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PROGRAMME

NATIONAL PLAN OF ACTION TO COMBAT DESERTIFICATION IN THE UNITED ARAB EMIRATES

94-0023

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ABBREVIATIONS

ACSAD	Arab Centre for Studies on Arid zones and Drylands.
ALECSO	Arab League Educational, Cultural and Scientific Organization.
AOAD	Arab Organization for Agricultural Development.
CAMRE	Council of Arab Ministries Responsible for the Environment.
DC/PAC	Desertification Control Programme Activity Centre.
DDCC	Directorate of Desertification Control Coordination.
ESCWA	Economic and Social Commission for Western Asia.
FAO	Food and Agriculture Organization of the United Nations.
GCC	Gulf Co-operation Council.
GEMS	Global Environmental Monitoring System.
Ha.	Hectare.
HA&F	Ministry of Agricultural and Fisheries.
MRM&E	Ministry of Regional Municipalities and Environment.
MWR	Ministry of Water Resources.
NaDeCC	National Desertification Control Commission.
NGO	Non-Governmental Organization.
NPACD	National Plan of Action to Combat Desertification.
PACD	Plan of Action to Combat Desertification.
RO	Omani Riyal.
UN	United Nations.
UNCED	United Nations Conference on Environment and Development.
UNCOD	United Nations Conference on Desertification.
UNDP	United Nations Development Programme.
UNEP	United Nations Environment Programme.
UNEP/ROWA	UNEP Regional Office for West Asia.
UNSO	United Nations Sudano - Sahelian Office.

INTRODUCTION

Historical

Old civilization in the land which is now known as the United Arab Emirates (UAE) depended on sea resources and uses. The role of agriculture has always remained constrained by the scarcity of water and suitable soil. Nonetheless, the inhabitants in parts endowed with reasonable agricultural base as in the northern triangle and Al-Ain and Liwa Oasis developed their agricultural practices mainly for production of dates, vegetables, some cereals and fodder.

In the sixties a drive for greening the land through agriculture and afforestation was prominent in the policies and plans especially in the Emirate of Abu Dhabi. This was reflected in the efforts spent on afforestation and land reclamation. An indication of advanced environmental awareness was the UAE participation in the United Nations Conference on Desertification (UNCOD) in 1977 and their contribution to its documentation by a country report.

Planning Desertification Control

Greening of the land, reclamation of degraded or desertified land and prevention of further desertification continued to receive increasing attention in the UAE. Contacts between the UAE Government on one hand and UNEP and ESCWA on the other culminated in an agreement by which the two organizations agreed to offer assistance to UAE in formulating its National Plan of Action to Combat Desertification (NPACD).
A-one-man mission (Dr.M.Sabir M.Hilmi, a soil scientist) prepared the background section for the Plan in 1991 which constitutes Part ONE of this document. The substantive part of the Plan - the strategy, programmes and projects - was prepared in the second half of 1993 by a three-man mission (DR. Gaafar Karrar, Dr. Omer Joudeh and Dr. Kamal Tadros).

The Background Section of the Plan consists of three chapters which cover inventory of natural resources, the socio-economic setting, and a review of past and current efforts for combating desertification.

The substantive section of the Plan consists also of four chapters: National Plan of Action to Combat Desertification; Establishment of the National Institutional Capabilities; Priority programmes and projects for the short-term 1994-1999; and finally, Concluding remarks and follow-up.

It will be seen that some complementary information relating to the background sections is included in Part Two. This has been necessary for completion and relevance.

The Plan in its totality - Chapters I to VII plus the annexes takes care of all issues and problems concerning fighting desertification in drylands under conditions somewhat different from those prevailing in developing countries in Asia, Africa or Latin America. The UAE has its distinctive features as a very rich country, hampered with the serious situation of

scarcity in water and agricultural land, insufficient technical man-power and inexpensive energy source.

The total sum of the effects of these features will have its impacts during implementation of the NPACD. The NPACD has seven targets addressing, interalia, food security, social and economic welfare, sustainable use of land and water, public participation and development of national scientific research and technology capabilities.

Given the continuation of the drive towards greening of the land prevailing at the state leadership, and the marked concern of the Council of Arab Ministers responsible for the Environment (CAMRE) and the Gulf Cooperation Council (GCC) with environmental and desertification matters, implementation of the UAE NPACD is expected to proceed unhampered. When this comes true, one of the few success stories in this field would have been completed.

The situation may, hopefully, unveil a peculiar and exceptionally beneficial form of regional cooperation in the Arabian Peninsula where several neighboring countries already have their NPACD(s) with wide scope for regional cooperation. UNEP and ESCWA may consider taking the initiative of inviting these countries to a meeting in order to promote an additional bond in their regional cooperation pattern.

EXECUTIVE SUMMARY

This report, "The National Plan of Action to Combat Desertification in the United Arab Emirates" is the result of a joint effort by the United Nation Environment Programme and the UN Economic and Social Commission for Western Asia. The report was prepared in two parts. First, Part ONE - the Background Section and Part-Two, comprising the Plan, its programmes and projects.

PART ONE

This Background section consists of three chapters and annexes. The "Inventory and Potential of Natural Resources" is elaborately dealt with in chapter I. The main sections are General Information, the Physical Environment and Natural Resources.

The Emirates main source of income before World War II was natural pearl which later received a serious blow from Japanese cultured pearls. After the war, oil exploration began and resulted in 1960 in the flow of commercial oil in huge quantities in the Emirates and began to transform the economies and the society with dramatic speed. The chapter tells the recent political history of the UAE which came into being as a federal state of seven Emirates in December 1971.

In 11 tables and 12 figures chapter I gives detailed information and data on sand dunes, rainfall, temperature, relative humidity, wind, surface and ground water, soil types and characteristics and natural vegetation. The State total area is 77700 k^2 lying in the dry equatorial region.

Since high temperature, low rainfall and salinity level are dominant factors in UAE environment, natural vegetation tend to fall under the following classification:

(i) Halophytes (salt tolerant plants);
(ii) Xerophytes (drought resistant plants);
(iii) Phreatophytes (characterized with long root system); and
(iv) Ephemerals (winter/spring annuals).

The vegetation in UAE is reported, as fairly rich, running into several hundred species.

Chapter II - the socio-economic setting consists of three sections: economic development, social setting and agricultural potentialities . The UAE has a population of over 1.8 million; its GDP, in 1992 was estimated at 127.8 billion Dh.

The share of the agriculture, animal resources and fisheries sector in the GDP in 1990 was only 1.4%; however, its average annual increase rate, between 1980 and 1990 has been estimated at 10%. This is the result of heavy investment in agriculture. Thousands of small farms have been established, while agro-industrial units like dairy and poultry farms have also been constructed. Vegetable production covers most of UAE needs for much of the year and poultry eggs, milk and meat production is

rapidly growing. Development of the agriculture sector during the last 10 years has increased agricultural production five-fold to reach nearly 600,000 tons per year. In a similar development the numbers of livestock in UAE have doubled between 1981 and 1991.

Chapter III reviewed past and current efforts for combating desertification in UAE. Despite harsh climatic conditions, scarcity of water and suitable soils commendable achievements have been recorded. Afforestation has well advanced, in Abu Dhabi report, 80 000 ha have been successfully planted with trees. In Al-Ain an area of 27 000 ha has been afforested. Shelter belts have been planted along highways with a width of 100 meters. The most successful of these are found between Zayed City, Liwa, and Ghaithi.

Extension efforts are recorded in the field of rangeland development. Efforts in expanding agricultural areas have been impressive. Farmers are encouraged in various ways and this policy has yielded promising results as agricultural production registered very high increases during the last 10 years.

Efforts in improvement of land capabilities and water conservation are recorded either as a joint operation with FAO or a purely governmental achievement.

Two research centers affiliated with the UAE university have been engaged in investigations relating to desertification. An interesting record of UAE financed afforestation activities in some Arab countries reflects the very cooperative concept in desertification control.

PART TWO

This section deals with the substantive part of the NPACD. Chapter IV entitled National Plan of Action to Combat Desertification opens with a section on the magnitude of the desertification problem. According to an ESCWA estimate, about 99% of UAE is either desert or desertified land, 76.5% of the area is classified as severe to very severe; 23.4% as moderate while only 0.1% is slight desertification. The area suitable for cultivation is 59662 ha which is less than 0.7% of the total area of the country. Actually cultivated or cropped area ranges from 0.4% to 0.56%.

The continued efforts of the UAE in agricultural development and afforestation which started as early as 1969 reflects an advanced sound perception of the dangers of desertification and the importance of greening activities for improving the environment in the country.

Severe desertification was also seen during field visits in the Central and Eastern Regions. Dhaid and Falaj Al Mualla are hit with serious dropping of water table and rising salinity. Unproductive wells reached about 15% in 1991.

The common processes of desertification seen in UAE are: excessive increase in groundwater salinity leading to soil salinity, continuous dropping of water table and loss of vegetation cover.

Certain factors with accelerating influence on desertification included harsh environmental conditions (climate in particular) and excessive multiplication of livestock numbers.

A section on national participation towards the preparation of the Plan mentions the following works: 11 entries under surveys and research ; three entries under conferences and symposia; and two studies under other works. National contribution in the formulation of the NPACD may be considered to have started when UAE participated in the United Nations Conference on Desertification in 1977 and presented a country report. The section also noted the advance environmental awareness and determination in the highest level of authority in the State.

The chapter also includes a section on the national goals which are quoted from a Government document approved in 1974. The first 5 - year Development Plan for 1981-85 reflected UAE serious intentions; however, the Plan, for various compelling reasons including the first Gulf War, was not implemented. During the following years concern of the State with agricultural development was evident and contacts with UNEP and ESCWA culminated in agreement to assist UAE in the preparation of its NPACD.

A long-term strategy is proposed for desertification control in UAE. It covers the period 1994-2020. Taking guidance from UAE's national goals, the long term strategy set 7 aims addressing, interalia, food security, welfare of man, sustainable use of land and water, promotion of public participation and development of national scientific and technology capabilities.

Eight programmes were selected for the elements of the strategy covering: (i) assessment and monitoring, (ii) water resources management with 5 sub-programmes, (iii) public awareness and participation, (iv) conservation farming, (v) drought relief insurance, (vi) strengthening national scientific and technological capabilities, (vii) strengthening national institutional capabilities, and (viii) regional and international cooperation.

Chapter V addresses the establishment of National Institutional Capabilities. It reviews the institutions involved in environmental matters in UAE and their history till the creation of the Federal Commission for the Environment in April 1993. Particular stress was made on the role of municipalities.

The chapter then elaborates on the proposed national machinery for desertification control. The principal organ is the National Desertification Control Commission, chaired by the Minister of Agriculture and Fisheries and which has 11 members. The other organs are: The directorate for Desertification Control Coordination; Regional Units for desertification Control Coordination and land user's ant-desertification committees. The chapter goes on to describe the functions of these organs and suggested a procedure for implementation.

Chapter VI deals with the Priority Programmes and projects for which a short-term 1994-1999 has been suggested. The 27 proposed projects are listed under the 8 major programmes of

chapter IV. These projects are mentioned in a brief form at this stage; elaboration awaits approval of the Government of UAE.

There was emphasis on action or field-oriented projects which amounted to 14 ; the share of the water resources programme was 7 of these action-oriented projects. For each project the presentation was limited to title, objectives, duration, location, cost and execution. These priority projects are subject to modification and changes as well as addition during the periodical revision of the plan which is strongly recommended.

These project proposals were presented by the mission to a round-up meeting with government representatives. The meeting which did not discuss details, expressed general agreement on the main findings and the principal recommendations.

Concluding remarks and Follow-up were given in the final chapter . A first remark considered the challenging task of greening the desert and records achievements in figures. Under the harsh natural conditions continuously threatening the life of the these green spots the desertification control machinery should carefully guard against degradation.

A second remark addressed the structure and format of the Plan which is presented in two parts. This is the second time a plan is submitted in this format and may be that it offers an opportunity for evaluation of this methodology.

A third remark concerns future water security and consider using the available inexpensive energy sources (oil and gas) to provide the bulk of the present water needs and also to secure long-term strategic fresh water storage for future. As the oil and gas are non renewable it is suggested that development of solar energy technology for this purpose be considered.

A fourth remark considered identification of important issues that needed stress. These are (i) serious consideration of environmental matters should be based on holistic approach; (ii) urgent adoption of this draft NPACD and its implementation; (iii) continuous periodical revision of the path of NPACD and continuous watching for its link , compatibility and integration within the national socio-economic plan.

On problems and priorities, a procedure was recommended for assigning priorities. The macro-priorities suggested are: (i) assigning prime priority to the water resources management programme, (ii) protection and promotion of what has been accomplished in agriculture and afforestation, (iii) preparation of well trained competent cadres, and (iv) availability of the institutional machinery and legislative framework.

Follow-up was finally considered. Although regarded a responsibility of the UAE Government, an initial step from the UN organizations was necessary. This is the presentation of this proposed NPACD, after which the General Secretarial of the UAE Municipalities is to shoulder this responsibility. Four follow-up steps are suggested: (i) secure Government approval, (ii) establish the whole hierarchy of the institutional set up, (iii) formation of the steering committee for the National Seminar, and

(iv) convening the national seminar and completion of project formulation.

Chapter I
Inventory and Potential of Natural Resources

1.1 General Information

The Federation of the United Arab Emirates (U.A.E.) is the youngest independent state in the Arab world. The U.A.E. was proclaimed as an independent state on 2 December, 1971. It comprises of seven emirates once known collectively as the Trucial States: Abu Dhabi, Dubai, Sharjah, Ras-Al-Khaimah, Umm Al-Qwain, Fujeirah and Ajman (Table 1.1).

The U.A.E. is located north of the equator between latitude 22, 26.5 and longitude 51, 56.5.

The total area is about 77700 sq. km. excluding islands. It lies in the heart of the Gulf, bordered to the north and north east by the Gulf, and to the west by the State of Qatar, the Kingdom of Saudi Arabia and to the south by the Sultanate of Oman and Saudi Arabia, and to the east by the Oman Gulf and Sultanate of Oman.

The borderline starts from the Emirate of Abu Dhabi, stretching along the south east of the Gulf for a distance approximately 644 km. The borderline then extends through the interior parts to engulf the Emirates of Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al-Qwain and Ras-Al-Khaimah (Fig. 1.1). It continues towards the eastern region to encompass the Emirate of Fujeirah, stretches for a distance 90 km along the Gulf of Oman, which is linked to the Red Sea through the Mandab Gate.

The strategic geographical location of the U.A.E. to the east, poses a physical phenomenon, securing this vital region of the Arab world.

(1) Abu Dhabi

It is the biggest of all seven emirates comprising the U.A.E., having an area of 67340 sq.km., equivalent to 86.67% of the country's total area. The city of Abu Dhabi is an island situated on the Gulf, opposite to the Emirate of Abu Dhabi, and is both the capital of the emirate and U.A.E. A number of other smaller islands are part of the emirate. The most significant islands in this chain are Das, Mubraz, Syeer Bani Yass and Al-Sadyaat. The latter one has got the major agriculture research station. It produces about one ton of vegetables, besides being the last island in this chain.

Abu Dhabi counts 70% as desert area and 20% as low land. The pastoral area of Dhafra, which has rich water resources, lies to the centre of the emirate. The area of Mahader Lewa includes about 60 small villages.

Table 1.1 AREA * OF UNITED ARAB EMIRATES BY EMIRATE

Emirate	Area		
	%	Sq. Mile	Sq. Kilometre
Abu Dhabi	86.67	26000	67340
Dubai	5.00	1500	3885
Sharjah	3.33	1000	2590
Ajman	0.33	100	259
Umm Al-Qiwain	1.00	300	777
Ras Al-Khaima	2.17	650	1683.5
Fujeira	1.50	450	1165.5
Total	100.00	30000	77700

* Excluding Islands (Central Statistical Dept. 1989)

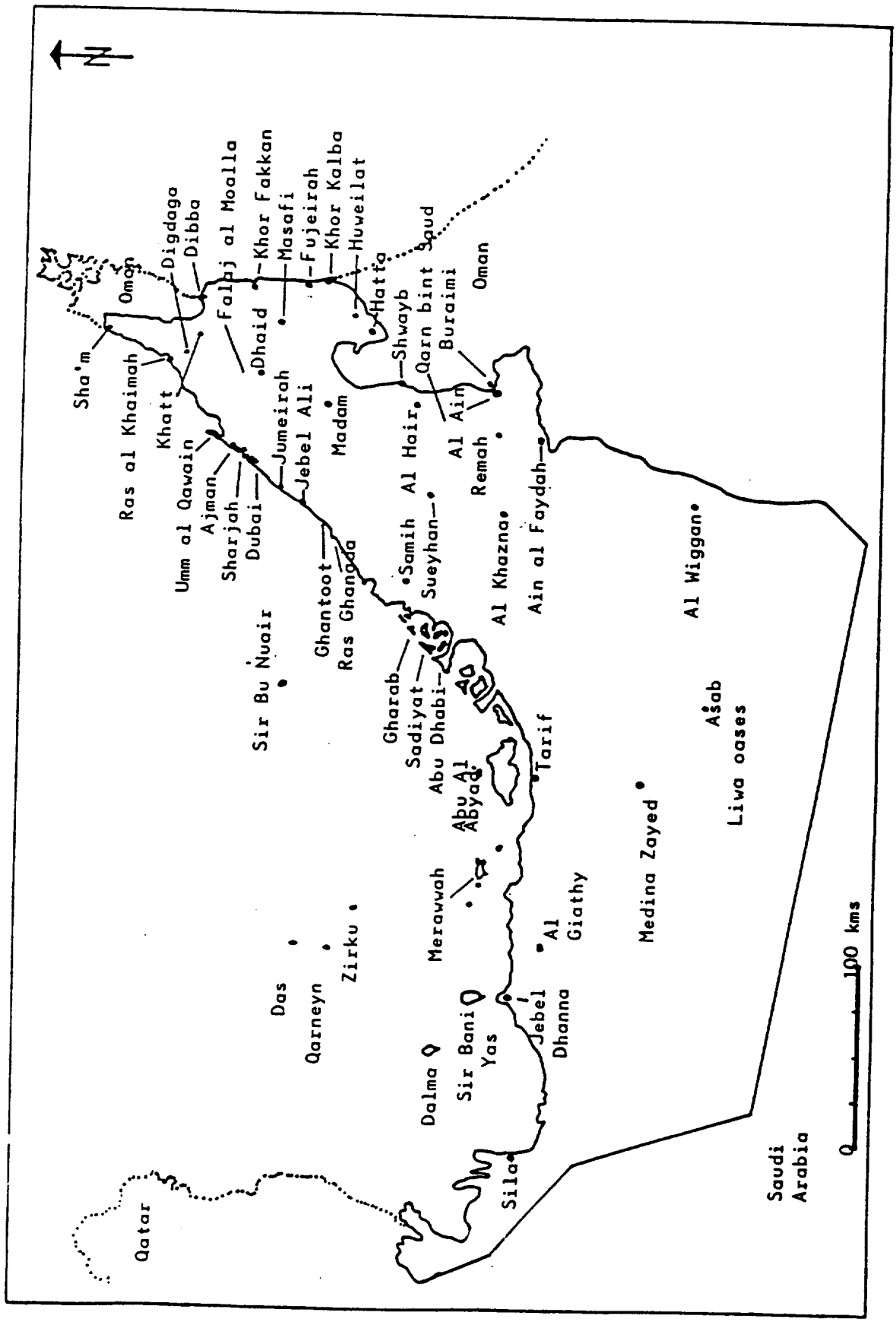


Figure 1.1 The State of United Arab Emirates (Western 1989)

The town of Al-Ain, the capital of the eastern region, is the most fertile part. The area is rich in water and artesian wells are numerous.

(2) Dubai

The Emirate of Dubai lies on longitude 55.16 and latitude 25.6 north, overlooking the Gulf, over a distance about 72 km long, boarded to the north by the Gulf and to the north and east by the Emirate of Sharjah, and to the south of the Emirate of Abu Dhabi.

The area of Dubai is 3885 sq.km. approximately, equivalent to 5% of the country's total area. Most lands are arid desert lands, with the exception of a strip of low lands along the coast. The town of Dubai, the capital of the emirate, is penetrated by a water creek known as Al-Khour, 10 km long, dividing the town into two divisions; Dubai to the south and Diera to the north.

The agricultural district known as Al-Khwaneej, lies 12 km west of Dubai, famous for being a resort area for Dubai and other emirates. Al-Aweer district which lies 25 km to the south of east Dubai, has most wells supplying drinking water to the emirate. The Hatta district is an agriculture area, lying 100 km of Dubai, in the middle of the desert area.

(3) Sharjah

The Emirate of Sharjah is located in the middle of U.A.E., on longitude 55.21 east and latitude 25.20 north overlooking the coast of the Gulf, over a distance 16 km long, and extending into the interior for a distance exceeding 80 km. The three other parts of Sharjah lying on the Gulf of Oman are, Kalba, the most rich agricultural area, Khor Fakhan, having the main port for the eastern regions and Dabba district.

Sharjah has an area of 2590 sq.km. equivalent to 3.33% of the country's total area. Sand plains constitute a major portion of the land, extending from the western coast, up to the gravel parts at the foot of the western Hajar mountains. The eastern region of this area, at the Gulf of Oman stretches over a semi-fertile coastal plain connected to the Hajar mountains. Some oases are scattered to the interior, the most known is Zeid with very rich and fertile soil, and includes various plantations. The other known islands in the area, are Hamriah, Abu Mousa and Sayeer bou Naa'eer.

(4) Ajman

The Emirate of Ajman is situated on the coast of the Gulf, extending over a distance 16 km long, between the Emirates of Umm Al-Qwain and Sharjah, which surrounds the emirate from all sides. The two major

regions in the emirate are Masfout lying at the south east and Manama located 60 km to the east.

The area of Ajman is 259 sq.km. equivalent to 0.33% of the country's total area. Most of Ajman and Manama are covered by sandy plains, while Masfout is surrounded by high mountains from all directions. The town of Ajman, the capital of the emirate, lies on a small creek about 16 km. long to the north east of Sharjah.

(5) Umm Al-Qwain

The Emirate of Umm Al-Qwain is located on the coast of the Gulf, stretching over a distance 24 km long, between Sharjah to the west and Ras-Al-Khaimah to the east. It lies 43 km south west of Ras-Al-Khaimah, and 32 km north east of Sharjah, and the inland spreads towards the interior for a distance of 32 km approximately.

The region of Falaj Al-Mulla is known to be the agricultural part in the emirate, located 50 km south east of Umm Al-Qwain. The other large part is Senayah island, located one km away from Umm Al-Qwain, with a total area of 90 sq.km. known to harbour large species of birds.

The total area of the emirate is 77 sq.km. equivalent to 1% of the country's total area. The surface and structure of the coastal area is salty marshland, while other parts in the emirate are sandy plains. The region of Falaj Al-Mualla, stretches over a high area known as al Batta valley. The town of Umm Al-Qwain is the capital of the emirate situated on a deep creek on km in width and 5 km long.

(6) Ras-Al-Khaimah

The Emirate of Ras-Al-Khaimah is located on the Gulf for a distance 64 km long, marking one of the farthest locations in the eastern part of the Arab world. It lies between latitude 25.26 north and longitude 55.60 east, with an area of 1684 sq.km., equivalent to 2.17% of the country's total area. It has an extremely long borderline with the Sultanate of Oman to the south and north east. The distance towards the interior exceeds 128 km. A number of important islands are part of the emirate, the most well known are Bigger Tunub, Smaller Tunub and Red Island (ZAAB).

The western part overlooking the Gulf of Oman is formed of low sandy plains. The mountains and sea stretch to meet at the northern part. The slopes extend towards the interior, up to the high mountainous area in the east. This chain of mountains extends up to the town of Shaam at the edge of the Gulf, where arable lands lie between this chain of mountains and the coast.

The town of Ras-Al-Khaimah, the capital of the emirate, is divided into two parts by a water gill named Al-Khour. The western part is known as Ras-Al-Khaimah, while the eastern part comprises a number of residential districts. The town of Ras-Al-Khaimah stands at the terminal in the paved asphalted road starting from Abu Dhabi and connecting the rest of the other six emirates.

The district of Shaam, situated 30 km north of Ras-Al-Khaimah, has got plenty of water resources and plantations. The biggest advanced agricultural centre in the area is established in Dagdaga district, 18 km to the south east of Ras-Al-Khaimah.

(7) Fujeirah

The Emirate of Fujeirah is located in the eastern region, to the east of Sharjah and Ras-Al-Khaimah, extending over a distance 90 km long approximately, along the Gulf of Oman, and bordered to the north by Ras-Al-Khaimah and the Sultanate of Oman, and to the south by Kalba which is part of Sharjah, and the Sultanate of Oman.

The area of the emirate is 1165 sq.km., equivalent to 1.5% of the country's total area. The physical feature is basically formed of rough mountains, containing in between them and the Gulf of Oman, the most fertile lands known as Al-Batinah plains, extending over a distance 32 km in width and getting narrower towards the edge of the sea. The known valleys in the area are Seejai and Haam.

1.2 Physical Environment

1.2.1 Physiography

Although there are distinct physiographic zones, their boundaries are indistinct, hence the following divisions are generalised. (Fig. 1.2, 1.3 and 1.4). Apart from the mountains, the landscape is dominated by geologically recent overlying limestone sediments plus marls, shale deposits and evaporites. Folded sediments occasionally protrude through the sand as isolated Jebels, or hills such as Hafit and Hawrah. Present-day scenery is a relict of Pleistocene and Pleistocene times when the climate was wetter and the alluvial fans of the east were created. Increasing aridity since then, plus some uplift has led to riverine cutting of wadi sediments and the formation of coastal salt flats.

1.2.1.1 Coastal Lowlands

The U.A.E. has two coastlines, the first east and the second west. The western coastline extends the length of the state for 600 km along the Gulf coasts. The eastern one runs from 75 km along the Gulf of Oman. Between the State of Qatar and the Emirate of Dubai lie vast areas of recently-farmed saline flats (sabkha), extending inland for

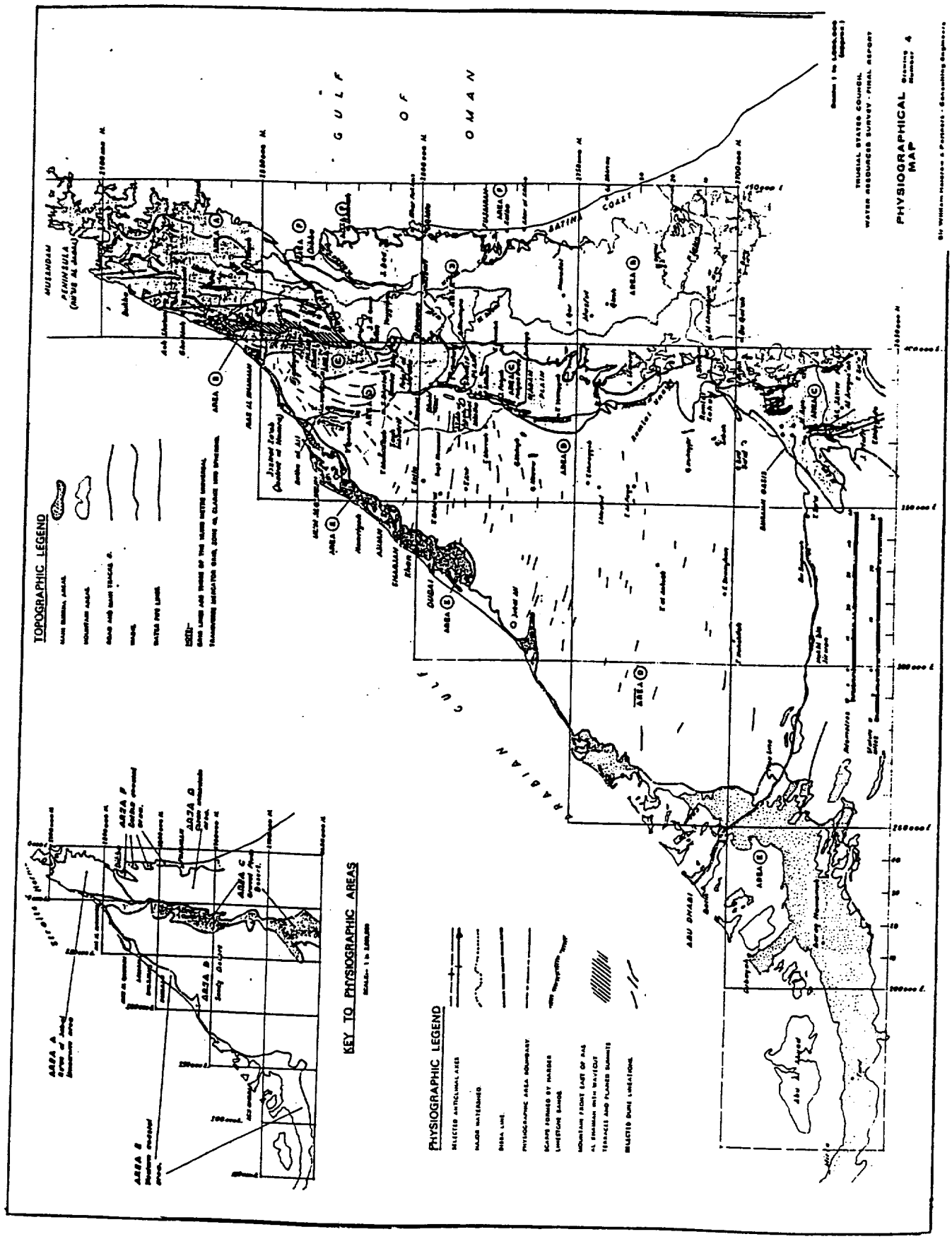


Figure 1.2 Physiographic divisions of U.A.E.

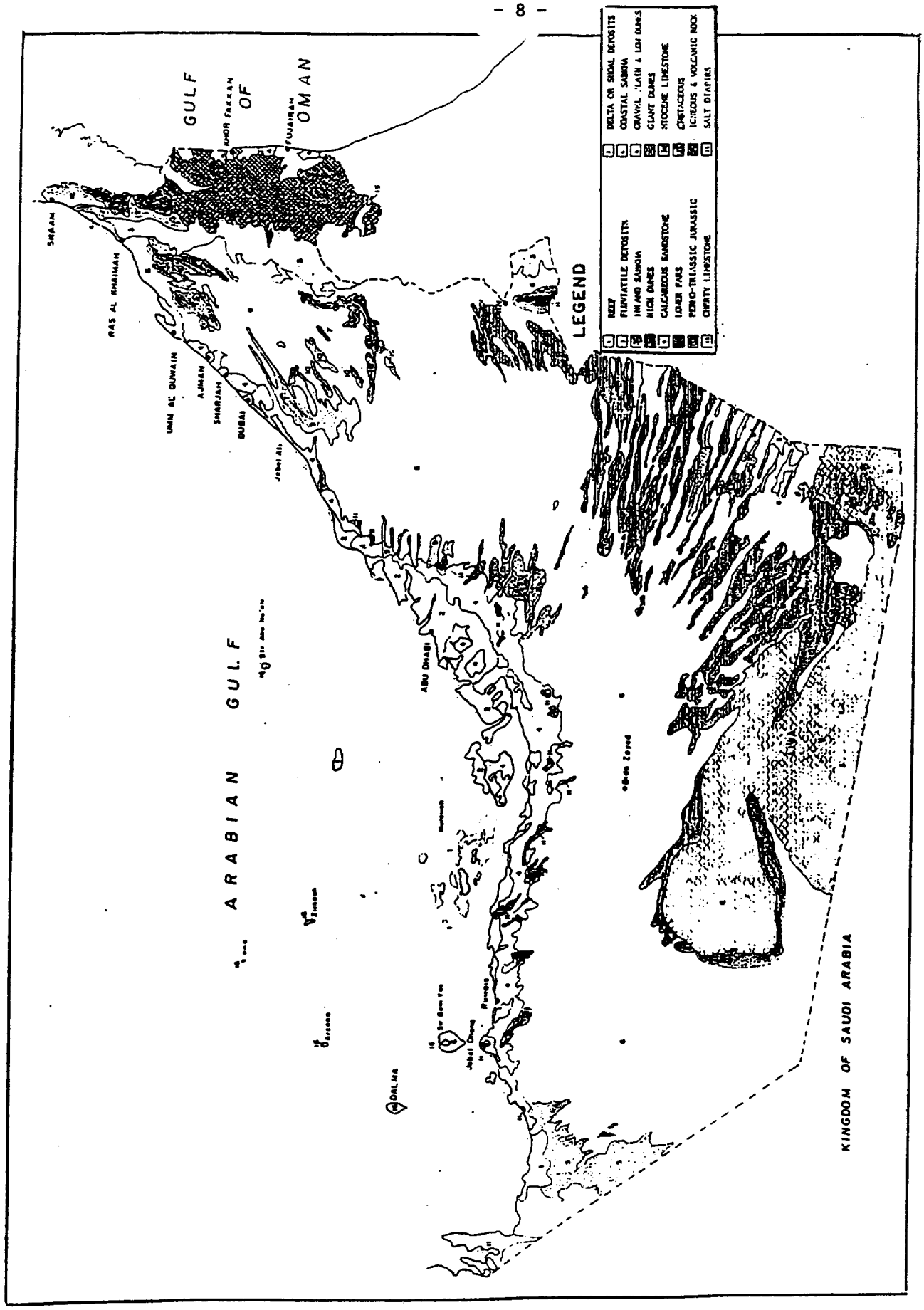


Figure 1.3 Geomorphological and geological map of U.A.E.

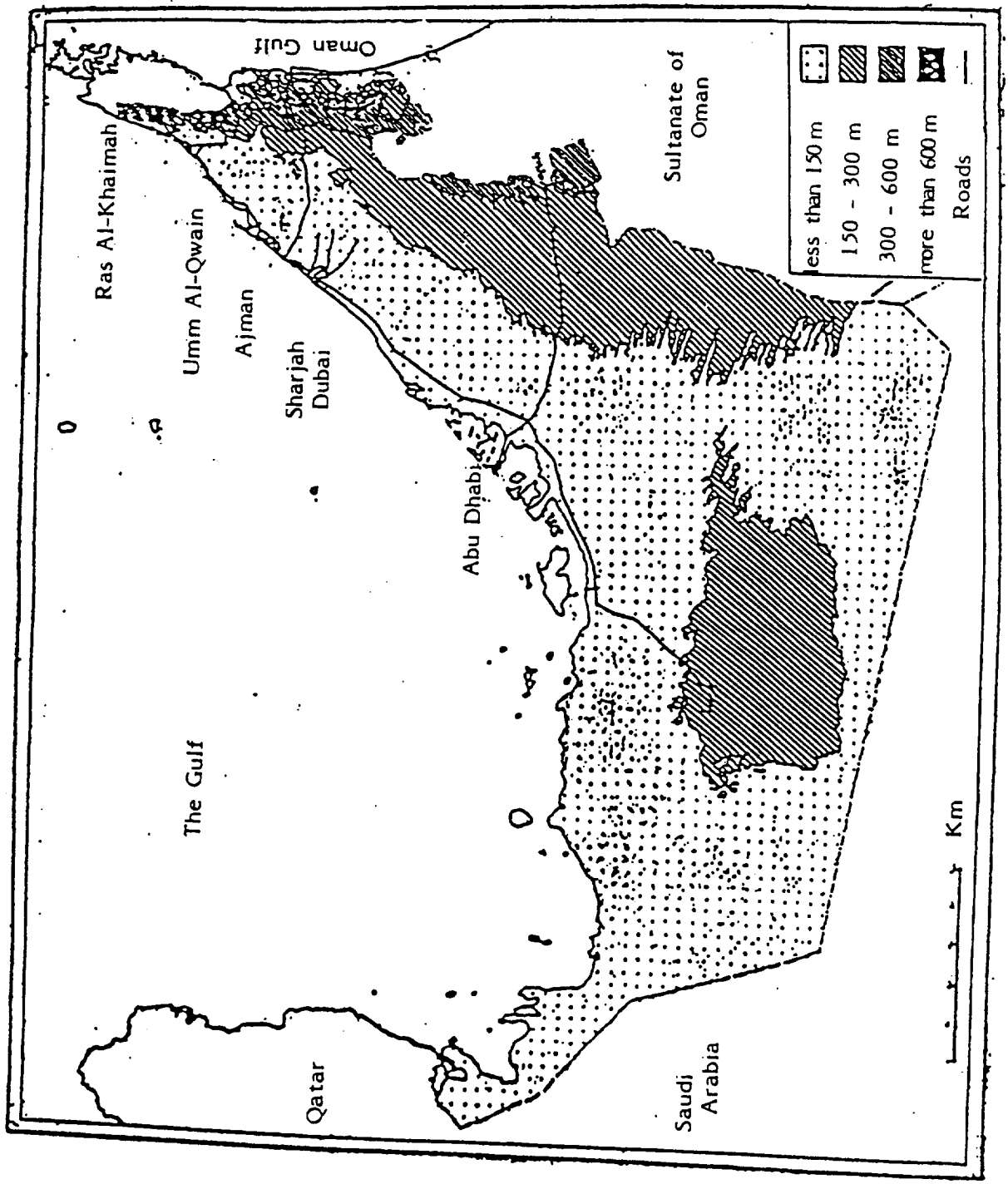


Fig. 1.4 Topography of U.A.E.

up to 30 km. These are bounded at the tidal zone by a very narrow raised beachline of calcareous sand, and on the island side by a low escarpment of Tertiary rocks. The sabkha is most extensive in the far west where it is barely above present high tide level, and after prolonged rain it might remain inundated for several weeks. In late February and March 1988, several dozen square kilometers were flooded up to a depth of 50 cm east and west of Tarif. The true sabkha with its impermeable substrata and evaporitic crust of gypsums, anhydrides and calcites, supports no vegetation except subsurface algae. After the floodwaters have evaporated, the surface is crusted with an unbroken layer of dazzling crystalline salt. Eroded flat-topped limestone and sandstone outcrops are a feature of this bleak landscape, these often form raised areas extending to the coast and thus effectively separate the salt flats. These two barriers exist at Al Hamra and Al Marfa.

Abu Dhabi region consists of a drowned coastline with a high number of inshore islands, some of them only true islands at high tide. North of the federal capital the coast gradually becomes more clearly-defined and open with a beach barrier directly facing the prevailing northwesterly winds. The creek and lagoons of Dubai, Sharjah, Ajman and Umm Al-Qwain are interspersed with small sabkhas, some of them with a thin covering of wind-blown sand. Southwest of Ras Al-Khaimah the coastline is a little higher but still indented with lagoons and minor promontories, as at Jazirat Al Hamrah. The lagoon at Ras Al-Khaimah town is now partially infilled and the surrounding coastline is raised and capable of supporting some vegetation. Inland from the coast, the land rises very gradually in a series of shallow graded slopes to a maximum height of about 100 m. Generally the elevation is much lower, and the coastal highway rarely rises above 30 m. except in Ras Al-Khaimah.

In the far west the landscape is very flat and monotonous apart from the few flat-topped bluffs, and the region between the border post at Al Sila and Jebel Dhanna is dominated by the extremely low-lying Sabkhat Matti which extends from the coast to some 100 kms inland. Further east the landscape is more undulating around al Marfa and Tarif, and from there on to Abu Dhabi, a low escarpment is generally visible inland beyond the sabkha. Between Abu Dhabi and Dubai the slope inland is imperceptible except for the presence of small stabilized dunes. Fossil dunes are a feature north of Sharjah, but beyond Ras Al-Khaimah the coastal plain becomes more and more constricted by the curve of the mountain belt which reaches to the sea at Ash Sha'm and which provides a physical boundary between the U.A.E. and the northern tip of Oman.

