



UNITED NATIONS ENVIRONMENT PROGRAMME

REGIONAL OFFICE FOR WEST ASIA



**THE STATE
OF THE ENVIRONMENT
IN QATAR**

1984





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FOREWORD

In the course of discussions carried out during my visit to Qatar in April, 1983, it was recommended that the UNEP Regional Office for West Asia should assist the Permanent Environmental Protection Committee (EPC) of Qatar by commissioning a study on the environmental situation in Qatar to identify priority areas that should be addressed by the EPC in the biennium 1984/1985. This recommendation was further elaborated and approved during the official visit of Dr. Mostafa K. Tolba, Executive Director of UNEP, to Qatar in November, 1983.

As a follow-up to this decision, the UNEP Regional Office for West Asia entrusted Dr. Essam El-Hinnawi (Research Professor at the National Research Centre, Cairo ; and Senior Adviser to UNEP) with the preparation of the present report on the state of the environment in Qatar.

I hope that this report will be found to give an accurate assessment of the environmental situation as existed in 1983 in Qatar and that it will be useful for planning the work of the Environmental Protection Committee. It is also my sincere hope that other organizations in Qatar, and in particular the scientific community, will pick-up the environmental problems identified in this report and accelerate the efforts to find adequate solutions to these and other issues that may emerge.

Salih Osman

Regional Representative of UNEP
Director, UNEP Regional Office for West Asia

Manama, January, 1984

PREFACE AND ACKNOWLEDGEMENTS

The present report on the state of the environment in Qatar was prepared with the following in mind : the report should identify different environmental problems encountered or likely to be encountered in Qatar; it should identify inadequacies in environmental protection measures; and it should be action-oriented.

In the preparation of this report, I have relied heavily on published information and on data gathered during extensive discussions carried out in Doha and at Umm Said.

Dr. Mostafa K. Tolba, despite his many commitments, as the Executive Director of UNEP, followed closely the preparation of this report and provided most valuable guidance, advice and support. A great deal of credit goes also to Mr. Salih Osman, Director of UNEP Regional Office for West Asia, who provided all possible assistance and a thorough briefing before I started my assignment.

The present report would not have been possibly written without the whole-hearted co-operation and assistance extended to me in Qatar by Dr. Hassan Kushkush, Secretary General of the Environmental Protection Committee, Mr. Hussein El-Baker of EPC, and the EPC Administrative Staff.

I would especially like to express my deep gratitude and thanks to officials of the following organizations who provided all possible assistance and information in the course of my discussions with them : Electricity Department, Water Department, Sewerage Department, Ports Authorities, Traffic Department, Agricultural Research Department, Fisheries Department, Qatar Petroleum Corporation, Regional Centre for Food Contamination Monitoring (Ministry of Public Health), Occupational Health Division (Ministry of Public Health), Industrial Development Technical Centre (IDTC); Qatar Petrochemical Company at Umm Said (QAPCO), Qatar Steel Company at Umm Said (QASCO), and Qatar Fertilizer Company at Umm Said (QAFCO). Mr. Osman Abu Salma of the Occupational Health Division, Ministry of Public Health accompanied me to Umm Said; his assistance is gratefully acknowledged.

Finally, I have greatly benefited from discussions with several of my distinguished colleagues at the University of Qatar and at the Centre for Scientific and Applied Research of the University of Qatar. To all of them, I am most grateful.

Essam El-Hinnawi
Research Professor
National Research Centre, Cairo

Cairo, January, 1984

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EXECUTIVE SUMMARY

THERE IS A GROWING CONCERN AMONG POLICY-MAKERS AND THE PUBLIC IN QATAR ABOUT THE QUALITY OF THE COUNTRY'S ENVIRONMENT. AN ENVIRONMENTAL PROTECTION COMMITTEE WAS ESTABLISHED BY THE GOVERNMENT IN 1981 TO UNDERTAKE MONITORING AND ASSESSMENT OF THE ENVIRONMENTAL SITUATION IN QATAR, TO PREPARE ENVIRONMENTAL LEGISLATIONS, POLICIES AND PLANS, AND TO CO-ORDINATE NATIONAL ACTIVITIES IN DIFFERENT FIELDS OF ENVIRONMENTAL PROTECTION.

SEVERAL ENVIRONMENTAL PROBLEMS ARE ENCOUNTERED IN QATAR, THE MOST IMPORTANT ONES ARE : SOIL DEGRADATION AND POLLUTION, OVER-EXPLOITATION OF GROUNDWATER, GROUNDWATER CONTAMINATION, MARINE POLLUTION (MAINLY FROM OIL SPILLS, THERMAL POLLUTION AND INDUSTRIAL DISCHARGES), AIR POLLUTION, AND LAND POLLUTION (THROUGH DISPOSAL OF UNTREATED WASTEWATER AND INDUSTRIAL WASTES, ETC). THE EXTENT AND SEVERITY OF THESE PROBLEMS REMAIN TO BE ASSESSED IN DETAIL THROUGH QUANTITATIVE ANALYSES, MONITORING AND EVALUATION.

ENVIRONMENTAL QUALITY STANDARDS ARE LACKING IN QATAR; THE FORMULATION OF SUCH STANDARDS IS OF PRIMARY IMPORTANCE FOR ENFORCING ENVIRONMENTAL POLLUTION CONTROL MEASURES AND ALSO TO SERVE AS THE SCALE FOR EVALUATING THE DEGREE OF ENVIRONMENTAL DEGRADATION. ON THE REGIONAL AND INTERNATIONAL LEVELS, QATAR HAS RATIFIED A NUMBER OF REGIONAL AND INTERNATIONAL CONVENTIONS DEALING WITH THE ENVIRONMENT; BUT THERE ARE 13 OTHER CONVENTIONS THAT SHOULD BE CONSIDERED.

A NUMBER OF RECOMMENDATIONS (P.42) HAS BEEN FORMULATED IN THE LIGHT OF THE PRESENT REPORT. THESE DEAL MAINLY WITH INSTITUTIONAL, LEGISLATIVE, MONITORING, ASSESSMENT, AND RESEARCH AND DEVELOPMENT QUESTIONS.

I. INTRODUCTION

The State of Qatar occupies an arid peninsula of approximately 11,600 km² extending northwards from the Arabian Peninsula mainland into the Gulf (Fig.1). The country is about 180 km along its north-south axis and the east-west width at its widest point is 85 km.

The surface of Qatar is of low to moderate relief, with the highest elevation of 103 m above sea level being attained in southern Qatar where mesa type hills and large barchan sand dunes serve to break the monotony of an otherwise flat eroded landscape. The central part of Qatar consists of a plateau known locally as barr Qatar (the stone desert or the central plateau of Qatar). The landscape is stippled by about 850 surface depressions, which lie below the surrounding land surface at a depth ranging from a few metres to as much as 20 m. These depressions are usually circular and range from a few hundred metres to two or three kilometres in diameter. They are usually called rodah (single : rodah). Another type of shallow depression, usually lineated and different in origin from the rodah, is the closed-in depression locally known as manga. These depressions lie just a few centimetres below the surrounding land surface. The rodah and the manga differ as regards water venue, soil characteristics and plant growth. The coastline of Qatar is gently emergent and presents an uneven outline with numerous inlets, islands, reefs, capes and bays and extensive areas of sabkhas (sabkha is an Arabic term denoting inland or coastal saline flats or playas with fine silt and calcareous sands). Coastal sabkhas are widespread along the coastal margins of Qatar, especially along the eastern coast to the south of Umm Said. Extensive inland sabkhas abound to the east of the Dukhan ridge and in southern Qatar. Sabkhas below sea level occupy a considerable area in Qatar, reaching 95 km². One of the remarkable features of plant growth along the coasts of Qatar is the occurrence of mangrove vegetation represented by Avicennia marina (Batanouny, 1981).

