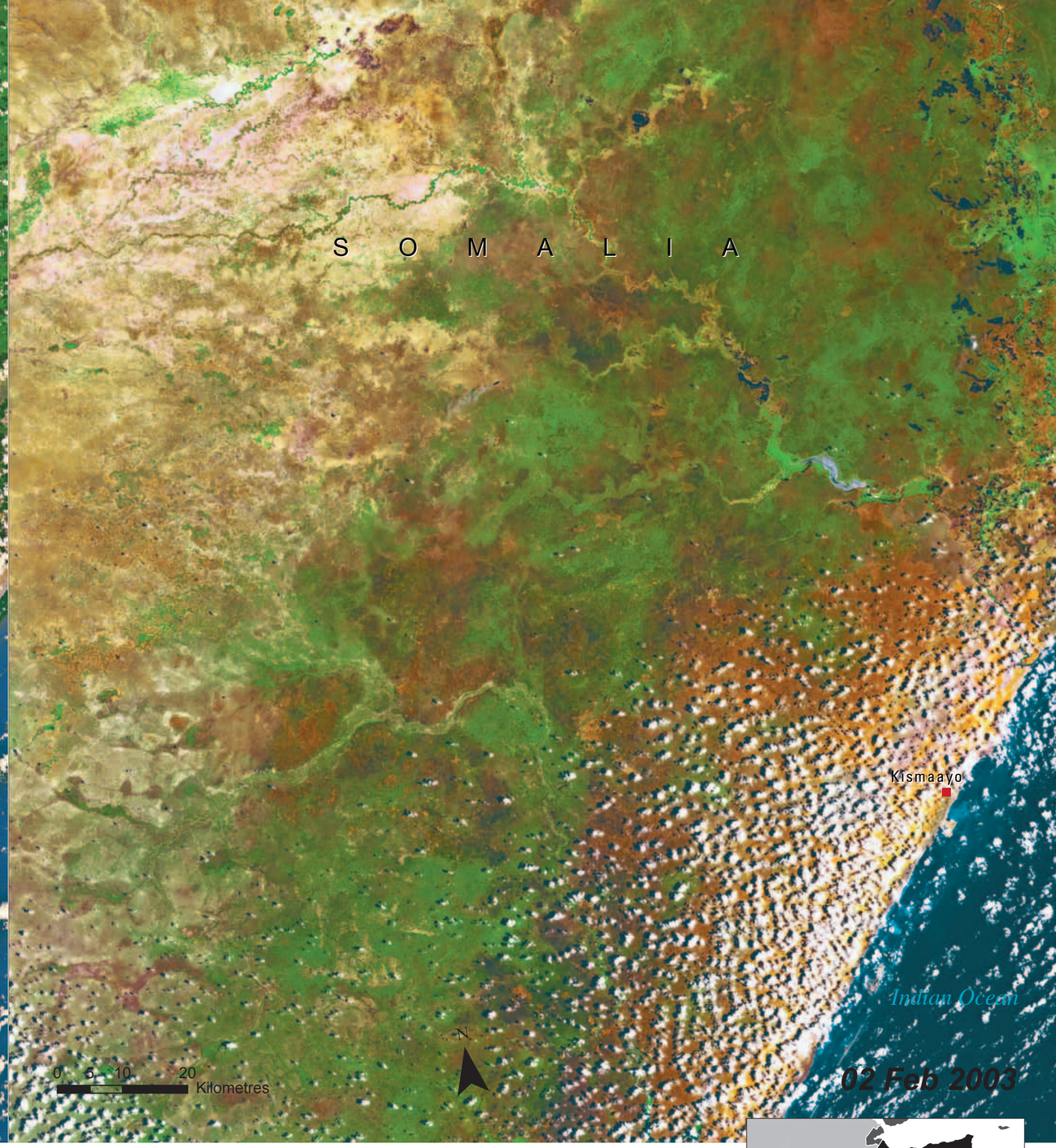


Hargeysa, Somalia

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.



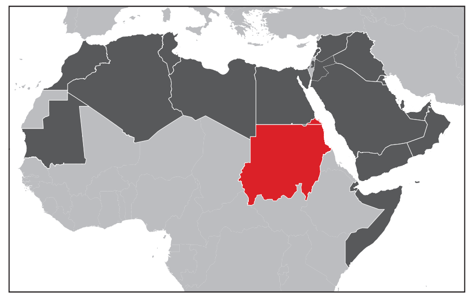


Southern Somalia Source: Yasso Ali

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

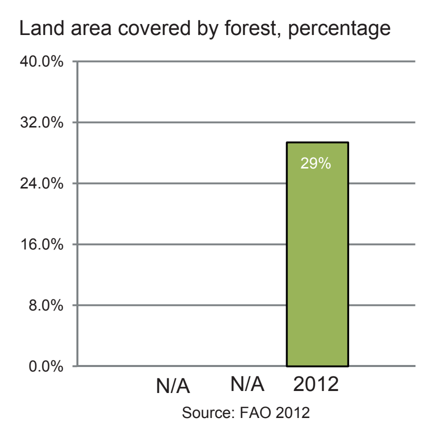
- Land Degradation and Soil Erosion
- Water Scarcity and Desertification
- Loss of Biodiversity

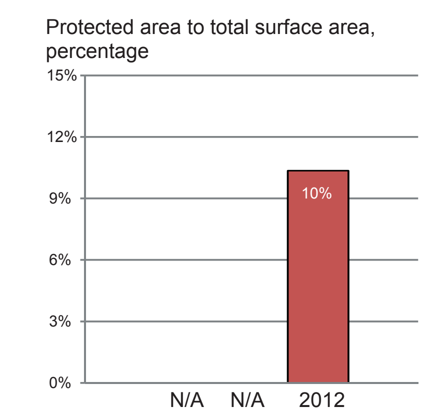
Progress Toward Environmental Sustainability

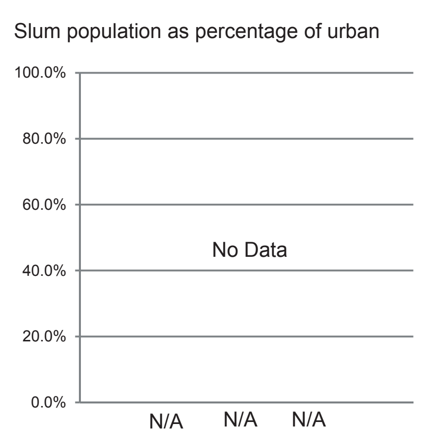
As defined by the United Nations Millennium Development Goal 7 Indicators

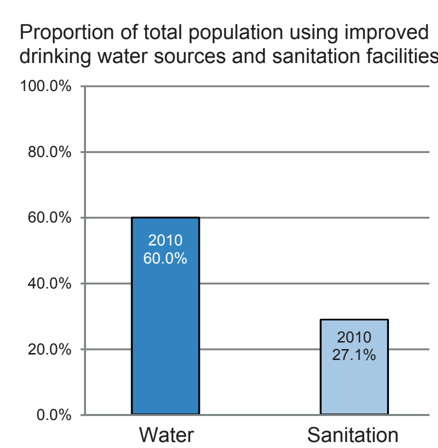
☆ Indicates Progress

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.







