Marine oil pollution and Saudi Arabia

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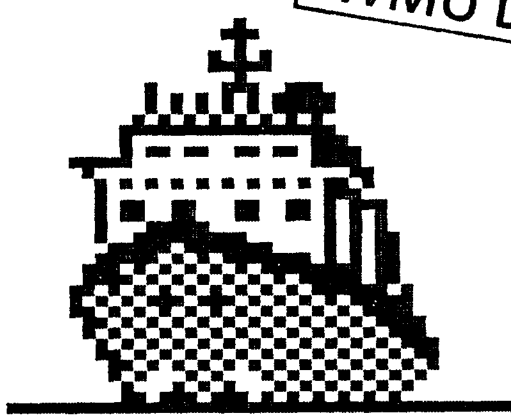

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MARINE OIL POLLUTION AND SAUDI ARABIA : AN OVERALL PERSPECTIVE

By

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SAUDI ARABIA

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The contents of this Paper reflect my personal views and are not necessarily endorsed by the UNIVERSITY

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IN THE NAME OF GOD, MOST GRACIOUS,

MOST MERCIFUL

DEDICATION

To my country, Saudi Arabia
as a gratitude to the favours with the hope that full use can be made of this work.

To the memory and the soul of my father, who had died before I accomplished this work. But treasuring the memories of his advice, encouragement and prayers were my real light in completing this work. May God Rest his soul peacefully in Heaven.

ACKNOWLEDGEMENTS

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Special thanks and appreciation are due to all my family, here and in Saudi Arabia, for their endless love, encouragement, patience, forgiveness, and prayers which were my real light in the past two hard-working years in this faraway hospitable country.

As in the beginning, I end with my thanks and prayers of gratitude to Almighty God to Whom I submit my work and for Whose sake I finished it. From Him will be the reward.

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INTRODUCTION

The history of oil pollution in Saudi Arabia goes back as early as 1938, when the Arabian American Oil Company (ARAMCO) first began producing and exporting oil. Saudi Arabian marine environment in the Arabian Gulf, encompasses the largest offshore oilfield (SAFANIYA), and the largest exporting terminal (RAS TANURA), in the world. As such, the Saudi marine environment in the Arabian Gulf must be considered as one of the highest risk areas of the world from the point of view of oil pollution.

In order to put the potential for oil spills, merely in the Saudi Arabian marine environment in the Arabian Gulf, into perspective the magnitude of the country's oil producing and terminalling operations must be considered first. In 1980, which represents the country's highest figures, an average of 9.9 million barrels per day were produced of which about 30% or 2.95 million barrels per day were from offshore oil fields and a total number of 3340 tankers loaded at Saudi terminals.

Environmental concern over the problems caused by oil pollution has been growing steadily in Saudi Arabia over the past ten years or so. For much of this time, the oil companies themselves have taken the initiative in developing a response to oil pollution beginning with an "in-company" capability to deal with purely local spillages occurring during routine operations and then, in 1972, expanding this to a Regional co-operative capability through the agency of the Gulf Area Oil Companies Mutual Aid Organization (GAOCMAO).

Saudi Arabia began to consider marine conservation measures in 1976 when the countries bordering the Red Sea, under the auspices of the Arab League Educational, Scientific and Cultural Organization (ALESCO) and the UN Environmental Program (UNEP), began developing a regional marine environmental program. In connection with this project, the International Union for the Conservation of Nature (IUCN) has been developing a program related to critical marine habitats. One of the IUCN's efforts has been the establishment of a network of marine reserves throughout the region.

In 1978, the countries bordering the Arabian Gulf joined togather to launch the Kuwait Action Plan for the Protection and Development of the Marine Environment and Coastal Areas. By 1981, an environmental assessment and management survey of the region had been undertaken and operational documents drawn up. A regional trust fund was established and the grounds for the establishment of the Marine Emergencies Mutual Aid Centre were prepared and finally established in 1983. The UN Environments Program supervised the implementation of the KAP and will continue, with other UN organizations, to serve as advisers to the regional governments in their cooperative efforts to protect and develop the Gulf region.

In 1981, a Royal Decree designated the responsibility for the control of pollution and protection of the Kingdom's environment to the Meteorology and Environmental Protection Administration (MEPA). In addressing its responsibilities, MEPA has established or is developing a number of programs and procedures to protect the environmental quality of the Kingdom. Among of which, the formulation and coordination of policies and measures for combating oil pollution. Through IUCN, MEPA has obtained inventory information on the habitats of most of the Red Sea coast and offshore islands along with management proposals. This information formed the basis for important resolutions on coastal protection at the first meeting in 1984 of the Environmental Protection Coordinating Committee (EPCCOM), a powerful body with the role of coordinating activities of Government organizations involved in environmental protection.

It is within the umbrella of the above management proposals that this present basic research, on the aspects of marine oil pollution in Saudi Arabia, is initiated. This in-depth study is not designed to be a complete and detailed scientific account of the specific aspects of oil pollution. Rather, it is an attempt to fulfill two objectives. The main purpose is to present a general picture of the various aspects of marine oil pollution and its relevance to Saudi Arabia in an appreciation for the growing awareness to the environmental problems, an account cast in such a way as to be of interest to specialist and the general reader alike. Secondly, it is an endeavore to summarize the present state of knowledge of this complex subject which will allow identification of gaps and deficiencies which in turn will lead to suggestions for possible improvements.

To achieve the objectives of the study, the most logical beginning point was to review the physical, biological and oceanographical characteristics of the Saudi Arabian marine environment and its natural resources threatened by oil pollution. In doing so, we had to rely heavily upon the most recent studies by UNEP and IUCN about the region, but other sources was given due considerations.

In the second chapter a statistical analysis is made of the major sources and amounts of oil pollution in the Saudi Arabian marine environment. A brief review of the properties of oil, its behaviour and fate in the marine environment is also presented in this chapter.

In the third chapter a brief survey of the potential effects of oil spills on the Saudi Arabian marine environment and its varied resources is provided. A referance is also made, where possible, to the recent major oil spills affecting the marine environment of Saudi Arabia.

In the fourth chapter the measures to combat oil pollution is briefly examined and the basic approach adopted within Saudi Arabia is discussed in relation to clean-up policy, designation of clean-up responsibility, organization for clean-up response, manpower and equipment resources, and research and development. The role of the oil industry in this regard is particularly emphasised.

The fifth chapter reviews some of the international conventions relating to oil pollution prevention. The national legislation is also examined. Of vital importance to Saudi Arabia, the Islamic values are discussed according to the "Basic paper on the Islamic principles for the conservation of the natural environment" prepared by MEPA during the process of its establishment. ARAMCO's program for the prevention of oil spills is also presented. Finally, the sixth chapter contains the findings, conclusions, and recommendations.

CHAPTER I

SAUDI ARABIA, THE MARINE ENVIRONMENT & ECOLOGICAL ASPECTS

CHAPTER I

SAUDI ARABIA,

THE MARINE ENVIRONMENT & ECOLOGICAL ASPECTS

INTRODUCTION

Marine oil pollution is no longer just a problem of specialists and the reality of its importance cannot be denied. It becomes more and more acute, not only because of accidents or related events, but essentially because of progress of ecological and oceanographical sciences which have demonstrated how important the sea is to keep the earth in balance.

A major constraint on the implementation of oil pollution prevention measures is the lack of the necessary environmental information base. Furthermore, a realistic assessment of oil pollution risk in order to identify areas particularly threatened is an essential element of contingency planning and fundamental to the establishment of an effective response capability.

The purpose of this chapter is therefore, to provide an overall review of the latest information and knowledge about the physical characteristics of the Red Sea and the Arabian Gulf in general, and the Saudi Arabian coasts in particular. It also identifies the significant marine resources threatened by oil pollution along the coastal zones of Saudi Arabia.

THE GEOGRAPHY OF THE AREA :

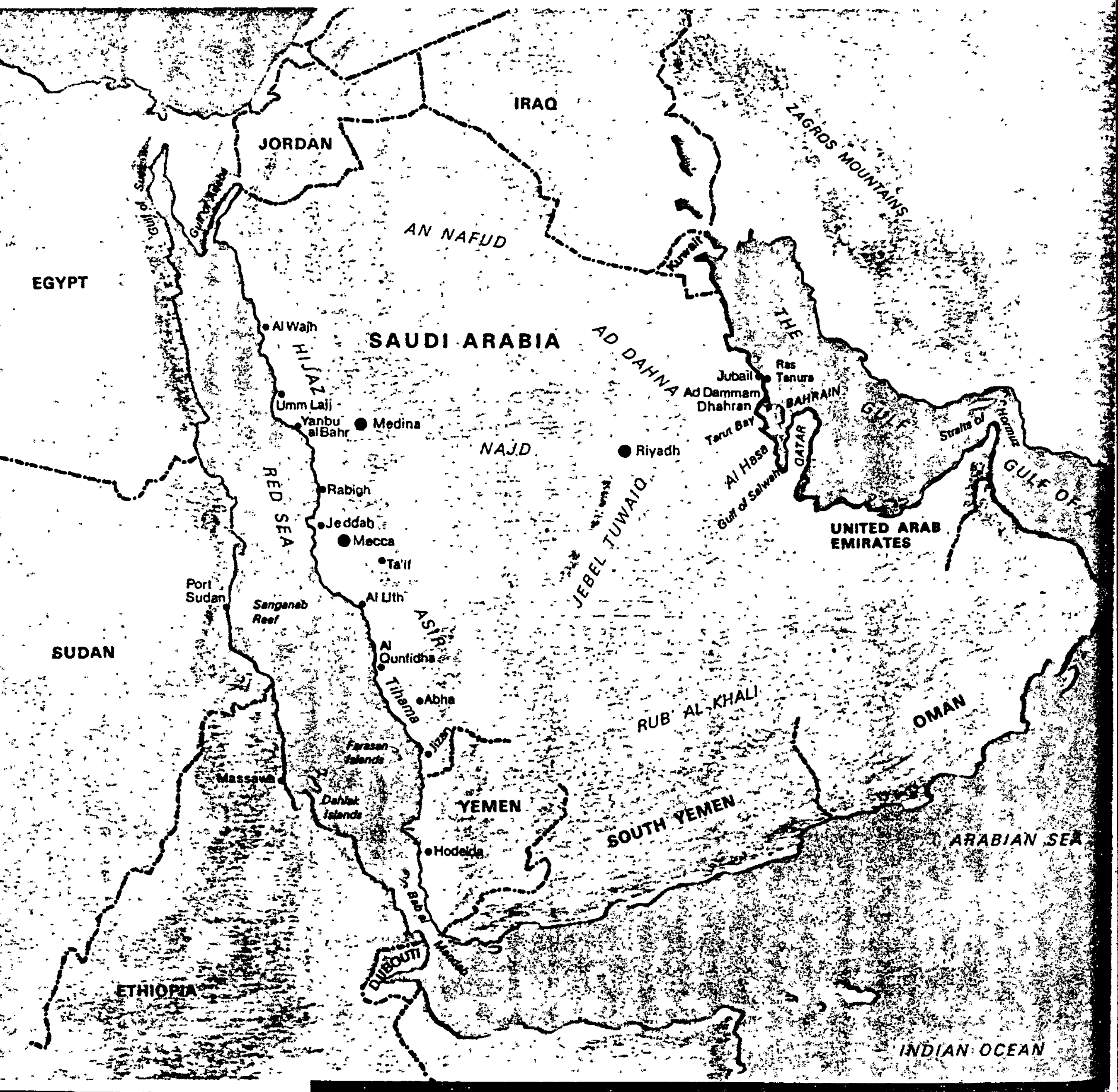
The Kingdom of Saudi Arabia encompasses approximately 80 per cent of the Arabian Peninsula and totals about 2,240,000 square kilometers. The entire western boundary of the Kingdom is the Red Sea; the tow Yemens edge the southern borders. to the north lies Jordan,Iraq,and Kuwait; to the east are the Arabian Gulf,the Island of Bahrain,the peninsula of Qatar,the United Arab Emirates,and the Sultanate of Oman. The length of Saudi Arabian coastline is approximately 2,250 kilometers, of which 1,800 km extends along the eastern side of the Red Sea and 450 km stretches along the western side of the Arabian Gulf. (See Figure I-1).

GEOGRAPHY AND OCEANOGRAPHY OF THE RED SEA :

Extending approximately 1,900 kilometers in a northwest-southwest direction, the Red Sea is a lush oasis of coral life surrounded by vast tracts of desolate mountain and plain. In all of this coast line, there is no permanent river flowing into the Red Sea and the northern half has very little rainfall. The Red Sea splits in the north into the shallow Gulf of Suez and the deeper Gulf of Aqaba. At its southern end, it narrows to the Straits of Bab al Mandab, the "Gate of Tears", where it joins the Indian Ocean via the Gulf of Aden.

The central channel of the Red Sea plunges from 1,000 meters to deeps of more than 2,000 meters and lies along a tectonic fault zone that forms part of the great interconnected rift system extending from the East African Rift Valley in the south, along the bottom of the Red Sea and up into the Jordan Valley in the north,(1).

Figure I-I : Map of Saudi Arabia.



The deeps in the central channel have recently aroused considerable interest because the water within them is very warm (up to 55 degrees C),very salty (up to eight times that of normal sea water),and contains very high concentrates of various metals, especially iron and manganese,(2).

Shoreward from the central channel, the bed of the Red Sea becomes shallower, with rocky islets and coral reefs advancing far out from the coastline. Extensive shallow areas with well-developed coral growth often result in a complex archipelage of reefs and islands, such as the Farasan banks off the southern Saudi Arabian coast. The Red Sea is also still widening up by a few centimeters each year as Arabia drifts further away from the African continent.

Tropical seas differ from temperate seas in that the life they support is much more dependent on the effects of winds,currents,and water clarity. Because of the way in which these factors are balanced, the Red Sea has become famous for its remarkably well developed coral reefs and their spectacular inhabitants,(3).

The main oceanographical feature of the Red Sea is its high salinity-up to 41 parts per thousand at the north end,compared to 35 parts per thousand in the open oceans. This higher salinity is a qonsequence both of the hot climate and the absence of any river adding fresh water to the sea. The surface sea temperatures range, according to the time of the year, from approximately 20 to 26 degrees C.in the northern part, and from 25 to 31 degrees C.in the central and southern parts.

The normal tides are small and occur on a semi-diurnal basis, with the whole sea oscillating around a nodal point approximately at the latitude of Port Sudan. The peak tides, at the northern and southern ends, are of about 0.5 meter, while in the centre there is virtually no daily tide, ($_4$).

The major winds affecting the Red Sea region are of two types. Trade winds are caused by rising equatorial temperatures, which creat depressions into which the tropic air masses flow and thus cause winds that blow permanently toward the equatorial tropics and cool the coastal regions. The prevailing wind in the Red Sea is north-northwest, although this direction is reversed in the winter in the south. Monsoons are recurring winds that change direction with the seasons; in winter they blow from the high-pressure zones over the land out toward the ocean, and in summer they draw breezes into low-pressure zones of overheated air over land masses. The northwestern monsoons account for the winter and spring high tides by pushing water into the Red Sea through the Straits of Bab al Mandab, and the southwestern monsoons create an eastward-moving current that draws water out of the Red Sea. Very high temperature also increase the rate of evaporation in summer, thus the winter sea level can be between 0.5 and 1 meter higher than the summer level. The narrowness of the Red Sea, only 306 kilometer wide, and its irregular coastline also account for the fact that its currents are more easily influenced by local winds than those in larger bodies of water, ($_5$).

MARINE RESOURCES OF THE RED SEA THREATENED BY OIL POLLTION :

-General Biology

There are two significant features relating to the biology of the open Red Sea that distinguish it from the Arabian Gulf and the Indian Ocean. The first is that the epipelagic zone from the surface to 100 meters is relatively nutrient poor. The second is that the region has a relatively low phytoplankton and zooplankton diversity.

A number of factors probably determine this situation. Firstly there are no significant nutrient rich upwellings in the Red Sea. Secondly there is little fresh water input and associated run-off of nutrient rich soil material.

The relative oligotrophy of the Red Sea obviously limits the numbers of higher animals that the open sea can sustain e.g.-fish,turtles,mammals. Indeed it can be seen that most of these animals are directly, or indirectly, dependent on shallow water substrates for their food.

In general most contributors to the biogeography of the Red Sea agree that epipelagic species are able to pass over the dividing sill at Bab-el-Mandab with the surface currents generated by the monsoon winds. This may explain the general decrease in phytoplankton and zooplankton diversity on moving up the Red Sea as the influence of the Indian Ocean flora and fauna is diluted.

Open soft-bottom habitats may be defined as those soft-bottom habitats where water circulation is not restricted. Several shallow water open soft-bottom habitats have been identified along the Saudi Arabian Red Sea. They include;

- wide expanses of sand/silt with characteristic hemichordate "hillocks" which may also support shrimp/gopy holes.
- regions supporting seagrasses.
- regions of fine sand supporting a veneer of micro-alge which may, in turn, support dense grazing populations of molluscs, characterised by Olive shells, and sand-dollars.

Because these areas (except for the seagrass beds) appear to be relatively unproductive they tend to be overlooked and until more is known about their importance this should not, necessarily, be so.

Enclosed soft-bottom habitats may be described as those habitats where water circulation is restricted. They tend to be subject to a higher range of temperatures, salinities and oxygen than occur in open water soft-bottom habitats. Because enclosed soft-bottom habitats occur in sheltered waters substrate particle size is generally smaller than that found at equivalent depths in open water soft-bottom habitats.

Enclosed soft-bottom habitats in the Red Sea are represented by bays, sharms and mersas. Recent opinion suggests that they have been formed as erosional features by rivers or wadis cutting through emergent reef at a time of more frequent rain and lower sea level.

Sharms and mersas typically have an enterance of 0.2 to 1 kilometer across. They may extend for up to 10 km inland and remain narrow and winding throughout - as at Sharm Obhur north of Jeddah, or widen out into "lakes" several kilometers across - as at Sharm Sulieman or Mersa as Sarraj north of Jeddah. however, many sharms and mersas are simply shallow bays partly or completely closed off by a coral fringing reef.

Enclosed soft-bottom habitats are often backed by extensive flats that are inundated on a seasonal basis. During this period of wetting they often develop a growth of micro-algae that may have seasonal significance to the primary production of the coastal zone.

Enclosed soft-bottom habitats are restricted in number and distribution. They also have a great value. Several sharms and mersas, particularly along the Red Sea coast of Saudi Arabia, are deteriorating or being destroyed through coastal development.

-Fisheries

Saudi Arabia's Red Sea fishery is not well developed compared to its Gulf coast fishery due in part to uneven bottom conditions and the high diversity in fish species. About 60% of the boats are dug-out or planked canoes, and most of the rest are 10-15 meter sambuks, (6).

Three major fisheries are exploited from Saudi Arabian ports-pelagic fish on the Farasan bank, taken by trolling or gillnetting; demersal fish and deep water reef species from around the offshore reefs of the outer, northern Farasan bank, taken by handlining; and a diverse inshore fishery carried on along the remainder of the coast. The major markets are at Jeddah, Jizan, Yanbu and Rabigh. Smaller amounts may be landed at Umm Lajj, Al Qunfidhah and Al Lith,(7).

The coastline of the Red Sea is in many areas dominated by coral reefs, which limits operations of modern fishing gears such as trawls and purse-seines.

The monsoon system is a characteristic dominating the whole area. Sharp seasonal patterns in wind and currents provide other constrains to the fisheries, making weather conditions hazardous for small crafts, and causes the availability of different fish species to vary on a seasonal basis.

The total annual catch of Saudi Arabia in 1981 from the Red Sea amounted 10200 tonnes, having a gross value output of US$ 15 million of which the value of exports amounted for US$ 1.8 million and per capita supply of 7.6 kg/year.

Commercial trawling in Saudi Arabian Red Sea waters started in 1983 with the establishment of a fishing company owned partly by the government, partly by the private sector. Government efforts to develop the fisheries include the construction of new fishing harbours. Propsals for a marine/brackish water fish farm experimental stations are being implemented near Jeddah. The species selected for farming are fishes fetching high market prices, such as Rabbitfish and Mullets.

As regards shrimp fisheries, no figure has been found for the Red Sea catch of Saudi Arabia, but most of the shrimp exploitation occurs on its Gulf coast.

As regards turtles, internationally significant levels of hawksbill nesting from islands in the northern Saudi Arabian Red Sea and from islands in the outer Farasan bank has been reported. Green turtle nesting also occur in similar locations. Nesting densities of 100 green turtle females per year are reported from a coastal site just north of Yanbu. Present exploitation of turtles in the Saudi Arabian Red Sea is slight, ($_8$).

-Birds

The seabirds of the Red Sea appear to be divided into three separate groups. One group contains widespread tropical species. A second smaller group comprises northern Indian Ocean species found only on the coasts of Arabia, northern east Africa and, perhaps north-western India. In this group just one or two species appear to be effectively endemic to the Arabian area-the white eyed gull, the sooty gull, the brown noddy, the white-cheecked tern, Saunders'tern, and the crab plover are restricted to the Red Sea and northern Indian Ocean. The third group of which the Caspian tern is the best example, comprises widespread, though not necessarily common, species occuring in both temperate and tropical latitudes.

White-eyed gull is endemic to the coast of north-east Africa and parts of Arabia, and is a candidate for future Red Data book treatment. Its endemism to the area merits great emphasis.

Sooty-gull is endemic to the coast of north-east Africa and parts of Arabia. The sooty gull reported to be fairly common in the Red Sea waters of Saudi Arabia. The first breeding record for Saudi Arabia from Al Hala island in the Farasan Bank has been reported. However, fledged juveniles were seen throughout the region and there is evidence to suggest that breeding is not uncommon in the region.

A number of other species have significance because they are notably abundant and breed regularly in the region.

The Sooty Falcon, has its breeding restricted to the Middle East though it winters in southeast Africa and Madagascar. Several records of breeding populations have appeared in the literature; from the Saudi Arabian Red Sea. It is also worth identifying the African collared dove, and the brown booby, in the category identified above.

