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MAP CAMP PROJECT "FUKA-MATROUH", EGYPT

FINAL INTEGRATED REPORT AND SELECTED DOCUMENTS

MAP Technical Reports Series No. 131
Volume II

UNEP/MAP

Athens, 2001

ISBN 92-807-2032-5

For bibliographic purposes this volume may be cited as:

UNEP/MAP: MAP CAMP Project "Fuka-Matrouh", Egypt: Final Integrated Report and Selected Documents. MAP Technical Reports Series No. 131, Vol.II, (2 Vols), UNEP/MAP, Athens, 2001.

This report was prepared under the coordination of the UNEP/MAP Priority Actions Programme, Regional Activity Centre (PAP/RAC).

The thematic structure of the MAP Technical Series is as follows:

- Curbing Pollution
- Safeguarding Natural and Cultural Resources
- Managing Coastal Areas
- Integrating the Environment and Development

This series contains selected reports resulting from the various activities performed within the framework of the components of the Mediterranean Action Plan: Pollution Monitoring and Research Programme (MED POL), Blue Plan (BP), Priority Actions Programme (PAP), Specially Protected Areas (SPA), Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), Environment Remote Sensing Centre (ERS), and Cleaner Production Centre (CP).

MAP CAMP PROJECT "FUKA-MATROUH", EGYPT

FINAL INTEGRATED REPORT AND SELECTED DOCUMENTS

Volume II

TABLE OF CONTENTS

VOLUME I

VOLUME II

Technical Note

This issue of MAP Technical Report Series presents a selected set of documents prepared within the MAP CAMP "Fuka-Matrouh-Egypt" project. Each CAMP project includes a number of individual project activities, prepared by national experts and/or institutions with the assistance and guidance of respective MAP Centres. The outputs of these activities are usually presented by final documents or final activity reports, each report containing 80 – 200 pages, and sometimes even more, including a number of maps, figures and technical annexes.

Therefore, it was not possible to present all project outputs in one issue of MAP Technical Report Series. The selection of the documents to be included was made by PAP/RAC, with the consent of the National Focal Point for Egypt and of the MAP Co-ordinating Unit. Due to the number of selected documents the issue had to be published in two volumes.

The first volume contains the Final Integrated Report of the project and the Report of the Final Presentation Conference, both documents presenting the synthesis of project results, and, as annexes, the final documents of the activities related to Integrated Coastal Area Management, Strategic Environmental Assessment, and Carrying Capacity Assessment.

The second volume contains documents relative to the activities on Systemic Prospective Analysis, Soil Degradation and Desertification, Assessment of Natural Resources and Soil Conservation Issues, Sites of Cultural Heritage, and Marine Ecosystems.

In addition, both volumes contain a preface, introduction and the list of all final outputs of the project.

All documents are presented in their original form.

PREFACE

The MAP Coastal Area Management Programme (further on referred to as CAMP or Programme) has been approved by the Sixth Ordinary Meeting of the Contracting Parties, held in Athens in 1989. Its adoption was preceded by four coastal management pilot projects, implemented by PAP/RAC in the 1987-1989 period.

During the 1989-2001 period eight CAMP projects were implemented in: Albania (the Albanian Coast), Croatia (the Kastela Bay), Egypt (the Fuka-Matrouh Coastal Area), Greece (the Island of Rhodes), Israel (the Israeli Coast), Syria (the Syrian Coastal Area), Tunisia (the Sfax Coastal Zone), and Turkey (the Izmir Bay). Presently, the CAMP "Malta" project is in implementation (since early 2000), the project for Lebanon started in 2001, and the project for Algeria is in preparation, likely to start in the year 2001 or early 2002. Finally, projects for Morocco and Slovenia are in preparation, to start in 2002 or later on.

Within the initial phase of CAMP, the MAP Co-ordinating Unit in Athens was responsible for the Programme as a whole and for the implementation of its individual projects. Since 1996 PAP/RAC has been the MAP Centre responsible for the co-ordination of the CAMP, under the supervision and guidance of the Co-ordinating Unit.

The conceptual framework of MAP CAMP is based on the principles of sustainable development and on Integrated Coastal Area Management (ICAM). The Programme performs practical coastal management projects in areas selected in accordance with the Programme objectives and defined criteria. The projects are implemented by MAP in co-operation with the responsible national and local authorities and institutions, by selected national teams or institutions, with the assistance of respective MAP Centres and MED POL.

The objectives of the Programme are:

a) to develop strategies and procedures at local and national levels for sustainable development, environment protection, and rational utilisation of coastal and marine resources, to be also used as inputs for the formulation of Mediterranean strategies of sustainable development,
b) to identify, adapt, and test, in a realistic operational context, methodologies, tools and practices of sustainable coastal management in the region,
c) to contribute to the upgrading of relevant national/local institutional and human capacities, and
d) to secure a wider use, at national and regional levels, of experience achieved by the Programme and by its individual projects, and create conditions for follow-up activities.

The Programme is of a multilevel nature, being oriented at local/project area level by dealing with area-specific priority problems, and at national and regional levels by applying the project results and experience as pilot ones.

Individual CAMP projects are structured into project units defined as individual project activities, each activity dedicated to a specific issue or to an interrelated multisectoral group of issues. Integration and co-ordination, data management, sustainability analysis, and a public participation programme are considered as mandatory activities of each CAMP project.

INTRODUCTION

The CAMP "Fuka-Matrouh-Egypt" project has been approved by the Seventh Ordinary Meeting of the Contracting Parties to the Barcelona Convention, held in 1991 in Cairo. The Agreement on the development and implementation of the project was signed in November 1992, and after the preparatory phase, the implementation started in 1993.

The project area was defined at two levels, the North - Western Mediterranean Coast of Egypt as the wider geographical context, and the Fuka-Matrouh area as the project study area. The wider project area administratively belongs to the Matrouh Governorate. The boundaries of the project study area are defined by the city of Matrouh at the western end, the Fuka area at its eastern end, the Mediterranean Sea in the North, and in the South by the 100 m contour line, resulting in a line 10-20 km distant from the coastline. The length of the coastline of the study area is approximately 100 km. The project study area is representative of the wider Mediterranean coastal region of Egypt, being scarcely populated, with Bedouin population in rural areas and immigrant population in the towns. The coastal strip and the adjacent marine area might be considered as among the most attractive natural sites of the Mediterranean. The area is also rich in valuable cultural heritage.

In spite of its great value and significance the area faces serious threats. In addition to the degradation which occurred over the centuries due to historic events, the fragile and sensitive ecosystems are presently under permanent pressure of uncontrolled development of tourism, inappropriate agricultural practices, absence of effective land-use and development planning, and insufficient integration of policies. It should also be noted that the national development policy aims at strengthening of development processes leading to a faster sustainable development of the area, providing increased employment opportunities for the resident population and for the expected further immigrants from the Nile area. Finally, there is a need for a better understanding of present and future development impacts on Bedouin population, now predominantly settled.

Taking all of the above into consideration, the long-term objectives of the project were to propose a sustainable development concept, and to create conditions for the establishment of the process of integrated planning and management of the project area. The immediate objective of the project was to propose solutions for urgent problems in the area, taking into account the long-term objectives of the project.

Accordingly, the project Agreement envisaged the implementation of 10 individual activities:

- systemic and prospective analysis,
- study on implications of expected climate change,
- integrated planning and management study,
- training and application of tools for integrated coastal management: GIS, Carrying Capacity Assessment for tourism activities, and EIA,
- development of environmental legislation and institutional framework,
- inventory of land-based sources of pollution, monitoring and research of marine pollution,
- study on protected areas and implementation of the Specially Protected Areas protocol,
- study on development of tourism,
- assessment of soil erosion and desertification, and
- water resource management study.

It was understood that the ICAM methodology would be applied by the project providing, among others, for integration of the project results into an integrated final project document.

The implementation of the project was completed in 1998, the final project documents presented in 1999, and the Final Presentation Conference held in June 1999. The MAP Co-ordinating Unit was responsible for general co-ordination and implementation of the project till the end of 1995. Since 1996 the Unit acted as the overall supervisor, providing guidance for the project implementation, while PAP/RAC, BP/RAC, SPA/RAC, ERS/RAC and MED POL were responsible for the implementation of activities within their mandates. From 1996 PAP/RAC was responsible for the co-ordination and implementation of all project activities, under the guidance and supervision of the Co-ordinating Unit.

The institutional arrangements at host-country level included the involvement of the Ministry of State for the Environment, the Egyptian Environmental Affairs Agency (EEAA), the Governorate of Matrouh and local communities, the Ministry of Tourism, and the National Authority for Remote Sensing and Space Sciences (NARSS). A large part of project activities was implemented by the University of Alexandria, Institute for Graduate Studies and Research, and by national teams, assisted by MAP Centres and experts. In addition, within individual activities, NGOs, the private sector, major stakeholders and the local population were involved.

It can be said that the activities and results of the project represent a milestone in the national coastal management programme, by introducing innovative methodologies and tools, establishing partnerships and involving stakeholders, and by a successful implementation of integrating activities (Integrated Planning, GIS and Database, Strategic Environmental Assessment, and Sustainable Prospective Analysis). In addition, the replicability of approaches, methodologies and tools applied enables the implementation of similar initiatives in other equally sensitive areas.

The sustainable development framework till the year 2020, elaborated for the project area proposes a spatial development concept consisting of: (i) mixed use, peri-urban villages east and west of the Matrouh city, (ii) tourism facilities in the forefront project area, (iii) residential rural areas behind, and (iv) agriculture and light industry facilities close to main transport corridors.

The sustainable tourism development programme was elaborated using the Carrying Capacity Assessment as a tool. The recommended development concept consists of: (i) identification of sensitive areas and elaboration of measures and actions for their protection (restricted development, buffer zones, access regulation), (ii) identification of areas for, and types of tourism facilities to be developed, (iii) measures to extend the tourism season duration, and (iv) support of the local population and expression of interest to be involved in such a tourism development concept.

The assessment of soil degradation and desertification processes was made by a successful use of the remote sensing technique, combined with field surveys, resulting in recommendations for conservation of resources and implementation of appropriate control management procedures.

Sites of particular natural and cultural value were identified and evaluated, measures and recommendations for their protection and sustainable use were formulated concerning their legal status, a network of protected areas was established, as well as a surveying system of marine ecosystems, and specific measures for the protection of the cultural heritage

The study on terrestrial ecosystems, in addition to a detailed inventory and assessment of the status and problems of these systems, recommended: (i) pilot areas for protection and controlled grazing, involving land-users and local authorities, to be established, (ii) systems for grazing management to be initiated, involving land-users and local authorities, (iii) extensive programmes for the propagation of protection of endangered plant species to be developed, and (iv) nature reserves to protect the representative habitats to be established and managed.

The Systemic Prospective Analysis indicated the trends and alternative options, in addition to the introduction of the relevant approaches and methodology into national practice.

Finally the project resulted in the identification of implications of the climate change and elaboration of respective recommendations, and provision of data, information and recommendations related to marine pollution.

The Final Presentation Conference and the final activity documents formulated a number of recommendations, to be taken into account when deciding on the use of project results and its follow up (see Annex Vi of the Conference Report, later in the text).

Finally, among recommendations formulated by the project, some issues to be dealt with as part of follow-up activities, might be mentioned:

- the use of the project results when elaborating and adopting plans and development programmes for the project area,
- the presentation of project results to the National Committee for ICZM,
- strengthening of institutional capacities for the implementation of large, complex, multidisciplinary projects, implementation of respective measures for capacity building,
- development of a land information system, to be used as input for land-use and development planning,
- preparation of a study on the position of Bedouins and impact of the development on their future in the project area, and
- implementation of other recommendations related to institutional and legal measures and protection / rehabilitation activities, as appropriate.

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2. Eid, El Mohamady: Integrated Planning and Management of Fuka Area (Egypt), Cairo, 1990 (PAP/RAC)
3. Draft CAMP Project for Fuka-Matrouh Area (Egypt), Athens, 1992 (MAP)
4. Agreement Relative to the Coastal Area Management Programme for the Coastal Area of Fuka Matrouh (Egypt), Athens, October 1992 (MAP)
5. Marine and Coastal Environment - Questionnaire, Split, March 1993 (PAP/RAC)
6. Ferrari, Giovanni: Proposal for the Study of Soil Erosion and Desertification in the Management Programme for the Coastal Area of Fuka-Matrouh (Egypt), Florence, April 1993 (PAP/RAC)
7. Beltagy, Ali Ibrahim: The Marine Ecosystems of Fuka-Matrouh Area (Egypt) – Status of Species and Habitats, Tunis, 1993 (SPA/RAC)
8. Kasparek, Max: Marine Turtle Conservation in the Mediterranean – Marine Turtles in Egypt – Phase I: Survey of the Mediterranean Coast between Alexandria and El-Salum, Tunis, 1993 (SPA/RAC)
9. Ayyad, Mohamed Abdel-Gawad: The Terrestrial Ecosystems of Fuka-Matrouh Area (Egypt): Status – Protection and Measurement Measures, Tunis, 1993 (SPA/RAC)
10. Fawzi, Mohamed *et al.*: Up-Dated On-Site Report for the Fuka-Matrouh Area, Egypt, Cairo, November 1993 (PAP/RAC)
11. Report of the Workshop on Geographical Information Systems in Integrated Coastal Area Management (Alexandria, November 13-18, 1993), Split, November 1993 (PAP/RAC)
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15. Aruoba, Celik: Systemic and Prospective Analysis for an Environmentally Friendly Management, 1995 (BP/RAC)
16. Ayyad, Mohamed A.: A Framework for Accumulating Consequential Data and Knowledge, Alexandria, 1995 (BP/RAC)
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19. Assessment of Land Resources Supported by Remote Sensing, Palermo, September 1995 (RAC/ERS)
20. Abdel-Kader, Fawzi, *et al.*: Soil Degradation and Desertification – Final Report, January 1996 (PAP/RAC)
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22. El-Raey, Mohamed, *et al.*: A Framework for Integrated Coastal Area Management Plan of Fuka-Matrouh Area (Egypt), Alexandria, June 1998 (PAP/RAC)

23. El-Raey, Mohamed, Fawzi Mohamed, *et al.*: Strategic Environmental Assessment of the Integrated Coastal Area Management Plan of the Fuka-Matrouh Area (Egypt), Alexandria, December 1998 (PAP/RAC)

24. Integrated Coastal Area Management Planning Study for Fuka-Matrouh Area, April 1999 (PAP/RAC)

25. Carrying Capacity Assessment for Tourism Development in Fuka-Matrouh Area, June 1999 (PAP/RAC)

26. Assessment of Natural Resources and Soil Conservation Issues in the Coastal Area of Fuka-Matrouh, June 1999 (PAP/RAC – ERS/RAC)

27. Final Integrated Report of the Coastal Area Management Programme "Fuka-Matrouh – Egypt", June 1999 (PAP/RAC)

28. Report of the Final Presentation Conference for the CAMP "Fuka-Matrouh" (Cairo, June 8-9, 1999), August 1999 (PAP/RAC)

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50. El-Raey, Mohamed, *et al.*: A Framework for Integrated Coastal Area Management Plan of Fuka-Matrouh Area (Egypt), Alexandria, June 1998 (PAP/RAC)

51. El-Raey, Mohamed, Fawzi Mohamed, *et al.*: Strategic Environmental Assessment of the Integrated Coastal Area Management Plan of the Fuka-Matrouh Area (Egypt), Alexandria, December 1998 (PAP/RAC)

52. Integrated Coastal Area Management Planning Study for Fuka-Matrouh Area, April 1999 (PAP/RAC)

53. Carrying Capacity Assessment for Tourism Development in Fuka-Matrouh Area, June 1999 (PAP/RAC)

54. Assessment of Natural Resources and Soil Conservation Issues in the Coastal Area of Fuka-Matrouh, June 1999 (PAP/RAC – ERS/RAC)

55. Final Integrated Report of the Coastal Area Management Programme "Fuka-Matrouh – Egypt", June 1999 (PAP/RAC)

56. Report of the Final Presentation Conference for the CAMP "Fuka-Matrouh" (Cairo, June 8-9, 1999), August 1999 (PAP/RAC)

ANNEX IV

SYSTEMIC AND PROSPECTIVE ANALYSIS FOR AN ENVIRONMENT FRIENDLY MANAGEMENT

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A contribution to Fuka-Matruh Coastal Area Management Programme

Systemic and Prospective Analysis for an Environment Friendly Management

By
Professor Celik ARUOBA

February 1996

TABLE OF CONTENTS

ENVIRONMENT FRIENDLY MANAGEMENT STUDY FOR THE COASTAL AREA OF NORTHWESTERN REGION OF EGYPT

SUMMARY AND CONCLUSIONS

Awareness in Mediterranean countries of actual and potential threats to natural environment has grown rapidly in the last few decades. Concerns about deteriorating ambient quality and natural resource depleting have raised the fear that permanent and unalterable destruction is being done to the environment of the Mediterranean basin through the exhaustion of limited natural resources, the lost of biodiversity and the cumulative ruin of land and water resources. Western part of Mediterranean coastal region of Egypt, in other words the Matrouh area, predictably is one of the focal points in this context.

Matrouh Region can best be described as a fragile ecosystem with unique features and resources. Expanding human demand and economic activities, on the other hand, are putting constantly increasing pressure on land and other particular natural resources in the Region, creating suboptimal use and even destruction. Land and distinctive environmental assets of the Region are finite resources. In other words, drastic cases of irreparable circumstances are undisputable.

Primary objective of this study is to help to seek and establish a structure in which future environmental and, also, socio-economic policy measures could be taken more readily and conveniently in order to arrange development-environment relations in Matrouh Region within the framework of balanced and consistent, in other words "sustainable" development principle. Consequently, the study, in order to contribute to the formulation of befitting public policies aims to discover future socio-economic development trends; establish the relationships and interdependence between present and future environmental structures and determine and demonstrate economic and social activities that impair proper ecological bearings.

Land and Population

The Governorate of Matrouh enclose the northwestern corner of Egypt. Although it is the largest Governorate in terms of land, (212 thousand sq.km.), more than 80 % of this area is the desert. Inhabitable and cultivable land area of Matrouh governorate is approximately 20 thousand sq. km. This region can be defined as the area extending between the border of Alexandria Governorate in the east and the Libyan border in the west, Mediterranean coastline in the north and a depth varying from 30 to 50 km. in the south.

Matrouh Region, in various respects, is a considerably diversified area. In addition to coastal zones, it contains depressions and terrains of varying degrees of accessibility. Arid Mediterranean climate and, topography, soil conditions and rainfall which merely permit grazing and dry farming agriculture are the salient features. Limited and haphazard use of available land and water resources mainly due to poor social and economic conditions, at least for the time being, ensue land degradation and water losses.

The resident population of Matrouh Governorate was approximately 250 thousand people in 1995. Even though it currently gives a more favorable population/inhabitable land ratio than the rest of the country, the Region experiences a higher population growth rate than Egypt as a whole, primarily due to, **i.** continual and intensifying migration from the Wadi and the Delta motivated and encouraged by thriving of various economic activities, and **ii.** Government efforts to establish new communities outside the Wadi. Estimates of population growth rates and trends indicate that resident population of northwest region of Egypt will ascend to almost 500 thousand people in the next thirty years, representing a two-fold increase. It should also be remembered that, even upon optimistic assumptions on the decline of the population growth rate, the total population of the country as a whole will escalate from its present level of approximately 60 million to 90 million in 2025.

One of the peculiarities of the Matrouh Region from the population point of view is the difference between resident (winter) and summer populations. It can easily be predicted that in 2025 summer time population will reach well above 950 thousand people in peak periods, putting an immense amount of pressure on all environmental resources and infrastructure.

It is rather clear that socio-economic developments, especially thriving service sectors and trade which provide a agreeable basis for employment and income in the region significantly attract both investors and workers from the Wadi and the Delta. The present demographic composition would best be described as "mixed." Ascending migration, on the other hand, is rapidly changing the percentage distribution of population between the migrants and the native Bedouin in the region and, particularly in the Matrouh City, resulting a continual social change and a new social structure. There exist a substantial amount of competition and a considerable difference between the preferences and priorities with regard to social and economic, and, inevitably environmental matters which lead to an escalation in ethnic-type frictions and conflicts on land ownership water use, etc. among the population.

One of the noticeable eventualities in the Region is the impressive growth of the city of Marsa Matrouh since 1970's and especially in the last decade due to a number of commanding reasons which stimulate extensive migration to the city. Existing trends, predictably instigate still very high population growth rates for the coming 30 years. Resident population of Matrouh City will expand to 245 thousand people which, in turn will represents a three-fold enlargement in 2025, and 54 % of total resident population of the Region shall live in Matrouh City. In summer months this number will increase to 325 thousand people.

Water

The existing water supplies are inadequate to meet water needs of the region, particularly during the summer months when stored rainwater is depleted and summertime influx of tourists contributes significantly to consumption. Current average water consumption even in the city of Matrouh is low due, both, to water supply shortages and socioeconomic reasons, suggesting a significant rise in need and demand for water in the future.

Various projects, on the other hand, has been conceived in order to increase water supply and it has, been assumed that the Region would be in a position to provide all its own needs of water in the future. In a framework of such an expectation it would, evidently, be feasible to expect a higher population growth rate in the coming decade(s) specifically due to a rise in the, -even currently high-immigration rate.

Economy

Range of economic activities in Matrouh is substantial, covering agriculture, livestock rising, trade, tourism, industry, mining and quarries, petroleum and various services. Schemes of private sector and the variety in types of private ownership, specifically in this new era of government development strategy and policies, seems to have major sectoral manifestations and a strong tendency to elevate. Private sector arrangements cover a range of national, foreign and mixed projects, corporate land holdings, cooperative agricultural development ventures, mining, specifically quarrying activities, touristic villages development, in addition to, smallholders and family enterprises in agriculture, trade, industry and services.

Existing trends indicate that, prospectively the sequence of importance of economic sectors which presently furnish the leading place to agriculture will change in the near future, as the present procession of development pattern persists, and, as the rise of per capita incomes will change the consumption patterns in line with applicable income elasticities of demand. In other words, in the study area, tourism and trade, will become more important sectors of activity than agriculture. Rapid development of tourism and trade, on the other hand, will, evidently, induce a more agile progression of transportation, building, energy and other infrastructure categories, and even small scale industry sectors.

Agriculture

Agriculture, still is the main economic activity and main source of income in the Region. Greater part of agricultural income generates from animal husbandry, orchards, vegetable cultivation and, although in limited quantities, barley and wheat. In the coastal cultivation strip which includes the beach and the coastal plain, cultivation of orchards and vegetables predominates. In the inland cropping/grazing strip, on the other hand soil is poor and grazing and farming of barley and, recently, wheat is prevalent. Marketing of agricultural products handled by private traders and wholesalers. Both in the case of livestock and fruits and vegetables a strong and growing local demand exists. An important section of livestock production is exported, especially to Gulf Countries. Libya which was the foremost market until 1970's before the border with Egypt was closed, seems to gain its former importance in recent years as an important market outlet, for agricultural -and all kinds of- commodities rapidly.

Agricultural land is limited. The only way to increase production is to increase yields. Although restrictions imposed by the scarcity of water resources, impede application of better farming practices, expanding of irrigation possibilities in recent years induces elaboration of fertilizers use. Similarly, as a result of various efforts to increase yields, use of pesticides and certain other chemicals application are called for, specifically in the coastal cultivation strip, that in turn could result in pollution and decay of underground water resources if not properly managed. There, also exist a tendency for a higher degree of mechanization in agricultural production. One of the causes of soil erosion in the Region, evidently, is inappropriate cultivation equipment and methods.

Intensification of agricultural production, by itself actuate environmental problems. Intensification or technoogical improvement means appending and augmenting of irrigation - in other words, diverting more water for irrigation- and increasing the use of so called technological inputs: machinery, improved seeds, fertilizers, pesticides and insecticides, etc. Intensification of agricultural production in northwest region also means introduction of new and alien crops -like sugar beets- to a exclusive and introspective, and also, fragile environment. Agricultural practices and policies in Matrouh area apparently fail to recognize the real value of natural resources of the region.

Tourism and Touristic Villages

The main aim of the Government policy, reflected by investment program of the Regional Development Plan and connected "Tourism Development Project", and recent progressions in the Region, is to promote the expansion of tourism sector. Plan indicates that by the year 2010 tourism sector will receive the first place by 38 % of total public investment in the Region. It is expected and estimated that both international tourism, incorporating a larger share of Arab tourists than the rest of the country, and domestic tourism will develop together and the number of tourists visiting Matrouh Region, which was approximately 600 thousand in 1995, will go beyond 1.5 millions in 2005 and 2.3 millions in 2010.

Probably the most important economic and social occurrence which also greatly influence, even impact environmental conditions in Matrouh Region is the so called "touristic villages." A very large number of such establishments, incorporating thousands of summer houses or apartments, one after another, all of them very near or on the sand beaches, isolate the coast from the rest of the area. Touristic villages construction as a project is extremely huge, maybe the largest in Egypt in respect with realized amount of investment based on funds created by voluntary domestic savings. It is estimated that, until this date capital investment to the project exceeded a total of 30 billion Egyptian Pounds, and the construction activities together with designing of new villages hastily continue.

Choice and decisions of construction of touristic villages are increasingly becoming subject to individual public or private investors' preferences -that is, in a haphazard fashion without any planning effort- based on economical (financial) and technical capabilities of these investors, without any environmental considerations taken into account. Consequently, rapid increase of touristic facilities on the coast, which is the main reason of severe active coastal erosion problem, also puts a substantial pressure on landscape and cause pollution of the coastal waters.

Transportation: Pan North African Road

Dual highway which extends from Libyan border to Alexandria, parallel to the Mediterranean Sea, is probably the most important infrastructure that will accelerate, even foster agricultural and industrial development, as well as tourism and trade and, also social mobility in the Region.
On account of this highway, Matrouh and its economy is now in easy access to the towns of the Delta and the Wadi and Sinai. Moreover, this coastal road has very important international connotations. It is a considerably substantial part of the so called Pan North African Road which connects the Arab countries of North Africa to the Middle East. It is rather easy to anticipate that the international road, already attending a constantly growing number of, specifically Libyan merchants and traders together with the development of domestic transportation activities, in the near future will encourage and cultivate a substantial amount of additional economic activity.

Environment

Environmental problems in Matrouh are fundamentally related to management of natural and environmental resources. In other words, the region, at least for the time being, do not face an excessive pollution problem -except some degree of water pollution and degradation of water quality, especially of underground waters and the sea, which is the result of rapid urbanization, haphazard increase of touristic facilities, certain agricultural production practices, and lack of proper sewage systems- that directly and adversely influence the lives of the people. This is one of the important reasons which explain the lack of interest of individual citizen, local administrators, representatives of economic sectors, etc. towards environmental issues.

Matrouh, on the other hand confront at least three severe specific environmental problems:

i.Excavating of limestone ridges running parallel to the Mediterranean coast for profiteering. The mining or, more accurately, ripping process is undertaken openly by generally unauthorized people in a completely uncontrolled and haphazard fashion which lead to a total destruction and exhaustion of each and every ridge in each and every drill area.

ii. Another natural resource degradation and depletion process, which is referred as "active coastal erosion" or "active sand movement" continues at the irreplaceable sand beaches of the region, specifically in touristic villages areas as a direct outcome of large scale construction activities very near to the sea and the wind erosion which is an outcome of loss of natural vegetation, especially dwarf fig orchards, again due to the touristic village construction activities.

iii. Another important and environmentally unfavorable eventuality is the damage to biodiversity and destruction of various groups of natural vegetation, specifically the loss of dwarf fig orchards to urbanization and touristic villages development, and, also to "new and advanced" modes of agricultural production. One of the important consequences of this development, obviously, is increasing wind erosion hazard.

It is also highly probable that various different environmental problems would arise in the Region due to certain developments and occurrences in coming years and decades like, construction of the proposed and planned nuclear power plant; furtherance of production and transportation of petroleum and natural gas; invigoration of the "sleeping project" of Canal to Quattara Depression and furtherance of the large scale irrigation project connected, to the construction of the Southern Canal.

It should strongly be emphasized that environmental degradation, particularly loss of rare natural resources, like destruction of limestone ridges, active coastal erosion or loss of natural vegetation in the Region, were appeared when those who make decisions about using or managing these resources ignore or underestimate the costs of environmental damage due to failures of public policy -that is structure of the list of economic and social priorities- on one hand and market failure -that the markets do not reflect the social value of the overexploited resources- on the other.

All economic activity, requires some environmental inputs and results in environmental changes. Specifically in an environmentally fragile region like Matrouh and in case of more environmental input consuming activities like agriculture and tourism together with urbanization, there exist a limit to the carrying capacity of the environment. As the economy expands this limit will eventually be reached. In other words, the prospective analysis of the Matrouh region almost clearly indicates that, while the density of the economic activity rises, there will come a point where the consumption of environmental resources will exceed the environmental renewal. Irreversibilities, which are very important in Matrouh case, will further aggravate the problem.

State and Public Policy

Presently and in the foreseeable future, due the inadequacy of elected appropriate regional management and lack of active and affluent non-profit and non-governmental organizations, the most influential and, also the most powerful actor in Region is and will be the State, defined as the Central Government and its extensions in the Matrouh Governorate. Likewise, only these public bodies are in a capacity to determine a standing between, both policy priorities and urgent environmental problems.

Priorities of the government in Matrouh, at least for the time being, do not include any environmental policies. The priority list of government expenditures, specifically in the Region includes items like construction and maintenance of infrastructure, improving community services like education and health and providing credit and financial incentives to private investors. Two most important sectors of private activity, from the perspective of the decision makers, at least for the time being are agriculture and tourism. From the governments point of view this understanding indicates the significance of developing these two sectors as a priority in Matrouh.

Egypt, has launched a substantial "structural adjustment policy" in early 1990s. Within this policy framework, it was aimed to move Egypt towards a market oriented economy and initiate a major campaign for the privatization of the economy. Although it is not easy to forecast the possible aftermath of this policy, it can be expected that Egypt will proceed with the process of economic growth and sustaining an annual GNP per capita growth rate of, say, 2.5 % during the next two decades with more and intensifying private sector involvement. Given the level of development and the socio-economic system of the region, Matrouh probably will enjoy an above the average level of economic growth and private sector involvement whilst the expansion of coming years.

This "structural adjustment policy" perceptively anticipates less public involvement and more private initiative within the functioning of various sectors of activity. This kind of adjustment in turn, means depressing of social minded approaches of government policies, reducing public spending, attenuation of public planning efforts and a greater dependence on profit oriented investment and economic development. This unprecedented turnabout, which, already begins to demonstrate its initial consequences in Matrouh together with the rest of Egypt, clearly indicates a kind of economic development which demands the most resource consumption and creates the most pollution, because of high level of economic activities and, more importantly, postponement of the utilization of measures which, aim at opposing the effects of resource exhaustion and pollution, rather than preventing them.

One of the important countenances of the new "structural adjustment policy" is, and probably will -at least in the near feature- be the anticipation on the diminishing economic and social role of the state. This premonition demand reduction in public spending, which necessitate lessened and reducing spending on environment.

Coming Years

Emerging trends in 1990's imply progressive government investment and encouragement in land reclamation, infrastructure, tourism and agriculture; rapidly increasing private investment, and a more favorable international atmosphere specifically among North African and Middle East Arab countries which, in turn will induce intensifying migration to the region and accelerating growth rates. Within these conditions which reflect a faster economic growth, population, urbanization, water demand, pollution, etc. pressures would, naturally appear higher and stronger. In other words, it may be appropriate to think in terms of a more strong economic growth which proves to be more harmful for the environment in Matrouh.

In 2025 northwestern part of Egypt will reveal an notably different setting and environment in almost all respects. Given the amount of available land and account of natural and environmental resources, Matrouh would be a crowded, even over-populated region and, additional increase of population, mainly due to ongoing migration will continue. Geographical limits would be significantly expanded into the agricultural lands surrounding Matrouh city and the touristic villages.

Analysis of Region reveals the scarcity and inadequacy of active and effective elected local governments and non-profit and non-governmental organizations. In other words, individual citizen, representatives of local communities, media, nonprofit organizations and associations and the representatives of the economic sectors, as mentioned before, are either inadequate and ineffective, or not interested in environmental problems. These actualities severely limit the number of influential actors. Perceptively, any effort towards protection and betterment of the environment, which, basically is a natural resources policy, should emanate from some kind of government action. Furthermore and most importantly, in Egypt, due to existing administration framework, solely the public bodies are in a position and capacity to determine a standing and, thus adapt a precedence agenda between economic, social and environmental problems.

Evaluation of economic and social development trends together with scenarios on environmental degradation and its causes, clearly reveal that unless some action is taken in the very near future damage to resources of the Region, including economic damage, will accelerate and could result in the total and irreversible collapse of certain natural/environmental systems. Any action which could actuate certain rewarding consequences, on the other hand, calls for improved management, that can be defined as integrated policy formulation and implementation. Such a management scheme should include:

i. Reconciliation of national and regional policy objectives with special regard for sustainable development of the region;
ii. Effective implementation of existing environmental laws and regulations through cooperation between related Government bodies;
iii. Formulation of an up-to-date and more adequate legal framework through drafting of new laws and reconciliation of existing laws and regulations;
iv. Integration of administrative provisions and appropriate definition of areas of proceeding from the regional point of view;
v. Creation of financing mechanisms through a combination of central government contributions and regional funds.

The approach which assumes that the economy and the society should try to function and develop within a "sustainable development" mode must be the basis of a process of planned and orderly development and convenient policy measures which also include cooperation and involvement of the private citizens and the business, seeking to minimize any environmental afflictions of economic and social progression. One rather important perception in order to activate environment protection and betterment policies is to generate a new type of interaction among governmental bodies itself.

A strategy for management and administration built around economic and ecological criteria should, also consist of a number of perceptions like goal setting, problem assessment by source, standards, pollution prevention, demand forecasting, property rights, proper pricing, together with appropriate regulatory mechanisms for managing environmental resources. Such a direction have to be determined within the rules established by long term strategic approaches. In other words, policies ought to be prepared and applied in an understanding and concord between the people and the public authorities and in harmony and compliance with the needs of inhabitants and environmental concerns.

As for the coming years, it will not be inaccurate to anticipate that both the number and influence of the actors of the environmental protection or sustainable development scene should increase. Economic and social development, educational improvements, prevailing liberalization policies, achievements towards a more democratic society, etc... will naturally create and augment the actors of the environment scene, like municipalities, private sector companies or sectoral associations NGOs, etc. Consequently, to actuate environment friendly government policies more appropriately, a new and different interaction among actors would be achievable in the coming years.

These developments, on the other hand, will amplify the importance of the state, defined as the central government, and Matrouh Governorate as the representative of the central government in the Region, as an actor, on account of its distinction as the principal organ for creation and coordination of public policies. In other words, only the state is in a position to initiate the emergence of more active and representative political parties, NGOs, media and private organizations, together with increasing the amplitude and fostering the independence of local or regional divisions of the government organization. And it is rather visible that the state in Egypt, more and more, is in the process of pronunciation of a desire in this direction.

This observation is not paradoxical, for it is evident that an ever growing number of people in Egypt, specifically among the intellectuals, academicians and more meaningfully, within the government itself, is in the comprehension of the fact that, like in Western countries of the last century and in an increasing number of developing countries of our time, a stronger and more effective state which, unquestionably asserts itself as the final arbiter in the society, was and is the result of the accomplishment of political and economic liberalism.

PART I

SYSTEMIC ANALYSIS

OF NATIONAL SOCIO-ECONOMIC STRUCTURE

AND NORTHWESTERN COASTAL REGION OF EGYPT

INTRODUCTION

This study aims to undertake a systemic and prospective analysis of the development/environment interrelationship in the Mediterranean coastal region of Matrouh Governorate of northern Egypt.

Primary objective of the study is to help to seek and establish a structure in which future environmental and, also, socioeconomic policy measures could be taken more readily and conveniently in order to arrange development-environment relations in Northwestern Coastal Region of Egypt within the framework of a balanced and consistent, in other words a "sustainable" development principle, which, analogously, is the main starting point of national and international environment policies. To reach above mentioned target, on the other hand, it should be kept in mind that, in the process of designing and applying environmental policies the "environment is, both, the source and the limit of development" principal must, never be left out of sight. Therefore, malfunctioning of ecological cycles as a result of economic and social development efforts, in other words, deterioration of environmental conditions and emergence of environment-related problems should constantly be traced down and dealt with.

Consequently, Northwestern Coastal Region Study, in order to contribute to the formulation of convenient public policies for the project region, aims to fulfill following tasks:

i. Discovering future socioeconomic development trends;
ii.Establishing the relationship and interdependence between present and future environmental structures;
iii.Determining and demonstrating economic and social activities that impair proper ecological cycles;
iv. Disclosing and suggesting environment friendly economic development activities.

Methodology

Methodology is, basically the subscribing of Blue Plan methodology of systemic/prospective analysis. The first step of this approach is, inevitably, to determine and to seek (a) the nature, (b) the development and (c) the past and present interrelationships of the relevant elements (dimensions) of the system. In Egypt/Matrouh case the pertinent elements (dimensions) were decided as follows:

i. Population and, land and water;
ii. National economic context;
iii. International relations;
iv. National development strategies

(economic and social policy);
v. Environmental considerations and policy.

The befitting sectors of activity are agriculture, industry, tourism, transport and energy.

The study encompasses three components. First component is an effort to analyze the "system" of Northwestern Coastal Region of Egypt from the viewpoints of (a) its connections with the Egyptian national "system" and (b) its long and middle term perspective. The second component, based on the findings and results of first phase of the study, includes the attempt to determine the hypothesis and actors in order to formulate the scenarios. And, finally the third component incorporate the scenarios.

Sources of Information

There exist a vast amount of international literature on every aspect concerning Egypt. The majority of this literature is by Egyptian researchers, scholars and authors. In other words, cumulated stock of information can be considered as sufficient to carry on the research. Reasonably, for the purposes of conducting of this study and preparation of this report a considerable amount of the said literature, specifically books, articles, reports, etc. of recent dates, were examined. Obtained ideas and conveyed parts or sentences were cited in footnotes. A certain number of studies, on the other hand, were utilized as basic and elementary sources of information. These texts are itemized in the "Bibliography."

Although the quality and magnitude of available statistics on agricultural and industrial production, structures of trade and industry, public goods, flows and capacity of transportation, communication and tourism, population, urbanization, employment and, in some extend, living standards, are not very satisfactory, from the viewpoint of expectations of this study, they may be considered as sufficient. Collected data on present standing of soil capability, environmental values like flora and fauna and abiotic environmental elements is, both for Egypt as a whole and for Northwestern Coastal Region, also, available and sufficient

The magnitude of literature, specifically in the form of reports, including reports prepared specifically for this study or the Blue Plan, and, also various books and articles about Northwestern Coastal Region, is, also rather expansive. These sources of information, again, are disclosed in the Bibliography.

Predictably, the most important source of information and, also insight was a set of interviews conducted with a rather large number of learned and concerned people of central and local government, academia, various national and international organizations, etc. in Cairo, Alexandria and the Region.

CHAPTER I

GEOGRAPHY, POPULATION, LAND AND WATER

* * * * *

One of the most striking features, and, probably the foremost determinate characteristic of Egypt which effectuate both, socioeconomic structure and development, and, also environmental circumstance, is her geographical distinction. Although the total land area of Egypt is 997,739 sq. km., only about 4 % of this aggregate (35,200 sq. km.) is inhabited and cultivated territory, the remainder being largely uninhabited desert.[1] The Nile Valley and the Delta, generally referred as "el wadi," on the other hand, comprise almost 90 % of the inhabited and cultivated domain. In other words, as in the past, contemporary Egypt's economy, society and culture are predominantly based in the Wadi. The vast majority of its rapidly growing population resides in some of the World's most densely packed villages, towns and cities. These communities are all crowded into the narrow confines of the Wadi, where residential, industrial, commercial and other land use patterns successfully compete for the rich but finite old agricultural lands.

Yet, only about a little more than 700 thousand people live in the vast territories of what Central Agency for Public Mobilization and Statistics (CAPMAS) classifies as the "frontier governorates" of Matrouh, Wadi el Gedid, The Red Sea, North Sinai and South Sinai.[2] And especially in recent decades the boundaries between the desert and the Wadi have become blurred as some of the "red lands" have been discovered and in many cases, converted to "new lands" or "reclaimed lands" for agricultural, industrial, touristic, residential, etc. use.

Although most of the newly reclaimed lands are adjacent to the Wadi or close to it, an outstanding and increasing amount of development and expansion is taking place in areas far distant from the Wadi like Sinai, Red Sea and, unquestionably, coastal regions of the Western Desert. New kinds of agriculture continues to expand while numerous touristic projects

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[1] Egyptians make a dualistic and rather strict division of the country when they contrast el wadi (the Wadi or valley) with el gabel (wilderness -literally the mountain-) which refers to the desert. Thus, all of the people living outside the Wadi, including the population of Matrouh Governorate, is referred as the "desert people" (or the desert dwellers). Similarly, the lands of the Matrouh Governorate, incorporating the Mediterranean seashore, is generally referred as the Western Desert.

[2] Statistical Yearbook, Arab Republic of Egypt, CAPMAS publication, Cairo, June, 1993, pp 11,12. According to 1986 census, total population of Frontier Governorates is 564,056 people which represents 1.17 % of total population. In the same year population of Matrouh Governorate is 161,163 people, representing 0.33 of the total population. ibid, p. 14. On the other hand, "Some governorates based in the Wadi includes areas in the desert. Thus the frontier governorates do not include all the people who can be said to live in desert communities... only part of the desert dwelling population in Wadi-based governorates can be clearly identified in the (above mentioned) census data." Sherbiny, N.A., Cole, D.P. and Girgis, N.M., Investors and Workers in the Western Desert of Egypt," The American University in Cairo Press, 1992, p.1

proliferate on the Western Desert coasts. Meanwhile, the city of Matrouh and the towns and villages of the Northwestern Egypt -like new and old cities of other desert regions- continuously expand and attract various kinds of economic activity. Thus, an increasing number of people from the Wadi now see the Western Desert as a new frontier, in other words, a new place in which to invest, to work and to live.[3]

Population and Population Growth

Egypt, (a) has an estimated population of 58.8 million people in 1994, and (b) a very high population growth rate. Even upon optimistic assumptions on the decline of the population growth rate, it can safely be predicted that the size of population will reach 77 and 89 million in 2010 and 2025, respectively.

Consequently, there exists an extreme imbalance between very limited inhabitable and arable land, and the population. In other words, the geographic concentration of land resources intrinsically impels the people into a very limited land area, leading to dramatically high urban and, also rural population densities.

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[3] Western Desert and its coasts, on the other hand, is home to numerous people, including the Bedouin, who have skillfully made productive use of the natural range lands, and, communities of traders, miners and fishermen. None of these people are likely to think of the Western Desert as a new frontier and or to describe the lands as being new. However, like the migrating people from the Wadi, these folks are also actively engaged in every kind of new and expanding economic activities. ibid.p. 2.

TABLE I/1 : POPULATION OF EGYPT

Population(000s)

Years	Total	Total Periodic Increase	Average Annual Growth	Average Annual Growth Rate(%)
1927[a]	14 178	-	-	-
1937[a]	15 921		174	1.23
1947[a]	18 967	3 046	304	1.91
1960[a]	26 085	7 118	547	2.89
1966[a]	30 076	1 743	665	2.55
1976[a]	36 627	6 551	655	2.18
1986[a]	48 254	11 627	1 162	3.17
1987	49 620	1 366		2.83
1988	51 034	1 414		2.85
1989	52 284	1 250		2.45
1990	53 591	1 307		2.50
1991	54 845	1 254		2.34
1992	56 192[b]	1 347		2.45
1995	60 012	3 820	1 273	2.26
2000	65 802	4 317	1 079	1.93
2010	76 683	8 881	881	1.65
2025	89 188	12 505	834	1.09
	134 000[c]	44 812		

[a] Census years. Statistical Yearbook 1993, p.7
[b] Official GOE estimate for mid-year. ibid., p.31
[c] Hypothetical size of stationary population. see: World Development Report, 1991, The World Bank publication, Oxford University Press, 1991, p. 268. This estimate is lessened to 120 millions in 1992 Development Report indicating a decrease in population growth rates.

Land Reclamation

Unavoidably, one of the most purposeful and resolute efforts in Egypt -since early 1950s- has been focused to reclaim and invigorate the desert. Government "Land Master Plan" of November 1986, which specifies the desert regions to be reclaimed, based on the types of soils and their production capacity and, more importantly, within the limits set by the availability of water resources, also, establishes the total amount of reclaimable land as 8400sq.km.[4] The plan, additionally, sets an annual reclamation target of 630 sq.km. This

[4] 2 million feddans.

target, however, could not be fulfilled during the first five years of operation. Between 1987 and 1992 890 sq.km. of land, in other words, 61 % of the planned total, has been reclaimed.

Under the assumption that the target amount and the programmed schedule accomplished, the total arable and inhabitable land will reach 44 310 sq.km. in 2002. In accordance with the general approach of, both the Land Master Plan and the Water Master Plan this total represents an upper limit. In other words, specifically due to the constraints imposed by restricted nature of present and calculable potential water resources, no more land can be reclaimed after the year 2002.

TABLE I/2 : USE OF INHABITABLE AND ARABLE LAND (sq.km.)

Year	Total	Urban and Industrial Land	Agricultural Land
1980	33 780	3 780	29 400
1987	35 700	4 200	31 500
1992	38 010	4 620	33 390
2002	44 310	5 880	38 430

Source: Egyptian Environmental Action Plan, 1992, (Accredited sources: Ministries of Public Works, Water Resources, Agriculture, and Land Reclamation) Table: 2.1., p. 6.

On the other hand, it is simple to approximate that, in order to preserve the 2002 population density level (1525 persons per sq.km.) in 2025, a minimum additional 14 000 sq.km. of desert land should be reclaimed.[5]

[5] A recent research estimates a significantly greater need and demand: "..an additional 5-6 million acres (approximately 25 000 sq.km.) of desert would be needed to accommodate the expected excess of population by the year 2025. Strategies for Sustainable Development in Egypt, Prepared by "Task Force on Strategies for Sustainable Development in Egypt, Bishay, Adli (ed.) Cairo, November, 1992, p.6. The same document, on the other hand, appraises the said total as, "an impossible target.., especially when considering water availability after 2000. ibid., p. 6.

TABLE I/3 : POPULATION DENSITIES (per sq. km.)

Years	Inhabited & Cultivated Land (sq.km.)	Density
1980	33 780[a]	1 205
1987	35 700	1 390
1992	38 010	1 478
2002	44 310	1 525
2010	44 310	1 731
2025	44 310	2 013

[a] Estimated mid-year population excluding Egyptians abroad is 40,722 m. Statistical.., op.cit., p.28.

Water

Water is, unquestionably, the most critical and strategic resource in Egypt. This important observation mainly stems from the peculiar distribution of sources of water: The Nile River, directly and indirectly -infiltration of ground water from the River, drainage water, treated sewage water, savings from management programs- supplies 98 % of the water utilized. Egypt is a Nilotic country and one of the 9 Nilotic countries.[6]

The Nile Basin countries all depend on the river water with different degrees, but Egypt, as its main source of life, probably, is the most contingent of them all.[7]

The Nile River, on the other hand, currently furnishes 55.5 billion m^3 of water to Egypt in accordance with international arrangement. In the medium term, when the planned Jonglei

[6] The Nile basin countries are Egypt, Sudan, Ethiopia, Tanzania, Uganda, Kenya, Zaire, Rwanda and Burundi.

[7] The River Nile is the only river that pours south of the Mediterranean Sea. The Nile is the longest river in the world as its water course runs for 6825 kilometers. Its basin area is 2,960,000 sq. kilometers which represents one tenth of Africa's area. Population of Nile basin is about 200 million people. Available quantity of water is 471 billion cubic meters a year of which 35 % come from the rain, 46 % from the rivers and 19 % from underground sources. The Nile basin countries depend on the river water to varying degrees. It provides Egypt with more than 90 % of its water needs while other countries needs range between 46 % (Sudan) to 18 % (Kenya). At present only 227 billion cubic meters, that is 47 % of the available quantity is utilized. For a detailed analysis of Nile and also agreements and projects on Nile, see, Fakhry Labib, "The River Nile Waters from Source to Mouth: Between Conflict and Cooperation in Past and Future," in Water as an Element of Cooperation and Development in the Middle East, Bagis, A.I.(ed.), Hacettepe University Press, Ankara, 1994, pp. 371-387.

Canal Project[8] accomplished, an additional 5.5 billion m^3 per annum would be withdrawn from the Nile. A new treaty, on the other hand, with Nile Basin countries, which will allow Egypt to remove more water, seems "unpredictable."[9] Consequently, currently 55.5 billion m^3 per annum, and in the medium future 60.1 billion m^3 per annum should be considered as the upper limit for what the Nile will provide

Total quantity of water supply, by any standard, is low (presently about 1 000 cubic meters per person per year) and, also, limited and, furthermore, constantly deteriorating quality effectively reduces the amount of water available for productive use.[10] Municipal sewage, agricultural fertilizer and chemicals, industrial waste, silt from runoff, continuously and seriously contaminate water intended and acutely needed for potable use, agricultural irrigation,[11] fish production, manufacturing, recreation, etc. In other words, any water pollution not only damages water quality, but virtually decreases the supplied quantity.

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[8] One of the most important ideas to increase the utilization of Nile waters is the "lakes reservoirs" project which involves a reservoir in Lake Albert, a regulator in Lake Victoria and another reservoir at the north of the mouth of Lake Victoria where the Owen Dam -the only part of the century old water storage plan that has been implemented so far- was actually built. Conservation of water in the lakes is only meaningful if it passes across the Dam marches. This gave rise to the idea of opening a new canal to carry water from Jongeli to Malakal for 360 kilometers. The Egyptian and Sudanese governments agreed, on a basis of equal sharing of costs, in 1974 on the canal project. Actual digging started in June 1978 but came to a stop in 1984 due to the civil war in Sudan. The canal is projected "to carry 3.9 billion cubic meters/annum of water in the first stage and 7 billion cubic meters/annum in the second stage." ibid. p.378, 379.

[9] Strategies for.., op.cit., p. 18.

[10] For a rather detailed analysis of pollution and degradation, status of water quality in Nile River System, in canals and drains and in lagoons and lakes, various sources of water pollution, consequences of water pollution, policy actions, etc. see: Environmental Action Plan, op.cit., pp. 5-29.

[11] Agriculture is most severely affected by water pollution and mismanagement. Roughly a third of agricultural land is burdened by salinity and/or waterlogging and, discharge of domestic, industrial and agricultural wastes into the agricultural drains seriously reduces opportunities for reuse. See: Environmental Program, USAID/Egypt, November, 1992, p. 3. (mimeo)

TABLE I/4 : WATER RESOURCES (billion m^3)

Source	1990	2000	2010	2025
Share from Nile	55.5	57.7[a]	60.1[b]	60.1
Ground Water (delta & valley)	2.6	4.9	9.2	15.6
Deep Ground Water (deserts)	0.5	2.5	2.8	2.8
Agricultural drainage water	4.7	7.0	9.4	10.5
Treated municipal sewage water	0.2	1.1	2.2	4.0
Savings from management programs	0.0	1.0	3.0	5.0
Total	63.5	74.0	86.7	98.0
Average annual increase (%)	-	1.65	1.72	1.30
Availability (m^3/per capita)	1175	965	1130	1099

[a] 1st stage of Jonglei Canal Project completed.
[b] Jonglei Canal Project is fully implemented.
[c] Approximately 47 % is supplied through infiltration from the Nile river.

Demand for water in the near and medium perspective, will continually increase specifically due to,

i. population growth,
ii. crucial exigency for expanding land reclamation efforts,
iii. per capita income growth,
iv. urbanization,
v. industrialization,
vi. growth of demand for agricultural products.

On the other hand, it will not be possible to increase the water supply under existent conditions and expectations, in par with the demand growth. Consequently, Egypt will face a more severe water distribution and allocation problem in the coming decade(s). Moreover the need for radical measures in order to develop and expand water resources will become more pressing. A list of such measures can be presented as follows:[12]

i. recycling,
ii. desalination of irrigation water,
iii. new distribution techniques,
iv. new agricultural crops which demand less water,
v. new irrigation techniques,
vi. new "structure of production" policies which accentuate growth of non-agricultural sectors,

[12] see: Strategies for.. op.cit., p.18.

vii. finding new resources: converting saline water,
viii. cultivating public awareness and public participation
ix. water pricing.

As it can easily be seen, all these measures will generate results only in the long term, therefore require immediate action, and, -possibly excluding water pricing- all claim sizable financial compliance, in other words, a substantial reallocation of investment funds.

Matrouh: The North Western Coastal Region of Egypt

The Governorate of Matrouh enclose the northwestern corner of Egypt. Although it is one of the smallest governorates of Egypt in terms of population, it is the largest in terms of land, covering about 22 % of total land (212 thousand sq.km.) More than 80 % of this area, on the other hand, is the desert. Inhabitable and cultivable land area of Matrouh governorate is approximately 20 thousand sq. km.[13], currently giving a more favorable population/inhabitable land ratio than the rest of the country. This piece of land can be defined as the area extending between the border of Alexandria Governorate in the east and the Libyan border in the west Mediterranean coastline in the north and a depth varying from 30 to 50 km. in the south.[14]

Northwestern part of Egypt, in other words, the Western Desert, in various respects, is a considerably diversified area. In addition to coastal areas, it contains oases, depressions and terrains of varying degrees of accessibility. Similarly, the area encloses different water sources and varied irrigation schemes. Rainwater is the basis of life and the economic activity in coastal territories, while underground water considerably contributes to the supply.[15] Nile waters, on the other hand, flows to certain parts of the area through canals and various pipe-line systems. Correspondingly the range of economic activities is substantial, covering agriculture, livestock rising, trade, tourism, industry, mining and quarries, petroleum and various services. Schemes of private sector and the variety in types of private ownership, specifically in this new era of government development strategy and policies, seems to have major sectoral manifestations and a strong tendency to cultivate. Private sector arrangements cover a range of national, foreign and mixed projects, corporate land holdings, cooperative agricultural development ventures, mining, specifically quarrying activities, touristic villages development, in addition to, smallholders and family enterprises in agriculture, trade, industry and services.

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[13] "The Northwest Coastal Region of Egypt covers an area of approximately 6 million feddans (2.4 million ha.)" Abdel-Kader, F.H. and Ramadan, H.M., Land Evaluation of Dabaa-Fuka Area, North Western Coast, Egypt Using Geographical Information System (GIS), Paper presented to "Environmental and Land Issues in the Mediterranean basin: An Economic Perspective" Conference in Zaragoza, Spain, CIHEAM, 7-9 February, 1994, p.2.

[14] For a very detailed description of land area of Matruh Governorate see: M.A.Ayyad, A Framework for Accumulating Consequential Data and Knowledge Required for the Coastal Area Management Study for Matrouh Region, Part I. Land Includes sections, i.Location, ii. Settlements and Cultivated land, iii. Topography and Geomorphology, iv. Climate and v.Siwa Oasis) May, 1994 pp. I-1 to I-20.

[15] Underground water is the dominant source of life in the five oases of the Western Desert.

Matrouh: Population[16]

The population of Matrouh Governorate will be approximately 250 thousand in 1995.[17] Northwestern Coastal Region experiences a higher population growth rate than the rest of Egypt. It can be estimated that
population of the Region will ascend over 300 thousand in 2010 and over 400 thousand in 2025. Projections based on series furnished by "Governorate Information System"[18] population numbers shall be realized as 374 thousand in 2010 and 471 thousand in 2025.

Continuous and especially recent socioeconomic developments in Northwestern region of Egypt, specifically in Marsa Matrouh and vicinity attract people, both investors and workers[19] from both the Wadi and the desert. The present demographic composition would best be described as "mixed." While Marsa Matrouh and environs has a very large and rapidly growing tourism industry that caters mainly to Egyptian clienteles with widely variant income and social status, trade and services flourish and provide a good base for employment and income. Tourism activities, operates mainly in summer months and lead to a very considerable difference between the amplitude of summer and winter populations.

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[16] For a detailed description and analysis of population related matters, e.g. total population and population growth; tribal system and land tenure; number of people per household and age distribution; immigration; education; etc. see: Ayyad, op.cit., "Chapter III: Population" pp. III-1 to 10.

[17] The only major village Matrouh Governorate outside the Northwestern Coastal Region is Siwa. The estimated population of Siwa is 13 thousand people. Approximately 10,000 people live in Siwa and 3,000 in the vicinity in small satellite villages. Based on a population growth rate estimate of 3 % per year for Siwa and 2 % for satellite villages until 2010, the projected population is estimated to be 23,000 (6 % of total governorate population) in 2010. It has been withhold to further the population projection for Siwa, facing difficulties for estimating a population growth rate for the period 2010-2025, due to geographical restrictions.

[18] See: Updated On-site Report for the Fuka-Matrouh Area, Egypt, Matrouh Resource Management Project Document, November, 1993, p. 17.

[19] A recent study of the region (the so called Western Desert) provides the following table on migration:

TABLE: ELEMENTS OF MIGRATION PROFILES

Element	Investors	Workers
Born elsewhere	56 %	56 %
Lived abroad	29 %	16 %
Permanent residence elsewhere	45 %	11 %
10 years or more resident in area	74 %	43 %

Source: Investors and.., op.cit., p. 16.
Note: Data reflects the percentages among people interviewed for the above mentioned field study.
For a detailed analysis of "migration, geographic mobility and community background, see ibid, pp. 15-18.

TABLE I/5 : POPULATION OF MATROUH GOVERNORATE AND TRENDS FOR THE FUTURE

Population of Matrouh Governorate(000s)

Years	Total	Average Annual Growth %	Total[b]	Average Annual Growth %	Marsa Matrouh City
1950		-	-50,0		
1960[a]	74,4	-	80,0	6.0	
1966[a]	85,9	2.59			
1970			120,0	5.0	
1976[a]	112,6	3.09			
1980			154,0	2.83	
1986[a]	161,2	4.32			
(1986)	184,0[c]	6,34			69,0[d]
1990			220,0	4.28	79,0
1995			255,0	3.18	92,8
2000			290,0	2.74	125,2
2010			360,0	2.41	169,0[e]
2025			455,0	1.76	245,0

[a] Census years. Statistical, Yearbook, op.cit., p.7
[b] Governorate of Matrouh statistics, see: Updated On-site Report, op.cit.
[c] Official GOE estimate for mid-year. Statistical Yearbook, op.cit., p.31
[d] Also, see: Ayyad, op.cit.
[e] Governorate statistics confirms.

It should be noted here that, other than the open and implicit encouragement of the expansion of touristic villages, coastal regions of north-western Egypt, at least for the time being, is not one of the targets of the government efforts to establish new communities outside the Wadi.[20]

[20] Among Frontier Governorates, government attempts to establish new communities outside the Wadi are mainly directed to Sinai. In the Western Desert, on the other hand, facilitation of new settlements take place on the eastern parts, rather near to the Wadi. Examples are Sadat City and South Tahrir which have been settled by migrants with different economic bases. Sadat City is a new town, launched in 1980, with an industrial zone and shopping center. Growth of Sadat City continues. South Tahrir, by comparison, is a combination of farm settlements and small service and trading villages. It should be expected that in the coming perspective the economic and social interactions between these centers and the Matrouh area will increase.

One of the striking occurrences in the Region is the phenomenal growth of the city of Marsa Matrouh since 1970's and especially in the last decade. It is not contradictory to anticipate still high population growth rates for the coming decade(s). Ayyad estimates an average 3.5 percent per year population growth rate for City of Marsa Matrouh till 2010.[21] In other words, Marsa Matrouh, already a large city with approximately 70 thousand inhabitants, will reach population levels of 107,000, 147,000 and 224,000 in years 2000, 2010 and 2025 respectively. Some of the salient reasons of this consequence can be listed as follows:

i. Rural to urban migration is primarily directed to Marsa Matrouh. Rural to urban migration is expected to continue because of limitations on the amount of arable Land; a more educated rural populations; increasingly more lucrative job opportunities in the city; better amenities in the city; etc.;
ii. The continued development and expansion of City of Marsa Matrouh as an administrative, commercial and tourism center;
iii.Continuing public housing projects;
iv. The projected adequacy of future water supplies will, evidently, encourage investment and development, especially in industry and tourism;
v. Improvements in medical services will reduce infant mortality and extend life expectancy.
vi. Increasing migration from out of the region will be directed, particularly to the City of Marsa Matrouh.

Matrouh: Water

Water, in Northwestern Coastal Region of Egypt is, basically, supplied from three main sources:

i. treated surface water from the Nile River;
ii. desalination plants;
iii. public and private brackish water wells.[22]

The existing water supplies are inadequate to meet water needs of the region, particularly during the summer when stored rainwater is depleted.[23] The summertime influx of tourists contributes significantly to this shortage. Current average water consumption of, especially households even in the city of Matrouh is very low due, both, to water supply shortages and socioeconomic reasons, suggesting a significant rise in need and demand for

[21] Ayyad, op.cit., p.V-3. Similarly USAID forecasts an identical population growth rate until 2010. USAID/Egypt, Water and.., op.cit., p. ES-3.

[22] For a detailed description of water facilities, water supply, and water demand see:, Ayyad, op.cit. Chapter V: Infrastructure: (1) Water, pp. V/1-16.

[23] For a very detailed analysis of water situation in the region see: Water and Wastewater Needs Assessment: Matruh Governorate, Egypt; Final Report, USAID/Egypt publication, 1988 (mimeo) and USAID Projects in Marsa Matruh Governorate (tables), USAID/Egypt publication, 1988 (mimeo).

water in the future.[24] Touristic establishments (hotels) on the other hand, consume an ample segment of supplied water particularly in the summer months.[25] Given the high rate of expansion of touristic villages and hotels and other businesses, it is easy to assume that they will contribute considerably to the mounting of water demand in coming years.

TABLE I/6 : NORTHWESTERN COASTAL REGION WATER USE PROJECTIONS[a]

Year	Peak Water use (m^3/per day)
1990	70,900
1995	91,700
2000	119,920
2005	142,740
2010	171,740[b]
2025[c]	218,400

SOURCE: Ayyad, op.cit., p. V-8.
[a] New Ameriyah excluded.
[b] Aid ES-4
[c] It is assumed that per capita water consumption will not increase between 2010 and 2025.

Water scarcity in the region activate both public and private bodies to resort to various methods to increase water supply or limit water use.

Various projects has been conceived in order to increase water supply of the Matrouh Governorate.[26] Two canals carry water from the Nile, particularly to the eastern parts of the region. Topographical reasons prohibits canals to extend to western parts. A connection, however, has been instituted from the Tahrir Canal to touristic villages region at the

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[24] Ayyad suggests that, "based on estimated growth in consumption of 4 lpcd per year, the estimated water consumption rate, including a 15 percent system loss factor, is estimated to 150 lpcd by the year 2010." Ayyad, op.cit., p. V-3. This number points out a three-fold increase in average consumption. It should be remembered that current average consumption level is about 30 lpcd.

[25] The consumption of two and three star hotels are rather high and close to international standards (300 liters per guest per day). Other hotels consume about 200 liters per guest per day. USAID/Egypt, Water Needs.., op.cit., p. ES-2.

[26] For a detailed list and analysis ("Characteristics of Institutional Options") of water supply projects see: USAID/Egypt, Water and.., op.cit., p. 6-2 and 3. Also, for "Committed Water Supply Development" see: Ayyad, op.cit., pp. V-8 to 11.

coast in order to meet irrigation needs. Although the Governorate is primarily dependent on AWGA, it has, even, been assumed that Matrouh Governorate "would be in a position essentially to provide all its own needs" of water.[27] In a framework of such an expectation it would, evidently, be feasible to expect a higher population growth rate in the coming decade(s) specifically due to a rise in the, even currently high immigration rate.

Matrouh: Wastewater

There are no proper sewage or water drainage systems established in the region. The wastewater in towns is discharged directly into creeks or depressions. The existing wastewater system for the city of Marsa Matrouh is not appropriate for the City and will, undoubtedly, become a major health and environmental problem as population, water supply and consumption increase. In towns and villages other than Marsa Matrouh, the greater portion of the population lives in scattered patterns and practice no sanitary sewage disposal except a few housings and establishments that have private separate units.[28]

The primary impact of current wastewater system on the local environment, especially in and around the, already highly populated, City of Marsa Matrouh, is groundwater contamination. Existing cesspools discharge untreated wastewater directly to the groundwater. This results in contamination of brackish water wells and pollution of seawater in Marsa Matrouh Bay and the nearby salt lakes. The central bay and the western salt lake are, at least for the time being, flushed out fairly well by the see, but eastern salt lake has been reported to have visible pollution and contamination especially during the summer months. Wastewater flows to, both the sea and brackish water wells by percolating through the soil to the saline groundwater and mounding up until a gradient is found toward the sea. Brackish wells are easily contaminated because they are designed to collect rainwater moving toward the sea in the same fashion as the wastewater. Water system contamination is also a high probability with the existing wastewater system. Contaminated groundwater predictably can and will enter leaky pipe joints when sections of water distribution piping are not pressurized and are located in saturated soils.[29]

In order to outline certain important observations on Northwestern Coastal Region the following inventory can be presented:[30]

i. Arid Mediterranean climate;
ii. Rainfall, topography and soil conditions which permit dry farming agriculture;
iii. Limited use of available land and water resources;
iv. Ensuing of land degradation and water losses;
v. Lack of information on different elements of water balance;

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[27] For an detailed analysis of water projects and related expectations in the Matrouh region see: USAID/Egypt, Water and.., op.cit., p.6-1.

[28] Ayyad, op.cit., p. v-18.

[29] A new 110 km. sewage network project that includes a water treatment unit has been conceived in Matrouh and scheduled to be completed in 1996. Ayyad, op.cit., p. V-18.

[30] After, Abdel-kader, F.H. and Ramadan, H.M., op.cit., p. 2.

vi. Lack of adequate information for proper management of land and water resources;
vii. A thinly populated region;
viii. Poor social and economic conditions;
ix. Lack of efficient training and extension institutions

Even in the framework of above mentioned observations, on the other hand, there exist a "considerable potential for economic activities based on available natural resources"[31] in the Northwestern Coastal Region of Egypt.

[31] ibid, p.2

CHAPTER II
PERSPECTIVE AND INTERNATIONAL RELATIONS

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According to IBRD (World Bank) statistics per capita income of Egypt was, approximately, US$ 610 in 1991, and, for that year IBRD has ranked Egypt among the "Low Income Economies" on the 37th. position amid the 127 economies included in the analysis.[32] Again, in recent years, specifically after 1988 annual growth rate of per capita GNP has been dropped to very low levels.

The development of the Egyptian economy after the Second World War can be analyzed under three headings, indicating three different eras and three disparate policy approaches:

i. Nasserist era of the so-called "Arab Socialism" of 1950's and 1960's;
ii."*Infitah*" or "open door policy" of President Sadat of 1970's and 1980's;
iii. Ongoing and somehow strengthening "Structural Adjustment Policy" of 1990's.

Arab Socialism of Egypt

Under president Nasser Egypt built up a dominant public sector of the economy by bringing banking, insurance, transport, major trading, mining, industrial development and agriculture under the overall control of the state. The most salient particulars of this period can be reviewed as follows:[33]

i. land reform laws of 1952 and 1961 ;
ii. the nationalization and appropriation measures of late 1950's and early 1960's ;
iii rapid increase of state investment in infrastructure, agriculture and industry which led to the absorption of large numbers of agricultural surplus labor in expansion of manufacturing and other industry, construction work in the cities and especially inirrigation projects, particularly High Dam project ;
iv. the raising of wages and of the rates of income taxes ;
v. expansion of economic and social subsidies

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[32] World Development Report 1993, Oxford University press (Published for the World Bank), 1993, p. 238, "Table:1 Basic Indicators." IBRD divides the economies into three -Low, Middle and High- income groups according to 1991 GNP per capita. "Low Income Economies Group" incorporates the most "poor" 40 economies with less than US$ 650 per capita. It is interesting to note that in recent years Egypt's ranking in this IBRD classification continuously declines: For example IBRD rankings of Egypt were 53rd., 48th., and 44th., (all in "Middle Income Economies Group") in 1986, 1988 and 1989 respectively. (see: related issues of World Development Report.)

[33] See; Amin, Galal, A., "Migration, Inflation and Social Mobility: A Sociological Interpretation of Egypt's Current Economic and Political Crisis," (Paper presented at the Conference on Politics and the Economy in Egypt under Mubarak, University of London, May 18th. 1987.) p.6, (mimeo)

vi.impulsive expansion of free education, and other social services and various forms of social security.

Liberalization of the Economy

Dominant features of the 1950's and 1960's, namely continuously expanding state ownership, bureaucratic controls including regulated pricing, purchasing and profit margins, suppressed productivity, efficiency and economic growth in early 1970's. Consequently, in 1974 a new era of Egyptian economic policy initiated by President Sadat. The economic, political and social reorientation effort towards a more liberal context is known as "infitah" or "the open door policy." This policy approach is usually understood to incorporate four specifics:

i. trade liberalization, particularly import liberalization ;
ii. opening of the economy for foreign capital and investment ;
iii. removal of restrictions imposed on domestic (national) investors ;
iv. gradual withdrawal of the state from playing a (very) active role in the economy.

It is rather coherent to distinguish several different manifestations of the so-called "infitah policy era":

i. during the 1970's and early 1980's economic growth rates reached very impressive amplitudes. Average annual GNP growth rate was 8.5 % in 1970/80 period, more outstandingly, this rate climbed to an imposing annual average of 10.5 % between 1975 and 1980. (see: Table: II.1) ;
ii. the economic expansion, on the other hand was, primarily, a result of very rapidly increasing foreign earnings from various sources, namely, export earnings due to sharply climbing oil prices of the so-called "first and second petroleum shocks," rapidly expanding workers remittances, rising Suez borrowing and bilateral aid, and, to a degree, direct foreign investment ;
iii. state, despite all expectations continued to play a very active role, both, in the economy and the social life. In other words, state intervention to allocation of resources and, to operation of markets and determination of prices perpetuated in unison with, if notexpanding social services and subsidies.

The pace of economic growth have slowed down and the Egyptian economy stagnated in mid 1980's. There has been a rather dramatic reversal in the short and even, middle term economic trends of 1970's and early 1980's, and, uncertainties have been introduced into the long-term economic outlook of Egypt. This was brought about by

i.the fall in the price of oil;
ii. slumbering of workers remittances and certain other sources of external revenue;
iii. sharp deterioration of terms of trade arising from higher import prices and
iv. world business downturn.

With the decline of growth of foreign exchange earnings, the Government found itself in a position of initiating expansionary fiscal policies to maintain public sector outlays resulting in increasingly arduous budgetary deficits. Similarly, even at the occurrence of decrease of imports, rapidly worsening balance of payments financed largely by foreign dept. Egypt, thus, by the end of 1980's exhausted its international reserves and, borrowing difficulties hindered new investments and economic growth.

Recent Economic Crisis

By 1990, a comprehensive economic crisis has, thoroughly, been emerged in Egypt. Main features of this crisis could be listed as follows:

i. suspended economic growth ;
ii. balance of payments deficits ;
iii. foreign exchange shortages ;
iv. a massive foreign debt ;
v. growing budgetary deficits ;
vi. rising inflation.

In addition, Government, despite insufficient resources and growing budget deficits, continued to persist on its commitments under the welfare state system.

Egypt, in order to cope with the crisis, launched a substantial "structural adjustment policy" under the aegis of IMF and IBRD in 1991. Within this policy framework, it was aimed to move Egypt towards a market oriented economy. In other words, it was intended to:

i. reduce the inflation ;
ii. decontrol the foreign exchange market ;
iii. eliminate ceilings on interest rates;
iv. reduce the budget deficit;
v. initiate a major campaign for the privatization of the economy.

Egypt negotiated and signed a new stand-by agreement with the IMF in May 1991.[34] Similarly, "to reduce the structural impediments to long term growth"[35] a Structural Adjustment Loan Agreement has been signed with IBRD in October 1991.

It seems that certain international developments remarkably helped Egypt to cope with this economic crisis. Primarily, the Gulf War, which initially looked as if it would further exacerbate Egypt's economic problems because of a further reduction of foreign exchange revenues from various sources, actually brought substantial benefits through a significant debt

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[34] Egypt, in order to cope with emerging economic crisis, that is, to stabilize the economy through specific macro-economic interventions and to correct certain ensuing imblances, negotiated a Stand-by arrangement with the IMF in 1987. Six months later the Stand-by was cancelled "because Egypt failed to adhere to the program." (Country Program Strategy, op.cit., p.1) In 1988 Egypt tried again but was unable to conclude a second agreement with the IMF. It is interesting to note that, all these developments took place before the so-called "Gulf Crisis."

[35] ibid, p.2.

relief and additional economic assistance. Furthermore, Egypt's expected and emerging role within the so-called "Middle East Peace" procedure reiterated its international importance. Additionally, the collapse of the socialist systems of Soviet Union and Eastern European countries and an overall movement towards free market concepts in those years, likewise discredited the socialist (or semi-socialist, statist, etc.) model that has been the basis of the economy for a long time in Egypt, and also appropriated the country of its trading partners in Eastern Europe with whom trade was regularly conducted within barter agreements.

TABLE II/1 : PROJECTIONS OF GROWTH OF REAL PER CAPITA INCOME

	1965-90	1980-90	1990	1991	1990-2000	(1990-203)
World	1.5					(2.6)
High-income	2.4	2.4	2.1	0.7	2.1	(2.1)
Low and middle income	2.5	1.2	-0.2	-0.2	2.9	(3.8)
Middle East and North Africa	1.8	-2.5	-1.9	-4.6	1.6	(2.3)
Egypt	4.1	5.0			1.8	(2.5)

SOURCE: World Bank

Prospects and Expectations

Given the well established and deeply rooted economic, social and political structure of Egypt, it is not easy to predict and project the possible outcome of present policies and related developments. On the other hand, it can, rather safely, be assumed that Egypt will reinstate and perpetuate the process of economic growth and per capita income increase, probably in a significantly different manner, e.g., with more and intensifying private sector involvement and greater industrial expansion. In the next few years expected developments within the framework of new set of government policies regarding interest rates, taxation, public expenditures and subsidies will crucially influence and most likely increase the level of domestic savings. Sustaining an annual GNP per capita growth rate of, say, 2.5 percent during the next decade(s) will no doubt pose a major economic challenge, particularly if the external circumstances do not remain distinctly less favorable than during the present decade.

One of the important countenances of the new "structural adjustment policy" is, and probably will -at least in the near feature- be the anticipation on the diminishing economic and social role of the state. This expectation, even premonition[36] insist -among others- on issues like reduction of subsidization of various services including water and energy and agricultural subsidies, contracting of the state, -in other words, curbing and repressing public spending-

[36] Of, Egyptian private sector and certain other domestic clusters, also, foreign instigators, primarily, IMF, IBRD, donors of economic aid and Egypt's partners in trade, in other words, USA and various European countries, Saudi Arabia and the Gulf Countries, etc.

which unavoidably necessitate lessened public employment and reducing spending for education, culture, health, etc. Understandably, these are not easy steps to take in Egypt.[37]

The Employment Problem

Population policy reinforces the general effect of economic and social development on levels of fertility and consequently affects the rate of population growth. Population programs are given tacit official support, but so far these programs have not had much impact on reducing the rate of population growth. It is reasonable to suggest that any significant population planning measures in the future which may lead to a rapid decline in the crude birth rate would have a favorable effect on economic development. The growth of dependent population would be slower and the ratio of dependents on working age population would improve. Also, on proper assumptions, the growth of per capita income in the long run would be higher.

However, in the perspective of the next, say, ten years, in terms of its effect on the employment situation the impact of any conceivable decline in the crude birth rate is likely to be negligible. The size of the working age population would be unaffected , and given the participation rate, the labor supply would be unchanged. Consequently the scale and character of the employment problem during the next decade will be governed primarily by other factors.

The following trends, germane to the employment problem in Egypt are noteworthy: (a) The total labor force has grown more slowly than the total population of working age, reflecting a decline in the labor force participation rate. (b) Total employment has increased more slowly than the labor force. The differences has been particularly large during the 1970s and 1980s. (c) The differences between the growth rates of the labor force and of total employment has not resulted in a rapid increase of unemployment because of migration of workers abroad until mid 1970s. This trends has been reversed since late 1970s. (d) The total number of unemployed has increased both absolutely and relative to the size of the labor force.

Consequently, unemployment is the most serious economic problem facing Egypt today. Furthermore, specifically from the viewpoint of the new economic reform program, in other words, the privatization policy, it should be a mundane prospect for the Government to close public sector outlets for new entrants to job market, and also to streamline public sector companies. Egyptian policy makers are well aware of this dilemma.[38] The government has

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[37] After Egypt finally signed an agreement with the IMF in 1991, President Mubarak declared that economic reform must be an "Egyptian reform," capable of maintaining "a balance with the international system and keeping the social balance in Egypt." Aftandilian, op.cit., p. 48.

[38] In an interview in February 1992, President Mubarak stated that finding jobs for Egyptian youth is his first priority and they have to create "half a million jobs every year." Al Ahram, February 7-8, 1992. Similarly, on his Labor Day address in 1992, President Mubarak said: "..I am aware of the difficulties every Egyptian suffers daily due to high prices, unemployment and problems of education and other services...I am aware of all these hardships and am trying to do everything I can to alleviate their impact on the honest and toiling citizens." Cairo MENA, May 1, 1992, as reported in Aftandilian, op. cit., p.50.

three options to alleviate the intimidating employment problem -which we, also, can surmise as the problem of growth and development-:

i. To proceed with the new economic reform program, which has (should have) the potential to yield middle and long term economic growth and, consequently create jobs, this time in the private sector;
ii. To attract foreign (both, western and Arabic, and, both, private and public) investment and directing, at least some of it to labor-intensive projects and ventures;
iii. Continue to find job markets outside Egypt for the excess work force.

The first option, that is economic growth mainly through industrial investment and expansion within a market economy framework, is the one Egypt will ultimately have to rely on, among other high priority economic and social purposes, to create jobs over medium and long term.

Egypt's experience with attracting foreign investment since the first economic liberalization policy (infitah of 1970's) did not correspond to its expectations. In spite of the close rapport between Cairo and Washington during President Sadat era American -and European- private business investment in Egypt was unexpectedly low.[39] Arab investment was more significant. But, various Arab investors, like their non-Arab counterparts were dissatisfied by Egypt's copious business regulations and consequently commenced to restrict their investments.[40] Egypt in 1990's has removed some impediments to foreign investments. Nevertheless foreign investors, Western or Arabian, are not "rushing in."[41] So far, flow of foreign funds even Arab private sector investment has been, like in the Infitah period, is rather low. Some observers believe that it will take some time until Egypt follows through on its economic reform program, for foreign investment to reach considerable levels.[42] Egyptian officials, on the other hand, seem to assume that, in order to actuate private investors of Saudi Arabia and other Gulf countries invest in Egypt, they should be instigated by their own Governments. One other significantly strong opinion among Egyptian authorities is that foreign investment, augmented by the new economic policy, particularly privatization, will

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[39] "Foreign investment has been below what had been forecast, and most of it has been concentrated in financial services. When that kind of investment netted out, Law 43 (foreign investment) flows has accounted for only 7 percent of gross fixed investment over the period 1974-79." Waterbury, J., "The Soft State and the Open Door: Egypt's Experience with Economic Liberalization, 1974-84," Comparative Politics, vol. 18, no. 1, October 1985, p.76. Also see, Hassan Ebid, op. cit., pp. 104-107.

[40] For a detailed discussion of the framework of foreign investment in Egypt, in this period of time, see, Ayubi, Nazih N.M., "Implementation Capability and Political Feasibility of the Open Door Policy in Egypt," Rich and Poor States in the Middle East: Egypt and the New Arab Order, Kerr, Malcolm h., and Yassin, El Sayyed, (eds.) Westview Press, Boulder, 1982, pp.347-379.

[41] Aftandilian, op. cit., p. 52.

[42] Handoussa, H., Egypt's Structural Adjustment Program and Prospects for Recovery, Report Prepared for Institute of Developing Economies for Workshop on "Japanese Economic Cooperation with Developing Countries," 1-6 December 1992, Tokyo.

conceivably be directed towards ventures and projects of quick returns and/or high profitability. According to these authorities, it is easy to perceive that foreign investors primarily seek ventures (sub-sectors, projects, activities, etc.) which attract Egyptian private companies in the first place, and try to invest in partnerships with those domestic companies. In other words, large scale projects which need extensive amount of capital, do not entice foreign private investment. In view of these observations "we should not expect a significant increase of foreign investment in private projects during oncoming years."[43]

Egyptians Working Abroad

Egypt, self-evidently, has a great need to expand its job markets outside the country, specifically in Arab countries where it has traditionally recommenced.[44] Moreover, access to foreign jobs play various important economic and social roles, offering these workers the opportunity to improve their economic and social standing when they return back, and bring considerable economic and political relief to Egyptian Government. For the time being, Egyptian workers being employed in various Arab countries represent some 15 percent of Egyptian labor force which means more than 2.5 million workers. Egyptian workers have started to go to other Arab countries rather a long time ago, after the Second World War.[45] In 1980 approximately 9 percent of Egyptian labor force was employed in various Arab countries.[46] In June of 1990, before the Gulf War number of Egyptians working in Arab countries reached 2.33 millions, yet, during and immediately after the Gulf War dropped to 1.37 millions in May 1991. Nevertheless, four months later, in October 1991 this number again raised to 2.43 millions.[47] Arab countries that took in the largest number of Egyptian workers in this period of time were Saudi Arabia and Libya.

Recently, the most important observation in relation with Egyptians working abroad and the one which avouches various important prospective alterations and adjustments is the expeditious increase of number of Egyptian workers in Libya. Egyptian labor force grew from 85,000 in June 1990 to over 1 million in September 1991,[48] and some domestic observers assert that this number exceed 1.5 millions by the spring of 1992.[49]

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[43] Hassan Ebeid, "Economic Reform and Privatization in Egypt," in Economic Reform and Privatization in Egypt, op. cit., p. 104.

[44] This observation is unlikely to change in coming years, despite Egyptian officials increasing efforts to create new opportunities at European job markets, or President Mubarek's idea of an economic grouping of Mediterranean countries (The Mediterranean Club), mainly due to persisting unemployment problems of European and Mediterranean countries and growing resentment toward immigrants and foreign workers in Europe. See, Aftandilian, op. cit., p. 53.

[45] Ghada Hashem Talhami, Palastine and Egyptian National Identity, Praeger, New York, 1992, p.34.

[46] Ibrahim Saad Eddine Abdallah, "Migration as a Factor Conditioning State Economic Control and Financial Policy Options," in The Politics of Arab Integration, Luciani, G. and Ghassan Salame (eds.), Croom Helm, London, 1988 p. 141.

[47] Foreign Labor Trends: Egypt, Report Prepared by U.S. Embassy, Cairo, 1991. (mimeo)

[48] Foreign Labor Trends, op. cit.

TABLE II/2 : EXTERNAL REVENUE

	Exports (f.o.b.)	Invisibles (services)[a]	Private Transfers	Loans Received	Direct Investment	Total	%Change
1970	817.0	145.0	33.0	325.0	-	1320.0	-
1975	1567.0	713.0	455.0	1162.0	8.0	3905.0	195.8
1980	3854.0	2662.0	2791.0	1799.03	543.0	11654.0	198.4
1985	3836.0	3442.0	3216.0	1836.0	1178.0	13508.0	15.9
1990	3604.0	7147.0	4284.0	1522.0	734.0	17291.0	
1991	3856.0	7951.0	4054.0	191.0			

[a] Inflows of interest, profit and dividends are included.

Determinants of Foreign Policy

Egypt, while determining its foreign policy objectives over the past several decades, almost perpetually, pursued guidelines which eventually aid its tormented economy.[50] Likewise, there exist a strong cohesion between the extent of Egypt's affiliation with Arab countries and the economic benefits that such a bond amasses.[51] To actuate and maintain a corresponding affiliation, on the other hand, takes political clout, and to accomplish this objective Egypt had to return to the Arab world, defend Arab causes and court old-time adversaries like Libyan leader Qadhafi. Since the late 1980's Egypt had completed the process of restoring relations with all Arab states, moved the Arab League headquarters back to Cairo, and work to ensure that an Egyptian was elected as the Arab League's secretary-general. In other words, after years of ostracism in the Arab world because of its peace treaty with Israel[52] and de facto alliance with the United States, Egypt has returned to a prominent role in Arab affairs. Furthermore, in the international arena, specifically its relations with Western

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[49] Cairo Middle East News Agency, April 12, 1992. see. Aftandilian, op.cit., p. 54.