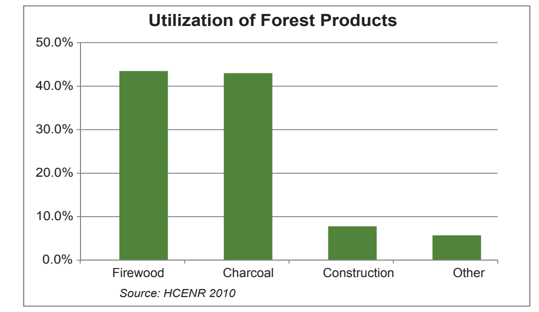


In recent years, major population migrations have occurred in response to conflict, climate change and desertification. Sudan has over four million Internally Displaced Persons.

Source: UNFPA 2012

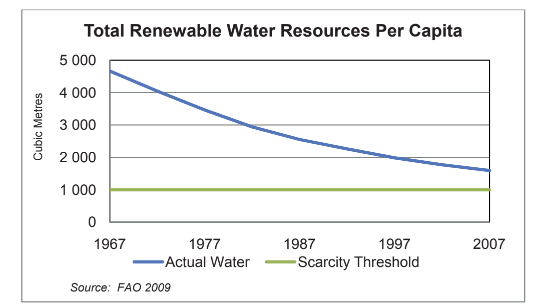
Land Degradation and Soil Erosion

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 decades; this and grazing pressure are leading to significant soil erosion throughout the county.



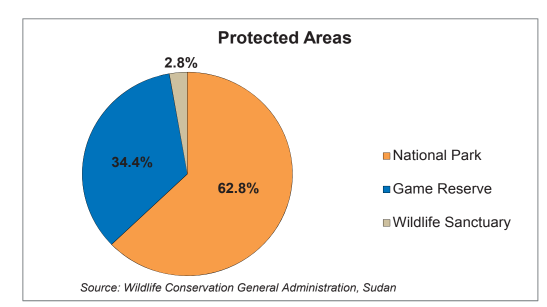
Water Scarcity and Desertification

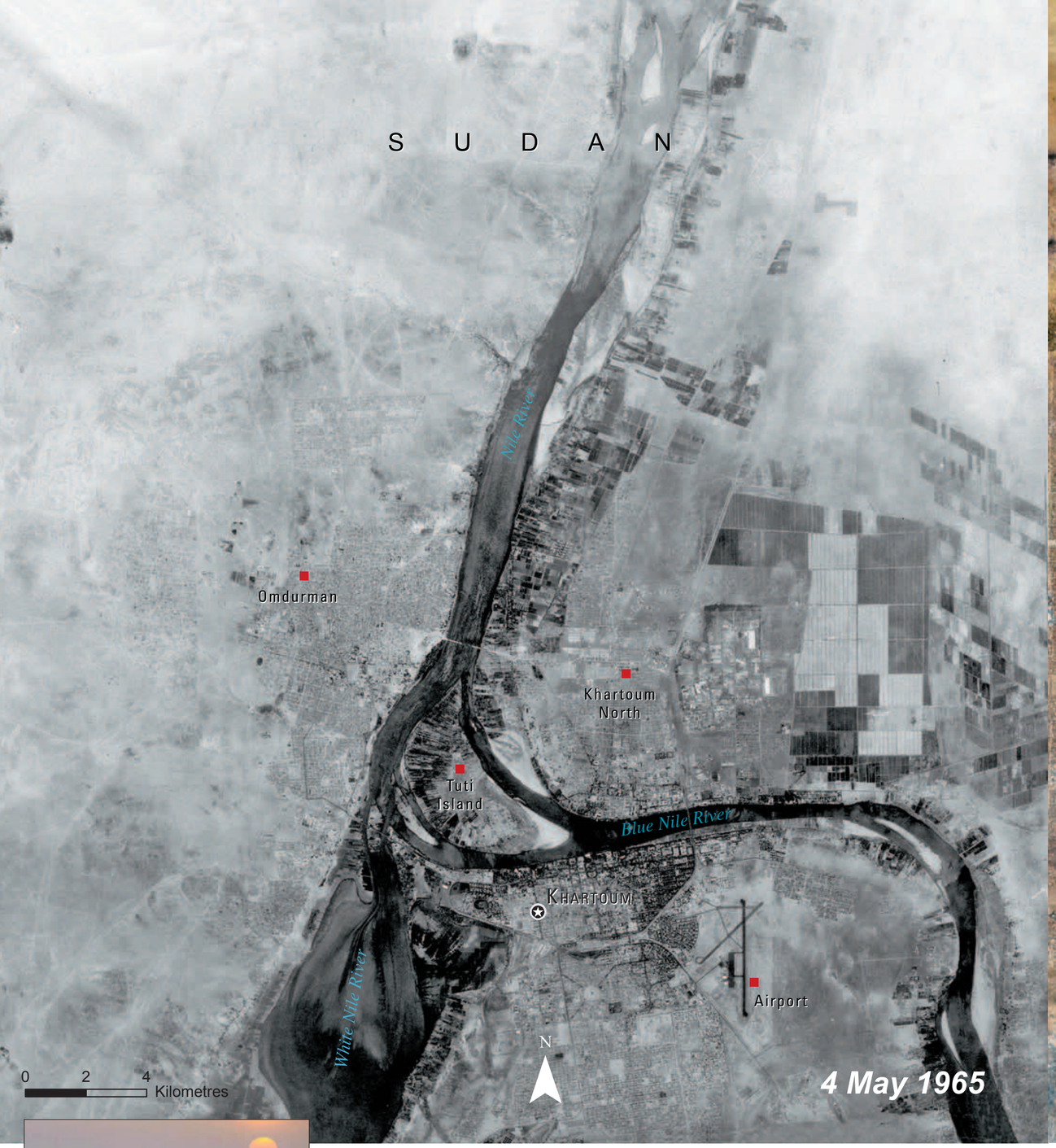
Sudan's water resources derive almost exclusively from the Nile River system, followed by groundwater and rainwater resources (Ahmed 2007; UNEP 2007). Sudan is primarily desert and semi-desert; the Sahara Desert spans the northern part of the country where temperatures can reach up to 52°C with rainfall 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).