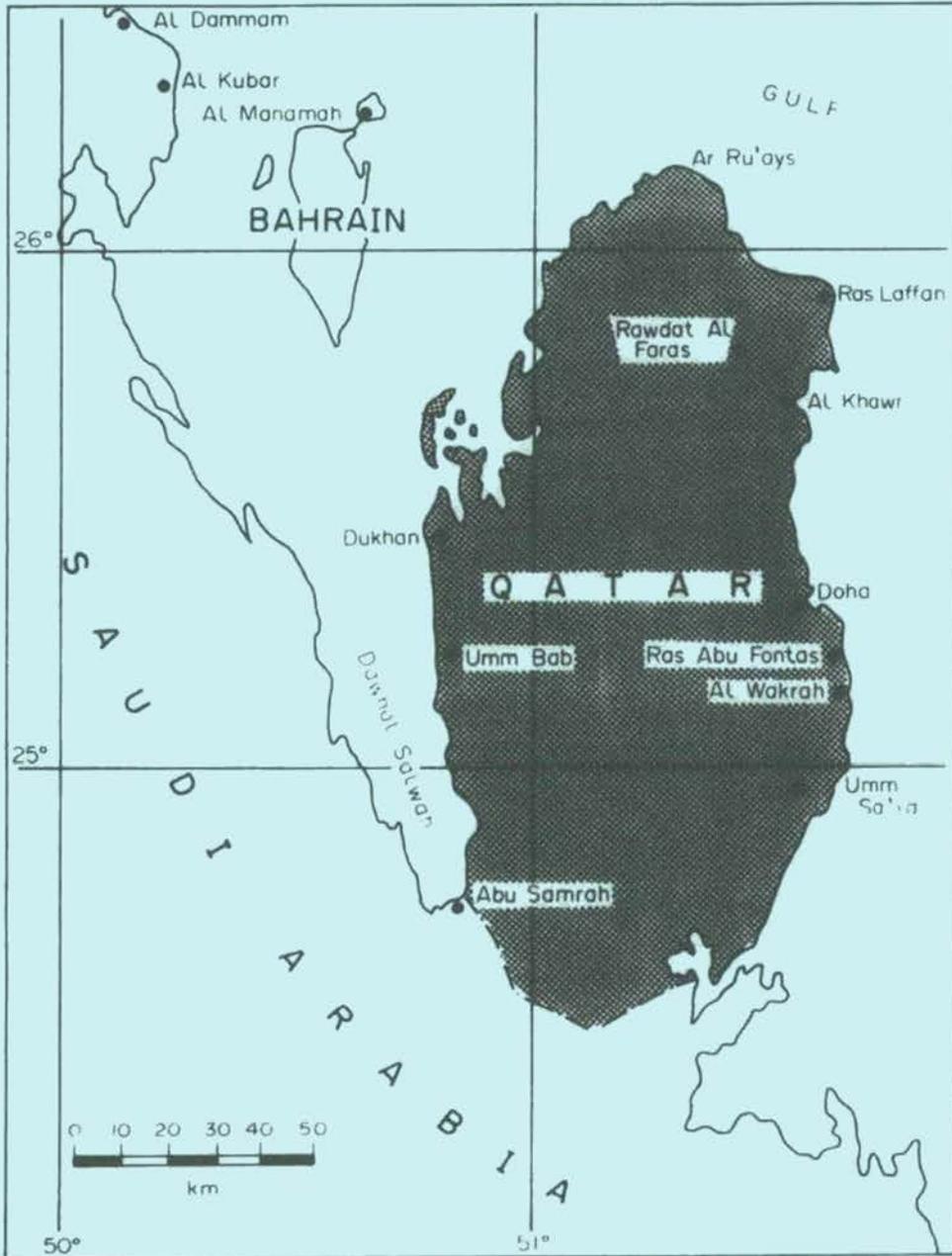


Figure 1. Map of Qatar

From the geological point of view, Qatar is a wide anticlinal arch or pericline, with gentle crest and steeper marginal dips and a north-south axis central to the peninsula culminating in the centre of the country. This arch is complicated by the presence of several other more pronounced structures, of which the Dukhan anticline (the main oil-bearing structure), the Sawda Nathil dome and the Simsimah dome are apparent (FAO, 1981). The geological succession is composed of Tertiary limestones and dolomites with interbedded clays, marls and shales covered in places by a series of Quaternary and Recent superficial deposits. The oldest rocks exposed are the limestones of the Rus Formation of Lower Eocene age although the most widespread outcrops are the dolomites and crystalline chalky limestones of the Upper Dammam Formation of Middle Eocene age.

Qatar has a hot desert climate, characterized by a scanty rainfall of about 50 to 80 mm per annum, high temperatures, hot dry summer winds and, because of its geographical position within the Gulf, experiences a high relative humidity for the greater part of the year (the mean annual relative humidity is 61.7 per cent). Climatological data show that the year may be divided into four distinctive climatic seasons of varying length : Period I (November to mid-February) constitutes the main growing season when temperatures range from a daily maximum of 30°C to a minimum of 7°C ; Period II (mid-February to mid-May) is marked by rapidly rising temperatures and increased wind speed; Period III (mid-May to July) is characterized by very high daily maximum temperatures of about 42°C and marked by sometimes sudden onset of greatly increased relative humidity and a decrease in wind speed whilst temperatures remain very high. Open water evaporation ranges from a minimum of about 2 mm per day in December to 10 mm per day in June.

Socio-Economic Aspects :

Prior to the initiation of oil exploration during the late 1930s, Qatar was a very sparsely settled country. In 1939, for example, the

total population was only about 28,000 (MEED, 1983). Members of various tribal groups, whose origin may be traced to the Najd region of Saudi Arabia settled in the northern coastal areas. In the southern part of the country there were nomadic groups who pursued an alternating transhumance with the interior of Saudi Arabia. All towns and villages were coastal, and pearl fishing and sailing were the main occupations; in the interior nomadic groups reared livestock.

The advent of the oil age completely transformed the socio-economic conditions of Qatar. Oil production began in 1948 and by 1981 income from oil has reached about US\$ 5500 million/year (MEED, 1983). The present level of oil production could be sustained for about 35 years from proven recoverable reserves. In 1972, a large gas field was discovered about 70 km off the north-east coast. Subsequent exploration has indicated that this deposit, known as the North Field, is one of the world's largest unassociated gas fields. In spite of the fact that the economy of Qatar is likely to be dominated by hydrocarbon production for a considerably long period, the Government of Qatar has been anxious to diversify the economy and an industrial base has been established at Umm Said, 48 km to the South of Doha. The Government is also according high priority to achieving some self-reliance in the production of basic foodstuffs.

Among the many changes brought about by the exploitation of Qatar's oil and gas reserves has been the increase in population through the influx of expatriates. In 1970, the population of Qatar was 111,000, of whom 47,700 (i.e. 43 %) were Qatari citizens. At present, the population of Qatar is about 250,000 according to estimations made by the United Nations (UN, 1980). About 40 per cent of the population are believed to be Qatari citizens. The total population of Qatar is estimated to reach about 434,000 by the year 2000; 85 per cent of the population will be living in urban areas.

The average GNP per capita in Qatar rose from US\$ 10,970 in 1975 to US\$ 27,720 in 1981 (World Bank Atlas, 1977 and 1983, respectively).

II. NATURAL RESOURCES, ENVIRONMENT AND DEVELOPMENT

1. SOIL AND AGRICULTURE

A soil survey and land classification study for the whole of Qatar was carried out during the early 1970s (UNDP/FAO, 1973). According to these surveys, the soils of Qatar have been classified into four main soil associations :

1. Rodah Soil Association (27,620 ha)

This soil association occupies the depressions of Qatar. The latter are nearly flat and filled with younger sediments which have been washed down from the surrounding areas and include fine soil material such as calcareous loam, clay loam, sandy loam, and sandy clay loam, overlying limestone boulders or limestone beds. The Rodah soils are not less than 30 cm and may reach as much as 150 cm deep.

2. Sabkha Soil Association (70,124 ha)

These soils are highly saline and normally found adjacent to the Gulf seashore. They are characterized by shallow to deep profiles from 30 to 150 cm. Texture is between calcareous clay loam, sandy clay loam and sandy loam.

3. Lithosol Association (1,020,997 ha)

This association constitutes most of the soils of Qatar. The soil is very shallow with rock fragments scattered on the surface, or rocky hills of limestone and sandstone outcrops.

4. Sandy Soil Association (36,167 ha)

These soils are sandy soils transported by wind and characterized by sandy shallow to deep profiles. Texture ranges from calcareous loamy coarse sand to coarse sand. Oolitic sand was found adjacent to the sea shore, characterized by saline calcareous coarse sand.

Based on the above-mentioned soil classification and on the physico-chemical properties of the soils, and their suitability for irrigation and the cost of reclamation, the lands of Qatar have been classified into the following four distinct categories (UNDP/FAO, 1973) :

1. Areas not yet cultivated but suitable for agriculture	18,929 ha
2. Areas conditionally suitable for agriculture.....	8,691 ha
3. Areas under cultivation	6,057 ha
4. Areas unsuitable for agriculture.....	1,127,289 ha
<hr/>	
Total area of Qatar	1,160,966 ha

The 18,929 ha of " suitable " land identified by the soil survey within Category 1 occur in some 900 depressions, where Rodah soils have accumulated to depths of up to 2 metres. Subsequent studies (Khalifa and Khalil, 1979 ; Ruwayha, 1980) have confirmed that, in addition, satisfactory crops can be grown on about 6,800 ha of sandy soils included in Categories 2 and 4. Of the 6,057 ha recorded as " cultivated " in the UNDP/FAO study only 3,030 ha are believed to have been usable arable land. In other words the total area suitable for cropping in Qatar has been estimated to be about 28,750 ha. Allowing for infrastructure development, poorly-shaped plots and areas too small for economic use, the total area suitable for cropping has been reduced to about 25,000 ha (Hall and Hill, 1983).

In 1980, 377 farms were believed to have been operating in Qatar, with an estimated cultivable area of 6,830 ha. Only 248 of these farms were considered to produce crops in commercially significant quantities; the remaining recorded holdings were operated mainly for their amenity values as gardens for the landowners and the small quantities of fruit and vegetables produced were consumed by the owners. The farming system in the cultivated Rodat varies from North to South, depending on the water quality and soil conditions. Three main farming systems are recognized : vegetable farming mainly in northern Qatar; vegetable-orchard-forage farming in northern and central Qatar, and orchard-forage farming in central and

southern Qatar (Batanouny, 1981). The UNDP/FAO study (1973) identified the following crops which are best suited for soil conditions in Qatar : vegetables, barely, groundnuts, strawberries, sweet potatoes, grapes and citrus. Fair development has been made in the cultivation of alfalfa as a source of animal feed * .

