



CHAPTER **2**

OVERVIEW OF ARAB REGION ECOSYSTEMS

Lead Author

Nancy Kanbar

Main Messages

The Arab region is endowed with a diverse set of ecosystems. However, this rich diversity is subject to a high degree of environmental risks.

The Arab region's ecosystems include dryland, forest, mountain, cultivated, coastal, marine and urban ecosystems. These systems are under severe pressures and challenges due to many natural events and anthropogenic activities.

Political unrest and armed conflicts can heavily contribute to ecosystem degradation.

The factors behind poor ecosystem services in many Arab countries are mostly anthropogenic, including pollution, population increase, urbanization, over - harvesting, lack of awareness and lifestyle.

Deterioration of the ecosystem can cause extreme poverty, particularly in communities where the poor depend on natural resources for nutrition, employment and income generation.

Extensive ecosystem consumption, with the subsequent resource depletion has been a major reason for the deterioration reported.

Climate change is one of the potential threats to a number of ecosystems, with special reference to dryland and coastal ecosystems. The expected drop in rainfall, as well as increase in temperatures in the Arab region will pose an extra burden on an already troubled ecosystem.

Arab countries need to develop and improve the sustainability of their ecosystems in order to conserve their services for current and future generations. In this respect, proper management and sound follow-up and maintenance programmes are considered the foremost response to help alleviate ailing ecosystem conditions.

2.1 KEY ECOSYSTEMS IN THE ARAB REGION

The Arab region refers to countries stretching from the Atlantic Ocean in the west to the Gulf in the east, and from the Mediterranean Sea in the north to the Horn of Africa and the Indian Ocean in the southeast. The Arab region covers an area of about 14.2 million km² with a combined population of 358 million people straddling North Africa and Western Asia. About 90 per cent of Arab land lies within arid, semi-arid and dry sub-humid areas (Abahussain and others 2002). The region consists of large arid deserts, namely the Sahara. It also contains several fertile lands, such as the Nile Valley, the High Atlas Mountains, and the Fertile Crescent which stretches from Iraq over Syria, and Lebanon and Palestine. The area comprises deep forests in Southern Arabia and Sudan.

Also, it includes key flowing rivers such as major parts of the Nile River, generally regarded as the world's longest river with a length of 6 650 km. Desert climate has ruled the majority of the Arab countries. Over time, conditions of repeated periods of drought, declining precipitation rates, irregular rainfall, heat waves and harsh winds have led to the diversity and fragility of ecosystems in these areas. Key ecosystems in the Arab region include drylands, forests, mountains, cultivated systems, and urban, as well as coastal and marine ecosystems. The following section describes these ecosystems, their characteristics and their main services.

2.1.1 Dryland Ecosystems

The World Atlas of Desertification defines drylands as areas with an aridity index value of less than 0.65 (Middleton and Thomas 1997). The UN Convention to Combat Desertification defined drylands as lands where annual precipitation is less than two-thirds of potential evapotranspiration. Dryland ecosystems are characterized by water scarcity, limited soil moisture, extreme rainfall variability, recurrent but unpredictable droughts, high temperatures, high evaporation rates, low soil fertility, high salinity, overgrazing and fires (Levy and others 2005). The water deficit of drylands limits agricultural production and has a great impact on livestock and humans. People in these areas attempt to expand agricultural production through shifting cultivation, reducing fallow periods, switching farming practices, overgrazing and cutting trees. All these practices result in greater environmental degradation.

Drylands constitute the vast majority of land in the Arab region. They dominate in areas like Saudi Arabia, the Great Sahara in North Africa and Empty Quarter in the Arabian Peninsula. Semi-arid systems are present in many areas like Aarsal, a mountainous locality (36 000 ha) in Lebanon, where nearly 5 000 ha are in serious danger of land degradation (Zurayk and others 2000). Dryland areas in general and those in the Arab region in particular are subject to land degradation, known as desertification and viewed as an expression of a persistent decline in the ability of dryland ecosystems to provide goods and

services. This reduction in land productivity in drylands is mainly caused by water and wind erosion, salinization, soil compaction and crusting, soil nutrient depletion, pollution, acidification, alkalization, and water logging (Oldeman 1994, Lal 2001, Dregne 2002). The dryland ecosystems are often associated with misery, poverty and conflicts (ICARDA 2006).



The Khanasser Valley in Syria, Site of a Long-Term Research Project to Fight Desertification
Source: ICARDA, 2006

Drylands are attractive for cultural tourism associated with historical and religious sites (such as El Maghara ecosystem), for coastal tourism (such as Mediterranean beaches), and for health-related tourism (such as the Dead Sea bordering Jordan and the West Bank). Despite harsh conditions, biodiversity and wildlife in drylands are quite high (White and others 2000); thus, they constitute major attractions for ecotourism (Oasis of Tafilalet, Morocco).



The Marsh Arab

2.1.2 Forest Ecosystems

Forest ecosystems occupy about 89.64 million hectares of land area in Arab countries (FAO 2007, Abido 2010). This represents only 7.2 per cent of total land area which is far less than the world forest cover of 30.3 per cent of total land area (UNDP 2009). It is estimated that about 83 per cent of forests in the Arab region are found in North Africa, Sudan and Somalia, with the remainder in the Mashriq countries and the Arabian Peninsula. Stretches of forest cover are found in Lebanon and Syria. The Green Mountains in Libya and the Atlas Mountains spanning from Algeria to Morocco are covered by forests (refer to table 2.1 for the most recent FAO data about forest cover in Arab countries).



Sudan Forests

Source: UNEP, 2007

Forests are central to human well-being and they have diverse ecological functions; namely, conservation of soil and water, positive effect on local climate, mitigation of global climate change, improvement of urban and peri-urban living conditions, protection of natural and cultural heritage, subsistence resources for many rural and indigenous communities, generation of employment, and recreational opportunities. Further, forests play a major role in the conservation of biodiversity as they provide habitation for about half of the world's known plant and animal species. Forest biodiversity is vital for the continued health and functioning of these ecosystems.