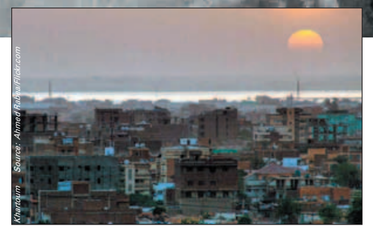


Loss of Biodiversity

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 conservation measures. Wildlife authorities report consistent problems with protected area management, ranging from poaching to livestock encroachment and land degradation(Suad Badri-USAID 2012).






Khartoum - Source: Ahmed Rushdi/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 km^2 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.

S U D A N

Rabak

Kosti

White Nile River

0 5 10
Kilometres

N

20 OCT and 6 NOV 1972

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

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

S U D A N

Asalaya Sugar Plantation

Rabak

Kosti

White Nile River

Kanana Sugar Plantation

Inset: Kenana Sugar Plantation Fields

0 5 10
Kilometres

N

28 SEPT 2009

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 km²

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

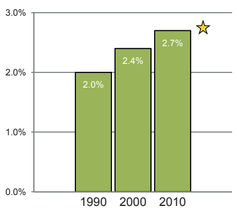
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

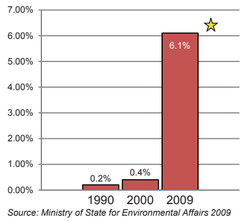
Although Syria has lost much of its forest cover, in recent times that trend has been reversed. Between 1995 and 2005, Syria regained 21.2 per cent of its forest cover, or around 105 000 ha (MAAR 2006). Syria is home to an increasing population that features one of the largest growth rates in the world (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

Land area covered by forest, percentage

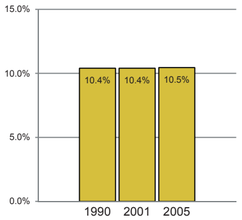


Protected area to total surface area, percentage

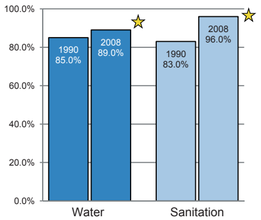


Source: Ministry of State for Environmental Affairs 2009

Slum population as percentage of urban



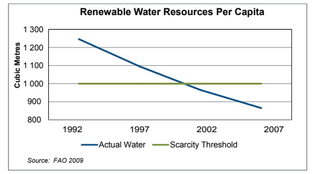
Proportion of total population using improved drinking water sources and sanitation facilities



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

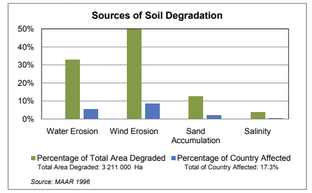
Water Scarcity and Water Quality

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.



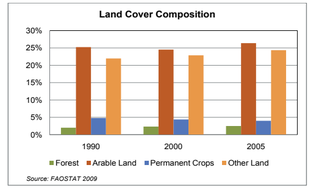
Land Degradation and Desertification

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).

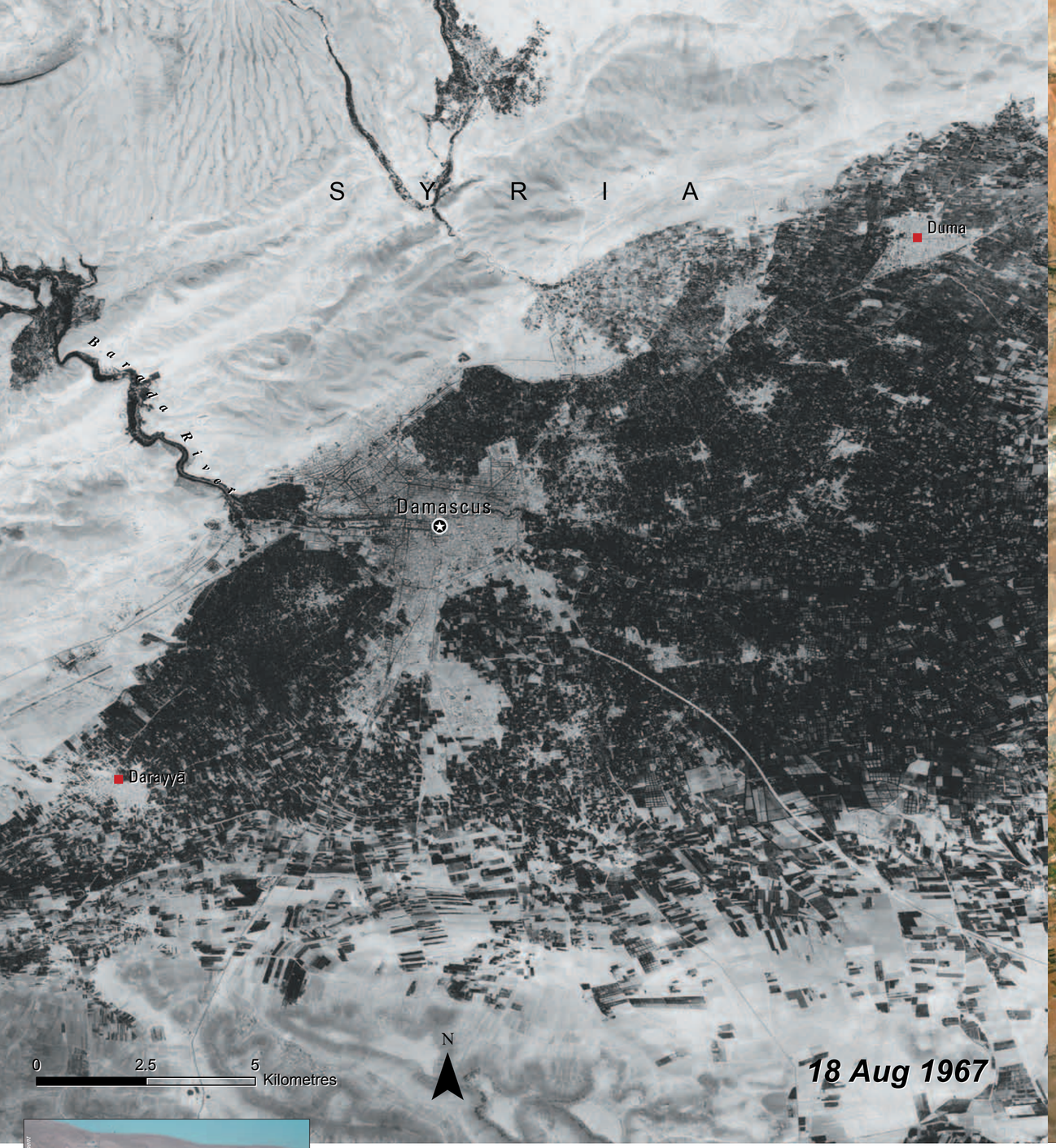


Deforestation

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).