Though the cultivated area in Qatar is limited, inappropriate agricultural and irrigation practices have caused the deterioration of some cultivable land. In 1980, 220 farms were recorded as abandoned due to salinization, lack of groundwater, formation of hard pans, erosion, etc. A considerable number of weeds appeared in many areas. Salinization of the soil due to faulty irrigation resulted in the appearance of plants with halophytic affinity in the farms (Batanouny, 1981). Detailed surveys on the extent of soil deterioration (and hence desertification) in Qatar are lacking. The causes of such deterioration should be assessed in detail to find ways and means of preventing such deterioration from occurring in other areas. In addition, studies should be carried out to restore the lands that had deteriorated and have been abandoned. This assessment is of primary importance to take the necessary measures for the protection of agricultural land in Qatar to achieve the maximum degree of self-reliance in most crops as envisaged in the proposed Agricultural Development Plan to the year 2000.

* Natural plant growth in Qatar is limited by the seasonal, erratic and variable rainfall. Plant communities are of two main categories : non-halophytic found mainly inland, and halophytic found mainly in sabkha and coastal sands (for an excellent description of these plant communities, see Batanouny, 1981).

2. WATER RESOURCES

Groundwater is the sole natural water resource of Qatar. The main groundwater province is the North and consists of two main aquifers (the Ras Formation and the underlying Umm er Radhuma Formation). This northern province is the major source of reasonable quality groundwater in Qatar and is estimated to contain about 2500 million m^3 of freshwater within the two aquifer systems. The safe yield of this aquifer system is estimated to be of the order of 27 million m^3 per year (the mean annual recharge over northern Qatar is of the same order). Throughout the remainder of Qatar, except in the extreme south-west, groundwater conditions are highly variable with generally poor yields and a higher salinity except in certain favourable areas where meteoric waters have gained access to the Ras and thence to underlying Umm er Radhuma aquifer. While the annual recharge is calculated to be of the order of 14 million m^3 over this area, for various reasons this cannot be entirely regarded as a usable water resource. In the extreme south-western region of the country, the Alat aquifer emanating in Saudi Arabia is estimated to have a safe yield of up to 2 million m^3 per year of variable quality brackish groundwater (total dissolved solids from 3,000 to 5,000 mg/l). The underlying Umm er Radhuma Formation is also artesian in this region and could yield about 10 million m^3 per year, but with a total dissolved solids of about 17,000 mg/l. On the average, the total usable groundwater resources of Qatar are about 40 million m^3 per year (FAO, 1981).

In the years prior to the early 1960s all municipal water supplies were based on pumped groundwater. For small settlements this was from small local wells but Doha was supplied from a number of well-fields in east-central Qatar. From 1964 onwards these groundwater supplies augmented increasing supplies of distilled sea water to reach a peak in 1975/1976 when withdrawals were reduced with the aim of phasing out groundwater extraction from existing well-fields within the northern fresh-water aquifer area and developing other, possibly more brackish, sources nearer Doha for distilled water blending purposes. At present there are 451 fresh-water wells situated within 10 well-

fields in the North of Qatar capable of supplying up to 11,000 m³/ day. However, only 10 % of this figure is now drawn from the well-fields to supply rural areas in and around the northern part of the country (Water Department, Statistical Report, 1971-1981).

There are two major desalination plants in Qatar : the one at Ras Abu Aboud has a total capacity of 56,000 m³/day and the second at Ras Abu Fontas has a capacity of 144,000 m³/day. However, due to necessary maintenance, the total production of desalinated water from both plants is about 162,000 to 171,000 m³/ day. Further development of a site at Ras Laffan to incorporate a power station and desalination plant complex will result in 8 more units with a total capacity of 180,000 m³/ day becoming available towards the end of 1985.

Water Supply and Demand :

Agriculture in Qatar is based almost entirely upon irrigation from pumped groundwater. Groundwaters in the northern and central parts of Qatar are satisfactory for irrigation but waters elsewhere are marginal for sustained crop production. In South-West Qatar the high salinity waters of the Alat Formation are at present being utilized to produce fodder and field crops at an experimental farm. The high chloride content of these waters (1200 to 1600 mg/l) is causing excessive corrosion in aluminium sprinkler irrigation pipes.

In 1970, groundwater withdrawals for agricultural purposes were about 36 million m³ and in 1980, this figure reached 76.2 million m³, i.e. more than doubled. Fresh groundwater withdrawals for domestic purposes reached a peak of 6.21 million m³ in 1975, but dropped to 1.17 million m³ in 1980 (more brackish water has been used for blending desalinated water). In other words, the total withdrawals of fresh groundwater in 1980 were about 77 million m³. Assuming that 25 % of the water used for irrigation returns to the aquifers as irrigation return, the net groundwater use in 1980 was about 58 million m³, most of which came from the northern aquifer system which can only yield about

27 million m³/ year on a sustainable basis. This means that there has been an excessive over-exploitation of fresh groundwater resources in Qatar. The annual deficit has been estimated at about 26 million m³, and if the present rate of groundwater withdrawals continue, the aquifers will be depleted in about 20-30 years (FAO, 1981). The over-exploitation of groundwater has affected its quality ; monitoring carried out since 1971 has shown an increase in the total concentration of dissolved salts resulting from both sea water intrusion and upward migration of deeper saline groundwater brought about by over-extraction (FAO, 1981). As a result of this deteriorating situation an Emiri Decree was issued in 1980 prohibiting any further development of groundwater for agriculture. This major conservation measure will arrest the continued and accelerating over-exploitation of the country's main freshwater reserves.

The domestic and commercial water consumption in Qatar increased from 6.8 million m³ in 1970 to 48.0 million m³ in 1980 (i.e. more than 7 fold). In 1979, the average per capita water consumption in Doha was estimated to be 610 litres/day, which is very high. This high figure is attributed to the fact that for the high- and middle-income groups, the dominant use of water was found to be for irrigating gardens, amounting to 35 per cent of their total consumption. In addition, there is considerable wastage caused by leaks in the water storage and transmission systems, estimated to be about 30 per cent in 1980 (Hall and Hill, 1983).

The total water withdrawals in Qatar in 1980 were as follows :

Agriculture	:	76.2 million m ³	fresh groundwater
		0.8 million m ³	brackish water (for experimental farms S-W Qatar)
		1.6 million m ³	treated sewage water (see later)
		<hr/>	
		78.6 million m ³	
Domestic/ commercial	:	44.4 million m ³	distilled sea water
		2.5 million m ³	brackish water for blending distilled water
		1.2 million m ³	fresh groundwater (for rural areas)
		<hr/>	
		48.1 million m ³	

Industry : 2.04 million m³ (from own desalination plants at Umm Said; this figure does not include sea water used for cooling)

In other words, the total water withdrawals in 1980 amounted to about 128 million m³ (agriculture, 61 % ; domestic and commercial, 37.5 % and industry, 1.5 %). From the total withdrawals for agriculture (78.6 million m³), about 19 million m³ return to the aquifers as irrigation return, and from the 48.1 million m³ withdrawals for domestic use, 14 million m³ (or 29 %) are lost in storage and distribution systems.

Projections of water demand to the year 2000 vary according to agricultural and industrial development plans, and to population growth. Estimates given by FAO (1981) and Annesley et al. (1983) are as follows :

Domestic and commercial	:	105 million m ³
Agriculture *	:	69 to 250 million m ³
Industry **	:	4 million m ³
		<hr/>
Total		178 to 359 million m ³

* High figure refers to an agricultural policy aiming at achieving self-reliance in production of basic foodstuffs including wheat; low figure refers to a limited agricultural policy to achieve self-reliance in certain products not including wheat.

** This figure will increase according to industrial development; it represents the figure by 1985.

Water Quality :

Water intended for irrigation must be assessed in relation to the soil type, crops and the climate. Although there is no uniform water quality classification for agriculture, there are certain recommended concentration limits for water used for livestock and irrigation crop production. Local standards of water quality for irrigation should, therefore, be established taking into consideration the chemical characteristics of the irrigation waters,

the characteristics of the soils and the types of crops to be cultivated.

Since water for domestic use is mainly produced by desalination, the distilled water is almost entirely devoid of any dissolved solids. For this reason the distilled water is blended with brackish groundwater (about 5 % of brackish water is used for blending) to "add" the necessary salts so that the water delivered to the consumers would have more or less the required specifications for domestic water. Although there is only a limited monitoring of the water quality (mainly through partial chemical and bacteriological analyses by the Water Department), there are no national water quality criteria and the WHO International Drinking Water Standards are not adhered to. A detailed systematic study of the quality of the water (chemical, physical, bacteriological, etc) at every point in the production and distribution system is, therefore, necessary to ensure that the quality of the water delivered to the consumers is meeting internationally accepted standards *.

* In recent years the Qatar Ministry of Health has become increasingly concerned regarding the absence of fluoride in distilled water and, on the other hand, its excessive concentration in groundwater in certain areas. Fluoride in small quantities has been shown to be beneficial in the prevention of dental caries in humans. However, fluoride in larger concentrations is harmful (FAO, 1981).
In addition, water for domestic purposes should be regularly monitored for metallic constituents. Some samples of tap water have shown traces of copper ; this was attributed by the Water Department to leaching from copper pipes and equipment at desalination plants.

