

## SAND AND SAND DUNE STABILIZATION IN THE UNITED ARAB EMIRATES

M.I.R. Khan\*

### 1. About the Emirates

The United Arab Emirates, a federation of seven Emirates, lies roughly between 22° 40' to 26° 10' N. latitudes and 51° 35' to 56° 25' E. longitudes. The Arabian Gulf lies to the northwest and the Gulf of Oman stretches along the east coast of the Emirates. The land surface of the mainland excluding the islands is about 77,700 square kilometers as given in the table below:

*Table 1. Area of the United Arab Emirates*

S. No.	Emirates	Area in sq. miles	Area in sq. kilometers
1.	Abu Dhabi	26,000	67,340
2.	Dubai	1,500	3,885
3.	Sharjah	1,100	2,590
4.	Ras Al Khaima	650	1,683.5
5.	Fujeira	450	1,165.5
6.	Umm Al Quwain	300	777
7.	Ajman	100	259
Total		30,000	77,700

The overall climate of the Emirates may be described as subtropical, warm and arid. Air temperatures range between 35° to 50° C from May to October during the middle of the day and they may vary between 20° to 35° C at midday during the winter months. In the interior of the desert the highest temperatures on the ground during summer go upto 70° C and the lowest may fall below 0° C during winter months. The average annual rainfall of the Emirates which falls mostly during winter months is less than 100 mm. Some monsoonic showers are also received during summer months on the east coast and in the mountain belt which forms the watershed between the Arabian Gulf and the Gulf of Oman. The rainfall, however, is very erratic and varies extremely both from year to year and place to place. Some moisture also condenses in the form of fog and dew especially in the coastal belts. Strong winds and sand storms are of common occurrence throughout the Emirates. They are especially more frequent and severe during summer months with the recorded maximum wind velocity going up to 31.8

\* The author is Agriculture Consultant, Abu Dhabi, U.A.E.

kilometers per hour. The sand dunes are a dominant feature of the landscape over most of the Emirates.

The soils are generally coarse, sandy and undeveloped. They are deficient in organic matter, nitrogen, available phosphorus and trace elements such as zinc, iron and manganese. Non-calcareous soils may also be deficient in potassium. Soils in the 'Sabkha' coastal belt and low lying areas and depressions in the interior of the desert are highly saline.

Most of the Emirates is an extremely arid area so that permanent and sustained agriculture is not possible without artificial irrigation. As a result of artificial irrigation and subsequent to occasional leaching, secondary salinization takes place very commonly. For a successful agriculture some protection against high velocity winds, sand invasion and high summer temperatures is necessary in most places. Dry and droughty years are quite common. Next to the Empty Quarter of the Arabian Peninsula, the United Arab Emirates is perhaps the most difficult area for practising sustained agriculture on a successful basis.

## 2. Destruction and Degradation of Natural Vegetation

The arid zone vegetation consisting of both woody and non-woody species occurring naturally in the United Arab Emirates has suffered a great deal because of the past over exploitation and mismanagement. The natural vegetation has either been completely destroyed from certain areas or it has degraded considerably over vast areas. The area occupied by the coastal mangrove forest has shrunk to a meagre less than 3000 hectares. Similarly, the area under inland forest of 'Ghaf' (*Prosopis spicigera*) and 'Samar' (*Acacia tortilis*) woody species, has been considerably reduced and the surviving forest is badly depleted and degraded. Inland vast range areas under major range types such as 'Suaeda' (*Suaeda Spp*) 'Haad' (*Carnulaca Spp.*), 'Ghada' (*Haloxylon persicum*), 'Rims' (*Hammada clegaus*) and 'Arta' (*Colligonum comosum*) have either been destroyed altogether or they are badly degraded.