Source: Charles Fred Flickr.com



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.

Mediterranean Sea

S Y R I A

0 1 2 Kilometres

N

26 Sep 1967

Mediterranean Sea

S Y R I A

Orontes River

0 1 2 Kilometres

N

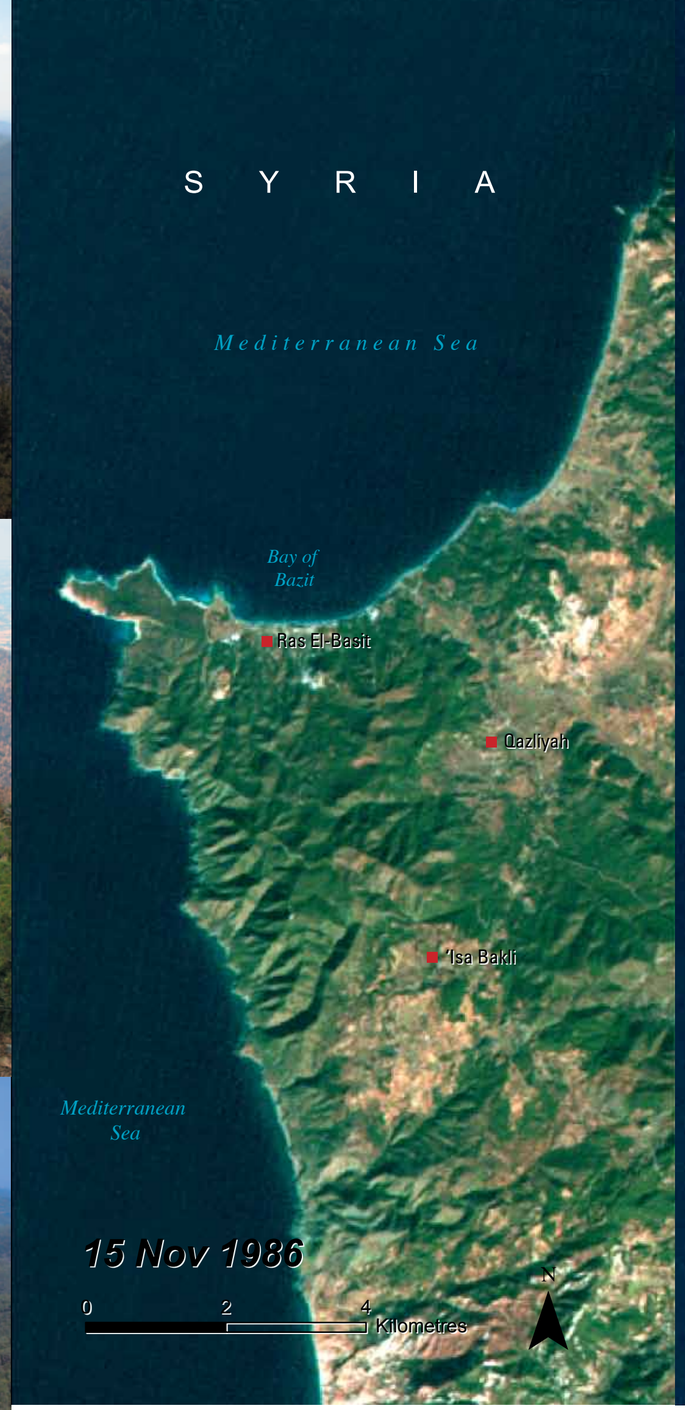
03 Feb 2008

Greenhouses along the Tartus coast, 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).

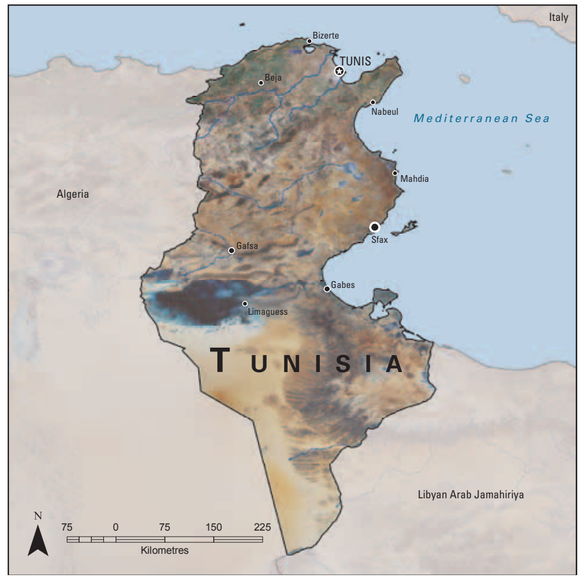
More recently, in Latakia, high unemployment, inflation and drought have attracted farmers to the more lucrative charcoal industry, causing abandonment of farmlands and the harvesting of oak trees to produce the charcoal (Asia Times 2009). Fires also lead to the degradation of forests in this region—about 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 km²

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

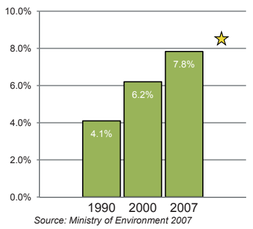
Progress Toward Environmental Sustainability

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.

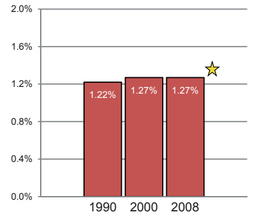
☆ Indicates Progress

Land area covered by forest, percentage

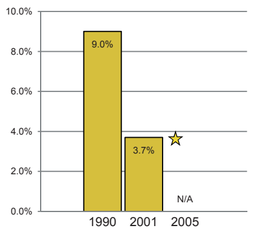


Source: Ministry of Environment 2007

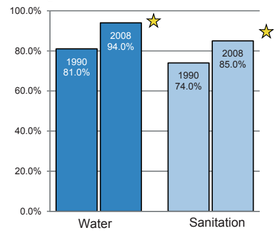
Protected area to total surface area, percentage



Slum population as percentage of urban



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



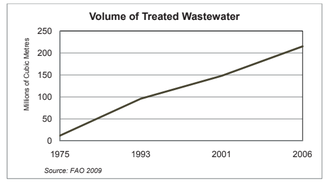
The scimitar-horned oryx (Oryx dammah), listed as extinct in the wild, was reintroduced in Tunisia's Dghoumes National Park in 2007

Source: Gilbert and Woodfine 2008

Water Scarcity

Tunisia is severely water-scarce with only 458 m^3 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/m^3) 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 of Tunisia's total water resources (GHEF 2008); 29 per cent of treated wastewater is re-used for irrigation of agricultural lands.

