7 Omayed Biosphere Reserve and its hinterland, Egypt

Boshra Salem, Department of Environmental Sciences, University of Alexandria, Egypt

General description and location

The Omayed Biosphere Reserve (OBR) is located in the western Mediterranean coastal region of Egypt (29°00' to 29°18' E and 30°52' to 20°38'N). It extends about 30 km along the Mediterranean coast from El-Hammam in the west to El-Alamein, with a width of 23.5 km to the south. Its north–south landscape is differentiated into a northern coastal plain and a southern inland plateau. The coastal plain is characterized by alternating ridges and depressions running parallel to the coast in an east–west direction. This physiographic variation leads to the distinction of six main types of ecosystems. They are arranged in the same sequence from the northern Mediterranean coast to the south.

Major habitats found in the OBR include five main habitat types:

- the coastal dunes
- inland ridges
- saline depression
- non-saline depressions
- inland plateau.

A complete description of these habitats and their major vegetation communities is provided in this chapter. The following is a list of faunal species found in all five habitats including mammals such as dorcas gazelle (*Gazella dorcas*), a number of gerbils (*Gerbillus spp.*), the east Mediterranean endemic mole-rat (*Spalax leucodon*), the fennec (*Vulpes zerda*), red fox (*Vulpes vulpes*), hare (*Lepus capenis*) and North African endemic fat sand rat (*Psammomys obesus*). There are fifty to seventy bird species including kestrel (*Falco tinnunculus*), quail (*Coturnix coturnix*); and between seven to thirteen reptile and amphibian species such as horned viper (*Cerastes cerastes*) and also the tortoise (*Testudo graeca*). Common insects are represented by the families of Terrebrionidae, Scarabaeidae and Carabidae. There are also records of sand roach (*Heterogamia syriaca*), harvester ants (*Messor spp.*) and a localized protozoan, *Acanthamoeba*.

The comparison of meteorological records from the two stations, one close to the Mediterranean coast (Burg El-Arab) and the other about 40 km to the south (Dammanhur), demonstrate the north–south climatic gradient in this region (see Table 7.1). These records indicate the increase in environmental aridity and thermal continentality from the north to the south.

Table 7.1. Annual average (over 15 years) of some meteorological data at two stations, one near the Mediterranean coast (Burg El-Arab) and the other about 40 km to the south (Dammanhur)

Meteorological factor	North station	South station
Max. air temperature (°C)	*24.1*	*28.4*
Min. air temperature (°C)	*15.2*	*15.2*
Mean air temperature (°C)	*19.5*	*20.4*
Rainfall (mm/year)	*168.9*	*90.4*
Potential evapotranspiration (mm/year)	*994.6*	*1033.5*
Aridity index (Emberger, 1955)	*26.9*	*10.7*

Source: Shaltout, 1987

The geological formations of the region are essentially quaternary and tertiary. The surface is formed of Miocene strata, about 300 m in thickness, overlain by pink limestone, tentatively assigned to the Pliocene. The Holocene formation is formed of beach deposits, sand dune accumulations, wadi fillings, loamy deposits, lagoon deposits, and limestone crust. The Pleistocene formation is formed of white limestone in the form of exposed ridges stretching parallel to the coast, and pink limestone of oolitic sand with Pleistocene microfauna.

Moghra Oasis is in the hinterland of OBR. Moghra is a small uninhabited oasis (latitude 30°14N, longitude 28°55E), situated on the northeastern edge of Qattara depression and centred by a brackish water lake. It has an area of approximately 4 km². The lake represents the area of lowest altitude (–38 m). The shallow water table and outward seepage of the lake's water accompanied by excessive evaporation create the wet salt marshes (saline flats) that surround the lake. Thick surface crusts of salt form and may prohibit the growth of several plant species. Sand formations dominate in the western and southern sides of Moghra Lake with deposits in the form of dunes in areas adjacent to the lake or in the form of deep sheets of sand in other places. Climatic data of Moghra Oasis, extracted from Wadi El-Natrun climatic data (at the same latitude as Moghra) show average temperature ranges from 13 to 30 °C in January to 27 to 60 °C in August. Annual rainfall is about

40 mm with a maximum of 13 mm in November. Relative humidity varies between 44.6 per cent in May and 63.0 per cent in November. Relative wind velocity ranges from 8.1 knots in December to 11.4 knots in April. The vegetation of Moghra Oasis is represented diagrammatically in Figure 7.1.

Main lines of action

Identification of the project's institutional framework, and administrative body

It was agreed that the Egyptian National Commission (Nat. Comm.) for UNESCO would be the hosting organization of the project. Accordingly, the project is now included for implementation under its science programme. Nat. Comm. will also act as the administrative body of the project, and has provided through its team all the required facilities and correspondence with the concerned bodies. The administrative team also includes experts from the Egyptian Environmental Affairs Agency (EEAA) and the manager of the OBR.

The constitution of the scientific team

This team covers different disciplines relevant to the methodology requirements. This includes experts in ecology, hydrology, pedology, range management, anthropology and spatial databases (remote sensing and GIS). The scientific team was able to produce the current assessment report, which has the following basic features:

- It is scientifically credible; it focuses on what has been observed with certainty by the scientific team, and identifies what remains uncertain.
- The scientific team is based on competence in the topic areas selected and experience in study area.
- Social and political legitimacy; where users of the assessment are fully brought into the process through workshops that were held during the assessment process: for example scientific experts, local inhabitants, investors, EEAA, biosphere reserve (BR) manager and rangers. The findings of this assessment were accordingly approved.
- Continuous interactions with the intended users to ensure the value of the assessment and develop a communication strategy that considers how to deliver findings to the local community and the BR manager.

Data collection

Experts of the scientific team were able to obtain almost all previous information on OBR and its hinterland from scientific publications, project reports, research programmes and so on. Information gaps were identified and covered during field visits.

