



Source: Dennis Stauffer/Flickr.com

Sand Dunes, Algerian Sahara

# CHAPTER 1

## THE ARAB REGION

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

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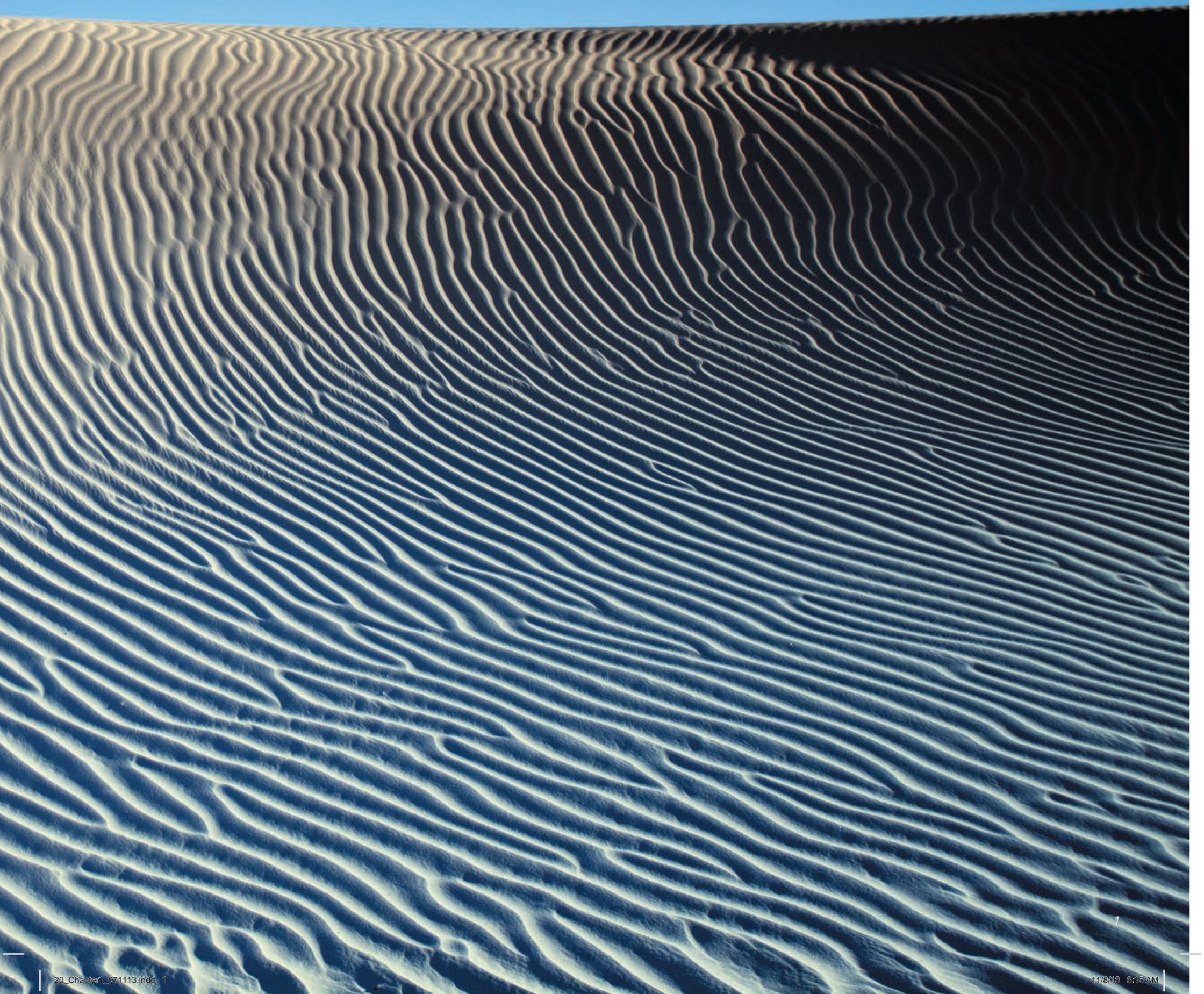
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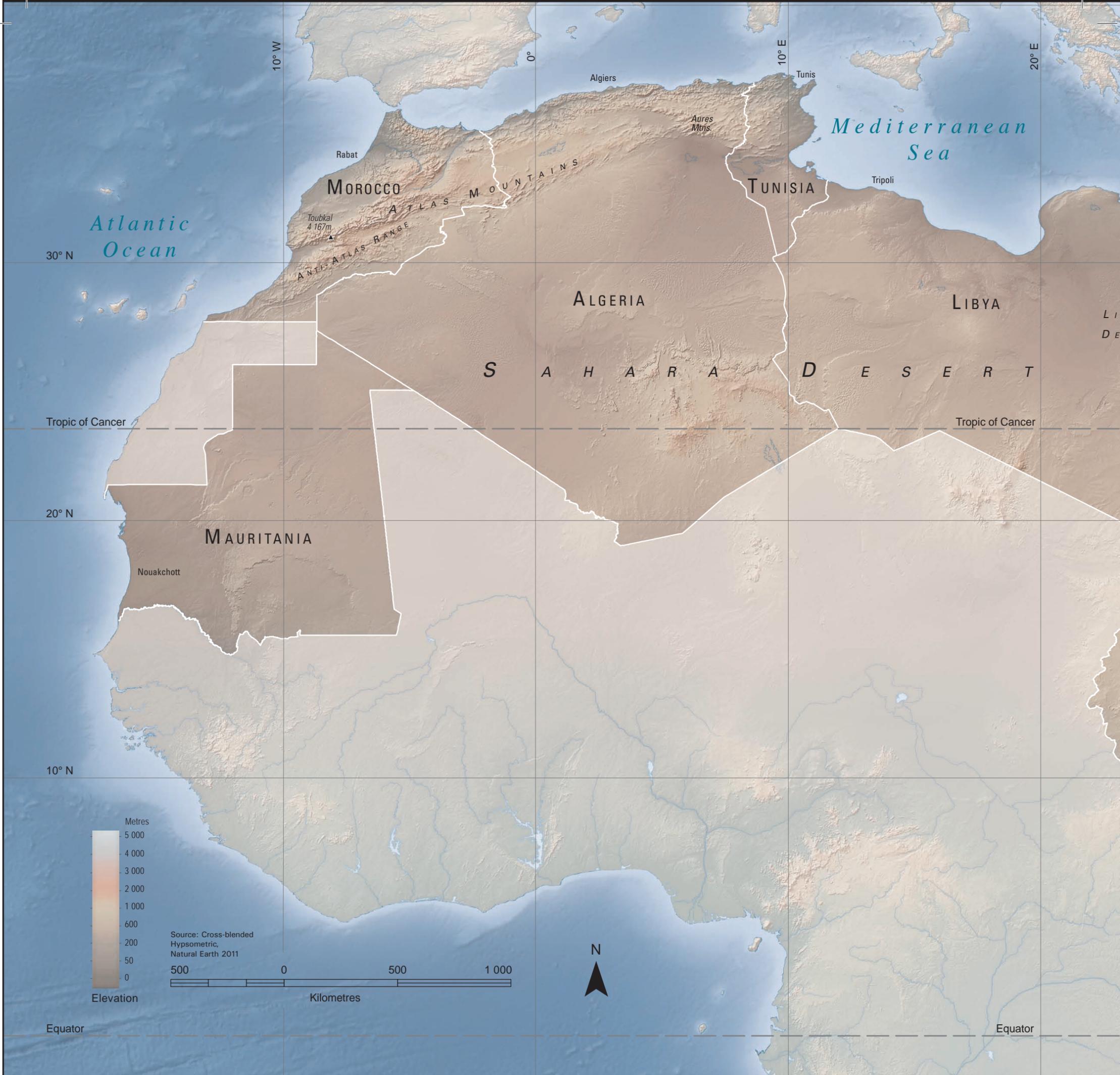
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## 1.1 GEOGRAPHY

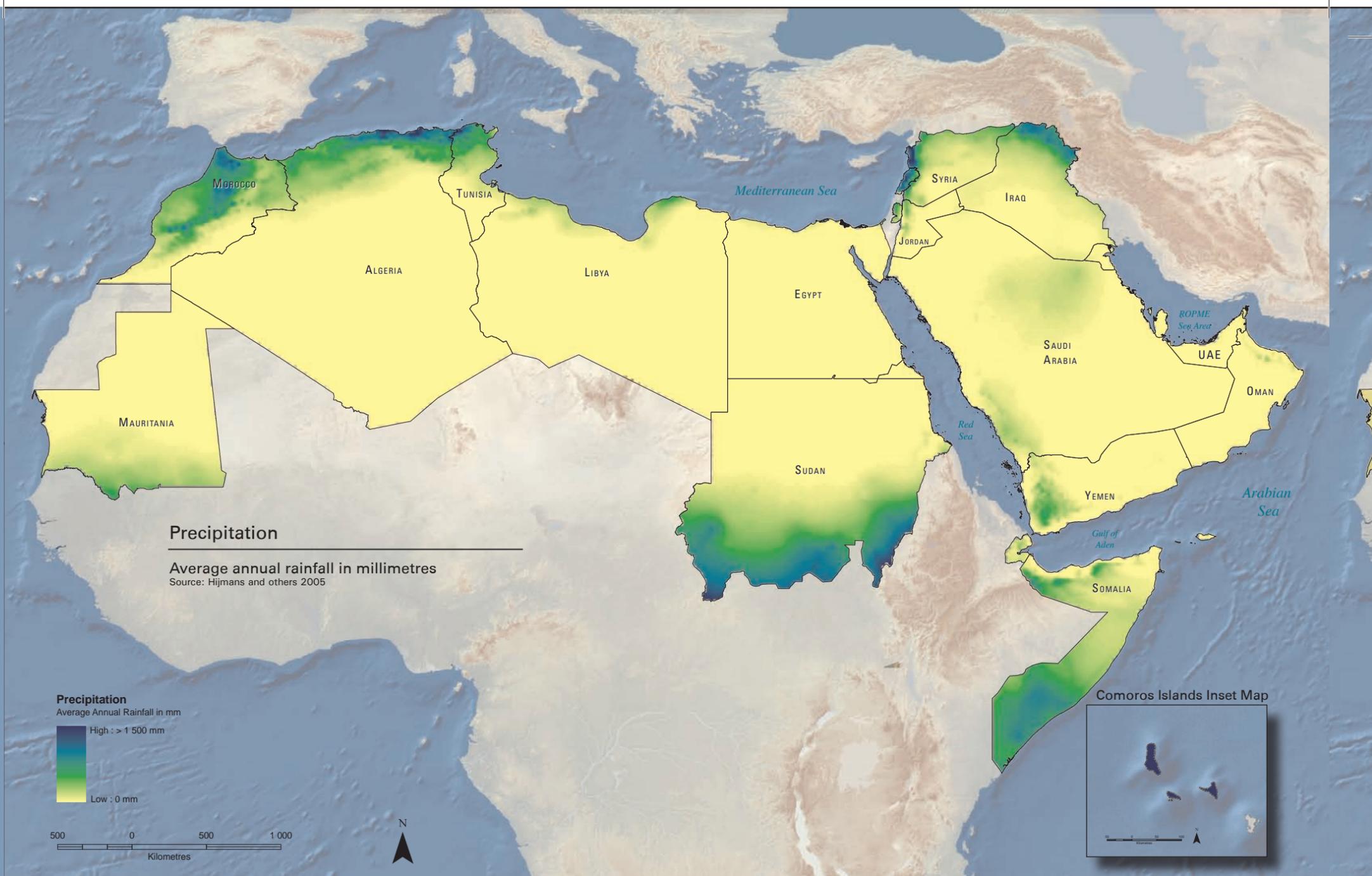
The Arab Region has undergone tremendous change in the past half century. The population now exceeds 352 million and is concentrated in urban areas (UN 2009). Pressures on natural systems in the region to provide for the burgeoning population are beyond the systems' ability to regenerate, causing unsustainable use of vital resources. Given the aridity of the climate, this is most poignant in the region's scarce water resources. As long as human

activities continue at levels above the regenerative capacity of the natural environment, the result will be a decline in the quality of life. Governmental and non-governmental entities in the region are progressing with efforts to address conservation of the region's natural resources, which will become more challenging under the pressures of population growth, economic development policies, and various climate change scenarios.



The Arab region contains some abundant natural resources, and though many perceive the entire region to be rich in oil and gas resources, major hydrocarbon production is limited to the countries of Saudi Arabia, United Arab Emirates, Kuwait, Algeria, Iraq, Libya and Qatar. These oil-producing countries contain a vast proportion of the world's hydrocarbon reserves, holding almost 60 per cent of the world's proven oil reserves and nearly 30 per cent of proven natural gas reserves (Oil & Gas Journal 2008). The region also has many other resources such as iron-ore, lead, phosphate, cobalt and manganese. Though limited, fertile lands are a resource with parts of southern Sudan, also referred

to as the 'food basket of the Arab world', containing some of the most fertile lands in the world. The flora, fauna and marine biodiversity are also a vital part of the region's natural resources and are integral to the fast-growing tourism industry. With a large imbalance in the amount of available resources and the amount of people in the region, the need for more strategic and sustainable development is clear. The priceless services of nature's resources such as the availability of clean water, clean air, fertile soil, and rich biodiversity must be preserved in order to maintain an adequate quality of life for current and future generations.



## CLIMATE

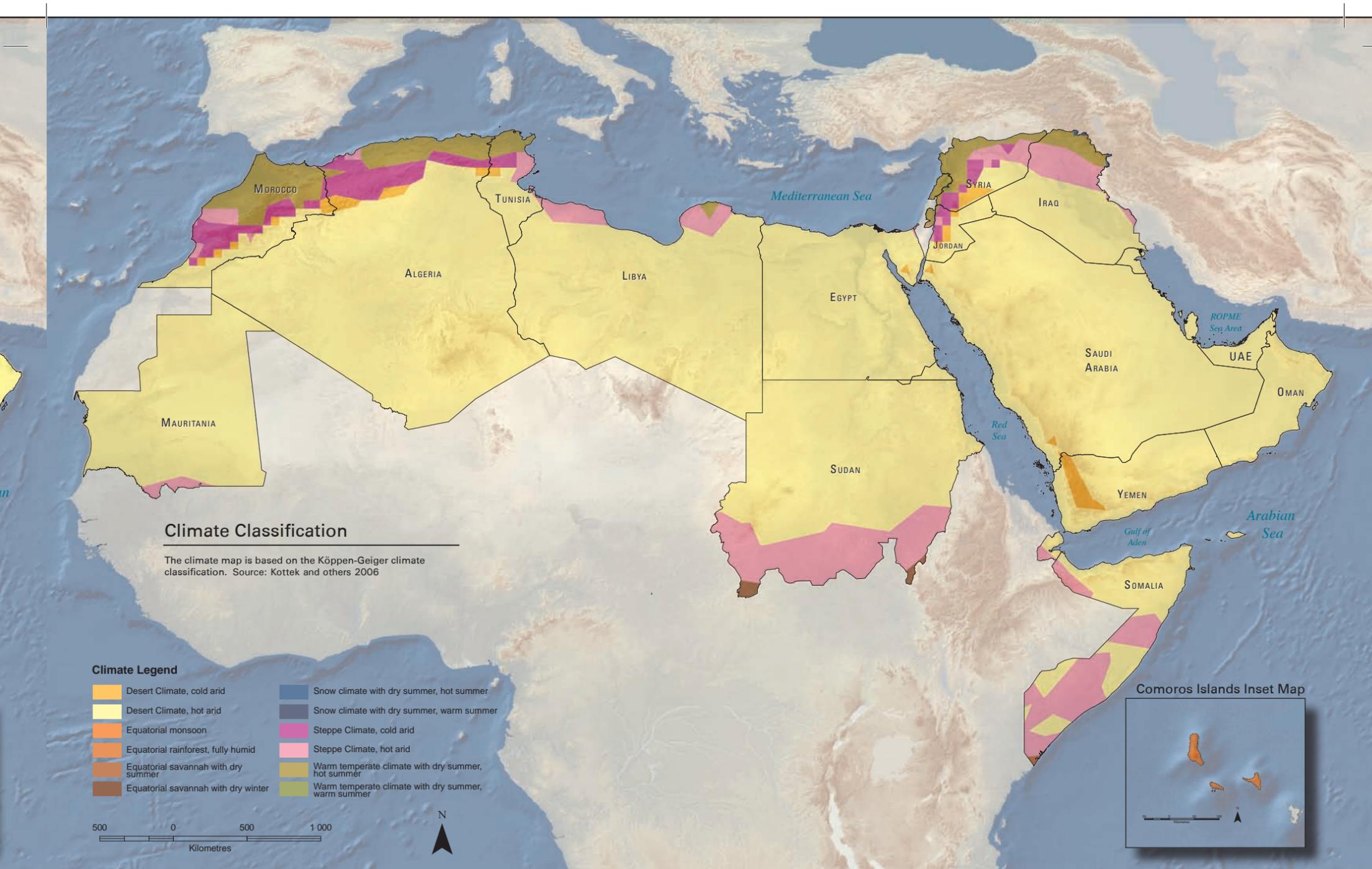
The climate of North Africa and West Asia is generally characterized as hot and arid. Desert zones dominate this region, with the Sahara Desert comprising 90 per cent of North Africa (AFED 2009). The Sahara Desert has one of the harshest climates in the world, with daytime temperatures reaching up to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

The precipitation map shows that the majority of the Arab region is subject to hyper-arid conditions, indicating that mean annual potential evapotranspiration exceeds mean annual precipitation. This indicates that the region is vulnerable to the impacts of climate change with even hotter

and drier conditions projected in the future. For the region as a whole, average annual rainfall varies between 0 and 900 mm, while the average evaporation rate is more than 2 000 mm per year (AFED 2009; FAO 2008). This moisture deficiency affects the type of land use in the region and makes the area highly vulnerable to impacts from climate change.

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

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



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

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

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



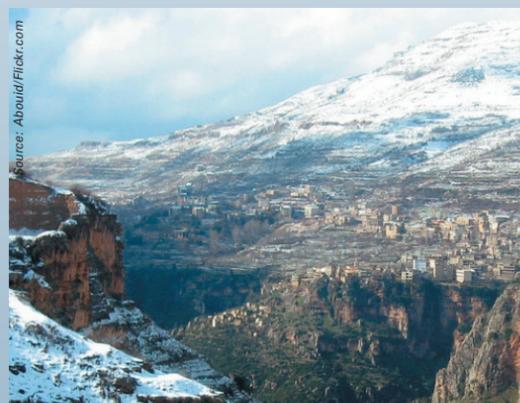
#### Arid Desert climate

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



#### Warm Temperate climate

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



#### Snow climate

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

## GEOMORPHOLOGY

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

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

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

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

Desert landscapes cover much of West Asia. The Arabian Desert consists of the Rub Al Khali or Empty Quarter, the largest sand desert in the world, which covers most of southern Saudi Arabia; the An Nafud Desert of western Saudi Arabia, with sand dunes that reach over 30 m high; and the Al Dhana Desert, in the east. The Syrian Desert covers portions of

Syria, Iraq, Jordan and Saudi Arabia; its varied landscape, which includes numerous oases, was shaped by ancient lava flows.