Volume of Treated Wastewater

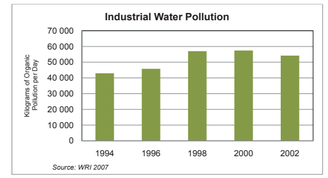


Source: FAO 2009

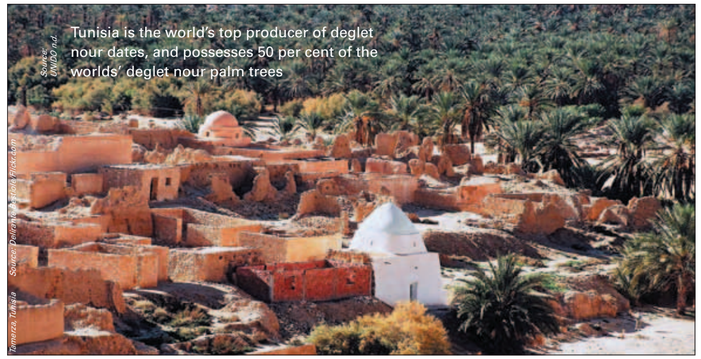
Air and Water Pollution

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 CO_2 and lead emissions. 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.

Industrial Water Pollution



Source: WRI 2007



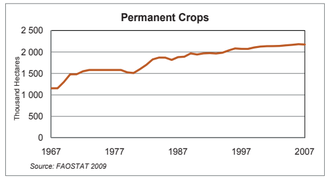
Tunisia is the world's top producer of deglet nour dates, and possesses 50 per cent of the worlds' deglet nour palm trees

Tamerza, Tunisia Source: David Stanley 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).

Permanent Crops



Source: FAOSTAT 2009

Souss, Tunisia Source: Flickr.com

Mediterranean Sea
TUNISIA
Sebkhet Ariana
La Marsa
Carthage
Ariana
Airport
La Goulette
TUNIS
Tunis Lake
Gulf of Tunis
Maqrin
Sebkhet el Sedjoumi
Parc Urbain El Mourouj
Ben Arous
Ez Zahra
Henchir El Yahoudia
El Mourouj
N
0 2 4 Kilometres
31 May 1972
16 Dec 2007 & 29 Jan 2008


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. Source: Sue Wah Cheng/Flickr.com

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.

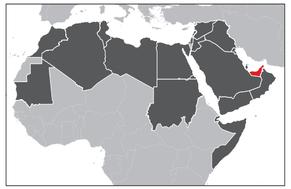
To improve the overall environment and revive the city, the Taparura Project was initiated in 2006. In addition to decontaminating and rehabilitating the former landfill site, the project aims to transform the northern coast of Sfax into a thriving urban area and reintegrate Sfax with its coastline through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

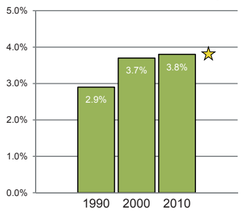
Progress Toward Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

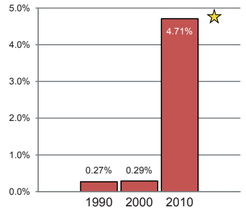
The discovery of oil and gas in the 1950s in the UAE rapidly transformed the country into a booming economy, providing income for infrastructure development and expansion of social services. With a gross national income of US$55 028 per capita in 2008, the UAE ranks as "high income" among industrialized 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

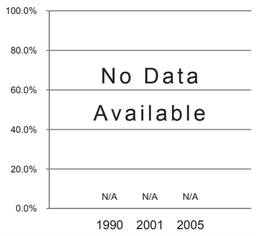
Land area covered by forest, percentage



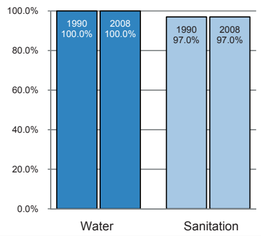
Protected area to total surface area, percentage



Slum population as percentage of urban



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

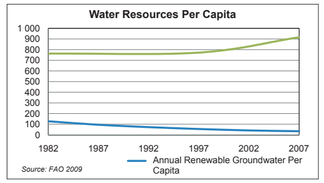


With a capacity of 9 000 000 m³/day the UAE is the second largest producer of desalinated water after Saudi Arabia - by 2015, the UAE's desalination capacity is expected to increase to over 11 000 000 m³/day

Source: UN 2009

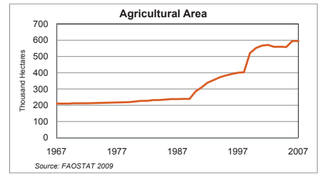
Water Demand and Water Scarcity

The UAE is below the international water scarcity threshold with only 916 m³ 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 m³ (UNU 1997). Advances in the standard of living, rapid economic growth and increases in population contribute to high water use.

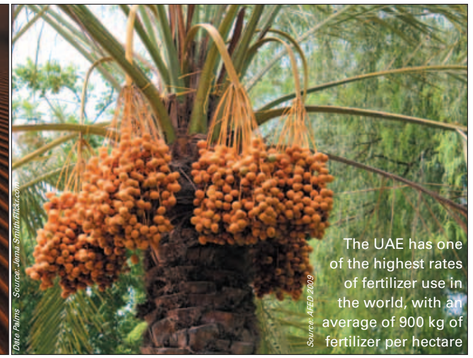


Land Degradation and Desertification

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.




Lime Dome, Abu Dhabi Source: Z.Hill

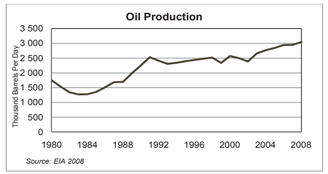

Date Palms Source: Anna Shvets/Pexels

The UAE has one of the highest rates of fertilizer use in the world, with an average of 900 kg of fertilizer per hectare