Field visits

The scientific team in collaboration with the EEAA and the OBR manager and rangers set out a field visit

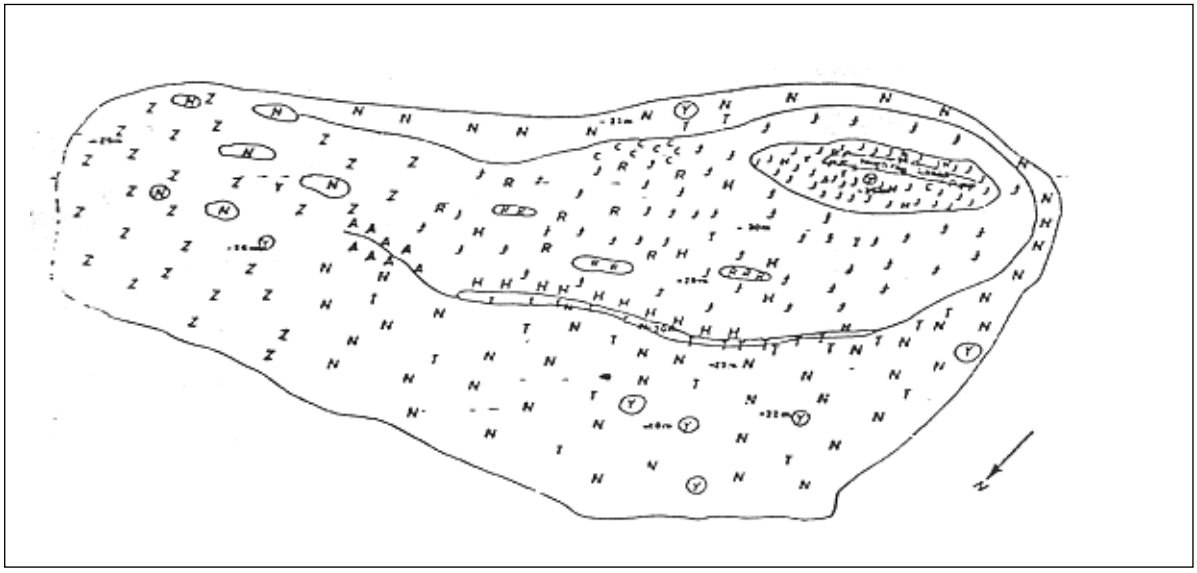

Figure 7.1 Moghra Oasis

J = Phragmites communis, t= Juncus rigidus, N= Nitraria retusa, T= Tamarix sp., Y= Phonix dactylifera, C= Cressa cretica, Z= Zygophyllum album, R= Arthrocnemum macrostachyum, H= Inula crithmoides

programme. This programme covers all the habitats of OBR and its hinterland reaching the borders of Qattara Depression. A local guide accompanied the scientific team in all their visits to indicate the location of the Roman cisterns, water catchment areas and ancient wells in both active and inactive states. Figure 7.2 shows the location of observation points in OBR and the path to Moghra. The field visits also included visits to local families in order to promote open discussion. The discussions covered all aspects regarding their traditional and adaptive knowledge, with special emphasis on the Moghra Oasis and the current use of its resources, and the potential extensions of using this oasis as an alternative in dry seasons. All the field visits were documented by digital photographing, GPS locations and individual reports on each visit.

Workshops

Two workshops were held throughout the assessment methodology time frame. The first workshop was held in a Bedouin tent with the local inhabitants. Participants in this workshop included representatives from the four villages covered by the OBR and its hinterland, including local community administrative bodies, investors, members of the local parliament, and the Mayor of Omayed. The workshop objectives were to openly discuss and share opinions with the local inhabitants and their administrative bodies regarding their perspectives on natural resource uses in the

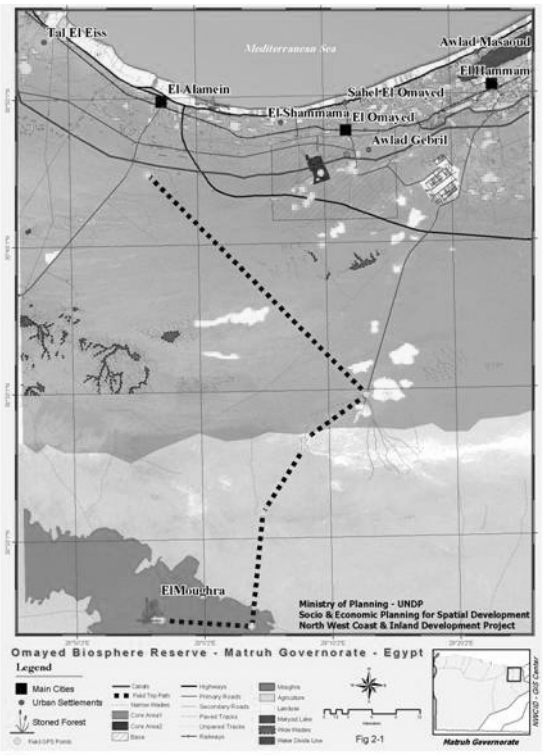

Figure 7.2: Location of observation points in OBR and the path to Moghra

OBR and its hinterland as well as the stresses posed on these resources as they saw them. Other considerations included the ways and means of dealing with these resources according to their traditional knowledge, the role of women in the Bedouin family, provision of social services (education, health, potable water and so on) and participants' awareness of the major environmental problems, such as water scarcity, land degradation as a result of overgrazing and wood cutting, habitat fragmentation and loss of biodiversity. The workshop was well documented, with thorough reporting by video recording and digital photography.