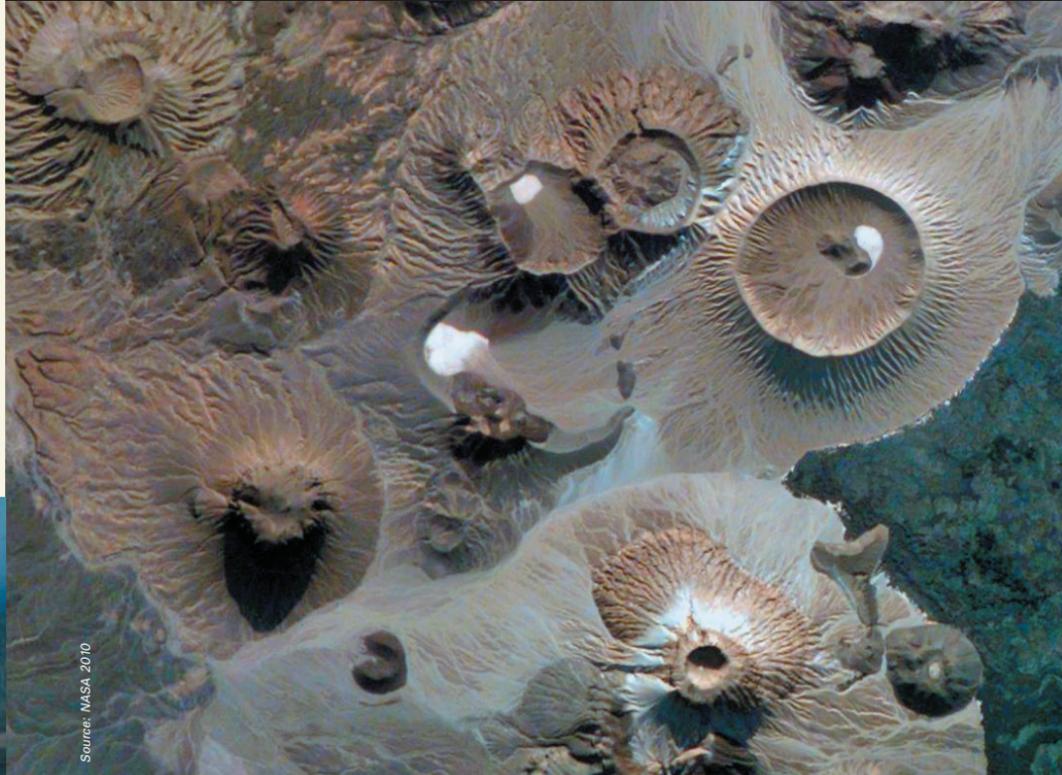
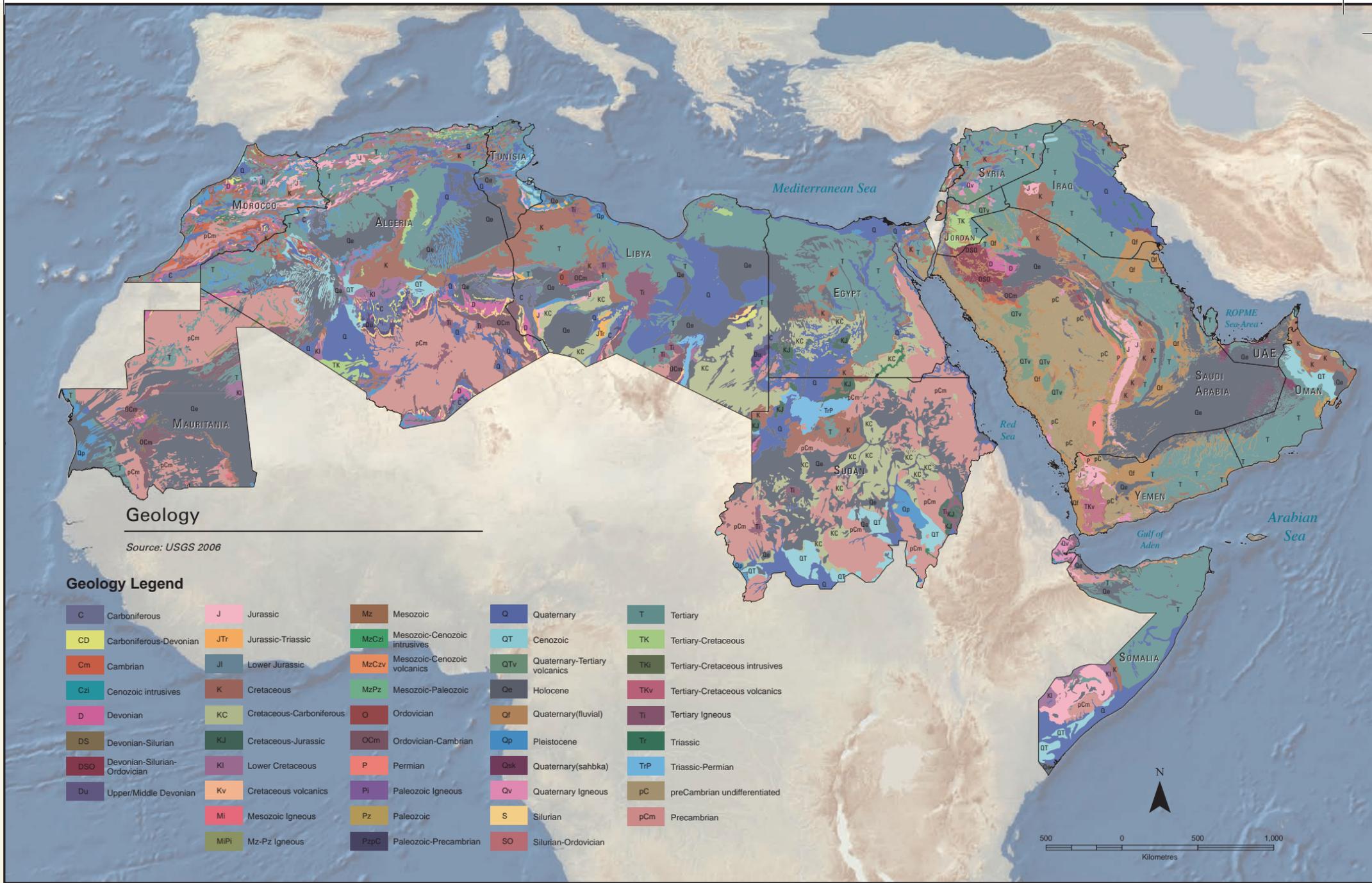
The Sinai Peninsula, the portion of Egypt that lies in West Asia between the Mediterranean Sea to the north and the Red Sea to the south, is largely desert with mountainous topography. The Asir and Hejaz Mountains extend along Saudi Arabia's Red Sea coastline, reaching heights of 2 130 m. Other mountains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

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



Harrat Khaybar, Saudi Arabia

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

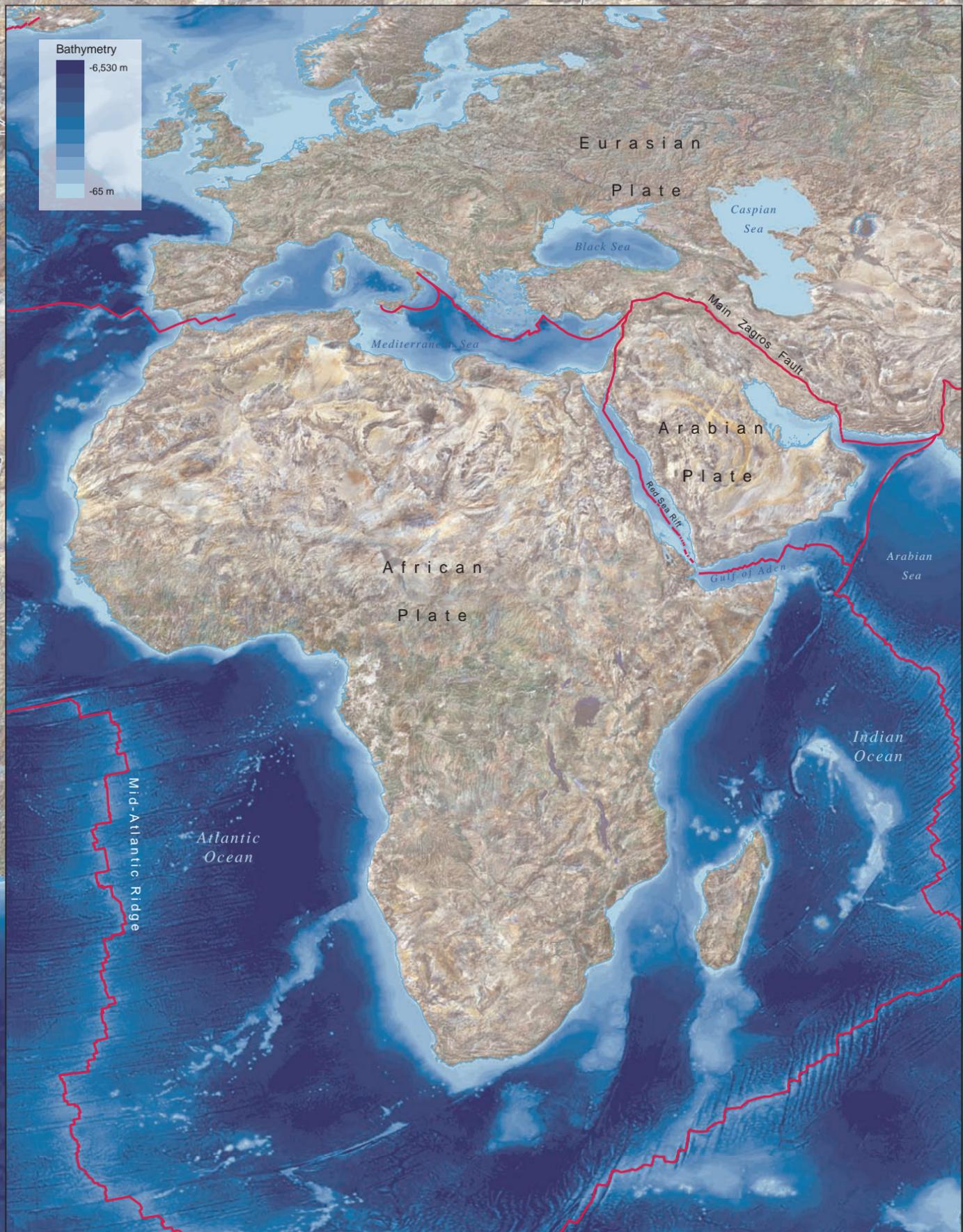


Source: NASA 2010

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

## GEOLOGY

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



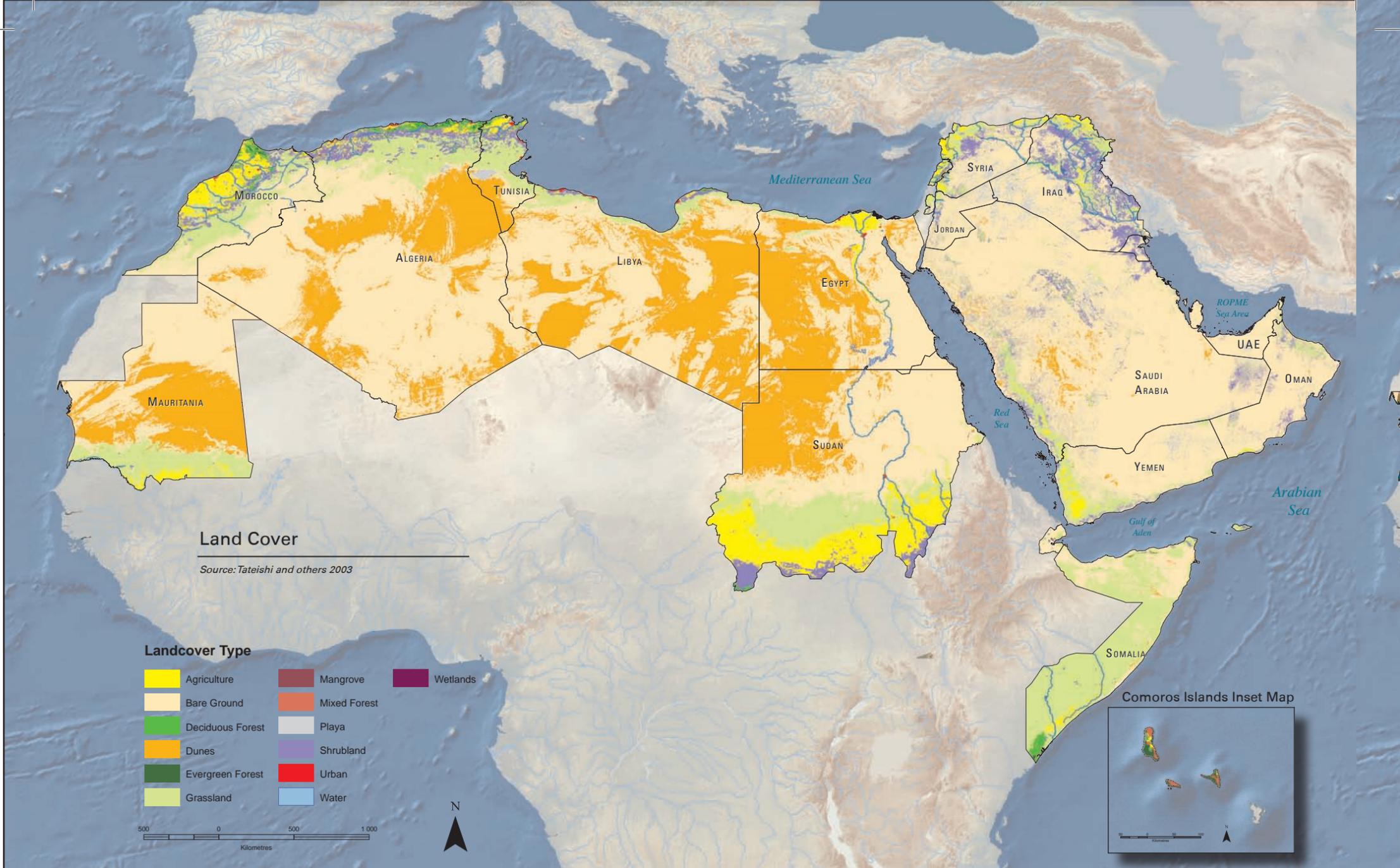


**Tectonic Plate Boundaries and Fault Lines**

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

Source: Coffin and others 1998





## LAND USE AND LAND COVER

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

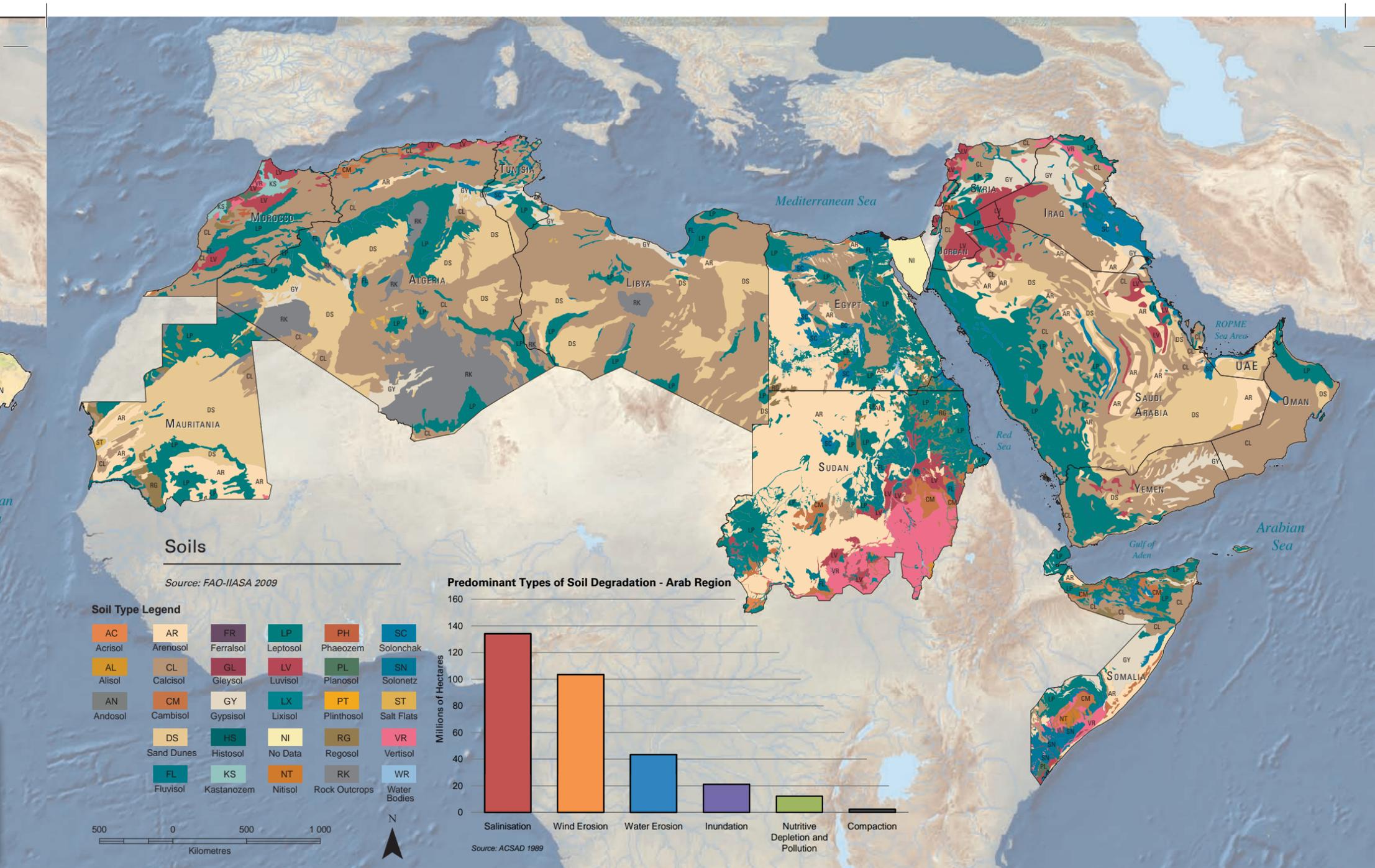
### Land Cover

The Arab region faces enormous challenges in safeguarding its natural resources and converting these challenges into opportunities for development. Of the total land area of 14.1 million km<sup>2</sup>, 89.3 per cent are arid or hyper-arid lands and 14.5 per cent are agricultural lands, of which only 4.2 per cent are cultivated (AOAD 2009). A huge portion of the region is desertified and highly vulnerable to desertification. For example, the GCC countries are 89.6 per cent desertified and the remaining lands are vulnerable to desertification. The countries in the Mashreq sub-region are the least desertified (35.6 per cent), but a large proportion of the total land area in that region is vulnerable to desertification (48.6 per cent) (ACSAD 2004). Though dryland deserts dominate the region, a variety of ecosystems are found in the Arab region that provide essential habitat and ecosystem services—these include Mediterranean forests, plains,

rangelands, savannahs, oases, mountains, rivers, mudflats, springs, marshes, and swamps. Rangelands in the region are a significant land type and cover more than 33 per cent of total area of Arab countries and constitute 13.5 per cent of global rangelands (FAO 2011).