The basic causes of extensive denudation, degradation and destruction of natural vegetation in the U.A.E. are intimately linked to the existence of a delicate ecological equilibrium and excessive pressure of population on the land resources. The environmental factors over most of the Emirates exist in a very delicate state of equilibrium. Their mishandling such as excessive use or some other form of mismanagement upsets the ecological balance and leads to serious losses of the natural resources. For example, by using the range lands beyond their carrying capacity either by intensive use or by grazing excessive number of livestock would lead to their gradual degradation and ultimate destruction. Under the harsh and variable climatic and environmental conditions prevailing in the Emirates, it is a delicate matter to maintain the ecological equilibrium which generally has lead to the degradation and destruction of natural vegetation.

Since the discovery and commercial exploitation of crude oil beginning in the early sixties, pressure on the local natural resources of the Emirates has increased tremendously. The human population which stood at about 180,000 in 1968, rose to about 320,000 persons in 1972.



Then it jumped to about 870,000 persons in 1978, 900,000 in 1979 and is now estimated to be over one million.

Similarly, the livestock population is also increasing at a rapid rate as would be seen from the table given below:

*Table 2. Livestock Population of the United Arab Emirates.*

S.No.	Kind of animals	Numbers during			
		1972	1978	1979	1980
1.	Goats	225,000	250,000	310,500	341,622
2.	Sheeps	85,000	95,000	120,000	132,237
3.	Cattle	20,000	18,600	23,300	25,665
4.	Camels	35,400	48,000	56,400	58,709
Total		365,400	411,600	510,200	558,233

In the Abu Dhabi Emirate an annual subsidy of 50 dirhams for every head of sheep or goat and 200 dirhams for every head of camel raised by the local inhabitants is paid by the government. The increasing numbers of livestock means greater pressure on the natural grazing lands which may be more than their carrying capacity in many cases. This increasing pressure of population has lead to the gradual degradation and destruction of natural vegetation.

In consequence of large scale destruction or degradation of natural vegetation cover, wind erosion and sand dune movement have become very active throughout the U.A.E. The denuded sandy areas and sand dunes are subject to severe wind erosion especially during the hot and dry summer months.

### 3. The Problem of Sand and Sand Dune Encroachment

Sand and sand dune encroachment is prevalent throughout the Emirates but is most severe in the south western areas adjoining the 'Ruba al Khali', falling within the Abu Dhabi Emirate. The problem has been further accentuated by the destruction or depletion of natural vegetation in the recent past. Roads, habitations, townships, cultivated land, date gardens and forest plantations, are all liable to be encroached upon by moving sand and sand dunes practically all over the Emirates. The excessive removal of sand by severe winds may also expose the foundations of buildings, water tanks, transmission poles and pipe lines.

The sand has to be physically removed by using heavy earth moving machinery to clear the roads or to save habitations, farm lands or forest plantations. Physical impediments such as cement asbestos sheets, galvanized iron sheets or date fronds are erected across the main prevailing direction of the wind to check encroachment by sand. The sand accumulated against the

physical barriers is also periodically removed. As a long-term measure live shelterbelts or wind breaks of arid zone species are raised to slow down the wind velocity and keep the sand away from openly invading the protected places. Both live shelterbelts or wind breaks and block plantations are being raised to lessen or check encroachment by sand. In other places where building foundations or underground installations are liable to be exposed by severe winds, sand and soil may have to be hauled in with heavy earth moving machinery to protect them from being exposed.

A variety of sand dunes are found in various parts of the Emirates. They are continuously growing, moving and changing their shapes and forms. Recent observations, made on the comparatively stable and mobile sand dunes in the Western region of Abu Dhabi indicate that they may be moving at the rate of one to three meters annually in the main direction of the prevalent wind. A number of methods and techniques are being used to stabilize them and to check their advance.

#### 4. Various Methods and Techniques Employed for Combating Sand Encroachment and Sand Dune Stabilization in United Arab Emirates

In order to combat sand encroachment and to check the movement of sand dunes various methods such as erection of physical impediments, protective afforestation, levelling with heavy earth moving machinery along with covering and consolidation with 'Kutch' (lime), spraying with crude oil and a few sand stabilizer have been used. The following paragraphs give a brief account of the different methods and techniques utilized so far.