Table 2.1 Forest Area by Country in the Arab Region

Country	Forest area (1 000 hectares)	Per cent of total land area
Sudan	69 949 (of which 43.469 million* hectares in South Sudan)	29
Lebanon	137	13
Somalia	6 747	11
Morocco	5 131	11
Tunisia	1 006	6
United Arab Emirates	317	4
Syria Arab Republic	491	3
Iraq	825	2
Occupied Palestinian Territory	9	2
Comoros	3	2
Algeria	1 492	1
Yemen	549	1
Jordan	98	1
Bahrain	1	1
Saudi Arabia	977	not significant
Mauritania	242	not significant
Libya	217	not significant
Egypt	70	not significant
Djibouti	6	not significant
Kuwait	6	not significant
Oman	2	not significant
Qatar	0	0

*calculated by the author

Countries are listed by decreasing per cent of forest area of total land area.

Source: FAO, 2010. *Global Forests Resources Assessment (FRA 2010): Main Report*

Forests are not distributed evenly across the globe. Of the top ten countries with the largest forest areas in the world, Sudan (70

million hectares of forests) is the only Arab country on the list (FAO 2010). It is important to note that the 70 million hectares of forest



Barouk Mountain. Al-Shouf Cedar Nature Reserve, Lebanon

area for Sudan comprises the area in both the Northern and the Southern parts of the country. After periods of deadly conflict, South Sudan became an independent state on July 9, 2011 and joined the African Union on July 28, 2011.

Although forest ecosystems are relatively rare in the Arab world, forests can be found in some distinctive regions. Data from the FAO show that forest ecosystems in the Arab region are being degraded due to agricultural and urban expansion as well as fires. Despite negative trends, forests still retain the potential to meet growing human needs if managed more sustainably. Many countries have developed solid legislative, economic, and social policies for sustainable forest management. Significant progress has been made in establishing national forest programmes through

participatory processes for the development and implementation of forest policies. Close to 75 per cent of the world's forests are covered by such programmes (FAO 2010).

2.1.3 Mountain Ecosystems

Mountains offer different ecosystem services, including provisioning services like supply of clean water, plant and animal production, pharmaceuticals and medicinal plants, as well as non-timber forest products. Moreover, they supply regulating and supporting services; such as biodiversity, climate regulation and soil fertility. They are also important in offering cultural services, mainly recreation and cultural diversity (Körner and Ohsawa 2005). In addition, mountains have intrinsic spiritual and aesthetic values (Daniggelis 1997, Bernbaum 1998).

Sulaymen Frangieh/www.wikimedia.org



Horsh Ehdan Nature Reserve, Lebanon

In the Arab region, high and steep lands are spread in Yemen, Djibouti, Morocco, KSA, Oman, Iraq, and in the Eastern Mediterranean region such as Lebanon and Syria. For example, the Sarawat Mountains – also known as Sarat al-Asir or Sarat al-Hijaz – extend from the border of Jordan in the North to the Gulf of Aden in the South running through Saudi Arabia and Yemen, parallel to the western coast of the Arabian Peninsula. Elevations of this mountain chain average around 1 200 - 2 000 metres, but Sarat al-Yemen reaches heights of over 3 300 metres above sea level. The rocky formations of Sarawat Mountains contain vegetation, unlike the Atlas Mountains in



Michel Gagnon/www.wikimedia.org

Atlas Mountains



Mckaysavage/www.wikimedia.org

Tunisia Atlas Mountains & Mides Canyon

Morocco. Among the cities located within the Sarawat is the Muslim Holy city of Mecca. The Atlas Mountains are a range of mountains that extend across Northern Africa, about 2 500 km through Morocco, Algeria and Tunisia. The highest peak is the Toukbal Mountain, with an elevation of 4 167 metres in southwestern Morocco. The Atlas ranges separate the Mediterranean and Atlantic coastlines from the Sahara Desert. The population of the Atlas Mountains is mainly Berber. The mountains have been home to a number of plant and animal species unique in Africa, many of which are endangered or have already become extinct.

Mountain ecosystems are extremely fragile because they are subject to both natural and anthropogenic drivers of change, mainly volcanic and seismic events, flooding,

climate change, extractive industries, forest destruction, overgrazing, and inappropriate agricultural practices (Körner and Ohsawa 2005).

Mountain populations have evolved a high diversity of cultures, languages and traditional agricultural knowledge commonly promoting sustainable production systems. In general, poverty and ethnic diversity are higher in mountainous regions, and people are often more vulnerable than people elsewhere. Ninety per cent of the global mountain population lives in developing countries. It is estimated that 90 million mountain people are considered poor and vulnerable to food insecurity (Körner and Ohsawa 2005).



Siwa Oasis, Egypt



Kabylia, Algeria

2.1.4 Cultivated Ecosystems

According to the MA definition, “an area is considered cultivated if at least 30 per cent of the underlying 1x1-kilometer land cover grid cell has been classified as cropland” (Cassman and Wood 2005). About 24 per cent of the Earth’s terrestrial surface is occupied by cultivated systems.

In the Arab region, cultivated systems are mainly spread in Sudan and in countries with direct exposure to the Mediterranean Sea, like Morocco, Tunisia, Syria and Egypt. In these countries, landrace varieties of wheat are cultivated. In Egypt, new technologies have been introduced in order to improve water productivity and wheat production.

In Algeria, cultivated systems are found primarily in the Kabylia fields and in oases planted with palm trees. Another example of cultivated systems is Tafilalet in Morocco, the most important oasis of the Moroccan Sahara, where wheat has evolved into different varieties under very hot conditions. This new variety of wheat was able to develop genes heat-resistant to the harsh climate of the region (ICARDA 2008). In Siwa oasis, located 50 kilometres east of the Libyan border and 560 kilometres from Cairo, dates and olives are primarily cultivated. The waste products from the olive industry have land pollution consequences (Al-Khouly 2004). In the last twenty years, Siwa Oasis suffered from population growth, development activities, overgrazing, expansion of cultivation area, and increase in industrial activities.