### Forests

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



## Protected Areas

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

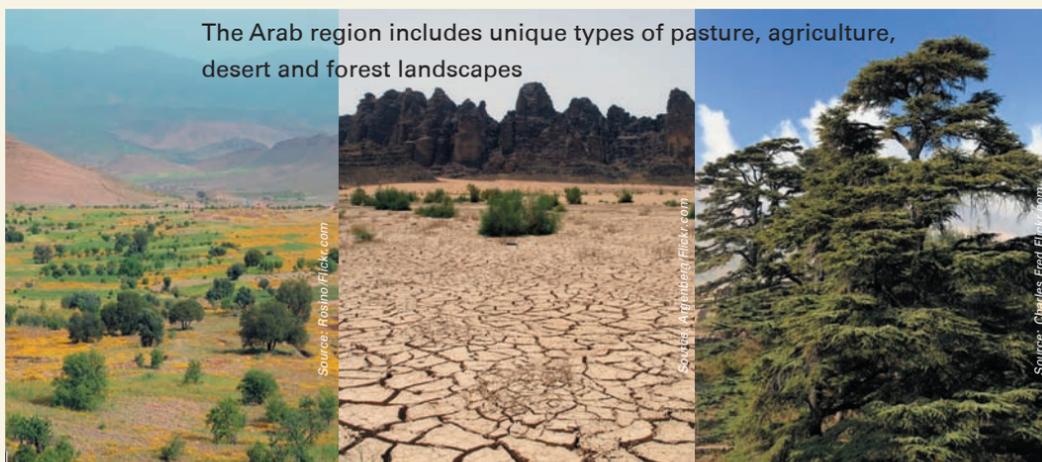
## SOILS

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

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



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



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

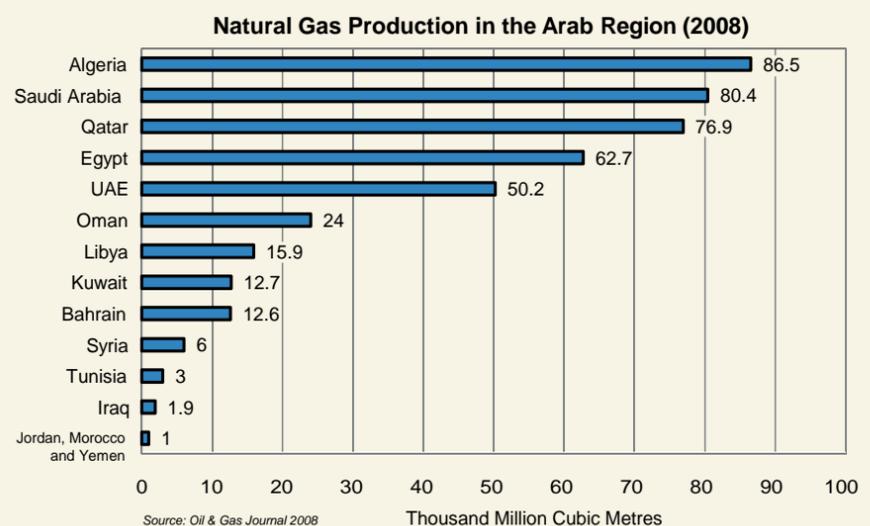
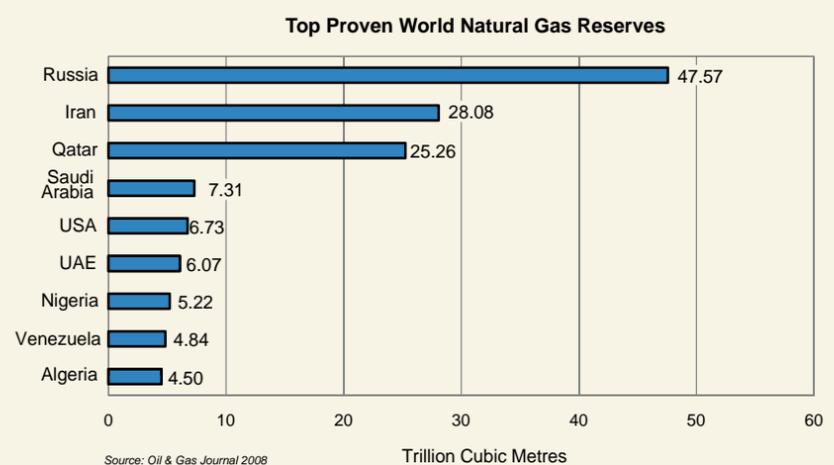
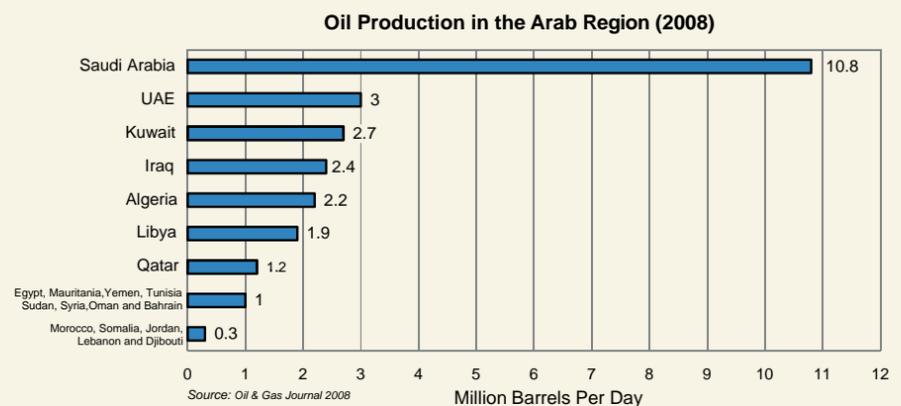
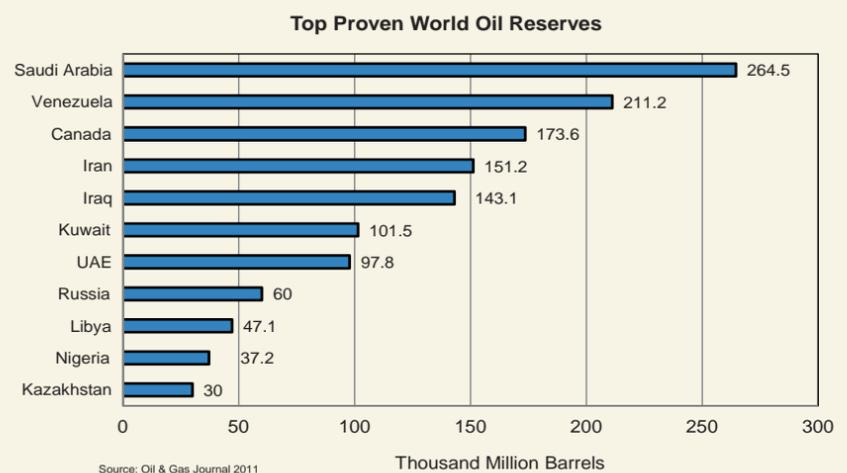
## HYDROCARBON RESOURCES (OIL AND GAS)

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

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

The recent global financial crisis adversely affected the energy sector,

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



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





## WATER RESOURCES

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

### Water Availability

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

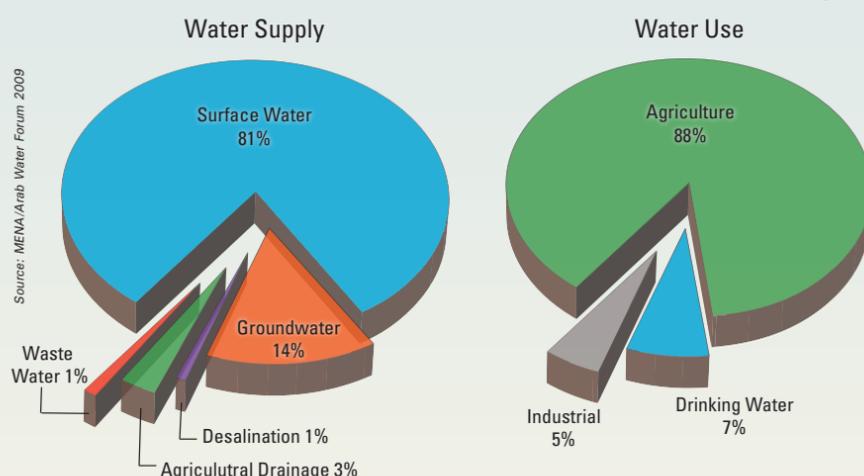
By 2025, most countries in the region will be classified as having absolute water scarcity. This scarcity is complicated by the fact that over 60 per cent of the surface waters originate outside the region, mainly in Turkey and the Ethiopian Plateau. Some countries such as Egypt, Mauritania, Iraq and Syria are almost entirely dependent upon water sources originating outside their borders. In the case of Mauritania, the waters of the Senegal

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

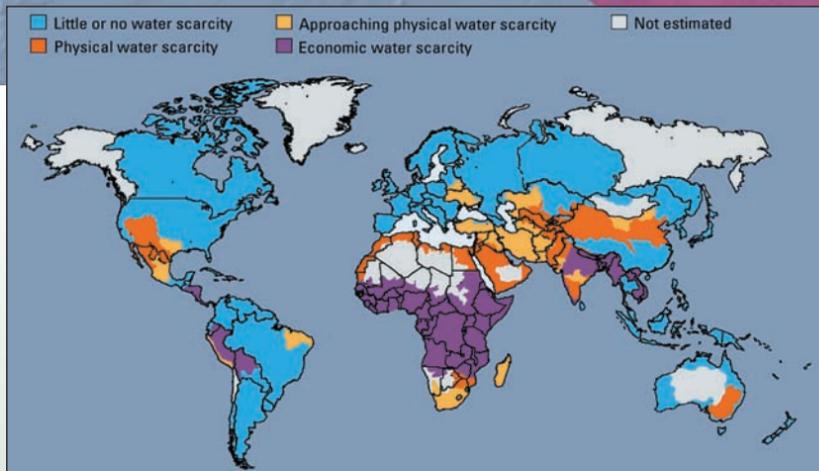
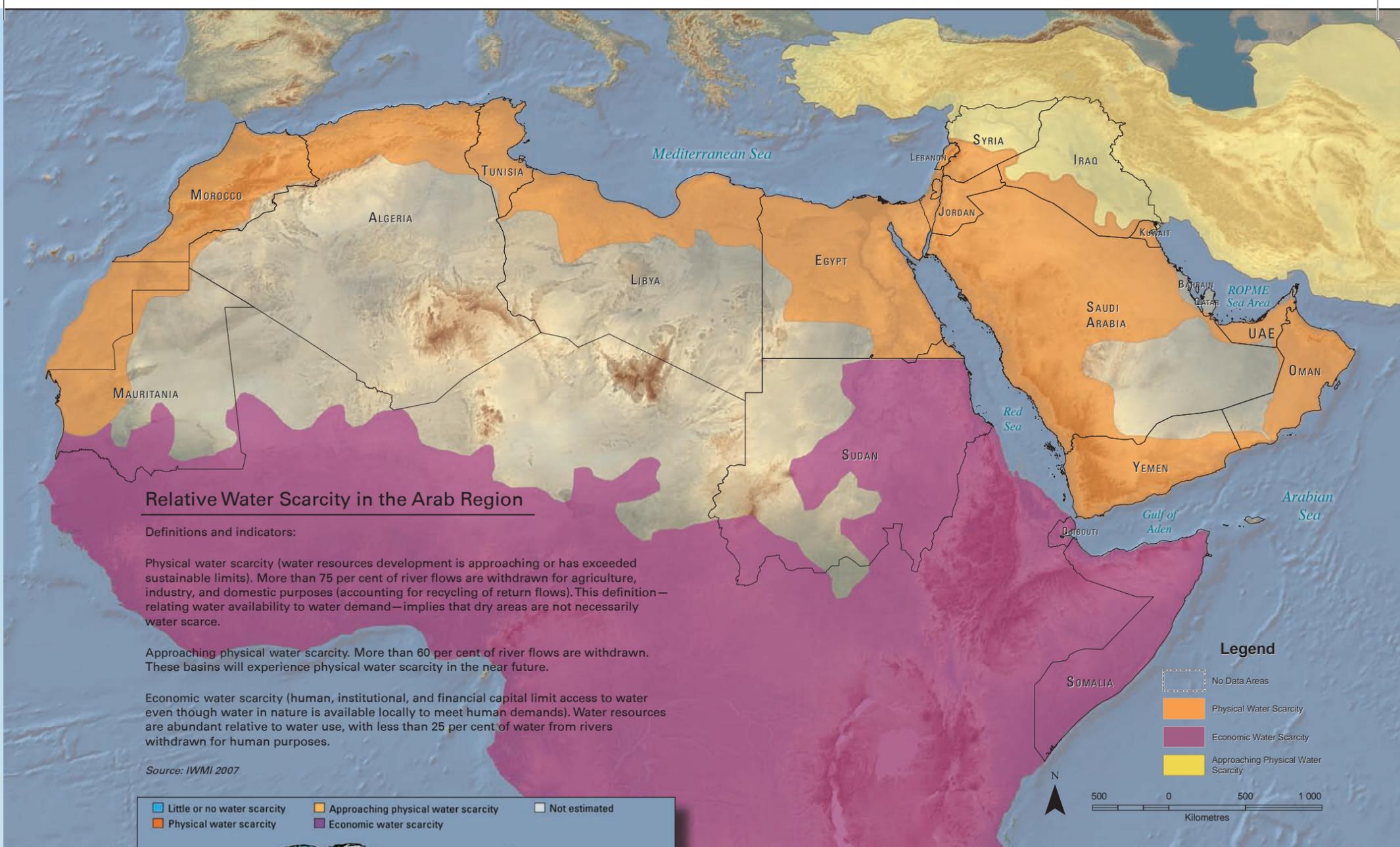
River, which originate in the Futa Jallon mountain region of Guinea, provide that country with most of their freshwater resources; the river valley also contains the only arable land in the country (FAO 1997). Transboundary water issues are discussed in greater detail in Chapter 2 and addressed in specific country profiles in Chapter 3.

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

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



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



## WATER QUALITY

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



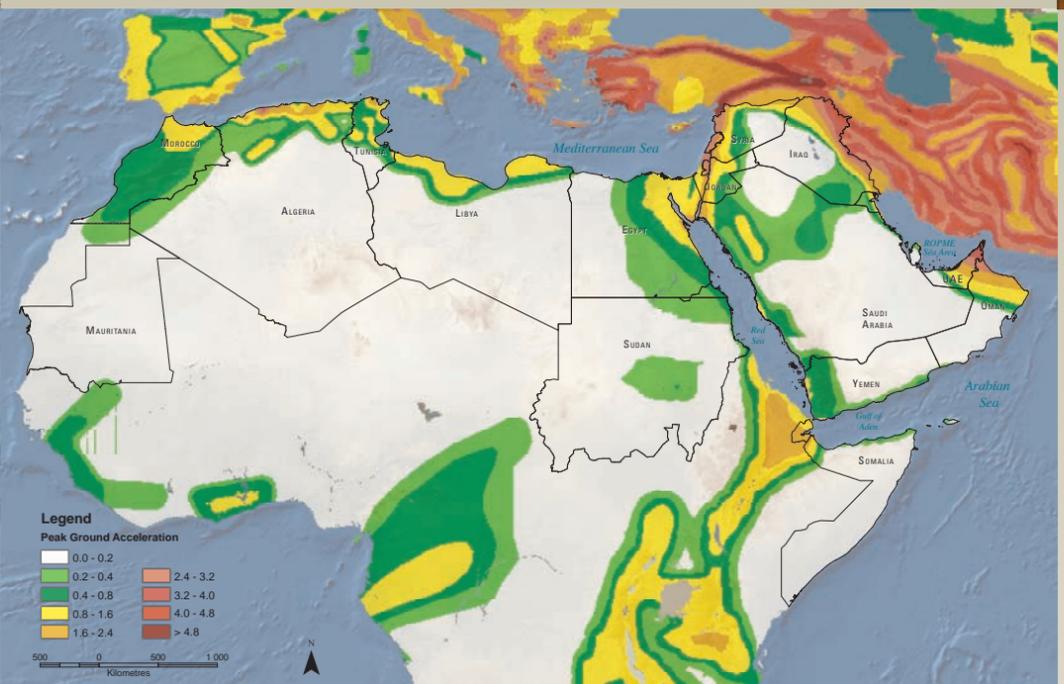
Drinking water pump in southern Sudan. If groundwater is available, wells often provide people in the Arab region with uncontaminated drinking water.



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

### Seismic Hazard Zones

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



## NATURAL HAZARDS

The hazards associated with natural disasters are attracting more attention worldwide. The 2004 Indian Ocean tsunami alerted the world to the extensive devastation that natural disasters can inflict. The Arab region is subject to a variety of natural hazards—the arid to hyper-arid climate lends itself to frequent drought, which is the entire region’s most pressing natural hazard (Al-Madhari and Elberier 1996). Desertification, earthquakes, flooding, extreme temperatures, wildfires, cyclones, sandstorms and dust storms are also prevalent in the region. Earthquakes in Algeria, Lebanon and the geologically active Great Rift Valley, along with cyclones in the Arabian Sea and the Indian Ocean, landslides in Egypt and Morocco, volcanism in Yemen and Comoros, and sandstorms that originate from the Sahara Desert, are natural events that negatively impact people’s lives and livelihoods.

Between 1980 and 2008, droughts, earthquakes, floods and storms affected more than 37 million people in the region and caused damage estimated at US\$20 thousand million (UN-ISDR 2009a). The Arab region has faced 276 disaster events in the past 25 years and more than 40 per cent of these natural disasters occurred in the past five years. An urgent need for disaster prevention and management has been identified for the region, especially in light of climate change and the increased frequency and intensity of natural disasters (UN-ISDR 2009a).

The graph (opposite page) shows the comparative extent of the hazards that affect the Arab countries. Drought is the most extensive and prevalent,

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

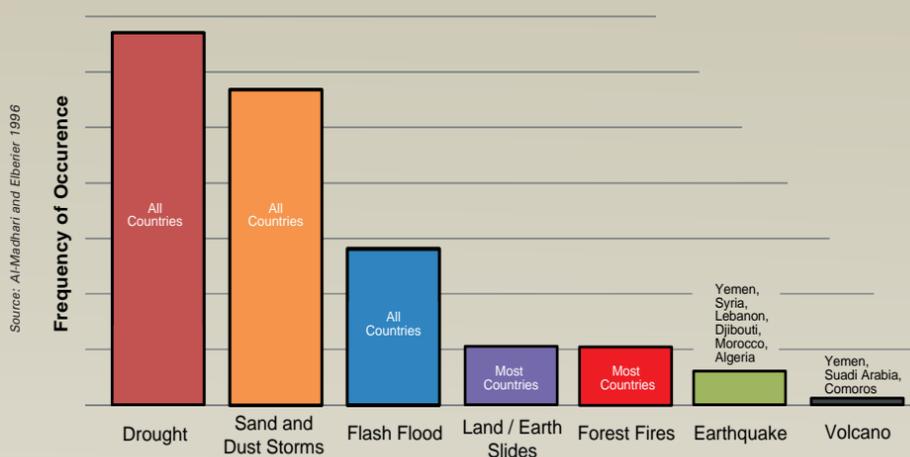
Cyclone Gonu, the strongest tropical cyclone on record in the Arabian Sea, struck Oman in June 2007, causing loss of life and widespread damage. Chapter 3 features images of the devastation brought by the cyclone to the eastern tip of Oman. Tropical Cyclone Three B made landfall in eastern Yemen in October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

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

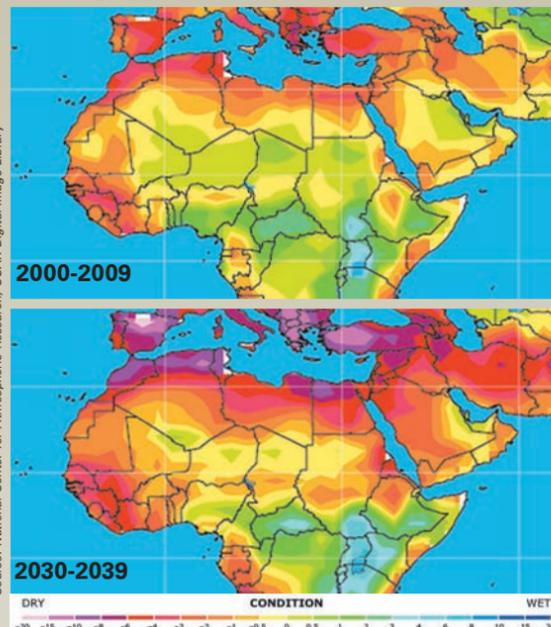


Dust storm rolling into Salmiya, Kuwait. Dust storms arise when a strong gust front blows loose sand and dust from dry surfaces. Particles are transported by saltation and suspension, causing soil erosion from one place and deposition in another. The Sahara and drylands around the Arabian Peninsula are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

**Comparative Schematic showing the frequency of natural hazards affecting Arab countries**



Source: Al-Madhari and Elberier 1996



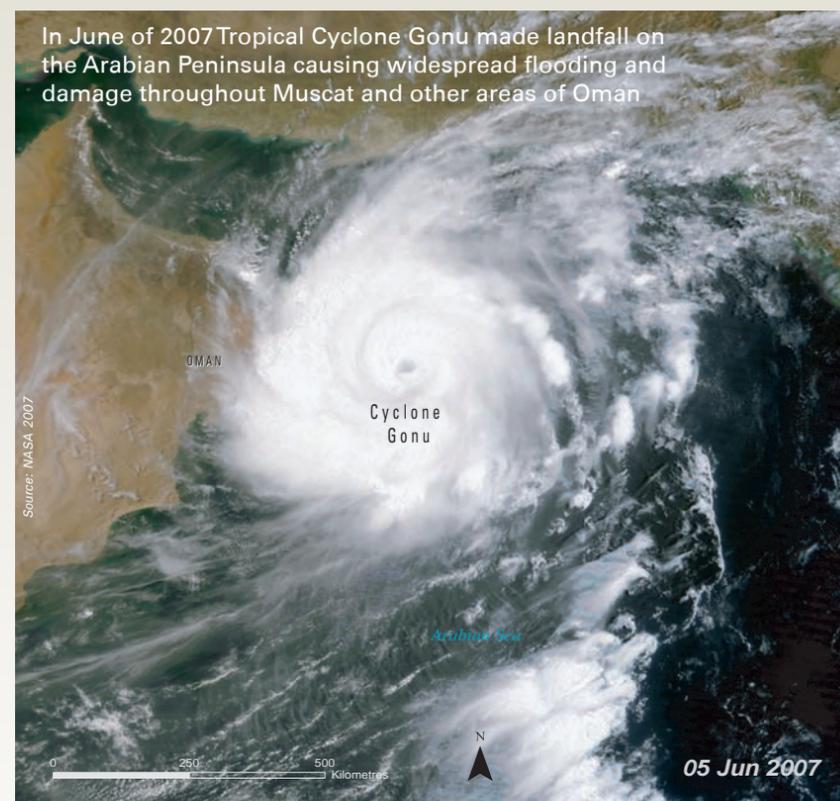
Source: National Center for Atmospheric Research, UCAR Digital Image Library

**Drought Vulnerability**

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

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

In an effort to more adequately respond to natural hazards, 168 governments adopted a 10-year plan (Hyogo Framework for Action) at the UN's 2005 World Conference on Disaster Reduction in Kobe, Japan, with



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

Source: NASA 2007

the goal of substantially reducing losses from natural hazards by 2015. Losses in life and property can be averted with early warning systems, adequate building codes, resilient infrastructure and government crisis response plans. The Arab League States are actively promoting the integration of disaster risk reduction in key regional policies on climate change, environment and disaster management. Though Arab countries have made progress, the commitments have not translated, in many cases, to operational capacities and commitments of resources. Progress has also been weak with respect to education and public awareness, and data collection and availability. Increased regional coordination and information exchange is needed to ensure that risks from disasters are adequately addressed (UN-ISDR 2009a).