The second workshop was scientific in nature and was held at the premises of the Egyptian Nat. Comm., Cairo. The opening speech was delivered by the general secretary of the Nat. Comm., and participants were experts in different disciplines, representatives from the EEAA and the OBR management. The purpose of this workshop was mainly to reach consensus on the assessment methodology adopted for project implementation. The scientific team of the project delivered a presentation on the status of the resources under investigation, the stresses on the resources in question, descriptions of traditional knowledge and an explanation of the suggested methodology and the suitability of its implementation according to the nature of the OBR and its hinterland. The workshop ended with comprehensive discussion among experts on the methodology adopted, and all the remarks and suggestions of experts were noted and added to the methodology. The workshop ended with satisfaction and approval of the methodology adopted. The efforts by the project's scientific team were commended. This workshop was also documented, with thorough reporting by video recording and digital photography.

Report preparation

Each member of the scientific team prepared a detailed and extensive report on the resource under investigation, presenting all the relevant information collected from literature and field visits, and proposed an appropriate and adjusted methodology for implementation including suggestions and consultations from the two workshops mentioned above. These reports were then compiled to form this chapter, which includes the scientific and administrative team efforts and the steps taken to collect the required information for the implementation of the project.

A geo-database based on participatory geographic information systems (PGIS) is suggested for use as the master database, a prerequisite of the project. It is structured to manage all forms of information, texts, tables, graphs, statistics and so on and spatial information (base maps, satellite imagery) from other accessible sources of literature, previous projects, field observation and data analysis and its interpretation. This will facilitate data

archiving, analysis and query as well as combining scientific, administrative and demographic data obtained and available in one common depository. Implementing this geo-database will enable comparative evaluation of the study sites and dissemination of information among the partner institutions.

State of existing natural resources

Habitats

Biodiversity

Richness of plant species: A total of 251 species were recorded in Omayed Biosphere Reserve of which 131 are perennials and 120 are annuals (that is, therophytes). These species belong to 169 genera and 44 families. The composites have the highest contribution to the total flora (15.9 per cent), followed by grasses (13.2 per cent) and legumes (12.8 per cent). Thirty-two species (twenty-two perennials and ten annuals) have wide ecological amplitudes (recorded in at least six out of seven prevailing habitats).

Eighteen species have a national distribution restricted only to the western Mediterranean region, where the OBR occurs: *Asparagus aphyllus, Fagonia cretica, Lotus polyphyllos, Centaurea alexandrina, Helianthemum sphaerocalyx, Prasium majus, Centaurea pumilio, Hyoseris radiata subsp. graeca, Rhodalsine geniculata, Ebenus armetagie, Leontodon tuberosus* and *Thymus capitatus* as perennials; and *Brachypodium distachyum, Daucus syrticus, Hyoseris scabra, Crucianella aegyptiaca, Hippocrepis cyclocarpa,* and *Matthiola longipetala subsp. hirta* as annuals.

Endemic, rare and threatened species: There is only one rare endemic species, *Helianthemum sphaerocalyx* (Cistaceae) that inhabits the coastal dunes in this region. According to the scheme of rarity forms , forty rare species were reported in the OBR: twenty-three perennials and seventeen annuals. The species of unique occurrence in the coastal sand dunes habitat are considered threatened species due to severe destruction resulting from the construction of summer resorts. This process leads to the severe fragmentation of this habitat (Salem, 2003).

Rangelands: Some of the most common rangeland species in the Mediterranean coastal region are *Anabasis articulata, A. oropediorum, Artemisia monosperma, A. herba-alba, Asphodelus ramosis. Convolvulus lanatus, Carduncellus eriocephalus, Eciochilon fruticosum, Echinops spinosissimus, Gymnocarpos decandrum, Helianthemum lippii, H. kahiricum, Lycium europaeum, Noaea mucronata. Deverra triradiata. Periploca aphylla, Scorzonera alexandrina*, and *Thymelaea hirsuta*. Of these species, 63 per cent are palatable, and 42 per cent are considered highly palatable.

Grazing activities take place mainly in three habitats in the OBR and its hinterland: the non-saline depression, the ridge habitat, and the inland plateau habitat. Heneidy (1992) reported that the annual above-ground dry matter production of the rangeland at OBR in the different habitats (maximum values in different seasons) was about 2,833 kg/ha in the non-saline depression, 1,448 kg/ha in the ridge, and 4,416 kg/ha on the inland plateau habitats. In general, preliminary field observations on the behaviour of grazing animals indicated that almost all the consumed forage throughout the year is made up of sixteen perennial species (most common) and annuals. In general the total phytomass of new growth is highest in the habitat of the inland plateau, and lowest in the ridge habitat.

Ecosystem services: the services provided by the OBR ecosystems can be divided into environmental services and economic services. Environmental services include the following:

- *Biodiversity conservation*: one of the main services of the OBR is its role in conserving biodiversity resources (in terms of habitat and species diversity). This area is efficient in the sense that it encompasses a sequence of interdependent habitats in a relatively small area including marine waters, sandy beaches, coastal calcareous sand dunes, saline and non-saline depressions, inland ridges, limestone plateau, inland siliceous sand formations (flats, mounds and dunes) and human-made rainfed farms. These habitats support diverse flora and fauna (about 250 flowering plants, 300 invertebrates, 200 avifauna, 30 herpetofauna and 28 mammals). Some of the biota are endemic and/or threatened.
- Some of the habitats act efficiently for water storage (for example, coastal sand dunes and the depressions at the foot of the ridges as a result of run-off water in addition to rainfall).
- Many of the plants play an important role in preventing soil erosion, increasing soil deposition and improving drainage of the lowlands. These include the species that form phytogenic mounds (for example, *Ammophila arenaria, Liomoniastrum monopetalum* and *Artemisia monosermum*).
- Maintenance of the rich and colourful traditional cultural heritage of the local inhabitants, which forms an important and integral part of the region's landscape.