Groundwater Contamination :

With increasing development in both the urban and rural sectors, contamination of groundwater has become a distinct probability and early signs of this are already apparent. In the agricultural sector all irrigation is presently supported by groundwater pumped at the site where it is used within the farms located within depressions. These are also the focii of storm water run-off and indirect recharge, and irrigation return; infiltration also takes place near the production wells. Various salts precipitated on the surface due to evaporation are, therefore, leached downwards to the aquifer and in some cases, such as on Government Experimental Farms, there has been a significant increase in nitrate content in groundwater, attributed to contamination from leaching nitrogenous fertilizers.

In Doha, the infiltration of water from leaking pipes and excess garden-watering is creating an irregular " freshwater " lens above saline water intruding from the sea. Water levels are already sufficiently high in some parts of Doha to create foundation and dewatering problems. A detailed study of this problem showed that, by the year 2000, some 10-15 million m³ per year of reasonable quality water could be extracted from this lens that would be suitable for amenity watering (Hall and Hill, 1983). However, exploitation of this potential source would require careful management and is dependent upon bacteriological pollution being kept to acceptable levels. It should be noted that leaking or overflowing septic tanks is creating a high contamination of groundwater in some places in Doha (FAO, 1981).

Wastewater Treatment and Use :

An extensive sewerage system exists in Doha. The Naijah sewage treatment works south of Doha handles an average flow of 50,000 m³ per day (the old treatment works handles about 15,000 m³ and the new treatment works handles about 35,000 m³). The works at Naijah will be extended to serve

a population of 180,000 and a second plant may be constructed north of Doha * . There are also smaller sewage treatment works at Umm Said and at Khor.

The sewage flowing into the Naijah treatment works is subjected to screening, grit removal, primary sedimentation, biological treatment (percolating filters in old works and activated sludge treatment in new works) and secondary sedimentation. After secondary sedimentation a part of the effluent passes to a pumping station for chlorination prior to being returned to Doha for irrigation (7400 m³ per day for irrigating trees and some gardens) ; the balance is pumped (without disinfection) to Abu Nkhalah, about 17 km from Doha where it is lagooned in the desert. In the future the effluent from the secondary tanks will be subjected to Tertiary treatment and the resulting total effluent will have been disinfected by chlorination.

At present the sludge that has been collected from the primary and secondary treatment is subjected to anaerobic digestion. The gases produced (methane and carbon dioxide) are burnt off on a flare stack as waste products. The digested sludge is then air-dried and used as soil conditioner.

Of the treated sewage effluent, about 20 % (about 10,000 m³/day) are used for irrigating trees and some gardens. A number of alternate sites for the development of between 1000 to 1600 ha of irrigated cropping with treated sewage effluent have been proposed. One proposal envisages the transfer of treated sewage effluent from Naijah by a

* The population of Doha is estimated to be 85 % of the whole of Qatar. The extra population served each year by the sewerage system has been estimated at 15,000. At present about 50 % of the population are served by the sewerage system; by the year 2000 a maximum service level of 95 % would have been reached.

pipeline (about 55 km long) to a site in the vicinity of Al-Ashara (about 60 km west of Doha) where some 1050 ha of suitable soils in a large number of scattered depressions could be developed. Another alternate site in the same area is in the vicinity of Rakaiyah-Wadi Jalal. The crops considered for cultivation include alfalfa, sorghum and wheat/barely.

The major components of the wastewater collected by the existing Doha sewage system is domestic effluent. Industrial or trade wastes are not considered to contribute significantly to the chemical or bacteriological composition of the effluent in the existing sewer network serving Doha. In other words, the sewage effluents are not likely to contain toxic substances (e.g. metallic constituents, toxic organic compounds, etc) that could affect soils or accumulate in the crops cultivated. However, this should be assessed in detail before embarking on extensive use of sewage effluents for irrigation of edible crops. If the level of the toxic substances is " acceptable " and the treated sewage effluents could be used for irrigation, measures should be taken to prevent new industries in Doha from discharging their effluents into the sewer network, without prior treatment (to remove or reduce to acceptable levels all harmful substances).

Treated sewage effluents have been used for irrigation in many countries. In many cases it has been reported that sewage effluents increase the yield per hectare (since the effluents contain several nutrients). However, the use of sewage effluents for irrigation might cause a number of potential health hazards to agricultural workers, residents living near the sites irrigated and to consumers of the crops produced (FAO, 1981). However, these health hazards can be greatly reduced by proper planning, choice of suitable crops and of irrigation techniques and by regular monitoring of the quality of treated effluents. Effluent quality standards should be formulated and adhered to to avoid any mishaps. A detailed environmental assessment of the proposed projects in Qatar should be carried out.

3. ENERGY PRODUCTION AND USE

Oil was discovered in Qatar more than 30 years ago. It contributes more than 90 per cent of the State's wealth, earning about US\$ 5500 million in 1981. Table 1 gives the amounts of oil produced in Qatar; the figures related to gas production refer to gas associated with crude oil.

Table 1 Production of Energy in Qatar
(in 1000 tonnes oil equivalent)

<u>Year</u>	<u>Total Production</u>	<u>Liquids</u>	<u>Gas</u>
1970	18,291	17,373	918
1975	23,300	21,277	2,023
1980	27,525	22,924	4,601

Source : 1981 Yearbook of World Energy Statistics, United Nations, 1983.

About half of the oil produced in Qatar is from offshore wells (in 1979, about 84 million barrels were produced from onshore wells, and about 100 million barrels from offshore wells).

Onshore oil production comes from the Dukhan oil field in central western Qatar. This field comprises three main areas, Khatiyah, Fahahil and Jaliha. There are gas separators and crude pumping units on the production sites and pipelines to carry oil to Umm Said terminal on the east coast. The Dukhan crude has an average sulphur content of 1.1 per cent. Offshore production comes from three main fields off the east coast of Qatar- Idd al-Shargi, Maydan Mahzam and Bul Hanine. Offshore oil is exported through Halul Island which has a tank farm with a capacity of six million barrels. Crude oil from offshore wells contain 1.4 per cent sulphur. In addition, there is the Bunduq oil field on the marine boundary between Qatar and the United Arab Emirates which is jointly exploited by the two countries. Bunduq crude is similar to that of Maydan Mahzam and contains 1.4 per cent sulphur.

Gas associated with crude oil is produced from both onshore and offshore fields. The utilization of gas has become an important feature of Qatar's plans for industrial expansion and diversification. At present, gas is used as feedstock for some industries, power stations and water distillation plants.

The total proven recoverable reserves of oil in Qatar are estimated at 4,700 million barrels (MEED, 1983), or about 600 million tonnes (see also World Energy Conference, 1980). At present output levels, these reserves will last for more than 40 years. Some exploration has been carried out in recent years, resulting in the discovery of additional reserves in existing production areas, but there seems little prospect of major new finds.

On the other hand, a major natural gas field (one of the world's largest gas fields) was discovered in 1972 about 70 km off the north-east shore of Qatar. The field holds enough gas for more than 100 years of production (the field's proven reserves are estimated at 100 to 300 X 10¹² cubic feet). Covering an area of about 2000 km², the field was for many years known as the North West Dome because of its position 95 km northwest of Halul island.

Production of oil and natural gas, whether carried out on land or offshore, have a number of environmental impacts*. Accidents and equipment failures can cause harm to workers and to the environment. Fires, explosions and accidental oil spills are the most common accidents. Despite careful treatment of effluents discharged and stringent controls to minimize the number of accidental oil spillage, offshore and terminal operations will result in some discharge to surrounding waters.

* For detailed review of the environmental impacts of production and use of fossil fuels see UNEP (1981).

It is necessary to monitor oil production and transportation facilities (both onshore and offshore) and to study the long-term effects of hydrocarbons on the marine eco-system. Tidal marshes, coastal wetlands and sheltered bays are sensitive eco-zones supporting a variety of organisms at all stages of development, and low levels of hydrocarbons may have some local long-term effects on these organisms.

Although the Qatar General Petroleum Corporation (QGPC) formulated a contingency plan for oil spills in Qatar marine areas (Doc. N. 0003 A, QGPC), there is need for a more comprehensive national oil spill contingency plan (both onshore and offshore should be considered). Such a plan will further strengthen the role of Qatar in the implementation of the Kuwait Regional Action Plan for the Protection of the Marine Environment from Pollution.

Table 2 gives the total and per capita energy consumption in Qatar. The per capita consumption of commercial energy in Qatar is the highest in the world (for comparison, the average per capita energy consumption in the world in 1980 was 1,339 kg oil equivalent ; in the U.S.A. it was 7,309).

Table 2. Commercial Energy Consumption in Qatar

Year	Consumption (1000 tonnes oil equivalent)			Per Capita (kg oil equiv.)
	Total	Liquids	Gas	
1970	1,012	95	918	9,117
1975	2,233	210	2,023	13,058
1980	4,981	379	4,601	21,017

Source : 1981 Yearbook of World Energy Statistics, United Nations, 1983.