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



Source: Wikimedia Commons



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

Source: seier + seier/flickr.com

## 1.2 POPULATION, ECONOMICS, CULTURAL RICHNESS



Crossing Dubai Creek. Dubai, UAE

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

Islam in the Arabian Peninsula in the 7th century, Arabic, the language of the Qur'an, became the dominant language in the Arab countries of North Africa and Western Asia.

Paradoxically, this same region today has one of the lowest literacy rates in the world. The average rate of adult literacy in the Arab region is 66 per cent, however, there are discrepancies within the region. Jordan, Kuwait, Lebanon, the Occupied Palestinian Territories and Qatar have literacy rates of over 90 per cent, while Mauritania, Morocco, Sudan, Somalia and Yemen stand at less than 60 per cent (WHO 2009) There is also a major gender discrepancy with two-thirds of illiterate adults being women. Literacy has been increasing steadily among the region's youth in recent years; literacy rates for the 15 to 24 year old range increased from 35 per cent in 1970 to 83 per cent in 2006. With a 2.3 per cent population growth rate, the Arab region is distinguished by having one of the highest rates of growth in the world (ESCWA 2003). In the past six decades, the Arab population grew from around 72 million to approximately 352 million (UN 2009), which accounts for about 5 per cent of the total world population. The total population is expected to reach 395 million, or 5.5 per cent of the world's population by 2015 (ESCWA 2003).



Yemeni gentleman in Sana'a

## POPULATION CHARACTER

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

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

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

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

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

Population and urbanization are major drivers of environmental degradation in this region, which is characterized by aridity and water

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

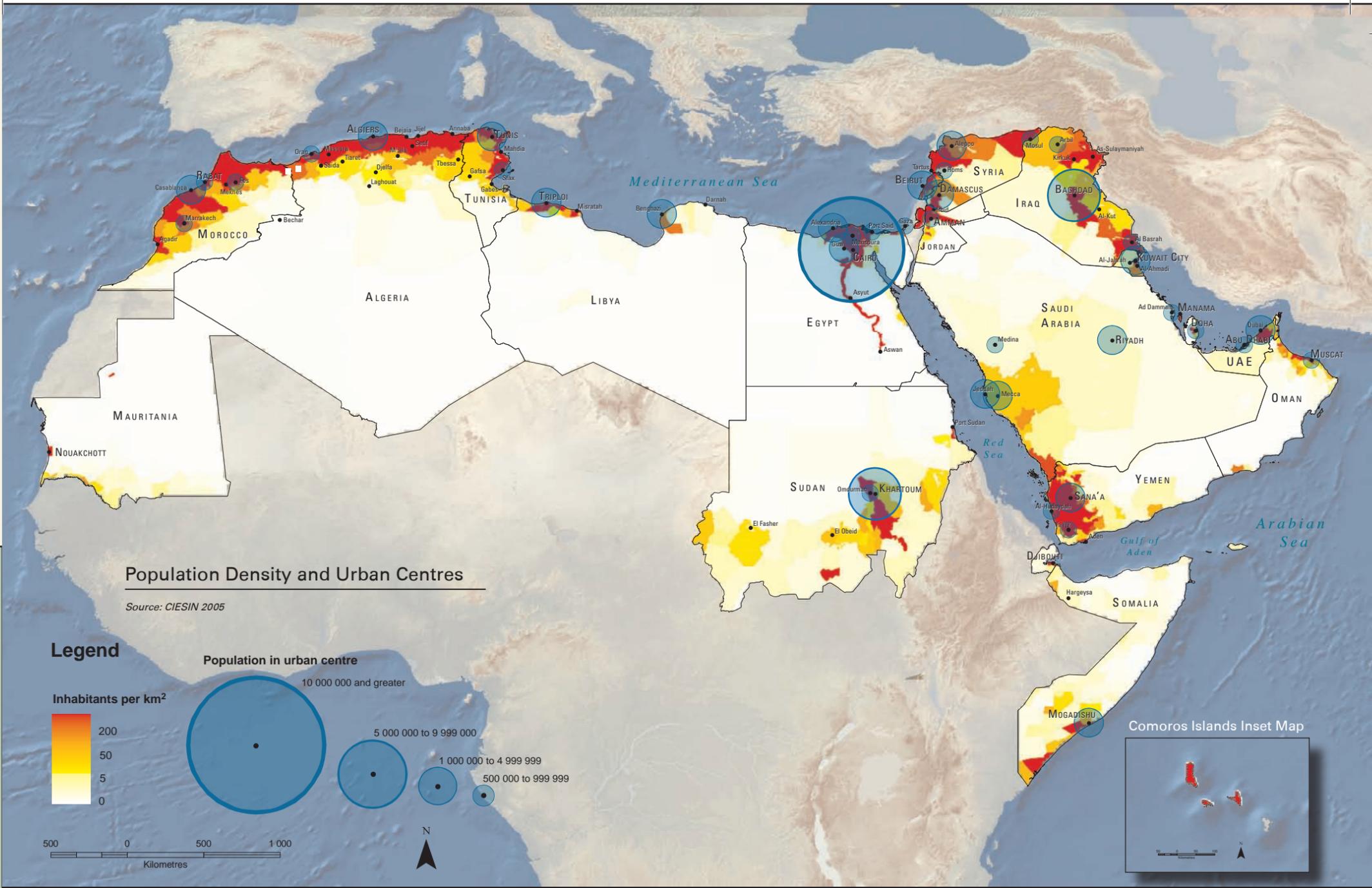
### BEYOND LITERACY:

#### EDUCATION IN THE ARAB REGION

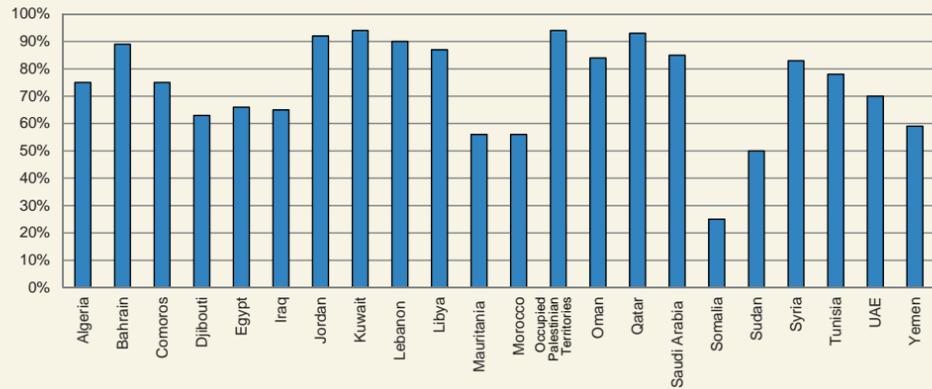
Education is integral to escaping poverty through employment. In the Arab region, the quality of education has dropped due to lack of investment. The increasing emphasis toward English-language education among the elite is resulting in wide gaps between them and the Arabic-educated population. Today,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

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

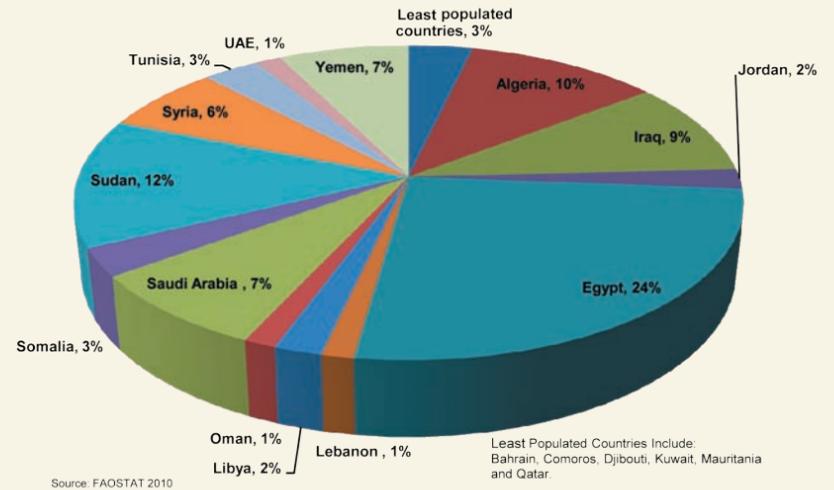
In addition, the public education system in the region has not fully responded to the needs of the present generation (ESCWA 2004). This has caused a loss of motivation among young Arabs, who face high levels of unemployment in their home countries. In fact, the poor state of education in the region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



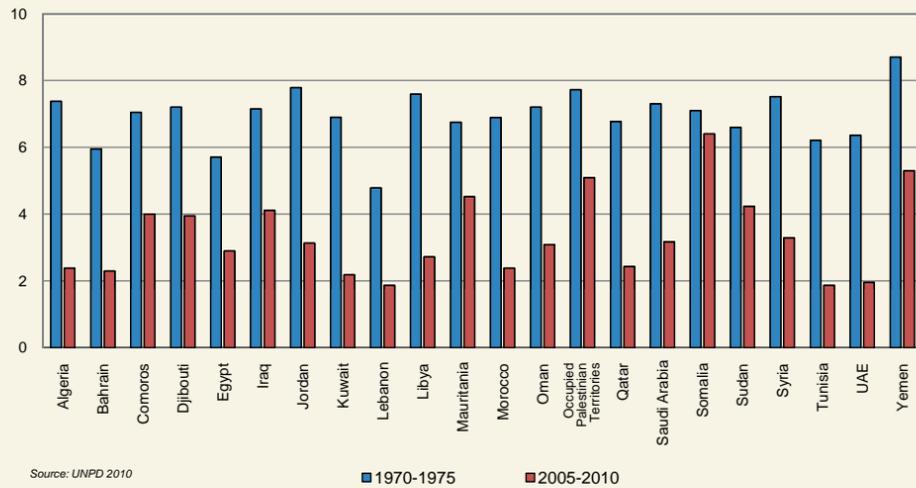
Adult Literacy Rates in Arab Region



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

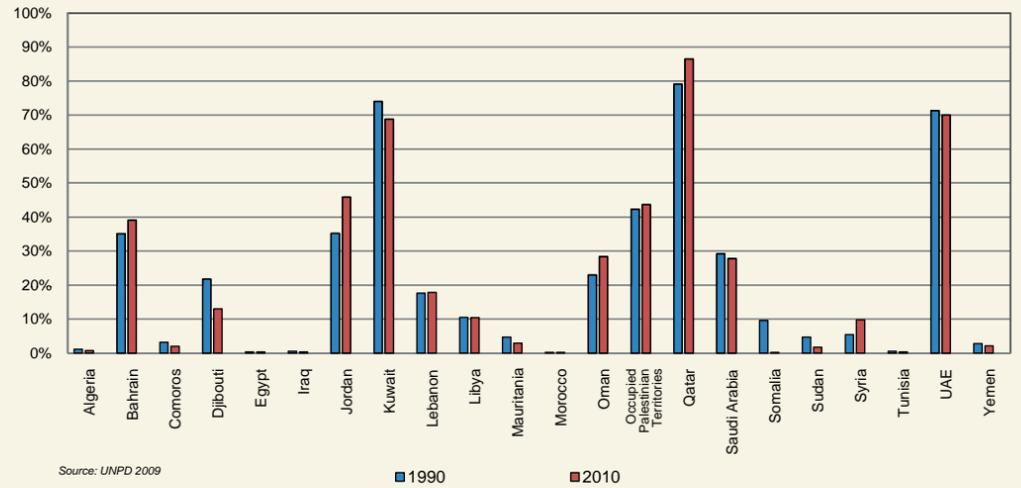


Fertility Rate in Arab Region



Migrants as a Percentage of Total Population by Country

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



## URBAN POPULATION AND SOCIAL VULNERABILITY

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

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

Chapter 3 of this atlas highlights change in many urban areas in the Arab region, and addresses the specific impacts of rapid urbanization. The agglomeration of people in urban areas has also put stress on rural areas, which are increasingly producing food for the cities, and often using poor agricultural practices that pose risks to the environment and human health. As a result, Arab cities rank low in terms of quality of living. The highest ranked Arab city in Mercer's (2009) quality of living survey was Dubai (ranked 77 worldwide). The ancient Arab cities of Cairo and Sana'a fell far behind; the lowest-ranked Arab city was Baghdad, at 215. The study cited security concerns for the low score. However, the cities of the oil-rich Gulf States continue to witness improvements in their living standards, especially in education, the economy and housing (Mercer 2009).

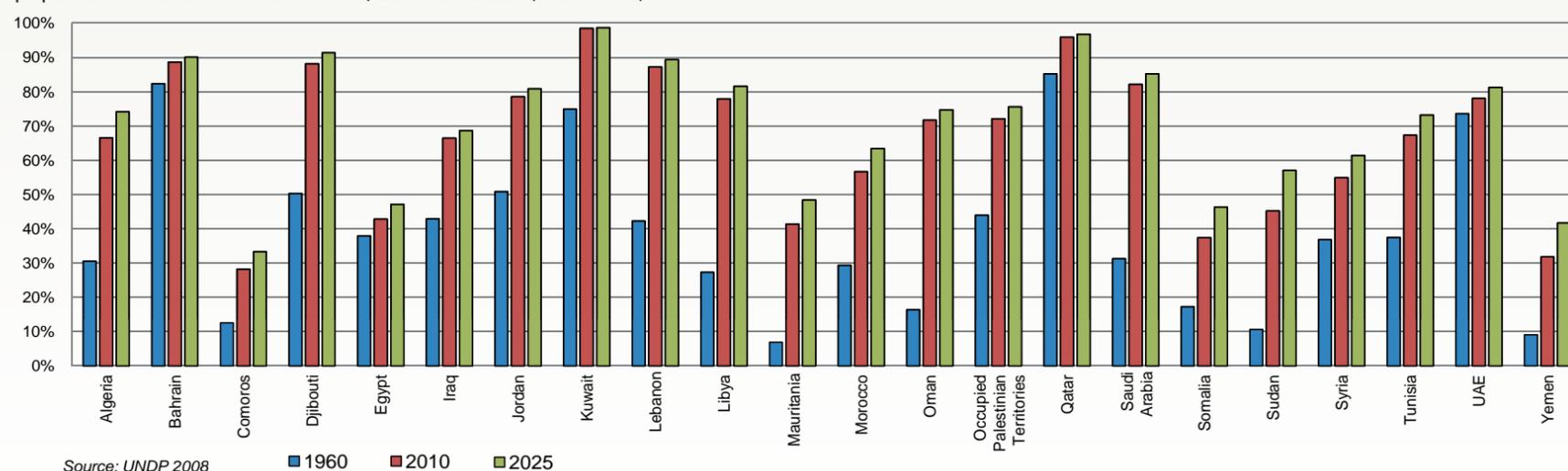
The problem of water scarcity is acute in the Arab region. Aridity, combined with drought, population growth and economic development, are the roots of the water shortage problem in the region. Water scarcity is defined as having less than 1 000 m<sup>3</sup> per year of renewable internal

freshwater resources available per capita; the global average is about 7 000 m<sup>3</sup> per capita (EOAR 2010). Yemen only has 200 m<sup>3</sup> per capita, and 33 per cent of the population is without access to safe water, the second highest percentage in the region after Comoros (IRIN 2009).

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

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

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



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

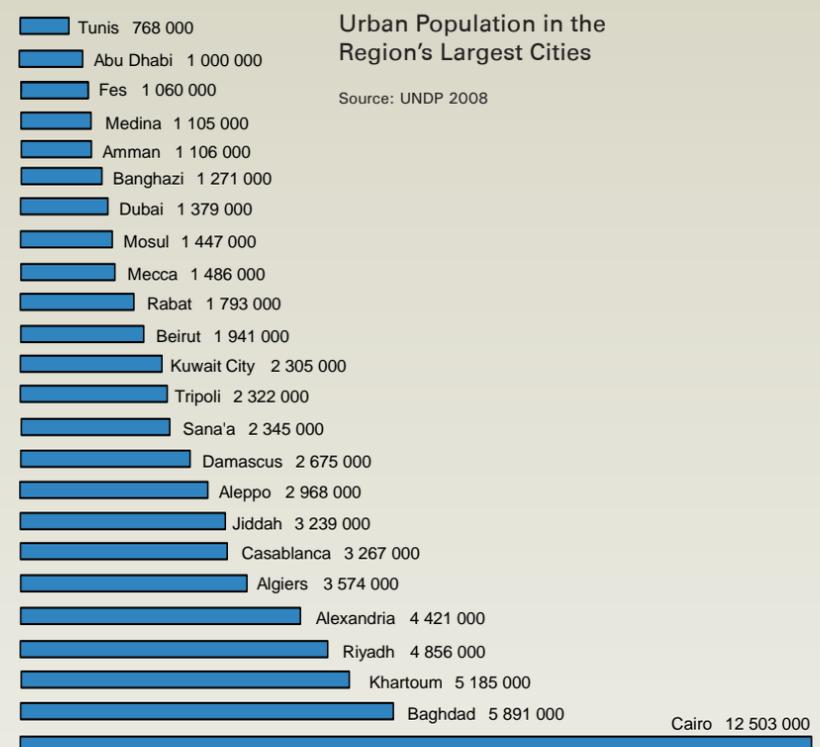
In recent years, both the international community and Arab governments have identified some of the region's basic health care needs, and they are currently working to meet them. In Yemen, where some 46 per cent of children are underweight and one-fifth of infants suffer low birth weight, joint UNICEF and governmental actions to address children's



Slum dwellings in Cairo

Source: mshammah/flickr.com

health problems are starting to bear fruit (UNICEF 2008a). For the entire region, as part of the Millennium Development Goals (MDG), efforts are underway to reduce child mortality and improve maternal health. The oil-rich Gulf States are on track to meet most of the MDG; investments in primary health-care infrastructure have improved child survival rates, though approximately 10 per cent of children under five are underweight region-wide. Maternal mortality rates are low, and most deliveries are attended by medical professionals. The prevalence of diseases such as HIV/AIDS remains low, however, there is a need to further educate the region's population about how these diseases are spread (UNICEF 2008b).