Economic services include:

- *Grazing*: domestic and wild animals graze and browse ninety-four species growing in this region (72.9 per cent of the total economic species). The highly palatable species in this area are *Echiochilon fruticosum, Plantago albicans, Stipa lagascae, Deverra*

tortuosa, Helianthemum lippii, Artemisia herba-alba, Althaea ludwigii, Malva parviflora and *Gymnocarpos decander* (El-Kady, 1987; Boulos, 1989).

- *Fuel*: almost all desert woody perennials are cut for fuel. Local inhabitants usually use the dry parts only, while travellers, workers or other visitor groups cut down green plants when they cannot find dry ones. Most of the shrubs are cut and harvested for fuel, such as *Anabasis articulata, Thymelaea hirsuta, Echiochilon fruticosum, Gymnocarpos decander* and *Lycium europaeum* (El-Kady, 1987).
- *Medicinal use*: there is a lengthy list of medicinal plants in the desert areas. Examples of these plants include *Artemisia herba-alba*, which is widely used as an anthelmintic in traditional medicine, a concoction of *Herniaria hirsuta* which is used for sore throats, and the boiled leaf of *Emex spinosa* which is used for the relief of dyspepsia, biliousness and as appetite stimulant. The seeds of *Malva parviflora* are used as a demulcent for coughs and bladder ulcers, and *Sonchus oleraceus* is reported to be useful for liver complaints, jaundice and as a blood purifier. *Salsola kali* is used as an anthelmintic, emmenagogic, diuretic and cathartic.
- *Foodstuffs*: the fruits, flowers or/and vegetative parts of thirty-three species in this region are eaten by local inhabitants. *Malva parviflora* is a popular potherb in Egypt. *Deverra tortuosa* and *Sonchus oleraceus* are eaten as a salad. *Colchicum ritchii* is used as one of the numerous ingredients added to a beverage prepared from the rhizomes of 'Moghat' (*Glossostemon bruguieri*), usually offered as a tonic at childbirth in Egypt. Mammals such as rats and rabbits, and some birds such as quail, are eaten by the local population.
- *Traditional uses:* rope is made using *Thymelaea hirsuta*.

Characterization of stresses

- *Encroaching developments*: an almost continuous row of tourist facilities occupies the coastline between Alexandria and El Alamein, and there are also plans to develop the rest of the north coast in a similar manner. This has not only led to the complete destruction of the habitats on which the developments were built, but has also led to the degradation of the vast areas of habitat surrounding them. Urban development is taking place in the north coast at a very rapid pace, to the extent that most of the structures found currently along the coasts of the region have been erected over the last five to ten years, and new developments are being established at an accelerated rate.
- *Unsustainable agriculture practices*: traditionally, the native inhabitants of the north coast cultivated small areas of rain-fed winter cereals, olives and figs. Today, with the growth of local populations and the introduction of modern machinery, almost all seemingly cultivable land receiving sufficient rain to grow crops is ploughed (usually) to cultivate winter cereals on an annual basis. The areas most intensively cultivated are those that held prime habitats for biodiversity in the past. Many of the western Mediterranean coastal areas cannot support intensive agriculture, which is leading to degradation of soil, water and rangeland resources. Ploughing using modern machinery is the most destructive recent development for agriculture. Modern machinery indiscriminately and completely removes perennial shrubs, which provide complexity and shelter to wildlife, and flattens the landscape, penetrating areas previously difficult to cultivate by traditional technology, and probably also killing animals in the process.
- *Over-grazing*: unlike the impact of agriculture, which is very easy to observe, even from long distances (the complete removal of natural vegetation), the impact of grazing is subtler, but is probably as serious. Sheep and goats severely deplete the natural vegetation and compete directly with native wildlife for food resources. Close examination of areas that appeared in good condition from a distance reveal that only unpalatable woody perennials remain (such as *Thymelaea hirusta* and *Artemisia monosperma*), while annuals were heavily browsed. Traditional pastoralism in the past was more limited than today. The human population was significantly less and summer grazing opportunities were very limited (thus limiting the possibility of maintaining excessively large herds).
- *Over-cutting*: there is an increasing demand for fuel wood (larger woody perennials) by local Bedouin populations. This demand leads to the notable degradation of habitats, particularly in areas distant from other sources of energy. The elimination of large woody perennials (which take many years to reach maturity) severely reduces the structural complexity of an already highly exposed environment, with the effect of rapidly accelerating soil movement and erosion, reducing retention potential and the chances of annuals and smaller plants to germinate and become established. In fact the removal of woody perennials probably initiates the first steps in a process of complete transformation of the natural landscape. The collection of wild native medicinal plants for commercial trade has no formal or informal regulation. The most serious aspect of this practice is that it usually targets rare and localized flora, and this further damages them.

- *Over-hunting*: hunting and falconry has had a profound impact on all wildlife in the region. Gazelles and Houbara bustards have been the most severely impacted, as they are the main targets for hunters. Off-road vehicular use by hunters, the military and Bedouins are a major contribution to the degradation of natural habitats in this region.
- *Introduction of alien species*: The introduction of non-indigenous alien species of plants is a widespread practice in many parts of Egypt. The introduction of non-indigenous species is recognized as one of the primary factors in the erosion of biodiversity throughout the world. The Australian *Casuarina spp*. and *Acacia saligna* have been widely introduced throughout the landscape in the north coast, including within the protected area, in order primarily to act as windbreaks and provide wood. Several native alternatives are available. Many other non-indigenous plant and animal species are expected to be observed in the area when the Nile waters finally reach the El Nasr canal. In addition to these main types of stresses, other specific stresses such as quarrying, pollution and waste disposal, and uncontrolled off-road vehicular use, are discussed in detail in the section entitled 'Characterization of stresses'.