The installed power capacity in Qatar increased from 78 MW(e) in 1970 to about 1000 MW(e) at present (the two major power stations are at Ras Abu Aboud, with an installed capacity of 210 MW(e), and at Ras Abu Fontas, with an installed capacity of 618 MW(e) ; both plants use associated gas/crude oil as fuel). The amount of electricity generated increased from about 278×10^6 kWh in 1970 to about 2416×10^6 kWh in 1980 and 3059×10^6 kWh in 1982. The per capita electricity consumption in Qatar is very high (in 1980, it was about 7000 kWh). At present, there is no policy for energy conservation in Qatar (electricity is provided to the consumers nearly free of charge). Attempts should be made to reduce waste and rationalize the use of energy, without causing undesirable impacts on the quality of life.

4. MARINE RESOURCES

The sea around Qatar is fairly shallow, the average depth being approximately 35 metres, the deepest only about 100 metres. The high salinity of the water is an important factor in limiting the marine life present. The coasts of Qatar are a rich habitat for plants and animals. Colonies of whelks, limpets and periwinkles can be found on the shore, while prawns, shrimps and rock lobster may be found under rocks and the seaweed. Several varieties of crab, starfish and sea anemone are also found close to the shore.

The fish catch in Qatar was about 1500 tonnes in 1970 and reached 2300 tonnes in 1975. In 1980, the figure dropped to about 1736 tonnes (constituting about 79.7 % of the total fish consumption in Qatar). In 1981, the fish catch was about 2272 tonnes (about 87.3 % of total fish consumed in Qatar in that year). In recent years it has been

noticed that the catch of shrimp has been dropping, and the Fisheries Department of Qatar prohibited shrimp fishing from February to the end of June every year to prevent over-fishing and to protect shrimps during their growth period (Fisheries Department, Statistical Report, 1980-1981). By adopting this conservation policy, the catch of shrimps increased from 48,150 kg in 1980 to 70,246 kg in 1981.

The marine environment in Qatar is, therefore, of primary importance not only for providing oil and natural gas from offshore wells, but also an an important source of food. A national marine and coastal zone development and protection plan should be formulated to protect such vital resources. The plan should in particular address the following issues : marine waste disposal, marine mining (oil, natural gas), marine transportation, accidental discharges (oil, chemicals, etc), coastal land use, and living marine resources.

III. INDUSTRY AND ENVIRONMENT

Industrial policy in Qatar is governed by four main criteria : first, to develop a diversified industrial base; second, to utilize local natural resources; third, to reduce demand for imports, and finally, to make a contribution to the country's exports.

Qatar's industrial area is at Umm Said, about 50 km south of Doha, where a number of industries have been established. All draw heavily on local reserves of natural gas either as fuel or feedstock.

1. Petroleum Refineries :

Local requirements of refined petroleum products are supplied by the National Oil Distribution Company (NODCO). Until 1983 all but a small portion of local needs were met by a 12,000 barrels/day topping refinery* at Umm Said. The mid-1983 start-up of a 50,000 b/d refinery, built by France's Technip at Umm Said, should ensure that for several years all local demand will be met and that there will be a surplus for export.

Oil refineries are industrial installations with air and water emissions, solid residues, and safety problems due to the risk of explosions and fires **. Table 3 gives estimates of different airborne and liquid effluents and solid residues generated at Umm Said refineries. It should be noted that these figures are only rough estimates calculated on the basis of average figures given by UNEP (1981) and WHO (1982) for topping refineries. Accurate figures should be determined through a

* Topping refinery is the simplest of the basic refinery types. Topping refers to the use of simple fractionation (distillation) processes to obtain straight run fractions such as naphtha, middle distillate, and fuel oils from crude oil.

** For a review of the environmental impacts of oil refining see, UNEP(1981), El-Hinnawi (1983,1984).

detailed assessment of the environmental impacts of Umm Said refinery facilities. This assessment is of primary importance to find ways and means of treating different effluents in order to reduce the pollution load to the environment.

Table 3. Estimates of Effluents from Umm Said Oil Refinery Facilities

Airborne Effluents

Sulphur oxides	2600	tonne/y
Organic compounds	2800	, ,
Nitrogen oxides	2200	, ,
Carbon monoxide	530	, ,
Ammonia	277	, ,

Liquid Effluents

Waste volume	237,000	m ³ /y
Biological oxygen demand	12	tonne/y
Chemical oxygen demand	133	, ,
Total organic carbon	28	, ,
Suspended solids	42	, ,
oil	29	, ,
Phenols	122	kg/y
Ammonia	4	tonne/y

Solid wastes 4717 tonne/y (oily and toxic sludge).

Notes : 1. These calculations are based on processing 62,000 b/d in both the old and the new refineries.

2. Liquid effluents are discharged into an evaporation pond.

2. Natural Gas Liquid Projects :

The natural gas liquids (NGL) projects at Umm Said consist of two fully integrated NGL plants. The first plant, NGL-1, which processes onshore associated gas (from the Dukhan onshore fields), was completed in late 1980 to replace a plant destroyed by fire in April, 1977. Daily capacity is 1,290 tonnes of propane, 850 tonnes of butane, 580 tonnes of condensate and 1,350 tonnes of ethane-rich gas. NGL-2, designed to use associated gas and gas liquids from the offshore fields has a daily capacity of 1,080 tonnes of propane, 990 tonnes of butane and 900 tonnes of condensate and 1,145 tonnes of ethane-rich gas. Both units provide the feedstock and fuel for several neighbouring industries and power plants.

3. Petrochemical Industry :

The steam cracker (for the production of ethylene) and the low-density polyethylene (LDP) plants at Umm Said run by Qatar Petrochemical Company (QAPCO) are a major producer of ethylene and polymers in the Gulf region. The plant was built between 1977-1980 using France's CDF-Chimie process for the LDP plant, and the steam cracker was built by France's Technip.

The steam cracker at Umm Said can produce 280,000 tonne of ethylene annually from about 600,000 tonnes of ethane-rich gas supplied by the near-by natural gas liquids (NGL) plants. The gas consists of about 60 % ethane, 20 % methane and 20 % acid gases (H_2S , CO_2 , etc). The gas is first treated to remove the acid gases and methane. The H_2S is transformed into sulphur which is stored for export, and the separated methane is used as fuel in the fuel gas system. The ethane-rich gas is then fed into the cracker furnaces where it is subjected to steam cracking at a temperature of $850^{\circ}C$, at low pressure. The high purity ethylene produced

is either sent to storage (30,000 m³ tank, -104°C, atmospheric pressure) or is directed to feed the polyethylene plant.

The low-density polyethylene plant at Umm Said has a capacity of 140,000 tonne/y in one line. This is the second largest in the world after COPENOR (in France) having such a unit capacity. The high purity ethylene (99.95 %) from the steam cracker is compressed in two stages up to 1000 to 2000 bars. The compressed ethylene is then polymerized in a reactor; the reaction is controlled by temperature, pressure and the catalysts used. After the reaction is terminated, the pressure is gradually reduced to allow the separation of the polymer from the non-polymerized ethylene, which is then recycled for further polymerization. The percentage of polymerization in each reaction run is about 20 %. The polyethylene produced is then granulated, washed, dried and homogenized.

At present almost all the ethylene produced by the steam cracker is used to manufacture LDP. But when the plant is running at capacity of 280,000 tonne of ethylene per year, 145,000 tonnes would be used to make 140,000 tonnes of LDP, and the remaining 135,000 tonnes would be exported in a liquid state.

From the environmental point of view, the petrochemical complex generates a number of effluents, the amounts of which remain to be assessed in detail. According to a survey carried out by the Preventive Health Department of Qatar in 1981, the petrochemical complex generated about 26 tonne/day of sulphur oxides and 1.4 tonne/day of nitrogen oxides as airborne effluents. In another survey carried out in May 1982, the Department estimated that 549 minor and 43 major occupational accidents occurred at QAPCO in one year. In addition the following types of occupational diseases were encountered in the same year : 222 cases of skin dermatitis, 4 cases of gas inhalation and 113 cases of eye irritation.

Discussions with senior staff of QAPCO in December 1983 revealed a number of additional environmental impacts, which should be assessed in detail. The liquid effluents produced contain a number of organic compounds; these effluents are subjected to physical treatment (decantation) to separate the suspended material which is collected and ignited; the liquid effluents are then discharged into the sea. Cooling water for QAPCO is taken from the sea and the used water is discharged back into the sea through an open channel on the coast. The solid wastes generated at the factory (sulphur, polyethylene, etc) are dumped on land. Radio-isotopes (Co-60) are used to control the level of polyethylene in the separators. No radioactive wastes have yet been generated by QAPCO. When these become available (after the expiration of the life time of the radio-isotopes), it is not known what will be the measures to be adopted to manage these wastes (whether it will be buried underground or shipped back to the supplier).

4. Ammonia and Urea Plant :

The Qatar Fertilizer Company (QAFCO) started production in 1973. At present it has a daily capacity of 1,800 tonnes of ammonia and 2,000 tonnes of urea, virtually all for export. Of the daily ammonia output about 1200 tonnes are used in the urea process section for the production of prilled urea and the rest is exported.

The process units are supported by a power station of seven 9MW gas turbine generators, and a desalination plant with a capacity of 800 m³/d. There are two liquid ammonia storage tanks with a capacity of 47,000 tonne, and a 135,000 tonnes capacity urea bulk storage facility. Urea is exported in bulk or bags from the jetty, designed to take vessels of up to 40,000 dwt.