The east coast, from Khor Kalba in the south to Dibba in the north, consists of a very narrow plain dividing the shoreline from the mountains which extend rocky spurs to the sea. This coastal plain is up to 6 kms wide in the south, but narrower further north apart from the wide alluvial Dibba plain. The highest of the coastal peaks is Jebel Jabsah, northwest of Fujeirah town, at 881 m. There

are no permanent streams along the coast but at Fujeirah and Dibba wide seasonal wadis debouch into the sea. There are major bays at Khor Fakkan and Dibba, both of which are being developed into modern harbours. Around Khor Kalba and Fujeirah there are some saline marshlands but further north the coast is rocky. Significant passes through the mountains occur only at Fujeirah (Wadi Ham) and at Dibba.

1.2.1.2 Offshore Islands

Whereas the mainland coast and associated islands consist of recent sedimentary carbonates, the isolated offshore islands have a much older origin. Through a process of salt diapirism the cores of these islands are pre-Cambrian Hormuz outcrops which have pierced the earth's surface at the highest point of the salt dome to form conical hills. In Pleistocene times low carbonate plains accumulated around these hills, along with associated coral reefs, particularly on the more protected south and east sides. None of the islands is very large and because most have no natural source of fresh water (Delma is an exception), they were generally uninhabited until recently when a few of them were adopted as bases by oil companies. One or two of the islands, such as Sir Bu Nuair, reveal deposits of igneous rock, and the numerous fissures are often rimmed with yellow sulphur deposits. Jebel Dhanna is the one example in the country of these formations that does not in fact lie off-shore. The hills of these islands are steep and deeply incised as a result of erosion, and the original elevations are now much reduced, through the summits are still higher than any point on the corresponding coast, apart from Jebel Dhanna. Zirku for instance rises to 130 m., compared with 33 m. for the highest point of the road between Qatar and Abu Dhabi. The coastline of these islands consists of undercut limestone ledges up to 3 m. high and a few tiny sandy coves. Only the larger islands have developed miniature shallow wadi system fanning out from the hills.

1.2.1.3 The Central Desert

Between Abu Dhabi and Al-Ain semi-mobile dunes are the dominant visual feature, with a relatively high water table resulting in evaporitic crusts in the many depressions. As along the coastal region, these inland sabkhas might hold surface water for many weeks after winter rains, especially around Sueyhan. While the dunes become increasingly stable further north and inland of the coastal lowlands, they remain high in the east and actually abut on to the Hajjar Mountains at Shwayb. Limestone outcrops of the Simsima and Hawasima formations occur in a thin line running north from Al Ain, though many of these are virtually covered with wind-blown sand, as at Jebel Mahijir near Al Hair and at Qarn bint Saud.

The central desert region extends north beyond Falaj al Moalla where it is dissected by Wadi Lamah. The sands remain fairly well demarcated between the coastal oolitics and the inland aeolian, and in the northern Emirates the gravel depressions largely disappear. The landscape is

gently undulating, lacking in surface water, and there are few large outcrops apart from the Jebel Faiya group between Madam and Dhaid.

There is greater vegetation cover than on the western dune plains, especially further north. In particularly wet winter rainy seasons there can be a high incidence of annuals and new grass growth might be very extensive. Remnants of Acacia forest occur between Shwayb and Al Hair and inland of Jebel Ali, but the stands are becoming more scattered and individual trees are often in poor condition.

1.2.1.4 The Alluvial Plains

The alluvial fan that spreads out westwards from the Hajjar range from extensive plains with a shallow and ever-decreasing slope until leveling out when they meet the central desert. These piedmont fans consist of pebble and rock detritus overlying gravelly alluvium close to the mountains and sand and gravels further west where the grain size decreases and winds have formed low dunes interspersed with fluviatile deposits. Here the main wadi systems lose themselves, through their courses are marked by occasional sabkha areas and thin lines of vegetation.

Around Khatt and Digdaga the Jiri Plain is fertile with a high concentration of sands and silts in the alluvium. Combined with a high water table this results in a fairly dense vegetation cover. Further south the Dhaid, Gharif, Madam and Al Ain plains also constitute the major agricultural regions of the country, though in each case a caliche horizon exists below the gravels which with recent water drawoff is beginning to have a serious effect on permeability. Small sections of the Fujeirah coast also fall into this category. Around Al Ain the plains have a depleted vegetation cover and surface erosion is greater. The Jaww Plain, between Jebel Hafit and the Wadi Jizzi, is being extensively quarried and this has already led to surface degradation as fragile layers are broken up and blown away contributing towards a dust bowl effect.

1.2.1.5 The Mountain Belt

The Hajjar range form the easterly boundary of the U.A.E. near Al Ain and northerly extension separates Fujeirah from the rest of the country. Hatta and Masfut nestle in westward facing enclaves among the mountains which here straddle the border with Oman. Geologically this mountain zone is a distinct entity, comprising a suite of metamorphic and igneous rocks which are rarely found on the earth's surface elsewhere. These lavas, oozes and crusts are believed to have been formed at the site of a mid-oceanic ridge in the Indian Ocean. This mantle was gradually shifted and deposited on the edge of the Arabian Peninsula during cretaceous times. During the subsequent Tertiary the region was uplifted, and ever since then erosion has carved out the spectacular scenery of today. Many of the mountains peak at over 1000 m. and in the southern Ruus al Jibal the highest are over 1500 m. Forming an effective barrier between the two Gulfs, this

mountain range is some 30 kms wide in U.A.E. territory and portrays an almost lunar effect with its ragged open slopes and numerous deeply-twisting wadis, a few of which contain permanent streams. Some of these wadis were originally much wider, as evidenced by the wide terraces and gullies cut through the consolidated sediments of former river beds. The wadi Albih is the largest of these wadi systems in U.A.E. territory, extending from the Ruus al Jibal to Ras Al-Khaimah.

Although geologically and physically separated from this main range, there are two other notable outcrops. Jebel Hafit, just south of Al Ain, is a 10 km long foreland anticline of late Miocene date overlain with a limestone mantle, peaking at 1180 m. It is surrounded by alluvial detritus scored by numerous dry wadi systems, the eastern ones merging into the Jaww Plain and the western ones losing themselves in the red dunes either side of Ain Al-Faidah. Oligocene reefs extend northwards into the suburbs of Al Ain. Further north, between Madam and Dhaid, lie Jebel Faiya and Mileiha, peaking at 421 m. and 394 m. respectively. These are cretaceous in origin and huge sand deposits have built up on their eastern flanks. Like Jebel Hafit, the limestone mantles of these outcrops contain a highly varied suite of marine fossils.

1.2.1.6 The Dune Plains

Landsat images show that the predominant landform system is the aeolian system since it prevails in most of U.A.E. area. In this system dunes of various types and patterns were developed by the energy of wind on an original flat to undulating surfaces with rise from several meters in the north along the coasts to 100 - 200 m. above sea level in the south and the east (Fig. 1.5). This aeolian system is a part of the well known sand sea of the Empty Quarter, which extends beyond the borders of U.A.E. into Saudi Arabia and Oman.

Dune classification is primarily based on the external shape of the sand mass and the number and arrangements of slip faces. Table 1.2 shows the major dune types and their morphological characteristics in U.A.E.

The southwest of the country comprises extensive gravel plains with banks of aeolian sand piled up by the prevailing winds. Low towards the coast, these banks increase until they form awesome dune barriers with slip faces rising 70 m. above the gravel floor. In contrast to the white calcareous sand of the coast, these inland dunes are yellow or orange with iron oxide and quartize grains. The whole region conforms to a hyperacid bioclimatic zone with thin vegetation cover, a limited number of species and an absence of trees. In the centre lies Al Liwa, an east-west crescent of oasis hamlets and gardens stretching for some 80 kms. Until very recently Al Liwa was the only permanently inhabited part of this region but several towns and villages have recently been established to the north and there also exist oil camps and several forestry plantations and nurseries. The presence of high water

Table 1.2 Major types of Dunes in U.A.E.

Name	Form	Silp -face(s)	Wave-lengh (km)	length (km)	Width (km)	Height* (m)
Linear	Symmetric-assymmetric ridge in cross section	one or more	1.5-10.0	5-140	0.2-6.0	10-115
Barchan	Crescent in plan view	one or more	0.3.4.0	0.1-3.0	0.1-6.0	3-160
Barchanoid	Rows of connected crescents in plan view	one or more	0.3-60	0.1-1.5	0.2-5.0	3-120
Transverse	Assymmetric ridge in crosss section	one	0.2-0.7	0.5-1.0	0.2-0.4	15-60
Star	Central peak with three to five arms	three-five	0.3-1-0	0.1-0.5**	0.2-1.0***	20100

* Measured on topographic maps.
** Length of arms
*** Diameter

(Embabi 1991)

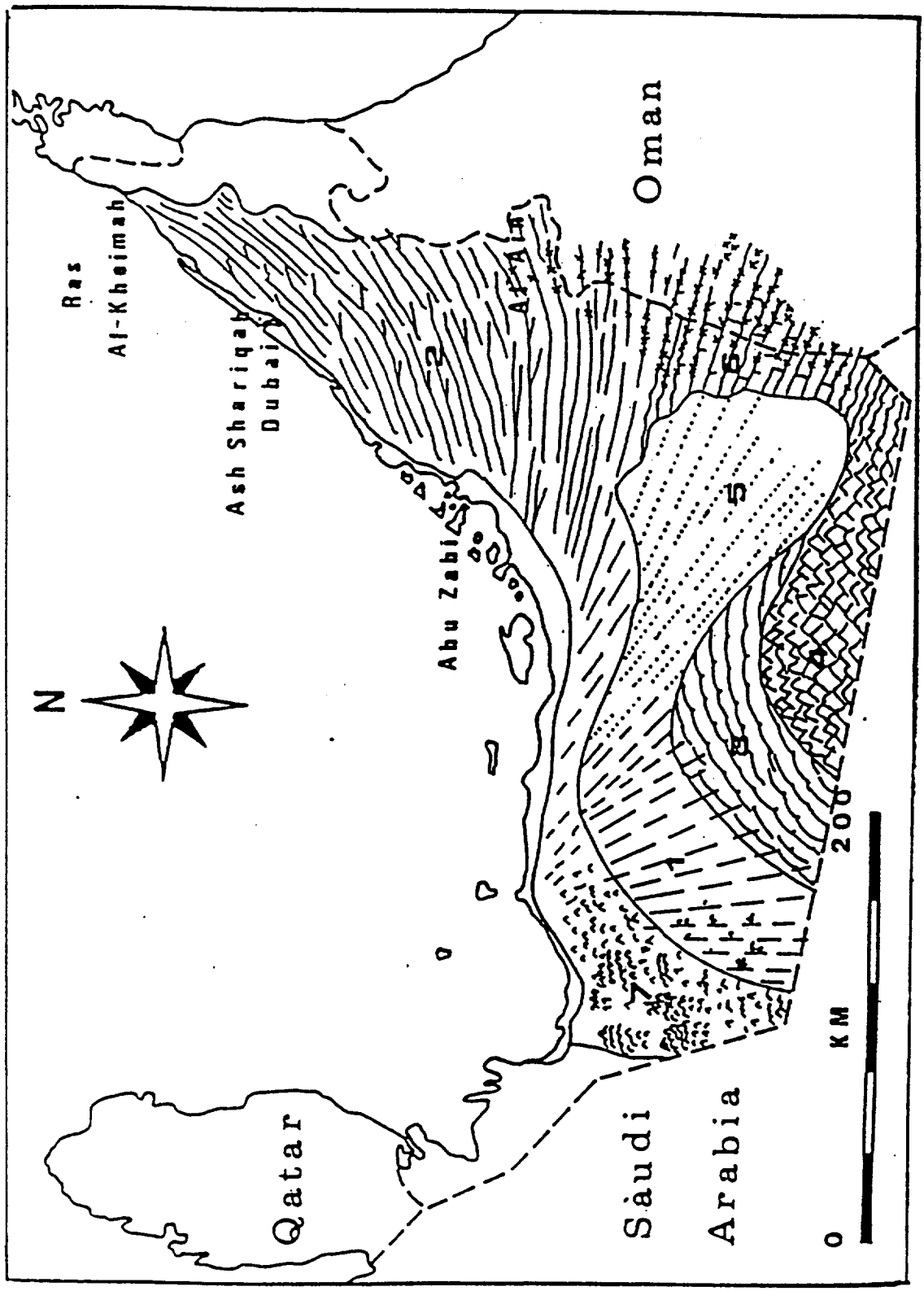


Figure 1.5 Distribution of Dune Patterns in U.A.E. (Embabi 1991)

table at the base of the higher dunes led to the development of date palm cultivation, but nowhere is there any surface water. The small gravel plains interspersed between the dunes are saline to a greater or lesser degree, partly depending on their height above sea level, often with a fine horizon of blown sand. That the region must have been more habitable within the last few thousand years can be seen from the number of post-Neolithic flint finds on the surface. Al Liwa is bounded on the west by Sabkhat Matti while the rest of the gravel plains increase in area as they encroach upon the alluvial fans of the Hajjar Al Gharbi mountains of Oman. To the northeast the dunes though remaining extensive, decrease in individual size towards the central desert.

Not all winds are able to move dune sands, only those with a velocity exceeding 11 - 12 knots can do so. Table 1.3 shows percentage occurrence of sand moving winds in five meteorological stations located along or near the coast except for Al Ain station. The total percentage of wind frequency decreases eastwards and inland, however, velocities between 6 to 11 knots predominate in all stations. The rate of sand movement is lower inland that at coasts. Most of the sand drift might be towards east or southeast.

1.2.2 Climate

The U.A.E. lies in the arid tropical zone extending across Asia and northern Africa. The strong ocean effect has direct bearing on the climatic conditions in the area, as the country lies on the coastal zone of both the Gulf and gulf of Oman. This, however, explains why high temperature in summer is always accompanied by high degree of humidity. Some noticeable differences in the climatic conditions might be observed in between coastal areas, the interior desert areas and mountain areas. A typical desert climate of the country is characterized by high summer temperatures, low humidity in inland areas and diurnal variation in temperature.

1.2.2.1 Rainfall

Rainfall had been erratic and quite less during 1989 compared to the previous year. Table 1.4 shows that annual rainfall during 1989 varied between 46.70 mm in El-Betain and 183.80 mm in Kelhalmahla. Significant variations in rainfall were recorded overtime. At Bateen Airport in Abu Dhabi, for instance, annual total rainfalls were 195.2, 97.7, 24.5 and 2.4 mm respectively in the years 1982, 1983, 1984 and 1985.

Table 1.3 Percentage occurrence of sand moving winds in U.A.E.

wind Direction	Wind velocities categories (knots)																			
	Abu Zabi				Dubai				Ash-Shariqah				Ras Al-khelmah				Al-Ain*			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
N	2.6	0.8	-	3.4	1.1	0.1	-	1.2	0.4	-	-	0.4	0.2	-	-	0.2	0.9	0.1	-	1.0
NE	2.2	1.0	-	3.2	0.4	-	-	0.4	0.2	-	-	0.2	0.2	-	-	0.2	-	-	-	
E	0.2	-	-	0.2	0.6	-	-	0.6	1.0	0.4	-	1.4	0.2	-	-	0.2	0.4	-	-	0.4
SE	1.6	0.2	0.2	2.0	0.5	0.1	-	0.6	1.0	0.2	0.1	1.3	2.0	0.3	-	2.3	0.1	-	-	0.1
S	0.7	0.5	-	1.2	0.9	0.1	-	1.0	1.0	-	-	1.0	0.5	-	-	0.5	2.3	0.1	-	2.4
SW	0.4	-	-	0.4	1.9	0.2	-	2.1	1.3	-	-	1.3	0.6	-	-	0.6	0.3	-	-	0.3
W	0.7	-	-	0.7	4.3	0.6	-	4.9	3.5	0.4	-	3.9	1.1	0.1	-	1.2	0.3	0.1	-	0.4
NW	10.6	2.0	0.7	13.3	7.2	0.7	-	7.9	4.2	0.1	-	4.3	3.0	0.1	-	3.1	1.1	-	-	1.1
Total	19.0	4.5	0.9	24.4	16.9	1.8	-	18.7	12.6	1.1	0.1	13.7	7.8	0.5	-	8.3	5.4	0.8	-	5.7

(1)11-16knots, (2)17-12 knots,(3)22-27 knots,(4)Total
Source :U.A.E.Climatological Summaries,1984-1989,
***Available data for 1988-1989 only.**

(Embabi 1991)

Table 1.4 Total annual rainfall by region in U.A.E. (1988-1989)

(mm)

Station	1988	1989
Al-Dagaga	151.60	135.80
Al Biriedat	173.00	128.20
Ras Al-Khaimah A.P.	176.90	53.30
Sharjah A.P.	67.20	139.40
Dubai A.P.	220.60	143.40
Abu Dhabi A.P.	221.40	56.80
El Betain	178.30	46.70
Al Ain	115.20	120.60
El-Hibab	232.00	119.40
Malieha	207.40	149.80
Masfout	301.00	113.20
Masani	222.00	138.60
Dabba	221.41	99.60
Kelhalmahla	188.80	183.80
Kalba	305.60	103.00

Source: AOAD, 1990

Rainfall continues to be limited in the cooler months when the average relative humidity is high. Regionally, the inland areas of northern Emirates continue to receive the highest rainfall (Fig. 1.6). Records for the decade show that there was a large amount of rainfall during 1982 and 1988.

There were more rainy days in the inland areas of northern Emirates as compared to other regions of U.A.E. (Table 1.5). Ras Al-Khaimah had 24 rainy days compared to 17 days in Dubai and Sharjah and 15 days in Abu Dhabi. The regional distribution of rainfall by month illustrated in (Fig. 1.7) shows that rainfall was highest during March and December. Inland areas received a small amount of rain during summer months. The temporary freshening effect of summer showers is soon dissipated by heat and evaporation, but such rainfall is vital for the germination of some species. Winter and spring rains are of the cold front type, although essential for aquifer recharge and to dampen soil surface, might not occur until several weeks after the most recent rainfall.

The distribution shows that the foothill areas of Hajjar Mountain received the highest amount of rainfall while the southern and western regions, particularly Abu Dhabi received the least of it.

1.2.2.2 Air Temperature

The monthly average maximum temperature during May to September in al ain was above 40^{0}C and reached an average of 43.8^{0}C in August. In the coastal areas, (Fig. 1.8), the average temperature reached 41.9^{0}C in Abu Dhabi and 42.4^{0}C in Dubai during the month of July. The lowest monthly average temperature (9.7^{0}C) was recorded in Ras Al-Khaimah

Table 1.5 Rainfall in mm and number of rainy days by month and station 1988

Station / Month		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Abu Dhabi Airport	Rainfall	0.5	202.3	tr.	18.1	-	-	tr.	0.5	-	-	tr.	tr.
	Rain days	1	8	-	3	-	-	-	1	-	-	-	-
Al-Ain	Rainfall	1.8	94.2	0.2	14.8	-	-	0.4	3.6	-	-	-	...
	Rain days	-	5	-	2	-	-	-	1	-	-	-	...
Dubai Airport	Rainfall	1.3	190.4	0.3	20.3	-	-	0.5	-	-	-	.-	7.8
	Rain days	6	12	1	4	-	-	2	- -	-	-	-	2
Al-Hibab	Rainfall	3.6	211.4	1.8	8.4	-	0.2	0.6	0.4	1.4	0.4	0.4	1.4
	Rain days	1	8	-	1	-	-	-	-	-	-	-	-
Sharjah Airport	Rainfall	1.4	132.9	0.5	17.7	-	-	0.7	-	-	-	-	4.0
	Rain days	4	13	1	4	-	-	2	-	-	-	-	4
Kalba	Rainfall	0.4	242.8	0.4	23.4	-	-	8.8	-	-	-	-	29.8
	Rain days	-	7	-	2	-	-	1	-	-	-	-	1
Meleiha	Rainfall	5.6	182.4	2.4	6.8	-	-	1.8	-	-	6.4	0.4	-
	Rain days	1	7	-	1	-	-	-	-	-	1	-	-
Masfut	Rainfall	8.4	278.6	-	17.0	-	-	6.2	-	-	0.4	-	0.4
	Rain days	1	7	-	1	-	-	1	-	-	-	-	-
Falag Al-Mualla	Rainfall	3.0	154.4	1.2	23.0	0.4	-	0.3	-	-	2.2	0.4	8.0
	Rain days	-	5	-	2	-	-	-	-	-	-	-	1
Ras Al-Khaima Airport	Rainfall	17.8	121.7	2.2	18.0	-	-	8.5	-	-	-	0.6	8.1
	Rain days	3	12	1	3	-	-	1	-	-	-	1	3
Masafi	Rainfall	4.6	168.9	2.6	31.5	-	-	14.0	-	-	-	-	2.4
	Rain days	1	5	1	2	-	-	1	-	-	-	-	-
Buraimat	Rainfall	20.2	100.0	2.4	26.1	-	-	16.6	-	-	-	-	6.6
	Rain days	2	3	-	2	-	-	1	-	-	-	-	1
Degdaga	Rainfall	12.8	91.6	4.0	22.6	0.4	-	13.0	-	-	-	1.0	5.2
	Rain days	1	4	-	1	-	-	1	-	-	-	-	1
Diba	Rainfall	0.8	129.8	5.0	25.0	-	-	42.2	-	-	-	17.6	-
	Rain days	-	4	-	2	-	-	1	-	-	-	2	-

Source: Central Statistical Department (1989)

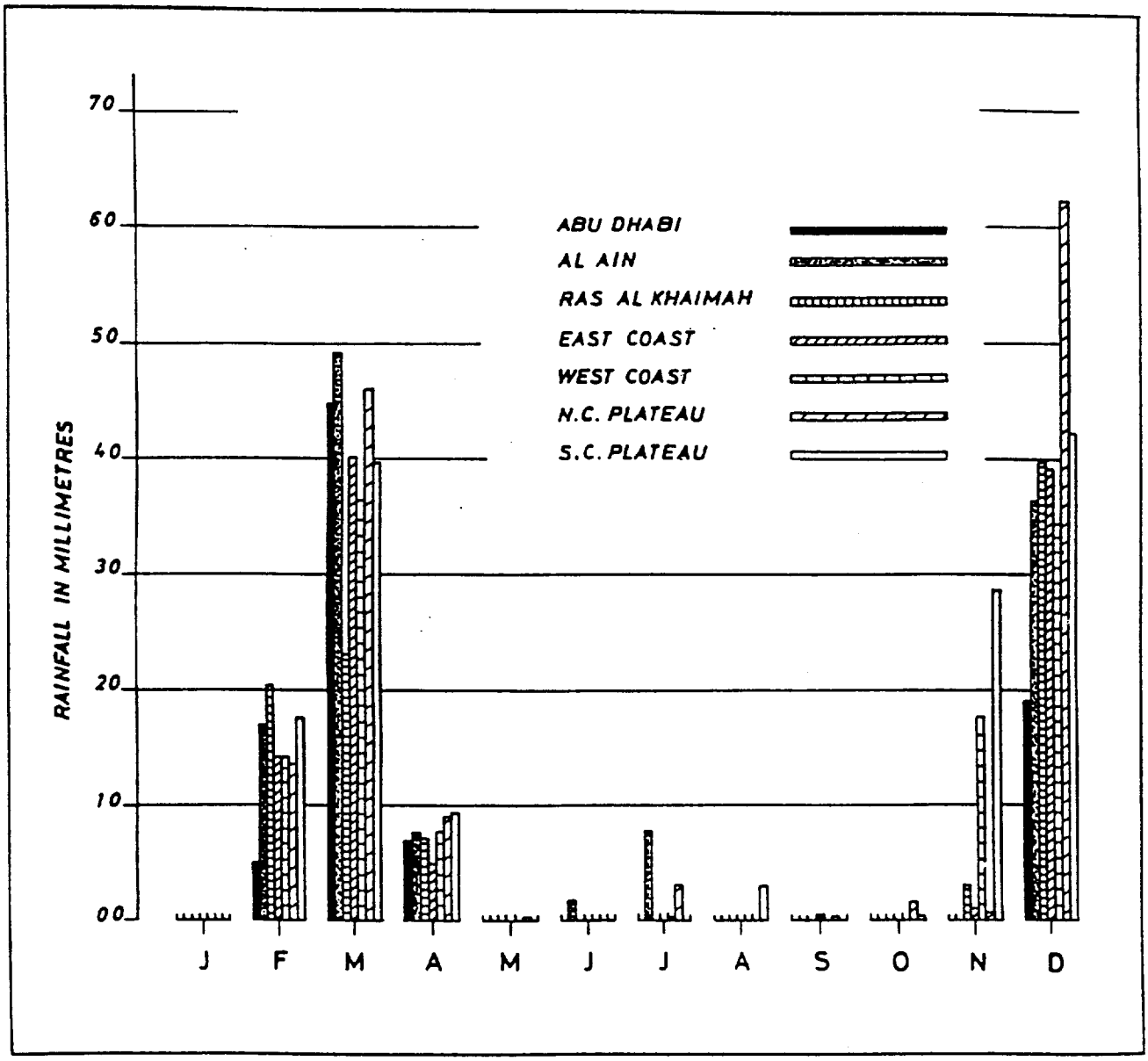


Figure 1.6 Total monthly rainfall in U.A.E. during 1989

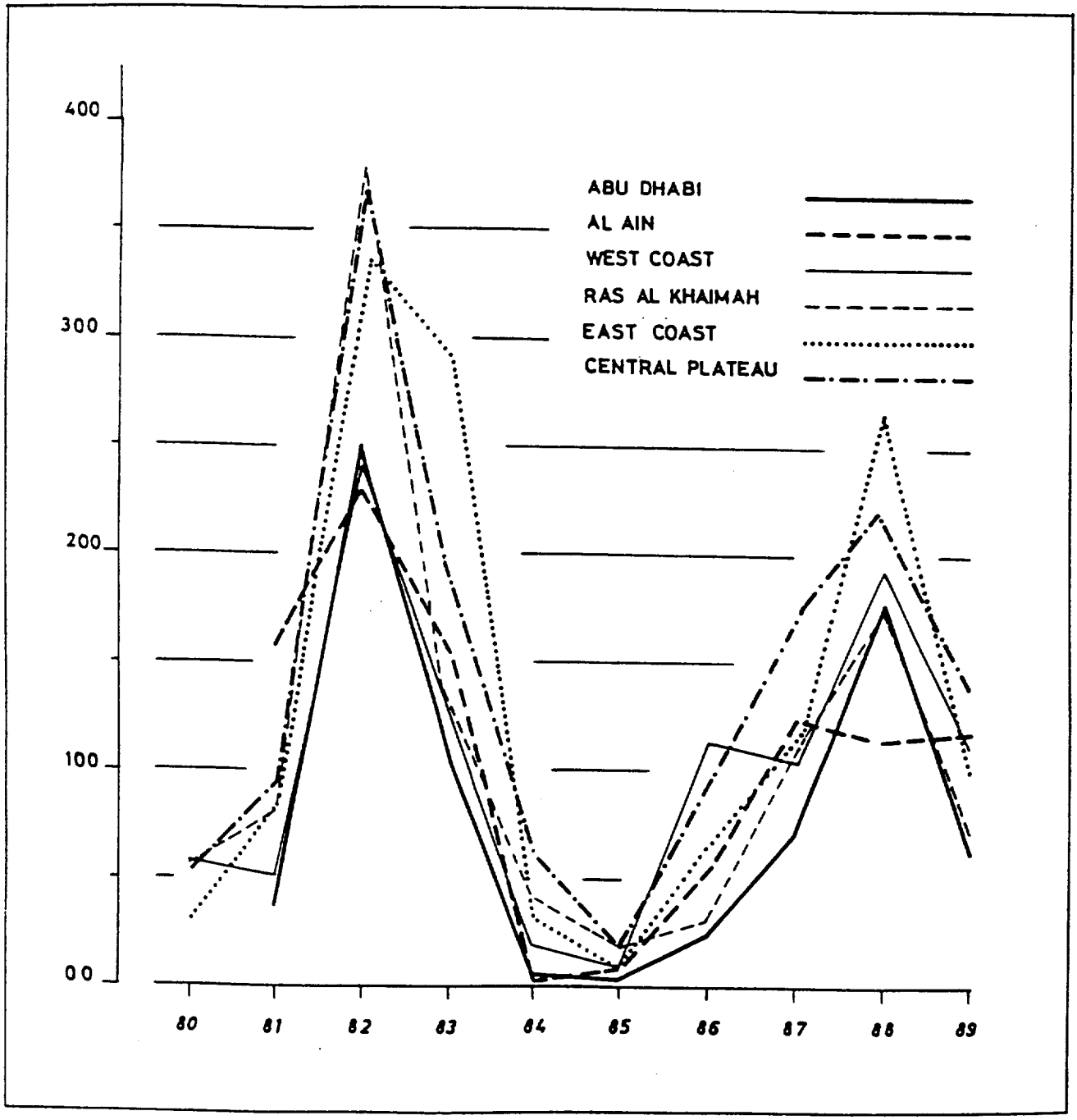


Figure 1.7 Annual rainfall in millimetre by region in U.A.E. during 1980-1989

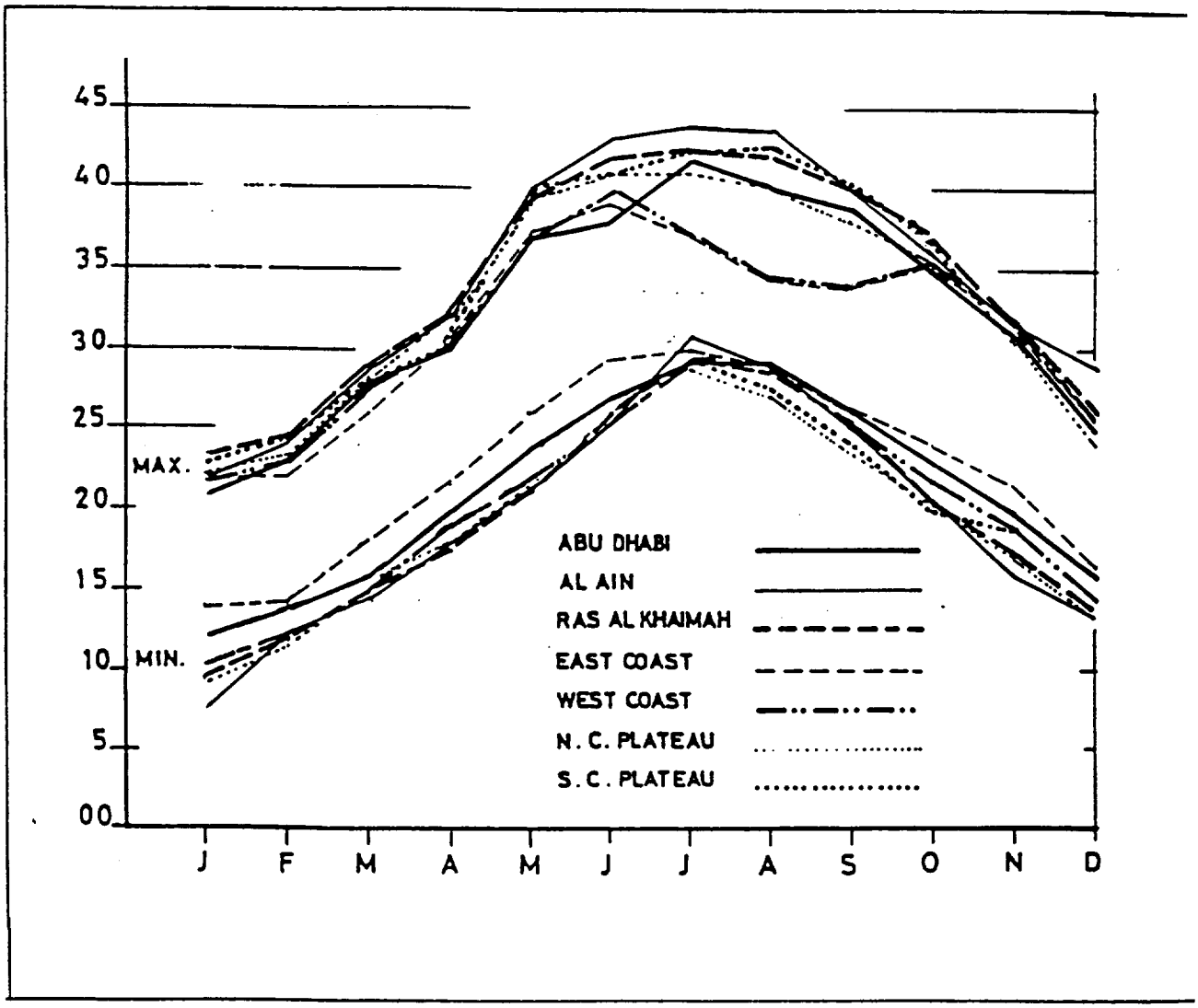


Figure 1.8 Monthly average max. and min. temperature in U.A.E. during 1989 (in ^{o}C)

during the month of January. The coastal areas are very hot and humid in summer. Temperatures rise steadily in all parts of U.A.E. from January to June/August where they attain their peak. Table 1.6 shows slight variation between temperatures on the coast and inland as temperatures tend to get higher towards the interior desert areas, and moderate in high areas, however, marked ones are easily recognizable between maximum and minimum temperatures.

1.2.2.3 Relative Humidity

Maximum average relative humidity percent was recorded between October and November. Visible differences are obvious in the different locations. The highest maximum record was registered in Digdaga and Falag Al-Mualla during January 1988 reaching 98%, and the lowest maximum was recorded in Dubai airport during October 1988 reaching 84% (Table 1.7). On the other hand, minimum average humidity percent was recorded during May and June. The lowest minimum average was 4% in Abu Dhabi during June 1988 and the highest minimum average (49%) being registered in Dubai during February 1988.

Monthly average relative humidity was less in the inland areas compared to that in the coastal regions. It was lowest during the early summer months (Fig. 1.9).

Local fogs are frequent in the early hours of the morning inland of the sabkhas. The relative cooling effect around Al-Dafrah, south of Abu Dhabi, causes moist air in that region brought in by afternoon sea breezes to condense and form fog. Cold air valleys between the dunes enhance this surface condensation effect and dense fogs might result which can penetrate to the coast. As solar radiation is weak in winter, it takes some time to burn off this fog. Advective fogs also occur, when air of high dew point over the sea moves landwards where it is forced to rise over the cooler and denser desert air. Such fog blankets might extend inland for up to 100 kms.

Dewfall is the only fairly regular source of moisture for plants since fogs and rain are mostly restricted to the winter and spring months. Dew does not occur every night, but it is a feature of a large number of nights each month, and in the summer constitutes the only source of surface moisture over much of the desert. Little data has been collected with the U.A.E., but the results of experiments conducted by a Royal Geographical Society team in the Wahiba sands south of Muscat in Oman in early 1986 indicate that dewfall is a most vital contribution to surface moisture.