Costal wetlands along the Red Sea support large numbers of resident and migrant waders and may well have international significance for a number of species. Finally a number of birds of prey (in addition to the sooty falcon) follow passerines through the Red Sea and Gulf of Aden on their annual migration.

A number of birds breed in mangrove in the Red Sea most notably the pink backed pelican. An even greater number roost and shelter in the mangroves. A number of cases are reported of deterioration of halophytes on offshore islands in the Farasan Bank in the Saudi Arabian Red Sea. Several species of birds, particularly the brown noddy,

brown booby, and bridled tern, use these halophytes for nesting.
As can be seen several birds are endemic to the region and, therefore, have international conservational significance.

Most of the birds of the Red Sea have relatively little commercial value. Resident doves and migrant passerines are trapped for food and, perhaps most significantly, there is a great deal of money to be made from trapping, and selling for falconry training, certain species of migrating birds of prey as they pass through the region.

Birds have value as indicators of the state of the environment and this is particularly the case for those birds at the top of the food chain.

-Coral Reefs

The most conspicuous shallow water marine habitat in the Red Sea is formed by the extensive coral reefs which fringe much of the coastline and often extend offshore for many kilometers.

The maximum depth at which corals normally live depends on the water clarity, for those algae symbiotically associated with corals must have light to convert carbon dioxide and water into food substances.

The reefs in the Gulf of Aqaba are, in fact, the most northerly, fully developed reefs in the world. The distribution of reefs through the Red Sea can be related to tectonic movements and block faulting of suitable foundations for reef growth.

The resultant geomorphology largely determines the extent of sedimentation and exposure to wave action. The two factors determine the vigour of coral growth, the extent of reef consolidation, the form of the upper part of the reef, and the species of coral which come to dominate the coral assemblage. several types of reefs can be encountered:

-fringing reefs: adjacent to the shore along most of the coastline.

-patch/platform reefs: groups of reefs including patch reefs, platform reefs, submerged reef banks and ring reefs typically lying between 13-15 km offshore and arranged in a series-called the barrier system, examples are the Wejh bank, and Farasan bank off Saudi Arabia.

-pillar reefs/atolls: occasional reefs much further offshore(15-20 km) arising from much deeper water and including pillar reefs and atolls-for example reefs in the north outer Farasan Bank off Saudi Arabia.

Structural and species diversity of coral reefs and corals is higher in the Red Sea than in the Arabian Gulf but is lower than that reported from major coral areas in the Indian Ocean. However, the beauty of coral reefs in the Red Sea is world renowned partly because Red Sea waters tend to be clear because there is relatively littile freshwater input from the land.

Over 150 species of coral are recorded from the northern and central Red sea. There are possibly twice as many discrete reef communities in the Yanbu area of Saudi Arabia as there are in the Gulf of Aqaba. Coral species diversity is probably highest in the central Red Sea.

In general terms there is a decrease in the quality and extent of coastal coral reef communities on moving south of about 20° N. Reef quality around the main Farasan islands was relatively low. This is partly because the southern Red Sea has a shallower bathymetry and a higher turbidity than the central and northern Red Sea. However, other factors may be involved.

Rocky substrates in the coastal area of Saudi Arabia become scarcer and available substrates are increasingly domainated by macrophytic algae. The conservational status of coral reefs in the Red Sea is generally good. However, there is locally significant deterioration of coral reefs in the vicinity of Jeddah, Yanbu, and Rabigh on the Saudi Arabian coast as a result of coastal development.

The coral reefs and communities are almost certainly the most economically significant of the marine habitats in the Red Sea. The significance of the reefs for fisheries relates in part to their very high primary productivity.

Reefs may have proved invaluable for education and science, as the large amount of biological research recently undertaken in reef areas suggests.

As a result of their diversity reefs represent a major genetic resource. Many reef animals have been found to contain pharmacologically active compounds which may be of a medical value or lead to advances in medical research.

In particular, coral reefs are generally regarded as being of considerable economic and social value for recreation and tourism.

See Figure I-2: Distribution of major coral reef areas in the Red Sea.

-Coastal Vegetation :

Mangroves

Mangroves are halophytic plants that live in the intertidal fringe of tropical shallow waters. They can survive in this environment through a specially developed salt secretion process that makes them particularly vulnerable to coating by both inert and chemically active materials.

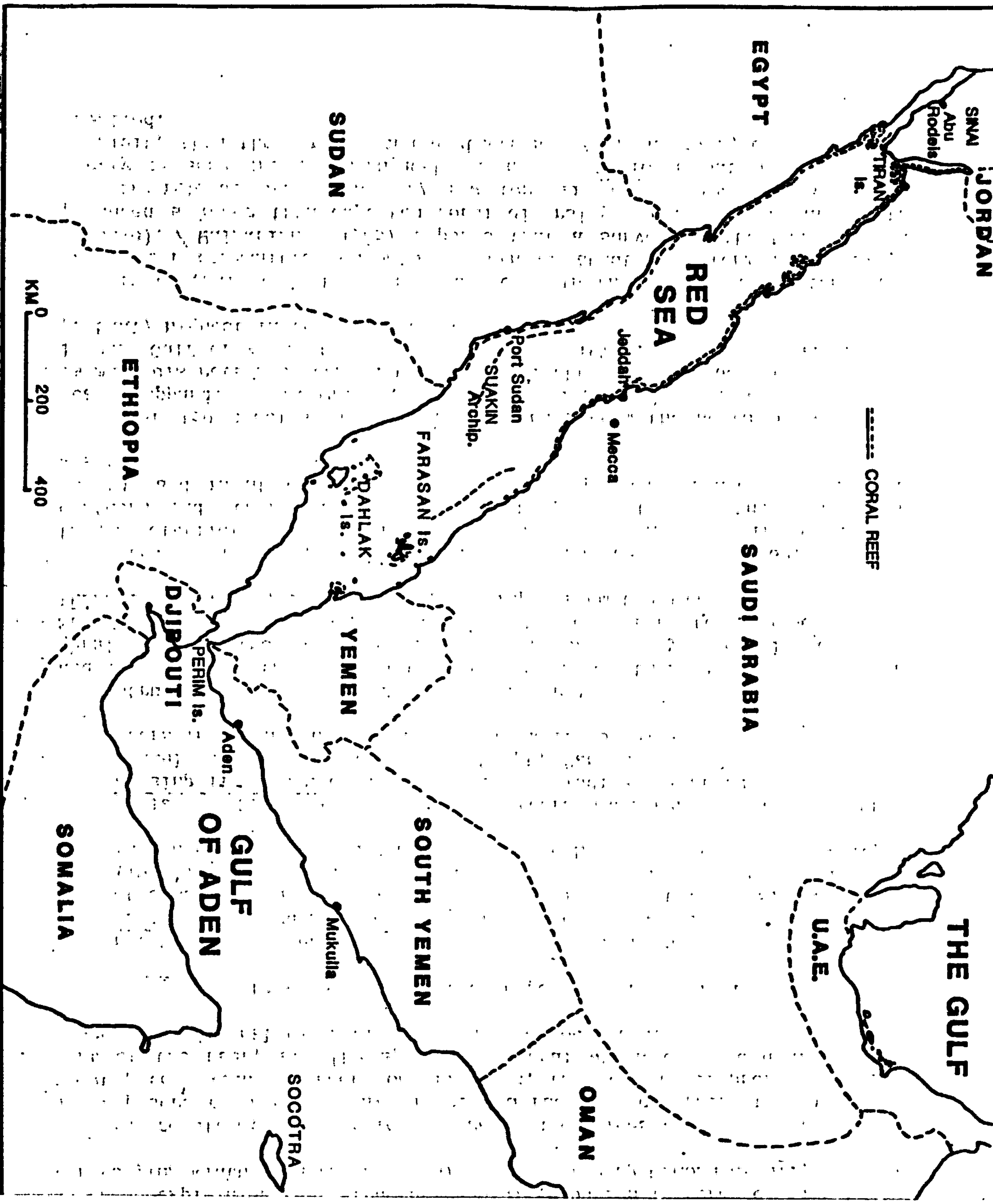


Figure I-2

Distribution of major coral reef areas in the Red Sea. (Dashed lines near-shore indicate fringing reefs and associated patch reefs. Dashed lines offshore indicate offshore complexes of islands, patch reefs, atolls etc.) Source: UNEP, 1985.

Two species of mangrove are reported from the Saudi Arabian Red Sea. They are: Avicennia marina which is found in the Saudi Arabian Red Sea south of 27° 30'N. Rhizophora mucronata is only found at 5 restricted sites in the Saudi Arabian Red Sea and is always associated with A.marina. The total area of R.mucronata is probably less than 20 hectares.

Tidal range in the Red Sea is low and many of the most extensive mangrove stands occur in the south where tidal range is higher than in the central Red Sea. Where extensive stands do occur in the central Red Sea, for example on Birema Island in the Wejh bank off Saudi Arabia, they tend to be associated with existing reef rock structures that mimic the dendritic system of consolidated mud tidal channels that supply and support large mangrove stands in areas with a higher tidal range. Mangrove consolidated tidal exchange channels were found in several large stands in the southern Saudi Arabian Red Sea.

In recent years it has come to be appreciated that mangroves constitute very valuable and ecologically highly significant natural habitat. Numerous uses of mangrove have been documented. Mangroves in the Red Sea are grazed,(particularly by camels), used for building material (net stands, shacks, and bird traps) and for cooking and heating.

It has been suggested that the Avicennia marina mangrove stands at Yanbu al-Sinaiyah may have significance as a filter bed for sewage. An increasing number of people, particularly in Saudi Arabia, have access to the coastal zone and to associated mangrove stands. Mangroves also act as a focus for wildlife which can be viewed by visitors.

In addition mangroves also have an indirect value in tending to control both coastal erosion and coastal flooding.

Most significantly, however, it has been found that mangrove communities are often highly productive especially by comparison with the productivity of neighbouring areas of the open ocean. Consequently, the mangrove is frequently the basis for important marine fisheries either directly or through export of nutrients. In addition mangrove roots can provide recruitment habitats for juvenile fish invertebrates.

Mangroves in the Red Sea are important bird breeding areas. In addition, and in a desert environment with little green vegetation, the mangrove stands have a landscape value that should not be underestimated.

See Figure I-3: Distribution of known mangrove stands in the Red Sea.

Seagrasses

An important feature of the seagrass plant is its extensive root and rhizome system which enables it to colonise various soft-bottom substrates, provides a semi-permanence to the seagrass community, and also enables the plants to draw on mineral nutrients from within the sea-bed.

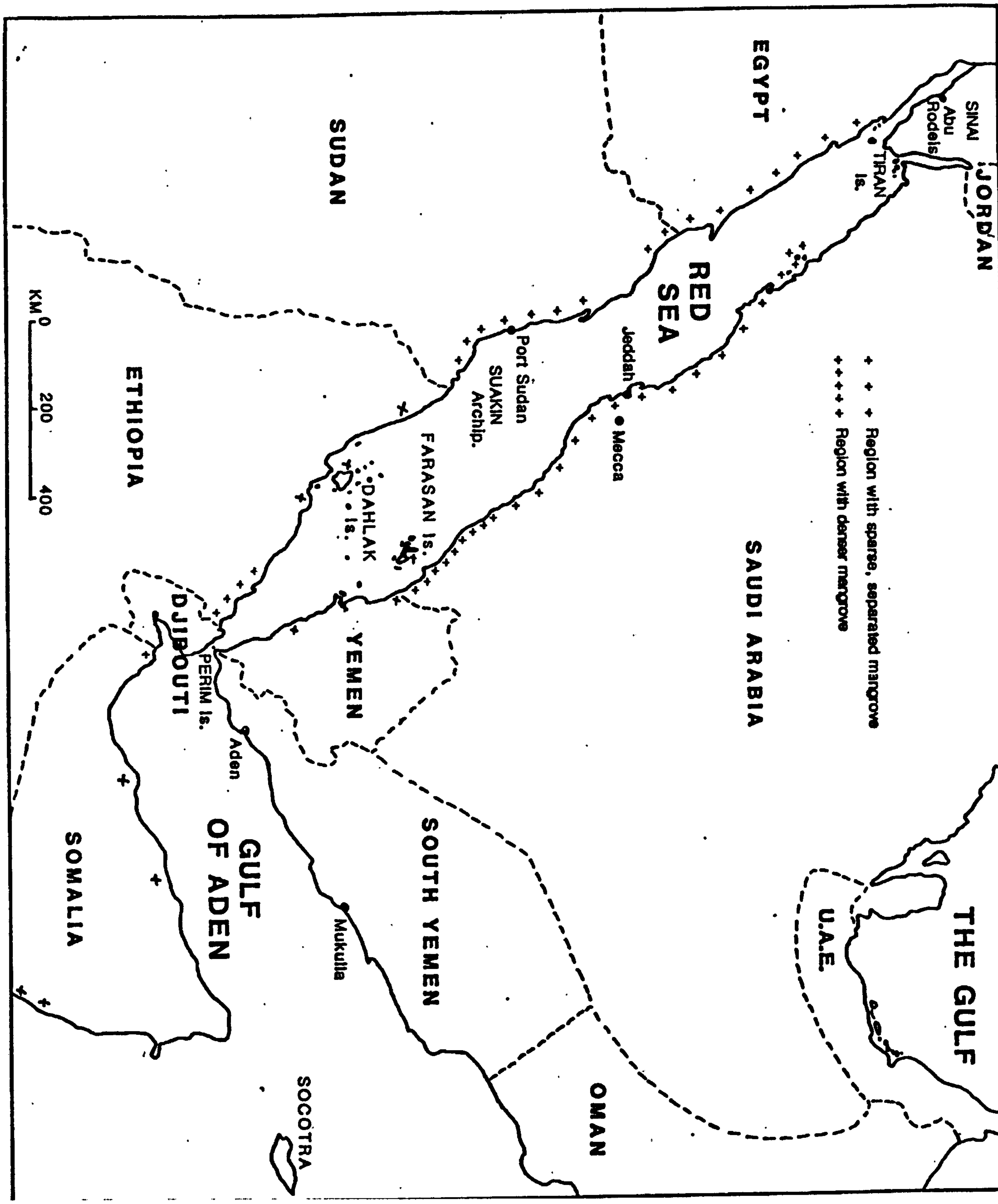


Figure I-3

Distribution of known mangrove stands in the Red Sea and Gulf of Aden region. (Note that for some countries of the region (e.g. Somalia, Djibouti, North & South Yemen and Ethiopia) information is incomplete Source: UNEP, 1985.

10 species were found on the Saudi Arabian coast between Yanbu and Shu'aiba. Seagrasses tend to occur on soft-bottom substrates in the lower intertidal and shallow sublittoral in the Red Sea. However, two of the ten species occur down to 20 meters or more.

The importance of seagrass is well documented and a brief summary of features is presented below:

-High productivity which supports turtle, dugong, stocks of commercially important fish and invertebrates, and the detrital food chain.

-Shelter for fish and invertebrates some of which are commercially important.

-Substrate for a diverse epiphytic flora and fauna.

-Substrate consolidation.

-Nutrient recycling.

Direct destruction of seagrass beds in the Red Sea is limited. Much of this damage has occured in the vicinity of Jeddah through direct infilling, indirect sediment effects, and alteration/blocking ofwater circulation. The low level of damage to seagrass beds in the Red Sea is in marked contrast to the situation in the Arabian Gulf,(9).

GEOGRAPHY AND OCEANOGRAPHY OF THE ARABIAN GULF :

Unlike the Red Sea, which is fairly deep trough to the west of the Arabian Peninsula, the Arabian Gulf is a shallow, east-dipping platform that is an extention of the peninsula covered by water and forming a huge inland sea. It extends some 1000 km along its major northwest-southeast axis and 200-300 km wide. Its only opening being at the narrow Strait of Hormuz, which restricts the inflow of Indian Ocean waters. Apart from a trough lying parallel to and in front of the Zagros Mountains on its eastern coast, the Gulf is nowhere deeper than 100 meters, its average depth being only 35 meters. Because of this extreme shallowness, its waters undergo rapid temperature changes, both daily and seasonally. The surface temperatures of coastal water can vary from 10^{o} C to 36^{o} C; offshore temperatures range from 15^{o} C to 34^{o} C.

The land masses surrounding the Gulf are all arid. Surface evaporation in the Gulf therefore exceeds all input, the result being highly saline waters ranging from 37 parts per thousand at the entrance to 41 parts per thousand at the northwestern end and occasionally reaching 53 to 66 parts per thousand in the partially enclosed inlets and bays of the eastern end; one example, the Gulf of Salwah, lies between Saudi Arabia and the Qatar Peninsula and is nearly cut off from the Arabian Gulf by Bahrain. And easily exceeds 100 parts per thousand in shallow lagoons, (10).

The main body of water is well mixed for most of the year although, at the mouth, there is a dense, high-salinity flow outwards along the bottom of the Strait of Hormuz which is balanced by a surface influx of Indian Ocean water passing along the east coast. This gives rise to a weak counter-clockwise circulation. The tides have a range of 0.5 meter in the mid-region, increasing to about 3 meter towards both the head and the mouth. Along much of the western coast, this is enough to uncover an expanse of sand and mud often several kilometers wide at low water; extensive sabkhas (salt-flats) may periodically become flooded at high water. However, tidal currents are strong only in coastal channels where bi-directional movements are concentrated. The wind is therefore an important factor: it blows predominatly from the north and most strongly from the north-west, as the Shamal. All down the western coast in the inner part of the sea area, which trends NW-SE, the headlands demonstrate this with an extended sandspit which curves in the downwind direction. The fetch is thus greatest in the south-east, where bottom sediments are of course sand as a result of greater wave-energy: elswhere, especially in deeper water, they are of fine sand or mud. The waters of the inner sea area are more turbid than in the Red Sea or Indian Ocean generally, with a euphotic zone about 20-30 meters deep-which nevertheless mcludes a large area of the bottom along the western side,($_{11}$).

See Figure I-4 : The Arabian Gulf.

The Gulf coast of Saudi Arabia is about 450 kilometers long and is divided into several zones. The northernmost zone curves roughly northwest to southeast in a gentle arc from the Kuwait border through Ras Tanura, across Bahrain's islands to the northern tip of the Qatar Peninsula. The southernmost zone of coast lies between the city of Dammam and the base of the Qatar Peninsula,

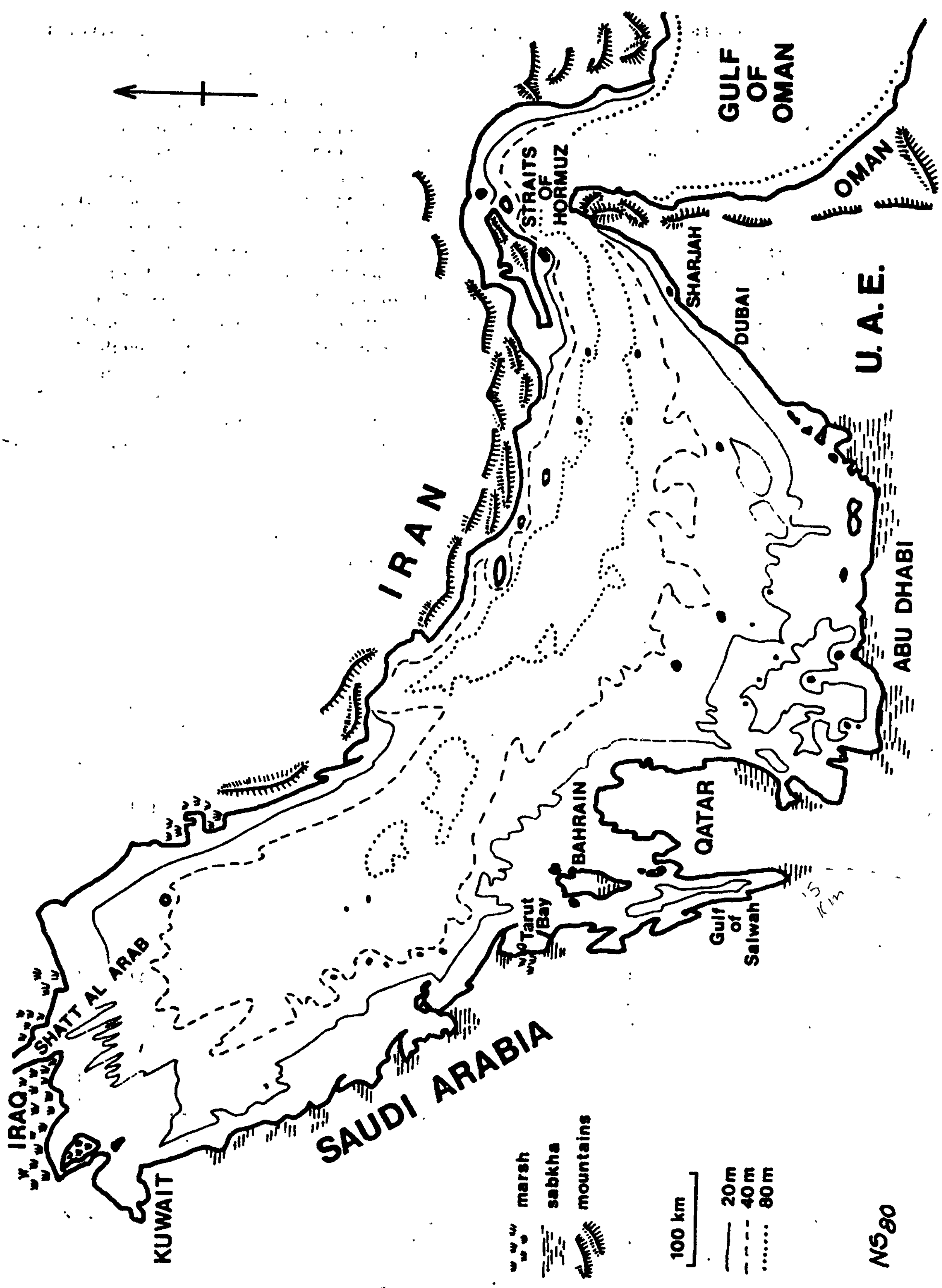


Figure I-4
The Arabian Gulf

and curves in a southerly direction, therefore being more nearly parallel to the prevailing winds. Much of this part of the coastline lies along the Gulf of Salwah and is protected from wave action not only by its position but by a stretch of extremely shallow water between Saudi Arabia and Bahrain that forms a barrier to tidal water movement. Between the northernmost and southernmost coastal stretches (between Dammam and Ras Tanura) lies an area called Tarut Bay, which in many ways is unique. This area contains extensive tidal flats and grassbeds and is the major shrimp nursery of the Gulf,(12).

