

LAND DEGRADATION IN THE NORTHWESTERN COASTAL ZONE OF EGYPT: PAST AND PRESENT

ABSTRACT

The inhabitants of the northwestern coastal zone (NWCZ) of Egypt are mostly Bedouins who used to rely on rangeland grazing for living. The ambient environment affords several alternative activities including agriculture, mining, and tourism. In addition, the area was once productive during the Graeco-Roman times as efficient “infrastructures” were established. These infrastructures were demolished during wars and civil strifes in the tenth and eleventh centuries, and desertification prevailed since. Recent rehabilitation campaigns in the twentieth century reintroduced olive, fig, vine, carob, and date palm plantations, and several trials to improve the rangeland were undertaken. Tree plantations were successful but controlled grazing proved impracticable under the prevailing social traditions. Currently, many large-scale projects induced far-reaching socio-economic changes. Earnings from trading, civil services, and marketing have provided increasing proportions of the local people’s income. Unfortunately, the concomitant price tag is expensive in terms of environmental degradation. The present stocking rate of the rangeland exceeds the carrying capacity, introducing devegetation and desertification as imminent ecosystem threats. Agricultural chemicals are used without vigilant extension service. More serious yet, is the obliteration of the oolitic limestone ridges in many places to manufacture bricks for the construction of tourist resorts, which would diminish the proportion of harvested rainwater. The NWCZ case testifies that more emphasis should be given to the integrated utilization of natural resources to ensure sustainable development.

Keywords: Egypt, Mareotis, desertification, sustainable development

INTRODUCTION

Egypt could be sub-divided geographically into four distinct regions, each extending longitudinally from the Mediterranean coast in the north towards the inland of Africa in the south. Along an east-west geotraverse, these regions are the Sinai Peninsula, the Eastern Desert, the Nile Valley and the Delta, and the Western Desert (Said, 1962). About 95% of the population, which stands now at 65 millions, is concentrated in the Nile Valley and the Delta. In parallel, most of the national socio-economic activities are concentrated in this region, which entails strenuous demographic pressure and subsequent environmental degradation (Tahoun, 2000).

The land mass area of the country is fairly large, as it extends over one million square kilometers. However, the actively cultivated area is only 3.6 million hectares, located mostly in the Nile Valley and the Delta. (The traditional area unit for land in the country is the feddan, which is 4,200 square meters, equivalent to 0.42 ha.) Even with the prevalent favorable weather conditions, which enables cultivating a given land area two or three crops per year; the limited active land resources represent a major constraint for present and future development of the country. The current rate of population growth is 2.1 %, and yet the present share of land is 0.05 ha per caput. This is an exceedingly small share compared to 0.22 ha per caput in most countries of the Near East Region and 0.28 ha per caput for the world average (Gaddas, 2000).

CANDIDATE SITES FOR DEVELOPMENT

The Western Desert

Portions of the Western Desert offer the possibility for alleviating the present demographic anomalies in the country. The Western Desert is a large geographic extension, representing 67% of the land mass area of the country, and possesses many valuable natural resources. The Nubian Sandstone formation in the south is a huge fresh groundwater reservoir, with capacity running around $2 \times 10^9 \text{ km}^3$ (Shata, 1991). This water resource has been utilized to sustain the local communities of the oases. Rather recently, plans are being formulated for a grand development scheme in the area; better known by the name of Toshka project. Water from the River Nile coming through a massive engineering installation would supplement local water resources to sustain a "new valley".

Aside from the oases of the Western Desert, von Rabenau (1994) estimated that more than 80 % of the area is not habitable, and the remaining 20 % are habitable by Bedouin populations who are well adapted to harsh climatic conditions. The population is estimated to be about 250,000 most of them are concentrated in the coastal belt. Traditionally, Bedouins have relied on a nomadic life style that combined rangeland grazing of sheep, goats, and camels with barley cultivation to support their herds during the dry season. Over the last 30 years, considerable numbers of Bedouins have settled, and agriculture now represents a major sector of the economy.