2.1.5 Coastal Ecosystems

Coastal ecosystems are among the most prolific, yet vulnerable, ecosystems in the world (Agardy and Alder 2005). They are highly productive, valuable to human beings, and ecologically critical. Coastal ecosystems produce more services related to human well-being than most other systems (Agardy and Alder 2005). Nonetheless, these ecosystems are experiencing rapid environmental changes. In the last centuries, human reliance on coastal systems has increased with intensified demands of growing populations and the continuous pursuit for higher productivity.

The Arab region has 22.4 thousand kilometres of coastline and 16.6 thousand kilometres of rivers, freshwater and semi-freshwater lakes (UNDP 2009). Additionally, many coastal wetlands occur in many



Cultivated Systems in Tafilalet, Morocco

countries of the region, such as in Algeria, Morocco, Lebanon and Mauritania among others.

Population expansion in urban cities along the coastline in the Arab region is causing pollution problems and growing pressures on the natural resources. Coastal areas in Arab countries are inhabited by 40 to 50 per cent of their populations (UNDP 2009). These ecosystems are experiencing serious environmental challenges, mainly due to competition for land and natural resources (UN 2010). As most urban populations and associated commercial sectors in the Arab region are concentrated along the coastline, negative impacts are felt in coastal and marine ecosystems, especially related to the fisheries sector.

The region produces some 3.8 million tonnes of fish, mostly in Morocco, Mauritania, Egypt, Yemen, and Oman (UNDP 2009). Given the high level of economic productivity of coastal ecosystems, it is not surprising that overfishing and intensive aquaculture have caused significant ecological and social challenges in these ecosystems. With increased economic activity in coastal areas, particularly urban and industrial expansion, these ecosystems are being threatened by pollution from petroleum and heavy elements (UNDP 2009). Also, the wastewater release from cities and industries as well as agricultural run-off charged with chemicals have caused the depletion of the rich biodiversity of coastal ecosystems. For instance, in Lebanon, the Nahr El-Kalb watershed is a coastal area on the

Mediterranean Sea that has suffered severe pollution. Moreover, Shatt al-Arab, which is formed by the convergence of the Tigris and Euphrates rivers in Iraq, has become polluted due to the direct dumping of wastewater, industrial wastes, petroleum materials, and arms scrap after the Iraq wars.

2.1.6 Marine Ecosystems

In the Arab region, marine ecosystems are found in all countries of the region, such as Egypt, Lebanon, Syria, Yemen, Sudan, Libya, Algeria, Morocco, Tunisia, Oman, KSA, and other Gulf countries. Poor coastal



Figure 2.1 Jiyeh Oil Spill, Lebanon

communities in this region depend on the fisheries sector for nutrition, employment and income generation. Additionally, several countries in the Maghreb region rely on fisheries as a major export sector (UN 2010).

Many marine ecosystems in the Arab region, especially those in the Gulf and in a number of touristic resorts in other countries, show signs of stress due to invasive species, unorganized coastal development, pollution caused by large volumes of desalination plant effluents, coastal run-off from urban areas, as well as sewage and waste disposal. Other reasons leading to the degradation of marine biodiversity are the overexploitation of fish stocks and the pollution caused by oil exploration and industrial pollution (UN 2010).

Wars and conflicts in the region have also contributed to marine pollution. An example is the bombing of storage tanks at the Jiyeh power plant in South Lebanon in July 2006, which resulted in the release of approximately 10 000 - 15 000 tonnes of fuel oil into the Mediterranean (UNEP 2007). A substantial proportion of the spilled oil sank into the water covering the seabed over an area of a few hundred metres out to the sea and affecting about 150 kilometres of Lebanon's coastline. These damages adversely impacted the country's economy, environment, and public health. Negative effects were also recorded on environmentally sensitive ecosystems like the Palm Islands Nature Reserve, on nature-based tourism like sandy beaches, as well as on the livelihoods of fishermen and communities dependent on



Mediterranean Monk Seal

marine ecosystems (UNDP 2007). A World Bank study on the economic assessment of environmental degradation due to July 2006 hostilities in Lebanon estimated the overall cost of environmental degradation between US\$ 527 and 931 million averaging at US\$ 729 million, or about 3.6 per cent of GDP in 2006 (World Bank 2007b).

In an effort to conserve marine ecosystems and restore marine habitats and species, Arab countries recognize that national policies such as establishing marine protected areas are important. An example for such conservation effort is the Palm

Islands Nature Reserve, a unique and integrated natural marine-island ecosystem in the Eastern Mediterranean. The ecosystem is an important site for migratory birds and it is listed as a Wetland of International Importance in the directory of Birdlife International (Evans 1994).

2.2 OVERALL CONDITIONS, TRENDS AND IMPACTS

Ideally, conditions, trends and impacts refer to past and current conditions of ecosystems and their services. Human exploitation and abuse of these services put more pressures on fragile ecosystems and can lead to serious environmental impacts. Globally, about 60 per cent of ecosystem services that are directly associated with human well-being are declining (SCBD 2006, Abido 2010). Anthropogenic and environmental forces that drive ecosystem changes, and thus changes in ecosystem services, are highly variable in various locations. Thereby, general statements of causality are hard to create and a one-to-one linkage between particular driving forces and changes in ecosystems and their services is difficult to make (Janetos and Kasperson 2005).

This section explores the major changes in ecosystem services over the last few decades and the trade-offs that have occurred as a result of the increased exploitation of those services in the three sites selected by the Arab MA. Overall conditions, trends and impacts of these ecosystems will be described and the major drivers of change that have led to the

degradation of the environment in these sites will be discussed. The selected ecosystems include:

- El Maghara, Sinai Peninsula in Egypt.
- Tafilalet Oasis in the Kingdom of Morocco.
- Asir National Park in the Kingdom of Saudi Arabia.