Natural gas from the oil fields of Dukhan is the raw material for production at QAFCO. Small amounts of sulphur compounds, mainly H₂S, in the feed gas are removed by the sulphur removal plant. The gas is then passed to the reforming section, where gas, steam and air react at high temperature in the presence of catalysts to form carbon monoxide and hydrogen. The nitrogen needed for the ammonia reaction is introduced through the air. The ammonia is stored at temperatures of around -34°C. Liquid ammonia and carbon dioxide are the two components used in the urea production. These components are introduced in the urea autoclave at high pressure to form urea. The liquid leaving the autoclave goes to the decomposition section where excess ammonia and CO₂ are recovered and returned to the synthesis. After filtration and crystallization *, the urea crystals are melted and prilled in a prilling tower to form a free flowing final product. From the base of the prilling tower this product is conveyed to the bulk storage. The produced urea has a nitrogen content of 46.3 %. QAFCO's production in 1982 was 528,000 tonnes of ammonia and 662,000 tonnes of urea.

Based on production data of 1982, Table 4 shows the calculated estimates of airborne and liquid effluents generated by QAFCO in that year.

Table 4 Estimates of Discharges from QAFCO

<u>Airborne Effluents</u>		
Sulphur oxides	463	tonne/y
Nitrogen oxides	1324	,,
Particulates	6620	,,
Hydrocarbons	23,760	,,
Ammonia	56,600	,,
<u>Liquid Effluents</u>		
Waste volume	1,108,800	m ³ /y
Biological Oxygen demand		106 tonne/y
Chemical oxygen demand		137 ,,
Oily material		5280 ,,
Nitrogen-nitrate		63 ,,

Note : Calculations made using average effluent data given by WHO (1982)

* In the new urea plant the crystallization step is omitted, the urea being prilled after evaporation of the urea solution.

Most of the particulates emitted are from the urea prilling tower and consist of fine urea particles. The pattern of transport of these urea particles in the atmosphere has not been established; no monitoring of air quality is carried out at QAFCO or in the neighbourhood. The odour of ammonia is rather strong especially where urea is stored in bulk. Workers handling stored urea use special masks and are not allowed to work continuously for more than two hours. QAFCO uses about 50,000 m³ of sea water per hour for cooling ; the used water is discharged into the sea through a channel on the coast. The discharged water is 8°C warmer than the sea water. QAFCO uses a number of catalysts and used ones (containing various amounts of zinc, nickel, etc) are placed in containers which are dumped in a site near the factory. Several radio-isotopes (Co-60, Cs-137, etc) are used for inspection of weldings, control of production, etc. QAFCO claims that there is an agreement with the supplier of the radio-isotopes to take back the radio-active wastes.

5. Steel Production :

Steel production began at Umm Said in 1978 with the commissioning of the Qatar Steel Company (QASCO). The raw materials are imported iron ore pellets and scrap unloaded at the wharf which can receive ships of 100,000 dwt. The pellet storage yard covers an area of 36,000 m³ and the scrap yard covers an area of 42,000 m³.

The iron ore pellets are transported by a belt conveyor to the charging device installed at the top of a shaft furnace (the Midrex Direct Reduction Plant). The ore is reduced by the ascending hot reducing gases (bustle gas), which are composed mainly of hydrogen and carbon monoxide (QASCO uses natural gas from the Dukhan onshore oil field ; the gas is passed through a desulphurization plant at QASCO). The sponge iron produced is cooled in the lower zone of the furnace by cooling

gas, and discharged from the bottom of the furnace at temperatures not more than 65^oC to avoid its re-oxidation.

Fine iron oxide dust is emitted from the pellet yard especially when the wind is strong. Such dust is also generated during the transport of the iron ore pellets to the direct reduction furnace. The latter is collected and sold by QASCO to cement factories (Meraikib et al, 1980). The sponge iron dust produced in the direct reduction shaft is collected and fed into the electric arc furnace for steel making.

QASCO has two electric furnaces with a capacity of 70 tonnes each. Environmental problems related to the electric arc furnace are essentially related to particulates emitted during charging and tapping of the furnaces. The dust carried by the gas is collected in dust collectors. The amount of slag produced per tonne of liquid steel is about 150 kg/tonne; the slag is disposed of in slag pits.

The steel from the electric furnaces is subjected to continuous casting and rolling. The main sources of environmental problems associated with the continuous casting and rolling mill shops are the flue gas from the reheating furnaces, the mill scale produced and the waste water. At present, the mill scale is dumped in the slag yard. Table 5 gives estimates of different residues resulting from the production of 500,000 tonne of steel bars per year. These estimates were calculated using the data given by Meraikib et al (1980), and the average data given by WHO (1982). It should be noted that these solid residues are collected by QASCO, which is searching for the best ways to manage these "wastes". It is, however, not known what fractions of particulates and other airborne effluents (gases) escape and are emitted in the air (no monitoring of air pollutants in and outside the factory are carried out).

Table 5 Estimates of Residues generated at QASCO

<u>Iron ore oxide fines</u> :	18,240 tonne/y	
<u>Direct Reduction Plant</u> :		
Iron dust	24,320	,,
Sulphur (from natural gas desulphurization)	760	,,
Sponge fines	15,200	,,
<u>Electric Arc Furnace</u> :		
Iron dust	4,560	,,
Slag	68,400	,,
<u>Continuous casting</u> :		
Scale	2,280	,,
<u>Rolling Mill</u> :		
Mill scale	5,380	,,

These figures represent residues generated during the manufacture of 500,000 tonne steel bars.

The process water at QASCO flows in a closed system and cooling is achieved by using sea water. From the fresh process water system, about $10 \text{ m}^3/\text{hour}$ flow at the back-end of the system from a thickener tank to a settling pond (these $10 \text{ m}^3/\text{hour}$ are contaminated water that cannot be recycled through the system). In other words, the settling pond receives about $87,600 \text{ m}^3/\text{year}$. The quality of the water in the pond is not known, also the rate of evaporation and effect of this pond on groundwater should be assessed in detail. Sea water used for cooling at QASCO is discharged at a flow rate of about $12,500 \text{ m}^3/\text{hour}$ (or about $109,500,000 \text{ m}^3/\text{year}$) into the sea through outlets on the coast. The discharged water is about 5 to 6°C warmer than the sea water. Partial analyses showed that this water may contain 0.002 to 0.008 mg/l cadmium and 0.05 mg/l cyanide (Meraikib et al , 1980). An oil fence has been installed at the exit channel of the sea water trench for easy collection of oil and grease that might contaminate the cooling water.

Radio-isotopes (Co-60, Cs-137, etc) are used at QASCO to control some processes (e.g. for controlling the thickness of the steel melt in continuous casting, etc.). The radioactive wastes generated are placed in lead canisters and disposed of by shallow land burial in a site at QASCO. Periodical checks are normally made to measure the levels of radiation near the site. The site selected for burial and the methods adopted for the storage of radioactive wastes should be re-examined and modified, if necessary, to conform with internationally accepted practices and specifications.

It is appreciated that the Industrial Development Technical Centre (IDTC) of Qatar is according high priority to the environmental impacts of industrialization. The IDTC has established an analytical laboratory at Umm Said for the analysis of air, water and soil samples. In addition, a mobile unit for in-and around factory measurements has been commissioned. Both the laboratory and the mobile unit are expected to be operational in the near-future. In addition, the Occupational Health Division of the Preventive Health Department, Ministry of Health, is closely monitoring, together with the health units of different industries at Umm Said, occupational health and safety measures at different industries.

Special attention should, however, be given to the following main issues :

1. Environmental criteria for the siting of different industries. This is of particular importance both for the expansion of existing industries and for the establishment of new plants.

2. Detailed assessment of the environmental impacts of existing industries * .
3. Formulation of criteria (standards) for discharges from different industries.
4. Development of appropriate measures and technologies for reducing emissions and for the management of different industrial residues.
5. Assessment of the environmental impacts of planned industrial activities. Non-waste and low-waste technologies should be given priority.

* See, for example, " Guidelines for assessing industrial environmental impact and environmental criteria for the siting of industry; UNEP (1980); see also ; El-Hinnawi (1983).

IV. QUALITY OF THE ENVIRONMENT IN QATAR

1. Air Pollution :

Air pollution became an issue of social concern in many countries when, due to the increasing vigor of economic activities, pollutants released into the air began to prove injurious to human health and adversely affect the living environment. Recently the factors of air pollution have become exceedingly complex, as can be judged by the emergence of photochemical smog and acid rain, or air pollution due to secondary pollutants.

The air emission loads in Qatar have been estimated by Economopoulos (1980) and are shown in Table 6 below.

Table 6 Air Emission Loads in Qatar
(in tonnes/ year)

<u>Pollutant</u>	<u>From Mobile sources</u>	<u>From Stationary sources *</u>	<u>From industries**</u>	<u>Total</u>
Particulates	378	370	29,647	30,395
SO _X	2,099	29,576	64,021	95,696
NO _X	1,831	10,526	9,535	21,892
Hydrocarbons	2,104	1,064	36,688	39,856
CO	20,678	2,911	9,380	32,969
Ammonia	-	-	52,975	52,975

* Power production

** Includes natural gas flaring, effluents from oil export terminals and oily sludge burning.

It should be noted that these figures are estimates of "inputs" into the atmosphere from different sources; they are not "concentrations" of pollutants in the air.