- (a) *Physical Impediments*: Physical impediments such as the erection of barriers with date fronds, cement asbestos sheets and galvanised iron sheets have been commonly used. Date frond barriers have been used specially to save the date gardens surrounded by sand dunes. Asbestos and iron sheets have been used to save houses and buildings. The sand accumulated at the base of the physical barriers has to be removed at intervals.

Thus it will be seen that the physical impediments mentioned above provide only a temporary relief and are not a permanent cure against sand and sand dune encroachment.

- (b) *Protective Afforestation*: This is perhaps the most widely used method employed to combat wind erosion and sand encroachment in UAE. Shelterbelts and wind breaks of trees and bushes have been raised to protect highways and major roads against sand encroachment. Green belts and block plantations of forest trees have been raised with drip irrigation to protect habitations and townships. Farm lands and date gardens are also protected against wind erosion and sand encroachment by raising protective rows of trees around them.

Afforestation has been carried out on the undulating land as found in nature



or it is first levelled with heavy earth moving machinery along important highways such as the Beda Zayed — Liwa Road and new townships like Beda Zayed and Ghiati. Land scaping around buildings is also done after proper levelling.

Besides arid zone afforestation, work has also been done on improving the depleted and degraded range lands. This involves fencing and treating fairly large chunks of areas. Even artificial rain with cloud seeding has been attempted to provide enough moisture for the restoration and rehabilitation of the depleted range lands. The artificial rain experiment tried in the beginning of 1982 has proved fairly successful.

- (c) *Levelling with Heavy Earth moving Machinery and covering and Consolidation with 'Kutch'*: This method involves the levelling of undulating sandy areas with heavy earth moving machinery and covering the levelled sandy areas with a layer of ground lime rock ('Kutch') of varying thickness depending upon the purpose for which the area is required to be used. It may be only about a foot for a date garden or a farming lot or it may be a few feet for an asphalt road. The consolidated hard surfaces do not accumulate sand and are then used for farming, gardening or road making. They are, however, to be protected from sand coming from the surrounding unconsolidated areas by raising live shelterbelts of trees and bushes.

A layer of ground lime rock is also used to cover the underground water and crude oil pipe lines to prevent their exposure by wind erosion. This has been commonly practised in areas where 'Kutch' is easily and readily available.

- (d) *Spraying with Crude Oil*: Spraying with crude oil has been very widely practised to protect the oil and gas pipe lines against wind erosion. The bases of the transmission poles are also sprayed with crude oil to protect their foundations being eroded away by high velocity winds and sand storms.

Spraying with crude oil is repeated at intervals after the previous sand storms have blown away the covering sand and debris layer. Sometimes the pipe lines etc. are to be provided with a fresh layer of sand cover before spraying them again with crude oil.

Stretches of dirt roads may also be stabilized by spraying crude oil over them. The crude oil, however, gives an ugly look and pollutes the environment in its immediate vicinity.

- (e) *Use of Sand Stabilizers*: A few sand stabilizers have been tried in the UAE in the past few years as briefly discussed below:

- (i) *Stabilization with Wood Fibers Spray* by M/s. Sta-Soil Corporation of North Hollywood, California, USA. They attempted this stabilization on an experi-

mental basis over an area of about six hectares in Al Babha plantation, in the Western region of Abu Dhabi, during 1978. The stabilization was neither very strong nor durable.

The crust formed by the wood fiber spray was easily broken under human feet and under the tracks of the vehicles. The stabilised crust almost completely disappeared after about six months.