2.2.1 El Maghara, Sinai Peninsula, Egypt

The Sinai Peninsula is a land bridge between Asia and Africa; it lies between the Mediterranean Sea to the north and the Red Sea to the south. This dryland ecosystem is characterized by the aridity of its climate and water scarcity, typical conditions in the Arab region. Sinai is distinguished by its sacred sites, such as St. Catherine's monastery, one of the oldest Christian establishments in the world, and Gebel Mousa where Moses is believed to have received the Ten Commandments.

El Maghara ecosystem in the Sinai Peninsula is known for its natural landscape, ecological landmarks, medicinal plants, biodiversity as well as its cultural and spiritual heritage. El Maghara ecosystem remains the one area in Sinai where Bedouin culture and tradition prevail. Bedouins in this region have the highest illiteracy rate in Sinai and the highest ratio of aged dependent inhabitants (UNEP 2010). Throughout history, the region was exposed to severe environmental degradation and loss of natural resources. With their indigenous knowledge and familiarity with the

harsh environmental conditions of the area, the Bedouins were able to survive the many problems they faced.

Today, El Maghara suffers from excessive environmental degradation; namely due to water scarcity, heavy pollution, resource depletion, land use changes and loss of biodiversity. Environmental degradation is considered a key factor underlying the high poverty level of local Bedouins. Climate aridity and water scarcity have severe impacts on agriculture, health, economy, education and migration in this ecosystem. With the impact of climate change, the possibility of less rainfall in drylands seems high and the situation is worsened.



Mohamed Tawfic

Bedouins of El Maghara, Sinai, Egypt

Source: UNEP, 2010

Additionally, harsh environmental conditions are caused by anthropogenic factors such as heavy industries, coal mining, overgrazing, clearing shrubs for fuelwood, and building new roads for quarrying. It is important



Mohamed Tawfic

Water Scarcity and Failing Crops in El Maghara

to highlight that El Maghara ecosystem is considered one of the most important floral centers for medicinal plants in the Middle East (Abd El-Wahab and others 2004, UNEP 2010). Unique traditional knowledge of these plants and their uses is held by the Bedouin tribes. However, severe environmental degradation has caused damage to the floral diversity of the ecosystem, affecting the welfare of the inhabitants. The natives of El Maghara area are among the poorest in Sinai. Since ecosystem services in El Maghara are a core component of human survival, it is believed that poverty in this region is partially an environmentally caused phenomenon.

Current conditions and trends of El Maghara ecosystem are highlighted. Special emphasis was laid on major services, namely floral

diversity, medicinal plants, and the provision of water and minerals. Laboratory and field observation techniques, image processing of satellite data, Geographic Information Systems (GIS) and remote sensing tools were useful in examining the ecosystem changes and the impacts caused by man-made activities. In addition, the Sinai assessment studied the socio-economic profile of the Bedouins through extensive meetings and interviews with the locals. Additionally, questionnaires were designed to map out the socio-economic conditions of the Bedouins in the various villages. The study sample targeted about 100 individuals from the assessment area. The elderly community represented a reliable source of information related to local knowledge and the use of medicinal plants (UNEP 2010). Women were knowledgeable about the floral species. The region was characterized by its relatively low population due to high out-migration of young males looking for job opportunities in other parts of Egypt.

The primary occupation of the Bedouin population is livestock grazing and agriculture. However, with the increasing water shortage problem and the severe droughts, unemployment in the region has become a serious issue. Poverty in El Maghara is not limited to the economic aspect but also includes lack of access to schools, clean water and social services (UNEP 2010). The survey attempted to rank Bedouin demands according to their importance. Results showed that 93 per cent of the Bedouins cited clean drinking

water and the availability of schools as top priority issues. Their other main concerns were the availability of irrigation water for agriculture, cited by 83 per cent, and the availability of electricity, cited by 62 per cent (UNEP 2010). The high environmental degradation in El Maghara ecosystem is a key factor underlying the high poverty level and the miserable quality of life of local Bedouins who depend on environmental resources for their livelihoods.

2.2.2 The Oasis of Tafilalet, Morocco

The oasis ecosystem of Tafilalet in the Kingdom of Morocco represents another example of the arid ecosystem in the Arab region. An oasis is “an area intensively cultivated in a desert or heavily characterized by the dry climate” (UNEP 2009). The oasis is located in the Sahara in southeast Morocco. This area is selected for examination due to its natural characteristics and the human-environment interactions. Protecting the oasis was identified as a priority and the study was developed by the Environment Department of the Ministry of Land Use, Water and Environment (MATEE) through the Moroccan National Observatory of the Environment (ONEM). The assessment aims at a systematic evaluation of the current conditions, trends and impacts of the ecosystem and its services as well as their effects on well-being. It provides decision-makers with information to design sustainable plans to improve the welfare of the local population who depend on the ecosystem resources.

Historically, humans were successful in developing the oasis civilization without degrading the environment. Today, environmental degradation, driven both by natural factors and anthropogenic actions, is reflected in the deterioration of the ecosystem and its services. The current state is aggravated by widespread poverty in the region. Problems such as population growth, water shortage and pollution, arid climate, recurrent droughts, and flashfloods are major issues.

Local communities, depending on agriculture for subsistence, exerted intense pressure on limited agricultural lands. This situation created desertification, soil erosion and sand encroachment, loss of productivity, salinity, overexploitation of palm and olive trees, as well as overgrazing and deforestation that seriously threaten the ecosystem. Despite the

richness of the oasis in biodiversity, many species are threatened with extinction due to the loss of natural habitats.

The diversity of the oasis is an attraction to many tourists. However, tourism in the area does not respect the natural environment.

The population of the oasis continues to grow rapidly. Population growth is accompanied by agricultural intensification and the expansion of infrastructure, which has caused intense pressures on the natural ecosystem. The population is poor and depends largely on the natural resources of the oasis, particularly agricultural lands. With high levels of unemployment, the inhabitants were forced to overuse agricultural lands to generate additional income. This situation further contributes to the ecosystem deterioration and loss of biodiversity (UNEP 2009).