Existing state of water resources

The existing water resources are:

- Groundwater is the only important resource in the northern part of the area (Coastal ridge and second ridge).
- Runoff water is the main source to the south of Khashm El-Eish and directly at its northern sloping surface.
- Nile water (extended canal).

Groundwater

Precipitation is considered the main recharge source of groundwater aquifers in the northwestern Mediterranean coastal zone, and this greatly affects the amount of water stored in such aquifers. The Mediterranean coastal zone of Egypt receives notable amounts of rainfall, especially in winter. The rainy months are October, November, December, January and February. In summer, no rain is recorded, while in autumn, occasional heavy rain may occur. The rainfall shows a general steady decrease from north to south, ranging from 168.9 mm/year at the coast (Burg El-Arab) to 16.2 mm/year at Siwa Oasis to the south. The Omayed Biosphere Reserve receives most of the rainfall in winter. It receives about 151.8 mm/year, accounting for 106.26 x 10^6 m^3 of water. The catchment would receive rainfall volume of about 140.415 x 10^6 m^3, which contributes to water resources within the catchment (El-Shinnawy, 2003). About 98 per cent of this volume recharges the groundwater aquifer system during heavy storms, and 2 per cent is returned back to the atmosphere via evapotranspiration.

Wind: The prevailing wind is from the northwest direction, which is generally cool. However, variable wind directions were recorded in the different seasons: for example, during spring the area is subjected to the southeast Kamasien wind which results in severe sandstorms and causes visible degradation of the area. The mean monthly wind speed may reach 27.75 km/hr.

Groundwater aquifers: The important groundwater aquifers in the Omayed Biosphere Reserve are classified into the following categories: dune sand accumulations (Holocene), oolitic limestone (Pleistocene), and fissured limestone (Middle Miocene).

Groundwater conditions: Groundwater in the proposed area occurs mainly under water table conditions. The only source of water supporting the main water table in the northwestern coastal zone is the localized rainfall directly precipitated on the coastal plain and the southern tableland. The free surface of the main water table has a level at or about the mean sea level up to about 20 km inland. The main freshwater table forms a thin freshwater layer floating on the main saline water. The hydrological relation between these two water tables is controlled by the well-known principle of salt-water intrusion into coastal aquifers. Shata (1970) pointed out that near the sea, the inflow of seawater maintains a dynamic equilibrium, with a comparatively thin layer of fresh water existing on the upper surface of the salt water. Most of the wells along the coastal zone depend on their supply from the main water table.

Runoff water

Hydro-physiography and drainage pattern: a great number of drainage lines dissect the elevated tableland, which acts as a major watershed area. Rainwater flows to the north following the regional slope of the tableland surface, towards the low coastal plain and/or towards the sea. The remaining rainwater infiltrates through joints to feed the lower limestone aquifers. However, the presence of a thin hard crust accelerates surface runoff to the north, as in the case of Khashm El-Eish. The low coastal plain acts as a collecting basin for the rainfall and runoff water from the southern tableland. The coastal ridges lead to the conservation of soil and surface water. Meanwhile, the elongated depressions act as collecting basins for the runoff water from both the ridges and the tableland. The factors involved are evaporation and evapotranspiration, surface runoff and infiltration.

Evaporation and evapotranspiration: evaporation is the process by which water is transferred from a liquid

state to a gaseous state. It includes evaporation from ground surface, evaporation from open water surfaces, evaporation from the shallow water table and plant transpiration. The total mean annual evaporation increases towards the south where desert conditions prevail. Swidan (1969) noticed that the values of free surface evaporation and potential evapotranspiration increase towards the west along the northwestern Mediterranean coast. On the other hand, these values increase towards the south as the temperature becomes higher and the wind speed becomes less than in the coastal areas.

Surface runoff: in the northwestern Mediterranean coastal zone, surface runoff is generally poor due to the low average precipitation. However, some ephemeral streams may occasionally flow through channels of dry wadis already engraved in the tableland during the Pleistocene era. Ezzat (1976) considered that the infiltration in the northwestern coastal zone is as follows: a coefficient of 20 per cent in the wadi runoff zone; a coefficient of 30 per cent in the plane zone; and a coefficient of 50 per cent in absorbed water reaching the lower strata as groundwater.

The OBR hinterland 'Moghra Oasis'

The Moghra Formation occupies most of the floor of the Qattara Depression. It is made up of sandy and clayey layers of the Lower Miocene. The maximum thickness of the Moghra aquifer is about 930 meters in the northeastern part. Along the Mediterranean Sea, the aquifer's thickness decreases sharply to zero where it retrogrades into an impervious, clayey facies. The Moghra aquifer is recharged from five different sources:

- direct rainfall on the aquifer's outcrops
- groundwater seepage from the overlying Marmarica limestone aquifer
- the Mediterranean Sea
- the Nile Delta aquifer
- upward leakage from the Nubian artesian aquifer (Rizk and Davis, 1991).

The estimated amount of groundwater flow to the depression is 3.2 m^3/s, while the total evaporation from the depression is 7.2 m^3/s. Upon evaporation, the groundwater seepage to the Qattara Depression increases in salinity. The near-surface groundwater ranges in salinity from 3.3 g/l around the Moghra Lake at the east, to 38.4 g/l at the centre to about 300g/l in the Sabkha area to the west (Aref et al., 2002).

Most of the water samples are of the chloride type ($MgCl_2$ and $CaCl_2$) of marine origin. A few samples are usually of the $NaHCO_3$ and Na_2SO_4 types of meteoric origin. This indicates either the large influence of original seawater invasion, or the dissolution of salts of the Moghra aquifer water from the host rocks or pre-existing salts. In the eastern part, the low salinity of the near-surface groundwater table is encountered. During one field visit, a groundwater sample was collected and its salinity was found be about 2,400 mg/l, meaning that it could be used as a livestock drinking water resource during dry seasons in the OBR.