The pollutants emitted into the atmosphere undergo several complex changes (transformation, transportation, deposition, etc) depending on the prevailing meteorological conditions. The concentration of different pollutants in the ambient air should, therefore, be determined by direct measurement and monitoring. The latter is of primary importance to determine seasonal variations and annual averages to estimate different trends in air quality.

Monitoring of airborne emissions (with particular reference to sulphur oxides, nitrogen oxides, carbon monoxide, hydrocarbons and oxidants *) should be carried out, especially in Doha and Umm Said. Air quality standards should be formulated ; These standards should serve as a goal for enforcing air pollution control measures and also as the scale for evaluating the degree of air pollution.

2. Water Pollution :

Water pollution refers to such conditions where water bodies (groundwater and the sea in case of Qatar) have been polluted with substances that might cause harm to living organisms, man and his environment.

The degree of groundwater pollution in Qatar is not accurately known, in spite of the fact that it has been reported (FAO,1981) that groundwater in some depressions contains high nitrate content derived from the nitrogenous fertilizers used in agriculture. Of all human activities that influence the quality of groundwater, agriculture is probably the most important-as a diffuse source of pollution from fertilizers, pesticides, and animal wastes (El-Hinnawi and Hashmi,1982).

* Lead should also be monitored especially in Doha ; lead is used as gasoline additive in Qatar.

No information is available on the concentration of pesticides in groundwater in Qatar (a number of pesticides is used in agriculture in different farms).

Septic tanks and cesspools contribute filtered sewage effluents directly to the ground and are the most frequently reported sources of groundwater contamination, especially in rural and suburban areas (such contamination has been reported at some sites in Doha).

Because groundwater is of vital importance to agriculture in Qatar (it is also used to supply the domestic needs in rural areas and brackish groundwater is used for blending distilled water used in urban areas), monitoring of the quality of groundwater, with particular emphasis on potential pollutants, should be carried out. There is also an urgent need for the formulation of national environmental quality standards for water. These standards should include : drinking water standards, standards for agricultural water, standards for wastewater discharge, etc. A national " Water Pollution Control Law " could include all these necessary standards.

3. Marine Pollution :

Qatar is party to the Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, and to the Action Plan for the Protection and Development of the Marine Environment and the Coastal Areas. According to the Kuwait Regional Convention : " marine pollution means the introduction by man, directly or indirectly, of substances or energy into the marine environment resulting or likely to result in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea and reduction of amenities. "

Phenomena of compound water pollution are appearing in ports, harbors, and surrounding coastal waters due to effluents discharged from some industries, waste oil and other discharges from ships and ship ballast water discharges associated with oil export. Oil spills from accidents are also common in territorial waters. Economopoulos (1980) estimated the discharges into the sea in Qatar as follows :

From large industries :

Waste volume	:	3,347,000	m ³ / year
BOD	:	488	tonne/y
Suspended solids	:	87	,,
Oil	:	5,016	,,
Nitrogen	:	5,860	,,

(In addition to these, cooling water of all industries at Umm Said is discharged into the sea. The discharged water is about 6-8°C warmer than the receiving sea water; the impact of this thermal pollution is not known)

From oil export terminal :

Waste volume	:	14,000,000	m ³ / y
Oil discharges	:	21,000	tonne /y

In Qatar, there are no regulations to control discharges into the marine environment. Therefore, the formulation of a national Marine Pollution Prevention Law is timely and necessary. Such law should be formulated to control marine pollution, and to conserve living marine resources. The formulation of such law and the establishment of a monitoring system and a national marine and coastal development plan will constitute important steps in the implementation of the Kuwait Regional Action Plan for the Protection and Development of the Marine Environment and the Coastal Areas.

4. Soil Degradation and Pollution :

It has already been mentioned (p.7) that in 1980, 220 farms were recorded as abandoned due to soil degradation, among other reasons.

The causes and extent of such degradation should be assessed in detail. This is of particular importance since Qatar is according high priority to agricultural development.

Serious damage to farm soil can result also from pollution (for example, through discharge of untreated wastewater, industrial wastes, use of polluted groundwater for irrigation, irrational use of agricultural chemicals, etc) Periodic analyses of soils to determine the levels of potential pollutants should be carried out. An Agricultural Land Soil Pollution Prevention Law should be formulated to provide limits for different soil contaminants. As for soil pollution by agricultural chemicals, the Law should provide the screening criteria for their toxicity, residual effects before they are registered, and measures to restrict the use of chemicals causing soil pollution*.

5. Other Types of Pollution :

A. Noise

Some measurements have been carried out for noise levels in some industries (e.g., at QASCO steel plant) within their occupational safety programmes. No regular measurements have been made for automotive or aircraft noise. At present, the noise levels at Doha and Umm Said are believed to constitute no problem.

B. Waste (Garbage)

Municipal solid wastes (garbage) are collected and composted in a plant near Doha. Law No. 8 (1974) regulates the storage and collection of such wastes.

* Organochlorine compounds, Aldrin and other pesticides are widely used in Qatar. Due to the tendency of some of these pesticides to remain as a residue in foods and in the environment and due to their suspected adverse effects, their use has been severely restricted in several countries. In Qatar, Law No.10 (1968) regulates the importation of about 60 types of pesticides; the Law does not, however, regulate the use of such pesticides.

V. ENVIRONMENTAL PROTECTION ACTIVITIES IN QATAR

1. Institutional Activities :

There is a growing concern among policy-makers and the public in Qatar about the need for environmental protection. Although the peak of this concern becomes evident when " trigger " events occur (for example, when an oil spill occurs or a major incident), there is a fair degree of sustainable interest for the protection of the environment. This interest has recently culminated by the establishment in 1981 of a Permanent Environmental Protection Committee (established by Law No. 4, 1981). The Environmental Protection Committee (EPC) is attached to the Cabinet and has a wide range of responsibilities in the fields of environment. The EPC is particularly concerned with :

1. Submitting proposals for environmental protection policies.
2. Preparation of draft environmental legislations.
3. Co-ordination between different bodies involved in environmental protection activities.
4. Compilation of environmental data, and undertaking studies related to the state of environment and sources of pollution, etc.
5. Ensuring the presence of monitoring stations and their proper function.
6. Evaluation of environmental impact assessments of all development projects, and approval of these projects before their implementation.
7. Building of specialized man-power in environmental fields and undertaking of training programmes.
8. Promotion of environmental education and of environmental awareness.
9. Representation of Qatar at International and Regional environmental meetings and organizations.
10. Monitoring and evaluation of environmental incidents and preparation of emergency plans to deal with such situations.

The EPC should have a technical secretariat to assist the Committee in undertaking the above-mentioned responsibilities.

In addition to the EPC, several governmental bodies have been involved in different activities related to the environment. The following is a summary of the activities of the main institutions :

1. The Industrial Development Technical Centre (IDTC)

As mentioned on p. 30, the IDTC has established (within the framework of a joint IDTC-UNIDO project) a laboratory at Umm Said for the analysis of air, water and soil samples. In addition, a mobile unit for in-and around factory measurements of pollutants has been commissioned. Both the laboratory and the mobile unit should soon be operational. The IDTC is also according high priority to the assessment of the environmental impacts of industry projects.

2. Occupational Health Division, Ministry of Public Health

The Division is monitoring occupational health and safety measures in different industries, especially at Umm Said. These industries have their own medical units, which are well-equipped to monitor the health of the workers and to deal with occupational hazards and emergency situations.

3. Qatar University and its Research Centre

A number of research projects dealing with environmental issues have been carried out by Qatar University and its Research Centre. The Marine Sciences Department of the University is staffed by highly-qualified scientists and is undertaking a number of studies on the marine environment in Qatar. The Research Centre of the University published recently an atlas of Qatar prepared from satellite photographs, and is supporting a flora conservation project. An excellent description of plant communities in Qatar has been recently published by Batanouny (1981), a staff member of the University.

The Research Centre of Qatar University is the leading scientific research centre in Qatar and is co-operating with different bodies in several research programmes.

4. Qatar General Petroleum Corporation (QGPC)

The main activity, from the environmental point of view, is to deal with oil spills (onshore and offshore) when they occur. The QGPC has formulated a contingency plan for dealing with oil spills in Qatar marine areas.

5. Regional Centre for Food Contamination Monitoring, Ministry of Public Health

This Centre was established in 1979 (originally it was the Food Control and Research Laboratory) and is one of the participating centres in the WHO/FAO Global Food and Animal Feed Contamination Monitoring Programme. The Centre performs local, regional and international functions. On the local level, the Centre is responsible for the quality control of imported and local food (chemical and microbiological contaminants in food and water, including edible marine species).

6. Agricultural Research Department, Ministry of Industry and Agriculture

The Department is undertaking research on soils in Qatar. A soil map was prepared (through a joint FAO project). A detailed study of the hydrology of Qatar (Groundwater hydrology, hydrogeology, and water quality and balance) has recently been published (also in collaboration with FAO).

2. Environmental Legislations :

Some of the laws issued in Qatar refer to environmental protection measures one way or another. Of the laws issued, the following are directly related to environmental protection :

1. Law No.8 (1974) on general cleanliness
2. Law No. 10 (1968) on regulation of importation of pesticides
3. Law No. 4 (1977) on conservation of petroleum resources
4. Food Control Law issued in 1967, which refer to the question of food contamination.

This shows that there is an urgent need to formulate a number of environmental legislations in Qatar; reference to these legislations has already been made on previous pages of this report.