1.2.2.4 Wind

The prevailing wind in U.A.E. tends to change between southern or south easterly, western or northern and northwestern. The area is occasionally hit by storm originating over the Arabian Peninsula. The persistent summer wind is the north west which occurs as a result of

Table 1.6 Max. and min. average temperature °C by month and station, 1988

Station \ Month		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Abu Dhabi Airport	Min.	11.7	14.8	16.7	20.1	22.5	25.3	29.1	28.8	26.3	22.2	18.2	14.4
	Max.	23.3	24.4	29.1	33.6	37.5	40.1	41.1	41.3	40.2	36.4	30.8	26.6
Al-Ain	Min.	8.8	12.8	13.8	18.7	20.2	23.7	30.0	28.4	25.0	20.8	17.0	14.6
	Max.	24.2	25.7	32.3	36.8	42.0	44.0	44.1	44.5	42.0	38.0	31.8	27.8
Dubai Airport	Min.	13.1	15.5	17.0	20.7	23.2	25.9	30.4	29.5	26.8	23.6	19.6	15.6
	Max.	23.4	24.0	27.3	31.8	35.2	38.7	39.5	40.4	38.2	35.4	30.7	26.5
Al-Hibab	Min.	11.3	14.4	16.7	19.0	21.8	24.6	29.5	27.8	24.1	20.1	15.5	12.0
	Max.	23.8	24.4	30.1	34.6	39.5	42.3	41.9	42.3	39.7	35.7	29.5	24.2
Sharjah Airport	Min.	11.3	14.1	15.5	18.4	21.6	24.1	29.1	27.7	24.9	20.8	16.8	13.1
	Max.	23.6	24.4	29.0	33.3	37.6	40.8	41.1	41.7	39.6	36.5	31.4	26.9
Kalba	Min.	...	...	...	...	...	...	...	...	...	...	...	...
	Max.	...	...	...	...	...	...	...	...	...	...	...	...
Meleiha	Min.	10.9	13.9	15.7	20.4	21.7	24.7	30.1	28.7	24.4	20.0	16.5	12.8
	Max.	24.2	24.9	30.9	36.2	41.7	44.1	32.9	43.8	41.6	38.3	32.5	27.7
Masfut	Min.	11.9	14.4	14.9	19.8	23.3	26.1	28.9	27.9	25.3	21.1	16.3	12.9
	Max.	21.9	23.1	31.2	36.9	41.1	42.4	38.9	39.3	38.7	36.1	30.3	25.1
Falag Al-Mualla	Min.	10.6	14.1	15.1	16.6	21.0	23.8	29.4	28.0	23.5	19.6	16.4	11.5
	Max.	24.3	25.0	30.5	36.0	41.1	43.4	42.3	43.0	40.1	38.0	33.0	22.7
Ras Al-Khaima Airport	Min.	11.7	15.0	16.4	19.2	23.3	25.6	30.5	29.6	25.3	21.0	17.1	13.2
	Max.	24.2	25.1	29.9	34.7	39.9	42.5	41.3	41.4	40.1	37.2	32.4	28.0
Masafi	Min.	12.6	14.5	16.7	21.8	25.8	28.1	28.7	27.9	26.2	23.1	18.8	15.0
	Max.	21.3	21.9	28.4	32.7	39.4	41.2	38.3	38.1	37.0	35.0	29.6	24.5
Buraimi	Min.	15.4	15.9	18.6	23.2	27.0	29.2	31.9	31.5	28.2	24.6	21.1	17.2
	Max.	23.4	25.7	28.8	34.7	38.2	41.0	39.8	39.7	38.2	35.5	30.9	26.7
Dagdaga	Min.	10.1	13.1	17.3	20.0	21.4	23.7	29.3	27.4	23.3	18.5	14.7	11.4
	Max.	25.2	25.8	30.5	36.9	40.7	42.2	41.4	41.4	40.0	37.7	31.9	28.8
Diba	Min.	15.7	18.9	17.9	24.5	27.3	31.1	...	30.2	26,2	23.8	20.8	17.2
	Max.	24.4	25.3	29.9	34.4	38.2	41.0	...	35.8	34.3	34.4	29.7	25.7
Fujeira	Min.	16.0	16.4	19.6	25.7	29.1	30.6	30.8	29.9	28.5	25.5	22.4	17.2
	Max.	24.4	23.4	29.0	35.6	38.2	39.8	35.6	34.9	36.5	34.4	30.6	27.0

Source: Central Statistical Department (1989)

Table 1.7 Max. and min. average relative humidity % by month and station, 1988

Station \ Month		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Abu Dhabi Airport	Min.	39	52	31	26	25	24	29	32	29	30	37	41
	Max.	86	88	82	81	83	80	80	86	88	85	83	84
Al-Ain	Min.	24	38	...	08	03	04	...	...	22	10	31	37
	Max.	97	75	...	65	68	67	...	...	79	71	89	92
Dubai Airport	Min.	42	52	43	34	36	33	42	38	37	36	37	43
	Max.	75	83	83	76	77	78	79	83	87	84	75	78
Al-Hibab	Min.	32	49	17	13	05	09	23	16	15	15	19	18
	Max.	95	98	89	87	86	88	85	86	89	95	97	80
Sharjah Airport	Min.	37	45	29	28	26	26	34	31	29	28	31	37
	Max.	83	84	84	83	85	84	76	82	88	88	82	86
Kalba	Min.	...	...	...	...	...	...	...	...	...	...	...	...
	Max.	...	...	...	...	...	...	...	...	...	...	...	...
Meleiha	Min.	33	43	13	15	10	22	30	21	13	11	20	25
	Max.	90	95	90	81	81	93	85	93	91	93	93	96
Masfut	Min.	20	29	07	08	05	08	31	28	13	06	10	12
	Max.	94	95	87	55	59	59	93	93	84	92	93	93
Falaj Al-Mualla	Min.	36	41	10	11	04	07	23	13	59	11	17	...
	Max.	95	90	85	85	84	82	85	90	88	96	98	...
Ras Al-Khaima Airport	Min.	42	51	33	28	25	30	39	37	33	28	32	38
	Max.	88	90	84	79	76	79	77	78	84	84	82	85
Masafi	Min.	33	43	13	12	04	12	34	29	17	08	32	40
	Max.	90	95	90	56	54	61	93	91	73	71	91	95
Buraimi	Min.	41	52	30	16	22	15	34	35	28	...	...	...
	Max.	91	94	88	74	77	80	80	85	85	...	...	...
Degdaga	Min.	32	36	25	22	23	16	26	25	26	29	38	35
	Max.	98	96	96	95	89	93	91	97	96	95	99	95
Diba	Min.	28	43	26	07	13	35	...	56	36	27	33	36
	Max.	71	77	80	77	66	94	...	94	92	88	84	87
Fujeira Airport	Min.	46	58	40	30	26	32	62	63	44	40	42	45
	Max.	80	90	84	74	75	80	86	86	80	76	72	78

Source: Central Statistical Department (1989)

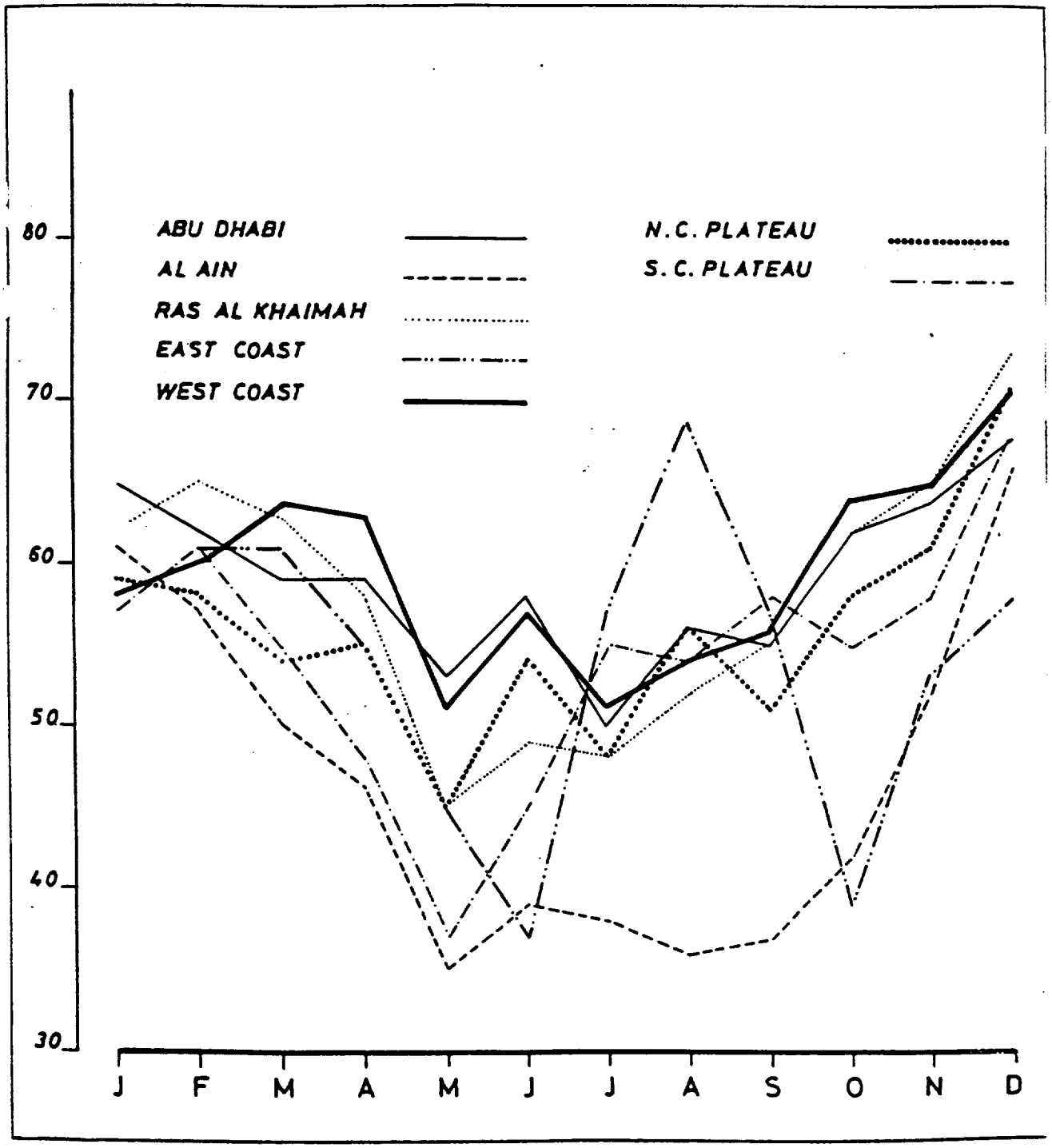


Figure 1.9 Monthly average relative humidity in U.A.E. during 1989 (in%)

two circulating pressure centres, a low one over Iran and Afghanistan and a high one over Saudi Arabia. The Gulf in between acts as a conduit for enhanced winds from surface level up to 500 feet, and it is this force which brings so much dust haze into the country. The winds generally drop during the night. In the winter the winds are more variable (Table 1.8) but velocities are raised during storms caused by low pressure and passing jet streams (Table 1.9).

Mean daily sunshine for the year is 10.3 hours at the new Abu Dhabi airport (1985 records) with a maximum mean of 11.4 hours in June and a daily mean of 8.4 hours in January.

1.3 Natural Resources

Man is the user of natural resources and consequently presents a major threat to their future availability. Population growth and rapid development in U.A.E. are placing constantly increasing demands on natural resources, particularly water (Table 1.10). In addition, over-exploitation and poor management in some areas have led to serious modification or depletion of the natural resources on which many lives depend.

Table 1.10 Number of productive and unproductive wells according to the regions for the year 1988

Item			
Region	Total	Unproductive Wells	Productive Wells
Western	4194	49	4145
Central	8615	830	7785
Northern	3159	148	3011
Eastern	21076	1383	19693

Source: Planning and Statistical Office (1987-1988)

1.3.1 Water Resources

Supply of water is fundamental to sustain life and support economic activity. Increasing population, with supporting agricultural and urban use imply rapidly increasing demand for fresh water. Given a very limited recharge due to climatic factor, the balance of hydrological cycle is effected. Data on water resources in the U.A.E. in this report represents a compilation from various study reports and gives an approximate measure of the national water resources.

Table 1.8 Average Monthly Summary of Surface Wind Speed km/ H in U.A.E. for the year 1988

	Al-Birieart	Ras-Al-Khaimah Airport	Sharjah Airport	Abu Dhabi Airport	Dubai Airport	Dabba	Al-Dagdaga	Masfout	Masafi	Kelhalmahla	Malieha	El-Hibab
January	4.1	9.3	11.1	13.0	13.0	8.9	1.6	6.6	6.9	2.3	2.9	2.7
Februay	4.5	11.1	11.1	16.7	14.8	9.7	-	8.3	7.5	3.5	3.6	3.8
March	5.9	10.6	12.8	14.8	14.8	12.7	2.0	7.6	7.3	1.2	5.0	6.5
April	5.2	9.	11.0	12.0	13.0	9.5	2.0	6.1	6.8	2.0	3.5	5.1
May	6.	11.1	11.9	13.0	13.0	-	2.4	6.2	6.6	-	4.1	6.4
June	5.5	11.7	12.8	14.8	14.8	11.6	2.9	7.1	7.5	2.9	4.6	7.1
July	6.5	11.1	13.	13.0	14.8	3.4	2.2	-	20.6	4.2	4.5	6.6
August	4.9	11.1	11.1	13.0	13.0	6.9	1.8	9.9	11.3	3.7	3.7	5.9
September	4.3	9.3	11.1	13.0	13.0	6.7	1.8	8.2	8.6	2.9	3.1	5.0
October	3.5	8.1	9.3	-	11.1	5.4	1.3	5.1	5.9	2.3	2.1	3.8
November	2.8	7.2	9.3	11.1	11.1	6.3	-	4.8	5.5	1.	1.3	2.9
December	-	7.8	9.3	11.1	11.1	7.4	1.1	5.3	6.1	1.9	1.5	4.1

Source: Planning and Statistical Office (1987 - 1988)

Table 1.9 Average atmospheric pressure at sea level by month and station (in millibars), 1988

Station / Month	Fujeira Airport	Ras Al-Khaima Airport	Sharjah Airport	Dubai Airport	Abu Dhabi Airport
January	1018.2	1017.9	1017.7	1018.3	1017.9
February	1015.8	1015.3	1015.0	1015.5	1014.7
March	1011.9	1012.1	1012.0	1012.4	1012.1
April	1009.6	1010.5	1010.3	1010.3	1009.9
May	1004.3	1005.2	1005.1	1005.0	1005.1
June	999.4	1000.0	1000.0	999.7	999.8
July	997.3	996.3	996.4	995.9	995.6
August	1000.1	998.7	998.7	998.3	998.0
September	1004.5	1004.1	1004.0	1003.7	1003.3
October	1011.3	1011.4	1011.2	1011.1	1010.7
November	1016.3	1016.5	1016.2	1016.4	1016.1
December	1017.4	1017.7	1017.4	1017.7	1017.2

Source: Central Statistical Department (1989)

Water resources in the U.A.E. originate from two main sources, groundwater drawn from aquifers and desalinated water from the Gulf. Surface water flows do not occur except during periods of flood and are quickly absorbed into the groundwater system, or evaporated into the sea. Treated sewage effluent is reused as source of irrigation water for the gardens scattered in most urban areas. Desalinated water is mainly used for domestic and industrial consumption after being blended with brackish groundwater. Groundwater, on the other hand, is principally used for irrigation of agriculture and forestry as well as to complete domestic and industrial consumption.

1.3.1.1 Groundwater

Underground aquifers throughout the country continue to be depleted as the investment in agriculture grows. As the aquifers are depleted salinity levels rise and seawater seeps into coastal areas.

In Abu Dhabi Emirate groundwater is drawn from two main aquifers of Al Ain and Liwa. Within the Emirate, groundwater aquifers hold most of the sweet and brackish water reserves.

Abstraction rates have been increased substantially since 1970 exceeding the natural recharge for the aquifer. In 1985, abstraction of fresh water for domestic uses and agricultural demands totalled 108 mm^3 and abstraction of brackish water totalled 329 mm^3 for agriculture and forestry. W.S. Atkins and Partners estimated the cumulative depletion of sweet water reserves for the period 1970-89 at 1222 mm^3 fresh water.

Cumulative depletion of sweet and brackish groundwater reserves for the period 1986 to 1987 is estimated at 950 mm^3 and has lately been on the increase.

1.3.1.2 Surface Water

Apart from a few permanent wadis in near-inaccessible areas, and the surface water channels in oasis (AFLAJ), there is no lasting source of surface water present in U.A.E. Rainfall on dunes infiltrate to various depths depending on the intensity and period of precipitation. After brief summer storms the sandy hollows between dunes can be damp to a depth of up to 20 cm though at that time of year the dune surfaces dry out fast.

Relatively fresh water accumulates beneath the dunes along the coasts, sufficient in the past for the establishment of urban communities, including the major towns of the Gulf littoral.

Apart from irrigation, the only other forms of moisture available for plants is dew and night fog. Although neither of these contributes to water shortage in soil they are important for shallow and lateral-rooting species.

1.3.2 Land Resources

1.3.2.1 Landforms

The whole land surface can be thought of as comprising a mosaic of land forms of various sizes ranging from mountains, plateaus and plains to wadis, dunes and small hills. Those land forms are not distributed haphazardly on the earth's surface, but each of them represents a component in a set of forms forming morphologic systems.

Space images provide an excellent tool for analyzing landform systems in the United Arab Emirates. Although the land surface of this country is characterized by its diversity in landforms, inspection and interpretation of space images made it possible to divide the forms in three major groups. The landforms in each group are linked together by a specific type of process acting at present or acted in the past on them, forming process-response systems. These systems are the aeolian system, the mountain-bahada system and the coastal and marine system (Fig. 1.10).

The aeolian system is the most wide-spread one in U.A.E., since its landforms prevail in about 90% of the total area of the country. This vast area is originally a stony to gravelly undulating plain, extending westwards from the bahada subsystem of Oman Mountains to the coastal system and southwards beyond the U.A.E. boundaries to Saudi Arabia. This plain is also characterized by the presence of inland sabkhas which cover several wide tracts in various localities in the west (Mati), south (Liwa), north-east (Umm Al-Qwain) and north (south Abu Dhabi), and which control the flow of sand material by wind energy.

Landforms of the aeolian system are mainly sand dunes and are composed of medium size loose sand (0.25 - 0.30 mm). They are shaped by wind energy. Analysis of wind data of Dubai and Abu Dhabi stations (Table 1.11) reveals that the frequency percentage of sand moving winds is higher in Abu Dhabi (24.1%) than in Dubai (19.1%). Although in both stations, sand moving winds blow from all directions, the prevailing directions are from NW and N in Abu Dhabi and from W and NW in Dubai. In both stations wind velocities of 11 - 16 knots predominate but winds of higher velocities are more frequent in Abu Dhabi than in Dubai. When sand drift potentials were calculated for both station from Table 1.11, it was found that wind energy environment is intermediate in Abu Dhabi (247 vector unit) and is low in Dubai (96 vector units). This explains why dune density is higher in subsystems lying southwards of Abu Dhabi.

It is expected that 73% and 65% of sand drift potentials are coming from W and NW directions in Dubai and from NW and N directions in Abu Dhabi respectively. A reasonable percent of 20% of sand drift is expected to come from NE and SE and S in Abu Dhabi, while in Dubai a relatively smaller percentage (15%) of sand drifts is expected to come from SW and S directions. This means that sand source is more diversified in Abu Dhabi area than in Dubai region.

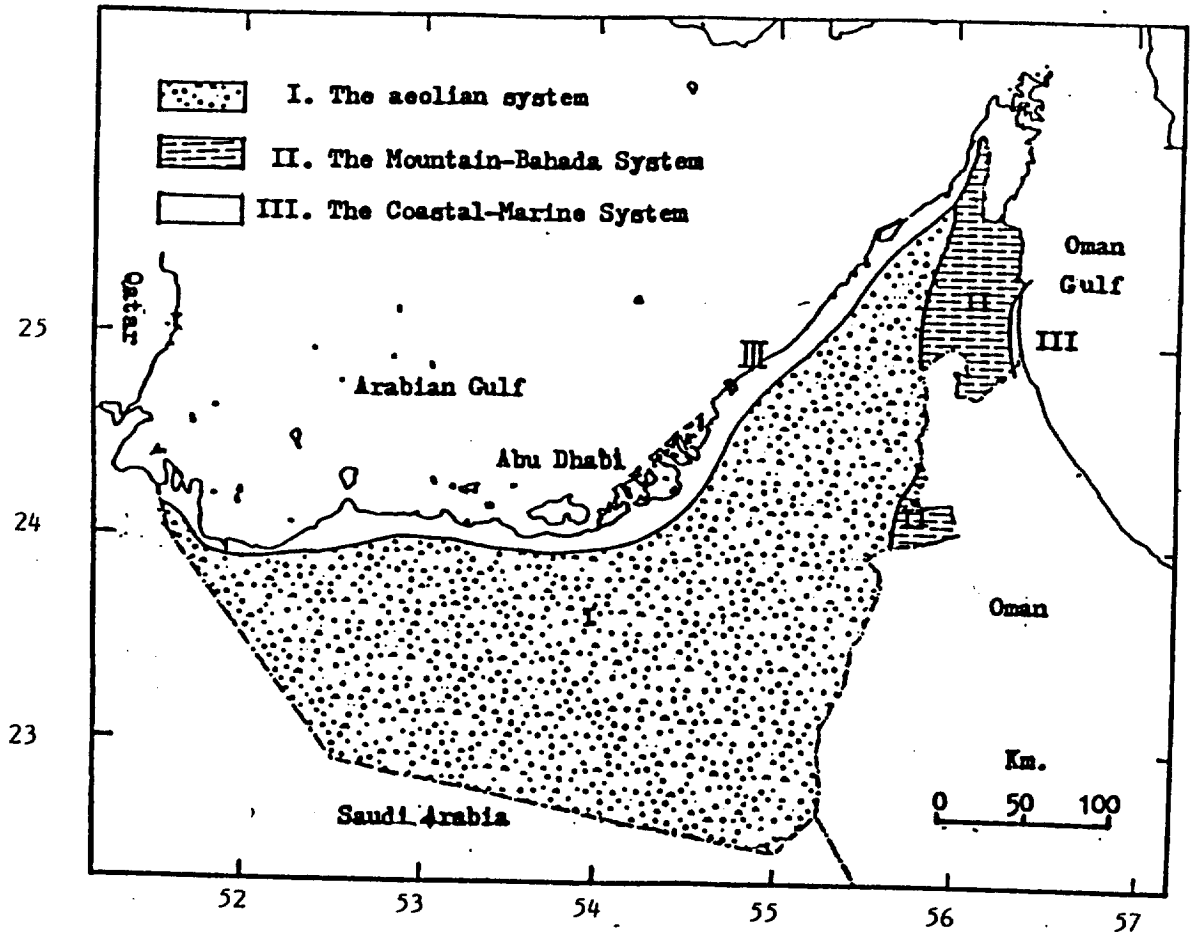


Figure 1.10 Landform system in U.A.E.

Source: Embabi and El-Sharkawy (1990)

Table 1.11 Percentage occurrence of sand-moving winds in Abu Dhabi and Dubai

Wind Direction (Degrees)	Wind Velocity Categories (Knots)							
	Abu-Dhabi				Dubai			
	11 - 16	17 - 21	22 - 27	Total	11 - 16	17 - 21	22 - 27	Total
20 - 40	1.5	0.50	-	1.65	0.2	-		0.20
50 - 70	0.7	0.50	-	1.20	0.2	-	-	0.20
80 - 100	0.20	-	-	0.20	0.6	0.01	-	0.61
110 - 130	0.40	-	-	0.40	0.4	-	-	0.40
140 - 160	1.20	0.25	0.25	1.70	0.5	0.04	-	0.54
170 - 190	0.65	0.50	-	1.15	0.9	0.10	0.01	1.01
200 - 220	0.20	-	-	0.20	0.5	0.03	-	0.53
230 - 250	0.20	-	-	0.20	1.4	0.20	-	1.60
260 - 280	0.70	-	-	0.70	4.3	0.60	0.04	4.94
290 - 310	3.00	0.80	0.30	4.10	4.2	0.30	0.03	4.53
320 - 340	7.60	1.25	0.40	9.25	3.0	0.40	-	3.40
350 - 10	2.60	0.80	-	3.40	1.1	0.10	-	1.20
TOTAL	18.60	4.60	0.95	24.15%	17.3	1.78	0.08	19.16%

Source: Embabi and El-Sharkawy (1990)

But in both, however, the most probably main source is beach sands. A secondary source is the inland fluvial deposits of the bahada subsystem. Although the aeolian system in the U.A.E. is a part of the vast sand sea of El-Rub El-Khali, dunes are locally organized into various secondary systems according to wind environment, sand supply and local relief. Three major subsystems can be recognized, i.e. the linear subsystem, the mega-barchan subsystem and the transverse subsystem.

The mountain-bahada system in U.A.E. is a part of Oman Mountains which extend mainly in the Sultanate of Oman. In the U.A.E., this system covers an area which extends 150 km in a S - N direction, and 50 km in an E - W direction at its widest portion. The mountains themselves coincide with a major upward zone, but the bahada is a depositional compound subsystem which is dependent on the energy of water flowing on the slopes of the mountains. Since the mountains form a watershed, two bahadas developed at the footslopes of both sides of the mountain range. At present, no permanent streams are flowing due to the aridity of climate. Therefore, the landforms of this system (wadis and alluvial fans) are not forming under present arid conditions. They are inherited from previous times when there was enough rainfall to develop permanent running water.

Although the mountain and bahada form one landform system, each is characterized by specific forms due to difference in material and energy flow. Therefore, they are divided into two subsystems (Fig. 1.11) i.e. the mountain subsystem and the bahada subsystem. The coastal and marine systems develop along the western and eastern coasts of U.A.E. Energy of this system comes from water movement along the coasts or in the near shore zone. Along the Gulf and Oman Gulf coasts, there are three coastal actions. Along shore current moving eastwards in the Gulf, wave action and tide action. The energy of each process depends on several variables e.g. wind velocity, coastline orientation, rock type structure, relief of the coastal area, and marine sediments. Therefore, it is more probably that several coastline marine subsystems develop and evolve along long coastlines like those of the U.A.E. where such variables change locally. In each subsystem, a group of forms develop contemporaneously or consecutively due to the presence or absence of some variable or when the three marine processes work together or separately. Inspection of space images reveals the presence of four subsystems, i.e. the embayment subsystem, the barrier island-lagoon subsystem (Fig. 1.12) and the beach-sabkha subsystem. In the meantime, landform characteristics and type show that two of the landform systems in U.A.E. are still operating at the present time (the aeolian and coastal and marine systems), while the third one, the mountain-bahada system, is not working. Landforms of the latter system are inherited from previous times, when operating environment processes were different. At present, the inherited forms of this system might be modified slightly when water flow - which occurs not frequently - has the energy to carry out

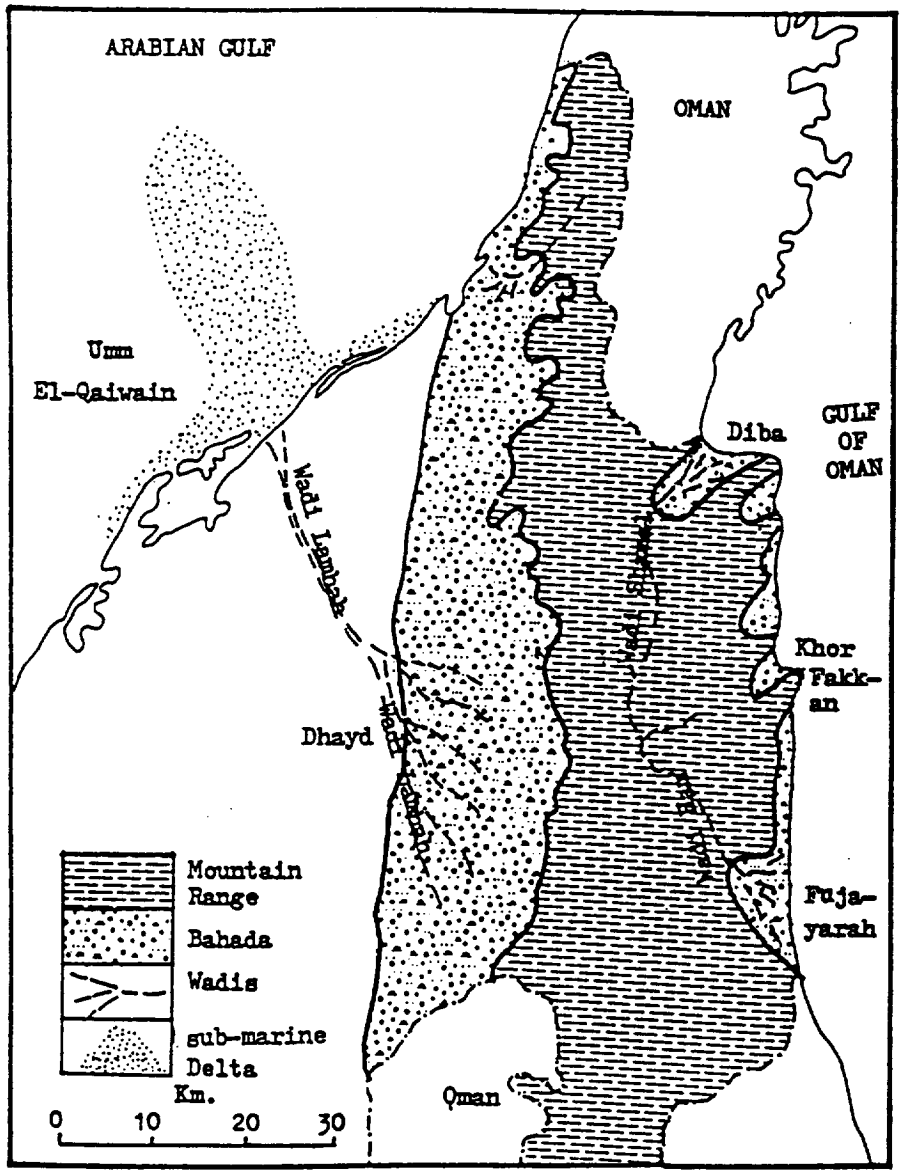


Figure 1.11 **Morphological features of the mountain-Bahada System**

Source: Embabi and El-Sharkawy (1990)

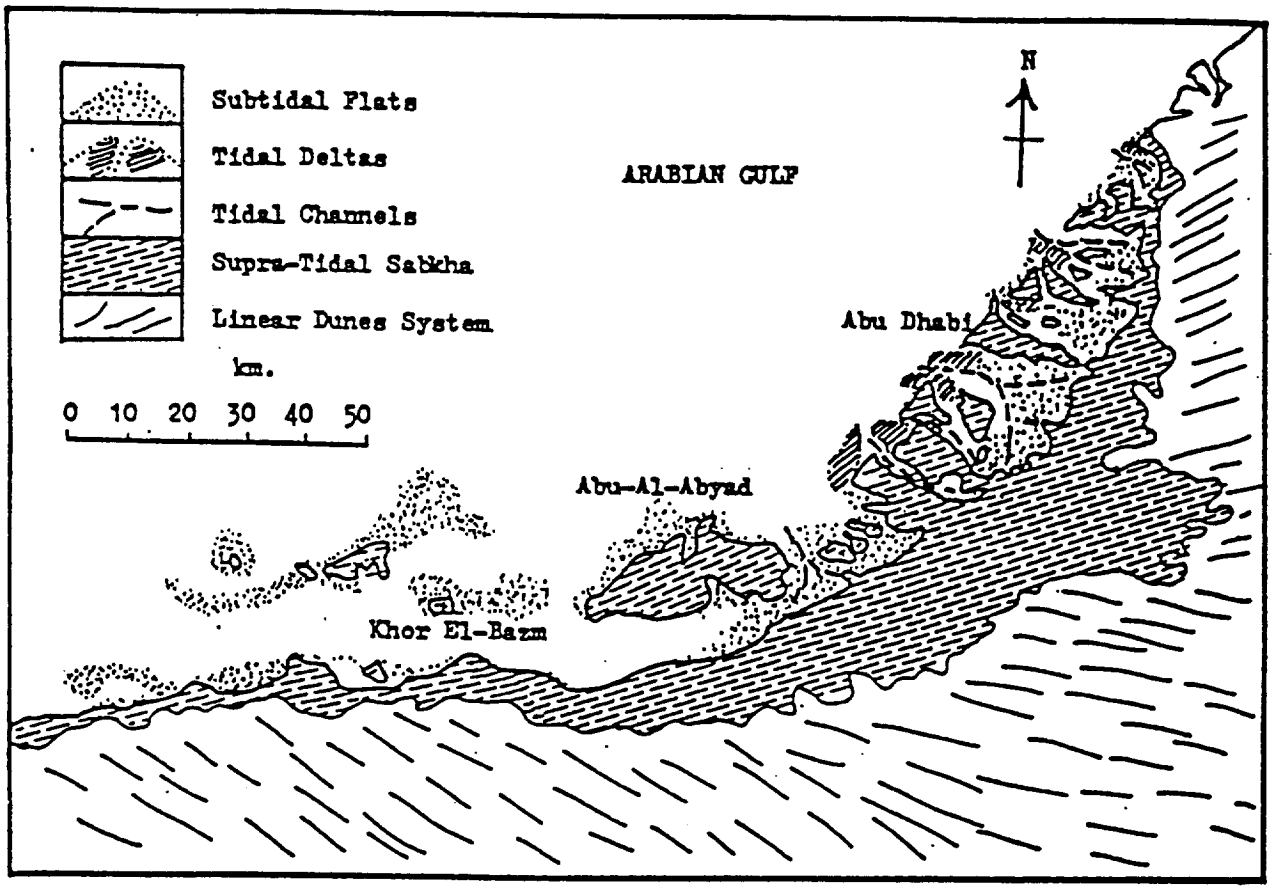


Fig. 1.12 Morphological features of the Barrier islands - Lagoon Subsystem

Source: Embabi and El-Sharkawy (1990)

the weathered material from the mountain to the bahada or to the sea.

Due to present arid conditions, the prevailing wind environment, and the spatial distribution of the three systems, interaction takes place between them. This is due to the fact that material output from one system becomes input of another system. This is also because some modification may occur in the forms of one system by the processes of other systems. Marine sand is driven inland by N, NW, W prevailing winds, contributing to the material supply necessary for the development of aeolian landform system. Also winds occurring from E, SE and S directions drive off sand material from the bahada subsystem representing another source of material for the aeolian system. It is expected, at present, that winds from these latter directions might carry out aeolian sand from inland to the coastal areas. In the past and occasionally at present, water flow carried out material removed from the mountain block directly to the sea or to coastal zone leading to the development of specific forms like the sub-marine delta of Wadi Lamhah, or contributing to the material of costal spits and beaches. Water flow at the bahada surface modifies at present the marginal aeolian forms which are formed along the contact zone between the bahada and the aeolian systems.

1.3.2.2 Soil Types

The sabkha deposits adjoining the coast between Qatar and Dubai often have a deep profile but the texture is poorly developed because of the anaerobic conditions between a high water table and a surface crust of salts and gypsums. These soils are devoid of surface vegetation. The western region of Abu Dhabi Emirate contains the bulk of high, unstable aeolian dunes of mixed fine-grained sand in the country. There is little or no horizon differentiation and plants have a precarious existence on the steeper slopes. The gravel depressions in the central plains are very close to the water table which varies from between one and ten meters below the surface in most of such regions. Samples of subsurface water from the Abu Dhabi to Sueyhan Road analyses in August 1984 gave the following figures: 50 kms inland from the coast samples contained up to 36 grams per liter of dissolved salts and a high magnesium and calcium content, 25 km further inland the figure was up to 46 gms/liter but with lower magnesium and calcium content. Both samples came from a water table less than one meter below the ground surface.

The gravel plains around Al Ain, Madam, Dhaid and Khatt are partly sandcovered to a shallow depth. The gravel layer itself is often thin and might overlie a horizon of loamy calcium which is low in nutrients, phosphorous in particular being unavailable in natural form. Continuous irrigation leads to a leaching and the development of salinity at higher levels, affecting all vegetation. Further east are alluvial soils with a high lime content. Soils here are often deep though not well consolidated and despite the frequency of Acacias sp., the number of

perennial species tends to be limited. The mountain soils are often rich but shallow because of extensive runoff, though in places terraces have been built in the past to create and preserve silt deposits suitable for cultivation. The cracks and crannies present on all mountain slopes, however, still contain a large number of perennials even to the summits, and they also support the widest variety of ephemerals of any physiographic zone in the country.

In general, biological activity in local soils is very low, and less than one percent of the whole country (MA & F, Annual Statistical Bulletin) of Agric. & Fides 1991 is naturally suitable for arable farming. The only soils that tend to develop in the flat surface of a desert environment are fine-grained silts, the result of rainwater runoff collecting in large pools. Initial absorption of water is high, but the clay particles swell and the soil rapidly seals into a pan. The surface water is then evaporated, resulting in a precipitation of salts and attendant problems.

1.3.2.3 Soil Characteristics

In terms of fertility, the soils in U.A.E. are generally characterized with their alkaline pH value which ranges between 7.5 and 8.5. The calcium carbonate content varies, in soils, between 25 and 40% and may reach 90% in certain sites. The organic matter content is very low, not exceeding 1% in most soils, and is decomposing at a distinctively high rate. The higher the colloidal fraction, organic and/or mineral, in soil the higher the cation exchange capacity, which lies in the soils of U.A.E. between 6 and 12 milliequivalent/100 gm soil.

As regards texture, the prevailing soils in U.A.E. have a sandy texture mixed in many cases with fine and coarse gravels. The most important soil property affecting agricultural production in U.A.E. is the salinity of soil and water. Most of U.A.E. soils are affected with salts, however, at varying extents.

1.3.3 Natural Vegetation

The U.A.E. offers an interesting and quite varied range of vegetation. The average rainfall in the country is low, however, plants have adapted various mechanisms to compensate for the lack of rainfall and to the conditions of extreme heat, high salinity and overgrazing.

The mosaic of habitats and associations throughout the U.A.E. represents present status only. Whether bordering the salt flats, or in mountain crevices, or among the high dunes, each habitat contains fairly distinct associations, but this remains true only while present conditions prevail. The vegetation cover fluctuates according to a number of variables, including short-term climatic change and the influence of man's pressure upon finite land resources. A steady increase in rainfall over a number of years would very likely result in the establishment of a greater number of perennials. This was dramatically

illustrated by the vast increase in the number of Zygophyllum hamiense plants in depressions along the road between Abu Dhabi Airport and Sueyhan attributable directly to the heavy winter and spring rains of 1982 and 1983. On the other hand, man's exploitation of the desert can have the opposite effect. The raking of surface soils for the construction industry has left patches of eroded and depleted desert, an increase in windborne particles and the disappearance of some species of the original vegetation. The resilience of some species even in the most disturbed areas, however, is a tribute to nature's capacity for survival against the odds.

There is not the same distinction of seasons in the U.A.E. as in temperate climate. The transition from winter to summer is fairly rapid in terms of temperature rise and plants and seeds respond to the stimuli of increasing warmth in soil and air, as well as to the presence of moisture. Given that there is sufficient depth of soil there is a surge in growth, though this might not be luxuriant if rainfall has been minimal.

1.3.3.1 Basic types of vegetation

Three basic types of vegetation are able to cope with desert environment in U.A.E.

The first type, **Ephemerals**, consist of herbaceous, non-woody species which opt out of the most rigorous months of the year by remaining dormant as seeds. They constitute over half of all plant species present, and have a typically short growing and reproductive season. Roots are shallow, the mature plant small or slender, but they do produce copious amounts of seed, much of which is lost by various means but enough always survives to ensure the continuation of the species. In the U.A.E. there are both winter and spring ephemerals, but the vast majority and those making the strongest visual impression appear as the temperatures gradually rise between February and May.

The second type, **Succulent Perennials**, occur when the outer leaf or stem cells enlarge so as to increase volume for water storage. A waxy layer on the outside prevents moisture loss as well as lending extra support for the leaf and/or stem. Such plants are very common fringing the coasts, sabkha and in the land depression in U.A.E. They can usually tolerate a high level of salinity and are often fleshy throughout the year. Many of them flower in the summer and autumn, but the petals are generally minuscule, yellow or white and should not be confused with the papery fruit wings that follow on several species.

The third type, **Woody Perennials**, are dominant in terms of individual size, as this category includes trees and most larger shrubs. Numerically, however, they constitute the smallest type. All species in this group are tough and able to contend with heat, wind, drought and herbivores. These plants are slow growing with long, central root system to tap deep aquifers. Seeds are less numerous than

is the case with other types, but tend to be individually larger and very tough.

1.3.3.2 Plant Associations

The coastal zone of the U.A.E., which includes lagoons and mudflats, harbours salt-tolerant plant types including the dwarf mangrove. The semi-desert zone, whose plant communities differ based on soil types, is located immediately inland from the coastal sabkhas and is vegetated by various types of grasses, low lying bush and prosopsis and acacia trees.

The desert zone, which is composed of wind blown deposits of sand, is considerably less saline than either the coastal or semi-desert zones. Calligonum comosum is a typical shrub that appears as a small tree in its favourable habitats. Some grasses also appear in the desert zone, although less common in the other zones, as well as a smaller number of plants which occur in the more sheltered areas. Unlike other zones, the hill zone in the U.A.E. which is confined to the east and north bordering the Oman Mountains, has a rich variety of flowering plant species throughout the year.

The vegetation is open throughout most of Abu Dhabi Emirate, increasingly so towards the south and west. The other emirates, which lie between them occupy less than a quarter of the U.A.E. total land area, have a denser vegetation cover due to varying factors of topography, soil structure and water supply. These factors make it difficult to classify the country into distinct bioclimatic zones, especially as changes do occur in vegetation patterns over the short term. An exceptionally wet season, for example, affects the cover of ephemerals and might enable some perennial species to become dominant locally. The cover of some off-shore islands has been totally altered by man's activities and urban areas have also seen dramatic changes in a short time. Vegetation patterns are never static even in untouched localities, though most species rely on certain environmental parameters such as water supply, shade and adequate soil depth. There is also a strong relationship among species, whether in competition or in dependence (e.g. parasites), or in complement (e.g. the different root depths of perennials and ephemerals).

Since high temperature, low rainfall and salinity level are vital factors in the U.A.E. environment, natural species tend to fall under the following classification:

1. Halophytes (salt tolerant plants)
2. Xerophytes (drought resistant plants)
3. Phreatophytes (characterized with long root systems)
4. Ephemerals (winter/spring annuals)

Grazing is also an important factor, but adaptation in order to survive is a feature of desert plants.

Given these constraints, the vegetation in the U.A.E. is fairly rich, running into several hundred individual

species. There is a high number of distinct habitats, each of which contains a range of species known as a plant association. Knowledge of habitat, therefore, can help in the identification of major species.

Chapter II
The Socio-Economic Setting

2.1 Economic Development

The U.A.E. has witnessed drastic changes in its development since 1971 as a result of great economic achievements. The standard of living has risen to high levels with social, health and educational services now reaching all parts of the country. An advanced industrial base has been built and the agriculture sector has been able to meet a large part of local demand for foodstuffs. The policy of intensive investment in different sectors of the economy after the establishment of the Federation has played a major role in boosting the economy.

The economic policy depends mainly on the following points, as specified in a governmental document outlining development objectives in U.A.E.:

a. Achievement of balanced economic social and cultural development.

b. Providing support for the national economy and boosting its resources to realise self-reliance by utilizing the accomplishments made in the country and diversifying activities.

c. Fulfillment of the country's national requirements in the field of social services.

d. Ensuring community welfare and social justice as one of the main goals of development by continuously increasing living standards in consumption and social services.

e. Development of national manpower.