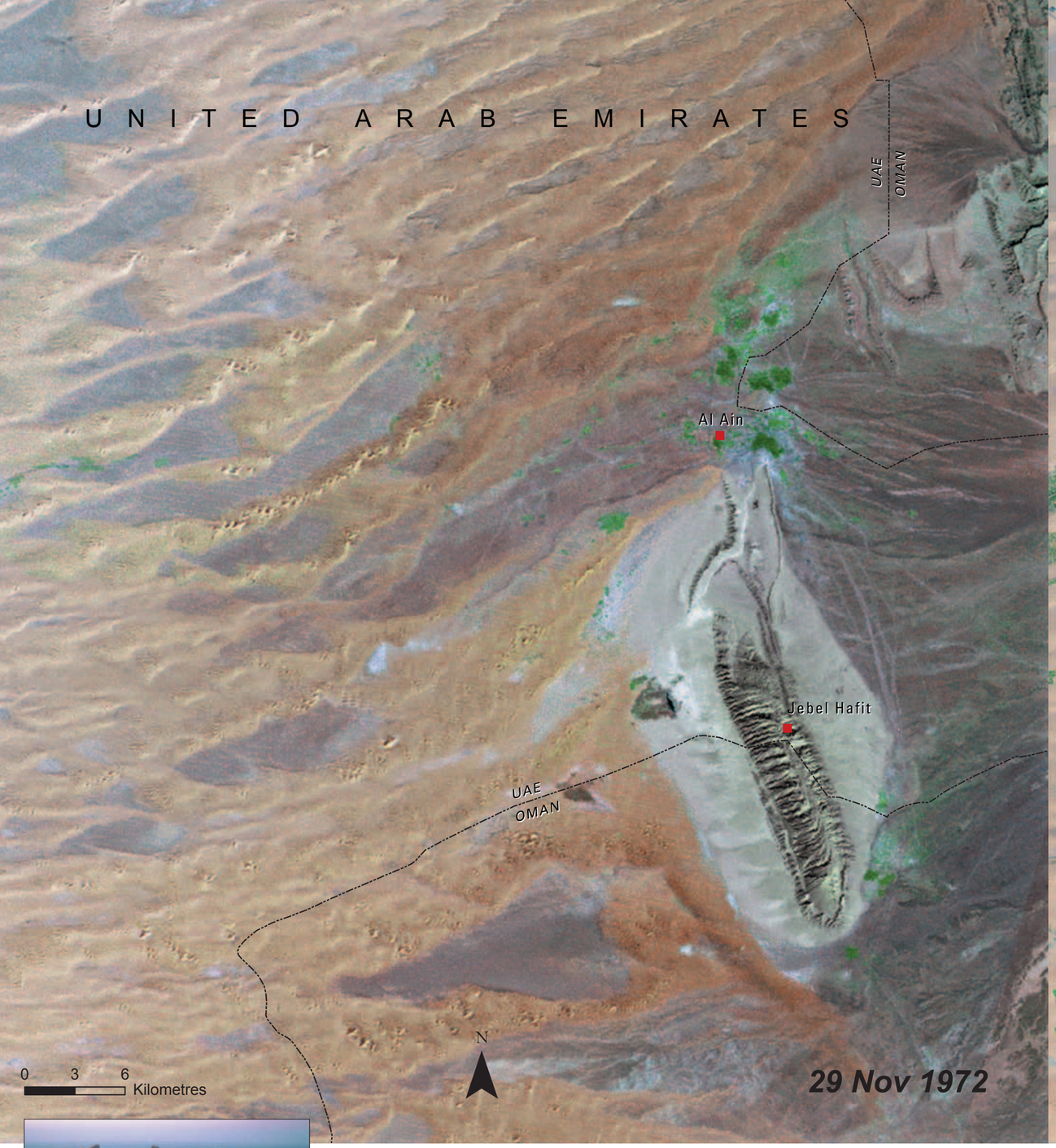
Source: AgroDesign

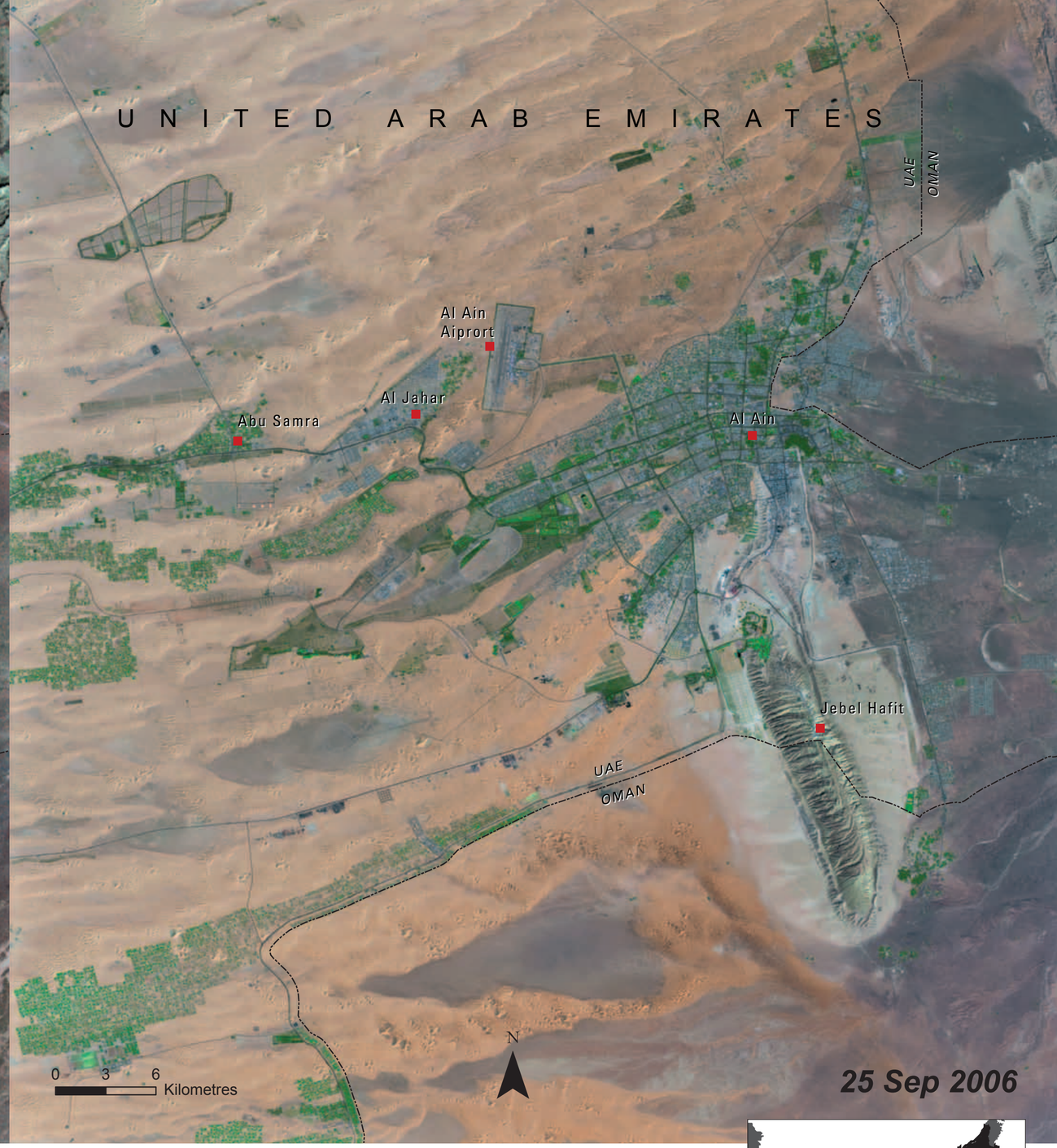
Threats to Marine and Coastal Ecosystems

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: 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: British Federation

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.