[50] See, Ali E. Hillal Dessouki, "The Primacy of Economics: The Foreign Policy of Egypt," in The Foreign Policies of Arab States, Baghat Korany and Ali E. Hillal Dessouki (eds.), Westview Press, Boulder and London, 1984. "In the 1970's.. Sadat's decision to visit Israel was largely motivated by economic considerations...Even before this step Sadat's Arab policy and his forging of Cairo-Riyadh alliance had also been predicated on expected economic gains." ibid, p. 124.

[51] The interplay between Egypt's Arab politics and the economic benefits that such a policy gathers is not new. "By the early 1940's and by the independence of much of the Arab region new economic realities began to attract Egypt's attention... (It began to look to Arab markets as a potential outlet for surplus products and labor force." Ghada Hashem Talhami, Palestine and Egyptian national Identity Praeger, New York, 1992, p. 34.

[52] Egypt signed the Sinai II disengagement agreement in 1975, President Sadat visited Jerusalem in 1977, signed the Camp David accords in 1978 and concluded a peace treaty with Israel in 1979. These developments prompted most Arab states to break diplomatic relations with Egypt and move the Arab League headquarters from Cairo to Tunis.

countries, Egypt exults a rather high degree of prestige because of its consequential role in forging the Arab coalition in the Gulf War, its constantly improving relations with important international bodies like IMF and IBRD, and, also with USA and various European countries, and the fact that current UN secretary-general is an Egyptian.

Extensive number of scholars of inter-Arab relations in general and Egyptian-Arab relations in particular tend to minimize the value of Arab interdependence on the basis of trade statistics.[53] "Inter-Arab trade never exceeded 8 percent of overall Arab trade and for Egypt only about 6 percent of its trade is with Arab countries."[54] It would not be misleading, on the other hand, to argue that in the Arab context trade statistics, at best, a small part of the overall picture. The Arab world constitutes a regional system and the Arab countries prorate distinctive attributes, that go beyond particular economic relations, trade statistics, shared borders or dictates of geography. With their common "language, religion, social culture, political history and, (most importantly) self definition as Arab states, these countries are more than a collection of states whose interactions are governed primarily by the fact of proximity. They constitute a regional system or order."[55]

Egyptian interdependence with the Arab world, similarly, is intense and structural than, frequently, estimated. Salient reasons for this structural and powerful interdependence can be listed as follows:

i. Labor migration in the Arab world profoundly influences Egyptian society, economy and politics.[56]
ii. Workers remittances represent a very significant share of hard currency flows to Egypt.
iii. Workers remittances, also, function as an important source of investment in Egypt.[57] Similarly, Egyptian finance sector heavily depends on the savings of Egyptians who worked or are working in Arab countries. Additionally, remittances and workers who return back have a trong positive and sustaining effect on the development of small-scale manufacturing in Egypt.[58]

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[53] Abdel Monem Said Aly, "Egypt: A Decade after Camp David," in The Middle East: Ten Years after Camp David, William B. Quandt (ed.) The Brookings Institution, Washington D.C., 1989, p.84.

[54] ibid, p. 84.

[55] Yezid Sayigh, "The Gulf Crisis: Why the Arab Regional Order Failed?," International Affairs, vol. 67, no. 3, p.488.

[56] "More than 3.5 million Egyptians have, at some time, migrated to work in the Arab countries, with the result that in almost every Egyptian family at least one member has worked or is working abroad." Abdel Monem Said Aly, "Egypt: A Decade after Camp David," op. cit., p.84.

[57] "57 percent of total direct investment under Law 43 was Egyptian money generated by Egyptians working in Arab countries. If this figure is added to the 25 percent of direct Arab investment under the same Law one finds that 82 percent of (foreign) investment was derived from Arab money." Saad Eddin Ibrahim, "Oil, Migration, and the New Arab Social Order," op. cit., p.40.

[58] "See, Günter Meyer, "Socioeconomic Structure and Development of Small-scale Manufacturing in Old Quarters of Cairo," Paper presented at the annual meeting of the Middle East Studies Association, Baltimore, November 15-17, pp. 4-5. Cited by Abdel Monem Said Aly, op. cit., p.86.

iv. Labor migration and remittances are not the only important sources of income from Arab countries. Some additional and significantly substantial economic rapport can be listed as follows:
(a) receipts from OPEC official development assistance (bilateral OPEC aid);[59] (b) receipts from special GCC (Gulf Cooperation Council)fund; (c) receipts from Arab tourists;[60] (d) receipts from the sales of intellectual properties, e.g., films, television programs, produce of news agencies, books, etc.;[61] (e) receipts of Egyptian private hospitals from the large number of Arab callers.

"Consequently it is not surprising that many Egyptians, even they stay at home, have a source of income related to Arab countries."[62]

For the time being, there are two significant factors that, one adversely and one favorably, impact Egypt's economic concern with the Arab countries. First, the Arab countries are going through a period of economic sluggishness, and, at least in the short run, it is not easy to expect a very rapid expansion of, both, the number of Egyptian work force in Arab countries and amount of receipts from various sources. Second, it is fairly coherent to anticipate that Egypt's significantly improving political (consequently, social, cultural, etc.) affiliation with the Arab world will, also, and very positively influence its economic relationships. Prospectively, one may assume that economic laggardness in Arab countries, which, evidently is an outcome of overall (world) recession, in the near future, will give way to a new cycle of economic expansion. Then, above mentioned two factors, obviously, will start to impact towards the same direction.

In view of the analysis of recent international political and economic developments with respect to Egypt and the Middle East, it, also, is conceivable to assume that Egypt's rapport with international bodies like IMF, IBRD, UN, etc. and with US and the European countries, if not improve, will maintain in the coming decade(s).

Agriculture

Agriculture, accounts for approximately 17 % of GDP and 33 % of total employment[63] and, undoubtedly, is one of the most important economic and social sectors in Egypt. According to various

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[59] Egypt received more than 6 billion dollars between 1973-1981 (approximately 20 % of the total, of bilateral OPEC aid. Abdel Monem said Aly, op. cit., p. 87. Total amount of net flows from OPEC countries as official development assistance climbed over 6 billion US dollars in 1990. World Development Report 1993, op. cit., p. 275.

[60] A considerably large segment of tourists going to Egypt are from the Arab countries. "In 1987 the Arab countries share of tourism in Egypt -an estimated 2 million people- reached 40 %." Abdel Monem Said Aly, op. cit., p.87. Moreover Arab tourists' contribution to Egypt's income is much larger because they stay longer and spend more than European and American tourists. ibid., p 87.

[61] "Arab journalism, broadcasting and television are dependent to" Egyptian products. ibid., p.87.

[62] ibid., p. 87.

[63] Five Year Plan for Economic and Social Development, 1992/93-1996/97, Ministry of Planning, Cairo,1992.

experts and officials, despite problems, hardships, structural and policy deficiencies, "agriculture still remains the backbone of attaining economic growth and progress for such a dominantly agricultural and developing country as Egypt."[64] Agriculture, on the other hand, is also a very important economic sector from foreign trade angle: in recent years, it accounts for approximately 13 % (1990) to 6 % (1991) for total merchandise exports and over 15 % (1991) of total merchandise imports.[65]

Egypt was self-sufficient in food and a net exporter of agricultural commodities in the early 1970's. Ten years later, by the early 1980's, nonetheless, Egypt was running an annual net deficit of $ 3 billion on agricultural trade, in other words, amplitude of food imports started to perpetuate 60 % of the countries food needs, costing around $ 4 billion a year. It may, rather strongly be concluded that "the performance of the Egyptian agricultural sector has weakened (or, "in heavy decline"[66]) during the past two decades."[67] Reasons of this agricultural setback are, generally, specified as follows:

i. Problem of water and repercussions of its relationship to cultivable land are constantly amplifying.
ii. Population growth and urbanization are rapidly devouring scarce agricultural land.
iii. Population growth and urbanization (together with increasing per capita GNP, industrialization, etc.) perpetually enlarge the need and demand for agricultural products, notably food.
iv. There appear to exist various structural[68] institutional[69] and technological[70] constraints to accelerate or, even, maintain agricultural growth.
v. Numerous experts seem to agree on that pricing,[71] subsidization, marketing and quota policies,[72] also, adversely influence agricultural production and growth.

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[64] e.g. see, Khadiga El-Aasar, Economic Reform for Agricultural Sector: Landlord-Tenant Relationship and Pricing Policy, in Economic Reform and Structural Change in Egypt, op. cit., p. 115.

[65] Central Bank of Egypt, Annual Report, Cairo, 1992.

[66] Egypt: Country Profile 1992-93, The Economist Intelligence Unit, London, 1992, p. 18.

[67] Economic Reform for Agricultural Sector..., op. cit., p. 115.

[68] For a recent and detailed analysis of structure of land distribution and landlord-tenant relationships and their impact on agricultural production and development see, Khadiga El-Aasar, Economic Reform for Agricultural Sector: Landlord-Tenant Relationship and Pricing Policy, in, Economic Reform And Structural Change in Egypt, op. cit., pp. 115-145.

[69]"Institutional shortcomings are attributable to a large government profile reaching untenable proportions. The bureaucracy is over-staffed and cumbersome and its overlapping responsibilities prevent effective management of resources and programs." Country Program Strategy, op. cit., p. 5. e.g., "The diffusion of research agendas among competing agencies prevents the government research system from concentrating on the highest priorities. Furthermore the agricultural research system is relatively isolated from outreach and extension mechanisms. Hence, technologies developed have little chance of reaching farmers. ibid, p.5.

[70]"Technological constraints affect the productivity...(and) inefficient on farm water management...,inefficient processing technology causes post harvest losses of up to 20%." ibid, p.5.

[71] Egypt Country Profile, op. cit., p. 18. For a recent and detailed analysis of agricultural price policies in Egypt see, Khadiga El-Aasar, op.cit., pp. 115-145.

Agriculture : Matrouh

Agriculture, still is the main economic activity and main source of income in the Northwestern Coastal region of Egypt.[73] Majority of agricultural income generates from animal husbandry. Orchards, also provide a considerable share. Vegetable cultivation and barley furnish limited contribution. The agricultural lands of the Region can be classified in three production strips :

i. Coastal cultivation strip: Extends from the seashore 5 to 10 km. inland, including the beach and the coastal plain. Average annual rainfall is about 150 mm. Cultivation of orchards and vegetables predominates especially in the deltas of the wadis. the inhabitants are settled.
ii. Inland cropping/grazing strip: South of coastal strip between 5 to 15 km. from the coast. Average annual rainfall is about 100 to 140 mm. Soil is poorer. Grazing, especially sheep and goats and cropping, especially barley is dominant. Inhabitants are sedentary.
iii. Inland grazing strip: This strip lies between 15 to 50 km. from the seashore. Average annual rainfall is about 50 to 100 mm. Grazing predominates.

Marketing of agricultural products does not present any important problems. The market system is manipulated by private traders and wholesalers large in number to ensure reasonable competition. Cooperatives, also, market a sizable portion of the agricultural production, further help producers to receive a competitive price. Both in the case of livestock and fruits and vegetables a strong and growing local demand exists. An important section of livestock production is exported, especially to Gulf Countries. Libya was an outstanding market until 1970's when the border with Egypt was closed. Potentially it still represents an important market outlet.

Some important observations and expectations on agriculture in the Region can be itemized as follows:

i. Land is limited. The only way to increase production is to increase yields. Limitations imposed by the scarcity of water resources, on the other hand, restrict application of better farming practices.
ii. As there is little or no fertilizer response in dryland crops currently there is practically no fertilizer use in the area. Given water scarcity and drought conditions farmers are unlikely to start to use fertilizers. Agricultural producers are expected to continue to apply animal manure for vegetable production and fruit trees.
iii. As a result of various efforts to improve the production techniques and increase yields, use of pesticides and certain other chemicals application are called for. This development could result in some health risks and water contamination if not properly managed.
iv. There exist a tendency for a higher degree of mechanization in agricultural production. Prospects will depend on credit policies. One of the causes of soil erosion in the Region, evidently, is inappropriate cultivation equipment and methods. Given the high average wind speed, deep ploughing contributes to accelerated erosion. Increased use of tractors may also induce over-utilization of soilresources for cultivation and increase over grazing.

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[72] See, Country Program Strategy, op. cit., p. 5.

[73] For a very detailed analysis of agricultural lands, agricultural production, main production zones, main crops, farm income, etc. see: Annex I: Ayyad, op.cit., pp.VI- 1 to 7.

Tourism

Tourism is one of the leading economic sectors and an elementary source of foreign exchange in Egypt.[74] In addition to country's unique archaeological heritage and the availability of well tested international formula of sun, sea and sand, the main reasons of very rapid expansion of tourism in late 1980's, despite various and primarily political unfavorable occurrences,[75] can be specified as follows:

i. Depreciation of Egyptian Pound against US$ and other Western currencies;
ii. Opening of the skies to charter flights;
iii. More sophisticated promotional campaigns;
iv. A vigorous Government policy and, consequently a very rapid expansion of tourism facilities.

Tourism sector's growth rates of almost all variables averaged around 17.5 % since 1986. Incentives offered to investors have resulted in a major expansion of tourism facilities, not only in the traditional tourism areas around the Nile but also in the Sinai, the Red Sea, the Oases of the Western Desert and Northwestern (Mediterranean) Coastal Region. Hotel capacity is expected to reach 70 thousand in 1994/95 season compared with 24 thousand rooms in 1985.

It should be mentioned here that Ministry of Tourism has been in the forefront of Government's recent economic restructuring program and an active proponent of privatization efforts.

TABLE II/3 : FOREIGN TOURISM IN EGYPT (millions)

	Number of Tourists		
Years	Arrivals	Nights	Tourism Revenue (bl. US$)
1985/86		8.0	0.9
1989/90	2.8	22.1	2.5
1990/91[a]	1.9	16.5	1.5
1991/92	3.1	26.0	3.2

[a] Iraq invades Kuwait: The Gulf war.
SOURCE: Ministry of Tourism.

33. One of the foremost features of Egyptian Tourism is its attractiveness for Arab tourists. Almost 1/3 of arrivals in recent years are of Arab tourists. Arab tourists specifically come in Summer months, on average stay longer and spend more then the western tourists. Recent very favorable political developments in the Middle East and more favorable expectations will, undoubtedly and considerably

[74] By 1988 tourism had overtaken oil as the most important source of foreign exchange and has remained a top money earner ever since.

[75] e.g., Achille Laura hijacking in 1985, Cairo riots and USA bombing of Libya in 1986, the Gulf War, continuing disturbances caused by radicals in the country, etc.

increase Arab World's touristic demand towards Egypt. Moreover a sizable part of this demand, due to the prior patterns and anticipations of Arab tourists will de directed to Mediterranean Coast and Northwestern Coastal Region.

Another important particular of Egyptian tourism is domestic tourism. Unavoidably with the development of the socio-economic conditions and, predictably as one of the results of new restructuring and liberalization policy, domestic demand for tourism will, probably very rapidly, increase and Northwestern Region will, evidently emerge as one of the important targets of this demand.

Tourism : Matrouh

In addition to a succession of beaches, bays and lagoons, the climate prevailing along the Northwestern Coastal Region can be qualified as "arid Mediterranean with mild winters." It is one of the mildest of the Mediterranean basin. Winter temperatures are higher than in any other part of the Mediterranean coast and frosts are not met with. Summer temperatures, on the other hand never exceed critical values. evaporation is reduced by not-to-hot summers and by rather high relative humidity, especially in July and August. Thus the Region provides an excellent setting for the so-called "beach-sun-sand" tourism.

The main aim of the Government policy, reflected by investment program of the Regional Development Plan and connected "Tourism Development Project", and recent progressions in the region is to promote the expansion of tourism sector.[76] Plan indicates that by the year 2010 tourism sector will receive the first place by 38 % of total public investment. Agriculture (water investments included) and animal husbandry, together with poultry and fisheries, will rank second. (37 % of total public investment). All other sectors (Infrastructure, industry, housing and services) will acquire the rest. (25 %)[77] The plan, naturally the Government policy, furthermore, gives geographical priority for tourism development to Bagoush-Hawwala near Marsa Matrouh.

[76] For a very detailed analysis of the present situation and the prospect of tourism sector in Northwestern Coastal Region see: Annex I: Ayyad, op.cit., Part VI: Economy (b) Investment pp. VI/8-18, and, (b) Production/3. Tourism pp. VI/36-38. Also, Ghabbour, op.cit., pp. 42-47 (Economic Evaluation).

[77] ibid, p.vI/14.

TABLE II/4 : EXPECTED TOURIST DEMAND IN NORTHWEST COAST

Years	Number of tourists (thousands)	Average annual increase (%)
1995	606	-
2000	976	12.2
2005	1,537	11.5
2010	2,366	10.8
2025[a]	4,000	4.6

[a] This number is not a projection result. It is an estimate to exhibit a sequence.
SOURCE: Ayyad, op.cit., p.VI/37.

It is, justly expected that both international tourism, incorporating a larger share of Arab tourists than the rest of the country, and domestic tourism will develop together in the region. Currently, in addition to tourists staying in existing hotels,[78] summer populations (transient population) in the villages, specifically in Marsa Matrouh is, also, considerably higher than winter populations.[79]

Transportation: Pan North African Road

Agricultural and industrial development, together with trade and tourism depend on road transportation. Main arteries or the so-called principal roads, at least for the time being, can be considered as sufficient.[80] There, however exist a large amount of criticism and complaints for feeder (or secondary) and tertiary roads connecting various locations with feeder roads. It, on the other hand, is strongly presumed that recently completed dual highway which extends from Libyan border to Alexandria, parallel to the Mediterranean Sea, is probably the most important infrastructure that will accelerate, even foster agricultural and industrial development, as well as tourism and trade and, also

[78] 1988 USAID survey indicates that there are 57 Hotels in Marsa Matrouh with a total capacity of 3568 visitors. Occupancy rates of these hotels rise to almost 100 percent in July and August and over 78 percent in June and September. Similarly, hotel employment increases over fourfold in summer months. USAID, Water and.., op.cit., pp. 2-9 and 2-10.

[79] 1988 USAID survey, for summer months predicts a 24 % rise in population. This ratio indicates approximately 20 thousand visitors. ibid, p.2-25.

[80] It is frequently asserted that maintenance of all kinds of roads, primarily due to competing demands to already limited public resources is inadequate both in Egypt and in the Matrouh region, resulting a rapid deterioration of transportation conditions.

social mobility. On account of this highway Matrouh region and its economy is now in easy access to the towns of the Delta and the Wadi and Sinai.[81] Moreover, this coastal road has very important international connotations. It is a considerably substantial part of the so called Pan North African Road which connects the Arab countries of North Africa to the Middle East.[82] It is rather easy to anticipate that the international road, already attending a constantly growing number of, specifically Libyan merchants and traders together with the development of domestic transportation activities, in the near future will encourage and cultivate a substantial roadside development in the region.

[81] A recent research on Northwest Egypt, probably due to the completion of coastal highway, suggests that among the constraints to regional development, transportation is not a high priority. The following table, produced upon the findings of above mentioned research, reflects the persuasions of both investors and workers on constraints to development in the region:

TABLE: CONSTRAINTS TO DEVELOPMENT IN NORTHWEST COASTAL REGION OF EGYPT

Constraint	Investors' Frequency	Workers' Frequency
Production Inputs	92	49
Labor	83	18
Marketing	66	12
Credit and Finance	55	6
Water	55	36
Land Ownership	44	0
Electricity and Fuel	39	11
Equipment and Machinery	37	11
Transport	37	12
Permits and Licences	32	0
Taxes	26	3
Number of Respondents	125	147

SOURCE: Investors and..., op.cit., p. 61.

[82] With the completion of the Sallum-Alexandria segment, this international road that joins Europe to Asia is now fully operational.

CHAPTER III
THE ENVIRONMENT

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Environmental problems as environmental pollution on one hand and loss of environmental resources on the other, are taking their places in the agenda of Egypt, with amplifying severity. Nevertheless, the placing of these problems into a system of modern economic thought and corresponding public policies is rather new and rudimentary. The main barriers precluding the development and application of suitable and more economic policies is the gap between the ever increasing importance of the problems and the established approaches of the central authority, together with the lack of sensitivity of the public.

Although some of the issues can be considered as totally national, it can easily be demonstrated that a variety of current and more importantly, potential environmental problems in Egypt are local and regional occurrences, a good example being the North Western Mediterranean Coast.

Environmental Issues in Matrouh Region

Environmental problems in Matrouh Region, in other words, the western Mediterranean Coast of Egypt can be conceived in two groups, as general and specific issues. Definitions and fundamental features of the dimensions of environmental problems, on the other hand can be formulated as follows:

i. **Material elements** of the general environmental problems of the region, in other words, detachment of their relation to basic environmental entities, are primarily water, and soil. This dimension, on the other hand, can be detailed on localities basis.[83]
Locational dimension is defined as a municipality, township, village or an environmental problem area. In the same manner, urban pollution situation should be expressed within alist of problems, including, sewage systems and urban waste management.
ii. **Causes** of the environmental problems
in the region are, particularly, the procedures of urbanization, agricultural production, animal husbandry and tourism.
iii. **Nature** of the general environmental problems, on the other hand can be limited as, deprecation and degradation of soil and pollution of water.
iv. As for the specific environmental problems two rather important developments in the region immediately and openly introduce themselves : a. ripping and destruction of limestone ridges, and b. active coastal erosion of the sand beaches.

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[83] Ayyad, op. cit., p.

v. As for the **Time dimension** of the environmental problem : a. it is not easy to detect past but still commanding problems; b. there, on the other hand, are severe emerging or current problems; c. there also exist considerable threat with probable or potential problems.

v. As for the **Degree of priority** of the general environmental problems in the region, it can be claimed that, at least for the time being, it is not significantly coherent to detect **urgent**, environmental problems, in other words problems that threaten human existence and welfare in the short run.

vi. The cases of the ridges and the sand beaches, on the other hand, pose immediate danger of extinction for some unrenewable inanimate natural resources. In other words, there exist a handful of environmental problems which should be itemized and detailed in accordance with their **degree of priority** in order to be dealt within the **short, medium or long term.**[84]

vi. As for the **Degree of importance** of the salient environmental problems, a.destruction and ruin of limestone ridges; b.active coastal erosion of sand beaches; c.soil loss and degradation; d.destruction of natural vegetation e. water pollution and f.urban pollution can be listed in that order.

[84]Any environmental problem, placed in any section of this table is, also, classified by other 5 dimensions (cause, category, time, priority and degree of importance of the problem). Problems and Locations Table is neither a data-bank, nor a guide to collecting statistical information. This matrix functions as an inventory of environmental problems. Every data collecting and evaluating practice does not, necessarily, detect an environmental problem. In order to institute an inventory of problems, on the other hand, it is essential to be able to collect and evaluate sufficient information.

TABLE : III/1 ENVIRONMENTAL PROBLEMS AND THEIR DIMENSIONS IN NORTHWESTERN MEDITERRANEAN REGION OF EGYPT

PROBLEMS		**DIMENSIONS :** a. Material Element ; b.Location c. Cause ; d. Nature ; e. Time; f. Priority	
1.	**Destruction of Limestone Ridges**	a.	Limestone ridges
		b.	Problem Area
		c.	Market Demand
		d.	Destruction and Exhaustion of Natural Resource;
		e.	Current and Potential
		f.	Urgent
2.	**Active Erosion**	**Coastal**	**a. Sand Beaches**
		b.	Problem Area and Regional
		c.	Touristic Villages and Second Houses
		d.	Destruction and Exhaustion of Natural Resource
		e.	Current and Potential
		f.	Urgent
3.	**Loss of Natural Vegetation**	**a.**	**Fig Orchards**
		b.	Regional
		c.	Touristic Villages and New Agricultural Practices
		d.	Destruction and Exhaustion of Natural Resource
		e.	Past, Current and Potential
		f.	Urgent
4.	**Wind Erosion**	a.	Soil
		b.	Regional
		c.	Agricultural Practices and Loss of Natural Vegetation
		d.	Destruction and Exhaustion of Natural Resource
		e.	Past, Current and Potential
		f.	Short and Medium Term
5.	**Groundwater Pollution**	**a.**	**Water**
		b.	Local
		c.	Urbanization and Touristic Villages
		d.	Pollution
		e.	Current and Potential
		f.	Short and Medium Term
6.	**Water Erosion**	a.	Soil
		b.	Regional
		c.	New Agricultural Practices, Irrigation
		d.	Destruction and Exhaustion of Natural Resource
		e.	Current and Potential
		f.	Medium and Long Term

7.	**Pollution of Coastal Waters**	a.	Sea
		b.	Regional
		c.	Urbanization and Touristic Villages
		d.	Pollution
		e.	Current and Potential
		f.	Short and Medium Term
8.	**Nuclear Energy Plant**	a.	Soil, Water, Natural Vegetation
		b.	Problem Area
		c.	Market Demand
		d.	Pollution and Destruction and Exhaustion of Natural Resource
		e.	Potential
		f.	Long Term
9.	**Loss of Coastal Landscape**	a.	Landscape
		b.	Regional
		c.	Touristic Villages and Urbanization
		d.	Destruction and Exhaustion of Natural Resource
		e.	Current and Potential
		f.	Short and Medium Ter
10.	**Destruction of Limestone Ridges**	a.	Limestone ridges
		b.	Problem Area
		c.	Market Demand
		d.	Destruction and Exhaustion of Natural Resource
		e.	Current and Potential
		f.	Urgent

TABLE : III/2 : ENVIRONMENTAL PROBLEMS ACCORDING TO THEIR CAUSES IN NORTHWESTERN MEDITERRANEAN REGION OF EGYPT

CAUSES		ENVIRONMENTAL PROBLEMS
Touristic Villages	1.	Active Coastal Erosion
	2.	Loss of Natural Vegetation
	3.	Groundwater Pollution
	4.	Pollution of Coastal Waters
	5.	Urban Pollution
	6.	Loss of Agricultural Land
Agricultural Practices	1.	Wind Erosion
	2.	Groundwater Pollution
	3.	Water Erosion
	4.	Loss of Natural Vegetation

Urbanization	1.	Groundwater Pollution
	2.	Pollution of Coastal Waters
	3.	Urban Pollution
	4.	Loss of Agricultural Land
Other	1.	Destruction of Limestone Ridges
	2.	Planned Nuclear Energy Plant

The Case of Limestone Ridges

One of the impressive and eye-catching activities currently perpetuating in the northwest region is the ripping and excavating of limestone ridges running parallel to the Mediterranean coast. Limestone bricks, extensively used in construction, not only in the region but also in the Valley and the Delta, specifically became very demandable in recent years due to receding of brick-making activities from the silt brought by Nile. The mining or, more accurately, ripping process is undertaken openly by generally unauthorized people in a completely uncontrolled and haphazard fashion which lead to a total destruction and exhaustion of each and every ridge in each and every drill area. It seems that this limestone ripping process and its adverse environmental consequences are well known and comprehended by almost every person and institution, especially in the region and in Alexandria. Any action or policy to prohibit or control and regulate this activity, on the other hand, do not exist. Even the size of the operation, that is, annual extraction amount, is not clearly known. Therefore, it is not easy to estimate the probable date of the complete exhaustion of this rare environmental asset.

The Case of Active Coastal Erosion

Another and, rather similar natural resource degradation and depletion process, which is referred as "active coastal erosion" or "active sand movement" continues at the very rare, probably unique and irreplaceable sand beaches of Mediterranean coastal line of the region, specifically in touristic villages areas. This loss of clear, colorful and shiny sands to the sea, and blackening of the beaches is generally the result of direct repercussion of large scale construction activities very near to the sea and the wind erosion which is an outcome of loss of natural vegetation, especially dwarf fig orchards, again due to the touristic village construction activities. It, recently became a common practice to transport unspoiled sand from undamaged coastlines to cover blackened beaches in the touristic villages areas. Coastal erosion and sand loss is, again a well identified and conceived issue in the region and in Alexandria. The size of the progression that is, amplitude of sand destruction, on the other hand, is not clearly known and any action or policy to prevent this irreplaceable loss do not exist.

The Case of Downfall of Natural Vegetation

Another important and environmentally unfavorable eventuality is the destruction of various groups of natural vegetation, specifically the loss of dwarf fig orchards to urbanization and touristic villages development, and, also to "new and advanced" modes of agricultural production. One of the important consequences of this development, obviously, is increasing wind erosion hazard.

There are various direct and indirect causes for ecosystem degradation especially soil erosion in the northwest Coastal Region. The direct causes are related mainly to the ways in which man has misused the natural resources of the Region since its early history. Continued uncontrolled wood cutting, overgrazing and rainfed farming for cultivation of annual crops have dominated the Region for many centuries. More recent land use activities are even more devastating. For example, the area between Matrouh and Salloum, during the last decade, witnessed the clearing of natural vegetation for rain-fed cultivation of barley and wheat, which have a very serious impact on the existing biota, and which cause a state of irreversibility for the process of land degradation.[85] It is estimated that most of the agricultural area under annual crops is subject to moderate water erosion hazard.[86] When barley and wheat fields are in fallow with no vegetation, on the other hand, they provide no forage and wind erosion significantly contributes to the desertification of the area in general.[87] Wind erosion hazard largely increases in cases of tractors use.

Increasing food production, due to high and rising demand, low measures of per capita consumption for certain foodstuffs and comparatively high level of food imports, is one of the highest priority policies of the Egyptian Government. In order to proceed with this policy, Egypt, both tries, both, to intensify production on land already in use -technological improvement- and expand into new areas -land reclamation.- This twofold approach to agricultural policy, like elsewhere in Egypt, also, recommences in the northwestern part of the country.

Although, the impact of these two seemingly separate approaches[88] should be evaluated simultaneously and in unison in northwestern region, intensification of agricultural production, by itself actuate environmental problems. Intensification or technological improvement means appending and augmenting of irrigation -in other words, diverting more water for irrigation- and increasing the use of so called technological inputs: machinery, improved seeds, fertilizers, pesticides and insecticides, etc.

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[85] For a detailed analysis of degradation of flora and fauna in the Region, see: Ayyad, op.cit., Part: II, Flora and Fauna. Also, Samir I. Ghabbour, The Mediterranean Littoral of Egypt Between Alexandria and Salloum: Resources and Demands Unpublished report prepared for Blue Plan, describes landscape, climate, soils, water resources, traditional crops, vegetation and flora and wildlife and fauna, and extends of environmental impact and problems. Cairo, 1984.

[86] Abdel-kader and Ramadan, op.cit., p. 9. The study discloses that 9 to 18 % of agricultural land display a severe water erosion hazard. ibid, p.9.

[87] Ayyad, op.cit., p.C/22.

[88] Even though it is widely argued, these to separate policy approaches, at least within the framework of existing trends, should not be subscribed as tradeoffs in Egypt's case due to the persisting structure and conditions of the country, and more importantly well established and insisting government policies. That is, the argument instigating, "if more food can be produced on the same amount of land that will ease the pressure to cultivate new lands and will permit the preservation of natural resources, biota, etc." is not valid in both Egypt in general and northwest region in particular.

Intensification of agricultural production in northwest region also means introduction of new and alien crops -like sugar beets- to a exclusive and introspective, and also, fragile environment.

The alternative policy approach to intensification, in other words, expanding agricultural lands in favor of annual crops like wheat and barley or various "new" produces, which means a dramatic change in land use patterns, specifically in the Western Desert is equally, -if not more- problematic. Expansion[89] occurs in two directions: First, grazing lands are transformed. A significant segment of rural people in northwest Egypt raise livestock on rangelands that already have low carrying capacity because of poor quality and low and unreliable rainfall. These rangelands, on the other hand, in addition to overgrazing, are threatened by land appropriations as a result of above mentioned expansion policies. Second mode of change in land use patterns is the converting of lands under certain "traditional" crops, dwarf fig orchards being the principal example.

This kind of expansion of agricultural lands, or, more precisely change of land use patterns, is, as we asserted above, led by government policies and accomplished by -both, native and immigrant or "settled"- farmers driven by growing market demand. Various expert people of the region[90], on the other hand, strongly assert that, while this manner of change in land use patterns may, although in a limited capacity, meet immediate efforts to increase food supply and farmer incomes, it is not a long time solution, for these lands of the Western Desert are very distinctive, even unique and fragile.

It should be remembered that, shockingly little information exists about the long term productivity of agriculture -data on the effects of agricultural practices on soil fertility and soil loss, and also on hydrologic processes- in dry conditions in Egypt, and as well as, in most of the developing countries. This observation becomes more appropriate in cases of converted -from forestland, grazing lands, natural pastures, etc.- agricultural lands.

Agricultural practices and policies in Matrouh area apparently fail to recognize the real value of natural resources of the region. In other words, there arise a failure to endorse that natural resources are ultimately in limited and finite supply and divergences in private and social costs of land use -that is, resource exploitation- are essential causes of various environmental problems in the region, erosion, losses of land fertility and biodiversity being the primary examples. Lack of better knowledge of the extend, quality, value and potential of the resource base of the region, readily contribute to the policy failure. Additionally, established approaches and institutions do not match responsibility for resource management with accountability for results, basically because of the nature of expected results.

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[89] Land reclamation from the desert for agricultural purposes is not very significant in northwest region.

[90] e.g. certain faculty members of University of Alexandria. Various observations on agricultural practices and developments, and specifically recurrent analysis on the subject that appear in the text are primarily based on the outcome of several interviews undertaken in the region.

Environmental degradation, especially loss of rare natural resources, like the destruction of limestone ridges -or active coastal erosion, loss of natural vegetation- in northwestern region, occurs when those who make decisions about using these resources ignore or underestimate the costs of environmental damage to society. The reasons for this ignorance, or more precisely, divergence in interests, can be dealt in two main categories:

i. Failures of public policy: Configuration of the list of economic and social priorities both in Egypt in general and in northwestern region in particular, that is, housing sector, construction of touristic establishments or expansion of agriculture being considered on top of and disparate to environmental issues, on the one hand, and lack of a proper regional environmental authority or institution, on the other limit the efforts to protect and preserve natural resources like limestone ridges, distinctive sand beaches or natural vegetation. One of the important issues in this respect is the lack of a proper definition of property rights. As it is well known, when property rights to natural resources are nonexistent or unenforced, that is, when there is open access, no party bears the full cost of environmental degradation or destruction, and there is no mechanism for regulating the use of these resources. In order to assert public control over the resource, in other words, to exclude others from exploiting and depleting the asset, concepts like public or state property, common property or commons, etc., should be elucidated and comprehended.
When a resource is public or common property governments are expected to make decisions on its use and on behalf of the society. Even then, notably in countries like Egypt[91] or regions like Matrouh, establishment of an appropriate -e.g. immune to political pressures or pressures from interest groups- authority or institution is rather imperative.

ii.Market failure: Markets do not reflect the social value of the overexploited resources for some uses of the resources -limestone bricks, touristic second houses, increasing agricultural product, etc.- are marketed, but others -watershed protection, wind erosion prevention or environmental and societal goodness- are not. In other words, the nonmarketed benefits are ignored and, while other -marketed- uses of the resources are overexploited.

Touristic Villages

Probably the most important economic and social occurrence which also greatly influence, even impact environmental conditions in northwest region is the so called "touristic villages." A very large number of such establishments, incorporating thousands of summer houses or apartments, one after another, virtually all of them very near or on the sand beaches for kilometers and kilometers, isolate the coast from the rest of the area. The salient observations on this phenomenal development can be listed as follows:

i. Touristic villages as public, cooperative or private enterprises, are constructed on geographical considerations. In other words, environmental considerations do not count. Organized and dispersed touristic constructions continue, specifically in Marsa Matrouh

[91] Or Turkey, for that matter.

area and other coastal zones before completion of their infrastructure. In other words, choice and decisions are increasingly becoming subject to individual public or private investors' preferences based on economical (financial) and technical capabilities of these investors.

ii. These establishments were and, are constructed in a haphazard fashion without any planning effort. Furthermore they seem to be immune to legal limitations. For example, rules established by 1984 Law to regulate coastal management were not enforced on touristic villages progressions. Similarly, authorities in Alexandria believe that, it will not be possible to enforce the very recent "coordination of coastal management law" which prohibits coastal construction in a 200 meter zone and anticipated "coastal zone management plan," even to probable future touristic villages constructions in the region.

iii. Touristic villages construction as a project is extremely huge, maybe the largest in Egypt in respect with realized amount of investment. It is estimated that, until this date capital investment to the project exceeded a total of 30 billion Egyptian Pounds, and the construction activities together with designing of new villages hastily continue. Furthermore, these were investment funds created as a result of voluntary domestic savings. In other words, these villages should be considered as examples of non-productive use of real and limited resources and to this kind of waste a solution has to be found on a macro level. Instead of legalizing disastrous cases of environmental use and destruction with minor taxes and fees, the laws protecting the society and the environment should be enforced. For, the degradation caused to the natural environment by touristic villages at the coastal regions, are much greater than can be measured with symbolical environmental protection shares or taxes. The solution of reducing those losses must be explored in staying within the boundaries of the city plan discipline and in the application of the environmental standards without any exemptions.

iv. Touristic villages, generally were designed and constructed as summer houses. In other words, it is not possible to utilize them as regular housing enterprises. Similarly, it will not be easy to optimize these establishments as regular summer resorts or hotels, for example in order to cultivate foreign tourism.

v. Rapid increase of touristic facilities on the coast, in addition to severe active coastal erosion problem, put a substantial pressure on landscape and cause pollution of the coastal waters.[92]

Water Pollution

Rapid an unplanned urbanization, extremely rapid and haphazard increase of various kinds of touristic facilities, second houses, together with certain categories of agricultural production practices, side by side with lack of proper sewage systems cause a considerable degree of water pollution and degradation of water quality, especially of underground waters and the sea.

[92] Moreover, "the sale of land to build tourist resorts" and new housing complexes, "truly threatens the Bedouin's existence and life-support ecosystems. These are projects" and developments, "which have no regard for the Bedouin and do not make room for his integration into the new environment." Ghabbour, op.cit., p.62.

Potential Environmental Problems

It is highly probable that various environmental problems would arise due to certain developments and occurrences in coming years and decades. A tentative itinerary of some of the anticipated environmental complications and their probable causes can be listed as follows:

i. Nuclear power plant: A nuclear power plant is proposed and planned. A very large piece of land -over 10 kms. on east-west direction by the main highway- is, already allocated and fenced between the road and the coast. It is quite conceivable that such a development project would create intense environmental impact. Primarily, the allocated piece of land is between Matrouh City on the East and the concentration of touristic villages on the West. In other words it is a very valuable land with prominent possibilities for future economic and social use and development. Moreover, it is covered with natural vegetation, which unavoidably be destroyed, together with kilometers of precious sand beaches, by the anticipated construction. Additionally, the ostensible impact of such an operation on the sea should be carefully calculated.
ii. Irrigation: The large scale irrigation project connected, specifically, to the construction of the Southern Canal envisages introduction of new and irrigated agricultural crops, like sugar beets, to the region. It is maintained, on the other hand, that the nature and quality -e.g. its average depth- of the existing agricultural land is not well-suited for irrigated agricultural production, and such a development will probably result with loss -erosion- of land.
iii. Petroleum and natural gas: Large scale petroleum and natural gas reserves exist in the Western Desert and searching activities and prearrangements for production are already commenced. The transportation of petroleum and gas -pipeline systems, loading ports, etc.- on the other hand, will, inevitably effect the environment, especially at and near the coast.
iv. Canal to Quattara Depression: Various persuasions assert that the "sleeping project" of channeling Mediterranean waters to the Quattara Depression in order to generate electric power can become fashionable again due to the rapidly growing demand for more energy and following the example of launching of similar joint Israel-Jordan project of Death Sea Canal. If realized, this development project, will notably impact various environmental variables, specifically groundwater resources. It is also alleged that such a project will also create important seismic effects.

Solving of local environmental problems, as a rule, should be left to municipalities and other local administrations, but, provincial extensions of the central environmental authority, equipped with the technical and financial support of the central authority, naturally are responsible for supplying and imposing the environmental standards, uncovering and observing the regional environmental problems, designing projects to solve those problems, and coordination between local administrations. Thus, three responsibility levels appear within the national environmental administration framework:

i. Local administrations;
ii. Regional extension departments of the central environmental administrations;
iii. Central environmental administration.

The conduct of investments and services aimed to wards environment at higher levels and with increasing efficiency depends on one hand on the development of the effectiveness of the Egyptian environmental organization with its central and provincial departments and on the other hand on the improvement of the information, directive and financing relations of the central environmental authority with local administrations and the establishment of a surveying and monitoring system.

Dynamic and rapidly changing nature of the environmental problems discourages the accumulation of a wide, detailed and active inventory of projects for Matrouh area. Nevertheless, central environmental administration together with the local authorities, and also with certain related international bodies, should predict such an inventory as far as approximate number of projects and probable financial needs are concerned. For a region which is at the early stage of determining the critical environmental problems, like North Western part of Egypt, problems, at data availability, feasibility and engineering levels, represses the efforts to determine the resource needs and establish quantitative targets. At this point, it may be convenient to refer to other countries experiences and to try to set targets by "analogy". It will be beneficial for Matrouh region of Egypt to determine a "rate of environmental expenditures" at this stage. Such a rate will enable the policy maker to gain an understanding on the amount of required resources, and take measures to prevent selected projects to enter a financial bottleneck.

Environmental protection and improvement efforts, especially within the basic approaches of the present market oriented economic policies, can be financed through three main sources in Matrouh region:

i. Charges and fines to be obtained in accordance with the rule of "the polluter pays". Pollution fines and, even pollution permit fees can be asserted as examples of these revenues.
ii. Amounts (or shares) paid by the users of natural, resources in accordance with the "user pays" rule against the actual or potential loss of these resources.
iii. Shares from income and wealth taxes.

CHAPTER IV
ACTORS GAME ANALYSIS

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Economic and social development and, also, a better environmental management include all societal actors. In other words, individuals, public bodies, private companies and organizations, certain international entities are, all, participants. Evidently, every other actor tries to maximize its own benefit and, consequently, craves to utilize the environment in its own interest.

Environment related problems in the northwest region of Egypt, to a great extent, originate from socioeconomic system, that, on the other hand describes the setting where the various societal actors act. Systemic analysis which has attempted to examine and explain the socioeconomic system of the region, also and reasonably, predicates the actors. Similarly, actors game analysis should come forth as an integral part of the systemic and prospective analysis.

Societal actors in Matrouh region

In order to proceed with the prospective analysis and try to seek probable future roles of important and influential actors, specifically in environment related issues, it is preferably worthwhile to define and classify these societal actors of geographical and socioeconomic setting of Matrouh Region in respect to their social functions, political, legal and economic strengths, commissions and responsibilities, and, also sectors of activity and interests.

Public law legal entities: Central Government in Cairo is the most important actor in every and each issue of Egypt. The Regional Government of Matrouh Governorate, on the other hand, is basically composed of the Governor, Governorate Diwan of Matrouh and service directorates in Matruh Governorate that represent central ministries and organizations in Cairo. All important components of the regional government are agents of the central government.

The service directorates, namely the directorates of Social Affairs, Agriculture, Agricultural Cooperation and Veterinary Medicine, are directly linked to the governorate decision making procedure, and serve both as technical departments for the Governorate, as well as links to central government. These directorates are responsible for implementing sectoral projects in the governorate. [93] The Sector of Development and Reconstruction, that includes Department of Land Reclamation is more independent in its relations to regional

[93] For a very detailed description of administrative structure see: Ayyad, op. cit., part IV: Administration.

government and more closely linked to the central government. Central agencies of Building and Development of the Egyptian Village and Handicrafts and Productive Cooperatives, together with the Ministry of Tourism are represented in the Matrouh Governorate Diwan as offices. It should be noted here that another central agency, Egyptian Environmental Affairs Agency is not represented in the Matrouh regional government.

Local representation in regional decision making process: Under this category two societal actors seem to appear. First is the "Umda", who is employed by the Directorate of the Interior, and is the official representative from the tribal society to the regional government specifically in the Matrouh Region, for he is appointed by the Governor on the basis of election/nomination by members of his tribe. Second is the town and village councils. Both Umda and the councils are, only, supposed to designate the needs and opinions of their communities to the governmental authorities. One other function of the councils, during the preparation of 5-year plans, is to submit their investment proposals to the districts, in this case to the City Council of Marsa Matrouh, which in turn submit the collection of proposals to the Planning Department of the Governorate.

It is rather clear that local representation in, or contribution to decision making process is notably weak, for the individual or institutional representatives are tightly attached to the public authorities.

It is also evident that -at least for the time being- the local agents, reflecting the priorities of the people are not sensitive towards environmental problems.

Civic or nongovernmental section of the society, more precisely institutions like trading, transportation and industrial companies, cooperatives, or individuals like real person merchants, farmers, livestock breeders, investors and private sector administrators, specifically in the new climate of liberalization and privatization, are very strongly inclined to maximize only their own benefits in their respective fields of activity. These group of actors, at least for the time being, are not interested in contributing to community services or creation of public goods, and, consequently in environmental problems of the region.

Associations, foundations, non-profit organizations, etc., on the other hand, either non-existent or significantly ineffective.

The individual citizen, in general, is not actually interested in environmental problems.

There exist a considerable number of international cooperation projects that include International organizations active in the region like USAID, World Food Program (WFP), FAO, ILO, The German Agency for Technical Cooperation (GTZ) and the World Bank. These significantly effective international bodies run or contribute to projects on village development, school provision, development of household industries (USAID), improvement of resources and socioeconomic conditions (WFP), development of agricultural production (FAO), rural development (GTZ), and sustainable agricultural development (World Bank). Although none of these projects are direct environmental projects, almost all of them, implicitly or openly include environmental emphasis and inquisitiveness. Specifically, the recent World Bank development project actively incorporate an environmentally sustainable development approach, reflecting the ever increasing environmental precedence of this influential institution. Similarly, USAID/EGYPT is actively interested in, and contributing to solving of environmental problems of both Egypt as a whole and, also Matrouh Region.

Media, particularly in regional issues is ineffective and in environmental problems, uninterested.

One other actor that can be influential in the process of identifying and solving environmental problems, notably in the specific setting of Egyptian society, may appear as the group of intellectuals academicians, scholars, etc. This group, although unorganized, retain two important particularities. They are well aware of national and regional environmental problems, and they usually are in close contact and good relationships with the national and regional authorities.

If one, out of above catalog, tries to select and define the societal actors that carry a capacity to determine and/or influence the coming decades, specifically from a environmental preservation and betterment point of view in the Northwestern Coastal Region of Egypt, it will not be erroneous to present the "State" or more precisely the "public law legal entities" as the most effective and, also the most powerful actor, or group of actors.

Scarcity and inadequacy of active and affluent elected local governments and regional and also national non-profit and non-governmental organizations, as mentioned before, only the public bodies in Matrouh Region are in a position to decide and spend for research, design, planning, project development, technology, training together with purchasing of necessary hardware and, construction activities for the environmental protection and betterment.

Furthermore and most importantly, in Egypt, due to existing administration framework, solely the public bodies are in a position and capacity to determine a standing and, thus adapt a precedence agenda between economic, social and environmental problems, which demonstrates a high degree of priority from regional and also, national policies viewpoint. It should be remembered that these kinds of decisions are, basically, political preferences, which necessitates value judgments. These decisions, besides, are based on the application of economic and social accounting indicators, in other words, various GNP concepts.

The priority list of government expenditures, specifically in the Matrouh Region includes items like construction and maintenance of infrastructure, credit and financial incentives to private investors and improving community services like education and health. Two most important sectors of activity, from the perspective of the decision makers, that provide formal employment opportunities are industry and tourism. From the governments point of view this understanding indicates the significance of developing these two sectors as a priority in northwest part of Egypt.

It is rather conspicuous, on the other hand, that in order to include environmental problems and solutions in the decision making process, in addition to conventional social accounting concepts, different socioeconomic criterion and guidelines that include perceptions like public goods and/or social costs, (cost-benefit analysis, etc.), should be utilized during the practice of identifying environmental issues and determining the standings among environmental, economic and social policies. Urgent environmental problems of every and each kind (water, soil, natural environmental resources etc.), and of every and each locality in the region, similarly should be specified, valued and ranked among themselves by application of scientific methods.

Actors game in Matrouh region

During the analysis of game of societal actors in Matrouh region from an environmental point of view, one should critically keep in mind that the problems are fundamentally related to management of natural and environmental resources. In other words, the region do not face an excessive pollution problem that directly and adversely influence the lives of the people. This is one of the important reasons which explain the lack of interest of various societal actors, namely individual citizen, local administrators, representatives of economic sectors. etc. towards environmental issues. One exception to this observation probably is the case of the active coastal erosion. The temporary remedy of transporting pristine sand to deprived beaches, seemingly at least for the time being, detain the expected stress from related citizens and institutions.

The analysis of societal actors in Matrouh region clearly disclose that any effort towards protection and betterment of the environment, which, basically is a natural and environmental resources policy, should emanate from some kind of government action. It is rather obvious, on the other hand that priorities of the government in this region, at least for the time being, do not include any environmental policies. Assessments on the structure and attitudes of authorities in Egypt, on the other hand undoubtedly indicate that almost every governmental body and its individual representative retain approving persuasions towards the environment and environmental issues. Consequently, in order to actuate environment friendly government policies, a different interaction among actors, more precisely passing along the necessity, by various actors to the decision maker is needed.

Individual citizen, representatives of local communities, media, nonprofit organizations and associations and the representatives of the economic sectors, as mentioned before, are either inadequate and ineffective, or not interested in environmental problems. These observations, if valid, severely limit the number of influential actors, emphasizing probable roles of intellectuals and academicians (universities) together with international organizations.

One rather important perception in order to activate environment protection and betterment policies is to generate a new type of interaction among governmental bodies itself. In other words, if we presume disparate government bodies as unconnected actors in relation with environmental issues scene, in particular national and regional setting of Egypt, proceeding by one or several of these bodies conceivably induce designing and implementation of more environment friendly economic and social policies.

As for the coming years, it will not be inaccurate to anticipate that both the number and influence of the actors of the environmental protection or sustainable development scene should increase. Economic and social development, educational improvements, achievements towards a more democratic society, etc. will naturally create and augment the actors of the environment scene, like municipalities, NGOs, etc. Specifically the framework of the prevailing liberalization policies will also and predictably induce various other actors, for example, private sector companies or sectoral associations to appear in a more influential stature. In other words, the prospective analysis of Matrouh region from an environmental point of view should surmise the alterations in actors composition and effectiveness.

The consequential expectation for the coming decades in Egypt and naturally in Matrouh region, which is closely related to the emerging sociopolitical tendencies, in addition to the rising levels of living and to the altered position of the individual in the society where he lives and functions, is the democratization of political process by which the public will of state will begin to be established.

This development increases the importance of the state, defined as the central government, and Matrouh Governorate as the representative of the central government in Matrouh region, as an actor, for it is the central organ for creation and coordination of public policies in both the national and regional communities in Egypt. In other words, only the state is in a position to initiate the emergence of more active and representative political parties, media and private organizations, together with increasing the amplitude and fostering the independence of local or sectional divisions of the government organization. And it is rather visible that the state in Egypt, more and more, is in the process of pronunciation of a desire in this direction. This observation is not paradoxical, for it is evident that an ever growing number of people in Egypt, specifically among the intellectuals academicians and more meaningfully within the government itself, is in the comprehension of the fact that, like in Western countries of the last century and in an increasing number of developing countries of our time, a stronger and more effective state which, unquestionably asserts itself as the final arbiter in the society, was and is the result of the accomplishment of political and economic liberalism.

The structure and system of the Egyptian society, together with the experiences of Western democracies and an increasing number of developing countries, on the other hand, clearly demonstrate that it is only on the instigation of the state and/or its compliance, and within the framework of its legislation and administration, the various private organizations which, undoubtedly are important manifestations of a more "organized" society, are conceded to function. Moreover, the state instigation and control, do not diminish, but attain the influence and increase the scope of action of these private organizations and more independent regional and local governments. In other words, it may not be erroneous to anticipate that in the coming decades, upon central government volition and policies, the increasing strength, number and activities of private organizations as well as the provincial and municipal self-governments in Egypt as a whole and, also in Matrouh region will illustrate the spreading out of participation, initiative and influence of larger sections of the people themselves in their various localities and occupations.

At this point, and from the viewpoint of above discussion, it might be accurate to emphasize that the idea of activating a new type of interaction among governmental bodies in order to generate more desirable environment protection and betterment policies, as mentioned before, also, and to a great extend, calls for central government initiative.

PART II

PROSPECTIVE APPROACH

CHAPTER I
THE FRAMEWORK FOR THE SCENARIOS

* * * * *

The Environmental Components

The analysis of the system of Northwestern Coast of Egypt and suppositions on prospects and expectations manifest that the environmental components and their order of vulnerability can be determined as follows.

i. Soil
ii. Water
iii. Flora and fauna
iv. The coast
v. The sea

The sectors of activity

Systemic analysis of the region clearly indicates that the sequence of importance of the sectors of activity can be established as follows:

i. Agriculture
ii. Tourism
iii. Trade, industry and energy
iv. Transportation
v. Building

It should, however, be noted that, prospectively this sequence of importance will change, even in the near future, as the present procession of development pattern persists, and, as the rise of per capita incomes will change the consumption patterns in line with applicable income elasticities of demand. In other words, in the study area, tourism and trade, will become more important sectors of activity than agriculture. Rapid development of tourism and trade, on the other hand, will, evidently, induce a more agile progression of transportation, building, energy and other infrastructure categories, and even small scale industry sectors.

In order to proceed with the prospective analysis for the study area, it may be convenient to develop three different prerequisite assumptions upon the relations and interactions between the sectors of activity and environmental components:

i. The economy and the society will function and develop without any environmental considerations.
ii. The economy and the society will consider the environmental damage and pollution and try to repair and reciprocate.

iii. The economy and the society will try to function and develop within a "sustainable development" approach and strategy.

The Dimensions

The major themes inside and outside the system on which different hypotheses will be conceived are:

i. Population
ii. National development strategies and policies
ii. The international economic and political context
iii.Land use management
iv. Environmental considerations

The Hypothesis

·The fundamental use of the scenarios would be to establish various relationships between today and the future of Matrouh region. Each scenario, on the other hand, should be build on a particular set of hypothesis on the above mentioned dimensions that make the sectors of activity and their impact on environmental components develop differently. Consequently there will be as many sets of hypotheses as scenarios. The hypotheses were actuated upon, both, results of the systemic analysis of both Egypt as a whole and Northwestern region, and expert opinion. The hypothesis on which we shall build the scenarios, on the other hand, were implemented in accordance with various preestablished rules, in other words, the primary purpose has been to try to establish: i. coherent; ii. realistic; iii. consistent; iv. applicable and v. sufficient hypothesis.

One set of hypotheses in order to develop the primary (reference) trend scenario (T1) can be itemized as follows:

i. On population
a. Rates of population growth and urbanization will continue in accordance with present trends, both in Egypt and in Northwestern Region ;
b. Employment problem will continue to amplify;
ii.On development and strategies
a. Liberalization and privatization strategies will cultivate;
b. Government of Egypt will increase its support to the private sector, notably for industrial and tourism development;
c. Government of Egypt will proceed to expand its infrastructure investments, particularly its efforts to create new sources of water;
d. The supply of water in the Northwest Region will increase as anticipated;
e.d. Government of Egypt, in spite of the pursuing
liberalization program, will try to proceed with its, particularly, social commitments and policies;
e. Relationships of central government and governorate administrations, in spite of the new liberalization policy, will, to a considerable extend, maintain its present structure,

f. The new liberalization and privatization policies, at any rate, will increasingly influence economic and social vitality and developments in the Region.

iii. On international economic and political context

a. Egypt's relations with the Arab world will continue to improve;

b. Egypt's present mode and structure of rapport with United States and certain European countries will perpetuate;

c. Similarly, undertakings of various foreign and international bodies aimed at infrastructure, economic, agricultural, and social development in Northwestern region will continue.

iv. On land use management

Loss of agricultural land to nonagricultural ends will prevail principally due to:

- Urban expansion
- Touristic establishments
- Small scale manufacturing

v. On environmental considerations

a. Economic and social policies will continue to suppress environmental considerations and environmental policies;

b. Stress on environment will ascend.

Hyphotesis for Other Trend Scenarios

Although the hypotheses for the reference (T1) trend scenario is based on the systemic analysis of both Egypt and Northwestern Coastal Region, and reasonable assumptions on expected developments and expectations for the future, it, evidently is plausible to formulate different sets of hypothesis that will actuate disparate trend scenarios. For example, a worse trend scenario (T2) can be formulated by introducing various new hypotheses, again, based on the systemic analysis and by altering some of the hypothesis of the (T1) scenario. Noticeable hypothesis for a worse trend scenario can be itemized as follows:

i. On population

a. Rates of population growth and urbanization will continue in accordance with present trends, both in Egypt and in Northwestern Coastal Region;

b. Employment problem will continue to amplify;

ii.On development and strategies

a. Liberalization and privatization strategies, in other words, the new economic policy will fail to produce anticipated results;

b. Government of Egypt will try to expand its drive towards increasing infrastructure investments, but, particularly efforts to create new sources of water do not evolve as expected and hoped for;

c. Government of Egypt, will try to proceed with its, social commitments and policies;

d. GNP growth rates will continue to remain at present lower levels and attempt to expand industrial production will not yield favorable outcome;

e. Relationships of central government and governorate administrations, will, maintain its present structure;

f. Domestic political disturbances, mainly due to acts of radical movements will increase.

iii. On international economic and political context

a. Egypt's relations with the Arab world, specifically with Libya will not upgrade as

anticipated;
b. Egypt's present mode and structure of rapport with United States and certain European countries, and, also with international organizations like IMF and World Bank will set back particularly due to comedown of liberalization and privatization policies;
c. Undertakings of various foreign and international bodies aimed at infrastructure, economic, agricultural, and social development in Northwestern region, albeit less enthusiastically, will continue.

iv. On land use management

Loss of agricultural land to nonagricultural ends will prevail principally due to:

- Urban expansion
- Touristic establishments
- Small scale manufacturing

v. On environmental considerations

a. Economic and social policies will continue to suppress environmental considerations and environmental policies;
b. Stress on environment will ascend.

The systemic and prospective analysis of both Egypt and Northwestern Coastal Region indicates that there are some considerable changes in various important trends. If the anticipated "favorable" developments, partly reflected in T1 scenario hypotheses are justified, it would be appropriate to think in terms of a more strong economic growth. (T3 scenario) Although the legislative and financial resources and technical means to undertake environmental protection are more easily available in a framework of the T3 scenario, it should be remembered that this kind of scenario, paradoxically, proves to be the most harmful for the Northwestern Coastal Region of Egypt. For,the kind of economic development described by this scenario shall be the one which demands the most resource consumption and creates the most pollution, because of high level of economic activities and, more importantly, delays in the application of measures which, in any event, aim at opposing the effects of resource exhaustion and pollution a posteriori, rather then preventing them. If this kind of development could be conjectured, it can be argued that the significance of alternative scenario exercises notably increase.

Alternative Scenarios

The objective of the alternative scenario(s) is to demonstrate the probable outcome of various deliberate (intentional, conscious, voluntary, etc.) acts (policies, guidelines, programs, conducts, etc.) upon the relations and interactions between economic development (progressions at the sectors of activity) and environmental components. In this sense disparate alternative scenarios can be drafted within the framework of previously delineated "prerequisite assumptions" (Paragraph:3). The third assumption which postulates that the economy and the society will try to function and develop within a "sustainable development" approach and strategy, can and will be the basis of the alternative scenario (A1) which shall try to demonstrate an alternative, namely, a more environment friendly, development pattern than the trend (T1) or a probable (T2) scenario for Northwestern Coastal Region of Egypt.

TABLE I : HYPOTHESIS FOR DEVELOPEMENT/ENVIRONMENT SCENARIOS FOR NORTHWESTERN COASTAL REGION OF EGYPT.

I.POPULATION DIMENSION

HYPOTHESIS	TREND SCENARIO	ALTERNATIVE SCENARIO
Population	Present growth trends will prevail both in Egypt and Matrouh.	Growth rates will reduce in accordance with Government policy. Higher growth rates in Matrouh.
Urbanization	Rapid growth of Matrouh City.	Slowed down of urbanization in Egypt as a whole. Rapid growth of Matrouh City continues.
Migration	Migration of both " investors and workers " from the Wadi continues.	Better administration practices fasten the migration rate.
Employment	Employment problem amplifies in Egypt. Better employment opportunities in Matrouh.	A more balanced employment structure in Matrouh. Active private sector.

HYPOTHESIS	TREND SCENARIO	ALTERNATIVE SCENARIO
Liberalization of the economy continues. Intensifying of privatization efforts.	Higher private sector activity in Matrouh Region. Slower tempo in rest of Egypt.	Higher private sector activity both in Egypt and Matrouh. Faster tempo.
Investments.	Rapid expansion in Matrouh.	Higher expansion rates in Matrouh.
Integration to world market.	Weak, but stronger relationships with the Arab world. Stronger relationship with Libya in Matrouh.	Stronger relationships with the Arab countries and the rest of the World.
Economic growth.	Sluggish. Rapid growth in Matrouh.	Faster growth rates. Fast economic growth in Matrouh.
Tourism.	Slower expansion of Arab and western tourism in Egypt. Growth of touristic villages continues in Matrouh.	Faster growth in all kinds of tourism. Expansion of foreign tourism. Integration of touristic villages to regional economy.

III. INTERNATIONAL, ECONOMICAL AND POLITICAL CONTEXT

HYPOTHESIS	TREND SCENARIO	ALTERNATIVE SCENARIO
Geopolitical situation	Uncertain and un reliable. Possible protectionist measures following new trade agreement. USA leadership continues.	Harmonious and agreeable. Liberalization, incurbed markets. International cooperation.
Egypt/Europe ties.	EC, still uninterested.	Accessible EC markets. Stronger relationships with Italy and France.
Middle East	Improving ties with Arab world.	Very good accord with Arab world. Full economic and plitical concord with Libya. Satisfied stability in Middme East.
International Organizations.	Present trends.	Better and improving relations with IMF, IBRD, etc. Improving cooperation in environmental matters.

IV. LAND USE MANAGEMENT

HYPOTHESIS	TREND SCENARIO	ALTERNATIVE SCENARIO
Institutional aspect.	Perpetuation of control and predominance of central government.	Improvement of local control and decision making. Advancement of private sector weight.
Land use patterns.	Predominance of current economic priorities.	Planning according to natural resource valuation practices. Preservation.
Protected zones.	Lack of interest. Underestimation of importance.	Expansion to preserve typical and unique natural resources.
Touristic villages.	Haphazard expansion. Loss of agricultural land. Loss of irreplaceable beaches.	Planned property allocation. Consideration for natural resource loss.
Regional planning	Incomprehension of actual meaning.	Better recognition. Implementation of proper framework for space management.
Landscape.	Not taken into consideration.	Landscape, specifically at the coast and limestone ridges, is considered as a resource.

V. ENVIRONMENTAL CONSIDERATIONS

HYPOTHESIS	TREND SCENARIO	ALTERNATIVE SCENARIO
Role of EEAA.	Limited responsibility and financial means. Very limited activity in Matrouh.	Full concern for northwest coast.
Role of central and regional governments.	Economic and social policies abrogate environmental considerations.	Importance of sustainable development fully conceived.
Natural resources management.	Short term production rise and profit making. Continuing loss of limestone ridges and sand beaches. Misallocation of land.	Rational and patrimonial resource management. Preservation of beaches and limestone ridges.
Quality of environments.	Comprehensive absence of awareness.	Ecological quality is fully valued. Efficient public participation. Active NGOs.

The breaking points

Even though it is justifiable to maintain that certain important turnabouts in the "dimensions" (namely, population, national economy, international relations, development strategies and environmental considerations) which were previously decided for the systemic analysis of Egypt and Matrouh, e.g., war and peace in the Middle East, petroleum price shocks of 1970's, initiation of the Infitah policy, etc., has induced certain major alterations in economic and social patterns of economic, social and political development in Egypt, the interesting and important observation that come forth during the analysis of trends indicate that the change and development in Matrouh region is rather gradual in comparison with Egypt as a whole. In other words, it is not easy to detect any breaking points in economic and social trends in the region which might have been caused by major changes and shifts in the said dimensions.

Even the ongoing and progressively strengthening structural adjustment policy, although implementing certain important repercussions on the development and change of economic and social life in the region, does not seem to impose any major shifts in the continuing trends beyond accelerating and fortifying them. Thus, it may be rather reasonable not to expect or assume any breakpoints for the prospective analysis of the region.

Introduction of the Scenarios

The scenarios will, mainly study the impact of agriculture, tourism and urbanization, which emerged as the most important sectors of activity, on the environment, specifically soil, water and the coast, which again emerge as the most vulnerable environmental components, both in Northwestern Coastal Region of Egypt. The aim of the prospective exercise (scenarios) is not to recommend certain types of development for the Region, but to illustrate their effect on the environment. The systemic and prospective analysis, on the other hand, almost clearly indicate that, in the Northwest Coastal Region, all conceived types of development are, primarily effected by population trends, urbanization, central government's choice of development/environment strategies, Egypt's international relations, particularly relations with Arab countries, and, naturally, regional constraints of space and natural resources.

CHAPTER II
TREND SCENARIO

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The scenarios will, mainly study the impact of sectors of activity, on the environment in northwestern coastal region of Egypt. The aim of the prospective exercise (scenarios) is not to recommend certain types of development for the region, but to illustrate their effect on the environment. The systemic and prospective analysis, on the other hand, almost clearly indicate that, in the northwest region, all conceived types of development are primarily effected by population trends, urbanization, central government's choice of development/environment strategies, Egypt's international relations, particularly relations with Libya and, naturally, regional constraints of space and natural resources.

The objective of the trend scenario (T1) is to demonstrate the probable outcome of impact of development in sectors of activity on specified environmental components, under the assumption of continuation of trends determined by the systemic and prospective analysis of the region and presented as "the hypothesis for the trend scenario."

First section of the T1 scenario is a general outlook of the region in 2025 from an environmental perspective, under trend hypothesis. Second section, on the other hand deals with three distinct environmental problems of the region and seek to establish their prospects in 2025.

Distinct environmental problems

The impact of various sectors of activity already initiates several explicit environmental problems in the region and it is rather coherent to anticipate an enlargement, both, at the repercussions of the sectors of activity and negative results created by environmental problems. Perceptively, the scenarios should, principally, seek to establish expected and eventual progressions in these problem areas.

The environmental problems created by the activities of economic sectors can be itemized, ranked and limited in compliance with their degrees of importance and priority (urgency). It may be reasonable to propose that the systemic and prospective analysis of the region suggests the following order:

1. Loss of natural vegetation
2. Active coastal erosion
3. Destruction of limestone ridges

Probability of T3 conditions

Although the hypothesis for the reference (T1) trend scenario is based on the systemic analysis of both Egypt and Northwestern Coastal Region, and reasonable assumptions on expected developments and expectations for the future, it, evidently is plausible to formulate different sets of hypothesis that will actuate disparate trend scenarios. For example, a worse trend scenario (T2) can be formulated by introducing various new hyphotesis.

The systemic and prospective analysis of northwest region indicates that some considerable changes in various important trends can be expected. In other words, it may be appropriate to think in terms of a more strong economic growth. (T3 scenario) Although the legislative and financial resources and technical means to undertake environmental protection are more easily available in a framework of the T3 scenario, it should be remembered that this kind of scenario, paradoxically, proves to be the most harmful for the environment. For, the kind of economic development described by this scenario shall be the one which demands the most resource consumption and creates the most pollution, because of high level of economic activities and, more importantly, delays in the application of measures which, in any event, aim at opposing the effects of resource exhaustion and pollution a posteriori, rather then preventing them. Furthermore, the present "structural adjustment policy" that aims to move Egypt towards a market oriented economy and initiate a extensive effort for the liberalization and privatization of the economy, perceptively anticipates less public involvement and more private initiative within the functioning of various sectors of activity. This kind of adjustment in turn, means depressing of social minded approaches of government policies, reducing public spending, attenuation of public planning efforts and a greater dependence on profit oriented investment and economic development. This unprecedented turnabout, which, already begins to demonstrate its initial consequences in northwest region together with the rest of Egypt, clearly indicates T3 scenario conditions for the coming decades. If this kind of development could be conjectured, it can be argued that the significance of alternative scenario exercises notably increase.

One important limitation that come forth during the study is the lack of systematic and methodical numerical and statistical information. Specifically in the Matrouh region, it is not possible to create numerical trends in almost each major economic and social variable. The methodological approach of the systemic and prospective analysis, on the other hand, do not approbate this circumstance as a crippling shortcoming and reiterate that both process of the constructing the system and creating the scenarios should continue by using all the means available.

Certain maps can be prepared to reveal some environmental problem areas more efficaciously, like active coastal erosion and destruction of limestone ridges, and also the location and amplitude of the designated nuclear power plant plot. The maps, due to the scope of environmental problems in the region, should concentrate on the area between El Alamein and Marsa Matrouh.

In 2025 northwestern part of Egypt will reveal an notably different setting and environment in almost all respects. In accordance with the assumptions actuated by an acceptance of continuation of major trends of 1990's, (T1 scenario hypothesis) some salient specifics of the region in 2025 may be registered as follows.

General perspective in Matrouh region and Marsa Matrouh city

OUTLOOK:

1. Population and Urbanization :

Resident population of northwest region of Egypt is almost 500 thousand people representing a two-fold increase in last thirty years since mid 1990's. Total summer population, on the other hand climbs to 980 thousand people,[94] putting an immense amount of pressure on all environmental resources and infrastructure.

Resident population of Matrouh City is 245 thousand people which represents a three-fold enlargement in the last 30 years. Now, 54 % of total resident population of the region lives in Matrouh City. In summer months this number increases to 325 thousand people.[95]

Geographical limits has been significantly expanded into the agricultural lands surrounding the city. Matrouh city, in this period, has witnessed a process of never-ending, even amplifying construction activities.

Continued and increased migration from the Wadi and the Delta in the last thirty years has changed the percentage distribution of population between the migrants and the native Bedouin in the region and, particularly in the Matrouh City, resulting a continual social change and a new social structure. In other words the social scene in the communities of the region, specifically in the capital city is still in flux.

Competition and relative deprivation has lead o an escalation in resultant ethnic-type conflicts and conflicts on land ownership , water use, etc. among the population.[96]

Land prices, specifically in and nearby Matrouh City and touristic villages areas are very high and increasing.

Traffic concentration and number of motor vehicles, specifically in and nearby Matrouh City and touristic villages areas in summer months, is very high and increasing.

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[94] The present capacity of touristic villages, including the ones under construction is 100 thousand people. Additional development and construction, on the other hand, is planned for 400 thousand people expanding the capacity to almost 500 thousand in early 2000's. see Ayyad, op.cit., p.V-6.

[95] It is projected that in 2010 the transient (summer) population of Matrouh City will be 63 thousand people. ibid, p. V-5.

[96] For a detailed analysis of conflicts in the northwest region and evaluation of future developments see: Sherbiny, Cole, Girgis, Investors and Workers.., op.cit., pp. 21-28.

2. Sectors of Activity :

Main dual highway of the region, that is an important section of the so-called Pan North-African Road connecting the countries of North Africa to the Middle East, and, which extends from Libyan border to Alexandria is in full thrust, establishing transportation as one of the most important economic activities in the Region.

Number of retail trading houses, together with petrol stations restaurants, coffee-houses, etc. are significantly high in Matrouh City, and also in other communities and along the main highway. There exist various wholesale trading and transportation companies and warehouses instigated by the significance of the highway.

Probably the most important sector of economic activity in the region is tourism. Although tourism is basically a second-house kind of activity and directed to Egyptians from the Wadi, number of hotels is also high. Construction of individual and cooperative second houses perpetuate. Share of foreign tourists is relatively small and principally are people from Arab countries.

Small scale industry, specifically in categories like auto-repairing, food, and construction is rather widespread and, also scattered in and around the city in an unplanned fashion.

Transportation and exportation of petroleum and natural gas from the Western Desert, in spite of very slight benefits to the economy of the region is, nowadays, an important national enterprise. This transportation and loading procedure of petroleum and natural gas by means of pipe-line systems and large scale port facilities, in addition to its polluting consequences, produce various environmental afflictions.

The nuclear power plant is in operation. A very considerable piece of environmentally and economically valuable coastal land between the Matrouh City and its environs on the west and concentration of touristic villages on the east is occupied by this institution.

3. Water Demand and Use :

In the last 30 years water use in the northwest region, west of New Ameriyah, experienced a three-fold increase in total water consumption. This enlargement is, mostly the result of increase in urban consumption. In other words, in spite of increased supply of the Nasr Canal and expansion of irrigated cropping the share of agricultural use in total water consumption has dropped. The additional supply has been provided, mainly by constantly added, mostly public, in some cases private desalination plants of generally sea water and to some extend brackish water. Supply is still behind ever increasing demand.

Supply and demand management is based on water requirements, which in turn, projected on growth forecasts of population urbanization and sectors of activity, rather on demand forecasts using alternative price assumptions. This method of estimating water requirements fails to take into account of the possibility of changing in water use technologies, the probable improvements in water use efficiency through appropriate pricing and the environmental consequences of the prevalent supply policy. Regulatory mechanisms for demand management, understandably, consist largely of restrictions on water use during shortages, specifically in summer months.

Water resource management and environmental management are not linked and are not conducted through an integrated policy approach. In none of the areas of water use and in sectors of activity environmental costs are not included in the price of water services. Magnitude of environmental impacts are not calculated, and as a result, water pricing from both the economic and the environmental point of view can be specified as acutely inadequate.

4. Pollution :

Although still a relatively unimportant environmental problem, air and noise pollution, as a repercussion of rapidly increasing number of motor vehicles and various manufacturing workshops and factories, is a disturbing awareness in Marsa Matrouh City. The immense amount of dust generating from the quarrying of limestone ridges, on the other hand, in addition to its extremely adverse effect on nearby vegetation, heavily increase air pollution both in touristic villages areas and Matrouh City.

Soil and underground water pollution is an important environmental problem. In the last thirty years, gradually increasing use of pesticides and insecticides both in agricultural sector, specifically in irrigated areas, and, also in urban areas notably in touristic villages for gardening reasons on the one hand, and improper modes of disposing of rapidly proliferating wastewater, containing increasing amounts of detergents and other chemicals on the other, are reasons behind pollution of initially vulnerable soils and ground water resources of northwest region. In other words, serious and continuing deterioration of groundwaters, still prompt a need for implementation of a strategy for water quality management. The present goal setting practices for quality of water resources is basically health-oriented in order to minimize the impacts of bacteria and chemicals contained in water, but not concerned with economic and ecological criteria.

A considerable amount of marine pollution exists, primarily due to i. transportation and loading of petroleum from the Western Desert; ii. harbor pollution from traffic, shipyards, and port facilities; iii. open and concealed discharge of wastewater from coastal establishments; iv. pollutants carried by the sea to regional coasts; v. off-shore oil exploration and exploitation. Discharges of the nuclear power plant also and heavily contribute to adversities that influence marine water quality.

Waste management is still one of the important environmental problems, both in Marsa Matrouh and also in other towns of the region. Ineffectiveness of collecting practices on one hand and, mode of disposal of municipal wastes on the other, pose inadequacies which seems to threaten valuable environmental and economic resources. Amount of glass, metals and specifically plastics is constantly rising in the composition of municipal wastes. Disposal practices are limited with landfill to dumping in quarries, and in some places to sea. Recycling is almost nonexistent.

SIGNIFICANCE:

Given the amount of available land and account of natural and environmental resources the northwest Egypt can be considered as a crowded even, over-populated region and, although at a slower pace, additional increase of population, mainly due to continuing migration, is expected in coming years. Growth in all sectors of activity, on the other hand are in par with trends in 1990's and, similarly urbanization patterns are also alike, resulting a well known, environmentally unfavorable setting of growth of industry and cities: difficulties in preparing and enforcing city plans due to rapid increases in population growth, specifically migration; rapid increase in scattered, unplanned, and polluting small industry and workshops; inadequate infrastructure -sewage network, waste management, roads and streets, in-city parks, parking spaces, etc. to meet the demands of rapid growth, mainly due to lack of sufficient technical planning and financial resources.

COMMENT :

Above indicated projections are, as stated before, are results of a T1 trend scenario. A T2 trend scenario, which assumes a faster economic growth may also be feasible for the research area, for, especially the emerging trends in 1990's imply a more favorable international atmosphere specifically among North African and Middle East Arab countries, intensifying migration to the region and accelerating growth rates in various sectors of activity due to progressive government investment specifically in land reclamation,infrastructure, tourism and agriculture together with rapidly increasing private investment. Under assumptions reflecting a faster economic growth, population, urbanization, water demand, pollution, etc. projections would, naturally appear higher and stronger.

Loss of natural vegetation

OUTLOOK:

Natural vegetation cover is dramatically reduced even exhausted due to continued expansion of (a) woodcutting, (b) extensive clearing of natural vegetation for rain-fed cultivation of wheat and barley, (c) expansion of intensive irrigated agricultural practices west of Burg El-Arab region together with the Nasr Canal.

Similarly, arid rangeland in the region is almost completely degraded, and lost its economic value due to continuous overgrazing, lack of proper rangeland management practices and unsuitable restoration approaches.

SIGNIFICANCE:

Loss of an innate and valuable economic natural resource and, considering the distinguishing characteristics of the region, perish of a rare environmental asset.

Destruction of limestone ridges

OUTLOOK:

A very large measure of Coastal Ridge, and Abu-Sir Ridge where the depression separating two ridges narrows and particularly the areas near to the main highway have, to a great extend, been exhausted, leaving behind ugly cavities of quarrying and excavation.

Haphazard and unplanned quarrying of limestone, successively including more of existing nine ridges continues due to ongoing, even increasing demand from the building sector, specifically in the Valley and the Delta.

SIGNIFICANCE:

Loss of a very distinctive and precious natural resource and environmental asset.

Breakdown of both the coastal and, ridges and depressions systems. Limitation of underground water accumulation. Intensifying land erosion.

Loss of an admirable landscape. Loss of environmental quality.

Air pollution, result of immense amounts of dust in the process of quarrying.

Active coastal erosion

OUTLOOK:

Due to active coastal erosion, in other words active movement and blackening of sand, specifically at touristic villages regions, and environs of Matrouh City, sand beaches are highly degraded and in many instances the sand cover is completely lost.

Active coastal erosion or blackening of the beaches was and still, is the direct consequence of large scale construction activities very near to the sea, together with the wind erosion which is an unavoidable repercussion of loss of natural vegetation, specifically dwarf fig orchards, again the ramification of unplanned, haphazard and unconcerned ouristic villages, touristic hotels and second houses construction activities.

It is now a common practice, even a small-time business to transport unspoiled sand from undamaged coastlines to cover blackened beaches in touristic villages areas and in hotel beaches.

SIGNIFICANCE:

Active coastal erosion means loss of a very rare, probably unique and irreplaceable sand beaches of Mediterranean coastal line of the region enclosing clear, colorful and shiny sands .

Irreplaceable loss of a unique and precious natural resource and environmental asset. Loss of an admirable landscape. Loss of environmental quality.

CHAPTER III
ALTERNATIVE SCENARIO

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The assumption which postulates that the economy and the society will try to function and develop within a "sustainable development" approach and strategy, will be the basis of the following alternative scenario (A1) exercises which shall try to demonstrate an alternative, namely, a more environment friendly, development pattern than the trend scenario (T1) for northwest region of Egypt.

Alternative scenario exercise will bear a similar construction with the trend scenario, that is, prospects of three distinct problems will follow a general outlook under a set of alternative hypothesis.

In 2025 northwestern part of Egypt will reveal an notably different setting and environment in almost all respects. In accordance with the assumptions actuated by an acceptance of a more environment friendly policy approach during the past 30 years, some salient specifics of the region in 2025 may be registered as follows.

General perspective in Matrouh region and Matrouh city

OUTLOOK:
1. Population and Urbanization :

Resident population of northwest region of Egypt is almost 500 thousand people representing a two-fold increase in last thirty years since mid 1990's. Total summer population, on the other hand climbs to 980 thousand people.

Due to increasing pressure on environmental resources and infrastructure, created by population increase and summertime activities certain environmental policies and measures are implemented by local governments and cooperation and collaboration of citizens and the business.

Resident population of Matrouh City is 245 thousand people which represents a three-fold enlargement in the last 30 years. Now, 54 % of total resident population of the region lives in Matrouh City. In summer months this number increases to 325 thousand people.

Although and unavoidably geographical limits has been significantly expanded into the agricultural lands surrounding the city, Matrouh city, in this period, has witnessed a process of planned and ordered development, emerging as a pleasant Mediterranean city.

The planned nature of development and continuous cooperation and involvement of the private citizens and the business smooths the frictions created by continued and increased migration which changed the percentage distribution of population between the migrants and the native Bedouin. Thus ethnic-type of conflicts are, to a considerable degree, prevented.

Land prices, specifically in and nearby Matrouh City and touristic villages areas are quite high. Similarly, traffic concentration and number of motor vehicles, specifically in and nearby Matrouh City and touristic villages areas in summer months, is high and increasing.

2. Sectors of Activity :

Main dual highway of the region, that is an important section of the Pan North-African Road connecting the countries of North Africa to the Middle East, and, which extends from Libyan border to Alexandria implemented transportation as one of the most important economic activities in the Region.

Number of retail trading houses, together with petrol stations restaurants, coffee-houses, etc. are significantly high in Matrouh City, and also in other communities and along the main highway. There exist various wholesale trading and transportation companies and warehouses instigated by the significance of the highway.

Probably the most important sector of economic activity in the region is tourism. Tourism, gradually changes its structure as a second-house kind of activity towards an international enterprise.

Number of hotels is high. Construction of individual and cooperative second houses slowed down and regional planning practices arefully implemented.

Share of foreign tourists is continuously rising.

Small scale industry, specifically in categories like auto-repairing, food, and construction is rather prevalent. Small and medium size industry, now is located in pre established and developed "industrial park" or "organized industrial estate of Marsa Matrouh" enjoying well developed infrastructure, and sharing a basic treatment facility so as to benefit from economies of scale in addition to better environmental management.

The authorities and the companies seek to minimize any environmental afflictions which is the result of transportation and loading procedure of petroleum and natural gas by means of pipe-line systems and large scale port facilities.

The nuclear power plant project is abandoned. (?)

3. Water Demand and Use :

In the last 30 years water use in the northwest region, west of New Ameriyah, experienced a three-fold increase in total water consumption. This enlargement is, mostly the result of increase in urban consumption. In other words, in spite of increased supply of the Nasr Canal and expansion of irrigated cropping the share of agricultural use in total water consumption has dropped.

The additional supply has been provided, mainly by constantly added, mostly public, in numerous cases private desalination plants of generally sea water and to some extend brackish water.

Although supply is still behind ever increasing demand, demand management of water services, now consist of a number of specific elements like total, sub-regional, sectoral and seasonal demand forecasting, water rights allocation, proper water services pricing, and, also regulatory mechanisms for managing demand, resulting a more effective water supply management.

Pricing of water and sewage services are now based on the user pays principle and are applied to water supplies and sewage services. The price of water covers the capital, operation, maintenance and environmental costs of providing water.

Water quality management, also is one of the important aspects of environment friendly strategy and policy approach and now, consist of various perceptions like goal setting, problem assessment by source, standards, pollution prevention, specific groundwater areas, in the region etc.

As a result, water quality goals and standards to preserve water resource quality are established by the water authority and sources of present and future contamination are identified. An information base for the comprehensive understanding of present and likely future water supply and quality problems has been established.

4. Pollution :

Air and noise pollution, is still a relatively unimportant problem due to convenient policy measures and, more importantly due to citizen cooperation. Termination of quarrying of limestone ridges, specifically near coastal areas, ended the dust problem generated by this activity.

A strategy for water quality management built around economic and ecological criteria together with health risk criteria, substantially contributes to the confinement of pollution of groundwater resources and, evidently, both soil and underground water pollution is gradually losing its significance as an important environmental problem, first due to increasing limitations in the use of pesticides and insecticides both in agricultural sector, and, also in touristic villages for gardening reasons. Similarly, elevation of proper modes of disposing of wastewater significantly contribute to prevention of soil and groundwater pollution.

For the completion of necessary wastewater treatment plants planning, identification of financial needs are accomplished. A small amount of marine pollution still exists, primarily due to harbor pollution from traffic, and pollutants carried by the sea to regional coasts. Other reasons of marine pollution are significantly eliminated due to decisive public policies.

SIGNIFICANCE :

Given the amount of available land and account of natural and environmental resources the northwest Egypt can be considered as a crowded even, over-populated region and, although at a rather slower pace, increase of population, mainly due to the continuing migration, is expected in coming years.

Growth in all sectors of activity, on the other hand are in par with trends in 1990's.

Urbanization patterns, on the other hand, are considerably changed via implementation of regional and city planning disciplines. The result is, naturally, a more friendly environmental setting.