Typical Fields of Traditional Agriculture, Tafilalet, Morocco

Source: UNEP, 2009

The oasis is largely characterized by limited water resources. Several factors contribute to excessive water shortages, mainly lack of and poor dam maintenance, low and irregular precipitation, poor water management, successive droughts, and unsuitable agricultural practices that threaten the sustainability of agricultural production. In addition, water quality in the oasis is polluted due to the lack of sanitation and wastewater treatment as well as waste dumping (Kelly and Mahboub 2006).

The climate of the oasis is characterized by its aridity. Recurrent droughts cause loss of agricultural productivity and desertification. Further, uncontrolled flashfloods threaten agricultural lands. In recent years, the problems caused by floods have intensified due to climate change and anthropogenic activities.

Agriculture in the oasis is generally traditional subsistence agriculture. It is practiced around water resources and it is characterized by a significant biodiversity, with local varieties, such as date producing palms and olive trees that are an income source for farmers. Currently, however, the increasing need for food has forced expansion into less fertile lands or overexploitation of existing ones. In addition, salinity, uncontrolled use of fertilizers, intense irrigation systems, and excessive pumping of groundwater have caused further loss of productivity. Additionally, sand encroachment and desertification, resulting from harsh weather conditions and anthropogenic actions, are other causes of environmental degradation, which have negative effects on the farmers' incomes (UNEP 2009).



Dates and Other Date Derivatives

Source: UNEP, 2009

The oasis of Tafilalet is classified among the main Moroccan palm areas. Palms produce dates and they are used for different purposes, such as, manufacturing doors, baskets, and ropes from their trunks and leaves. Currently, palms are suffering from overexploitation and are witnessing a sharp decline due to water shortage and desertification. Furthermore, the current date production is of poor quality, which negatively impacts their commercial values, and hence reduces the incomes of the local population. Similarly, olive trees are infested by insects that cause devastating effects threatening the sustainability of their production. Additionally, the local population generates income from animal production, such as cattle breeding, poultry and beekeeping. Though known for high productivity, beekeeping witnesses

a decrease in production mainly due to the degradation of nectar plants and bee mortality caused by pesticides overuse, drought, and diseases. Honey production, a valuable source of income, is negatively impacted (UNEP 2009).

Biodiversity in the oasis is rich in variety and in number of species available. However, many species are threatened with extinction due to the loss of natural habitats. Also, agricultural intensification and overgrazing have contributed to the loss of agrobiodiversity. The well-being of the local population, whose lives depend on wildlife and ecosystems goods and services, is affected. With their rich biodiversity, local traditions and the uniqueness of their landscape, the oasis is an attraction to many tourists. However, tourism development exerts a great pressure on natural resources, especially water. In addition, the region is known for its traditional crafts. Craftsmanship is an important source in promoting the socio-economic conditions of the local population, by creating additional incomes to the locals.

2.2.3 Asir National Park, Saudi Arabia

The assessment of Asir National Park (ANP) in the Kingdom of Saudi Arabia was undertaken with regard to the concepts of ecosystem services and human well-being (UNEP 2009). The objective was to examine the current conditions, trends and impacts of ecosystem change on humans' welfare. ANP is located in southwestern Saudi Arabia in the Asir Mountains that occupy the south part

of the Sarawat Mountains, extending from Al Taif in the north to Najran in the south. ANP represents a forest ecosystem in the Arab region. It is the first park established in the Kingdom and it was opened to the public in 1981. It has been estimated that 2 - 3 million tourists visit ANP annually.

The park is spread over 45 000 hectares and it encompasses three main habitat types: sandy desert, high altitude habitat, and the marine habitat of the Red Sea. It comprises four ecosystems; including a mountain ecosystem with juniper forests, a terraced agricultural area, a grazing land, and a coastal and marine ecosystem. The forest ecosystem is the main focus of this assessment because of its vital services, such as food, conservation of soil and water, mitigation of climate change, and protection of biodiversity.

The Kingdom of Saudi Arabia extends over an estimated area of more than two million square kilometers. It is known for its dry climate and its limited natural resources. Limited rainfall and recurrent droughts contribute to the high levels of water scarcity in the Kingdom. The inhabitants of the Asir Mountains were dependent on the natural forests. In the past, a traditional system called Al Hima was put in place by the local Bedouins in order to protect the forest ecosystem. Under Al Hima, no one was allowed to access the forests without the permission of the local tribe. Literally, the word 'Hima' means 'protected area' in Arabic.

Traditional Himas were very successful in integrating land conservation and sustainable use of natural resources with human well-being. In recent decades, however, the traditional Hima system has deteriorated.

Recent studies have warned of the many threats to the forest ecosystem in Asir, which are subject to severe deterioration. These threats include poor forest management, land-use changes, urban expansion and road construction, deforestation, wood cutting, overgrazing, uncontrolled pests and diseases, pollution, drought, erosion, soil salinity, hunting, overfishing, dumping of refuse, and abuse of agrochemicals (UNEP 2009). Consequently, Juniper forests in ANP have suffered tremendously. The forest outlook study carried out for Saudi Arabia in 2004 explained that if the current forest status persists, many of the southwestern forests of the Kingdom, including the Asir region, will lose their green cover, leading to environmental and socio-economic problems (Ministry of Agriculture of Saudi Arabia 2004).

Among all natural resources, water in the Asir region has the greatest impact on people and the ecosystem. Water scarcity is a major concern for human well-being in the region. Limited and erratic rainfall is the main sources of water. Water shortage forces people in this area to rely on the utilization of groundwater and desalinated water. Not only is the water availability a problem in the region, but water quality is also of great concern. A serious problem is water pollution where discharges from wastewater treatment

plants and septic tanks flow down into the Red Sea and affect the fish population and other marine biodiversity. Water pollution negatively affects all ecosystem services, such as food, agriculture, land and the fish population (UNEP 2009).