The Northwestern Coastal Zone

The northern extremities of the Western Desert along the Mediterranean coast represent the so-called northwestern coastal zone (NWCZ), which extends from Alexandria in the east for 520 km to El-Salloum on the Libyan border to the west. The average width of the zone varies between 30 and 50 km overlapping with the limestone plateau of the Western Desert in the south (El-Miniawy et al., 1992; von Rabenau, 1994; Ayyad, 1995, and Abdel-Kader, 1998). Based on geomorphological and land use considerations, five land categories can be identified in the NWCZ as follows:

- the coastal strip extends from the coastline inward for about 2 km southward. The land is mostly flat with elongated ridges running sub-parallel to the coast. These ridges are built of cross-bedded oolitic limestone and have an average elevation of 10m. The land of this strip is the subject of intense land use competition. Traditional uses have been agriculture, mostly for orchard, and limestone quarries in hardened dunes. New additional uses are the establishment of tourist villages as summer time resort, and the newly constructed intercontinental east-west highway;
- the second strip consists of an alluvial plain that gradually slopes upward to an escarpment 3 to 8 km from the coast. Wadis, particularly west of Matruh, bisect the plain. The local population has traditionally learned since the Roman times to terrace the landscape of the wadis, and as such, despite centuries of erosion they still maintain thick soil cover. Stream channels of the wadis are filled with calcareous loamy materials derived from the northern plateau, which are mostly divided into alluvial fans. In most cases, the grain size of sediments is coarser in the large wadis;
- the third strip is rather diffuse terrain extending for 15 to 20 km southward. Some wadis of the second strip run into the area, and are often terraced for water harvesting and soil conservation. The rainfall is rather limited, and as such agricultural activities are limited. Barley is grown mostly as animal feedstock, and farmers harvest barley during years of plentiful rain, but use their fields for grazing when output is insufficient to warrant harvesting. In addition, there are widely scattered orchards in small depressions where the soil is deep enough to allow adequate water accumulation or in localized slopes where water can be collected in cisterns. These cisterns are cut into limestone, as a traditional inheritance from the Roman times. Water is stored in the cisterns for the whole season without requiring waterproofing;
- the fourth strip extends from 20 to 40 km inland, and is used mainly as rangeland. Intermittent streams draining the tableland might have induced intensive water erosion, and thus initiating the formation of depressions. Wind

erosion could have contributed to sedimentation in the depressions, which appears as hummocky surface characterized by coarse textured materials. Barley may be grown in the depressions or along slopes where sufficient water can be harvested. The vegetative cover of the land is very sparse, and consequently, population settlements are widely dispersed;

- the fifth strip extends beyond 40 km and consists of a high plateau with elevation above 200 m, except for a number of depressions. The surface of the plateau is covered by calcareous rocks in alternating beds of limestone and clays with occasional sandstones. The surface of this tableland is not rough and thus has developed into typical hamada type desert. In places, shallow sediments of Pleistocene origin were subjected to severe erosion during the Holocene, may be present as shallow depressions characterized by rock fragments mixed with sand. The rainfall is very limited, unpredictable, and localized. Vegetation is too sparse to allow meaningful socio-economic activity. Thus, the small number of population in the neighborhood is nomadic, supported economically by breeding and grazing small herds, camels in particular.

El-Naggar et al. (1988) and El- Miniawy et al. (1992) reported some statistics on the relative contribution of job alternatives to family earning. In areas close to sea resorts and other tourist facilities, only 25 % of the population depends on farming and grazing as a principal source of income. In areas far from tourist activities, such as Sidi Barrani, 70% of the populations rely on farming and grazing for most of their income. The proportion of income from livestock increases gradually southward to the rangeland area away from the shoreline.

Three intrinsic characteristics of the NWCZ qualify it to contribute larger proportion to the socio-economic activities of the country. First, the ambient environment of the area affords several alternative human activities including agriculture, fishing, mining, and tourism (El- Miniawy et al., 1992; Klemann and Regner, 1993; and Rabenau, 1994). It enjoys milder climatic conditions, compared to the rest of the country. The mean monthly temperature is a minimum of 12.8°C in January and a maximum of 25.6°C in August. Up to a distance of 20 km from the coastline, winter rainfall ranges from 200 to 170 mm, averaging about 130 mm per annum. Farther inland, up to a distance of 40 km, rainfall is about half as much reaching 60 to 70 mm. The relative humidity ranges between 63% in March and 73% in July. Evaporation is highest in August at 9.7 mm/day and lowest in December at 6.6 mm/day.