Qatar has ratified a number of regional and international legislations related to environment; these are :

1. International Convention for the Prevention of Pollution of the Sea by Oil, 1954 . Qatar became party to the Convention on 1.5.1980.
2. Agreement for the Establishment of a Commission for Controlling the Desert Locust in the Near East, 1965. Qatar joined on 31.12.1968.
3. Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea-bed and the Ocean Floor and in the Subsoil thereof, 1971. Qatar joined on 12.11.1974.
4. Convention on the Prohibition of the Development, production and stockpiling of bacteriological (biological) and toxin weapons, and on their destruction, 1972. Qatar joined on 17.4.1975.
5. Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, 1978. Qatar joined on 1.7.1979
6. Protocol Concerning Regional Co-operation in Combatting Pollution by Oil and other Harmful substances in cases of Emergency, 1978. Qatar joined on 1.7.1979.

The following legislations dealing with environment have not yet been ratified by Qatar :

1. International Plant Protection Convention, 1951.
2. Treaty banning Nuclear Weapon Tests in the Atmosphere, in Outer space and under Water, 1963.
3. International Convention on Civil Liability for Oil Pollution Damage, 1969.
4. International Convention Relating to Intervention on the High Seas in Cases of oil pollution Casualities, 1969.
5. International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971.
6. Convection concerning the Protection of the World Cultural and Natural Heritage, 1972.
7. Convention on the Prevention of Marine Pollution by Dumping of Wastes and other matter, 1972.
8. Convention on International Trade in Endangered Species of wild Fauna and Flora, 1973.
9. Convection Concerning the Protection of Workers Against Ionizing Radiation, 1960.
10. Convention on the Prohibition of Military or Any Hostile Use of Environmental Modification Techniques, 1976.
11. Convention Concerning the Protection of Workers against Occupational Hazards in the Working Environment due to air pollution, noise and Vibration, 1977.
12. Convention Concerning Protection against Hazards of Poisoning Arising from Benzene, 1971.
13. United Nations Convention on the Law of the Sea, 1982.

VI. RECOMMENDATIONS

An understanding of the interrelationship between people, resources, environment and development is absolutely essential for successful implementation of any strategy for the protection and management of the environment. Similarly, for development strategies to be sustainable over a long-term, they must explicitly recognize the opportunities and constraints provided by the environment. This outlines the philosophy of "development without destruction" which has been advocated by the United Nations Environment Programme, and has been repeatedly emphasized by its Executive Director, Dr. Mostafa Tolba (see Tolba, 1982). This concept is of particular importance, especially for developing countries. Good management of the environment minimizes the risks of pollution and degradation and wastage of resources. To prevent or minimize such risks at an early stage in the development process is certainly more efficient and less costly than to redress them after they have occurred.

The State of Qatar is embarking on an extensive development programme in the fields of industry, agriculture and use of natural resources. That is why the concept of "development without destruction" is of primary importance at this stage in Qatar. The present report has identified several environmental problems that are related to the development process. There is an urgent need to deal with these problems, and to take the necessary measures to avoid further environmental degradation. The following recommendations have been formulated on the basis of the present survey; they represent priority areas that need accelerated action.*

* see Annex I for a proposed programme for 1984/1985

I. INSTITUTIONAL ARRANGEMENTS

The Permanent Environmental Protection Committee (EPC) of Qatar was established by Law No.4 of 1981. The Executive Director of UNEP during his official visit to Qatar in November, 1983, has already made a strong recommendation to strengthen the institutional arrangements in the Country by establishing a small Ministerial Committee for environmental protection to be chaired by the Crown Prince; the members of the Committee should be the ministers most closely connected with environmental issues. Such Committee could meet once every two or three months to consider policy matters. The existing Committee should become the executive committee, taking actions within the policy guidance of the Ministerial Committee. Such structure as recommended by the Executive Director of UNEP should have a small but efficient Technical Secretariat to undertake different studies in the fields of environmental protection and to assist the EPC in discharging its responsibilities.

To optimize resources and to ensure operational efficiency, it is recommended that :

1. The Secretary General of the EPC should also be the Secretary General of the Technical Secretariat.
2. The Technical Secretariat should consist as a start of four persons to handle the following four Units :
 - i- Documentation and Information Unit (to be responsible for developing and operating a national environmental data bank).
 - ii- Environmental Laboratory (to undertake environmental analyses, monitoring and environmental quality checks).
 - iii- Unit of Co-ordination, Research & Assessment (to prepare environmental quality reports, to co-ordinate activities and research projects carried out by different organizations to initiate research programmes, etc.)

- iv- Training and Public Information Unit (to organize training seminars, meetings, and to act as liaison with the media to promote public awareness on issues of public interest).
3. The Technical Secretariat should act as the technical focal point for regional and international organizations dealing with environmental matters.
 4. The Technical Secretariat, through its Information Unit, should also be the focal point for UNEP/INFOTERRA and UNEP/IRPTC global systems.
 5. The Technical Secretariat should co-ordinate its activities with other organizations, and in particular with :
 - The Industrial Development Technical Centre (IDTC)
 - Relevant Divisions of the Ministry of Public Health
 - Agricultural Research Department
 - The Centre for Scientific and Applied Research of the University of Qatar
 - Relevant Departments of the University of Qatar.

II. ENVIRONMENTAL LEGISLATIONS

According to para.5 of Law No. 4 of 1981, the EPC should undertake the preparation of draft legislations, regulations, etc for the protection of the environment, and should follow their implementation. The importance of the formulation of environmental legislations and environmental quality standards has been underlined in this report. It is recommended that a National Environmental Protection Law be formulated. Annexed to this law, the following seven laws dealing with :

1. Air Pollution,
 2. Water Pollution,
 3. Marine Pollution,
 4. Agricultural Land and Soil Pollution,
 5. Hazardous Chemicals,
 6. Noise
- and 7. Nature Conservation should be formulated. All these

Annexes should include the relevant environmental quality standards; some of them will most probably have to be in a unified form with those of other countries in the Gulf Region.

On the international level, consideration should be given to the ratification of International Conventions referred to on p.41 of this report (it should be noted that some of the Gulf Countries have already ratified these conventions).

III. ENVIRONMENTAL ASSESSMENT

The following priority areas have been identified in the present report :

1. Assessment of the causes and extent of soil degradation and pollution.
2. Assessment of the degree of pollution of groundwater.
3. Assessment of the quality of water used for domestic purposes, and its conformity with international standards.
4. Assessment of the quality of treated wastewater, and its suitability for agriculture.
5. Assessment of the degree of marine pollution.
6. Detailed assessment of the environmental impacts of the following industries :
 - Petroleum refining
 - Natural Gas Liquifaction
 - Petrochemical Industry
 - Fertilizer Industry
 - Steel Production
 - Cement Production

This detailed assessment will help in the formulation of criteria (standards) for discharges from different industries, and in development of appropriate measures and technologies for reducing industrial emissions and for the management of industrial wastes.

IV. MONITORING

The following monitoring programmes should be given priority :

1. Monitoring of soil degradation and pollution.
2. Monitoring of groundwater quality (with particular emphasis on potential pollutants).
3. Monitoring of water quality for domestic use.
4. Monitoring of air quality, especially in Doha and at Umm Said.
5. Monitoring of marine pollution, especially near Doha and Umm Said.
6. Monitoring of noise levels in industry (Umm Said) and in urban centres (Doha).

V. RESEARCH AND DEVELOPMENT

Efforts should be made to address the following important subjects :

1. Adaptation of: (a) soil conservation and protection measures to suit local conditions; (b) irrigation techniques to reduce the degree of over-exploitation of groundwater resources.
2. Feasibility studies (from the environmental point of view) on the use of sewage effluents for irrigation.
3. Formulation of a national marine and coastal development plan within the framework of the Kuwait Action Plan.
4. Studies on the treatment and disposal (or beneficial use) of industrial wastes.
5. Safe storage of radio-active wastes generated at Umm Said industries.
6. Study on the fate of pollutants in the atmosphere (this is of primary importance because of the special climatic conditions in Qatar; there is a possibility that sulphur oxides emitted might be quickly transformed to form acid haze because of the very high humidity and high temperature prevailing).

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ANNEX I

PROPOSED PROGRAMME FOR 1984/ 1985

Activity	1984	1985
1. Establishment of Technical Secretariat A. Documentation and Info. Unit B. Environmental Laboratory		
2. Steps to Join INFOTERRA and IRPTC		
3. Recommend ratification of international conventions		
4. Formulation of draft environmental legislations and standards.		

Notes : Activities 1.A and 1.B. include the purchase of necessary equipment , installation of equipment, operation and testing. Details of each item will be submitted to EPC on approval of this proposed programme.

For items 3 and 4, detailed reports should be commissioned and presented to EPC for consideration and for finalization.

(contin.)

Activity	1984	1985
5. Assessment of soil degradation	←	→
6. Assessment of environmental impacts of different industries & formulation of criteria for discharges from industries	←	→
7. Installation and testing of air, water monitoring equipment	←	→
8. Feasibility study of use of sewage effluents for irrigation.	←	→
9. Studies on radio-active waste management (generated by Umm Said Industries)	←	→
10. Development of national marine research and monitoring programme	←	→

Note : Please refer to the text of the present report and to the recommendations for details on the different items given in this Table.