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

Source: sidelle/flickr.com

## POLICY DIMENSIONS FOR HUMAN SECURITY

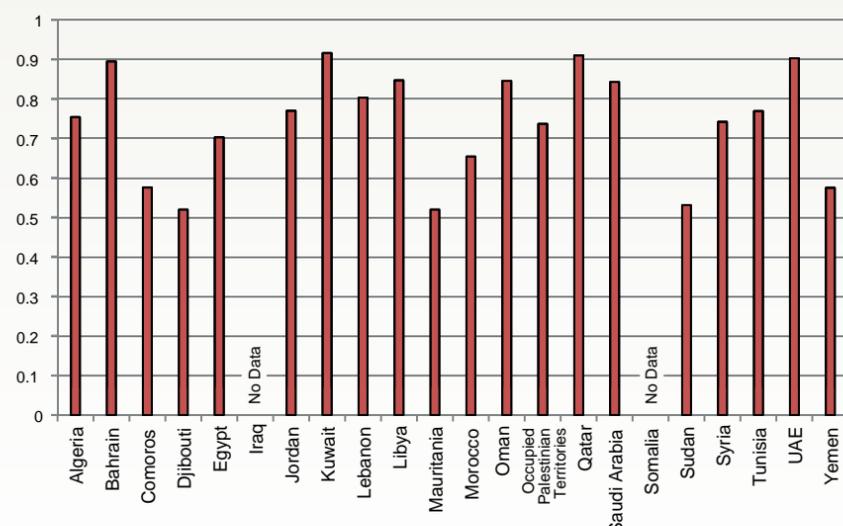
The UNDP defines human security as ‘the liberation of human beings from those intense, extensive, prolonged, and comprehensive threats to which their lives and freedom are vulnerable’, and identifies seven forms of security: economic, food, health, environmental, personal, community and political (UNDP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

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

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

Human Development Index (HDI) for Arab Countries

Source: UNDP 2009



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

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

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

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

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

## ECONOMIC CONTEXT

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

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

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

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

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

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

## MOVING AWAY FROM OIL DEPENDENCY: THE UAE

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

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

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

Abu Dhabi, UAE



## ECONOMIC CONTEXT (CONTINUED)

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

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

As the Arab economies grow, so too does their reach into the international markets. This has resulted in more liberal economic policies, with both positive and negative outcomes. As of 2011, there are 12 Arab member countries in the World Trade Organization (WTO): Bahrain, Djibouti, Egypt, Jordan, Kuwait, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and the UAE. Those with observer status include Algeria, Comoros, Syria, Yemen, Iraq, Lebanon, Libya and Sudan (WTO 2008, WTO 2011). The rapid accession into global markets has come at a price for some. In Jordan, membership in the WTO has resulted in poor patients having less access to cheaper generic drugs. Jordan was required to make this compromise, leading to a drastic increase in the price of medicine (due to the complex Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement implemented by the WTO as a condition of membership) (Oxfam 2007).

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

of individual countries while promoting regional economic growth.

### ARAB ECONOMIC DIVERSIFICATION: CLOTHING AND TEXTILE

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

### ARAB AGRICULTURE: EGYPT

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

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

### ECONOMIES IN CONFLICT: OCCUPIED PALESTINIAN TERRITORIES

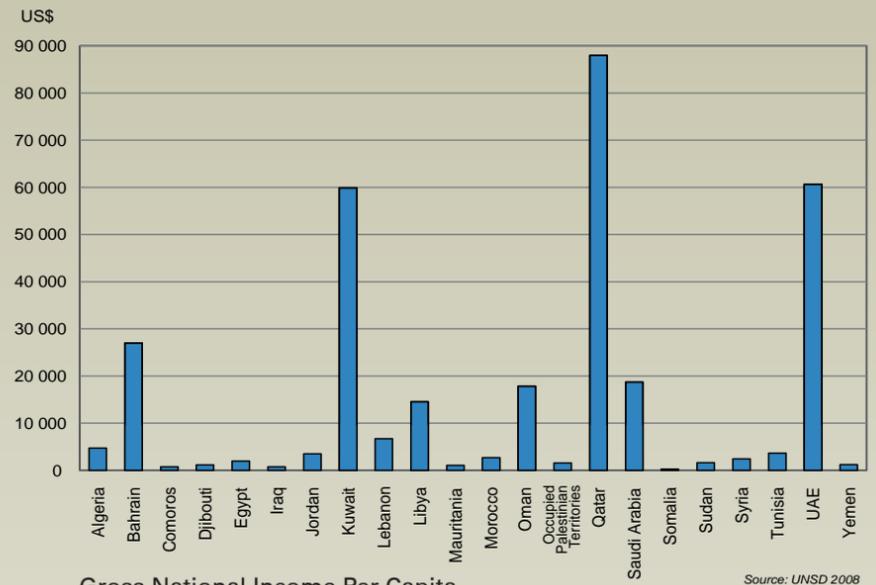
While the past several years have seen a boom in construction, tourism and free trade in many Arab countries, those that suffer from conflict, such as Iraq, the Occupied Palestinian Territories, Somalia and Sudan, have been left behind. In the Occupied Palestinian Territories, more than six decades after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

## ECONOMIC IMPACTS OF OIL DEPENDENCY

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

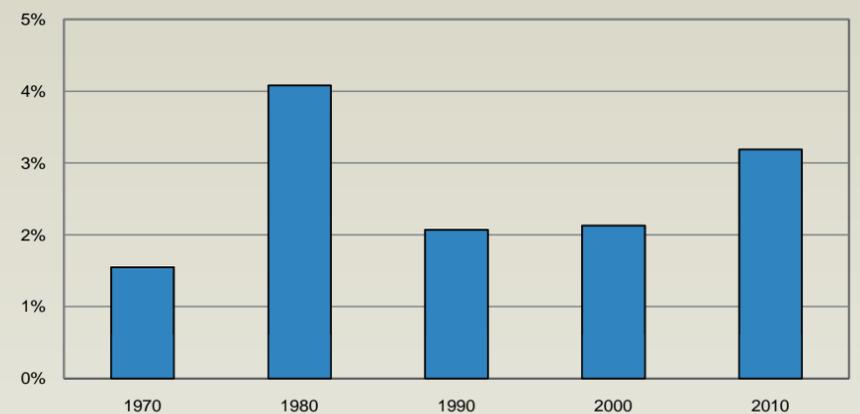


Traffic in Cairo, Egypt



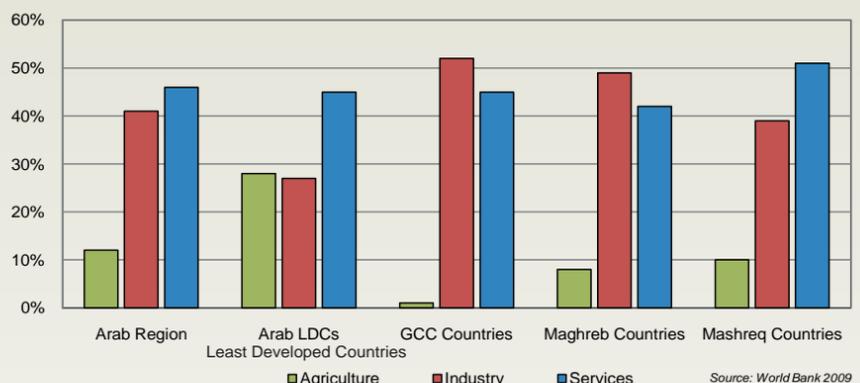
Gross National Income Per Capita

Source: UNSD 2008



Arab Region GDP as a Percentage of World GDP

Source: World Bank 2009; and IMF 2010



Economic Sectors as a Percentage of GDP

Source: World Bank 2009

## HUNGER IN THE ARAB REGION

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

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





## CONSUMPTION CHARACTER AND GDP

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

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

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

Despite the Arab region's economic dependence on oil, the ratio of the states' consumption to GDP and of their revenues to GDP is greater than that of their developing world counterparts. This is mainly due to their high oil revenues and thus, high rates of personal consumption. This gives Arab countries control over economic life that is unmatched in most developing countries. In 2005 this ratio reached 25.6 per cent

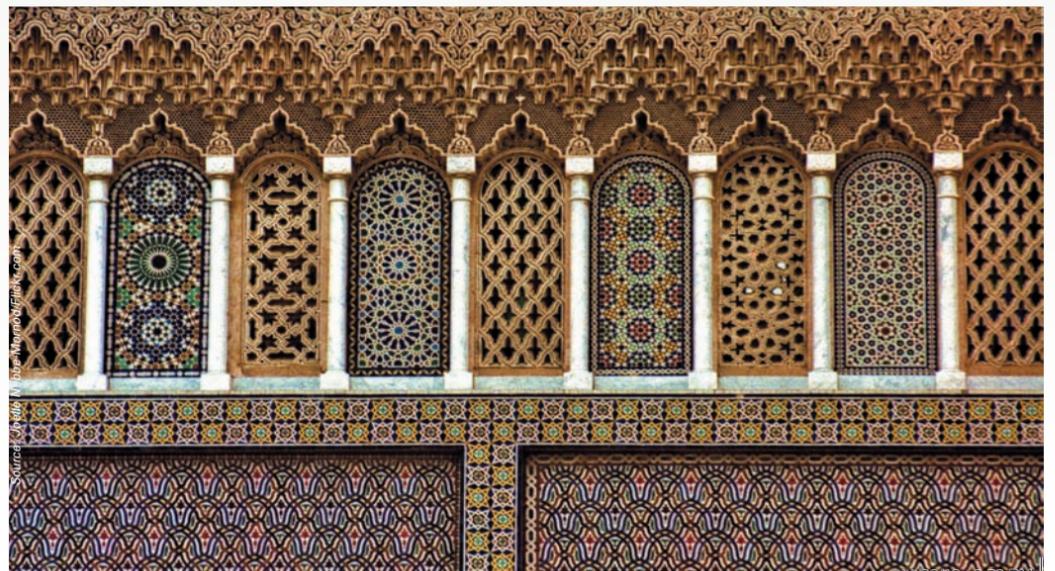
in the Arab region, while in low-income countries it was 13 per cent; in 1995, the average for the Arab countries was 26.1 per cent, while it was 13.3 per cent for low-income developing countries, and 17.2 per cent for the middle-income developing nations. This ratio reached a peak in 2005 among the OPEC-member Arab states, with 68.04 per cent in Libya; 48.62 per cent in Saudi Arabia; around 40 per cent or less in Algeria, Oman, Qatar, and Kuwait; and between one-third and less than one-fifth in the other Arab states. The lowest rate was in Sudan where it reached 17.84 per cent (UNDP 2009). While this has provided a certain degree of economic comfort and security for some Arab countries, in the long-term this could delay political and environmental reform in the region.

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

## HUMAN AND CULTURAL RICHNESS

The Arab region is home to some of the oldest, richest and most diverse cultures and traditions in the world, from the early Ugarit alphabet (the birthplace of the three monotheistic faiths) to the oldest learning institutions and architecture. It is home to the longest continuously operating universities in the world, and during the times of the Middle Ages the region was a centre for learning. In 1859, the University of Al-Kairawan was founded in Fez, Al-Azhar University was founded in 970 in Cairo, and Mustansiriya University was founded in Baghdad in 1233. Students studied math, science and philosophy centuries before universities in the West opened their doors. Throughout its history, the region has been a crossroad of civilizations, attracting some of the world's largest empires, with merchants from as far as China travelling through and leaving their mark. The ancient empires of what is now the Arab region go as far back as 2000 B.C., when the Sumerians ruled the area.

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



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

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

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

While many Arab artists have made names for themselves, the region is much better known for its heritage sites, considered some of the most important in the world. These include the ancient pyramids of Egypt, the hanging gardens of Babylon in Iraq, the Roman city of Palmyra in Syria, the Roman ruins of Baalbek in Lebanon and the Nabatian city of Petra in Jordan.

In 1954, in response to the proposed Aswan Dam in Egypt, UNESCO launched a cultural heritage safeguarding campaign to protect the treasures of ancient Egypt, such as the Abu Simbel temples. The Abu Simbel and Philae temples were taken apart, moved to a higher location, and put back together. This led to further campaigns to preserve cultural heritage sites throughout the world. The Arab region boasts 65 UNESCO World Heritage sites, most of which can be found in the Eastern

Mediterranean countries of Egypt, the Occupied Palestinian Territories, Lebanon and Syria (UNESCO 2010).

UNESCO believes that it is important to foster worldwide understanding of Arab culture, which, throughout history has developed enriching contacts with the rest of the world. For example, Arab scholars such as the traveler Ibn Batuta, the scientist Ibn Sina and the philosopher Ibn Khaldun have expanded humankind's knowledge in the fields of geography, medicine and astronomy. Even relatively new cities in the Gulf, with their global influence, continue to spread Arab culture today (Matsuura 2003). The League of Arab States is working with UNESCO to educate and preserve cultural traditions of the Arab region. However, despite successful efforts made by both organizations, the shifts from traditional to modern ways of life have often come at the expense of historical preservation.

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

In the future, the biggest threat to the Arab region's cultural history could be environmental degradation. With population pressures, rapid economic development and the impacts of climate change, the challenges to the conservation and management of World Heritage sites are formidable. This is particularly true for developing countries with weak institutions, policies and management (UNESCO 2009). Although laws aimed at preserving ancient sites have had a measure of success, the region's rapid urbanization remains an ongoing threat that is placing tremendous stress on these priceless monuments.

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





**Dugong (*Dugong dugon*)**

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

# 1.3 BIODIVERSITY

## ECOSYSTEMS, SPECIES, THREATS AND CONSERVATION

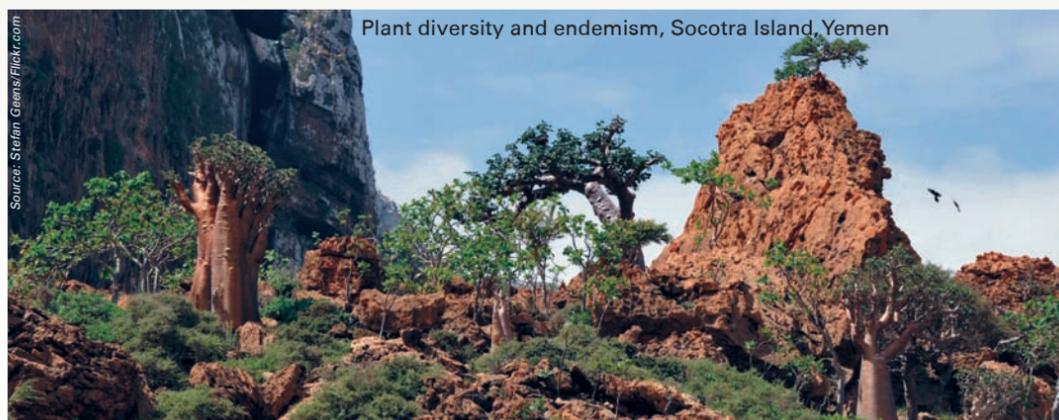
The biosphere, the relatively thin layer of Earth where all life occurs, is a mosaic of living communities of species interacting with their environment; a mosaic of ecosystems. Biodiversity (or biological diversity) is the term given to the variety of life on Earth and the natural patterns it forms,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

### Terrestrial Biodiversity

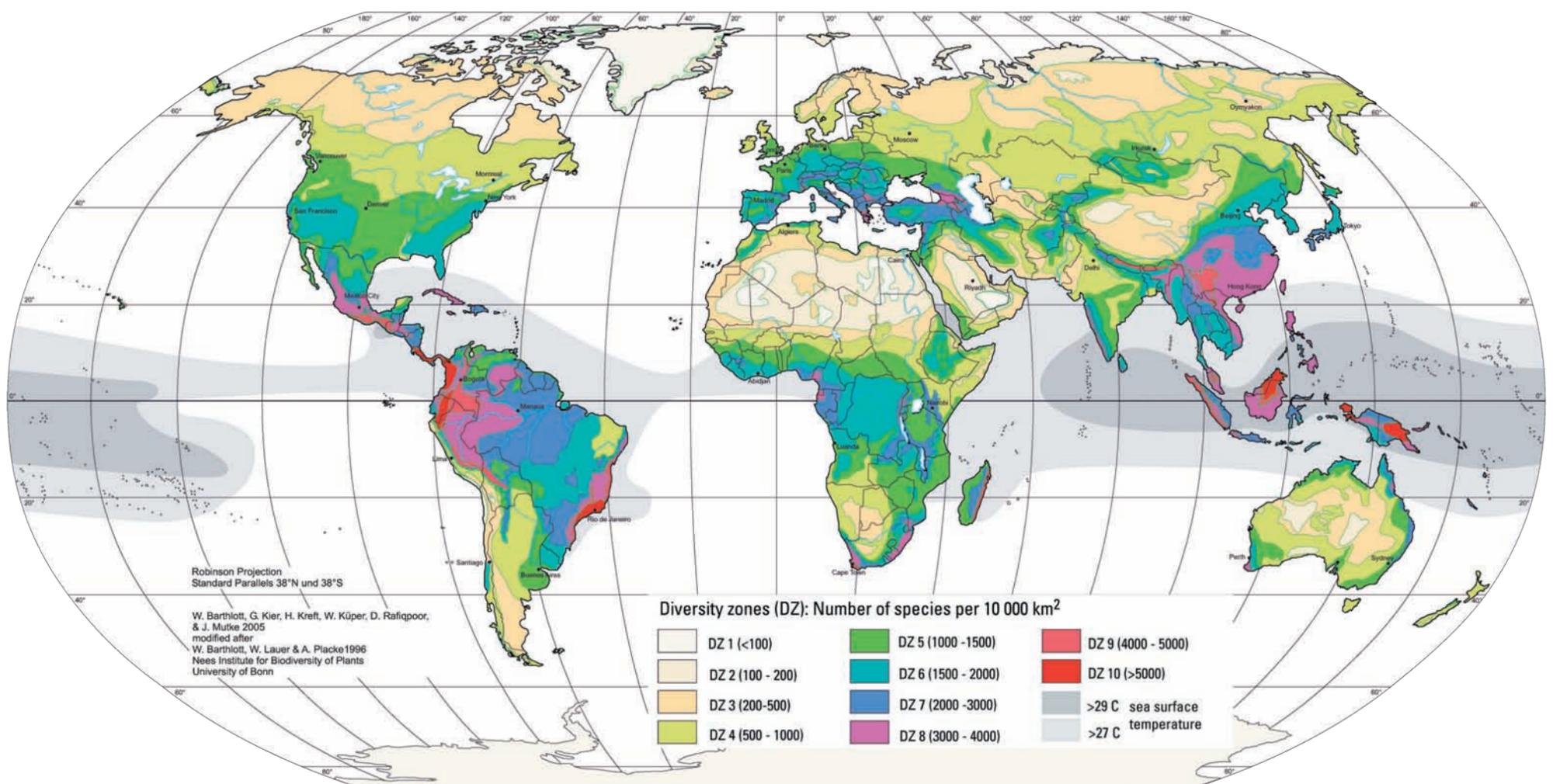
The Arab region is a meeting place and a transitional area between various phytogeographic and zoogeographic regions of the world. Floristic elements of five floral provinces exist in the region representing the Mediterranean, Irano-Turanian, Saharo-Sindian, and the Sudano-Deccanian (Zohary 1973). The spectacular terrain and various climatic conditions that prevail in the Arab region, along with the diverse biogeographic origins of the species, contribute to the diversity of flora and fauna at the species level, particularly to the endemism of these taxa. The number of plant species varies among the sub-regions of the Arab region, reaching up to 4 000 species in some countries. Morocco, Tunisia, Iraq and Algeria have the

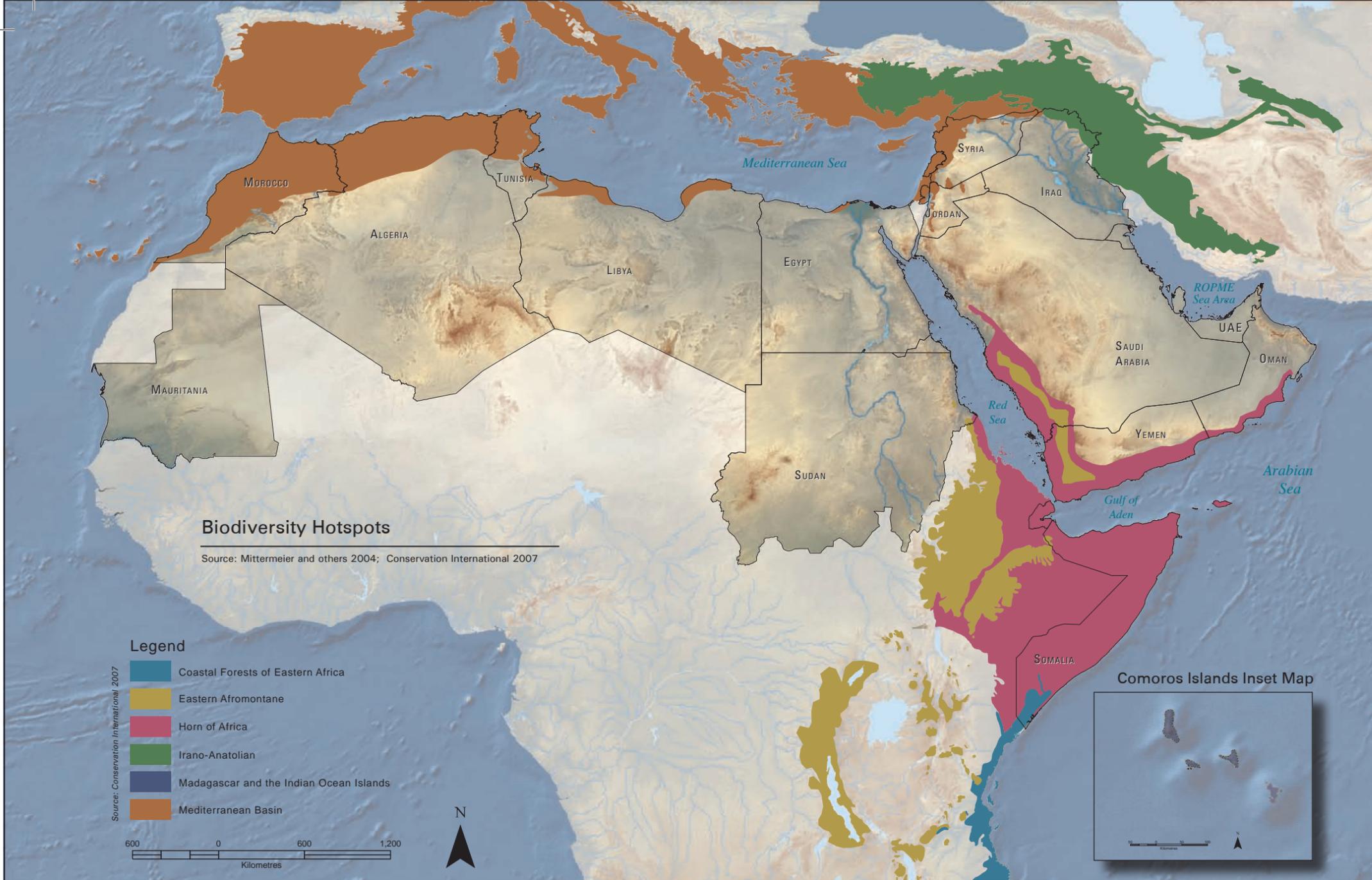
highest number of known vascular plant species, while Kuwait, Bahrain, Qatar, and the UAE have the lowest. A large number of endemic taxa also occur in the region; the total number of known endemic flora is about 3 397 (Boulos and others 1994; Ghabbour 1997).