COMMENT :

For alternative scenarios, due to developments and trends of 1990's which are suggested by the T scenarios, it does not seem feasible to assume slower population and urbanization growth rates. Similarly, a faster economic growth is also highly probable for the research area, for, especially the emerging trends in 1990's imply a more favorable international atmosphere, progressive government investment specifically in land reclamation,infrastructure, tourism and agriculture together with rapidly increasing private investment. Under assumptions reflecting a faster economic growth, population, urbanization, water demand, pollution, etc. projections would, naturally appear higher and stronger.

In this case, importance of alternative scenario exercises, reasonably increases, and alternative scenarios have to be developed, almost solely on better environmental management assumption.

Loss of natural vegetation

OUTLOOK:

Steps to preserve and, restore and develop the natural vegetation cover is in progress due to initiation of a long term strategy.

The policies established within this strategy and more importantly voluntary cooperation between the residents and the public authorities, resulted in prevention of indiscriminate woodcutting and overgrazing and control and hindering of adverse effects of mechanical removal and uprooting of woody plants together with plowing out the herbaceous species, and irrigated agriculture.

Similarly, arid rangeland in the Mediterranean coastal region is now dealt with, within the rules established by the long term strategic approaches. In other words, various policies are prepared and applied in harmony and compliance with the needs of the inhabitants and environmental concerns.

Within this context a cooperative system for grazing is established and an extensive program of range improvement, by propagation of multipurpose species, mainly native species, but also a number of carefully selected introduced (foreign to the region) drought resistant species, is in progress.

Moreover, demonstration pilot areas in order to protect and control grazing are established in each of the main habitats and biotic communities.

Various nature reserves are, also established.

SIGNIFICANCE:

Preservation and restoration of precious vegetation cover and flora and fauna of the region.

Continuation of agricultural activities and livestock production in accord with the natural resources provisions of the region.

Better socioeconomic and sociopolitical situation due to a desirable understanding and concord between inhabitants (tribes) themselves and between the people and the public authorities.

COMMENT:

Agricultural policies, specifically in the research area are, as a rule designed by the government authority. In other words, opinions or cooperation of the farmers (or rural population) are generally ignored. This observation is especially true for rangeland management policies. It should be noted that successful agricultural policies, are the ones that always seek and secure participation. Particularly, from a sustainable development point of view this kind of participation and cooperation should be the basis of government undertakings in dealing with this specific environmental problem in the region.

Destruction of limestone ridges

OUTLOOK:

A considerable amount of limestone ridges are saved, protected and conserved, basically due to a more rational and patrimonial environmental resource management policy and practice of both central and provincial state authority.

Dimensions and magnitude of limestone formations are measured. Regions accommodating this unrenewable resource are mapped. Size of past damage is carefully estimated and valued in accordance with proper pricing principles, i.e. within a cost-benefit analysis application.

SIGNIFICANCE:

Preservation of a very distinctive and precious natural resource an environmental asses, an admirable landscape and the environmental quality.

COMMENT:

If the authorities continue to appraise the limestone formations as an economic and necessary input for the building sector, the mining of this unrenewable resource should be conducted within the limits of a careful environmental resource-use planning application, based on sustainable development principle.

Similarly, if inevitable, limestone mining should, strictly be conducted in accordance with economic, i.e. user pays principle, tied to proper market prices.

Active coastal erosion

OUTLOOK:

Coastal erosion, in other words active movement and blackening of sand of the beaches has, to a great extent, been stopped, mainly due to the understanding and efforts of the private citizens and local private and government administrators, since the 1990's. Environmental planning and corresponding of construction activities to plans and rules, together with measures in order to diminish wind erosion produced the fortunate result.

SIGNIFICANCE:

Active coastal erosion means loss of very rare, probably unique and irreplaceable sand beaches of Mediterranean coastal line of the region enclosing clear, colorful and shiny sands.

Irreplaceable loss of a unique and precious natural resource and environmental asset. Loss of an admirable landscape. Loss of environmental quality.

COMMENT:

The process of saving and preservation of sand beaches is a good example of public awareness and participation in defining, comprehending and solving an environmental problem. It also represents a fruitful cooperation between private citizens, technicians and public bodies.

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ANNEX V

FINAL REPORT OF THE SOIL DEGRADATION AND DESERTIFICATION ACTIVITY

UNEP

UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

MAP

PRIORITY
ACTIONS
PROGRAMME

FINAL REPORT

Prepared by:
University of Alexandria - Faculty of Agriculture
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Priority Actions Programme
Regional Activity Centre
Alexandria, January 1996

University of Alexandria
Faculty of Agriculture
Department of Soil and Water Sciences
Alexandria, Egypt

FINAL REPORT

Activity Title :

Soil Degradation and Desertification, CAMP.
The Area of Fuka-Egypt.

Subcontract : 55/PAP/94

Date : January, 1995.

Project Staff :

National team :

Team leader : Prof. Dr. Fawzy Abdel-Kader
Team staff : Dr. Mohamed Bahnassy
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Dr. Abdel-Aziz El-Menshawy
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TABLE OF CONTENTS

APPENDICES

1. INTRODUCTION

The Governmet of Egypt and the Mediterranean Action Plan (MAP) signed in 1992 an agreement on the implementation of the Coastal Area Management Programme for the Area of Fuka-Egypt. The Priority Actions Programme (PAP) of MAP is implementing a number of activities within that programme. "Soil Erosion and Degradation" is one of these activities.

Soil erosion is strongly emphasized as the most emerging constraint to agricultural development on "Soil erosion and desertification" of the "Agreement relative to the Coastal Area Management programme for the coastal area of Fuka-Matrouh (Egypt)". Actually, the project area, as it happens for the majority of arid environments, is very fragile for the convergence of numerous and strong environmental limitations; some of them are concerned with soils.

The results of the first exploratory meeting (3/4/1993 to 4/4/1993) concluded that a general process of soil degradation is present and active in the project area. The most outstanding aspects are: water and wind erosion, excess of salts, physical degradation, formation of cemented soil horizons, biological degradation. These characteristics represent different levels of danger, from risks of degradation to real constraints to agricultural and animal husbandry development.

The main long-term objectve to be achieved during the two year activities of the project is the necessary knowledge to prevent the agricultural loss and degradation. The Soil Survey of representative areas will allow to ascertain the variability of soil constraints and other soil characteristcs and qualities in the landscape.

The proposed scheme of the present work try to consider all the soilscapes from single water basins to the project area as a whole chosen :

a) Three typical areas 100 km2 in area, will be studied by aereophotointerpretation. These study area will represent the environmental situation of the coastal plain, of the agricultural land and of the upland grazing land.

b) A soil survey at the level of semi-detailed scale (1:25.000) will be realized to obtain basic maps. Chemical and physical analysis will characterize the soils, taking into account soil characteristics and qualies involved in the main constraints of the study areas.

c) The data obtained during the phase (b) will represent the input for the elaboration of maps of risks of soil degradation relative to erosion, physical and chemical degradation, soil salinization.

d) The transfer of the results to the complete study area will be performed by using the Geographical Information System.

2. AREA STUDIED

Two pilot zones in the area of Fuka which are by their physical characteristics representative of a larger part of the Fuka area were identified (Appendix 4, map 1) :

Wadi Qassaba :

Wadi Qasaba is located at 26 km east of Matrouh, which is typical for wadi bottom agricultural use, and for soil conservation and water harvesting practices by stone dams across the stream. It covers an area of approx. 5300 ha. within the bounadary coordinates 31 05 00 - 31 12 30 N and 27 20 15 - 27 30 16 E. The area is bounded to the north by the Mediterranean Sea, on the south by contour 160 m.(A.S.L), on the west by Wadi El-Haraka, and on the east by 27 30 16 E longitude. The elevation ranges from sea level to 160 m. (A.S.L) in the south.

Fuka Basin :

Fuka Basin is located at 80 km east of Marsa Matrouh, which stretches over an area of 17,000 ha and contains three distinctive geographical units: the lower coastal plain, the upper coastal plain, and the table land. It lies approx. between 30 30 00 - and 31 07 30 N, and 27 30 00 - 28 05 00 E. The area is bounde to the north by the Mediterranean Sea, on the west and south by contour 130 m.(A.S.L.), and on the east by 28 05 00 E longitude. Land elevation ranges from sea level to 130 m. (A.S.L) to the south.

3. METHODOLOGY

3.1. Training on Aerial Photo Interpretation :

Date	: 11-25 March 1995
Location	: Matrouh
Local personal	: Dr. Ashraf Moustafa
	: Dr. Abdel Aziz El-Menshawi
	: Eng. Alaa Abd El-Monaem
	: Eng. Wahid Mahmoud
International Expert	
	: Dr. S. Carnicelli
	: Dr. P. Martens
	: Dr. U. Galligani

Materials :

Topographic maps at scale 1 : 25000 and 1 : 50000 , aerial photographs 1954,1977, existing soil and land use studies, geologic and geomorphologic maps and reports.

Schudel :

11/3 Travel to Matrouh and setting up of materials.

12/3 Introduction to soil survey, soil classification using key of soil taxanomy (1994) and land degradation studies. Introduction to areial photo reading and interpretation.

13/3 Field trip to wadi Qassaba sample area and comparing between the areial photo features with actual geomorphic units.

14/3 Field trip to Fuka sample area and did same as above.

15/3 Presentation of the preliminary API legend.

16/3 Field check of API legend in Wadi Qassaba sample area and description of some augers samples.

17/3 Aerial photo interpretation of Wadi Qassaba area.

18/3 Field trip to Wadi Qassaba area.

19/3 Final map and legend of Wadi Qassaba area.

20/3 Soil profile description and sampling from the Wadi Qassaba area.
21/3 Aeria photo interpretation of Fuka sample area.
22/3 Field trip to Fuka area and description of some auger samples.
23/3 Soil profile description and sampling from Fuka area.
24/3 Back to Alexandria
25/3 Debriefing, Dept. of Soil and Water Science, Alex.

3.2. Field and Lab Work :

Through July-October 1995, field and laboratory work were carried out to characterize the main soil units of Qassaba and Fuka sample areas. Fifty one soil profiles and fifteen augerholes were described. The soil description was complied according to guidelines suggested by FAO (1990). The following soil horizon characteristics were studied: depth; horizon type and thickness; dry Munsell color; horizon boundary; texture; rock fragments; structure; presence of pans; concretions and effloresence; and root abundance and distribution. Moreover, the following site characteristics were described : elevation , slope , aspect , natural vegetation , parent material; rockiness; stoniness; erosion; surface charcteristics; and ground water depth. Each soil horizon was sampled for laboratory analysis. In the laboratory, pH and electrical conductivity of saturation extracts were measured. Moreover, the soil texture, total calcium carbonate, soluble calcium, magnesium, sodium,potassium, chloride, sulphate, carbonate and bicarbonate ions were determined. In addition to the above, organic carbon content and grain size distribution were determined in surface samples (Page *et al.*, 1982).

Field data and laboratory analysis allowed the classification of soils in conformity with the Keys to Soil Taxonomy (Soil Survey Staff, 1992).

3.3. GIS spatial analysis :

Topographic and geomorphological maps of Fuka and Qassaba were digitized that included the following features : a) contours , b) roads: rail, road and tracks, c) wadi coarse, d) agricultural land, e) well locations used and unused , f) houses , and g) spot-hights.

Topographic feature contour was used to geneate Digital Elevation Model (DEM). The DEM was used to generate Slope and Aspect maps. The areas of the geomorphological units were obtained after processing the vector area theme of the geomorphology units. Cross table operation was applied to the geomorphology map with DEM, Slope, and Aspect maps to determine the topographic characteristics of each mapping unit. The geomorphology maps were reclassified using the soil attribute of each mapping unit to get the soil classification map.

3.4. Climatic data collection and analysis :

The historic rainfall distribution and the climatic conditions were evaluated using the existing climate data from the station at the Mersa Matrouh airport some 60 km from the test area (FAO, 1970 and Abdel-Kader, 1995). For more comprehensive assessment of rainfall and wind conditions the data of the fully automated climate station of Wadi Nagamish area east of Matrouh, 30 km from the Qassaba area was used (Abdel-Kader, 1995). The fully automated climate station measures rainfall intensity, air and soil temperature, air humidity, wind speed, wind direction and global radiation. Analysis of climate data followed the methods of Skidmore (1965), FAO (1978) and Morgan (1995).

3.5. Assessement of Soil Degradation Types :

3.5.1. Water erosion :

Factors of the Universal Soil Loss Equation (USLE) (Wischmeier and Smith (1978) were considerd :

$$A = R\,K\,L\,S\,C\,P$$

where ; A is the soil loss in t/a/a
R is rainfall erosion index
K is soil erodibility factor
L is length of slope combined into LS factor
S is % slope combined into LS factor
C is cropping management factor
P is erosion control practice factor

Calculatoin of Rainfall erosion index "R", Soil erodibility factor "K", Length and Percent Slope Factor "LS", are given in Appendix 3.

3.5.2. Wind erosoin :

Wind erosion forces : Direction and relative magnitudes of wind erosion forces for 1994/95 season were calculated according to Skidmore (1965). The wind erosivity "C" was calculated according to FAO (1978) (Appendix 3).

4. RESULTS AND DISCUSSION

4.1. Geomorphological Units :

Tables (1 and 2) show the output of the photo interpretation and the field work carried out through the training coarse.

With regard to the stratigraphic sequence of the layered rocks, Shata (1955) and El-Shazly and Shata (1969) indicate that the major geomorphic units in the area of the study area are :

1. The Coastal Plain dominated by Pleistocene formations covered by more recent deposits.
2. The Libyan plateau, formed of Miocene rocks with two distinct horizons; an upper component of middle Miocene age, composed of shallow water marine limestone, and lower horizon of lower Miocene age represented by fossiliferous limestone and marls.

In the following is a breif descraptoin of the geomorphological units and subunits in the studied areas (See Appendices 1 & 2). The geomorphological units comprise the following features :

1. The Coastal Plain.
2. The Northern Plateau (degraded plateau).
3. The Southern Plateau.

4.1.1. The Coastal Plain:

This coastal plain runs almost parallel to the present Mediterranean coast. It trends in an east-west direction and has a width from north to south of about 8 km., diminishing gradually westward. The plain displays all signs of a typical emergent coast and is bounded on the southern side by a low "sea cliff" of Miocene rocks. The landscape in the coastal plain is affected by a number of elongated ridges which form gentle sweeping curves running sub-parallel to the present Mediterranean coast. These ridges are built of cross-bedded oolitic limestone and are comparable to the local modern oolitic sands of the Mediterranean beaches of that area.

Several ridges are discernable and are separated by successive shallow depressions. The coastal plain of Matruh Fuka area is charactrised with the following geomorphological units :

1. Coastal Ridges.
1. Lagoons.
1. Depressions (interridges).
1. Wadi system.

4.1.1.1. Coastal ridges :

These ridges have an average elevation of +10 m.; in some places, it rises to +20m. due to the local accumulations of modern dune oolitic sands. Remnants of these ridges are noted in the off-shore area, and this is obviously due to erosion by subsequent high sea level as well as the effects of the northerly currents. This process of erosion has tended to obscure some parts of the foreshore ridge in both localities and as a result, remnants of these ridges occurring in the form of isolated islands are left stranded above the present sea level. Due to its clearly younger age and lower diagenesis development, the first foreshore ridge has been indicated in this work as "Coastal dune".

4.1.1.2. Lagoons :

Between the foreshore ridges, there is a conspicuous topographical depression, often containing a shore lagoon. This lagoon is rather shallow and has a width from north to south of about 0.5km. It has an elevation rarely exceeding 5m. above sea level, although in some localities it is about sea level. The lagoon is well defined in the eastern portion of the area and is occupied by a series of salt lakes, these sites are gradually evolving into marshy land dominated by salt tolerant plants. In Wadi Qassaba area , parts of this land are elevated enough to be relatively free of salts and water tables.

Table 1 : Geomorphological units and subunits of Qassaba area.
(API of 1:25000, 1970 maps)

Unit	Subunits
1. Coastal Dunes	1. Coastal Dunes
2. Coastal Lagoon	2. Salt march with high water table
	3. Higher land without water table above 1m
3. Ridges	4. Ridges
4. Inter Ridges	5. Hummocky deep land
	6. Harvesed sand plain
	7. Eroded hill
	8. Depressions
5. Dissected plateau	9. Roiling land
	10. Rocky hill
	11. Foot slope
	12. inter hill land
	13. Complex
6. Southern Plateau	14. Stony plateau
	15. Hummocky shallow depressions
	16. Accum. in drains
7. Wadi system	17. Wadi course
	18. Wadi Terraces
	19. Alluvial fan
	20. Short wadies

Table 2: Geomorphological units and subunits of Fuka area.
(API of 1:50000, 1954 maps)

Unit	Subunits
Dunes and ridges	1 . Coastal dunes
	2 . Ridges
	3. Low, smooth ridges
Depression	4 . Intra-ridge depressions
	5 . Coastward depressions
	6 . Hummocky land
Plain	7 . Alluvial plain
	8 . Harvested sand plain
	9 . Fine-textured alluvial plain
Dissected plateau	10 . Low dissected plateau
	11 . High dissected plateau
	12 . Escarpment
Plateau	13 . Stony plateau
	14 . Depressions in plateau
Wadi system	15 . Wadi course
	16 . Alluvial fans

4.1.1.3. Depressions (interridges) :

The topographical depressions located between the coastal ridges are well defined to the east of Matruh and have width of about 1 km. They are occupied by yellowish brown thickness of more than 4m. This formation may be caused by intensive water erosion caused by a number of intermittent streams which drain the tableland area. These erosional depressions take occasionally take the shape of sub-isolated depressions, locally known as "Ibbat" and are partly filled with alluvial deposits where spare cultivation is witnessed. In places, particularly in Fuka basin, sedimentation within such depressions gets a significant contribution from wind deposition: these areas show the typical "hummocky" surface aspect and are characterized by quite coarse-textured soils. When the thickness of sediments are deep, they are cultivated with figs and olives. Within this depressions, cisterns are not uncommon and water wells are numerous. In recent years, adoption of flood and sediment control practices has increased water sedimentation in theses areas.

4.1.1.4. Wadi system :

The stream channels of the wadi system are recognized in coastal plain area. Some of them are intermittent with narrow captures while the others are continuous. They are filled with calcareous loamy soil derived from the northern calcareous plateau. The terminiis of wadi courses are principally occupied by loamy deposits which are mostly divided into the alluvial fans of numerous streams draining the tableland area as well as the lake-like dominating the northern portion of the coastal plain. Locally, these loamy deposits were characterized by the development of a limestone crust which is found either exposed or covered partly by thin mantle of such deposits. The loamy deposits are excavated in a later stage as the result of a degradation phase resulting from the lowering of the Mediterranean sea. The result of this process of excavation is the occurrence of "matched terraces" remaining both sides of the wadi coarse. These are occupied by wadi fillings composed of well worn cobbles and gravels with fine sand and silt. Concerning sediments in the wadi bottoms and alluvial fans, a well defined trend appears to exist in agreement with the size (length, watershed area) of the wadis, sediment and soil particle size being coarser in larger wadis.

4.1.2. The Northern Plateau :

The northern plateau constitutes a portion of the arid and sub-arid belt which dominates the southern Mediterranean region where the annual rainfall rarely exceeds 150 mm. It has an elevation varying between 80 and 200m. and occupies the northern extremity of the "Marmarican Homoclinal Plateau" extending many kilometers to the southern plateau. The plateau is characterized by three steps variying in the elevation between 80-120 m. (zone 1), 120-150 m.(zone 2), and 150-200 m. These steps each have different land-scape features due to differences in the erosion and accumulation processes. The Northern Plateau of Matruh is distinguished into the following main geomorphological units :

1. Escarpment and foot slope.
2. Dissected Plateau.

4.1.2.1. Escarpment and foot slope :

The northern plateau is separated from the coastal plain by the escarpment facing north and oriented mostly in an east-west direction. A little farther to the west, it makes a rapid swing in the north-west direction. This cliff, originally developed by marine erosion and probably by some local structures, marks the location of the Mediterranean Sea in Pliocene times. According to Shata(1957), this escarpment is "presumably fault determined and represents a sharp line of demarcation between two contrasing morphological and ecological steps of the Libyan plateau". In Fuka area, existence of north-south fault lines, that have lowered the basin, has caused a specific shape of the escrpment ; in the area where these faults have been active, the western border of the basin, a stepped escarpment has resulted, with an upper step showing a different dissection pattern. Escarpment landscape has been subdivided according to dissection pattern and relative position on the slope sequence.

4.1.2.2. Dissected Plateau :

The surface of the northern plateau is essentially occupied by calcareous stones of medium hardness belonging to the Tertiary and Quanternary Eras. This stones exhibit a continuum of sizes ranging from gravels to cobbles. The shape of these stones is related to the degree of weathering of the Miocene limestone and cardium limestone of Pleistocene age. Stones are either exposed or covered with a thin layer of mixed deposits of calcareous sands and soft loam. This surface is characterized by the occurrence of shallow topographical depressions where the water of some drainage lines accumulated to form short lived fresh water lakes whereby continuous deposition of fine homogenous material of sandy loam took place. Although the deposits of these two localities may look suitable for cultivation, the water balance tends to be unfavourable. Also, higher soil thickness is found in areas of more intensive wind deposition, giving rise to shallow hummocky lands.

4.1.3. The Southern Plateau :

The southern plateau has an elevation varying between 180 and 220m. above the present sea level and extends many kilometers to Quattara depression. The plateau is divided into the following main geomorphological units :

1. Stony plateau.
2. Shallow deprssions.

4.1.3.1. Stony Plateau :

The surface of the southern plateau is predominantly occupied by calcareous rocks composed of alternating beds of limestones and clays with occasional sandstones. The surface of this tableland is not very rough and has thus developed into a typical hamada type of desert. Local isolated outliers, "Madara", are common to the surface of this area.

4.1.3.2. Shallow deprssions :

This type of deposits is a result of shallow sediments covering the tableland surface during Pleistone times which were then subjected to severe erosion particularly during the holocene. Depression sediments are characterized by rock fragments in a matrix of brown loam.

4.2. Soil Units :

4.2.1. Soil units of Wadi El-Qassaba :

According to the morphological features, see Appendix (1), and the physical and chemical properties tables, the soils of Wadi El Qassaba were classified into Entisols and Aridisols orders.

4.2.1.1. Entisols : Two great group were identified :

4.2.1.1.a. Xeropsamments :

Xeropsamments dominated in the wadi system, in coastal lagoons and the dissected plateau (Table 3). The soils have A/C profile (profiles 2, 3, 9, 13, 19, 27 and 28). They are characterized by sandy or loamy sandy texture to a depth of 1m., the absence of diagnostic horizons and are never saturated with water. The pH value ranged from 7.4 to 8 and EC ranged from 0.27 to 64 dS/m. The Total $CaCO_3$ varied from 4.9 to 23 % (Table 2).

4.2.1.1.b. Xerothents :

Xerorthents dominated the lateral branches of the wadi system and the short wadis, and were also present in the dissected plateau and inter ridges (Table 3). The Soils represented by profiles (l, 5, 7, 8, 11, 15, 16 18, 22 and 25) have an ochric epipedon, loamy sand, sandy loam or sandy clay loam texture below a depth 25cm and are not permanently saturated with water. The pH value ranged from 7.2 to 8.3, the electrical conductivity ranged between 0.28 and 12.6 ds/m. The total $CaCO_3$ ranged from 8.9 to 29.8%. The sand ranged between 44% to 90%, and clay content varied between 6 to 32% (Tables 4, 5 and 6).

Table 3. Qassaba land units and soil units.

Main Geomorphological Units	Land Units	Soil Units	Profile N.
Coastal dunes	1. Coastal dunes	-	-
Coastal lagoon	2. Salt marsh 3. Higher land	Calcic Aquisalids Typic Xeropsamments	29 28
Ridges	4. Ridges	-	-
Inter Ridges	5. Hummocky deep land 6. Harvested sand plain 7. Eroded hills 8. Depressions	Xeric Petrocalcids - - Xeric Haplocalcids Xeric Petrocalcids Typic Xerorthents Typic Xerorthents -	4,6 - - 26 24 1 25 A11
Dissected Plateau	9. Rolling Land 10. Rocky hills 11. Footslopes 12. Interhill Land 13. Complex	- - Typic Xeropsamments Typic Haplosalids Typic Xerorthents Xeric Haplocalcids Typic Xerorthents	- - 9 17 8,16,18 21 15
Plateau	14. Rocky plateau 15. Hummocky shallow land 16. Accumulations in drains	Xeric Petrocalcids Xeric Petrocalcids Xeric Petrocalcids	10,20 14 12
Wadi system	17. Wadi course 18. Wadi terraces 19. Old alluvial fans 19.1- All. fans in short Wadies 20. Short Wadies	Typic Xeropsamments Typic Xerorthents Typic Xeropsamments Typic Xerorthents Typic Xerorthents Xeric Haplocalcids	2,3,13,19 11,7 27 22 5 23

Table 4. Grain size analysis Of Qassaba soil samples (Dry sieving).

Prof. No.	Depth	Weight >2mm %	Weight <2mm %	2 - 1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1* mm %
1	0-20	25.35	74.65	4.40	11.50	18.70	23.22	29.45	13.25	57.5
	30-50	32.13	67.87	6.60	17.588	21.62	17.88	27.34	8.82	
	50-70	55.42	44.58	6.15	15.22	21.01	34.64	16.41	6.21	
	70-100	39.74	60.26	3.43	10.27	31.19	34.89	15.62	4.50	
2	0-30	15.13	84.87	4.93	13.45	22.12	33.05	19.00	6.61	61.1
	30-60	35.49	64.51	3.07	12.41	37.29	24.89	17.41	4.55	
	60-110	32.76	67.24	3.08	10.43	30.70	30.19	20.43	4.79	
3	0-20	4.25	95.75	0.44	2.14	4.85	19.08	62.62	10.50	8.2
	20-60	18.18	81.82	1.39	4.69	8.39	14.48	59.61	11.28	
	60-100	22.34	77.66	1.42	5.08	12.10	30.69	39.94	10.25	
4	0-30	39.29	60.71	5.79	14.87	14.42	37.03	24.51	3.24	56.6
	30-65	48.72	51.28	8.48	21.25	20.07	18.86	26.13	4.75	
5	0-15	13.15	86.85	2.22	7.12	11.14	18.72	50.7	10.39	29.2
	15-35	55.06	44.94	7.34	23.23	20.50	16.96	21.14	10.37	
	35-65	52.58	47.42	16.39	28.31	17.89	13.54	18.57	4.74	
6	0-30	39.01	60.99	8.58	21.84	17.18	25.74	22.31	3.39	56.2
	30-70	53.38	46.62	8.28	19.34	16.84	16.79	27.23	10.50	
7	0-20	19.75	80.25	2.59	9.91	7.72	9.94	51.91	17.33	32.8
	20-55	43.27	56.73	11.5	27.66	17.41	13.31	19.83	9.37	
	55-100	42.10	57.90	12.41	28.15	20.01	15.40	13.95	9.51	
8	0-25	21.16	78.84	2.07	9.14	10.11	15.92	48.86	13.44	34.1
	25-60	48.10	51.90	6.48	18.61	15.18	15.86	25.88	17.10	
	60-90	59.26	40.74	7.58	20.59	15.78	17.11	27.44	10.81	
9	0-15	20.12	79.88	1.77	7.73	7.62	12.46	52.81	17.85	24.8
	15-55	35.63	64.37	4.45	13.78	10.55	22.27	35.85	12.80	
	55-100	26.76	73.24	3.47	9.57	7.99	32.52	36.18	9.36	
10	0-20	29.25	70.75	5.15	16.17	12.91	33.43	24.99	6.54	47.5
	20-45	55.38	44.62	10.35	22.78	16.84	21.32	22.99	4.69	

* Untreated soil samples.

Table 4. Continued.

Prof. No.	Depth	Weight >2mm %	Weight <2mm %	2-1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1 mm %
11	0-15	24.68	75.32	3.68	10.88	11.72	46.86	23.15	3.19	40.7
	15-50	27.49	72.51	3.83	11.47	10.65	30.86	33.30	8.96	
	50-80	49.31	50.69	16.89	27.82	17.02	12.95	17.36	6.40	
12	0-30	33.15	66.85	5.65	17.39	14.19	41.82	17.18	3.64	50.7
13	0-30	11.67	88.33	0.79	5.41	20.76	43.93	24.58	4.52	9.9
	30-60	10.56	89.44	0.80	4.04	19.14	59.02	14.19	2.08	
	60-100	9.21	90.79	0.77	4.41	28.86	44.36	17.93	3.37	
14	0-30	47.45	52.55	6.45	16.38	22.08	38.66	13.80	2.15	45.8
15	0-10	27.95	72.05	2.19	9.05	8.35	32.06	37.37	11.31	29.0
	10-40	41.64	58.36	6.92	15.60	12.8	20.77	37.74	6.17	
	40-65	76.25	23.75	8.46	19.77	16.23	16.14	26.07	12.47	
16	0-30	20.52	79.48	2.18	9.67	9.90	15.60	52.88	9.75	25.8
	30-65	49.68	50.32	8.76	24.14	18.74	16.49	22.67	8.35	
	65-95	48.75	51.25	10.26	23.99	17.52	17.99	6.43	20.68	
17	0-15	29.34	70.66	5.88	17.69	13.29	17.82	40.45	4.90	45.0
	15-55	38.36	61.64	7.31	22.16	18.32	16.67	28.11	7.32	
	55-100	42.19	57.81	14.64	27.95	23.67	21.44	9.35	2.90	
18	0-30	29.56	70.44	5.53	11.97	15.99	24.05	31.49	10.61	39.2
	30-70	46.99	53.01	6.73	17.56	16.40	18.45	32.63	8.01	
	70-100	37.96	62.04	4.75	12.80	19.81	24.64	29.66	7.57	
19	0-5 W.S			0.00	0.18	28.61	66.39	3.57	0.99	14.2
	0-20	10.00	90.00	0.41	2.40	11.05	42.94	34.9	8.89	
	20-50	33.02	66.98	1.43	16.86	50.78	24.01	4.51	2.11	
	50-90	12.31	87.69	1.06	9.60	35.18	32.53	16.70	4.92	
20	0-25	27.79	72.21	2.46	10.68	24.13	35.99	22.97	4.64	35.6
	25-50	52.93	47.07	6.80	18.22	21.79	20.83	23.69	8.43	
21	0-30	23.46	76.54	3.85	14.29	12.86	16.73	46.80	4.87	47.7
	30-65	37.32	62.68	10.16	25.12	19.58	19.65	19.44	5.33	
	65-110	63.76	36.24	10.94	21.22	15.56	19.65	24.54	7.43	

Table 4. Continued.

Prof. No.	Depth	Weight >2mm %	Weight <2mm %	2-1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1 mm %
22	0-20	35.00	65.00	10.10	27.04	17.31	19.97	21.96	2.76	60.0
	20-60	38.29	61.71	16.25	32.31	18.17	13.11	16.26	3.52	
	60-90	49.89	50.10	13.44	32.00	22.31	14.74	11.77	5.44	
	90-110	43.64	56.36	12.61	28.29	21.61	17.67	14.14	5.30	
23	0-25	23.23	76.77	6.11	16.31	15.20	31.30	26.58	4.57	32.1
	25-60	48.23	51.77	10.52	24.96	20.08	21.68	18.24	4.29	
	60-85	64.52	35.48	11.29	27.07	24.93	18.38	12.14	5.04	
24	0-15	26.93	73.07	6.45	14.36	17.34	21.91	34.48	6.41	44.6
	15-35	54.26	45.74	11.34	24.16	21.51	20.10	19.10	4.10	
	35-55	85.88	14.12	9.50	18.18	24.34	26.89	15.99	4.11	
25	0-25	32.35	67.65	4.73	15.13	19.66	28.73	27.60	3.59	45.0
	25-60	39.47	60.53	9.09	25.04	19.04	16.98	22.64	6.87	
	60-90	48.65	51.35	11.09	24.52	19.53	18.03	20.30	6.45	
26	0-15	30.98	69.02	4.95	14.52	17.96	17.58	38.55	6.09	47.0
	15-60	42.93	57.07	11.40	29.28	22.73	18.36	14.52	3.56	
	60-100	50.35	45.65	16.22	29.03	22.94	17.28	10.15	3.46	
27	0-15	21.09	78.91	3.60	10.20	29.08	38.20	15.05	3.83	24.8
	15-65	44.57	55.43	10.93	27.32	30.09	18.91	10.03	2.61	
	65-115	34.42	65.58	5.81	16.86	30.84	30.16	13.38	2.99	
28	0-15	21.82	78.18	4.39	15.95	21.03	23.10	29.85	5.46	35.3
	15-40	25.12	74.88	2.89	9.91	16.41	30.20	35.53	4.64	
	40-70	15.25	84.57	2.56	15.56	27.89	26.52	24.82	3.07	
	70-110	19.53	80.47	2.53	9.44	12.07	31.09	38.80	6.34	
29	0-15	57.81	42.19	18.54	51.2	20.27	7.79	1.53	0.36	74.8
	15-60	65.41	34.59	18.87	33.76	21.27	12.96	2.70	10.20	
	60-85	48.03	51.97	13.92	38.55	34.34	10.31	1.63	0.95	

Table 4. Continued.

Prof. No.	Depth	Weight >2mm %	Weight <2mm %	2-1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1 mm %
A1		57.83	42.17	6.36	20.09	22.79	23.84	19.87	5.79	64.09
A2		41.03	58.97	6.23	16.84	15.77	31.08	22.75	3.81	51.62
A3		54.79	45.21	16.16	14.43	13.75	15.68	37.75	12.32	52.70
A4		32.36	67.64	3.35	10.47	8.53	13.97	56.25	7.19	38.40
A5		0.00	100.00	0.00	0.79	23.13	67.81	7.54	0.62	0.00
A6		41.91	58.09	8.76	21.84	20.29	32.3	14.65	1.52	58.71
A7		5.49	94.51	0.00	12.1	50.63	38.62	9.05	4.65	7.10
A8		42.91	75.90	0.66	21.22	25.32	22.14	19.11	4.70	46.98
A9		34.36	65.64	5.04	17.79	14.18	26.46	32.47	4.89	41.91
A10	0-20	–	–	9.90	14.4	11.42	11.83	23.76	7.68	-
	20-40	–	–	17.62	13.32	12.00	11.94	12.91	7.45	
	40-60	–	–		15.13	11.75	11.95	12.20	6.12	
	60-80	–	–	12.79	10.70	9.03	9.07	8.57	10.13	
	80-90	–	–	10.48	15.66	13.18	13.30	14.10	7.02	
A11	0-20	–	–	13.74	12.28	11.14	10.13	17.3	7.57	-
	20-40	–	–	16.54	15.92	15.52	11.84	15.5	0.75	
	40-60	–	–	15.66	13.12	14.38	10.93	8.34	6.03	
	60-80	–	–	16.56	14.25	11.57	9.82	9.18	10.27	
	80-100	–	–	13.97	11.23	13.75	11.15	8.65	4.90	
	100-120	–	–	10.22	8.66	14.60	13.47	12.79	6.26	

Table 5. Soil texture, total carbonate, organic matter, K-water erodability soil factopr and I-wind erodability soil factor of Qassaba soil samples.

prof. No.	Depth cm	$CaCO_3$ %	Texture Sand %	Silt %	Clay %	Textural Class	O.M. %	100 K	I ton/ acre
1	0-20	15.90	84.00	5.00	11.00	L.S	0.10	20.11	24
	20-50	14.90	73.00	10.00	17.00	S.L			
	50-70	19.20	83.00	5.00	12.00	L.S			
	70-100	21.30	71.00	8.00	21.00	S.C.L			
2	0-30	14.90	81.00	5.00	14.00	S.L	0.25	15.25	20
	30-60	13.40	86.00	3.00	11.00	L.S			
	60-110	18.60	84.00	2.00	14.00	S.L			
3	0-20	12.80	91.00	3.00	6.00	S	0.12	34.82	150
	20-60	9.40	89.00	5.00	6.00	S			
	60-100	6.30	89.00	5.00	6.00	S			
4	0-30	9.50	78.00	8.00	14.00	S.L	0.06	18.83	25
	30-65	15.90	63.00	15.00	22.00	S.C.L			
5	0-15	19.80	86.00	3.00	11.00	L.S	0.17	28.01	76
	15-35	12.00	66.00	13.00	21.00	S.C.L			
	35-65	23.40	60.00	13.00	27.00	S.C.L			
6	0-30	23.40	70.00	10.00	20.00	S.C.L	0.03	17.75	25
	30-70	21.30	66.00	13.00	21.00	C.L			
7	0-20	12.70	79.00	5.00	16.00	S.L	0.19	27.80	71
	20-55	15.30	54.00	21.00	25.00	S.C.L			
	55-100	14.00	61.00	18.00	21.00	C.L			
8	0-25	19.80	86.00	5.00	9.00	L.S	0.22	28.55	67
	25-60	16.10	67.00	15.00	18.00	S.L			
	60-90	17.90	68.00	10.00	22.00	S.C.L			
9	0-15	23.10	85.00	5.00	10.00	L.S	0.96	28.40	88
	15-55	14.90	82.00	8.00	10.00	L.S			
	55-100	20.40	87.00	5.00	8.00	L.S			

Table 5. Continued.

prof. No.	Depth cm	$CaCO_3$ %	Texture Sand %	Silt %	Clay %	Textural Class	O.M. %	100 K	I ton/ acre
10	0-20	28.00	80.00	10.00	10.00	S.L	0.13	20.49	47
	20-45	23.80	71.00	11.00	18.00	S.L			
11	0-15	6.00	82.00	5.00	13.00	L.S	0.46	16.84	54
	15-50	17.40	90.00	3.00	7.00	S			
	50-80	15.20	74.00	13.00	13.00	S.L			
12	0-30	22.60	80.00	10.00	10.00	S.L	0.13	17.20	36
13	0-30	18.90	92.00	0.00	8.00	S	0.14	16.36	134
	30-60	16.20	90.00	3.00	7.00	S			
	60-100	22.10	92.00	0.00	8.00	S			
14	0-30	9.01	80.00	10.00	10.00	S.L	0.20	15.72	48
15	0-10	14.10	85.00	8.00	7.00	L.	0.29	25.32	76
	10-40	11.20	74.00	13.00	13.00	S.L			
	40-65	13.80	61.00	16.00	23.00	S.C.L			
16	0-30	13.00	82.00	8.00	10.00	L.S	0.00	31.67	86
	30-65	20.90	61.00	13.00	26.00	S.C.L			
	65-95	19.40	61.00	13.00	26.00	S.C.L			
17	0-15	10.00	77.00	10.00	13.00	S.L	0.14	26.18	48
	15-55	8.20	71.00	16.00	13.00	S.L			
	55-100	13.10	80.00	13.00	17.00	L.S			
18	0-30	24.10	81.00	13.00	6.00	S.L	0.72	24.46	58
	30-70	25.30	60.00	18.00	22.00	S.C.L			
	70-100	8.90	63.00	18.00	19.00	S.L			
19	0-20	14.90	94.00	0.00	6.00	S	0.72	7.25	121
	20-50	11.20	94.00	0.00	6.00	S			
	50-90	8.20	94.00	0.00	6.00	S			

Table 5. Continued

prof. No.	Depth cm	$CaCO_3$ %	Texture Sand %	Silt %	Clay %	Textural Class	O.M. %	100 K	I ton/ acre
20	0-25	9.80	81.00	10.00	9.00	S.L	0.58	19.28	65
	25-50	13.70	73.00	13.00	14.00	S.L			
21	0-30	9.20	81.00	10.00	9.00	L.S	0.47	12.22	45
	30-65	12.10	70.00	16.00	14.00	S.L			
	65-110	20.70	83.00	8.00	9.00	L.S			
22	0-20	21.90	60.00	21.00	19.00	S.L	0.90	12.46	21
	20-60	15.60	49.00	21.00	30.00	S.C.L			
	60-90	29.80	44.00	24.00	32.00	C.L			
	90-110	28.30	54.00	16.00	30.00	S.C.L			
23	0-25	9.80	81.00	8.00	11.00	L.S	0.57	10.11	71
	25-60	16.50	60.00	13.00	27.00	S.C.L			
	60-85	18.10	57.00	13.00	30.00	S.C.L			
24	0-15	11.90	83.00	8.00	9.00	L.S	0.78	9.47	50
	15-35	13.80	70.00	10.00	20.00	S.C.L			
	35-55	15.80	65.00	10.00	25.00	S.C.L			
25	0-25	5.10	78.00	8.00	14.00	S.L	0.59	12.22	48
	25-60	7.20	70.00	16.00	14.00	S.L			
	60-90	11.30	58.00	15.00	27.00	S.C.L			
26	0-15	13.40	76.00	10.00	14.00	S.L	0.55	11.37	45
	15-60	20.90	60.00	16.00	24.00	S.C.L			
	60-100	19.40	59.00	13.00	28.00	S.C.L			
27	0-15	18.90	88.00	5.00	7.00	S	0.45	11.36	88
	15-65	21.30	78.00	13.00	9.00	L.S			
	65-115	21.60	86.00	3.00	11.00	L.S			
28	0-15	10.30	91.00	3.00	6.00	S	0.41	7.91	65
	15-40	13.80	86.00	5.00	9.00	L.S			
	40-70	19.40	91.00	3.00	6.00	S			
	70-110	17.10	84.00	5.00	11.00	L.S			
29	0-15	15.60	74.00	11.00	15.00	L.S	1.22	12.33	7
	15-60	17.90	44.00	22.00	34.00	L.C			
	60-85	12.20	64.00	20.00	16.00	L.S			

Table 5. Continued

prof. No.	Depth cm	$CaCO_3$ %	Texture			Textural Class	O.M. %
			Sand %	Silt %	Clay %		
A1	0-20	9.70	11.00	13.00	76.00	S.L	0.63
A2	0-20	19.70	14.00	15.00	71.00	S.L	0.63
A3	0-20	8.90	11.00	8.00	81.00	L.S	0.50
A4	0-20	22.40	8.00	8.00	84.00	L.S	0.94
A5	0-20	21.10	6.00	0.00	94.00	S	0.57
A6	0-20	18.60	14.00	15.00	71.00	S.L	0.65
A7	0-20	11.60	6.00	0.00	94.00	S	0.36
A8	0-20	11.20	12.00	10.00	78.00	S.L	0.66
A9	0-20	22.40	11.00	8.00	81.00	L.S	0.77
A10	0-20	21.60	19.00	15.00	66.00	S.L	0.78
	20-40	20.70	14.00	16.00	70.00	S.L	
	40-60	18.40	14.00	16.00	70.00	S.L	
	60-80	17.30	14.00	13.00	73.00	S.L	
	80-90	22.60	14.00	13.00	73.00	S.L	
A11	0-20	21.70	22.00	18.00	60.00	S.C.L	0.75
	20-40	23.60	24.00	13.00	63.00	S.C.L	
	40-60	19.50	29.00	13.00	58.00	S.C.L	
	60-80	18.60	32.00	13.00	55.00	S.C.L	
	80-100	21.60	32.00	10.00	58.00	S.C.L	
	100-120	22.40	30.00	10.00	60.00	S.C.L	

Table 6 . pH and soluble salts of saturated extracts of Qassaba soil samples.

Prof. No.	Depth cm	pH	EC dS/m	Cations , meq/l				Anions , meq/l			
				Na	K	Ca	Mg	CO_3	HCO_3	Cl	SO_4
1	0-20	7.70	0.75	2.60	0.60	4.20	2.20	0.00	5.00	12.50	0.00
	20-50	8.00	0.34	2.10	0.40	5.00	4.00	0.00	2.50	5.00	0.00
	50-70	8.30	0.54	4.80	0.20	6.00	4.20	0.00	5.00	4.00	0.00
	70-100	7.80	0.61	5.70	0.30	9.00	4.00	0.00	5.00	6.50	0.00
2	0-30	7.60	0.45	1.70	0.30	2.30	10.40	0.00	2.50	3.50	0.00
	30-60	7.80	0.36	1.80	0.20	7.20	5.80	0.00	5.00	1.50	0.00
	60-110	7.60	0.36	2.10	0.20	5.40	11.60	0.00	7.50	3.00	0.00
3	0-20	7.60	0.68	1.80	0.40	8.00	2.00	0.00	10.00	7.00	0.00
	20-60	7.70	0.32	1.60	0.50	13.20	4.60	0.00	12.50	1.50	0.00
	60-100	7.70	0.29	1.20	0.30	7.00	5.00	0.00	5.00	2.50	0.00
4	0-30	7.80	0.82	2.60	0.50	10.00	7.80	0.00	7.50	7.50	0.00
	30-65	7.80	0.82	8.30	0.30	9.00	5.00	0.00	5.00	8.50	0.00
5	0-15	7.70	0.42	2.10	0.40	7.00	7.00	0.00	5.00	2.00	0.00
	15-35	7.70	0.36	1.60	0.40	5.00	1.00	0.00	2.50	5.00	0.00
	35-65	7.80	0.36	2.20	0.40	5.40	4.60	0.00	5.00	4.50	0.00
6	0-30	7.90	0.39	3.50	0.40	7.80	9.20	0.00	5.00	4.50	0.00
	30-70	7.70	3.12	6.10	1.50	5.00	9.00	0.00	12.50	57.56	0.00
7	0-20	7.70	0.59	3.70	0.80	11.00	7.00	0.00	7.50	12.50	0.00
	20-55	7.80	0.89	10.00	0.40	8.00	10.40	0.00	7.50	11.50	0.00
	55-100	7.50	0.82	3.90	0.50	6.00	7.00	0.00	5.00	11.50	0.00
8	0-25	7.40	4.63	84.30	2.10	18.00	13.00	0.00	7.50	88.50	0.00
	25-60	7.20	12.08	182.60	1.90	41.00	29.00	0.00	7.50	265.00	0.00
	60-90	7.70	1.46	15.70	0.60	8.00	12.00	0.00	10.00	23.50	0.00
9	0-15	7.60	64.00	1.70	0.50	13.20	25.80	0.00	10.00	0.00	0.00
	15-55	7.40	1.46	3.30	0.60	19.00	11.00	0.00	12.50	9.00	0.00
	55-100	7.70	49.00	4.50	0.20	6.00	9.00	0.00	7.50	6.00	0.00
10	0-20	7.70	0.82	4.30	0.50	5.00	11.00	0.00	10.00	15.00	0.00
	20-45	7.60	1.38	16.10	0.60	11.00	4.40	0.00	7.50	20.50	0.00
11	0-15	7.70	0.47	2.60	0.30	6.00	5.00	0.00	7.50	10.50	0.00
	15-50	7.70	0.28	1.60	0.30	7.00	2.00	0.00	12.50	11.00	0.00
	50-80	7.70	0.32	1.20	0.20	6.00	6.00	0.00	12.50	2.00	0.00
12	0-30	7.30	41.00	639.10	19.20	18.00	4.00	0.00	7.50	370.00	32.50

Table 6. Continued.

Prof. No.	Depth cm	pH	EC dS/m	Cations, meq/l Na	K	Ca	Mg	Anions, meq/l CO_3	HCO_3	Cl	SO_4
13	0-30	7.90	0.77	2.60	0.30	6.00	6.00	0.00	10.00	33.50	0.00
	30-60	7.90	0.35	1.60	0.40	7.00	7.20	0.00	7.50	15.00	0.00
	60-100	7.50	0.88	1.50	0.50	5.00	6.00	0.00	5.00	7.00	0.00
14	0-30	7.90	0.45	2.60	0.30	8.20	6.90	0.00	7.50	5.50	0.00
15	0-10	7.70	0.64	2.60	0.40	8.00	10.00	0.00	5.00	8.50	0.00
	10-40	7.90	1.53	18.00	0.50	5.00	7.00	0.00	12.50	30.50	0.00
	40-65	7.60	7.09	16.50	2.60	0.00	6.00	0.00	5.00	70.00	0.00
16	0-30	7.70	0.74	3.50	0.40	6.00	6.00	0.00	10.00	12.50	0.00
	30-65	8.00	0.63	2.40	0.10	12.00	6.20	0.00	12.50	4.50	0.00
	65-95	7.90	0.42	28.00	0.10	4.00	5.20	0.00	10.00	8.50	0.00
17	0-15	7.90	1.73	23.90	0.60	8.00	4.10	0.00	5.00	19.50	0.00
	15-55	7.90	9.14	168.70	1.50	21.00	25.00	0.00	7.50	155.00	0.00
	55-100	7.20	48.00	639.10	9.60	75.00	119.00	0.00	7.50	525.00	0.00
18	0-30	7.80	0.58	2.40	0.30	5.20	2.80	0.00	7.50	25.00	0.00
	30-70	7.30	12.60	1.90	1.30	6.00	4.00	0.00	5.00	230.00	0.00
	70-100	7.50	11.40	65.20	1.30	4.00	8.00	0.00	5.00	212.50	0.00
19	0-20	7.70	0.59	3.00	0.50	6.00	3.00	0.00	10.00	25.00	0.00
	20-50	7.60	0.48	2.60	0.40	8.20	5.80	0.00	7.50	22.50	0.00
	50-90	7.60	0.27	2.60	0.10	6.00	9.80	0.00	5.00	12.50	0.00
20	0-25	7.70	0.47	3.70	0.40	9.00	6.70	0.00	7.50	17.50	0.00
	25-50	7.60	4.58	50.00	0.60	7.00	7.00	0.00	7.50	125.00	0.00
21	0-30	7.90	0.65	7.00	0.30	0.00	0.60	0.00	7.50	22.50	0.00
	30-65	7.50	16.35	163.00	1.00	18.00	36.50	0.00	5.00	350.00	0.00
	65-110	7.30	19.50	185.80	1.00	25.00	41.70	0.00	10.00	650.00	0.00
22	0-20	7.90	0.89	10.00	0.30	11.00	2.00	0.00	10.00	17.50	0.00
	20-60	7.90	0.44	2.80	0.30	4.00	1.00	0.00	7.50	10.00	0.00
	60-90	8.00	0.63	5.70	0.10	9.00	3.00	0.00	75.00	25.00	0.00
	90-110	8.30	0.60	6.10	0.30	2.00	0.80	0.00	10.00	35.00	0.00
23	0-25	7.80	0.56	0.60	0.40	4.00	0.20	0.00	10.00	25.00	0.00
	25-60	7.80	0.37	2.00	0.30	1.00	1.80	0.00	5.00	15.00	0.00
	60-85	7.70	0.39	2.00	0.10	3.00	1.00	0.00	7.50	33.00	0.00
24	0-15	7.80	0.49	3.50	0.30	2.50	1.00	0.00	7.50	25.00	0.00
	15-35	7.50	5.24	34.80	1.30	12.00	11.00	0.00	5.00	200.00	0.00
	35-55	7.30	3.41	12.20	0.80	9.00	13.00	0.00	5.00	350.00	0.00

Table 6. Continued.

Prof. No.	Depth cm	pH	EC dS/m	Cations , meq/l				Anions , meq/l			
				Na	K	Ca	Mg	CO_3	HCO_3	Cl	SO_4
25	0-25	7.70	0.51	1.50	0.60	2.50	0.50	0.00	5.00	24.00	0.00
	25-60	7.70	0.35	5.00	0.10	2.20	0.30	0.00	7.50	20.00	0.00
	60-90	7.80	0.28	9.30	0.10	1.00	2.00	0.00	5.00	25.00	0.00
26	0-15	7.60	0.40	6.10	0.30	2.80	1.20	0.00	5.00	23.00	0.00
	15-60	7.70	0.38	5.00	0.30	2.40	1.60	0.00	7.50	31.00	0.00
	60-100	7.80	0.41	3.70	0.80	2.00	2.00	0.00	10.00	15.00	0.00
27	0-15	7.60	0.61	3.50	0.50	2.00	1.00	0.00	10.00	21.00	0.00
	15-65	7.70	0.59	3.00	0.30	2.00	2.00	0.00	5.00	18.00	0.00
	65-115	7.80	0.40	2.00	0.30	4.00	8.00	0.00	10.00	23.00	0.00
28	0-15	7.50	2.03	4.30	0.50	4.00	12.00	0.00	10.00	8.10	2.20
	15-40	8.00	1.03	1.80	0.30	2.00	2.00	0.00	15.00	6.50	0.00
	40-70	7.60	2.23	4.10	1.00	4.00	4.00	0.00	20.00	17.50	0.00
	70-110	7.50	5.88	13.00	1.00	3.00	12.40	0.00	15.00	55.00	0.00
29	0-15	7.20	120.00	195.70	19.20	8.40	444.00	0.00	20.00	950.00	230.00
	15-60	7.30	40.00	55.40	5.80	36.00	88.00	0.00	15.00	500.00	0.00
	60-85	7.10	38.00	45.70	5.80	32.00	120.00	0.00	15.00	500.00	0.00
A1	0-20	7.10	66.00	141.30	9.60	92.00	128.00	0.00	15.00	550.00	95.00
A2	0-20	7.90	3.07	5.20	1.00	8.00	2.00	0.00	20.00	125.00	0.00
A3	0-20	7.80	1.99	3.90	1.00	6.00	4.00	0.00	20.00	90.00	0.00
A4	0-20	7.70	1.60	7.00	1.30	4.00	24.00	0.00	10.00	70.00	0.00
A5	0-20	7.30	0.53	4.90	0.30	2.00	0.80	0.00	5.00	17.00	0.00
A6	0-20	7.60	8.82	212.00	2.60	2.00	8.00	0.00	5.00	160.00	0.00
A7	0-20	7.60	0.60	3.90	0.40	0.80	2.40	0.00	10.00	11.00	0.00
A8	0-20	7.70	5.84	106.00	1.60	4.00	28.00	0.00	10.00	103.00	0.00
A9	0-20	7.40	3.40	72.30	1.30	2.00	0.80	0.00	10.00	66.00	0.00
A10	0-20	7.20	14.00	42.40	0.40	36.00	22.00	0.00	5.00	500.00	0.00
	20-40	7.00	30.00	529.90	8.00	48.00	68.00	0.00	1.00	750.00	0.00
	40-60	7.10	43.00	619.60	11.50	86.00	64.00	0.00	5.00	500.00	0.00
	60-80	7.10	30.00	529.90	12.80	52.00	62.00	0.00	5.00	500.00	0.00
	80-90	7.30	16.86	317.90	71.20	4.00	6.00	0.00	10.00	500.00	0.00
A11	0-20	7.90	0.63	15.20	2.20	3.60	0.40	0.00	5.00	2.00	0.00
	20-40	7.90	0.49	9.30	3.50	1.20	4.80	0.00	5.00	7.00	0.00
	40-60	7.80	0.54	12.40	3.30	1.20	4.40	0.00	5.00	10.00	0.00
	60-80	7.90	0.54	14.50	2.20	1.20	2.80	0.00	5.00	13.00	0.00
	8-100	7.80	0.45	13.70	1.80	1.60	0.20	0.00	5.00	5.00	0.00
	100-120	8.00	0.53	12.60	1.50	1.40	2.80	0.00	5.00	8.00	0.00

4.2.1.2. Aridisols :

Four great groups were identified :

4.2.1.2.a. Aquisalids:

Aquisalids dominated in the coastal lagoon. The soils represented by profile 29 have an ochric epipedon and a loamy sand or clay loam texture. The pH varied from 7.1 to 7.3. The electrical conductivity ranged between 38 and 120 ds/m. The total $CaCO_3$ varied from 12.2 to 17.9%. The sand varied from 44% to 74% and the clay content ranged from 15% to 34% (Tables 4, 5 and 6).

4.2.1.2.b. Haplosalids :

Haplosalids were present in the Dissected plateau. The soils represented by profile 17 have an ochric epipedon, loamy sand or sandy loam texture. The pH varied from 7.2 to 7.9. The electrical conductivity ranged between 1.73 to 64 dS/m. The total $CaCO_3$ varied from 8.2 to 23.1%. The sand content varied from 71% to 87% and the clay content ranged from 8% to 17% (Tables 4, 5 and 6).

4.2.1.2.c. Petrocalcids :

Petrocalcids dominated in the plateau and were present in the inter ridges and the southern plateau. The soils represented by profiles (4, 6, 10, 12, 14, 20 and 24) were classified as Petrocalcids. They have petrocalcic horizon that has its upper boundary within 100 cm of the soil surface. They are characterized by pH values ranging from 7.3 to 7.9 and electrical conductivity from 0.39 to 41 ds/m. The total calcium carbonate content ranged from 9.1% to 28%. The sand and clay content varied from 63% to 83% and from 9% to 25% respectively (Table 4, 5 and 6).

4.2.1.2.d. Haplocalcids :

Haplocalcids were present in the inter ridges, dissected plateau and wadi system. The Soils represented by profiles (21, 23 and 26) were classified into Haplocalcids. They have a calcic horizon that has its upper boundary within 100 cm of the soil surface.

They are characterized by pH values ranging from 7.3 to 7.9 and electrical conductivity from 0.37 to 19.5 ds/m. The total calcium carbonate ranged from 9.2% to 20.9%. The sand and clay content varied from 57% to 83% and from 9% to 30% respectively (Tables 4, 5 and 6).

4.2.2. The soil units of Fuka pilot area :

Soils of Fuka sample area were classified into Entisols and Aridisols orders. The Aridisols order is defined on the basis of the soils having an aridic moisture regime. Within the Aridisols, great groups are recognized based on the presence of gypsic and/or calcic horizon. The Entisols include the soils where horizon differentiation is limited only to that of an ochric epipedon, (Soil Survey staff 1972).

4.2.2.1. Entisols :

Entisols include soils of slight or recent development, that have an ochric and/or anthropic diagnostic horizon. They are represented by profiles (1, 2, 3, 4, 10, 14, 15, 16, 17, 18 and 21). Two great group and three subgroup were identified:

4.2.2.1.a. Xeropsamments :

Xeropsamments dominated in the wadi system and were present in the following geomorphological units : inter ridges and low dissected plateau (Table 7). The soils have A/C profile (profiles 3, 10, 14, 15, 16 and 17). They are characterized by sandy texture to a depth of 1m., the absence of the diagnostic horizons and are not saturated with water. Main chemical and physical properties were reported Table (1). The pH. value ranged from 7.2 to 7.7 and EC ranged from 0.32 to 0.93 ds/m. The Total $CaCO_3$ varied from 12 to 29.8 %. The sand ranged between 67% and 97% (Tables 8, 9 and 10).

Table 7. Fuka land units and soil units.

Geomorph. unit	Land Units	Soil Units	Profile No.
Dunes and ridges	1 . Coastal dunes	-	-
	2 . Ridges	-	-
	3. Low, smooth ridges	Lithic Haplocalcids	13
Depression	4 . Intra-ridge Depressions	Xeric Haplocalcids	5,6
	5 . Coastward depressions	Xeric Haplocalcids	12,22
	6 . Hummocky land	Typic Xeropsamments	10
Plain	7 . Alluvial Plain	Xeric Haplocalcids	9
		Typic Xeropsamments	14
	8 . Harvested sand plain	Xeric Haplocalcids	20
	9 . Fine-textured alluvial plain	Typic Xerorthents	21
Dissected plateau	10 . Low dissected plateau	Typic Xeropsamments	17
	11 . High dissected plateau	Xeric Haplocalcids	7
		Calcic Petrocalcids	8
	12 . Escarpment	Lithic Haplocalcids	19
Plateau	13 . Stony plateau	Lithic Xerorthents	1,18
	14 . Depressions in plateau	Lithic Xerorthents	2
Wadi system	15 . Wadi course	Typic Xeropsamments	3,15,16
	16 . Alluvial fans	Typic Xerorthents	4

4.2.2.1.b. Xerorthents :

Xerothents dominated in the thouthern plateau and were also present in inter ridges and wadi system. The soils represented by profiles 1, 2, 4, 18 and 21 have an ochric epipedon , sandy , loamy sandy , sandy loam or sandy clay loam texture and were not permanently saturated with water. The pH value range from 7.3 to 7.8, the electrical conductivity ranged between 0.39 and 3.48 ds/m. The total $CaCO_3$ ranged from 13.7 to 37.8%. The sand content ranged between 47% to 92%, clay content varied between 5 and 33% (Tables 8, 9 and 10).

4.2.2.2. Aridisols :

The Aridisols have an ochric and one or more of the following subsurface horizons: salic, argillic, cambic, natric, gypsic, calcic, petrocalcic or duripans. The Aridisols of Fuka area are represented by profiles (5, 6, 7, 8, 9, 12, 13, 19, 20 and 22).

4.2.2.2.a. Haplocalcids :

Haplocalcids dominated in the inter ridges and in the escarpment and were also present in high dissected plateau. The soils represented by profile (5, 6, 7, 9, 12, 13, 19, 20 and 22) which have a calcic horizon that has its upper boundary within 100 cm of the soil surface without any indurated layers. They are charcterized by pH varied from 7.0 to 7.8, and electrical conductivity from 0.36 to 17.4 ds/m. The total $CaCO_3$ varied from 15.9 to 43.2 %. The sand and clay content varied from 46% to 95% and from 5% to 36%, respectively (Tables 8, 9 and 10).

4.2.2.2.b. Petrocalcids :

The Petrocalcids were found, in the high dissected plateau (profile 8). The soil has a calcic horizon at 45 cm. depth overlying a deeper petrocalcic horizon. It has a sandy loam to sandy clay loam texture, neutral pH and low total soluble salts (Tables 8, 9 and 10).

Table 8. Gain size analysis of Fuka soil samples (Dry sieving).

Prof. No.	Depth cm	>2 mm %	<2 mm %	2 - 1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1 * mm %
1	0-15	39.7	60.3	4.7	19.5	23.3	32.7	16.5	3.3	51.7
	15-40	42.7	57.3	18.8	34.2	19.9	13.3	11.2	3.1	
2	0-15	28.4	71.6	5.7	20.0	21.1	34.2	17.6	1.4	39.5
	20-50	50.0	50.0	11.4	29.7	22.9	29.5	5.1	1.4	
3	0-30	8.8	91.2	1.0	9.2	29.6	44.6	13.8	1.8	3.3
	30-70	5.0	95.0	0.5	4.6	23.7	62.8	7.4	1.0	
	70-110	2.3	97.7	0.4	9.0	45.7	40.6	3.7	0.6	
4	0-30	19.0	81.0	2.6	14.3	25.8	47.3	8.8	1.2	17.6
	30-60	51.0	49.0	15.8	38.5	25.0	16.4	3.7	0.6	
	60-100	41.5	58.5	12.4	30.1	21.9	19.7	13.5	2.4	
5	0-20	33.8	66.2	10.7	24.6	21.8	26.4	14.6	1.9	45.6
	20-50	54.6	45.4	16.3	30.9	20.2	16.9	14.2	1.5	
	50-90	60.7	39.3	14.5	30.1	20.6	19.4	13.7	1.7	
6	0-25	47.1	52.9	9.7	27.4	21.8	33.3	6.3	1.5	64.2
	25-55	60.8	39.2	14.2	31.2	19.8	18.3	14.8	1.7	
	55-90	71.0	29.0	16.7	30.7	19.6	14.1	16.5	2.4	
7	0-10	19.6	80.4	2.6	10.5	26.5	35.7	21.9	2.8	16.4
	10-60	47.3	52.7	13.1	35.2	26.4	22.0	2.8	0.5	
	60-100	41.6	58.4	8.8	24.1	27.8	29.5	7.8	2.0	
8	0-15	33.9	66.1	6.1	18.8	23.5	39.6	10.2	1.8	40.1
	15-45	55.3	44.7	12.2	31.7	24.7	18.4	10.8	2.2	
	45-70	57.6	42.4	14.6	30.6	22.2	18.0	12.5	2.1	
9	0-15	52.3	47.7	9.4	23.7	21.6	23.6	18.8	2.9	63.0
	15-55	51.4	48.6	27.7	55.9	13.4	1.8	0.8	0.4	
	55-100	49.4	50.6	18.8	49.2	24.1	5.6	1.7	0.6	

* Untreated soil samples.

Table 8. Continued

Prof. No.	Depth cm	>2 mm %	<2 mm %	2 - 1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1 * mm %
10	0-25	1.7	98.3	0.9	13.2	31.6	35.6	16.1	2.6	1.2
	25-60	1.4	98.6	0.2	6.7	25.4	35.8	27.7	4.2	
	60-110	57.6	42.4	11.0	24.1	16.0	42.6	5.3	1.0	
12	0-30	29.8	70.2	4.7	12.4	18.4	51.7	11.1	1.7	33.2
	30-60	43.6	56.4	11.4	25.6	19.2	18.0	23.3	2.5	
	60-100	44.7	55.3	6.3	16.2	14.3	41.7	17.9	3.6	
13	0-15	30.3	69.7	7.3	17.9	15.4	44.8	11.4	3.2	38.8
	15-50	38.9	61.1	5.9	16.0	22.6	27.2	25.5	2.8	
14	0-30	26.4	73.6	5.6	14.9	18.3	44.0	15.0	2.2	29.0
	30-80	21.1	78.9	5.6	8.7	28.0	47.6	9.1	1.0	
	80-110	38.9	61.1	8.4	18.9	37.7	26.6	7.1	1.3	
15	0-10	9.1	90.9	1.2	2.3	2.3	12.0	72.4	9.8	1.6
	10-40	9.9	90.1	0.3	1.6	4.9	24.3	61.9	7.0	
	40-70	25.3	74.7	5.0	10.3	11.3	48.4	20.7	4.3	
	70-110	26.6	73.4	3.4	9.8	11.4	26.2	39.2	10.0	
16	0-30	7.6	92.4	0.4	4.5	24.4	55.3	13.8	1.6	1.3
	30-70	16.7	83.3	1.3	3.2	12.8	43.6	35.9	3.2	
	70-110	11.2	88.8	0.6	3.3	21.8	59.1	13.0	2.2	
17	0-20	21.4	78.6	3.2	9.4	15.0	34.3	32.7	5.4	13.0
	20-60	28.1	71.9	4.2	13.9	22.9	30.2	24.4	4.4	
	60-100	37.5	62.5	5.9	15.4	17.9	36.3	19.8	4.7	
18	0-15	30.7	69.3	4.9	16.9	23.0	39.2	13.6	2.4	42.1
	15-35	56.6	43.4	12.0	26.0	20.1	33.3	7.8	0.8	
19	0-15	45.0	55.0	7.8	17.8	23.7	39.1	10.3	1.3	53.2
	15-30	71.3	28.7	10.0	22.2	32.0	32.5	2.5	0.8	

Table 8. Continued

Prof. No.	Depth cm	>2 mm %	<2 mm %	2 - 1 mm %	1 - 0.5 mm %	0.5 - 0.25 mm %	0.25 - 0.125 mm %	0.125 - 0.063 mm %	<0.063 mm %	>1 * mm %
20	0-20	12.6	87.4	1.0	5.8	17.1	53.8	19.4	2.9	9.5
	20-55	42.2	57.8	10.9	26.7	22.1	27.9	9.7	2.7	
	55-100	66.0	34.0	22.5	37.2	19.0	10.8	9.3	1.2	
21	0-15	38.6	61.4	13.1	30.4	22.6	20.6	12.2	1.1	64.7
	15-60	50.9	49.1	17.7	31.5	16.9	14.1	15.6	4.2	
	60-100	55.5	44.5	16.0	29.0	20.2	19.2	13.0	2.6	
22	0-15	39.7	60.3	8.2	18.1	15.0	42.2	13.2	3.3	48.0
	15-45	70.6	29.4	16.0	25.5	15.6	29.2	11.8	1.9	
	45-80	67.7	32.3	17.3	27.5	17.9	21.3	13.9	2.1	
A1	0-25	46.8	53.2	13.3	27.6	20.2	21.3	15.5	2.1	54.5
A2	0-20	16.1	83.9	2.8	9.3	15.6	54.5	15.9	1.9	25.2
	20-40	19.5	80.5	3.0	12.1	26.6	52.4	5.4	0.5	
	40-60	23.3	76.7	4.2	10.9	17.9	57.6	8.2	1.2	
A3	0-20	39.3	60.7	7.5	15.5	14.4	57.8	4.4	0.4	50.6
	20-40	37.9	62.1	10.9	38.3	37.8	10.1	2.2	0.7	
	40-60	48.5	51.5	11.0	21.8	43.2	22.5	1.0	0.5	
A4	0-20	31.6	68.4	6.9	19.4	17.1	41.9	13.1	1.6	49.1
	20-40	32.2	67.8	9.5	25.6	23.4	33.4	7.1	1.0	
	40-60	30.1	69.9	9.7	26.5	23.0	34.8	5.2	0.8	

Table 9. Soil texture, total carbonate, organic matter, K-water erodability soil factor and I-wind erodability soil factor of Fuka soil samples.

Prof. No.	Depth cm	$CaCO_3$ %	O. M. %	Texture Sand %	Silt %	Clay %	Textural class	100 K	I tone/ acre
1	0-15	17.10	0.32	72.00	13.00	15.00	S.L	17.21	36
	15-40	16.50		59.00	18.00	23.00	S.L		
2	0-20	19.60	0.21	87.00	5.00	8.00	L.S	15.45	58
	20-60	18.50		59.00	23.00	18.00	S.L		
3	0-30	26.80	0.18	97.00	0.00	3.00	S	12.05	220
	30-70	28.60		97.00	0.00	3.00	S		
	70-110	23.90		96.00	1.00	3.00	S		
4	0-30	13.70	0.21	92.00	3.00	5.00	S	11.00	109
	30-60	20.10		54.00	20.00	26.00	S.C.L		
	60-100	18.20		47.00	20.00	33.00	S.C.L		
5	0-20	19.90	0.15	87.00	5.00	8.00	L.S	14.20	48
	20-50	32.30		64.00	18.00	18.00	S.L		
	50-90	36.10		57.00	15.00	28.00	S.C.L		
6	0-25	16.20	0.25	77.00	13.00	10.00	S.L	13.80	17
	25-55	25.30		56.00	18.00	26.00	S.C.L		
	55-90	34.10		53.00	18.00	29.00	S.C.L		
7	0-10	19.80	0.18	92.00	3.00	5.00	S	16.86	113
	10-60	20.10		72.00	13.00	15.00	S.L		
	60-100	16.30		74.00	13.00	13.00	S.L		
8	0-15	17.00	0.04	78.00	10.00	12.00	S.L	14.11	56
	15-45	25.30		50.00	23.00	27.00	S.C.L		
	45-70	37.20		63.00	13.00	24.00	S.C.L		
9	0-15	15.90	0.01	57.00	21.00	22.00	S.C.L	20.14	18
	15-55	23.20		65.00	15.00	20.00	S.L		
	55-100	23.90		60.00	21.00	19.00	S.L		
10	0-25	14.80	0.18	96.00	0.00	4.00	S	13.02	310
	25-60	18.50		96.00	0.00	4.00	S		
	60-110	21.50		70.00	13.00	17.00	S.L		
12	0-30	21.20	0.40	86.00	5.00	9.00	L.S	12.46	69
	30-60	30.60		60.00	18.00	22.00	S.C.L		
	60-100	19.19		83.00	8.00	9.00	L.S		
13	0-15	28.70	0.75	80.00	10.00	10.00	S.L	14.29	60
	15-50	38.80		64.00	18.00	18.00	S.L		

Table 9. Continued

Prof. No.	Depth cm	$CaCO_3$ %	O. M. %	Texture Sand %	Silt %	Clay %	Textural class	100 K	I ton/ acre
14	0-30	13.30	0.41	87.00	5.00	8.00	L.S	14.18	76
	30-80	12.40		87.00	5.00	8.00	L.S		
	80-110	12.00		77.00	10.00	13.00	S.L		
15	0-10	12.10	0.80	95.00	2.00	3.00	S	37.96	310
	10-40	14.30		92.00	3.00	5.00	S		
	40-70	14.80		85.00	5.00	10.00	L.S		
	70-110	15.90		85.00	5.00	10.00	L.S		
16	0-30	29.80	0.06	95.00	2.00	3.00	S	13.04	310
	30-70	17.10		95.00	0.00	5.00	S		
	70-110	17.30		95.00	0.00	5.00	S		
17	0-20	15.70	0.55	90.00	2.00	8.00	S	20.21	125
	20-60	18.50		87.00	3.00	10.00	L.S		
	60-100	13.20		80.00	7.00	13.00	S.L		
18	0-15	19.90	0.24	82.00	8.00	10.00	L.S	14.76	52
	15-35	35.50		67.00	15.00	18.00	S.L		
19	0-15	19.80	0.76	87.00	5.00	8.00	L.S	8.51	31
	15-50	32.80		77.00	7.00	16.00	S.L		
20	0-20	17.30	0.42	95.00	0.00	5.00	S	14.23	140
	20-55	20.40		72.00	10.00	18.00	S.L		
	55-100	25.30		46.00	18.00	36.00	S.C		
21	0-15	17.40	0.45	47.00	23.00	30.00	S.C.L.	16.58	17
	15-60	28.70		54.00	24.00	22.00	S.C.L.		
	60-100	37.80		47.00	23.00	30.00	S.C.L.		
22	0-15	32.30	0.45	73.00	10.00	17.00	S.C.	14.42	43
	15-45	27.20		65.00	8.00	27.00	S.C.L.		
	45-80	43.20		52.00	13.00	35.00	S.L.		
A1	0-25	20.70	0.02	81.00	7.00	12.00	S.L.		
A2	0-20	16.60	0.24	78.00	10.00	12.00	S.L.		
	20-40	18.10		83.00	5.00	12.00	L.S		
	40-60	16.20		81.00	5.00	14.00	S.L.		
A3	0-20	33.40	0.59	76.00	12.00	12.00	S.L.		
	20-40	38.90		63.00	16.00	21.00	S.C.L.		
	40-60	41.10		63.00	16.00	21.00	S.C.L.		
A4	0-20	15.40	0.52	75.00	10.00	15.00	S.L.		
	20-40	18.50		57.00	16.00	27.00	S.C.L.		
	40-60	28.90		55.00	16.00	29.00	S.C.L.		

Table 10. pH and soluble salts of saturated extracts of Fuka soil samples.

Prof.	Depth	pH	EC	Cations , meq/L				Anions , meq/L			
No.	cm		dS/m	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
1	0-15	7.50	2.63	0.90	3.10	24.3	0.38	-	5.00	13.0	8.30
	15-40	7.50	3.48	3.40	5.60	70.4	0.77	-	5.00	20.0	
2	0-20	7.50	0.69	2.80	4.40	3.0	0.19	-	5.00	3.0	0.11
	20-60	7.70	1.38	1.80	3.80	14.8	0.38	-	5.00	5.0	
3	0-30	7.40	0.44	6.20	0.80	2.6	0.26	-	5.00	3.0	0.01
	30-70	7.60	0.32	2.20	5.20	2.5	0.77	-	5.00	2.0	
	70-110	7.60	0.65	0.80	3.00	4.9	0.06	-	5.00	2.0	
4	0-30	7.30	0.57	4.00	3.40	2.2	0.19	-	5.00	1.0	0.11
	30-60	7.70	0.39	3.00	5.60	4.9	0.13	-	5.00	1.0	
	60-100	7.50	0.64	3.00	3.00	7.2	0.19	-	5.00	4.0	
5	0-20	7.40	0.55	2.20	3.30	2.5	0.19	-	5.00	3.0	0.08
	20-50	7.20	1.88	7.00	4.20	21.3	0.51	-	2.50	17.0	
	50-90	7.40	1.47	5.00	1.00	15.7	0.13	-	5.00	12.0	
6	0-25	7.30	0.96	2.20	4.80	26.5	0.85	-	5.00	3.0	0.01
	25-55	7.00	2.31	7.20	9.20	19.1	0.38	-	2.50	21.0	
	55-90	7.50	1.91	2.40	8.00	17.8	0.26	-	5.00	20.0	
7	0-10	7.40	0.45	3.00	5.20	2.0	0.77	-	5.00	2.0	
	10-60	7.60	0.36	3.20	0.40	2.2	0.13	-	5.00	3.0	
	60-100	7.20	0.65	3.20	4.40	5.7	0.13	-	2.50	6.0	
8	0-15	7.40	0.66	4.00	1.00	4.9	0.19	-	5.00	4.0	
	15-45	7.40	1.38	2.40	3.40	20.0	0.38	-	2.50	6.0	5.30
	45-70	7.10	5.09	6.20	8.80	62.6	0.77	-	2.50	40.0	8.40
9	0-15	7.50	0.67	2.20	7.80	4.6	0.26	-	2.50	3.0	1.20
	15-55	7.70	0.39	1.80	2.00	2.4	0.13	-	5.00	3.0	
	55-100	7.60	0.36	1.80	3.20	3.3	0.13	-	2.50	1.0	0.10
10	0-25	7.20	0.43	2.40	4.80	2.2	0.32	-	2.50	2.0	
	25-60	7.30	0.39	3.80	2.60	2.6	0.38	-	5.00	2.0	
	60-110	7.30	0.72	3.40	4.60	7.3	0.19	-	5.00	5.0	
12	0-30	7.00	4.76	14.00	15.80	43.5	3.08	-	2.50	20.0	25.10
	30-60	7.00	9.03	17.00	28.00	191.3	1.92	-	2.50	120.0	
	60-100	7.00	10.89	31.00	43.20	202.2	1.92	-	2.50	150.0	
13	0-15	7.40	0.95	3.00	2.40	10.4	1.15	-	2.50	4.0	3.00
	15-50	7.70	0.48	3.20	2.80	3.9	0.38	-	5.00	1.0	

Table 10. Continued

Prof. No.	Depth cm	pH	EC dS/m	Cations , meq/L				Anions , meq/L			
				Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4
14	0-30	7.40	0.70	5.20	3.60	3.5	0.38	_	5.00	4.0	
	30-80	7.70	0.42	3.40	5.80	3.3	0.26	_	5.00	1.0	
	80-110	7.70	0.36	3.20	2.60	3.5	0.19	_	5.00	3.0	
15	0-10	7.30	0.93	5.20	4.20	3.7	0.64	_	5.00	3.0	1.02
	10-40	7.40	0.47	4.00	7.20	2.0	0.26	_	7.50	2.0	
	40-70	7.30	0.62	6.00	5.00	2.5	0.32	_	5.00	3.0	
	70-110	7.20	0.38	4.00	2.20	2.0	0.19	_	2.50	3.0	
16	0-30	7.40	0.39	3.00	2.40	1.7	0.31	_	2.50	2.0	
	30-70	7.40	0.42	4.40	1.00	2.5	0.38	_	5.00	3.0	
	70-110	7.30	0.34	3.00	3.40	1.5	0.26	_	5.00	3.0	
17	0-20	7.30	0.48	4.00	3.00	3.7	0.38	_	5.00	3.0	
	20-60	7.50	0.39	3.80	2.20	3.7	0.19	_	2.50	3.0	
	60-100	7.20	0.62	4.20	4.00	4.1	0.45	_	5.00	5.0	
18	0-15	7.30	1.45	4.20	5.20	16.5	0.64	_	5.00	9.0	0.50
	15-35	7.50	0.87	4.20	2.20	10.4	0.19	_	2.50	5.0	1.20
19	0-15	7.20	13.50	31.00	21.70	109.2	2.88	_	2.50	108.0	24.50
	15-50	7.10	17.40	25.00	36.80	177.7	1.92	_	2.50	160.0	11.50
20	0-20	7.60	0.82	4.00	2.20	6.7	1.73	_	7.50	5.0	
	20-55	7.80	0.52	2.80	0.20	5.4	0.19	_	5.00	3.0	
	55-100	7.50	0.68	1.80	1.00	5.7	0.26	_	5.00	2.0	
21	0-15	7.40	0.79	3.00	1.80	4.6	0.38	_	5.00	2.0	0.90
	15-60	7.60	0.42	2.00	0.50	3.5	0.19	_	5.00	3.0	
	60-100	7.80	0.52	3.20	0.60	4.9	0.19	_	5.00	2.0	
22	0-15	7.10	5.08	24.00	14.00	45.7	1.92	_	2.50	42.0	6.30
	15-45	7.00	4.88	15.60	12.00	58.7	1.28	_	2.50	35.0	11.30
	45-80	7.00	11.76	17.00	17.60	126.1	1.28	_	2.50	90.0	25.10
A1	0-25	7.50	1.59	7.00	2.00	12.6	0.38	_	5.00	11.0	
A2	0-20	7.40	0.85	2.40	2.60	5.2	0.38	_	5.00	5.0	
	20-40	7.40	0.89	2.80	3.00	7.8	0.38	_	5.00	5.0	
	40-60	7.60	1.45	3.20	0.60	10.9	0.26	_	2.50	7.0	5.00
A3	0-20	7.10	8.82	21.80	16.20	65.2	1.92	_	5.00	52.0	31.20
	20-40	7.10	10.04	12.80	15.60	108.7	1.92	_	5.00	82.0	13.40
	40-60	7.00	19.97	32.00	36.20	178.3	2.56	_	2.50	112.0	85.20
A4	0-20	7.60	0.74	4.00	2.80	4.9	0.45	_	5.00	5.0	
	20-40	7.60	0.45	2.00	7.00	3.9	0.19	_	5.00	4.0	
	40-60	7.40	0.75	4.20	6.00	4.4	0.19	_	5.00	5.0	

4.3. GIS spatial analysis :

Topographic feature contour was used to geneate Digital Elevation Model (DEM) for Wadi El-Qassaba and Fuka areas. The DEM was used to generate Slope and Aspect maps. The areas of the geomorphological units were obtained after processing the vector area theme of the geomorphology units. Cross table operation was applied to the geomorphology map with DEM, Slope, and Aspect maps to determine the topographic characteristics of each mapping unit, (Tables 11 and 12). The geomorphology maps were reclassified using the soil attribute of each mapping unit to get the soil classification map. Based on the values of K and I water soil erodability and wind soil erodability maps were generated (Appendix 4 and maps 2 to 13).

4.4. Climate data analysis :

4.4.1. Rainfall distribution :

All available climate data for Matrouh region was collected and a summary of 30 year record is provided in Tables (13 and 14). Table (15) and Fig.(1) give number and amount of rainy days of different intensities for rain season of 1994/95.

4.4.2. Individual storms :

Table (16) shows the maximum 30 minutes rainfall intensity I_{30} of the 1994/1995 season. The I_{30} values ranged between 2.4-18 mm/h in November-February to 1.2-1.6 mm/h in March-May.

4.5. Soil Degredation :

4.5.1. Water erosion :

4.5.1.1. Rainfall erosivity factor "R" :

Table (16) and Figure (2) show the variability of rainfall erosivity factor "R" throughout 1994/95 season. The values ranged between 0.3 and 4.7. The annual rainfall erosivity factor "R" for 1994/1995 is 21.96.

Table 11. Main topographic characteristics of Qassaba.

Geomorphological Unit	Area		Elev. Range	Slope		Aspect	
	km^2	%	m	range	%	range	%
Coastal Dunes	1.42	2.64	1-18	flat	2106	flat	4.91
				1-2	44.46	N, NE, NW,	37.00
				3-4	20.26	E	1.90
				5-8	10.14	SE, S, SW	54.16
				9-17	4.08	W	2.03
Coastal Lagoon	3.40	6.39	1-15	flat	82.18	flat	2.27
				1-2	17.53	N, NE, NW	44.78
				3-4	0.29	E	12.86
						SE, S, SW	29.51
						W	10.58
Ridges	2.12	3.99	5-37	flat	23.12	flat	4.20
				1-2	75.05	N, NE, NW	86.54
				3-5	1.83	E	4.23
						SE, S, SW	2.99
						W	2.04
Inter Ridges	10.74	20.20	9-57	flat	32.59	flat	4.63
				1-2	65.50	N, NE, NW	79.66
				3-4	1.75	E	4.59
				5-7	0.16	SE, S, SW	4.37
						W	6.75
Diss. Plateau	8.78	16.50	41-120	flat	9.59	flat	2.62
				1-2	55.25	N, NE, NW	66.00
				3-4	22.14	E	7.54
				5-8	11.38	SE, S, SW	15.05
				9-15	1.45	W	8.79
				16-25	0.06		
				26-64	0.13		
Plateau	22.40	42.11	78-153	flat	52.09	flat	5.46
				1-2	42.88	N, NE, NW	77.04
				3-4	2.65	E	3.73
				5-8	1.60	SE, S, SW	5.54
				9-15	0.72	W	8.23
				16-22	0.06		
Wadi System	4.35	8.17	9-141	flat	24.88	flat	9.77
				1-2	37.27	N, NE, NW	51.91
				3-4	12.83	E	8.18
				5-8	16.86	SE, S, SW	16.64
				9-15	9.44	W	13.49
				16-23	0.98		

Table 12. Main topographic characteristics of Fuka Basin.