The general economic situation has recovered since 1987 due to a relative improvement in the oil market and the domestic policy adopted during 1982 - 1986. The Gross Domestic Product (GDP) rose by nine per cent in 1987 over 1986. The year 1988 saw the resumption of expansion in economic activity and led to a boom in 1989 as is clear from economic activities.

2.1.1 Gross Domestic Product (GDP)

It is evident in Table 2.1 that the share of the oil sector in the GDP declined from 63.2 per cent in 1980 to 32.0 per cent in 1986 due to the recession in the economy, instability in the region caused by the Iraq-Iran war as well as the decline of oil prices to a low level in 1986. Thereafter, the oil sector's share began to increase and reached 46.6 per cent in 1990. The share of non-oil sectors rose from 36.8 percent to 68.0 percent in 1986 as a result of decline in oil prices, however, it fell again to 53.4 per cent in 1990. The non-oil industrial sector's

Table 2.1

The GDP according to economic sectors at production factors cost and current prices

Year / Sector	1980 value	per cent	1986 value	per cent	*1989 value	per cent	**1990 value	per cent	(Dh Billion) Average annual increase rate 1980-1990
Crude oil production	70.5	63.2	26.2	32.0	38.8	38.1	59.6	46.6	-1.6
Other sectors	41.0	36.8	55.6	68.0	63.0	61.9	68.2	53.4	6.6
Agriculture, Animal Resources & Fisheries	0.9	0.8	1.6	2.0	1.7	1.7	1.8	1.4	10.0
Mining and Quarrying	0.2	0.2	0.3	0.4	0.3	0.3	0.3	0.2	5.0
Manufacturing	4.2	3.8	7.2	8.8	8.6	8.5	9.3	7.3	12.1
Electricity & Water	1.3	1.2	2.1	2.6	2.2	2.2	2.3	1.8	7.7
Construction	9.8	8.8	9.0	11.0	9.2	9.0	10.1	7.9	0.3
Wholesale & Retail Trade, Restaurants & Hotels	9.1	8.2	9.4	11.5	10.9	10.7	11.7	9.2	2.9
Transportation, storage and Communications	3.8	3.4	4.2	5.1	5.2	5.1	5.7	4.5	5.0
Finance & Insurance	2.1	1.9	5.5	6.7	5.6	5.5	6.1	4.8	19.0
Real Estate	4.0	3.6	4.5	5.5	6.4	6.3	7.2	5.6	8.0
Other Services	0.8	0.7	1.8	2.2	2.2	2.2	2.4	1.9	20.0
Less imported bank services charge	1.4	-1.3	1.0	-1.2	1.8	-1.7	1.9	-1.5	3.6
Government services producers	6.0	5.3	10.6	12.9	11.8	11.6	12.7	9.9	11.2
Household services	0.2	0.2	0.4	0.5	0.4	0.4	0.5	0.4	10.0
Gross Domestic Product	111.5	100.0	81.8	100.0	101.8	100.0	127.8	100.0	1.5

*Preliminary figures
** Preliminary estimates

Source: Ministry of Information and Culture (1991)

share in the GDP also increased to 7.3 per cent in 1990 from 2.8 per cent in 1980, and its value increased to 9.3 billion dirhams from 4.2 billion dirhams.

When oil prices plummeted in 1986, GDP dropped from 111.5 to 81.8 billion dirhams in 1980. However, it later began to recover to reach 127.8 billion dirhams in 1990. The annual growth rate did not exceed 1.5 per cent, underlining the need to develop non-oil sectors in order to increase their contribution to the GDP.

Consumption expenditure grew by 14.4 per cent during the 1980s reaching 46.3 dirhams in 1990 from 19.0 billion dirhams in 1980. This reflects a phenomenal increase in private consumption arising from the growth in population, incomes and spending rates. Private consumption expenditure constituted 17.3 per cent of the total expenditure of the GDP in 1980. It rose to 41.7 per cent in 1989 before declining to 36.7 per cent in 1990.

Despite increased consumption, fixed capital (investment) is relatively high due to the availability of cash surpluses from local and foreign investments.

Investment reached 30.2 billion dirhams in 1980 in comparison with 23.9 billion dirhams in 1990, registering a negative annual growth of 1.5 percent. Net expenditure on foreign trade including goods and services declined during the 1980's due to a fall in oil exports despite a rise in other exports and re-exports. As a result, net foreign transactions dropped from 47.5 billion dirhams in 1980 to 33.8 billion dirhams in 1990.

2.1.2 Imports and Exports

The United Arab Emirates' imports declined by 25 percent from 33 billion dirhams in 1980 to 25 billion dirhams in 1986 due to a drop in oil prices. They later started to increase reaching 37 billion dirhams in 1985. Machinery and transport equipment topped the country's imports during the 1980's, accounting for 36.5 percent in 1980 and 29.5 percent in 1989. Manufactured goods came second amounting to 21 percent in 1980 and 24.4 percent in 1989. In 1981 and 1982 mineral fuel and lubricants came in third place while foodstuff and livestock occupied the same rank in 1982, accounting for 9.7 percent and 14.2 percent in 1989 (Table 2.2).

The U.A.E.'s non-oil exports increased during the 1980's from one billion dirhams in 1980 to three billion dirhams in 1989, registering an annual growth of 21.9 percent. Exports of manufactured goods formed the biggest part, totalling 500 million dirhams in 1980 (48.7 percent) compared with 1.7 billion dirhams (56.7 percent) in 1985. Exports of mineral fuel and lubricants declined from 411 million dirhams in 1980 to 306 million dirhams in 1984 and to 146 million dirhams in 1985, while chemical exports rose from 18 million dirhams in 1980 to 217 million dirhams in 1989.

Table 2.2 Progress of U.A.E. Imports during 1980 - 1989

Weight = kg million
Value = Dh million

Year	1980		1982		1984		1986		1988		1989	
Weight and value Commodity classification	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value	Weight	Value
Foodstuffs & Livestocks	1242	3290	1314	3362	1543	3465	1976	3986	1926	4491	2274	5259
Beverages & Tobacco	67	638	61	411	65	388	59	371	59	450	55	479
Raw Materials	666	563	602	425	1222	491	784	441	843	634	900	951
Mineral Fuel & Lubricants	3232	3704	2649	2606	2417	2006	2585	1182	1508	894	1468	933
Vegetable and Animal Oils and Fats	29	109	29	85	32	114	48	123	54	145	89	247
Chemicals	541	1553	875	1881	416	1459	543	1668	631	2238	817	2682
Manufactured Goods	2040	6918	1976	7248	2024	5642	1726	5415	1250	7153	1640	9019
Machines & Transport equipment	576	12060	586	13667	1178	8329	1795	7634	346	10112	368	10919
Miscellaneous Products	139	3907	158	4664	155	3874	153	4009	363	5524	212	6412
Non classified commodities and transactions	8	260	11	360	4	157	2	49	4	151	3	72
Total	8540	33002	8261	34709	9056	25925	9671	24878	6984	31792	7826	36973

Source: Ministry of Information and Culture (1991)

Exports of raw materials (excluding food) rose from 23 million dirhams in 1980 to 225 million dirhams in 1989 and foodstuff and livestock from 19 to 171 million dirhams. Exports of beverage and tobacco jumped from 12 to 69 million dirhams.

The U.A.E.'s re-exports increased during the 1980's rising from 3.8 billion dirhams in 1980 to 9.4 billion dirhams in 1989, a growth of 14.7 percent. Apart from 1983, machinery and transport equipment topped the list of re-exports, standing at 2.3 billion dirhams in 1989 against one billion in 1980. Their share of the total re-exports declined, however, from 26.2 percent in 1980 to 25.1 percent in 1989. Manufactured goods, foodstuff and livestock shared second and third places.

As regards re-exports according to geographic distribution, the AGCC ranked first during 1981-1988, receiving 40 percent of the U.A.E.'s re-exports, and second in 1989 accounting for 30 percent. Apart from 1982 and 1983, Asian countries occupied the second place with a level of 25 percent and they topped the list in 1989 when they took 36.7 percent of the total.

2.2 Social Settings

2.2.1 Population

The total population at the last national census in 1985 was 1,622,464 out of which over 670,000 lived in the Emirate of Abu Dhabi, mainly in two cities, Abu Dhabi, the federal capital, and the inland oasis city of Al Ain. Over 400,000 lived in the Emirate of Dubai, mainly in the twin towns of Dubai and Deira, the commercial centres of the U.A.E., with the remainder in the smaller Emirates. The population growth in the country has been very fast, mainly due to the immigration of large number of labour force from the nearby region. The internal movement of the population from rural to urban areas has been substantial. There is also an increase in rural population due to the expansion of agriculture along wadis and oases, where the imported agricultural labour force was employed.

Data presented in Table 2.3 reveals that the total population in U.A.E. increased from 1,640,000 in 1988 to 1,844,000 in 1990. The percentage of males ranged between 60 and 62 during the period 1988-1990. Total births all over the country reached 47,703 in 1982 and rose to 51,903 in 1989. Most of these births were registered in the Emirate of Abu Dhabi, followed by the Emirates of Dubai, Sharjah, Ras Al-Khaimah, Fujeirah, Ajman and Umm Al-Qwain.

Estimated distribution of recorded population by age and sex during the years 1988-1990 carried out by the central statistical department is shown in Table 2.4. A noteworthy feature of this table relates to its frequency distribution which shows a peak in the age range between 25 and 40 years. The U.A.E.'s women are playing an increasingly important role in the economy and government, this is due to a massive drive for female education and eradication of

Table 2.3 Some population characteristics in U.A.E. (1987 - 1990)

	1987	1988	1989	1990
Total (1000)	-	1640	1739	1844
Male	-	1115	1068	1022
Female	-	729	671	618
Total Births	47703	50836	51903	-
Abu Dhabi	20667	22113	21686	-
Dubai	12208	13557	14461	-
Sharjah	6817	6780	7213	-
Ajman	1470	1555	1596	-
Umm Al-Qwain	662	695	756	-
Ras Al-Khaimah	3419	3228	3472	-
Fujeirah	2460	2608	2719	-
Citizen	18305	18717	18952	-
Non-citizen	29398	32119	32951	-
Registered Deaths				
Citizen	1402	1528	1550	-
Non-citizen	1829	1919	2090	-
Total	3231	3447	3640	-

Source: cited from Ministry of Information and Culture (1991)

Table 2.4 Population estimates in U.A.E. by age groups and sex, 1989 - 1990
(in thousands)

Years and Sex / Age Groups	1988			1989			1990		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
0 - 4	116.4	118.5	234.9	123.4	128.5	251.9	130.1	138.9	269.0
5 - 9	100.9	95.3	196.2	109.5	102.1	211.6	118.3	110.0	228.3
10 - 14	64.0	60.3	124.3	69.0	65.6	134.6	74.3	71.7	146.0
15 - 19	43.3	40.1	83.4	45.1	42.5	87.6	46.9	45.2	92.1
20 - 24	68.2	53.6	121.8	66.2	56.6	122.8	64.3	60.4	124.7
25 - 29	142.0	72.3	214.3	140.5	77.5	218.0	139.3	83.2	222.5
30 - 34	157.9	62.0	219.9	162.9	68.6	231.5	168.2	74.5	242.7
35 - 39	139.9	49.3	189.2	149.8	57.6	207.4	160.7	67.1	227.8
40 - 44	79.8	22.1	101.9	84.3	24.4	108.7	89.0	26.5	115.5
45 - 49	53.6	15.3	68.9	57.8	16.6	74.4	62.2	18.0	80.2
50 - 54	26.1	8.8	34.9	27.6	9.2	36.8	29.1	9.7	38.8
55 - 59	13.0	6.2	19.2	13.9	6.7	20.6	14.8	7.4	22.2
60 - 64	6.3	4.8	11.1	6.6	5.0	11.6	7.0	5.3	12.3
65 - 69	3.9	3.5	7.4	4.1	3.8	7.9	4.2	4.2	8.4
70 - 74	2.8	2.7	5.5	3.0	2.9	5.9	3.1	3.1	6.2
75 - 79	1.4	1.3	2.7	1.5	1.4	2.9	1.6	1.5	3.1
80 - 84	1.1	1.2	2.3	1.2	1.3	2.5	1.3	1.3	2.6
85+	0.8	0.9	1.7	0.9	0.9	1.8	0.9	1.0	1.9
Total	1021,4	618.2	1639.6	1067.3	671.2	1738.5	1115.3	729.0	1844.3

Source: Central Statistical Department (1989)

illiteracy. Thousands of young women graduate each year from universities, colleges and technical institutes and more of them are beginning to participate in public and the private sector.

2.2.2 Education

Before independence most of U.A.E.'s residents had to travel to neighbouring states like Qatar and Bahrain for education, while health services were, to say the least, rudimentary. Now, as a result of the progress during the past two decades, all services can be found locally, for both citizens and expatriate population alike.

Statistics from the Ministry of Education indicate that for the 1991-1992 academic year, there are around 510 government schools and education centres, with some 217,768 students (Table 2.5). The government education system now reaches into every small village, even in the remote mountain regions (Fig. 2.1). Since 1977, the U.A.E. has had its own institution of higher education, in the inland oasis-city, Al Ain with nearly 10,000 students, both men and women. It has already produced nearly 10,000 graduates. Since 1988, this has been complemented by a chain of Higher Colleges of Technology, in Abu Dhabi, Dubai and Al Ain, providing more technology oriented form of training.

2.2.3 Labour Force

Labour force in U.A.E. recorded in the last national census in 1985 reached 683,825, 95% are males. Data illustrated in Fig. 2.2 indicated that more than 70% of U.A.E. population (15 years and over) are employed. The number of unemployed people (over 15 years old) are modest, not exceeding 7,836 in 1985 (less than 10% of the population). The percentage of people out of labour force, in the same age range, averaged around 234,000 representing 25% of total population over 15 years.

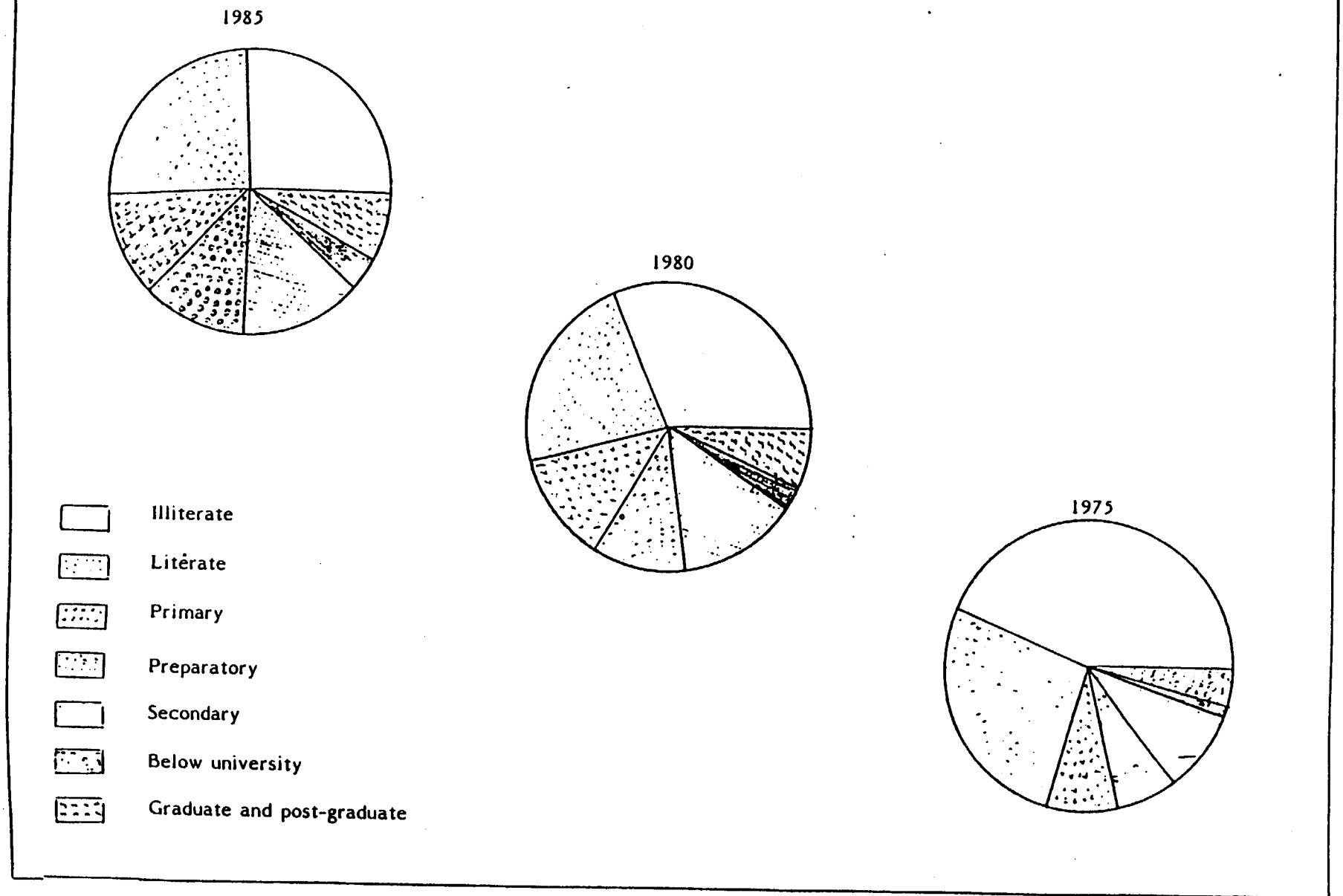
Recent estimates on labour force published by the Ministry of Information and Culture in 1991 are tabulated in Table 2.6 Data points out that the total labour force in the U.A.E. reached 654,745, 641,578 and 654,511 respectively in 1987, 1988, 1989. The vast majority of labour force are working in construction followed by trade, restaurant and hotel sectors. The labour force in the agriculture, livestock and fishing sectors were represented by 39,113 in 1987 and rose to 40,120 in 1989. These estimates indicate that labour force in the agriculture sector amounted to 16.3% of total labour force in 1989. It is expected that the labour force in the agricultural sector might be pronouncedly increased with the few coming years as a result of the agricultural growth in the country. Table 2.7 briefs the distribution of employees at the Ministry of Agriculture and Fisheries according to nationality and scale statistics for 1988. It indicates that the vast majority of the labour force in the Ministry of Agriculture and Fisheries (78%) are U.A.E. citizens.

Table 2.5 Some Indicators on Education in U.A.E.

Students	89/90	88/89	87/88
Kindergarten	47011	44555	40470
Primary	216457	199114	181780
Preparatory	62640	56136	50554
Secondary	34014	30003	26228
Religious	1501	1591	1730
Technical	690	720	591
Adult Literacy	21159	20147	21183
T.& A.Staff	26668	24335	22119
Class Rooms	14014	12887	11519
U.A.E. University Students by Faculty			
Arts	1535	1572	1612
Sciences	743	726	715
Education	2415	2260	2030
Public Administration	1354	1383	1348
Islamic & Legislation	231	326	415
Engineering	336	353	356
Agriculture	177	180	141
Med. & Health Science	92	64	33
Tutorial External Studies	502	235	405
Teaching Staff	730	620	578
Higher Studies	1624	1660	1650
Gov. Exp. on Education In Millions of Dirhams	2323.7	2220.0	2102.6

Source: Ministry of Information and Culture (1991)

Fig. 2.1 Population (10 years old and over) by education status



Source: Central Statistical Department (1989)

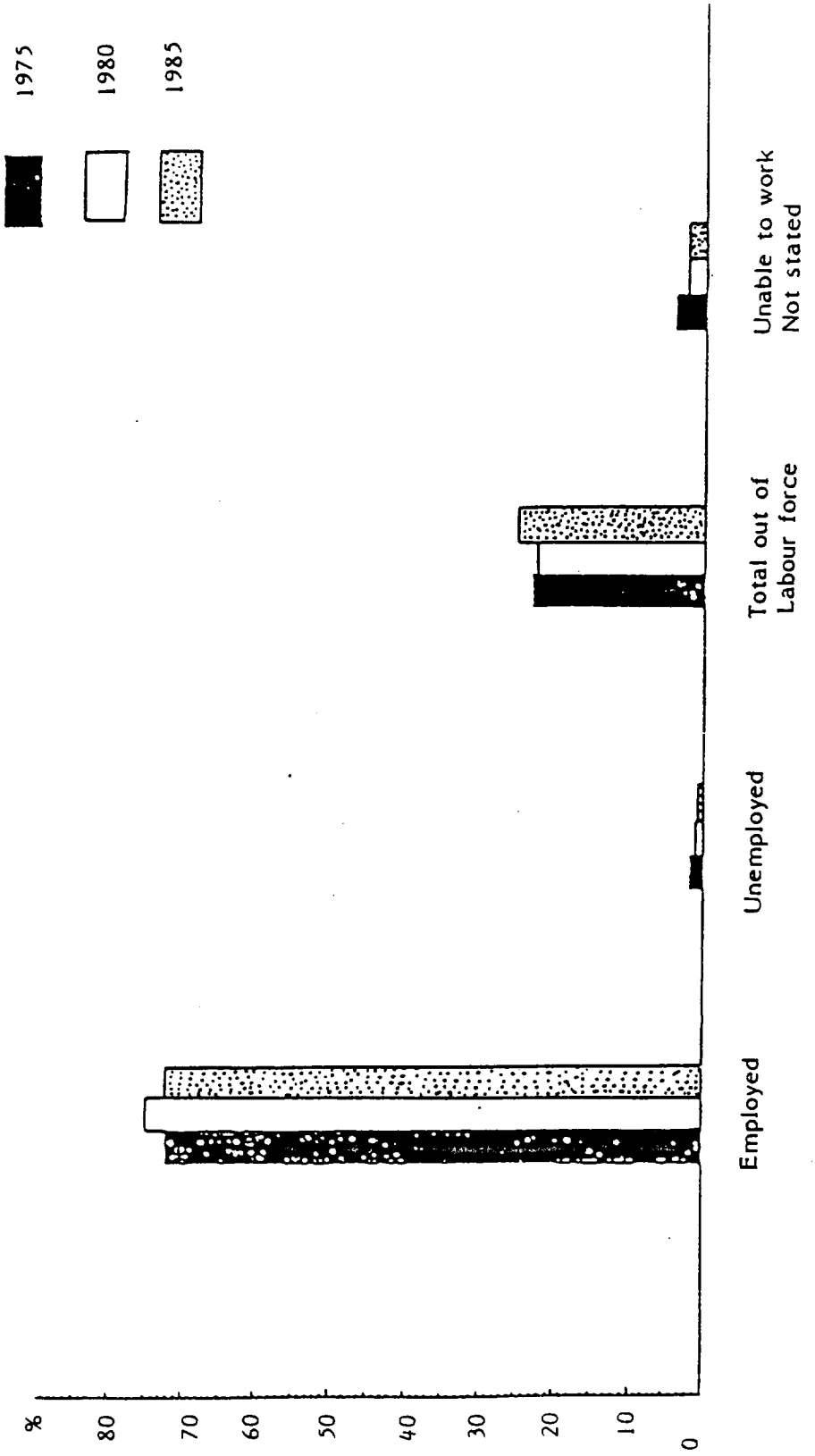


Fig. 2.2 Population (15 years and over) by relation to labour force (1975 - 1985)

Source: Central Statistical Department (1989)

Table 2.6 Labour Force in U.A.E.

	*1989	*1988	*1987
Agriculture, Live-stock & Fishing	40120	39535	39113
Mining & Quarrying	9450	9140	8900
Manufacturing	61770	61065	69820
Electricity & Water	20058	19760	19953
Construction	113000	110000	104000
Trade, Restaurants & Hotels	97950	96240	95850
Transports, Storage & Communication	68300	68000	67000
Financing, Insurance & Real Estate	18056	17414	16858
Services	225807	220424	213252
Total	654511	641578	624746

Source: Ministry of Information and Culture (1991)

Table 2.7 Distribution of employees at Ministry of Agriculture and Fisheries according to nationality and scale statics for the year 1988.

Nationality / scale and status		Total	Other	U.A.E.
First scale	1/1	6	-	6
	1/2	3		3
Second Scale	2/1	7		7
	2/2	81	40	41
	2/3	31	16	15
	2/3	31	16	15
Third Scale	3/1	64	39	25
	3/2	82	38	44
	3/3	124	28	96
	3/4	73	13	60
Fourth Scale	4/1	70	20	50
	4/2	141	17	124
	4/3	347	10	337
	4/4	42	2	40
Total		1102	239	863
		100%	22%	78%

Source: Planning and Statistical Office (1987 - 1988)

2.3 Agricultural Potentialities

2.3.1 Plant Production

Although the bulk of the countryside, in U.A.E., is arid desert or semi-desert with only occasional rainfall, there has been heavy investment in agriculture and tree planting programmes, making use, where possible, of desalinated water. Thousands of small farms have been established, and a large number of dairy and poultry farms have also been established.

U.A.E. is now largely sufficient in vegetables for much of the year, with a small surplus of some vegetables available for export, and for packing at Al-Ain packing unit. The Emirate produces most of the poultry and eggs that it needs. Milk and meat production is rapidly growing. Out in the desert, nearly 200,000 hectares have been planted with trees which total nearly 70 million fruit trees and 14 million palm trees, helping to change the face of U.A.E. The cities, Abu Dhabi and Al Ain have been provided with substantial gardens and parks.

The huge efforts deployed in the agricultural sector during the past two decades have been reflected in total production on the gross value of output in agriculture and fisheries (Table 2.8). The total value of plant, livestock and fish 1978/1988 amounted to 730,836 (excluding date production of 200,085 thousand Dh.), 607878 and 357,345 thousand Dh. respectively. At the sectorial level, it increased from 1,646,004 to 1,696,059 thousand Dh. (excluding date value) in the 1986/1987 and 1987/1988 production years.

The long highways from Abu Dhabi to Al Ain and to Dubai are now lined for much of their distance with well-established plantation trees, each individually watered to enable them to survive. Some of these plantations, are nearly twenty years old, and help to anchor the shifting sands that once covered roads and tracks. The cultivated area around Al Ain, in Abu Dhabi's eastern region, more than doubled during the period 1985 and 1989. Planting has also been carried out though on a smaller scale, in the northern Emirates, where the soil is less sandy and more suitable for cultivation.

In the towns and cities, parks and gardens have been planted. The capital, Abu Dhabi, has over twenty parks. Other parks can be found in the oasis city of Al Ain, Dubai, Sharjah, Ras Al-Khaimah, Fujeirah and right throughout the country.

The total area under agricultural holdings (Table 2.9) increased from 380,192 Dunum in 1985/1986 to 416,200 Dunum in 1987/1988. Area of agricultural holdings by type of production in each district (1987/1988) are given in Table

Table 2.8 Gross output by value and quantity in agriculture and fisheries sector, 1986/1987 - 1987/1988

(Qnty. in Thousand Ton - Value: in Thousand Dh.)

Quantity and Value	Value		Quantity	
Type of production	1987/1988	1986/1987	1987/1988	1986/1987
Plant Production:				
Vegetables	220,159	229,263	148.0	164.0
Dates	...	200,085	...	71.4
Fruits and citrus	78,874	90,113	28.7	28.8
Clover	324,640	232,987	240.4	172.6
Tobacco	1,019	873	0.5	0.5
Other crops	106,144	79,983	111.4	347.2
Total value of plant production	...	833.304	-	-
Livestock Production:				
Meat and poultry	306,491	273,048	23.4	21.5
Milk & milk products	240,445	170,724	48.1	43.2
Eggs	55,500	53,333	8.3	8.0
Other livestock production	5,442	4,531	-	-
Total value of live-stock production	607,878	501,636	-	-
Fishing Production:				
Surface & medium fish	158,632	135,446	53.5	47.4
Depth fish	194,478	175,618	35.6	32.0
Snails and molluscs	4,235	-	0.5	-
Total value of fishing production	357,345	311,064	-	-
Grand Total Sector		1,646,004		

Source: Central Statistical Department (1989)

Table 2.9 Estimation of area under agricultural holdings by district, 1985/1986 - 1987/1988

(Area by Donum)

Years / District	1987/1988 **	1986/1987	1985/1986
Southern	158600	153187 *	139273
Middle	131593	126601	120530
Northern	79607	81197	76047
Eastern	46400	45307	44342
Total	416200	406292	380192

Source: Central Statistical Department (1989)

* Does not include the area grown with fruit trees in Al Ain district.

** Excludes the area grown with date palms.

2.10.[1] Four types of agricultural production are tabulated in the different districts in U.A.E. Total areas cultivated with vegetables, field crops and fruit trees reached 71,203, 73,017 and 29,897 (excluding date palms) respectively in the year 1987/1988. Most of cultivated areas lie in the southern and middle districts. The areas cultivated with either field crops or vegetables are more or less the same, while areas of fruit tree (excluding date palms) are much less.

The most important crops grown in U.A.E. are clover, tobacco, green fodder and wheat (Table 2.11). Out of the total field crop areas, 46% are cultivated with green fodder, 43% by clover, 9.2% by wheat and 0.01% by tobacco. The total production in 1987/1988 reached 111, 240, 474, 544 and 537 tons of green fodder, clover, wheat and tobacco respectively.

The most prevailing fruit trees in U.A.E. are given in Table 2.12. The total number of date palm amounted to about eleven million trees. Most of the fruit tree areas are planted with citrus trees (14,832 Dunum in 1987/1988). Other important fruit trees are mango, followed by guava and figs. The total production in the agricultural season 1987/1988 was about 17,431 tons for citrus, 6,980 tons for mango, 3,874 tons for guava and 1,722 tons for fig. Other fruit trees are less important as they are grown in smaller areas.

Large scale afforestation programmes are being implemented in the U.A.E. with the intention, as far as possible, of greening the desert. The afforestation schemes are also intended to stabilize the environment through sand dune fixation. Fig. 2.3 illustrates the number of trees in afforested area in Abu Dhabi during the period 1975-1990. The forestry section with its four departments of afforestation, nurseries, plant protection and general maintenance is responsible of organizing, administering and supervising afforestation projects being carried out.

As regards vegetables production, Table 2.13 shows the most important crops grown in the U.A.E. in terms of area, quantity, yield and value (1987/1988). The total area cultivated with vegetable crops in U.A.E. in the year 1987 amounted to 71,203 Dunums. The main vegetable crops are tomato, squash, cauliflower, onion, and sweet melon. The total value of vegetable production during the agricultural season 1987/1988 (148,076 tons) amounted to 220,159 thousand dirhams.

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[1] Figures for 1989/1990 that total agricultural area was 454,056 dunums (excluding date palm) of which 77,099 dunums under vegetables, 94,903 under field crops, 29,708 under fruit trees and 202,347 others. (Paper presented at the Symposium on "Desertification and Land Reclamation in The Gulf Cooperation Council States", Bahrain 1993.

Table 2.10 Area of agricultural holdings by type of utilization and district, 1987/1988

(Area by Donum)

Type of Utilization \ District	Southern	Middle	Northern	Eastern	Total
Vegetables	38,324	18,282	8,670	5,927	71,203
Field Crops	33,679	26,383	9,814	3,141	73,017
Fruit Trees	2,399	15,811	2,710	8,977	*29,897
Other	84,198	71,117	58,413	28,355	242,083
Total	158,600	131,593	79,607	46,400	416,200

Source: Central Statistical Department (1989)

* excludes date palms.

Table 2.11 Estimation of field crop products by agricultural district, 1987/1988

(qnty.: In Ton - Area in Donum)

District / Item	Total		Eastern		Northern		Middle		Southern	
	Qnty.	Area	Qnty.	Area	Qnty.	Area	Qnty.	Area	Qnty.	Area
Clover	240474	32073	4069	890	14318	3476	178612	17417	43475	10290
Tobacco	537	616	201	177	32	42	304	397	-	-
Green Fodder	110940	33598	5120	2074	33839	6266	54506	8569	17475	16689
Wheat	544	6730	-	-	15	30	-	-	529	6700
Total	352495	73017	9390	3141	48204	9814	233422	26383	61479	33679

Source: Central Statistical Department (1989)

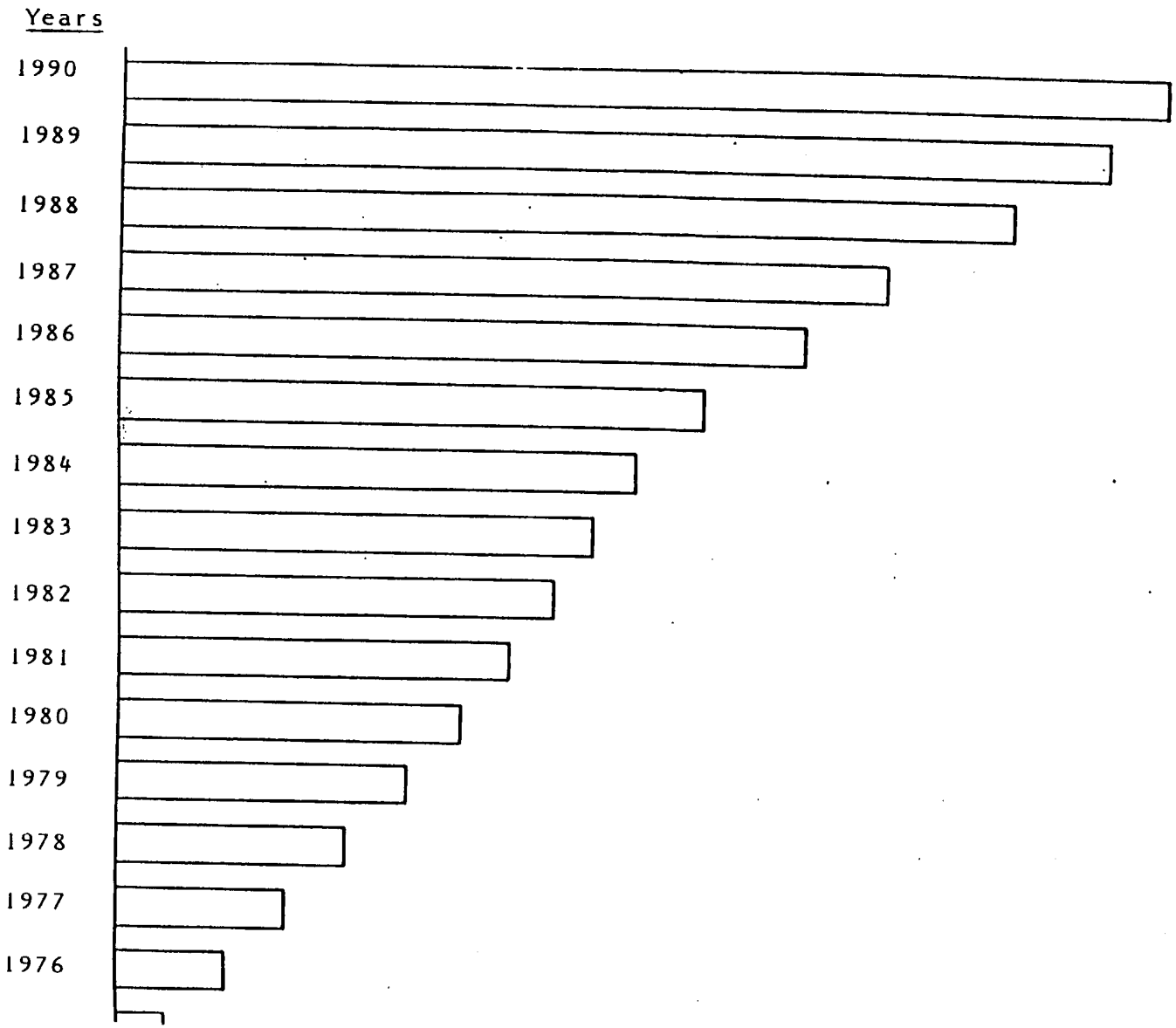
Table 2.12 Estimation of area and dates and fruit products in U.A.E. 1987/1988

(Area: by Donum - qnty: in ton - Value: in thousand Dh.)

Item	Production		No.of Trees		Area
	Value	Quantity	Productive	Total	
Dates	...	...	...	10750000	...
Citrus	38585	17431	283970	428048	14832
Sedre	1084	544	14194	33014	722
Guava	3874	1291	37343	54314	1716
Mango	29918	6980	85472	165180	5833
Almond	228	218	10157	16142	514
Pompegranate	805	214	13085	18938	704
Pig	1722	501	26171	35475	1046
Grape	339	91	15135	24274	364
Banana	327	164	10492	13539	904
Others	2028	1269	40264	99340	3262
Total	...	...	...	11638264	...

Source: Central Statistical Department (1989)

Fig. 2.3 Development in afforestation activities in Abu Dhabi



Years	Area (hectares)	Trees
1990	90,000	18,000,000
1989	80,000	16,000,000
1988	72,200	14,000,440
1987	68,600	13,000,720
1986	61,600	12,000,320
1985	56,300	11,000,326
1984	52,500	10,000,500
1983	45,000	9,000,000
1982	35,000	7,000,000
1981	27,000	5,400,000
1980	20,000	4,000,000
1979	14,000	2,800,000
1978	10,000	2,000,000
1977	8,000	1,600,000
1976	3,000	600,000
	500	100,000

Table 2.13 Vegetables production in the U.A.E. (1987/1988 season)

(Area: Dunum; Quantity: Ton; Value: in Thousand Dh)

Item	Area	Yield	Production	Value
Tomato	10154	2.5	25992	31444
Egg-Plant	2568	5.9	15276	14952
Okra	2624	1.1	2907	8647
Deans	1005	1.1	1199	4269
Cow - Peas	2100	0.9	2093	5720
Jew's Mallow	1940	2.0	3893	6353
Chard	1354	5.5	7502	6742
Squash	5261	1.6	8842	11375
Cucumber	1724	2.3	3976	10994
Cabbage	3441	3.6	12625	13844
Cauliflower	3385	2.3	7933	10057
Potato	2567	2.1	5489	8425
Onion	4184	1.9	8006	12551
Water Melon	7064	1.2	9007	16032
Sweet Melon	3892	0.7	2769	7233
Lettuce	1311	3.1	4167	4555
Radish	1454	2.0	2945	3075
Parsley	851	1.5	1290	2062
Carrot	2009	0.7	1589	2989
Pepper	1512	2.4	3717	6939
Others	10803	-	16859	31901
Total	71203	-	148076	220159

Source: Central Statistical Department (1989)

The increase in agricultural production has meant that the U.A.E. has also been able to build its own agricultural industry. Canning plants, like the one at Al Ain, pack, can and preserve vegetable produce that cannot be absorbed by the local market, while some crops like tomatoes are used for the production of juices.

Agricultural development activities have created a demand for agricultural supplies and equipment (Table 2.14). Fertilizer and composting plants have been established, while a factory to manufacture simple farming equipment is also being built in Fujeirah, with the objective of satisfying local demand and reducing imports.

2.3.2 Animal Husbandry

Another sector which has seen rapid development in the U.A.E. has been the dairy and poultry industry. Poultry farms in Al Ain, Fujeirah, Umm Al Qwain, Rash Al-Khaimah and Abu Dhabi produce millions of eggs and hundreds of thousands of chickens a year (Table 2.15).

Much of the progress in animal production and fisheries has occurred in raising beef cattle. The number and production of goats, sheep, cows and camels increased continuously during the last years. Table 2.16 presents for the year 1988 the estimated number and production of goats, sheep, cows and camels by sex and agricultural districts in U.A.E. during 1988. The total number in all districts was 573,507 goats, 221,997 sheep, 43,086 cows and 98,561 camels.[2] Milk and meat production (in tons) reached 1,992,413 goats, 44,051,165 sheep, 43,771,444 cows and 149,535,862 camels respectively.