Of the six major faunal realms, three are represented in the region: the Palearctic, the Ethiopian and the Oriental (Ghabbour 1997). There are approximately 1 700 mammals, of which 39 (or 3 per cent) are endemic (WRI 2002; Animal Info. database 2005; SCBD 2010). In addition, 30 species of birds are endemic to the region along with 132 species of reptiles and eight amphibians (FAO 1997; WRI 2002; SCBD 2010). Endemism is highly exceptional in some localities like Socotra archipelago where more than 30 per cent of the biota is endemic. For the Arab region, mammal species diversity is fairly low and ranges from 0.002 to 0.005 km<sup>2</sup> (Mackay 2009).



Global Biodiversity: Number of Vascular Plant Species





## BIODIVERSITY HOTSPOTS

There are 34 internationally recognized biodiversity hotspots in the world representing various habitats (Conservation International 2007). By definition, these hotspots are home to at least 1 500 species of endemic vascular plants and have lost at least 70 per cent of their original natural vegetation (Conservation International 2007). These hotspots represent some of the most remarkable places on Earth, yet they are also the most threatened—as reservoirs of some of the richest plant and animal life on Earth, their conservation is essential.

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



## Arab Region Biodiversity Hotspots

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

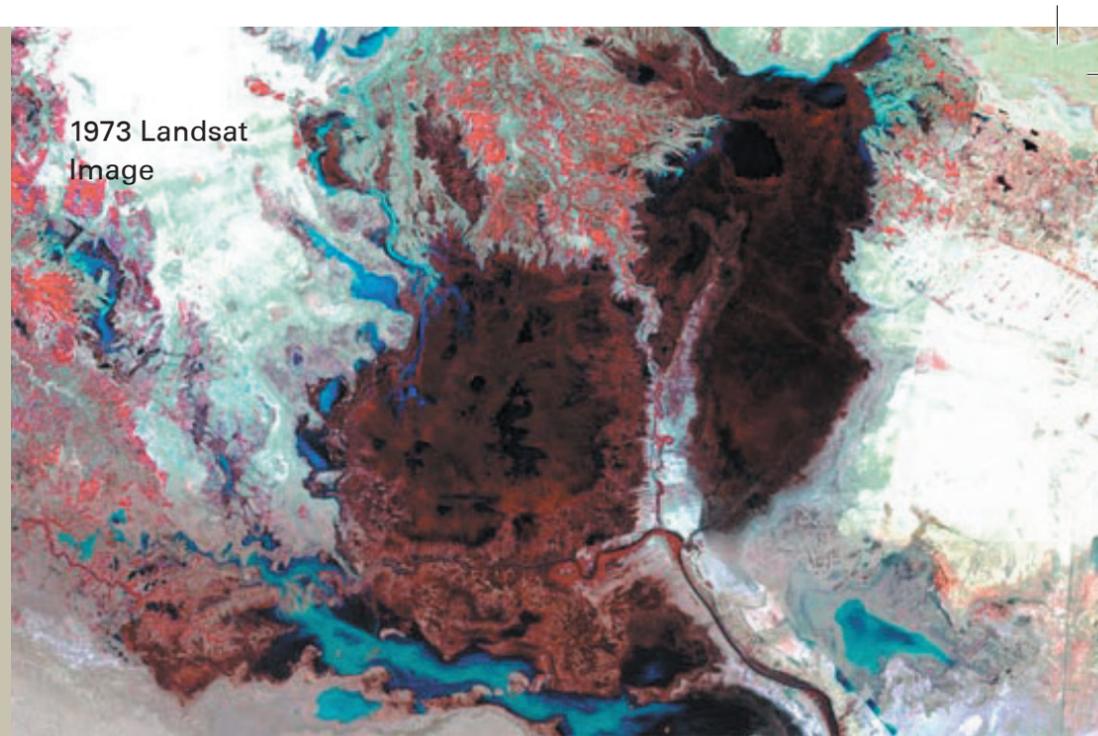
**Mediterranean Basin Hotspot-** This hotspot stretches over 2 085 292 km<sup>2</sup> and includes parts of European Mediterranean countries, Turkey, the Mashreq and Maghreb countries of the Arab Region, as well as around five thousand islands scattered throughout the Mediterranean Sea. It includes 15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

## MESOPOTAMIA WETLANDS

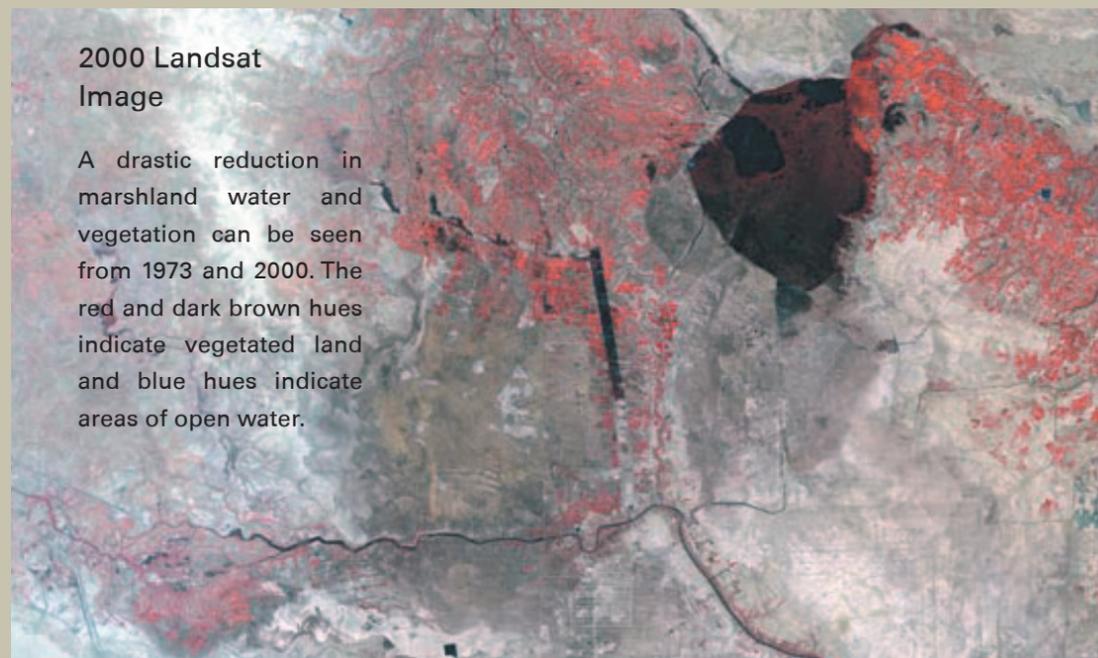
### “THE DEMISE AND REVIVAL OF AN ECOSYSTEM”

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

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



1973 Landsat Image



2000 Landsat Image

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

### Coastal Forests of Eastern Africa-

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

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

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

## SOCOTRA ARCHIPELAGO, YEMEN

### A WORLD HERITAGE SITE -“GALÁPAGOS OF THE INDIAN OCEAN”

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

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



Source: Stephen Geens/Flickr.com

## MANGROVE ECOSYSTEMS

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

Mangroves entrap sediments and nutrients, reducing seawater turbidity. Mangrove forests along the coasts of the ROPME Sea Area and the Red Sea are experiencing pressures due to the combined effects of grazing and cutting, commercial shrimp farming, pollution and large-scale development along the coasts of Arabia and Egypt (PERSGA 2004). The coastal zone in Bahrain was increased by 40 km<sup>2</sup> in less than 20 years due to reclamation projects (see Bahrain's profile in Chapter 3) (UNEP

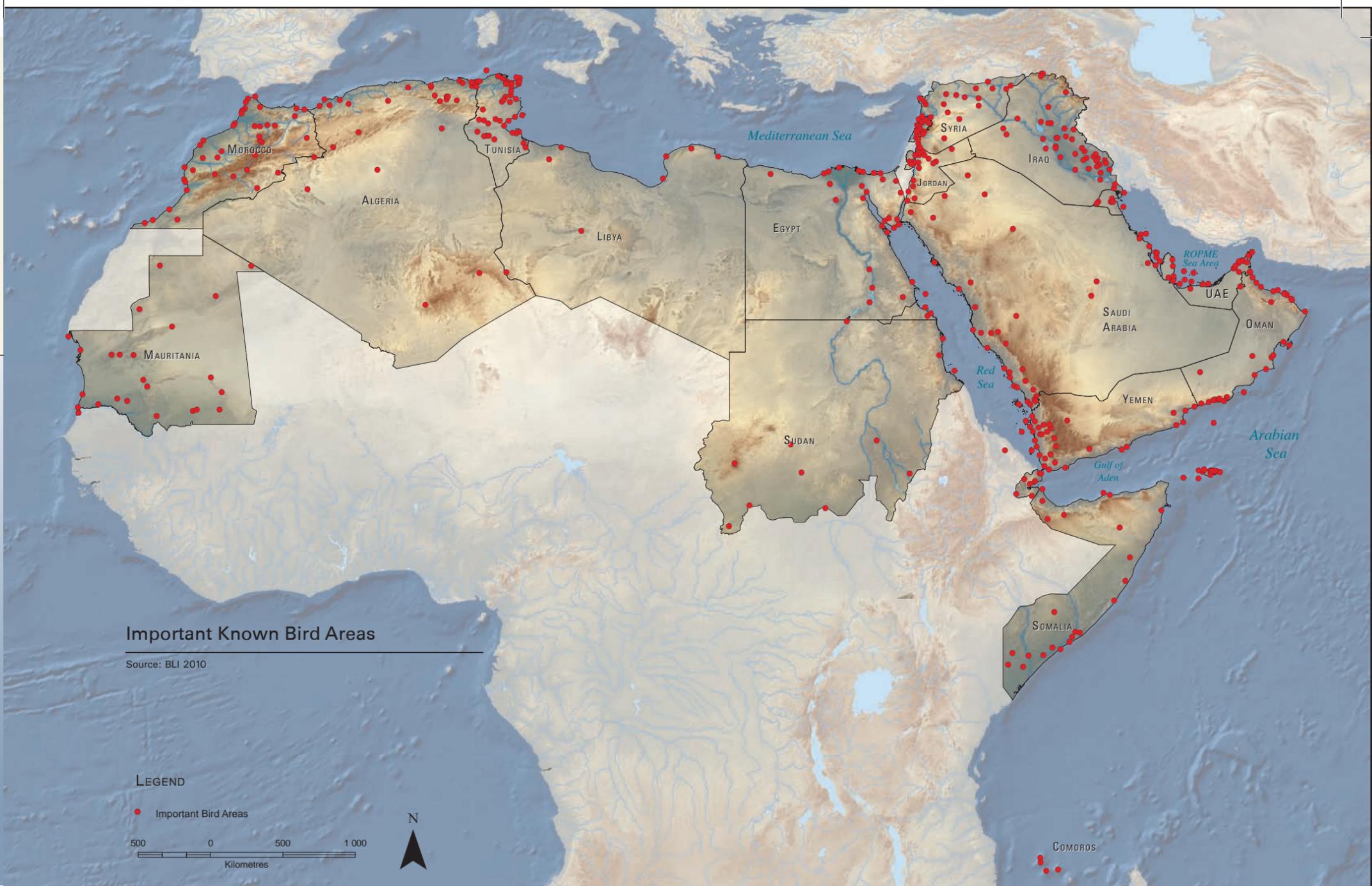
2004). In Saudi Arabia, more than 40 per cent of the ROPME Sea Area coastline was reclaimed and almost 50 per cent of the mangroves were lost (Sheppard and others 1992). Similarly, the Palm Islands on the coast of Dubai (UAE) will increase Dubai's shoreline by 120 km (see UAE's country profile in Chapter 3 for more information). This trend is affecting pristine areas and disturbing critical habitats.

## IMPORTANT BIRD AREAS

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

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

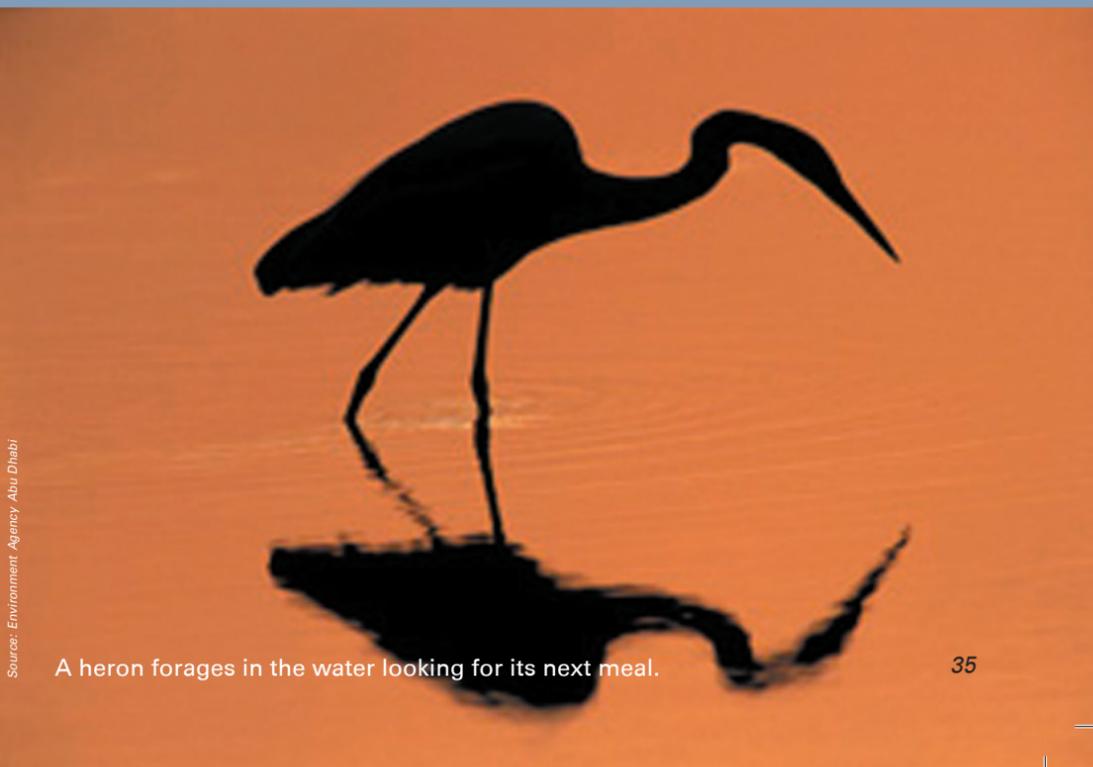
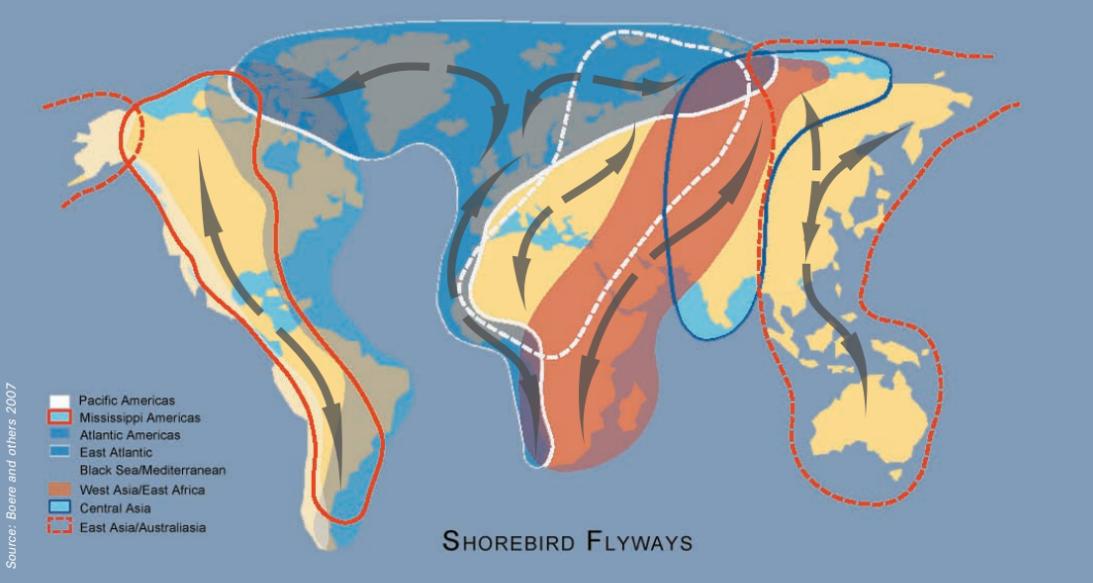
Mangrove ecosystem



## MIGRATORY BIRDS

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

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



## BIODIVERSITY THREATS AND CONSERVATION

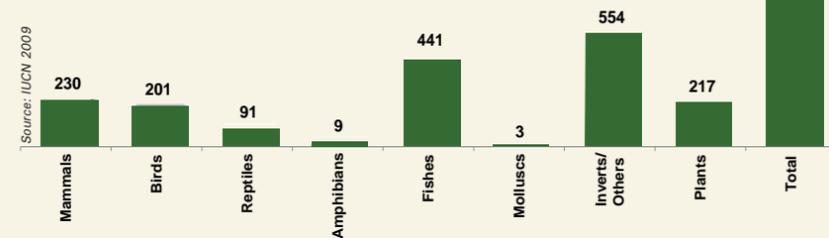
### Threats

Biodiversity is declining across the Arab region due to habitat degradation and loss, and associated species decline. Species populations, especially of large mammals, have declined in the last 100 years as a result of habitat degradation and over-hunting. The Queen of Sheba's gazelle (*Gazella bilkis*), the Asian lion (*Panthera leo persicus*) and the Ostrich (*Struthio camelus syriacus*) became extinct in the wild in the last century (IUCN 2009). Presently, pressures on species are still mounting, endangering some species survival and restricting others to smaller areas. Scimitar-horned oryx (*Oryx dammah*) is now extinct in the wild over all its range in the Maghreb sub-region; other species such as the Arabian tahr (*Hemitragus jayakari*), Rhim (*Gazella leptoceros*), Cuvier's gazelle (*Gazella cuvieri*) and Mesopotamian fallow deer (*Dama mesopotamica*) are considered endangered (IUCN 2009). Northern Bald Ibis (*Geronticus eremita*) is a critically endangered bird (IUCN 2009) and the Mediterranean monk seal (*Monachus monachus*) and sea cow (*Dugong dugon*) are two critically endangered sea mammals in the Mediterranean Sea and ROPME Sea Area (IUCN 2009). Others such as cheetah (*Acinonyx jubatus*), wild goat (*Capra aegagrus*), mountain gazelle (*Gazella gazella*), dorcas gazelle (*Gazella dorcas*), and Reem gazelle (*Gazella subgutturosa*) are vulnerable throughout their natural range in the Arab region (IUCN 2009).