MARINE RESOURCES OF THE ARABIAN GULF THREATENED BY OIL POLLUTION :

-General Biology

The high salinity, generally high but also fluctuating temperatures, other less important environmental conditions and the enclosed nature of the sea area all contribute towards restricting the variety of plants and animals which can survive there. Some early accounts give the impression that the diversity of many groups is very low, but further studies have shown that the marine biota of the Arabian Gulf is, in spite of these factors, quite rich.

A recent puplication (Basson, Burchard, Hardy and Price, 1977) which contains the essence of many years' work along the entire Saudi Arabian coast and offshore, demonstrated that most habitats do indeed exhibit considerable diversity (table I-1). From sublittoral soft bottoms alone they collected more than 167 different species of polychaete, 125 species of gastropod mollusc and 73 different bivalves, over 39 different amphipod crustaceans and 66 species of decapods (shrimps, crabs, etc.).

Because the surrounding land is very largely desert, nutrients can enter the system only via Shatt-al-Arab or, periodically, through the Strait of Hormuz; but intertidal micro-algae, seagrass beds in the shallows and, to a smaller extent mangroves and other halophytes around sheltered bays apparently make a contribution sufficient to permit relatively high productivity.

Table I-1. Diversity of Species in Particular Habitats along the Western Coast of the Arabian Gulf

Rocky shores	131+
Intertidal rocks	314+
Sublittoral rocks	194+
Coral reefs	543+
Artificial structures	178+
Sandy beaches	218+
Intertidal sandflats	191+
Sublittoral sand	638+
Intertidal mudflats	109+
Sublittoral mud	610+
Seagrass beds	530+
Tidal creeks	33+
Plankton	355+
Open water	83+

Source: "Biotopes of the Western Arabian Gulf" Basson, Burchard, Hardy & Price (1977)

The plankton has not yet been exhaustively studied, but seems to be most diverse in the lower part of the Arabian Gulf, which receives a small contribution from the main Indian Ocean stock; in the shallower inner waters, certain components are missing but, in productive bays and lagoons, densities may be quite high. The zooplankton contains a high proportion of the larvae of benthic invertebrates. Amongst these, numerous species of crab and smaller crustaceans are important as adults in scavenging detritus and turning over surface sediments- a function is also carried out by polychaete worms. Intertidal flats may support huge numbers of tiny gastropod snails, while rocks at low water can become heavily encrusted with bivalves and tubeworms.

-Fisheries

Traditional methods utilizing nets and lines from the shore or small boats have, of course, been followed for centuries. In shallow water - as in Tarut Bay -fixed traps or fish-weirs may also be used. About 135 species of fish found in the Arabian Gulf are regarded as edible. The fishery for pelagic species (sardines, mackerel, tuna and barracuda) lies mainly in the south-east and is exploited by Iran to supply a cannery at Bandar Abbas; trawling for demersal (bottom-living) species such as bream, jack, snapper, grouper or various flatfish can be carried out wherever the sea-bed is flat and fairly shallow. Estimates of potential yield range from 200,000 to 600,000 tonnes per year-i.e. from around five to ten times the present catch.

The most important fishery, since modern trawling began in 1963, is for the large pink shrimp Penaeus semisulcatus which makes up by far the greatest bulk of commercial landings both in Saudi Arabia and other Gulf states. The major stocks appear to be one or more in the north, fished by Iran, Kuwait and Saudi Arabia; a southern one, fished by Saudi Arabia, Bahrain and Qatar. The estimated maximum sustainable yield of the two in which Saudi Arabia participates as around 2,500 tonnes each per year, rationally managed.

Various investigators have suggested means of improving the shrimp fishery itself, ranging from protection of the natural breeding-grounds, through the early release of artificially-reared young to boost "wild" stocks, to a Japanese-style culture of mature shrimp in tanks.

As regards turtles, at present, very few turtles are taken in the Arabian Gulf. Green turtles are amongst the best-known of these, feeding on sea-grass beds and breeding on certain of the offshore islands; four others (the hawksbill, leatherback, logerhead, and Ridley's turtle) are also known to use the Arabian Gulf,(13).

Karan Island off Saudi Arabian Coast is used by an estimated 80% of the turtles of the Arabian Gulf-several thousand breeding pairs- which represents an appreciable proportion of the total world population. It is doubtful whether these turtles now use any mainland beaches, however isolated, not only because they are still taken in relatively small numbers for food, but merely because of their dislike of any form of disturbance,(14).

There used to be a flourishing fishery for pearl-oysters, mainly from Kuwait and the Emirates, in the southern part of the Arabian Gulf; this declined with the advent of cultured pearls, but conditions would still seem to be suitable for the farming of oysters and other bivalves for food,(15).

Sea-snakes - perhaps fortunately - seem to be less frequently seen, although at least six species are recorded. Dugongs have been reported but are thought to be very rare now, may be because of the scarcity of dense mangroves which were their favoured habitat. Several species of porpoise, dolphin and killer-whale occur in the Arabian Gulf, and a number of the larger whales regularly visit it.

-Birds

The wide variety of birds reported from the Arabian Gulf includes both typically marine species such as cormorants, sea-duck, gulls or terns and those associated more with the water's edge, like the herons, egrets, waders and kingfishers. Ospreys and kites also feed along the coast. The offshore islands are important breeding sites for three species of tern as well as for the turtles, and provide a resting-place for many other birds on the spring or autumn migrations across the Arabian Gulf.

-Coral Reefs

Reef-building corals do not occur in the northern part of the Arabian Gulf, but form numerous reefs in the shallow waters to the south-west, towards the Strait and around the Gulf of Oman, togather with broad fringes around the offshore islands. Basson et al. (1977) listed 43 species of scleractinians (stony corals) in 28 genera, togather with 2 species of soft coral, from reefs off the Saudi coast alone. This might be compared with the 30 or so species recorded for the northern end of the Red Sea which, although at the extreme edge of their geographical range, offers more stable environmental conditions, ($_{16}$).

Coral reefs are common in the shallower parts off the Saudi coast, but they differ widely in size and development. On the open coast, reefs grow to the low-tide mark but the diversity of coral species is smaller than it is in reefs in the open sea. In offshore waters, the lower depth limit for continuous coral cover is usually 15 meters, but, in these coastal areas of the Gulf, where waters are more turbid, coral may only grow to depths of 10 meters or less. The predominant type of reef in this part of the Gulf is the relatively small patch or platform reef. When sand bars form on the leeward side of the larger platform reefs, low, flat coral islands are formed which increase the types of habitat and, therefore, the number of species found in this environment. Coral growth tends to proteed in a ringlike fashion, even around single coral heads; in fact, this type of growth is a prominent feature of the reef flats surrounding the coral islands of the Gulf, where there is no real distinction between platform reefs and fringing reefs, (17).

-Coastal Vegetation

Mention has already been made of the cotribution of blue-green algae to the productivity of the Arabian Gulf: extensive mats of these micro-organisms, occurring on sheltered intertidal flats, have much the same importance as salt-marsh vegetation in temperate seas. Mangroves, which offer a valuable coastal habitat in tropical regions elsewhere, are poorly developed in the area and occur only patchily along the southern and western shoreline-perhaps partly because of intensive human use in the past. The densest stands occur along each side of the Strait of Hormuz. Smaller halophytes are widespread in bays and creeks, covering the intertidal flats above the level of algae or mangroves and merging with reedbeds in the few localities (as around Tarut Bay, Saudi Arabia) where there is a fresh water seepage. Just below tidemarks, sea-grass beds are probably a source of nutrients even more important than the blue-green algae; they stabilize large areas of soft sediments and also provide support or shelter to many species ranging from protozoans to reptiles, ($_{18}$).

CHAPTER I

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CHAPTER II

SOURCES

OF OIL POLLUTION

IN THE SAUDI ARABIAN

MARINE ENVIRONMENT

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SOURCES OF OIL POLLUTION

IN THE SAUDI ARABIAN MARINE ENVIRONMENT

INTRODUCTION

The pottential for oil spill incidents in the Saudi Arabian marine environment is high because of present and projected large-scale petroleum operations and associated marine traffic. More important on a continuing basis, however, are the regular losses of oil to the sea during routine transfer operations involving loading, deballasting of oil tankers in preparation for loading, during offshore drilling, and from coastal refineries and other sources.

In order to assess the magnitude of oil pollution in the Saudi Arabian marine environment, to identify areas and activities of high risk that require regulations, this chapter identifies the major source of oil pollution in Saudi Arabia and estimates the amount of oil pollution from each source.

A complete understanding of the problems associated with oil pollution is dependent upon a comprehension of the basic properties of petroleum derived oils, their behaviour and fate in the marine environment. Many detailed accounts of these aspects are available in the published literature. To aid understanding of the main chapters of this study, a brief review is also presented in this chapter.

STATISTICAL ANALYSIS OF OIL POLLUTION IN THE SAUDI ARABIAN MARINE ENVIRONMENT

-Methodology For Spill Estimates :

In calculating the amount of oil pollution entering the marine environment of Saudi Arabia on an annual basis, we have adapted the methodology developed by Golob and Brus, who made an estimate for oil pollution in the KAP Region (Kuwait Action Plan) based on data contained in the NAS report (National Academy of Sciences), the Beyer and Painter paper and according to the methodology developed by the Research Planning Institute (RPI) in Columbia, South Carolina. We have also used data from the following sources: 1) Saudi Arabian Ministry of Petroleum & Mineral Resources Statistical Bulletin,1983; 2) British Petroleum Co., Offshore Magazine, and the U.S. Department of Energy for statistics on oil production, consumption, refining, and export in individual countries; 3) the U.N. Census for world-wide population figures; 4) The Times Atlas of the World for geographical data.

-Terminology and Assumption :

The term "Saudi Arabian Marine Environment" refers to the marine environment and the coastal areas of Saudi Arabia, both on the Red Sea and the Arabian Gulf.

In our calculations, we have used the statistical data for 1982 as it reflects the average production and export figures of the last ten years. For consistency in our calculations, we have converted all final amounts into metric tonnes. When our original data sources have provided amounts in barrels, we have converted the barrels into tonnes, using average densities of 7.314 barrels per tonne for crude oil, and 7.392 barrels per tonne for all exports, including both crude oil and products. We have included spill estimates to the nearest tonne, in part to make our calculations easy for the reader to follow, and in part to maintain the precision of the various spill estimates.

-Estimates For Oil Pollution :

Natural Seeps

"Wilson et.al,1974" subdivided the world's continental margins into regions of low, moderate, and high seepage potential and assigned the following average seepage rates to those regions respectively: 0.1, 3, and 100 barrels per day per 1,000 square miles (1 square mile=2.59 square kilometers). Previous studies indicated that the sea area of the Arabian Gulf has a moderate seepage potential. Since offshore oil fields in Saudi Arabia are mainly on the Arabian Gulf, then the offshore concession areas of Saudi Arabia and Saudi Arabian-Kuwaiti divided zone, which totals 64,200 square kilometers (24,788 square miles) are used. Based on these data, the amount of oil entering the Saudi Arabian marine environment each year from natural seeps would total **3711 tonnes per year:**

$$\frac{365 \text{ days}}{\text{year}} * \frac{3 \text{ bbls.}}{(\text{day})(1000 \text{ miles}^2)} * 24{,}788 \text{ miles}^2 = \frac{27143 \text{bbls.}}{\text{year}}$$

$$\frac{27{,}143 \text{ bbls.}}{\text{year}} * \frac{\text{tonnes}}{7.314 \text{ bbls}} = \frac{3711 \text{ tonnes}}{\text{year}}$$

Offshore Production

Golob and Brus and RPI used the following three methods developed by the NAS(1975), Beyer and Painter (1977), and Devanny and Stewart (1974) to estimate the amount of oil entering the KAP region from offshore platforms and pipelines. We have used a similar approach with updated and relevant statistics to estimate the amount of oil entering the Saudi Arabian marine environment from offshore platforms and pipelines in the Arabian Gulf where the offshore oil production of Saudi Arabia is concentrated.

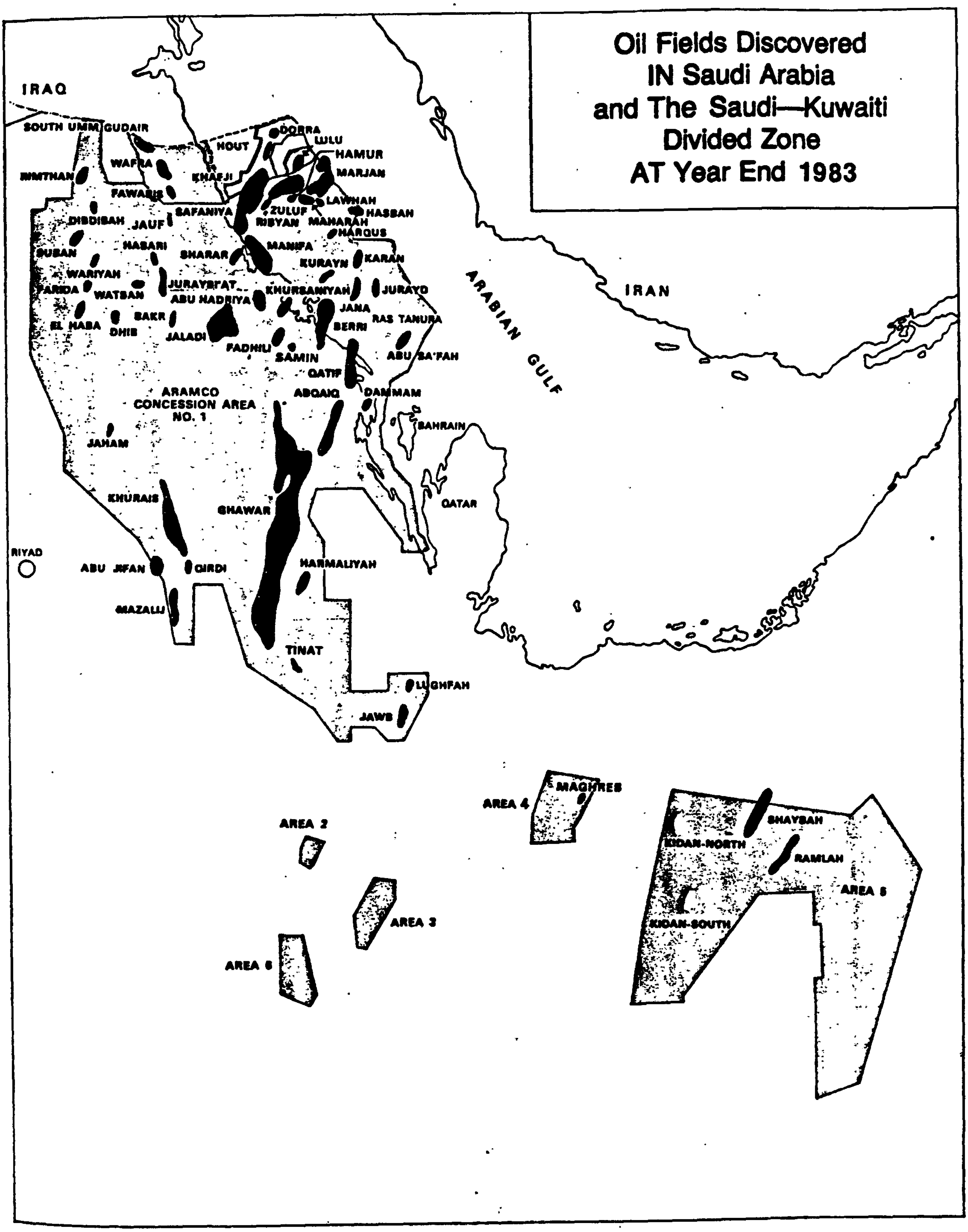
Method 1: The NAS estimated that the average oil loss from minor spills involving less than 50 barrels and from briny discharges totals between 8.6 tonnes per million tonnes produced and 32 tonnes per million tonnes produced. The NAS also calculated that, for spills greater than 50 barrels, the total oil loss would amount to approximately 140 tonnes per million tonnes produced. The statistics of Offshore Magazine showed that the total 1982 offshore production in Saudi Arabia amounted to 2,392,000 barrels per day, or119,371,069 tonnes per year:

$$\frac{2392000 \text{ bbls}}{\text{day}} * \frac{365 \text{ days}}{\text{year}} * \frac{\text{tonnes}}{7.314\text{bbls}} = \frac{119,371,069 \text{ tonnes}}{\text{year}}$$

Based on 1982 production figures, we calculated the amount of oil entering the Saudi Arabian marine environment from the following offshore production sources:

Figure II-I

Source: Ministry Of Petroleum & Mineral Resources Statistical Bulletin.



a) Briny discharges and spills involving less than 50 barrels:

Low value: $\frac{\text{8.6 t.spilt}}{\text{million t.}}$ * 119.371 million t.= 1027 t.spilt

High value: $\frac{\text{32 t.spilt}}{\text{million t.}}$ * 119.371 million t.= 3820 t.spilt

b) Spills involving more than 50 barrels :

$\frac{\text{140 t.spilt}}{\text{million t.}}$ * 119.371 million t. =16,712 t.spilt

Therefore, the total estimated spillage from offshore production activities has an average value of **19,136 tonnes:**

Low value: 1027 t. + 16712 t. = 17,739 tonnes.

high value: 3820 t. + 16712 t. = 20,532 tonnes.

average value: $\frac{\text{17,739 t.+ 20,532 t.}}{2}$ = 19,136 tonnes.

Method 2: Beyer and Painter estimated that the average spill rate for offshore development activities is 72 tonnes spilt for every million tonnes produced. Using this method we have deduced that the amount spilt in 1982 from offshore activities is approximately **8,595 tonnes:**

$\frac{\text{72 t.spilt}}{\text{million t.}}$* 119.371 million t.= 8,595 t.spilt.

Method 3: Devanny and Stewart estimated that the amount of oil lost from offshore platforms is 60 tonnes per million tonnes produced, and that the spillage from offshore pipelines averages 110 tonnes per million tonnes produced. Using these estimates with 1982 Saudi offshore production figures, we have calculated the following:

a) Losses from offshore platforms:

$$\frac{60\ \text{t.spilt}}{\text{million t.}} * 119.371\ \text{million t.} = 7,162\ \text{t.spilt}$$

b) Losses from offshore platform:

$$\frac{110\ \text{t.spilt}}{\text{million t.}} * 119.371\ \text{million t.} = 13,131\ \text{t.spilt}$$

The total estimated spillage from platforms and pipelines is 20,293 tonnes:

7,162 tonnes + 13,131 tonnes = 20,293 tonnes spilt

Since the three methods exhibit a wide variation in the estimated amount of oil spilt into the Saudi Arabian marine environment from offshore operations, we believe that the best final estimate would be an average of the value derived from the three methods, or **16,008 tonnes:**

$$\frac{19136t\,(NAS) + 8595t\,(Beyer\&Painter) + 20293t\,(Devanny\$Stewart)}{3}$$

= 16,008 tonnes spilt

Tanker Transportation

During the transportation of oil in tankers, oil pollution may result from either tanker accidents or operational oil discharges. Based on tanker casualty data for the period of 1969 to 1972, Beyer and Painter used the following variables to estimate the average amount of oil spilt from tanker accidents within 80 kilometers of shore: 1) valume of oil transported, and 2) number of port calls.