Assessment of the current conditions of the forest ecosystem in ANP has found that the area has undergone intense deterioration, which has adversely affected ecosystem services. These are likely to become exacerbated in the future as a result of many natural and anthropogenic drivers; such as population growth, urbanization, tourism pressures, agricultural expansion, road building within the forests, pollution, water scarcity, desertification and climate change. The Kingdom of Saudi Arabia, aware of these threats, is trying to enhance remediation efforts for a sustainable use of natural resources. However, despite the ongoing attempts to develop cost-effective conservation practices, the forest ecosystem degradation in ANP continues to take place at a fast pace.

2.3 LINKAGE TO GLOBAL ECOSYSTEMS

The MA is considered one of the most large-scale efforts to date that assesses ecosystem change and its impacts on human well-being. In addition to the global assessment of ecosystem changes, the MA includes a set of sub-global assessments at multiple spatial scales. These assessments are novel compared to other international studies that focus on global or regional scales

alone, in that they have provided valuable insights related to the influence of scale and knowledge systems on the complex relationship between ecosystems and human well-being. As for local assessments, they emphasize the importance of relationships between ecosystem services- particularly cultural services- and drivers of change that were often not observed at global scales (Capistrano and Samper 2005). Drivers of ecosystem change act in distinct ways in various regions. Although similar drivers were existent in different studied regions, the processes through which these interacting drivers cause ecosystem change vary among the sub-global assessments.

This section is intended to outline major trends of global drivers examined in the sub-global assessments. It will draw conclusions about the connections between Arab and global ecosystems. Examples include global population growth, urbanization and resource consumption, land cover change, the extensive use of fertilizers and pesticides to intensify agricultural production, fisheries exploitation, air pollution and climate change, land degradation, water scarcity and pollution, and loss of biodiversity.

2.3.1 Land Cover Change

Population growth and urbanization have caused changes in global consumption patterns, and increased demands for food and ecosystem services; resulting in land cover change, especially conversion to cropland. Growing demands for provisioning services lead to deterioration

in other ecosystem services. As forests are converted into cropped lands, the services they once provided decline. Currently, cropped areas cover approximately 30 per cent of the Earth's surface (UNEP 2005). The Arab region, dominated by drylands, shows various examples of land cover change in different countries; mainly due to agricultural intensification, overgrazing, deforestation and forest degradation, urbanization, as well as other anthropogenic activities and natural causes.

The findings of the sub-global assessments and the results of the current conditions and trends of the key ecosystems in the Arab region were consistent with global observations on land cover change (refer to section 2.2). For instance, population growth in the oasis of Tafilalet is accompanied by infrastructure works and agricultural intensification. In addition, land cover has been changed by other human activities, such as overgrazing, clearing shrubs for fuelwood, coal mining and quarrying industries (such as in El Maghara ecosystem). Land cover change comprises various processes, including urbanization and building new roads, deforestation and encroachment on natural ecosystems by agriculture (such as in Asir National Park).

2.3.2 Climate Change

Climate change is considered a major driver of ecosystem change on a global level. Continued greenhouse gas emissions at or above current rates would cause significant changes in the global climate system inducing increasingly warmer temperatures (IPCC



2007a). According to the Intergovernmental Panel on Climate Change, global mean temperature increased by 0.4°C to 0.8°C over the twentieth century (Petschel-Held and Lasco 2005). Most arid and semi-arid areas are projected to become drier with an expected increase in heavy precipitation leading to more floods and droughts (Nelson 2005). Worldwide, warmer temperatures and associated changes in the global climate have had many effects on biological systems.

In the Arab region, climate change represents an added stress that ecosystems are subjected to in this dry arid and water-scarce region. If current development activities persist, it is estimated that large increases in greenhouse gas emissions might occur during the next twenty to fifty years in the Arab region (UNEP 2009). Thus, air quality emerges as a very important environmental parameter that affects sustainable development on the regional as well as the global scale.

Emissions responsible for climate change and the impacts of this global challenge have undesirable consequences for all sectors of development. Thus, all ecosystems must be monitored and assessed for added risks from climate change. Managing climate risks and developing the resilience or adaptive capacity of the ecosystems is crucial to protect and sustain human lives and livelihoods. Countries of the Arab region need to consider their national and international policies for air emission control to manage the negative effects of climate change.

2.3.3 Land Degradation

Another global concern is land degradation in drylands known as desertification. The United Nations Convention to Combat Desertification (UNCCD) defines desertification as “land degradation in arid, semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities” (UNCCD 1994).

Desertification is accompanied by the persistent reduction in the provisioning services by drylands (Safriel and Adeel 2005). Factors such as population increase, land-use and land cover change, and climate change are expected to contribute to an accelerated water shortage and degradation of drylands. Safriel and Adeel (2005) indicate that the water availability in drylands is projected to decline from the existing average of 1 300 cubic metres per person per year (in 2000), which is already below the threshold of 2 000 cubic metres essential for minimum human well-being. This increased water pressure will lead to a further land degradation.

In the Arab region, the per capita renewable water resources are currently estimated at 1 100 m³ per year, compared to a global average of 8 900 m³ per person per year. This figure is expected to drop to 547 m³/year by 2050. Data show that fifteen of the 20 countries in the world with the lowest internal renewable freshwater supply (below the water stress threshold of 1 000 m³) are Arab countries (IFAD 2009).

The rainfall pattern further increases the problems of low productivity, low soil moisture, and salinization in drylands. The average amount of rain received by the Arab region is estimated at 2 148 km³ annually, of which about 50 per cent occurs in the Sudan (IFAD 2009). The oasis of Tafilalet and Asir National Park are ecosystem examples showing that extremes of natural drivers - such as rainfall fluctuations - when coupled with anthropogenic drivers - such as demographic, economic and socio-political drivers - jointly become drivers of change that push the exploitation of ecosystems, intensifying pressure on drylands and leading to further land degradation and decreased service provision (Safriel and Adeel 2005).