Second, as given by Draz (1984) and Ayyad (1995), the western coastal region is floristically and faunistically one of the richest phytogeographical regions in Egypt. Of the total number of plant species recorded in Egypt, 50% occur in this region. The composition of plant growth forms in the region expresses a typical desert flora. The majority of species are drought evaders and drought enduring. In most cases, animals are confined to plant canopies where they are protected from wind and radiation and where food is available.

Third, many historical and archeological evidences point out that the area was once productive for many centuries in the past. Kassas (1972) reported after many scientists and geographers such as Butler (1902), Weedon (1912), and De Cosson (1938), that the area west of Alexandria contained great number of towns and villages that were well populated and prosperous during the Graeco-Roman times until late in the eleventh century.

Rise and Fall of Mareotis

In the rather old literature, the NWCZ used to be named Mareotis, Mariout, or Marmarica in a strong relevance to the Graeco-Roman times. Kassas (1972) gave a comprehensive review of the literature concerned with the rise and fall of Mareotis. Careful reading of this review would crystallize a thesis that the rise and fall of any dryland ecosystem is the associated mirror image of rational and irrational water management practices.

The topographic features of the Mareotis region comprise a series of about 10 parallel limestone ridges (bars) running along an east-west direction to form a Pleistocene sequence of shoreline bars as reported by Ball (1952) and Said (1962). These ridges are effective means of natural redistribution of rainwater; farms are usually located at the feet of these ridges where run-off water can be manipulated to accumulate.

As reported by Kassas (1972), efficient utilization of water resources necessitated the establishment of several "infrastructures". He referred to Hume and Hughes (1921), and De Cosson (1935) to describe one of these infrastructures; the karms. Structurally, the karms are artificial hillocks established mostly in areas of five-meter

contour above sea level and are seldom found above the forty-meter contour. A karm is usually 3-4 meters high; its raised embankment-like sides may not extend completely round the enclosed space. The flanks allow local run-off water of the rainfall to flow to the inside the karms, and consequently collect it onto limited areas where plants are grown.

Another feature of the infrastructure is a variety of cisterns for water storage. Shata (1991), El-Miniawy et al. (1992) described cisterns, which are sometime named Roman wells, as large underground chambers excavated in the limestone ridges serving as covered-in rainwater reservoirs. The chamber is plastered from the inside to prevent leakage, and its capacity ranges from 200 to 500 cubic meters. The sites are carefully chosen with a view to collect run-off from large areas. Subsidiary drainage channels conduct the water to an orifice leading to the chamber. Shata (1991) estimated that in the distance from Alexandria to El-Salloum, there are 3000 cisterns with a total capacity of 2 million cubic meters of good quality water.

Kassas described after Walpole (1932) a subterranean aqueduct discovered near Mersa Matruh in 1931. The aqueduct is comprised of a main channel and numerous side galleries that collect and store water. The length of the system is 854.5 m, average height is 2.1 m, average width is 1.1 m, and the number of manholes is 25. In all likelihood, the site of the facility was chosen at no random. It was dug through an oolitic-limestone ridge associated with a considerable body of sand dunes on its seaward side and an extensive catchments area of rocky plateau dissected by an intricate system of wadis on the inland side.

Kassas (1972) reported after Weedon (1912) that the first record of the decline of Mareotis is dated back to 950 AD. By the 10th century it gradually declined, and the vineyards were replaced by desert. Only a tiny town was in existence west of Alexandria by the year 1400 AD. The district was described during the nineteenth century as covered with ruins of towns, villages, and cisterns dating mostly to Greek and Roman times. De Cosson (1935) added that wind, rain, and sand of continuous seasons completed the destruction, leaving only the foundations of countless buildings to tell the tale of this once prosperous land.

Some would think that the decline of Mareotis cultivation could be attributed to a climate change towards dryer conditions. De Cosson (1935) referred to some earlier writers who supported this hypothesis based on the extinction of ostrich from the nearby Libyan Desert. Another school of thought argued that the intellectual activity of the Greek times in Egypt, when Alexandria was the center of arts and sciences, would have necessitated a temperate climate than that now prevailing in Egypt. Weedon (1912) presented several evidences to indicate that the climate of the region did not change during the last 2000 years. His most convincing evidence is the presence of some ancient plaster constructions of the time, and he argued that the existence of these plaster walls is therefore, presumptive that the climate in 400 AD was not markedly wetter that it is at present.