As mentioned earlier, Beyer and Painter calculated that the average spillage within 80 kilometers of shore as a result of tanker accidents would be 87 tonnes per million tonnes transported. Petroleum Statistical Bulletin of the Saudi Arabian Ministry of Petroleum & Mineral Resources (1983) shwoed that, during 1982, Saudi Arabia's exports of crude oil amounted 2,058,392,000 barrels (281,431,775 tonnes) and of refined products 195,095,000 barrels (26,392,722 tonnes). The total amount exported in 1982 was 307,824,497 tonnes. If we assume that all the nearshore oil pollution associated with tankers carrying oil from Saudi Arabia actually occured in the nearshore of Saudi Arabia, the total oil spillage from tanker causualties within 80 kilometers of the shores in Saudi Arabia during 1982 would have totalled **26,781 tonnes :**

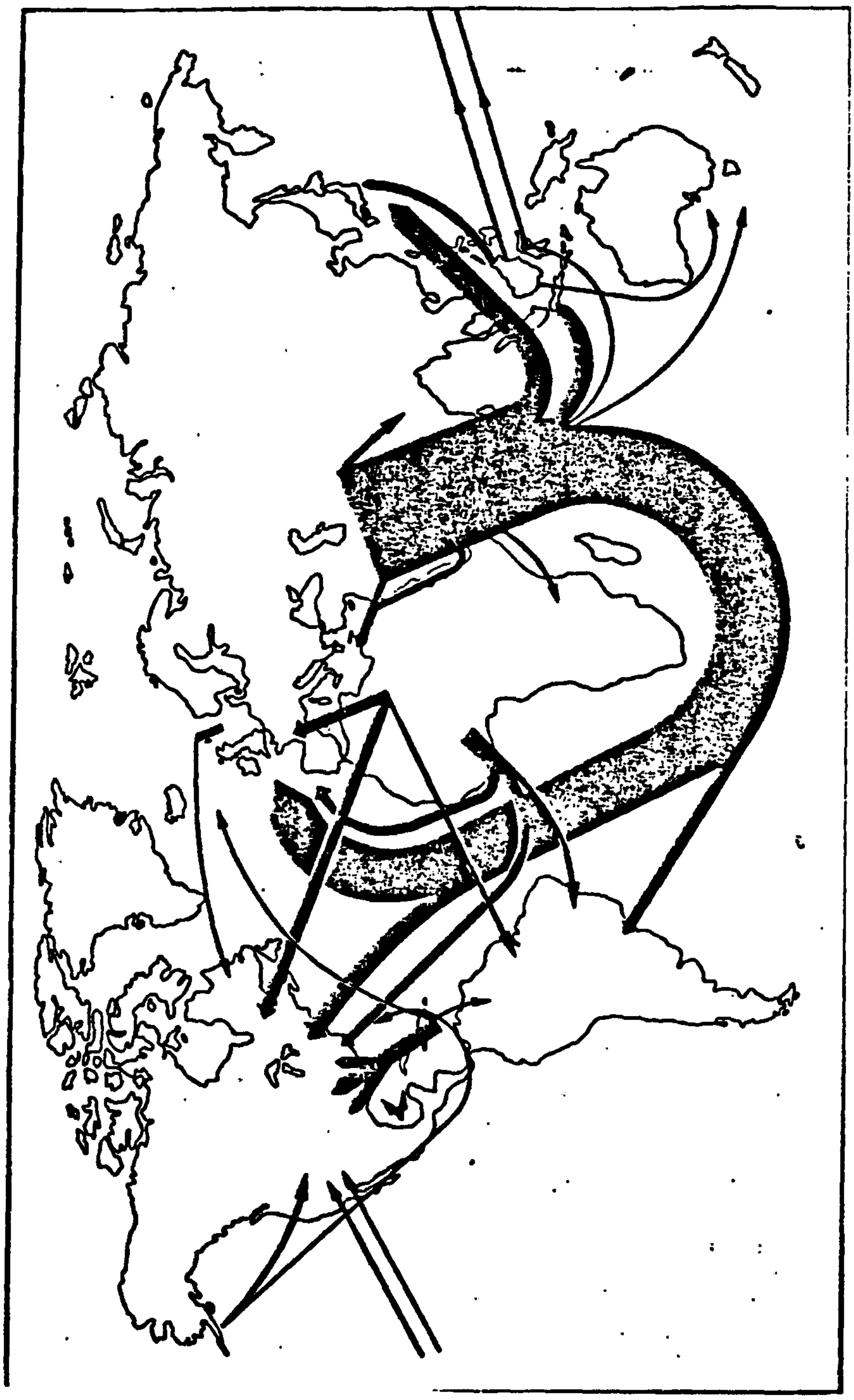
$$\frac{87 \text{ tonnes spilt}}{\text{million t transp}^{d}} * 307.8245 \text{ million t exported} = 26780\text{t. spilt}$$

In actual fact, however, tankers carrying oil from Saudi Arabia pass within 80 km of the shore at the following point locations : the point of origin, the point of destination, intermediate port calls, and the nearshore

Figure II-2

Major Oil Movements at Sea in 1979.

The width of the arrows represents the relative volume of oil.



portions of shipping lanes. For our calculations, we have assumed that tankers carrying oil from Saudi Arabia pass within 80 km of the shore at the following three points during a voyage :

1) during passage nearshore Saudi Arabia from the point of origin;

2) at an intermediate port call or while rounding a continent and;

3) while approaching the point of destination.

We have assumed that nearshore causualities will have an equal distribution at these three locations and that one-third of the nearshore accidental spillage, amounting to 8927 tonnes, will occur in the nearshore of Saudi Arabia :

$$\frac{26{,}780 \text{ tonnes}}{3} = 8{,}927 \text{ tonnes}$$

According to Beyer and Painter, world-wide casualty data for the period 1969 to 1972 indicate that the average spill rate is 0.92 nearshore spill per 1,000 port calls and that the average spill size is 7,124 barrels per spill. Petroleum Statistical Bulletin (1983), Petromin Annual Report (1983), and Aramco Annual Report (1983) indicates that in 1982, total of <u>4,353 tankers</u> called at Saudi Arabian ports and Saudi-Kuwaiti zone: at Ras Tanura & Juaymah, Ras Al-Khafji, Mina Saud, Jeddah Refinery and Yanbu terminals.

Using Beyer and Painter's port call estimate for spillage, a total of 4,353 port calls would correspond to a total spillage of **3,860 tonnes :**

$$\frac{0.92 \text{ spills}}{1000 \text{ port calls}} * 4{,}353 \text{ port calls} * 7{,}124\text{bbls} * \frac{\text{tonnes}}{7.392 \text{ bbls}}$$

$= 3{,}860$ tonnes

Since the two methods exhibit a wide variation in the estimated amount of oil spilt into the Saudi Arabian marine environment from tanker accidents, we believe that the best final estimate would be an average of the value derived from the two methods, or <u>6,394 tonnes:</u>

$$\frac{8,927 \text{ tonnes} + 3,860 \text{ tonnes}}{2} = 6,394 \text{ tonnes}$$

Tanker Cleaning & Ballasting

According to the NAS, Load On Top (LOT) procedures could eliminate 90 % of the operational discharges associated with tanker cleaning and ballasting. Tankers using LOT procedures retain cargo tank washings and oil ballast water on board to separate out the oil from the water for incorporation into the next shipment. When tankers do not use LOT measures, they typically discharge about 0.35 % of their carrying capacity during their ballst voyage. NAS estimated that, when tankers use LOT, the procedure reduces the pollution by 90 % and that therefore a typical discharge from such tankers would contain only 0.035 % of the tanker's cargo capacity.

Oil industry statistics indicate that, during the mid-1970's, approximately 80 % of all tankers used LOT, with the remainder discharging their tank washings and ballast water directly into the ocean. If we assume that the same ratio of LOT usage applies for tankers transiting Saudi Arabian marine environment, the 80 % of the tankers that use LOT would discharge a total of 86,190 tonnes of oil while carrying oil from Saudi terminals:

307,824,497 t. exported * (0.035% loss) * 80% = 86,190 t.

The 20 % of the tankers that dont use LOT would discharge **215,477 tonnes :**

307,824,497 t. exported * (0.35% loss) * 20% = 215,477 t.

The total oil loss from tankers carrying oil from Saudi Arabia would amount to 86,190 tonnes plus 215,477 tonnes, or 301,667 tonnes. Since tankers carrying oil to North America, Europe, and Asia travel about 5% to 10% of their total voyage distances in the confines of Saudi Arabian waters, only about 5% to 10% of the total loss would occur in the nearshore waters of Saudi Arabia if the tankesrs distributed their tank cleaning and ballasting activities evenly along their routes. Since tanker captains would probably be more likely to release ballast water some distance from land, away from close scruting by national and international maritime authorities, we have estimated that only about 5% of the total ballasting and tank cleaning discharges, amounting to approximately 15,083 tonnes of oil, takes place in the nearshore of Saudi Arabia.

Terminal Operation

According to "Brummage(1973)", the average loss rate at the Milford Haven, U.K. tanker terminal was 1.1 tonne per million tonnes throughput during nine years of operation. For a similar port in Portland, Maine, the loss rate was about 2.2 tonnes per million tonnes throughput. We applied these two rates to oil terminals in Saudi Arabia and used the export total of 307,824,497 tonnes in 1982 as the Saudi Arabian terminals throughput. Our calculations indicate an estimate range of between 339 and 677 tonnes as the total oil loss from terminals in Saudi Arabia during 1982 :

1.1 tonnes spilt * 307.8245 million t.throughput = 339 t.
million t.throughput

2.2 tonnes spilt * 307.8245 million t.throughput = 677 t.
million t.throughput

Since Saudi Arabia have somewhat less strict environmental laws than does either the U.S. or U.K., and since historical data indicate that indivisual terminal spills as large as 5,000 tonnes have occured in Saudi Arabia during the past decade, we have estimated that the annual loss from terminal operations is greater in Saudi Arabia than at either Milford Haven or Portland. If we assume a spillage rate of 1.5 times the average spillage rate at Portland, or 3.3 tonnes spilt per million tonnes exported, then our estimate for total oil discharges from terminals in Saudi Arabia would be 1,016 tonnes :

3.3 tonnes spilt * 307.8245 million t.throughput= 1016 t.
million t.throughput

Total Tanker-related Losses

In summary, we calculated that tanker-related losses amounted to a total of 22,493 tonnes :

Tanker casualties	6,394 tonnes
Tanker cleaning & ballasting ..	15,083 tonnes
Terminal operations	1,016 tonnes
Total :	22,493 tonnes

Non-tanker Accident Losses

The NAS estimated that non-tanker accidents contribute approximately 100,000 tonnes of oil each year into the marine environment world-wide. We believe that a reasonable estimate of the oil lost through non-tanker accidents in Saudi Arabia may be based on the total level of industrial development in both the coastal and non-coastal areas of the country. We have further assumed that the level of industrial activity may be linked directly to the level of oil consumption in Saudi Arabia.

According to the Saudi Arabian Ministry of Petroleum & Mineral Resources' Statistical Bulletin (1983), the total puplic and oil industry consumption of refined products and natural gas in Saudi Arabia in 1982 was 327,817,000 barrels, or approximately **44,347,538 tonnes.** World-wide oil consumption in 1982 was 2,824.9 million tonnes (BP,1984), we estimate that 1,570 tonnes of the 100,000 tonnes of oil lost world-wide from non-tanker accidents is spilt in Saudi Arabia:

$$\frac{44.348 \text{ million t.}}{2824.9 \text{ million t.}} * 100,000 \text{ t.spilt} = 1,570 \text{ tonnes spilt}$$

Coastal Refineries

The NAS reported that refineries using a gravity separation/dissolved air flotation system may reduce the oil content of refinery discharges to about 20 parts per million. According to Saudi Arabian Ministry of Petroleum & Mineral Resources' Statistical Bulletin (1983), the total production of refined products in Saudi Arabia in

1982 was 470,484,000 barrels. If we exclude the production of Riyadh refinery which was 37,851,000 barrels, coastal refineries in Saudi Arabia would account for 432,633,000 barrels, or approximately **58.5272 million tonnes throughput :**

$$432,633,000 \text{ barrels} * \frac{\text{tonnes}}{7.392 \text{ bbls}} = 58.5272 \text{ million tonnes}$$

With a discharge rate of 20 PPM, a 58.5272 million tonne throughput would lead to a discharge of 1,171 tonnes:

$$\frac{20 \text{ tonnes discharged}}{\text{million t.throughput}} * 58.5272 \text{ million t.throughput} = 1171\text{t.}$$

Atmospheric Fall-out

The NAS estimated that oil pollution from atmospheric fall-out will total 600,000 tonnes in the early 1980s, the same figure given for 1973 when world-wide oil consumption was only about 80% of current levels. This estimate of no change was probably based on the assumption that increasingly strict hydrocarbon emission standards in industrilised countries would balance out any increase in pollution which might otherwise occur from increased petroleum consumption. Our estimates for atmospheric fall-out in 1982 make a similar assumption. According to the Times Atlas of the World, the surface area of Saudi Arabian's marine environment totals 186,200 km^2, or 0.052% of the total surface area of the world's lakes and oceans, which is 361,719,030 km^2. If the 600,000 tonnes from atmospheric fall-out were distributed equally over the world's lakes and oceans, the pollution from atmospheric fall-out over the sea-area of Saudi

Arabia would total 0.052% of the total, or about <u>312 tonnes per year.</u>

<u>Coastal Municipal Wastes and Coastal Non-refinery Industrial Wastes</u>

The NAS study estimated that coastal municipal wastes and coastal non-refinery industrial wastes in the U.S. contributed about 8 grams of petroleum into the marine environment per day for each person living in the coastal zone. To estimate the oil input from these wastes in the marine environment of Saudi Arabia, we used the following reasoning : In 1982, the entire U.S. population of about 232.057 million consumed a total of 705.5 million tonnes of oil, or about 3.04 tonnes per person. The United Nation's estimate of the population of Saudi Arabia in 1982 was about 9.684 million. Oil consumption in Saudi Arabia during the same year was 44.4 million tonnes, or an average of 4.58 tonne per person, or 150.66 % of the 3.04 tonnes per capita U.S. consumption in 1982. If we assume that the discharge of municipal wastes and non-refinery industrial wastes is directly propotional to per capita consumption, and that the population in the coastal zone of Saudi Arabia has the same per capita oil consumption as the population in both the coastal and non-coastal zones of Saudi Arabia, then about 12.05 grams of oil would be discharged per capita per day in the coastal zone of Saudi Arabia.

As a very rough estimate, about one quarter of the population in Saudi Arabia live in the coastal zone, or 2.421 million. Assuming an average per capita discharge from coastal municipal wastes and coastal non-refinery wastes of 12.05 grams per capita per day, the wastes in

1982 would be 10,650 tonnes :

12.05 grams * 365 days * 2.421 million persons * tonnes
person/day million gms

= 10,650 tonnes

Urban Run-off

The NAS estimated that the oil pollution from urban run-off is approximately 50% of the total world-wide input of oil from coastal municipal wastes and coastal non-refinery wastes into the marine environment. Assuming that this propotion holds for Saudi Arabia, urban run-off would account for approximately 5,325 tonnes of oil pollution in the Saudi Arabian marine environment during 1982 :

50 % * 10,650 tonnes = 5,325 tonnes

Summary of Spill Estimates :

Table II-2 summerizes the estimates that we derived in the earlier sections for each major source of oil pollution in Saudi Arabia. According to our estimates, approximately 61,240 tonnes of oil spilt into the Saudi Arabian marine environment during 1982. This amount represent about 2.1 per cent of the NAS estimate of the world-wide oil pollution statistics by sources discussed earlier minus the figure for pollution from river run-off as there is no input from this source into the Saudi Arabian marine environment.

TABLE II-2

Total Estimates of Oil Pollution in the Saudi Arabian Marine Environment in 1982

Source	Estimate in Tonnes	%of total
Natural Seeps.	3,711	6.1
Offshore Production	16,008	26.1
Tanker Transport	22,493	36.7
Non-tanker Accidents	1,570	2.6
Coastal Refineries	1,171	1.9
Atmospheric Fall-out	312	0.5
Coastal Municipal Wastes & Coastal Non-refinery wastes	10,650	17.4
Urban Run-off	5,325	8.7
River Run-off	N/A	N/A
TOTAL	61,240	100 %

A comparison of the NAS world-wide oil pollution statistics in Table II-1 with Saudi Arabian estimates in Table II-2 offers the following insights :

1) Whereas the oil pollution statistics for the world show that 23.6 % of the total minus river run-off figure comes from tanker transport and 6.7 % from offshore production, the estimates for Saudi Arabia show that 36.7 % of the total comes from tanker transport and 26.1 % from offshore

production. This high percentage of pollution from tanker transport and offshore operations in Saudi Arabia is consistent with the high concentration of oil production and transportation activities in the Saudi Arabian marine environment.

2) The oil pollution statistics for Saudi Arabia show that 17.4 % of the total comes from coastal municipal wastes and coastal non-refinery wastes, whereas the estimates for the world show that 15.2 % of the total comes from coastal wastes. This difference reflects the relatively high consumption of oil per capita despite the relatively low population density along the coasts of Saudi Arabia compared with the nations of western Europe and North America.

3) Although Saudi Arabian marine environment comprises only 0.052 % of the surface area of the world's marine environment, our estimates indicate that it contributes 2.1 % of the world's marine oil pollution, which is 40 times the average estimated amount for a marine environment of similar surface area.

TABLE II-1

NAS Estimated Inputs of Petroleum Hydrocarbons in the World Marine Environment during the Early 1980's

Source	Estimate in Tonnes	%of total
Natural Seeps.	600,000	20.2
Offshore Production	200,000	6.7
Tanker Transport	700,000	23.6
Non-tanker Accidents	100,000	3.4
Coastal Refineries	20,000	0.7
Atmospheric Fall-out	600,000	20.2
Coastal Municipal Wastes & Coastal Non-refinery wastes	450,000	15.2
Urban Run-off	300,000	10.1
River Run-off	Excluded	N/A
TOTAL	2,970,000	100 %

-Historical Major Oil Spills In The Saudi Arabian Marine Environment :

Although we estimated that approximately 61,240 tonnes of oil pollution entered the Saudi Arabian Marine Environment during 1982, we could not compare our estimates with hard data, due to the lack of a single comprehensive source of historical spill data for Saudi Arabia. In an effort to fill this information gap, we compiled a list of major accidental spills that occured in Saudi Arabia during the period between 1970 and April 1982.

In developing the list, we used the relevant data for Saudi Arabia from the list prepared by Golob and Brus for the spills in the Arabian Gulf. We also used data from Aramco's study report prepared by Haight, Gardner, Poor & Havens, 1983.

Although our list has limited usefulness given its preliminary nature, it nevertheless illustrates that single major spills may have a major impact on the total oil spillage per year in the Saudi Arabian marine environment. For example, the Tarut Bay pipeline repture in 1970 and the Hasbah 6 well blow-out in October 1980 each involved the spillage of an estimated 14,000 tonnes of oil into the Saudi Arabian marine environment, and that amount represents almost the whole of our estimate for the total yearly spillage from offshore operations. The 1974 terminal spillage from Mina Saud resulted in the loss of more than 5000 tonnes of crude oil, and that amount was almost five times more than the 1,016 tonnes estimated for annual spillage from terminal operations in Saudi Arabia.

-Recent Major Spills in the Saudi Arabian Marine Environment

In late August 1980, a 25 km^2 oil slick impacted the north and west coast of Bahrain. The oil was washed ashore along 65 km of coastline, including several amenity beaches, and caused serious damage to fishing traps, nets, and tackle, as well as fishing boats. At the peak of the clean-up, a total of 800 workers were involved in the recovery of the spilled oil and the restoration of the beaches there. By early October, the crews had cleaned up the most severely affected regions, and the work force had been reduced in sixe about 300 people. Several reports indicate that the oil spilt from a loading terminal in Saudi Arabia. If the terminal was indeed the spill source, rapid notification of pollution authorities might have resulted in the containment of the spilt oil near the terminal in Saudi Arabia waters and prevented its eventual movement onto the Bahrain coast, $(_1)$.

In the second major incident, between 80,000 and 100,000 barrels of heavy crude oil were lost when the Arabian American Oil Company (ARAMCO) well Hasbah 6 about 100 km off the Saudi Arabian coast blew out on 2 October 1980. Nineteen workers were killed by toxic hydrogen sulphide gas on board the jack-up drilling rig Ron Tappmeyer, which was evacuated after the blow-out.

The major clean-up and oil recovery effort was at first directed at preventing the leading edge of the slick washing ashore along the north western coast of Bahrain. This coast had been seriously polluting by the first major incident mentioned earlier in August 1980 which killed about 1000 birds, caused extensive mortality to intertidal marine life, contaminated beaches and restricted fishing. By late October, wind and currents in the Arabian Gulf carried the oil to the east and south of the well site and towards Bahrain and Qatar. Tar balls from the spill later washed ashore along 100 km of the northern Qatar coast, and along 12 km of the Bahrain coast. By the end of November, 320 km of the Qatar coast was affected, of which 30 km was described as severely damaged.

The slick at the time covered an area of 25,000 km^2, making it the largest oil slick in surface area after the Ixtoc 1 slick. Owing to the heaviness of the oil, the slick was made up mainly of tar balls and sheen, the former having a neutral buoyancy which increased the difficulty of recovery and of protecting water intakes at power stations and desalination plants.

Mechanical equipment and chemical dispersants were both used to deal with the enormous slick. Calm weather and low wave energy increased the problem of providing mixing energy for the dispersants to function properly, and the neutrally buoyant tar balls were almost impossible to contain with booms. Nevertheless, some oil was recovered at sea, and by the end of October fresh winds and choppy seas helped to break up the slick. The extensive clean-up on the Qatar coast alone was estimated to cost $7 million. Overall, this could be one of the costliest blow-outs to clean up after Ixtoc 1, (2).

PROPERTIES AND FATE OF OILS IN THE MARINE ENVIRONMENT

Although oil is often referred to as though it is a uniform substance it is in reality a complex mixture of mainly hydrocarbon components with differing physical, chemical and biological properties. The basic product, as obtained from geological strata, is termed crude oil. From this a wide range of other products are derived during the refining process. In order of increasing density (specific gravity) the main ones can be classed as gases, petrol, kerosene, fuel oils, lubricating oils, residual fuel oils, asphelt and paraffin. The physical and chemical characteristics of these products differ enormously, to some extent dependent upon the crude from which they are derived.

Whilst all crude oils containe lighter fractions similar to petrol as well as heavier tar or wax fractions, the composition of any particular crude will depend upon the source (from which its name is derived) and may vary in consistency from a light volatile fluid to a viscous semi-solid. Crude oils originating from different parts of the world will therefore differ considerably in their physical and chemical properties. These differences become important in relation to the behaviour of spilled oil in the environment and subsequent clean-up operations.