2.3.3 Fisheries

The U.A.E. has extensive resources of fish, both in the Gulf and in the Gulf of Oman. Local fishermen, organized in co-operatives, have been encouraged to adopt more modern methods of fishing. The Mariculture Station of the Ministry of Agriculture and Fisheries in Umm Al-Qwain has proved that it is possible to raise some of the more popular species like 'hamour' in fish farms. Fish catch has been substantially increased during the last years as given in Table 2.17. The number of full-time fishermen has increased over the last decade from 4,000 to 10,611, while the annual catch has doubled to reach 90,000 tons.

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[2] Figures for the year 1990 give the total number of goats at 656,608, of sheep at 254,165, of cattle at 49,328 and for camels at 112,842.

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[2] Figures for the year 1990 give the total number of goats at 656,608, of sheep at 254,165, of cattle at 49,328 and for camels at 112,842.

Table 2.14 Agricultural inputs and engines distributed to holders, 1986 - 1988

Inputs \ Years	Unit	Quantity Distributed		
		1988	1987	1986
Improved Seeds for Crops:				
Potatoes	Ton	400	388	400
Other seeds	Ton	41	41	40
Fertilizer:				
Chemical	(50)KG	201513	160681	161085
Organic	(25)KG	66300	88080	93208
Insecticide:				
Liquid	Litre	184226	145285	146776
Powder	Kg.	102417	79331	85551
Nurseries:	*			
Fruits	*	114	123	145
Forest & ornamental	*	199	377	387
Vegetable	*	52463	63115	46005
Engine and Fences:				
Irrigation Engines	Engine	644	675	1058
Fences	Bundle	-	1416	1512

* in (000) Nursling

Source: Central Statistical Department (1989)

Table 2.15 Output of poultry farms in U.A.E. by Emirate, 1984 - 1988

(in Thousand Chickens and Million Eggs)

Emirate	1988		1987		1986		1985		1984	
	Eggs	Chickens	Eggs	Chickens	Eggs	Chickens	Eggs	Chickens	Eggs	Chickens
Abu Dhabi	56.0	1936	62.0	2500	61.0	2200	60.0	1615	50.0	1479
Dubai	-	400	-	400	-	400	-	425	-	230
Sharjah	60.0	680	60.0	573	58.0	573	62.0	348	50.0	228
Ajman	-	-	-	-	-	-	-	-	-	-
Umm Al-Qiwain	25.0	2000	15.0	2000	15.0	1500	15.0	1500	15.0	1500
Ras Al-Khaima	13.5	3300	15.0	3325	14.0	3275	15.0	2773	15.0	1851
Fujeira	12.0	4000	12.0	3600	12.0	3400	6.0	1500	-	-
Total	166.5	12316	164.0	12398	160.0	11348	158.0	8161	130.0	5288

Source: Central Statistical Department (1989)

Table 2.16 Estimation of number and production of (goats, sheep, cows and camels) by sex and agricultural district, 1988

A. Goats

No.of Goats and The Quantity of Production / District	Goats Production		Number of Goats							
			Grand Total	Females				Males		
				Total	One Year and Over		Less Than One Year	Total	One Year and over	Less Than one Year
	Meat(in ton	Milk (in ton)			Non Milking	Milking				
Sothern	570	2391	125209	112909	45192	48844	18873	12300	3970	8330
Middle	961	4912	210901	184318	54233	100837	29248	26583	14319	12264
Northern	669	3980	146714	122887	10330	82359	30198	23827	9808	14019
Eastern	413	1992	90683	76524	19370	41113	16041	14159	4958	9201
Total	2613	13275	573507	496638	129125	273153	94360	76869	33055	43814

Table 2.16 continued

B. Sheep

No. of Sheep and The Quantity of Production / District	Sheep Production		Number of Sheep							
				Females				Males		
	Meat(in Ton)	Milk(in Ton)	Grand Total	Total	One Year and over		Less Than One Year	Total	One Year and Over	Less Than One Year
					Non Milking	Milking				
Southern	246	838	46392	37995	13638	17378	6979	8397	4516	3881
Middle	685	2600	129237	106750	33940	53969	18841	22487	12876	9611
Northern	186	792	37036	28948	4812	16463	7673	8088	3838	4250
Eastern	48	175	9332	7236	2179	3659	1398	2096	1352	739
Total	1165	4405	221997	180929	54569	91469	34891	41068	22582	18481

Table 2.16 continued

C. Cows

No. of Cattle and the Quantity of Production / District	Cows Production		Number of Cows						
			Grand Total	Females			Males		
	Meat (in ton)	Milk (in ton)		Total	One Year and Over	Less than One year	Total	one Year and Over	Less than one over
Southern	206	829	5863	5066	4113	953	797	267	530
Middle	937	2356	28474	13744	11457	2287	14730	12888	1842
Northern	197	820	5737	4521	3399	1122	1216	283	933
Eastern	104	372	3012	2272	1901	371	740	182	558
Total	1444	4377	43086	25603	20870	4733	17483	13620	3863

Table 2.16 continued

D. Camels

Number of Camels / The Quantity of Production / District	Camel Production		Number of Camels						
			Grand Total	Females			Males		
	Meat (in Ton)	Milk (in Ton)		Total	Four Years and Over	Less Than Four Years	Total	Four Years and Over	Less than Four Years
Southern	3772	10006	63532	56541	47044	9497	6991	3480	3511
Middle	1771	4235	29684	24135	19908	4227	5549	2671	2878
Northern	305	682	5120	3865	3204	661	1255	610	645
Eastern	14	30	225	175	140	35	50	34	16
Total	5862	14953	98561	84716	70296	14420	13845	6795	7050

Table 2.17 Estimation of quantity and value of fish catch by type, 1986 - 1988

(qnty: in ton - Value: in Thousand Dh.)

Total		Demersal Fish & Shrimp		Pelagic Fish		Year
Value	qnty	Value	qnty.	Value	qnty.	
311064	79500	175618	32018	135446	47482	1986
334209	85410	188859	34420	145350	50990	1987
357345	89691	198713	36146	158632	53545	1988

Source: Central Statistical Department (1989)

Chapter III
Review of Past and Current Efforts for Combating Desertification in United Arab Emirates

The age old image of the U.A.E. consisting of vast areas of arid desert is rapidly becoming a reputation of the past, as funds are allocated to finance the establishment of agriculture as a major industry. The technical aspect of arid-zone afforestation and agriculture embraces many difficulties created not only by the natural conditions, but also because previous experience is rare. The climate is hot and dry from May to October, and relatively mild with small annual rainfall during winter season. Although prevailing winds blow from north-west, stronger winds come from the opposite direction, which can expose the roots of young plants, and at other times bury the plants completely. In such arid conditions, the soils are often encrusted with gypsum and limestone, and the shifting dunes have frequently proven too active for widespread afforestation. Water supplies are limited and the quality of the water leaves much to be desired.

While others have claimed to combat desertification, none have faced the harsh climatic conditions existing in U.A.E. The task is formidable, but science and technology are providing new opportunities for mankind to conquer nature.

Over the course of the past few years, as the challenges of human development in U.A.E. have been confronted and overcome, the government and people have been able to turn their attention increasingly to the challenge of preserving the environment. Today moves are being taken to ensure that the balance of man and nature is being preserved. Review of past and current efforts for combating desertification in United Arab Emirates might be presented in the following:

3.1 Action at the National Level

3.1.1 Afforestation

1. During the past couple of decades, large scale attempts to create forest are proving successful. The forestry schemes that now cover much of U.A.E. help to combat desertification by inhibiting the movement of the great sand dunes that in the past buried everything in their path.

   A total of 80,000 hectares in the western region of Abu Dhabi have now been successfully planted with trees and further afforestation is underway with an annual rate approaching 10,000 trees. In Al Ain, the total afforested area reached 27,000 hectares, despite afforestation started in 1969 (Table 3.1). In the Emirate of Dubai, two major afforestation projects are proposed to be implemented during 1992, the first in Mashrif (400 hectares) and the second in a landfill area (400 hectares) near Al-Kasees.

   The trees proved to be suitable for growing in U.A.E. are prosopis spicigera (Ghaf), Prosopis juliflora (Goif

Table 3.1 Numbers of forest, ornamental and fruit trees during 1989/1990 compared with basic year 1985/1986

Type	Item	% From Basic Year	89/1990 No. of Trees	Basic Year 85/1986 No. of Trees
Shrub,s	Glory Tree	483.6	7607	1573
	Lantana Camara	410	2046	499
	Dodonaea Viscosa	-	25	-
Total		467.1	9678	2072
Desert Shrub,s	Calligonum Comosum (Arta)	100	537	537
	Salvadora Persica	303.6	4427	1458
Total		248.8	4964	1995
Traze Plants	Atriplex	117.3	1663	1418
Total		117.3	1663	1418
Ornament Shrub,s	Hibiscus	190.7	103	54
	Bottle Brush	100	12	12
	Poinciana Regia	107.4	58	54
	Acania	100	17	17
	Tecoma Stans	289.4	136	47
	Coloniae	100	16	16
	Bougain Villae	469.1	1093	233
	Latania Washengton	-	-	61
	Olander	-	-	7180
Total		18.7	1435	7674

Source: Agriculture Department and Animal Production, Al Ain (1989-199

Mesquite), Acacia arabica (Kereth), Acacia tortilis (Samar), Acacia leucophloea (Tal), Acacia radiana (Salam), Azardiract S indica, Melia azedarach (Neem), Albizzia lebek (Albizzia), Pithecolobium dulce (Frywood tree), Terminalia arjuna (Terminalia), Parkinsonia aculeata (Jerusalem thorn), Zizyphus jujuba (Siddar, Jujube), Zizyphus spinachristi (Siddar), Tamarindus indicus (Tamarind), Thespesia populnea (Adam apple), Delonix regia (Flamboyant), Pongamia glabra (Pongam), Erythrina indica (Coral tree), Cassis fistula (Golden shower), Bauhinia purpurea, Langerstroemia indica (Queen's crepe myrtle), Millingtonia hortensis, Murraya exotica, Atriplex lentiformis (Atriplex), Oystelma sp (Merk), Salvadora sp (Rak), Haloxylon sp, Avecennia marina (Mangrove, Gurum), and Calligonum comosum (Arta).

2. Wind erosion in certain regions is a serious problem partly solved by means of shelterbelts. There is a wide scale attempt to create forests in some of the most arid parts of U.A.E. which, though it is very unlikely to have any real effect on the overall climate, will increase the range of micro-habitat. The main benefit of such projects, though, is in the provision of shelterbelts and stabilization of dunes, thus reducing but not wholly preventing the effects of desert encroachment, A green shelterbelt is now being established in main roads all over the country. The greenbelt with a width of 100 m and trees are grown at the corners of 7 x 7 m squares and irrigated, in most cases, with drip irrigation. The most important achievement, in this respect, is the greenbelt between Zayed city - Liwa, Ghiathi/Al-Rowis in Abu Dhabi and in Nid-Shaba near Dubai.

The most proper trees grown as wind breaks are Casuarina equisetifolia (Casuarina), Tamarix anglica (Jess), Eucalyptus camaldulensis (Eucalyptus), Vitex latifolia (Kaffhariam), and Sesbanuia aculeata (Sesbania).

Extensive efforts are being exercised in the field of rangeland development, particularly through artificial seeding with proper vegetation.

3.1.2 Farming development

The ambitious aim of the U.A.E. is to reach a level of agricultural production capable of satisfying the needs of the population. Table 3.2 shows the percentage of contribution of each Emirate in agricultural production.

The Government is exercising extensive efforts to encourage farmers. Among these efforts - well digging, veterinary services, agricultural loans, providing farms with the agricultural requirements (seeds, fertilizers, seedlings, tractors ... etc.), as well as extensive visits.

One of the most successful agricultural projects is the farming activities in Delma, a tiny island with a population of 6,000. It becomes one of the biggest farm producers in the country.

Table 3.2 Contribution percentage of each Emirate in Agricultural Production

Emirate	1988				1989				1990				1991 (predicted)			
	Plant	Animal	Fish	Total	Plant	Animal	Fish	Total	Plant	Animal	Fish	Total	Plant	Anima	Fish	Total
Abu Dhabi	32.7	36.1	27.5	32.8	32.8	36.5	27.5	33.0	23.1	37.2	29.5	33.8	33.4	37.1	32.0	34.1
Dubai	8.5	7.0	14.6	9.0	8.5	6.9	14.6	9.0	8.4	6.9	16.1	9.1	8.2	7.0	18.8	9.5
Sharjah	31.7	13.7	19.0	24.7	31.7	13.0	19.0	24.2	31.4	12.5	20.4	24.2	31.6	12.4	21.3	24.4
Ajman	1.5	1.5	3.2	1.8	1.6	1.5	3.2	1.8	1.6	1.4	3.3	1.8	1.6	1.4	3.3	1.8
Umm Al-Qwain	2.4	10.0	4.2	4.8	2.4	10.0	4.2	4.9	2.4	9.5	4.4	4.8	2.4	9.2	4.3	4.7
Ras Al-Khaimah	16.4	20.4	21.9	18.4	15.9	20.0	21.9	18.0	15.9	20.0	18.0	17.4	15.8	20.1	13.6	16.8
Fujeirah	6.8	11.3	9.6	8.3	7.1	12.1	9.6	9.1	7.2	12.5	8.3	8.9	7.5	12.8	7.0	8.7
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Source: Central Statistical Department (personal communication)

Many greenhouses are used now in vegetable production in the U.A.E. The total number of greenhouses in the country (1988) is 1,867; 522 in the southern region, 181 in the central region, 1,123 in the northern region and 41 in the eastern region. El-Sahadat project is one of the leading activities for vegetable production. It is comprised of two hectares of protected agriculture and produces around 100 tons of vegetables per hectare. The project might be considered also, as a research station for arid lands, where R and D activities are done in cooperation with the University of Arizona.

3.1.3 Improvement of Land Capabilities

1. In cooperation with FAO, the Faculty of Agricultural Sciences, United Arab Emirates University and Ministry of Agriculture (Soils and Water Department) are about to start a major project aiming at the preparation of a Land Master Plane in U.A.E.

2. Soils and Water Department, Ministry of Agriculture and Faculty of Agricultural Sciences, United Arab Emirates University are implementing, at present, a major project to study the salt affected soils in the northern, middle and southern regions.

3. The organic portion of municipal wastes is sorted, composted and re-cycled as organic manure in many regions of U.A.E., particularly in Abu Dhabi and Dubai Emirates.

3.1.4 Water conservation

Water is the critical factor limiting agricultural development as well as plans to combat desertification in U.A.E. The government is paying great attention towards conserving the limited water resources and rationalising its uses. Many programs are being implemented in the country.

1. Water surveys for surface and underground resources, are going on, all over the country including both quantity and quality particularly salt content. Some of these surveys are about to finish, by an American company, in Al Ain.

2. A meteorological monitoring net is being established to provide the decision makers with accurate information and data on rainfall.

3. Recent technologies in irrigation systems e.g. drip, sprinkler and subsoil irrigation, are being implemented everywhere in the agricultural regions (e.g. in Deba, Fujeirah), Sac (Kelba), Falg Al-Mahla (Umm Al-Qwain), Nakheel (Ras Al-Khaimah).

4. Treated sewage effluent is recycled for irrigation purposes (e.g. 45,000 cu meter/daily in Dubai).

5. Desalination of sea water is practiced in many regions to meet the domestic demands.

3.1.5 Research and Development

Two research centres, affiliated to the United Arab Emirates University are interested in R and D activities dealing with desertification. These two institutes are 'Remote Sensing Centre, Faculty of Agricultural Sciences' and 'Desert and Marine Environment Research Centre, Faculty of Science'.

The Remote Sensing Centre aiming at collection, analysis and application of information obtained from remote sensing from space, especially those relating to the fields of agriculture, forestry, water resources, ecology control, research on natural resources and major civil projects. The centre has completed a number of major stages in building up its capabilities and has also started assuming its role on the university level. During 1990 - 1991 the centre acquired a complete set of recently collected Landsat TM data in digital form. This set is composed of eleven Landsat scenes covering all the U.A.E. lands. TM data has as is known a 30 x 30 m spacial resolution and seven spectral bands covering visible part of the near infra red and also a 120 x 120 m spacial resolution band in the far thermal infra red portion of the spectrum.
In addition to the digital data set a complete set of photographic print outs of all U.A.E. lands using the digital data acquired. The print outs are very high quality paper prints in 1:100,000 scale. TM spectral bands 2, 3 and 4 were used in photoproduction of these print outs, each Landsat scene is produced on four 90 x90 cm print outs corresponding to the four quarters of a scene. No special enhancement technique was applied to the data. Merely stretching of the digital data for general purposes was applied.

As part of the contract for delivering the ERDAS image system, installation and training were included.

The Desert and Marine Environment Research Centre aims at the preparation of basic and applied studies and researches of the various ecological components including soil, water, minerals, plants, animals, energy and others, making assessment of these resource potentials with a view to ascertaining their proper utilization and maximizing the productivity rates therein. The ultimate aim of this action shall be develop the desert and marine environment without exposing their components to any deleterious effect. The centre shall effect its research, in the field of desert environment development studies, on most of the articles dealing with desertification.

3.2 Regional and International Action

Activities to combat desertification in the U.A.E. were not limited to the national level but extended to a regional and international action. In the field of afforestation and garden establishment, U.A.E. had the following projects:

1. Afforestation of 63.8 hectares in Saudi Arabia, 13.8 hectares in 1987 and 50 hectares in 1980.

2. Afforestation of 58 hectares, plantation of 165 date palms and cultivation of 7.5 hectares of garden in Qatar during 1981.

3. Afforestation of 128 hectares and digging of 6 wells in Bahrain during 1987.

4. Cultivation of 10 hectares of gardens, and afforestation of 166 hectares in Kuwait in 1989.

5. Cultivation of two gardens representing U.A.E. in the International Gardens in Cairo and Alexandria during 1989.

The U.A.E. has participated in many international exhibitions on agriculture and afforestation e.g. International Exhibition on Agriculture and Afforestation held in Japan (1990), International Exhibition held in Paris (1991).

Chapter IV

4.1 The Magnitude of the Desertification Problem

4.1.1 General

The UAE, composed of seven Emirates has an area of 77700 Km^2. Basic facts and general information on the State has been presented in chapter I. According to an ESCWA estimate, about 99% of UAE is either desert or desertified land; 76.5 of the area is classified as severe to very severe desertification; moderate desertification is about 23.4% while slight desertification is about 0.1% of the total area, (ESCWA, 1991).

The area suitable for cultivation (arable land) is 59662 ha i.e less than 0.7% of the total land area of the country. The area, actually cultivated (cropped area) ranges from 0.4% (Ministry of Planning,1992) to 0.56% (MA&F,1992). Although this reflects scarcity of arable land, the scarcity of water is considered a more serious limiting factor to agricultural development. Total requirements for water in UAE has been estimated at 565 million m^3 of which 410 million m^3 for agriculture and 95 million m^3 for drinking(Arab Organization for Agricultural Development, 1991). Available sources are under 300 million m^3 leaving a huge deficit which makes water the critical and limiting factor for development (ibid).

4.1.2 Definition of Desertification:

The definition of desertification adopted by the United Nations Conference on Desertification (UNCOD) in 1977 was found inadequate and a more precise definition was required in the face of several suggestions put forward by individuals and institutions.

Taking into consideration the results of additional studies and consultations undertaken by UNEP, the following was finally adopted for presentation to the United Nations Conference on Environment and Development (UNCED).

"Desertification is land[3] degradation in arid, semi-arid and dry sub-humid areas resulting mainly from adverse human impact" (UNEP, 1991).

This definition however, in 1992 was modified by UNCED as follows:
"Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities. (Cardy,1993).

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[3] Land in this concept includes soil and local water resources, land surface and vegetation or crops (UNEP 1991).

4.1.3 Perception of Desertification

Organized agricultural work in what is basically sandy soils in Al-Ain area started in 1966. At that time there were only date palm oasis. In 1968 vegetable cultivation was started; in 1969 the Department of Agriculture was formed, and later the Department of Forestry was formed, both under the Diwan. Horticultural work remained in the municipality.

Improving the soil which was mainly sandy by addition of manure and loamy soils brought from wadis constituted the first efforts in Al-Ain area to green desert or desertified lands. The second problem was that of water availability. Wells, were dug by hand in 1966 up to 27', by 1990 it reached 150' in the same area.

While water levels were dropping in wells, salinity content was rising from below 1000 ppm to 8000 ppm and above, reaching 20000 ppm in certain areas.

In 1969 the Forestry Department was instructed to start afforestation. The department was thus faced with the difficult task of planting new forests at a time when land degradation was advanced, irrigation water was saline and limited, and rainfall averaged 50-70 mm. Old natural forests in the north eastern corner of Al-Ain area were vanishing under heavy overgrazing. Tree plantation started in 1969 with exotic species and work continued and several plantations were established.

The work in Al-Ain on the poor soils, declining water levels, increasing salinity and tree plantation under difficult conditions, constituted, in essence, reclamation of desertified lands and in some places prevention of further land degradation/desertification.

Progress in afforestation was monitored and in 1982 the use of exotic species was stopped. Afforestation work using only indigenous species took over and the best known species were chosen e.g. Prosopis spp. **Acacia tortilis**, Arak, Date Palms, **Zizivus spina chrisiti** and **Prosopis geoflora**.

The pragmatic approach towards greening 'suitable' areas formed the basis of the country's perception of desertification as an environmental problem which can be controlled or ameriolated by greening the land by afforestation, cultivation or gardening. This view soon fell into the same stream which was created towards the end of the 70s and early 80s by the impact of the World Conference on Desertification which was held in 1977.

4.1.4 Examples of the Extent of Desertification

4.1.4.1 Field Visits

During its stay of 18 days in the UAE, the mission made extensive field visits in the seven Emirates: Abu Dhabi, Dubai, Sharjah, Ras-Al-Khaimah, Umm Al-Qwain, Al-Fujairah

and Ajman. A map showing the routes taken by the mission is attached (Fig 5.1)

4.1.4.2 Abu Dhabi

Agricultural lands in Abu Dhabi are found mostly in Al-Ain area and Liwa oases. Some agricultural lands in Liwa Mahadir are threatened by drifting sands. In Al-Ain area moderate desertification was observed in the form of degradation in native forests as a result of overgrazing.

4.1.4.3 Northern Region

Responsible officials in the Ministry of Agriculture stated that expansion in agricultural activities demanded over-pumping of irrigation water. This led to lowering of water table, depletion in wells and rising salinity in water and in the soil. The result was failure of crops and death of fruit trees and date palms. A large number of farms were therefore, completely abandoned or neglected which added to the rate of degradation.

Areas severely affected with desertification were seen in Ras Al-Khaimah up to Wadi-Sha'am. The causes were increased salinity in water and soil and encroachment of urbanization/construction into farmlands. Farms with many dead palm trees were seen near to Ras Al-Khaimah town. But in Wadi Sha'am area salinity level in many farms was so high that only date palms could be grown. The authorities have realized that conditions have so deteriorated that measures had be taken, and no more wells can be dug without government permit.

Between the group of villages - El Nakheel, Al Ma'amora and Al-Hudaiba, there is an **Acacia tortiles** forest undergoing invasion by **Prosopis geoflora**. On the way to Digdaga, a zone of sand dunes was observed in which **Prosopis cinaria** prevailed, but the degree and direction of its threat could not be determined.

Digdaga, a fairly extensive agricultural zone includes animal production and fodder farms (alfa alfa and Rhodes grass) under drip irrigation. Water and soil salinity are moderate and this is the rating of desertification seen in some farms.

In Al-Humrania, another agricultural zone, known for vegetable production, water salinity has reached 1500-2000 M Mohs. The Ministry of Agriculture office for the Northern Region and an Agricultural Research Station are found at Al Humrania. There are several sections in the Research Station engaged in work on date palm, fruit trees, vegetables, fodder and cereals.

The main water problems in the area are salinity and drop in level which is now one metre/ year. Wells depth of 150' in the eighties is now over 400'.

4.1.4.4 Central and Eastern Regions

On the road between Al-Shayah and Dhaid drifting sands were observed. Dhaid and Falaj Al-Mualla are both agricultural zones seriously affected by drought and dropping of water table.

The water level in wells dropped from the range of 200'-500' in 1970 and drilling had to go down to 500'-700' about 1980 and to 700'-900' about 1985. Presently drilling goes down as far as 1000'-1200'.

As a result of this drop 75 wells out of 682 in Dhaid 1 became unproductive. In Dhaid 2, 100 wells out of 947 became dry while 50 are classified as poor wells.

In Dhaid area tens of farms which were productive up to 1985 are now desertified.

In Falaj Al Mualla (Um-Al Qwain) farms are affected with sand dune encroachment and drying up of wells. The place was the best known for water melon and sweet melon up to 1977. Presently farms have only date palms and some vegetables.

In Al-Fujaira increasing salinity caused serious damage to the vegetable farms which until 10 years ago used to produce thousands of tons of vegetables. High levels of water salinity coupled with soil salinization reduced the farms into plots covered with natural vegetation which has returned to occupy the abandoned farms.

The country-wide picture of wells productivity in 1991 shows that of 31949 wells 3915 (12.25%) are poor wells and 28034 (87.74%) are productive.

4.1.4.5 Causes and Types of Desertification

The causes and types of desertification in these areas are the following:

(i) Excessive increase in ground water salinity (which is the main source for irrigation) above the tolerance limits of many crops, particularly in the following areas: Al-Fujaira, Kalba and Murbah on the eastern coastal plain, Ras Al-Kahima upto Wadi Sha'am and Al-Ain.

(ii) Depletion of the ground water resources observed as continuous drop in the water table and serious reduction in wells productivity. This situation is most obvious in Falaj Al-Mu'alla

This problem of water shortage was also observed in Masfout and Mizaira'a areas. However, the ground water resource situation has significantly improved in Masfout area after building the recharge dam upstream of Masfout agricultural area. The situation in Mizaira'a is still suffering and is expected to

deteriorate rapidly if remedial measures are not taken.

This situation has also occurred, but to a lesser extent in Al-Ain area. Reduction of well yields in this area has forced farmers to drill deeper wells to replace the shallower ones.

Slighter but continual reduction in well yields and drop in the ground water levels are taking place in the rest of the country. Close monitoring is therefore required, and appropriate measures should be taken.

(iii) Loss of vegetation cover followed by wind and water erosion and/or sand encroachment.

Cutting of native shrubs and trees in the past for fuel reduced the vegetation cover which needs long periods of time to recover even if good measures have been taken due to the unfavourable conditions. The denuded surface soon becomes ground for wind and water erosion. This is observed in the presently poor rangelands in the Northern, Eastern and Central Regions in UAE.

(vi) Overgrazing of native vegetation and spread of unpalatable species. This is due to increasing numbers of animals beyond the grazing capacity of the rangelands especially after the settlement of herders where animals started to move shorter distances and to stay longer on the range.

Another factor that encourages people to raise more animals is the incentive they receive in the form of 200 dirhams per camel and 50 dirhams per sheep or goat and the subsidized prices when selling animals (mainly camels) at certain ages to the government slaughterhouse in Abu-Dhabi Emirate and the free veterinary services and subsidized prices of forages in all the Emirates.

The influence of climate and livestock in the process of desertification

The role of certain factors in UAE deserves mention. First there is the harsh environmental conditions prevailing in the UAE including low and erratic rainfall, high temperatures and high evaporation rates. Total annual rainfall varied between 46.7. in El-Betain and 183.8 mm in Kelhalmahla in 1989 and between 6.8 mm in Al-Fujairah airport and 230.7 mm in Ras Al-Khaimeh airport in 1990.

Second the increasing numbers of livestock beyond the capacity of rangelands. The Arab Centre for the Studies of Arid Zones and Dry Lands (ACSAD) and the Arab organization for Agricultural Development (AOAD), evaluating the status and potential development of animal feed resources in the United Arab Emirates estimated the number of animals in the U.A.E in 1976 to be 198100 goats, 73500 sheep, 15900 cattle

and 39400 camels (ACSAD&AOAD,1981). In 1980 these figures were 341622 goats, 132237 sheep, 25665 cattle and 58709 camels. The expectation for the year 2000 were, 617000 goats, 216700 sheep, 38200 cattle and 79000 camels. Livestock distribution shows that sheep, goats and cattle are concentrated in the middle districts as the vegetation cover is fairly rich and the forage production is more whereas camels are concentrated mainly in the southern districts (Abu-Dhabi). Degradation of the vegetation cover and subsequently of the land is pronounced in the middle districts.

Total numbers of goats increased from 357150 head in 1981 to about 702572 head in 1991; sheep numbers increased from 138248 to 271957 in 1991, camel numbers increased from 61378 to about 120740 head, and cattle numbers increased from 26832 to 52781 for the same period.

Comparing the above-mentioned figures for livestock numbers with ACSAD and AOAD expectations, it is clear that these expectations were exceeded by the year 1991 and not by the year 2000 as the report expected.

4.2 National Participation Towards the Preparation of the Plan[4]

4.2.1 General

This section is included to reflect the importance and significance of the participation of national institutions and experts in the preparation of this plan. It will bring to the notice of those who wish to co-operate with the UAE in connection with desertification study or control the existence of this contribution.

The following record gives details of the work by Institutions and experts in UAE which helped directly or indirectly in this study. A lot of this work has not been done in connection with the problem of desertification, nor was it done as preparatory material in anticipation of formulation of a NPACD. Nonetheless it was useful to the mission. The following list comprises the important works:

4.2.2 Surveys and Research

(i) El-Ghonemy, K.H (1981) Ecology and Flora of Al-Ain Regions. University of United Arab Emirates.

(ii) El-Ghonemy A.A. & Al-Ghotb, Z. (1982). Man and the Environment in UAE. Al-Ain for Advertising, Publication and distribution. Al-Ain (In Arabic).

(iii) Embabi, N.S (1991) Dune types and patterns in the United Arab Emirates using Landsat TM-DATA. 24th International Symposium on Remote Sensing of Environment, Rio de Janiero, Brazil.

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[4] This section also includes works prepared by expatriates in UAE institutions.

(iv) Embabi, N.S. and El Sharkawy F.M. (1990). Land Form Systems of the United Arab Emirates from space images. J.Arts. U.A.E. Vol.6:476

(v) Afforestation in the UAE (Experience in the Emirate of Abu Dhabi and its suburbs). A 14-pg note prepared by the Forestry Division in the Municipality of Abu Dhabi.

(vi) El-Nashar, Ali M. (1992) Desalination and Water Resources in the UAE. Current Status and Future Developments. A contribution to the symposium on greening of the GCC Countries. PP 12.

(vii) The Department of Agriculture and Animal Production published a book in 1987 entitled: "Department of Agriculture and Animal Production and the Steps of Agricultural Development". Pg. 404 (In Arabic).

(viii) Sagr, Ibrahim (1980) An introduction in Hydrogeology of Al-Ain. DAR Al-Khaleej Printing Press- Al-Sharjah. (In Arabic).

(ix) ACSAD (1986). (In arabic) Preliminary survey of natural range resources in the Gulf States and the Arabian Peninsula. The UAE.

(x) ACSAD, AOAD (1981). Evaluation of present status and potential development of animal feed resources in UAE (in Arabic).

(xi) ACSAD, ALECSO (1986). An Encyclopedia of Animal Resources in the Arab World - United Arab Emirates.

4.2.3 Conferences and Symposia

(i) ACSAD, UNESCO, (1981). Report on the third Training Course on Management and Development of Natural Range in the Arab World.

(ii) Faculty of Agriculture,UAE,(1985). In Arabic - see references list.

(iii) International Conference on High Salinity-tolerant Plants in Arid Regions. United Arab Emirates University, AL-Ain, Abu Dhabi, UAE. December 8-15, 1990. Book of Abstracts. Sponsors:UAE University and International Association for Ecology.

4.2.4. Other Works

The Department of Agriculture, Al-Ain mentioned they have undertaken jointly with NASA (USA) a study on Water resources.

A study was also prepared for the Department of Agriculture on water table levels by Mr. Obeid Al-Karaki.

4.2.5 National Contribution in the formulation of the NPACD

Interest in Agriculture in general (inspite of the very small area suitable for cultivation) and in controlling desertification in a country several references considered that 100% of its land is desert, goes back to the late sixties. One of the first activities relating to desertification control-afforestation-on the basis of long-term planning, started in 1980.

The initiation and continuation of this activity is a direct result of advanced environmental awareness and determination in the highest level of authority in the State. This is a rare example of the kind of political will which is normally missed in developing countries.

Fighting desertification, in the UAE, which has been undertaken by the State, almost alone , has been an issue in correspondence with UNEP and ESCWA since the preparation for UNCOD in the seventies. UAE first contribution in this respect goes back to that time when UAE participated in UNCOD in 1977 and presented a country report to the Conference. In the late 1980s UAE requested UNEP and ESCWA for assistance in the preparation of a NPACD.

In response to this request UNEP and ESCWA included UAE in their programme for providing, to countries in the ESCWA region, assistance in order to prepare their NPACD.

One expert was sent in late 1991 to prepare the background section of the NPACD for the UAE. His report,comprising the first four chapters of this report, was prepared in December 1991.

The information and data in these first four chapters was obtained from the UAE experts and government officials. Additionally, persons met by the UNEP/ESCWA expert were very helpful in providing their views on the basis of their long experience. (list of these experts appears at the end of Part ONE). This was a very valuable national contribution to part I of this report.

It took sometime before follow-up to the first mission could be organized. It was in May 1993 that a second mission composed of three experts could be assembled and assigned the job of preparing the substantive part of the NPACD in the UAE.

The mission spent 18 days in UAE. Its programme was organized by the General Secretariat of the UAE Municipalities in close cooperation with the office of the UNDP Resident Representative in UAE.

The mission held 19 meetings and met 51 national experts who have kindly offered information and data and made their knowledge and valuable experience at the disposal of the mission. The names of these persons are included in Annex 1.

The national experts who accompanied the mission in its long travel trips, not only provided information and explanations for various questions but effectively contributed towards shaping the conclusions and recommendations reached by the mission.

Several documents including published work as well as reports written by International Organizations or departmental reports were made available by national experts to the mission. This was indeed an important component of national participation in the preparation of the NPACD.

4.2.6 National seminar on the suggested plan

4.2.6.1. Steps in the preparation of NPACD

The essential steps in preparation of a national action plan to combat desertification are:-

(i) Preparatory works in the country concerned with the plan;

(ii) Visit of the team of experts for some weeks to prepare the draft plan;

(iii) Government initial agreement or preliminary acceptance of the plan outline presented by the UN mission to the Government representatives in the round-up meeting;

(iv) Government approval of the suggested PACD; and

(v) Organization of a national seminar on the suggested PACD.

4.2.6.2 Proposed programme for the National Seminar

The principal objective of the national seminar is to further the involvement and participation of national institutes and cadres in the formulation and setting the NPACD document ready for implementation. Details of the proposed programme for this seminar are described in Annex 2.

4.3 National goals

4.3.1 The UAE came into existence in 1971 and a Ministry of Planning was created in 1972. The state did not adopt any comprehensive development plan during the seventies. However, a most important document approved in 1974 and used by the State during that period was the Principal General Development Goals Document. This Document is considered as the long-term National Goals Document, which addresses all national aspirations. It consists of seven items, four of them address issues relevant to the concerns of this report (Ministry of Planning, 1987). In brief these are:

(i) Economic development should proceed on a balanced basis at the level of the whole Federal State and the level of individual Emirates.

(ii) Support of national economy on the basis of self dependence with emphasis on augmentation and expansion of agricultural-crops and animal resources-vertically and horizontally - in order to achieve the maximum possible level in agricultural production...

(iii) Man remains the ultimate goal for developmental efforts in the UAE.

(iv) Development of man-power and establishment of well trained cadres.

4.3.2 The first Five-Year Development Plan for 1981-85

A great deal of effort and organization was spent in the preparation of this Plan over a period of two years. Four of the nine aims of this plan addressed issues relevant to the concerns of this report. These, in brief, are:

(i) Development and strengthening of human resources.

(ii) Conversation of natural resources and its development.

(iii) Expansion of the productive base though maximum production of food and agricultural commodities locally.

(iv) Provision of economic and social conditions for achieving balanced development for all Emirates in the State.

4.3.3 The Significance of Agriculture, Animal and Fish Resources

The contribution of the agricultural sector in the Gross Domestic Product (GDP) is relatively small compared with other sectors. Nonetheless, the sector, acquires special importance as the sector in which UAE nationals constitute the highest percentage of its manpower. Moreover the sector produces 20% of the total food requirements of the country.

For these two reasons, the agricultural sector deserved special attention which was reflected in the sectoral aims assigned to it in the Plan. These were:

(i) Producing as much as possible of the State's food needs and increasing the capability for food security.

(ii) Increasing the production capacity of the pastoral lands and plant resources and taking action for their rehabilitation and development.

(iii) Conversation of under ground water resources, developing water sources and improvement of their utilization.

(iv) Raising income level of farmers and fishermen to narrow gab with other sectors.

(v) Organizing marketing operations of agricultural production.

(vi) Vegetable production for 1985 was estimated at about 155 thousand tons, milk and milk products at about 35 thousand tons, red meat about 12 thousand tons, poultry about 6 thousand tons, about 200 million eggs in addition to 106 thousand tons of fish.

The history of developmental steps in the agricultural sector deserves respect. Despite limitations set by natural conditions on this sector, its products, as a result of continuous developmental efforts, have come to satisfy an important portion of the national food needs. The development in figures between 1975 and 1991 appears in table 4.1.

Table 4.1: Total Cultivated areas , agricultural production and livestock numbers in 1975,1985 and 1991.

	1975	1985	1991
Total Cultivated Land(ha)	14500	37300	59662
Vegetable Production (tons)	13000	285000	342262
Palm Dates (tons)	23000	97000	173110
Other Crops (tons)	4000	253000	446784
Total Livestock (head)	259000	765000	1148050
Egg production (unit)	4,000,000	158,000,000	209,900,000
Milk production (ton)	12000	38000	51,932

Source: Figures for 1975 and 1985 obtained from the report of the Ministry of Planning 1987. (see reference list). Figures for 1991 obtained from MA&F,UAE (1992). Annual Statistical Bulletin for year 1991.

4.3.4 Development objectives in 1991

The Annual Economic Report (1992) stated in its introduction that the "objectives-mix is to develop the country's economy, by promoting and enhancing the various productive and services sectors, attaining desirable standards of living, establishing national cadres, continuing to provide social and economic assistance to various developing countries ... etc.

Nothing in this statement, addresses desertification or land degradation as such. But in view of the importance of the agricultural sector among the various productive sectors and UAE's concern with the environment and development, and decision to make 'concern and interaction with environmental matters' one of the functions of their Faculty of Agriculture (Faculty of Agriculture, UAE,1985) in as early as 1985, justifiably leads to the conclusion that prevention of land degradation and desertification must be a priority if these aims are to be achieved.

4.4 A long-term strategy for desertification control (1994-2020)

4.4.1 Guidance from the long-term national goals

The national goals, sometimes referred to as targets or Plan objectives, during the last twenty years have been reviewed under section 4.3. Since attention was directed to the question of development in the mid-seventies, serious concern with agricultural production was eminent. This evidently led to concern with the environment which found expression in 1985 in the inauguration of the First Scientific Seminar on Agriculture, Water and Food Security in UAE (ibid). This connection established a link between priority for environmental action and the original objectives of UAE's long-term strategy embodied in its document of 1974.