De Cosson (1935) recollected that the area was the theatre of extended wars during the period from 913 to 969 AD, after which the Fatimids were able to successfully complete their march from Tunisia to Egypt. As the battles were heated, people of Mareotis withdrew to Alexandria for shelter, then for living. The demolition of the main infrastructure of the production system of the region was almost completed in the 11th century by the destructive invasion of Beni Hilal and Beni Soleim nomads, as these tribes were pushed westward out of Egypt.

Recent Rehabilitation Trials

Recent attempts to rehabilitate the NWCZ can be dated back to the early decades of the twentieth century. The extension of railway from Alexandria westward was an essential prerequisite for any development. Kassas (1972) reported after De Cosson (1935) that plantation of fig, vine, olive, carob, and date palm were reintroduced in the area as early as 1918. A field experiments was undertaken by the Ministry of Agriculture from 1917 to 1919 to the improve dry farming of crops especially barley. An experimental station was later established at Borg El-Arab, 45 km west of Alexandria, mainly for horticulture crops and barley. Rainfall was collected from five feddans to irrigate trees growing on one feddan during the period from 1946 to 1953. He observed that the yield will vary from year to the next according to rainfall; but it will not drop to zero as in the case of barley crop. Therefore, it was concluded that depending on an annual crop in an area with considerable variation in annual rainfall might constitute a considerable risk.

Pearse (1955) and more recently Draz (1984) reported the results of some experiments to improve the rangeland in the Ras El- Hekma area, about 230 km west of Alexandria. Bedouins in the area obtain meager livelihood from herds estimated at the time to be 200,000 sheep equivalents. Vegetation cover was poor because desirable perennial grasses and nutritious legumes are scarce and stunted. The underlying conviction of the researchers at the time was a notion that the land and forage resources of the area could, if properly used, yield several times more livestock products, and thus change the area from a present liability to a future asset.

The experimental work covered an area of 25,000 feddans where trials with 300 promising plant species and water application techniques were developed. Windmills were utilized to pump groundwater for supplementary irrigation. Experiments dealing with sand dune stabilization and soil conservation practices were carried out. Educational and extension activities included a training school and on "farm" extension programs. Moreover, several research projects on animal breeding, vegetation, soil surveys, geology, geomorphology, and hydrology were undertaken.

The planners of this endeavor hoped that the entire project area would be grazed as an efficient, highly productive livestock unit by 1959. However, the area was no better in 1959 than in 1954. Irrigation by windmills caused accumulation of salts and, consequently, irrigated plots were less productive than rainfed and run-off-fed plots. Enlightened grazing could not be enforced, and animal feed for the experimental flocks had to be transported some 400 km from the Nile Valley.

Kassas (1972) contrasted the failure of this range management experiment with the success of fig and olive plantations in the area. Controlled grazing would require organizational measures that may prove to be impracticable; and if implemented its administration will be too expensive. The fig and olive plantations, on the other hand, lead to settlement, at least for part of the family. Therefore, trees will be protected within the framework of the prevailing social traditions, not imposed, and thus no administrative expenses are incurred.

Gaddas (2000) reached the same conclusion many years later, though stated in a different context. It was reiterated that conventional top-down schemes for land degradation management have little impact. A better alternative is the holistic approach that integrates socio-economic aspects within the biophysical elements of the solution proposed to meet the population needs and aspiration. Such approach would motivate land users to implement land management schemes that are conducive to better land vegetative cover.

Current Activities

The agricultural sector of the NWCZ has undergone significant transformations in the last decades. Thanks to the impetus of many large scale projects supported by the national budget and by the international donor community. Most prominent of the international projects are the Qasr Rural Development Project (QRDP) supported by the GTZ (Ergenzinger, 1989; Bartels, 1990; and Klemann and Regner, 1993) and the Matruh Resource Management Project (MRMP) supported by the World Bank (El-Naggar et al. 1988). One important aspect of these projects is the emphasis on long-term climatic records on rainfall frequency, quantity and limits, together with data on land resources and farming systems. Necessary adjustments were introduced to management practices to achieve feasible returns that are sustainable and acceptable to farmers.