Geomorphological Unit	Area		Elev Range	Slope		Aspect	
	km^2	%	m	range	%	range	%
Dunes and Ridges	69.04	20.34	1-54	flat	48.98	flat	2.87
				1-2	42.56	N, NE, NW	53.78
				3-4	5.26	E	9.68
				5-8	2.59	SE, S, SW	26.77
				9-15	0.54	W	6.90
				16-27	0.07		
Depressions	12.29	3.62	12-53	flat	70.96	flat	2.82
				1-2	27.99	N, NE, NW	57.90
				3-4	0.82	E	10.70
				5-8	0.21	SE, S, SW	20.28
				9-14	0.02	W	8.30
Plains	21.44	6.32	20-51	flat	78.29	flat	1.72
				1-2	21.43	N, NE, NW	50.83
				3-4	0.22	E	18.79
				5-8	0.07	SE, S, SW	24.50
						W	4.14
Diss. Plateau	84.16	24.80	24-121	flat	30.42	flat	3.41
				1-2	56.97	N, NE, NW	52.73
				3-4	8.63	E	21.28
				5-8	3.29	SE, S, SW	18.47
				9-15	0.61	W	4.11
				16-29	0.08		
Plateau	145.58	42.89	60-145	flat	60.06	flat	2.02
				1-2	35.90	N, NE, NW	59.05
				3-4	2.37	E	21.92
				5-8	1.26	SE, S, SW	15.21
				9-15	0.34	W	1.80
				16-25	0.06		
				26-38	0.01		
Wadi System	6.88	2.03	39-106	flat	44.72	flat	6.36
				1-2	38.42	N, NE, NW	57.51
				3-4	6.26	E	15.75
				5-8	6.49	SE, S, SW	16.14
				9-15	3.27	W	4.24
				16-25	0.77		
				26-47	0.08		

Table 13. Historic climate data for Matrouh (1921-1975).

P mm	129.6
O	56.8
Cv	43.8
Iav	68.9
$(Iav)_{rel}$	55.2
B(Gamma)	24.818
Y(Gamma)	5.221
Max. rain in one year	276.8
Min. rain in one year	36

Mean (P), Standard Deviation (O), Coefficient of variance (Cv), Interannual variability (Iav), and Relative Interannual variability $(Iav)_{rel}$

Table 14. Mean annual of rainy days for Matrouh, up to 1995.

Month	P>0.1 mm	P>1.0 mm	P>5.0 mm	P>10.0 mm
Jan.	8.5	5.3	1.7	1.0
Feb.	5.8	3.3	0.9	0.3
Mar.	5.1	2.6	0.6	0.2
Apr.	2.1	0.8	0.1	0.0
May	1.3	0.6	0.0	0.0
June	0.1	0.1	0.1	0.1
July	0.0	0.0	0.0	0.0
Aug.	0.1	0.1	0.0	0.0
Sep.	0.3	0.2	0.1	0.0
Oct.	3.5	1.8	0.7	0.5
Nov.	5.9	3.4	1.3	0.7
Dec.	7.5	5.0	1.9	0.8
Annual	40.2	23.2	7.4	3.6

Table 15. Number and amount of rainy days of different intensities for rain season 1994/95,Automated meteorological station, East Matrouh.

Season 94/95	Oct.94	Nov.	Dec.	Jan.95	Feb.	Mar.	Apr.	May	Total
No. of rainy days	0.0	14.0	15.0	7.0	10.0	9.0	2.0	2.0	59.0
Monthly total, mm	0.0	83.0	35.6	3.0	26.3	6.4	2.1	3.0	159.5
No. of rainy days 0 - 1 mm	0.0	4.0	7.0	6.0	5.0	7.0	1.0	1.0	31.0
Amount of rain on days with 0 - 1 mm	0.0	2.0	1.4	2.0	0.8	1.6	0.5	0.5	8.8
No. of rainy days 1 - 5 mm	0.0	5.0	4.0	1.0	3.0	2.0	1.0	1.0	17.0
Amount of rain on days with 1 - 5 mm	0.0	11.8	11.8	1.0	7.1	4.8	1.6	2.6	40.7
No. of rainy days 5 - 10 mm	0.0	2.0	3.0	0.0	1.0	0.0	0.0	0.0	6.0
Amount of rain on days with 5 -10 mm	0.0	8.2	13.0	0.0	6.4	0.0	0.0	0.0	27.6
No. of rainy days > 10 mm	0.0	3.0	1.0	0.0	1.0	0.0	0.0	0.0	5.0
Amount of rain on days with > 10 mm	0.0	61.0	9.4	0.0	12.0	0.0	0.0	0.0	82.4

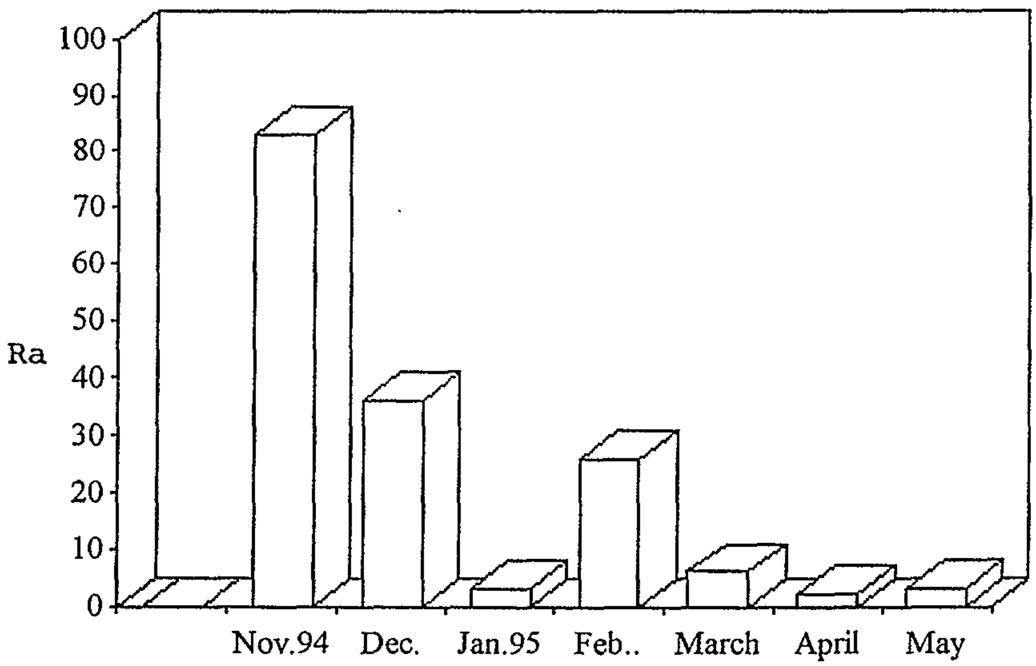

Fig. 1. Total monthly rainfall, rain season 1994/95, Automated Meteorological Station, Matrouh.

Table 16. Rainfall erosivity indices, rain season 1994/1995, Auto. station, Wadi Naghamish, East Matrouh

Month	I_{30}	Rain Intensity mm.\hr	Kinetic Energy J m^{-2} mm^{-1}	Total Kinetic Energy J m-2	Erosion Index EI_{30} J m^{-2}.mm h^{-1}	Rainfall erosivity factor "R" Storm	Rainfall erosivity factor "R" Month
November							
storm 1	9.0	18.00	23.93	430.77	4695.55	4.70	
storm 2	1.4	2.80	14.84	41.55	730.42	0.73	
storm 3	3.8	7.60	19.72	149.87	1982.57	1.98	
storm 4	1.6	3.20	15.49	49.58	834.76	0.83	
storm 5	2.8	5.60	18.23	102.07	1460.84	1.46	
storm 6	2.2	4.40	17.05	75.01	1147.80	1.15	
storm 8	1.2	2.40	14.09	33.81	626.07	0.63	11.48
December							
storm 1	2.6	5.20	17.87	92.90	1356.49	1.36	
storm 2	1.8	3.60	16.07	57.85	939.11	0.94	
storm 3	7.2	14.40	22.84	328.92	3756.44	3.76	6.06
January							
storm 1	1.6	3.20	15.49	49.58	834.76	0.83	0.38
February							
strom 1	3.6	7.20	19.45	140.08	1878.22	1.88	
storm 2	1.0	2.00	13.20	26.39	521.73	0.52	3.23
March							
storm 3	0.8	1.60	12.11	19.37	417.38	0.42	0.42
April							
storm 1	0.9	1.80	12.68	22.83	469.56	0.47	0.47
May							
strom 1	0.6	1.20	10.70	12.84	313.04	0.31	0.31
Total					21964.75		21.96

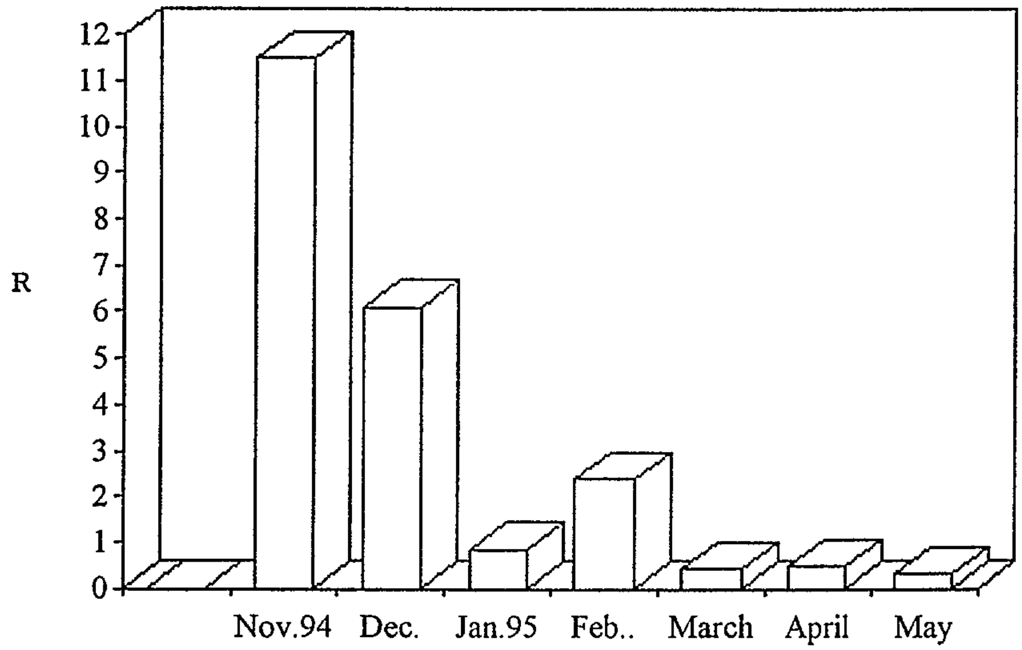

Fig. 2. Rainfall erosion index "R" (j m^{-2}.mm h^{-1}), rain season 1994/95, Automated Meteorological Station, Wadi Naghamish, East Matrouh.

4.5.1.2. Water soil erodability factor "K" :

Tables (5 and 9) give the water soil erodability "K" values of the surface horizons of the studied soil units. At Qassaba the K values ranged from 7.25 to 34.8. At Fuka the K values ranged from 8.5 to 37.9.

4.5.1.3. Length and percent slope factor "LS" :

Tables (11 and 12) give the percentages of the slope classes. The 1-2% slope class dominates the studied areas followed by the 3-4% slope class. The equivalent topographic factor "LS" for 150 feet slope length ranged from 0.15 to 0.44 and from 0.6 to 0.7, respectively (Renard *et al.*, 199).

4.5.2. Wind erosion :

4.5.2.1. Wind erosion forces :

The data of frequency of occurrence, directions by wind speeds groups was obtained from Automated meteorological station, Mersa Matrouh for year 1994/1995. The magnitudes of the wind erosion forces are presented on Table (17) and illustrated in Figure (3). The strong wind erosion forces occur during the spring and summer months. The maximum ratio "R" of parallel to perpendicular wind erosion forces is presented in Table (17). The smallest value of the "R" ratio was 1.17 for August. The greatest value of ratio "R" occurred for January, where the wind erosion forces parallel to the direction, were 2.17 times as great at the perpendicular wind erosion forces.

4.5.2.2. Wind erosivity "C" :

The wind erosivity values for rain season 1994/1995 presented in Table (18) and illustrated in Figure (4). The total value of C was 331.51 for that year, that could be rated as "very high" (FAO, 1978). The maximum value of C was 63.67 (high) for July, while the minimum value was 0.61 for January (none to slight).

4.5.2.3. Wind soil erodability "I" :

Tables (5 and 9) give the wind soil erodability factor (I) of the surface horizons of the studied soil units. At Qassaba the I values ranged from 7 to 134 ton/acre. At Fuka the I values ranged from 17 to 220 ton/acre.

Table 17. Wind erosion forces for East Matrouh, 1995.

Month	Monthly magnitude	Parallel / perpendicular wind erosion ratio (R)
Jan.	1352.20	1.80
Feb.	0.00	0.00
Mar.	7357.90	1.30
Apr.	2177.55	1.40
May	8462.45	1.26
June	5722.40	1.17
July	3511.36	1.34
Aug.	2973.06	1.17
Sep.	6481.33	1.25
Oct.	3425.56	1.46
Nov.	0.00	0.00
Dec.	0.00	0.00

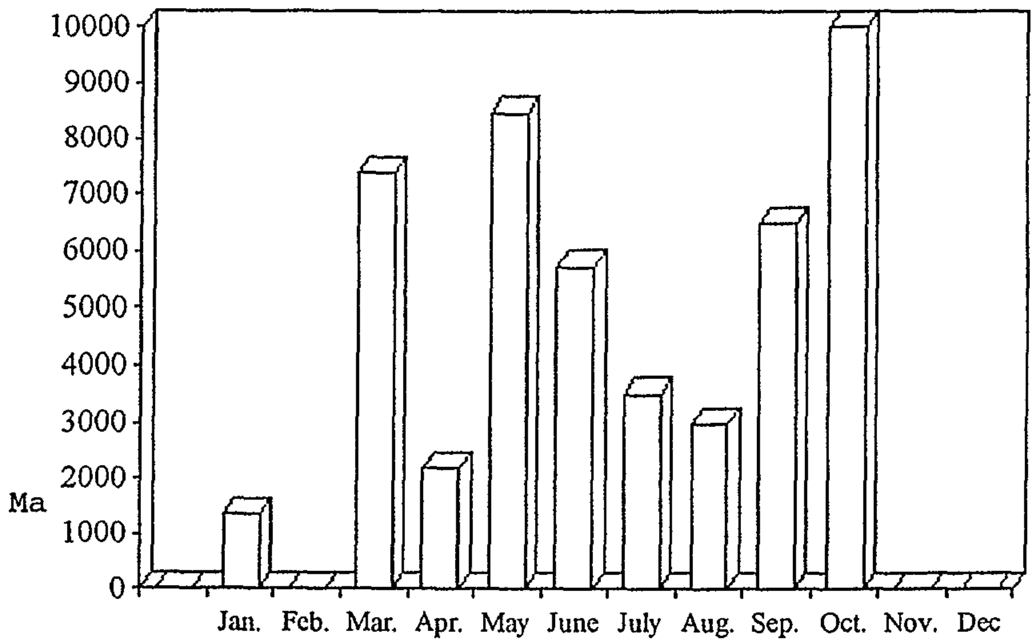

Fig. 3. Monthly magnitudes of wind erosion vector forces, East Matrouh, 1995.

Table 18. Wind erosivity, C for rain season, 1994/1995, Automated station, Wadi Naghamish, East Matrouh.

Month	Mean wind velocity V, m\sec "monthly"	Total rain mm/month P	ETP mm/month	ETP-P/ETP mm	Monthly Wind Erosivity C
Nov., 1994	2.26	83.00	81.00	-0.02	-0.088
Dec.	3.10	35.60	65.10	0.45	4.185
Jan., 1995	2.00	3.00	62.00	0.95	2.360
Feb.	2.90	26.30	81.20	0.68	4.617
Mar.	3.50	6.40	108.50	0.94	12.507
Apr.	5.00	2.10	150.00	0.99	36.975
May	5.20	3.00	161.20	0.98	42.777
June	5.50	0.00	165.00	1.00	49.913
July	5.90	0.00	182.90	1.00	63.667
Aug.	5.70	0.00	176.70	1.00	55.558
Sep.	4.90	0.00	147.00	1.00	36.471
Oct.	4.30	0.00	133.30	1.00	23.852
Total		159.40	1513.90	9.96	332.79

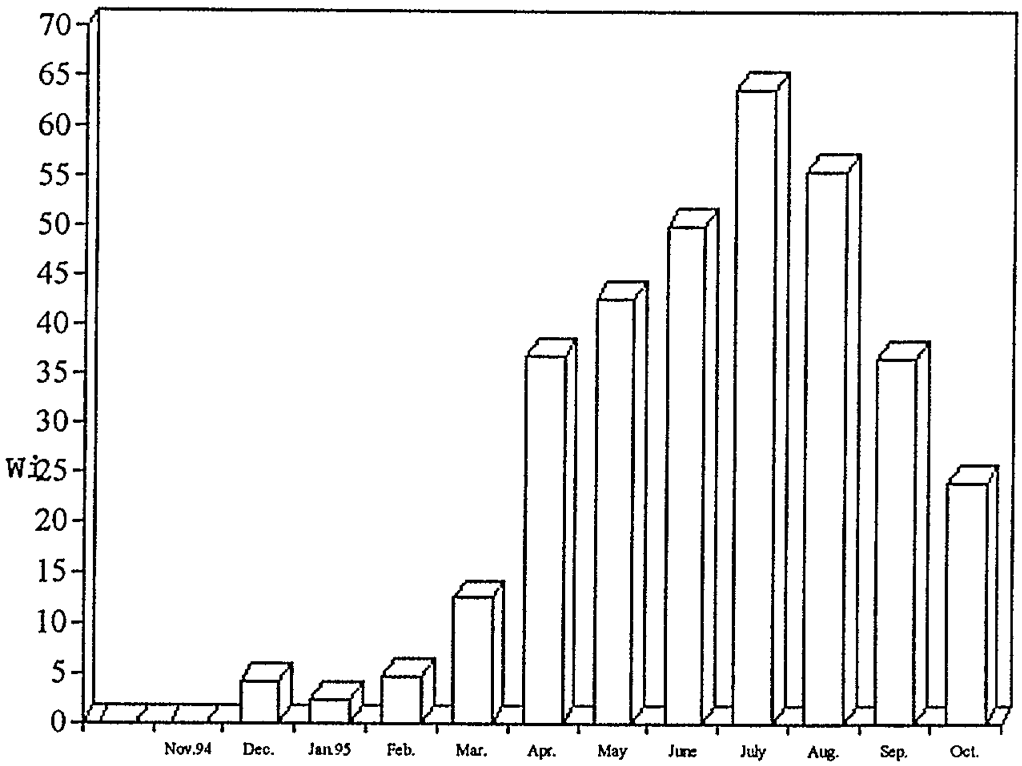

Fig. 4. Monthly wind erosivity (C), Automated Station, Wadi Naghamish, East Matrouh, 1994/1995.

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Appendix (1) : Qassaba

1.1. Main geomorphological units and land units.

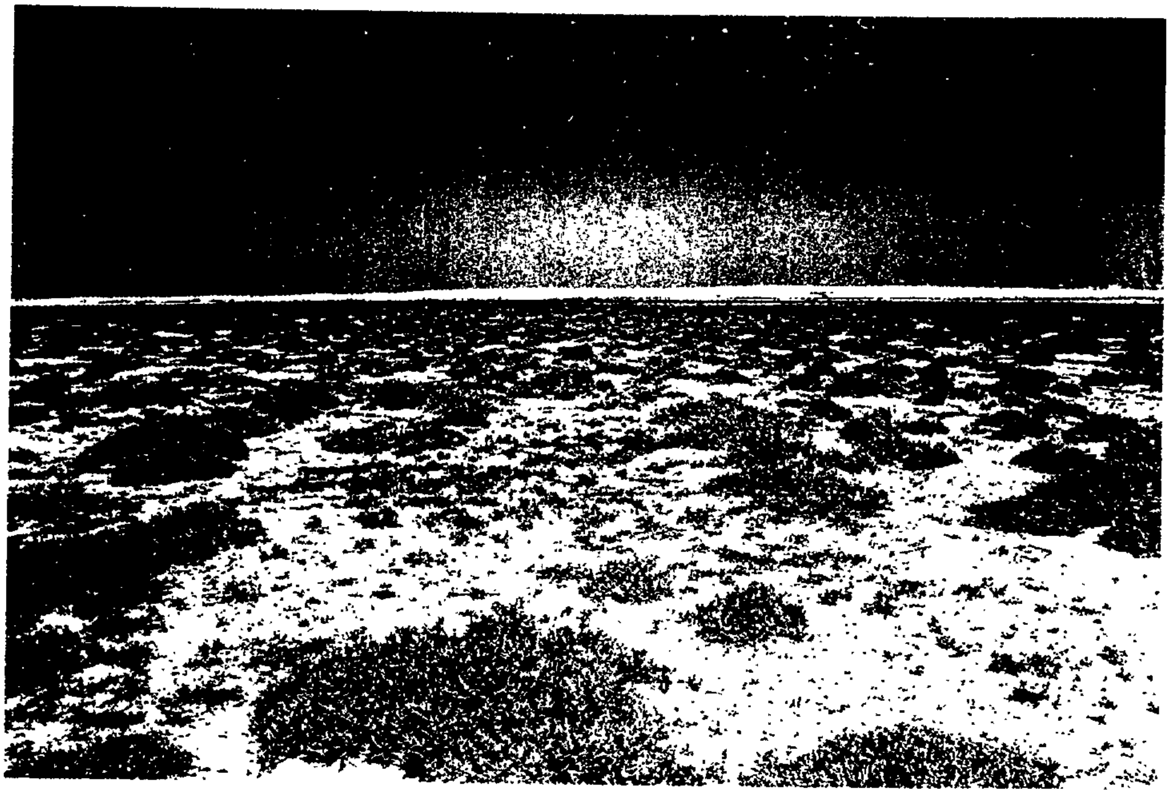


Fig.5.

Geomorphological Unit	:	Coastal lagoon
Lant Unit	:	Salt marsh

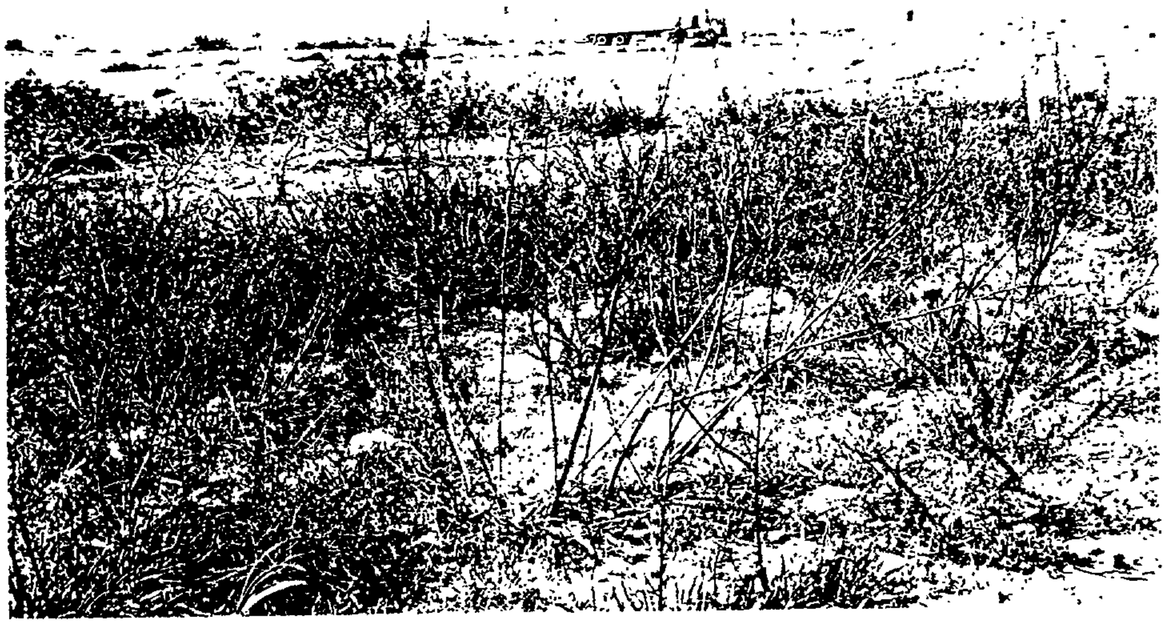


Fig.6.

Geomorphological Unit	:	Inter ridges
Lant Unit	:	Depressions

Fig.7.

Geomorphological Unit : Wadi Systems
Lant Unit : Wadi course and terraced

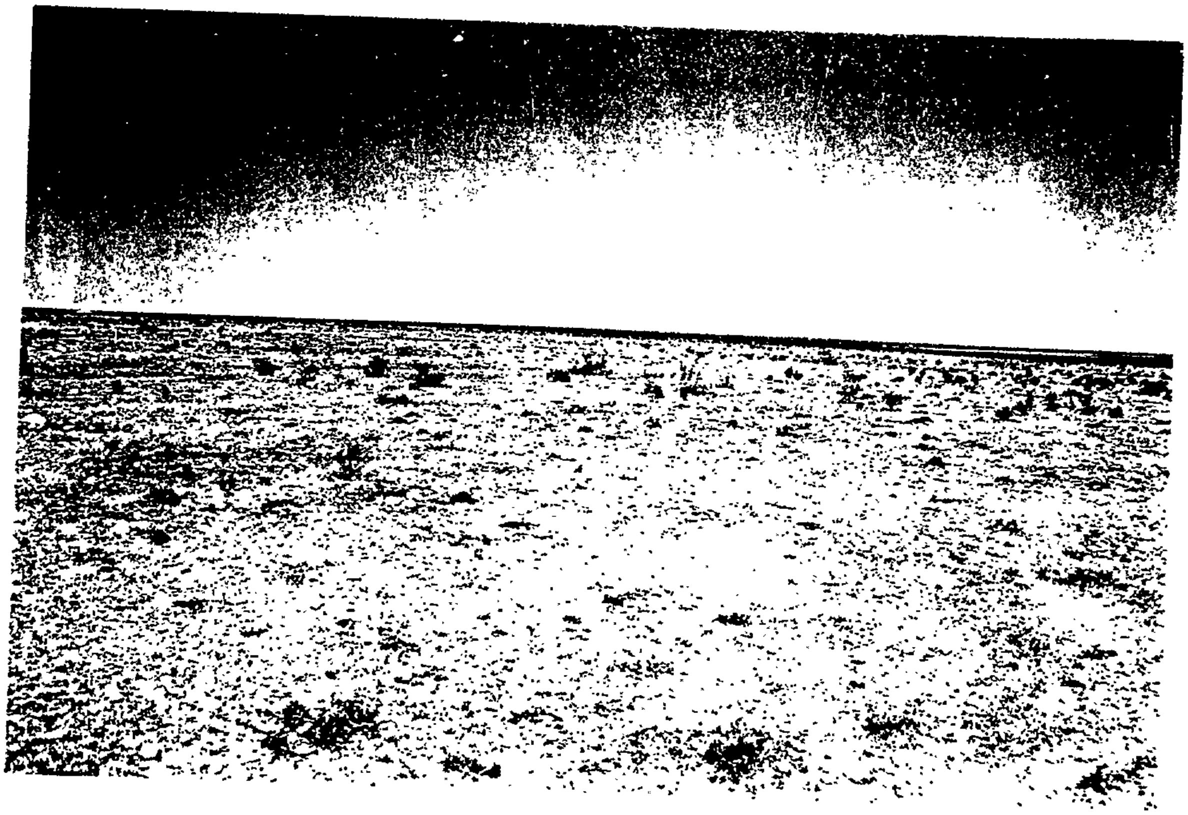


Fig.8.

Geomorphological Unit : Plateau
Lant Unit : Stony plateau

1.2. Morphological description of representative soil profiles of Wadi El-Qassaba

Profile number	: Qassaba 11 (Fig.9)
Date of examination	: 15-6-1995.
Geomorphological unit	: Wadi system.
Land unit	: Wadi terraced.
Soil unit	: Typic Xerorthents.
Mapping unit	: Deep, sandy loam over sand over bed
rock	and stone.
Location	: At about 8.5km to the south of the km258 of Alex.-Matrouh desert road.
Elevation	: +100 m. A.S.L.
Parent material	: Recent alluvial deposites
Land use	: Rainfed agriculture.
Vegetation cover	: Fruits tree (figs).
Salting/crusting	: Nil.

Horison **Description**

0-15 (cm), brown (5YR 5/8) moist and yellow (10YR 7/6) dry; sandy loam; moderately weak granular; slightly sticky, slightly plasticity, firm moist, friable, calcareous; smooth boundary to.

15-50 (cm), light brown (5 YR 6/6) moist and yellow (10 YR 8/6) dry; sand; single grains; non sticky, non plasticity, friable moist, soft dry; friable; calcareous; smooth clear boundary to.

50-80 (cm), brown (5YR 5/8) moist and yellow (10 YR 7/6) dry; sandy loam; moderately week granular; slightly sticky, slightly plasticity, firm moist, friable, calcareous, few to many medium white hard lime rock fragments.

Profile number	: Qassaba 21 (Fig.10)
Date of examination	: 16-6-1995.
Geomorphological unit	: Dissected plateau.
Land unit	: Interhill land.
Soil unit	: Xeric Haplcalcids.
Mapping unit	: Deep, loamy sand over sandy loam.
Location	: At about 6 km to the south of the km 259 of Alex.-Matrouh desert road.
Elevation	: +36 m. A.S.L.
Parent material	: Pleistocene marine deposit.
Land use	: Range land, olive trees.
Vegetation cover	: Fruits trees and cereals crops.
Salting/crusting	: Nil.

Horizon **Description**

0-30 (cm), brown (5 YR 5/6) moist and reddish yellow (7.5 YR 7/6) dry, loamy sand, massive, slighly sticky, slightly plastic, friable moist, soft dry; friable; calcareous; few fine fibrous dead roots; smooth clear boundary to.

30-65 (cm), brown (5 YR 5/6) moist and yellow (10 YR 7/6) dry, sandy loam; moderately weak granular; sticky, plastic, firm moist, hard dry; compact, calcareous, many hard line nodules; irrigular boundary to.

65-110 (cm) light yellowish brown (10 YR 6/5) dry; moderate, thick platy; sticky, plastic, very hard dry; very compact; very calcareous. many medium to coarse hard lime nodules.

Profile number : Qassabsa 4 (Fig.11)

Date of examination : 13-6-1995.

Geomorphological unit : Inter ridges.

Land unit : Hummocky deep land.

Soil unit : Xeric Petrocalcids.

Mapping unit : Shallow, sandy loam over sandy clay loam.

Location : At about 3.5 km to the south of the km258 of Alex. Matrouh desert road.

Elevation : +37 m. A.S.L.

Parent material : Pleistocene marine deposit.

Land use : Rainfed agriculture.

Vegetation cover : Fruit trees (Figs).

Salting/Crusting : Nil.

Horizon **Description**

0-30 (cm), brown (5 YR 5/8) and riddish yellow (7.5 YR 6/8) dry; sandy loam, blocky; slightly sticky, slightly plasticity, firm moist, hard dry; compact; calcareous, few fine fibrous fresh roots. smooth boundary to.

30-65 (cm), brown (5 YR 5/8) and yellowish yellow (10 YR 6/8) dry; sandy clay loam; moderately weak granulare; very sticky, very plasticity, very firm moist, hard dry; very compact; very calcareous, many rock fragments.

> 65 (cm), bedrock fragments.

Profile number : Qassaba 25 (Fig.12)

Date of examination : 17-6-1985.

Geomorphological unit : Inter ridges.

Land unit : Depressions.

Soil unit : Typic Xerorthents.

Mapping unit : Deep, sandy loam over sandy clay loam.

Location : At about 2 km to the south of the km 259 of Alex.-Matrouh desert road.

Elevation : + 31 m. A.S.L.

Parent material : Pleistocene marin deposit.

Land use : Rainfed agriculture.

Vegetation cover : Wheat, barley, figs, olives and watermelon.

Salting/crusting : Crusting.

Horizon **Description**

0-25 (cm), light brown (10 YR 6/6) moist and reddish yellow (7.5 YR 6/6) dry; sandy loam; blocky; sticky plastic; firm moist, hard dry; compact; slightly calcareous; few fine fibrous fresh roots, smooth clear boundary to.

25-60 (cm), the same as above horizon but, sandy clay loam, very sticky, very plastic.

60-90 (cm), the same as above horizon but, very calcareous.

Profile number	: Qassaba 14 (Fig.13)
Date of examination	: 15-6-1995.
Geomorphological unit	: Southern plateau.
Land unit	: Hummocky shallow depression.
Soil unit	: Xeric Petrocalcids.
Mapping unit	: Shallow,Sandy loam over bed rock and stone.
Location	: At about 14 km to the south of the km 258.5 of Alex.-Matrouh desert road.
Elevation	: +141 m. A.S.L.
Parent material	: Pleistocene marine deposit.
Land use	: Range land.
Vegetation cover	: Herbaceous and short grass.
Salting/crusting	: Nill.

Horizon	Description
0-30 (cm),	brown (5 YR 5/6) moist and light yellowish brown (10 YR 6/5) dry; sandy loam; single grains slightly sticky, slightly plasticity, form moist, hard dry friable; calcareous, many coarse rock fragments.
> 30 (cm),	bedrock.

Profile number	: Qassaba 15 (Fig.14)
Date of examination	: 15-6-95.
Geomorphological unit	: Dissected plateau.
Land unit	: Complex.
Soil unit	: Typic Xerorthents.
Mapping unit	: Shallow, sand loam over sandy clay loam.
Location	: At 12 km to the south of the km 259 of Alex.-Matrouh desert road.
Elevation	: +91 m. A.S.L.
Parent material	: Pleistocene marine deposit.
Land use	: Range land.
Vegetation cover	: Herbaceous and short grass.
Salting/crusting	: Nil.

Horizon **Description**

0-10 (cm), brown (5 YR 5/6) moist and very pale brown (10 YR 7/4) dry; Loamy; massive; slightly sticky, slightly plasticity; friable, loose dry; friable; calcareous, few to common fine fibrous dead root; many fine to medium white hard lime rock fragments; irrigular clear boundary to.

10-40 (cm), brown (5 YR 5/6) moist and riddish yellow (75 YR 7/6) dry; sandy loam; sticky, plastic; firm moist, hard dry; compact; vern calcareous; many medium to coarse hard lime nodules, irregular clear boundary to.

40-65 (cm), bedrock.

Profile number	: Qassaba 9 (Fig.15)
Date of examination	: 14-6-1995.
Geomorphological unit	: Dissected plateau.
Land unit	: Footslopes.
Soil unit	: Typic Xeropsamments.
Mapping unit	: Deep, loamy sand.
Location	: At about 6 km to the south of km 257 of Alex.-Matrouh desert road.
Elevation	: +96 m. A.S.L.
Parent material	: Pleistocene marine deposit.
Land use	: Range land and cereal crops.
Vegetation cover	: Herbaceous and short grass.
Salting/crusting	: Crusting.

Horizon **Description**

0-15 (cm), light brown (10 YR 6/6) moist and pink (7.5 YR 7/4) dry; loamy sand; massive; slightly sticky, slightly plasticity, friable, moist hard, friable; very calcarous, few to common medium to coarse white lime nodules, smooth boundary to.

15-55 (cm), such as above horizon but compact ; many medium to coarse hard lime nodules.

55-100 (cm), such as above horizon.

Fig.9. Profile No.11

Geomorphological Unit	:	Wadi system
Land Unit	:	Wadi terraced
Soil Unit	:	Typic Xerothents

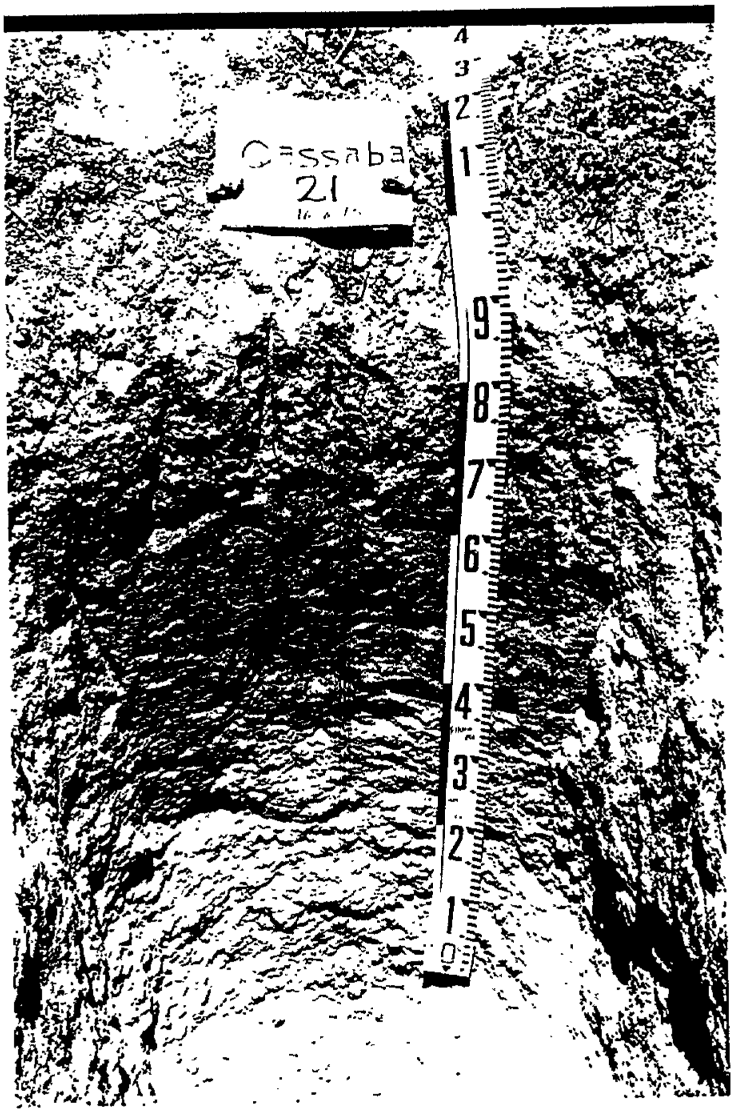


Fig. 10. Profile No.21

Geomorphological Unit	:	Dissected plateau
Land Unit	:	Interhill land
Soil Unit	:	Xeric Haplocalcids

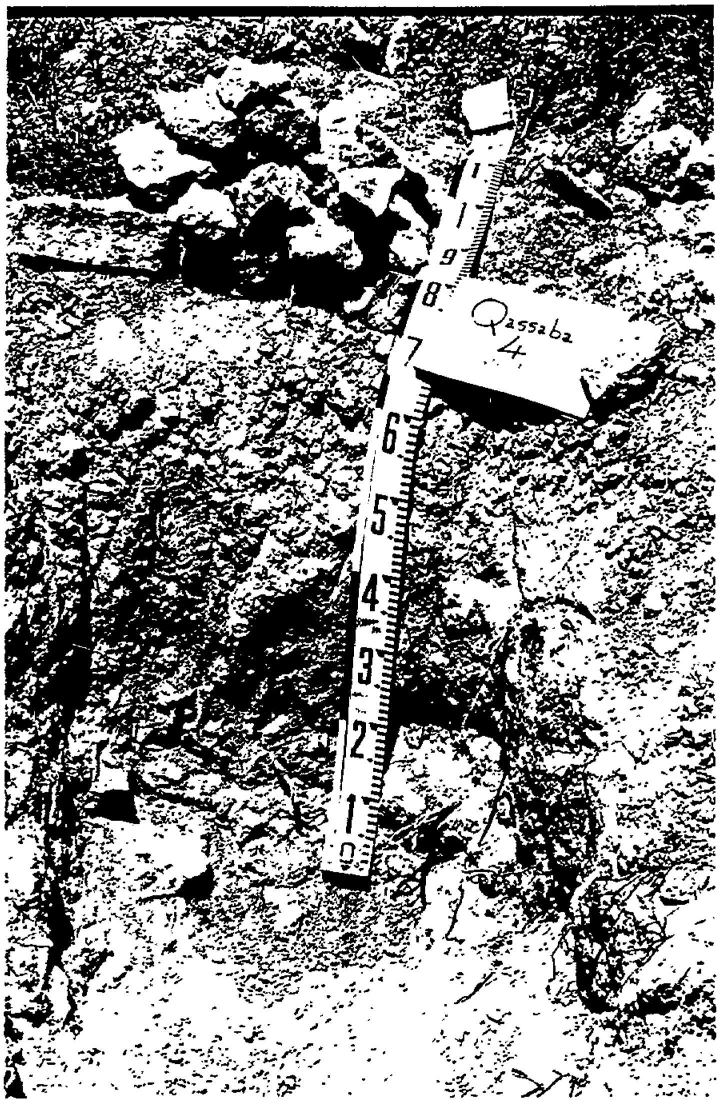


Fig. 11. Profile No.4

Geomorphological Unit	:	Inter ridges
Land Unit	:	Hummocky deep land
Soil Unit	:	Xeric petrocalcids

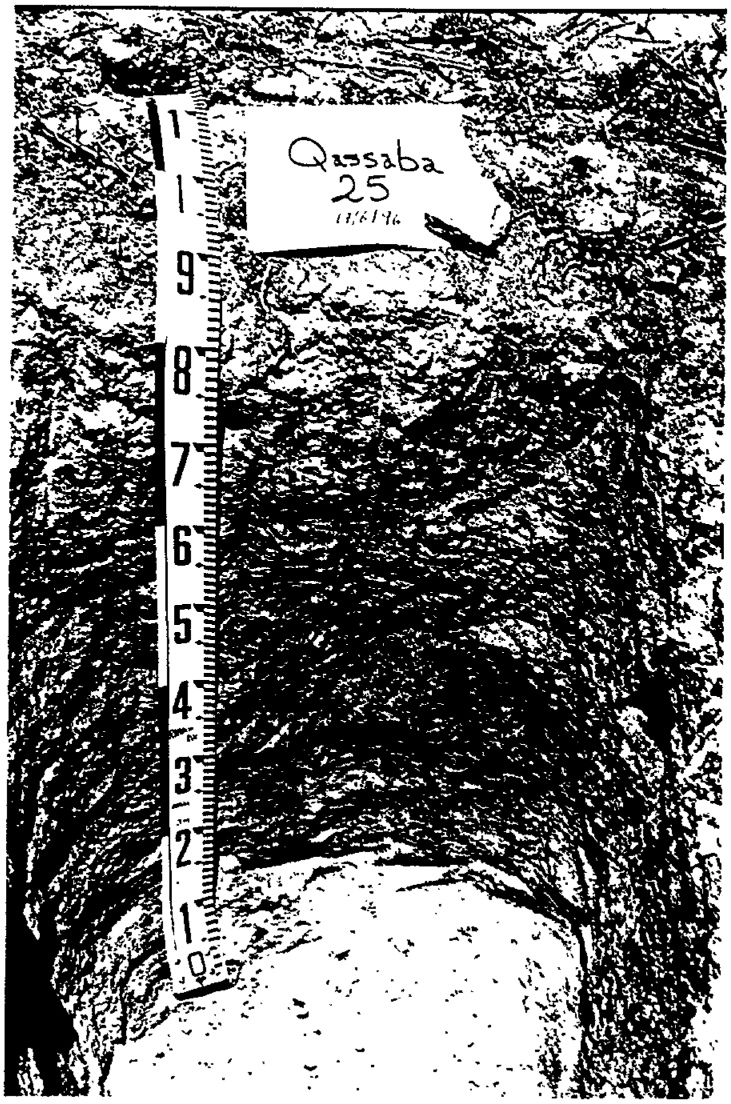


Fig. 12. Profile No.25

Geomorphological Unit	:	Inter ridges
Land Unit	:	Depressions
Soil Unit	:	Typic Xerothents

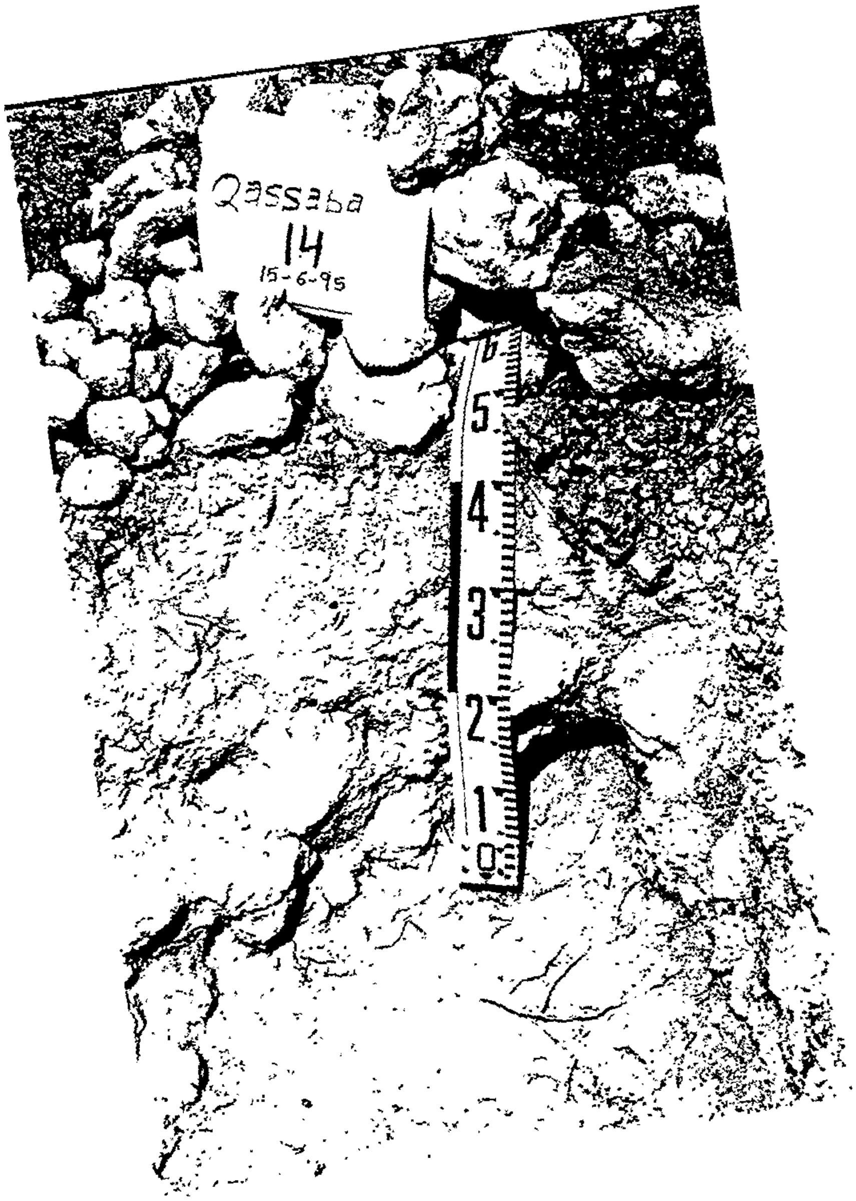


Fig. 13. Profile No.14

Geomorphological Unit : Southern plateau

Land Unit : Hummocky shallow depression

Soil Unit : Xeric Petrocalcids

Fig. 14. Profile No.15

Geomorphological Unit	:	Dissected plateau
Land Unit	:	Complex
Soil Unit	:	Typic Xerothents

Fig. 15. Profile No.9

Geomorphological Unit	:	Dissected plateau
Land Unit	:	Footslopes
Soil Unit	:	Typic Xeropsamments

Appendix (2) : Fuka

2.1. Main geomorphological units and land units of Fuka.

Fig.16.

Geomorphological Unit	:	Plains
Lant Unit	:	Alluvial plain

Fig.17.
Geomorphological Unit : Depression
Lant Unit : Hummocky land

Fig.18.

Geomorphological Unit : Wadi System

Lant Unit : Wadi course

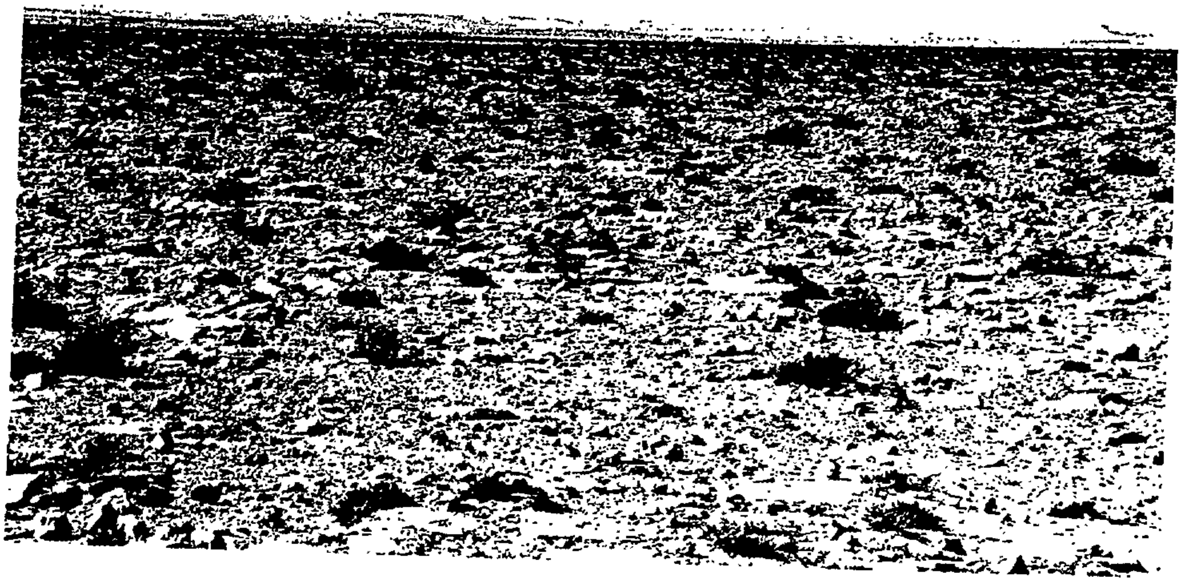


Fig.19.

Geomorphological Unit : Plateau
Lant Unit : Stony plateau

2.2. Morphological description of representative soil profiles of Fuka

Profile number	: Fuka 6 (Fig.20)
Date of examination	: 12-10-1995.
Geomorphological unit	: Depressions.
Land unit	: Intra ridge depressions.
Soil unit	: Xeric Haplocalids.
Mapping unit	: Moderately deep, sandy loam with calcic horizon.
Location	: At about 3 km to the south of the km 215 of Alex.-Matruh desert road.
Elevation	: +40 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
Land use	: Range land.
Vegetation cover	: Natural vegetation.
Salting/crusting	: Nil.

Horizon **Description**

0-25 (cm), pale yellowish brown (10YR 5/4) moist and bright yellowish brown (10YR 7/6) dry; sandy clay loam; strong medium subangular blocky; sticky, plastic, firm moist, hard dry, very calcareous; slightly compact; many fine plant roats, smooth clear boundary to ...

25-55 (cm), brown (5YR 5/8) moist and reddish yellow (7.5YR 6/8) dry; sand clay loam;massive; sticky, plastic, firm moist, hard dry, very calcareous; compact; many fine soft to hard white lime nodules, smooth clear boundary to ...

55-90 (cm), yellowish brown (10YR 5/6) moist and bright yellowish brown (10YR 6/6) dry;sandy loam; massive; slightly sticky, slightly plastic, firm moist,hard dry, extremely calcareous; very compact; dominant medium soft to hard white lime nodules and pale yell carbonte patches.

Profile no	: Fuka 13 (Fig.21)
Date of examination	: 18-10-1995.
Geomorphological unit	: Plains.
Land unit	: Low smooth ridges.
Soil unit	: Lithic Haplocalcids.
Mapping unit	: Shallow, sandy loam over bedrock.
Location	: At about 0.5km to the south of the km 212 of Alex.-Matruh desert road.
Elevation	: +25 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
Land use	: Range land.
Vegetation cover	: Natural vegetation.
Salting/crusting	: Nil.

Horizon **Description**

0-15 (cm), brown (5 YR 5/6) moist and reddish yellow (7.5 YR 7/6) dry, sandy loam, massive, slightly sticky, slightly plastic, firm moist, friable, very calcareous slightly compact, common fine to medium hard lime nodules; few fine plant roots; irregular diffused boundary to ..

15-50 (cm), pale yellowish brown (10 YR 7/3) moist and ligh yellowish brown (10 YR 8/4) dry, sandy loam, massive, slightly sticky, slightly plastic, firm moist,very hard dry,extremely calcareous; very compact many medium to coarse hard white lime nodules, smooth sharp boundary to ..

> 50 conslidated oolitic limestone.

Profile no	: Fuka 20 (Fig.22)
Date of examination	: 16-10-1995.
Geomorphological unit	: Plains
Land unit	: Harvested sand plain.
Soil unit	: Xeric Haplocalcids.
Mappling unit	: Deep, sandy.
Location	: At about 6.5km to the south of the km215 of Alex.-Matruh desert road.
Elevation	: +60 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
Land use	: Rainfed agriculture.
Vegetation cover	: Orchards and some natural vegetation.
Salting/crusting	: Nil.

Horizons **Description**

0-20 (cm), brown (5YR 5/8) moist and yellowish brown (10 YR 7/8) dry; sandy, subgke grains; non sticky, non plastic, friable moist, loose dry, very calcareous few fine hard lime nodules; few fine plant roots, irregular diffused boundary to

20-55 (cm), the same as above horizon but slightly compact and common fine hard lime nodules.

55-110 (cm), bright brown (7.5 YR 5/8) moist and yellow orange (7.5 YR 7/8) dry; sandy single grains, non sticky, non plastic, friable moist, loose dry, calcareous;few fine soft lime nodules;many yellowish brown iron mottles.

Profile no	: Fuka 8 (Fig.23)
Date of examination	: 13-10-1995.
Geomorphological unit	: Dissected plateau.
Land unit	: High dissected plateau.
Soil unit	: Calcic Petrocalcids.
Mapping unit	: Moderately deep, sandy loam with calcic horizon.
Location	: At about 5.5 km to the south of the km210 of Alex.-Matruh desert road.
Elevation	: +40 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
Land use	: Range land.
Vegetation cover	: Natural vegetation.
Salting/Crusting	: Nil.

Horizons **Description**

0-15 (cm), brown (5 YR 5/6) moist and very pale brown (10 YR 7/4) dry; sandy loam; strong fine subangular blocky; slightly sticky, slightly plastic, firm moist, hard dry, very calcareous; slightly compact; common fine to medium hard lime nodules; common fine plant roots; smooth clear boundary to

15-45 (cm), brown (5 YR 5/6) moist and reddish yellow (7.5 YR 7/6) dry; sandy clay loam; massive; sticky, slightly plastic, firm moist, very hard dry, very calcareous; very compact; many medium hard lime nodules, Dominant soft white lime patches; smooth diffused boundary to

45-70 (cm), same as above horizon but extremely calcareous dominant coarse white lime nodules and many coarse bedrock fragments.

Profile no	: Fuka 14 (Fig.24)
Date of examination	: 19-10-1995.
Geomorphological unit	: Plains.
Land unit	: Alluvial plain.
Soil unit	: Typic Xeropsamments.
Mapping unit	: Deep, sandy.
Location	: At about 2.5km to the south of the km217 of Alex.-Matrouh desert road.
Elevation	: +30 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
land use	: Rainfed agriculture.
Vegetation cover	: Natural vegetation and figs.
Saling/Crusting	: Nil.

Horizon	**Description**
0-30 (cm),	brown (5 YR 5/8) moist and brownish yellow (10 YR 6/6) dry; sandy; single grains; non sticky, non plastic, losse moist, lossdry, calcareous; losse; many fine to medium fresh plant roots; smooth clear boundary to..

30-110 (cm), same as above horizon but slightly calcareous.

Profile no	: Fuka 18 (Fig.25)
Date of examination	: 14-10-1995.
Geomorphological unit	: Plateau.
Land unit	: Stony plateau.
Soil unit	: Lithic Xerothents.
Mapping unit	: Shallow, sandy loam over conslidated bedrock.
Location	: At about 8 km to the south of the km 219 of Alex.-Matruh desert road.
Elevation	: +60 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
Land use	: Uncultivated.
Vegetation cover	: Natural vegetation.
Salting/Crusting	: Nil.

Horizon	**Description**
0-40 (cm),	brown (5 YR 5/8) moist and yellowish brown (10 YR 6/8) dry; sandy loam; massive; slightly sticky, slightly plastic, firm moist, hard dry, very calcareous; many medium to coarse bedrock fragments, few plant roots.

> 40 Conslidated bedrock.

Profile no	: Fuka 19 (Fig.26)
Date of examination	: 12-10-1995.
Geomorphological unit	: Dissected plateau.
Land unit	: Escarpment.
Soil unit	: Lithic Haplocalcids.
Mapping unit	: Shallow, sandy loam with calcic horizon.
Location	: At about 7 km to the south of the km 217 of Alex.-Matruh desert road.
Elevation	: +45 m.(A.S.L)
Parent material	: Pleistocene marine deposits.
Land use	: Uncultivated.
Vegetation cover	: Natural vegetation.
Salting/Crusting	: Nil.

Horizon	**Description**
0-25 (cm),	brown (5 YR 5/8) moist and yellowish brown (10 YR 6/8) dry; sandy loam; massive; slightly sticky, non plastic, firm moist, slightly hard dry, calcareous; common fine to medium hard lime nodules; few fine plant roots; irregular diffused boundary to ..
25-50 (cm),	brown (5 YR 5/8) moist and reddish yellow (7.5 YR 6/8) dry; sandy loam;massive;slightly sticky, slightly plastic, firm moist,harddry extremely calcareous; many medium to coarse hard lime nodules;few coarse bedrock fragments.

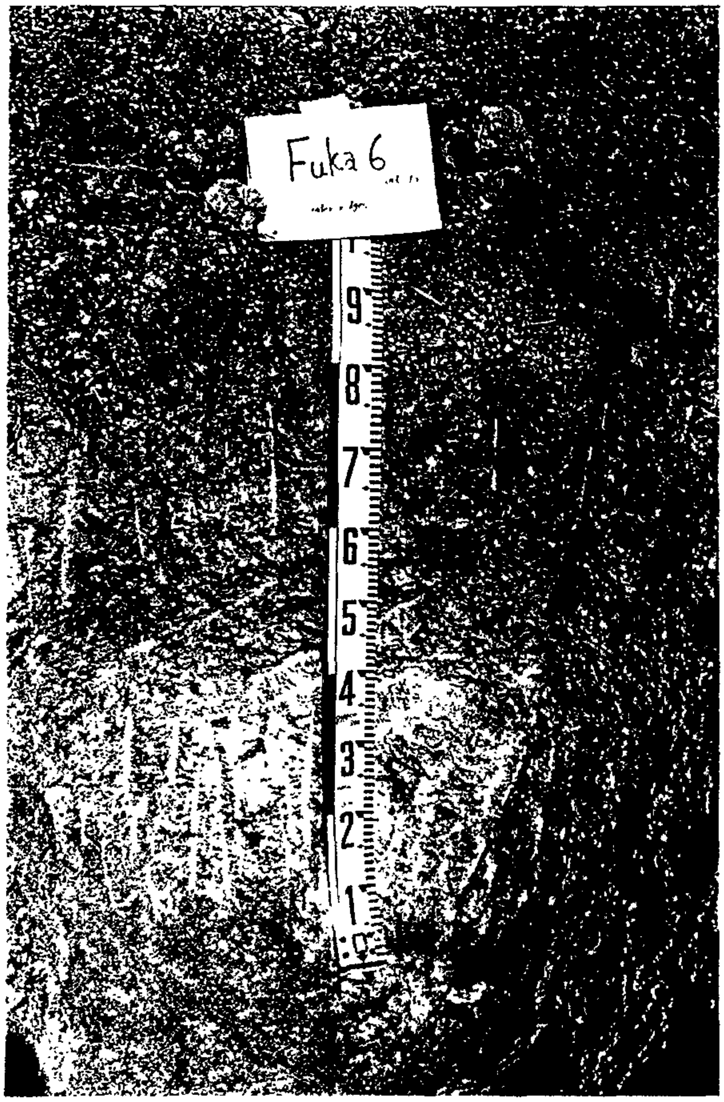


Fig. 20. Profile No.6

Geomorphological Unit	:	Depressions
Land Unit	:	Intra ridge depressions
Soil Unit	:	Xeric Haplocalcids

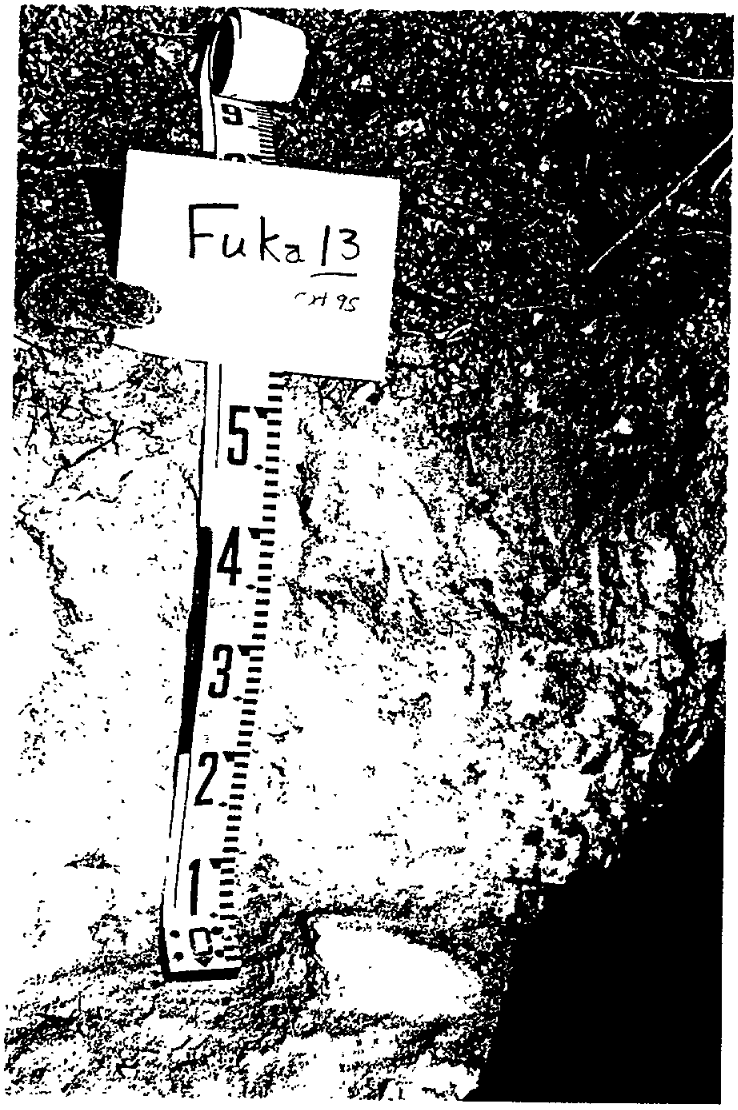


Fig. 21. Profile No.13

Geomorphological Unit	:	Plains
Land Unit	:	Low smooth ridges
Soil Unit	:	Lithic Haplocalcids

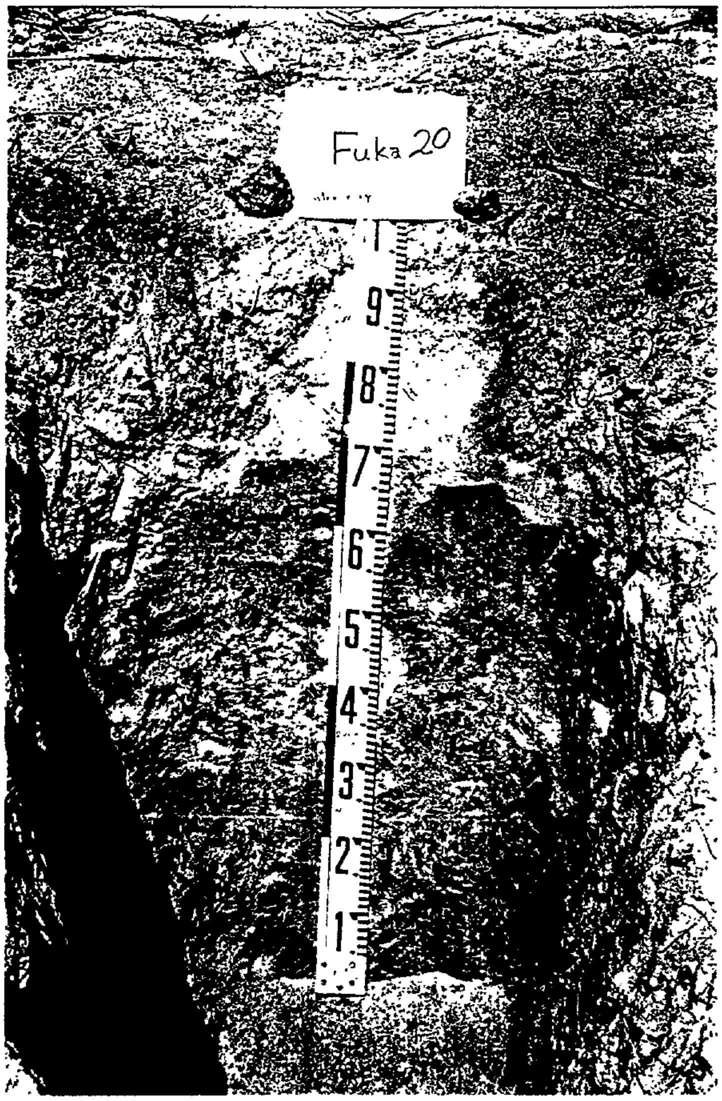


Fig. 22. Profile No.20

Geomorphological Unit	:	Plains
Land Unit	:	Harvested sand plain
Soil Unit	:	Xeric Haplocalcids

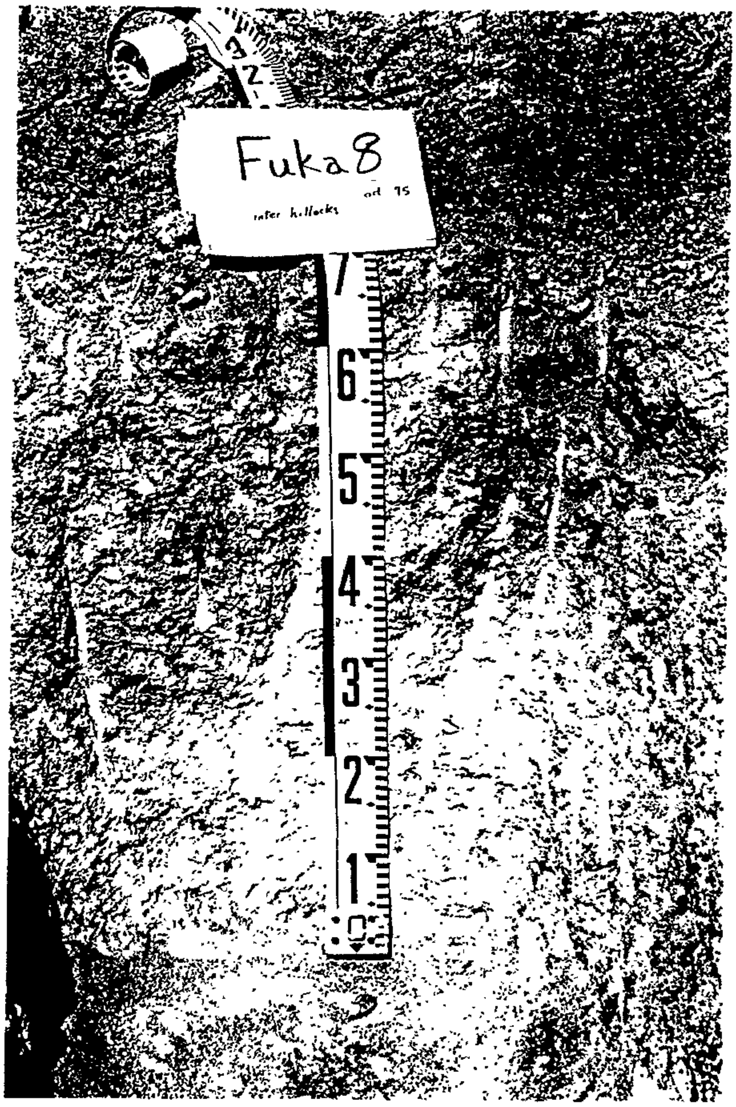


Fig. 23. Profile No.8

Geomorphological Unit	:	Dissected plateau
Land Unit	:	High dissected plateau
Soil Unit	:	Calcic Petrocalcids

Fig. 24. Profile No.14

Geomorphological Unit	:	Plains
Land Unit	:	Alluvial plain
Soil Unit	:	Typic Xeropsamments

Fig. 25. Profile No.18

Geomorphological Unit	:	Plateau
Land Unit	:	Stony plateau
Soil Unit	:	Lithic Xerothents

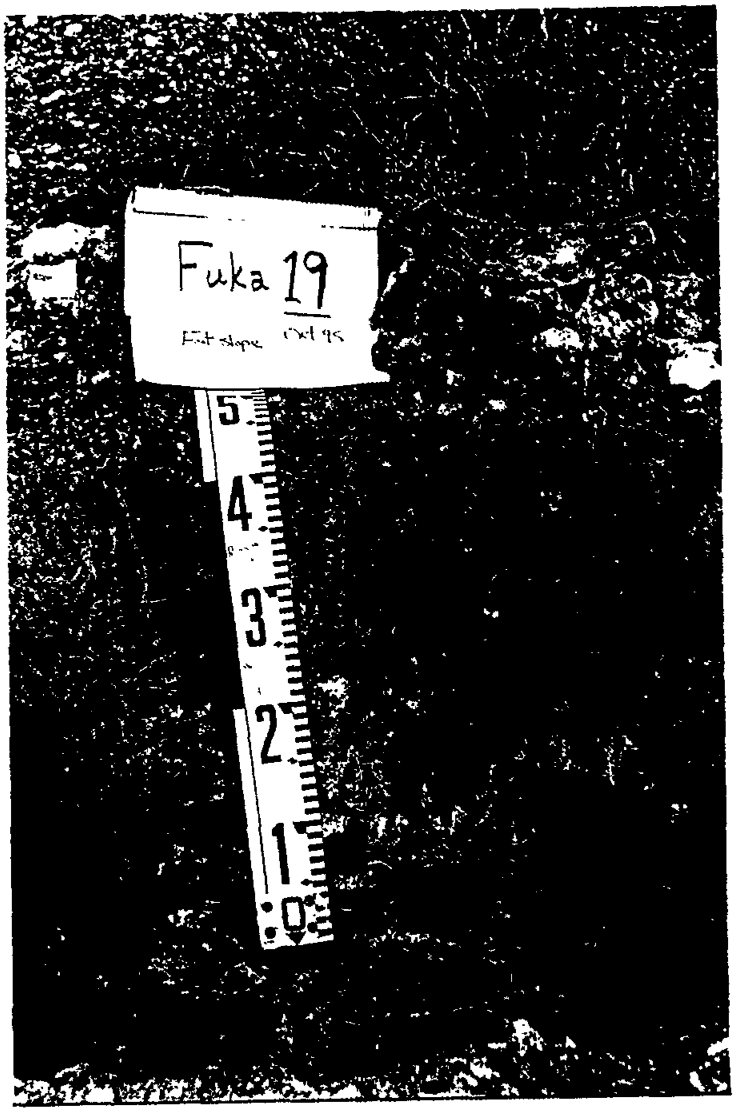


Fig. 26. Profile No.19

Geomorphological Unit : Dissected plateau

Land Unit : Escarpment

Soil Unit : Lithic Haplocalcids

Appendix (3) : Erosion Hazard

3.1. Water erosion indices

3.1.1. Rainfall erosivity factor "R" :

16 individual storms for 1994-1995 were identified. Analysis of each storm followed the method ofWischmeior and Smith, 1978 and Morgan 1995. The rainfall intensity (mm) as a function of time (5 min. interval) was used. Rainfall kinetic energy (Jm^{-2} mm^{-1}) for each time interval was calculated. For each storm the maximum 30 minute rainfall intersity I_{30}(mm/h) was identified.

The Wischmeier ET_{30} index =

Total kinetic energy of each storm (E) J/m^2 $X.I_{30}$.

The rainfall erosivity factor r_i for each sotrm in metric units = $EI_{30}/1000$.

The total rainfall erosivity factor "R" = $\sum_{1}^{n} r_i$, n = No. of storms of season

3.1.2. Soil erodibility factor "K"

(Wischmeies and Smith 1978)

$$K = (2.1X10^{-4})(12 - OM)\, M^{1.14} + 3.25(S - 2) + 2.5\,(P - 3)$$

where ; OM = percent organic matter,

M = (% silt + very fine sand) (100 - % clay),

S = structure index, and

P = permeability class.

3.1.3. Length and Percent Slope Factor "LS"

(Wischmeierul Smith 1978, Renard *et al.*, 1992)

$$LS = (x)^{0.5}\,(0.0076 + 0.0053s + 0.00076s^2)$$

where; x is the field slope length in feet, and

s is the gradient expressed as slope percent e.g. 4% as 4).

3.2. Wind erosion indices :

3.2.1. Magnitude of wind erosion forces : (Skidmore, 1965)

The collected data were analyzed based on the frequency of occurrence of direction by wind speed groups using windrose model to calculated the magnitute of wind erosion force vectors "r_j".

For a specified direction :

$$r_j = \sum_{i=1}^{n} U_i^3 f_i \qquad (1)$$

where ;

r_j = magnitude of wind erosion force vector.

U_i = mean wind speed within the speed group greater than 12 miles/h.

f_i = duration factor as % of total observation within the i^{th} speed group.

n = number of speed groups.

The sub j's indicate direction and take on value form 0 to 15, inclusive, representing the principle compass directions.

The sum of the magnitudes of the wind erosion force vectors for all directions gives the total Magnitude of wind erosion forces I_T for a location and is expressed by the following equation :

$$I_T = \sum_{j=0}^{15} \sum_{i=1}^{n} U_{ij}^3 f_{ij} \qquad (2)$$

The value obtained by equation (2) indicates the relative capacity of the wind to cause soil blowing at particular location.

The magnitude of erosion forces parallel to a particular direction as well as the maximum-minimum ratio of barrier orientation were obtained from the wind erosion force vectors "r_j".

3.2.2. Wind erosivity "C" : (FAO, 1978)

Wind erosivity "C" was calculated using equation

$$C = \sum_{1}^{12} \frac{V^3}{100} \times \frac{PET - P}{PET} \times n$$

where ;

V = mean monthly wind speed at 2 m. height, m/sec.

P = precipitation, mm/day

PET = potential evapotransipitation, mm/day

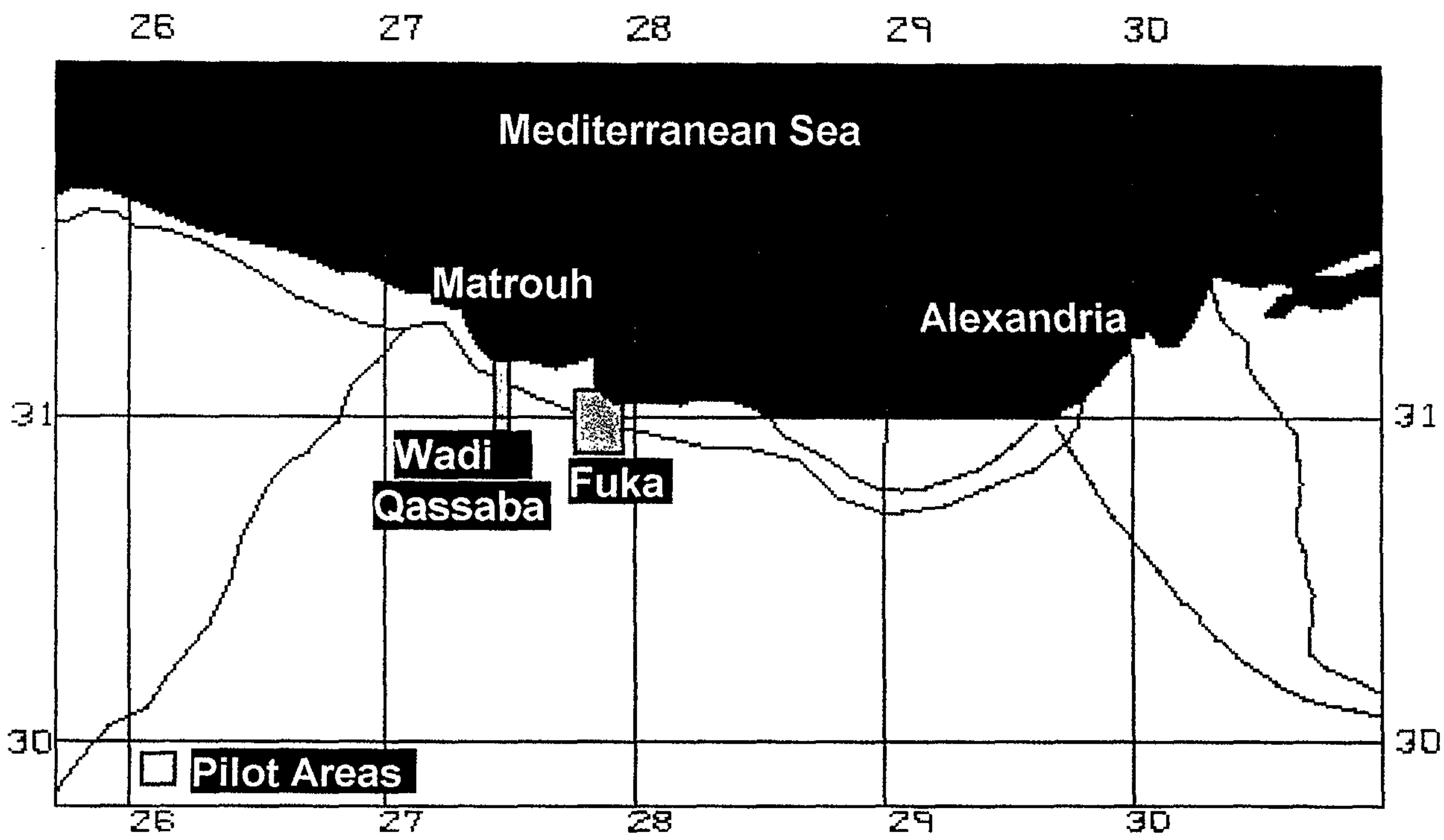
n... number of days in month

3.2.3. Wind soil erodability (I) :

For rating of % of dry soil fractions >1mm, values of Woodruff and Siddoway (1965) were considered.