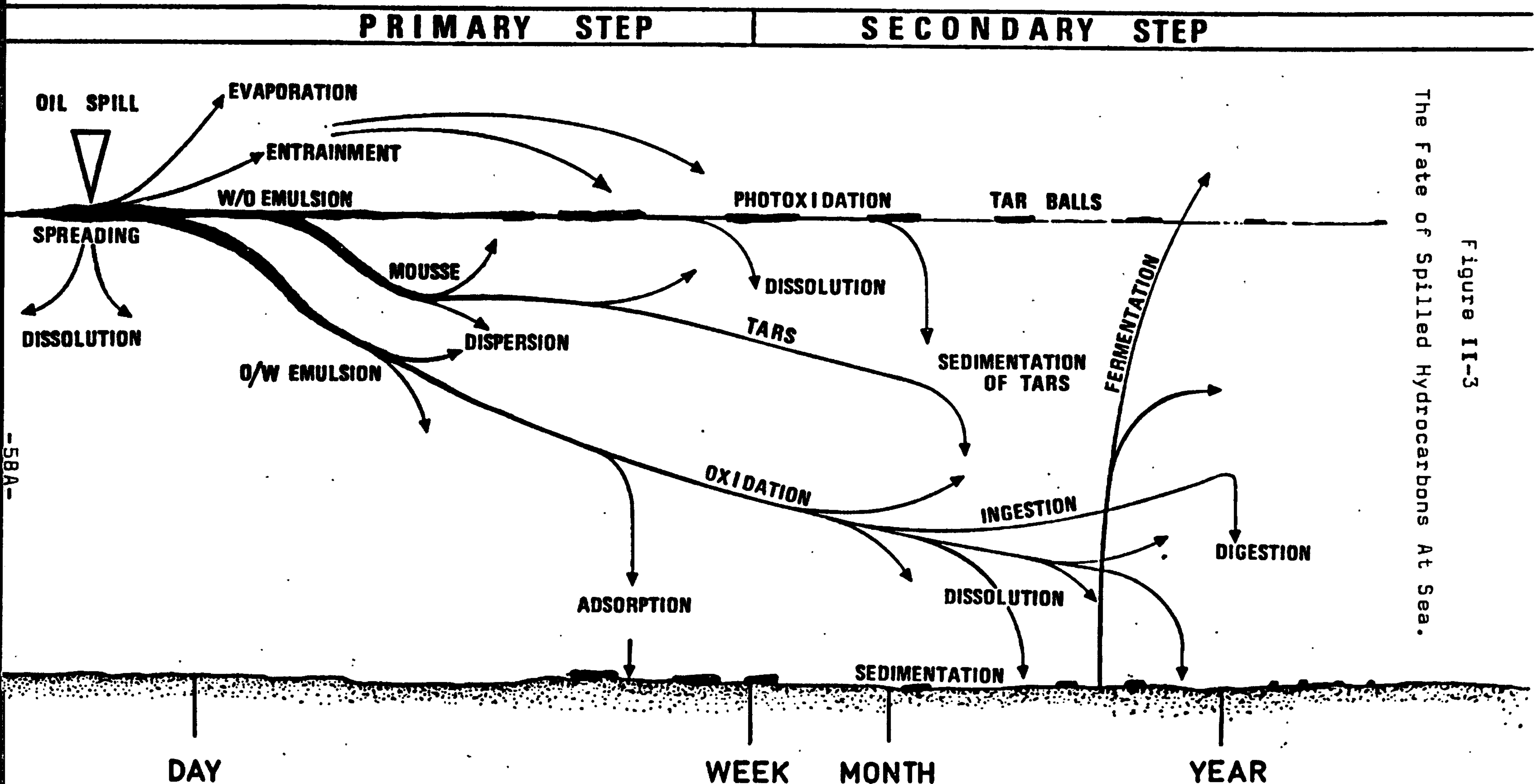


Figure II-3
The Fate of Spilled Hydrocarbons At Sea.

When petroleum oils are spilled on to the sea, a number of mechanisms come into play :

-Spreading

The first observable phenomenon following a spill is the tendency of the oil to spread into a slick over the water surface. Exceptions are certain crude and heavy residual fuel oils which have a high specific gravity causing them to solidify or sink.

The horizontal spreading of oil over the water surface will occur even in the absence of wind and currents and is caused by the force of gravity and the surface tension of water which is generally greater than that of the floating oil mass. As a general rule the oil slick spreads relatively quickly immediately following a spill. During this initial period, when the force of gravity has an important role, the spreading rate tends to be a function of the volume of oil spilled with large spills spreading faster than smaller ones. However, after a number of hours the major spreading force becomes surface tension and the rate of spreading decreases. Typically, oil spilled on water will form a thin lens with the inner portion being thicker than the edges.

Whilst rates of spreading will vary depending upon the properties of the oil and the ambient conditions it can be taken as a rough guide that most crude oils will spread to a thickness approx. 3 mm in one hour and approx. 0.3 mm in ten hours. In the absence of other factors and processes spreading will continue until the oil forms a virtual monomolecular layer (approx. 0.5 micrometer thick) on the sea, only discernible as an area where the surface capillary waves are damped and giving the appearance of a slight silvery sheen. When such a situation is reached natural dissipation of the oil is rapid.

-Movement

Oil on the surface of the sea moves under the influence of wind and current. The effect of current alone is direct, that is the surface slick will move in the same direction and at the same velocity as the surface water. Wind alone moves oil at about 3% of its own velocity, thus a wind of 60 km/h will move oil downwind at 2 km/h. A wind speed in excess of about 16 km/h will also tend to break a slick up into streaks or windrows. When both wind and current are significant their effects are additive with the resulting movement being a vector of the two components. This situation is often complicated by local variations in wind and currents. Whilst tidal currents can be an important consideration when predicting the movement of oil near shore their cyclic and generally self-cancelling nature means that only wind and residual currents are usually significant for long range predictions.

Although accurate surface current and wind data are rarely available for the site of a spill, useful predictions of movement can normally be made on the basis of more general data and be validated by aerial observation of the actual slick. A number of computer models have been developed to predict oil spill movement and are of particular value as an aid to contingency planning for static installations such as offshore oil production platforms.

Lehr and Cekirge from the University of Petroleum and Minerals, Dhahran, Saudi Arabia, 1980 have constructed a model for estimating the trajectory of oil spills for various locations in the Arabian Gulf based upon seasonal average climatic data. While chiefly of use for statistical conclusions, their model could be used by oil spill detection agencies to provide an expected spill path on the basis of minimal information about such a spill. Such a "first guess" trajectory would, for example, help assess governmental responsibility for clean-up in the region. It could also determine whether such a spill is likely to come ashore in any area where it could do severe damage and hence must be further monitered and controlled or whether only minimal risk is involved and less urgent response required. They concluded that the southern Iranian coastline has the highest danger for oil pollution although the Emirate coasts also show a considerable risk potential. The other coasts are relatively safe except for the southern Saudi Arabia and Qatar region which shows high risk for oil drifts in the Summer and Fall. Northern Saudi Arabia, while fairly safe from spills, has its greatest pollution risk season in the Spring. This may suggest that any oil spill task force for Saudi Arabia be stationed in the north during the first part of the year and moved south for the Summer and Fall.

-Weathering

At the same time as the oil is spreading and moving over the sea surface a number of processes will be occuring which will give rise to changes in the physical and chemical properties of the oil. In combination these processes are termed weathering. The rate of weathering of an oil depends upon a number of factors including oil type and ambient climatic conditions. Rates of the various processes also vary throughout the duration of an oil spill with many being greatest in the first few hours.

The most significant initial weathering processes for oil spills on the sea is evaporation. Thus the more volatile fractions of an oil (the light ends) are lost within the first few hours. Thereafter the rate decreases and the less volatile components will form a residue which as a higher specific gravity and viscosity than the original oil. Whilst the rate of evaporation is influenced by factors such as air and water temperatures, sea state, wind and rate of spreading, it is the volatility of the various components present that is the crucial factor determining the extent of evaporative loss. It is therefore highly dependent upon the type of oil spilled.

Another important mechanism affecting the natural fate of oil on the sea surface is dispersion or the formation of oil-in-water emulsions. This is the incorporation of small particles or globules of oil from 5 micrometres to several millimetres diameter into the water column. The rate of disperation is a function of sea state and of the nature of the oil. Under moderate sea conditions, thin films of liquid oil disperse rapidly and readily into the top metre or so of the sea to the potential enhancement of other weathering processes such as dissolution and biodegration. The persistence of oil-in-water emulsions is encouraged by the presence of surface active agents (surfactants). In their absence the relatively large droplets formed by wave action will not normally remain

CHAPTER III

THE IMPACT OF OIL POLLUTION ON THE SAUDI ARABIAN MARINE ENVIRONMENT

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ON THE SAUDI ARABIAN MARINE ENVIRONMENT

INTRODUCTION

Despite the somewhat unexpected richness of marine life in the Saudi Arabian marine environment, as seen in chapter I, it is very demanding environment to which many of its inhabitants have to make special adaptations. In this, as in other special environments, the biota make up for low diversity by a great abundance of the few tolerant species; but there is always the danger that such an ecosystem may be unable to adapt to changed circumstances. The results of human interference, superimposed upon demanding natural conditions, may lead to serious disturbances of the equilibrium which a less stressed system could more readily absorb.

Oil spills can have a deleterious effect on all marine life. Organisms in the water column are affected directly by the oil in the water, either because of its toxicity or because it coats or smothers the organisms. Much of the oil floats on the surface as a thin film. This can have a disastrous effect on aquatic birds which alight in the slick. Eventually, much of the oil will settle to the seafloor, where it can wreak havoc on benthal organisms. Oil which washes up on beaches is unsightly, but more importantly it can poison sublittoral organisms and destroy beach flora and marsh grasses. In addition, fish and shellfish may take up hydrocarbons in their tissues, thereby posing a human health problem if they are ingested.

The impact of oil pollution depend upon a number of factors not least the type of oil, the amount, the degree of spreading and weathering and the clean-up response adopted. Moreover, the severity of the effects will depend on the season and weather conditions prevailing at the time of the spill.

Because of this and the variation in the characteristics of the Saudi Arabian marine environment and resources at risk, the range of potential effects is considerable and a comprehensive review is beyond the scope of this study. A brief survey of this complex subject is therefore provided in this chapter. A referance will also be made, where possible, to the recent major oil spills affecting the marine environment of Saudi Arabia. Finally, a brief description of the environmental sensitivity analysis conducted by Aramco of the coastal areas along the Arabian Gulf will be provided. This analysis identified the most vulnerable biotopes, permitting the on-scene co-ordinator to determine which areas should receive protection priority.

EFFECTS OF OIL POLLUTION

-Toxicity of Petroleum Hydrocarbons

Water-soluble components of crude oils and refined products include a variety of compounds that are toxic to a wide spectrum of marine plants and animals. Eggs, larvae, and young forms are generally more sensitive than adults. At sub-lethal concentrations, oil constituents cause physiological or behavioural disturbances and, possibly more importantly, may cause developmental abnormalities in fish and other animals, almost certainly resulting in their early death.

Aromatic compounds are more toxic than aliphatics, and middle-molecular-weight constituents are more toxic than high-molecular-weight tars. Low-molecular-weight compounds are generally unimportant because they are volatile and rapidly lost to the atmosphere. A spillage of diesel fuel, with a high aromatic content is therefore much more damaging than bunker fuel and weathered oil which have a low aromatic content. A spillage of petrol or other "white spirit" may present a serious fire hazard, but has little impact on marine organisms in the water.

It is impossible to make more precise statements about the toxicity of oil. Any sample of crude oil or refined petroleum product may contain several thousand different compounds in varying proportions which begine to change from the time the crude oil is extracted from the ground. Toxicity tests on aquatic organisms have to be carried out on water-soluble extracts of an oil but the nature and concentration of the toxic compounds in the extract are unknown. Studies of the toxicity of individual hydrocarbons may give greater precision, but give no guidance to the toxic effects of the complicated mixture in an oil sample.

In any oil spill, a great variety of compounds in various proportions are released; they are toxic to various degrees to the wide variety of plants and animals exposed to them; and the organisms vary in their susceptibility to oil pollution damage depending upon their age, and maturity, the time of year, and other factors. The pollution is likely to cause mortality which, depending on the circumstances, may be very heavy. In addition to the immediate damage, there may be long-term effects resulting from sublethal doses of the toxins to eggs and young. The long-term effects could well be of more concern than the immediate losses. Laboratory toxicity tests are of little value in these circumstances and attention must, instead, be turned to the experience of the impact on the natural environment following oil spills of various types in different circumstances, (1).

EFFECT OF PETROLEUM HYDROCARBONS ON MARINE COMMUNITIES

Damage from oil contamination may result either from single spills or from low-level continuous discharges. In a single spill, the organisms often experience a severe initial impact which may cause the death of less-resistant species. Eventually, however, the area will become cleansed of the oil, and the marine communities will recover. This recovery may take only a matter of weeks for rocky shores where the area can be cleansed rapidly, or it may take up to several years in soft-bottom or marsh areas where the oil may persist for long periods of time. Continuous, low-level contamination from ports, refineries, or wastewater treatment plants may not cause sudden changes in the community structure as oil spills do, but they may lead to a gradual, permanent population shift due to the chronic sublethal effects of oil.

-Effects on Fisheries

Any adverse effects of oil on fisheries is of prime importance because of their commercial value. Fish kills due to oil pollution have occurred, but the numbers involved are not usually significant. This is most likely due to the ability of fish to avoid oil-impacted areas. Areas exposed to chronic oil ampacts, such as waters around oil production platforms, have usually experienced little or no reduction in numbers of fish present. The greatest threats are to benthic fish which may encounter high cocentration of oil, and to spawning areas, since the larval stages of fish are much more sensitive to oil poisoning.

Although evidence of fish kills is rare, tainting by oil or the accumulation of carcinogenic aromatic fractions in fish tissue can be a serious problem. Exposure of some species to as little as 1 mg dissolved petroleum hydrocarbons per liter can result in tainting. Humans can taste petroleum hydrocarbons in animal tissue at concentrations between 5 and 20 ppm. In addition, it is known that fish and shellfish bioconcentrate carcinogenic aromatic compounds in their tissue. At present it is not known whether consumption of these materials poses a hazard to human health,(2).

The biological effects of reported spills in Saudi Arabian Gulf coast have been considered in detail by Aramco since the early seventies, following a pipeline rupture at the northern end of Tarut Bay,(14,000 tonnes spillage). Mortalities amongst the plants and animals of the shore were low enough to permit fairly rapid recovery, and, although local fisheries were temporarily disrupted, the approximate synchrony of this spillage with the decline in shrimp landings is clearly coincidental,(3).

The second study was organised by IMO and FAO at the request of the Government of Bahrain, with the purpose of assessing the impact of a relatively large oil spill contaminated the north and west coast of Bahrain during the last week of August and the first two weeks of September 1980,(up to 2,750 tonnes spillage).

During the acute phase of the spill, observations of dead fish were reported. Thus, dead jacks, groupers and sardine-like fishes have been observed, although no massive mortality has been reported. At the end of September no observations of dead or dying fish that could be related to the oil spill could be made.

In some areas the fish catches had dropped after the spill according to some fishermen, although others had claimed that there had been no effect on catches. The basic impact of the oil on fisheries in the Bahrain area appears to be due to :

(1) Destruction of fishing gear. Barrier and wire traps and gill nets that become smeared with oil were in most cases destroyed and had to be renewed;

(2) Loss of catch. During the period when the oil was floating on the surface it prevented fishing in the area;

(3) Contamination of other equipment. Boats, engines (water-cooling systems), ropes, etc.were smeared with oil and had to be cleaned before use.

A total figure of 225,000 dinars has been calculated as the likely figure for equipment destroyed and catch lost. This damage appears to have been substantial,(4).

The third study was recently carried out by the Saudi Arabian Meteorological and Environmental Protection Administration (MEPA) following the major oil spill (up to 205,000 tonnes) into the Arabian Gulf from the Nowruz oil field located in Iranian waters (January 1983-January 1985). The chronic nature of the Nowruz spill produced frequent incursions of heavily weathered oil into Saudi Arabian waters. The oil appeared in three basic forms, namely, rafts of oil-mats, sheen, and tarballs of varying sizes.

From early March until the end of April 1983 MEPA collected evidence of a wide spread kill of marine animals along the Gulf coastline of Saudi Arabia. Initial sightings occurred at Abu Ali and Dawhat Zalum and involved a wide variety of marine organisms ranging from marine invertebrates (molluscs, crustaceans) to air breathing marine reptilas (sea snakes, sea turtles), mammals (dolphins, dugongs, and one whale) and seabirds.

Mortality figures were gathered during beach survillance of about 60 % of the coastline south of Abu Ali, and ground survillance of Arbiyah and Qiran islands. Several of the survillance areas such as the north coast of Abu Ali and the Gulf of Salwah are collector sites. Extensive ground survillance was carried out to enable reasonable assessment of the magnitude of the kill event.

By the end of April 1983 the tally of marine animal kills observed was :

Fish (pelagic, reefal, benthic)	600
Sea snakes	1,500
Turtles (hawksbill, green)	56
Birds	200
dugong	36
Porpoise	33

The large majority of the dead animals found were too decomposed to permit either chemical analysis or pathological examination of their tissues. Gross examination indicated extreme irritation of skin of the reptiles (turtle skin redness, snake skin shedding) and extreme irritation of oral membranes, lungs, and gills of the vertebrate types. Also, individual air-breathing organisms were observed gasping for breath at the water surface prior to beaching and death.

As part of the hydrocarbon and heavy metal study, pathological examination were made of fresh fishes and shrimp. Here, symptoms and lesions were considered not significantly different to normal populations. Coincident in time with the "marine animal kill" reports was the entry of oil sheen and tarballs into and progressing through Saudi Arabian waters. However, there is no proof that the "kill" was a result of Nowruz oil or its chemical/physical effects on Gulf waters. No repeat of the kill was apparent during the period of May-June when intrusions of Nowruz oil into Saudi waters reached their peak. Observation at Qiran and Jana islands, in April and May show reef flat areas contained usual assemblages of reef fishes but with reef front species occurring in atypically large numbers in the shallows. This may have been a response to a local change in the food chain as MEPA surveys in September indicated a "normal" distribution of coral reef fish.

At the onset of the Nowruz spill the Gulf of Salwah dugong population was estimated to be in the region of 50-60 individuals based on a survey from 1979. As a result of the marine kill the dead dugong on the Saudi Arabian shore totaled 34 (ca.50 % juveniles) with an additional two specimens reported from Bahrain. These surveys did not include all the Saudi Arabian Gulf of Salwah shore and no information was available from Qatar. Two live dugong were sighted by aerial surveillance in late April. The MEPA assessment was that the Gulf of Salwah dugong population may have been reduced to a dangerously low and probably non-viable level and may very well become extinct if the 1979 population estimates were accurate.

While dead green turtles were found during beach surveillance, from June to September considerable nesting activity and swiming adults were observed on the islands. The status and well-being of nesting and newly-hatched green turtles continued to be monitored.

Irrespective of the causal factor involved in the death of the dugongs and hawksbill turtles, these populations have been severely affected. A faunal replenishment program has been commenced by MEPA and is aimed at determining census and habitat surveys with a view to producing a viable management plan for these threatened species, ($_5$).

Over all, it can be concluded that no long term adverse effects on fish stocks have been attributed to oil, although local impacts can be extremely damaging in the short term.

-Effects on humans

Recently, GESAMP (1985) convened a group of experts to prepare a preliminary report on 'the impact of carcinogenic substances on marine organisms and implications concerning puplic health'. It was concluded that when carcinogens in marine organisms were not metabolized or destroyed by cocking, there existed some risk of cancer induction in humans consuming such organisms. The magnitude of these risks is not known, but may be assumed to be related to the nature of the compound, its concentration in the organisms and the actual quantity of marine produce consumed. Thus it is probable that only in those populations with a very high dietary intake of contaminated seafood are there likely to be detected any adverse health effects.

Crustaceans, fish and molluscs exposed to oil conditions can acquire an objectionable oily taste, associated with the presence of volatile compounds derived from oils, refined products or dispersants. The range and quality of odorous compounds vary with the type of oil-refining process, with the middle distillate fractions such as diesel oil containing the greatest number.

Oil pollution may also affect human populations by fouling nets and fish traps. This is likely to cause particular local hardship in shallow water subsistence fishing areas, (6).

The waters of the Arabian Gulf are valuable national food resource for Saudi Arabia and sustain important commercial and artisanal fisheries. Because of the potential threat to puplic health posed by the marine animal kill and the Nowruz oil spill a Royal Decree was issued to place a ban on fishing in the Gulf waters of Saudi Arabia.

On May 14, 1983 MEPA commissioned studies of factors affecting fisheries on the east coast of Saudi Arabia. The purpose was to determine whether the environmental factors producing the marine animal kill affected fish taken in commercial fishing, thus posing a threat to the health of people including fish in their diet. The study aimed at producing recommendations on the issue of whether the ban of fishing should be continued to whether the evidence permitted it to be lifted.

The study sampled fish species representative of those taken commercially in Saudi waters in numbers representative of the relative proportions of commercial catches. Fish were collected in major commercial fishing grounds to the northeast of the Qatar peninsula. The species samples were :
Hamour, Shaeri, Shirwi, Shrimp, Hamra, Safi, Baagha

Fish samples were analysed for :

i) Hydrocarbons derived from Petroleum

ii) Toxic metals

iii) Any pathologically indicated toxin.

All resultant data were compared with national and international standards and guidelines appropriate to the safeguard of puplic health. The results of the study showed that the fish tissue had levels of n-alkanes comparable with values found in clean water environments and indicated no obvious oil pollution. Significantly no aromatic hydrocarbons were detectable and this is the group where carcinogens would occur.

Concentrations of cadmium, chromium, nickel, and vanadium were below levels set as maximum permissable levels internationally, and could not be considered a health threat. Pathological examination did not reveal any conditions considered to be significant and there were no pathologically indicated toxins.

The results of the study did not justify a continuance of the ban on fishing. All pollutants were below levels set as a threshold to puplic health, and MEPA recommended the reopening of the fisheries,(7).

-Effects on birds

The main effect of oil on marine birds is matting of the waterproof plumage, thus allowing water to displace air trapped between the feathers and skin. Surface-active agent contamination of the plumage also facilitates wetting, even if the feathers are not matted. The loss of trapped air results in reduced buoyancy and insulation.

Those birds which do not sink and drown require an increased metabolism of food reserves to counter heat loss. Since a severly oiled bird is unable to forage efficently, rapid depletion of fat reserves and muscular energy resources leads to death. Fumes from freshly spilled petroleum hydrocarbons are often toxic and birds may ingest sufficent amounts of oil, in preening attempts, to induce intestinal irritation and hepatic and renal damage. The effects are all likely to be compounded by stress and shock in the affected individual,(8).

Considerable numbers of dead or dying birds were observed during the acute phase of the oil spill in the north and west coast of Bahrain (1980). Particularly on the island of Umm Nasan and from the Muhammadi areas, relatively large numbers of affected birds have been reported. Based on these reports, the actual number of birds that have died due to the oil spill may be as many as 1,000. The species that seem to have been most affected by the spill are common cormorants, and Socotra cormorants. The number of cormorants killed, although large in itself, does not seem large enough to produce any long-term effects on the populations of these species in the coastal areas of Bahrain,(9).

MEPA's report of the Nowruz oil spill indicates that initial observations (March-July) indicated bird life had been little affected by the oil spill. However, in April a considerable number of dead birds were reported on the Saudi Arabian shores of the Gulf of Salwah, including at least 45 cormorants near one rookery. The cause of death here is not known, although a number of oiled birds was observed.