Many experts think that the cultivated area of orchards was doubled and furthermore could be doubled again in the future. Von Rabenau (1994) pointed out that there are two approaches to calculate land potential for fruit trees in rainfed areas. First, there are calculations based on experience gained from projects already implemented in the area. The results obtained by the QRDP could be taken as an illustrative example. Adapted harvesting schemes would sustain a comparatively intensive production of vegetables and fruits within the ratio of 240 feddans / km of coastline. Assuming that the QRDP experience can be duplicated along the entire coast, the land potential in the NWCZ is 130,000 feddans for such type of production.

Estimates of the second approach are based on the harvesting rate, which is defined as the land area needed for water collection per unit area cultivated. It is a function of amount of rainfall, efficiency of water harvesting, and water requirement of crops. Typically, higher harvesting rates would need higher investments. It should be recalled

that not all sites are easily adapted for water collection, and that the soil cover may sometimes be too thin to support vegetation or to store water (Gaddas, 2000). Geomorphology determines run-off proportions, water retention, and cistern construction, and any of these may affect site suitability. For the average sites of the NWCZ, it is reasonable to conclude that water is the constraining factor in land cultivation, and hence the land potential is based on the amount of water that can be harvested in the area. The calculations indicate that 133,000 feddans are potentially cultivatable for fruit and vegetable production, almost equal to that obtained by the first estimate.

It should be recalled, however, that neither methods for determining orchard cultivable area is concerned with economic feasibility. If the harvesting rate is high, cultivation of marginal land will not be economically feasible. Unfortunately, the optimal harvesting rate is not well defined, i.e. the rate that just equates the economic return to the opportunity cost of capital. Therefore, future analysis will have to scrutinize explicitly the economic feasibility of extension into new rainfed land. Moreover, the dryland ecosystems are well known for their extreme climatic variability as reported by Ayyad (1995) and Gaddas (2000). Therefore, a safety factor should be taken into consideration to ensure the sustainability of the production system. A safety factor of 50% would reduce the cultivated area by a proportional extent.

Environmental Impacts

The agricultural improvements of the NWCZ in the last two decades were concomitant with some far-reaching socio-economic and environmental changes in the area. These changes are the impacts of implementing many activities including oil exploration and production, and the establishment of needed infrastructure facilities. Most prominent of these are the intercontinental east - west highway connecting to oil-producing Libya, the El-Dabaa power station, and the extension of the El-Nasr canal conveying Nile water to El-Hammam area, about 30 km west of Alexandria. Moreover, the tourism sector has undergone an explosive growth as many medium and large sea resorts were established along the shoreline. It is all too natural to concur with El-Naggar et al. (1988), Rabenau (1994), and Ayyad (1995) that trading, civil services, and marketing have expanded in recent years and that earnings from these activities provide increasing proportions of the local people's income. Qualitative indicators point out that the number of populations has markedly increased, and that the quality of life has definitely improved.

It is unfortunate, however, that the price tag for such improvement is expensive in terms of environmental degradation. Three negative impacts could be enumerated. First, as reported by Ayyad (1995), the number of raised animals in the area increased from 0.6 million in the early seventies to one million in the mid eighties and then to 1.4 million in the mid nineties. There is a general consensus that the present stocking rates far exceed the normal carrying capacity of the rangeland. Feed concentrates have to be used to supplement the nutritional requirements of the animals. However, overgrazing, leading to possible devegetation and desertification is becoming an eminent ecosystem threat.

Second, traditional agricultural products in the NWCZ used to be almost natural; that is organic farming in the strict sense of the words (El-Miniawy et al. 1992, and von Rabenau, 1994). Greater market demands generated strong stimulus to increase the productivity of the existing orchards by using fertilizers and pesticides. Utilization of these chemicals would increase yield, but environmental pollution is a possible side effect. An efficient extension service is needed to convince farmers with the virtues of clean products and clean environment.