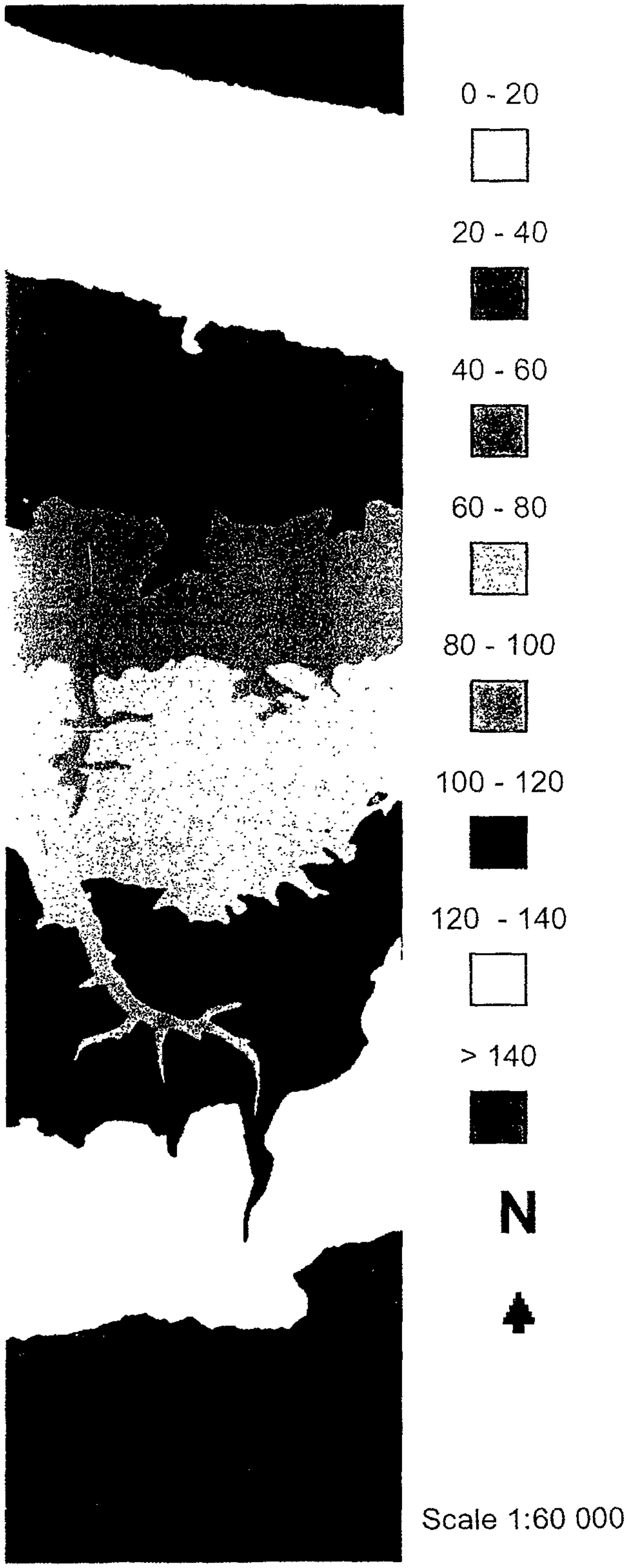
Appendix (4)

Maps

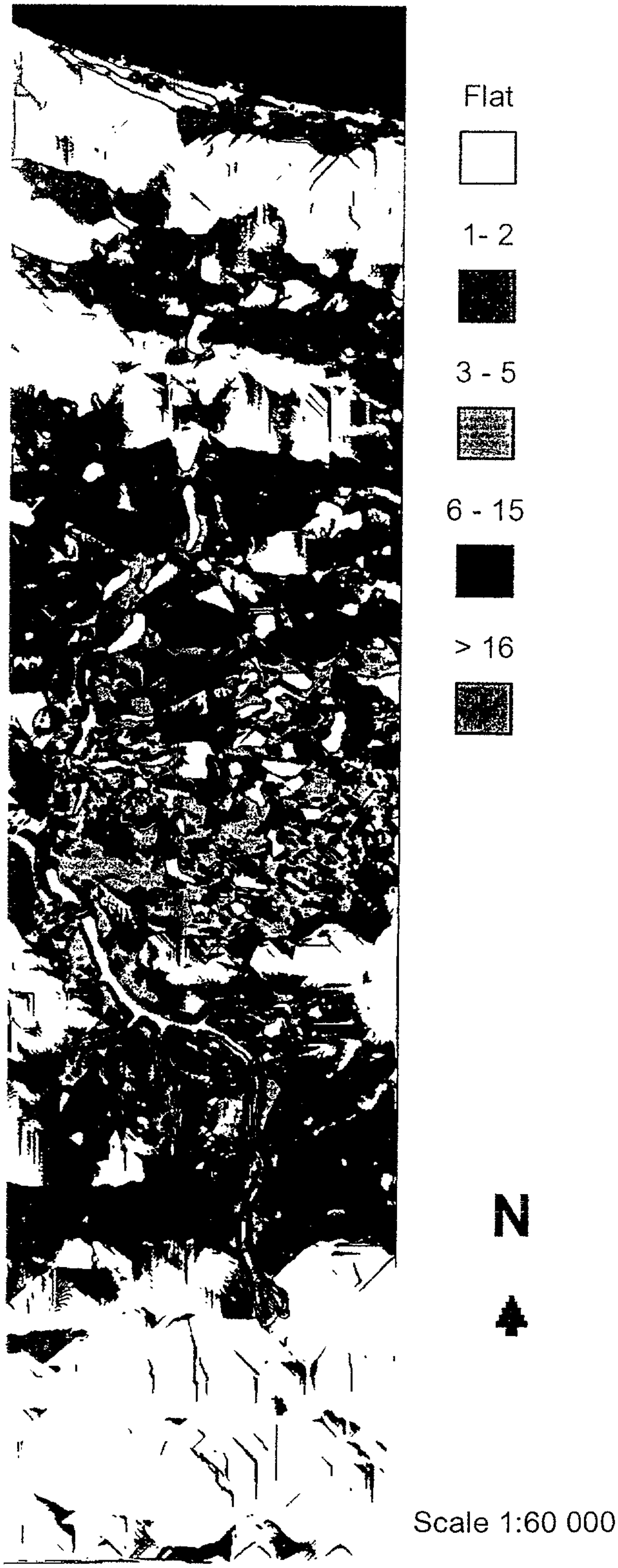

26
27
28
29
30
Mediterranean Sea
Matrouh
Alexandria
31
Wadi
Qassaba
Fuka
30
Pilot Areas

Map 1

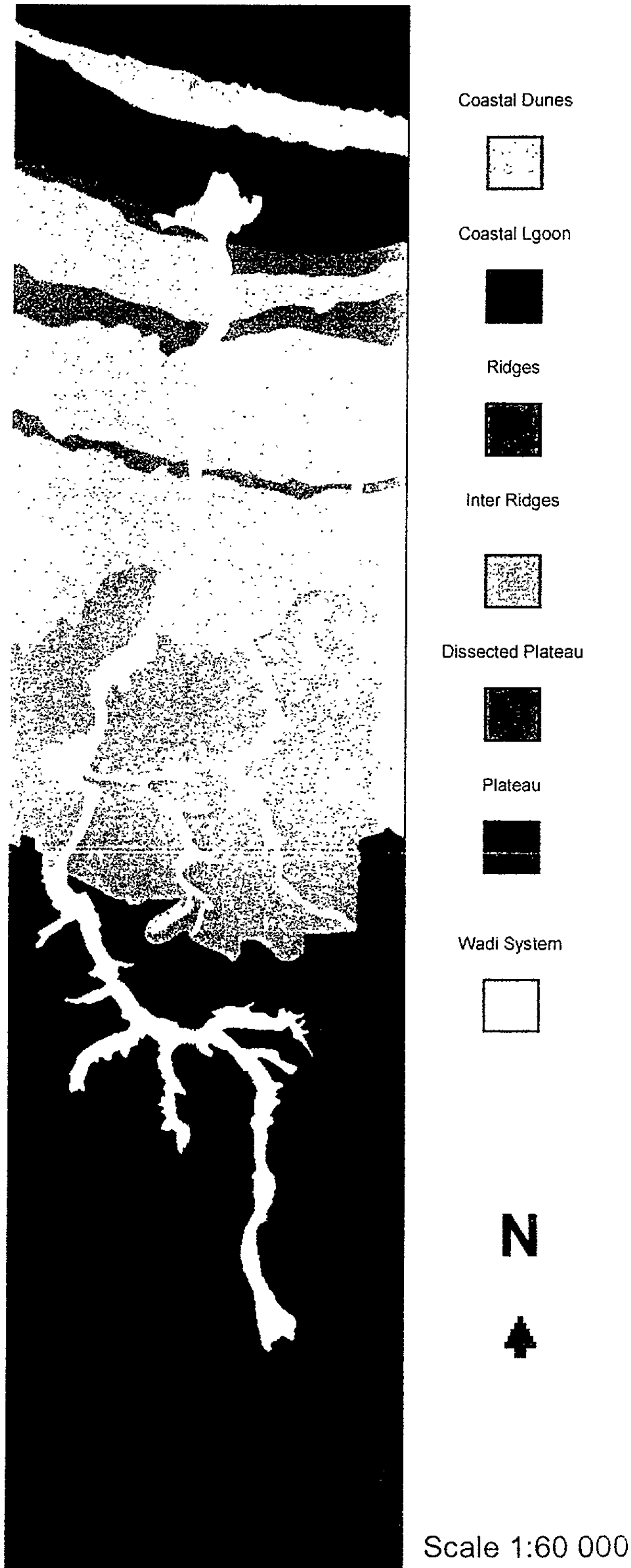
Map 2 Wadi Qassaba DEM



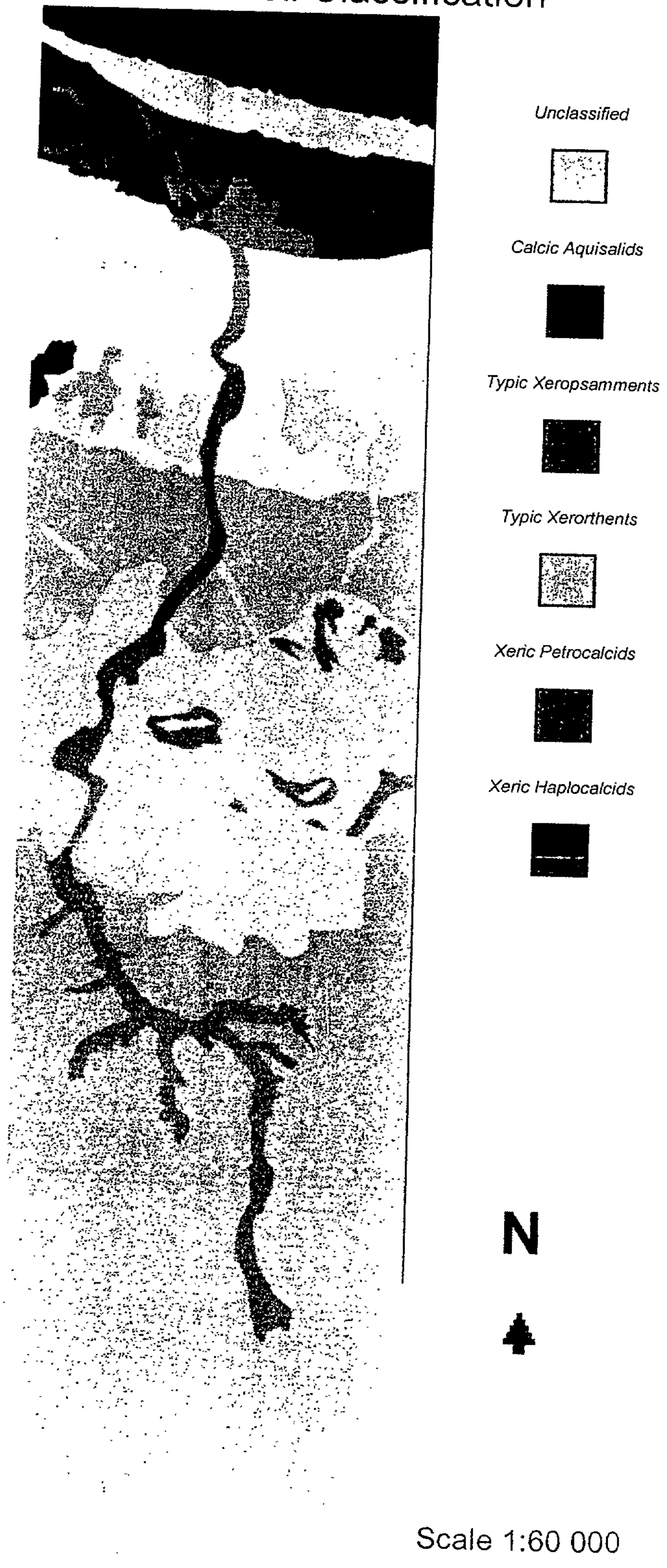
Map 3 Wadi Qassaba Slope



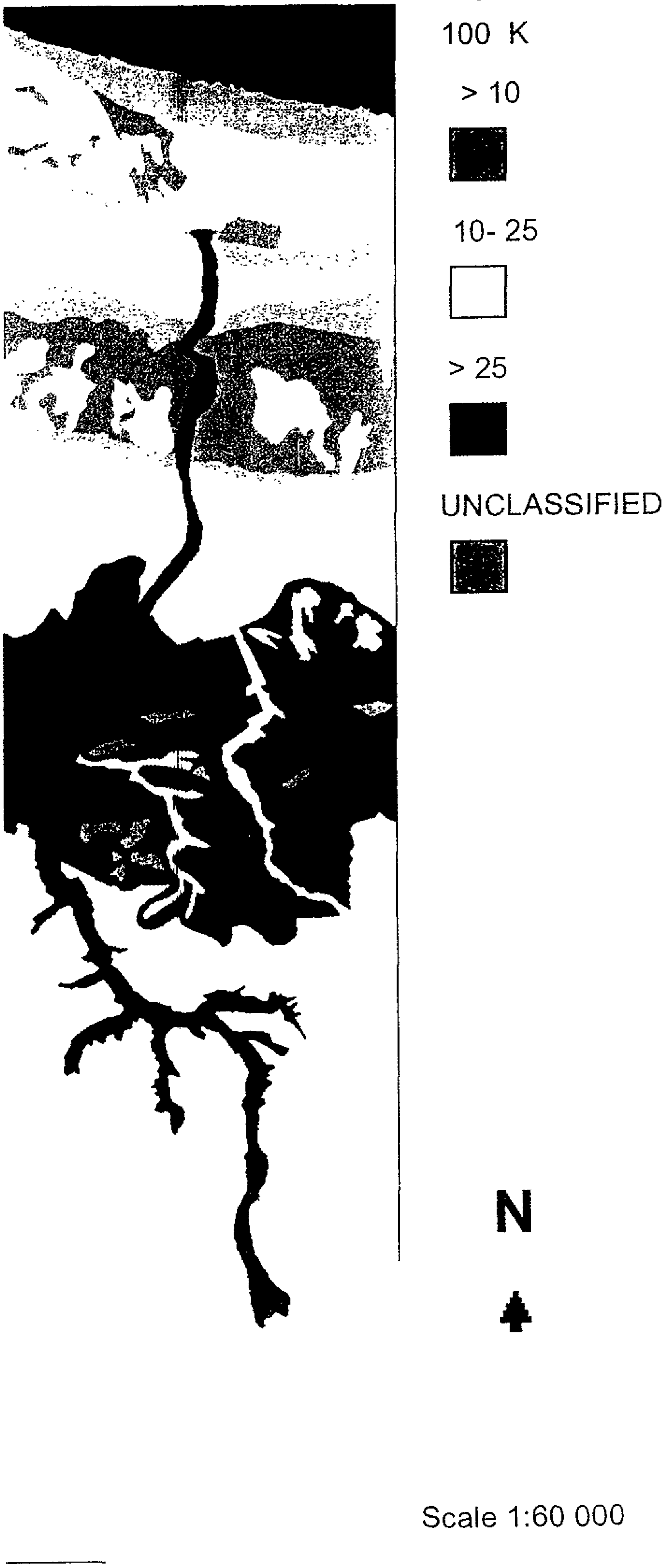
Map 4 Wadi Qassaba Geomorphology



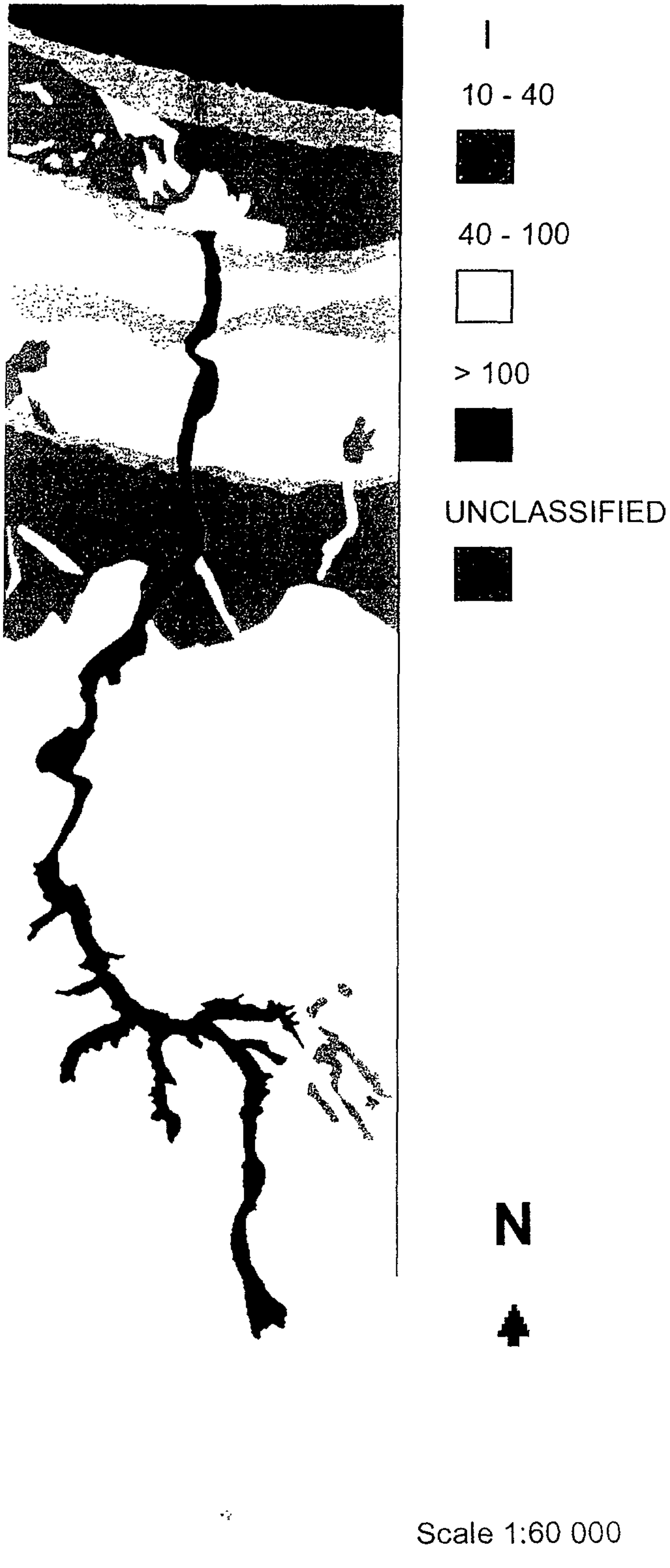
Map 5 Wadi Qassaba Soil Classification



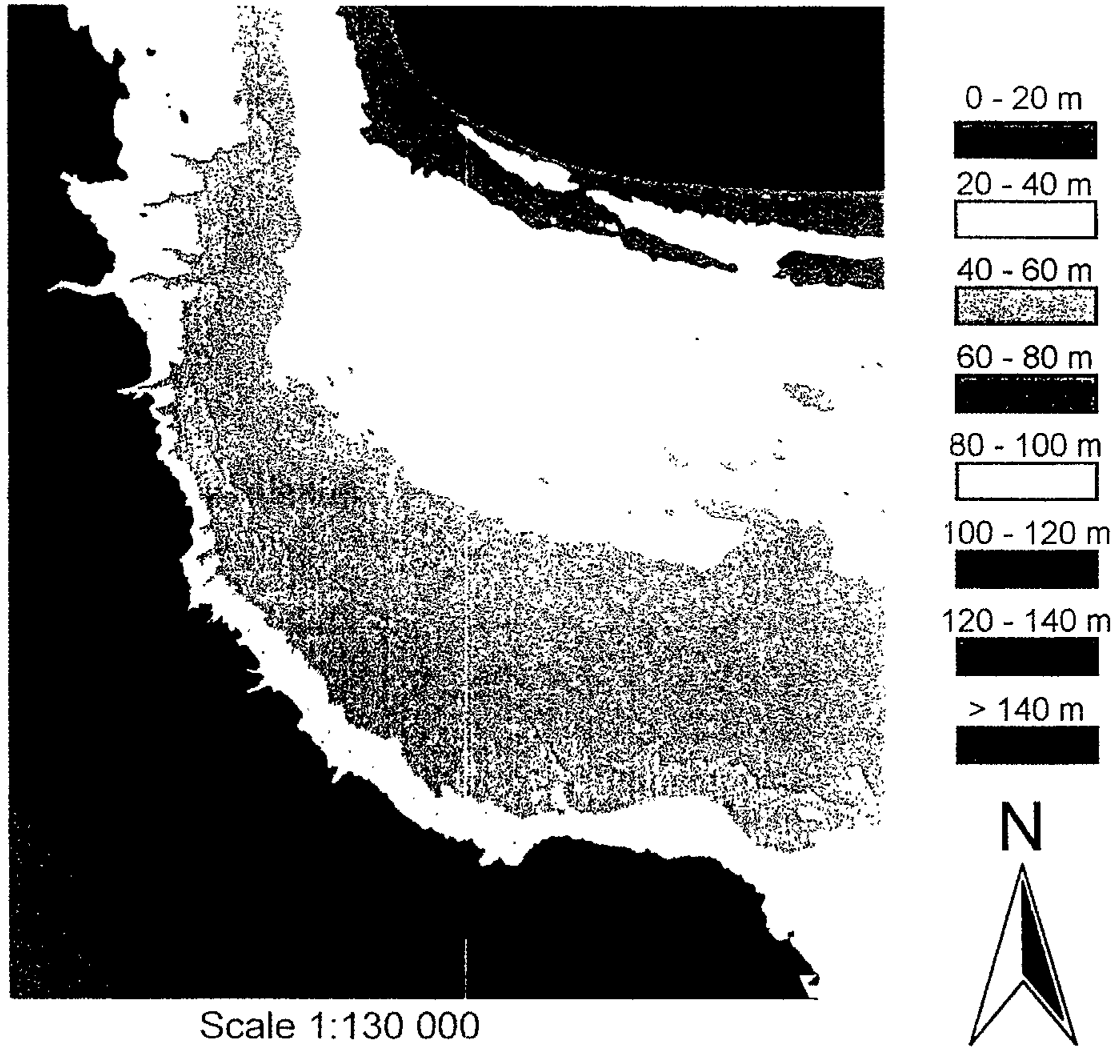
Map 6 Wadi Qassaba Water Soil Erodibility



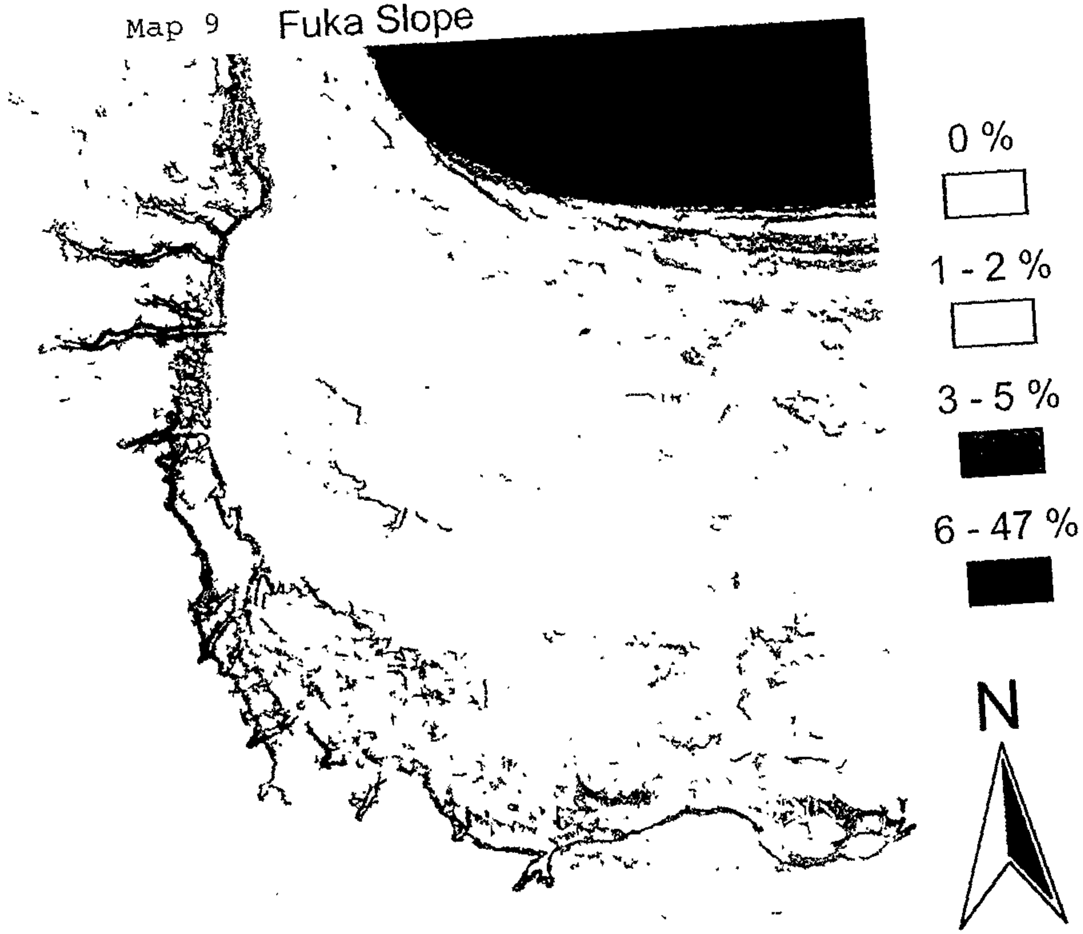
Map 7 Wadi Qassaba Wind Soil Erodibility



Map 8 Fuka Digital Elevation Model

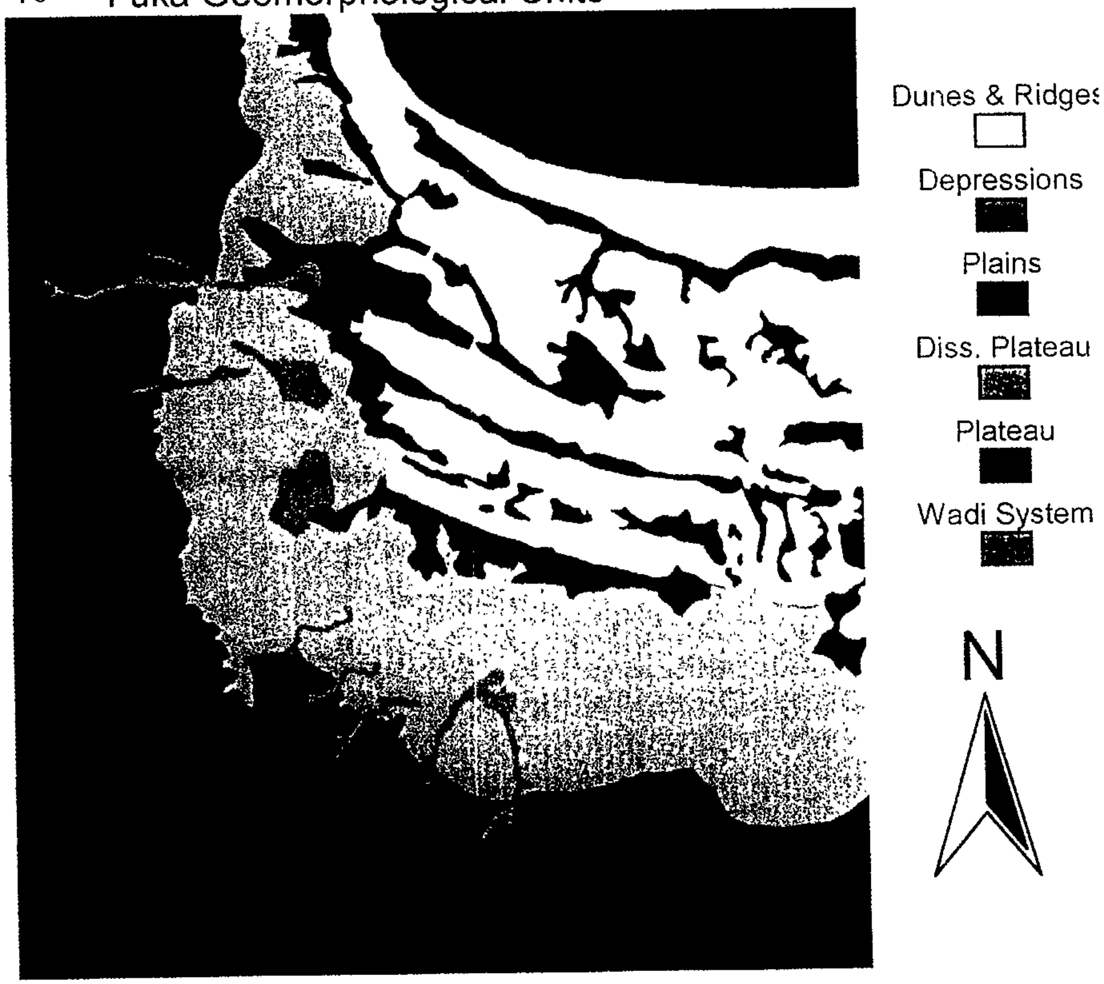


Map 9 Fuka Slope



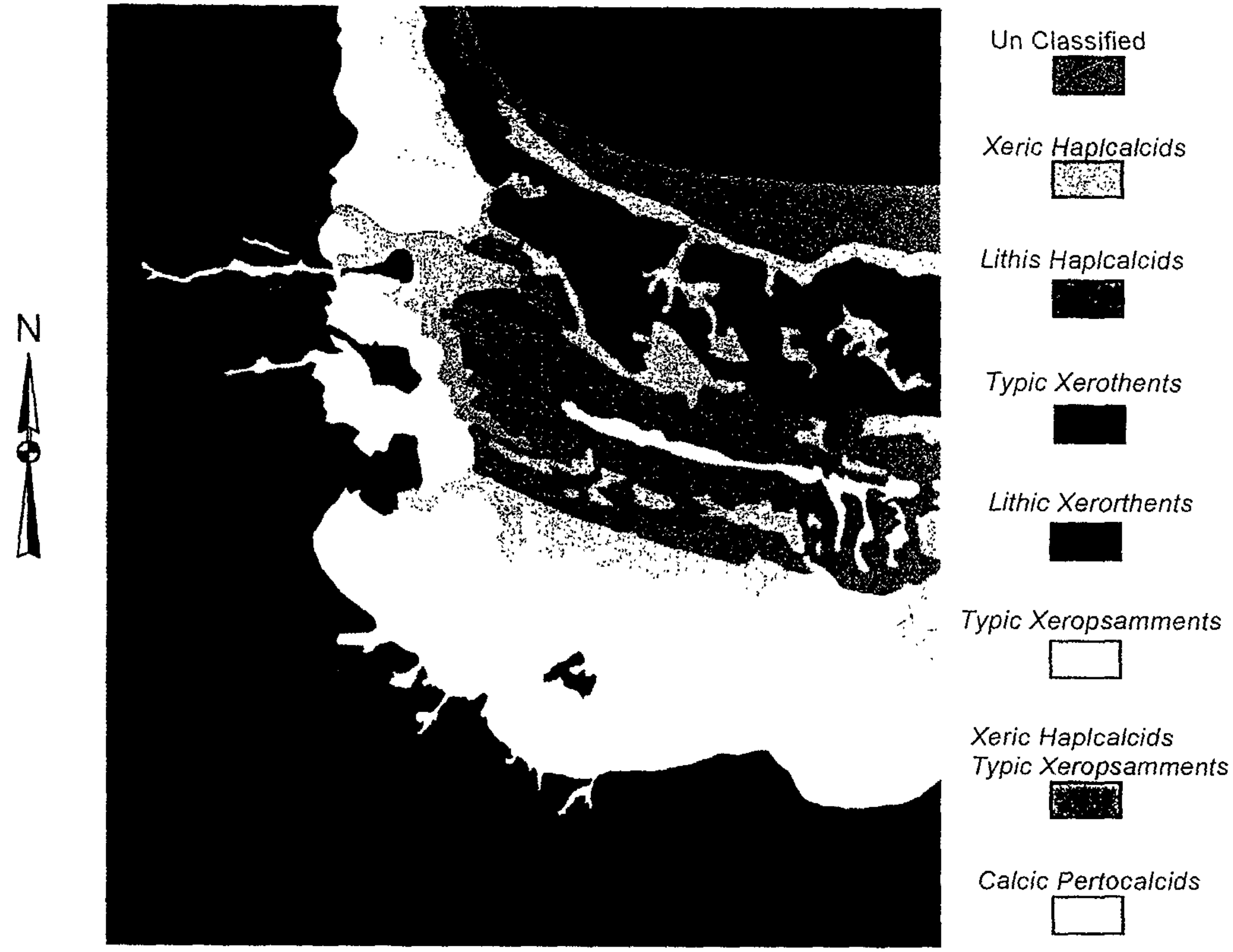
Scale 1:130 000

Map 10 Fuka Geomorphological Units



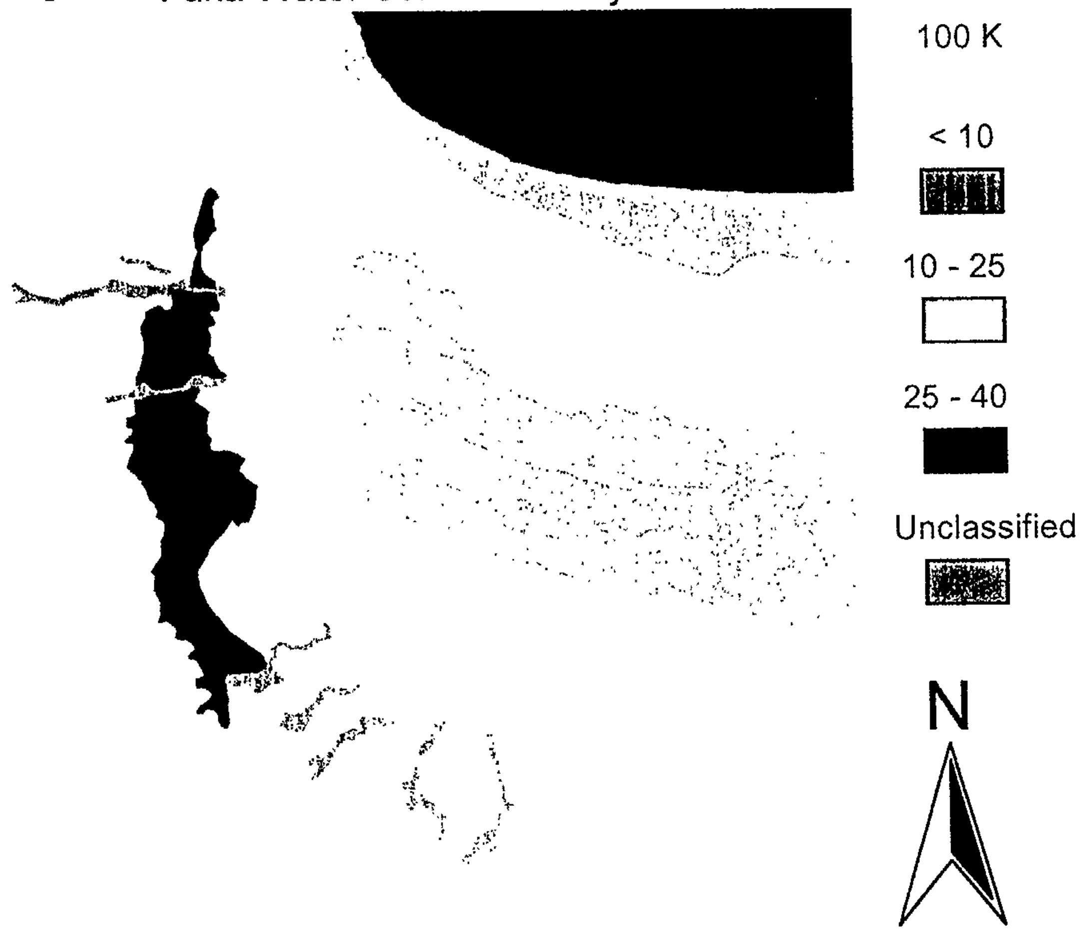
Scale 1:130 000

Map 11 Fuka Soil Classification



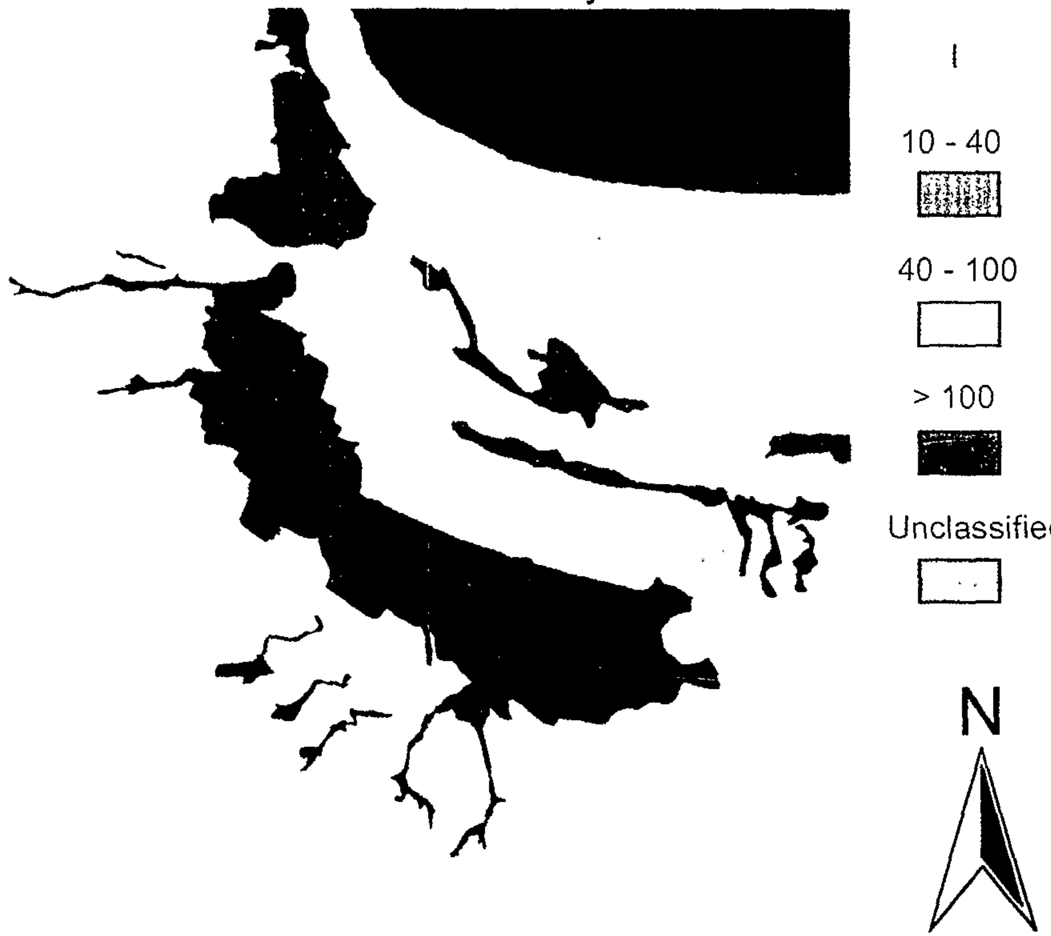
Scale 1:130 000

Map 12 Fuka Water Soil Erodability



Scale 1:130 000

Map 13 Fuka Wind Soil Erodability



Scale 1:130 000

ANNEX VI

ASSESSMENT OF NATURAL RESOURCES AND SOIL CONSERVATION ISSUES IN THE COASTAL AREA OF FUKA-MATROUH

UNEP

UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

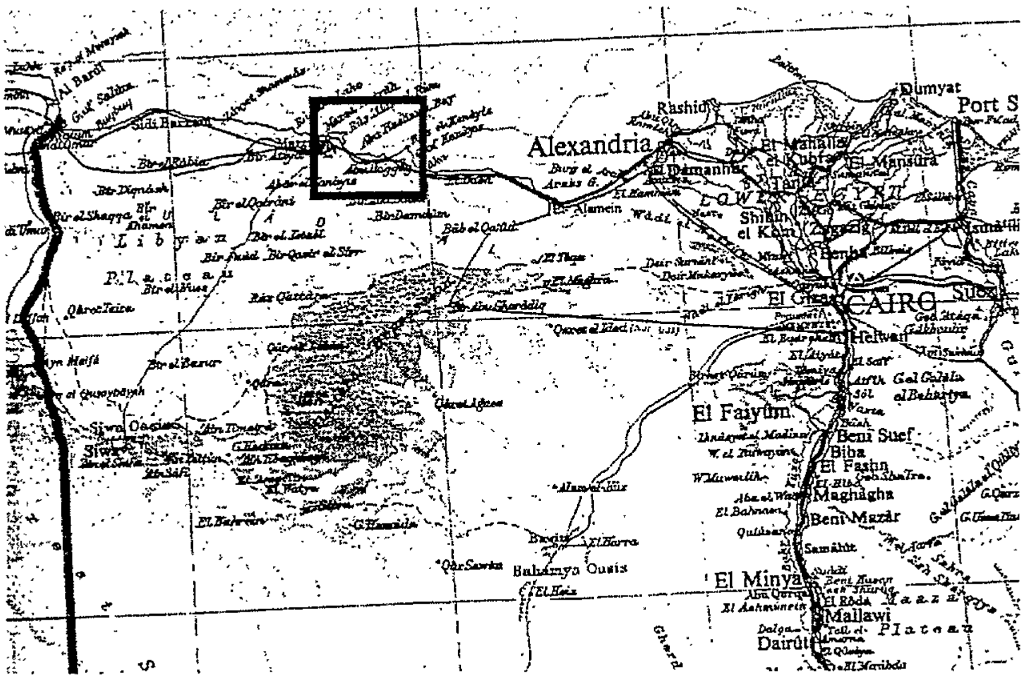
MAP

PRIORITY
ACTIONS
PROGRAMME

CTM

Coastal Area Management Programme (CAMP)
FUKA-MATROUH - Egypt

Assessment of Natural Resources and Soil Conservation Issues in the Coastal Area of Fuka-Matrouh



Priority Actions Programme
Regional Activity Centre
Split, June 1999

Prepared and Supervised by:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF FOLDERS

ACKNOWLEDGMENTS

The authors are grateful to all the partners involved in this work and in particular to the Egyptian Organizations and experts that made it possible and effectively supported the development of the activities.

Thanks are due for their logistic and scientific support to Mr. Fawzi, Director of Water & Coastal Areas Protection Projects – Egyptian Environmental Affairs Agency; to Prof. El Raey, Dean of the Institute for Graduated Studies and Research – University of Alexandria, team Leader of the RAC/ERS Egyptian counterpart; to Prof. F. Abdel-Kader from the Soil and Water Department, College of Agriculture - University of Alexandria, team Leader of the PAC/RAC Egyptian counterpart; to Mr. Sherif Moustafa, Officer-in-charge of the qasr Rural Development Project – LUPEM Station at Marsa Matrouh.

Grateful acknowledgments are made to the Egyptian researchers of the University of Alexandria who strongly contributed to the successful accomplishment of the present work.

1. INTRODUCTION

Following the adoption - by the Contracting Parties to the Barcelona Convention - of the setting-up of the Coastal Areas Management Programme (CAMP) for Fuka, on 9th November 1992 a formal agreement between the Government of the Arab Republic of Egypt and the United Nations Environment Programme, Mediterranean Action Plan, was signed.

In the framework of the envisaged activities relevant to the integrated planning and management programme of the CAMP, the MAP's Regional Activity Centre for Priority Action Programmes (PAP/RAC) and Regional Activity Centre for Environment Remote Sensing (RAC/ERS) - the latter established in October 1993 - conceived and carried out complementary tasks, as a result of a sound and coordinated approach.

Therefore, the present report, jointly prepared, shows the outcomes of the activities of the two Centres, that, even if mainly individually and autonomously developed, are nevertheless strictly related.

They are jointly aimed at the same objective - which is the MAP's as well - of providing the Egyptian Authorities with proper methods and effective support systems to the decision-making processes for the sound planning and the sustainable development of the coastal areas.

Capacity-building, through educational activities and training- on-the-job of local experts, was also carefully performed as a main priority of these multidisciplinary interventions by PAP/RAC and RAC/ERS.

Thus, as a further result, firm foundations for possible future cooperation - between MAP and Egyptian Institutions - in the field of application of advanced technologies and methods to environment and development, have been laid.

The final hope is that on the basis of the concrete achievements of this action, all the Mediterranean Countries and the Mediterranean community will be encouraged to resort to such techniques and methods for pursuing an improved knowledge on land resources and on its suitability to proper exploitation, without affecting the overall environmental balance.

Our best thanks go to Prof. M. El Raey, Dean of the Institute for Resarch and Graduate Studies of the University of Alexandria and to Prof. Abdel Kader of the Institute of Agriculture, as well as to the researchers and assistants involved in the data processing and in the field campaigns under their coordination.

Without their scientific participation and precious cooperation the CAMP for Fuka would not result as effective.

2. DESCRIPTION OF THE STUDY-AREA

2.1. Location

The studied area is located in the middle upper portion of the Governorate of Marsa Matrouh that covers the north-western part of Egypt. The Matrouh Governorate is one of the largest governorate of Egypt, with an area of 212,000 square kilometres representing the 22% of the whole country.

Nevertheless, the population density in the governorate is very low. According to the 1986 census, the inhabitants of the governorate amount to 160,000 that means a population density of less than one person per square kilometer. Many governorates in the Nile Valley and the Delta have a population density of about 1,500 per square kilometer.

Figure 1 depicts a map showing the general location of the study-area.

The Fuka-Matrouh region stretches along the north-western Egyptian coast for about 120 kilometres from the town of Marsa Matrouh to the west, to about Ras El Daba to the east; northward it is limited by the Mediterranean sea, while it extends southward for about 20-30 km.

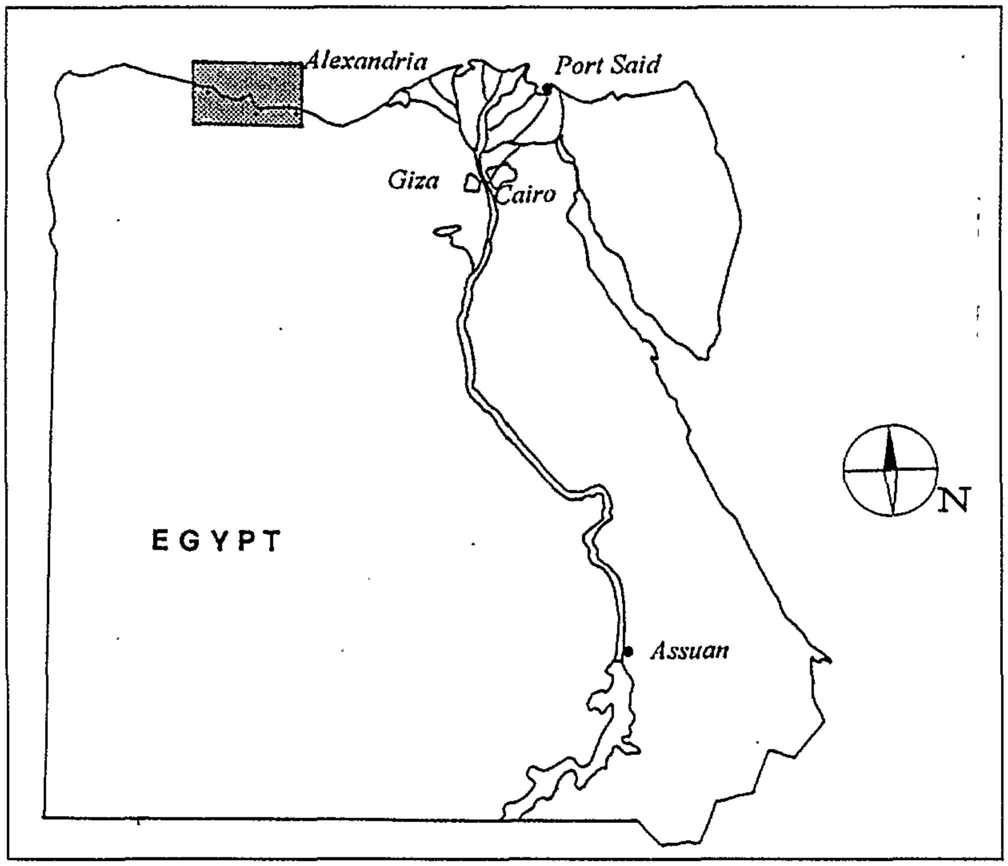

Figure 1: Map of Egypt: Location of the Study Area (Dotted Square)

The coast includes a number of open bays: Kanayis Gulf (El-Hekma Gulf) along the eastern side of Ras El-Hekma and Abu Hashaifa Bay at the eastern side of Matrouh, with several bays separated by points in between. The headland and bays seem to be related to some regional structure pattern. Between Ras El-Rum and Ras El-Hekma, the coast is indented by several sandy bays bounded inland by sand dunes.

2.2. Climate

As for the weather conditions, the area is characterized by an arid Mediterranean climate with a brief, mild, rainy season in winter and a long hot dry summer (from May to September) with clear sky, high radiation, and no rain. The picture changes in October when a windy and relatively rainy winter begins.

The main factors controlling the climate of this region are:

- the general circulation of the atmosphere;
- the proximity of the sea which directly affects temperature and humidity, and, as a consequence, evaporation and condensation; and
- the orientation of the coast with regard to the prevailing NW wind direction, responsible for the different distribution of rainfall along the coast.

2.2.1. Rainfall

The amount of rainfall in the Project Area is approximately 140 mm/yr in the areas closer to the coast, rapidly decreasing inland.

Rainfall variability is relatively high if compared to other arid climates. The rainy season begins during the second half of October. About three quarters of the total amount of rain falls from November to February. December and January are the rainiest months with an average rainfall of 35 mm per month.

Summers are virtually dry (from March to September 0 mm).

Dew in arid and semi-arid areas is a valuable source of moisture to plants. Climatic conditions in the Mediterranean region of Egypt are in some seasons favourable to water vapour condensation, such as considerable temperature gradient between different soil strata and overlying air, high relative humidity and still wind, particularly in summer and autumn.

2.2.2. Air Temperature

In summer and winter monthly mean air temperatures do not reach extreme values. In Marsa Matrouh and Daba (boundary location of the Project Area) minimum monthly mean air temperature is reached in January (8,4°C and 7,3°C respectively); while maximum in July (Marsa Matrouh 29,1°C) or in August (Daba 29,9°C).

2.2.3. Wind

The direction of prevailing winds is north-west. In springtime, however the area is exposed to Khamaseen hot winds which blow from the south-west, carrying sand and dust from the desert. Winter and early spring in Marsa Matrouh are characterized by strong wind blows (22.01 km/hr in January), while in autumn the wind speed drops to some extent (15.17 km/hr in October).

2.3. Geology

The north-western coastal plain of the Mediterranean Sea is located between Alexandria and the border of Libya over a distance of about 500 km.

The coastal zone varies from a minimum width westward - where the sea erodes directly the Miocene limestone that forms a wave-cut cliff - to several tens of kilometers eastward - where a wide coastal plain and a narrower piedmont plain can be differentiated.

The coastal plain is mainly composed of oolithic and biogenic calcareous sand forming the coastal beach/dune ridges and including coastal sabkhas. Parallel to the coastal ridges and lying inland, there are series of older indurated calcareous beach/dune ridges separated by depressions filled up with lagoon-sabkha deposits.

The studied area, which is one of the most representative areas in the north-western region, is characterized by two main geologic systems: a coastal plain of quaternary age and a tableland formed by middle Miocene limestone belonging to the Marmarica formation that bounds the coastal plain southward (Figure 2).

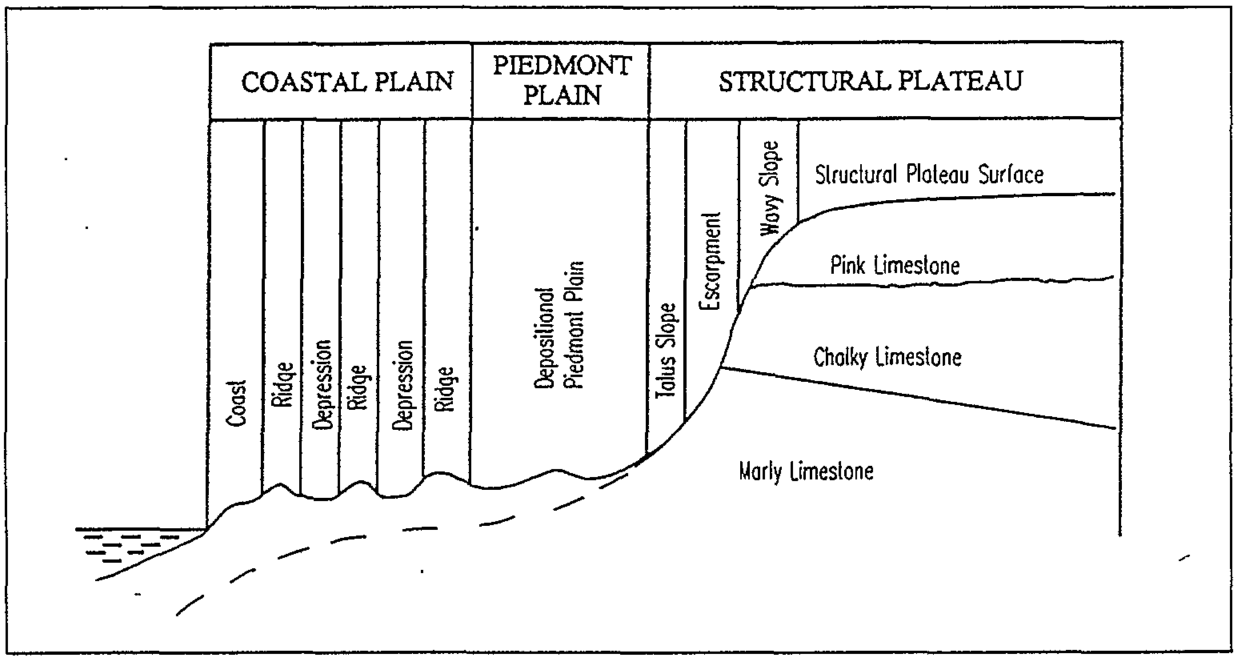

Figure 2: Schematic Geological Section showing the Geometric Relationship among the Main Landforms

More in detail, this tableland is the "northern" part of the great homoclinal plateau which slopes gently northward towards the Mediterranean sea and eastward to the Nile delta.

The exposed rocks have all a sedimentary origin and date from the Miocene until the Holocene; the maximum thickness reached is about 200 metres.

The stratigraphic sequence may be outlined as follows:

Quaternary age

- Holocene (oolithic calcareous sand; wadi filling; loamy deposits)
- Pleistocene (oolithic limestone of consolidates ridges; cardium limestone; pink limestone)

Tertiary age

- Pliocene (creamy limestone, upper series; brown limestone, lower series)
- Miocene (alternation of limestone and marls - middle Miocene; fossiliferous limestone and marls - lower Miocene)

The quaternary coastal plain is characterized by the presence of three elongated carbonate ridges separated one another by three longitudinal depressions filled with lagoon-sabkha deposits[1].

The foreshore ridge, about 10 metres high, is composed of friable limestone mainly consisting of oolithic grains together with organic components, e.g. calcareous algae, gastropods and few foraminifera.

The second ridge, reaching 25 metres, is very similar in composition to the previous one, but the ooliths in this layer have gradually lost their shape and have become smaller until they are obliterated.

The third ridge (+45 m) is characterized by the presence of quartz and heavy minerals and by an increase in the amount of calcareous algae. The faunal content is mainly of Mediterranean type.

The last two more inland ridges are capped by caliche deposits, due to the effect of rain water and to the high humidity of the region, which form a distinctive superficial, indurated, brownish to pinkish carbonate crust.

A fourth ridge is also present, running parallel to the escarpment which is the northern border of the homoclinal plateau.

The homoclinal plateau is characterized by Pliocene and Miocene limestone.

The rock outcrops constitute a flat structure slightly sloping towards NE. The surface is weathered and highly fractured, so that a lot of gravels and blocks are scattered around the main outcrops.

Wind transported sands from the desert are deposited between the rocky elements.

Sand deposits of hummock type are common especially in the northern part of the plateau.

2.3.1. Tectonics

In the study-area, several evidences of a tectonic control of many morphological structures can be detected (Figure 3).

In this connection, it must be mentioned that the main protrusions of the coastline are structurally controlled by master joints and faults parallel to them with north/north-west, east/north-east and west/north-west trends. While, the structural control in the drainage pattern is less evident being mostly overshadowed by the stronger gravitative control that makes the drainage lines generally perpendicular to the slope and subordinately parallel to local structures such as fractures and joints.

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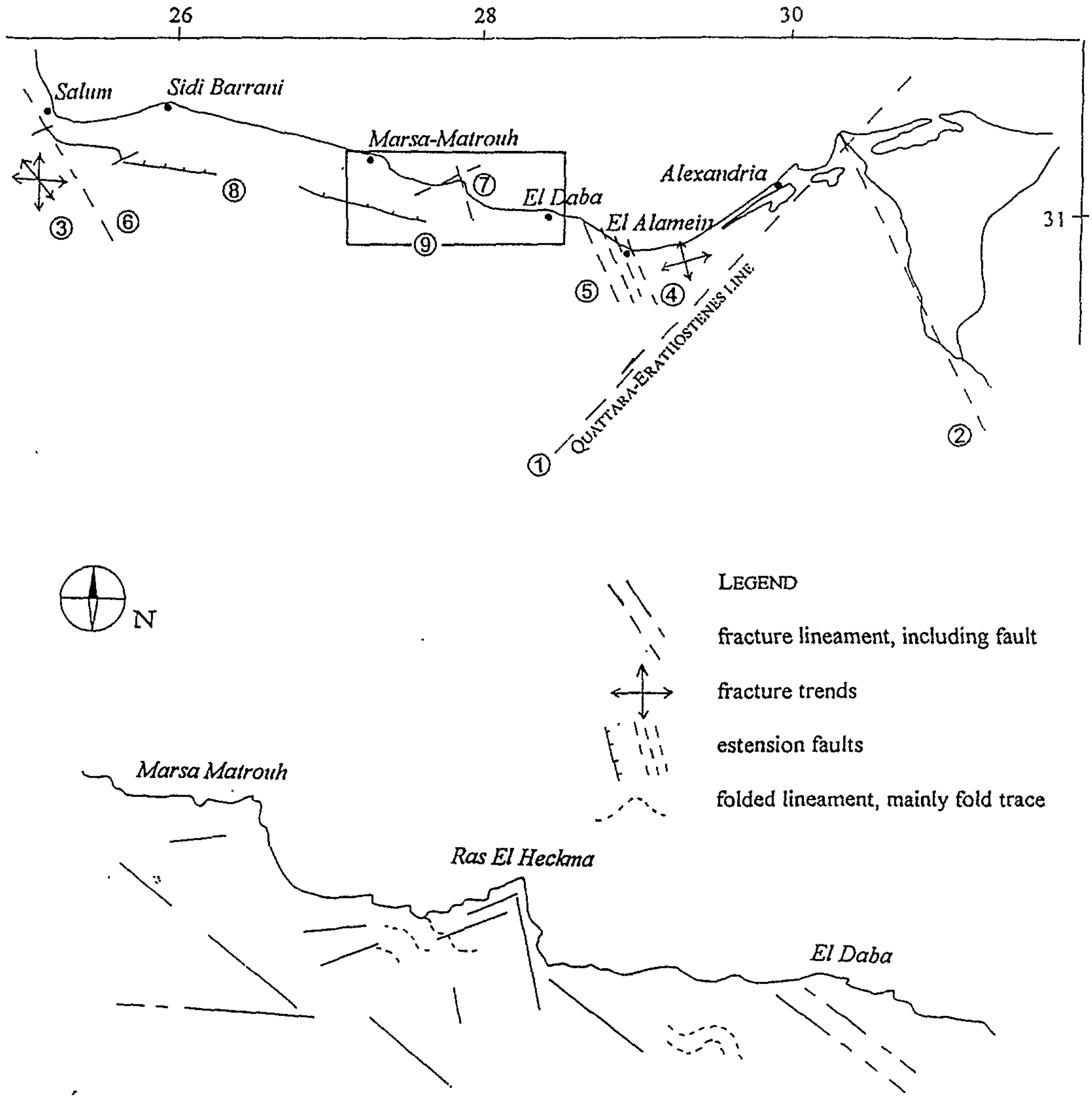
[1] The term *sabkha* refers to an evaporitic facis located, in this case, in the salty coastal plain, characterized, from the bottom to the top, by the following distribution of sediments: sand and lagunal carbonatic mud, gypsum macrocristals, levels of anhydrite with or without diapiric structures, alitic crust modelled in poligons by the compression.

The precipitation of gypsum and anhydrite cristals can occur in wide areas and in prehexisting sediments , also in the capillary fringe lying above the water table.

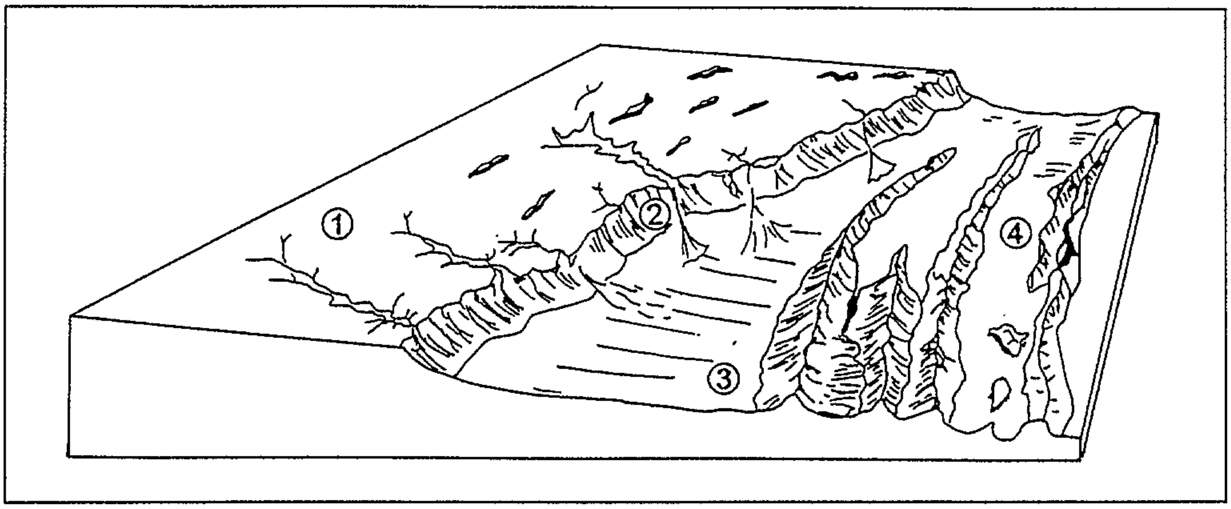


① Neev, 1975-77
② Zaghloul & El Nasharty, 1981
③ El Gamal, 1968
④ Mohammad, M.R., 1996
⑤ Metwalli & Abdel Hadi, 1973
⑥ Shata, 1957
⑦ El Etretal, 1973 & Hammad, 1972
⑧ Zaki, N., 1984
⑨ El Shazly & Shata, 1969

Figure 3: Regional and Local Fracture Trends
(Compiled by Mohammad, M.R., 1996 – Dept. of Geology, Fac. of Science, Alexandria University)

2.4. Geomorphology

The Fuka-Matrouh area, like most places in the north-western coast of Egypt, is covered mostly by sedimentary rocks belonging to the Quaternary and Tertiary periods. A geotraverse along the north-south direction crosses the following main geomorphologic units: the coastal plain, the piedmont plain, the escarpment and the structural plateau (Figure 4).



① plateau surface; ② escarpement; ③ piedmont plain; ④ coastal plain

Figure 4: Block Diagram Illustrating the Various Landform Patterns in the Area

2.4.1. Coastal Plain

The Coastal plain covers the northern part of the area and runs parallel to the coast constituting a narrow and irregular strip between some metres to about 6 kilometres wide. It is characterized by the presence of elongated ridges alternating to depressions that run parallel to the shoreline.

Ridges

Ridges exist in most parts along the coastal plain and extend parallel to the shoreline. The ridges vary in number from place to place, for example, in the Matrouh region there are three ridges, while in the Fuka area there are four. The width varies from several metres to about one-two kilometres. Length varies from few to many kilometres. The ridge closest to the shoreline has the smallest width, the largest extension and the lightest tone if compared to other ones. It has a gentler inland slope and a steeper seaward slope. The elevations of the ridges vary increasing southward.

In many places the ridge closest to the shoreline appears to be composed by loose calcareous material with a snow white tone.

Other ridges are darker in tone and are either continuous or locally incised by drainage channels and appear in the form of hillocks (e.g. in the Matrouh area and east of El Daba).

Depressions

Depressions represent the lowland lying between the ridges, they show dark tones on satellite images. Their width is different and ranges from several metres to about five kilometres. In some areas where the depressions are closer to the sea or reach the sea level, marshes or lagoons may be found.

2.4.2. Piedmont Plain

The Piedmont plain is located in the transitional zone between the coastal plain and the plateau. Its surface is almost flat and varies in width from place to place. In some areas, it may be subdivided into depositional and degradational phases. The first is marked by the development of alluvial fans whereas the second is characterized by rocky lands with undulating barren soil surface.

Alluvial fans

They exist at the foot of the scarp that borders the coastal plain to the south (e.g. Matrouh and Fuka). Alluvial fans mark the ending of some drainage channels on the coastal plain where they discharge their loads forming a number of well-developed fans. They are mainly elongated in shape and vary in size; ranging from 0.5 to 2.5 square kilometres.

2.4.3. Escarpment

The escarpment marks the northern edge of the plateau, separating it from the piedmont plain. In some areas it has the form of a long and gentle slope while in most places there are steep slopes of high relief.

The scarp is facing north and is dissected by a large number of streams whose heads are cutting well within the plateau surface. Their discharge areas are either extended to the sea or within the coastal plain.

Slope

The slope appears mainly steep, forming a cliff in areas close to the sea. In some places (e.g. west of Fuka) the steep slope is divided in a series of two or even three steps.

On the contrary, where the slope appears gentle, it is mainly characterized by an upper short free face and a general concave profile due to the hard resistant limestone bed that caps the plateau.

2.4.4. Structural Plateau

The Plateau covers the southern part of the study-area; it is a large plateau with a gentle northward dip, with a north facing escarpment or gradually merging to the coastal plain.

In the study-area the plateau either closes to the coast (e.g. the area of Ras El Hekma) facing the sea with a high cliff, or exists quite away from the coast (e.g. the area of Fuka).

Plateau surface

The plateau surface is essentially characterized by the outcropping of limestone rarely covered by thin soils. The surface is occasionally mottled with shallow deflation hollows, especially in the northern part. The northern edge of the plateau surface is dissected by a large number of drainage lines. In some areas the plateau is characterized by marked steps, while in other localities it dips gently northwards.

Deflation hollows

On the satellite image they appear as patches on the plateau surface that mostly have a dark tone but sometimes have a light tone. They are very shallow, and characteristic of the Marmarica Plateau. Those hollows are filled up with unconsolidated deposits whose density varies from place to place. Their shape is irregular, mostly oval, with the long axes preferably north-west oriented.

2.5. Soils

Soils in this area are poorly developed and essentially alluvio-colluvial (Harga, 1976).

Beaches are composed of white, loose carbonate sands, well polished and round. Moving towards inland, the loose carbonate sands gradually change to fairly consolidated limestone forming ridges that skirt the coast. The ridges of marine origin are separated by depressions. In such depressions where soils are mainly made of deposits with a sandy-loam texture, and a good drainage, intense and regular fields can be identified.

The depressions closer to the shore are characterized by marshes and lagoons with loamy-sandy soil deposits, poorly drained and highly saline, and are not suitable for agriculture activities.

In the structural plateau, where the parent material is constituted by alternating strata of limestone and shale, soils are mainly loamy and loamy sandy, with a profile from medium to shallow in depth.

Cultivation in the structural plateau characterizes no more than 5% of the total extension of the landscape. Cultivated areas appear either as geometrically regular areas, mainly in the wadis dissecting the plateau, or as scattered patches, in those places of the plateau surface where thin soils are found.

2.6. Vegetation

Natural vegetation is mostly represented by sparse shrubs and by a discontinuous herbaceous layer, which becomes almost continuous only in local situations where a particularly good water supply is present. Vegetation cover generally decreases moving southwards and with increasing elevation, becoming virtually absent in the southern plateau.

Numerous species are represented, most of them providing fodder for domestic animals. Useful plants include: *Thymelea hirsuta,* belonging to the family of Thymeleacee, which is a branchy shrub whose branches are pilose/hairy and whitish; *Pituranthos tortuosum,* belonging to the family of Umbrelliferae, with rare branches without leaves; *Atriplex spp.*, genus belonging to the family of Chenopodiacee which includes several both herbaceous and shrubby species, some of which extremely proof against dry climate; *Anabasis articulata*, belonging to the family of Chenopodiacee, it is a small shrub with little articulate branches having very little leaves, common in the stony soils of the Sahara 'till the southern Sahara; *Halocnemum strobilaceum*, belonging to the family of Chenopodiacee, it is a yellowish branchy shrub common in sandy and moderately salty soils.

2.7. Water Resources

The hydrology of the studied area is determined by several factors, the most important of which are: climatic conditions, geography, geological and tectonic features.

Those factors are responsible both for the water balance of the area and for the typology of surface and ground drainage.

The main elements of water balance of the area are rainfall and dew, as to input, while, as for output, the evaporation, the runoff (sheet and wadi runoff), the recharge of ground water and the change in soil moisture storage.

For the development of the surface drainage network, as well as for the infiltration rate, very important features are the permeability of the outcropping rocks, their structure and geometry in deep, as well as the soil generated by them.

In the studied region, the surface drainage is characterized by a considerable number of wadis, some of which - especially in the area between Marsa Matrouh and Ras El-Hekma - are important and also highly ramified (i.e. wadi Nagamish, wadi Zarga and wadi Qassaba), in this zone wide areas are affected by heavy to moderate over land flows.

In the area between Ras El-Hekma and Fuka, wadis are medium-sized and run from west to east. Some of them, even if very ramified, carry a very little amount of water, since the areas receive, in general, less rainfall.

Surface water

Surface water, as sheet runoff or wadi runoff after rather heavy rains, is the main water resource in the area as for irrigation and drinkable water both for animals and people.

In the extreme southern portions of the area, where the landscape is elevated but almost flat in topography, rainfall water is partially lost during evaporation, while a lesser part infiltrates into the shallow soil where it may subsequently either be lost by evaporation or used by some native vegetation.

Northwards, the landscape shows some wadi catchment areas. Runoff is more developed and a considerable amount of water may percolate into deeper soil layers or can be stored in underground reservoirs (cisterns) either Roman cisterns or recently made ones, to be subsequently exploited as necessary.

Those cisterns are generally excavated in the outcropping rocks and sited in the lowest part of a wide catchment area so that water can flow into them by the surroundings.

Finally, in the coastal areas, characterized by the presence of several wadis, water runoff can reach considerable values. In particular, where the wadis longitudinal profile is almost flat and their section becomes wider, the water runoff is slowed by a very effective system of dams which allows the flooding of the cultivated areas there present.

Ground water

Ground water can be found under both artesian and non-artesian conditions. Relatively large quantities of ground water located at depth, in Cretaceous and Miocene rocks, cannot be used for agricultural purposes because of its bad quality (from brackish to highly saline).

The non-artesian aquifers in the coastal plain, recharged directly by the rainfall and by the infiltration of surface runoff, can be found in Miocene, Pliocene, Pleistocene and recent deposits as the main water table.

Water can be found in dunes deposits, alluvial materials and older limestone, characterized by a permeability of primary type, as well as in limestone and consolidated dune deposits with a permeability due to solution phenomena, and then of secondary type.

The depth of the water table varies from less than 1 m to more than 50 m, depending on the existing relationship between topography and hydrology and the considered season. In the inter-dunal plain behind the coastal dunes, the water table generally lies at a depth less than 5 m below the surface.

In the coastal dunes the water table generally ranges from 5 to 10 m below the surface, depending upon the height of the dunes.

The depth of the water table in the structural basins varies according to topography and the depth of the subsurface confining layers. Where locally perched water tables occur in wadis, the depth of water is generally less than 10 m.

The quality of the water in the several aquifers of the area varies widely. Water quality also varies with seasons, being best immediately after the winter rains and worst in the late autumn before the beginning of the rainy season. Water from the main water table aquifers may contain as much as 20,000 ppm total dissolved solids or less than 1,000 ppm. In the alluvial sediments, near the coast, the water quality is more uniform having commonly less than 3,000 ppm. In the coastal dunes the water often contains less than 1,000 ppm. Water from the structural basin is commonly good but the locally perched aquifers in the wadis generally contain water with high total dissolved solids.

2.8. Land Use

The historically prevalent land use in the area has been, until recent times, semi-nomadic pastoralism. In the last few decades, a sedentarization process has entailed the conversion to an agro-pastoral system, with substantial extensions of land being converted to agricultural use. Given the climatic hardships of the area, agricultural conversion has been possible mostly thanks to an extensive system of works for the collection of runoff water in depressed areas, wadi bottoms and flood areas. These works have been supported both by the Egyptian government and by international organisations, like FAO, World Bank and GTZ.

The dominant crop in the area is barley, which has modest water requirements that can be supplied from rainfall and associated water harvesting practices. Highly drought-resistant wheat strains have been introduced in the last few years, having requirements almost comparable to barley; highly subsidized, they have taken up substantial areas. In favourable areas, fig and olive trees are common and expanding, while in very favourable places vegetables, especially water melon, are grown.

Nevertheless, in terms of surface, agricultural land use remains secondary to grazing, even in the coastal areas, and is very marginal in the plateau.

Requirements for different utilization of the land, such as urban development, quarrying and, especially, tourist settlements, are rapidly growing, creating growing land use conflicts.

3. METHODOLOGICAL APPROACH

For the assessment of natural resources and soil conservation issues in the Fuka-Matrouh area, an integrated approach was adopted.

This approach was based on the integrated use of different working tools, properly combined according to the scale of the survey and the time devoted to the various phases of the study.

Such tools are the ones of remote-sensing (satellite imagery, aerial photos and ground control points) as well as those of direct in situ measurements and laboratory analysis.

The necessity of such an integrated approach, common to many disciplines studying geographically distributed phenomena, arises from the specific requirements of the CAMP.

As a matter of fact, there was the need of assessing natural resources over a relatively large area where water availability and soil depth are the main determining factors for agricultural purposes. In such conditions, a detailed survey of the whole area would result beyond the available means both in economic and in temporal terms; furthermore, the attention devoted to planning in the CAMP objectives required final products in the most suitable scales, i.e. from 1:100,000 to 1:200,000.

On the other hand, the typical occurrence scale of relevant soil properties is a larger one, and consequently the necessity of a more detailed survey of some strategic pilot areas has been acknowledged.

In summary, two different surveys were carried out[2]; one, extended to all the area, was made taking into account as a whole the main landscapes elements - vegetation, geomorphology and soils - mainly based on the satellite image interpretation and its subsequent validation in selected ground control points; the other one located in two pilot areas and based on a detailed survey of soils characteristics.

The adoption of an integrated approach allowed, first of all, an effective cooperation and exchange of know-how among the involved experts, and thus the possibility to combine the information acquired, producing as a result a survey of the whole area with an information content perfectly suitable to the purpose of the study.

3.1. Working Team

During the project implementation two different teams of experts have worked in close cooperation, the team made up of experts from the RAC/ERS and the Institute for Graduated Studies and Research (IGSR) of the University of Alexandria together with the team of PAP/RAC consultants and the College of Agriculture of the University of Alexandria.

During the first phase of activity the two teams worked at different scales; as a matter of fact, the RAC/ERS experts mainly considered synoptic and small scale aspects relying on remote sensing techniques coupled with a ground control program, while the PAP/RAC

[2] A detailed description of the two methodologies is provided in the attached annexes

experts implemented a detailed soil survey in the two pilot areas of Wadi Qassaba and Fuka.

In the second phase, integration of these two approaches for the homogeneous cover of the project area was sought. The RAC/ERS study was deepened, while the soil information was extended to the whole area at 1:100,000 scale; this process of extension was accomplished mainly through aerial photointerpretation (API), supported by the knowledge gained in the pilot areas, integration with the RAC/ERS study, existing knowledge from other sources and additional field controls.

The efforts made towards the integration and exchange of ideas and information between the two groups brought to the creation of an integrated system of legends for the two final cartographic products, actually representing two different levels of a single hierarchy of landscape elements.

3.2. Integrated Legend System

The creation of an integrated legend system has been based on the Land Systems concept. According to this concept, a territory can be represented as a hierarchical assemblage of elements, where the lowest levels are made up of simple, homogeneous elements. The grouping of simple elements in complex ones proceeds by taking into account their genetical links, so that any higher level unit can be regarded as a logical association of smaller ones.

Five levels have been considered to represent adequately the main features of the region (Figure 5).

For the elementary level, the classical term of land facet has been used (Dent and Young, 1981). In this context, land facet equals to a simple landform as identified by aerial photointerpretation, and a pilot area survey has allowed to establish a land facet-soil relationship, which means that land facet and soil borders have been strictly associated. Nevertheless, similar landforms in different areas are known sometimes to have different soils; in this case, to avoid undue proliferation of land facets, they have been separated in distinct units at the next higher level. In this way, land facets within the same higher unit are internally homogeneous for practical management purposes.

The subsequent level has been defined as that of land units; land units are the smallest mappable units at a 1:100,000 scale, and are set up as associations of land facets, in estimated proportions, with homogeneous soils within each land facet.

The following two levels in the legend system are mainly based on geomorphological criteria, and represent the reference mapping units used by the RAC/ERS team. The land system level represents the major geomorphological units found in the area, while the landscape level has been adopted as a subdivision of the land systems, according to specific characters of relevance from the management point of view. The integration between the two working lines has produced a good hierarchical relation between the landscape level and the land unit one. Generally, land units belong to a specific landscape, although there are some exceptions. In the plateau areas, landscapes and land units actually correspond; this is due to the fact that the work of the PAP/RAC team has been mainly focused on the coastal areas, that are of greater importance for agriculture, while, in large homogeneous areas with extensive land use, the approach used by the RAC/ERS team produces all the necessary information for planning purposes.

The highest level in the integrated legend is represented by the geographic region. The study area has been subdivided in three main regions - coastal lowlands, northern plateau and southern plateau - on the basis of their characteristics relevant to climate, land use and human settlement patterns; the borders of such regions are marked by the main escarpments.

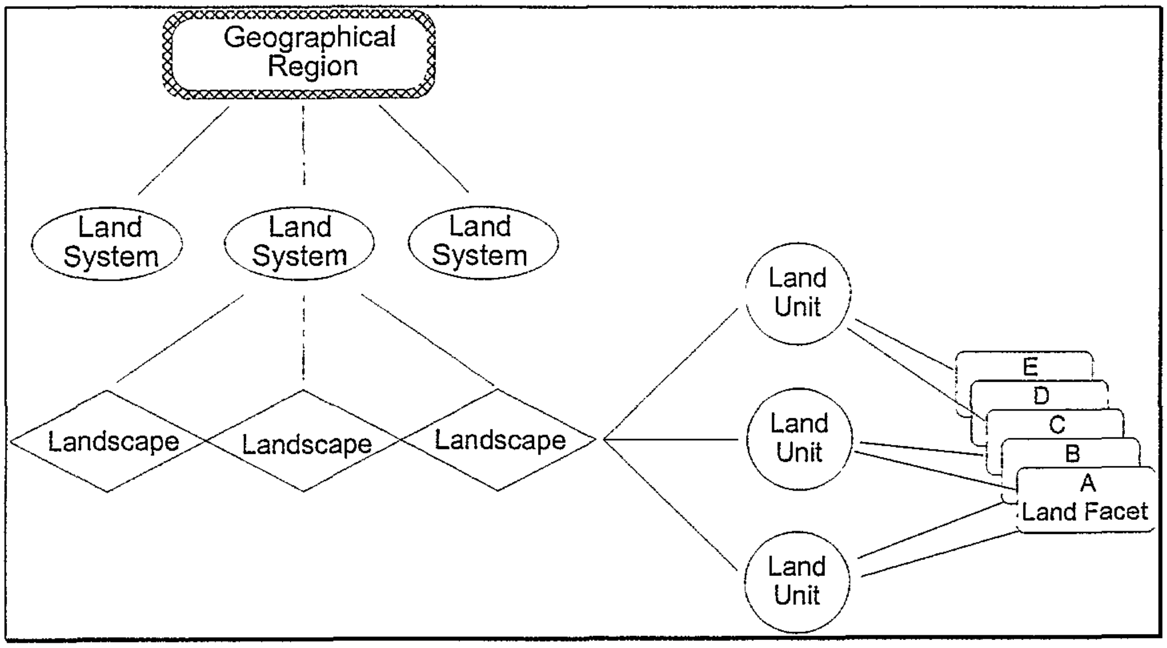
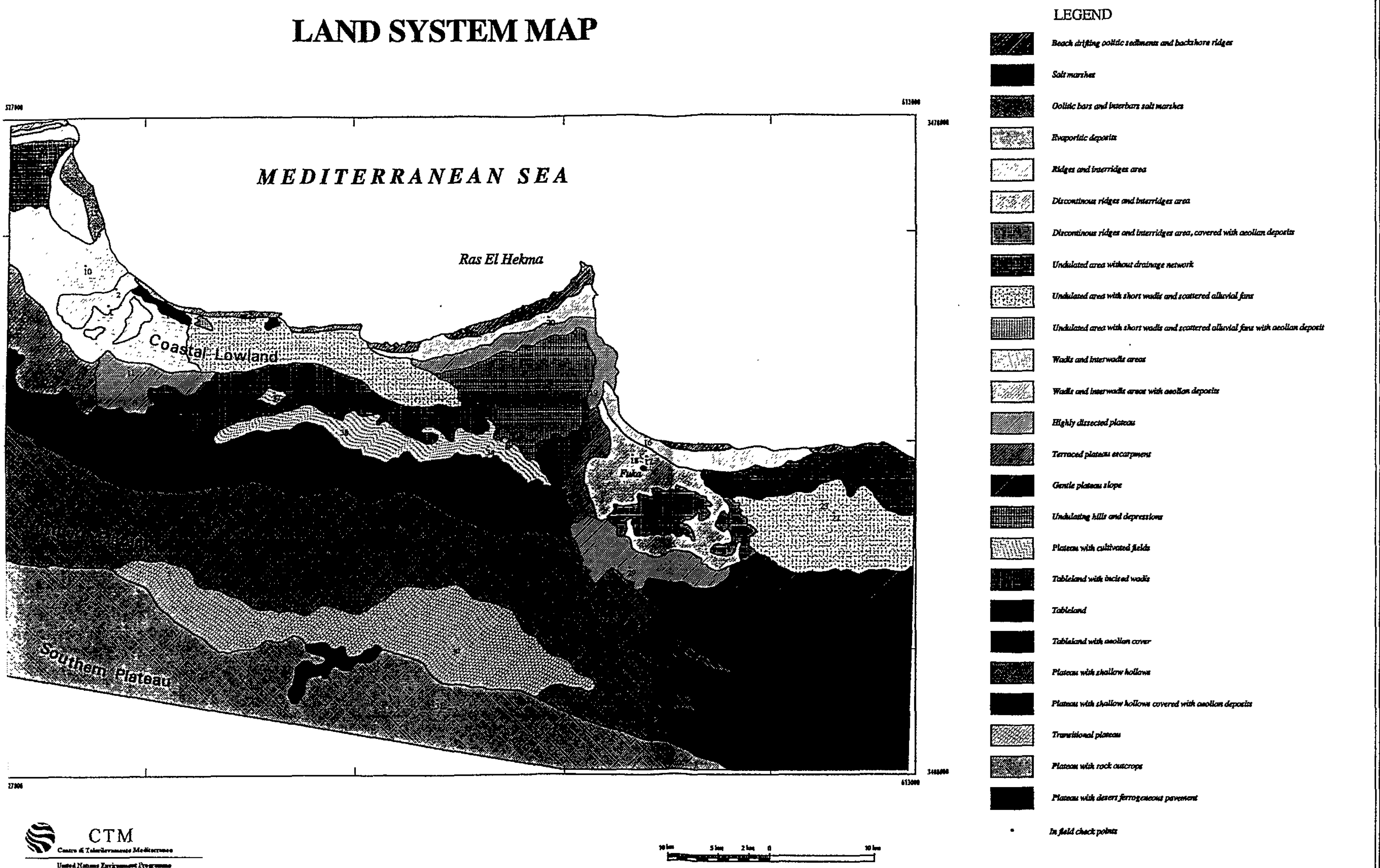


Figure 5: Structure of the Integrated Legend System

LAND SYSTEM MAP



CTM
Centro di Telerilevamento Mediterraneo
United Nations Environment Programme
Mediterranean Action Plan
RAC/ERS
Regional Activity Center for Environment Remote Sensing

4. RESULTS

The results, jointly achieved by the two Centers - PAP/RAC and RAC/ERS - in the CAMP, are synthetically presented through the two Land System and Land Unit maps.

The activities carried out for the production of those maps, together with the capacity-building of local experts and the exchange of useful information with the competent Authorities have thus provided, in terms of land resources knowledge and assessment, an effective tool which allows planners and decision-makers to pursue a sound and sustainable management of the CAMP area.

4.1. Land System Map

The Land System Map has been produced at 1:200,000 scale, even if the work was carried out at 1:150,000 scale. The three main Geographic Regions have been distinguished on the map by using different colours, respectively green for the Coastal Lowland, blue for the Northern Plateau and orange for the Southern Plateau. The various landscapes have been then individuated through different shades. The relevant map is attached to this report, while a smaller scale reproduction (1:350,000) showing the main Land Systems (Figure 6) is hereinafter provided together with the map legend (Table 1) and a reduced copy of the satellite image (Figure 7) where the landscapes limits and the releves location is reported.

The description of the landscapes identified in the Land System map is reported as follows.

4.1.1. Coastal Lowland

The Coastal Lowland is the Geographic Region closest to the sea; it is bordered northward by the Mediterranean sea and southward by the plateau escarpment. It extends for 735.84 km^2 and is subdivided into the following four Land Systems:

BL: Backshore Land
LE: Low Energy Coastal Plain
HE: High Energy Coastal Plain
HW: High Energy Coastal Plain with long wadies

BL: Backshore Land

This Land System stretches along narrow, discontinuous strips beside the sea, including the hereinafter listed landscapes:

BL1: Beach, drifting oolithic sediments and backshore ridges
BL2: Salt marshes
BL3: Oolithic bars and interbars salt marshes
BL4: Evaporitic deposits

BL1: Beach, drifting oolithic sediments and backshore ridges

Geomorphology

This unit is characterized by beaches and unconsolidated backshore ridges made up of oolithic sand sediments. The ridge is almost parallel to the shoreline with elevation ranging between 0-20 m above sea level. In some places, such as in the Ras El Hekma area, it appears partially consolidated and buried by recent sediments. The surface is undulating in shape and the slope-form ranges between convex-concave to irregular. The main geomorphological process is a moderate wind erosion affecting about 10-25% of the total area. In some places near the coastline, wind erosion is more severe and heavily affects figs plantations.

Soils

Soils are generally loose, with a high $CaCO_3$ content (35-40%). Most of them are non saline (E.C. < 1 dS/m), and non sodic (SAR < 4). Their texture is sandy (Sand > 90%) and colour is white.

Vegetation

The vegetation type of this unit is open scrub, covering about 1.5% of the total surface. The dominant species is *Zygophyllum album*, with a relative cover around 1%. The area is not grazed, while the vigour of the plants is fair. No cultivated soils are found: recreation is the only land use for this unit and in some places, especially near Marsa Matrouh, a lot of land has already been allocated for construction of touristic settlements.

BL2: Salt marshes

Geomorphology

Salt marshes are usually found in the depressions behind the backshore ridge and are maintained by occasional flooding from wadies that cannot discharge directly into the sea. Due to the morphological position, those depressions are filled up with fine sediments, dry at the surface and wet in the subsoil for most of the year; such a wetness makes soils able to sustain a relatively high vegetation cover, quite unusual for the rest of the studied area. The surface is flat and its elevation ranges between 2 to 10 m above sea level. The main geomorphological process is accumulation of fine sediments transported by water, but in places also a moderate aeolian sand accumulation, affecting 25 - 50% of the total area, is significant.

Soils

Soils are deep, compact, with moderate $CaCO_3$ content (> 13%). They are highly saline and extremely sodic at the surface (E.C.=68, SAR=124); sodicity decreases with depth. In some places, a thin superficial salt crust is found. The texture is sandy to loamy sand, and the profile often shows a layer of gypsum crystals at a depth of 50 cm. Most soils are poorly to very poorly drained and usually have a high groundwater table. Most of the surface is covered with small, very saline hummocks. Soil colour is brownish yellow to very pale brown.

Vegetation

The vegetation type of this unit is closed scrub; total cover is about 40%. Only highly salt-tolerant species are found: the dominant plant species are *Anabasis spp.*, *Halocnemum strobilaceum*, *Salicornia fruticosa*. Due to the very low palatability of those species, grazing is sporadic, while the vigour of the plants is fair.

BL3: Oolithic bars and interbars salt marshes
Geomorphology
This unit is present only near Marsa Matrouh: it is constituted by two ridges and relative inter-ridges, sub-parallel to the shoreline. Ridges are formed by cemented oolithic sediments, 4-6 m high, broad convex; slope rarely exceed 3%. Processes of rill and sheet erosion are well evident and affect more than 50% of the area. Soil compaction, particularly along wheel tracks, is widespread. Between ridges, elongated depressions filled up with sediments are present; they are highly saline and can be considered true salt marshes (see BL2).
Soils
The soils of the depressions are similar to soils found in BL2. Ridges are highly cemented, with very thin soils and a high percentage of rock outcrops and rock fragments (medium gravel, coarse gravel and stones).
Vegetation
Vegetation in the depressions is a closed scrub, with a total cover of about 50-60 %. The dominant plant species are *Halocnemum strobilaceum* and *Salicornia fruticosa* (relative cover about 60-70%). There are no signs of grazing and the vigour of the plants is nearly good. On the ridges the vegetation is highly damaged by human activities (some touristic settlements are going to be built); vegetation cover is very low, less than 3%, and is represented mainly by *Zygophyllum album*, *Salicornia fruticosa*, *Aleuropus massariensis* and *Piturantos spp*.