The coral islands sustain tern rookeries, wading bird populations and are commonly visited by migratory bird species. From individual observations during the middle to late breeding season (August/September), MEPA observers estimated a total breeding population of ca.5,000 terns at Qiran island and ca.6,000 terns at Jana island. A total of 47 (Qiran island) and 89 (Jana island) oiled, flightless birds (mainly terns) were sighted; most of these birds have died.

The oiled, flightless birds are unable to continue active feeding and frequently starve. Loss of insulation by feathers may also decreased through September during the seasonal migration of the terns away from the nesting sites,$(_{10})$.

-Effects on coral reefs

The destruction of coral reef communities by oil pollution may have a wide-ranging consequences due to their importance as seen earlier in the previous chapter. Further, if an ecosystem is isolated, delay in the replacement of organisms will considerably prolong the duration of the effects of oil, long after the pollutant itself is dispersed.

Evidence that oil damages corals has been inclusive in studies where crude oil was floated above natural reef outcrops and experimental specimens. Other studies have demonstrated that corals such as Acropora spp. and Pocillopora spp. can be coated with oil and seriously damaged. Field studies in the northern Gulf of Aqaba, Red Sea, which recorded the near-complete demise of shallow-water corals exposed to oil pollution at an unusually low tide have been complemented by laboratory experiments on the Red Sea coral Stylophora pistillata. Sublethal, chronic exposure to Iranian crude oil in the latter study induced a significant ($P<0.05$) decrease in the number of female gonads per polyp in 75 % of polluted colonies of the hermatypic coral. A useful bibliography on the effects of oil spills and dispersant use on coral is to be found in the recent review of this subject by Knap et al.(1983),($_{11}$).

There is little evidence for significant deterioration of reefs due to oil pollution in the Red Sea. This may partly be because reef communities are essentially sublittoral and oil floats over them. Reefs in the Red Sea do support a limited amount of coral growth in the intertidal. However, this growth is, perhaps, not as significant as it is in those regions with a higher tidal range. An oil spill will kill off any intertidal coral that it smothers. Coral growth in the sublittoral is unlikely to be affected by an oil spill except in a restricted number of cases where the oil spill is massive and/or the coral is growing in an area where water circulation is limited and the oil is not blown/carried away.

The greatest danger to coral reefs from an oil spill is probably the indiscriminate use of dispersants. Dispersants may either cause the oil to sink onto the reef, smothering sublittoral coral growth, or through their own chemical toxicity pollute the water column and damage, or kill, the corals growing in that column,($_{12}$).

In Tarut Bay, Arabian Gulf, healthy growing Acropora spp. in 2.5 - 4.6 meter of water has been observed in an area subjected to chronic oil pollution from a nearby oil terminal (Ras Tannura), (13).

MEPA's report on Nowruz oil spill indicates that the offshore island waters were impacted with oil sheen and tarballs during late March to June. Heavy concentrations of tarballs have been observed in the intertidal zone with subsequent beach burial and intertidal/subtidal working of the oil occuring, with resultant leachate spreading from the shore to the surrounding reef flats. Periodic beachline clean-up has been carried out.

Detailed observations continued to be made of the leeward system at Qiran island and the reef system at Jana island. At Qiran island between late March and May there was evidence of widespread mortality of corals, mucus and zooxanthellar release (a sign of physiological stress), a bloom of a single macroalgal species (*Colpomenia*), and an apparent absence of the usually commonly found grazing organisms (eg.the sea urchins *Diademe* and *Echinometra*) were not commencurate with purely seasonal variations normally associated with these and other high latitude reefs.

MEPA observers believe that Nowruz oil derivatives, especially local leachates, may have been responsible directly for coral mortality, and indirectly for the *Colpomenia* bloom (here through mortality of grazers).

By mid-September,1983 reef communities at Qiran island were establishing "typical" forms with sea urchin populations and other invertebrate grazers being present, existing coral colonies apparently in an actively growing mode, encrusting red algae and algae turf communities evident in characteristic niches, and an absence of the earlier bloom of Colpomenia macroalgae.

A program of qualitative and quantitative monitoring of the benthic reef communities is continuing. Unfortunately the reef and islands have been subjected to continuing impactions from spills from the Tanker war and other sources, and assessment is a continuing program,(14).

-Effects on coastal vegetation

Salt marshes and, in the tropics, mangrove swamps are, like intertidal mud-banks, low-energy areas likely to trap oil, and the plants which form the basis for these ecosystems suffer accordingly. Both are important ecosystems at the boundary between land and sea. They control coastal erosion, are a source of organic production which is transferred to the sea, and they provide shelter for the young stages of marine organisms, some of commercial value.

The effect of oil pollution on annual plants living in a salt marsh depends on the season: if the plants are in bud, flowering is inhibited; if the flowers are oiled they rarely produce seeds; if the seeds are oiled, germination is impaired. Generally it may be expected that annuals will be killed by oiling and be dependent on reseeding from outside the area; recovery of annual populations may therefore require two or three seasons. Perennials show a range of reactions. Shallow-rooted plants with no or small food reserves, such as Sueda maritima or Salicornia are readily killed. Others will generally survive at least a single exposure to oil and perennials with large food reserves, e.g. with taproots, survive repeated oilings. Generally the foliage is cut back, but decomposing oil has a nutrient effect and there is rapid and luxuriant renewed growth (a 'flush'). Experience of isolated oil spills suggests that oil pollution of this kind is less damaging to salt marshes than efforts to clean up the oil.

Mangroves present a rather different problem. They live in anoxic muds and have extensive air spaces carrying oxygen to the submerged part of the tree. Lenticels, by which the air is taken up, occur on the aerial roots of Avicennia or proproots of Rhizophora, and if the lenticels are clogged with oil, the oxygen level in the root air spaces fall to 1-2 % of normal within two days. Although mangroves have certainly suffered damage by oil spills, there are a number of cases where heavy oilings have not killed the plants. Too few studies of these tropical ecosystems have been made to allow a proper assessment to be made of their vulnerability to oil pollution,(15).

There is little evidence of damage to mangroves and seagrass beds in the Red Sea coast of Saudi Arabia through oil pollution. However, there are many locations where seagrasses occur in shallow/intertidal water where an oil spill would have a significant impact,(16).

MEPA's report on Nowruz oil spill indicates that the effects on seagrasses and soft-bottom communities have not been assessed in detail. However, there were no reported changes in bed distribution or atypical mortality adjudged from beachline and drift observations. A detailed survey is being undertaken as part of a major study of the marine environment of the Arabian Gulf,(17).

-Effects on beaches

The most obvious effects of marine oil pollution is the residue stranded on beaches and shorelines, covering rocks, sand, plants, and animals with a dark film. Lumps of tar, formed by weathering of oil, drift into shore and are also stranded. The sight and odor of these materials substantially diminishes the aesthetic appeal of the beach area. Unfortunately, their occurrence on beaches is rapidly increasing. It is becoming increasingly difficult to find any stretch of beach not contaminated to some degree by oil.

Researchers have recently come to realize, however, that the cleaning procedures often do more biological harm than the oily pollutants themselves. Thus their is a conflict between the desire to have an aesthetically pleasing beach on the one hand and the need to protect the shoreline ecosystem on the other. These conflicts have been resolved in many places by the adoption of a shore classification system which will allow contingency planners to best protect coastal environments most likely to be seriously damaged by oil. One such system, called a "vulnerability index," is shown later in this chapter, ($_{18}$).

MEPA's report on Nowruz oil spill indicates that tarball and tarball mats have impacted the intertidal zones of most coastlines and oil aggregates are noticeable in the subtidal areas of sandy beaches. The degree and lateral extent of the impact is less than expected in relation to the oil discharge rates. Shoreline impacts since August 1983 have been minimal. Limited clean-up of certain amenity beaches and of Qiran island has been carried out, (19).

-Effects on industry

Industries that rely on seawater for their normal operations can be adversely affected by oil pollution. Power stations, in particular, are often located close to the coast in order to have access to the enormous quantities of water required for cooling purposes. If large quantities of oil are drawn in through intakes located near to the sea surface contamination of the condenser tubes may result, requiring a reduction in output or total shutdown whilst cleaning is carried out. Such measures can have widespread and costly consequences on other industries and the community as a whole. Whilst considerable concern is always expressed for the safe operation of power stations during oil spills detailed investigation of the problem or the incorporation of adequate protective measures at the design stage have rarely been carried out.

Other industries that use water for cooling purposes can be similarly affected. The normal operation of desalination plants that draw water from near the sea surface can also be jeopardised by oil spills. A cessation of operations may again result, causing water supply problems to the community.

Oil spilled in harbours and ports or in their approaches can also disrupt ship movements and result in contaminated mooring lines and jetties. Booms operations to contain oil or to prevent its ingress into docks can cause further disruption. Ship movements may also have to be temporarily suspended whilst clean-up operations are implemented in areas of confined waters.

Further disruptions can be caused if the spilled oil is a fresh crude oil or a light refined product as the high concentration of volatile components in the air will cause a risk of explosion and fire. This may result in the temporary cessation of local industries, such as shipbuilding and repairing, loading and unloading of vessels, general traffic and all other activities that might give rise to a spark or naked flame,(20).

MEPA's report on Nowruz oil spill indicates that coastal industrial sites, including desalination and power plants, oil refining and loading facilities, naval commerical and industrial ports, have been minimally affected by Nowruz oil. Several large underwater mats of oil were observed near the Ghasalan power plant water intake. Underwater surveillance near other sensitive coastal industrial sites is maintained and underwater remote sensing equipment is being considered for deployment.

The Jubail and Al Khobar desalination plants have maintained production throughout the spill period, with limited shut-down at Al Khobar while protective booms were deployed.

The Saline Water Conversion Corporation (SWCC) plants, Aramco and port facilities are protected by a combination of emplaced booms and mechanical collection equipment. Nowruz oil collected in the vicinity of the industrial facilities has been of small volume and generally has involved tarballs or tarball aggregates,(21).

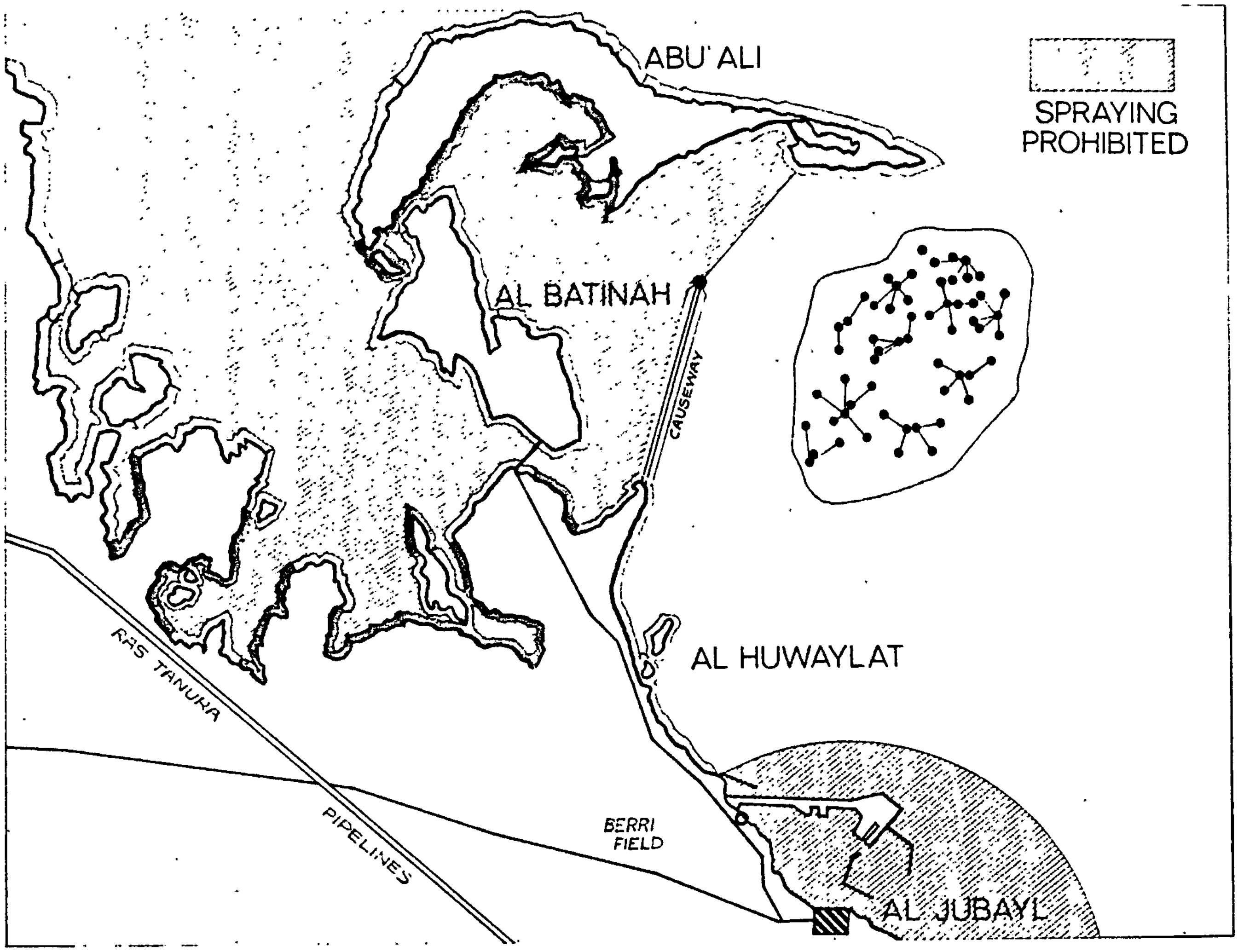
OIL SPILL VULNERABILITY MAPPING

Along the Arabian Gulf coastline of Saudi Arabia, the coastline varies significantly from mangrove marshes to rocky beaches. As the type of beach varies, so does the environmental sensitivity of the shoreline to oil spill impacts.

Contingency plans prepared by all oil companies must identify the areas most vulnerable to the effects of an oil spill. One system found to be effective in evaluating long coastlines was developed by the USA's Environmental Protection Agency (EPA) in their Manual of Practice for Protection and Clean-up of Shorelines. This system classifies the shoreline as one of 10 types: sheltered tidal flats, exposed tidal flats, sand beaches, mixed sand and gravel beaches, gravel beaches, cobble beaches, boulder beaches, sheltered rocky coasts, exposed rocky headlands and exposed wave-cut platforms.

The sensitivity of each type of shoreline to oil pollution has been studied and is well documented in the literature. Once the shoreline is surveyed and each section classified as one of the 10 generic types, the most environmentally sensitive shoreline sections are easily identified and the oil spill clean-up coordinator is guided in allocating his resources. Use of this system reduces the need for site specific research, which is time consuming and very expensive.

In order to prepare a vulnerability index for the Aramco operating areas, an Aramco marine biologist conducted a survey in 1980 of the entire Arabian Gulf shoreline of



COASTAL VULNERABILITY INDEX

COASTAL TYPE	VULNERABILITY	REMARKS
MANGROVE MARSH	1	MOST PRODUCTIVE COASTAL AREA. SENSITIVE TO OIL
OFFSHORE ISLANDS	2	CRITICAL TO GULF ECOLOGY NESTING LOCATION FOR THREATENED SPECIES. OILED SHORELINE EFFECTS BIRDS AND TURTLES
MUD FLATS	3	PRODUCTIVE AREA SUBJECT TO HARM IF DISPERSANTS USED IN SHALLOWS
CORAL REEFS	4	PRODUCTIVE AREA SUBJECT TO HARM IF DISPERSANTS USED IN SHALLOWS
MUDDY SAND	5	MODERATELY PRODUCTIVE. PREVENT OIL FROM PENETRATING SAND
ROCKY BEACHES	6	LOW TO MODERATE PRODUCTIVITY HARD TO CLEAN
SAND BEACHES	7	LOW BIOLOGICAL PRODUCTIVITY

Figure III-I: Oil Spill Volunerability Mapping. (ARAMCO)

Saudi Arabia. Helicopter flights and vehicles were used to inspect the entire length. Following this inspection, the following classifications -slightly different from those of the EPA because of special coastal features- were established. They are presented here in order of decreasing environmental sensitivity.

<u>1) Mangrove/salt marsh:</u> These are similar to sheltered tidal flats. This is a highly productive but diminishing habitat. Rapid industrial and urban development has taken over many marsh areas, increasing the importance of protecting those that remain.

<u>2) Offshore island:</u> This is a special classification to reflect the importance of the offshore islands to the ecology of the Arabian Gulf. These islands are fringed by environmentally sensitive coral reefs and are breeding grounds for birds, turtles and fish.

<u>3) Mudflats:</u> This a type of tidal flat not commonly found along the Arabian Gulf shoreline. These are highly productive habitats that have low water exchange.

<u>4) Coral reefs:</u> This is another special classification to reflect the biological importance of coral reefs in the western Arabian Gulf. Due to the relatively high salinity and poor water exchange found in the Arabian Gulf, coral reefs are not widely present.

<u>5) Muddy sand:</u> A type of exposed tidal flat, this habitat is more prevalent than mangroves or mudflats along the Saudi Arabian coastline. It is moderately productive and will support mechanized equipment to conduct a clean-up operation.

6) Rocky beaches: This low to moderately productive habitat is not a common beach type along the Saudi Arabian coastline. It is normally difficult to clean effectively and the oil must often be left to weather naturally.

7) Sand beaches: This is the most common shoreline type in Saudi Arabia and has low biological productivity. Generally, mechanical devices are useful to remove heavily oiled sand. Minor oiling can be left to weather naturally, unless the beach is a publicly used amenity.

After classifying the coastline and adding the location of key industrial water intakes, the Aramco oil spill clean-up coordinator has the information he needs to assess the priority of shoreline protection and allocate his equipment accordingly. The vulnerability index maps have been given to local authorities to assist in national oil spill contingency planning, (22).

See figure III-1: Coastal Vulnerability Index of the Arabian Gulf coast of Saudi Arabia.

A similar classification study is believed to be prepared by the International Union for the Conservation of Nature and Natural Resources (IUCN) with the cooperation, advice and financial support of MEPA as part of a work programme on "Conservation and Management of the Saudi Arabian Red Sea Coastal Areas".

EFFECTS OF CHEMICAL DISPERSANTS ON THE MARINE ENVIRONMENT

The important consequences of adding dispersants to the environment are three-fold. Firstly the dispersants can exert their own toxic effect on plants and animals in the water or on the shore; secondly, they may modify the form and availability of the oil to exert its effects; and thirdly, they may interact with the oil to produce more, or less, harmful effects. Generally dispersants increase the amount of oil in the water column, either as emulsion or solution, and therefore they increase the risk of effects from this type of pollution. When used on shore, dispersants can reduce the viscosity of stranded oil so taking it into contact with animals deep in burrows or crevices that would otherwise have avoided contact with the oil. Concentrated emulsions or solutions of oil and dispersant may run off beaches into shallow water and there affect sublittoral organisms. Dispersants can lead to the deeper penetration of oil in soft sediments such as sand and mud, where it may produce greater biological damage or prolong the period over which the amenities of the beach are affected, (23).

Consequently, care must be taken to limit or avoid dispersant use where environmental impact might be greater for dispersed oil than for undispersed surface oil. Three habitats have been identified along the Saudi Arabian Gulf coast to be of particular concern: (1) shallow coral reefs (less than 3 meters depth); (2) tidal mud flats; and (3) lagoons with poor water exchange. Although not a habitat, concern needs to be directed at water intakes, particularly those used for desalination plants, (24).

CHAPTER III

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CHAPTER IV

COMBATING OIL POLLUTION IN THE SAUDI ARABIAN MARINE ENVIRONMENT

CAPTER IV

COMBATING OIL POLLUTION

IN THE SAUDI ARABIAN MARINE ENVIRONMENT

INTRODUCTION

It is an unfortunate fact of life that many oil spills occur close to coastal areas which may be of ecological importance or socioeconomical value, and if these are to be protected, some form of response is required to combat the oil before it can cause damage.

The basic policy of most countries is that if an oil spill is likely to pose a threat to its coastal resources then every attempt should be made to deal with it at sea, thus preventing the damage, high clean-up costs and public outcry that are often associated with extensive pollution of inshore waters and shorelines. However, the limitations of most offshore response techniques frequently result in extensive contamination of inshore waters and shorelines.

The fundamental attitude of most countries is that the party causing the spillage should be responsible for cleaning it up. However, the extent to which this policy is implemented depends upon factors such as size, nature and location of the incident. Thus most governments expect industry to respond to minor oil spillages at fixed installations such as terminals, refineries, or offshore exploration and production platforms as the operators are already on site and therefore should be able to respond rapidly and effectively.

The combating of oil pollution of the sea may call for close international co-operation. This is particularly necessary when one is faced with large quantities of oil and the pollution occurs in restricted sea areas surrounded by many countries, e.g. the Red Sea and the Arabian Gulf. This need for co-operation is mainly based on two factors. First, the nature of the oil itself - it spreads and moves with the effect that the pollution in a short time may cover an extended area constituting a threat to one or more of the coastal states in the area. Secondly, oil combating is difficult as well as expensive. It calls for large resources of equipment and personnel as well as for a quick response capability in every part of the sea area in question.

To aid understanding of the main sections of this chapter, a brief review of the available offshore and onshore clean-up techniques with particular emphasis on those which have found widespread use is presented in the first part of this chapter.

The main purpose of this capter is however, to review the measures to combat oil pollution in Sausi Arabia. First, at the national level with particular emphasis on the role of the oil industry. Secondly, at the regional level in which Saudi Arabia is a party to several regional agreements. The basic approach adopted within Saudi Arabia is discussed in relation to clean-up policy, designation of clean-up responsibility, organisation for clean-up response, manpower and equipment resources, and research and development.

OIL SPILLS CLEAN-UP TECHNIQUES

-Chemical Dispersants

The natural process of emulsification of oil in the water can be speeded by the addition of chemical agents. Sufficient energy of agitation must be provided to produce emulsification and dispersion of the oil droplets so that they do not coalesce and re-form as a slick. The emulsifier is sprayed on to the slick from booms slung over the side of the vessel and agitation provided by the vessels screws (which is not very effective) or by a structure rather like a five-bar gate which is towed behind the spraying vessel.