- (ii) *Spray with Sandstill* provided by M/s. Energy systems Associated, Inc. Washington, D.C., USA. Sandstill is an adhesive resinous substance of light colour which is water soluble. It is also nontoxic and nonflammable. It was tried on an experimental basis by M/s. Pakistan Forestry Consultants in Abu Dhabi during 1980-81. The results of their experiments have not been too encouraging. It has not been tried on a large or commercial scale.

The sand stability produced by spraying sandstill is reported to be neither very strong nor long lasting. The price of a gallon of sandstill concentrate is reported to be about four US dollars.

- (iii) *The Petroleum Mulch*: The use of the petroleum mulch for sand dune fixation started in Iran in 1968. Since then it has been used on a fairly large scale for sand dune stabilization followed by sowing and planting with arid zone species such as *Haloxylon spp.*, *Tamarix stricta*, *Acacia spp.*, *Calligonum sps.* and *Zizyphus spina-christi* etc. in Southwest Iran.

After visiting this sand dune stabilization work in Iran, the Abu Dhabi government under an agreement with the government of Iran decided to lease out an area 3000 hectares of undulating sandy terrain interspersed with high sand dunes in Al Khatim and Beda Zayed areas for stabilization and planting with arid zone species to be raised with drip irrigation. The area is first fenced and layed out with automatic drip irrigation system and then sprayed with the petroleum mulch during summer months. It is later planted with transplants of arid zone species such as *Prosopis spicigera*, and *Acacia spp.* etc., 7 x 7 meters apart. The transplants are irrigated by drip irrigation. The project has been handled in Abu Dhabi by the staff of the Iranian government during 1979-82.

The petroleum mulch seems to have given better results than the previous two sand stabilizers. The area sprayed with the petroleum mulch, however, does give a dirty look and may be polluting the local environment. The work could be fully evaluated only after about a couple of years.

The entire project to stabilize 3000 hectares and then plant it up with arid zone species by drip irrigation was estimated to cost Dh. 780,000,000.



### 5. Scope of Future Work and Likely Demand for Sand Stabilization:

There would appear to be a continuous and growing demand for sand and sand dune stabilization in the UAE. This is needed not only for practising stable agriculture but also for road construction, and development of airports, habitations and industrial areas etc.

In the field of agriculture the national policy is to gradually become self sufficient in food production. The area under various types of crops and agricultural holdings is increasing rapidly as will be seen in the following table.

*Table 3. UAE – Development of Land in Agricultural Holdings, 1973 to 1980*

Land Use	(In Donums)					
	1973	1975	1977	1978	1979	1980
Fruit Trees	50,000	44,272	45,949	62,533	67,934	70,964
Vegetables	23,800	12,810	15,999	31,089	45,426	46,615
Field Crops	11,240	8,564	6,870	10,535	16,401	18,500
Other Cultivated land	42,060	79,380	84,570	76,191	63,276	98,670
Total	127,100	145,026	153,388	180,357	193,047	234,749

Thus it will be seen that the land developed into farms almost doubled from 12,710 hectares in 1973 to 23,475 hectares in 1980. After initial development of agricultural land, it would require to be continually protected against sand encroachment. To achieve permanent protection of cultivated land, a combination of the use of sand stabilizers and growing of live shelterbelts or windbreaks would appear to be necessary.

Similarly, for the protection of highways and roads both the use of sand stabilizers and protective afforestation on the windward side of the roads would appear to be ideal. Sand stabilization on a strip along the outside of the protective forest belts is also indicated.

A large number of new habitations, townships, airports and industrial areas are also being developed throughout the UAE. To protect them against sand invasion and encroachment a great deal of land levelling, sand stabilization, land scaping and raising of protective tree belts would be needed.

So far, the petroleum mulch seems to have given the best results in sand dune stabilization, but from aesthetic and environmental point of view it has serious draw backs. It would, therefore, be worthwhile to try other sand stabilizers which do not have the defects of the petroleum mulch. To introduce new suitable stabilizers some initial experimental work would be necessary. This could be undertaken with organisations such as the Agriculture and Forestry Departments, Government of Abu Dhabi, and the Central Agricultural Laboratories of the Federal Ministry of Agriculture and Fisheries Resources near Al-Ain.