Since a principal direction in the UNCOD Plan of Action, Recommendation 22, calls for integration of anti-desertification programmes into development plans, it becomes imperative that the long-term strategy for desertification control should anchor its roots into the national long-term development strategy of the mid seventies and ensure that its objectives are in line and supportive of those currently proclaimed. In this way integration of programmes and projects formulated for desertification control will naturally be easily achievable.

Desertification is an environmental problem; when left to spread unchecked it will, no doubt, develop into an environmental disaster. Control of desertification which is known to have spread in Al-Fujaira, Kalba & Murbah; Ras Al Khaimah, Falaj Al Mualla, Dhaid and Al- Ain area can be undertaken under the national development objective "to develop the country's economy, by promoting and enhancing the various productive and service sectors, attaining desirable standards of living, ...etc."

4.4.2 Target Dates

Experience in implementing the UNCOD-PACD during 1978-1991 shows that desertification is not the kind of problem that can be solved once and for all. It is a process that will generate new problems to be tackled once the more urgent ones have been dealt with, (UNEP,1991). Therefore time targets should be set forth with the intention of implementing major control measures against desertification.

The long-term horizon for this plan is proposed for 2020. This date is chosen to coincide with the date set in the second assessment (UNEP,1991) to complete execution of a set of practical steps proposed for implementation to combat desertification at the national, regional and international levels (ibid).

The short-term period is set for 1994-1999. The short-term horizon takes into consideration the agreement of the Governments of the GCC that development plans start at the

beginning of or middle of the decade. So it is suggested that the initial short-term period during which a priority projects programme is formulated will cover the period 1994-1999.

4.4.3. Aims of Strategy for Desertification Control Guiding Policies.

A National Plan of action to Combat Desertification whose primary function is to halt desertification in any country is at the same time a building block in the design to implement UNCOD/PACD. It is therefore recommended that it should be prepared on the basis of the general policy guidelines as directed by UNEP (1991).

The principal aim, as spelled out in UNCOD/PACD, (UN, 1978); "is to prevent and to arrest the advance of desertification and, where possible, to reclaim desertified land for productive use". Under its objectives and principles the Plan (ibid) (paragraph 10) stipulates that: "The ultimate objectives is to sustain and promote, within ecological limits, the productivity of arid, semi-arid, sub-humid and other areas vulnerable to desertification in order to improve the quality of life of their inhabitants. A campaign against desertification should take its place as a priority among efforts to achieve optimum and sustained productivity. For the countries affected, {and the United Arab Emirates is one of them} the implementation of this Plan of Action implies more than a campaign against desertification; it is an essential part of the broad process of development and the provision of basic human needs".

This quotation from UNCOD plan, which was unanimously endorsed by the UN General Assembly in December 1977 establishes the basis for assigning a very high priority to the issue of desertification control in the UAE. To accomplish this principal aim on the basis of national goals the following targets/objectives are set for the year 2020[5].

(i) Raising the percentage of self sufficiency in food production.

(ii) Improvement of the quality of life of the inhabitants of lands affected by desertification and protection of the environment.

(iii) Sustainable development of the two limiting factors - water and land, in accordance with the need and potential of country's natural resources.

(iv) Ensure people participation in design and implementation of the programmes side by side with

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[5] These targets are formulated along the lines of the 16 targets suggested in UNEP (1991) to be addressed nationally, regionally and internationally.

developing and improving public perception of the desertification problem.

(v) Development of indigenous national and regional scientific research and technology capabilities.

(vi) Establishing national institutional and technical facilities for assessment and monitoring of desertification.

(vii) Contribute to strengthening of regional programmes and international cooperation in the campaign against desertification.

4.4.4 Basic assumptions and conditions

(i) The strong move and political will prevailing in UAE behind afforestation, greening and general care for range protection is expected to continue.

(ii) Coordinated fighting of desertification as an environmental undertaking will form an integral part of the State's efforts and long-term strategy.

(iii) The validity of desertification control projects should not solely be judged by standard methods of economic and financial feasibility. Some of the parameters important to this issue cannot be measured by these yardsticks.

(iv) The proposed long-term and short-term programmes, including projects, would be subject to frequent revision and changes in view of the dynamic nature of the phenomenon.

(v) There will be close co-ordination and mutual support among all the national projects, irrespectively of geographical location, and also between this group of national projects and regional projects.

4.4.5. Basis of the Strategy: A long-term programme (1994-2020).

The UN Conference on Desertification adopted a PACD in 1977. After adoption by the UN General Assembly, implementation started in 1978. Since then a general assessment of progress in the implementation of the Plan was made in 1984 and concluded that little was done by way of controlling desertification and that desertification continued to spread ever since.

Another general assessment was made in 1990/91. On the basis of its conclusions, UNEP report (1991) presented to UNCED new guiding policies and 11 practical steps worded in the form of modified UNCOD Plan recommendations (Annex 3), under preventive, corrective, rehabilitation and suppositive measures. In the modified recommendations of 1991 and in the recommendations of UNCOD Plan, the choice of priorities and suitable action to be taken was left to the individual governments to decide upon. UNEP Governing Council considered the general assessment of 1990-91 and reaffirmed its conviction that the UNCOD,PACD is an appropriate instrument to assist governments in developing

national programmes for arresting the process of desertification.

In light of the above, the following programmes are proposed for the NPACD in the UAE.

4.5 Elements of Strategy: Selected Programmes.

4.5.1. Programme for Assessment and continuous monitoring of the status of desertification in affected territories including the socio-economic status of the rural population

This programme addresses activities dealing with determination of the status of desertification and its continuous monitoring in view of the dynamic nature of this phenomenon. National and global statistics of desertification are lacking and reliable quantitative local measurements are needed at the national level in order to formulate appropriate projects and to monitor the steps of progress.

Since fighting desertification is essentially action for improving the lot of man, the programme should include monitoring the human conditions in areas desertified or threatened with desertification.

Assessment of the status of desertification is accorded very high priority in UNCOD-PACD; it is the subject of its first recommendation. It is also the subject of recommendation 9 of the 1990/91 General Assessment.

4.5.2 Water Resources Management Programme

4.5.2.1. General

Most of the UAE is desert. The area of the present cultivated land is about 43100 ha and constitutes about.56% of the total area of the country. The water resources in UAE are scarce and in fact water is the limiting factor for agricultural as well as for other socio-economic developments.

Over-use and over-exploitation of the water resources are factors of major influence in the desertification process in UAE. Therefore, changing such practices within the frame-work of a country-wide rational and integrated water resources management is a key factor in combating desertification. The success of this programme, however, depends on its firm lodging as part of the comprehensive efforts needed at all levels and in other resources/sectors and their faithful execution. Additionally the programme should direct special emphasis to the relationship of water to the land productivity in terms of agricultural crops and natural vegetation.

4.5.2.2 Objectives

The main objectives of the programme are:

(i) To protect the existing available water resources which have not been seriously affected by over pumping.

(ii) To control water salinization resulting from different causes, in both the coastal aquifers as well as for the inland aquifers.

(iii) To augment the depleted ground water resources by artificial recharge.

(iv) To propose alternative water resources development projects to meet the present and future water demands.

4.5.2.3. Policy requirements

These objectives can be achieved through implementation of appropriate activities and measures. To ensure successful a policy for developing, protecting and managing the water resources should consider using, as a basis, the following guiding lines, as appropriate:

(i) Continuous resource assessment, planning and proper management have become essential to maintain an adequate supply of good quality water to sustain human activities and meeting water demands.

(ii) An Integrated approach for water resources development, utilization and management should be adopted. This integrated approach should be applied at the entire country level rather than individual regions, and for all types of uses (agriculture, domestic, industrial and landscaping), and for all the available water resources (ground water, surface water, treated sewage, and desalinated water and brackish ground water).

(iii) Fresh and slightly brackish ground water should be assessed and protected from depletion and advanced deterioration in their quality. Protection against toxic pollution should also be considered. Where possible these resources should be augmented by artificial recharge of unshed flood flows, surplus desalinated water and treated sewage effluent.

(vi) Domestic water supply for relatively remote areas can depend on local fresh ground water resources or a small desalination units for brackish ground water.

(v) Municipal supplies for the major cities and population centres and other smaller coastal and near coast communities should rely mostly on desalinated sea water.

(vi) Irrigation for landscaping in cities and towns should be based solely on treated sewage effluent.

(vii) With the exception of uses in (iv) and (v) above, the ground water resources, augmented, where possible by flood flows and treated sewage effluent should be used for irrigated agriculture. In view of the wide range

of ground water salinities over the country, appropriate agricultural crops should be adopted for the appropriate range of groundwater salinity. Therefore, zonation of agricultural crops (fruits, date palm, vegetables, field crops and forest) should follow the zonation of groundwater salinity and its geographic distribution.

(viii) Accordingly, the existing cropping pattern should be revised and modified to suit the crops salinity tolerance and the available quality of groundwater. This would result in optimal use of groundwater for agricultural production.

(ix) Implementation of the above actions means that exchange of water resources between the various uses needs to be considered and adopted.

(x) Appropriate legislation needs to be strictly enforced for protecting and managing the available groundwater resources.

4.5.2.4 Sub Programmes and Activities:

The water resources management programme will include the following sub-programmes.

(i) **Data collection and analysis, and monitoring sub-programme: Activities**

(a) Field inventory of groundwater wells in the different basins.

(b) Periodical monitoring of groundwater levels, quality, and pumping rate in the affected areas.

(c) Establishment of a water resource and water use data bank.

(ii) **Investigation and Studies sub-programme: Activities**

(a) Assessment of rainfall quantity, distribution and frequency.

(b) Assessment of surface runoff in the mountain region.

(c) Assessment of the long term practical and sustainable groundwater yield for the various groundwater areas and well fields. The ongoing hydrogeological study, at the country level, can form the basis for the proposed detailed quantitative studies.

(d) Assessment of the performance of the existing recharge dams with a view to selecting new potential recharge sites and methods.

(e) Assessment of sea water intrusion problems, (magnitudes, extent) in the coastal plains; particularly in the eastern coast.

(f) Assessment of the present crop water use and actual demand for irrigation.

(iii) Development and New Installations sub-programme:

(a) Increasing the desalination capacity of water through a development to meet most of the municipal water demand.

(b) Expand sanitary services and treatment plants to include all major cities and large population centers.

(iv) Research sub-programme, to study:

(a) Appropriate methodologies for increasing groundwater recharge from surface runoff.

(b) Aquifer recharge using treated sewage water, (assessment of appropriate methodologies and environmental impacts).

(c) Hydraulic ridges or troughs as a possible means for control of sea water intrusion.

(v) Protection and rehabilitation sub-programme

This sub-programme aims at conducting studies on the present status of ground water resources in order to classify the groundwater areas (geographical) into 3 classes. Each class receives its priority and special set of activities to attain its protection and rehabilitation measures. The detailed protocol of this sub-programme is included in Annex 4.

For references and additional information see recommendations 5,8 and 26 of the UNCOD PACD of 1977 and Recommendation 4 of the 1990/91 General Assessment (Annex 3).

4.5.3. Public awareness and participation programme

Successful prevention and combating of desertification and reclamation of desertified lands depend on public awareness and participation. People must be directly involved in the making of decisions which profoundly affect their lives. Recommendation 3 of UNCOD PACD calls for making public participation an integral element of the prevention and combating of desertification. Affected people should be involved in the planning and execution of activities. In this way people will put their collective wisdom and skill to obtain gainful functioning of the project. However, to make public participation rewarding it is essential to take the following action at the national level:

(i) organization of a series of demonstration sites showing examples of anti-desertification land use and appropriate technologies.

(ii) Publication in local language and extensive use of extension services for distribution of pamphlets and leaflets.

(iii) Use of media network - radio, television, newspapers- for spreading special regular anti-desertification material.

(iv) Introduction of special courses on desertification in all public schools in rural areas affected by desertification.

(v) Organization through extension services of anti-desertification networks, anti-desertification on-the-job training of farmers and pastoralists in areas affected by desertification.
(For reference see Recommendations 3,12 and 20 of the PACD of 1977 and Recommendation 7 of the 1990/91 General Assessment).

4.5.4 Conservation Farming and Land Husbandry (land care) Programme

This is the biggest programme in the Plan. It is based on one of the main principles proposed in the third general assessment of progress in the implementation of the PACD in 1990/91. The principle reads, "After decades of trying to save the soil '*from the people*', a more promising approach should be adopted: to help land users save the soil and water for themselves, for improved agricultural production, i.e., to practice Conservation Farming and Land Husbandry (Land Care) instead of soil and Water Conversation", (UNEP,1991).

Perhaps in a situation and conditions like those prevailing in UAE, with the two basic resources-soil and water-posing as limiting factors, this principle seems to be the most appropriate for application.

The programme covers activities on soil, forestry and rangelands. It also deals with improved farming systems. Obviously this is a very wide base to cover. The programme deals with several corrective anti-desertification measures described in Recommendation 5,6,7,8 and 9 of the 19977 PACD and in Recommendations 1,2,4, and 5 of the 1990/91 General Assessment.

4.5.5. Drought Relief and Insurance Measures Programme

The importance of this programme stems from the fact that drought in UAE affects seriously the irrigation water sources on one hand and the livestock and rangelands on the other. It is therefore important to develop and introduce a national insurance scheme against the risk and effects of recurrent droughts. Recommendation 17 of the PACD of 1977 should be referred to in this respect.

4.5.6 Strengthening the National Scientific and Technological Capabilities Programme

This programme is concerned mainly with training in sciences and technology and in building up the research capabilities needed for the development and implementation of the desertification control plan in UAE. A GCC (1990) publication put the total number of professionals trained and engaged in environment protection work, at 44 including 40 expatriates. Although the reference document seems to have omitted professionals in some relevant disciplines such as forestry, there is obvious need for expansion of research and training facilities in the country.

Three of 28 recommendations in UNCOD plan (Nos. 18,19 and 20) are concerned with man-power training and research particularly in planning and administration and in directing them towards the direct needs of development. Implementation of the programmes in this plan need to be supported by relevant research while the availability of trained cadres is a prerequisite for successful implementation of the plan.

4.5.7 Strengthening the National Institutional Capabilities for Implementing the NPACD

The establishment of the institutional set-up for implementation of the NPACD will be dealt with in detail in chapter VI.

4.5.8 Regional and International Co-operation Programme

This programme deals with issues and problems that cannot be adequately managed by one country. During the previous decade the United Nations Sudano-Sahelian Office (UNSO) proved to be a successful instrument for organizing regional cooperation in combating desertification. The achievement of UNSO in mobilization of resources needed for combating desertification should be considered for replication in the region of West Asia. In this respect, it is fortunate that the instrument needed already exists- the Council of Arab Ministers Responsible for the Environment (CAMRE). The Gulf Co-operation Council (GCC) may be considered as an alternative vehicle.

The areas identified for co-operation (UNEP,1991) are:-

(i) Mobilization of financial resources and provision of financial assistance to the countries that cannot cope with the problem by themselves. UAE has already been involved in this activity and has extended assistance in the field of afforestation and garden establishment to several countries;

(ii) Development of pricing and trade policy that would favour agricultural development and sustainable productivity of drylands;

(iii) Provision of technical assistance to the countries in need;

(iv) Development of appropriate ant-desertification technologies and technology transfer to the needy countries on favourable terms;

(v) Monitoring and coordination of the anti-desertification campaign at the global level;

(vi) Information exchange;

(vii) International legislation as appropriate.

For reference see Recommendations 23,24,25 and 26 of the PACD, 1977 and Recommendations on the course of action regionally and internationally (Annex 3).

4.6 Remarks

Eight programmes comprise the lot suggested for the long-term strategy of the NPACD in UAE which covers the next 25 years. These programmes are interdependent and complement each other. Similarly the priority projects which will be identified within the framework of these programmes and described for implementation in the short-term (1994-1999) must share the same qualities of interdependence and complementarity. The priority projects will be presented in chapter VI.

The implementation of this NPACD, formulated on the basis of a long-term strategy comprising eight programmes and tens of priority projects for 1994-1999 which will be followed by perhaps hundreds of projects for the period 2000-2020, requires setting up a highly competent and capable institutional machinery. This complex activity, mentioned under 5.5.7 will be elaborately described in the next chapter.

At the end of this chapter it should be emphasized that all desertification work, whether it is part of the long-term strategy or the priority projects group in the short-term, they should all form an integral part of the national social and economic development plan.

Chapter V
Establishment of National Institutional Capabilities

5.1 Background

Several important administrative government offices and institutions in the UAE have been established before the present federal state came into being in 1971. Of particular importance in this respect are the well established municipalities. They have been set-up and grown to be responsible for both services and developmental activities. In fact the Divisions of Agriculture or of Forestry in the Municipalities of Abu Dhabi and Dubai are in structure (staff composition) and function as large as ministries.

During the past three to four decades these municipalities have undertaken huge tasks in the wide field of agriculture and infrastructure building and in the process have accumulated invaluable experience and knowledge. In their work they were not far or isolated from environmental concerns.

5.2 Institutions involved in Environmental matters in UAE

The history of bodies that had environmental responsibility probably goes back to the early 70's, i.e. some 3 or 4 years after the formation of the UAE. The following are the main bodies.

5.2.1 The Municipalities

The municipalities in all Emirates had responsibility on environmental matters through their functions in afforestation agriculture and provision of various services and authority of issuing regulations and licenses.

5.2.2 Ministries

Three ministries seem to have certain environmental responsibility as a result of performing their normal duties. These are the Ministries of Health, Agriculture and Fisheries and the Ministry of Water and Electricity.

5.2.3 Higher Environmental Committee

The Higher Environmental Committee was established by a council of Ministers decision in 1975. The main function of the Committee was coordination of environmental work undertaken by different departments and offices. The membership of the Committee consisted of all concerned ministries. The Committee, however, did not have a separate budget approved for its functioning.

5.2.4 Environment Steering Committee

In 1983 an Environment Steering Committee came into being. It was composed of the General Secretariat of

Municipalities, Ministry of Agriculture, Ministry of Health, Border and Coastal Guards, U.A.E. University. The Steering Committee did not accomplish any significant task presumably for lack of a separate approved budget for it. By the end of 1990 the State decided to create an active executive body instead. A proposal for the creation of a Federal Commission for the Environment was submitted to the Council of Ministers.

5.2.5 The Federal Commission for the Environment

In April 1993, the Head of the State, issued a decree authorizing the creation of the Federal Commission for the Environment. The decree consists of 26 articles (Municipalities,1993). The general objective of the Commission is the "**Protection and development of the Environment**" In order to achieve its objectives the commission will undertake 19 actions. Several of these actions deal with matters relating to desertification or to land degradation.

Article 10 in section 4 reads:

"Undertake studies on soil, water and energy and suggest ways of protecting them from deterioration by laying down appropriate regulations that will limit their misuse or depletion. There should be stress on the studies of groundwater, desert areas and prevention of desertification".

The Commission according to section 1 of the Decree will have administrative and financial autonomy and will be attached to the Council of Ministers. Its headquarters will be at Abu Dhabi Town and it may establish branches within the State as decided by the Council of Ministers.

5.2.6 The Higher National Commission for Water

The Commission was created in the 1980s and was charged with developing a national water policy, follow-up and coordinate its implementation by the concerned ministries and municipalities. All concerned ministries and municipalities are represented in the commission.

This commission, through its responsibility on the country's water resources has a direct influence on the environment and on desertification control. (It has been reported, however, that it needed reactivation).

5.2.7 Food and Environment control Centre-Abu Dhabi Municipality

The centre has various responsibilities on food and environment. On the latter, the centre is concerned with environment pollution control with, interalia, monitoring pollution of the environment as an important task.

5.3 Institutions currently concerned with desertification matters

5.3.1 General

The nature of desertification whose causes, symptoms, and consequences affect or are connected with man, livestock, soils, climate, water resources, makes it a subject that falls within the jurisdiction or concerns of many government institutions. These institutions would therefore claim a share in the responsibility for planning and implementing a campaign for the control of desertification. A brief account on these institutions is given in the following paragraphs.

5.3.2 The Federal Commission for the Environment

The Commission was created by a Presidential Decree in April 1993 as the organ concerned with environmental affairs. The main functions of the Commission are:

(i) Protection and Development of the environment

(ii) Formulation of plans and policies for protection of the environment

(iii) Fighting and control of pollution.
The commission, however, specifically number 10 of its 19 tasks is assigned responsibility of "studying ground water, Desert areas and prevention of desertification". The Decree stated that the Commission, in order to achieve its aims will cooperate and coordinate with all sectors involved.

5.3.3 Ministries and Municipalities

The situation regarding these bodies remains the same as described in the previous section. None of them, in the April 1993 Decree received additional responsibility nor did it lose it of what it had regarding desertification.

5.4 Proposed National Machinery for Desertification Control

5.4.1 Structure of the National Machinery

The control of desertification is the concern of several disciplines and professions, and therefore no single profession or discipline can claim overall responsibility for this complex field. Therefore , the placement of the coordinating organ should be decided on the basis of the local circumstances and the views of the national experts.

Recommendation 21 of the UNCOD plan calls for establishment of coordinated national machinery to combat desertification and drought. It further expressed the desire that the machinery be in the form of a national desertification commission at the highest level of government, composed of high ranking representatives of the appropriate ministries, agencies and institutes, together with community leaders and non-governmental organization (NGOS). The

recommendation gives advice on the task of coordinating and consolidating activities, as well as the need for administrative and scientific support for the national body. This recommendation was slightly modified and elaborated in the UNEP report presented to UNCED (UNEP 1991) as Recommendation 6 in chapter III (Annex 3). It read "To establish or to strengthen the national institutional capabilities for implementing the NPACD, including hierarchical networks down to the grassroots level:-....."

In elaboration it called for:

(i) Establishing a national authority (Commission, Advisory Board, or Department) within the government with access to the highest executive and decision - making level;

(ii) Establishing commissions/boards in regions or provinces.

(iii) Establishing land users' committees in affected rural communities.

(iv) Organizing working cooperation among the local authorities, extension services and land user's committees in planning and implementing anti-desertification measures.

(v) Supporting existing or newly established NGOs ... and strengthening their working cooperation with the national and local authorities concerned with the implementation of the NPACD, with a view to their active participation in the national anti-desertification campaign. (In implementing this recommendation reference should be made to Recommendations 3,18 and 21 of the NPACD of 1977).

Along the lines of the above two recommendations following institutional structures are recommended. It should be added that with the knowledge of the creation of the Federal Commission for the Environment in 1993, and the level of authority and responsibility practiced in the various ministries and municipalities, there is reason and need for the establishment of the urgently needed action - oriented coordinating machinery.

5.4.2 National Desertification Control Commission (NaDeCc)

After its extensive and elaborate discussion with the senior government officials, the field visits and review of the literature, the mission came to the conclusion that the executing government bodies most concerned with desertification are the Municipalities with their General Secretariat and the Ministry of Agriculture and Fisheries. The mission further solicited the views of some senior officials on the placement of the proposed national body charged with desertification control. The views converged on the Ministry of Agriculture as the choice.

It is therefore recommended that a national Desertification Control Commission (NaDeCc) be established under the chairmanship of the Minister of Agriculture and Fisheries and with the following membership:

- General Secretary, General Secretariat of UAE Municipalities
- Deputy Permanent Secretary, Ministry of Agriculture and Fisheries;
- Representatives of Municipalities involved in Desertification control activities such as afforestation, crop and horticultural activities.
- Representative of the University of the UAE
- Director of Soil and Water Department, Ministry of Agriculture and Fisheries
- Representative of the Federal Commission for the Environment - Head of the Unit responsible for the studies on soil ground water, energy and desertification control.
- Director, Department of Desertification Control, MA&F[6]
- Director of the range management unit or Division, MA&F 1
- Representative of the Ministry of Planning
- Representative of the Ministry of Education;
- Representative of the Ministry of Labour and Social Affairs.

5.4.3 Directorate for Desertification Control Coordination

It is recommended that a directorate for Desertification Control Coordination (DDCC) of Agriculture and Fisheries (MA&F). This Directorate should find urgent staffing by a suitable number of professionals and technicians. The Director would be designated secretary of the NaDeCC. The number of staff required would be determined in accordance with the amount of administrative and technical support required for the functioning of the commission and for whatever executive activities the unit becomes responsible for.

5.4.4 Regional Units

Recommendation 6 of the revised recommendations in UNEP Report to UNCED (Annex 3) called for the establishment of anti-desertification boards within provincial local governing or executive bodies in accordance with the existing administrative structure of the country. It is, therefore, recommended that the Directorate for

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6 A newly proposed unit to be established in the MA&F

Desertification Control should establish regional units in Abu Dhabi, Central,Northern and Eastern Regions. The selection of membership in the regional units should be guided by the pattern in the NaDeCC.

5.4.5 Land User's Anti-Desertification Committees

Formation of land user's anti-desertification committees should be pursued in response to the call of recommendation 6 (opcit) for the establishment of "hierarchical networks" ..... down to the grass roots. This could be one of the first functions of the Regional units with assistance from the Ministry of Labour and Social Affairs.

5.4.6 Responsibilities of the National Machinery

5.4.6.1 The responsibilities of the National Desertification Control Commission might include the following:-

(a) Analysis, evaluation and dissemination of existing information on desertification.

(b) Preparation of a national plan of action to combat desertification that would co-ordinate all national activities formulated in accordance with the modified recommendations of the plan as stated in UNEP, Report (1991).

(c) Arrangement of the financing for the implementation of the NPACD through national institutions;

(d) Monitoring the progress of measures to combat desertification and recommending necessary changes to the national plan of action.

(e) Participation in international and regional programmes and maintaining liaison with regional and international organizations on the problems of desertification.

5.4.6.2 Functions of the Directorate for Desertification Control Co-ordination

(a) To service NaDeCC as its technical and administrative arm;

(b) To undertake co-ordination and consolidation of activities related to desertification;

(c) To execute alone or in co-operation with national, regional or international bodies, desertification control projects of a multi-disciplinary nature;

(d) To maintain an up-to-date inventory of all programmes and projects as well as present and planned activities, in order to identify the gaps related to finance or technical omissions.

(e) To prepare preliminary surveys and studies for the formulation of programmes and projects for the implementation of the national plan following the practical

steps (preventive, corrective and rehabilitation measures and the supporting measures) described in UNEP's report (opcit).

(f) To monitor the implementation of the national plan and to prepare an evaluation of its effectiveness;

(g) To record the results of the monitoring of human conditions in areas prone to desertification including demographic and social indicators with particular reference to recommendation 9 (opcit).

(h) To liaise with regional and international organizations (ESCWA UNEP Regional Office, Desertification Control Programme Activity Centre (DC/PAC), the Global Environmental Monitoring System (GEMS), etc.) in order to receive and update knowledge on the international situation and to contribute to the regional and international monitoring/assessment operation.

(i) To prepare and publish a quarterly newsletter giving news and information on programmes, desertification processes and progress made in the implementation of the national plan.

5.4.6.3 Functions of the Regional Units

The functions of these regional units are essentially the execution of projects and the provision of an extension and reporting service. The stress will be more on field action detailed in the section on practical steps in Annex 3.

5.4.6.4 Implementation of the recommended National Machinery

After the Government of the UAE accepts the above proposals, UNEP,ESCWA and FAO could be requested in order to assist in formulating details and providing advice on implementation, staffing and financial requirements.

Chapter VI
PRIORITY PROGRAMMES AND PROJECTS FOR THE SHORT-TERM 1994-1999

6.1 General

Priority programmes and projects for the short-term, 1994-1999, form part of the programmes proposed for the long-term (1994-2020). An attempt will be made to follow the same titles and sequence of presentation as in chapter IV. This has the benefit of enabling those responsible for implementation to see how these short-term activities relate to the long-term programmes presented in chapter IV. It will also facilitate amendments or additions in the future; and lastly progress in each area, can be measured and gaps identified.

Priority projects under each of the programmes identified in Chapter IV will be presented in a brief form. Only in a few cases is an elaborate description given in an annex or in the main report if the information could be reasonably accommodated. It is not intended at this stage to present project proposals in any great detail because it is not certain that these proposals would be accepted by the Government. It will thus save time, effort and funds to work out the details at a later date, and only for those proposals which are accepted by the government. Along these lines the following projects are proposed for implementation during the short-term 1994-1999.

6.2 Assessment and continuous monitoring of the status of Desertification in affected territories including the socio-economic status of the rural population (4.5.1)[1]

6.2.1 Project No.1: Survey and Assessment of Desertification

Objectives:

(i) To investigate the immediate causes and processes of desertification.

(ii) To assess the desertification rate over fixed time periods.

(iii) To prepare desertification maps of the UAE.

(iv) To establish a desertification monitoring section within the suggested Desertification Control Office.

(v) To assess and monitor the status of desertification in the UAE.

(vi) To monitor the human conditions in selected areas.

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[1] The information given for projects regarding duration and cost is only a rough approximation. Figures in brackets refer to the serial number of the programme in chapter V.

(vii) To provide the Government with an up-to-date information on desertification for use at all stages of planning and implementing national development programmes.

Location : All over the State of UAE

Cost : U.S.$ 1,000,000

Execution: National with assistance from UN organization concerned e.g UNEP, UNESCO, FAO,ESCWA and ACSAD etc...

6.3. Water Resources Management Programme (4.5.2)

6.3.1. Project No.2: Ground water Artificial Recharge

Artificial recharge by small scale spreading and retention dikes on Wadies where recharge dams have not been constructed.

Objectives:

(i) To utilize unused flood water during the winter season in the underground storage using simple, practical and inexpensive techniques.

(ii) To augment the existing limited and stressed groundwater resources.

Duration : 6 years

Location :

- Wadi Sha'am and Wadi Ghalila in Ras Al-Khaimah.
- Selected Wadies in the eastern coast, particularly on the wadies draining into the plains of Al-Fujairah, Kalba and Murbah. Such as Wadi Al-Basseirah, Wadi Madah, Wadi Al-Warrayah, Wadi Al-Hulu' and Wadi Al-Qawr.
- Wadi Naqab, Wadi Khub, Wadi Ashwani, Wadi Sifuni and Wadi Shawkaw in the northern and central gravel plains.

Cost: U.S. $ 15,000,000

Execution: National - (MA&F), Consultants and advisory service from ESCWA.

6.3.2 Project No.3: Improvement of the existing recharge facilities at the existing recharge dam's sites

Objectives:

(i) To utilize unused flood water during the winter season in the underground storage using simple, practical and inexpensive techniques.

(ii) To augment the existing limited and stressed groundwater resources.Duration : 2 years

Duration : 2 years

Locations: All existing recharge dams.

Cost: U.S.$ 3,000,000

Execution: National, MA&F & advisory services from ESCWA.

6.3.3 Project No.4: Study the feasibility of constructing ground water dams on selected wadis

Objectives:

(i) To utilize unused flood water during the winter season in the underground storage using simple, practical and inexpensive techniques.

(ii) To augment the existing limited and stressed groundwater resources.

Duration: one year

Location: Selected streams draining into the sea in the northern region, eastern and western coasts, such as Wadi Sha'am and other Wadies where alluvial deposits are thick and underlain by igneous rocks.

Cost: U.S.$ 3,000,000

Execution : MA&F & ESCWA (Advisory service).

6.3.4. Project No.5: Aquifer Storage of Desalinated Sea Water

Objectives:

(i) To alleviate the pressure on the depleted groundwater resources with severely deteriorated water quality.

(ii) To create a long-term strategic storage of fresh water for the future generations by storing it in properly selected aquifers or parts of the aquifers.

(iii) To augment some irrigation groundwater sources in areas where salinity has increased and alternate water sources are not available.

Duration: (a) Construction and testing of injection wells at five sites: 2 years.
(b) Operation:Continuous during the low water demand and water surplus periods.

Location:

1- Coastal areas near the major water consumption centers particularly in areas mostly dependent on groundwater, and where quality deterioration has occurred such as Ras Al-Kaimah, Ajman, Al-Fujaira and Al-Ain.

2- A priority pilot project for aquifer storage of desalinated sea water is recommended in Flaj Al-Mu'alla where severe depletion of groundwater has occurred.

Cost: U.S.$ 0.5 per cubic meter

Execution: National, Ministry of Water and Electricity, according to short-term and medium-term plans specifying priority areas and plants' capacities.

6.3.5 Project No.6: Increased production of treated sewage water and its reuse.

Objectives:

To provide alternate water source for the exhausted groundwater sources which are presently used for landscaping in some areas.

Duration: 5 years

Location and scope:

* Increase collection and production capacities in cities with existing sewage facilities.
* Construct new facilities in Ras Al-Khaima, Ajman and Al-Fujairah.

Cost: U.S.$ 0.35 per cubic meter of treated sewage water.

Execution: National Municipalities and consultants.

6.3.6 Project No.7: Strengthening of the existing monitoring and data collection and analysis programmes for groundwater.

Objectives:

To provide basic data needed for aquifer assessment studies. This would include groundwater levels, water quality analysis and pumping rates estimates. This information is essential for managing the groundwater resources.

Duration: 2. 5 years

Location: (Priority areas):
- The Northern and Central regions.
- Al-Ain area.

Cost: U.S.$ 500,000

Execution: National: MA&F

6.3.7 Project No.8: Groundwater assessment studies

Objectives:

(i) To assess aquifers and well fields potentials and their behavior at various pumping rates.

(ii) To compose optimum courses of action to protect the groundwater resources.

Duration: 4 years

Location: Groundwater production areas in the Central and Northern regions.

Cost: U.S.$ 5,000,000

Execution: National MA&F, Consultants and ESCWA (Advisory services).

6.4 Public awareness and Participation Programme "4.5.3".

6.4.1. Project No.9: Urgent messages on desertification problems and control through extensive use of media networks.

Objectives:

(i) To increase public awareness on the nature of desertification and its damage.

(ii) To improve public understanding of specific problems of water sources degradation - increasing salinity and lowering of water table;

Duration: Continuous 1994-1999;

Location: All over the country with special stress on rural areas.

Cost: U.S.$ 1,000,000

Execution: National + International technical assistance.

6.4.2 Project No.10: Environmental education programmes with emphasis on control of desertification for the young and youth.

Objectives:

(i) To equip children and youth with basic knowledge on the desertification phenomenon and methods of its control.

(ii) To establish public perception of desertification as a threat to food security, stability of the society and the basic needs of future generations.

Duration: Continuous

Location: All the country

Cost : U.S.$ 3,000.000

Execution : National - Ministry of Education, MA&F with UNEP technical assistance.

6.5 Conservation Farming and Land Husbandry (land Care) Programme "4.5.4".

6.5.1 **Project No.11: Survey of rangelands and forest resources:**

ACSAD,AOAD 1981 (Annex 5) and ACSAD 1985 (Annex 6) made a preliminary survey of range resources in the U.A.E. There is need to make a more detailed qualitative and quantitative survey of rangeresources.

Objectives:

(i) To study the vegetation types and distribution of natural range and forest plants.

(ii) To study the present condition and potential of range and forest plants.

(iii) To prepare a vegetation list of the native range and forest species and rank the main species according to their importance.

(iv) To study the ecology and production of the main range and forest species.

Duration: 3 years

Location: All range and forest areas in the U.A.E.

Cost: U.S.$ 500,000

Execution: U.A.E. University, range management unit (established within the Ministry of Agriculture) with the help of experts in range and forest sciences from FAO, ESCWA, ACSAD and other international agencies.

6.5.2 **Project No.12: Establishment of range enclosure**

Objectives:

(i) To established a number of range enclosures to protect natural vegetation cover.

(ii) To study plant succession, recovery, and development of natural vegetation cover inside these enclosures.

(iii) To estimate vegetation production and its improvement under protection or controlled use.

Duration: This may be a continuous project to establish range reserves but for the short-term it is suggested to start with few sites during the period 1995-1999.

Location: 1000-2000 hectares to be chosen and fenced at each of the following areas,Al-Dhaid (in Sharjah), Al-Humrania (in Ras El-Khaimeh), and Al-Aweer (In Dubai).

Cost: U.S.$ 400,000

Execution: Suggested Range Management unit with the help of some experts in range vegetation studies from ESCWA, FAO, ACSAD.

6.5.3 Project No.13: Plantation of fodder shrubs

Objectives:

(i) To plant and extend the activity of fodder shrubs plantations in different suitable sites of the U.A.E. similar to work at Baynonah where the salinity of under groundwater is about 10,000-20,000 ppm.

(ii) To plant Atriplex shrubs or other fodder shrubs as a source of animal feed, and as a means of combating desertification through increased vegetation cover.

(iii) To estimate forage production and to control its use through cutting or grazing.

Duration:
This may be a continuous project to extend fodder shrubs plantation to larger areas, in connection with project No.14 on adaptability of fodder shrub species to different water regimes. For the short-term 5 years, 1995-1999 are suggested for the plantations and studies.

Location:
100 hectares at each of the following areas. The western district of Abu Dhabi (Ghayathi or Madenat Zayed) Al_Ain, Al-Aweer (in Dubai).

Cost: U.S.$ 2,200,000

Execution: National - Agricultural divisions at the municipalities. The suggested range management unit, Department of Agriculture (Al-Ain) with the help of one range management specialist from ESCWA or FAO.

6.5.4 Project No.14: Investigations into the adaptability of fodder shrub species to local conditions.

Objectives:

(i) To study the adaptability of some fodder shrub species (mainly Atriplex species) to local conditions, and to the conditions of non-irrigation and little irrigation.

(ii) To study the adaptability of some fodder shrub species (mainly Atriplex species) to sabkha conditions, as it is known that this type of fodder shrubs accumulate salts in the leaves and when it is cut or grazed, it reduces soil salinity and is a good source of feed.

Duration: 5 years, 1995-1999.

Location: Four sites may be chosen (4-5 hectares each) at:

1. Al-Humrania Research Station.
2. Khat unit (in Ras-Al-Khameh).
3. Al-Thaid research station (in Sharjah).
4. A Sabkha area (to be chosen later).

Cost: U.S $ 250,000

Execution: National, Research division in the MA&F, the suggested range division or unit, with the help of short term range research expert from FAO, ESCWA or ACSAD.

6.5.5 Project No.15: Protection of native forests

Objectives:

(i) To protect some sites where native forests as ghaf, sidr, samar, and others have been degraded at Masakin forest and Bu-Harmah forest (in Al-Ain area).

(ii) To study the development of protected forests compared to non-protected areas.

Duration: This is a long term project. But for the short-term, it is suggested to be for six years (1994-1999).

Location: The following areas are suggested: Ghiyathi, Madenat Zayed,Al-Ain,Al-Aweer, the specific sites will be chosen later. The area of each site may range from 5-10 hectares.

Cost: U.S.$ 200.000

Execution: National, Local forest divisions in the municipalities and the suggested Desertification Control unit.

6.5.6 Project No.16: Establishment of afforested areas and green belts with drought resistant species.

Objectives:

To establish afforested areas and green belts of trees and shrubs that are drought resistant from local and introduced spp to protect the agricultural areas, roads and increase the green cover. A list of promising species was prepared by ACSAD (1985) Table 12.

Duration: This is long term project, but for the short term, it is suggested that this project to be for 5 years 1995-1999.

Location: Dubai-Abu-Dhabi road and other roads and suitable areas around agricultural areas. Suggested Areas to be covered by this project are about 1000 hectares.

Cost: Following the procedures used now in afforestation by the forestry divisions in the municipalities, the cost of afforesting 1000 hectare will be about US $ 6,500,000.

Execution: National - Local forest divisions in the municipalities and the suggested Desertification Control Co-ordination unit.