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

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

Threatened species in the Arab Region (totals by taxonomic group)



13 per cent of which are mammals, 12 per cent birds, 5 per cent reptiles, 0.5 per cent amphibians, 25 per cent fish, and 12 per cent plants (IUCN 2009). A majority of these species are critically endangered (69 per cent of animals and 39 per cent of plants). The number of birds and reptiles threatened with extinction in the region doubled between 2002 and 2006, and the number of threatened fish species increased 14 times over this same period (UN/LAS 2007; IUCN 2009). In the Mediterranean, out of the nine species groups (amphibians, birds, cartilaginous fish, cetaceans, crabs and crayfish, endemic freshwater fish, mammals, dragonflies and reptiles) one-fifth are threatened with extinction - 5 per cent are critically endangered, 7 per cent endangered and 7 per cent vulnerable (Cuttelod and others 2008).

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

### Conservation

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

**1 746** species; the total number of known threatened species in the Arab region.

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

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



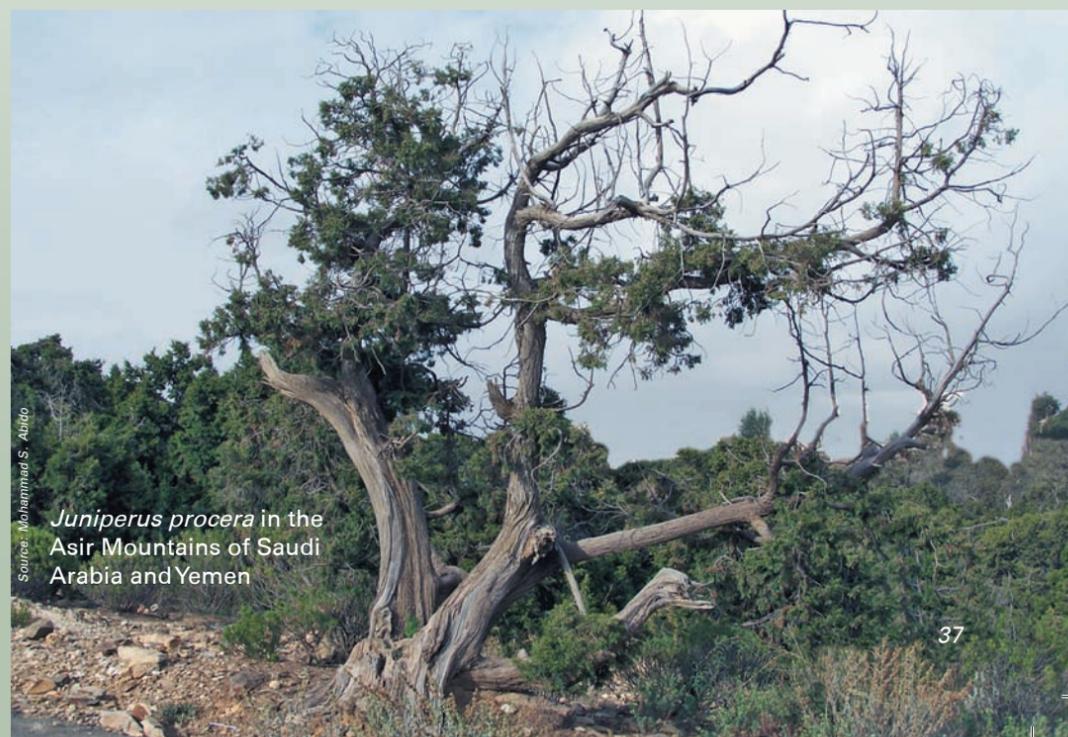
## SOUTHWESTERN ARABIA

### A CASE OF ECOSYSTEM DECLINE

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

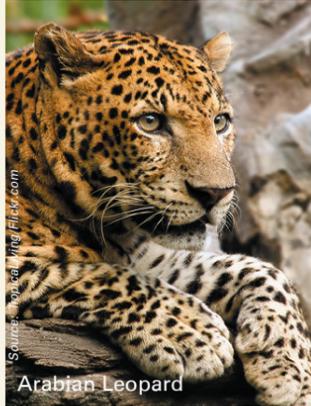
Arabian Peninsula. Habitat loss across its range, along with hunting, are the gazelle's primary threats.

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



## THREATENED SPECIES

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

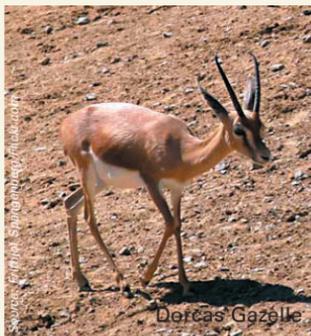


### The Arabian Leopard (*Nimr*) (*Panthera pardus*)

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

### The Arabian Oryx (*Oryx leucoryx*)

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



### Dorcas Gazelle (*Gazella dorcas*)

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

### Northern Bald Ibis (*Geronticus eremite*)

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



### Dugong (*Dugong dugon*)

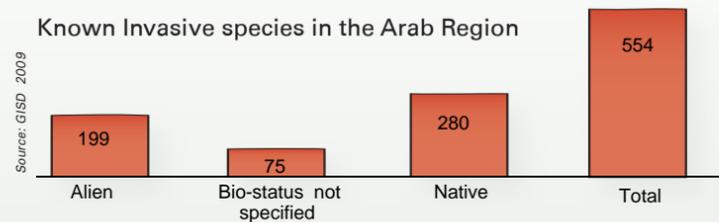
The dugong, vulnerable throughout its range, is declining or extinct in at least one-third of its range; its status is unknown in half of its range and considered stable in the remainder on the remote coasts of Australia. Australian waters are estimated to support upwards of 85 000 dugong, while the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

### Mediterranean Monk Seal (*Monachus monachus*)

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



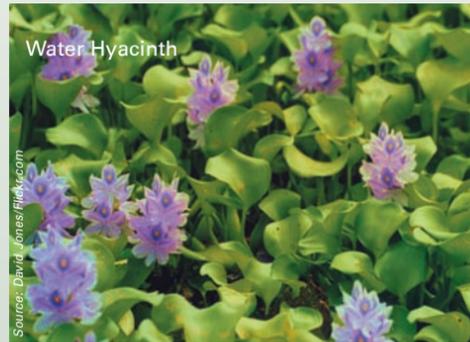
## INVASIVE SPECIES



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

### Mesquite (*Prosopis juliflora*)

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

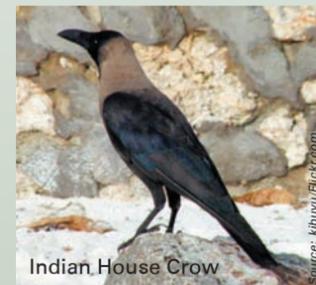


### Water hyacinth (*Eichhornia crassipes*)

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

### The Indian house crow (*Corvus splendens*)

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



### Red palm weevil (*Rhynchophorus ferrugineus* Olivier)

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

### The wild common carp (*Cyprinus carpio*)

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



## THREATENED SPECIES RICHNESS IN THE MEDITERRANEAN

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

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

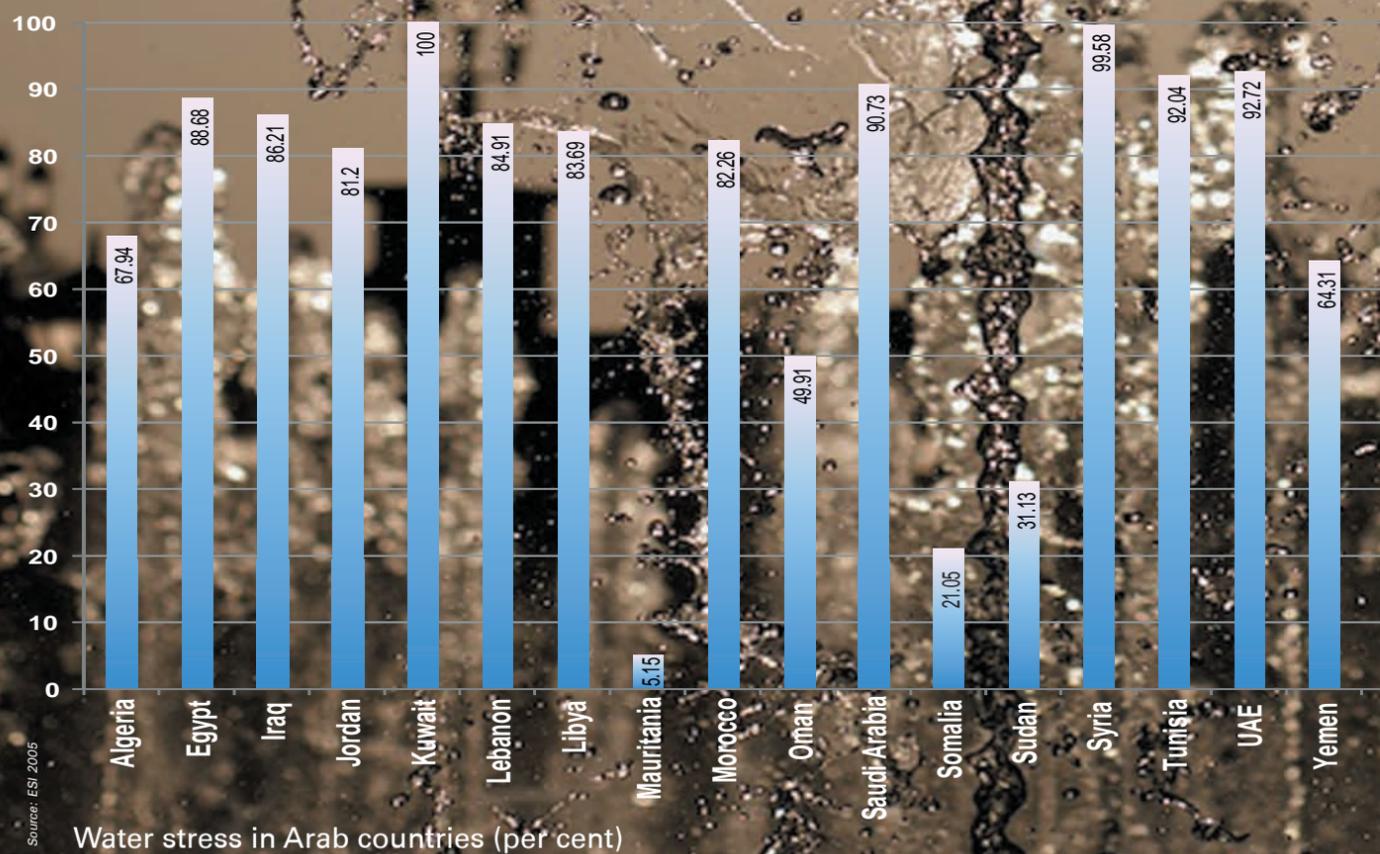


### The most significant threats for Mediterranean species (by order of importance)

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

Source: IUCN 2009

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



Water stress in Arab countries (per cent)

## 1.4 CHALLENGES AND OPPORTUNITIES

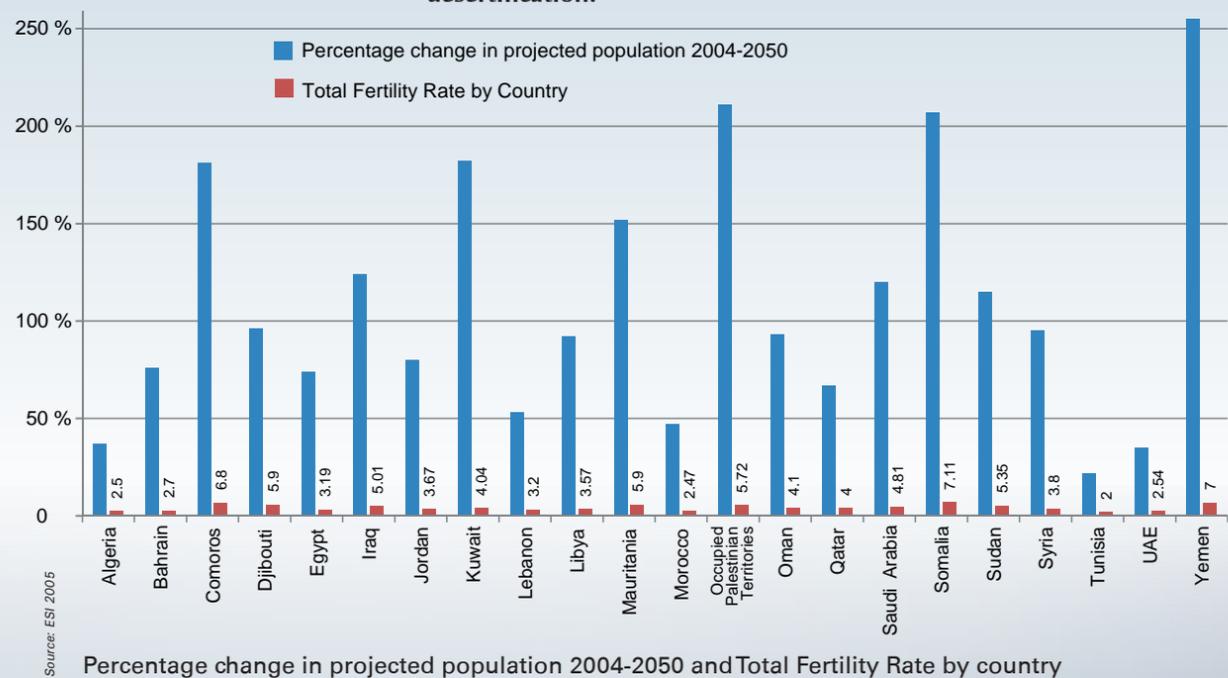
The Arab region is facing distinctive environmental circumstances and challenges. Although this region is endowed with some unique and rich natural resources, it is also scarce in renewable natural resources, such as water and land resources. Moreover, the environmental agenda has not been given adequate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

### Challenges

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

- Limited freshwater resources, over-exploitation of ground and surface waters and contamination by industrial, agricultural and domestic wastes;

- Rapid urbanization resulting from high population growth rates and the influx of migrants from rural areas and outside the region, which has led to environmental degradation and pollution;
- The depletion of natural resources and encroachment of agricultural lands as a result of the need to maintain economic growth and satisfy the needs of expanding populations;
- The vulnerability of many Arab settlements to environmental risks and natural disasters, including the impacts of climate change, such as heat waves, floods, sea-level rise, the loss of biodiversity, drought and desertification.



These challenges are exacerbated by a number of issues, including poverty. The Arab region has poverty levels that are significantly lower than those of countries with similar levels of income, mostly due to effective safety nets. Rates of poverty decreased substantially from 1970 to 1980 (the proportion of the population living with less than one dollar a day in the region went from 11 to 2.4 per cent). Poverty rates again decreased substantially during the periods 1990 to 1995 and 2000 to 2004 (UNDP 2005). Access to basic human amenities, however, are lacking in many Arab countries, particularly the non-oil producing nations such as Yemen, Somalia and the Sudan.

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

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

Management of resources in the Arab region is a major issue. The Arab region possesses significant reserves of oil and natural gas. Arab countries invest most of the profits from oil and natural gas sales in American and European companies (El-Naggar 2005). For example, in 2000, oil-producing Arab countries invested an estimated US\$1.4 trillion outside the



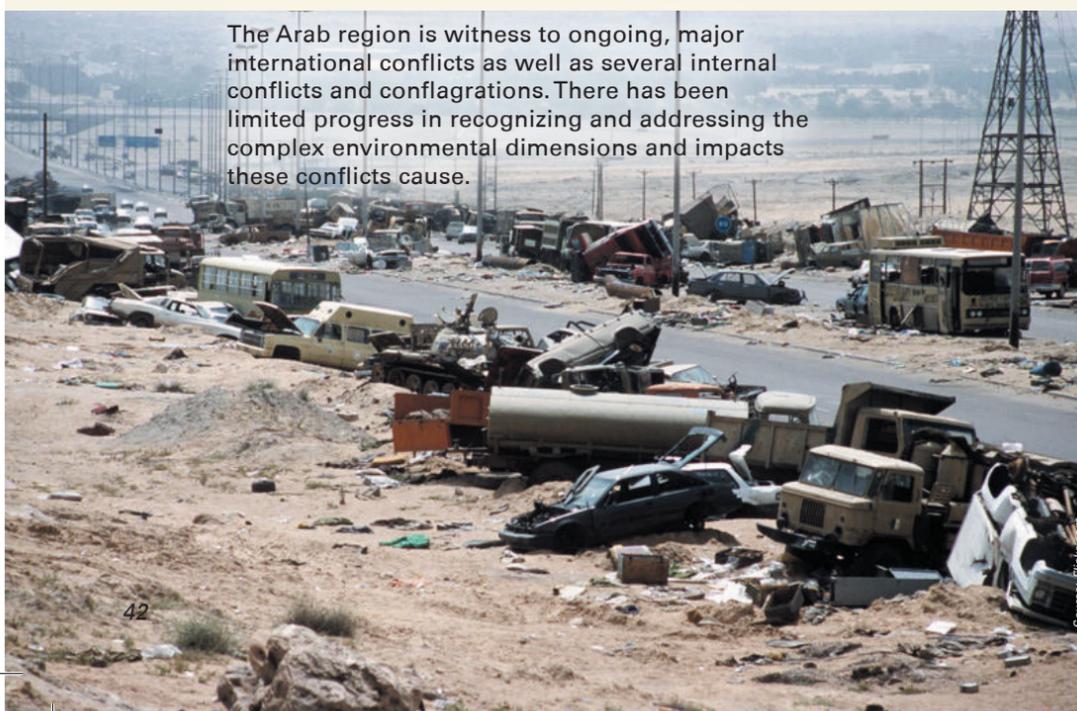
Slum settlement outside of Baghdad, Iraq.

region, despite the fact that economic and social development initiatives in the region are desperately seeking funding. Many Arab oil-producing countries depend on foreign labour, which often means that earnings are transferred outside the Arab region in the form of remittances rather than reinvested locally (El-Naggar 2005).

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

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

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





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

## Opportunities

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

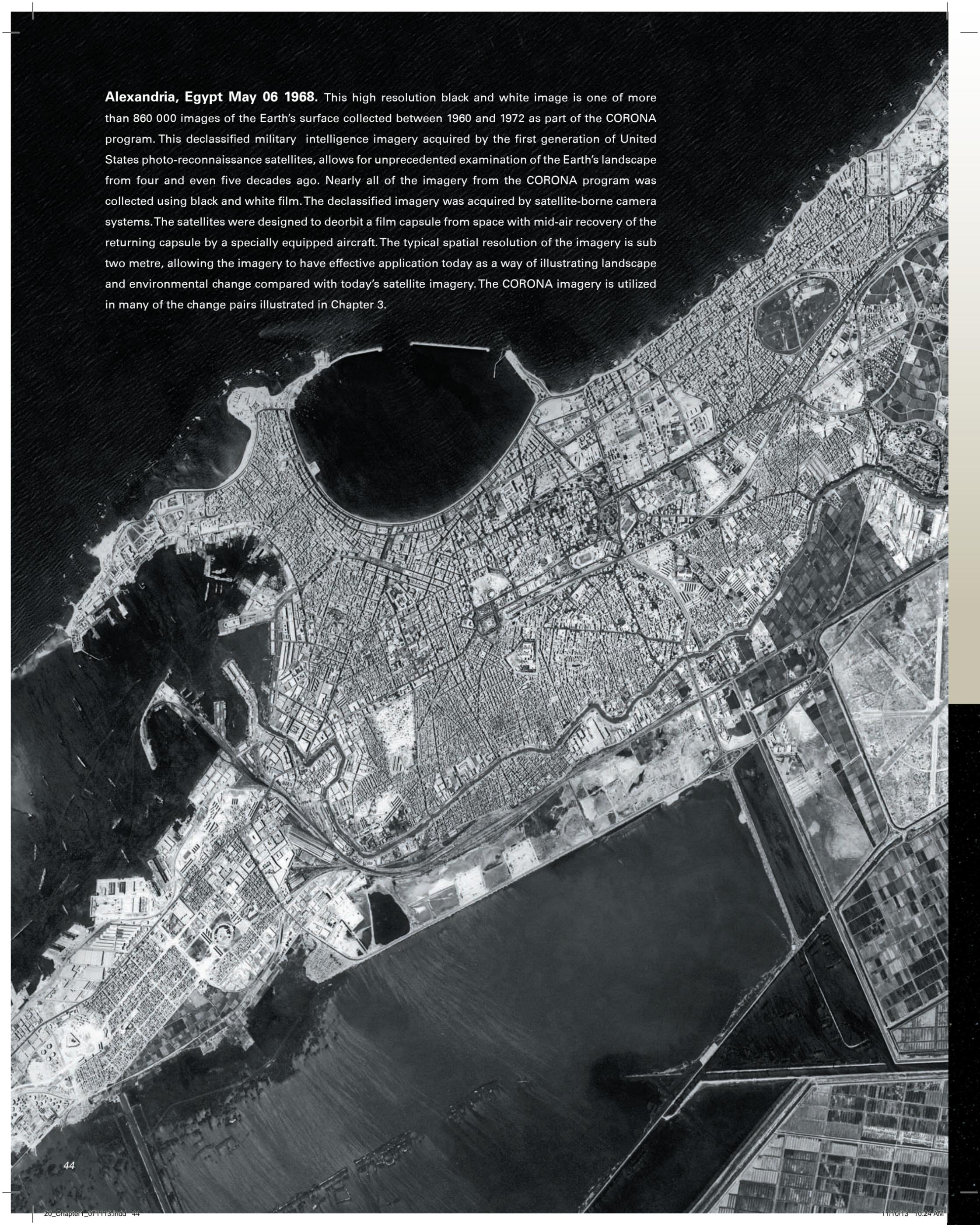
General economic improvements have a positive impact on natural resources, human resources and overall quality of life. The Council of the Arab Economic Unity (CAEU), which has been in effect for decades, will promote inter-Arab trade and prepare for establishing the Arab Common

Market during 2017-19. CAEU has also prepared a strategy for Arab economic integration from 2000 to 2020. This strategy is meant to serve as an investment map for Arab countries and includes a mechanism for developing investments in the Arab region and promoting greater intra-Arab regional trade.