Dispersants in use at the time of the wreck of the Torrey Canyon were more toxic to marine organisms than the oil they were meant to disperse, and in a number of countries there was a marked reluctance to use these products. Modern dispersant emulsifiers have a reduced toxicity of two or three orders of magnitude and there use is not usually allowed unless the toxicity of the oil/dispersant mixture is no greater than that of the untreated oil.

The chief limitation on the value of dispersants is not their effectiveness but their operational application. A single spraying tug can treat a swath of oil slick perhaps 20 meter wide, so numerous tugs are required to disperse a sizeable slick within a useful time. The limited horizon from the bridge of the tug also makes it difficult to locate streamers and isolated slicks of oil. A new generation of dispersants can be sprayed onto the oil from the air and cause dispersion without added agitation. This technique provides the opportunity to treat larger slicks more effectively, ($_1$).

The following conclusions and recommandations were derived at from field experiments on natural and chemically-induced dispersion of oil performed in the North Sea by the North Sea Directorate of Rijkswaterstaat and Delft Hydraulics Laboratory in 1983:

1) There is no point in trying to disperse an oil which can not be dispersed effectively. Non dispersable oils are:

- non spreading oils
- high viscosity oils (>2000 cSt)
- water-in-oil emulsions
- oil slicks in the third phase of spreading.

2) Above mentioned stages of non dispersable oils will be reached in short notice due to weathering processes. The time available for effective chemical dispersion might be as little as a few hours.

3) The mechanical recovery method has always first priority and could be used up to a significant wave height of 1.50 meter. Above these wave height natural dispersion is the best and effective combating method.

4) Only when dealing with larger slicks may it be necessary to consider the chemical dispersion method in addition to the recovery method. But in case of non dispersable oils or marginal effectiveness of the chemical dispersion method it may be wise to accept the unrecovered oil come ashore to be treated there.

5) In case dispersants are used the dispersant/oil ratio should be higher than laboratory experiments have shown to achieve an effective dispersion.

6) Instead of using dispersants to increase the dispersion process additional energy could be applied on dispersable oils by boats as an alternative, $(_2)$.

-Physical Removal

One objection to the use of dispersants is that while they remove the slick, the oil is still present in the water and this may be regarded as brushing the dirt under the carpet rather than solving the problem. A better solution, if it is practicable, is to remove the oil from the surface of the water.

It is possible to absorb oil into materials such as powdered cork, peat, or straw, but this is not effective on large quantities of oil. First, the absorbent has to be distributed over the whole slick and this presents similar problems of locating the oil as with spraying dispersant on it. Next, having distributed the absorbent, it has to be collected up again, so doubling the work-or halving the amount of oil that can be treated within a limited time.

A variety of "slick-lickers" have been developed in which a continuous belt of absorbent which dips through the oil and is then passed through rollers to extract the oil as the belt comes on to the ship. Such devices have proved useful for mopping up small oil spills in sheltered waters in harbours, but they are not very effective at sea.

Floating booms can be used to channel the oil to one place where the slick is then thick enough to be pumped out and much of the water can be separated from the oil. Properly sited, such booms are effective in rivers where they can be anchored. It has proved more difficult to devise effective booms for use at sea. A boom consists of an air-filled core with a weighted "skirt" below and a "sail" above, but at current speeds of more than a few knots or in waves 30-50 cm high, oil is carried under or over the boom. One solution has been to build bigger booms and to allow them to drift with the current; since they travel more slowly than the oil slick, oil accumulates behind the boom and can be pumped out. Even when booms have been successfully deployed at sea, much oil inevitably escapes in any large spillage and the usefulness of booms is limited.

-Sinking

If a dense oleophilic material, such as sand coated with stearates, is distributed on an oil slick, the oil is carried to the sea bed. This method of disposing of an oil slick has been tested experimentally, but is not favoured for operational use because of uncertainty about the fate of the sunken oil. There is a suspicion that much of it later returns to the surface, or if it stays on the seabed that it is transported to other areas by bottom currents. There is thus a danger of fouling fishing gear, and it is likely that bacterial degradation of oil clumped in masses by the sinking agent is slow.

-Burning

Among the measures used to limit oil pollution from the Torrey Canyon, were attempts to burn off the oil. While a considerable amount of oil was disposed of in this way, coastal pollution was still massive. A number of wicking agents have been developed; these provide wicks standing above the surface of the oil to assist combustion. In practice it is difficult to ignite floating oil and because of the cooling effect of the seawater underneath the slick, it is difficult to sustain combustion. Furthermore, the oil is rarely in a continuous slick but is broken into separate streamers, each of which needs to be ignited separately. On the whole, burning is not a realistic way of disposing of oil spilled on the sea.

-Gelling Agents

Chemical agents have been developed which convert the oil from a liquid to a gel. Theoretically, these agents can be sprayed on an oil slick which could then be rolled up like a carpet. The principal difficulty, as with other treatments, is that of applying the chemicals to a large enough area of oil for this to be an effective remedy. Gelling agents have not been used operationally.

-Natural Dispersion

Whenever oil is spilled in the sea there is always the option to do nothing and leave the oil to disperse naturally. The vast majority of oil slicks disappear at sea without human assistance and even 20,000 - 30,000 tonnes of oil discharged into the North Sea following the blow-out in the Ekofisk field dispersed naturally.

-Beach Cleaning

The foregoing methods are designed to treat oil while it is still at sea, but if these are ineffective, oil may come ashore and it may be necessary to clean contaminated beaches. If a large quantity of oil is stranded and the shore is accessible, much of the oil can be pumped into road tankers and removed, thus reducing the chance of the oil being removed on a succeeding tide and redeposited elsewhere, thereby extending the area that is contaminated. Even when it is possible to recover some of the oil from the beach, a considerable amount remains on and between rocks and drained into the substratum. The techniques employed to remove this depend on the nature of the shore and since the treatment is often more damaging to the fauna and flora than the oil itself, It is often preferavble not to attempt to clean up an oiled beach. The decision to clean or not to clean depends on the value placed on the beach. A tourist amenity beach has a high priority for cleaning because the fauna and flora is of far less interest than the preservation of oil-free conditions.

Rocks, harbour walls, and similar surfaces may be cleaned by high-pressure hoses, high-pressure steam or dispersants. If chemical agents are used, they must be accompanied by a large volume of water in which the oil can be dispersed. To achieve this, rocks are sprayed with dispersant ahead of a rising tide when breaking waves provide the agitation and water volume to remove the oil. Alternatively, the rocks must be hosed down after the dispersant has been applied.

Dispersants are useless on pebble or sandy beaches because the dispersed oil merely drains into the beach; it disappears from the surface only to reappear at some later date. The only means of cleaning such beaches is to remove the oiled surface layers of the substratum, either manually or by bulldozer.

These are drastic treatments and the damaging effects on the fauna and flora can be reduced by using straw or cut vegetation as an absorbent to mope up much of the oil. On sheltered rocky shores with a good algal growth, a large amount of oil is trapped in the seaweeds which can be cut and gathered. Physical removal of the oil by these methods results in only partial cleaning and much oil remains.

Unless beach oil can be dispersed into the sea, any beach cleaning operation produces a large volume of oil-contaminated debris. A few tonnes of oil can easily result in hundreds of tonnes of oily sand, pebbles, and other debris, and disposal of this material presents a serious problem. It can not be incinerated unless the oil content is very high; it is usually unsuitable for dumping on waste tips because of the risk of the oil leaching out and contaminating water courses; and oil refineries can not deal with it. It is possible to plough oily material into land where bacterial degradation eventually disposes of it, but this is unlikely to be an effective way of dealing with large quantities of oily material. At present tipping on waste dumps where the oil can be contained appears to be the only practicable, if unsatisfactory, solution, (3).

CLEAN-UP POLICY

A major percentage of Saudi Arabia's combat capability against oil spill is centred around the use of chemical dispersants. The MEPA policy on dispersants is based on two primary considerations which consider :

1) What sort of dispersants and chemical response agents may be used; and

2) Where approved dispersants may be used.

In addressing item (1) the policy sets down procedures for approval. In addressing item (2) the policy recognises three classes of area.

1) Those where dispersant use is permitted at the discretion of the On-Scene Commander;

2) Those where dispersant use is permitted only with prior MEPA approval; and

3) Those where dispersant use is prohibited.

These classes of area are based on sensitivity maps prepared on the basis of environmental and puplic health considerations. The map for the Arabian Gulf is completed, and is based on best available data. MEPA policy also envisages frequent review of designated areas as the data-base and dispersant technology change, (4).

"The Nowruz Oil Spill 1983-Plan of Action" developed and published by MEPA, reaffirmed that shoreline clean-up where necessary was to follow the general guidelines of the Oil Companies International Study Group for Conservation of Clean Air and Water - Europe (CONCAWE) Report 9/81 titled "A Field Guide to Coastal Oil Spill Control and Clean-up Techniques", (5).

DESIGNATION OF CLEAN-UP RESPONSIBILITY

The overall authority and responsibility for implementation of the National Contingency Plan for Combatting Pollution by Oil and Other Harmful Substances, is vested in the Environmental Protection Co-ordinating Committee (EPCCOM) whose members are drawn from all the Government Ministries likely to be involved in any incident involving major pollution. The working secretariat for EPCCOM is the Meteorology and Environmental Protection Administration (MEPA). The Plan is designed to ensure a co-ordinated national response to any pollution emergency which may threaten puplic health or welfare. The Plan allows for the creation of two main centres (one for the Red Sea coast and one for the Arabian Gulf coast) with smaller centres covering the principal ports in each of the main areas. Responsibility for operational aspects will mainly fall on the Saudi Arabian Port Authority and the Ministry of Petroleum in the first instance, but it is possible that eventually the Royal Saudi Navy and Saudi Frontier Forces (Coastguard) will also play an active part in oil spill clean-up activities.

Although the plan is aimed primarily at oil spill emergencies, it is flexible to be able to address environmental emergencies of other types. The Plan has been approved at the first meeting on 29.4.1984 of EPCCOM and is presently before the Council of Ministers for consideration, (6).

The full text of the National Contingency Plan for Combatting Pollution by Oil and Other Harmful Substances has been included as Appendix 1

Subject to the environmental specifications and measures provided by MEPA, all organizations having marine or coastal facilities will undertake combat and clean-up of oil spilled within their areas and shall provide and maintain adequate equipment to undertake that task. These organizations are:

- Ministry of Petroleum and Mineral Resources and the associated oil companies;
- Ministry of Industry and Electricity;
- Saline Water Conversion Commission;
- Saudi Frontier Forces;
- Royal Saudi Navy;
- Saudi Ports Authority;
- Royal Commission for Jubail and Yanbu; and
- any other organization having marine or coastal facilities which is designated by MEPA.

Outside these areas the appropriate Municipality and the Frontier Forces are responsible under the supervision and co-ordination of MEPA's Regional Co-ordinator, (7).

ORGANISATION FOR CLEAN-UP RESPONSE

At the onset of the Nowruz blow-out MEPA through its charter was responsible for the provision of National Coordination for Spill response in Saudi Arabia. To meet the requirements of the Nowruz Spill, MEPA established an Oil Spill Response Task Team in March 1983. After an initial interagency meeting MEPA formed two groups to meet with relevant authorities and agencies. The responsibilities of the groups were:

Group A Identification of protection needs; allocation of priorities; evaluation and coordination of protection activities and capabilities; identification of sensitive coastal facilities.

Group B Identification of environmental protection capabilities and zones for response activities; identification and evaluation of clean-up and disposal capabilities and techniques; establishment of methodologies and response priorities.

The activities of Group A resulted in the coordinated deployment of immediate protection capabilities according to an agreed priority schedule. Desalination plants were accorded top priority. The requirements for additional and specific combat and protection equipment were identified and recommended to responsible authorities.

The activities of Group B resulted in agreed division of the coastline of the Eastern Province into eight operational zones which recognised, the wishes and jurisdiction of authorities; and clean-up capabilities for coastal regions. Within these zones clean-up activities required MEPA's approval and coordination. Clean-up techniques were recommended to follow those set down in CONCAWE Report No.9/81 titled "A Field Guide to Coastal Oil Spill Control and Clean-up Techniques". MEPA undertook and prepared sensitivity maps for the Arabian Gulf coastal regions and laid down policy for dispersant use. With the cooperation of various agencies MEPA identified, and ground-truthed disposal sites for recovered oil.

The Nowruz Oil Spill Action Plan, mentioned earlier, formed the basis for the management, co-ordination, and integration of all activities associated with spill response. From March through May 1983 field operations were co-ordinated through the Eastern Province Directorate of MEPA at Dhahran. From May 28, 1983 the Oil Pollution Control Centre (OPCC) was established at King Fahad Industrial Port, Jubail and this became the focal point for control of operations.

Through OPCC, MEPA co-ordinates daily surveillance operations, carries out local assessments, and provides advice and recommendations for operational activities. This information and regional data are channelled to MEPA's Headquarters in Jeddah for national, regional and international assessment and integration, (8).

MANPOWER AND EQUIPMENT RESOURCES

The oil companies provide the majority of the hardware for use in spill clean-up operations. Some port authorities do have equipment and more in order, but precise details are not available of what is on hand or planned for the future. The Arabian American Oil Company (ARAMCO) holds the largest stock of oil pollution control and clean-up equipment in the Arabian Gulf, most of it being dispersant spray equipment of one sort or another. ARAMCO is unique amongst the oil companies in the Arabian Gulf in having a full-time oil spill clean-up group dedicated to the task of oil pollution control in and around the Company's oil exporting terminals. The equipment held by the Arabian Oil Company at Ras Al Khafji in the Divided Zone further augments the equipment holding of ARAMCO, (9).

RESEARCH AND DEVELOPMENT CAPABILITY

During and following the Nowruz Oil Spill MEPA through its charter gave special attention to studies on innovative combat measures and environmental and public health related studies.

The use of modified fish nets for collection of oil-mats had some success in Saudi Arabia. Several techniques using absorbents were examined, those included the use of granulated charcoal; and the use of the inert substances, perlite, for oil aggregation. The use of biological degradation methodologies such as mass-cultured oil-degrading bacteria; and the provision of a food substrate containing an appropriate balance of carbon:nitrogen:phosphorous to encourage an increase of naturally-occurring, oil-degrading bacteria in oil/water areas.

In conjuunction with Exxon and ARAMCO, MEPA arranged and evaluated a special product test on a wethered slick in an area free of sensitive receptors. The test protocols were developed by MEPA and not only sought information on the ability of the product to visually disperse the oil from the surface, but also gave prominence to the environmentally important issues of the trajectory and rate of dilution of the plume of dispersed oil-dispersant.

MEPA carried out studies on the behaviour of oil in collaboration with the University of Petroleum and Minerals (UPM), Dhahran, using samples of wethered Nowruz oil taken from the surface of the Arabian Gulf and samples of Arabian Gulf seawater. The observed behaviour under simulated laboratory conditions provided a theme which unified the range of apparently puzzling surveillance data, the erratic trajectories, the apparent disappearance of sighted oil and the observation of sheen, light brown oil, and heavily matted oil slicks.

MEPA has addressed the environmental factors affected or likely to be affected by the rapid resource based development of the eastern province, and has developed a study program to investigate basic oceanographic parameters, the chemistry of marine animals, sediments, and water column, and current and tide statistics. Additionally attention has been focused on quantifying coastline and water column impactions of oil. The study is being undertaken on MEPA's behalf by UPM and has commenced. The protocols adopted are such that the study will be used to fulfil the Saudi Arabian commitment for oceanographic studies called for under the Kuwait Action Plan, ($_{10}$).

In addressing its responsibilities for the control of pollution and protection of the environment, MEPA has established or is developing a number of programs and procedures to protect the environmental quality of Saudi Arabia. These include:

- the establishment of environmental protection standards to protect air and water quality,
- the development of standards for groundwater quality, land pollution, noise pollution and toxic and hazardous substances,
- the development of environmental impact assessment procedures,
- the development of a protected areas program,

- the establishment of a national environmental public awareness program,
- the drafting of proposals to stop trade in endangered species and their products,
- the issuing of licenses for the export of fauna, and
- the formulation and co-ordination of policies and measures for combatting oil pollution.

Most of these activities are Kingdom-wide in scope. Some of the programs such as measures for combatting oil pollution and establishment of marine protected areas are specifically orientated towards the coast, (11).

The Faculty of Marine Science, King Abdulaziz University, Jeddah is actively engaged in the management of the Saudi coastal waters by three research projects. The first is mainly concerned with fisheries and aims to evaluate the commercial fisheries, search for new ground for commercial fish and introduce and apply new methods and techniques for fishing. The second research project is mainly an environmental assessment program designed by the Faculty of Marine Science and will be implemented with the cooperation of the National Oceanic and Atmospheric Administration to evaluate the increasing impact of domestic and industrial activities on the marine environment in the Red Sea water along the Saudi coast between latitudes 21^{o}-25^{o} N. The third project is dealing with the ecological survey of the coral reef ecosystem in the vicinity of Jeddah with the cooperation of University of Nice, France. The Faculty of Marine Science had plans to establish a Training Centre for marine and meteorological technicinas. The Faculty of Marine Science had planned to establish a National Data Centre to collect and process marine data from the Red Sea, the Gulf and other adjacent seas, (12).

ARAMCO OIL SPILL RESPONSE PROGRAMME

ARAMCO has prepared for oil spills in four ways: 1) response planning, 2) equipment development, 3) training and 4) developing and strengthening the Gulf Area Oil Companies Mutual Aid Organization (GAOCMAO). The planning aspect had to come first in order to develop an adequate response to an oil spill. Planning included developing a basic philosophy or policy of spill control, deciding on the size of spill to which the response preparations should be geared, setting up an organization to respond to a spill when it occurred and detailing as such as possible what had to be done in the event of a spill. It must be remembered, however, that each major spill is unique, and planning, no matter how through, can not cover every conceivable contingency.

ARAMCO's policy on spill control has been established for a number of years. It is based on three principles: 1) protection of human life, 2) protection of critical facilities and 3) protection of the environment. Only the second part of this three-pronged policy needs further comment. Many spill response plans do not actually state that protection of critical facilities is a basic requirement, but because of ARAMCO's unique role in world oil production, this point has been specifically identified as an integral part of the company's spill control philosophy. Loss of a major facility due to a spill could have severe repercussions on world oil supply as well as cause economic losses to the Saudi Arabian Government. This is why protection of facilities is stressed.

As mentioned previously, everything about ARAMCO's operations is exceptionally large: tonnage shipped, tankers loaded, offshore pipelines, etc. The potential spill size could conceivably be 3 to 4 million barrels if two tankers collided. This, however, is a highly unlikely event and one does not plan a spill programme to meet such an occurrence; indeed the whole of western Europe could not handle a spill of such magnitude. Instead, the decision was made to be able to control a spill in the 50,000 barrel range. This decision was based on likely losses through a damaged loading hose, a wing tank of a VLCC, an offshore trunkline or a well blow-out at five to ten thousand barrels per day. These are the types of spills that are far more likely to occur than a catastrophic tanker accident like that of Amoco Cadiz.

With the philosophy of the spill control laid down and a limit placed on the magnitude of spill that should be dealt with, a response organization was developed. The concept used was to structure the organization so that it could handle both large and small spills. The organization was therefore compartmentalized both vertically and horizontally, so that only certain segments would be activitated for smaller spills. An organizational digram is shown in figure IV-1. Each block represents a specific function which has been detailed in a response manual. In other wards, there is a job description for each block in the diagram, with an individual and an alternate assigned to each function. These assignments are fed into a computer and given a quarterly update to reflect personnel changes.

The particular Depatment or Business Line at whose facility a spill occurs is responsible for the clean-up

OFFSHORE OIL SPILL RESPONSE TEAM

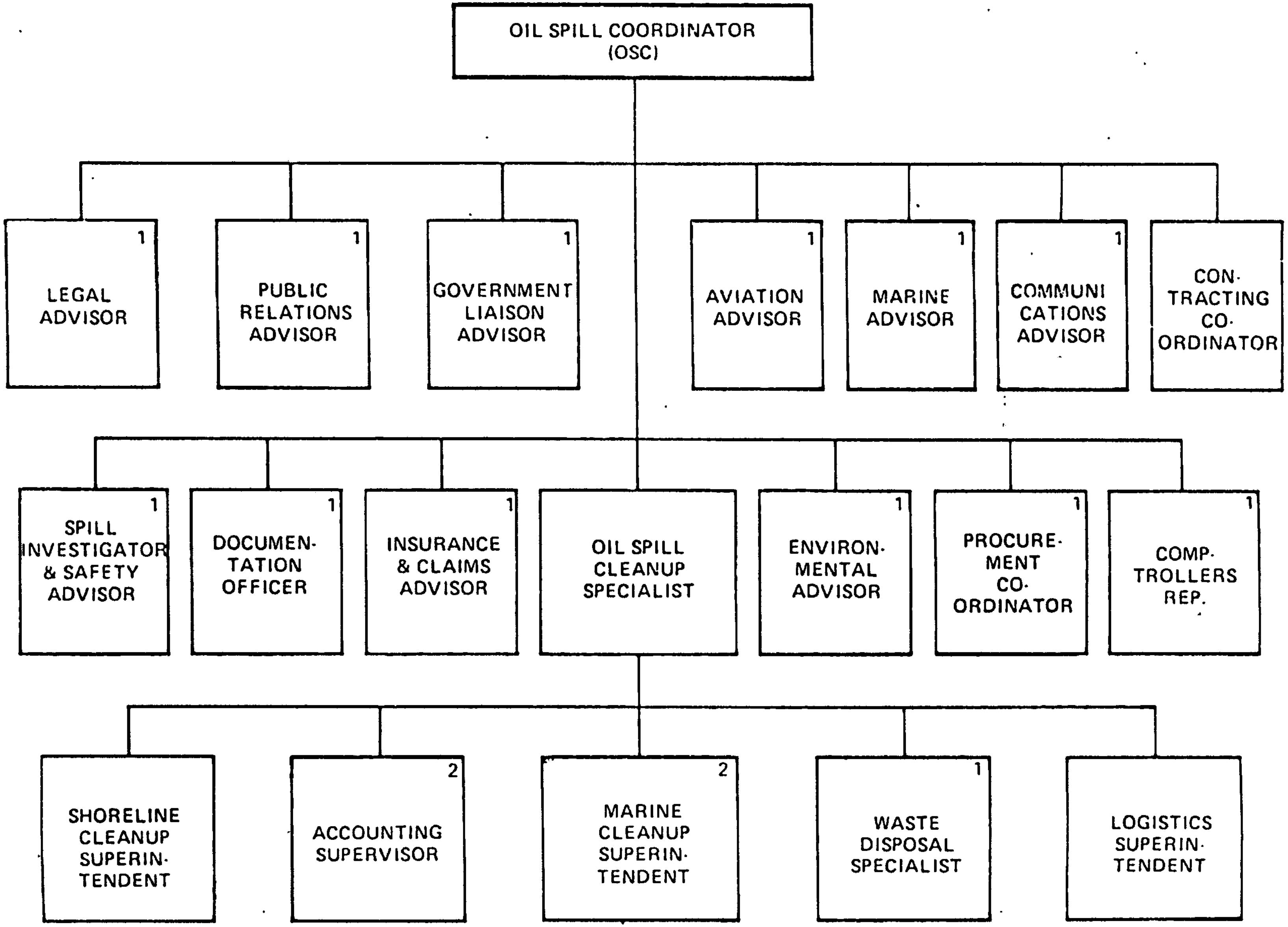

Figure IV-1

operation, although the actual clean-up may be carried out with the assistance of a large number of diverse departments. This responsibility moves higher up the company's management hierarchy as the spill size increase. For example the entire clean-up for a 20 barrel spill may be handeled at the foreman level, where as a 25,000 barrel spill would involve the Administrative Area Vice-President togather with the representatives of various support organizations. This is the vertical compartmentalization mentioned earlier. The oil response teams shown in figures IV-2 and IV-3 illustrate how the organization would be activated in different spill situations.