Characterization of stresses

In the last few years the area under investigation has witnessed many stresses on water resources, which have led to undesirable consequences related to both quantity and quality. Summer resorts recently established in the coastal area have damaged the important freshwater aquifer (dune sand accumulation) near the coast. In addition, groundwater pollution either by saltwater intrusion or by sewage from septic tanks or landfills (summer resorts) has been observed in some areas.

Groundwater has become an important source of fresh water in coastal areas because of the increased demands placed on potable water supplies. Indiscriminate utilization of groundwater from a coastal aquifer could result in saltwater intrusion that renders the aquifer unsuitable as a source of potable water. As surface and groundwater are integral parts of the same hydrological whole, changes in the salinity of one will most likely affect the salinity of the other. If the objective of a saltwater intrusion control programme is to maintain a zero increase in salinity of freshwater resources, this objective is seldom attainable, especially in areas of high water use. A decrease in the amount of precipitation and number of rainy days (climatic variability) leads to an decrease in the amount of runoff water and ecosystem degradation. In addition, most of the cisterns are filled with transported sediments, and their leading channels were destroyed by forced activities that have the effect of decreasing their efficiency as a rainwater harvesting method.

Description of indigenous, adaptive and innovative approaches

Local inhabitants in the Omayed Biosphere Reserve are using different methods for groundwater abstraction and rainwater harvesting. Most of these methods are traditional and some date back to Roman times. Surface runoff water is collected by applying two principal methods: cisterns (commonly named Roman wells) and stony dams.

In general, the water harvesting system depends on the following:

- average rainfall
- number of rainstorms

- topography
- evapotranspiration
- surface roughness
- land features.

Soils

The formation and persistence of soil cover in the Omayed area are strongly influenced by the arid climate. The scarcity of water for reactions within the soil, and the leaching of soluble components from the soil itself, restrict the extent of soil formation processes. All soils in the area are considered to be very young and immature, and as such are highly influenced by the geological and geomorphological conditions of their formation. Soil texture is controlled by geological and geomorphological factors as well. Weathering of the omnipresent marine limestone produces soils of medium texture, sandy loam or, less commonly, sandy clay loam, but this can be altered by two main factors. The first one is the presence of Aeolian sediments. These are deposited quite close to their source, and are consequently very sandy. The second factor is the sorting of sediments. The sparseness of the vegetation cover and the harsh climate cause extensive soil erosion. The quantity of water is not enough to eliminate most of the eroded material that accumulates in depressions. High-standing surfaces are generally bare, also because of the hard parent rock, while soils of medium to high depth are formed by accumulation processes in depressions. Flat areas generally exhibit shallow and often stony soils, whose depth rarely exceeds 30 cm. In depressions, soil depth is proportional to depression level and catchment size, and increases progressively towards the centre of the depression.

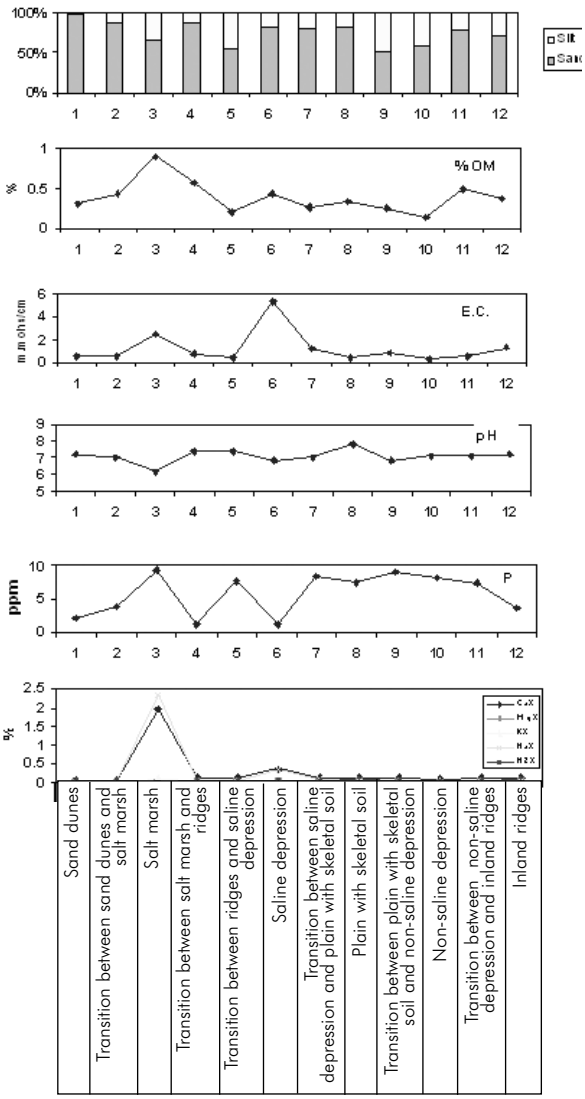

Figure 7.3: Physical and chemical characteristics of the soil

Chemical and physical characteristics

In Omayed, soils are characterized by their bright yellowish brown or orange colour, and sandy and loamy sand textures. Generally, the chemical analysis of these soils indicates that they have a characteristically low salt content. Organic matter and the total nitrogen content are relatively higher in the cultivated (olives and figs) soils than in non-cultivated areas. Calcium carbonate is generally very high in the coastal areas. In general, the physical and chemical characteristics of the soil exhibit a wide range of variation along the topographic gradient (Figure 7.3).

In the case of Omayed Biosphere Reserve, it is necessary to stress the origin of sand deposits, particularly those due to wind action, and their lime content, in the upper horizons. Accordingly, three categories of soils may be distinguished: extremely calcareous soils containing more than 60 per cent carbonates; very calcareous soils containing from 20 per cent to 60 per cent carbonates and calcareous soils with less than 20 per cent carbonate, but containing at least some calcareous elements (>2–3 per cent) (based on Abd el Kader et al., 1981; FAO, 1970).