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

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

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



## 1.5 EARTH OBSERVATIONS

### ENVIRONMENTAL MONITORING AND MODERN TECHNOLOGY



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

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

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

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



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

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

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

Egypt is a pioneer in the Arab region with the first remote sensing centre established in 1976. Saudi Arabia has invested considerable resources in creating a remote-sensing infrastructure; the Saudi Centre for Remote Sensing, established in 1983, has advanced data analysis capabilities (Johnson and Levite 2003). Saudi Arabia has been in the satellite field for years with its SaudiSat micro-satellite programme. Saudisat 1A and 1B

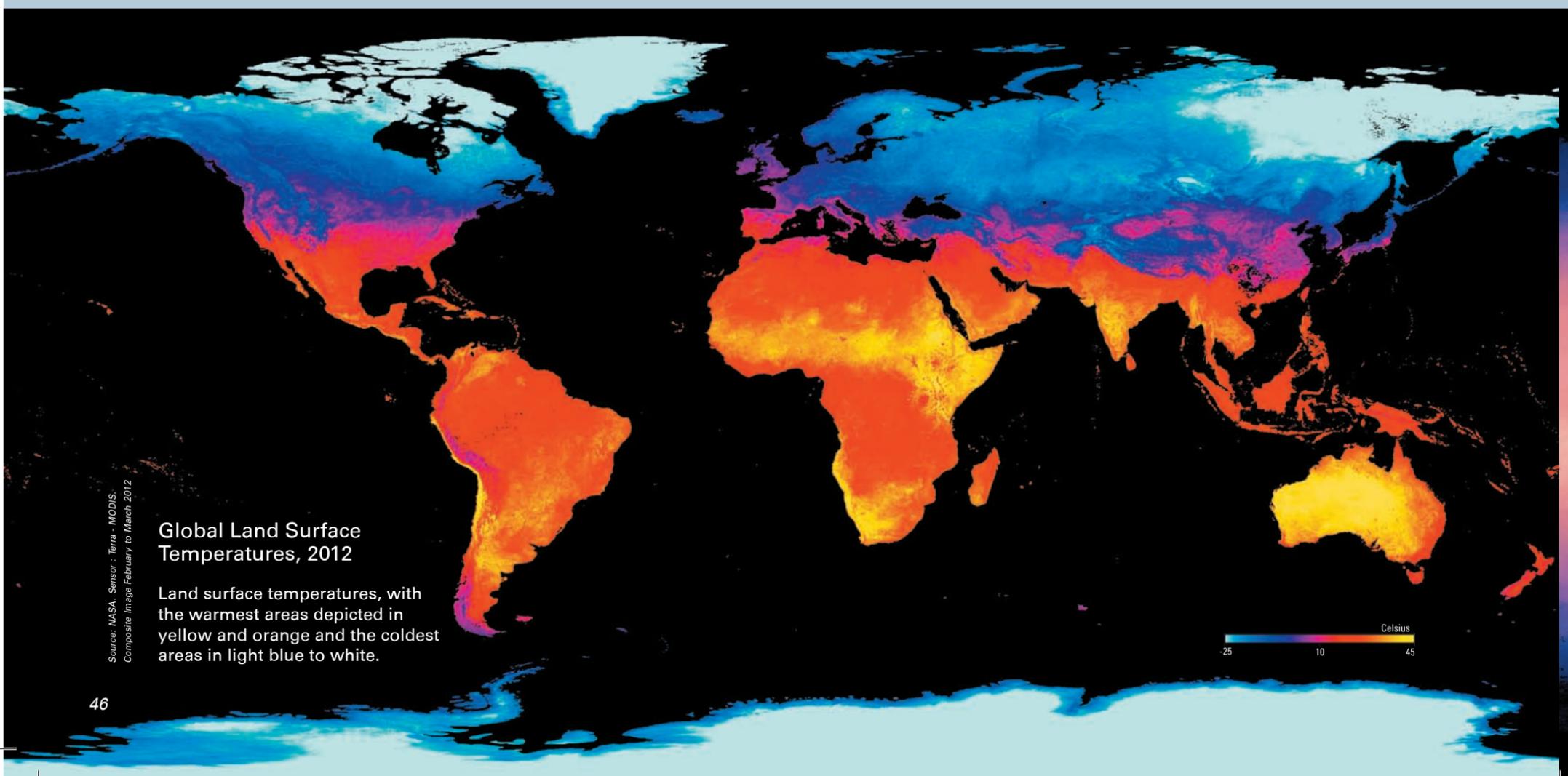
were developed by the Saudi Institute for Space Research at KACST (King Abdulaziz City for Science and Technology), Riyadh.

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

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

### Global Land Surface Temperature

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

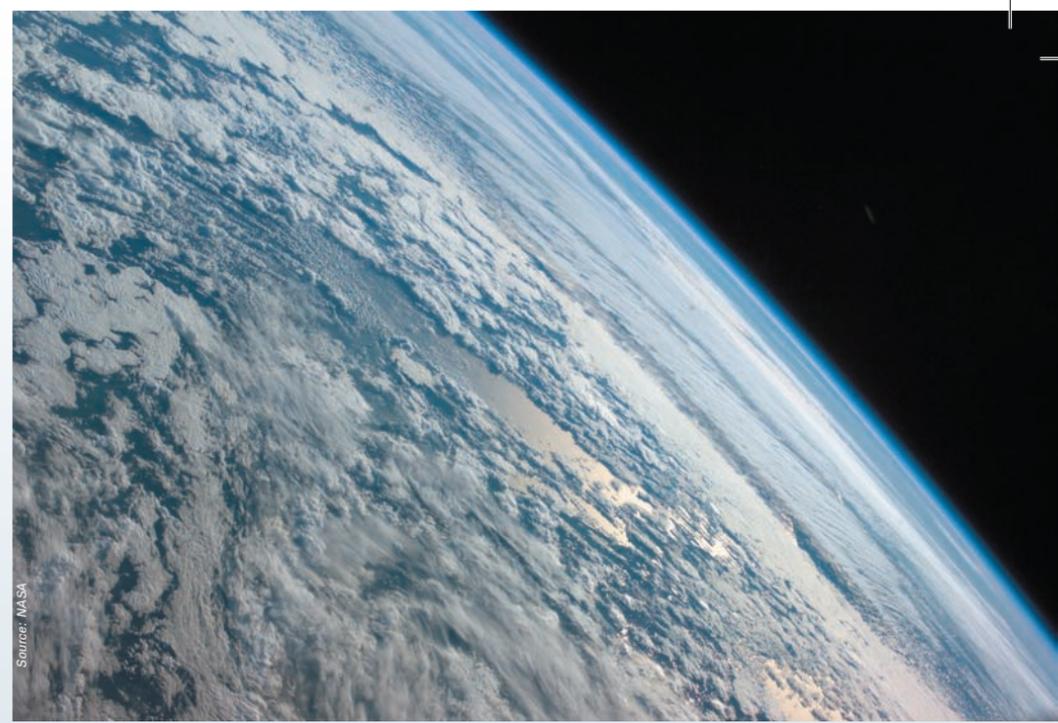


## Global Sea Surface Temperature

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

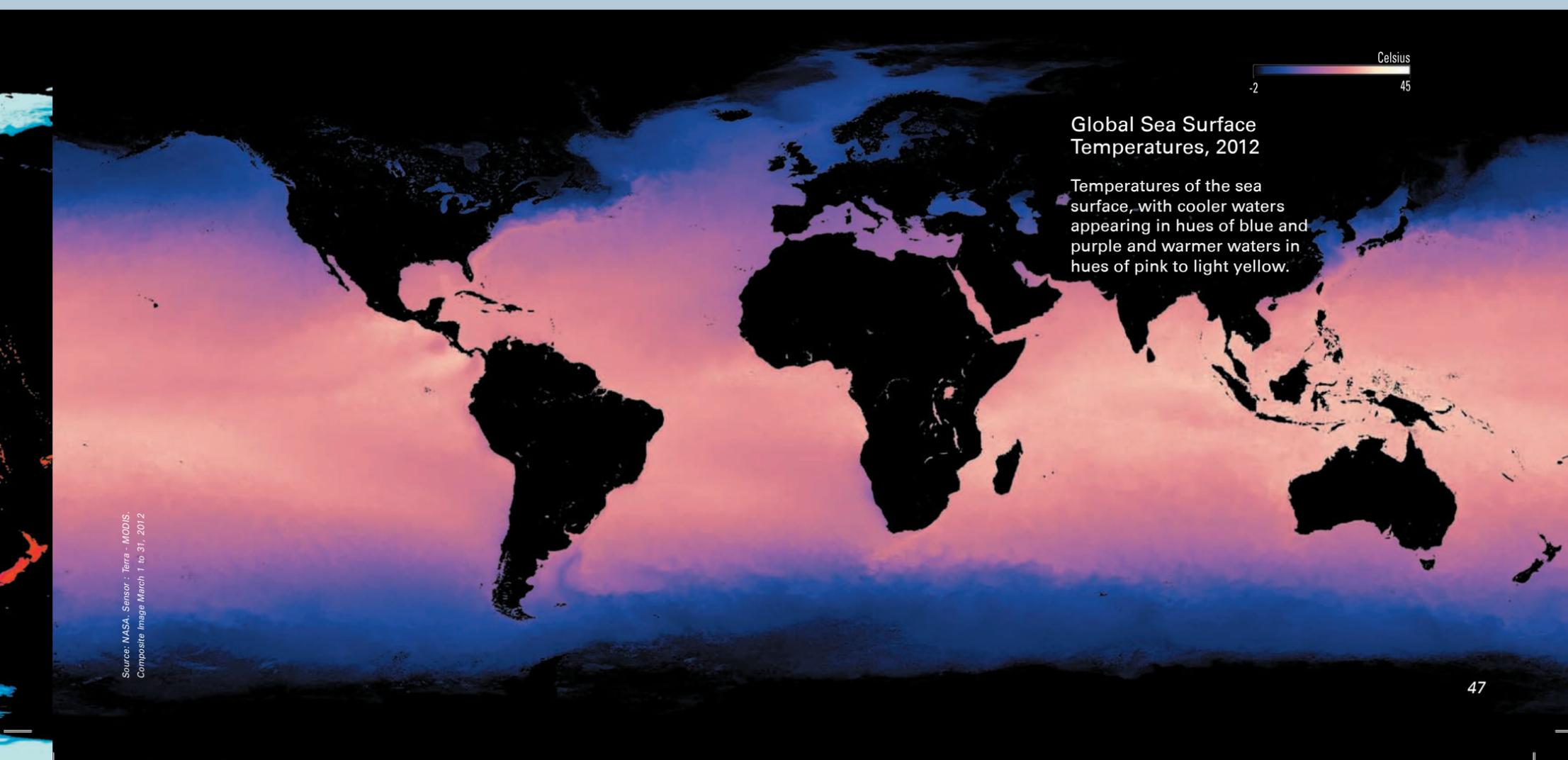
## Remote Sensing in Oil and Groundwater Exploration

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



for exploration purposes but also for oil spill planning and response.

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



U N I T E D A R A B E M I R A T E S  
A B U D H A B I

Land Use Change in Abu Dhabi, UAE  
1965 to 2009

These images display Abu Dhabi's astounding growth from 1965 to 2009, driven largely by wealth derived from the oil and gas sectors. Rapid urban development and economic growth in Abu Dhabi has occurred mostly on the coastline, which has had significant effects on coastal and marine ecosystems.

**22 May 1965**

0 4 8 Kilometres



U N I T E D A R A B E M I R A T E S  
A B U D H A B I

**13 Jul - 12 Aug 2009**

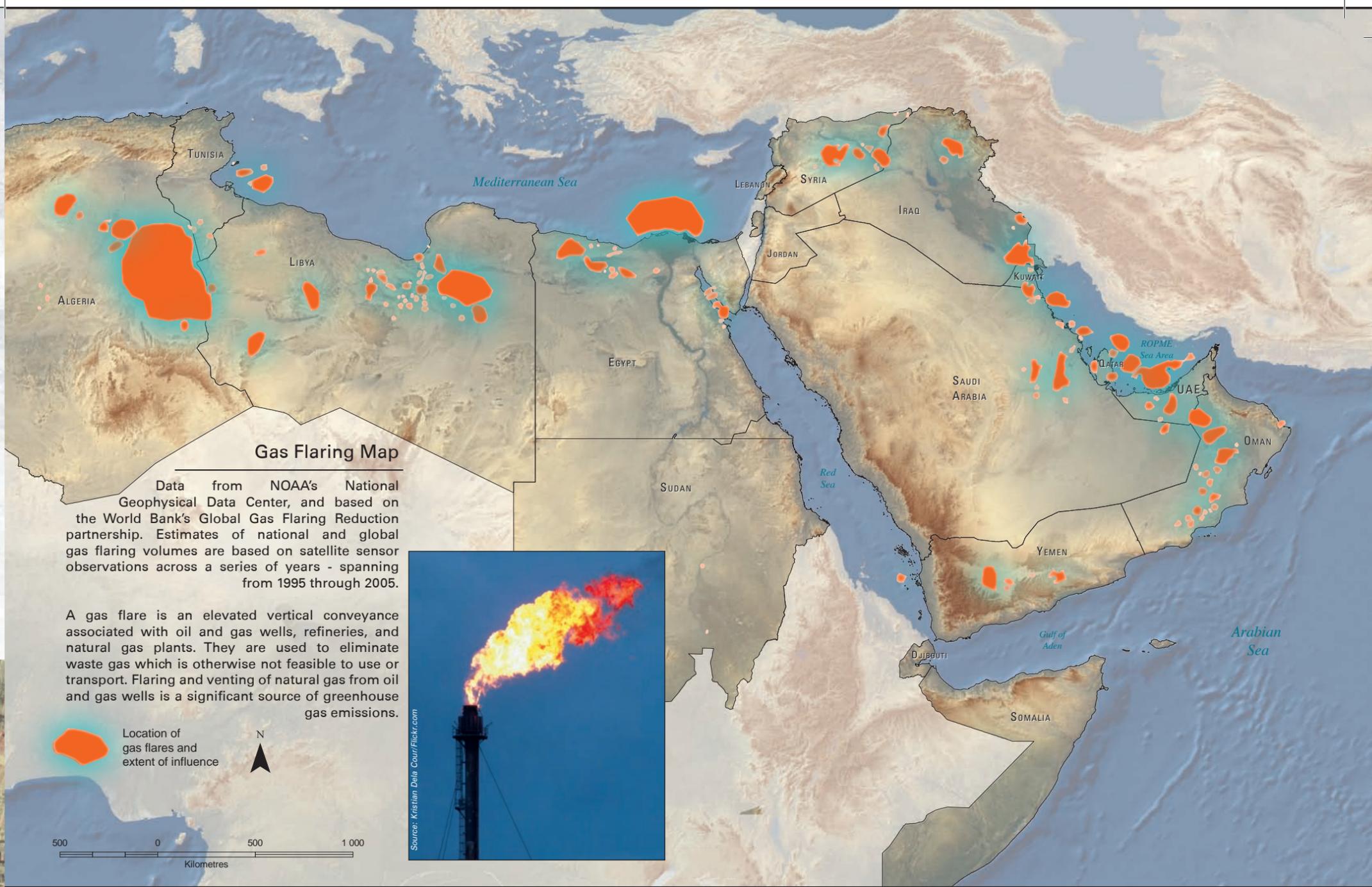
0 4 8 Kilometres



### Monitoring Land Use Change in Coastal Areas

In the last few decades, dynamic changes have occurred along the world's coastlines. As of 2003, three thousand million people—or half of the world's population—lived within 200 km of a coastline; by 2025 that figure is likely to double (Creel 2003). As the 'earth at night' imagery displays (shown at the beginning of this section), much of the population of the Arab region is confined to these coastal areas, mostly due to the extensive desert that covers much of the region. Coastal areas along the Mediterranean, Red Sea and ROPME Sea Area are experiencing heavy pressures from population growth and urbanization. Socio-economics play a significant driving role in putting pressure on the coastal zone, for example part of the Nile delta coast is completely re-shaped due to socio-economic and market trends in the last two decades (Abou El-

Magd and Hermas 2010) Sea level rise associated with climate change will impact huge areas of Arab coastal lands—in fact, a one-metre rise in sea level is expected to directly affect 41 500 km<sup>2</sup> of coastal area, mostly in Egypt, Tunisia, Morocco, Algeria, Kuwait, Qatar, Bahrain and the UAE (AFED 2009). These climate change scenarios, coupled with increased development of coastal areas, have forged the need to adapt land use regulations and apply remote sensing technologies to monitor coastal land use changes. Time-series satellite imagery and GIS models are being used in urban planning; for example, Oman used satellite imagery from 1991 to 2003 to analyze the extent of urban growth along a narrow strip of coastline (Al-Awadhi and Azaz 2003). These technologies are also being used to monitor mangrove habitat and seagrass beds in the emirate of Abu Dhabi, UAE (Howari and others 2009).



## Remote Sensing in Monitoring Desertification

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

## Gas Flaring

With over 30 per cent of the world's proven natural gas reserves and low production levels, the Arab region will account for some of the largest increases in natural gas production in the coming decades. Natural

gas, which is the cleanest fossil fuel, is increasingly comprising a larger proportion of world energy consumption; in 2007, natural gas contributed 21 per cent of global electricity generation, up from 12 per cent in 1973 (IEA 2009).

When crude oil is brought to the surface during the extraction and production process, the associated gas also surfaces and may be used at the installation as fuel, transported elsewhere, or injected into the ground; where there is a lack of gas infrastructure, this associated gas is usually released into the atmosphere by flaring or venting. For years, gas flaring has been an accepted practice in the industry; however, today it is considered to be wasteful and harmful to the environment. Though gas flaring declined by more than 13 per cent between 2005 and 2008, globally it remains a significant issue with over 140 thousand million m<sup>3</sup> of natural gas flared annually, which is equivalent to the combined gas consumption of Central and South America (World Bank 2010). Gas flaring has a global impact on climate change by adding about 363 million tonnes of CO<sub>2</sub> (or around 1 per cent of total anthropogenic CO<sub>2</sub> emissions) in annual emissions. Satellite data are being used to estimate global gas flaring volumes to determine the effectiveness of efforts to reduce gas flaring over time and to improve spatially explicit estimates of anthropogenic carbon emissions into the atmosphere (NOAA 2010c) — the top gas flaring countries in the world identified using satellite data from 2005 to 2008 are: Russia, Nigeria, Iran, Iraq and Algeria (World Bank 2010). Future reductions in gas flaring will lessen the waste of this valuable energy resource and reduce the amount of carbon dioxide emitted into the atmosphere.

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