BL4: Evaporitic deposits
Geomorphology
This unit, covering only a small area right to the east of Marsa Matrouh, has not been surveyed; it consists of evaporitic deposits, presently flooded by marine water, and used for salt extraction.

LE: Low Energy Coastal Plain

The Low Energy Coastal Plain System is concentrated along two main locations: a smaller one east of Marsa-Matrouh and a more extended one in the basin of Fuka eastwards. This System has been subdivided into the following four landscapes:

LE1: Ridges and interridges area
LE2: Discontinuous ridges and interridges area
LE3: Discontinuous ridges and interridges area covered by aeolian deposits
LE4: Undulating area without drainage network

LE1: Ridges and interridges area

Geomorphology

The main characteristic of this unit is the continuity of the ridges, with respect to their relative dissection in the following one (LE2). The surface form is gently undulating. The slope gradient ranges between 2 - 5%. The shallow depressions between ridges, representing about 10% of the total area, are usually cultivated with fig trees and barley. Sheet and rill erosion are locally active, affecting about 5% of the total area: rills 50 cm deep and 200 m spaced are common. In some places, a slight sand accumulation is present.

Soils

The ridges are highly cemented: rock outcrops and coarse fragments are found in scattered places. The soils in the depressions are moderately deep, with loamy sand texture or finer. The $CaCO_3$ content is high (40%), and colour is very pale brown. The salinity degree is highly variable: in Ras El-Hekma area non saline (E.C.<1 dS/m) and non sodic soils have been found. In Ras Alam El-Rom and Fuka the soils of inter ridges are very saline (E.C.= 8 dS/m) and the surface is covered by scattered hummocky dunes.

Vegetation

The formation type is sparse scrub; total cover is about 2%. The dominant plant species is *Thymelea hirsuta* (cover about 1%), with *Zygophyllum album*, *Anaplex spp.* and *Piturantos tortosus* as associated species. Grazing is fair, the vigour of the plants ranges from good to fair conditions. Soils of the ridges are too shallow to be cultivated, while in the interridges olives and figs plantations are common. The dark tone on the satellite image, characteristic of the interridges, is associated to ploughed fields.

LE2: Discontinuous ridges and interridges area

Geomorphology

Together with LE3, this unit represents most part of the Fuka basin. Ridges of this unit are less pronounced than in LE1 and they are frequently interrupted by drainage lines; relief energy is much lower than in LE1. The surface is almost plain, and only on the margins of the unit some areas with small, rounded hills, representing likely remainders of former ridges, are found; the elevation ranges between 20-30 m above sea level. The main active geomorphological processes are sand accumulation and wind erosion but the first one is often prevailing. Depressions between ridges, wider than in the former landscape, are almost flat and intensively cropped.

Soils

The soils of the ridges are very shallow, with dominant rock fragments on the surface. Texture is loamy sand and the $CaCO_3$ content is high (22%); colour is strong brown. The soils of the inter ridges are mainly composed of alluvial and colluvial material; depth varies from shallow to moderately deep, colour is brownish yellow. Also, coarse fragments on the soil surface are common.

Salinity and sodicity show a wide range of variation: in the north-westernmost part of the Fuka basin, very saline and sodic soils (E.C.=69 dS/m, SAR= 159) are found, while elsewhere soils are non saline and non sodic (E.C.=1 dS/m, SAR=3.7). Due to the low intensity of survey, it is not possible to correlate the distribution of saline and/or sodic soils with geomorphological characters or with the dynamic of surface water, but the risk of finding patches of highly saline or highly sodic soils is not negligible all over the unit.

Vegetation

The vegetation type of this unit ranges from sparse scrub to sparse field, with a total cover lower than 5%. The dominant plant species are *Thymelea hirsuta* and *Anabasis articulata*. The grazing intensity is fair and is almost limited to the crop residues. Soils of the depressions are cropped with barley, olives and figs.

LE3: Discontinuous ridges and interridges area covered by aeolian deposits

Geomorphology

The presence of an aeolian sheet cover on the surface is the main distinguishing character of this unit with respect to the former one. The surface is almost flat, the slope gradient ranges between 0.5-2%. The elevation range is between 40-50 m above sea level. Geomorphological processes are wind erosion, sheet erosion and sand accumulation; the latter is the prevailing one, affecting more than 25% of the area; sometimes the aeolian cover can reach 8-10 cm. The presence of hummocks 20 - 50 cm high is common, particularly around *Thymelea hirsuta* shrubs; in some places, also sand removal is important.

Soils

In the interridges area, soils are shallow or moderately deep over a hard rock (consolidated limestone with lenses of marl and marly limestone) and covered with a sheet of shifting sand, probably coming from the southern desert. The soils are non saline (E.C.=1 dS/m) and non sodic with sandy texture. The $CaCO_3$ content is high (16%).

Vegetation

The vegetation type is sparse scrub; the total cover can reach 10% in the best conditions. Dominant plant species are *Thymelea hirsuta* and *Anabasis articulata*; grazing is fair and plants show usually a good vigour, while most of the land is cultivated with barley; also figs and olives plantations are common, although sand removal and deposition are likely to be an important limiting factor in the productivity of such plantations.

LE4: Undulating area without drainage network

Geomorphology

This landscape is present in two distinct areas, the first one is located in the easternmost part of the studied area and the second one west of Fuka. It is characterised by the nearly complete absence of hydrographic network together with an unusually undulated relief. The general pattern of this unit is represented by a regular series of small depressions surrounded by more elevated areas; only in some places drainage lines and small alluvial fans are clearly identifiable. The surface form is gently undulating, its elevation ranges between 40-50 m above sea level. The slope gradient ranges between 2-5%. Sheet and rill erosion affect an area of about 25-50%, with slight rate of activity. Also sand accumulation is present and affects 1-2% of the total area: some depressions are filled up with aeolian sands; thickness of such sediments can be up to 1 m.

Soils

The isolated rocky hills show many rock outcrops with coarse fragments covering the surface. The rocky ridge is covered by very shallow soils (< 10 cm), non saline (E.C.<2 dS/m) and non sodic (SAR < 7). The soils in the depressions are deep (> 60 cm), non saline (E.C.<5ds/m) and non sodic (SAR < 24), with a texture ranging from sandy loam to loamy sand; the $CaCO_3$ content is high, ranging from 22% to 39%; soil colour ranges from brownish yellow to pinkish white; soft, as well as, hard nodules of $CaCO_3$ have been found; shell fragments are present on the surface.

Vegetation

The vegetation type is a sparse scrub, with a total cover often less than 2%. The depressed areas are cultivated with olives and figs. The small hills surrounding the depressions are characterised by the presence of small hummocks and a little cover of natural vegetation (<1%). The dominant plant species are *Thymelea hirsuta*, *Halocnemum strobilaceum*, *Anabasis articulata*, *Zygophyllum album* and *Piturantos tortuosus*. The area is fairly grazed and the plants show usually a fair or good vigour.

HE: High Energy Coastal Plain

This Land System covers a wide belt of the coastal plain in the central part of the studied area and a portion east of Fuka. It is represented by two landscapes:

HE1: Undulated area with short wadies and scattered alluvial fans
HE2: Undulated area with short wadies and scattered alluvial fans, covered by aeolian deposits

HE1: Undulated area with short wadies and scattered alluvial fans

Geomorphology

In this unit, the plain is incised by a series of short, shallow wadies: most of them does not reach the sea and, during occasional floodings, discharge their sediments in the lowest part of the coastal plain, forming a series of small alluvial fans. The resulting landform is a very gently undulating plain, which includes, in its southernmost part, the pediment connecting the escarpment to the coastal plain. The elevation range is between 20 and 60 m above sea level. The slope gradient ranges from 2 to 5%. The interwadies areas, representing about half of the total surface, do not receive sediments at all; here soils are very shallow and rock outcrops are common; in the wadi catchments, that are intensively cultivated, sheet and rill erosion are both active, affecting about 5 -10 % of the area. Also aeolian sand accumulation is locally present.

Soils

Soils of interwadies areas are shallow (10 cm) and overlie a consolidated limestone. Saline (E.C. > 11 dS/m) and sodic (SAR > 30) soils are present in patches; $CaCO_3$ content is high (44%); texture is loamy sand. Soils of the alluvial fans show a wide range of characteristics: they are usually non saline, non sodic on the surface and with salinity increasing with depth; texture is loamy sand, and the $CaCO_3$ content increases with depth. Soils are deep, without rock fragments. In some places, coarse fragments are present on the soil surface, as well as along the profile.

Vegetation

The vegetation type of this unit is open scrub, which reaches a cover of about 16% in the best conditions, i.e. when soil is enough deep and can store a sufficient amount of water. In the interwadies, a very little cover of natural vegetation has been detected. This unit is fairly grazed; the vigour of the plants range from good to fair.

HE2: Undulated area with short wadies and scattered alluvial fans, covered by aeolian deposits

Geomorphology

This unit differs from the former one for the presence of a thin sheet of aeolian sand cover on the surface, easily recognisable from the satellite image because of the reddish colour. Geomorphological, vegetation and pedological characteristics are similar to those one o the previous landscape (HE1).

HW: High Energy Coastal Plain with long wadies

This Land System is located in the western part of the studied area close to Marsa-Matrouh; it is represented by two landscapes:

HW1: Deep wadies and interwadies areas
HW2: Deep wadies and interwadies areas with aeolian deposits

HW1: Deep wadies and interwadies areas

Geomorphology

In this unit the coastal plain shows particular characteristics. The escarpment moves back from the shoreline and the plain becomes wider; in this belt the drainage network is well developed and a series of long, deeply incised and branched wadies cut the plain and reach the sea; the drainage pattern is highly controlled by geological structures. The width of the watersheds feeding those wadies is responsible for periodical flooding that discharge a huge amount of water and sediments into the wadi beds, thus creating the best conditions for the development of deep, fertile soils, highly suitable for agriculture. Sometimes, as for Wadi Qassaba, the foreshore ridge acts as a barrier causing the development of a salt marsh.
The interwadies areas are usually flat or gently undulating, with a slope gradient ranging between 0 and 5%; rock outcrops are common and soils are very shallow; here infiltration rate is little and the resulting runoff water is responsible for the high intensity of sheet erosion and, as a consequence, for supplying sediments for wadies; rill erosion has been also recognised, but to a minor extent than sheet erosion; about 50% of the interwadies area is estimated to be affected to some extent by sheet and/or rill erosion. Some small, closed depressions are found in the interwadies areas, acting as a trap for aeolian sands.

Soils

In the wadies bottom, soils are deep, non saline, non sodic; the $CaCO_3$ content varies from 5 to 23%; the texture along the profile is sandy, rarely sandy loam. Rock fragments in the profile are absent or very few; those soils are usually well drained and never saturated with water.
Soils in the interwadies are almost completely eroded; soil depth is just a few centimetres and most of the surface is covered by medium and coarse gravel; in the small, shallow depressions soils are slighty deeper and locally planted with cereals.

Vegetation

Three main facets are present:
(i) Wadi beds: they are intensively planted with barley, vegetables, watermelons, figs, olives, almonds;
(ii) Interwadies areas: the vegetation type found in this facet is sparse field; vegetation cover is very low, usually less than 1%. Small depressions, where soil is just a bit deeper, are sometimes planted with barley and wheat;
(iii) Wadi slopes: vegetation cover is about 15%; dominant species are *Thymelea hirsuta*, *Atriplex spp.*, *Echinops galalensis* and *Piturantos tortuosus*.
Both interwadies and wadi slopes are heavily grazed and plants usually show a fair vigour.

HW2: Deep wadies and interwadies areas with aeolian deposits

Geomorphology

In the same Land System some places are particularly interested by deposition of aeolian sands, that in places gives rise to true sand dunes. This is the case of Wadi Garawla, where several meters of aeolian sediments can be found. To a minor extent, other areas are covered by aeolian sediments: the rate of accretion is moderate and covers more than 50% of the total area. Both wind erosion and deposition are active and those two processes have a high degree of dynamism: as a consequence, agricultural areas surrounding this unit have to be considered at risk.

Soils

Soils found in the surroundings of the sand dune in Wadi Garawla area are deep (> 90cm), non saline and non sodic, with a low $CaCO_3$ content; texture ranges from sandy to loamy sand. Lower horizons are highly stratified, indicating different deposition cycles, and contain a lot of very small shell fragments.

Vegetation

In this unit vegetation is very sparse: only few shrubs, less than 50 cm high, and grasses have been found; the total vegetation cover is <1%. The area is grazed and the regeneration capacity of the plants is very weak.

4.1.2. Northern Plateau

The Northern Plateau follows inland the Coastal Lowland being separated from it through the escarpment. It extends for 2,132.31 km^2 and is subdivided into six Land Systems.

PS: Plateau slope
UP: Undulated northern edge of the plateau
TB: Tableland
LT: Low Tableland
TS: Tableland with sink holes
TP: Transitional Plateau

PS: Plateau slope

This Land System represents the linkage between the Northern Plateau and the Coastal Lowland; the part of the escarpment which results very steep was not mapped separately, but associated to the uppermost Plateau System. According to the different shapes, it was subdivided into three landscapes:

PS1: Highly dissected plateau
PS2: Terraced plateau escarpment
PS3: Gentle plateau slope

PS1: *Highly dissected plateau*

Geomorphology

This landscape represents one of the three possible kinds of connection between the coastal plain and the plateau: the highly dissected plateau is located south of the Land System "High Energy Coastal Plain with Long Wadies", almost all around the Ras El Hekma promontory and south of the Fuka basin. The plateau slope is deeply incised by wadies and results in a highly dissected landform, with isolated small hills as remnants of the original escarpment; in some places the structure of the underlying limestone creates a series of undulated, elongated banks, sub-parallel to the escarpment, that usually act as a trap for wind blown sands. The general landform is undulating, its elevation range between 80-100 m above sea level. The slope gradient ranges between 5-10% and only locally can reach higher values. Sheet, rill and gully erosion are the dominant geomorphological processes, with intensity ranging from moderate to severe; sheet erosion affects the most part of the surface; gullies up to 2 m deep and 400 m spaced are common.

Soils

Soils are generally very shallow and highly eroded, with many coarse rock fragments. Along drainage lines and in the depressions, where sediments, transported by wind and water, accumulate, soils are slight deeper. In some places, a thin layer of shifting sands covers the surface. Texture is sandy. Soils in sampled areas are non saline (E.C.<1ds/m), but salinity is likely to be present in patches. The $CaCO_3$ content is highly variable, ranging from 22% to 42%.

Vegetation

The vegetation is mainly represented by sparse scrub; the vegetation cover is about 1-2 % and only in particularly favourable conditions, as along drainage lines, can reach 5%. The dominant plant species are *Thymelea hirsuta*, *Hammada spp.*, *Atriplex spp.*, *Piturantos tortuosus* and *Echinops spp.*. The unit is fairly grazed and, though the vegetation cover is very low, plants usually show a good vigour. Some depressed areas, with more favourable moisture conditions, are cultivated.

PS2: Terraced plateau escarpment

Geomorphology
The presence of a terrace is the main distinguishing character of this unit; since the terrace scarp is small, it is recognisable only on aerial photographs or in the field. Here the plateau escarpment is incised by a series of wadies but it is less dissected than in PS1; as a consequence, the escarpment slope is steeper than in PS1. The elevation range is from 100 m at the foot of the escarpment to 120 m at his head. Where slope is not excessive, wadi beds are cultivated.
Soils
Soils of this unit are moderately deep; rock fragments in the profile range from few in the first horizon, to many in the second one. Soil texture is sandy loam; the $CaCO_3$ content is usually very high (more than 19%) and increases with depth; the sampled soil profile is highly saline (E.C. = 17 dS/m in the second horizon) and sodic (SAR > 20).
Vegetation
Vegetation of this unit is very similar to that of the former one. The dominant plant species are *Thymelea hirsuta* and *Asphodelus spp.*, with a vegetation cover of about 2%. The unit is grazed, but not excessively: the vigour of the plants ranges from fair to good. No cultivated areas have been found, except for some wadi bed.

PS3: Gentle plateau slope

Geomorphology
This unit represents the third typology of connection between the coastal plain and the plateau; it is present in the easternmost part of the study area. In this unit the plain gradually rises with a series of gentle undulations and rounded hills. The passage from the first to the second geographical region is hardly recognisable; since a real escarpment is missing, any boundary between plateau and coastal plain should be considered arbitrary. The slope gradient ranges from 0.2 to 2%. The drainage network is almost absent.
Soils
This unit is a transition belt between the Northern Plateau and the Coastal Lowland; rock outcrops are dominant and only in the shallow depression that are scattered all over the unit very shallow soils may be found. No soil profile description has been performed for this unit.
Vegetation
Vegetation cover is about 5%. The dominant plant species are *Thymelea hirsuta, Piturantos tortuosus* and *Asphodelus spp.* . The unit is almost used as rangeland; no cultivated areas have been found.

UP: Undulated northern edge of the plateau

This Land System is located in the area limited northward by Ras El Hekma. Its peculiar geographic position is determined by a system of tectonic features which caused the northward movement of this part of the Plateau. Only one landscape was assigned to this System.

UP: Undulating hills and depressions

Geomorphology

This landscape is the only one, belonging to the Northern Plateau, showing a relatively high relief energy: small and medium rounded hills alternate to inter hills depressions, with slope gradients ranging from 2 to 10%; the lithology of this area also differs from that of the rest of the plateau, being mainly made up of oolithic limestone, white coloured and highly friable. The elevation range is between 100 and 110 m above sea level. Wind erosion and deposition are both active and redistribution of sand severely affects figs plantations that are widespread in the depressions all over the unit. Rocky hills represent about 55% of the area, the remaining 45% being represented by depressions where moderately deep soils, most of them cultivated with figs and olives, are found.

Soils

Soils of the rounded hills are very shallow (less than 10 cm) and the surface is covered by many medium to coarse rock fragments; rock outcrops are common. In the depressions moderately deep soils (> 75 cm), non saline, non sodic, sandy to loamy sand in texture and without rock fragments are found. The $CaCO_3$ content is high (32%).

Vegetation

The vegetation type of this unit is sparse field, with a very low cover (usually no more than 1%). The whole area is grazed, and plants are generally in bad conditions. Most of the depressions are used for figs, olives and almonds plantations, but the high rate of sand deposition threaten them seriously; several figs plantations almost completely buried by oolithic sands have been observed.

TB: Tableland

The Tableland is the typical Land System of the Northern Plateau. It is located in the central part of the study-area, subdivided into three landscapes.

TB1: Tableland with incised wadies

Geomorphology

This landscape represents the northernmost part of the tableland; it is found in two different areas: west of Fuka basin and south of the Land System "High Energy Coastal Plain". In the latter area the escarpment linking the plateau to the plain is very steep and too narrow to be mapped separately and consequently it was included in the plateau system. The surface is flat, abundantly covered by rock fragments, mainly coarse gravel and stones; the elevation range is between 120 and 130 m above sea level. The tableland is incised by a series of shallow wadies that gather sediments generated by sheet erosion and discharge them into the plain, giving rise to a series of small alluvial fans. The main geomorphological process is sheet erosion and, to a very moderate extent, sand accumulation. In some places, small depressions, some of which cultivated, are present.

Soils

The soils of this mapping unit are very shallow (usually less than 20 cm); rock outcrops are common, as well as coarse rock fragments; only in the wadi beds and in the depressions soils reach greater depths.

Vegetation

The vegetation type of this unit is sparse scrub; vegetation cover is about 2%. In the wadi beds vegetation cover increases, reaching about 5%. The dominant plant species are *Thymelea hirsuta*, *Anabasis sp.*, *Asphodelus spp.*, *Zygophyllum album* and *Halocnemum strobilaceum*. Grazing is intense, but plants seem to have a good vigour as well as regeneration capacity.

TB2: Tableland

Geomorphology

This unit represents the simplest form of Northern Plateau, characterized by an almost complete absence of drainage network; the surface form is flat, with only very wide, quite invisible in the field, undulations that are probably important in the redistribution of surface runoff water. Its elevation ranges between 150-160 m above sea level. The homogeneity of this unit is almost absolute, with only small variations in the amount of vegetation cover, depending on the local availability of water, as well as on the intensity of grazing. Main geomorphological processes are wind erosion and sand accumulation; although it is not the common feature of this unit, in places small hummocks are found. Rock outcrops are common and the surface is covered by few gravels, from fine to coarse in size.

Soils

Soils of this unit are usually very shallow (5-10 cm) and only in some places deeper soils (25-30 cm) are found; a thin sheet of sand is present. Salinity is low (E.C. = 2 dS/m for the surface horizon of the sampled soil), and the $CaCO_3$ content is high (23% for the same horizon). Texture is loamy sand, with common coarse fragment on the surface. Very small, scattered hummocks are present.

Vegetation

Vegetation composition and cover are very similar to those of the previous landscape (TB1); vegetation type is sparse scrub, with a cover of about 5%. The dominant plant species are *Thymelea hirsuta*, *Anabasis spp.*, *Zygophyllum album*, *Halocnemum strobilaceum* and *Piturantos tortuosus*. The land is used only as grazing land, and the general plant conditions show a high grazing pressure, that probably endanger regenerating capacities of plants.

TB3: Tableland with aeolian cover

Geomorphology

This landscape covers a very wide belt in the central part of the Northern Plateau and, as for the former one, shows very homogeneous patterns over the whole area. The general characteristics of this unit are very similar to those of TB2, the distinguishing feature being the presence of an aeolian sheet cover, rich in very small shell fragments, on the surface; the thickness of such cover is seldom less than 2 cm and increases moving eastward; the presence of small to medium (up to 100 cm high) hummocks around shrubs is common. The elevation ranges between 150-160 m above sea level. Both wind erosion and deposition are active, but it is hard to understand the dynamics of the two processes from the distribution pattern of sand deposits. Rock outcrops are few, while the percentage of rock fragments (coarse gravel stones and boulders) on the surface is higher than in the former mapping unit.

Soils

Soils are usually shallow (20-30 cm) and only locally moderately deep, but rarely exceeding 45 cm; often rock fragments (from fine gravels to stones) are abundant in the second horizon; salinity varies from low to moderate (from 1 to 5 dS/m). The $CaCO_3$ content ranges between 13% and 23%. Texture ranges from sand to loamy sand. Shell fragments on the surface and in the upper horizon are very common.

Vegetation

This unit has the same characteristics of TB2, the vegetation type being open scrub. The dominant plant species are *Thymelea hirsuta*, *Hammada spp.*, *Zygophyllum album*, *Halocnemum strobilaceum* and *Piturantos tortuosus*; the vegetation cover ranges between 5 and 10% but, given the width of the unit, it could be locally higher, up to 12-15%. Signs of grazing are common nevertheless, the general conditions of the plants are good.

LT: Low Tableland

This Land System, located, in the shape of an elongated tongue, just northward of the landscape "Tableland with aeolian cover", shows very peculiar characteristics, affecting also its land use, that cannot be found anywhere else. It is completely characterized by the following landscape.

LT: Plateau with cultivated fields
Geomorphology
This unit is almost completely cultivated, this shows an availability of water quite unusual for the plateau, where rainfall is very scarce. Well recognisable on the satellite image, this area is likely to be in a slightly lower topographic position with respect to the surrounding lands, thus collecting runoff water from a very large surface. Nevertheless, this is not reflected in soil characteristics (soil depth in this landscape is not much greater than elsewhere in the plateau). The surface form is almost flat, its elevation ranges between 130-140 m above sea level. Geomorphological processes are wind erosion and sand accumulation; a moderate wind erosion affects about 25-50% of the total area. Rock fragments (mainly medium gravel) on the surface are scarce.
Soils
The soils of this mapping unit are highly variable: their depth ranges form 10 to 50 cm. Also salinity shows a high degree of variation: sampled soils have an E.C. varying from 0.69 and 29 dS/m. Texture ranges from sandy to loamy sand. The $CaCO_3$ content ranges from 9% to 43%. In some places some rock fragments cover the surface. Shell fragments in the upper horizon are a common feature. Consolidated limestone is detected at variable depths.
Vegetation
Agricultural areas, presently not cultivated, have a very low vegetation cover, often less than 1%; vegetation type is sparse field. Most of the surface is cultivated with barley. No signs of grazing were detected.

TS: Tableland with sink holes

This Land System extends continuously in a wide belt along the study area. Two different landscapes were identified:

TS1: Plateau with shallow hollows
TS2: Plateau with shallow hollows covered by aeolian deposits

TS1: Plateau with shallow hollows

Geomorphology

The southern belt of the plateau is characterized by a large number of elliptical depressions, most of them very small, (1-2 ha) but sometimes greater (10-15 ha). The genesis of those depressions is likely linked to the dissolution of limestone in depth and the consequent collapse of the overlying rock strata, giving rise to the so-called sink holes, that have been subsequently filled up with fine sediments transported both by wind and water; at the same time, those depressions collect runoff water from surrounding areas, as it is shown by their unusually high vegetation cover. The distribution pattern of the sink holes (most of them elongated according to preferential trends) suggests a strong tectonic influence. Outside the sink holes, the landscape is very similar to those of the tableland: the surface is almost flat, covered by many, locally abundant, rock fragments (mainly coarse gravels); there are no signs of drainage network. Rock outcrops, very few in the western part of the unit, increase moving eastward. The elevation ranges between 170 and 180 m above sea level, slightly decreasing eastward. Sand deposition is predominantly active in the depressions, while outside them sheet and wind erosion, both moderate in intensity, affect about 5-10% of the total area. In some places small or medium hummocks are present.

Soils

Soils of the sink holes are moderately deep (soil profiles up to 60 cm have been detected) and have a thick (10 - 20 cm) layer of fine aeolian sand at the top. Those soils are non saline (E.C.<3) and the $CaCO_3$ varies from 11% to 28%. Texture ranges from loamy sand to sandy loam. In the plateau, soils are usually shallow (no soils deeper than 35 cm have been found).

Vegetation

In the sink holes the vegetation type of this unit is open scrub, with a vegetation cover that can reach 40%, the dominant species being *Thymelea hirsuta* and *Anaplex spp.*; sink holes are intensively grazed, but plants usually show a good vigour; the widest sink holes, are cultivated with barley. The tableland has a very low amount of vegetation, ranging from 3 to 10%. The dominant species are *Thymelea hirsuta, Anabasis spp.* and *Zygophyllum album*.

TS2: Plateau with shallow hollows covered by aeolian deposits

Geomorphology

Eastward, sink holes seem to decrease in number while the amount of aeolian sands on the surface of the plateau progressively increases: this is the main distinguishing characteristic of this unit. The presence of hummocks seems to be related to the intensity of sand deposition; furthermore, where sand deposition is greater, a slight increase in vegetation cover is noticed. Rock outcrops are scarce, while the amount of rock fragments on the surface is often high: stones are predominant, but also medium and coarse gravels are common. The elevation ranges between 80-90 m above sea level. Wind erosion is also active, severely affecting more than 50% of the whole area and playing an important role in the redistribution of aeolian sediments.

Soils

The soils of this unit are shallower than those of the previous landscape (TS1); soil depth rarely exceed 15 cm. They have a thicker layer of shifting sand on the surface and the profile is rich in rock fragments. They are non saline (E.C. < 1 dS/m) and non sodic. Texture varies from sandy to loamy sand and the $CaCO_3$ content is moderate (10-20%).

Vegetation

The vegetation type of this unit is sparse scrub; the vegetation cover is about 7% but locally can reach higher values. The dominant species are *Thymelea hirsuta*, *Piturantos tortuosus*, *Anabasis spp.* (with excellent vigour), and *Zygophyllum album* (usually in very bad conditions). Camel and sheep grazing is particularly intense, and the general vigour of the vegetation is almost poor.

TP: Transitional Plateau

This Land System stretches in the central part of the study-area at the border with the Southern Plateau. It is characterized only by a single landscape.

TP: Transitional Plateau.

Geomorphology

The southernmost part of the Northern Plateau shows a progressive change in some characteristics as the amount of rock outcrops and the vegetation cover, the degree of salinity and sodicity and, as a consequence, the kind of vegetation. This transitional belt is present where the small escarpment (2-3 m high) that exactly marks the boundary between Northern and Southern Plateau is missing and only a very gentle slope connects the two regions. The surface form is still flat, its elevation ranges from 150 to 160 m above sea level. Dominant geomorphological processes are sand accumulation and wind erosion, which affects more than 50% of the area, with slight to moderate intensity.

Soils

Soils are shallow (> 15cm) and have a thin layer of shifting sand. They are saline (E.C.=13 dS/m for the sampled soil) and sodic. The $CaCO_3$ content is high (32%). Many rock fragments (fine and medium gravel) are present on the surface as well as in the profile, which is rich also in shell fragments.

Vegetation

The vegetation type of this unit is sparse scrub; the vegetation cover is usually very low (about 2%) but in some places can be much higher, up to 10-15%. Most halophytes are found, the dominant plant species being *Halocnemum spp.*, *Anabasis spp.*, and *Salicornia spp.* Probably due to the low palatability of existing species, the area is fairly grazed, mainly by camels.

4.1.3. Southern Plateau

The Southern Plateau extends for 496.79 km^2 limited northward by a small escarpment not always detectable, even in the field. It is subdivided into two Land Systems.

SR: Plateau with rock outcrops

SC: Plateau with desert ferrogeneous pavement

SR: Plateau with rock outcrops

This Land System is the most representative one of the considered Geographic Region being present almost in its whole extension. In this case the Land System correspond to the landscape.

SR: Plateau with rock outcrops
Geomorphology
The main characteristics of this unit are the high percentage of rock outcrops, the shallowness of soils and the extremely low vegetation cover; the landscape is highly homogeneous: surface is flat, its elevation ranges between 170-180 m above sea level. Rock outcrops are common, associated with many coarse fragments (mainly stones and boulders). Since rainfalls in the Southern Plateau are extremely scarce, wind erosion is likely to be responsible for the almost complete removal of fine sediments. Because of the absence of shrubs, hummocks are very rare. In places extremely shallow depressions are present; they are recognisable in the field because of their relatively higher vegetation cover rather than because of their topography.
Soils
Where present, soil is very shallow (10-15cm) and overlies the consolidated limestone. Salinity is very high: the two sampled profiles have respectively an E.C. of 10 and 30 dS/m; sodicity is also high (SAR is about 30 for both the sampled profiles). Texture is sandy, coarse fragments are common on the surface and abundant in the profile, where stones and boulders are nearly prevailing on the fine fraction. The $CaCO_3$ content is high, ranging from 25% to 32%.
Vegetation
The vegetation type of this unit ranges from sparse scrub to sparse field; the vegetation cover ranges between 1 and 3%. Most of the species are salt-tolerant but the plants are usually in bad conditions. The area is grazed only by camels.

SC: Plateau with desert ferrogeneous pavement (serir)

This Land System is represented by a very small area, located approximatively in the central part of the Southern Plateau, showing very peculiar characteristics if compared to the surrounding region. Also in this case the Land System correspond to the landscape.

SC: Plateau with desert ferrogeneous pavement
Geomorphology
This unit represents a particular environment of the Southern Plateau because of the presence of a desert pavement, formed by carbonatic rocks, cracked in coarse, platy gravels, weathered on the surface, that is covered by a thin ferrogeneous crust, responsible for the dark reddish colour of those gravels. The surface form of the unit is plain, very gently sloping; the slope form is straight and the slope gradient is 1-2%. The elevation range is between 170 and 180 m above sea level.
Soils
The soils of this unit are unique because of the presence of the desert pavement that most likely protected them from wind erosion; as a consequence, they are exceptionally deep (more than 60 cm), highly saline (E.C. = 43 dS/m) and sodic (SAR = 38 for the surface horizon); the $CaCO_3$ content ranges from 30% to 40%, and texture is sandy. Shell fragments ore found on the surface and within the surface horizon.
Vegetation
This unit is almost completely bare. Its only character is the presence of a pavement of purple-red colour ferrogeneous carbonatic rocks. Lichens having different colors (dark red, yellow, white, pale green, and orange) are living on the surface of the pavement fragments.

For the description of the vegetation types, the following definitions have been adopted.

CLOSED SCRUB: closed even or uneven canopy of scrub elements; no definite emergents. Generally less than 3 m tall, but if of definitely shrubby aspect may be taller.

OPEN SCRUB: open even or uneven layer of scrub elements; trees absent or negligible. Herbaceous layer present or not; generally an open scrub is less than 3 m tall, but if of definitely shrubby aspect may be taller.

SPARSE SCRUB: trees absent or negligible; scrub elements scattered; herbaceous layer sparse or absent for more than 9 months of the year (for less than 3 months the herbaceous layer may be denser).

SHORTPLANT FIELD: trees and scrub elements absent or negligible; ground layer closed or open all year or at least for some period during the year; all of it is always less than 1 m. tall or, if part reaches or surpasses 1 m. at any time during the year, that part has an absolute cover of less than 10%.

SPARSE FIELD: trees and scrub elements absent or negligible; ground layer sparse of any height; ground layer never denser than sparse at any time of the year.

As for the description of rock outcrops and rock fragments abundance, the following ranges have been taken into account:

None	0 %
Very few	0 - 2 %
Few	2 - 5 %
Common	5 - 15 %
Many	15 - 40 %
Abundant	40 - 80 %
Dominant	> 80 %

The size of the rock fragments has been defined according to the following classes:

Fine gravel	0.2 - 0.6 cm
Medium gravel	0.6 - 2 cm
Coarse gravel	2 - 6 cm
Stones	6 - 20 cm
Boulders	20 - 60 cm
Large boulders	> 60 cm

4.2. Land Unit Map

4.2.1. Approach and Methodology

The land unit map was produced at a 1:100,000 scale, a classical scale for objectives such as those of the CAMP. Nevertheless, since the beginning of the CAMP project it was clear that the relevant scale for soil properties in the area was a quite larger one, in the range of 1:25,000 to 1:50,000.

Surveying the whole area at 1:50,000 would not have been feasible considering the time schedules and budget of the CAMP, so a specifically planned two-phase approach was devised, that has demonstrated its validity and that is the source of the structure of the present legend.

In the first phase, two pilot areas were selected in such a way to be as representative as possible of the whole area; this was accomplished mostly on the base of the experience of the Egyptian team of experts led by Prof. Abdel-Kader. The two selected pilot areas were the Wadi Qasaba watershed in the western part of the CAMP area, and a larger area centred on the Fuka basin, making up effectively the whole far eastern part of the CAMP area. These areas were surveyed in detail in the first year of the project, and the relevant maps and data are accounted for in the relevant reports.

The detailed knowledge gained in the pilot areas allowed to establish the basic understanding of the fundamental relationships between soil characteristics and externally visible landscape attributes, such as landforms and land use, and this knowledge allowed the drawing-up of the map for the whole area with a limited amount of effort, time, and costs.

The second phase of the project saw as a matter of fact the production of the generalised Land nit map for the whole CAMP; this was accomplished by extending the knowledge gained in the pilot areas with the help of a combination of aerial photo-interpretation, soil data from other sources, satellite image interpretation and soil data from the RAC/ERS group and a limited number of new field observations.

4.2.2. Legend Structure

The structure and content of the legend are the direct result of the used approach. During the first phase of the project, clear associations have been established between soil properties and a series of simple landforms, easily acknowledgeable by aerial photo-interpretation; in the terminology of the legend, those simple landforms are named "land facets"; a complete list of the land facets retained after the final revision is given below.

It was not possible, in many cases, to map single land facets in the final map, as they mostly occur in sizes incompatible with a 1:100,000 map. So, most of the map units are made up by an association of several land facets; an estimate of the percentage area covered by each facet is given when relevant to management purposes.

Different land units have then been created for one of the following reasons:

- They include different land facets;
- They include the same land facets but in quite different proportions; and
- It has become known, by any of the tools used, that similar land facets, in different areas, are associated with soils that are significantly different from the management point of view.

GEOGRAPHICAL REGIONS	LAND SYSTEMS	LANDSCAPES	CODE	RELEVE NUMBER	AREA (km^2)
COASTAL LOWLAND	Backshore Land	Beach, drifting oolitic sediments, and backshore ridges	BL1	15,21	38.37
		Salt marshes	BL2	14	6.06
		Oolitic bars and interbars salt marshes	BL3	12,13	11.77
		Evaporitic deposits	BL4	-	1.98
	Low Energy Coastal Plain	Ridges and interridges area	LE1	16,20	87.72
		Discontinous ridges and interridges area	LE2	17,18	84.35
		Like LE2, but covered by aeolian deposits	LE3	3	43.91
		Undulated area without drainage network	LE4	24,25,41,42	98.97
	High Energy Coastal Plain	Undulated area with short wadis and scattered alluvial fans	HE1	22,23	215.99
		Like HE1, but with aeolian deposits	HE2		1.20
	High Energy Coastal Plain with Long Wadis	Wadis and interwadis areas	HW1	10	120.62
		Like HW1, with aeolian deposits	HW2	1,2	24.90
NORTHERN PLATEAU	Plateau Slope	Highly dissected plateau	PS1	11,19,29	122.22
		Terraced plateau escarpment	PS2	-	77.13
		Gentle plateau slope	PS3	-	75.35
	Undulated Northern Edge of The Plateau	Undulating hills and depressions	UP1	8,9	100.69
	Low Tableland	Plateau with cultivated fields	LT1	34,37,38	73.40
	Tableland	Tableland with incised wadis	TB1	36	128.57
		Tableland	TB2	40	71.84
		Tableland with aeolian cover	TB3	6,35,39	229.90
	Tableland with Sink Holes	Plateau with shallow hollows	TS1	7,28,33	663.68
		Like TS1, but covered by aeolian deposits	TS2	26-27	362.98
	Transitional Plateau	Transitional plateau	TP1	5,30	226.55
SOUTHERN PLATEAU	Plateau with Rock Outcrops	Plateau with rock outcrops	SR1	4,31	480.7
	Serir	Plateau with desert ferrogeneous pavement	SC1	32	16.09

Table 1: Land System Map Legend

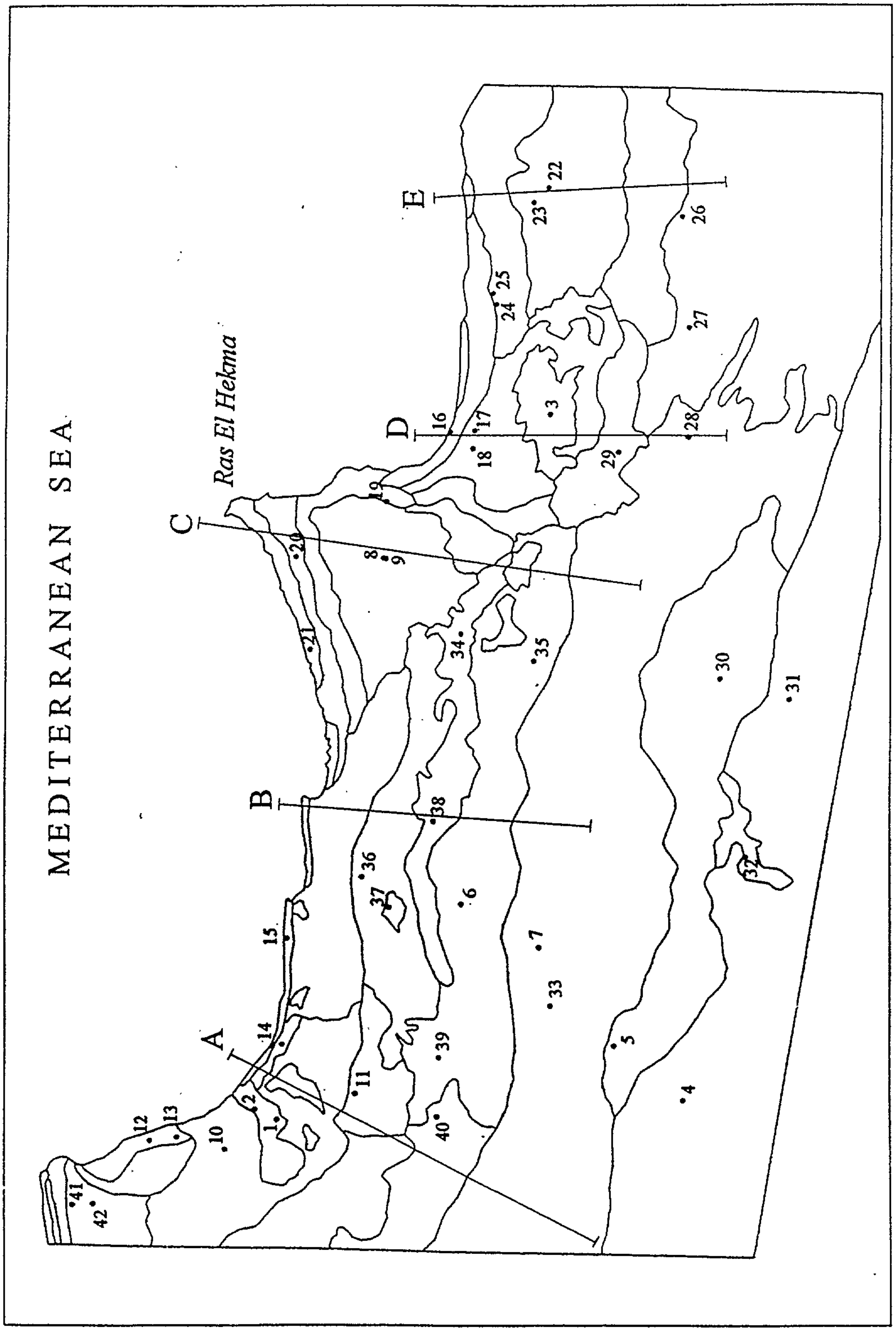


Figure 6: Land System Map (scale 1:400,000) Reporting the Locations of the Topographic Sections of Figure 8

Figure 7: Satellite Image of the Study Area Reporting Landscapes Limits and Releves Location (Approximate Scale 1:350,000)

The soil agricultural potential rating system was applied to the land facet scale, as this was the only possibility, so units containing different facets are characterized as a mosaic of different landforms hosting different soils with a different agricultural potential.

This representation is partly a limit to the usefulness of the map, but it was the only solution that allowed the production of a 1:100,000 map without completely losing part of the information about soil properties obtained by the CAMP project. For practical purposes, land units can be read rather easily in their components by a simple expedient: in most cases, those facets ranked high in agricultural potential will occupy low-lying, depressed, landscape positions, while facets devoid of useful soil will occupy high-standing positions.

4.2.3. Fuka-Matrouh Area Land Facets Inventory

4.2.3.1 Coastal Lowlands Geographical Region

- C1 Beaches
- C2 Coastal uncemented ridge
- C3 Salt marsh
- C4 First swale
- C5 Cemented ridges
- C6 Second swale
- C7 Main valley floor
- C8 Lateral valley floor
- C10 Closed depressions
- C11 Inland swales
- C12 Coalescent alluvial fans in swales
- C13 Shifting dunes
- C14 Sand plain
- C15 Flat elevated land
- C16 Salt marsh with sand sheet cover
- C17 Low hillocks

4.2.3.2 Wadis

- W1 Terminal wadi courses
- W2 Long wadi alluvial fans
- W3 Long wadi bottoms
- W4 Long wadi flanks
- W5 Short wadis alluvial fans
- W6 Short wadis
- W7 Suspended wadis sections

4.2.3.3 Northern and Southern Plateau Geographical Regions

- P1 Hills
- P3 Small swales
- P4 Broad inland swales with aeolian cover
- P6 Terraced escarpment
- P10 Tableland
- P11 Depressions
- P12 Large depressions
- P14 Steep escarpment
- P15 Smooth hills

Table 2: Legend of Land Unit Map

LANDSCAPE	UNIT	LAND FACETS and percentage		SOIL PROFILE**	RATING	LIMITING FACTOR(S)
BL3	1	C2	70		IV	Bare
		C1	10		IV	Bare
		C3	10		IV	Salinity, sodicity
		C10	<10			
		W1	<10			
BL2	2	C3			IV	Salinity, sodicity
HW1	3	C15	60		IV	Very thin soil
		C10	40	N4104	III	Depth
BL1	4	C1			IV	Bare
		C2			IV	Bare
HW1	5	W3	60	N2001	I	°°°
		W4	40		IV	Bare, slope
HW1	6	C15	60		IV	Bare
		C10	30	N4096	III	Depth
		W3	<10			
		W4	<10			
		W6	<10			
BL2	7	C3		Q29	IV	Salinity, sodicity
PS2	8	W7		Q10,Q20	III	Depth
HW1, LE2	9	W2		Q27,Q28	I	°°°
HW1, HW2, LE1, LE2, LE3, HE1	10	C5			IV	Bare
HW1	11	C11		H2	II	Depth, salinity
LE1, HE1, HW1, HW2	12	C11		Q26,Q1,Q25, F5,F6	II	Depth
HE1, HW1, HW2	13	C11	70	Q24	III	Depth, salinity
		C10	20	Q6	II	Depth
		C5	<10			
		W3	<10			
		W4	<10			
HW1	14	W3	60	Q2,3,13,19	I	°°°
		W4	40		IV	Bare, slope
HW1, HE1, PS1	15	W4	70		IV	Bare
		W3	30	Q11,Q7	I	°°°
HW1, HE1	16	W5	80	Q22	I	°°°
		W6	20	Q5,Q23	II	Depth
HW1	17	C11		H6	IV	Salinity, sodicity
PS1	18	P1	70		IV	Bare
		P3	20	Q8	III	Salinity, sodicity
		W6	<10			
		W5	<10			
PS1	19	P1	60		IV	Bare
		P3	30	Q15	II	Depth, salinity
		W5	<10			
		W6	<10			

* Percentage area covered in unit, estimated when different facets host soils with different rating
** Representative soil profile for the land facet, not necessarily physically located in the unit
°° Some wind erosion risk
°°° Special wadi conditions

Table 2: Legend of Land Unit Map - continued

LANDSCAPE	UNIT	LAND FACETS and percentage		SOIL PROFILE**	RATING	LIMITING FACTOR(S)
BL1	20	C1			IV	Bare
		C2			IV	Bare
		C3			IV	Salinity, sodicity
HW2	21	C13		RS2	IV	Shifting dune
		C14		NV34	IV	Drifting sand sheet
		W3				
HW1, HE1	22	C15	>80		IV	Very thin soil
		C10	10		II	Depth
		C5	<10			
PS1	23	P1	50		IV	Bare
		P4	>40	23	II	Depth
		W3	<10			
HW1	24	C15	80		IV	Very thin soil
		W6	10		II	Depth
		W3	<10			
		W4	<10			
HW1	25	C15			IV	Very thin soil
LE1	26	C6/C11		26	I	
LE1	27	C2	70		IV	Bare
		C6/C11	30		I	
LE4	28	C11/W3	70		I	
		W4	30		IV	Bare, slope
LE4	29	C10			III	Depth
LE4	30	C15	90		IV	Depth
		C10	10		III	Depth
LE4	31	C15	70		IV	Depth
		C10	30		III	Depth
LE1	32	C5	90		IV	Bare
		C11	10	RS41	III	Depth
HE1	33	C12		33	I	
HE1, HE2	34	C2			IV	Bare
		C4			IV	Saline, sodic
HE1, LE1	35	C12		35	I	
HW2	36	C16			IV	Salinity, sodicity
HE1	37	C12		37	III	Salinity, sodicity
HE1, LE1	38	C2	70		IV	Bare
		C10	30		III	Depth
HE1	39	C11	70	Q24	III	Depth
		C5	10		IV	Bare
		W3	10	Q11,Q7	III	°°°
		W4	10		IV	Bare
HE1, LE2	40	C17	75		IV	Thin soil
		C10	15		III	Depth
		W3	10	Q11,Q7	I	°°°
		W4	<10		IV	Bare
TB1	41	P14	90		IV	Bare
		W6	<10			

* Percentage area covered in unit, estimated when different facets host soils with different rating

** Representative soil profile for the land facet, not necessarily physically located in the unit

°° *Some wind erosion risk*

°°° Special wadi conditions

Table 2: Legend of Land Unit Map - continued

LANDSCAPE	UNIT	LAND FACETS and percentage		SOIL PROFILE**	RATING	LIMITING FACTOR(S)
HE1	42	C10	80	42	II	Depth
		C17	10		IV	Bare
		W3	<10			
		W4	<10			
BL1	43	C5			IV	Bare
		C10		RHK7	IV	Drifting sand
LE1	44	C6		44	I	
LE1	45	C10	60		III	Depth
		C5	40		IV	Bare
LE1	46	C10		RHK9	IV	Salinity, sodicity
UP	47	P12	80	48	II	Depth
		P15	20		IV	Depth
UP	48	P15	60		IV	Depth
		P11	20	RS8	III	Depth
		P12	20	48	II	Depth
UP	49	P15	80		IV	Depth
		P11	20	RS8	III	Depth
TB1	50	P10			IV	Depth
		W4			IV	Bare
TB1	51	P10	80		IV	Depth
		W7	20	Q10,Q20	III	Depth
PS2	52	P14	80		IV	Bare
		W6	20	Q5,Q23	II	Depth
PS2	53	P6		F19	IV	Depth
		P14			IV	Bare
LE3	54	C12		F20	I	°°
LE2	55	C7		F14	I	
LE2	56	C8		F21	I	
LE3	57	C11		F10	II	Very sandy soils, wind erosion risk
LE1	58	C6		F12,F22	III	Sodicity,salinity
LE2	59	C5	60		IV	Bare
		C10	40	F13	III	Depth
HW1	60	C15	50		IV	Bare
		C10	40	N4096	III	Depth
		W3	<10			
		W4	<10			
TB2	61	P10		F1,F18	IV	Depth
LT	62	P12		RS34	III	Depth
TS1	63	P10		F1,F18	IV	Depth
		P11		F2	IV	Depth
TB3	64	P10		Q14	IV	Depth
TP	65	P10			IV	Depth
TS2	66	P10			IV	Depth
		P11				
SR	67	P10		RS4	IV	Depth
SC	68	P10			IV	Depth

* Percentage area covered in unit, estimated when different facets host soils with different rating
** Representative soil profile for the land facet, not necessarily physically located in the unit
°° Some wind erosion risk
°°° Special wadi conditions

4.3. Synthetic Description of the Main Landscape Elements

4.3.1. Geomorphology

Geomorphology is probably the most important factor in conditioning land management in this area.

Given the nature of landscape and climate and the very embryonic nature of soil forming processes, soil properties - as well as the possibility for the soil to receive additional water - are strongly controlled by morphogenetical processes. This control directly affects soil potential and vegetation cover (Figure 8). The width of the coastal lowland is driven by the position of the northernmost escarpment which, in turn, is influenced by structural elements.

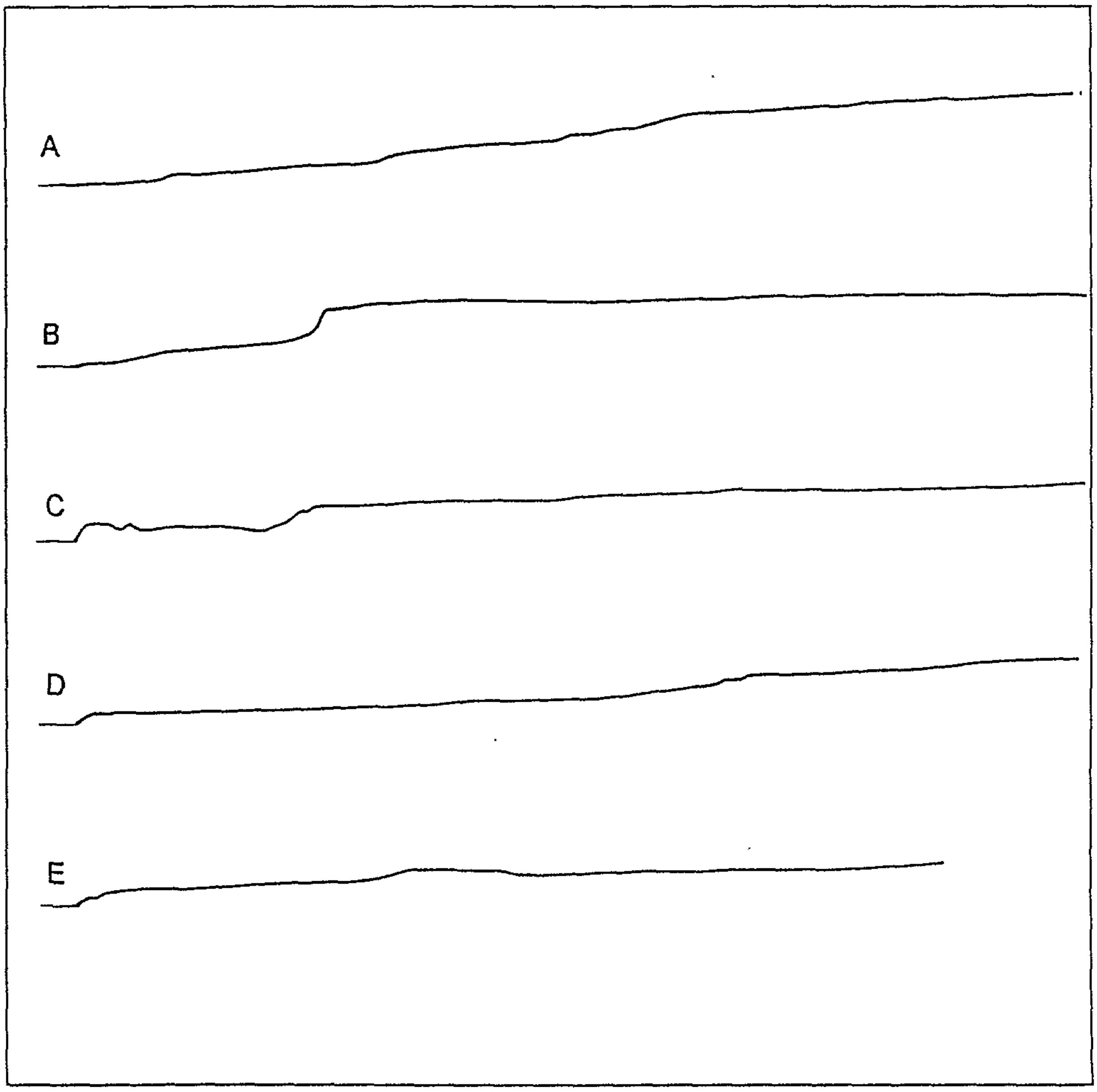


Figure 8: Topographic Sections showing the Various Kind of Connection Between Coastal Plain and Plateau, in the Study Area (Height-scale 1:15,000; Length-scale 1:150,000)

As a matter of fact, zones can be identified where the escarpment results to be very steep or terraced and can take a NS direction in contrast with the normal EW one.

The coastal lowland is thus shaped by such an escarpment course, appearing wider where the slope is mainly stratigraphically controlled, and narrower where it is mainly structurally controlled.

The combinations of width and average slope of the coastal lowland belt are such that this belt can be differentiated in three main domains; these are easily identified by their peculiar drainage networks, and characterized by different prevalent simple landforms.

The low-energy coastal plain is found close to Marsa Matrouh and in the Fuka area; it is wide and very gently dipping towards the sea. The drainage network is absent or very poorly developed, landforms due to fluvial processes are marginal and the dominant landforms are those linked to the sedimentation of the underlying rock, the oolithic limestone with its series of elongated bars, presently exposed and forming the typical pattern of ridges and swales.

The high-energy coastal plain stretches between the structural escarpment, west of Ras el Hekma, and the sea; it is quite narrow and shows a well developed drainage network of short wadis. In this situation, landforms conditioned by the oolithic limestone are obliterated, as ridges are dissected and swales filled up with alluvial fan deposits. The same Land System has been found in the inland area east of Fuka, although with a somewhat less developed drainage network.

A different kind of high-energy coastal plain is the area of the large wadi watersheds, located between Wadi Nagamish and Wadi Qassaba. Here the plain is wide but significantly sloping; the drainage network is much developed, with long wadis discharging - at least partially - to the sea. Interwadis are characterized by wide degradational areas, small depressions and alluvial fans of minor wadis. In the lowest, eastern part, some ridges and swales become visible.

A narrow strip of backshore land bounds the sea for most of the area, taking different landforms such as beaches and unconsolidated bars composed by drifting oolithic sediments.

Behind the first foreshore bar, in areas at, or below, the sea level, lagoons and salt marshes may be found. The widest ones have been observed close to Marsa Matrouh and between the mouths of Wadi Qassaba and Wadi El Hareka.

Aeolian deposition is a rather widespread phenomenon in the coastal lowland; two main areas have been observed: in the south-east of Fuka and along Wadi Gharawla, in the south of Matrouh. In the latter, deposition is particularly important; a large shifting dune has buried the main wadi channel in its lowest portion and is trailed inland by an extensive area of sand sheets. In other areas, also present on the plateau, the main aeolian sedimentation features are wide stretches of hummocky land.

As already outlined in the description of the former geographical region, the plateau escarpment plays a significant role in determining the relationship between the coastal lowland and the northern plateau region.

Where the escarpment appears extremely steep - as in the area west of Ras El-Hekma - it was mappable only at the land unit level, and it was considered as part of the tableland at the highest levels.

The plateau escarpment also shows three different possible aspects: a terraced slope, a gentle slope and a dissected pediment. The first one is not very widespread and it is found in the west of Fuka and in the westernmost portion of the study-area. It displays one or two orders of structurally controlled terraces, whose edge is not always well evident.

The gentle slope is found in the easternmost part of the area and it consists of a linking belt between the plateau and the coastal plain where there is not a real escarpment, but rather a gently dipping undulated landscape, with rounded hills and short, shallow wadis with their alluvial fans.

The dissected pediment is found south of Fuka and of the large western wadis; the dissection pattern appears highly influenced by stratigraphical and structural features of the limestone rock, giving a characteristic pattern of curved crests and valleys, occasionally cut by wadi incisions. Crests and valleys are usually narrow, except in some western areas where they sensibly broaden. A belt of smoother relief is found downslope in the Fuka area.

The plateau surface is characterized by different Land Systems; the simplest one is the tableland *sensu strictu* stretching west of the Fuka escarpment in an elongated EW belt - from 120 to 160 m high - constituted by a flat surface which results locally incised by the wadi heads towards the escarpment edge.

In the central portion of the tableland, there is a shallow depressed area representing a catchment zone for water and sediments, as proven by the presence of intensively cropped fields.

Southwards the plateau surface is pitted by a series of sink holes with irregular oval shapes and differently sized, most of them being filled with aeolian deposits. Their long axis is generally oriented according to the prevailing structural lineaments.

A particular aspect of the plateau is found in the triangular area extending northward towards Ras El Hekma; here the plateau surface shows a more pronounced relief, with alternating, broad and shallow, mounds and depressions.

The Southern Plateau, separated from the northern one by a small discontinuous escarpment, is geomorphologically similar; it was distinguished mostly on the basis of climate and natural vegetation.

4.3.2. Soils

The formation and persistence of soil cover in the area are strongly influenced by the arid climate. The scarcity of water for reactions within the soil and for the leaching of soluble components from the soil itself restricts the extent of soil formation processes.

All soils in the area are to be considered very young and immature, and, as highly influenced by the geological and geomorphological conditions of their formation.

The sparseness of the vegetation cover and the harsh climate cause extensive erosion phenomena, but water is not enough to eliminate most of the eroded material, that accumulates in depressed areas. As a consequence, 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 depressional areas, soil depth is proportional to depression and catchment size, and increases progressively towards the centre of the depression.

All soils are rich in carbonates; salinity is a frequent characteristic, and always accompanied by a high sodium content; soils are, anyway, never alkaline, as sodium is associated with abundant soluble salts.

Salinity and sodicity are particularly frequent in coastal areas, but are found occasionally in other places.

Soil texture is controlled by geological-geomorphological factors as well. Weathering of the omnipresent marine limestones 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 through the wadi systems.

Soils in areas subject to aeolian sedimentation show, then, a more or less thick sandy cover, contrasting with the underlying horizons, while soils related to wadi sediments vary in texture according to wadi size and presence of aeolian sedimentation in the watershed.

Short wadis, and their alluvial fans, generally produce intermediate soil textures; long wadis receiving small amounts of aeolian accretions produce soils with loamy sand texture, while long wadis with strong aeolian contributions are characterized by sandy soils.

Relatively wide stretches of deep soil are mostly found in the low energy coastal plain Land System. Here many soils are deep, not too sandy in texture, and generally free from salinity/sodicity problems, except in limited areas coastwards.

In areas of intensive aeolian sedimentation, especially south-east of Fuka, depressional soils have a very thick sandy cover, while patches of quite silty soils occur in the same area.

In the high-energy coastal plain Land System, deep soils are less common; they are usually found in the largest depressions or in the alluvial fans of short wadis. These soils are sandy loam to sandy clay loam and often at least 1 m. deep; salinity problems are frequent in the lowest lying areas.

The high-energy coastal plain with long wadis sees a clear separation between wadi and interwadi areas. Soils in the bottom and in alluvial fans of long wadis may be very deep but are usually coarse textured, loamy sand to sandy, and have no salinity. These soils usually occupy rather wide stretches, since the transverse profile of wadis is U-shaped, with steep flanks and a wide bottom. In interwadi areas, most of the surface is taken up by flat, degradational plains with shallow soil.

These plains are interrupted by small depressions and smaller wadis, where medium-depth soils are found; these are medium textured and occasionally saline.

In the plateau slope Land System, barren land occupies all the crests of the dissected pediments, while in the valleys soils are highly variable both in depth and salinity.

The range of depths observed is very wide, but deep soils are probably confined to very narrow stripes at the valley centres.

The presence of salinity could be linked to parent rock layers having high salt content, and it was however very difficult to map.

The terraced escarpment supports shallow soils in the terraces, similar to soils in the tableland.

On the northern plateau, soils are mostly shallow, less than 30 cm deep, deeper soils being only found in sink holes. Soil texture varies from sandy to sandy loam, with evidence for the sandy and loamy sand textures being associated to aeolian contributions. Most soils observed on the northern plateau are not saline, nevertheless single saline profiles have been found.

Two Land Systems in the northern plateau region are characterized by extensive cultivation; these are the low tableland and the undulated northern edge Land Systems.

From the available data, it appears that soils deeper than the typical plateau ones do exist in these systems, but are not very widespread.

Many other soils in these systems are actually not dissimilar from those observed elsewhere in the tableland; occasional saline soils are also present in these areas. It is very likely that the success of cultivation in these Land Systems is more linked to the presence of water-catching depressions and to the relatively northern geographical positions than to soil characters.

Soils in the southern plateau are shallower, stonier and sandier than in northern plateau, and all the observed soils were found to be quite saline.

The soil in the serir Land System is fairly deep, but still sandy and very saline.

4.3.3. Vegetation

Natural vegetation in the area is often disturbed by man's activities; the intensification of cultivation in the coastal lowlands and of grazing on the plateau makes it almost impossible to identify associations or other phytosociological entities.

Vegetation cover reflects water availability, as rainfall increases from south to north; besides, in the depressions, in the wadi bottoms and in any kind of catchment areas a denser vegetation cover may be found.

Total vegetation cover very rarely exceeds 15%, with the only exception of the salt marshes, where particularly favourable moisture conditions allow a thicker vegetation cover, up to 40%.

Most species show xerophytic characteristics, while halophytes are found in coastal saline areas, but also in occasional patches elsewhere.

The dominant kind of natural plant community ranges from open scrub to open field; these are associations of grasses and limited amounts of low scrubs; as a general trend, scrub density decreases from north to south, as also does the density and volume of grasses.

A significant change in scrub composition marks the transition from the northern to the southern plateau, with the disappearance of *Thymelea hirsuta,* one of the most common scrubs in the other regions.

The different grazing and watering potentialities of the two plateau regions is marked by the change in the kind of livestock being bred: sheeps and goats in the northern plateau, and camels in the southern one.

The distribution and management of agricultural land also follow a general north-south trend, according to rainfall; besides, the pattern of depressions exerts the strongest influence on agricultural land: with the partial exception of the most northern areas, agriculture is confined to depressed areas.

Tree crops, olive and fig, are rather widespread close to the coast, while moving inland they become confined to specially favourable areas and then disappear; the same happens with the rare vegetable gardens. The basic crops in this region, barley and wheat, are found from the coast to some areas in the northern plateau, but in general agricultural land decreases rapidly moving from the coastal lowlands to the plateau.

5. RECOMMENDATIONS FOR LAND RESOURCE MANAGEMENT

The main role of land resource assessment, in support of land management planning, lies in the supply of the information needed for various crucial tasks of the planner; these include optimisation of the solution of land use conflicts, planning the introduction of new land management techniques, and the relaxation of the frictions between economical development and preservation of natural resources. It is understood that it is just this kind of support that is specifically needed in the framework of the CAMP objectives.

According to the specific field of activity of some authors of this report, and to the kind of land use policy, whose results are evident throughout the CAMP area, agriculture, as a land use mode, plays a central role in this specific chapter.

It is evident how, in the recent past, agriculture has been granted the priority for land use, so that it is, by now, the land use mode around which most land management issues will revolve.

The *peculiarities of the agricultural system existing in the Fuka-Matrouh area need to be* illustrated clearly and in detail, as they carry important consequences on the perspectives of soil resource management.

The amount of rainfall, even in the coastal lowlands, is practically insufficient for any crop to have serious chances of success.

Agriculture then relies on ways to concentrate, on cropped lands, more water than allowed by natural rainfall. This is obtained by extensive arrangements to exploit runoff water from higher-lying lands, that are barren or have a very shallow soil and are then not able to allow all rainfall to infiltrate. This water is sometimes directly conveyed, in a controlled way, to cultivated depressions. In other cases it flows, intermittently, through the wadis, where appropriate water regulation and field protection works ensure cultivation of wadi bottoms, while other works allow controlled spreading of water on low lands subjected to flooding.

As a specially important consequence, this particular agricultural system creates strong links between cultivated and non cultivated land; these links oblige prospective land use planners to make some adaptations, on whose consequences more will be said later.

5.1. Land Use Conflicts

In considering the issue of land use conflicts, it is first of all necessary to define the potential conflicts among existing land use modes, and then the new kinds of land use likely to be introduced and to create conflicts in the near future; information on these issues has been gathered from the Egyptian experts and from other participants to the CAMP.

The only potential conflict for land allocation, in the present status of the Fuka-Matrouh CAMP area, is likely to be the one between agriculture and grazing.

In the recent past, it appears that all decisions have considered agriculture as having priority, so that a decision aimed at improving grazing could have, in some ways, some conflicting effects. As an example, improving pasture vegetation and preventing erosion of pasture land would reduce the amounts of runoff water and soil sediments made available to the cropped land downslope or downstream.

In the very near future, anyway, the demand of land for other uses is going to increase very rapidly, as can be easily extrapolated from what has already taken place in other areas of the Egyptian northwestern coast. This effect will be mostly due to the wish to expand development for tourist exploitation and residential purposes, with the associated demand for building materials and consequent quarrying.

The demand of land is going to become significant, in both amounts and prices offered, so the potential conflicts involved may become very serious, and this is clearly the most serious kind of land use conflict to be considered in the present situation.

Another potential issue for land use conflict has been raised in the framework of the CAMP, in the shape of a requirement for conservation measures to protect sensible biotopes, like beaches and salt marshes; while protection of beaches is not likely to create serious conflicts with agriculture, a possible effort to protect some of the most significant salt marshes would do so. Salt marshes are created and maintained by wadi water that, due to the first foreshore ridge, cannot drain freely to the sea. It appears very clearly that the increasing efficiency of the techniques to capture and utilise wadi water for agriculture is bound to endanger the marshes, by threatening their desiccation. Then it appears that a serious decision to preserve the marshes would imply limitations to agricultural water management in the watershed upstream from the marshes themselves, so creating a conflict.

5.1.1. The Classification of Soil Agricultural Potential

A first basic tool to process land resource information to support land use conflict solution is a soil potential rating system. This is a well-known tool to make soil information visible for non specialists, and to outline the highest-valued agricultural land.

Worldwide experience has demonstrated how much full visibility of the distribution of soil potential is helpful to optimise solution of land use conflicts; this is particularly true for conflicts between agriculture and urban utilisation, that is the primary issue in this area.

The soil rating system used in the present report was expressly adapted for Fuka-Matrouh CAMP area. A few comments are due about the rationale for this choice and for the systems' structure. Straightforward application of existing land evaluation schemes, such as those produced by FAO (1983, 1985), and many other similar ones, was not found satisfactory. According to the background of such schemes - that were produced for worldwide use and as such cannot consider the peculiarities of any single agricultural system - all the land in Fuka-Matrouh area is to be considered of marginal agricultural potential. Then, their application would have resulted in a flattening of all land in, say, the two lowest classes; this would have provided little scope for planning choices and, especially, would not have reflected the reality of agriculture and soil management in this area.

An adapted scheme was then created; it is based on three kinds of assumptions:

- The requirements of present crops, in terms of soil properties. Introduction of new crops does not appear possible unless very significant changes of either management or technology take place.
- The most variable soil properties in the area, as evidenced by the soil surveys.

- The specific necessities of the peculiar existing agricultural system.

The adapted scheme allowed to create four classes of agricultural potential, that, in the opinion of the experts participating to the "Soil Erosion and Desertification" activity in the Fuka-Matrouh CAMP, fairly reflect the present situation.

The details of the rating system are summarized in table 3; it is a simplified version of the scheme adopted for the pilot areas, (see intermediate report by the Egyptian team of experts); the main simplification is the exclusion of the FAC parameter; this exclusion is due to the realization that determining such a complex parameter for the whole CAMP area was not feasible in a reasonable time frame.

Soil property	CLASS I	CLASS II	CLASS III	CLASS IV
Depth (cm)	>100	100-60	60-30	<30
Salinity (ECs, $dS \cdot m^{-1}$)	<4	4-8	8-16	>16
Sodicity (SAR)	<13.5	13.5-30	30-45	>45
Texture (class)	Any class except sandy	Any class	Any class	Any class

Table 3: Soil properties used for the soil agricultural potential rating scheme for the whole area of Fuka-Matrouh CAMP, and their respective ratings

The considered soil properties are those showing considerable variation in the area; the usually much considered properties, like soil pH, carbonate content and organic matter, are neglected by the scheme as, throughout the Fuka-Matrouh CAMP, they are either practically constant or strictly associated to soil depth; soil texture plays a secondary role, as it shows low variability; the most important parameters are soil depth, salinity and sodicity.

Selected threshold levels are geared to the requirements for barley and olive trees, with some integration concerning water melon requirements; these have been considered representative of existing crops. Data about requirements of fig trees are quite sparse, while data concerning wheat were not considered, as it is known that wheat cropping in the area relies on recent varieties having special characters of salt and drought tolerance, for which the existing requirement data are not valid.

In assigning soils to the various classes, some exceptions have been made, to take account of micro- and macro-climatic considerations. The requirement concerning soil texture was not applied to soils in wadi bottoms and alluvial fans, as explained in more detail later. In considering the potential of soils lying in the southern part of the area, on the tableland, it was necessary to consider the decrease of rainfall from north to south. Data about this variation in rainfall are not complete enough to insert them in a numerical scheme, but nevertheless it is known that rainfall decreases rapidly, though irregularly, along a north-south trend. Soils on most of the tableland, thus, receive quite less rainfall than soils in the coastal lowlands. It has then been considered that soils on the tableland, excluding the most northern areas near Ras El Hekma, would need more water storage ability, and as a consequence more depth, to keep the same potential productivity. This consideration has mostly resulted in the placement in class IV of many soils that would have been placed in class III if the system would have been adhered to strictly.

5.1.2. The Soil Potential Classes

The practical significance attached to the four classes of soil agricultural potential is outlined as follows.

Class I - This class includes soils that, within the context and limitations of the existing agricultural system, present no serious constraints to crop choice and productivity. Soils in this class can support any of the current crops with very limited failure risk and satisfactory productivity.

The modifier "special wadi conditions" has been added to account for soils lying in wadi bottoms and alluvial fans. These soils exhibit some added problems, but these are balanced by additional advantages. The need to protect fields and crops from the wadi floods entails extra costs, for the maintenance of water regulation structures (that almost invariably already exist); furthermore, these soils are often very sandy, and so have little water storage capabilities and are theoretically subjected to wind erosion. On the other hand, the plentiful supply of water to these soils compensates for most of the above problems, as wadi bottom soils are actually those that enjoy the best moisture regime in the area. The same good moisture regime, that allows good vegetation cover throughout the year, and wadi topography, effectively shelter them from most wind erosion risks.

Class II - In this class, some limitations arise; water melon and other vegetables are not viable, and productivity of figs and olives is bound to be generally reduced. Performance of barley and wheat should instead be only slightly worse than in class I.

Class III - This class is only really suitable for wheat and barley cropping; olives and figs are sometimes grown in coastal areas, but usually requiring irrigation assistance for the first years and, anyway, with a low productivity. Cereals should perform rather variably, with high risk failure but also with good crops in favourable years. The class is to be considered of marginal value for agriculture, even in this special context.

Class IV - Includes soils unsuitable for agriculture, either for their shallowness or for very serious salinity problems, and bare land. Actually, limited areas of such soils are cultivated, but with so bad economics and so high risks that they are considered examples of expansion of agriculture beyond logical limits.

5.1.3. Distribution of Soil Agricultural Potential

As outlined and summarised in figure 9 and table 4, good agricultural land is actually a small portion of the total surface concerned by the CAMP.

Soil potential class	Coastal lowlands		Plateau (northern and southern)	
	Surface (ha)	%	Surface (ha)	%
I	6682	9.9	0	0.0
II	4051	6.0	2890	1.4
III	16409	24.4	2210	1.0
IV	40268	59.7	210900	97.6
Total	67410	100	216000	100

Table 4: Estimated surfaces occupied by the four classes of soil agricultural potential and total percentages

Figure 9 is actually quite optimistic; land units including only about 30% useful agricultural land are represented for the class assigned to this 30%.

It is well evident how land valuable for agriculture is just about 40% in the Coastal Lowlands and a negligible percentage in the Plateau. This is partly compensated by some concentration of the best land towards the coast, where demands for alternative land uses are going to be stronger.

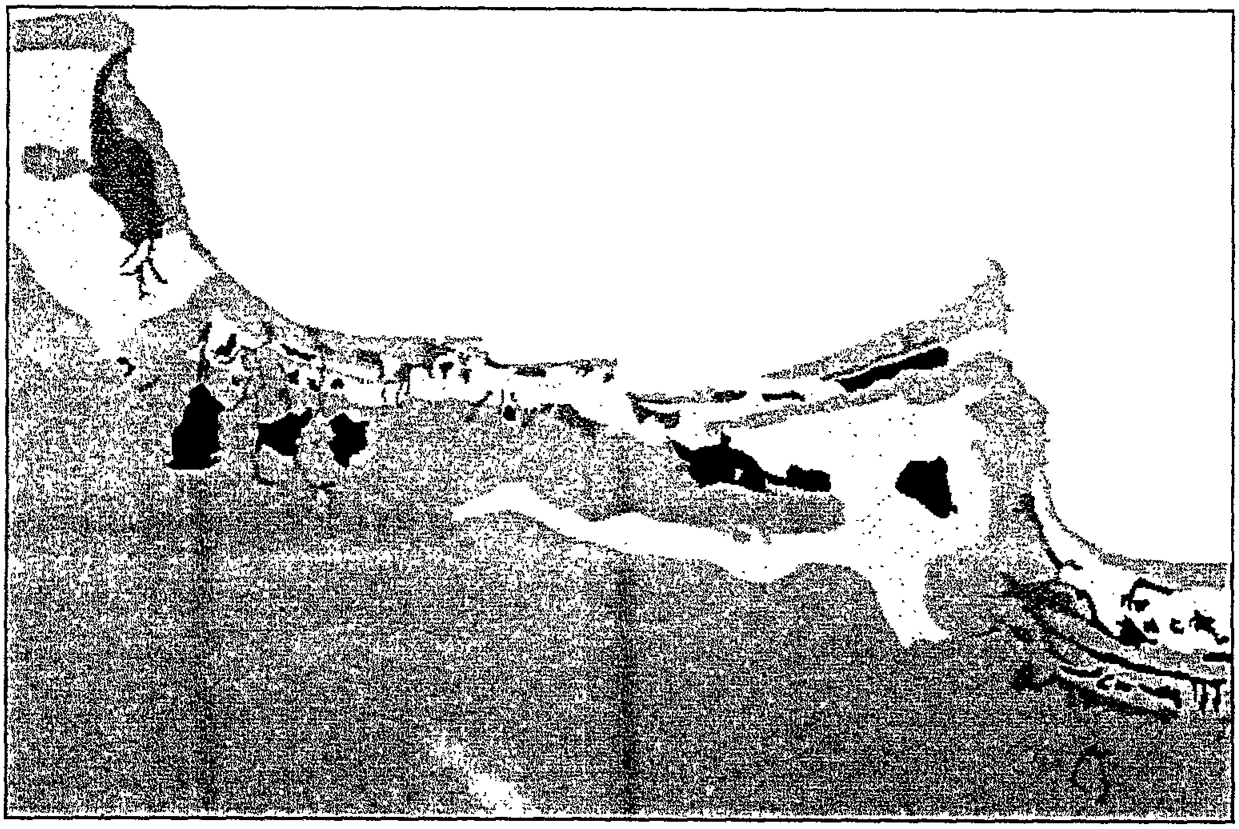


Figure 9: Map showing the approximate distribution of soils according to the four classes of agricultural potential

The map was prepared with the following procedure: if any land facet rated in class I to III was estimated to occupy at least 30% of a land unit, the land unit was marked according to the most frequent of such facets; in case that no facets in class I to III occupies at least 30% of surface, the unit was marked class IV. Green color: class I, Blue color: class II, Yellow color: class III, Brown color: class IV.

5.1.4. Managing Land Use Conflicts

In strictly conventional terms, land use conflicts in the area should not be very difficult to solve as there is so much land unsuitable for agriculture purposes; this land could be allocated to other uses without creating conflicts, allowing developments of other economical activities without significant reductions in agricultural production. Experience has shown, anyway, that this kind of solution is rarely reached spontaneously, but rather needs to be assisted by conscious and informed planning.

A more serious problem is caused by the indispensable position of water-harvesting in local agriculture; it is clear, in fact, that any unit of cropped land actually requires a larger amount of non-agricultural land, working as water supplier, to remain viable for agriculture. Then, agriculturally unsuitable land cannot be light-heartedly reallocated, as the unexpected consequence could be the dooming of a nearby piece of first quality cropland.

Then, planners have to be aware, at least, that development or quarrying of "waste" or grazing land, classed unsuitable for agriculture, may have consequences on agricultural land too. At the best, it would be nice that planners would have a quantitative instrument for previewing the consequences of any change in land use.

Unfortunately, such an instrument is beyond the present state-of-the-art, though undoubtedly it could be developed in a few years of applied research.

One preliminary help that a soil scientist can supply is a series of general considerations.

A coarse estimate, rather a kind of informed guessing, suggests that close to the coast an approximate minimum 1.5:1 ratio (1.5 ha of barren land for 1 ha of agricultural soil) should be maintained, while this ratio should increase with the rapid decreasing of rainfall while going south. This estimate is based on the necessity to obtain, through water harvesting, about as much additional water as supplied by rainfall, so getting an effective supply of 300 to 400 mm/yr, that is the minimum for rainfed agriculture in Mediterranean lands. It is then considered that the land working as water supplier cannot have a runoff coefficient of 100%, so that not all water falling on this land will show up as usable runoff.

As for landforms like swales and depressions, water donor areas clearly lie in the immediately neighbouring ridges and hillocks, while as to areas afffected by even small wadis, the patterns may easily become quite complex and difficult to understand.

A further support that may be given to the planner, in these circumstances, is a delimitation of the main watersheds; watershed boundaries represent, at least, lines across which independence of land pieces may be assumed. In fact, the possibility of steering land allocation on a watershed basis, i.e. to give priority to a single type of use within any single watershed, is an attractive possibility to overcome current knowledge limitations.

The watershed map, supplied together with this report, was prepared by processing the digitized 1:100,000 scale topographic maps of the CAMP area. It could not be field checked, and is anyway bound to include some imprecisions. It is nevertheless the result of the careful processing of high quality topographical maps, using recent and widely acknowledged algorithms (Jenson and Domingue, 1988) and is considered a tool worth including.

5.1.5. Specific Land Use Conflicts

The conflict between agriculture and grazing was usually solved in the past at agriculture's advantage; a partial reversion of this is essentially a matter of political decision-making. From the technical point of view, some considerations are anyway possible. There is no doubt that some piece of land could be reallocated to grazing without significant losses to agricultural production; this includes all class IV land that is presently cultivated, and could also include important stretches of class III land, especially in southern inland areas. If, anyway, these surfaces would be negligible for agriculture, they would also be negligible for grazing, that works on a much larger scale. The possibility of a serious effort to improve pastures, by introducing new species able to grant a better cover and to reduce soil erosion, should be carefully balanced against the risk of reducing contributions of runoff water to downstream croplands. This balance can be considered at the watershed level in the coastal lowlands, while, unfortunately, this is not possible in the Plateau, where a realistic reconstruction of watershed borders was not allowed to the means used in this project.

The necessity of managing and equilibrating land between agriculture and development is going to be the most serious land planning issue in the following years; actually, most of the efforts made in preparing these "recommendations" was geared to this problem, so that all the general considerations reported in the above and below chapters directly apply to it and were not considered worth repeating.

Considering the possibility of protecting the backshore marshes, the potential conflicts do not arise from the possibility that the marshes themselves could be requested for agriculture, as they are totally and irremediably unsuitable for cultivation. The potential problems arise from the fact that salt marshes are created and maintained by wadi water that, due to the first foreshore ridge, cannot drain to the sea. It appears very clearly that the increasing efficiency of the techniques to capture and utilize wadi water for agriculture is bound to endanger the marshes, by reducing the water input in them and so threatening their dessiccation. The concurrent decrease in solid sediment input would instead have a more mixed effect, with reductions in nutrient input balanced by reduction of the risk of desiccation by silting. Again, there are no instruments for quantitative predictions, but it anyway appears that a serious effort to preserve the marshes would imply limitations to agricultural water management in the watershed upstream from the marshes themselves, so creating a conflict. In this case, the potential usefulness of planning on a watershed basis is self-evident.

5.2. Potential Management Innovations

The main innovation in land management that it was required to be considered is the introduction of irrigated agriculture.

For potential irrigation, insufficient data about the context of such irrigation did not allow to develop a detailed land suitability scheme. General considerations were then developed, adapting from the soil agricultural potential scheme when required.

An evaluation of irrigation perspectives in the Fuka-Matrouh CAMP area must, in this report, necessarily skip detailed economical considerations and concentrate, instead, on technical issues. In preparing this report, there was no knowledge of the kind of solutions that can be foreseen for providing irrigation water in the area; consequently, considerations concerning the cost of irrigation water and the economics of irrigated agriculture will unavoidably be of a very general nature.

On the base of the geography of the area, it appears likely that any scheme for providing irrigation water is going to be more on the expensive side than not. Though it is clear that political considerations can, and often do, completely alter irrigation economics as they result in the farm balance sheet, it seems anyway unlikely that low intensity irrigation schemes, like relief irrigation and complementary irrigation, will ever expand much from the present limited use. These schemes rely on low-cost irrigation water, supplied in limited amounts, and it is unlikely that low-cost water will be made available in larger amounts than at present. Rather, it is likely that the scale of resource commitment needed for providing water will push towards fully fledged, large scale irrigation, with its relevant requirements.

Once set such a general and somewhat hypothetical frame, one can consider the physical factors likely to condition the perspectives for irrigated agriculture in the CAMP area.

5.2.1. Basic Physical Constraints for Irrigation

Three physical factors appear to be of basic importance:

1. The problem of soil salinity/sodicity, and its implications as for feasibility, productivity and sustainability of irrigation schemes.
2. The availability of soils that, if irrigated, can provide a suitable combination of production quantity and quality.

3. The existence of large patches of such high quality soils in reasonably nearby locations, to allow economical arrangements of the irrigation plants and of all the related production organization.

Point 1

The salinity and sodicity problems are most serious. The area is, given to climate and geology, to be considered a high risk one. The fact that the majority of the examined soil were found free of such problems should not induce excessive confidence, for several reasons. Firstly, because single saline or sodic soils have popped up in a rather haphazard manner throughout most of the area; in several cases, the intensity of the survey has not allowed to acknowledge the distribution of such soils within the units where they were found. This means that, practically, no mapping unit may be assumed 100% free from salinity-sodicity risks, although, in many units, they are improbable and would only be occasional. Secondly, several soils were found to be actually quite deeper than the depth at which they could be examined; presence of salt and/or sodium in deeper layers cannot be excluded and, although irrelevant under the present management, would not at all be so under irrigation.

Any implementation of an irrigation scheme would then need a previous detailed soil survey of potentially suitable areas, to fully trace salinity/sodicity problems, as required by standard practice by all international organizations.

The extent of the risk of salinization/alkalization of presently non-troubled soils, caused by irrigation, is difficult to assess as, for instance, no hypothesis can be formulated about the quality of irrigation water, a crucial factor in this context.