6.5.7 Project No.17: Investigations into the water requirements of forest and range plants.

Objectives:

(i) To define the water requirements of a number of forest and range species (Such as ghaf, samar, sidr, Atriplex, arta and others.

(ii) To choose the drought resistant species in afforestation or range improvement activities, to stop the excessive use of scare water sources.

(iii) To study the effect of gradually decreasing supply of irrigation water on the survival and production of the experimented species.

Duration: This is a long term activity as with some species experiments may start from the seedling production in the nurseries;with others it may start with already established plantations. For the short term project this activity may be two phases: first phase two years (1994-1995) in the nurseries and second phase 1995-1999 in the permanent site.

Location: Ghiyathi Afforestation Centre, El-Humrania Research Station.

Cost: U.S.$ 300.000

Execution: Forestry division in Abu-Dhali, the Research Division in the Ministry of Agriculture and the suggested range division or unit. There may be a need for international expert in plant - water relations from FAO or other agencies.

6.5.8 Project No.18: Improvement of range vegetation using water spreading by small earth dams.

Objectives:

(i) To collect rainfall water which comes as showers in very short time from the mountains in the northern Emirates.

(ii) To distribute the collected rainfall water to larger areas to improve range vegetation or to plant these areas with fodder shrubs or other crops.

Duration: 3 years 1994-1997-to establish the small earth dams and to plant suitable areas behind them with suitable fodder shrubs or other crops or to broadcast seeds of suitable fodder shrubs.

Location: Wadis that benefit from rainfall flooding. Suitable sites to be chosen later depending on soil characteristics.

The main areas could be in Ajam, Sharjah, Dubai and Fujeirah Emirates.

Cost: U.S.$ 300.000

Execution: Soil and Water division and the Agricultural Research Division in the Ministry of Agriculture.

6.5.9 Project No.19: Sand dune fixation at selected sites in Abu Dhabi, Central and Northern regions.

Objectives

(i) To stabilize sands which threaten agricultural lands, forest plantations in areas affected by sand movement by establishing shelter belts. It is suggested to use temporary barriers as palm branches until the planted seedlings of suitable species as Date palm, Ghaf, Alrak or others establish themselves.

Duration: 4 years 1994/1995-1997/1998

Location: 300 kilometers are suggested to establish shelter belts in 5 rows and at selected areas affected by desertification in Abu-Dhabi, Al-Ain area, Al-Aweer (Dubai) Al-Thaid (Sharjah), Al-Hamedei (Ajman) and Ras-Al-Khameh area.

Cost: U.S.$ 9.8 million

Execution: National - Local forestry divisions in the municipalities, and Desertification Control Unit in cooperation with international agencies.

6.5.10 Project No.20: Establishment of a demonstration farm in Masfout - Ajman

Objectives:

(i) To organize for demonstrations and training purposes a farm on the basis of best suited land use principles and most appropriate technologies.

(ii) To use the demonstration farm to ensure peoples access to correct knowledge of desertification phenomenon and its prevention.

Duration: Five years

Location: Masfout,Ajman

Cost: U.S.$ 500,000

Execution: National - (Na DeCC and Ajman Municipality) and FAO.

6.6 Drought relief and insurance measures programme" 4.5.5".

6.6.1. Project No.21: Insurance against the risk and effects of drought.

Objectives:

(i) To compensate farmers losses as a result of drought.
(ii) To assist farmers in taking precautionary Measures against the risks and effects of drought.

Duration: Continuous.

Location: All over UAE.

Cost: Initial cost for preparatory work $ 250,000 Revolving fund $ 5,000,000.

Execution: National + technical assistance from UNEP-DC/PAC.

6.7. Strengthening the national scientific and technology capabilities programme"4.5.6".

6.7.1 Project No.22: Establishment of, or strengthening Desertification Control Research Centre in the University of UAE.

Objectives:

(i) To conduct basic and applied research on the desertification phenomenon and control.

(ii) To undertake crash and regular training programmes for national cadres needed to staff the newly created national machinery for desertification control and make available the required cadre needed for the implementation of the NPACD.

Duration: Two years for establishment and one year for the crash programme. Then the centre becomes part of the University budget.

Location: UAE University

Cost: U.S.$ 2,000,000

Execution: University of UAE with technical assistance from UNEP & FAO.

6.7.2 Project No.23: Regional Research, Training and Communication Programme on Desertification Control in the ESCWA Region (Phase 1).
Note: This is a UNEP Project document[8] prepared in

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[8] The complete project document could be obtained from UNEP-ROWA-Bahrain. It has also been reproduced as Annex 8 in the National Plan of Action to Combat Desertification in the Yemen Arab Republic,

collaboration with ESCWA and other UN organizations in a meeting in 1984. Since then a degree course in Desertification studies has been established in the Gulf University and this was supplemented with post graduate studies. Nonetheless the need for this regional project on research, tracing and communication is perhaps even more than it was in 1984.

Objectives:

Short-term objectives

(i) To provide a vehicle for the exchange of information and expertise between countries of the region in fields directly related to desertification;

(ii) To facilitate the immediate application of information and technologies available in the region and abroad for the control of desertification and the management of natural resources.

(iii) To identify, formulate and implement individual research projects which would cover gaps in existing knowledge and its application;

(iv) To identify, formulate and implement the desertification control training programme to meet the immediate needs of the countries in the region.

Long-term objectives

(i) To establish a system of collection, collation, dissemination and utilization of the existing information and technologies on the control of desertification, drawn both from the ESCWA region and abroad;

(ii) To strengthen national capabilities in utilizing available manpower and infrastructure resources for conducting research on desertifaication and its control;

(iii) To optimize the management and utilization of natural resources of the region;

(iv) To strengthen regional co-operation and the coordination of efforts for the benefit of each country.

Duration: Five years

Location: Western Asia (Escwa Region), Dubai in UAE.

Cost:		
	Total cost of project	$ 9,100,000
	Estimated contribution by all participating governments	$ 3,100,000

E/ESCWA/AGR/88/2;1988.

Execution: National and regional institutions with assistance from UNEP,UNESCO,ACSAD ..etc.

6.7.3. Project No. 24: Collection, Abstracting and synthesis of the voluminous data and information on the environment specially on land degradation/desertification

Objectives:

(i) To bring to the attention of the concerned professionals and administrates important information on environment and desertification.

(ii) To train national cadre in research and preparation of sound corrective and conservation projects formulated on the basis of available information.

Duration: Six months

Location: UAE-Relevant Government Offices.

Costs: U.S.$ 150,000

Execution: National/(MA&F,Ministry of Planning, UAE University and the Federal Commission for the Environment.

6.7.4 Project No.25: A study of the polluting effects of the continuous and escalating use of insecticides,pesticides and fertilizers, on the groundwater aquifers and the environment.

Objectives:

(i) To monitor pollution of the environment, especially groundwater aquifers and soil as a result of the continuous and increasing amounts of insecticides, pesticides and fertilizers used.

(ii) To provide an early warning on the level of pollution before it reaches highly dangerous levels.

Duration: One year

Location: All lands in UAE

Cost: U.S.$ 250,000

Execution: National (Federal Commission for the Environment,MA&F and UAE University) and technical assistance from UNEP/ESCWA.

6.8 Programme for Strengthening the national institutional capabilities for implementing the NPACD. "4.5.7"

6.8.1 Project No.26: Establishment of the institutional set up for desertification control

Objectives:

(i) To establish the Directorate for Desertification Control Coordination (DDCC) and the hierarchical network for implementation of the NPACD.

(ii) To establish a range management division in the MA&F.

Duration: Six months

Location: Dubai Emirate

Cost: U.S.$ 400,000

Execution: National with technical assistance from UNEP, ESCWA & FAO.

6.9 Regional and international co-operation programme. "4.5.8".

6.9.1 Project No.27: Preparation of national priorities for execution in the short-term programme.

Objectives:

(i) To organize a national workshop/seminar to study and arrange the national priorities from among all those projects suggested in the long-term and in the short-term programme.

(ii) To prepare project files for the selected projects.

Duration: Six months.

Location: UAE, Abu Dhabi-Dubai

Cost: U.S.$ 250,000

Execution: National with technical and financial support from UNEP, ESCWA & FAO.

6.10 Round-up meeting with government Representative

A round-up meeting was organized in the offices of the General Secretariat of UAE Municipalities at Dubai on 18.5.1993. The meeting was chaired by the General Secretary and attend by representatives from the MA&F; Department of Agriculture and Animal Production, Al-Ain; Assistant Undersecretary for Forestry Affairs, Western Region; Abu Dhabi Municipality;Dubai Municipality and Ajman municipality.

The mission presented its findings and general conclusions and recommendations to the meeting. Details were not discussed, but general agreement was expressed on the main findings and the principal recommendations some of which were modified during the discussions.

6.11 Immediate and Future action in the implementation of the NPACD.

6.11.1 Immediate Action

Immediate action concerns the programmes and projects included in the priority projects group. When the Government of the UAE accepts the NPACD and sets its priorities on some or all of the projects proposed in this chapter, assistance from UNEP,ESCWA and FAO could be sought in order to complete project formulation and provide advice on subsequent steps.

6.11.2 Future Action

Twenty seven project proposals are included in chapter VII as priority projects over the short-term period. They have been presented under the eight programmes of the long-term strategy proposals in chapter V.

It will be seen that 14 project proposals of 27 fall under corrective anti-desertification measures. This bias is in line with the general directive of the conclusions and recommendations of the General Assessment of Progress in the Implementation of the PACD (1984) which emphasized the urgent need to focus on field action.

The priority projects submitted are not all that could be included in the programme, nor are they the only projects for inclusion in this group. Other experts may wish to add projects, which in their opinion, should have been included in the group.

Nothing will prevent this from happening. Such and other projects may be added whenever the opportunity for revision comes, in order to fill in gaps or to make use of a new technology for solving a problem that could not be tackled before.

Chapter VII
Concluding Remarks and Follow-Up

7.1 General

A rather unique picture prevails in the State of the UAE. A country with very little potential of the agricultural base facing a very strong drive and political will towards greening the desert. This seemingly paradoxical situation continues to unveil some spectacular results. The total number of maintenance projects (Abu Dhabi municipality, forestry division chart) rose from 3 in 1975 with an area of 16.6 ha to 84 in 1992 with a total area of 26090 ha. Another chart of afforestation activities in Abu Dhabi. (Fig 2.3) shows an increase in afforestation activities from 500 ha with 100,000 trees in 1975 to 90 000 ha with 18 million trees in 1990. The Department of Planning,Abu Dhabi (1990) gives the accumulated areas afforested in Abu Dhabi and Al-Ain in 1990 as 67604 ha. On the agricultural side the Ministry of Planning (1991) gives an estimation of the area under agricultural holdings as 23474.9 ha in 1980 and as 45405.6 ha in 1990, recording a doubling of the area in one decade.

The afforestation projects, particularly those alongside motor roads come under reclamation of desert or desertified lands. On the whole these activities - afforestation or agricultural practices could all be classified under efforts aimed at fighting desertification (Nahal,1987; AOAD,1991).
It should be remembered, however, that the greening policy which has been and is still being followed in the country is an act which is not assisted by prevailing natural conditions - scarcity in water and suitable soils. It is therefore extremely important that the desertification Control national machinery should watch very carefully the conditions in these greened lands and prevent any degradation in what has been achieved in afforestation and agricultural land expansion.

Furthermore, it should be remembered that the principal aim in the NPACD is to prevent desertification in the agricultural lands and stop any further degradation in its water resources or its harsh environment.

7.2 Structure of the Plan

This document, composed of two parts, was prepared by two different missions. PART ONE - THE BACKGROUND SECTION comprising chapter I to chapter III was finalized by December 1991. PART TWO THE PLAN - PROGRAMMES AND PROJECTS comprising chapter IV to chapter VII has been finalized by December 1993.

For better relevance supplementary information on the status of desertification and on past and current efforts related to desertification control was entered in appropriate positions in chapters V through chapter VII.

This is, perhaps the second time, a NPACD appears in two parts prepared by two different missions. This second attempt offers another opportunity for evaluation of this methodology or arrangement. As it happened in the first attempt, the second mission, entrusted with the preparation of the substantive part of the document, made minimum changes in the Background document to make the two parts complementary to each other. This second attempt offers another opportunity for evaluation of this methodology or arrangement.

7.3 Content of the NPACD

The Background Section provides lots of data and information in the form of tables totalling 34 and figures totalling 18 in number. This coverage of details provides a wide base in anticipation of its usefulness for the second mission which would follow to prepare the substantive part. Of course it will also be useful to readers of widely differing interests.

The substantive part. The Plan itself - came in much the same style and format recommended in the Guidelines (UNEP,ROWA 1989) and used in the preparation of NPACDs for the Republic of Yemen (ESCWA,1992),Bahrain and Sultanate of Oman. The preparation of this Plan made use of the most recent work by UNEP which was presented to UNCED in 1992. Recommended action, therefore, was referred where necessary to the relevant Recommendation of both the PACD of 1977 and to the modified recommendations (UNEP,1991 reproduced in annex 3).

The Plan consists of eight programmes under which 27 project proposals have been suggested for the priority programme group (1994-1999). Neither the number of these projects nor their types are definitive; they stand as part of the draft Plan to be submitted to the government of UAE for study and confirmation in a national seminar. The government is expected to organize this national seminar as described under section 5.2.6. The seminar will reach decisions on priorities and prepare fact sheets for those projects accepted by the Government.

7.4 A new Strategic Look

Since future water security may be more important and more difficult to achieve than at present time, it is suggested that the availability of inexpensive energy sources (oil and gas) at the present time should be used to provide, not only the bulk of the present water supply, but also to secure long-term strategic fresh water storage for the future. A project proposal based on underground storage of desalinated sea water has been included in the Priority Projects Group.

But it should also be remembered that oil and gas are basically non-renewable sources of energy, and their end may come sooner than anticipated. It seems, therefore, prudent and wise precautionary direction to turn from now towards development of Solar energy technology for

utilization as future promising renewable source of energy. Appropriately harnessed solar energy would be used in desalination of the inexhaustible ocean waters for use in satisfying the country's needs for drinking, industry, agriculture as well as for greening and fighting drought and desertification.

7.5 Identifying Important Issues

In this final chapter, it is prudent to recall and stress some very important issues and worthwhile actions.

First: Consideration of environmental matters should follow a holistic approach and avoid at all costs sectoral and compartmentalization of environmental issues.

Second: Urgent adoption of this draft NPACD and its implementation after introduction of modification, changes or additions of whatever the Government considers appropriate.

Third: Continuous periodical revision and amendment when necessary of the path of this NPACD while carefully watching its inseparable links, compatibility and integration within the umbrella of the national socio-economic development Plan or direction.

7.6 Problems and Priorities

Problems should always be diagnosed first before solutions are considered for them; solutions should be expressed with crystal clarity before priorities for action are assigned. The problems and priorities are therefore important issues and are inseparable. In the context of this NPACD the following macro-priorities are proposed:-

(i) assign prime priority to the water resources management programme;

(ii) protect and promote what has been achieved in agriculture and afforestation and prevent further degradation/desertification in land so far unaffected or slightly affected with desertification.

(iii) ensure availability of well-trained competent cadres, with a bias for field work;

(iv) ensure availability of the institutional machinery and legislative framework which will facilitate functioning of the proposed structures, projects and their man-power.

7.7 Follow-Up

7.7.1 Follow-up action is essentially the responsibility of the UAE Government. However, an initial step or a starter is required from the UN side by presentation of this draft

NPACD document to the Government of the UAE and expression of keen interest of both UNEP and ESCWA as well as FAO and others in assisting UAE in its endeavor to control desertification.

After this initiative, appropriate offices in UAE should proceed with subsequent steps. **The General Secretariat of Municipalities is recommended to shoulder this responsibility.** In this respect, it is important to complete the following **four steps**:

(i) A joint effort from the leadership in the Ministry of Agriculture and Fisheries and the General Secretariat of UAE Municipalities to secure the Government approval of the Draft NPACD in order to proceed with assigning priorities for the projects selected in a national seminar.

(ii) A combined effort from the leadership in both the MA&F and the General Secretariat of UAE Municipalities to establish all units of the suggested National Machinery for Desertification Control especially the National Desertification Control Commission and the Directorate for Desertification Control Coordination.

(iii) Formation of the Steering Committee for the national seminar on desertification control as described in chapter VI. The Steering Committee may be constituted by an order from the Ministries of Agriculture in his capacity as chairman of NaDeCC or by the Chairman of the Federal Commission for the Environment in his capacity as chairman of the national organ responsible for studies on desertification.

(iv) The last of these preparatory steps is convening the national seminar. A lot depends at this stage on the cooperation and support UN organizations extend to make this seminar a reality. The seminar should reach conclusions regarding priorities among proposed projects, time and date for preparation of projects fact sheets and the complete project documents. When this has been done it will constitute the first step in the implementation of the NPACD.

Finally it should be stated that the success of a NPACD is not determined only by execution of the programmes and projects listed in its document. This, in fact, is not enough. It should be complimented by monitoring, evaluation and follow up during and after completion of each function or project and introducing amendments or changes needed to correct the path of the Plan. The units responsible for monitoring should be part of the administration actually responsible for prevention of desertification and reclamation of desertified lands.

REFERENCES

Ministry of Planning, UAE. (1992). Annual Economic Report 1992.

W.S. Atkins and Partners Overseas, 1991. Abu Dhabi Comprehensive Development Plan. Technical Report 2, Regional Development Plan, Town Planning Department, Abu Dhabi.

W.S. Atkins and Partners Overseas, 1991. Comprehensive Development Plan of Abu Dhabi. Technical Report 1, Development Issues, Town Planning Department, Abu Dhabi.

Cardy, Franklin, (1993). Desertification - A fresh approach. Desertification Control Bulletin; 22, PP 4-8.

Western, A.R. 1989. The Flora of the United Arab Emirates, An Introduction. United Arab Emirates University.

UNEP, (1991). Status of Desertification and Implementation of the United Nations Plan of Action to Combat Desertification. UNEP, Nairobi, PP 88.

Ministry of Planning UAE (1987). In Arabic

ESCWA (1992). National Plan of Action to Combat Desertification in the Yemen Republic. E/ESCWA/AGR/1992/8. (In Arabic).

Nahhal, Ibrahim (1987). Desertification in the Arab Homeland, Scientific Books series,No.3 Arab Development Institute Beirut,1987.(In Arabic).

Department of Planning, Abu Dhabi Emirate. Statistical Year Book - 1990.

UNEP, Regional Office for West Asia (1989). Guidelines for Preparation of a Plan of Action to Combat Desertification. PP. 37.

Ministry of Agriculture and Fisheries, UAE. (1992). Annual Statistical Bulletin For Year 1991. PP.194.

Satchell, J.E. 1978. Ecology and Environment in the United Arab Emirates. J. Arid Envron., 40(3):201-226.

Planning and Statistical Office, 1987-1988. Annual Statistical Bulletin of Agriculture and Fisheries. Ministry of Agriculture and Fisheries, U.A.E.

Department of Information, 1976. United Arab Emirates - Essays. Ministry of Information and Culture, U.A.E.

Dubai Municipality, 1986. Comprehensive Development Plan for Dubai Emirate. Existing Conditions - Report No. 2 (Vol. 1). United Nations Development Planning Project.

Central Statistical Department, 1989. Annual Statistical Abstract (14th edition), Ministry of Planning, U.A.E.

AOAD (Arab Organization for Agricultural Development), 1990. Yearbook of Agricultural Statistics, Khartoum, Sudan.

Agriculture Department and Animal Production, Al Ain 1989/1990. Annual Statistical Bulletin, Emirate of Abu Dhabi.

El-Ghonemy, K.H. 1981. Ecology and Flora of Al Ain Region. University of United Arab Emirates.

Embabi, N.S. 1991. Dune Types and Patterns in the United Arab Emirates Using Landsat TM-DATA. 24th International Symposium on Remote Sensing of Environment, Rio de Janeiro, Brazil.

Khankarnarayan, K.A. and Sen, A.K. 1985. Combating Desertification. Central Arid Zone Research Institute, Jodhpur.

Ministry of Information and Culture, 1991. The United Arab Emirates 1991. Abu Dhabi - United Arab Emirates.

FAO/UNEP, 1984. Provisional Methodology for Assessment and Mapping of Desertification. United Nations.

ESCWA, 1991. Environmental Problems in Agriculture and Long Use of Natural Resources in the Arab World. Arabic Ministerial Conference on Environment and Development, Cairo, (in Arabic).

Embabi, N.S. and El-Sharkawy, F.M. 1990. Land Form Systems of the United Arab Emirates from space images. J. Arts. U.A.E. Vol. 6:476.

ANNEX 1

Persons met by the UNEP/ESCWA in the UAE during two missions

UNDP

- Mr. Abd ElRahman Abd alla - Resident Representative.
- Mr. Mohammed Suliman Mohamed - Senior Programme assistant.

General Secretariat of UAE Municipalities

- H.E. Jassim M.Darwesh - General Secretary.
- Mr. Yousif Al Sheikh - In-charge of Liaison Office.
- Mr. Mohy El Din A.Nafie - In-charge of Information and Documentation.

Abu Dhabi Municipality - Forestry Division

- Mr. Ali Bin Mohamed R. Al-Mansori - Assistant undersecretary for Forestry Affairs, Western Region.
- Mr. Abd El Magid Hassan Abd El Magid - Chief of Forest Section.
- Mr. Hayai Obeid Al-Mansori - Assistant Chief of Forest Section.

Emirate of Abu Dhabi (Al Ain)

- Eng. Ahmed Hussien, Chief, Forestry Department.
- Mr. Mohamed Akram Khan, Forestry Section.
- Eng. Ali Abu Zeid, Chief of Town Drainage.
- Mr. Amer Mobaruk, Vice Chief, Town Drainage.
- Mr. Matar Salmen, Underground Water Department.

Food and Environment Control Centre - Abu Dhabi

- Dr. Abdel Gadir Mohamed, Director.

Ghiyathi Forestry Office

- Dr. Osama Ahmed Omer - Plant Protection Expert
- Dr. Yousif El Naeim Tagali - In-charge of Forestry Research.

Zayed Town

- Mr. Mohammed Sohail Al-Mazroi - I/C of Forestry Projects.
- Mr. Mohammed Akram.

Al-Ain Municipality

- Mr. Abd alla Al-Darmaky - Director - Public Relations.
- Mr. Khalfan Ali - Public Relations Directorate.
- Mr. Khaja Mastan Sharief - Acting Chief Horticulturist.
- Mr. Ahmed Hassan Abd-El-Latif - Director of Forestry Department.

United Arab Emirates University

- Dr. Ahmed A. Al-Masoom - Chairman, Plant Production Department.
- Dr. Mahmoud Abdul Rahman Al-Afifi, Associate Dean, Faculty of Agricultural Sciences.
- Prof. Dr. Mahmoud El-Dowery, Dean, Faculty of Agricultural Science.
- Prof. Dr. Nabil Embabi, Professor of Physical Geography, Faculty of Arts.
- Prof. Dr. Essam Shawky, Professor of Soil Science, Faculty of Agricultural Sciences.
- Prof. Dr. Mohamed Adel Yahia, Director, Remote Sensing Centre, Faculty of Agricultural Sciences.

Department of Agriculture and Animal Production - Al-Ain

- Mr. Obeid Rashid Al-Zahiri - Assistant Director, Administration and Finance.
- Eng. Abdul Mawla Kamel Al-Sulh - Agriculture Department and Animal Production.
- Mr. Abd El Wahab Khidir - Agricultural Engineer.

UAE Ministry of Agriculture and Fisheries, Dubai

- H.E. Hamad A. Salman - Deputy Minister.
- Mr. Mohamed Sager Al-Asam - Director of Soil and Water Department.
- Mr. Obaid M. Juma Al-Matroohi - Director of Fisheries Department.
- Mr. Abd alla A.Ben Abdul Aziz Al Shihhi - Director of Plant Protection and Extension Service Department.
- Mr. Rashed M.K. Al-Shariqi - Director of Research and Agricultural Production.

Agricultural Research Station - Humrania - Ras Al-Khaimah

- Dr. Mansour Ibrahim Mansour - Director.
- Mr. Mohamed Saleh - Head, Water and Soil Section.
- Mr. Mohamad Aghdan - Forage and Cereal Expert.
- Mr. Younis Abu-Argoub - vegetables Expert.

Central Region - Ministry of Agriculture and Fisheries Office.

- Mr. Hamad Abdulla Al-Mutawa, Asst. Deputy Minister, Ministry of Agriculture and Fisheries.
- Eng. Abd alla Al Mualla - Regional Director.

- Eng. Mohammed Rhida awad Alla- First Engineer.
- Mr. Rashed Al-Shariqi, Director of Research and Agriculture Production.
- Eng. Mohamed Sakr El-Asum, Director, Soil and Water Section.

Eastern Region Ministry of Agriculture & Fisheries Office.

- Mr. Ali Badawi - Regional Director.
- Mr. Ibrahim Abd EL Rahman - Deputy Director.
- Dr. Mohammed Saeed Gassouma - 1/C Forestry Research.
- Mr. Ahmed Rashed - Agricultural Engineer.
- Mr. Mohammed Attia - Agricultural Engineer.
- Dr. Ahmed Al-Tahir - Veterinary Surgeon.

Higher Environmental Committee

- Dr. Saad Al-Numairi.
- Dr. Abdul Wahab Al-Muhaideb, Asst. Undersecretary, Ministry of Health and Vice Chairman, Higher Environmental Committee

Dubai Municipality-Horticulture and Public Parks Department.

- Mr. Medhat El Sayed Sharif - Director of Horticulture Section.
- Mr. Abdel Hakim Belshalat, Head of Agriculture Section.

Ajman Municipality

- Mr. Seif Salim Al-Shafie - Deputy Director General.
- Dr. Zuheir Amin - Economic Development Adviser, Economic Department, Ajman.
- Eng. Ibrahim Abd ElGadir - Head - Construction Division.
- Eng. Gassan Daban - Chief Town Planner.
- Eng. Subhi Abu Al-Niaaj - Chief, Agriculture Section.

Masfout

- Mr. Abd alla Saeed Sulatan - Director of Municipality Office.
- Mr. Abd El Hameed Hussein Mustafa - Assistant Director, Municipality Office
- Sheikh Saeed Bin Hamdan Al- Naaimi

General Secretariat OF U.A E Municipalities

- H.E Jassim M. Darwesh - General Secretary - Chairman of the Meeting.
- Mr. Ahmad Al-Shirhan - Director - Conferences & Meeting Affairs.
- Mr. Majid Al-Oais - Deputy Head of Information Division.
- Eng. Mr. Mohamed Sager Al-Asam - Director of Soil & Water Dept. Ministry of Agriculture and Fisheries.

- Eng. Abdul Mawla Kamel Al-Sulh - Agriculture Dept. & Animal Production. Al-Ain UAE.
- Mr. Ali Bin Mohed.R.Al-Mansori - Assistant Undersecretary for Forestry affairs, Western Region.
- Eng. Abdel Magid Hassan
- Mr. Abdel Magid - Chief of Forest Section - Abu Dhabi Municipality.
- Mr. Medhat El Sayed Sharif - Head of Horticulture section, Dubai Municipality.
- Eng. Gassan Daban - Ajman Municipality, Chief Town Planner.
- Mr. Mohamed Saeed Abdulah - Geologist. Soil & Water Dept.- Ministry of Agriculture and Fisheries.

Abu Dhabi Municipality , Agriculture Division

- Eng. Ibrahim Kamel Abdu.
- Dr. Matar Khalil, Agriculture and Animal Production Department.

Ministry of Planning, Planning Department

- Mr. Rihan M.Fayez - Deputy Director.
- Mr. Rashid Abdul Rahman Leflaiti, Acting Director, Central Statistical Department.
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UNEP/ESCWA/FAO Mission for the Preparation of A National Plan Action to Combat Desertification

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ANNEX 2

Proposed Programme for the National Seminar

A.5.1. This principle aim for holding this seminar, after the government approval or acceptance of the document is to further the involvement and participation of national institutions and cadres, modify and correct as necessary and draw up direction and steps towards which individual projects should be elaborated. The list of invitees to the seminar will include all ministries, universities and institutions concerned o interested in the issue. The list should also include UN and other organizations: UNEP, UNESCWA, FAO, UNDP, AOAD, CAMRE, ALECSO etc..

A.5.2. It is proposed that the seminar convenes for three days. The following actions are suggested for the sessions of the seminar:

a) Presentation of the plan to the participants so as to form a common general understanding of the main contents and to have a common language for discussion.

b) To define priorities for the programmes and projects proposed in the plan, and consolidate reasons and remarks needed to ensure inclusion of the projects in a revision or a supplement to the Five-Year Plan, for Economic and social Development.

c) Fixing a date and method for preparation of Project Fact sheets. This is the step which follows defining the priorities when essential information for each project are registered. That includes, the geographical position, execution, the duration, the cost, background, the goals (short or long-term), the expected results, the activities, follow-up, financing and estimated costs for various activities.

d) Fixing a date for preparation of full-fledged project documents. Normally these documents are prepared by multi-disciplinary teams. The members are selected from experts sent by countries, regional and international institutions willing to cooperate and assist in the execution of the proposed schemes after having studied the papers concerning the projects which were proposed in the previous stage - the project fact sheets.

e) Deciding on time and organization of a round-table meeting composed of representatives of governments, regional and international institutions with the aim of obtaining their support and assistance in financing the projects which they had previously either shared in preparing its documents or have studied them when called for the meeting.

A.5.3 It is proposed to prepare a working paper for each item of the five items suggested above. It is also suggested that international organizations should be invited to participate in preparing some of the working papers so that they could be called upon in future for financing part of the costs of activities or meetings or by sending an expert for assisting in the preparatory work of the seminar.

ANNEX 3

Reproduced from the Report of the Executive Director, UNEP/GCSS.III/3. The Status of Desertification and Implementation of the United Nations Plan of Action to Combat Desertification, UNEP (1991).

POLICY GUIDELINES AND COURSE OF ACTION FOR COMBATING DESERTIFICATION

A. POLICY GUIDELINES

1. Role and place of anti-desertification measures within the programmes for socio-economic development and protection of the environment.

1. Sustainable socio-economic development and protection of the environment are inseparable prequisites of human survival. This means that anti-desertification programmes should be managed as integral parts of socio-economic development of land resources and peoples of the drylands.

2. Prevention of desertification where it is likely to occur, as well as remedying its consequences where it has already occurred, are the bases of sustainable development of land resources in drylands. The protection of land against degradation under increasing human pressures must constitute an essential part of the general strategy for agricultural development. This strategy should include anticipating and preventing the expected negative effects of human action upon the land. If taken too late, corrective measures will be too costly or impracticable.

2. General goal and practical targets

3. The main goal of implementing the Plan of Action to combat Desertification remains identical to the one formulated by UNCOD in 1977 and endorsed by the United Nations General Assembly, namely:

"The immediate goal of the Plan of Action to Combat Desertification is to prevent and to arrest the advance of desertification and, where possible, to reclaim desertified land for productive use. The ultimate objective is to sustain and promote, within ecological limits, the productivity of arid, semi-arid, sub-humid and other areas vulnerable to desertification in order to improve the quality of life of their inhabitants. A campaign against desertification should take place as a priority among efforts to achieve optimum and sustained productivity. For the countries affected, the implementation of the Plan of Action implied more than a campaign against desertification, it is an essential part of the broad process of development and the provision of basic human needs."

4. To reach this goal, the following practical targets have been set for the year 2020. These should be addressed nationally, regionally and internationally on the basis of experience gained and taking into account certain achievements and failures in implementing the Plan of Action during 1978-1991:

Main environmental development targets:

(a) Preventing further deterioration of the World food security and sustaining productivity of land affected by, or prone to, desertification through the introduction of environmentally sound, socially acceptable and economically feasible land use systems based on social equity and appropriate technologies;

(b) Protection of non-degraded or slightly degraded lands prone to desertification and reclamation of desertified lands for productive use or their conservation for natural rehabilitation, as appropriate;

(c) Provision of adequate insurance against recurrent droughts and famine in the drylands;

(d) Improvement of the quality of life of the inhabitants of lands affected by desertification, including health, sanitation and family planning and the satisfaction of basic human needs in extensive areas of world drylands;

(e) Prevention of adverse desertification impact on global climate change and biodiversity, including germplasm materials for many crop and fodder plants.

Targets for the supporting measures:

(a) Incorporation on national actions to combat desertification into broader national development policies, plans or programmes;

(b) Mobilization of national, regional and international technical and financial resources needed for the full implementation of the Plan of Action to Combat Desertification;

(c) Mobilization and strengthening of national, regional and international institutional capabilities for implementing the Plan;

(d) Introduction of land use, economic and social policies conducive to the sustainable development of land and water resources;

(e) Making land users the chief actors in designing and implementing a national Plan and ensuring full public participation in anti-desertification campaigns;

(f) Development of indigenous national and ecoregional scientific research and technology capabilities.

(g) Coordination of current and new national, regional and international sectoral programmes (including those for combating desertification) within broader environment development programmes;

(h) Establishment of a global network of national, regional and international institutional and technical facilities for current operational assessment and continuous monitoring of desertification;

(i) Strengthening of regional programmes and international cooperation in the campaign against desertification;

(j) Provision of free flow of technology on favourable terms to areas affected by or prone to desertification;

(k) Improvement of infrastructures needed to provide support for the national PACD in areas affected by or prone to desertification.

3. Main principles in Implementing the PACD

5. The following main principles could form the basis of the global anti-desertification strategy:

(a) The United Nations Plan of Action to Combat Desertification, as adopted in 1977, remains valid;

(b) National Plans of Action to Combat Desertification (NPACDs) for all the countries affected by desertification should be fully incorporated into national programmes for development, including appropriate financial and institutional provisions;

(c) The current status of desertification in the territories affected, including the socio-economic status of the rural population and the state of the land, should be assessed and continuously monitored. These data should be taken into account at all stages of planning and implementing national development programmes;

(d) The way to prevent the exhaustion of drylands resources starts with providing alternative means for meeting the basic needs of the societies affected. The people must be able to satisfy their short-term needs without over-taxing land resources;

(e) Social, political and economic causes of over-taxing land resources and the resulting physical manifestations of desertification should be the bases for formulating appropriate national policies and courses of preventive and corrective actions;

(f) The participation of land users, including small-scale farmers and pastoralists and women in particular, should be ensured at all stages of planning and implementing the NPACDs;

(g) The tangible incentives and short-term benefits for land users, including small-scale farmers and pastoralists, to ensure their active participation in anti-desertification campaign should be developed.

(h) Ecological stabilization of agricultural lands through sustainable utilization of natural resources and appropriate land use policies should be the focus of NPACDs;

(i) Ongoing programmes addressing land resources in areas concerned, e.g. soil and water conservation, reforestation or afforestation, agricultural development, rangeland improvement, etc., should be coordinated and incorporated into NPACDs;

(j) A small-scale local community-based approach should be given preference in developing and implementing the NPACDs in order to strengthen the role of local institutions, e.g. village or farmers' committees, as managers of communal natural resources and major implementing agencies;

(k) Conservation of land and water resources in drylands that prevents ecologcial degradation and promotes the reclamation of degraded lands and the development of the terrestrial resources of drylands for agricultural and non-agricultural uses should constitute integral elements of programmes for combating desertification;

(l) All NPACDs should contain integrated chapters dealing with drought (relief and insurance measures) that will complement long-term anti-desertification actions;

(m) For countries that have both arid and humid regions within their territories, the NPACDs should be transformed into National Environment Action Plans for integrated management of natural resources in order to cover the problem of land degradation for the country as a whole- with, however, separate chapters for areas that differ ecologically;

(n) Combating desertification at the national level (i) should involve traditional systems used by local people to promote popular participation in programmes of desertification control and (ii) requires the establishment of effective institutional machinery for integrating desertification control programmes into overall national development plans and priorities;

(o) After decades of trying to save the soil "from the people", a more promising approach should be adopted: to help land users save the soil and water for themselves, for improved agricultural production, i.e., to practice Conservation Farming and Land Husbandry (Landcare) instead of Soil and Water Conservation;

(p) The following principles, adapted from the Den Bosh Declaration (1991), should be followed in the implementation of the PACD:

- Land use practices in drylands should be restructured in such a way that demands for sustainable land use and environmental protection will be met;

- The developed countries (regions/provinces within the partly affected countries) should recognize their role and responsibility for sustainable land use and socio-economic development in drylands by improving the international (national) economic relations to order to increase and stabilize incomes for farmers/ pastoralists and hence create incentives for appropriate investments in drylands;

- The international community should accept the need to provide technical and financial assistance in specific fields to promote the PACD;

- Population policies should be implemented in order to improve long-term prospects for sustainable development in drylands;

- Governments and society at large should recognize that agriculture/pastoralism and the rural peoples of the drylands collectively play an important and, in many countries, vital role in ensuring food security and maintaining the renewable natural resource base. This recognition must be reflected in the allocation of adequate financial resources, pricing policies, in the decentralization of institutions and in the empowerment of dryland people with particular attention to the poor;

- Fair terms of exchange should be established among drylands producers, industry and consumers within the countries affected;

- Farmers/pastoralists, particularly those who are small-scale and resource-poor, both men and women, should have better access to education and training, appropriate technologies and resources;

- Campaigns to increase public awareness of the need for and approach to sustainable development of drylands should be undertaken.

B. COURSE OF ACTION

1. Nationally

a. Guiding policies

1. National Plans of Action to Combat Desertification (NPACDs) should be prepared on the basis of the general Policy Guidelines outlined above and taking into account specific

ecological and socio-economic conditions in different countries affected by desertification. These Plans should be fully integrated into national programmes of socio-economic development and accorded their appropriate places, priorities, resources, etc. They may either be (i) a part of the National Nature Conservation Strategy; or (ii) a part of the National Environment Action Plan; or (iii) an independent programme. In any case, however, they must be a part of the National Development Programme. The current World Bank initiative of multi-donor National Environmental Action Plans (NEAPs), which is already being implemented in some 20 countries of Africa and Latin America, and which aims to define a time-bound plan outlining environmental policy needs, institutional and legal reforms, corrective measures to ongoing development programmes, and new investment programmes needed in this sector, could be considered as an important mechanism in resolving problems of desertification.

2. A useful way to address the causes of desertification is to construct a multi-level set of explanations for the cause of land degradation. Such a "chain of explanations" contains explanations commencing at the site with physical symptoms, such as falling crop yields or excessive soil erosion; it continues its explanation by broadening into land use practices that cause erosion, such as overstocking. It then examines the resources, assets, skills and technologies of the land users in, for example, the constraint of supplying additional family labour, widens further to the nature of agrarian society in, for example, distribution of land rights and the general division of labour, continues with the nature of the State, including conservation laws, effectiveness of institutions and government policies; and concludes with the international world economy, which may well in part explain desertification through foreign debt crises, oil and food prices and structural readjustment plans prepared by international financial institutions. These are not mutually exclusive explanations. However, each level in the "chain" may prompt possible interventions, the success of which will depend on their compatibility with other levels in the chain in preventing desertification and overcoming its consequences. These "pressure points" for attention should ensure a balanced approach to causes of the problem.

3. The NPACDs should integrate four closely interrelated elements:

   (i) Prevention of land degradation in areas prone to desertification by applying appropriate land use policies and conservation strategies;
   (ii) Reclamation of already desertified lands and bringing them back to their productive state, starting from those least affected and gradually proceeding to those that are more seriously affected in accordance with the prevailing economic and social feasibility pattern;
   (iii) Full conservation/reservation of the lands most seriously degraded, including those reduced to

desert-like conditions for their natural recovery or future rehabilitation actions;

(iv) Integrated development of land resources in drylands for their sustainable utilization in agricultural and non-agricultural uses.