UNITED ARAB EMIRATES

LIWA DUNES

0 5 10 Kilometres

N

30 Nov 1972

UNITED ARAB EMIRATES

Inset Image: Mouzaira'a Area, Liwa

Mouzaira'a

Shah

Khannur

Inset Area

LIWA DUNES

0 5 10 Kilometres

N

06 Jun 2006

Liwa Dunes, UAE. Source: EAD

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 km²
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

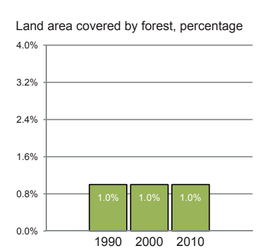
- Water Scarcity and Water Quality
- Population and Pressure on Land
- Soil, Water and Wind Erosion

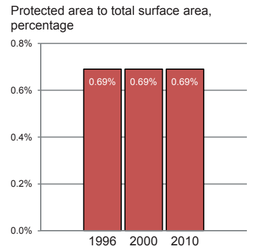
Progress Toward Environmental Sustainability

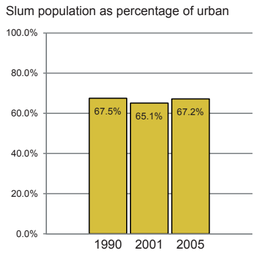
As defined by the United Nations Millennium Development Goal 7 Indicators

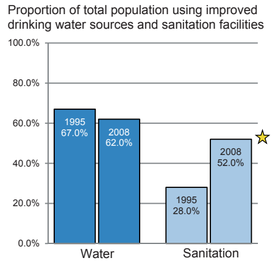
As one of the poorest countries in the Arab region, Yemen is struggling with many social and environmental issues. Yemen suffers from a lack of adequate drinking water and wastewater disposal systems for its urban and rural populations - 40 per cent of urban households are not linked to water mains and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

☆ Indicates Progress







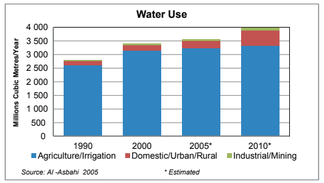


Socotra Island, home of the famous dragon's blood tree, is considered the "jewel" of biodiversity in the region with 900 plant species, 27 reptile species, and 190 different birds, many of which are endemic

Source: Socotra Conservation and Development Programme n.d.

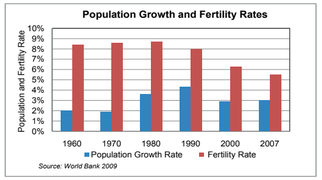
Water Scarcity and Water Quality

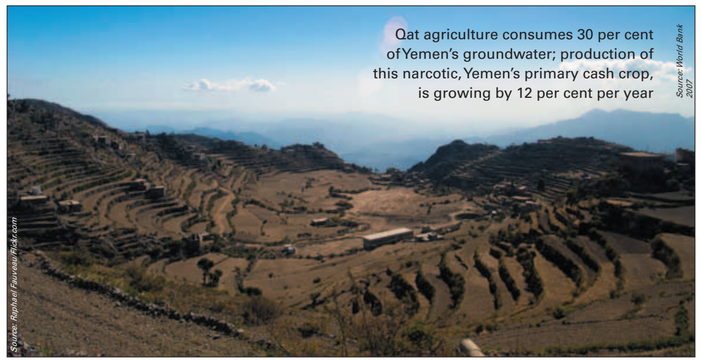
Yemen is considered one of the most water scarce regions in the world and suffers from grave water shortages. The country's water supply relies on limited groundwater, which has been heavily overexploited and polluted over the past 20 years (GTZ 2007). Renewable fresh water is very scarce; with an annual recharge of 2 100 million m³, the availability of water per capita is 130 m³/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

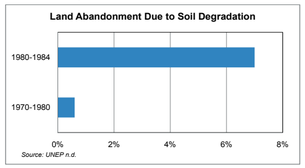
One of the major problems facing Yemen is the environmental degradation associated with population growth. In 1975, Yemen's population was only 7 million; in 2007 it was over 22 million and is expected to reach 43 million by 2035. Yemen has one of the highest fertility rates in the world with 5.5 births 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.





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

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.