Irrigation in areas with high salinity or salinization risk invariably requires using appropriate amounts of excess water and assuring that this excess can safely drain away from the soil. In the coastal lowlands area, soils rest on the oolithic marine limestone, forming, generally, an impermeable layer below the soil. Therefore, it would be probably necessary to build an artificial drainage system. The cost of such a system at field level, in the relatively coarse-textured soils of this area, would not at all be prohibitive, but further costs would occur to provide for ultimate disposal of saline drainage water. Hydrology, topography and land use patterns of the area rule out the simplest solution, discharging in the nearest water stream; it would rather be probably necessary to build the drainage network to the sea, and, given the low elevation of potentially suitable areas and the presence of the foreshore ridges, this would be expensive.

Point 2

Soil with potentially high productivity under irrigation is not unknown in the area. After discounting for the above considerations about salinity risks, all soils grouped in class I in the soil potential scheme have, in theory, a good potential for irrigated agriculture. Class I soils could, when irrigated, support industrial cultures (textiles, oilseeds), fruit cultures and high productivity vegetable gardens, the latter with some limitation in the choice of species. Class II soils have to be considered marginally suitable, unless the limiting factor is salinity/sodicity, in which case they must be considered totally unsuitable.

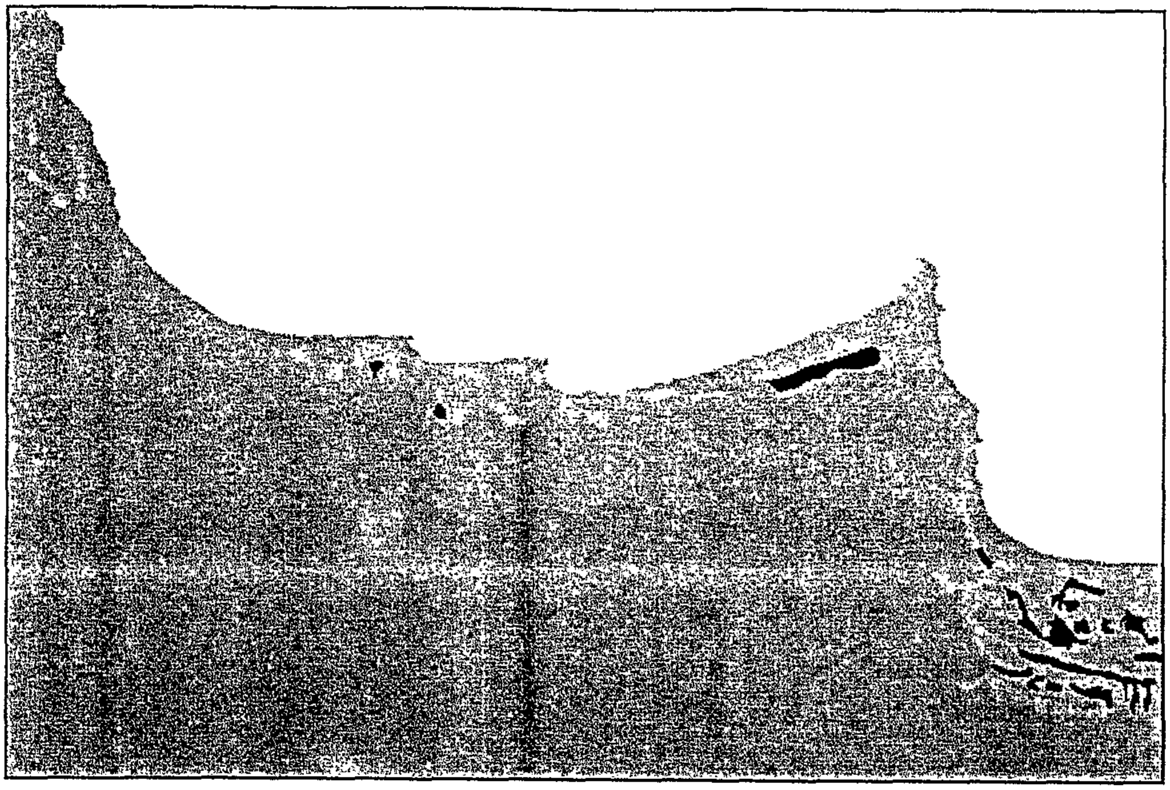


Figure 10: Map Showing the Location of Land Units having Some Potential for Irrigation

The map shows, in green color, all land units including at least 60% class I soils, with the exclusion of "special wadi conditions". In blue color are shown units having at least 60% of class II soils, provided the limiting factor(s) are not salinity/sodicity and that they are found nearby units selected in the previous step.

Point 3

A problem comes to light when one considers the spatial distribution of class I soil in the area; from figure 10, it is well apparent how they are generally quite scattered, in relatively small patches, and how the requisites of point 3) are difficult to fulfil. It is to be noted that class I soil marked as "special wadi conditions" would have additional problems. These soils generally occupy narrow, long strips on the wadi bottoms, in a quite uneconomical arrangement, while their position would require additional, and costly, measures to protect irrigation equipment and crops from the hazards of wadi floods.

By the viewpoint of the combined requisites of point 2) and 3), the only area actually showing some potential is the one immediately south-west of Fuka town, encompassing land units 33, 54, 55 and 56 of the general map; it is to be noticed that some class II soils in the immediate vicinity of this area (units 12 and 57) could also be suitable for irrigation, with some added caution. Unfortunately, this area looks mostly unfavourable for the building of an artificial drainage system, as it is very low-lying. On the other hand, it is unlikely to be significantly suitable for tourist development, as it is too far from the sea, and for quarrying, as fresh rock rarely outcrops there, so no strong competitions are envisaged.

5.2.2. Perspectives for Irrigation

In conclusion, perspectives for irrigation in this area are not completely lacking, but severely restricted. Land areas with the potential for irrigation are limited, and the implementation of an irrigation scheme would be expensive.

It appears that irrigation in the Fuka-Matrouh area is not going to be anywhere close to a self-supporting investment, but only feasible through a well supported and determined government investment plan.

5.3. Problems of Soil Conservation

Beyond the specific concerns expressed in the above chapters, as related to specific land use prospectives, it is useful to consider the issue of soil conservation in a broader view.

The significant potential agents of soil degradation that could play a role in the Fuka-Matrouh area are the following three:

- water erosion;
- wind erosion; and
- salinization/alkalization.

A fourth agent, deliberate destruction by development, is considered under the issue of land use conflict.

5.3.1. Water Erosion

Water erosion risks, for a given area, are conditioned by factors like rainfall aggressivity, slope, vegetation cover and soil erodibility. In the Fuka-Matrouh area rainfall aggressivity is high, and vegetation cover usually low; soil erodibility is also often high, especially in those soils having sandy loam, sandy clay loam and silty loam texture, that represent the majority of soils in the area; much less sensitive should be, instead, the sandy and loamy sand soils.

When considering slope, an aspect immediately comes to foreground about cultivated land: it is found almost exclusively on zero to very low slope gradients. This is explained by the fact that water erosion is so severe that no soil thick enough to support agriculture can survive on even gentle slopes. In this sense, however, a sort of equilibrium condition has been reached, as, by now, existing cropland does not run serious risks of water erosion; in fact, soil erosion has been actively exploited to increase soil thickness in depression areas, so becoming a positive factor for agriculture.

In some places, a water erosion problem has been caused by the water regulation works in wadi bottoms. In recent times, a trend has developed towards the substitution of relatively small dams, built in such a way to allow part of the water to filter through them, with larger dams, of impermeable construction. When dams of such type are interested by an amount of water overcoming their capability, concentrated flow occurs at spill-out points and, given the large amounts of water involved and the high energy of such water, this can cause serious erosional effects even on very gently sloping land. The exact extent of the phenomenon would require a specific multi-year monitoring to be assessed.

There is a further possible way in which modifications in land use could bring about water erosion problems on agricultural lands; the drainage systems of built-up areas, like roads, squares and buildings, tend to be generally designed to discharge in a rather concentrated way, for economical reasons. The possibility that discharges from such areas, having a runoff coefficient of about 100%, may become aggressive, for lands that are presently stable thanks to their very gentle slope, must be very seriously considered. According to experience, artificial drainage systems are dangerous, unless carefully designed, in areas where very high intensity storms can take place, like this one.

While moderately relevant for agriculture, the problem of water erosion is probably more significant for pasture soils; though no firm data exist, it is probable that water erosion is sensibly reducing pasture productivity. The economical relevance of this phenomenon is again to be balanced with the positive role taken by soil sediments in agriculture, but from the ecological point of view it would undoubtedly be necessary to take measures to control this erosion. The only erosion control measure lying in the realm of feasibility for pastures would be the introduction of new grass species, able to assure a more continuous, resistant and steady soil cover; however, such grasses should also be palatable for local livestock, and past attempts in this direction appear to have failed just on this ground.

5.3.2. Wind Erosion and Sedimentation

Soil erosion by wind and burial by wind blown sediments are clearly a more serious issue; the studies made have stressed how many large areas of strong wind sedimentation exist in the Fuka-Matrouh region.

The effects of wind sedimentation may either be bad, good or mixed, according to the mode of such sedimentation. The formation of huge deposits of wind-mobile material is clearly very harmful. The large shifting dune that buried Wadi Gharaula, and the extended sand sheets that it left behind, have covered and made unusable large amounts of relatively fertile land, while the moving dune remains a threat to any product of man's work. The large dunes that have formed inside the upper reaches of some of the big wadis, like Wadi el-Qasaba, have a mixed effect; on one hand, they bury some possibly useful land on the wadi bottoms, but on the other they have supplied sediments actively used to build-up soils in downstream areas.

Areas of diffuse wind sedimentation, that, when not disturbed by cropping, often take the shape of "hummocky lands", generally increase biological productivity, increasing soil thickness and fertility. This takes place specially in the "low tableland" land system and in land units 57 and 54.

Present rates of aeolian erosion are not very well known, but soil loss is probably significant.

The soils potentially most sensitive to wind erosion are the same ones that are influenced by wind deposition, as the nature of the surface soil material makes it more easily transportable.

At present, in these areas the net balance between erosion and deposition is positive, but two factors must be considered. The balance of wind erosion and sedimentation is controlled by wind speed, duration, direction and turbulence, and small changes can alter the balance. It is not safe to assume that these factors are completely constant in the medium term, and there are indications that they could change significantly. It is to be noticed that a soil map of the area produced by FAO in 1962 reports "hummocky lands" in places completely different from those observed in the present study, so suggesting that patterns of wind deposition could change rather rapidly. Another factor to be considered is the modification of the wind deposition patterns caused by transformation of land to cropland, as it has happened in the "low tableland" and in units 54 and 57. The "hummocky lands" are characterized by the building-up of small sandy mounds, hummocks, around medium-sized shrubs; when they are brought under the plough, the shrubs and the hummocks are destroyed, strongly modifying the surface and then the wind-sediment-soil interaction. It is not possible to tell with some certainty whether ploughing can transform wind deposition areas in wind erosion areas, but the concrete possibility exists.

5.3.3. Risks of Soil Salinization and Alkalization

The risks of this kind, relating to introduction of large-scale irrigation, have already been outlined above. Here consideration is given to risks inherent in the present land management regime.

Salinization/alkalization risks may arise, in the present situation, from three sources:

- Rising of saline water tables from the seaside, in depressed cultivated areas close to the sea;
- Present small-scale irrigation practices; and
- The water-harvesting practice itself.

The risk of saline intrusions could exist in soils like those of units 26 and 27, and also for some patches of unit 12, north-east of Fuka town; it is not possible to give a more exhaustive assessment without a detail study.

Small-scale irrigation is currently practised, in some places, using borehole waters; the main aim is to support establishment of tree plantations (figs, olive trees) on poor soils. In this fashion, irrigation is used for some years to assist the young trees, to be then discontinued. Insofar as these practices keep this short-term nature, the risk they generate is low; it is highly advisable that they are not transformed into a permanent arrangement. Irrigation with low water amounts is notoriously dangerous where salinization/alkalization are real risks, and such practices would better be avoided anyway on all soils not meeting class I requirements for both salinity and sodicity.

The question whether water harvesting itself can bring about the same risks of irrigation is a very difficult one, at the present state of knowledge, as the related physico-chemical phenomena have never been studied in this context. Concerning salt content, rainwater usually matches the best quality standards one can expect from freshwater, but the situation may be a bit less splendid close to the sea, in arid areas; furthermore, on becoming runoff water, rainwater is bound to catch salts deposited as dry deposition on uplands. It is to be noted that halophyte plants have been found widespread on barren ridges. An even more serious problem comes from the water balance; in many cases, irrigation causes salts lying deep in the soil to rise back to the surface, where they interfere with soil fertility; this is more probable when irrigation water is not enough for a fraction of it to flow through the whole soil and drain away. How all this can be relevant for water-harvesting is still an unknown factor, but the possibility is there.

Some situations of risk may be pointed out on the basis of the existing knowledge; those units including soils rated as II or III class for salinity/sodicity problems, and presently cultivated with water harvesting practices, could clearly run a concrete risk. This is particularly true as for the units found in depressed areas not far from the coast, like units 11, 13, 37 and 58. The continuation of the present agricultural practices in these areas cannot be taken as safe from the soil conservation viewpoint; it is to be noticed that these units lie in areas potentially highly requested for development, and this clearly suggests that their possible reallocation could be less damaging for agriculture, with respect to other units having a safer position.

Similar, though less severe, considerations could apply to other units lying in similar positions and rather near to saline areas, but at present not affected by salinity/sodicity. Units 26 and 27 and part of unit 12 have already been cited; other cases include units 31, 33, 35 and 38.

About the soil factors making the potential risk higher or lower, it can be noticed that coarse-textured soils, having high permeability and low capillary rise, are the less risky ones, and that the risk is considerably higher where the soil already has some salt/sodium content, even if too low to hamper present agriculture.

In terms of external factors, the risk is inversely proportional to the amount of water provided by water-harvesting, and so to the contributing surface. By combining the two factors, it appears that the soils in the wadi bottoms and alluvial fans are clearly the less exposed ones, while evaluation of the potentially more exposed soils is beyond available data and methods.

A specific observation about salinization risks in wadi bottoms concerns again the problem of the working of the new large, impermeable dams. They appear to hold excess water, eliminated through evaporation, a risky combination when salts are present.

A serious program of soil management and conservation in the long term, however, should establish a kind of monitoring program for potential soil salinization/alkalization phenomena; a program like this should not necessarily be either very large or very expensive.

6. CONCLUSIONS

The analysis made in the framework of the present work, devoted to the assessment of natural resources and soil conservation issues in the coastal area stretching between El Daba and the town of Marsa Matrouh in Egypt, is pertaining to one of the main concerns to be tackled in the southern Mediterranean areas - and not only in them.

The reference is to the very broad field of soil degradation and desertification phenomena, as well as to the relevant initiatives to be undertaken for reclaiming land to proper use, as well as to its productivity, through human targeted interventions.

The decision-making process for both protection and development of such areas needs to be assisted by effective and well-tested methods and procedures in order to build an information system representing a basic and clear platform upon which start planning well-aimed activities.

In the framework of the CAMP for Fuka this action has been developed, with the direct involvement of Egyptian responsibles and experts who are now -at the end of the activities - in the capacity of further cooperating with their national and local authorities for decisions relevant to the deepening and extension of those activities to other threatened or suitabe coastal and inland areas of their Country, by applying to the already experienced practices.

If the process goes on, PAP/RAC and RAC/ERS shall reach the expected goal and will be ready for further cooperation accordingly with the objectives of the Mediterranean Action Plan adopted by the Contracting Parties to the Barcelona Convention.

ANNEX1: APPLIED METHODOLOGY

1. INTRODUCTION

In the framework of the MAP's activities concerning the Fuka-Matrouh CAMP, the CTM RAC/ERS has oriented its intervention towards the provision of basic information on geomorphology, pedology and vegetation - geo-referred and presented in cartographic format - in order to allow the assessment of land resources in the area.

Through the CTM-RAC/ERS application, it has been demonstrated the time and cost-effectiveness of the methodology of integrated survey which relies on the most suitable combination of different observation tools and thus strongly supported by a multidisciplinary approach.

Furthermore, the achieved results proved to be really useful for the activities regarding the "Integrated Coastal Zone Management" for which the two MAP's Centres PAP/RAC and RAC/ERS have profitably cooperated.

The accomplishment of the work was made possible by the precious active involvement of a skilled team of Egyptian experts headed by Prof. El Raey from the Institute for Graduated Studies and Research of the University of Alexandria - officially designated by the EEAA as local counterpart of the CTM-RAC/ERS.

1.1. Background

During a first CTM-RAC/ERS experts' mission to Egypt, in June 1994, a meeting was held in Cairo and Alexandria to outline the main topics and objectives of the RAC/ERS' intervention in the CAMP.

On that occasion, a first survey of the Fuka-Matrouh region was carried-out as well.

The proposed activities basically consisted in the application of a methodology which relies on the integration among different observation tools, ranging from remote-sensing techniques to in situ measurements, able to produce a map of properly individuated "cartographic units", which are areas characterized by homogeneous features as for geomorphology, pedology and vegetation cover.

In this framework, the CTM RAC/ERS has promoted a joint cooperation programme with the Remote Sensing and GIS groups from the Institute of Graduate Studies and Research (IGSR) and the College of Agriculture of the University of Alexandria, under the aegis of the Egyptian Environmental Affairs Agency (EEAA).

The work started off by the selection of the most suitable remote-sensing image framing the Fuka-Matrouh region - taken from the Landsat 5 TM (Thematic Mapper) satellite - properly chosen in order to cover a period of the year favourable to the sensing of the requested information.

After the preliminary processing of the image - carried out in Italy by the CTM RAC/ERS experts - a second mission to Egypt (December 1994) was arranged in order to define all the logistic aspect relevant to the planning of further activities and their precise contents.

In particular, the contents and terms of the CTM RAC/ERS intervention, agreed upon with the University of Alexandria, envisaged the building-up of local experts' capacity as for the use of satellite data and the application of the methodology of integrated survey. In this connection the University of Alexandria, which has closely followed all the activities, appointed four Egyptian experts - from the Institute of Graduated Studies and Researches and the Faculty of Agriculture, Dept. of Soil and Water Sciences - skilled in different topics, ranging from remote-sensing and GIS, to geomorphology, vegetation and soil to which CTM-RAC/ERS addressed a training course on "Remote sensing and natural resources assessment" including an interesting module devoted to the training-on-the-job.

The training course was held in Alexandria from 5 to 24 June 1995.

During the course a preliminary map was produced, while a first document, RAC/ERS/FM/1, was presented in the framework of the First Presentation Meeting held in Matrouh in September 1995.

On that occasion an agreement between IGSR and CTM-RAC/ERS was properly devised in order to complete the work relevant to the land resources assessment in the Fuka-Matrouh area, by June 1996.

To this purpose, the local team proved its newly acquired expertise completing the field work necessary to the validation of the satellite image interpretation and, with the check and supervision of CTM-RAC/ERS it was completed the final Land System Map of the Fuka-Matrouh region, presented in this report.

1.2. Objectives and Benefits of the Study

The general objective of the proposed activity has been the implementation of a multidisciplinary application through which information on land resources could be obtained, in particular, taking into account several parameters concerning land forms, natural vegetation distribution, and soil characteristics.

Such a multidisciplinary approach is mainly based on the application of advanced techniques - like space remote-sensing - and on their most suitable combination with direct in situ measurements.

The results of the CTM-RAC/ERS intervention allowed to obtain useful information on the Fuka-Matrouh region, necessary to planners and decision-makers for the evaluation of land suitability to different potential uses.

As a matter of fact, the Egyptian Authorities have been provided with an effective integrated tool for setting up and planning measures devoted to "soil conservation", since the problem of fighting soil degradation and the related loss of agricultural land is particularly felt in this region.

A further aim of the CTM RAC/ERS' intervention has been the transferring of the applied methodology to local experts through their direct involvement in the activities, as far as both satellite image interpretation and field surveys are concerned.

They have been full-time involved in the implementation of the planned activities and have worked together, thus overcoming some communication hindrances due to their different professional approach to the study of natural resources.

The main benefits of the carried-out application are therefore linked to its characteristic of multidisciplinarity.

First of all, such an application is based on an innovative approach that, relying on the most suitable integration among different observation tools, proves in general to be highly time and cost effective to the needs of any activity devoted to resources assessment. More in detail, the achieved results will produce beneficial outcomes in terms of a sustainable exploitation of the land, thanks to the careful and updated knowledge of its characteristics.

Several benefits have been, thus, acquired at different levels and by several actors, in the respect of the inspiring principles of the CAMPs as well as of those of ICAM - Integrated Coastal Areas Management, according to which the concept of multidisciplinary approach is considered as a basic statement for granting the sound outcomes of the planned activities.

2. METHODOLOGY

2.1. Overall Methodology

The methodology followed for the carrying-out of the work has been set up in order to allow an assessment of natural resources over a very large area.

Such a methodology, developed by the Natural Resources Department of the "Istituto Agronomico per l'Oltremare" (Florence, Italy), originates from the Dutch approach to the analysis and classification of land resources; it has already been successfully implemented in Tunisia (scale 1:100,000), Algeria (scale 1:200,000) and Eritrea (scale 1:50,000).

On that basis, a reconnaissance survey (final scale 1:200,000) of Fuka - Matrouh area was planned and an holistic approach chosen in order to draw up a Land System Map.

According to the holistic approach (from the Greek "*olos*" meaning "all complete"), the main components of the land are not considered individually: they are mapped simultaneously, taking also into account interactions between them, considered important from a land use planning point of view, giving rise to a Land System Map, where the basic cartographic unit is represented by a portion of land composed by a series of "landscapes", each of them being considered homogeneous, at the scale of the survey, with regard to its geomorphological, pedological and vegetation characteristics.

This methodological approach to the analysis of land considers the various surface sections as a whole and assumes that the components of the environment (soil, vegetation, geomorphology, hydrology, man's influence) interact between them: therefore the earth's surface must be considered as something more than just the sum of all of them. As a consequence, the study of natural resources must be carried on by a team of specialists in different natural sciences such as geology and geomorphology, soil science, climatology and phytogeography.

The study of the existing relationships between different components of the environment and the type of interactions is an important tool for land management and land use planning, especially if we consider the absolute need to make a sustainable use of available resources in areas where they are scarce or have a fragile environmental equilibrium. In such situations an integrated approach to the study of natural resources is imperative and the applied methodology can show its advantages in the best way.

Satellite images and aerial photographs are essential tools of the survey as they provide a reliable basis for the interpretation of the landscape and allow a "landscape guided" approach (Zonneveld, 1979) to the survey of natural resources, resulting in a better cost-effectiveness of the work.

The weight of image/photo processing and interpretation, compared to the weight of the field work, increases as the scale of the survey decreases, reaching its maximum at smaller scales, such as exploratory and reconnaissance surveys.

The flow chart of the whole methodology is shown in Figure A1, while below, a brief description of the meaning of some terms is provided.

Land Resources

The term "natural resource" implies a notion of usefulness of something which exists in nature: from this point of view man has usually considered the natural resources as the "inexhaustible offer" of the environment to its "complex demands" (Giordano, 1989). To avoid overexploitation or waste of natural resources several land use planning policies have been recently adopted in order to:

- assess the characteristics of existing and potential resources;
- define qualitatively and quantitatively the anthropic demand;
- study possible equilibrium conditions among them;
- devise the necessary actions to pursue such conditions;
- plan the short, medium and long-term environmental impact assessment.

Geomorphology

Since when man begun to be shepherd and farmer, geomorphology has been considered, often unconsciously, as a resource. Geomorphological features were the first element taken into account in selecting suitable sites for agriculture and husbandry.

The geomorphology of a given site is the result of a sum of elements: some of them (topography, lithology, geological structures, hydrology) describe the "static" conditions of the area, while exogenous morphogenetic processes (rock degradation, erosion, sedimentation, etc.) as well as the endogenic ones (earthquakes, volcanism, etc.) delineate the "dynamic" aspects; both the aspects are important in order to provide concrete answers to the different morphologies of the earth surface.

Climate

Climate is undoubtedly a resource: vegetation needs heat, light and water; the term "climate" refers to the integration of these and other meteorological conditions during a certain interval in a given area. The main climatic factors affecting vegetation are:

- temperature: provided that enough water is available for plants, the intensity of photosyntethic processes, and consequently the primary biomass production, is directly related to this factor;
- rainfalls: the relevance of rainfalls is evident, since they play a fundamental role in balancing the hydrological cycle and restoring the amounts of water lost by evaporation and transpiration;
- wind: it is not only the main determining factor for circulation of air masses, but it also affects directly plant growth, being related with processes of evapotranspiration; furthermore, wind is an important geomorphological agent.
- evapotranspiration: its intensity resumes the effects of many other climatic factors in determining the vegetation type of a given area.

Hydrology

The water resources are perhaps among the most important ones, since their availability is essential in almost every kind of land use (agriculture, industry, urban settlements, etc.): a modern and rational management of waters must begin from the knowledge of where and to which extent it is possible to carry the exploitation of this resource optimising the complex scenario of possible water uses and avoiding depletion.

Soil

The soil represents the linkage between the physical sphere and the biological one. "Soil is the collective term for the natural bodies made up of mineral and organic materials that cover much of the earth's surface, contain living matter and can support vegetal associations" (Soil Conservation Society of America, 1976). Since soil is the natural body supporting life, it needless to stress the importance of soil protection from erosion and other degradation processes, as well as its sound management in the perspective of a sustainable use.

Vegetation

"The vegetation cover or simply vegetation is the whole of the plants which covers a territory with more or less continuity. Its components are the vegetal associations, i.e. the combination of plants which regularly occur, impressing to the landscape a characteristic aspect, like, for instance, conifers or broadleaves woods, range or pasture, reed thicket or swamp" (Pignatti, 1977).

The same plant association should be determined by homogeneous areas as far as geology, morphology, climate and soil are concerned; the correspondence is seldom complete, since many factors, especially man's influence, contribute to modify distribution patterns and relevant cover of the different species.

Vegetation is the pre-eminent renewable resource since, through the solar radiance and the photosynthesis, it continuously produces biomass.

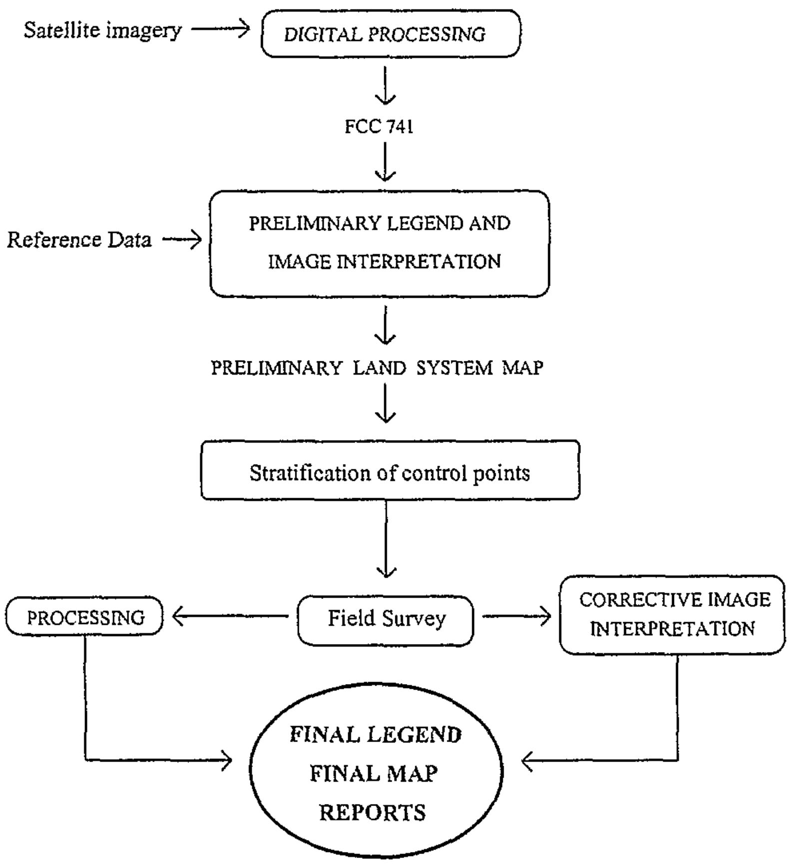


Figure A1: Flow Diagram of the Used Methodology

2.2. Image Processing

A Landsat 5 TM (Thematic Mapper) image (path/row: 179/38; acquisition date: 2 November 1992) was selected to be used for preliminary interpretation of the area under study. The acquisition period of the image (November 1992), falling about at the end of the dry season, was the best one possible since available spring imagery for this area was affected by an excessive percentage of cloud cover. As a matter of fact, an image acquired during the early springtime would have been much more useful for the detection of the vegetation status and of the crops as it would have offered the best combination between the low inclination of solar radiation at soil - which helps the observation of morphological aspects - and plants growth.

Before using the image, some manipulations and procedures were applied to it, such as image rectification and restoration procedures, in order to correct geometric distortions, to radiometrically calibrate data and to eliminate possible noises in the digital data.

The processing operations of the satellite image was carried out in the Remote Sensing laboratory of the Istituto Agronomico per l' Oltremare (Florence, Italy) and was finalized to provide the utmost information about land forms and surface characteristics.

The following pre-processing techniques have been applied:

- Destriping: due to the strong presence of a periodical noise, typical of Landsat TM images, a horizontal smoothing filter was applied to all the bands in order to remove it;
- Geometrical correction: since the available topographic maps were extremely poor in easily identifiable ground features suitable for image correction, this has been performed by means of a series of ground control points acquired through a GPS[1] (Global Positioning System) during the first preliminary mission to the study area (December 1994); although, the majority of those points were located in the neighbourhoods of the main road, and thus almost in a horizontal belt in the centre of the image, the correction performed with a second order polynomial algorithm produced almost good results, with an error of about 4 pixels (120 m) just in the southernmost part of the image, quite far from the main road.

After rectification and restoration, image enhancement procedures have been applied to digital data in order to improve their information content by increasing the optical resolution of the different features of the scene that can be visually interpreted.

Image enhancement mainly concerned the analysis of spectral characteristics of each band and of the information content of the different False Colour Composites (FCC) in order to select the most suitable one. Then it was selected the FCC 741, where marine and sand deposits are clearly detectable through band 1, while band 4 provides several information about distribution patterns of vegetation and band 7 is useful in the detection of water collecting areas and in the analysis of hydrological networks. Through histogram analysis of bands 1, 4 and 7, a manual contrast stretch was performed for each selected band and the resulting FCC was digitally transferred onto photographic film and printed at the approximate scale of 1:150,000.

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[1] The GPS Global Positioning System, based on a series of orbiting satellites (at least three) properly launched, allows the determination of the precise geographic coordinates of the standing point.

2.3. Preliminary Legend and Visual Image Interpretation

After collecting and analysing the available bibliographic material about natural resources, a first preliminary legend was drawn up in order to define the keys to be used during the satellite image preliminary interpretation. The detail level of this legend was obviously balanced to the scale of the survey, seeking not only to keep in mind which characteristics are really important from a land management point of view, but also to separate different units on the bases of homogeneous criteria.

Once defined the interpretation keys, hard copies of the satellite image have been used for the preliminary analysis of the study-area. Such an analysis has been carried out following the *landscape guided method* (Zonneveld, 1979), through the direct visual observation of the image: the main factors taken into account were colour, texture and form of the surface features.

The direct observation of the image was integrated with specific digital image classification - Maximum Likelihood Classification - in order to solve some doubts about certain features in the image. Furthermore, because of the particularly flat morphology of the area, considerable help in finding some morphological boundaries came from the analysis of the topographic maps, 1:100,000 and 1:25,000 scale.

The recognition of features in a satellite image strongly depends, apart from the preliminary information gathered, on the personal skill and the field experience of the interpreter, furthermore to rely on the contribution of a multidisciplinary team of experts strongly enhances the quality and detail of the identified features.

Thus, the image interpretation has been performed in two steps, during the first one, each specialist has drawn his own interpretation on the hard copy of the image, while the second step was needed in order to merge the four performed interpretations into a single one. During this last phase, a great effort was requested to the working team in order to integrate the different opinions and points of view of the specialist.

As a result, a preliminary map of areas showing internal homogeneous spectral properties has been produced. The related preliminary legend describes the information content associated to those areas, which comes from the hypothesis made, mainly in terms of geomorphological features, about the meaning of the identified cartographic units.

2.4. Planning of the Field Survey

Once the preliminary interpretation has been performed, a field work was required in order to both validate the hypothesis made during the previous phase and to gather necessary detailed information for the characterisation of each cartographic unit.

In this connection, sets of field data needed to describe each map unit have been identified and proper fact sheets (see tables A1,A2,A3), to be used during the field work, prepared.

For the three land resources to be investigated in the field (namely soil, geomorphology and vegetation), those fact-sheets allow to quickly describe the typology and relevant range of variability of the considered factors.

The availability of properly performed sheets is important especially for geomorphology.

As a matter of fact, in reconnaissance surveys, the cartographic units are mainly separated on the basis of landforms, therefore, a precise geomorphological description of each unit becomes a key element for the accurate accomplishment of the work.

GEOMORPHOLOGY

RELEVE N. ____

COORDINATES UTM (m) N		DATE		SURVEYORS	
E		LOCATION			
		A. PHOTO N°		TOPO MAP	
PRELIMINARY CODE		FINAL CODE		CARTOGRAPHIC CODE	

SITE DESCRIPTION

ELEVATION (m)	EXPOSURE (°)	SITE POSITION	

SLOPE FORM	SLOPE GRADIENT (%)	SLOPE LENGTH (m)

CREST FORM	VALLEY FORM	RELIEF INTENSITY (m)	SURF. SOIL COLOUR

SKETCH SITE POSITION

LANDUSE	VEGETATION	HUMAN INFLUENCES	PARENT MATERIAL

ROCK OUTCROPS	COARSE FRAGMENTS abund.	COARSE FRAGMENTS size	EFFECTIVE SOIL DEPTH (cm)

LAND FACET DESCRIPTION

ELEVATION RANGE (m)

RELIEF TYPE

SURFACE/GROUNDWATER

SURFACE HUMIDITY	GW DEPTH (cm)	GW FLUCTUATION (cm)

WATER POINT TYPE	WP LATITUDE (UTM)	WP LONGITUDE (UTM)

ROCK

LITHOLOGY	STRUCTURE

FLOOD

FREQUENCY	DURATION	AREA

EROSION

EROSION TYPE	AREA	RATE

SHEET	AREA (%)	RATE		
RILL	AREA (%)	DEPTH (cm)	SPACING (m)	AGE (y)
GULLY	AREA (%)	DEPTH (cm)	SPACING (m)	AGE (y)
RAVINE	AREA (%)	DEPTH (cm)	SPACING (m)	AGE (y)
Mass Movement	AREA	TYPE	RATE	ZONES

EXPOSED ROOTS HEIGTH (cm)

CONSERVATION PRACTICES

PLAN

DRAINAGE WAYS

ACTIVE ACCUMULATION AREA ? YES/NO

AGGRADATIONAL TYPE	AREA	RATE

SYNTHESIS: geology, relief, geomorphological unit, active processes, etc..

Table A1: Fact Sheet Relevant to Geomorphological Analysis

% OF THE LAND UNIT REPRESENTED BY THIS FACET

OTHER LAND FACETS IN THE MAPPING UNIT (map polygon). GIVE A SHORT DESCRIPTION OF OTHER FACETS IN TERMS OF MORPHOLOGY/VEGETATION/SOIL/LAND USE ETC..

NOTES AND SKETCHES

VEGETATION

RELEVE

COORDINATES UTM (m) N | E

DATE | SURVEYORS

LOCATION

A. PHOTO N° | TOPO MAP

PRELIMINARY CODE | FINAL CODE | CARTOGRAPHIC CODE

SITE DESCRIPTION

ELEVATION (m)	EXPOSURE (°)	SITE POSITION	SKETCH SITE POSITION
SLOPE FORM	SLOPE GRADIENT (%)	SLOPE LENGHT (m)	
LANDUSE	VEGETATION	HUMAN INFLUENCES	PARENT MATERIAL
ROCK OUTCROPS	COARSE FRAGMENTS abund.	COARSE FRAGMENTS size	EFFECTIVE SOIL DEPTH (cm)

VEGETATION DATA

LAYERS (m)	> 2	2-1	1-0.5	0.5-0.25	< 0.25	TOTAL
COVER (%)						

FLORISTIC LIST	COVER	PHENOL.	VIGOUR	DAMAG.	REGEN.	GRAZING

NOTE

VIGOUR		PHENOLOGY		DAMAGES		REGENERATION		GRAZING	
excellent	3	fruit only	5	abundant	3	abundant	3	intense	2
good	2	some flowers + fruit	4	frequent	2	frequent	2	fair	1
fair	1	complete blossoming	3	occasional	1	occasional	1	absent	0
poor	0	some buds + flowers	2	absent	0	absent	0		
		no buds, flowers or fruit	1						
		no leaves	0						

Table A2: Fact Sheet Relevant to Vegetation Analysis

TRANSECT				
DISTANCE (cm)	SPECIES	D1	D2	H

NOTES:

SOIL

RELEVE N.

COORDINATES UTM (m) N		DATE		SURVEYORS	
E		LOCATION			
		A. PHOTO N°		TOPO MAP	
PRELIMINARY CODE		FINAL CODE		CARTOGRAPHIC CODE	

SITE DESCRIPTION

ELEVATION (m)	EXPOSURE (°)	SITE POSITION	SKETCH SITE POSITION

SLOPE FORM	SLOPE GRADIENT (%)	SLOPE LENGHT (m)

LANDUSE	VEGETATION	HUMAN INFLUENCES	PARENT MATERIAL

ROCK OUTCROPS	*COARSE FRAGMENTS abund.*	*COARSE FRAGMENTS size*	*EFFECTIVE SOIL DEPTH (cm)*

SOIL PROFILE DRAFT

0
25
50
75
100
125
150
175
200

SEALING -thickness-	SEALING -consistency-

CRACKS -width-(cm)	CRACKS -distance-(cm)

MICRO-TOPOGRAPHY TYPE	MICRO-TOPOGRAPHY HEIGTH	DRAINAGE

NOTES

Table A3: Fact Sheet Relevant to Soil Analysis

SOIL PROFILE

RELEVE N.

	1			2			3			4			5		
HORIZON															
LOWER BOUNDARY															
BOUNDARY	DISTIN.		TOPOG.	DISTIN.		TOPOG.	DISTIN.		TOPOG.	DISTIN.		TOPOG.	DISTIN.		TOPOG.
MOISTURE STATUS															
COLOUR (moist)															
COLOUR (dry)															
MOTTLES	AB	SZ	BO	AB	SZ	BO	AB	SZ	BO	AB	SZ	BO	AB	SZ	BO
colour															
ROCK FRAGMENTS	AB	SZ	SH	AB	SZ	SH	AB	SZ	SH	AB	SZ	SH	AB	SZ	SH
TEXTURE															
STRUCTURE	TY	SZ	GR	TY	SZ	GR	TY	SZ	GR	TY	SZ	GR	TY	SZ	GR
CONSISTENCY	DRY	MOI	WET	DRY	MOI	WET	DRY	MOI	WET	DRY	MOI	WET	DRY	MOI	WET
PENETROMETER															
VOIDS	SIZE		ABUND.	SIZE		ABUND.	SIZE		ABUND.	SIZE		ABUND.	SIZE		ABUND.
CUTANS	AB	NAT	LOC	AB	NAT	LOC	AB	NAT	LOC	AB	NAT	LOC	AB	NAT	LOC
EFFLORENCES	LOCAT.		ABUND.	LOCAT.		ABUND.	LOCAT.		ABUND.	LOCAT.		ABUND.	LOCAT.		ABUND.
CEMENTATIONS	STR	NAT	DEGR	STR	NAT	DEGR	STR	NAT	DEGR	STR	NAT	DEGR	STR	NAT	DEGR
CACO3 (HCl)															
pH															
ROOTS	ABUND.		SIZE	ABUND.		SIZE	ABUND.		SIZE	ABUND.		SIZE	ABUND.		SIZE
BIOLOGICAL FEATURES	ABUND.		KIND	ABUND.		KIND	ABUND.		KIND	ABUND.		KIND	ABUND.		KIND

FAO CLASSIFICATION

NOTES

Moreover, since a very wide range of possible landforms can be taken into account and, on the other hand, similar landforms can be originated from different geomorphological processes, it is almost impossible to assess standard classes that could be fitted to any surveying area; as a consequence, the classes used to describe each property of the land must be strictly linked to the particular characteristics of the area under study.

To locate the observation sites (or *check points*) in the field, it has been followed the *stratified sampling method* rather than the *grid sampling* one.

According to the latter method, a series of parallel traverse lines are traced on the map along which at fixed intervals, the observation sites are placed. It is common in case of detailed surveys, especially in certain landscapes such as alluvial plains, which appear uniform on air photographs but showing agriculturally significant variations, e.g. in soil texture or in salinity.

In less detailed surveys covering large areas such a method becomes less suitable, since its inherent inflexibility does not allow to place observation sites in particularly interesting places, or causes some cartographic unit to be over sampled, while other units can remain without check points at all.

In such cases the stratified sampling method, which is essentially a particular form of the random survey method, results to be much more effective: the area under study is subdivided into strata, represented by each cartographic unit, and check points are quite randomly located within each stratum. With such a method, the sampling intensity is usually not uniform all over the area, with the exception of two cases in which location of check points is not completely at random.

The first one occurs when practical considerations suggest that points located near roads or tracks are more easily accessible and, as a consequence, they can be reached in a shorter time, lowering the cost of the field survey; this is not of secondary importance in developing countries, where the need to map very large areas, with a scarce or very scarce road network, is not uncommon.

The second one is mainly based on the methodological consideration that the observation sites should be located in places representative of the unit which has to be described; in such a way, it is possible to modulate the sampling intensity not only on the basis of its complexity and of the presumed internal variability of the cartographic unit, but also on the basis of the relative importance of that unit for specific land uses. Through such a method is therefore possible to magnify the usefulness of the gathered information for each check point, avoiding to perform field surveys in useless areas, thus enhancing the cost-effectiveness of the survey itself.

About fifty checkpoints (releves) have been selected to cover and represent all the land units. For each releve, the UTM geographical positions (longitude and latitude) were identified. These releves were selected to be surveyed and studied taking into account their vegetation cover, geomorphological characteristics, and soil profiles.

2.5. Field Survey

The project team visited the study area to carry out direct observation and analysis in the planned releves in order to check the visual classification of the satellite image and to update the preliminary map.

In order to facilitate the location of the control points by using the GPS in the field, the preliminary map has been overlaid to a satellite image upon which a geographic grid of reference had been previously overprinted.

Globally, forty-two releves have been surveyed during two different periods spent in the field, the previous one in June 1995 and the second one in January 1996.

For each releve the field work consisted first of all in the general description of the standing point as well as in the one of the relevant facet of the landscape there represented. Thus, according to the fact-sheets, all the necessary additional information about geomorphology has been provided. Furthermore, significant areas which soundly represent the considered facet, have been chosen in order to carry out vegetation assessment and soil profiles description.

During the field survey plants and soil samples have been collected respectively for recognition and laboratory analysis.

Photographs have been taken to depict the general view of the area of each releve, the soil profile and any significant feature to be taken into account.

2.6. Laboratory Analysis

Forty-one surface and subsurface soil samples have been collected from the CAMP area. Subsurface samples were collected directly from the digged profiles or by using Auger sampler.

After collection of soil samples in the field, representative samples were then transferred into labelled plastic bags.

In the laboratory, samples were dried at room temperature by spreading them on glass sheets and by disaggregation with fingers. A representative part of each soil sample was obtained by using the *cone and quarter* method. About 250 grams of each sample were stirred and washed several times with double distilled water to remove soluble salts. These washed soil samples, dried in an electric oven at 85°C, were used for grain size analysis and total carbonate determination.

Grain size analysis: Ro-Tap machine with standard sieves has been used for determination of grain size characteristics of the investigated soil samples. 2 mm and 0,063 mm mesh sieves have been used to respectively differentiate coarse and sandy fractions. Silt and clay were determined by means of the standard *pipette* method.

Carbonate analysis: About 5 grams of each representative soil sample were rewashed several times with double distilled water. The air dried washed soil samples were ground using agate mortar, then the powdered samples were dried at 105° C and kept in dry, clean and well stoppered labelled containers. The carbonate content was estimated through a gasometric measurement of carbon dioxide released from the sample upon digestion with hydrochloric acid using the calcimeter technique.

pH and Electric Conductivity (EC): soil/water ratio of 1:5 have been used for determination of pH, while soil/water saturated extract have been used for determination of EC. A Bekman pH is used for measurement of pH and a Cole Parmer conductivity meter is used for measuring EC.

2.7. Data base Implementation

In this phase a properly selected subset of ancillary data, both those gathered during the field survey and those coming from the laboratory analysis of collected soil samples, were stored into a data base linked to related spatial data in order to be managed within a Geographical Information System for an integrated analysis of the study-area.

The integration of ancillary and spatial data allows the geo-referred representation of singular attributes or of a combination of features defined by the user itself, thus supporting the suitable access to the acquired information and improving the effectiveness of the work.

As an example, Table A4 shows a list of soil analysis data coming from such database.

Topographic profiles made up by using topographic maps and the satellite image, allow to better explain the different kinds of connection between the main geographical regions of the study-area. Five transects were properly defined on the Land System Map in order to show the most common morphological patterns of this area. The transects were plotted in the topographic maps. Elevation variations along each transect were determined.

2.8. Corrective Image Interpretation

Once all the field and laboratory data were made available, a revision of the original image interpretation and of the legend has been carried out.

During this phase, a really effective exchange of information with the PAP/RAC consultants has contributed to follow uniformity and correlation criteria to review the Land System Map in order to improve the compliance of the various classes with the purposes of the project in the framework of the CAMP.

The map reviewing essentially consisted in:

a) adjusting boundaries between Land Systems;

b) structuring the legend in a hierarchical order (Geographic Regions, Land Systems, Landscapes);

c) reaching a reasonable agreement with the semi-detailed Land Unit Map (1:100,000) performed by the PAP/RAC team.

As for the first point, all the boundaries have been revised, especially for those areas where the contribution of field data was critical for solving doubts about relevant changes in land characteristics. Moreover some additional classes have been considered to better explain some geometries in particularly complex systems, such as the plateau slope, or to introduce some peculiar features resulting fundamental for the land use assessment of the area.

As to the second item, the main subdivision into Geographic Regions has been made according to climatic and geographic criteria, while Land Systems refer to the main geomorphological macro-units that can be found within each region.

Finally, the Landscapes divide the Land Systems into areas where peculiar geomorphological processes have determined, and still do, certain soil characteristics (soil depth, salinity, intensity of water erosion, wind erosion and deposition, etc.) that are important from a land management point of view.

The third item deals with the close co-operation set up in this phase with the PAP/RAC team; for this reason, a lot of work was devoted to establish a common terminology and a common legend structure where the different hierarchical levels have the same meaning.

The final Land System Map of Fuka-Matrouh area is composed of 3 Geographical Regions, 12 Land Systems and 25 Landscapes.

Profile No.	Landscape	Depth cm	Ec dS/m	pH	Cations meq/l Ca	Mg	Na	K	SAR	CaCO3 %	Diameter of the Sieve (mm) 2	1	0,5	0,25	0,125	0,063	< .063	Color Dry	Sand %	Silt %	Clay %	Soil Texture
											gm								-	-	-	
2	HW2	0-40	0,33	7,60	2,60	1,90	2,20	0,35	1,47	6,10	0,00	0,31	3,52	30,70	42,82	19,64	2,94	7.5 YR 7/6 REDDISH YELLOW	97	3	0	Sand
		40-90	0,41	7,90	3,10	2,50	4,70	0,37	2,81	6,20	0,71	7,72	12,33	29,88	25,71	20,02	3,15	7.5 YR 7/6 REDDISH YELLOW	87	3	10	Loamy Sand
3	LE3	0-25	1,00	7,50	3,70	5,13	10,95	0,43	5,21	16,60	0,71	19,45	20,67	17,64	18,97	18,99	3,64	10 YR 7/6 YELLOW	90	2	8	Sand
4	SR1	0-15	10,79	7,00	28,65	20,35	145,78	1,68	29,45	25,40	0,25	8,69	14,67	23,63	39,97	10,30	2,40	7.5 YR 7/6 REDDISH YELLOW	87	5	8	Loamy Sand
6	TB3	0-15	0,63	7,40	4,20	2,64	7,20	0,36	3,89	3,30	0,67	10,05	13,67	25,63	28,19	18,04	1,08	7.5 YR 6/8 REDDISH YELLOW	90	2	8	Sand
7	TS1	0-15	0,70	7,50	3,47	5,13	8,07	0,27	3,89	20,60	0,46	16,82	24,59	20,22	19,23	15,64	2,59	10 YR 7/6 YELLOW	87	5	8	Loamy Sand
		15-35	2,95	7,50	5,47	7,43	13,80	0,23	5,43	28,50	1,33	24,99	27,69	16,81	14,30	12,47	1,94	7.5 YR 7/6 REDDISH YELLOW	82	8	10	Loamy Sand
8	UP1	0-10	0,60	7,30	4,00	2,10	7,10	0,36	4,07	32,50	0,19	9,60	15,42	24,39	28,53	16,45	5,01	10 YR 7/6 YELLOW	90	2	8	Sand
		10-50	0,30	7,40	2,60	1,80	2,10	0,35	1,42	32,90	0,53	17,97	21,34	17,91	15,58	20,29	5,78	10 YR 7/6 YELLOW	84	7	9	Loamy Sand
14	BL2	0-20	68,00	7,90	68,20	41,80	923,90	9,60	124,58	11,30	5,50	24,80	30,00	17,00	15,20	6,40	1,80	10 YR 6/6 BROWNISH YELLOW	90	1	9	Sandy
		20-50	16,00	7,00	48,00	42,00	434,80	7,70	64,82	12,10	20,30	20,40	23,90	11,30	18,20	2,60	0,30	10 YR 8/4 VERY PALE BROWN	86	4	10	Loamy Sand
		50-85	8,50	7,80	46,00	14,00	226,10	2,60	41,28	0,90	2,40	5,60	32,90	37,30	16,70	3,80	1,00	10 YR 8/3 VERY PALE BROWN	87	3	10	Loamy Sand
15	BL1	0-15	0,89	7,90	2,80	6,50	9,10	0,10	4,22	35,40	0,50	10,00	59,30	24,00	4,70	0,30	0,30	7.5 YR 8/ WHITE	91	1	8	Sandy
17	LE2	0-15	69,00	7,20	115,40	83,60	1080,75	9,60	108,35	26,90	10,00	11,50	16,00	15,30	36,20	7,40	1,30	7.5 YR 5/8 STRONG BROWN	84	6	10	Loamy Sand
18	LE2	0-10	1,14	7,80	6,00	4,00	8,30	0,80	3,71	5,30	11,10	10,00	13,10	15,70	41,00	7,50	1,60	10 YR 6/6 BROWNISH YELLOW	84	7	9	Loamy Sand
20	LE1	0-25	0,48	8,00	3,80	4,00	5,00	0,40	2,53	40,00	10,40	14,90	21,50	16,80	29,70	4,70	1,90	10 YR 8/3 VERY PALE BROWN	86	4	10	Loamy Sand
21	BL1	S.D.	0,69	8,00	5,00	5,00	9,60	0,10	4,29	40,60	0,00	0,70	30,30	55,60	11,00	0,30	0,30	7.5 YR 8/ WHITE	91	1	8	Sandy
22	HE1	0-10	11,63	7,30	38,20	20,80	180,40	1,30	33,21	43,90	20,00	17,50	15,10	12,20	11,70	16,70	6,80	7.5 YR 8/4 PINKISH WHITE	84	6	10	Loamy Sand
		10-35	3,13	7,90	7,00	7,40	12,00	0,30	4,47	34,40	15,40	10,30	12,90	17,90	31,40	8,20	0,80	10 YR 7/6 YELLOW	86	4	10	Loamy Sand
23	HE1	0-20	1,36	7,70	10,40	13,60	6,10	1,20	1,76	22,40	7,70	8,40	11,10	20,00	47,00	2,30	0,50	10 YR 7/6 YELLOW	86	4	10	Loamy Sand
		20-70	6,06	7,50	26,00	47,20	94,60	1,30	15,64	33,30	8,90	11,90	16,30	14,80	34,60	8,70	1,80	10 YR 6/6 BROWNISH YELLOW	84	6	10	Loamy Sand
24	LE4	0-20	1,14	8,00	2,00	1,00	11,30	0,40	9,23	25,20	10,60	11,00	15,70	16,90	24,90	16,20	1,40	10 YR 6/6 BROWNISH YELLOW	83	7	10	Loamy Sand
		20-45	3,36	7,90	3,80	2,20	37,00	0,30	21,36	38,90	11,60	16,60	15,80	14,60	30,00	8,60	1,70	7.5 YR 8/4 PINKISH WHITE	84	6	10	Loamy Sand
		45-65	5,60	7,80	6,00	4,00	54,30	0,60	24,28	33,00	14,20	22,00	17,20	14,80	21,20	8,30	0,80	7.5 YR 8/4 PINKISH WHITE	71	12	17	Sandy Loam
25	LE4	0-10	1,35	7,90	5,20	5,80	16,10	0,50	6,87	37,40	10,00	11,20	21,40	23,30	27,00	6,30	0,80	10 YR 6/6 BROWNISH YELLOW	80	10	10	Loamy Sand
26	TS2	0-15	0,58	8,30	2,00	1,00	7,00	0,40	5,72	10,80	6,10	7,60	17,70	28,10	33,30	3,70	0,30	10 YR 6/6 BROWNISH YELLOW	81	12	7	Loamy Sand
27	TS2	Surface	0,71	8,20	1,80	2,00	12,00	0,30	8,71	20,00	14,10	15,30	21,40	17,60	24,00	5,00	1,00	10 YR 7/6 YELLOW	91	2	7	Sandy
28	TS1	Surface	2,39	8,30	3,00	2,50	13,70	0,20	8,26	20,80	11,30	11,60	17,30	18,90	34,90	1,90	0,30	10 YR 7/6 YELLOW	80	10	10	Loamy Sand
29	PS1	0-15 W.	0,72	7,80	3,60	8,40	2,60	0,40	1,06	27,10		0,60	3,70	10,90	56,40	24,00	2,40	7.5 YR 6/6 REDDISH YELLOW	91	1	8	Sandy
		15-40 W.	0,32	8,00	3,00	1,00	2,00	0,30	1,41	42,00		0,40	5,20	40,40	44,40	6,30	1,00	7.5 YR 6/6 REDDISH YELLOW	90	1	9	Sandy
30	TP1	0-15	13,72	7,60	24,00	34,20	160,90	2,60	29,83	32,10	10,00	11,50	24,90	19,50	18,80	13,90	2,00	10 YR 6/6 BROWNISH YELLOW	71	12	17	Sandy Loam
31	SR1	0-15	30,00	7,20	99,00	63,00	402,20	3,20	44,69	27,60	13,00	12,50	16,20	20,00	30,00	7,10	1,20	10 YR 6/6 BROWNISH YELLOW	90	1	9	Sandy
32	SC1	0-30	43,00	7,30	122,60	73,40	384,80	1,90	38,87	30,00	0,30	11,50	20,00	20,90	32,10	8,60	1,90	7.5 YR 7/6 REDDISH YELLOW	92	1	7	Sandy
		30-60	44,00	7,10	100,00	120,00	345,70	1,90	32,96	38,90	0,50	16,80	23,20	20,00	27,50	7,80	4,20	7.5 YR 6/8 REDDISH YELLOW	89	3	8	Sandy
33	TS1	0-10	1,12	8,10	5,00	7,00	10,40	0,80	4,25	15,60	0,80	2,40	12,70	22,10	53,10	6,20	0,60	10 YR 6/6 BROWNISH YELLOW	71	12	17	Sandy Loam
		10-30	0,54	7,80	3,60	1,40	2,00	0,30	1,26	23,60	2,10	3,00	13,70	23,70	47,00	9,20	1,00	10 YR 6/6 BROWNISH YELLOW	80	10	10	Loamy Sand
		30-60	0,36	7,90	2,20	2,80	2,40	0,40	1,52	11,80	4,00	6,00	16,60	30,50	39,10	2,90	0,90	7.5 YR 8/4 PINKISH WHITE	71	12	17	Sandy Loam
34	LT1	0-10	17,08	7,30	63,00	47,00	226,10	6,40	30,49	18,20	0,30	10,00	13,80	14,40	43,70	13,70	3,20	10 YR 8/3 VERY PALE BROWN	81	10	9	Loamy Sand
		10-25	29,00	7,30	50,00	82,00	243,50	1,30	29,97	43,40	12,90	18,00	17,80	12,10	31,90	3,70	0,40	10 YR 7/6 YELLOW	80	10	10	Loamy Sand
35	TB3	0-5	0,64	8,00	5,00	1,00	8,50	0,60	4,91	14,20		1,40	8,20	41,30	36,20	11,70	1,70	10 YR 6/6 BROWNISH YELLOW	92	1	7	Sandy
		5-30	0,63	8,00	2,00	3,00	5,70	0,30	3,60	23,30	12,20	13,80	18,00	14,70	36,20	2,90	0,30	10 YR 6/6 BROWNISH YELLOW	81	10	9	Loamy Sand
36	TB1	0-5	0,82	8,00	3,40	0,80	6,70	0,30	4,62	18,60	7,00	7,30	10,00	10,00	60,00	5,20	0,50	7.5 YR 6/6 REDDISH YELLOW	71	12	17	Sandy Loam
37	LT1	0-15	0,95	8,00	5,00	6,00	13,00	0,40	5,54	12,00	6,50	8,50	11,00	13,10	48,00	14,00	0,90	10 YR 7/6 YELLOW	81	10	9	Loamy Sand
	LT1	15-40	2,00	7,80	6,40	12,40	15,70	0,20	5,12	15,60	3,10	4,70	10,90	13,00	36,80	30,00	1,20	10 YR 7/6 YELLOW	80	10	10	Loamy Sand
38	LT1	Surface	0,69	7,90	7,00	3,20	5,20	0,40	2,30	9,90	5,50	5,90	8,50	15,00	45,90	16,20	1,00	10 YR 6/8 BROWNISH YELLOW	90	1	9	Sandy
39	TB3	Surface	4,74	7,60	10,00	8,20	20,70	0,60	6,86	13,40	7,70	8,40	17,50	20,00	34,10	8,40	1,40	10 YR 6/8 BROWNISH YELLOW	86	4	10	Loamy Sand
40	TB2	0-5	2,12	8,00	3,80	6,20	17,40	0,60	7,78	23,60	12,10	10,40	21,70	24,50	27,10	4,90	1,30	10 YR 6/6 BROWNISH YELLOW	84	6	10	Loamy Sand
41	LE4	0-20	0,55	8,00	2,80	7,00	2,40	0,10	1,08	21,70	3,60	6,20	10,00	10,00	55,50	11,00	3,70	10 YR 6/6 BROWNISH YELLOW	86	4	10	Loamy Sand
		20-50	0,67	7,70	3,00	2,00	4,60	0,30	2,91	26,40	0,30	7,10	12,50	15,30	38,10	21,00	5,10	10 YR 6/4 BROWNISH YELLOW	71	12	17	Sandy Loam

* W.B. = Wadi Bottom
* S.D. = Sand Dunes

Table A4: Soil Analysis Data

2.9. Description of Land System

The description of the Land System Map was made taking into account the peculiar features of the considered smallest cartographic units, that is the landscapes. As a matter of fact, each Geographic Region was defined according to its location in the area and to the Land Systems enclosed in it. The latter, at their turn, were described taking into account their subdivision in smallest cartographic units (landscapes), a description of which is provided aiming, above all, to underline the most important differences among them as for land use planning.

Their description was structured in three sections, concerning respectively geomorphology, soils and vegetation.

In the first section the main morphological characteristics (landforms, active geomorphological processes, elevation range, kind and rate of erosion and deposition, etc.) of the whole landscape were summarized; the description was made taking into account field data concerning the surveyed field control points, as well as the acquired knowledge about the whole area and its dynamic relationships with surrounding landscapes.

Data concerning soils were mainly referred to the described soil profile, which should be considered representative of the local "facet" investigated rather than of the whole landscape; general considerations about variability in the landscape of the most important characteristics were reported, whenever possible.

The third section, concerning vegetation and land use, was dealt with information about the vegetation association (because of the impossibility to perform a phytosociological analysis, terms such as "association" or "formation" should be avoided), the average percentage of covered areas and its general conditions, defined in terms of rate of grazing, regenerating capacity and vigour. Information about present land use was reported, when available.

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ANNEX VII

CULTURAL HERITAGE SITES OF THE NORTH-WESTERN COAST OF EGYPT

UNEP

UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

MAP

SPA/RAC

Cultural Heritage Sites of the North-Western Coast of Egypt

Feisal A.Esmael - 1995

RAC/SPA - 15 rue Ali Ibn Abi Taleb, Cité Jardins 1082 Tunis
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Cultural Heritage Sites of the North-Western Coast of Egypt

Study requested and financed by :

Regional Activity Centre for Specially Protected Areas (RAC / SPA)
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within the framework of the implementation of the agreement relative to the Coastal Area Management Programme for the Area of Fuka-Matruh (Egypt), signed between UNEP/MAP and the Egyptian Government on 9 November 1992.

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ACKNOWLEDGEMENT

It is the author's pleasure to admit his deepest debt of gratitude to the Director and efficient staff of the " Technical Cooperation Office for the Environment- TCOE" for coordinating, and greatly facilitating, field work essential for the pursuit of a meaningful investigation.

The author is also grateful to site managers and inspectors for readily lending much needed field assistance.

Table of Contents

List of Illustrations

I. Background:

As part of an agreement , signed in Cairo on 9 November 1992, between the Government of Egypt and the United Nations Environment Programme; aimed at the development and implementation of a Coastal Area Management Programme for the North-Western coastal area of Fuka-Matrouh (Egypt), the Cultural Heritage was identified and incorporated as a major feature and component of the intended programme. A complementary management plan for this particular national resource has subsequently become necessary. This report has, therefore, been prepared with this planning objective in mind ; as the outcome of a field investigation defining areas of interest, exploring their assets and explaining their prospects for a sustained healthy survival compatible with sustainable development concepts and sound practices.

II. Introduction :

Egypt has variously been described as the cradle of humanity or the cradle of civilization. While the former cannot be adequately substantiated, the latter is seldom- if ever- challenged; in view of continued successive idigenous cultures spanning a record of some 7000 years or more,with supporting relics and signs in great abundance throughout the land ; having denser concentrations in the Nile Delta and along the Nile Valley.

It is no wonder then that selected sites in Egypt are featured prominently on the List of World Cultural Heritage, nor is it only incidental that we find Egypt reserving first place in the order of entry into membership of the UNESCO-1972 convention on the " Protection of the World Cultural and Natural Heritage ".

When it came to applying for the World Heritage List,however, the Egyptian Cultural wealth constituted a dilemma that could be solved only by conceding to an initial group of five representative sites; on the basis of a firm conviction that other sites will definitely follow in due course. This has, as yet, to materialise.

The five Egyptian sites presented to, and finally accepted by, the UNESCO Meeting in Luxor (October 22-27, 1979) were:

1. Memphis and its Necropolis south west of Cairo, including the pyramid fields extending from Giza to Dahshur.

2. Thebes, with its Temples and Tombs ; including the temples of Karnak and Luxor on the east bank of the river Nile, and the Necropolis on the west- at Qurna.

3. The open air museum of Nubia including the group of temples at Abu Simbel, Philae and Kalabsha-and the Aswan Region.

4. Islamic Cairo including Al-Fustat.

5. The Archaeological town of **Abu Mena** south west of Alexandria towards **Matrouh**.

The area covered by the CAMP Agreement has been defined (Figure 1) as:
" Approximately 100 km of coastal length covering the Area which starts from the city of Matrouh to the Fuka area, extending also, in particular cases, to the Dabaa City in the East. As regards the depth of the Area, it was agreed that it will cover an area ranging from 5 to 10 km from the coast. In particular cases, (water sheds, mines and settlements) , the area may be extended up to 20 km".

Considering the prescribed area archaeologically, it has been found void of any yet recorded - or anticipated- major features; even to the outer farthest limits east or south. The nearest major culture heritage site east of the area is found at the Marina/ Alamein some 190 km, from Marsa Matrouh and is still being excavated as it comes under extremely heavy tourist development pressure on all sides. South of the area's coast line, on the other hand, the nearest major cultural heritage sites known to-date are only found in the Oasis of Siwa some 300 km away from Marsa Matrough but still within the boundaries of the same governorate. West of Matrouh, but still outside of the Agreement Area, one does not have to travel very far to meet with particularly interesting sites. In any event, these facts do not necessarily mean that the prescribed area is exceptionally poor in archaeological context but whatever cultural marvels it may hold, it still keeps through the good fortune of escaping the greedy eyes of rampant tourist development as it spreads like cancer along the coast; exposing and finally destroying cultural and natural wonders.

Following the cultural route from Alexandria to Matrouh we find that development in all its, hitherto, destructive forms (Industrial, Urban and Tourist) had taken its toll in raking havoc. We have excepted agricultural development since it has proven, despite all drawbacks, most benign on (hidden or salient) Ecological, Cultural and Aesthetical assets of an afflicted area.

As development in its broadest and widest sense is central to CAMP for the Fuka -Matrouh Area it will have, sooner or later, to tackle the question of proper approach to cultural heritage sites , as anticipated or deemed likely in the process. Since the principal objective of CAMP is to proceed with development projects applying the principles and concepts of sustainability - never (at all costs) to repeat mistakes inherent in past practices, the need becomes evident for extension of the area of cultural concern to the archaeological limits set by long established landmarks east, west and south of Matrouh; as administratively defined in the context of Antiquities boundaries. This framework, as dictated by archaeological necessity, takes us as far east as the World Heritage Site of Abu Mena, and as far south as the temple of Jupiter- Amun in the Oasis of Amun-Siwa, and as far west as the site of Zawiat Al-Agdab near Salum.

Selecting the Agreement Area for CAMP came luckily in time to save it, and spare it the (ill-)fate of the remaining parts of the coast line of Alexandria-Matrouh, and perhaps also beyond ; where affected, and development afflicted, areas are littered- and infested- with factories as well as holiday and omenous tourist villages. All those monumental disasters of mammoth proportions came up in the complete absence of both sound planning concepts and cultural sense, resting on the mistaken assumption that the beaches are breachable by the power of open property ownership; whether privately or by the state. Beach areas are natural and national resources and should not be subject to monopoly, but only to proper management and continued care.

III. Sustainability of Heritage Sites

To ensure healthy and sustained survival of an area selected for special protection, due to Cultural or Natural assets, a sound management plan will have to be set- and approppropriately implemented- on the basis of the concepts of preventive conservation, in which the planner resorts to exploring avenues to avoid, rather than maintain, the need for repair (or restoration) measures.

Such a management plan would , in our view, have to include the following principal features:

1. A comprehensive and detailed management policy for the Priority Site which should accommodate reconcilables visitors demand, operations and service activities, interpretation and revenue generating facilities (mechanisms) consistent with the Special Protection Objectives.
2. The related Document(s) should clearly identify the site's assets and prevailing problems.
3. The Document(s) should also evaluate Site's Chances for Survival, its sustainability and potential for sound and profitable running.
4. The Document(s) should, moreover, provide a conservation management programme prescribed for implementation at the Selected priority Site. Such programme should:
    a) Introduce immediate, short, medium and long-term measures to establish environmental order within the area and its vicinity.
    b) Incorporate environmental and conservation security boundaries for the whole Site , and complete protection zoning ; necessary -and substantial - for Specially Protected Areas (Natural and Cultural Heritage).
    c) Incorporate further inner zoning for particularly sensitive elements within the Site. The zoning here would be a reduced (in extent) version of the global zoning where; the core, the exclusion zone, the buffer zone, the separation zone/ belt, approaches and service area are clearly evident, and smoothly blend together and with the historical setting and landscape.

Since the Agreement Area is within the Mediterranean Region whose common heritage has , for many years (1984 -1993), been the concern of countries party to the Barcelona Convention, through a priority programme of the Mediterranean Action Plan (MAP), the common approach thus far adopted may have to be consulted; if only to achieve a measure of regional harmony.

Work towards that harmony in approach requires four main phases of action, namely:

1. Architectural survey
2. Analysis of Actual State
3. Evaluation (of assets and problems as related to treatment)
4. Implementation

To establish criteria, methodologies and procedures entailed in the prescribed phases, a number of corresponding workshops were organized by the Regional Activity Centre in Split- Croatia, leading to the formulation of:

" Guidelines for the Rehabilitation of
Mediterranean Historic Settlements"

issued, by the Centre, as Document PAP-5/1994/ G- volume (I). The objectives of the Guidelines were identified as :

- To contribute to a better management of Mediterranean hostoric sites;
- To present the methodology for the rehabilitation of Mediterranean historic settlements that was developed, tested and accepted during the (Priority) action;
- To provide basic guidelines for the application of this methodology, and
- To illustrate it through several selected case studies.

The document , further, states that it is directed to :

> " Professional and technical staff responsible for the built heritage, institutes for the preservation of monuments, as well as for institutions and agencies responsible for architectural design, relevant universities, etc."

It is , therefore, evident that the document constitutes a very useful background and implementation reference for Cultural Heritage management Projects within " Sustainable " Develoment Plans in Mediterranean Countries Party to the Barcelona Convention, in particular.

IV. Cultural Heritage Principal Assets relating to the Agreement Area :

We have , early in the " Introduction", explained how a meaningful coverage of a unified cultural line characterising the Area's coastline necessarily requires archaeological boundaries to be extended fairly far beyond the (physical development) boundaries , as defined in the Agreement. To present Cultural Heritage landmarks within this expanded area, it has been found convenient to divide the Matrouh Region archaeologically along the administrative pattern into:

1. East of Matrouh
2. West of Matrouh
3. South of Matrouh

One was, moreover compelled (and also tempted) to set the eastern boundary at the historic (though otherwise described, as archaeological) site of " ABu Mena ", which was originally within the antiquities bounds of East Matrouh but recent reorganization has placed it in a different Category within the Department of Coptic and Islamic Antiquities. In Mediterranean context, however, the site of " Abu Mena" cannot be ignored or even overlooked; as it eminently appears both on the World Heritage List and the list of " 100 historic sites of common Mediterranean interest ". The site, further, lends itself ideally to management patterns consistent with the concepts and principles of " Sustainable Development" in areas featuring a (particularly renowned) Cultural Heritage Site (of world importance and concern).

Other Major Sites East of Matrouh include:

1. Abu Seir, some 50 km out of Alexandria, Comprising a Pharaonic temple from the late period (c.660-330 B.C) , a Byzantine (c.395-640 A.D) Church, a number of rock tombs from the Roman Period (c. 30 B.C-395 A.D) and famous lighthouse-shaped grave column marking the Osiris Tomb. Excavations are also currently underway in search of a Roman Stadium beneath an archaeological mound at the neighbouring site of Kum El-Nijous .
2. Marina/ El-Alamein- the ancient " Leokathbes" about 100 km out of Alexandria; a housing settlement featuring Roman Villas with

a sub-surface water supply system (as part of its infra-structure), shops, public baths and a common water reservoir for the town. The site is still being excavated as it comes under the pressures of advancing holiday housing development.

To the west of Matrouh, however, there are numerous archaeological mounds extending to as far as Sidi Barani and Salum (Map, figure 2), among these we find of particular interest:

1. Cleopatra Site, directly on the beach some 15 km from Matrouh, featuring what is known as Cleopatra's Bath (on land within the mound) besides the famous Cleopatra's Rock.
2. Agiba Site, at Um Ar-Rakhm- about 30 km from Matrouh, featuring a Roman (c. 30 B.C- 395 A.D.) Catacombs with the characteristic loculi. The site is still being excavated, with 47 common burials hitherto discovered. There are also, revealed, the foundations of an associated temple of the same era.

Major Sites South of Matrouh , on the other hand are found in the Oasis of Siwa. Most important among them are those of the Temple of Jupiter Amun (Temple of the oracle), the temple of Nectanebo II (c. 380-343 B.C.) and Gabal Al-Mawta (Mountain of the Dead). Recently ,moreover, the (archaeological) world attention has been focused on the Site of Maraki where excavations are underway in search of the Tomb of Alexander the Great claimed (by some) to be at that location but the evidence in support remains much in dispute.

V. The Case of Two Sites:

The extent and scope of a Management plan for a Cutural Heritage Site naturally depend much on its nature, importance and particular assets. In cases, therefore, the plan could provide only for maintaining basic protection; in others, it may entail Comprehensive Development with the aim of ultimately achieving economic viability via fund-generating facilities.
In this section we will endeavour to present model sites considered in our view compatible with the two management planning concepts.

By way of example for the first we take the site of Agiba at Um Ar-Rakhm, which the Governorate selected (over 10 years ago) for tourist development involving the construction of economy (holiday) bungalows (or Cabins). Recently, however, another invasive modern feature has been introduced into the archaeological horizon, involving the construction of multi-storey buildings within yet another "Tourist Village " . Both Schemes are in the immediate vicinity encroaching upon the Heritage Site; the former to the north and the latter to the east, creating a state of utter environmental chaos. The disorder extends to the very fabric of what remained of the Heritage Site outside of the tourist development areas. The diminished state of the site readily suggests that the first priority in a management plan is to bring back- and maintain, and later enhance - a viable measure of Environmental Order. This begins with establishing physically well-defined (environmental security) boundaries.

In view of the lack of resources, besides administrtive handicaps, it has been suggested to administrators at the local Antiquities Office that they work within available means to create the required (though necessarily modest) physical separation between the two diverse worlds. The separation zone is suggested to incorporate (Figure 3) two environmental defence lines; the outer a moat to collect seeping subsurface water, and the other is a series of mounds created by the debris coming out of excavations. The latter may be appropriately landscaped in attractive formations and adorned with indigenous all weather plants. Ample , clean and t idy space can , in the process, be created to facilitate visitors circulation and workers movement (particularly as further excavations are anticipated). Once the environmental order is established in the site, any required repair or resoration work on affected elements may subsequently be conducted with greater ease and lasting effect.

The other compelling example, with vast capacity for comprehensive Development potentials, is that of the World- and Regional - Heritage Site of Abu Mena which lends itself readily to full resoration of function (if not also of form) whereby it can recover its past glory as a pilgrimage centre of great popularity and attraction throughout the Mediterranean Region.

In view of this latter Site's exceptional importance, we have briefly formulated what amounts to a project proposal incorporating design concepts and elements, by way of demonstrating the Site's Worthiness of exceptional attention and acceptance for regionally coordinated survival and revival transformation.

VI. Pilot Project Proposal

This final section is devoted to the detailed presentation of material pertinent to Rehabitation, if deemed acceptable, of the Pilgrimage Centre of the Christian Martyr Saint Menas, otherwise known as Abu Mena. The site had functioned fully as a pilgrimage Centre for several hundred years, and retained some practical religious importance for a few more centuries before it was finally abandoned and the Martyr's remains were later transferred to the Church of Saint Menas in Al Fustat (Old Cairo).

Site Potentials :

The Historic Site of Abu Mena is considered ideal for rehabilitation and reconstruction within the framework of Sound Environmental Management and Integrated Development practices. Justification for this conviction may be supported by the following features:

1. Its asserted importance; locally, regionally and internationally . Accordingly, it can very easily command a Highest Priority Status.

2. As it is representative of a living and viably continuing culture, the Christian Faith in general and the Orthodox- and possibly also Catholic- Denominations in particular, the conservation works necessary for the Rehabilitation Project can proceed with a greater degree of freedom in handling and treatment of architectural elements. The same cannot be said, for example, in the case of archaeological relics where extremely strict and stringent confining rules apply.

3. Activity in the immediate vicinity, Abu Mena Monastery, is not only very friendly but also compatible and conforming.

4. The surrounding area beyond has already been neutralised through a series of effective measures. These include:
   a) Expansion of the precinct from about 850 acres (almost 30 times the actual area of the Centre) to about 2000 acres (almost 75 times the actual area of the Centre); with ample room for proper zoning and development.

b) The establishment of an enclosing canal, separating and isolating the Centre and its expanded precinct from the nearby cultivation of the sugar beet plantation project.

5. The enclosing canal will, besides acting as environmental security boundary for the Site, serve as an exclusion barrier and as a reservoir for drainage water from adjacent fields. This water can, subsequently, be treated for a multitude of Site uses.

6. When reconstruction and development are fully-and properly-completed, final rehabilitation will be enshrined with full restoration of Site Function.

7. The ultimately recovered Pilgrimage Centre can easily retrieve, and retain, its older magnificence and compete and compare favourable with other pilgrimage attractions; for example, Lourdes (France) and Saint Fatima (Portugal), with the prospects of covering the total costs of the project in a fairly reasonable span of time.

Workplan:

Any serious implementation project cannot be set out without the selection of a team of competent professionals who will be entrusted with the first task of deciding on operational methodology. In the field of Historic Heritage, however, professional competence is necessary but not entirely sufficient and must be complemented and sustained by proven, profound and refined sense of culture. The latter asset will be the only guarantee against the repetition of town-planning tragedies and disasters ; for example, the renouned cases of squeezing the Country's only Antiquity Museum into an assortment of massive and offensive structures and public amentities, and forcing invasive overpass bridges through the very core of the Historic Pride of Cairo (close to Al Azhar Mosque).

The safest and surest approach in our view is, therefore, to draw on the reputed resources of the related Priority Programme at the Split Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan (MAP) where considerable experience has been building up through a number of highly specialised and well-organised workshops in the various aspects of Rehabilitation and Reconstrution of Mediterranean Historic Sites of Common interest.

Rehabilitation Framework:

Reconstruction and Rehabilitation endeavours will necessarily have to include substantial expansion of excavation activity, in an attempt to reveal- at least- the principal components of the Centre essential for restoring to the place the original religious functions and practices associated with the traditional pilgrimage procedures; for example, processions, Baptismal and Liturgical services and Retreats. Return to operation of health and healing facilities and provisions known from ancient times must also be envisaged.

Details of the itinerary for the pilgrims at the Centre will have to be prepared thoroughly from contemporary texts and related traditions, and plans for fulfilling them are drawn accordingly.

Certain components of the Centre may have to be restored only to their ancient form while their functions will have to be transferred to similar, and architecturally comparable and compatible, facilities at alternative- but convenient and appropriate - locations within the expanded enclosure. Examples are the two baths, the hospices, the sanatoria and other amenities.

Since water is the primary, and most significant, asset of the Centre; extraction and management (for example, bottling, distribution,.... etc.) system will have to be established. Indigenous flora (as water keepers and containers) may also be worthy of a similar handling and appreciation.
It is, moreover, suggested that alien structures already existing within the enclosure (for example, administrative officies and the few private dwellings) be made to blend smoothly with the present, and projected, ambience; preferably through appropriate plantation veiling.

Finally, the proper organisation of an international fund-raising campaign, including voluntary contributions in kind and labour, will be one of the major inputs throughout all phases of planning, design and implementation of the proposed project.

Conclusion:

The Historic Site of Abu Mena currently encloses Ruins; erroneously (in our view) described as Archaeological Ruins. This description is contradictory to the terms which established it as a World Heritage of exceptional cultural value, and as a Historic Site of Common Mediterranean Interest and cannot, therefore, be left in eternal RUIN. It is, moreover, representative and symbolic of a living Faith, and its religous significance and sanctity are still maintained in the hearts and minds of the believers; with a strong and profound conviction, evident in the yearning of the multitude of visitors to the nearby monastery to worship at the sacred site, even in its present state of desolation.

In conclusion, it has become abundantly clear that the Historic Pilgrimage Centre of Saint Menas is fully qualified for revival; in form and function. Restoring it to its past glory and vigour is, indeed, a global honourable commitment, and a fervent need of the devout faithful followers of Saint Menas, the pioneering Christian Martyr.

Illustrations

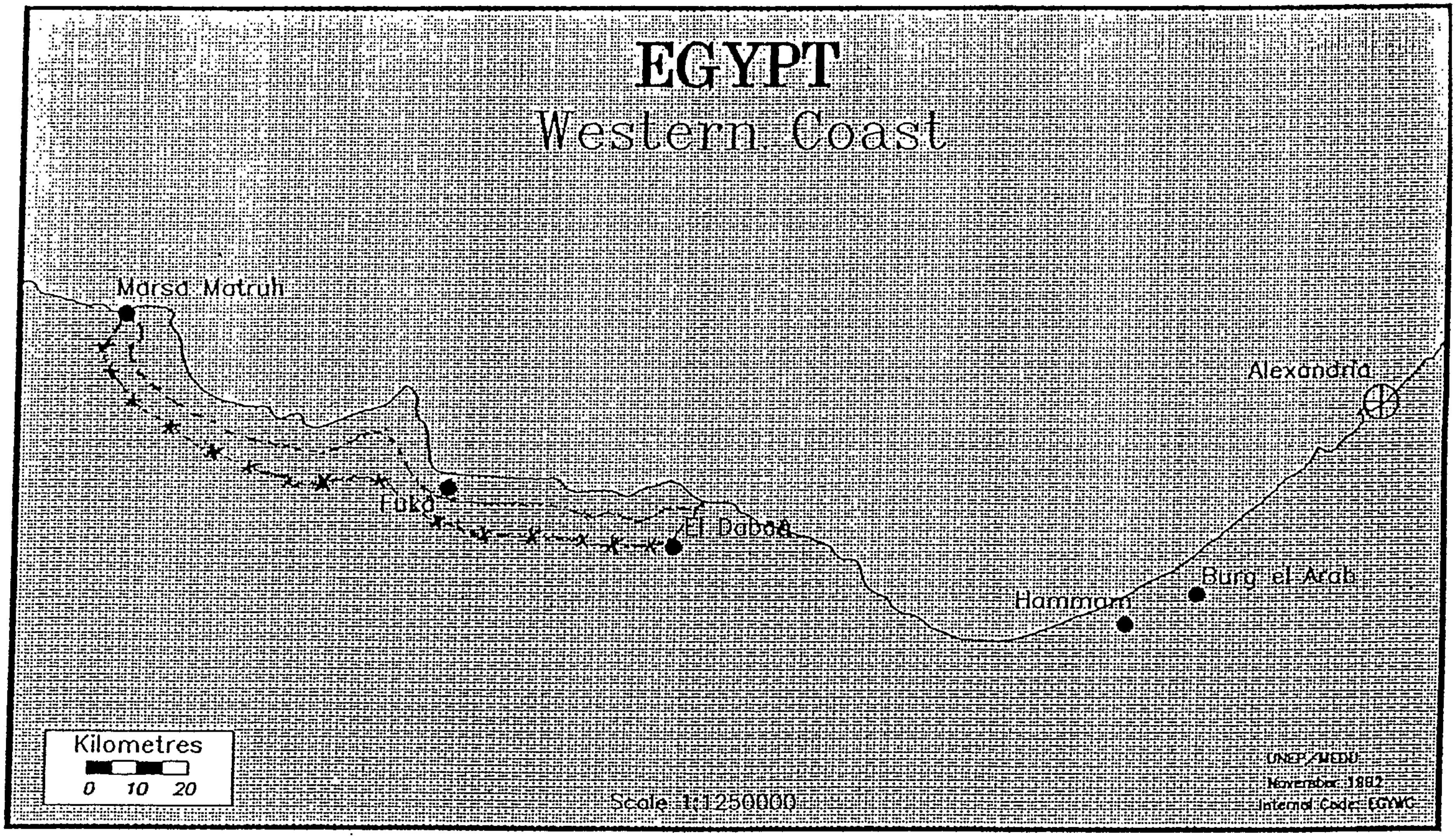


Figure 1.