Land degradation

One of the typical environmental stresses in OBR is land degradation. The approach adopted in this project is to view land degradation in general and soil degradation in particular as 'umbrella' terms, covering the many ways in which the quality and productivity of land and soil may diminish from the point of view of the land user (and of society at large). It therefore includes changes to soil quality and the many other ways in which the overall integrity of land is challenged by inappropriate use. Land degradation also includes many urban and

industrial problems, such as pollution, landscape alteration and waste dumping.

Description of indigenous adaptive and innovative approaches

In the OBR, it has been observed that poverty and lack of water, even for drinking, tend to encourage people to focus on immediate needs rather than on those benefits that may materialize only in the long term. This is not to say that poor land users are land degraders, while the rich are conservers. Soil conservation is always viewed as being a cost to land users in terms of additional efforts and more trouble. The traditional knowledge of the local inhabitants enables them to detect soil moisture and water-holding capacity using very simple methods. They examine the soil subsurface consistency for moisture, and the soil suitability of this moisture for agriculture, by rolling up a handful of soil and testing its compactness and stability. This traditional methodology allows the proper testing of soil moisture before cultivation, a procedure that enhances soil conservation.

The problems of soil erosion can be halted, and certain practices can lead to soil enhancement and rebuilding. These options include:

- Stopping the overuses that lead to the destruction of vegetation.
- Controlling overgrazing of animals, since their trampling and eating diminishes the vegetative cover.
- Enhancing rehabilitation techniques by propagation of native species (preferably multipurpose).
- Implementing agro-diversity with care, that is, avoiding the planting of a monoculture.
- Shelter-belts planted perpendicular to the prevailing wind direction are effective in reducing the wind speed at the soil surface (wind breaks).
- Strip farming: this involves planting crops in widely spaced rows but filling in the spaces with another crop to ensure complete ground cover. The ground is completely covered so it retards water flow, and the water soaks into the soil, consequently reducing erosion problems.

Description of Bedouin life and traditional knowledge

Amount of human population and families: The approximate numbers of people living within the proposed biosphere are as shown in Table 7.2.

The OBR comprises parts of four villages (Figure 7.4). The number of families and human population in each are as shown in Table 7.3.

In the northwestern coastal desert in general, and particularly in the OBR and its hinterland, the local population is nomadic or semi-nomadic, though there is a trend towards a sedentary lifestyle because of government policy. The Bedouin have always lived in the area, but the process from a semi-nomadic to a sedentary way of life began when they began to build stone houses about thirty years ago. However, this does not imply that house dwellers abandon grazing. The population of northern Omayed is the most sedentary, a fact that is probably encouraged by registered land holdings. This decreases toward the south, where up to half the Bedouins are still semi-nomadic. The community can be characterized by its inherited Bedouin traditions and values, both tangible, such as handicrafts, housing configuration, tools and clothing, and intangible, such as language, poetry, song and dance.

In the study area we find that traditional knowledge provides the basis for day-to-day living and for local-level decision-making about many fundamental aspects such as:

Table 7.2: Approximate numbers of people living within the Omayed Biosphere Reserve and its hinterland

	Permanently	Seasonally
Core area(s):	None	None
Buffer zone(s):	600	100
Transition area(s):	5500	2000

Table 7.3: Population and families in the four villages within the Omayed Biosphere Reserve

Village name	Number of families	Number of population	Age >30
Omayed	195	1600	640
Sahel El Omayed	112	1280	490
Shammamah	68	660	220
Awlad Gebreil	60	465	120
Total		4000	
Average		1470	

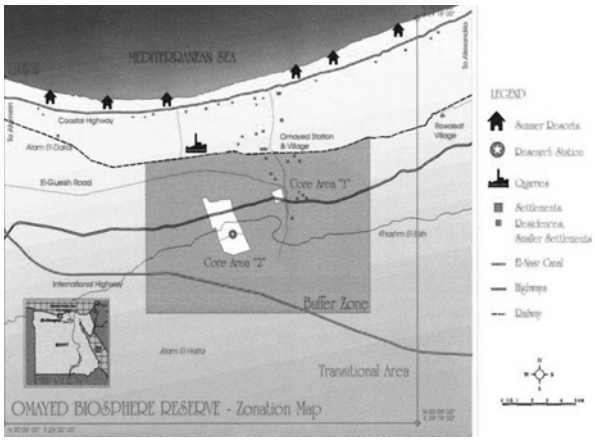

Figure 7.4: The Omayed Biosphere Reserve

- agriculture and husbandry
- preparation, conservation and distribution of food
- location, collection and storage of water
- coping with disease and injury
- interpretation of meteorological and climatic phenomena
- manufacture of handicrafts and tools
- construction and maintenance of shelter
- orientation and navigation on land for grazing activities
- management of ecological relations of society and nature
- adaptation to environmental/social change.

Women in Bedouin communities have an important role in managing and maintaining the family economy. Poverty is alleviated by the raising and selling of animals and by the production of wool handicrafts. However, Bedouin traditions are such that women are prevented from selling their handicrafts. Women are responsible for such daily chores as food preparation, carpet weaving, and occasionally cultivating small patches of vegetables and poultry breeding.

Innovative activities that have recently been developed in the region include:

- introducing groceries, and trading in agricultural products
- selling electrical tools, especially since the introduction of electricity in the region
- transportation by trucks or Kareta
- employment in the private sector
- brokers of land and houses.