2.3.4 Loss of Biodiversity

Biodiversity is fundamental to the function of ecosystems. The Convention on Biological Diversity defines biodiversity as “the variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are a part, including diversity within and among species and diversity within and among ecosystems” (UNEP 2003). This definition is broad, and the sub-global assessments tackled particular components of biodiversity. For instance, the Sinai assessment focused on medicinal plants, the Asir National Park assessment concentrated on Juniper forests, and the oasis of Tafilalet focused on palm areas.

The majority of sub-global MA reports indicate that there is a consistent trend of biodiversity loss at the global level (Pereira and others 2005). This finding is supported by the global analysis of biodiversity trends (Mace and others 2005). Many drivers were examined in the assessment of biodiversity condition in different areas of the world. Habitat loss was one of the most significant drivers, with several assessments basing their results on land cover information derived from remote sensing data (such as El Maghara). Many sub-global assessments used the conversion of natural land cover to other land uses (agricultural intensification and building of infrastructure) as an indication of the condition of biodiversity loss (Asir National Park and Oasis of Tafilalet). Degradation of ecosystems by overgrazing and overutilization of natural resources (the intensive use of medicinal plants in El Maghara as well as the exploitation of palm trees in the oasis of Tafilalet) was identified as another important driver of biodiversity loss. Some sub-global assessments cited ineffective and uncoordinated land-use planning as the main reason for the poor condition of biodiversity. For instance, in El Maghara, there is no state control over medicinal plants, thus the intensity of abuse depends on the natural availability of those plants. Other drivers highlighted in different regions around the world were wildlife hunting and introduction of invasive species that alter ecosystems, causing global extinctions of indigenous species (data are lacking about the latter driver in the Arab region).

2.4 POLICY IMPLICATIONS: ECOSYSTEM CHANGE AND HUMAN WELL-BEING

Progress towards sustainable development is vitally dependent upon sound human decision-making regarding ecosystems. With its emphasis on the human dimension of ecosystem change, this chapter can be considered as a contribution for the search for a sustainable development for the Arab region. It is the central message of this chapter to show that the resolution of environmental problems involves real changes in the behaviors and decisions of people towards their natural surroundings. Ecosystems and environmental resources are becoming overused and polluted. Empowering local communities through public awareness and community participation will provide more opportunities towards sustainable development policies. Although the role of government and regulations is needed to manage environmental problems, the role of individuals and societies is central. The link between public awareness, policy structure, and institutional framework needs to be recognized. Approaches to dealing with sustainable development issues are often complex due to information imprecision (Sage 1999). Despite this complexity, a political will as well as the will of the local populations can help bring about win-win solutions.

Finally, the chapter clearly demonstrates that human aspiration for better well-being is usually the primary factor that explains trends and impacts of ecosystem

change. Nevertheless, the interactions of modern human activities with ecosystems have contributed to increasing human vulnerability and to the impact of ecosystem changes on well-being (De Guenni 2005). Proper ecosystem management remains an important tool to enhance human well-being. Climate change, access to clean water, food and energy are key factors that can impact the health, stability and security of individuals and communities.

Today, Arab countries realize the dependence of local communities on their ecosystems as well as the profound association between ecosystem conditions and development. Thus, policy makers in the Arab region are beginning to integrate environmental factors into development decisions. Despite the limitations of data in the Arab region as a whole, sufficient knowledge exists in most countries to apply sound ecosystem management practices and sustainable development strategies in order to provide opportunities for better human well-being.

References

- Abahussain, A.A., Abdu, A.Sh., Al-Zubari W.K., El-Deen N.A. and Abdul-Raheem, M. (2002). *Desertification in the Arab Region: analysis of current status and trends. Journal of Arid Environments*, vol. 51, Issue 4, August 2002, pp. 521-545. <http://www.sciencedirect.com>
- Abdel Wahab, R.H., Zaghloul, M.S. and Moustafa, A.A. (2004). *Conservation of Medicinal Plants in St. Catherine Protectorate, South Sinai, Egypt: Evaluation of Ecological Status and Human Impact*, Proceedings of the first international conference on strategy of Egyptian herbaria, pp. 231-251

- Abido, M.S. (2010). *Biodiversity in the Arab Region*, Environmental Outlook of the Arab Region, UNEP, LAS
- Agardy, T. and Alder, J. (2005). Coastal Systems. Chapter 19 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1, Island Press, Washington DC. <http://maweb.org/documents/document.288.aspx.pdf>
- Al-Khouly, A. (2004). *Effect of Human Activities on Vegetation Diversity in Siwa Oasis*. International Conference on Water Resources & Arid Environment
- Bernbaum, E. (1998). *Sacred Mountains of the World*. University of California Press, Berkeley, Los Angeles, London, pp. 291
- Capistrano, D. and Samper, C. (2005). Reflections and Lessons Learned. Chapter in: Millennium Ecosystem Assessment. Sub-global Assessment: Findings of the Multiscale Assessments. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Cassman, K. and Wood, S. (2005). Cultivated Systems. Chapter 26 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC. <http://maweb.org/documents/document.295.aspx.pdf>
- Cultnat (2012). Siwa Oasis, Retrieved 1 February, 2012, from <http://cultmap.cultnat.org/siwa locator>
- Daniggelis, E. (1997). Hidden Wealth. *The Survival Strategy of Foraging Farmers in the Upper Arun Valley, Eastern Nepal*. Mandala Book Point & The Mountain Institute, pp. 26
- De Guenni, L.B. (2005). Regulation of Natural Hazards: Floods and Fire. Chapter 16 in: Millennium Ecosystem Assessment. Current States and Trends: Findings of the Condition and Trends Working Group. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Dregne, H.E. (2002). *Land degradation in the drylands*. *Arid Land Research and Management*, 16(2), pp. 99-132
- Evans, M. I. (1994). *Important Bird Areas in the Middle East*. Birdlife Conservation, Birdlife International, Series No.2
- FAO (2010). *Global Forests Resources Assessment (FRA 2010): Main Report*
- FAO (2007). *State of the World's Forests 2007*. Rome
- ICARDA (2008). *ICARDA Annual Report*. http://www.icarda.org/Publications/AnnualReport/ICARDA_AR2008.pdf
- ICARDA (International Centre for Agricultural Research in the Dry Areas). (2006). *ICARDA Caravan*. Issue No. 23 December 2006
- IFAD (International Fund for Agricultural Development). (2009). *Fighting water scarcity in the Arab countries*
- IPCC (Intergovernmental Panel on Climate Change). (2007a). *Summary for Policymakers*. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
- Janetos, A.C. and Kaspersen, R. (2005). Synthesis: Condition and Trends in Systems and Services, Trade-offs for Human Well-being, and Implications for the Future. Chapter 28 in: Millennium Ecosystem Assessment. Current States and Trends: Findings of the Condition and Trends Working Group. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Kelly, Y. and Mahboub, A. (2006). Water resources in Guir-Rheris-Ziz areas, Acts of the international symposium. *Future of oasis vis-à-vis desertification*. FSTE, UMI, September 2006, Errachidia, Morocco