Wadi Hadramawt Flooding. Source: Yemen Air Force

Wadi Hadramawt Flooding. Source: Yemen Air Force

SAUDI ARABIA

OMAN

Wadi Hadramawt

YEMEN

TROPICAL
CYCLONE 3B

Gulf of
Aden

Indian Ocean

SOMALIA

N

24 Oct 2008

Y E M E N

al-Jawl

Saywun

Shibam

Hawra

Hadramawt

0 50 100 Kilometres

N

16 Oct 2008

Y E M E N

al-Jawl

Saywun

Shibam

Hawra

Hadramawt

0 50 100 Kilometres

N

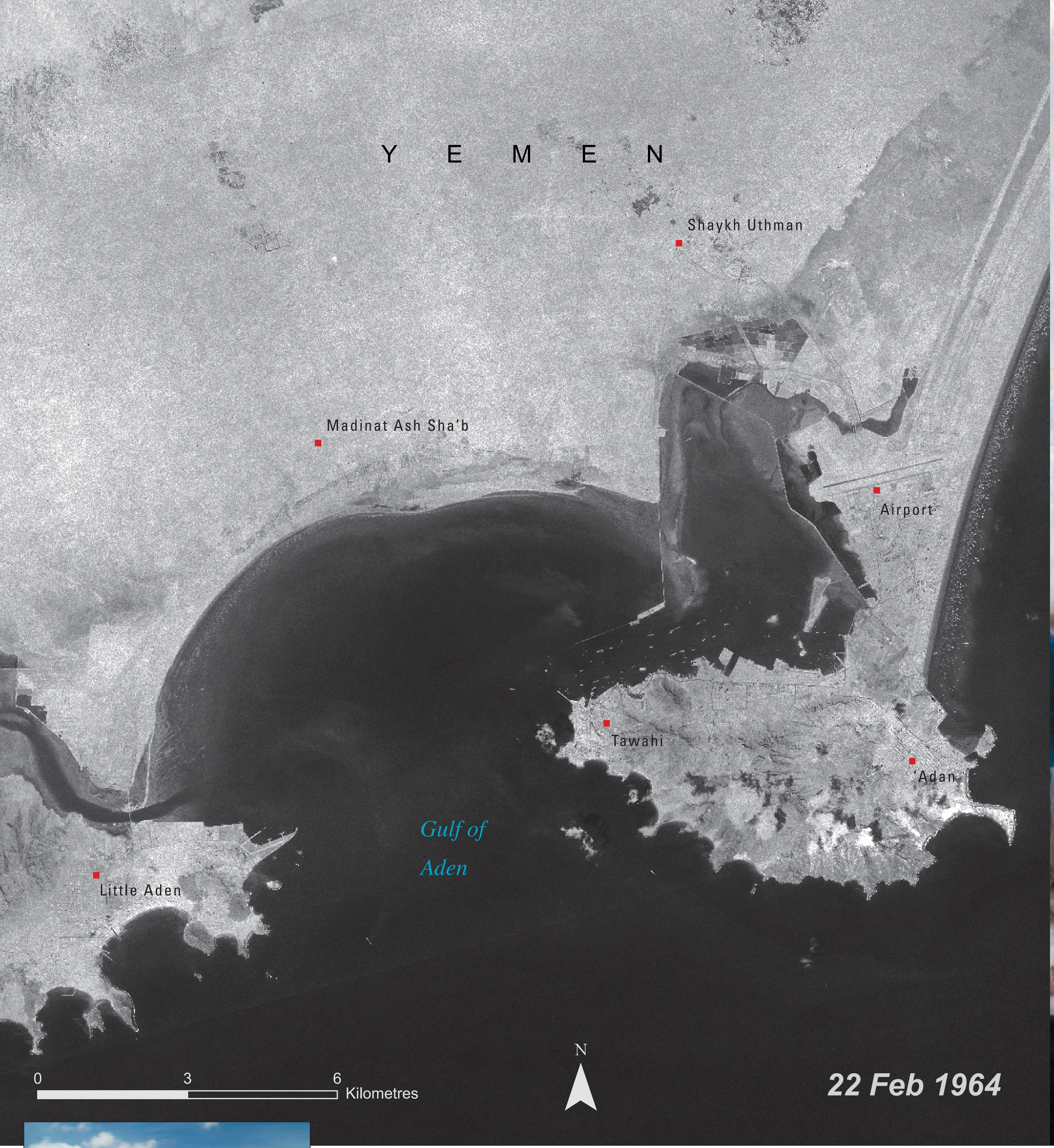
30 Oct 2008

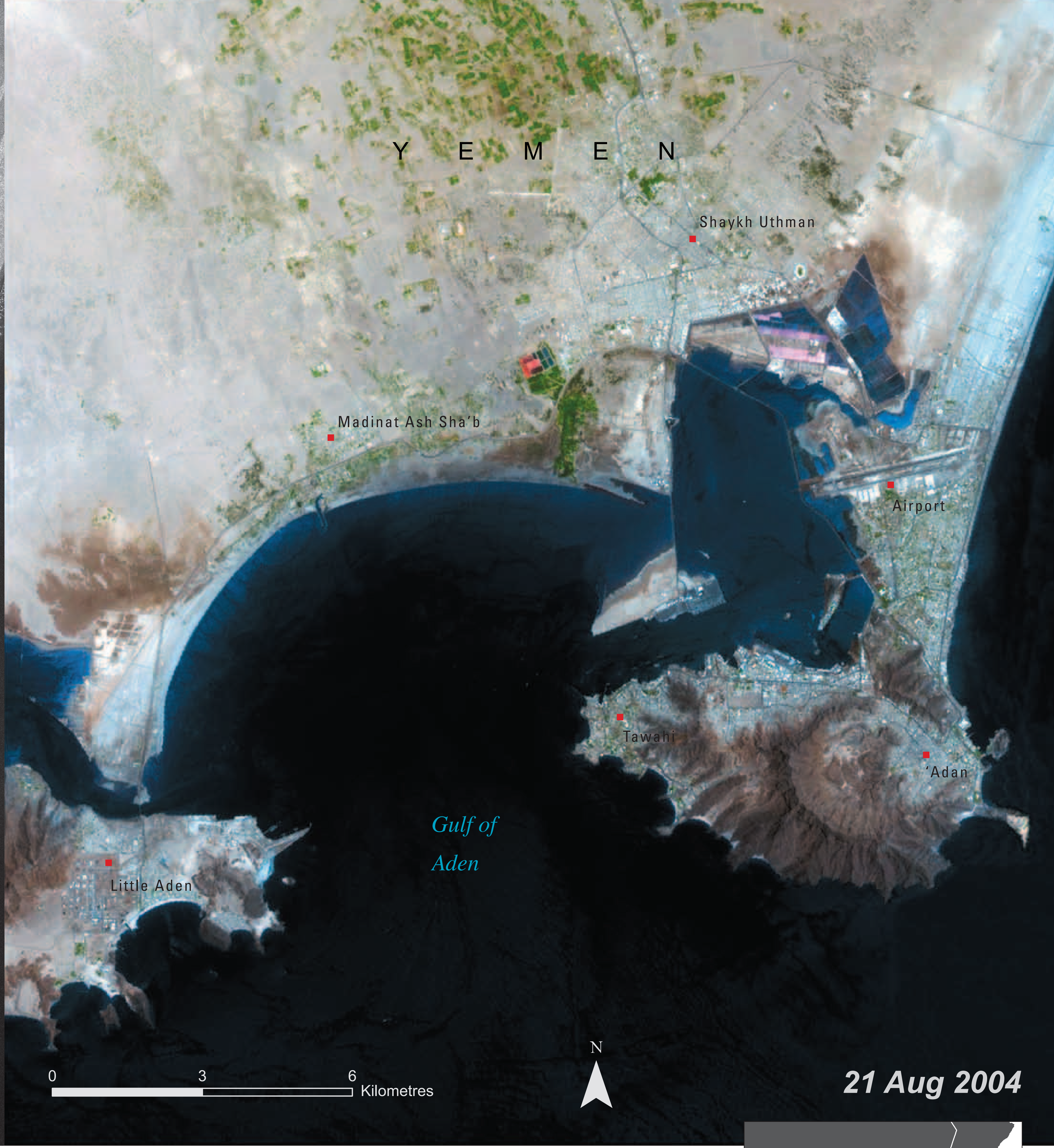
Wadi Hadramawt Flooding. Source: Yemen Air Force

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.





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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