Fig. 1. Eucalyptus shelterbelt raised in Al-Babha plantation, Abu Dhabi.

Photo: Author

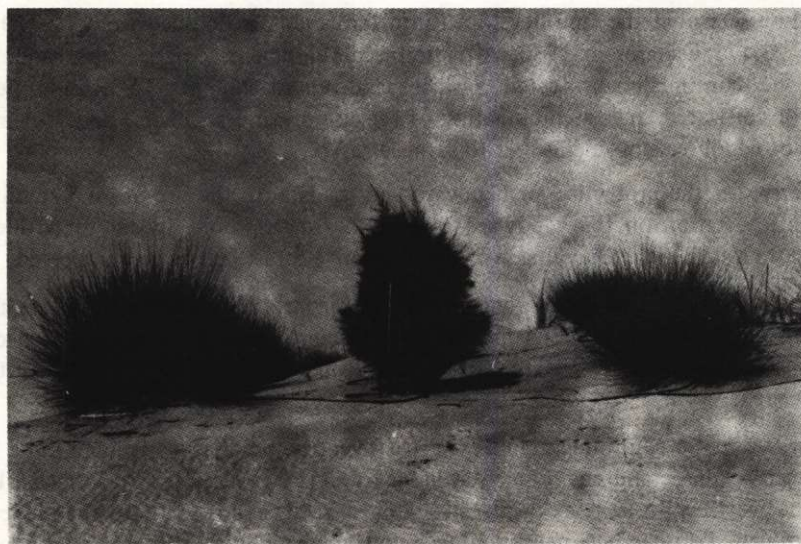


Fig. 2. Three rows shelterbelt of *Casurina glauca* and 'Markh' (*Leptadenia pyrotechnica*) in Madina-Zayed plantaion, Abu Dhabi.

Photo: Author





Fig. 3. A young date plantation at the foot of a sand dune at Beda Saif. Planting has been done to stabilize the dune.

Photo: Author

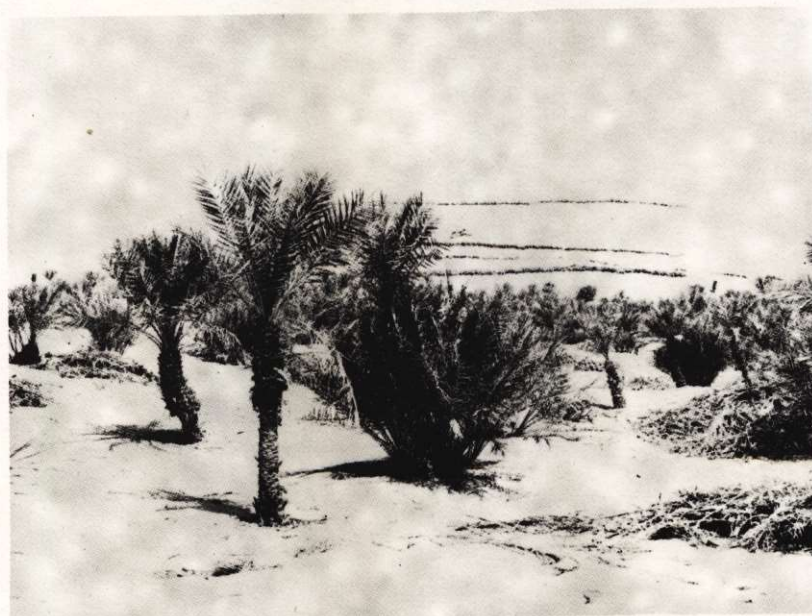


Fig. 4. A date plantation in Liwa Oasis at the foot of a dune. Shelterbelt of date fronds has been erected on the dune to protect the plantation.

Photo: Author