- Körner, C. and Ohsawa, M. (2005). Mountain Systems. Chapter 24 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Lal, R. (2001). Soil Degradation by Erosion. *Land Degradation & Development*, 12, pp. 519–539
- Levy, M., Babu S. and Hamilton K. (2005). Ecosystem Conditions and Human Well-being. Chapter 5 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1, Island Press, Washington DC
- Mace, G., Masundire, H. and Baillie J. (2005). Biodiversity. Chapter 4 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC <http://maweb.org/documents/document.273.aspx.pdf>
- Middleton, N. and Thomas, D. (1997). *World Atlas of Desertification*, Arnold, London
- Ministry of Agriculture of Saudi Arabia (2007). *Time series of agricultural statistics in Saudi Arabia during three decades*. Agriculture research development affairs, Department of planning studies and statistics. Riyadh
- Ministry of Agriculture of Saudi Arabia (2004). *Forestry Outlook Study for the Kingdom of Saudi Arabia*, Riyadh
- Nelson, G.C. (2005). Drivers of Ecosystem Change: Summary Chapter. Chapter 3 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1, Island Press, Washington DC <http://maweb.org/documents/document.272.aspx.pdf>
- Oldeman, L.R. (1994). *The Global Extent of Soil Degradation*. In Soil Resilience and Sustainable Land Use, D.J. Greenland and I. Szabolcs (eds.), CAB International, Wallingford, pp 99–118
- Pereira, H.M., Reyers, B. and Watanabe, M. (2005). Condition and Trends of Ecosystem Services and Biodiversity. Chapter 8 in: Millennium Ecosystem Assessment. Sub Global Assessment: Findings of the Multiscale Assessments. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Petschel-Held, G. and Lasco, R. (2005). Drivers of Ecosystem Change. Chapter 7 in: Millennium Ecosystem Assessment. Sub-global Assessment: Findings of the Multiscale Assessments. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Safriel, U. and Adeel, Z. (2005). Dryland Systems. Chapter 22 in: Millennium Ecosystem Assessment. Current State and Trends: Findings of the Current States and Trends Working Group. *Ecosystems and Human Well-being*, vol.1., Island Press, Washington DC
- Sage, A. (1999). Sustainable Development: Issues in Information, Knowledge, and Systems Management. *Information, Knowledge, Systems Management* 1:185-223.
- SCBD (2006). *Global Biodiversity Outlook 2*. Montreal
- UN (2010). *The Third Arab Report on the Millennium Development Goals 2010 and the Impact on the Global Economic Crisis*, New York
- UNCCD (United Nations Convention to Combat Desertification). (1994). *Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa*. Part I, Introduction, Article 1(a)
- UNDP (2009). *Arab Human Development Report 2009. Challenges to Human Security in the Arab Countries*. Regional Bureau for Arab States

UNDP (2007). *Lebanon Rapid Environmental Assessment for Greening Recovery, Reconstruction and Reform 2006*

UNEP (2010). Millennium Ecosystem Assessment. *Ecosystem Services and Human Well-being: El Maghara, North Sinai, Egypt*. UNEP, Malta

UNEP (2010). Millennium Ecosystem Assessment. *Saudi Arabia Millennium Ecosystem Assessment for Asir National Park*

UNEP (2009). *Air Quality and Atmospheric Pollution in the Arab Region*. Joint Technical Secretariat is composed of the League of Arab States, the United Nations Economic and Social Commission for Western Asia and the United Nations Environment Programme, Regional Office for West Asia

UNEP (2009). Millennium Ecosystem Assessment. *Evaluation of Tafilalet Oasis Ecosystem by the Approach of Millennium Ecosystem Assessment, Kingdom of Morocco*

UNEP (2007). *Lebanon: Post-Conflict Environmental Assessment*

UNEP (2007). *Sudan Post-Conflict Environmental Assessment*

UNEP (2005). Millennium Ecosystems Assessment. *Ecosystems and Human Well-being: Synthesis report*. Island Press, Washington DC 57

UNEP (2003). Millennium Ecosystems Assessment: *Ecosystems and Human Well-Being: A Framework for Assessment*. Island Press, Washington DC, pp. 245

White, R.P, Murray, S. and Rohweder, M. (2000). *Pilot Analysis of Global Ecosystems (PAGE): Grassland Ecosystems*. World Resources Institute, Washington, DC, p.69

World Bank. (2007b). *Economic Assessment of Environmental Degradation Due to July 2006 Hostilities*. World Bank, Report No. 39787-LB

Zurayk, R., Al-Awar, F., Hamadeh, S., Talhouk, S., Sayegh, C., Chehab, A. and Al Shab, K. (2000). *Using indigenous knowledge in land use investigations: a participatory study in a semi-arid mountainous region of Lebanon*