Characterization of stresses in the Bedouin life

In general, Bedouin communities experience stress as a result of either the harsh natural environmental conditions, to which they have adapted, or the inadequate provision of social services. The stresses may be further divided according to the spatial or temporal context. For example, Bedouin communities suffer more during the hot and dry seasons of the year because of water scarcity. They cope with these stresses by, for example, moving their herds to Moghra Oasis, storing water in cisterns, and transporting water using water tank trucks. Their houses are built in a naturally insulated style using palm midribs, and with windows directed towards the north. In summer, they use tents installed outside their homes in the direction of the wind. In terms of spatial environmental stress, Bedouin communities living in the coastal region endure less suffering because of better environmental conditions and greater rainfall. This enables the establishment of productive orchards (particularly figs), rangelands and a relatively better quality of life. Even during the dry seasons, communities living in the coastal region cope better with the difficulties posed by the environmental conditions as a result of accessibility to such amenities as transportation, potable water via water pipelines, and electricity.

Integrated methodology

- *Task 1*: assessment of the current status of integration between the conservation of natural resources, community development and scientific information (Year 1).
- *Task 2*: identification and implementation of practices for sustainable soil and water conservation, aimed at combating environmental degradation involving a combination of traditional knowledge and modern expertise (Years 2–4).
- *Task 3*: training and handling of data collection and inventory techniques and proven management technologies implementation (Years 1–3).
- *Task 4*: development of income generating activities based on the sustainable use of dryland natural resources (Years 1–4).
- *Task 5*: final reporting (Year 4).

Conclusions and recommendations

1 The idea behind the SUMAMAD project is very much needed, and if fully implemented would indeed demonstrate a good example of sustainable management in marginal drylands in the sites selected.
2 The western coastal desert of Egypt is a good example of a marginal dryland, which includes Omayed Biosphere Reserve and its hinterland, and would represent a perfect site for SUMAMAD-Egypt.
3 The main purpose of implementing this project in the case of the Egyptian site (OBR and its hinterland) is to identify the basic elements needed for the sustainable management of a marginal dryland, as a model, and building on the existing data on the natural resources rather than repeating an entire inventory (reinventing the wheel) that has been carried out from 1972 to 2002.
4 The OBR hinterland that extends to Moghra Oasis on the borders of Qattarra Depression is a very good case for implementation by SUMAMAD-Egypt due to the following points:
   - The local community is dependent on a very sparse and fragile natural vegetation cover for grazing activities, and consequently the area is prone to overgrazing and degradation and is in need of sound management.

- There is a potential freshwater resource in Moghra oasis that can support and improve the vegetation cover of rangelands and increase its grazing capacity by developing a rangeland development scheme including the possibility of generating a 'cultivated rangeland'.
- The proposed rangeland development scheme would be implemented with the involvement of the local community, where grazing activity would be carried out on a rotation basis in winter in the OBR hinterland according to carrying capacity. The local community would then move to Moghra Oasis in summer to benefit from the cultivated rangeland development. The species selected for cultivation should be native and highly palatable.
- The local community could settle in Moghra for at least five months if sufficient human health, transportation and veterinary services could be provided.
- In other areas, the grazing rotation scheme also could be implemented in order to encourage vegetation regeneration and rehabilitation.

5 With regard to water resources, there is an urgent need for a detailed map of the Roman wells and cisterns, as well as the assessment of water quality and quantity in relation to use. A perfect contribution to the current project would be the rehabilitation of selected wells, as well as support for the construction/reconstruction of water catchment areas for water harvesting.

6 Supporting the quality of life of the local community by developing traditional practices and income generating activities, by involving women, and by providing essential services (for example, education, health, transportation) would be central for the successful implementation of the project.

References

ABD EL-KADER, F. H.; AHMED, A.M. Soil and water studies in regional environmental management of mediterranean desert ecosystems of Northern Egypt. *Progress Report* 2, Vol. 3, 1981.

AREF et al., 2002. The role of salt weathering in the origin of the Qattara Depression, Western Desert, Egypt, *Geomorphology*, Vol. 45, pp. 181–95.

AUBERT, G. . Les sols sodiques en Afrique du Nord. *Ann. I. N. A. A.* No, 6, 1975, pp. 185—95.

BOULOS, L.; EL-HADIDI, M.N. *The Weed Flora of Egypt*. American University Press, Cairo, 1994, 361 pp.

EL-KADY, H. F. Effect of grazing pressure and certain ecological parameters on some fodder plants of the Mediterranean coast of Egypt. M.Sc. thesis, Faculty of Science, Tanta University, Tanta, 1980, 97 pp.

EL-SHINNAWY, I. A. Final Report on Al-Oomayed Hydrological Study (Catchment Area & Protectorate Area Studies). MedWetCoast, 2003.

EZZAT, M. A. 1976. Groundwater Resources in the Northwestern Coastal Zone, Part 1. Ministry of Irrigation, Cairo, Egypt.

FOOD AND AGRICULTURE ORGANIZATION (FAO). United Arab Republic: Pre-Investment Survey of North-Western Coastal Region; Comprehensive Account of the Project. Technical report 1, ESE: SF/UAR 49, 1970.

HENEIDY, S. Z. *An Ecological Study of the Grazing Systems of Mariut, Egypt*. Submitted to UNESCO, 1992, 51 pp.

RIZK, Z.S.; DAVIS, A.D. Impact of the proposed Qattara Reservoir on the Moghra aquifer of northwestern Egypt, *Ground Water*, Vol. 29, No. 2, 1991, pp. 232–38.

SALEM, B. Habitat fragmentation in Omayed Biosphere Reserve. Accepted for publication by the *Journal of the Desert Institute Cairo*, 2003.

SHATA, A. The geomorphology, pedology and hydrogeology of the Mediterranean coastal desert of U.A.R, *Symposium on the Geology of Libya, Tripoli, Libya*, 1970, pp. 431–46.

SWIDAN, A. S. Hydrological conditions of the groundwater reservoir in Mersa Matruh area. M.Sc. Thesis, Faculty of Science, Cairo University, Egypt, 1969, 222.