4. The NPACDs should be prepared taking full account of national land use and agricultural policies. They should aim at reducing conflicts and competitive demands on the land. They should also aim at achieving the objectives of agriculture: food sufficiency and security, sustainable production; settlement of pastoralists if profitable; etc. National policies should provide for the empowerment of local communities, so that individual production units have assured access to land, water and those resources that are critical for production and reproduction.

5. The NPACDs should be framed within national socio-political policies that take full account of: (i) equity of public participation; (ii) balance of urban and rural interests; (iii) organization of rural populations into community groups or institutions (to replace prior ethnic or kinship structures, for instance); (iv) self-reliance or dependence on external aid; (v) national food security or dependence on international trade and assistance, etc.

6. The provisions of the NPACDs outlined above should be translated into legislative instruments. New national land use policies that are environmentally sound and development-oriented should be developed, adopted through appropriate national legislation and implemented through competent institutions. These policies should contain, inter alia, explicit provisions for the following: (i) security of resource tenure; (ii) extension of appropriate technologies; (iii) provision of credit; (iv) sustained extension programmes; (v) reinforced systems of local food security; and (vi) support of rural institutions.

7. The implementation of the NPACDs needs to be managed by an effective national machinery with efficient institutional infrastructure, particularly at the grassroots level.

8. The implementation of the NPACDs should be supported by effective national scientific and technological capabilities. These must be associated with a national programme for extension services that provide for the transfer of scientific and technological knowledge to the field and the working people, farmers and pastoralists in particular.

9. In formulating the NPACDs, reference for detail should be made to specific recommendations of the Plan of Action to Combat Desertification as adopted by UNCOD in 1977.

b. Practical steps:

10. Scarcity of resources often demands that actions required at the national level be phased in accordance with certain priorities which may well be different from one country to

another. However, some general priorities might be recommended as follows:

Preventive, Corrective and Rehabilitation Measures

Recommendation 1: To introduce improved land use systems in areas affected by or prone to desertification:

- **STEP 1** - to introduce an integrated approach to the utilization of every piece of land in accordance with its ecological characteristics, natural capabilities and constraints. This should ensure equity and mutual reinforcement among farming, pastoralism and forestry, as well as among the economic and social goals of individual farmers/pastoralists local rural communities and the country as a whole in the utilization of the existing land resources, bearing in mind their limited extent and their difference in natural productivity. To this end, land use planning should be undertaken at all levels from the individual farm through local/provincial area and up to the national level;
- **STEP 2** - to introduce improved land/water/crop management systems based on innovative or adapted indigenous technologies in the existing irrigated lands with the following priorities:

  (1) Prevention of land degradation on 102 million hectares of non-degraded or slightly degraded lands;

  (2) Implementation of corrective measures on 34 million hectares of moderately degraded lands;

  (3) Reclamation of 9 million hectares of severely and very severely degraded lands. These improvements should aim at enhancing food production, efficient use of scarce water resources, reclamation of degraded soils, prevention of water-logging, secondary soil salinization and/or alkalinization, and prevention of air, water and soil pollution with excess of agricultural chemicals.

  The improvements shold be undertaken concurrently with the improvement of the living conditions of the peoples engaged in irrigated agriculture and of the infrastruclure of these territories. The development of new irrigation systems for crop production, particularly for the cash crops should be considered in veiw of the improvements achieved in existing irrigation systems;

- **STEP 3** - to stabilize rainfed croplands using the most potentially productive soils and avoiding marginal ones, particularly those that better belong to rangelands, and to introduce improved soil/crop management systems based on innovative or adapted indigenous technologies, using in particular the agroforestry approach, with the following priorities:

(1) Prevention of land degradation on 242 million hectares of non-degraded of slightly degraded lands;

(2) Implementation of corrective measures on 183 million hectares of moderately degraded lands;

(3) Reclamation of 33 million hectares of severely and very severely degraded lands.

These improvements should be directed to the growth of crop production, economical and effective use of land resources, reclamation of degraded soils, prevention of water and wind erosion of soils, prevention of environmental pollution by excessive use of agricultural chemicals. These improvements should also be undertaken in parallel with the improvement of living conditions of the peoples affected and of the infrastructure of these territories. The development of new lands for rainfed agriculture in drylands should be discouraged by all means for the time being;

- **STEP 4** - to introduce improved rangeland/husbandry management systems based on innovative or adapted indigenous technologies with the following priorities:

(1) Prevention of land degradation on 1,223 million hectares of non-degraded or slightly degraded lands;

(2) Implementation of corrective measures on 1,267 million hectares of moderately degraded lands;

(3) Reclamation of 2,066 million hectares of severely and very severely degraded lands.

These improvements should aim at enhancing production, rehabilitation of exhausted rangelands, prevention of the degradation of soil and plant cover. They should be undertaken concurrently with the improvement of the living conditons of the peoples affected and of the infrastructure of these territories; the establishment of extensive complementary irrigated pastures instead of intensive crop production irrigation systems, whenever appropriate, should be considered within the general framework of land use improvements;

- **STEP 5** - to undertake major afforestation/reforestation programme throughout areas affected by or prone to desertification, taking the agroforestry approach whenever appropriate. This programme should be directed to the establishment of protective forest belts for various purposes (around fields, roads, settlements, processing and other facilities, etc.) - shelter belts, windbreaks, etc., and to the creation of forest plantations;

- STEP 6 - to undertake, whenever appropriate, a major campaign on stabilization of shifting sands and for their protection for natural rehabilitation.

The above measures for improvement of land use systems in the areas affected by, or prone to, desertification should be adopted and prioritized in space and time within the NPACDs. (Reference here is made to Recommendations 2, 6, 7 and 19 of the original PACD of 1977).

Recommendations 2: To develop and introduce appropriate and improved agricultural and pastoral technologies that are socially and environmentally acceptable and economically feasible and compatible with new land use systems. The new technologies to be developed and adopted need to: (i) address immediate and short-term needs for food and income; (ii) to be based on existing practices, i.e. modify rather than replace; (iii) diversify farming practices; (iv) minimize capital/resource requirements and external inputs; (v) provide economic returns; (vi) meet labour availability. (Reference here is made to Recommendations 6, 7 and 19 of the PACD of 1977).

Appropriate technologies to be considered, include:

- In irrigated farmlands:

  * Provision of adequate drainage facilities;

  * Introduction of water conservation schemes, including efficient systems of water delivery, water harvesting, broad-bed-and-furrow systems, ridgiong and tied-ridging, small dams;

  * Irrigation water quality control;

  * Introduction of new irrigation-responsive crop varieties;

  * Biological control of crop pests and diseases;

  * Introduction of an ameliorative field into crop rotation;

  * Watering in accordance with current plant needs and the state of soil moisture to avoid soil deterioration and to economize on water;

  * Reduction of surface soil evaporation;

  * Reduction of chemical systems of plant nutrition by introducing adequate biological systems, use of organic and green manure and by adopting adequate crop rotation and mixed cropping;

- In rainfed croplands:

  * Introduction of soil conservation-oriented cropping and soil cultivation practices, including anti-erosion technologies as appropriate, based on reduced requirements for external input and, at the

same time, increased efficiency of added inputs: various mechanical structures, such as bench terraces, contour drains, contour ditches, contour ridges, small hollows and lunettes, also biological techniques such as mulching, barrier hedges;

* Introduction of integrated systems of soil fertility management, in which all input and output factors are judiciously adjusted;

* Introduction of new, more productive crop varieties;

* Diversification of farming practices in time, space and crop type (mixed cropping);

* Reduction of the chemical system of plant nutrition and plant protection by introducing appropriate integrated plant nutrition systems based on combinations of crop residue mulch, animal manure and mineral fertilizers with minimum tillage;

* Introduction of crop/land use rotation systems as appropriate, e.g. farming-tree (pasture), farming-tree (plantation) like shifting gum-arabic cultivation, farming-grazing-forestry, etc.;

* Creation of shelter-belts and other appropriate field protective tree plantations;

- In mixed farms:

* Appropriation of specific plots for every particular land use in accordance with slope and soil characteristics and the conditions of water availability;

* Introduction of an agro-forestry approach: shelter belts, biomass transfer techniques, live fences, fodder banks, fuelwood trees on range, reclamation forestry, etc.

Recommendation 3: To establish adequate communication infrastructure and sufficient processing and marketing facilities in areas affected or prone to desertification in order to provide rural producers with adequate outlets for increased production, thus creating an incentive for agricultural development. (Reference here is made to Recommendations 4 and 19 of the PACD of 1977).

Recommendation 4: To develop and conserve available water resources in areas affected by, or prone to, desertification and to introduce improved water management systems with particular attention to the development of advanced and efficient irrigation systems. (Reference here is made to Recommendations 5, 8 and 26 of the PACD of 1977).

Recommendation 5: To reclaim for productive use or to protect for natural rehabilitation, as appropriate, severely desertified lands that have either been inherited or become desert recently and, in either case, originated from adverse human impact on the

environment. (Reference here is made to Recommendations 9 and 10 of the PACD of 1977).

Supporting Measures

Recommendation 6: To establish or to strengthen the national institutional capabilities for implementing the NPACD, including hierarchical networks down to the grassroots level:

- To establish or to strengthen, as appropriate, national anti-desertification authority (Commission, Advisory Board, Department, etc.) within the Government with access to the highest executive and decision-making level;

- To establish anti-desertification commissions/boards within provincial/divisional/district or other local governing or executive bodies in accordance with the existing administrative structure of the country;

- To establish land users' anti-desertification committees in all rural communities affected;

- To organize working cooperation among the local authorities, extension services and land-users' committees in planning and implementing anti-desertification measures, including full-scale technical assistance to farmers and pastoralists;

- To support existing or newly established national NGOs, including cooperatives, women's, youth and children's organizations and school associations in particular, and to strengthen their working cooperation with the national and local authorities concerned with the implementation of the NPACD, with a view to their active participation in the national anti-desertification campaign. (in implementing this recommendation, reference here is made to Recommendations 3, 18 and 21 of the PACD of 1977).

Recommendation 7: To launch nation-wide major anti-desertification awareness/training campaigns through existing mass media facilities, educational net works and newly created or strengthened extension services, fully ensuring people's access to knowledge of desertification and to the Plan of Action to Combat Desertification.

- To organize a series of demonstration sites at the existing or newly established experimental stations, plots, villages (ecovillages), showing examples of anti-desertification land use and appropriate technologies ensuring the free access of local populations to these establishments;

- To publish in local languages and distribute through national anti-desertification networks or appropriate extension service locally adapted varieties of simple but attractive pamphlets or leaflets related to the problem of desertification and the struggle to halt it;

- To establish in all relevant national and local newspapers and radio and television programmes a special regular anti-

desertification page or a corner to provide the public, land users in particular, with day-to-day information specifically emphasizing problems involved in different localities, technological advice and success stories;

- To introduce in rural areas affected by desertification special courses on desertification in all public schools at an appropriate level of education;

- To organize, through existing or newly established extension services and anti-desertification networks, anti-desertification on-the-job training of farmers and pastoralists in the areas affected by desertification, providing them with appropriate learning materials. (Reference here is made to Recommendation 20 of the PACD of 1977).

Recommendation 8: To introduce a "loop model" in the existing or newly established extension service in the areas affected by desertification. The first step in introducing this model is to provide understanding of the rationale and ecological stability of traditional resource management systems and related indigenous knowledge. The second step is to use local and external expertise to investigate why these traditional practices are no longer adequate and to identify areas where management has to be adjusted. The third stage, completing the loop, requires the interaction of local and external expertise to develop potential innovations that solve the resource management problems. These must subsequently be field-tested with the communities or producers who have been involved in their development before large-scale introduction throughout the area. This loop process requires intensive communication between the local population, extension service and research centres. Extension agents should be trained in how to listen to the people, how to record indigenous knowledge, how to learn from the adaptive strategies that local people have developed in response to environments that are often difficult and inhospitable.

Recommendation 9: To finalize the operative large-scale local and national assessment of the current status of desertification, including (a) the status of rural populations; (b) the state of lands and physical causes of their degradation; (c) the trends in local climate changes; (d) social, economic and political causes of underdevelopment and the resulting immediate causes and processes of desertification, and to provide the Government with appropriate detailed and up-to-date information related to desertification.

Recommendation 10: To develop, adopt through appropriate national legislation and introduce institutionally a new set of national environment/development oriented land use policies that would be directed to the improvement of land use, appropriate management of common lands, provision of incentives to small farmers and pastoralists, ensuring the involvement of women, and encouraging private investment in the development of drylands. These policies should contain explicit provisions for the following institutional aspects: (a) security of resource tenure; (b) adoption of appropriate technologies; (c) provision of credit; (d) sustained extension programmes; (e) reinforced system of local food security; (f) support of rural institutions; (g)

appropriate pricing policy. Recommendations 2, 13 and 17 of the PACD of 1977 should be referred to while planning for the required actions.

Recommendation 11: To develop and introduce effective national insurance schemes against recurrent drought and famine. Recommendation 17 of the PACD of 1977 should be referred to in this respect.

11. In various countries affected by desertification the implementation of the above practical steps will undoubtedly vary in accordance with differences in ecological, socio-economic and political conditions. Some countries have already started their national anti-desertification campaigns and introduced appropriate programmes that are being implemented on a scale compatible with the available resources. Others are unable to start purposeful action because of civil strife and political instability. Still others are even one step back due to recent or current civil wars. Therefore, the situation varies greatly throughout the world. Consequently, a uniform world-wide time frame for the global implementation of the Plan of Action to Combat Desertification, cannot be envisaged. Furthermore, the struggle against desertification is a long-term process and not a one-act operation.

12. Countries affected by, or prone to, desertification might wish to set their own priorities in implementing their NPACDs. However, it seems logical that the first practical step would be to implement Recommendations 6 and 7 above, within 3 to 5 years. Recommendations 8, 9, 10 and 11 may take a longer time, probably up to the year 2000. Implementation of Recommendations 1 and 2 could start simultaneously on a trial basis. The Plan can thus become fully operational throughout affected areas by the year 2000 or thereabouts. Full-scale reconstruction will take a longer time, probably through the year 2010, by which time Recommendations 1 and 2 could be fully implemented. The stabilization period will take still a longer period, probably up to year 2020, by which time Recommendations 3, 4 and 5 would have been implemented.

13. The full implementation of the Plan of Action to Combat Desertification should result in: (a) ensuring that the objective of arresting desertification is attained; (b) the standard of living, health and culture of the populations affected will have improved substantially; (c) the environment of the areas affected will be improved and stabilized; (d) the productivity of affected lands will be sustained; (e) the economy of areas affected will be improved and stabilized; (f) the populations of the areas affected will be involved in progressive socio-economic development.

14. A programme for the implementation of direct world-wide action to combat desertification may be based on one of the following options:

(i) Implement programmes of direct preventive measures in productive drylands that are not desertified or only slightly desertified (about 30 per cent of the productive drylands). The total cost estimate is US$1.4 to 4.2 billion per year. This, however, will not save territories that are moderately desertified from further deterioration;

(ii) Implement the above programme, plus a programme of direct corrective measures in productive drylands that are moderately desertified (areas with 10 to 25 per cent loss of productivity in croplands and 25 to 50 per cent in rangelands). The total cost estimate is US$3.8 to 11.4 billion per year;

(iii) Implement a comprehensive programme of direct measures to combat desertification in all productive drylands (preventive-corrective rehabilitation). The total cost estimate is US$10.0 to 22.4 billion per year.

The above options could be considered as the sort of action priorities that could be adopted globally and nationally. They could be modified as appropriate within the areas concerned.

2. Regionally

15. The experience of the 1980s indicated clearly that the regional approach to international cooperation in solving major environmental and development problems is the most promising one. This was exemplified particularly by the achievements of UNSO in the mobilization of resources needed for combating desertification in the Sudano-Sahelian region of Africa. Some practically oriented regional programmes were recently developed, e.g. by the Arab League through ACSAD, by AMCEN through ADALCO and IGADD, by the Asian NGO Coalition for Agrarian Reform and Rural Development (ANGOCO), by CILSS, by ESCAP through the Regional Network of Research and Training Centers on Desertification Control in Asia and the Pacific (DESCONAP), and by SADCC. These initiatives should be fully utilized and further developed.

16. In addition to the above, the concept of eco-geographical regions of the world should be fully utilized, preferably combining the anti-desertification efforts of countries at different levels of development within united anti-desertification programmes, e.g. Mexico-U.S.A.; China-Mongolia-USSR, etc.

17. Institutional support for regional cooperation should be provided in order to plan, coordinate and monitor joint regional activities and to mobilize the resources needed for the implementation of the regional programmes. This support should be organized either through existing inter-governmental regional bodies or through those newly established for this purpose. The United Nations regional commissions and the existing regional inter-governmental organizations should be fully involved and be responsible for these regional actions.

18. The General Assembly could be invited to consider the establishment of small sub-regional office, probably within UNDP, analogous to UNSO, for some of the eco-geographical sub-regions in order to assist these sub-regions and their countries in the mobilization of the resources and technical assistance; they might well be created as joint ventures between UNDP, IFAD, WFP FAO and UNEP whenever appropriate.

3. **Internationally**

19. International cooperation at a global level in implementing the Plan of Action to Combat Desertification is to be organized on a partnership basis among all countries of the world as this environmental/developmental problem is of global magnitude and should not be considered as just another aid programme of the richer countries to the poorer ones.

This cooperation is needed in the following areas:

- Mobilization of financial resources and provision of financial assistance to the countries that cannot cope with the problem by themselves;

- Development of pricing and trade policy that would favour agricultural development and sustainable productivity of drylands;

- Provision of technical assistance to the countries in need;

- Development of appropriate anti-desertification technologies and technology transfer to the needy countries on favourable terms;

- Monitoring and coordination of the anti-desertification campaign at the global level;

- Information exchange;

- International legislation, as appropriate.

20. The first task might be addressed either bilaterally or through adjusting the Global Environmental Facility of the World Bank, UNDP and UNEP or the establishment of a special facility within the United Nations for funding the implementation of the Plan of Action to Combat Desertification. The second task should be more vigorously and effectively addressed through GATT and other relevant United Nations structures.

21. The Provision of technical assistance in combating desertification to needy countries should be organized bilaterally or through the existing specialized agencies and bodies of the United Nations system such as UNDP, FAO, WMO, WHO, UNEP, Unesco. For this purpose, all existing technical assistance or other relevant international programmes of these United Nations bodies, such as the Man and the Biosphere programme of Unesco; the Environment

Action Plan of the World Bank; the Global Environment Facility of the World Bank/UNEP/UNDP; the Tropical Forestry Action Plan of the World Bank/FAO/UNDP/WRI; the Energy Sector Management Action Programme of the World Bank/UNDP; the Tropical Diseases Research Programme of the World Bank/UNDP; the World Soils Policy of UNEP; the World Conservation Strategy of IUCN; the Programme of Action of the World Conference on Agrarian Reform and Rural Development (WCARRAD, 1989); the International Action Programme on Water and Sustainable Agricultural Development of FAO; and the International Cooperative Programme Framework for Sustainable Agriculture and Rural Development of FAO should be fully utilized and coordinated. Such technical assistance for the areas and regions identified as being affected by or prone to desertification should be fully coordinated within national development programme aimed at the prevention and rehabilitation of desertification impacts in accordance with the specific recommendations of the PACD.

22. The development of appropriate anti-desertification technologies, both modernized high-input and indigenous low-input, should be organized and internationally coordinated through existing national, regional and international research centres, particularly through the network of the Consultative Group on International Agricultural Research (CGIAR) or a comparable network to be specialized in drylands development and desertification matters. The transfer of technology developed internationally to needy countries should be organized through the existing international channels of technical assistance. The transfer of technology developed nationally on a commercial basis should be organized with assistance from the environment or anti-desertification funding facilities mentioned above.

23. A world mechanism for monitoring desertification and its operational assessment by using remote sensing technology with computerized data processing should be established. This machinery could be a section of the enlarged Earthwatch, including GEMS, GRID and the Desertification Database of DC/PAC in UNEP. The establishment of a network of the regional monitoring/assessment facilities coordinated by the Earthwatch should be considered. The existing facilities, in such centres as Dakar, Ashkhabad, Jodhpur, Damascus, Nairobi, and Lanzhou, could be part of the global network. It is important to stress that the desertification assessment/monitoring network should not constitute a separate establishment, but should be a part of the general global environment assessment/monitoring system that would regularly provide all necessary data on the status of the natural resources (soil, water, air, vegetation, animals, etc.) and peoples (number, health, etc.) of the world. The major immediate task would be to establish a Global Baseline Reference Database for future assessments of changes and trends.

24. World capability for advanced training in desertification assessment/monitoring should be substantially strengthened, particularly in such world centres as FAO; the

International Institute for Aerospace Survey and Earth Sciences in Enscheded, the Netherlands; the USA Environmental Systems Research Institute, Inc.; and the Catholic University of Louvain in Belgium.

25. Responsibility for overall global monitoring and coordination of the anti-desertification campaign should be given to UNEP with its existing inter-governmental and inter-agency mechanisms, including IAWGD and DESCON.

26. Once every five years, beginning in 1995, UNEP and UNDP should jointly review the implementation of the PACD and of corresponding development programmes in the areas affected by desertification in order to put forward timely recommendations for necessary corrective measures at the international level.

27. International legislation concerning the drylands should be developed: the desert fringes, which are prone to desertification, should be internatinally and nationally declared as "Particularly sensitive areas" with a wide variety of legal implications concerning their use and protection, such as prohibition of agricultural development in dry steppe virgin lands.

ANNEX 4

PROTECTION AND REHABILITATION SUB-PROGRAMME

As part of the overall management of the country's groundwater resources, and based on the assessment of the present status of these resources, appropriate preventive, corrective, and rehabilitative measures as well as other supportive measures are recommended.

Initially the groundwater resources, areas and well fields, are classified into groups (categories) according to their present status of deterioration.

Based on the type, degree and causes of this deterioration, appropriate sets of measures are recommended in each area or group of areas.

Within the context of the main objectives of the Water Resources Management Programme this sub-programme will attempt to:

1. Prevent degradation of water resources which have been affected or slightly affected by applying a set of precautionary and preventive measures which aim at conserving and efficiently using these resources.

2. Stabilize, reclaim and improve the situation for those groundwater resources which have been moderately or adversely affected by pumping, by applying appropriate corrective and conservation measures.

3. Rehabilitate those water resources which have been severely affected by pumping, by a set of rehabilitation measures which may include: augmentation, and improvement so as to prevent complete destruction of such resources.

Based on the field survey, discussions with persons in charge in the various offices visited in the UAE, the groundwater areas can be classified as follows:

Group (A):

The groundwater resources and status in these areas are characterized as follows:

The groundwater has not been affected or slightly affected by pumping i.e., the water salinity is still good, (within 1500 ppm), except locally in few wells, the ground water levels have not significantly dropped, and the well's productivity is still maintained. The water resources development in these areas seem to be in balance with the resource potential. This group includes the following areas:

a. The area between Madeenat Zayed and Liwa in the Western Region.

b. The area from Al-Ain upto 60 Km to the north of Al-Ain including Auha, Al Khadir, Kashouna, Ghamdh, Al-Shuwaib, Al-Hir, Al-Kattara, Jbaitha, Al-Shibak, Al-Fuquo.

c. Wadi Sha'am, north of Ras Al-Khaimah.

d. The gravelly plain in the Central and Northern Regions (locally affected by relatively higher salinity).

e. Dabba, Khour Fakkan and Dhadna in the Eastern Region.

f. Masfout, Mizaira'a and Hatta in the eastern mountain area.

In these areas, as mentioned above, the groundwater resources have not been affected or only slightly affected. However, they are highly susceptible to deterioration under over pumping conditions, particularly during prolonged drought periods. Therefore, the following precautionary and preventive measures are recommended for these areas in order to protect their water resources:

1. Initiate two-year intensive and purposeful monitoring and well inventory sub-programme for each area to include:

   - Physical data for all the private and government wells.
   - Ground water levels.
   - Water quality.
   - Pumping rates.

2. Analyze the collected data and conduct detailed hydrogeological studies, and determine the safe and sustainable pumping rate from each area or well field.

3. Based on the results of these studies determine the total area that can be irrigated in each area in comparison with the existing, and recommend needed adjustments.

4. Meanwhile, drilling of new wells should be controlled until the results of the recommended studies are completed.

5. The public, particularly the farmers, should be made aware of the critical water situation in these areas, and should be trained on appropriate water conservation practices in irrigation.

<u>Group (B):</u>

This group of water resources areas is in a way similar to group (A) in that: slight deterioration has taken place as a result of pumping. However, the groundwater salinity in these areas is relatively high (exceeding 1500 ppm). In addition, the groundwater storage in these areas has not been significantly affected in terms of depletion and water level decline. Groundwater development in these areas is mostly done by government agencies for municipal and for afforestation uses. These areas include:

a. Ghayathi area, where nine well fields, with thirty producing wells in each, are developed, five for municipal supply, and four for afforestation projects.

b. The area between Al-Khazna and Al-Ain, and the area south of Al-Ain.

c. The area between Al-Sad and Swaihan.

The groundwater resources in these areas are not highly developed. However, due to the already high water salinity in these areas, slight change or deterioration in their water quality could quickly shift these resources to a critical and serious state of degradation which makes their water unusable for irrigating moderately salt-tolerant crops.

For these areas, the following precautionary and preventive measures are recoomended:

1. Impose protection zones for the existing well fields witnin which no further drilling should be permitted. The size of these protection zones should be based on analysis of the hydraulic properties of the respective aquifers and well field.

2. Plan and control any further well drilling so that appropriate well spacing be maintained, and the overall pumping from each groundwater area does not exceed a pre-determined safe and sustainalble yield.

3. Monitor and assess aquifer behavior and response to present pumping rates and take action to prevent any further aquifer deterioration in terms of water quallity and storage depletion. Action may include reduction of pumping rates.

Group (C):

Areas where groundwater resources have been moderately or seriously affected by pumping. Adverse effects are obserrved in these areas as an increase in water salinity, decline in water levels, and/or reduction in wells yield. These include municipal and irrigation well fields in the following areas: Al-Ain, Al-Dhaid, Falaj Al-Mu'alla, Hamraniyah, Digdagga, Ras Al-Khaima and the north western coast till Sha'am, and al-Fujairah, Kalba and Murbah on the eastern coast.

The following corrective and rehabilitation measures are recommended for these areas in order to prevent complete and irreversible destruction of these resources:

1. For the municipal well fields of the major cities:

   * Stop drilling new wells and limit pumping at its present rate as an initial step.
   * Study and implement a plan for gradually but steadily replacing the groundwater supplies, for the municipalities and the large population centers, by desalinated sea water.

* Augment some of these groundwater sources, where possible, by artificially recharging surplus desalinated sea water, and winter flood flows.
* Plan for exchanging groundwater by treated sewage water for landscaping in the major population centers.

2. For the agricultural areas;

* Restrict drilling of new wells subject to the results of new aquifer evaluation studies.
* Close some wells in the least affected areas to secure well spacing of at least 100-200 meters. These figures are approximate, and need to be verified in more detailed studies. This process will minimize well interference and restore suitable and continuous pumping rates particularly in areas like Falj Al-Mu'alla.
* In the severely affected areas, more well closure will be required. This reduction of irrigation water supply in these areas as a result of well closure, may be compensated from new well field(s), to be located and developed in the upstream direction of the groundwater flow in these areas. Such new well fields could be developed and operated by the local offices of the Ministry of Agriculture or by farmers cooperatives.

<u>Detailed hydrogeological studies are needed to the relocation of these well fields.</u>

* Convserve and rationalize irrigation water use in these areas by introducing and training farmers on appropriate water saving agricultural and irrigation pratices and technologies.

* Encourage the plantation of salt-tolerant crops in areas where the groundwater salinity is relatively high.

* Finally, the above restrictive measures on agricultural activities would not be socially acceptable without simultaneous provision of incentives and short to medium-term benefits to the farmers to be able to survive through out the recovery or rehabilitation period of the respective groundwater resources.

ANNEX 5[1]

ACSAD, AOAD, 1981. Evaluation of present status and potential Development of animal Feed Resources in the U.A.E. (in arabic)

This study is meant to provide a reference which contains detailed information about the existing and expected potential feed resources and animal products and their nutritional needs. It would also be of great help and guidance for personnel and institutions that care about the development of feed resources in particular, and animal wealth in general.

This study is concerned with the survey and evaluation of feed resources in the U.A.E. where both animal and agricultural products play a minor role in comparison with petroleum production.

This study includes 4 main chapters;

Chapter No. 2: The role of animal production and forages in the agricultural economy.
Chapter No. 3: Animal wealth and feed requirements.
Chapter No. 4: Sources of animal feed and forage production.
Chapter No. 5: The Feed balance.

The other chapters are:

Chapter No. 1 : Introduction.
Chapter No. 6 : appendices.
Chapter No. 7 : References.
Chapter No. 8 : table of contents.
Chapter No. 9 : study summary in english.
Chapter No. 10: study summary in french.

Chapter No. 2: This chapter mentions that animal production in the U.A.E. still follows traditional methods and is mainly for home consumption becuase of many reasons of which:

1. The harsh environmental conditions.
2. The unavailability of good ranges.
3. The uncontrolled grazing and the absence of appropriate range policy.
4. The scarcity of water to increase the cultivated areas and to increase forage production.

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[1] The summary of ACSAD and AOAD (1981) study and ACSAD (1985) study are added to this document as Annexes 5 and 6 because: (a) they are probably the only two studies on the subject; (b) they contain valuable information; (c) very few people know about them and less saw or read them; and (d) it has been very difficult to trace them. When we found them we decided to make their summary available to readers of this document.

The government offers ..... to the people ..... in animal production in the form of casher production inputs. In 1980 this assistance was about 12.9 milion derhams (about 3.51 US$) on the basis of 200 derhams per camel and 50 derhams per a sheep or a goat. This beside providing all veterinary services.

Chapter No. 3: This chapter deals with animal production and Feed requirements.

The expected feed requirements of the different livestock classes in the year 2000 are estimated at about 801933 tons dry matter compared to the present requirements estimated at about 363877 tons dry matter in 1980.

Chapter No. 4: Talks about sources of animal feed and forage production. Also this chapter takls about geographical divisions, chimatic factors, water resources, soils, and population.

Rengelands were estimated at about 200000 hectares (Ministry of planning, 1981) and were divided according to the dominant vegetation associations into:

A. Shores and marches associations :

1. Avacdna mardna association.
2. Juncus maritimus association.
3. Frankenia sp. aeluropus sp.

B. Sand dune (White sands and sabkhas) assoication :

1. Zygophyllum coccinium and cornulaca leucantha assoication.
2. Helianthemum lippii association.

C. Longitudinal sand dune (red sands) association :

1. Calitropis procera and cyperus conglomeratus association.
2. Lepladenia pyrotchnica association.
3. Prosopis specigera association.

D. Gravelly sand plains and alluvial associations:

1. Prosopis specigera and anabasis articulata association.
2. Acacia tortilis and Haloxylon salicornicum association.

E. High wadis and mountain feet:

1. Acacia tortilis and Zizyphus spina christi.
2. Acacia tortilis and euphorbia sp.

F. Wadi bothoms and stoncy water falls association:

1. Acacia tortilis, prosopis specigera and Zizyphus. spina christi association.
2. ficus salicifolia and Nerium oleander association.

This chapter also covers the important range plants and their palatability classes in appendix 6 and also talks about the

forage production, Agricultural by-products and feed concentrates.

The study mentions on page 57 that rangelands productivity is low because of :

1. The absence of an authority for natural rangeland management.

2. The absence of a clear policy for range management and range utilization. This sector generally receives secondary importance.

3. The absence of a trained technical cadre in management of natural rangelands.

Chapter 4 also mentions some recommendation for development of forage production of which:

1. Survey of available water resources, and control of their utiliztion ... etc. .

2. Survey and classification of soils ...

3. Rangelands development through:

a. Establishment of range management unit and provide it with a trained cadre to cover all development activities from surveys to implementation of suggested developmental plans.

b. Survey and classification of range plants, study thier feed value and establishment of range exclosures to protect rangelands and restore their vegetation cover.

c. Establish laws and legislations to protectrangelands from degradation and to control their utilization.

d. To benefit from the experience available at other countries in range development especially in introduction of range plants to be tried under local conditions to use the suitable ones to improve rangelands productivity.

e. Establish programs for sand dune fixation.

Chapter No. 5: Of this study talks about the feed balance in 1980 and the expected one in 2000, depending on the animal requirements of feed. Although the increase in animal numbers was accompanied by an increase in feed production, the gab in the feed balance is till high. This gab amounted to about 320034 tons dry matter in 1980. Feed resources are the limiting factor in the development of animal production. Accordingly the situation of the feed balance may not change much. It is expected that local feed resources will constitute only about 12% of the animal requirement.

ANNEX 6[1]

ACSAD, 1985, Survey of Natural Range Resources in the United Arab Emirates (in Arabic).

This study included 9 chapters. It is considered an important step to preliminary evaluate the natural range resources and should be followed by more detailed quantitative and qualitative survey of these resources.

Chapter 1: This chapter deals with the physical features; area, location, physiography, population, climate, soil and water.

U.A.E. is an example of the hot coastal desert. It is classified as hot arid area except for the Oman hills area which is classified as steppe.

Average annual rainfall ranges from 60-135 mm. It comes as thunder storms and causes floods and soil erosion in the non-sandy areas.

Sand storms are formed because of wind velocity in about 30 days per year in Sharjah and coast. In the interior areas sand storms may reach double this number, and cause sand movement.

Chapter 2: The vegetation types that have been described in the U.A.E. include:

A. Vegetation cover on shores, islands and sea marches.

Mainly mangrove shrubs.

B. Vegetation cover on Al-Hajar mountains.

1. Upper wadis and mountain feed associations: mainly Acacia torlitis, Zizyphus spina-christ, and Euphoria larica.

2. Deep wadis and stony water falls associations: mainly Acacia tortilis, Presopis specigera, and Zizyphus spina-christi.

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C. Trees and shrubs vegetation cover.

Mainly prosopis spicigera and Acacia tortilis trees and lycium shawii and Euphoria larica shrubs. Beside some range grasses.

D. Oases and Agricultural areas.

These areas are planted with vegetable fruit trees, cereal crops and forages. The main graminae species: cynodon dactylon, chloris virgata, cenchrus ciliaris, etc.

E. Vegetation cover on the shrubby steppe.

Main trees: prosopis specigra, Acacia tortilis and Zizyphus spina-christi.

1. Calotropis procera association.

2. Leptadenia pyrotechnica association.

F. Vegetation cover on eastern wadis.

1. Moringa peregrina-periploca aphylla association.

2. Lycium shawii-Gerewia erythraea association

G. Vegetation cover on moving sands and gravelly and sandy plains.

Prosopis specigera trees and some grasses as panicum turgidum are found in wadis and depressions in the northern desert. In the southern desert and because of low and erratic rainfall only some annuals may appear.

H. Vegetation cover on the coastal white sands and coastal and interior sabkhas.

This coastal desert is almost bare of natural vegetation cover between Abu Dhabi and Qatar except some annuals. North Abu Dhabi, the vegetation cover includes some perennials. The main vegetation associations in this area include:

1. Cornulaca leucantha-zygophyllum spp.

2. Helianthenum lippii-cornulaca leucantha.

3. Calotropis procera-cyperus conglomeratus.

Chapter 3: Range Resources and its forage productivity.
Natural range resources in the U.A.E. include trees, shrubs and desert grasses, generally suitable for grazing by camels, sheep and goats.

The main trees: Prosopis specigera and acacia tortilis.

The main shrubs: Brachiaria eruciformis, Cassia italica, Rhantherium epapposum, and Artemisia herba-alba.

The main perennial grasses: Cenchrus ciliaris, panicum turgidum, cynodon dactylon, chloris gayana.

The main annuals: Chloris virgata, stipa tortilis.

The area of the natural rangelands is estimated at about 105 million hectares. The area suitable for transportation is estimated at about 50-60 thousand hectares. About 48% of this area was utilized until 1981.

3.1 Livestock numbers and their feed requirements
Livestock numbers in the U.A.E. were 341622, 132247, 58709 and 26825 for goats, sheep, camels, and cattle respectively in 1980.

The imported live-animals were 140840, 391621, and 2270 for goats, sheep and cattle respectively in 1980 (there are no available figures for imported camels).

From the above figures it could be extrapolated that market meat consumption is mainly from imported live-animals, as the animal husbandry in the U.A.E. is mainly for home consumption.

3.2 Assuming that a camel consumes 2400 kg dry matter/year, range production for red sands, white sands, and sabkhas and calcerous soils was 40, 20, and 35-40 kgs/ha/year respectively and the carrying capacity was 151, 302 and 151 ha/camel for the same soil types.

3.3 The middle district has the largest numbers of animals. Goats are the main livestock type in the U.A.E. followed by sheep and camels. Southern district has the highest numbers of camels.

This chapter includes information on green forage production, straw, and agricultural by-products in 1980 and expected production in the year 2000.

Feed requirements were estimated at about 498,000 tons in 1980. Local feed production was estimated at about 167,300 tons. So self sufficiency is about 34% and expected to be 42% in the year 2000.

Chapter 4: Forage production and animal husbandry.
This chapter deals with traditional animal husbandry, bedouin settlement, and incentives each family receives as a small house, a three hectare area near the village. Also, this chapter talks about the cereal production 1980 and the development of agricultural production from 1977-1980.

The government gives animal producers 50 dirhams for a camel, 30 dirhams for a cow, and 20 dirhams for a sheep or a goat.

There is a department for animal production within the Ministry of Agriculture and Fisheries. Rangelands is the responsibility of this Department, but there is no range division until now within this Department. There is no department for forestry, afforestation and amenity - these are the responsibility of the municipalities within the Emirates.

1980 figures reveal that imported animal products is much higher than local production. Expansion of forage production is limited by availability of irrigation water.

Chapter 5: Afforestation and important local species.
Afforestation activities started in 1960 near Al Ain and Dubai-Al Ain road and was extended to other areas.

The most important local species are Prosopis specigera, Panicum turgidum, Rhantherium epapposum, and Cyperus conglomeratus.

Chapter 6: Recommendations.
To develop and maintain natural ranges in the U.A.E., it is recommended:

1. To make trials to select the range species suitable for local conditions and to establish nurseries to propagate fodder species and other species suitable for stabilizing sand dunes.

2. To make trials to select the range species suitable for local conditions and to establish nurseries to propagate fodder species and other species suitable for stabilizing sand dunes.

3. To tie the monetary incentives the government offers to the animal producers with their agreement to keep productive animals and get rid of non-productive ones. This is to protect rangelands from degradation due to high grazing capacity.

4. Improvement of rangelands through water harvesting, water spreading, and plantation of fodder shrubs or re-seeding in the wadis and depressions that receive additional water.

5. Sand dune fixation with plant species that are not very palatable (so as not to be overgrazed) and protection of these plantations for at least first two years. There is a need also to support the technical staff working in this field.

6. There is a need to establish a range division in the Ministry of Agriculture to be responsible for suggesting legislations to protect rangelands, to improve rangelands and manage these lands properly, to establish range nurseries, and monitor and evaluate range conditions.

Chapter 7: is a list of some local plant species in the U.A.E.

Chapter 8: References in Arabic.

Chapter 9: References in English.

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