- - - - Inner Limits of the Agreement Area] (Approx.)
-x-x- Outer Limits of the Agreement Area]

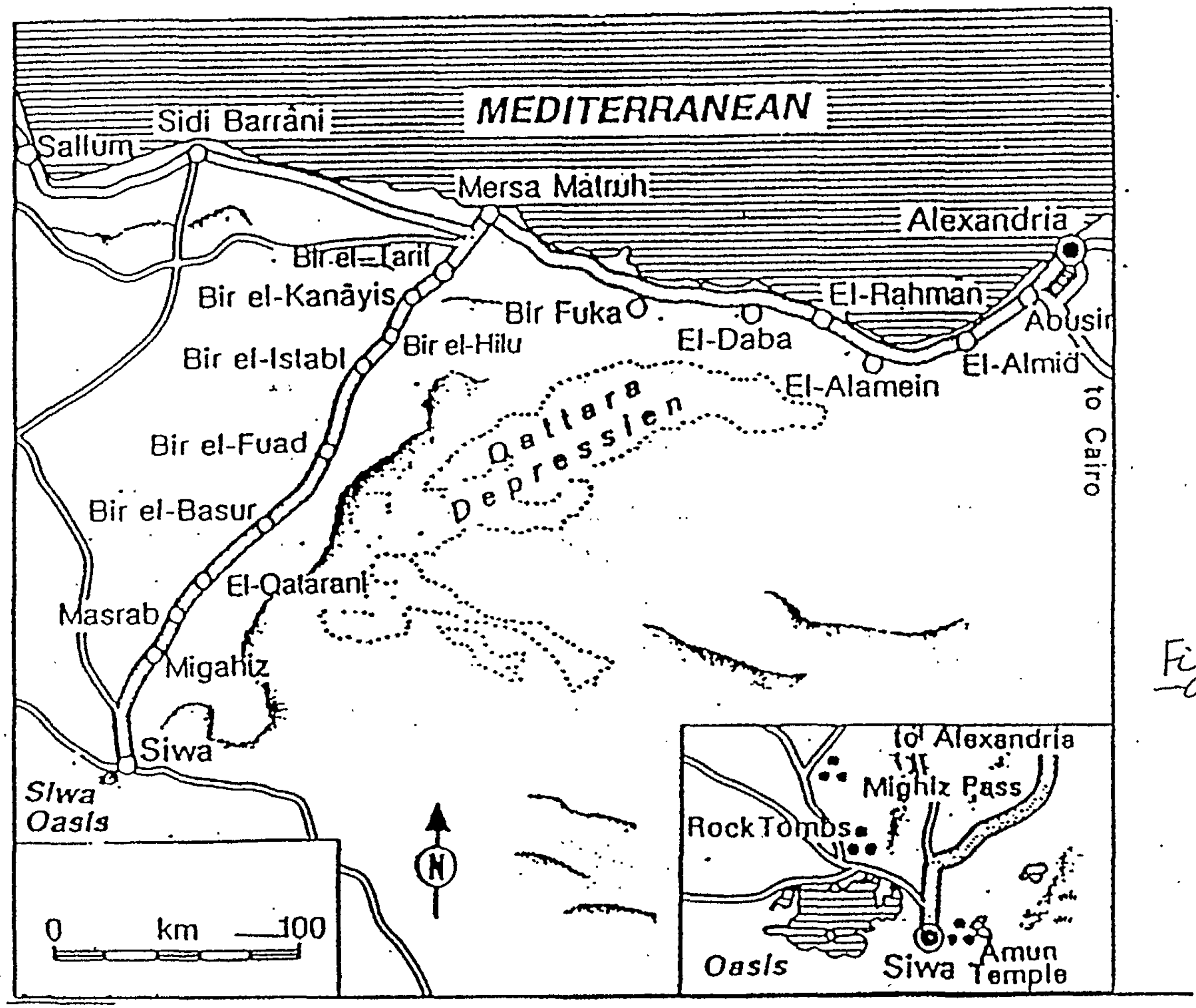

MEDITERRANEAN
Sallum
Sidi Barrani
Mersa Matruh
Alexandria
Bir-el-Taril
Bir el-Kanayis
Bir Fuka
El-Rahman
Abusir
El-Daba
El-Almid
Bir el-Hilu
Bir el-Istabl
El-Alamein
to Cairo
Qattara Depression
Bir el-Fuad
Bir el-Basur
El-Qatarani
Masrab
Migahiz
Siwa
Siwa Oasis
0 km 100
N
to Alexandria
Mighiz Pass
Rock Tombs
Oasis
Siwa
Amun Temple

Figure 2

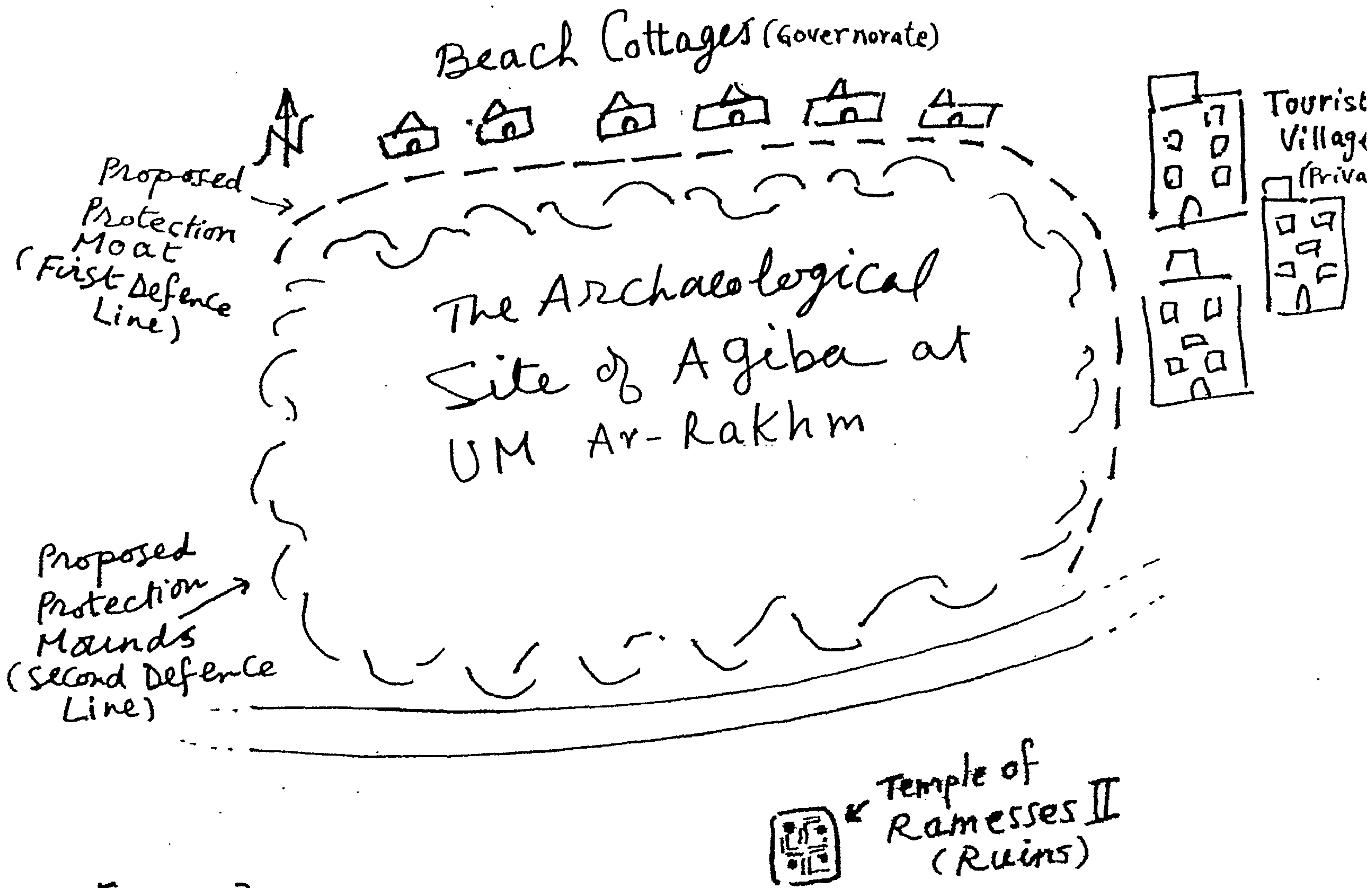
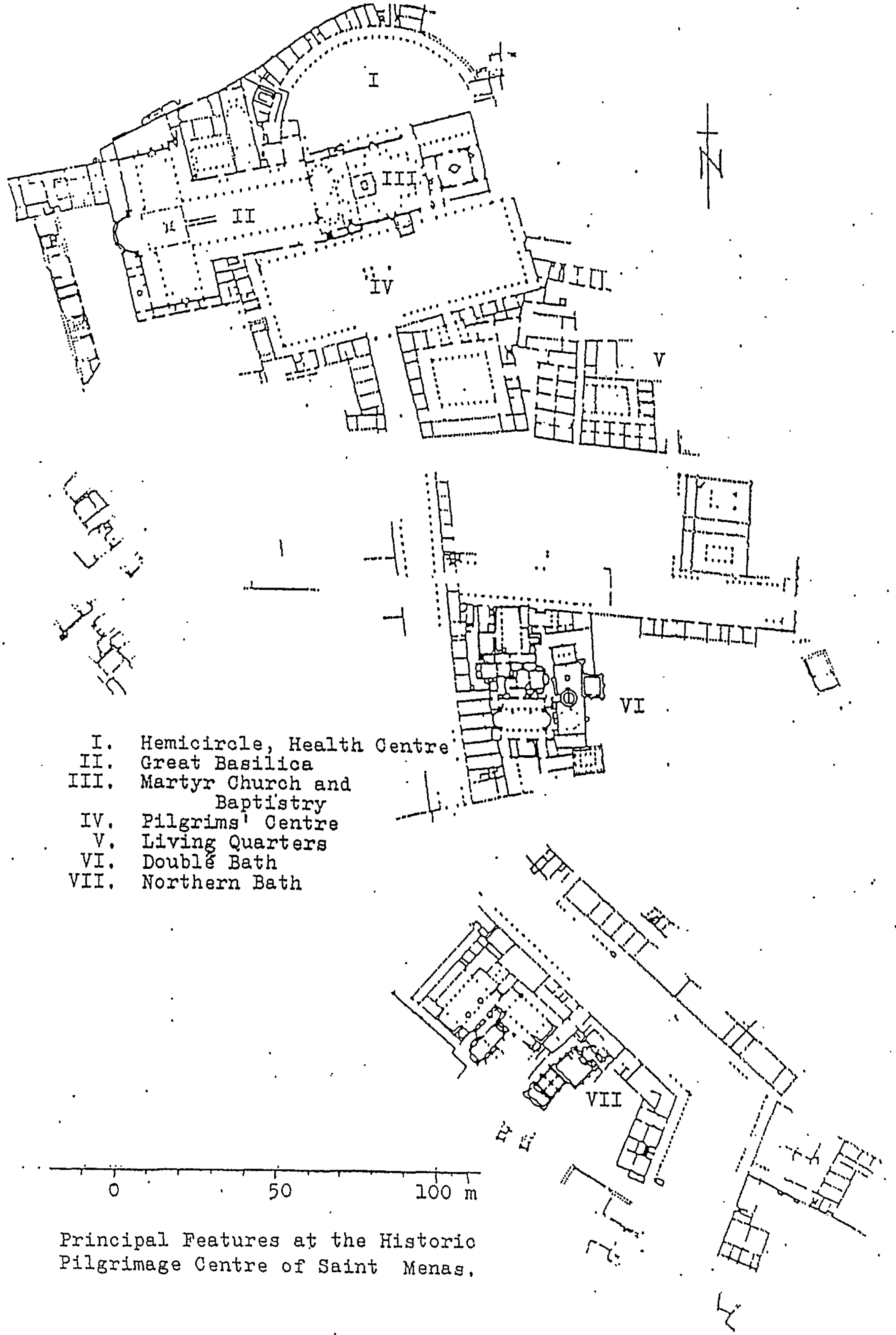

Beach Cottages (Governorate)
N
Tourist Village (Priva
Proposed Protection Moat (First Defence Line)
The Archaeological Site of Agiba at UM Ar-Rakhm
Proposed Protection Mounds (Second Defence Line)
Temple of Ramesses II (Ruins)

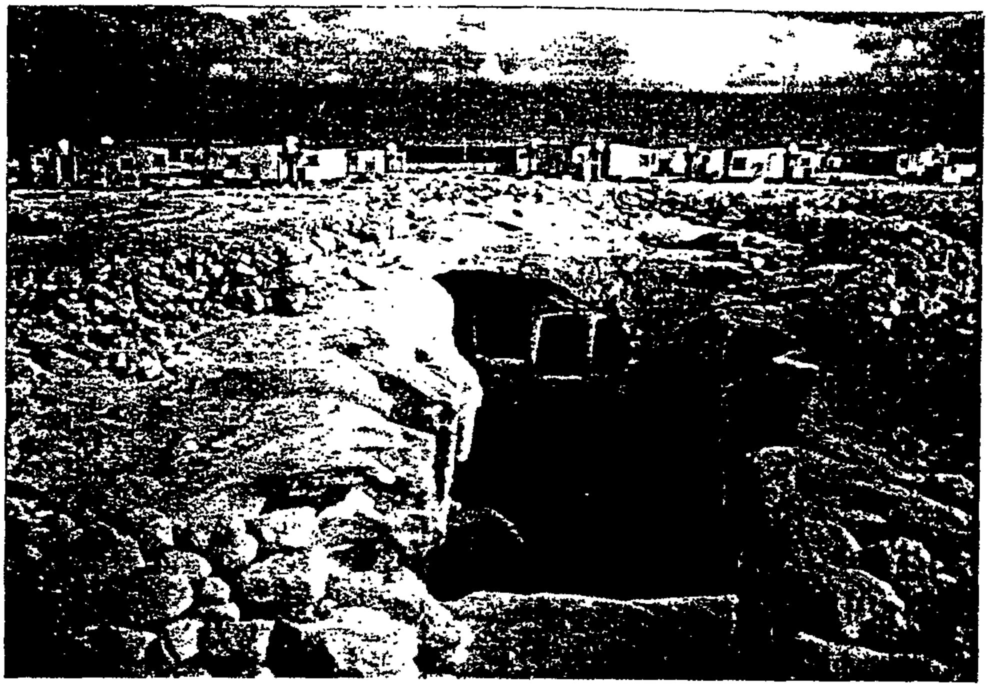
Figure 3



Principal Features at the Historic Pilgrimage Centre of Saint Menas.

Figure 4

List of Illustrations



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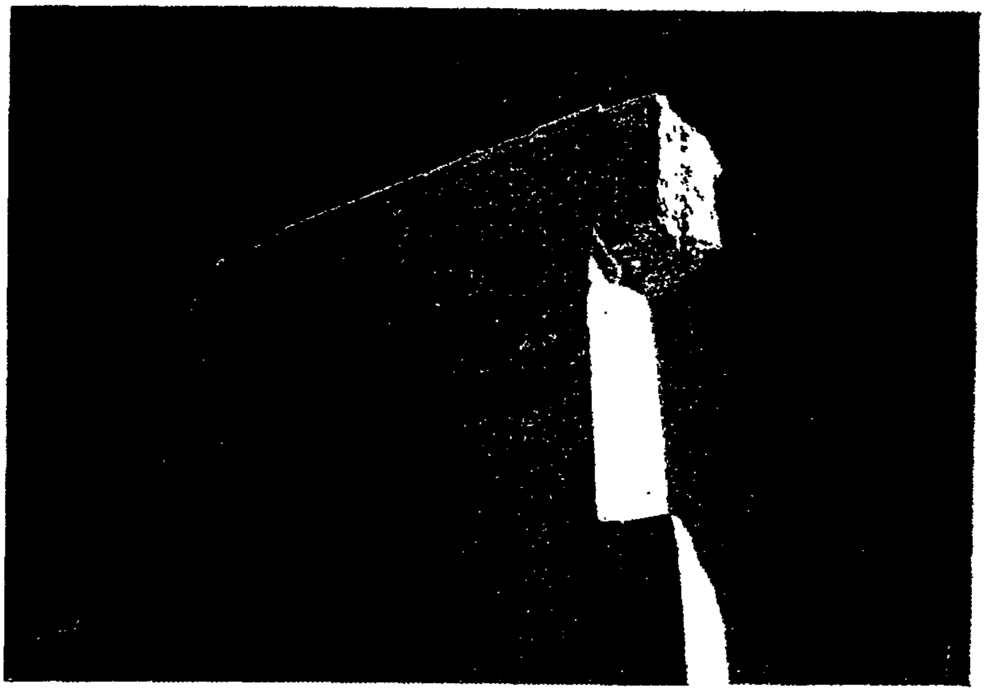

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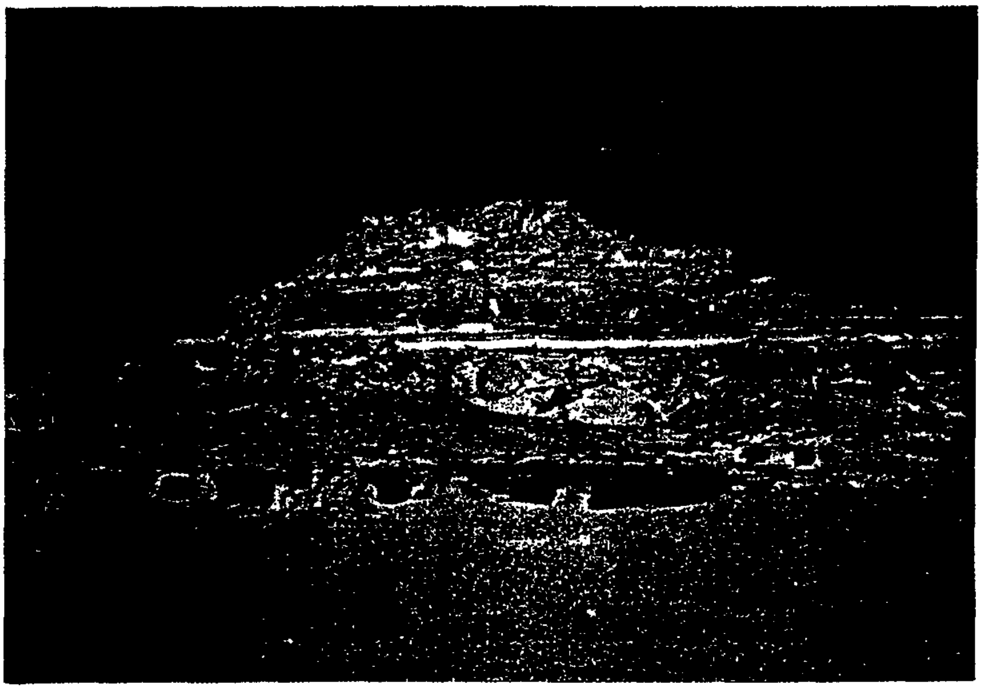

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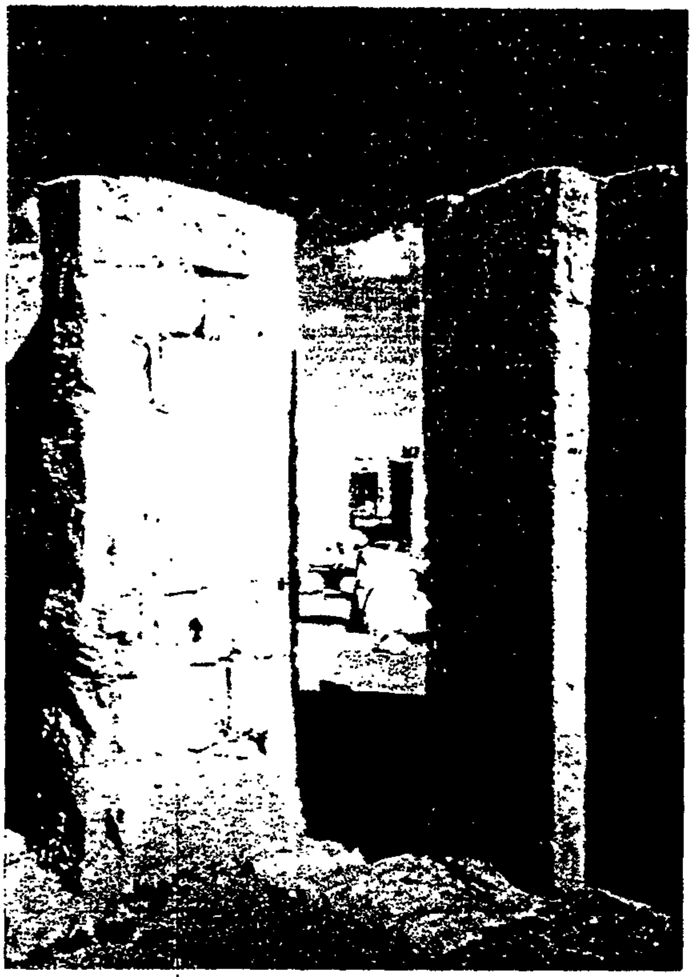

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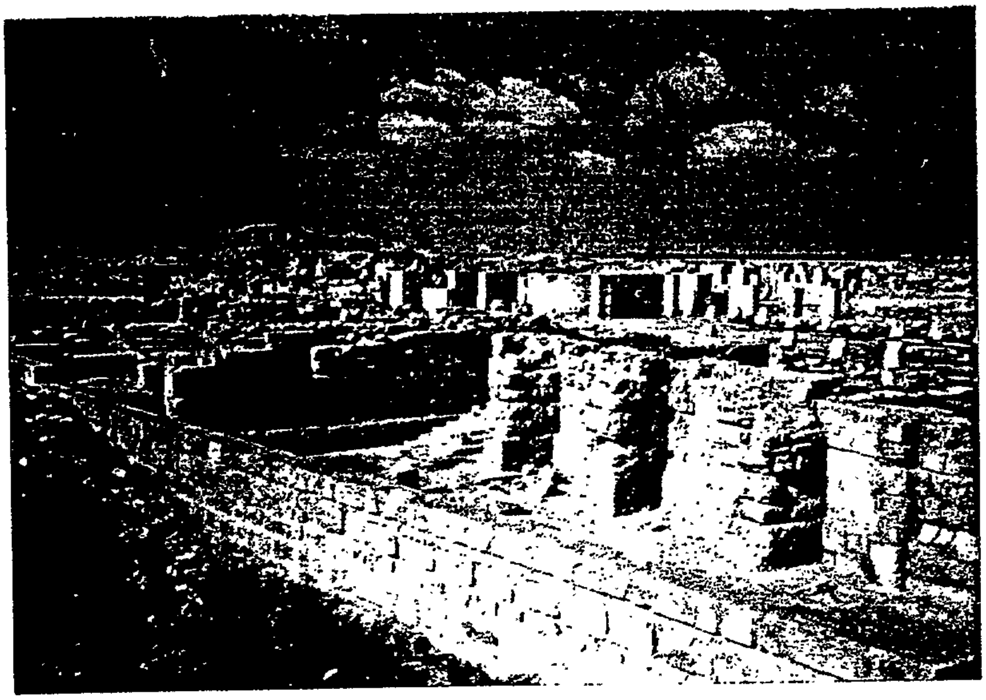

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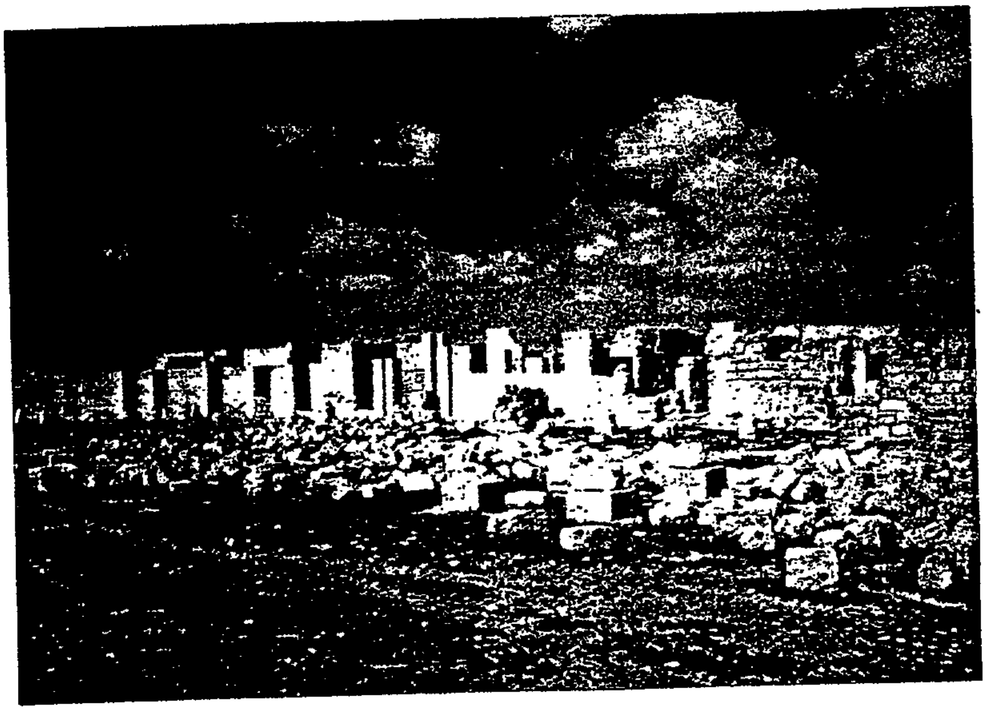

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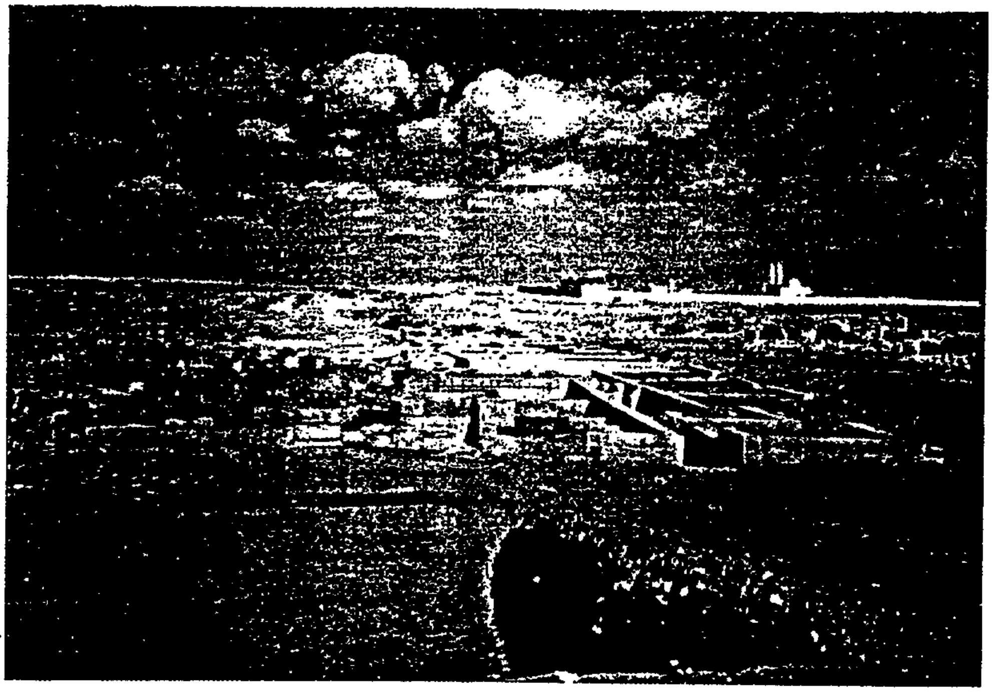

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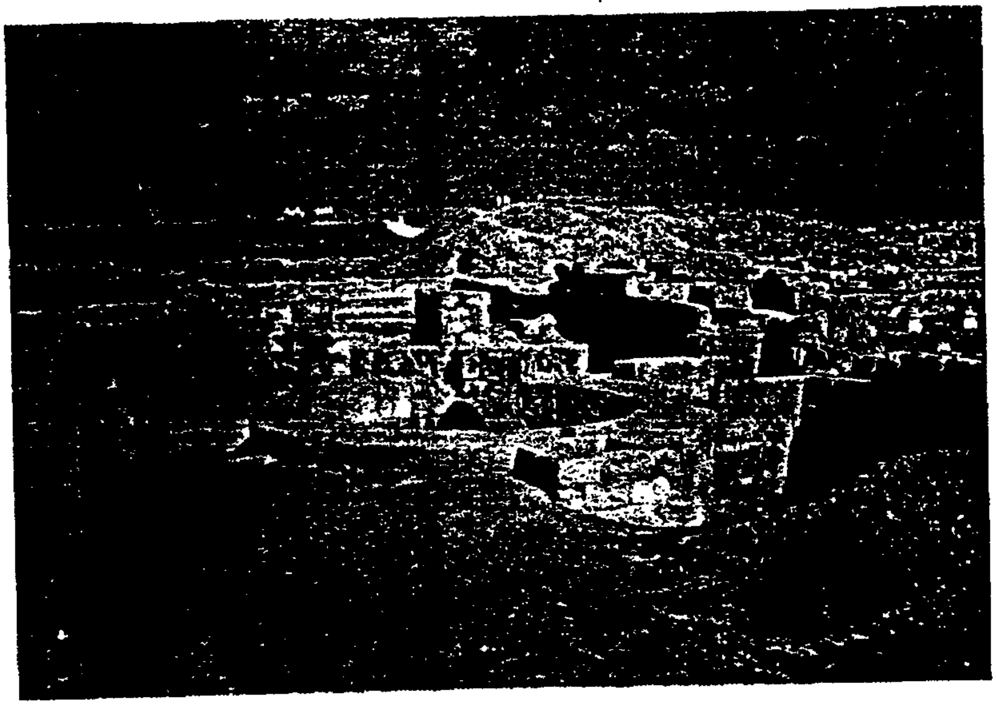

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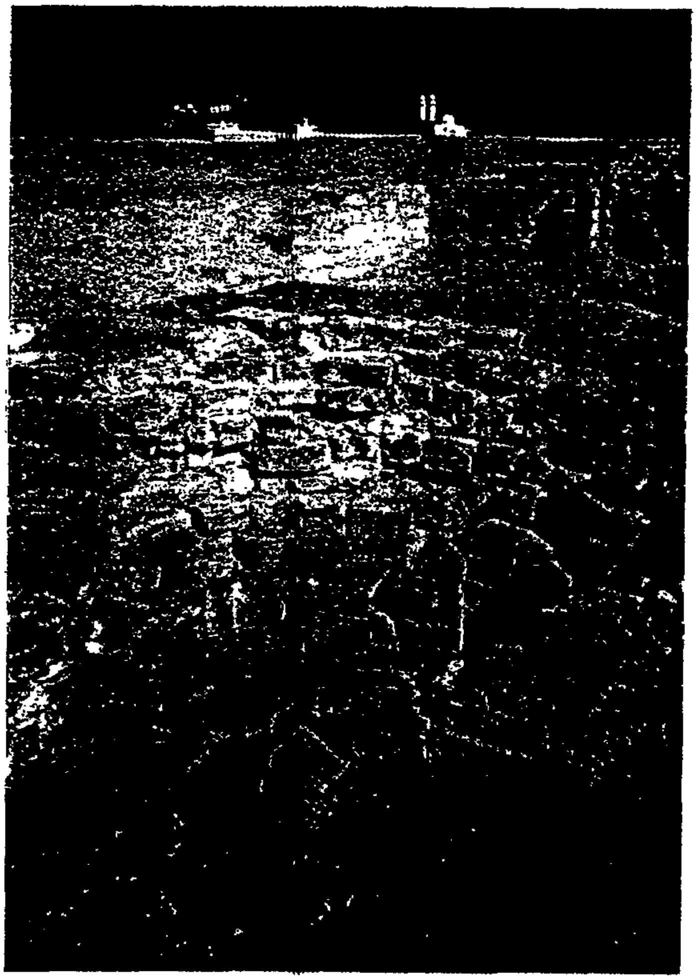

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ANNEX VIII

THE MARINE ECOSYSTEMS OF FUKA-MATROUH AREA (EGYPT): Status of Species and Habitats

UNEP

UNITED NATIONS ENVIRONMENT PROGRAMME
MEDITERRANEAN ACTION PLAN

SPA/RAC

THE MARINE ECOSYSTEMS OF FUKA-MATRUH AREA (EGYPT)
Status of Species and Habitates

ALI IBRAHIM BELTAGY - 1993

RAC/SPA - 15 rue Ali Ibn Abi Taleb, Cité Jardins 1002 Tunis
Tel: (216 1) 795 760 - Fax: (216 1) 797 349

THE MARINE ECOSYSTEMS OF FUKA-MATRUH AREA (EGYPT)

Status of Species and Habitates

Study requested and financed by :

Regional Activity Centre for Specially Protected Areas (RAC / SPA)
15, Rue Ali Ibn Abi Taleb
Cité Jardins
Tunis 1002 - Tunisia

within the framework of the implementation of the agreement relative to the Coastal Area Management Programme for the Area of Fuka-Matruh (Egypt), signed between UNEP/MAP and the Egyptian Government on 9 November 1992.

Person in charge : Mr. Mohamed SAIED
Director of RAC/SPA

Project Manager : Mr. Chedly RAIS
Expert of the RAC/SPA.

Consultant: Dr. Aly Ibrahim BELTAGY
Director of the National Institute of Oceanography
and Fisheries
Alexandria - Egypt

CONTENTS

I N T R O D U C T I O N

Within the frame work of FUKA Reserve Project, I was asked by the SPA in Tunis to prepare a report on the present status of the marine area of the reserve describing the main features and the fauna and flora in the area, in particular species of economic value and endangered sp. The report should also indicate areas for special protection and program for future work as monitoring in the area.

The report is prepared taking in consideration the following points:

1. The movement of the so many oil tankers in the Mediterranean which is the major oil route between oil producing countries in the Middle East and Europe, this movement represents areal and continued threat to many marine life forms and to critically important fisheries in the area.
2. With the ever expanding life style in the area a continued transformation is taking place with a fast population growth .
3. The demand of man for fish and other marine products is increasing steadily.
4. Increase in the standards of living particularly in major cities is bringing with it additional leisure time and demand for recreational and inspiring sites.

Collection and Analysis of data and documentation relevant to the marine ecosystem of the Fuka-Matruh area :

- Establishment, on the basis of the collected information, of an inventory of recorded species in the area which need a particular protection including specific recommendations to preserve the endemic and endangered species, with special reference to the marine turtles and marine vegetation.

- Selection of environmentally sensitive marine and coastal sites on the area, and proposal of some general measures in order to preserve their biological and ecological value.

- Proposal of detailed programs for the field studies necessary to improve knowledge on the marine ecosystems along Fuka-Matruh coasts.

Procedures and Limitations:

The report is mainly based on the very large inventory of studies conducted by the NIOF in the past years, which constitutes the backbone and the corner stone for the report. In addition to maps of the geological survey of Egypt, land reclamation plans.

Location

Ras El Dabaa is a small head 159 km west of Alexandria. It is located at lat. 31" 05′ 17 " N, long. 28° 25′ 30" E (Fig.1).

Climate

The area is characterized by a sub-tropical weather; i.e., Mediterranean-type climate. In this climate, the summers are prolonged, hot and dry with very little cloud., while the winters are short and mild with scanty rain. January and February are the coldest months (mean daily temperature range is 10-19 °C), while July and August are the hottest (mean daily temperature range is 22.25-30.5 °C). Rainfall is restricted to winter with an average of 140 mm. However, it shows great annual variations as it may drop to as low as 25 mm may be as high as 250 mm. The relative humidity is moderate in general. However,it drops severally in spring as a result of the *Khamasin* wind.

Geomorphology

Ras El Dabaa (Fig.2) is a small head 159 km west of Alexandria. It is located at lat. 31" 05′ 17 " N, long. 28° 25′ 30" E. In this area, the coastal Limestone Ridge protrudes seaward so as to stand directly at the water edge on the lee side of the head with an elevation of 34 m. However, this elevation

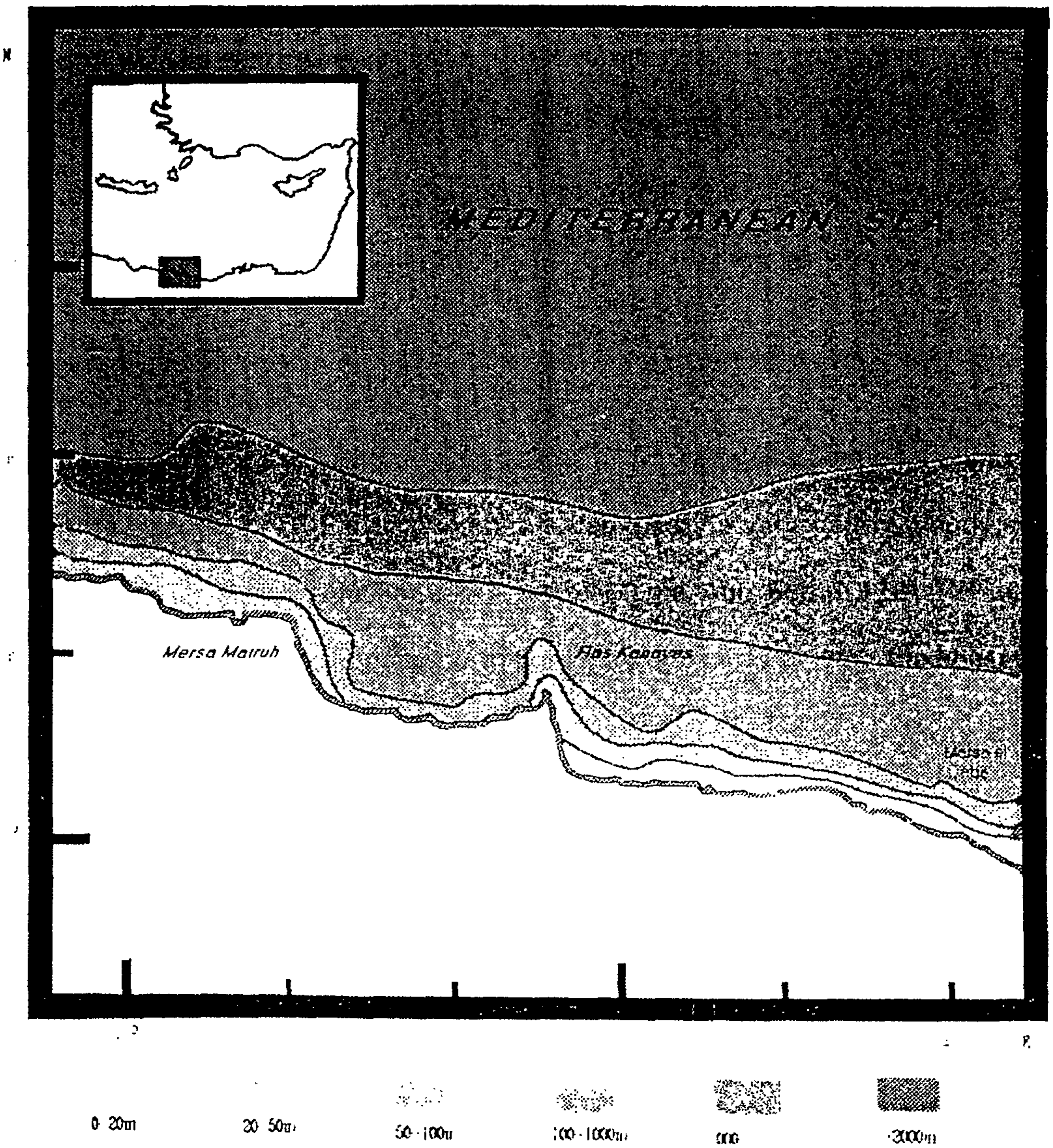
MEDITERRANEAN SEA
Mersa Matruh
Ras Kanayes
0-20m
20-50m
50-100m
100-1000m
-2000m

Fig (2)

increases westward so as to be 56 m at about 28° 21′ E. The ridge is recessed

landward in the same direction and is separated from the sea by a more or less peneplained area that merges imperceptibly with a dry sabkha followed by an area dunes farther to the west. Seaward, a number of rocky patches are dotted about the head area.

At about 28° 19′ E, the coastal Ridge protrudes seaward again forming a 26 m-high cliff. This is faced by Samra Reef. This cliff skirts the coast uninterruptedly up to about 28° 16′E after which it is flanked by a very narrow sandy strip up to the area of Mersa Abu Samra. West of Mersa Abu Samra (28° 12′ 30" E), the coastal sand strip disappears with the limestone cliffs skirting the coast up to Ras Abu Girab (28° 10′ E).

West of Ras Abu Girab, the limestone cliffs are recessed very little landward; a pattern which persists westward up to long. 28° 00′ E. At Ras el'Ghargan (about 28° 00′ 30" E), a number of submerged reefs and rock patches exist.

West of long. 28° 00′ E, the coast is occupied by white sand dunes that are 10 to 20 meters high. These extend westward up to about 27° 57′ E and are flanked landward by an area of seasonal marshes.

Farther to the west, the coastal sand strip widens notably up to Ras el'Kanayis; i.e., Ras el'Hekma (about 27° 51' 30" E) where it is at maximum width on the eastern side of the head, while the western one is made of limestone cliffs. This pattern continues westward up to about 27° 45' 30" E where the coast starts to widen considerably.

At long. 27° 40' E, there is an anchorage area (Mersa Baqqush), while Ras Abu Hashafa is located at about 27° 38' E. Offshore of this head, Abu Hashafa Island is located. Shortly to the south of the head, the coast area is low-lying and is liable to inundation in winter.

West of Ras Abu Hashafa; the coast continues to be relatively wide up to Ras Hawala (about 27° 33' 30" E). In the area of Mersa Haeala, however, the coast is temporarily occupied by a marsh in winter.

West of Ras Hawala, the coast widens considerably and is more or less flat. This pattern continues westward up to longitude 27° 28' 30" E where it narrows again and abuts against a narrow, 15 m-high ridge. However, the elevation of this ridge and the width of the coastal sand strip decreases farther to the west; i.e., toward Ras Alam el'Rum (long. 27° 21′ E). This is due to the convergence of the dry sabkhas flanking the coast between longitudes 27° 26′ 30" and 27° 20′ 30". These dry sabkhas converge gradually with the shoreline so that they occupy most of the coast between longitudes 27° 23′ and 27° 20′ 30" E.

West of Ras Alam el'Rum (long. 27° 21′ E), the coast continues to be made of a narrow strip that stands against a relatively high (20 m) ridge. This ridge is flanked landward by a number of salt lakes (5) along the way to Mersa Matrouh.

West of Mersa Matrouh, the coastal morphology continues to be the same as that found to the east but with a much larger salt lake flanking the coast to the south. This salt lake occupies the area between about 27° 13′ 30" and 27° 10′ 30" E.

The coastal morphology remains almost unchanged up to Ras Abu Laho (about 27° 00 15" E). In the area of Mersa Umm el'Rakham (27° 04′ 45" - 27° 04′ E), however, the coast is made of a dry sabkha. On the other hand, Ras Umm el' Rakham (27° 03′ 30" E) is faced by Umm el'Rakham Reef (27° 06′- 27° 05′ 15" E).

Bathymetry

In the Gulf of Kanayis (Fig.3); i.e., between Ras El'Dabaa (long. 28° 25′ 30" E) and Ras el'kanayis (long. 27° 51′ 30" E), the continental shelf is much narrower than found farther to the east in general. West of Ras el'Dabaa, however, it winds progressively so as to be at maximum width in the central part of the Gulf, but diminishes rapidly toward Ras el'Kanayis.

West of Ras el'Kanayis; i.e., in Abu Hashafa Bay, the continental shelf diminishes greatly so as to be at its minimum width along the whole Mediterranean coast of Egypt. It is most narrower probably at Ras Abu Hashafa. West of Ras Hawala, however, the shelf widens progressively toward Ras Alam el'Rum and Mersa Matrouh through still narrow in general.

West of Mersa Matrouh, the shelf width decreases gradually up to Ras Umm el'Rakham, after which it assumes a steady width to Ras Abu Laho.

Freshwater

Rainfall is the main source of freshwater for the area. In addition to replenishment of the ground water reservoir, rainwater is also stored in stony cisterns built in Roman times. These cisterns are abundant along the coast and have proved to be very effective in storage of rainwater. However, the amount of rainfall may vary greatly from year to year.

On the other hand, the ground water is almost invariably present at sea level; i.e., its depth corresponds closely to the height of the surface above sea level. Thus, wells sunk along the shoreline are usually very shallow, while those on the coastal ridge are deep as high as the ridge. There are 3 types of ground water in the area. The first type is that of Na_2SO_4 waters which are the most common type of ground water in Egypt. These are generally fresh with TDS typically less than 500 mg/l. They usually associate the high quality $NaHCO_3$ waters (TDS $<$ 1,000 mg/l) in small synclinal basins overlying the low quality water of the $MgCl_2$ type (TDS 2,500-12,000 mg/l). According to Shoton (1946), "The Fuka basin typically possesses high quality water in the limestone aquifer underlain by a clay horizon acting as an impermeable layer and separating the potable water from the more brackish one found within and below the clays".

Vegetation

In addition to the abundantly growing desert and marsh plants and herbs, fig, olive and barley are cultivated by resident bedouins in low lands of the area.

MARINE LIFE IN THE AREA

1.Plant Life In The Area

A- Phytoplankton

Introduction

Estimation of the phytoplankton in the Egyptian Mediterranean waters has been carried out by several investigators. These comprised systematic enumeration and seasonal variations of the 2 main components namely; diatoms and dinoflagellates in different localities, particularly around Alexandria. (Dowidar, 1965, 1974; Dowidar and Aleem, 1967; El-Maghraby and Halim, 1965; Hassan,1972, 1968, 1974).

The Phytoplankton community:

The phytoplankton community along the Egyptian Mediterranean coast comprises about 204 species and varieties and is represented mostly by diatoms and ,to a much lesser extent, dinoflagellates and silicoflagellates. Scattered specimens of chlorophytes and cyanophytes are also scarcely met with.

Bacillariophyceae (diatoms) constitutes about 95% of the total phytoplankton and are represented by about 126 species belonging to 45 genera. Nevertheless, few species formed main bulk of the population and these comprised *Skeletonema costatum, Chaetoceros affinis, Leptocylindrus danicus, Lithodesmium undulatm, Lauderia borealis, Ctclotella kutzingiana, Rhizosolenia delicatula, Melosria crusipunctata, Synedra affinis , Chaetoceros spp., Thalassiosira ratula* and *Asterionella japonica.*

The dinoflagellates comprise about 3.8% of the total phytoplankton. They includes 69 species and varieties belonging to 16 genera. *Ceratium* and *Peridinium* are the most important constituents, represented by 36 and 9 species, respectively.

The highest density of diatoms appeared mostly during the winter and less so in the Autumn, while the summer was the poorest season. On the other hand the dinoflagellates survived all the year round but their main occurrence was restricted to the summer.

Members of silicoflagellates (*Dictyocha* spp.), chlorophytes (*Scenedesmus* spp. & *Pediasterum* spp.) and Cyanophytes (*Merisnopedia* spp. and *Spirulina* spp.) were scarcely noticed as few cells during one season or an other.

Horizontal Distribution Of The Total Phytoplankton :

The South-eastern Mediterranean is considered poor in the number of phytoplankton (Oligotrophic). This is particularly along the Egyptian Mediterranean Coast west of Alexandria between El-Hammam and El-Sallum. The inshore neritic zone lying infront of the Nile Delta is usually more fertile due to the eutrophication effect of the Nile water and land drainage. At the offshore, however, the density of phytoplankton remains at a more or less constant lower values for the whole area. Table (1) gives a summary of the distribution of phytoplankton in the area west of Alexandria during 1977-78.

1-Horizontal Distribution of Phytoplankton during the winter:

The highest density of phytoplankton was reached during the winter with the exception of El-Hammam which sustained an autumn peak. The inshore of El-Max harboured a dense flora produced by eutrophication by land drainage. These values decreased gradually towards the offshore. The distribution of phytoplankton in the sections fluctuated with a narrow range for both inshore and offshore stations during the same period (1977-1978).

The winter flora was dominated by species belonging to the genera *Chaetoceres* and *Skeletonema* .

2- Horizontal Distribution of Phytoplankton During the Spring:

The numbers of phytoplankton decreased rapidly in the spring as compared with the winter season. The highest counts were still noticed at the inshore stations of El-Max . While it remained low at the offshore. The more dominant diatoms were found species of the genera *Cyclotella, Chaetocers, Melosira , Thalassiothrix* and *Navicula.*

3- Horizontal distribution of Phytoplnakton during the Summer:

A further decrease in the numbers of phytoplankton was noticed at most sections. The highest density of phytoplankton was still observed at the inshore of El-Max due to the increased numbers of Skeletonema. The offshore sustained more or less constant lower values. The more dominant diatoms that appeared in the summer included same species belonging to the genera *Navicula, Nitzschia, Cyclotella* and *Melosira.*

4- Distribution of Phytoplankton During the Autumn :

The average numbers of the total phytoplankton remained low in the western sections between El-Alamain and Marsa Matrouh while El-Hammam harboured a dense bloom of the diatoms *Asterionella Japonica*. The phytoplankton at El-Max remained relatively high but with lower number compared with the summer records. The more dominant diatoms at El-Max and El-Hammam area consisted of species of the genera: *Asterionella, Chaetoceros, Melosira, Rhizosolenia* and *Bacteriostium*.

B. Marine Grass and Algae

B.1. Along the western coast of Alexandria:

The flora growing along the shores showed a prounced ecological zonation. The sea grass *Posidonia* appeared frequently between El-Alamain and Marsa Matrouh, also patches of *Zostera* are noticed.

The green algae *Caulpera* and less so *Codium*, *Halimeda* and *Udotea* are present on the western part of the area.

Of the brown algae, several species of Sargassum are infrequently recorded inshore . Other species of Padina and Halimeda are rarely noticed.

The offshore zones are characterized by frequent vegetation of red algae, particularly calcarious species of Lithothamnion and Lithophyllum. Other infrequent red algae included the genera Gratelaupia, Vidalia, Gigartina , Peyssonnelia, Botryocladia & Opuntiella.

Generally, the algae increased during the spring and summer and decreased in the autumn and winter.

B.2. Vegetation of the Arabs Bay :

According to Ramadan (1979) and Farag (1981), the inshore of the Arabs Bay is characterized by strands of the brown algae Sargassum spp., a belt of the sea grass Posidonia oceanica spreads in El-Alamain and different batches of the green algae Caulerpa prolifera. Besides the above mentioned species, other algae are represented in the area, such as Codium bursa, Halimeda tuna and Udotea petiolata as well as the brown alga Laurancia spp.

The offshore is characterized by low vegetatíon of the green alga Caulpera prolifera and more representation for the red algae Lithothanion spp., and Lithophyllum spp.

2. Animal Life

A. The zooplankton population

Several investigations have been carried out on the distribution of zooplankton along the Egyptian Mediterranean coast. (El-Maghraby, 1965, Halim *et al.*, 1967, Dowidar and El-Maghraby, 1970, 1971, 1973, Drabishena, 1970 and Hussien, 1977). Further studies were also done concerning the seasonal variations of Chaetognatha (Gurgues; 1969) and Appendicularia (Abu El-Ezz, 1975). El-Maghraby (1961-1964) carried out morphometric measurements of some marine planktonic copepods of Alexandria region. Studies of the zooplankton along the western coasts of Alexandria till Marsa matrouh was mainly carried out by Samaan (1979).

Composition of Zooplankton :

The subclass copepoda represented the most important planktonic element since it formed about 82 % of the total zooplankton.

The dominant copepods comprised the genera *Paracalanus, Oithona* and *Euterpina*. The frequent forms include the genera Clausocalanus, Cerycoeus, Microstella, Oncoea, and Calocalanus. Other rare copepods genera like *Acartia,* *Candacia, Centropages, Euchaeta, Pleuromamma*, and *Temora* are also encountered in the plankton. The copepoda larvae appeared also in high counts all the year round and they formed collectively about 45 % of the total copepoda numbers. The highest density of copepods was noticed at the inshore location, otherwise it remained at a more or less constant. The copepods reached their peaks during the autumn.

The planktonic protoza included many species of the groups Tintinnids, Radiolaria, Acantharia and Foraminifera. They constituted collectively about 3.9 % by number of the total zooplankton. The family tintinnidae dominated protozoa and comprised the genera *Favella, Tintinnopsis, Cedonellopsis. Halicostomella* and *Coxbiella*. They attain their maximum counts at the inshore location during the spring. Foraminifera was mainly represented by *Globegerina spp*. They appeared infrequently, attains their maximum frequency in the autumn. Members of Radiolaria and Acanthoria are rarely encountered in the plankton and restricted to winter.

The genus Sagitta (Chaetognatha) appeared infrequently in the samples, being more common during the spring and autumn.

Appendicularia is represented by the two Urocordata genera *Oikopleura,* and

Firitillaria. *Oikopleura* comprised eight species of which *O. diocia* and *O. lengicouda* are the most frequent planktonic tunicates. *Oikopleura* appeared frequently all the year round with maximum frequently at the inshore location during the spring.

Firtillaria included 7 species but it is dominated by *F. borealis*. *Firtillaria* is observed all the year round in small numbers with highest records at the inshore of location during autumn and lowest in the summer.

Other rare holoplanktonic zooplankton included members of *Medusa, Mycidaceae, Pteropoda, Ostracoda, and Siphonophores*.

Siphonophores persisted as rare forms. Dowidar (1983) listed 18 *Siphonophores* species , 8 *Hydromedusae* species and one species of *Scyphomedusae* in the Egyptian Mediterranean waters. Among the recorded species , 12 *Siphonophores*, 5 *Hydromedusae* and one *Scyphomedusae* species were recorded for the first time in the Egyptian Mediterranian waters; of them one *Siphonophore* species *Chelophyes contorta* and one *Hydromedusa* species *Lizzia gracilis* is recorded for the first time in the Mediterranean sea.

Scattered specimens of Mycidaceae are scarcely noticed at El-Alamian in the winter, spring and summer.

Pteropodes are rarely noticed at most of the area with a maximum frequently at Foukah during the winter.

The moreplanktonic larvae included larval stages of the groups *Polychaeta, Cerripedia, Echinodermata* and *Decapoda*.

The polychaete larvae appeared frequently, all the year round. Their numbers remained low during the winter, increased slightly in the spring and rapidly in the summer and autumn. The distribution of cirriped larvae was mostly confined to the inshore locations. The highest value of 117 org./m^3 was noticed at El-Hammam in the autumn.

Echinoderm larvae were infrequently encountered in the plankton samples particularly at the inshore locations at El-Hammam, and it was scarce in the winter. Few scattered specimens of decapod larvae are noticed in the plankton hauls during most of the year, however, it persisted in relatively high counts during the autumn.

Lamellibranch villagers and gastropod villagers appeared as common forms at most locations and they formed collectively about 3.0 % of the total zooplankton.

Lamellibranch villagers appeared more frequent at the inshore locations at El-Alamain during the autumn. They persisted in low counts in the offshore of most locations throughout the year.

Crustacean eggs were common during most of the year and contributed about 1.7 % of the total zooplankton. The highest counts appeared at Marsa Matrouh and decreased gradually eastwards. The peaks of the crustacean eggs were noticed during the autumn and winter.

Distribution of the Total Zooplankton :

Respectively, lower values amounted to 1988 org./m3 at El-Alamain, 1423 org./m^3 at El-Dabaa, 1483 org./m^3 at Foukah and 1645 org./m^3 at Marsa Matrouh .

B. The Benthic Fauna

I. General :

The coastal waters of Alexandria exhibits different types of bottom deposits. The sea bottom at the inshore (extending to 50m depth) varies from coarse sand in the western locations to coarse gavels and mud in the eastern sections. Most of the shore is interrupted with patches of rocky nature.

The offshore region (50-100 m depth) shows homogenous type od sediment, frequently silt with different quantities of mud which decreased towards the west. There is no sharp boundaries, however, between the different zones.

Distribution of the total Fauna :

The macrobenthic fauna in the area included in 8 phyla , three of which dominated the community. These comprised Annelida, Mallusca and Echinodermata. The other infrequent forms consisted of Arthropoda , Brachiopoda, Ascidians, Nemertini and Sipunculida. Brachiopoda appeared only at the offshore.

Average number per haul (80 m^2) of macrobenthos recorded

in the area.

Species	Win .	Spr.	Su m.	Aut.	Win .	Spr.	Su m.	Aut .
Nemertini Polychaeta Sipunculida Crustacea Mollusca Brachiopoda Echinodermata Acidians	0.2 4.4 --- 1.0 2.8 --- 2.8 0.4	--- 9.3 0.1 6 1.0 5.8 --- 5.5 0.1 6	0.2 2.2 0.2 1.2 5 --- 1.0 0.8	--- 0.8 --- 0.8 2 4.3 --- 3.8 ---	--- 14. 3 0.2 5 --- 6.8 0.7 5 4.0 1.5	--- 14. 7 0.1 7 2.3 12. 3 4.5 4.8 2.3	0.8 15. 5 --- 0.6 3.8 0.8 1.8 10. 4	1.0 7.2 0.1 7 0.8 3 4.5 2.3 2.5 0.5
Av. No./80 m	12. 6	21. 9	10. 6	9.7	27. 6	40. 7	33. 6	18. 7

The Egyptian Mediterranean coast extending west of Alexandria harbours a diverse macrofauna which is numerically dominated by polychaetes, mollusca and echinoderms. Other groups such as crustaceans, ascidians, nemertini, and sipunculida were infrequent.

the inshore represent the areas extending from 10 to 50 m depth parallel to the coast line. The fauna there comprised mollusca (30.5 % of the total numbers of benthos) echinoderms (29.2 %) and polychaetes (22.5%).

The offshore zones extend to a depth ranging between 50 and 100 m depth. The benthos there included polychaetes (41%), mollusca (21.1 %) and echinderms (10%). The other groups previously mentioned were represented at the offshores.

Limy rocky, coarse gravel and Medium sand at El-Hammam and then become mainly coarse sand extending throughout the western inshore locations from El-Alamain to Marsa Matrouh. Each type of sediment is associated with specific faunal composition.

The community of the silty sand muddy bottom is dominated by the echinoderms *Amphiura* and *Schiaster*; the mollusca *Tysiria, Mucula, Cerula* and *Natica*, the polychaetes *Arenicola, Euclymene* and *Glycera* the crustacians *Gammarus* and *Portunus*.

The limy rock, coarse gravel of El-Hammam harboured mollusca *Glycemeris, Venus, Chamelea* and *Tellina*; the polychaetes *Hermodice, Aprodite, Lumbricoides*; the echinoderms *Asteropecten* and *Echinocardium* as well as the crustaceans *Maia* and *Ethusa*.

The rocky coarse sand bottom of the other western sections inhabited by the mollusca *Callista, Glycymeris* and Chamela; the polychaetes *Eunice, Hermodice* and *Aphrodites*; the echinoderns and crustaceans were found in few numbers.

The grounds of El-Dabaa and Foukah offshore are characterized by silty sand intermingled with pebbles. This type of substratum is inhabited by large quantities od sponges particularly at El-Dabaa. Beside the economic importance of sponges, certain types of them afford a good shelter and food for several marine invertebrates. For this reason, the population density of benthos there is fairly high and is dominated by polychaetes which constituted about 37 % and 75 % of the total benthos at El-Dabaa and Foukah, respectively. The most common polychaetes are *Hermodice, Eunice* and *Aphrodite*. Ascidians flourish well in these grounds and are mainly represented by *Cytoditus* and *Archidistoma*. Crustaceans particularly Synalpheus which lives as a parasite on sponges is also found frequently . *Astarte* was the most common molluscan species. the echinoderms *Echinus, Cedaris* and *Asteropecten* were also recorded in few numbers.

II. Main animal Groups :

II.1. Porifera

Inspite of the economic interest of the sponges and inspite that a big deal of its production comes from the Arabs Bay, nearly no studies have been performed on this group in the last decades except that of Burton (1936) on the sponges collected by Steuer from Alexandria and its vicinity 1933, and a study for M.Sc. degree performed in the National Marine Biological Reference Collection Center, Institute of Oceanography and Fisheries, Alexandria Kheriallah, *et al.*, (1989) and Ramadan *et al.*, (1989).

According to Burton (1936), fourteen species were procured from the region western to El-Agamy, i.e. the most eastern part of the Arabs Bay. These species can be listed as follows :

Cinacyra australiensis
Adocia cinerea
Adocia grossa
Myxilla prouhai
Tendania nigrescens
Clathria gradlis
Thlysias jolicoeuri
Rhaphidostyla hitchingi
Cliona viridis
Tethya aurantium
Spongia equina
Cacospongia molliar
Hircinia variablis

According to Kheriallah (1989) and Ramadan (1989) eleven species of sponges were recorded in the Egyptian Mediterranean coast west of Alexandria , namely *Suberites doumuncula, Agelas oroides, Petrosia ficiformiss , Calyx nicaensis , Spongia officinalis adriatica, S. officinalis mollissima, Spongia zimocca, Spongia agarcinia, Hippaspongia communis, Cacospongia scalaris* and *Ircinia fasciculata*. Of these species four sponges were recorded for the first time in the Egyptian Mediterranean waters, namely : *S. agarcinia* (commercial species), *Subrites domuncula, Calyx nicaensis*, and *Petrosia ficiformis* (non-commercial species).

II.1.1. Commercial sponge-beds in Arab's Bay

The Egyptian commercial sponges are considered the best all over the world. In the Arab's Bay (From Ras El-Agami headland to Sidi Abd El-Rhaman) some species of commercial sponges were found in economic quantities.

The following are commercial sponge species found in Arab's Bay:

1) *Spongia officinalis* (Schutze), common name Turkey cup.

2) *Hippospongia communis* (Lamdeck), common Honey comb.

3) *Spongia zimocca* (Schmidt), common Zimocca.

The majority of the commercial sponges beds are laying in the inshore neritic zone within the continental shelf of a depth less than 50 meters and they are not found before 15 meters deep.

The settlement of commercial sponges is confined to the solid rocky substrates.

The commercial sponge beds in Arabs Bay are more abundant in Abu Sir, Victorieuse, Medina, El-Shagig and Gibesiss reefs and on the rocks parallel to the coast from tell Alam el Milh to Gibeisn as shown in Fig. (4).

The beds are less abundant and scattered all over the Bay on the solid fragments, while the region between Tell Flex (before El-Imayid) to Tell Alam El-Melh is devoid of sponge beds.

The Honey comb sponge represent about 46 % of the total catch of Arabs Bay while turkey cup and zimocca were represented 40.6 % & 13.4% , respectively.

It must be taken in consideration tat the rush of water current specially in bottom is one of the important factors that destroy the sponge-beds besides the decrease in salinity.

II.2. Nemertini

Heteronemerteans were reported by Friedrich (1940) to be found off the Arabs Bay. Friedrich was not able to identify them because they were incomplete.

II.3. Polychaeta

Fauvel (1937) recorded fourteen polychaet species from the most eastern part of the Bay, these species were :

Sphaerosyllis hystriz
Syllis hyalina
Syllis spongicola
Polyphthalmus pictus
Arenicola claparedii
Autolytus longeferiens
Pontogenia chrysocoma
Hermione hystrix
Hermodice carunculata
Euphrosyne foliosa
Staurocephalus rubrovittatus
Lepidonotus clava
Glycera unicornis
Ceratonereis costae

While Farag (1981) recorded seventeen species of polychaeta from the middle part of the Arabs Bay i.e. between El-Alamain and El-Hammam), these species were

Ciratulus sp.
Arenicola marina

Euclymene lumbricoides
Euclymene oerotedi
Malane sp.
Eteone sp.
Aphrodite aculeata
Hermione sp.
Hesione sp.
Syllis sp.
Glycera sp.
Nephtys sp.
Hermodice sp.
Eunice sp.
Lysidic ninetta
Lumbrineris sp.
Vermiliopsis infundibulum
Family Neridae
Family Onuphidae

II.4. Sipunculida

Only one species of sipunculida was recorded from the eastern part of the Bay by Steuer (1939).

II.5. Crustacea

II.5.a. Stomatopoda

Only *Squilla massavensis* was recorded by Steuer (1938) from the most eastern part of the bay.

II.5.b. Decapoda

Balss (1936) recorded seventeen decapod species from the Arabs Bay, these species were

Sicyonia carinata
Athanas nitescens
Jaxea mocturna
Upogebia gracilipes
Porcellana longicornis
Paguristes oculatus
Diogenes pugilator
Eupagurus anachoretes
Ethusa mascarone
Inachus dorhynchus
Myra fugax
Macropodia longirostris
Pisa tetradon
Charybdis merguiensis
Actaea rufopunctata
Pilumnus hirtellus

Ramadan and Dowidar (1972) and Ramadan (1977) performed detailed study on the brachyuran decapods and their distribution along the Egyptian Mediterranean coast from Port Said to western of Alexandria, they enumerated fourty-two species from the area western to Abu Kir including the Arabs Bay, these species were ;

Dromia personata
Homola barbata
Dorippe lanata
Ethusa mascatone
Myra fugax
Ilia nucleus
Pirimela denticulata
Carcinus mediterraneun
Macropipus arcuatus
Macropipus depurator
Charybdis hellerii
Charybids longicollis
Portunus hastatus
Portunus pelagicus

Xantho incicus granulicarpus
Actea rufopunctata
Pilumnopeus vauquelini
Pilumnus hirtellus
Pilumnus spinifer
Pilumnus hirsutus
Eriphia verrucosa
Eucrate crenata
Ocypode cursor
Pachygrapsus marmoratus
Brachynotus foresti
Parthenope macrochelos
Macropodia rostrata
Inachus dorsettensis
Inachus leptochirum
Inachus phalangium
Inachus communissimus
Achaeus gordonae
Acanthonyx lunulatus
Pisa tetraodon
Pisa nodipes
Pisa muscosa
Eurynome aspera

Eleven decapod species were recorded from the middle of the Arabs Bay, these species were :

Penaeus sp.
Athanas sp.
Galathea sp.
Scyllarus arctus
Scyllarus sp.
Pagurus arrosor
Ethusa mascarone
Portumnus sp.
Macropodia longirostris
Pisa sp.
Maia sp.

II.5.c. Tanaidacea

Two species of Tanaidcea were recorded from the area by Larwood (1940), these were:

Parapseudes latifrons
Lepthochelia dubia

II.5.d. Isopoda

Larwood (1940) mentioned four species from the Arabs Bay near El-Agamy, these were :

Cirolana cranchii
Zenobiana prismatica
Bagaus stebbingi
Munna sp.
Farag (1981) added *Idotea sp.*

II.5.e. Amphipoda

Four species of amphipods were recorded by Schellenberg (1936) from the area, they were:

Dexamine spinosa
Leucothoe spinicrpa
Maera inaequipes
Leptocheirus pectinatus

II.6. Arachnida

II.6.a. Acari

Only one species was recorded by Viets (1935), namely *Agauopsis hirsuta*.

II.6.b. Dantopoda

Only one species namely *Pallene brevirostris* was recorded Helfer (1936).

II.7. Mollusca

The bivalves, gastropods and scaphopods were studied by Steuer (1939) who recorded 58 species from the eastern part of the bay and its offshore; and Farag (1981) who recorded 34 species from the middle part of the bay. The species recorded by Struer were :

Patella lusitanica
Calliostoma conulus
Tricoloa speciosa
Bittium latreillii
Cerithium vugatum
Atlabta leseuri
Aporrhais pes-pelecani
Aporrhais serresianus
Natica millepunctat
Polynices josephinus
Cassidaria echinophora
Tritonalia blainvillii
Murex trunculus
Columbella rustica
Euthria eornea
Nassarius corniculus
Nassarius sp.
Nassarius pygmaeus
Marginella mitrella
Cyxhara laevigata
Conus mediterraneus
Acteon tornatilis
Creseis acicula
Creseis virgula
Styliola subula
Dentalium dentale
Cadulus jeffreysi
Pinctada vulgaris
Modiolus adriaticus
Lithophaga lithophaga
Arca diluvii
Arca barbata
Arca noae
Glycymeris pilosus
Glycymeris violacescens

Modiolus adriaticus
Lithophaga lithophaga
Pictada vulgaris
Chlamys flexuosa
Astarte fusca
Cardita antiquata
Begunia trapezia
Diplodonta rotundata
Chama gryphoides
Cardium paucicostatum
cardium papillosum
Pitra rudis
Pitra thione
Venus ovata
Donax semistriatus
Solecurtus chamasolen
Abra ovata
Tellina pulchella
Tellina serrata
Aloidis gibba
Cuspidria rostrata

And those recorded by Farag were :

Solyma mediterranea
Nucula nucleus
Nuculana fragilis
Arca noae
Glycymeris glycymeris
Petria hirundo
Protopectin glaber
Anomia ephippium
Astarte sulcata
Cardita trapezia
Cardita sp.
Myretea spinifera
Ctena decussata
Thysiria ferruginea
Laevicardium papillosum
Callista chione
Venus verrucosa

Chamelea gallina
Gafrarium minimum
Azorinus chamasolen
Macoma cumana
Tellina donacina
Tellina pulchella
Tellina balaustina
Abra alba
Corbula gibba
Cuspidaria cuspidata
Astraea rugosa
Tenagodus obtusus
Naticarius stercusmuscarum
Natica dilwyni
Bulla sp.
Murex brandaris

II.8. Bryozoa

O'Donoghue and Watteville (1939) reported seven species of Bryozoa, four of them were offshore and three were inshore of the eastern part of the bay. The offshore species were :

Calpensia impressa
Tubucellaria opunsioides
Retepora imperati
Retepora couchii

And the inshore species were :

Cellulosa sp.
Chizoporella unicornis
Palmicellaria shemei

II.9. Brachiopoda

Steuer (1939) reported two species from the eastern part of the bay namely *Actinotrocha sp.* and *Muehlfeldtia truncata* and Farag (1981) reported *M. truncata* and *Trebratula vitrea* in the middle part of the bay.

II.10 Enteropneusta

Only one species *Tornaria dubia* was recorded from the eastern part of the bay Steuer (1939).

II.11. Echinodermata

Mortensen and Steuer (1937) recorded nine echinoderm species from the eastern part of the bay, these species were :

Astropecten bispinosus
Ophiopsila aranea
Amphiura chiajei
Paracentrotus lividus
Stylocidaris affinis
Ova (Schizaster) canalifara
Echinocardium cordatum
Cucumaria elongata
Thyone fusus

And Farag (1981) reported eight species from the middle region of the bay, these were:

Astropecten sp.
Amphiura chiajei
Ceramaster placenta
Echinaster sepositus
Echinocardium
Spatangus purpureus
Psammechinus sp.
Cidaris cidaris.

II.12. Ascidinas

Two species namely *Rhopalaea sp.* and *Clavelina sp.* were recorded from the most eastern part of the bay by Harant (1939), and other two species were recorded in the middle of the bay by Farag (1981), namely *Didemnum gelatinosum* and *Diplosoma sp*.

II.13. Acrania

Only one species *Branchiostoma lanceolatum* was recorded from the eastern part of the bay by Steuer (1939).

C. Fishes

C.1. Composition of the Egyptian Mediterranean Fish Stock:

El-Sayed (1992) prepared a checklist of the Egyptian Mediterranean Fishes which included 257 fish species, belonging to 87 families and 180 genera. Elasmobranch, (cartilagineous fishes) are represented by 44 fish species, 25 genera and 17 fisn families, while Teleosts (bony fishes) are represented by 213 species, 155 genera and 70 fish families.

Most of the fishes included in this list are of Atlantic origin or essentially native to the Mediterranean Basin. Only 38 species are of Indo-Pacific origin, migrated to the Mediterranean Sea through Suez Canal. Most of these fishes are bony, only two species belong to the Elasmobranches.

Of the economically important cartilagineous fishes are species of families: Scyliorhinidae, Squatinidae, Rajidae and Rhinobatidae.

More important bony fishes belong to the families: Carangidae, Clupeidae, Mugilidae, Scombridae, Serranidae, Siganidae, Soleidae and Sparidae.

Economic fish in the area from Alexandria to Marsa Matrouh

In the area between Al-Alamin to Marsa Matrouh Purse-seine is the only method of fish collection, trawling is restricted, mainly due to the clearance of the water. The important fishes of the Purse-seine are :

Sardinella aurita
Sardinella maderensis
Sardinella pilchardis
Dussumieria acuta
Engraulis encrasicolus
Boops boops
Trachurus mediterraneus
Scomber japonicus

It was found that *Sardinella aurita* dominated in the area east to El-Alamain, while *Trachurus mediterraneus* dominated in the area from El-Alamain to Matrouh.

C. 3. Biological Studies of the important Fish :

I. Food Investigations

a. *Sardinella aurita*

It is clear that copepoda, Amphipoda , Isopoda Decapoda (shrimps), fish fry, Zoea of crabs , polychaeta and eggs of fish invertebrates were present in the stomach of the fish .

b. *Sardinella maderensis*

The stomach of this consists of Isopoda, Amphipoda, Decapoda, Fish fry, polychaeta, Fish and Invertebrates eggs .

C. *Trachurus mediterraneus:*

The stomach content of the fish consists of Isopoda, Amphipoda, Decapoda, Cephalopoda, Fish scales, Fish fry and Polychaeta .

D. *Boops boops*

The stomach content of the fish consists of polychaeta, Decapoda, Amphipoda, Fish fry, Bivalvia, Ascidian, Green along and Formainfera.

II. Spawning Time

According to the stage of the gonad, maturity the spawning of the following species has been recorded.

a. *Sardinella aurita*
From July to August.
b. *Sardinella maderensis*
From July to August
c. *Trachurus mediterraneus*
From may to July.
d. *Boops boops*
From March to May

III. Size and Age at First Sexual Maturity :

a. *Sardinella aurita* : 11.0 cm long and age group I^+
b. *Sardinella maderensis*: 10.0 cm long and age group I^+
c. *Trachurus mediterraneus*: 15.5 cm long and age group I^+
d. *Boops boops*: 10.5 cm long and age group I^+

D. marine Turtles

Sea turtles occur in all tropical and warm-temperate seas. they inhabit shallow waters along coasts and around islands, but some species believed t be migratory and are found in the open sea. They are swift swimmers and some may attain speeds of about 35 km/h.

All species are compelled to return in regular intervals to the land during the nesting season when the females lay their eggs in nests dug into the sandy beach. Incubation period extends from 45 to 60 days or more, after which the hatchlings go back to the sea. Very little is known about their movements and fate before they attain sexual maturity after 10 years or more.

The majority of sea turtles are predominately carnivorous but some species are omnivorous or even herbivorous.

Some marine turtle specie are becoming scarce nowadays and are in bad need of protection from irrational exploitation; they are especially vulnerable on land during their nesting period. More recently, farming of sea turtles, especially the green turtle, has been successfully introduced to some parts of the world; it is hoped that this technique will become more wide spread in the near future and thus take off some of the fishing pressure exerted on the species. In addition to the enforcement of protective legislation, the establishment of natural reserves for sea turtles is highly desirable .

E.1. Egyptian Turtles :

Turtles sp. inhabiting the Egyptian Mediterranean waters are four in number and belong to two families, Chelonidae and Dermochelidae.

The Chelonid turtles are :

1. *Caretta caretta caretta*

   Commonly known as Loggerhead turtle.

2. *Chelonia mydas mydas*

   Common name: Green sea turtle.

3. *Eretmochelys imbricata imbricata*

   Common name: Hawksbill turtle.

N.B. : This species has been recorded in the Red Sea, Gulf of Suez and Suez Canal. It has been also recorded along the African Mediterranean coasts, except Egypt. Thus, it is believed to occur in our waters. Work is needed to satisfy this.

The other turtle family, Dermochelidae is represented only one species, *Dermochelys coriacea coriacea*; known as Leatherback turtle.

E.1.1. *Caretta caretta caretta :*

Distinctive Characters :

Carpace heart-shaped, depress, its width about 76% of the length.

Head rather large(about 28 % of carapace length) and very broad, with 2 pairs of prefrontal scutes and a strong horny beak. Five pairs of lateral scutes, anterior pair touching the precentral scute; 3 paris of enlarged inframarginal scutes on plastrom, 2 claws on each flipper. maximum carpace length recorded 125 cm; common to 110 cm . Maximum weight recorded 150 kg.; common to 105 kg.

Colour :

The upper side brownish red with light spots; underside pale yellow with diffuse orange spots.

Eggs and Hatchlings :

Eggs white, spherical, about 4.3 cm in diameter; hatching carpace about 4.5 cm in length.

Habitat :

Found entering streams of brackish water, but also encountered in the open sea and around islands. It is known to be a highly migratory species.

Attains sexual maturity at the age of 10 years. Mating takes place in the period from April to September. Incubation period range between 45-65 days.

This turtle is predominantly carnivorous feeds on mollusca, crustaceans, fish and jelly fish.

Distribution :

Widely distributed in all the Mediterranean basin and its adjacent seas. Also found in East Atlantic, the Red Sea and the Arabian Gulf.

E. 1.2. *Chelonia mydas mydas*

Distinctive characters:

Carapcace oval, depressed, its width about 80 % of the length. Head small (about 20 % of carapace length), width only one pair prefrontal scutes; edge of lower jaw coarsely toothed. Four pairs of lateral scutes on carapace, anterior pair not touching the precentral scuts; 4 pairs of inframarginal scutes on plastron; a single claw on each flipper.

Recorded maximum length of carapace 125 cm; common to 90 cm; recorded maximum weight 250 kg; common to 80 kg.

Colour :

Upperside dark olive brown or black, scutes of carapace shing with radiating yellow, green and black spots; underside pale grey or whitish.

Eggs and Hatchlings:

Eggs white, spherical about 4.5 cm in diameter. A hatchling has a carapace of 5 cm length, brownish black.

♦ Habitat:

Inhabits shoal waters abundant in submerged sea grass; but straggling individuals may be seen for from land. Sexual maturing is reached after 8 to 15 years of birth. Mating takes place in July. Incubation period ranges from 45 to 70 days.

Adult green turtles are primarily herbivorous, captive specimens accept pelleted or animal food.

Green turtle populations are heavily affected incidental trawling. Also caught with tangle nets, seines and harpoons.

♦ Distribution :

Covers all the mediterranean Basin and adjacent seas; occurs also in east Atlantic, the Red Sea and Arabian Gulf.

E.1.3. *Eretmochelys imbricata imbricata*

Some catalogues refer to the possibility of this species to occur in the Egyptian Mediterranean waters.

However, it is of spotty occurrence, inhabits coastal waters, including shallow vegetated bottoms as well as bays and lagoons with muddy bottoms.

Omnivorous species, feed on jelly fish, sponges, sea urchins, mollusca, sea weeds and sea grass.

E.1.4. *Dermochelys coriacea coriacea*

Distinctive characters:

Body covered by a smooth leathery skin laking lamellae r scutes. Head small, ending in a horny beak with a well defined cusp at each side of upper jaw and a central scup on lower jaw. Seven longitudinal ridges on carapace and 5 on plastron. Flippers very long, without claws.

Recorded maximum length of carapace 200 cm; common to 140 cm. Maximum weight 725 kg; common to 200 kg.

♦ Colour :

Upper side dark brown to almost black, whitish spots on neck. Underside pink and white.

♦ Eggs and Hatchlings:

Eggs white, spherical, 5.5 cm in diameter. Unfertilized small eggs are often of high proportion. Hatchling carapace is about 6.0 cm in length.

♦ Habitat :

* This is a predominantly pelagic species, highly migratory, usually found in the open sea, comes to land seasonally. Oviposition takes place from October to february. Incubation time ranges from 50 to 72 days.

Rarely caught :

Very important as an enemy to jelly fishes, one turtle can consume as much as 50 individuals of the large dangerous jelly fish species *Rhizostoma pulmo* per day. It also feeds on crustacea, fish and sometimes on algae.

E. Marine Mammals

Catalogues and records refer to 9 sea mammals species inhabiting the Egyptian Mediterranean waters, 8 of which belong to the order Cetacea and only one species of the order Pinnipeds.

Mammals of the Cetacea are included in four families, the first of which is to Balaen whates, to which the "Fin Whale", Balaenoptera physalus belongs. This is the only whale living in our waters. One whale of this species was found dead on sandy beach west of Alexandria in 1988.

The second marine mammals family is Delphinidae, while includes 5 dolphins of 5 different genera:

i) *Delphinus delphis* (common dolphin)

ii) *Globicephala melaena* (pilot whate)

iii) *Grampus griseus* (Risso's dolphin)

iv) *Stenella coeruleoalba* (Striped dolphin)

v) *Tursiops truncatus* (Bottle-nosed dolphin).

The third family physeteridae is represented only by one genus and one species, *Physter macrocephalus* (Sperm whale). the fourth cetacean family is Ziphiidae which has also one genus and one species, *Ziphius carvirostris* (Cuvier's beaked whale).

As for the marine mammal of the order Pinnipedes, the Monk Seal *Monachus monachus*, catalogues have no record of this species in the Egyptian Mediterranean waters, but the distribution map indicated the possibility of the existence of the monk seal in our waters. It is needed to be surveyed.

CONCLUSION AND RECOMMENDATIONS

From the previous description it is clear that the area of Fuka-Matruh is rich in many marine living organisms. But it is obvious that despite the richness in species composition the numbers are some what limited. These species are endangered because of pollution and urbanization activities.

It has to be mentioned that a disaster had occurred in Sponge fisheries in 1988, and this fisheries is still suffering from its results.

The last survey of the sea turtles along these shores indicate the scarcity of the areas suitable for laying eggs and the scarcity of sea turtles also, in spite of the fact that the Egyptian coasts in the past were rich in these organisms.

About the other organisms, it is clear that there is a lack in the information which leads to a certain conclusion. This may be due to the fact that this area was carefully studied for only one time so it is difficult to make any comparisons.

However, Sponge and sea grass beds are the most organisms which must be protected. But according to the available information it is very difficult to determine their exact positions, so we recommended an extensive survey to that area.

Provisionally three areas are recommended for conservation as marine protectorate i) The first area is the area known as Gulf of Kanayesw (Ras el'Hekma). This area is known for its beautiful beaches, clear water and as one of the best grounds for sponge production. ii) The second area is the area known as Abu Hashafa Bay between Ras Alam el'Rum which has similar characteristics to Gulf of Kanayes. iii) The third area is lagoon Matrouh with its extension in the open sea around hammam faraoon. The lagoon is the spawning ground of several fish species and the open sea area has rocky shore that host a variety of marine fauna and flora. The lagoon is currently used for cage culture of some marine fish species, disregarding the possibility of pollution. It is also anticipated that this area will be under sever stress due to urban development around it.

It has also and extension to the west as several small embayments that have unique geological outcrops on the coast and there are possibilities of the presence of rich off shore marine communities.

It is suggested that these area will be monitored according to the plan that follows, then in a later stage this order may be changed or adhered to.

Recommended monitoring strategy

It is recommended that the three areas given above be monitored for at least one year. During this year:

1) Samples will be collected from six to nine reference stations two near shore and two off shore stations at each location sampling should be made seasonally.

2) The species composition as well as the umber of organisms in each group should be recorded and a museum collection is to established.

3) Biological samples should include planktonic as well as benthic organisms.

4) Endangered species should be observed and recorded. These information will be the main input for the data base in the area together with the information resulting from other monitoring studies like pollution and oceanographic parameters, and sea level record.

The cost for this study project will be between 15000 and 18000 US$ distributed as follows:

1- Boat time and transportation

2- Travel expenses

3- Expandale material

4- Reporting

5- Wages

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MTS 2. (*) UNEP/FAO: **Baseline studies and monitoring of metals, particularly mercury and cadmium, in marine organisms (MED POL II).** MAP Technical Reports Series No. 2. UNEP, Athens, 1986 (220 pgs.) (parts in English, French or Spanish only). PNUE/FAO: **Etudes de base et surveillance continue des métaux, notamment du mercure et du cadmium, dans les organismes marins (MED POL II).** MAP Technical Reports Series No. 2. UNEP, Athens, 1986 (220 pgs.) (parties en anglais, français ou espagnol seulement).

MTS 3. (*) UNEP/FAO: **Baseline studies and monitoring of DDT, PCBs and other chlorinated hydrocarbons in marine organisms (MED POL III).** MAP Technical Reports Series No. 3. UNEP, Athens, 1986 (128 pgs.) (parts in English, French or Spanish only). PNUE/FAO: **Etudes de base et surveillance continue du DDT, des PCB et des autres hydrocarbures chlorés contenus dans les organismes marins (MED POL III).** MAP Technical Reports Series No. 3. UNEP, Athens, 1986 (128 pgs.) (parties en anglais, français ou espagnol seulement).

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MTS 5. (*) UNEP/FAO: **Research on the effects of pollutants on marine communities and ecosystems (MED POL V).** MAP Technical Reports Series No. 5. UNEP, Athens, 1986 (146 pgs.) (parts in English or French only). PNUE/FAO: **Recherche sur les effets des polluants sur les communautés et écosystèmes marins (MED POL V).** MAP Technical Reports Series No. 5. UNEP, Athens, 1986 (146 pgs.) (parties en anglais ou français seulement).

MTS 6. (*) UNEP/IOC: **Problems of coastal transport of pollutants (MED POL VI).** MAP Technical Reports Series No. 6. UNEP, Athens, 1986 (100 pgs.) (English only).

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MTS 8. (*)UNEP/IAEA/IOC: **Biogeochemical studies of selected pollutants in the open waters of the Mediterranean (MED POL VIII).** MAP Technical Reports Series No. 8. UNEP, Athens, 1986 (42 pgs.) (parts in English or French only). PNUE/AIEA/COI: **Etudes biogéochimiques de certains polluants au large de la Méditerranée (MED POL VIII).** MAP Technical Reports Series No. 8. UNEP, Athens, 1986 (42 pgs.) (parties en anglais ou français seulement).

MTS 8. Add. (*)UNEP: **Biogeochemical studies of selected pollutants in the open waters of the Mediterranean MED POL VIII). Addendum, Greek Oceanographic Cruise 1980.** MAP Technical Reports Series No. 8, Addendum. UNEP, Athens, 1986 (66 pgs.) (English only).

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