Third, construction of tourist resorts constitutes another adventitious degradation phase. Von Rabenau (1994) and Ayyad (1995) reported that the oolitic limestone ridges in many places were obliterated for making bricks necessary for buildings. It should be recalled, however, that the natural slope of these ridges serves as natural rainwater catching area. In all likelihood, tampering with the natural landscape of the ecosystem would diminish its ability to harvest water in proportion to the inflicted damage. Shata (1991) estimated that runoff coefficients vary from 1 to 25 % for landscapes with slopes varying between 1.2 and 13%. Bentonite shale deposits, abundant in the area, could provide required raw materials for the manufacture of bricks (Tahoun, 1992).

Therefore, it seems appropriate to conclude that the NWCZ of Egypt possesses considerable amounts of some precious and complementary natural resources. A comprehensive inventory of these resources along with assessment of past experience should be undertaken as a priority issue. Subsequently, there is an urgent need to formulate an

integrated framework for the sustainable development of the area. The local community should be involved in formulating this framework to fulfill the bottom-up approach, and relevant indicators should be used to monitor and adjust the implementation.

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References

- Abdel-Kader, F. H. 1998. GIS analysis of landscape units for coastal areamanagement of Fuka basin. *Alex. J. Agri. Res.* 43: 109- 127.
- Ayyad, M. A. 1995. A framework for accumulating consequential data and knowledge: a contribution to Fuka - Matruh area management programme. Blue Plan Regional Activity Center, UNEP.
- Ball, J. 1942. *Egypt in the classical geographers*. Government Press, Cairo.
- Bartels, M. 1990. Land use planning for the area of Qasr Rural Development Project. Egyptian Environment Affairs Agency, Cairo.
- Butler, A. J. 1902. *The Arab conquest of Egypt and the last thirty years of the Roman dominion*. Clarendon Press, Oxford.
- De Cosson, A. 1935. *Mareotis. Country Life*, London.
- Draz, O. 1984. Range and forage resources – Agricultural development in the northwestern coastal zone of Egypt. FAO Technical Report, TCO/Egy/2205(mf), Rome.
- El- Miniawy, H., F. Mark, and S. Tobah. 1992. Qasr Rural Development Project, proposed development plan: summary of final report. Egyptian Environment Affairs Agency, Cairo.
- El-Naggar, S., E. R. Perrir, and M. Shykhoon. 1988. Evaluation of farm resource management in the northwest coast of Egypt. Workshop for the Northwest coastal region. ARC, SWRI/ ICARDA, Cairo, Alleppo.
- Ergenzinger, P. 1989. Water budget and water supply for the Qasr Rural Development Project. Egyptian Environment Affairs Agency, Cairo.
- Gaddas, N. 2000. Promoting sustainable utilization of marginal lands in the Near East Region. Regional Workshop on Degradation and Rehabilitation of Marginal Land in the Arab Region, CEDARE. Cairo.
- Hume, W. F. and F. Hughes. 1921. The soils and water supply west of Alexandria. Survey Department Paper 37, Cairo.
- Kassas, M. A. 1972. A brief history of land—use in Mareotis region, Egypt. *Minerva Biologica* 1: 167-174.
- Klemann, P., and Regner, H. J. 1993. Callege for development of arid lands of Egypt's North-Western coast. Qasr Rural Development Project. Egyptian Environment Affairs Agency, Cairo.
- Pearse, C. K. 1955. Improving Egypt's range forage. *Bull. Instit. Desert d'Egypte*. 5:77
- Said, R. 1962. *The geology of Egypt*. Elsevier, Amsterdam.
- Shata, A. A. 1991. Water resources and the future of arid lands. Roundtable meeting, RIGW/IWACO, Cairo-Rotterdam.
- Tahoun, S. A. 2000. Environmental frontiers for the sustainable land management in arid regions. Accepted for publication, Egypt. *Soil Sci. Soc.*
- Tahoun, S. A. 1992. Detection of technical fraud in brickmaking by mineralogical analysis. *Appl. Clay Sci.* 7: 423-430.
- Von Rabenau, 1994. Sustainable Development strategies for the northwest coast of Egypt. Qasr Rural Development Project. Egyptian Environment Affairs Agency, Cairo.
- Walpole, G. F. 1932. An ancient subterranean aqueduct west of Matruh. Survey Dept. Paper 42, Cairo.
- Weedon, A. L. P. 1912. Report on Mariout district. *Cairo Sci. J.* 6: 201.