The spill response plan also includes the Oil Spill Task Force whose members provide the high-level authority needed to support an oil spill response at the expense of other operational activities. Normally, the Task Force duties are assigned to a representative of the Administrative Area Head during an oil spill. In addition, the Task Force acts as a management group for ARAMCO's overall spill prevention and clean-up programme. Individual Task Force members make sure that their respective organizations are prepared to do their assigned part when called upon in an emergency.

The final aspect of the response plan is a general description of what actions to take in the event of a spill. As already mentioned, each spill is unique so that all possible scenarios can not be planned in advance. However, general cases can be outlined and guidelines formulated to help the response team. These are spelled out in the ARAMCO Spill Response Manual, which details reporting procedures, equipment inventories, contractor information, spill trajectory forecasts and other information techniques.

ARAMCO trains the entire range of personnel likely to be involved in an oil spill, from executive managers to marine foremen and skippers who operate the equipment. At the management level, training includes short courses designed by specialists to give the overall picture of oil spill planning and response. These courses help management make decisions on capital equipment expenditures to prepare for a spill, on operational techniques and resources needed to combat a spill and on dicision-making processes which must be implemented in the event of a spill. While executive management is not generally directly involved in the day-to-day clean-up operation, it has been found that the advanced preparation given to management enables a spill response to be carried out more effectively. The management courses help to eliminate the need for detailed explanations during a time of crisis.

At the mid-management or supervisory level, training has become more specific. Again the short course approach has been taken, but in this case the courses are designed to cover actual equipment use and techniques. There are at least a dozen supervisory personnel who have participated in spill response programmes ranging from 40 to 80 class hours. This programme is ongoing with one or two individuals attending courses each year.

At the operating level, training is accomplished while on the job. A spill control unit in the Marine Department is used as a training group for the entire department. A core of permanent staff is kept in the unit and trainees from other units are cycled through the spill control course to give them practical experience. Training includes deployment of booms, maintenance of equipment, application of dispersants and familiarization with marine operations in the event of a spill. The personnel in this unit are also given a five-hour course in spill control that has been prepared on video tape. This course is both in Arabic and English and was adopted from a course professionally prepared in the USA for oil company personnel, (13).

REGIONAL AGREEMENTS FOR CO-OPERATION IN OIL SPILL COMBAT

-KUWAIT ACTION PLAN

In April 1978, a high level conference was held in Kuwait resulting in the signing of the Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from pollution. Its formation was the culmination of years of preparatory work among the eight Contracting States in the Region; Bahrain, Iran, Iraq, Kuwait, Oman, Saudi Arabia and the United Arab Emirates, to tackle urgently and jointly the growing problems of sea pollution and to protect the Marine Environment.

The Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, referred to as the KUWAIT ACTION PLAN (KAP), entered into force on 30 June 1979 and was a result of serious and hard efforts recognized by the Governments concerned and the United Nations bodies, to make such interim arrangements as might be required until the establishment of the Regional Organization for the Protection of the Marine Environment. Thus, the Interim Secretariat was officially inaugurated in Kuwait on 7 July 1980.

In November 1979, forty-six experts from the eight KAP countries met in Kuwait. They had before them the draft programme document setting forth the environmental assessment and management activities to be carried out within the Action Plan. The document described 17 specific projects which the experts revised and amended, as they felt necessary. They divided the projects into thematic groups and assigned them order of priority so that work on certain of them could be started immediately.

The first group of projects, to generate information for use as a basis for subsequent work, included surveys of national capabilities related to the Action Plan (such as the status of institutions, manpower and equipment available in the Region); the status of meteorological studies related to the transport and distribution of oil; a survey of land-based sources of pollution of the Region, and the organizing of a Workshop on marine pollution from ships.

The gathering of baseline information called for in these projects was greatly facilitated by the visit of an inter-disciplinary mission to the Region between March and July 1980. A working group of regional experts met in Kuwait from 5-7 July 1980 to review the results of the mission and to determine the operational details of a second group of projects. This second group of projects constituted a selected field giving a comprehensive picture of how serious pollution in the Region is and what the effects are likely to be. Included in this group are (1) baseline studies on the sources, transport and distribution of oil and petroleum hydrocarbons -(2) physical, chemical and biological oceanography as related to the transport, distribution and fate of oil as a pollutant -(3) assessment of the magnitude of pollutants affecting human health and marine ecosystems -(4) the productivity and distribution of plankton -(5) ecological studies of intertidal and subtidal zones -(6) assessment of geological processes related to the fate and impact of pollutants. The experts also cosidered the feasibility of an oceanographic cruise around the Region to collect data.

The remaining projects largely relate to environmental management and include the assessment of the environmental impact of development activities in the Region, the building up of engineering capabilities related to the environmental management, co-ordination of marine and land transport and establishing of guidelines for coastal development. Still others deal with the biology of commercially important species of marine organisms and assessment of their stocks, management of living resources, co-ordination of water management policies and strenthening of public health services, ($_{14}$).

ESTABLISHMENT OF THE MARINE EMERGENCY MUTUAL AID CENTRE (MEMAC)

The Kuwait Convention, included a protocol concerning Regional Co-operation in combatting pollution from oil and other harmful substances in cases of emergency which outlined -in detail- the objectives and functions for the establishment of a regional centre i.e. the Marine Emergency Mutual Aid Centre (MEMAC), with two immediate objectives:

1) To strengthen the capabilities of the Contracting States and to facilitate co-operation among them in order to combat pollution by oil and other harmful substances in cases of Marine Emergencies.

2) to assist Contracting States, in the development of their own national capabilities to combat pollution by oil and other harmful substances and to co-ordinate and facilitate the exchange of information, technological co-operation and training.

A later objective, namely the possibility of initiating operations to combat pollution by oil and other harmful substances at the regional level, may be considered by the council, after evaluating the results achieved in the fulfilment of the previous objectives and in light of financial resources.

MEMAC was established on 16 March 1983, in premises offered by the host country - State of Bahrain, to implement its programmes. However, since, at that time, the Nowruz blow-out incident was at its peak, becoming a considerable threat to the Marine Environment in the KAP Region, MEMAC's activities were focussed on this emergency. Other emergencies in the region occured over the past year, were large incidents varied in nature and effect MEMAC dealt with some of it, e.g. the blow-out of Khafji K156 in Saudi Arabia waters and the blow-outs of Ardashir and Furoozan oil fields in Iran waters, in addition to tankers on fire such as, Assimi in Oman waters, and Pericles G.C. off Qatar, before the on going attacks on ships and tankers started,(15).

-RED SEA AND GULF OF ADEN

A Plenipotentiary Conference convened by the Arab League Educational, Cultural and Scientific Organization (ALECSO) and held in Jedda, Saudi Arabia, in February 1982 adopted a Regional Convention on the Protection of the Marine Environment of the Red Sea and Gulf of Aden and a Protocol concerning Regional Co-operation in Combatting Marine Pollution arising from Emergencies as well as an Action Plan for the Protection of the Marine Environment of the Region.

The Protocol is closely aligned to that adopted in the Kuwait Action Plan region and it includes all the basic elements of regional agreements. For example, it provides for the establishment of a Regional Commission for Conservation of the Red Sea and Gulf of Aden and a subsidiary Marine Emergency Mutual Aid Centre to strengthen the capacities of the Contracting Parties. However, it is not known when such a Centre will be set up. The Red Sea and Gulf of Aden Environmental Programme (PERSGA), an arm of ALECSO, operating out of Jeddah, provides the secretariat support and technical backstopping for the implementation of the Protocol as well as the Convention and the Action Plan.

In this connection, Democratic Yemen has indicated its interest in establishing a sub-regional marine pollution combatting centre in Aden serving the Gulf of Aden costal States. UNEP has agreed in principle that when the agreement of the other two coastal States is obtained it will financially support a government experts meeting with a view to establishing such a centre with possible funding of the centre by UNEP and other sources along similar lines as the Sulawesi Sea sub-regional centre at Davao, Philippines,(16).

-GULF AREA OIL COMPANIES MUTUAL AID ORGANIZATION (GAOCMAO)

GAOCMAO Agreement of 1972 was perhaps the first of its kind in which the concept of mutual assistance in times of emergency is the keynote. Member companies are obliged under the terms of the GAOCMAO Agreement to maintain in readiness at all times defined minima of oil spill response equipment and oil dispersant chemicals for use in emergency situations, if required. These equipment/materials minima must be made available to a requesting member company when required by the latter for pollution response. In addition, member companies are expected to render such supplementary assistance as they are able when so requested by a member company which is experiencing an oil pollution emergency. The terms and conditions of this assistance are clearly laid out in the GAOCMAO Agreement and it is only in instances where the standard provisions are varied that further negotiations between member companies are necessary. The existance of these "ground rules" greatly facilitates the mobilization of equipment and materials in times of emergency. The original Agreement has been revised three times, the most recent revision being in 1984 when a wholly rewritten and more comprehensive Agreement was adopted by the member companies.

Probably the most significant feature of the GAOCMAO Agreement is the provision for voluntary liability, up to a total of US$20 million, for the oil spill response costs of other member companies, when a member company is itself responsible for oil pollution which affects, or threatens to affect, others. This liability provision has been a unique characteristic of GAOCMAO Agreements since the Organization was first formed. It has no known parallel in any other co-operative agreement between oil companies. The companies of GAOCMAO operate in seven different countries of the Sea Area. Thus, pollution generated in one country by a member company may adversely affect another member company operating in a neighbouring country. In the absence of established procedures, such a situation could be very difficult to resolve. However, through the liability provision of the GAOCMAO Agreement, an agreed claims procedure is available whereby the "innocent" party is able to obtain recompense. All this is done at an inter-company level. The recompense available encompasses only reparation for costs directly incurred by the member company in responding to the pollution; it does not address the question of consequential damage in any of its forms.

The Sea Area referred to is that sub-tropical sea shelf lying between latitudes 25° N and 30° N and centred on longitude 52.2° E. Its western boundary is the Arabian Peninsula whilst in the east it is deemed to terminate at the median line between the Islamic Republic of Iran and the Arab Gulf States. In addition to the water just defined, the Sea Area also includes the coastal waters of the Sultanate of Oman as far south as Muscat.

The objectives of GAOCMAO can be briefly stated as:

(1) to provide a means for joint response to oil pollution by the member companies;

(2) to establish and maintain effective inter-company communication during oil pollution emergencies;

(3) to develop member companies' basic spill response capabilities;

(4) to provide a forum for information collection, dissemination and exchange on all subjects relevant to the oil industry in the Sea Area, with special emphasis on matters relating to oil spill prevention control and response, (17).

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CHAPTER V

PREVENTION OF OIL POLLUTION & LEGISLATIVE ASPECTS IN SAUDI ARABIA

CHAPTER V

PREVENTION OF OIL POLLUTION

AND LEGISLATIVE ASPECTS IN SAUDI ARABIA

INTRODUCTION

In the previous chapter, various methods of dealing with oil pollution were reviewed. It can be left to disperse naturally, it can be dispersed by chemicals, it can be diverted from sensitive areas by booms or it can be recovered; but by far the best method of dealing with oil pollution is to prevent its occurrence.

There is no branch of environmental law which progresses at a faster rate than that relating to oil pollution prevention from ships. It may be pointed out here that shipping, although being recognized as an important source of pollution, should not be indicated as the main contributor to marine pollution.

It is well recognized that shipping is essentially international in character, and rules and standards relating to maritime safety and pollution prevention should be discussed, agreed and implemented at an international level. Since the formation of the Intergovernmental Maritime Consultative Organization (presently IMO), as a specialized agency of the United Nations in 1958, some 30 treaty instruments covering many aspects of maritime safety and pollution prevention has been adopted.

The conventions and recommendations adopted by IMO tackle the problem of marine pollution in a number of ways, namely:

1) Preventing operational pollution by introducing anti pollution measures into the design, equipment and operation of ships.

2) Reducing accidents by introducing strict standards and navigational procedures on a world-wide basis to make shipping safer and consequently help cut pollution resulting from accidents.

3) Reducing the consequences of accidents by measures designed to lessen the amount of pollution if an accident occurs.

4) Providing compensation for damages.

5) Helping implementation

There is no question that the international instruments will provide a complex as well as significant regulatory umbrella for the protection of the marine environment. But the implementation of these instruments depends on the existance of appropriate legislation, and legislation becomes more effective and useful when it emanates from a nation's creed and when it represents its cultural and intellectual heritage. Hence, it is necessary to consider of prime importance the Islamic religion as a factor which is the ultimum guiding influence in Saudi Arabia. Accordingly, this chapter will first discuss the Islamic principles for the protection and conservation of the marine environment. Then a brief examination of some international conventions of importance will be examined, followed by a survey of present national legislation and recent regulatory developments in the field of marine environment protection. Finally, ARAMCO's oil pollution prevention programme will be reviewed.

ISLAMIC PRINCIPLES FOR THE PROTECTION AND CONSERVATION OF THE MARINE ENVIRONMENT

It is necessary to discuss Islamic principles for the protection and conservation of the marine environment in some detail because of its considerable significance in relation to Saudi Arabia's position as a country founded on Islam, and as the only nation to use the Holy Quran as a State Constitution.

Furthermore, the implementation of environmental management depends on the existence of appropriate legislation, and legislation becomes more effective and useful when it emanates from a nation's creed and when it represents its cultural and intellectual heritage. This strong relationship between the effectiveness of legislation and the strength of its cultural roots appears to be all the more necessary when dealing with environmental issues, especially in Islamic societies. For Islam presents a way of life that encompasses an overall view of the universe, life, man and the inter-relationships existing between them and also combines conviction, belief, legislation and enforcement of this legislation, ($_1$).

-Protection and Conservation of All Basic Natural Resources in Islam

God created water as the source and origin of life. God says, "We made from water every living thing". Plants, animals and man all depend on water for life and existence. Without it their lives would cease to exist or continue.

God has also shown us other functions of sea and ocean water. It represents a suitable biotope for many organisms and creatures which play vital roles in the development of this world and the perpetuation of life. God said, "It is He who has made the sea subject, that ye may eat thereof flesh that is fresh and tender, and that ye may extract therefrom ornaments to wear; and thou seest the ships therein that plough the waves, that ye may seek thus of the bounty of God". He also says,"Lawful to you is the pursuit of water-game and its use for food - for the benefit of yourselves, and those who travel".

Conservation of this vital element is undoubtedly the basis for the preservation and continuation of life in its various forms whether vegetative, animal or human. Whatever fulfils and helps to achieve the basic necessities is itself a necessity. Therefore, any attempt at marring the vital and social functions of this element, whether by spoiling or polluting it with any material that would make it an unsuitable environment for some living organism or any such attempts to mar its function as the source of life, will necessarily lead to a complete halt or cessation of live itself. The juristic rule is "what leads to the forbidden is itself forbidden".

No one can doubt the importance, great use and benefit of plants and animals for mankind. Islam emphasizes all measures for the survival and prepetuation of these creatures so that they can fully perform the functions assigned to them, for He considers them living communities, exactly like mankind. God says, "There is not an animal (that lives) on the earth, nor a being that flies on its wings, but (forms part of) communities".

Islam looks upon these creatures in two ways:

- As living creatures in themselves attesting to God's wisdom and omnipotence;
- As creatures subjected in the service of man and playing a vital part in the development of this world.

Hence the necessity of conserving and developing them both for their own sake and for the benefit of mankind, (2).

-Protection of Man and the Environment from Outside Factors and Harmful Impacts in Islam

If Islam is thus keen on the protection of the basic elements of the environment for the benefit of present and future generations, it is equally keen on the protection of man and the environment against the harmful impacts of outside factors, chemical products and wastes. Damage of all forms and kinds is forbidden in Islam. One of the Prophet's traditions says, "No damage or retaliation for such damage is allowed". Prevention of damage and corruption before it occurs is better than cure after it occurs. The juristic rule is "elimination of mischief and corruption placed before the acquisition or production of goods and advantage". Therefore, all acts aiming at achieving good and ensuring benefit such as satisfying human wants, ensuring services and developing agriculture, industry and means of communications, should be carried out without causing damage, injury or corruption of any sort. It follows that necessary precautions should be taken in the processes of envisaging, planning and implementing such acts so that they may not, as far as possible, be accompanied by or result in any form of damage or corruption.

Wates and exhausts, resulting from man's daily and ordinary activities or from industrial activities and uses of modern and advance technology, should be carefully disposed of or eliminated, in order to protect the environment against corruption and distortion and to protect man from the effects of these harmful impacts on the environment, its beauty and vitality, and to ensure the protection of other environmental parameters. Hence, disposal of these wastes and exhausts should not be carried out in a way or ways that would cause or result in similar or more damage or harm. The juristic rule in this connection is "Damage or harm can not be eliminated or removed by causing similar or more damage".

This is also true of the harmful effects of cleansing and other materials used in homes, factories, farms and other puplic or private premises. It is absolutely necessary to take all possible measures to avoid and prevent their harmful effects before they occur, and to eliminate or remove such effects if they do occur in order to protect man and his natural and social environment. If, however, the damage resulting from these materials proves more than their benefits, they should be prohibited. In this case, we should look for effective and harmless or less harmful alternatives, (3).

<u>-Legislative Rules of Islamic Law which Govern All Procedures and Measures for the Protection and Conservation of the Environment</u>

1. Protection, conservation and development of the environment and natural resources is a mandatory religious duty to which every Muslim should be committed. This commitment emanates from the individual's

responsibility before God to protect himself and his community. It is also a common social duty which rulers, administrative and municipal agencies and organizations undertake in accordance with the responsibilities assigned to them.

2. Islamic law stipulates the interference of the ruling authorities for the good and interest of all people and to eliminate common mischief and corruption. This is their original and primary duty. This interference is also determined and limited by the general rules and implications of Islamic law and jurisprudence and by the actual, lawful tasks and responsibilities assigned to them. The juristic rule in this connection is "The leader's actions are determined and dictated by the common good". The State's legitimate interference is aimed at interests against any other conflicting interests.

3. The interests of the nation and the community should be preferred to the interests of individuals in the case of conflict. Any limited harm or damage to a particular individual could be accepted if it leads to a general avoidance and control of general damage to society and the environment at large. Similarly, overlooking, or even neglecting, private interest for the purpose of achieving and protecting the common interest of the public is the same as opting for the lesser evil and avoiding the greater damage by the accepting the lesser. The juristic rule in this respect is "If two evils or mischiefs confilict, the lesser could be accepted to avoid and prevent the greater".

4. Interests are to be assessed and classified according to their importance and urgency. There are fundamental interests, needed interests and luxury interests. Preference and priority should be given to fundamental interests if these conflict with needed or luxury interests. In the same way, priority should be given to needed interests if these conflict with luxury interests.

5. Interests differ in degrees of actuality and urgency. There are actual or urgent interests, and projected or probable interests. It goes without saying that priority should be given to actual or urgent interests in case of conflict with any other projected or probable interests.

6. Some actions help to achieve some interests, but they may bring about similar, even heavier, damage and mischief. The juristic or doctrinal rule in this connection is "Avoidance of mischief should be given preference and should come before the achievement of interests", because the first step towards the achievement and realization in the common good is to eliminate mischief.

7. The primary duty of the ruler and his assistants, whether they are administrative, municipal or judicial authorities, is to do their best to realize the interests of individuals for the betterment of life and society as a whole. This also includes protection, conservation and development of the environment and natural resources. This process covers two major phases:

- Prevention of damage;
- Remedy of damage.

8. The State has the right to take all measures and actions to avoid, prevent or minimize damage before it occurs in application of the following rules: "No damage or retaliation for such damage is allowed" and "annihilating all pretexts leading to mischief".

- The State has the right to forbid any action, wether temporary or permanent, that may lead or result in damage or mischief. No one is entitled to stop or even spoil the community's sustainable use of any of the basic elements or resources of the environment. This applies to air pollution by smoke, and exhaust from factories and cars. It equally applies to water pollution through the dumping of toxic materials into them to render them unsuitable or unfit for use.

- The State has the right to limit the scope of action, its place, time, kind and quality so as to prevent, avoid, control, minimize, or limit damage or restrict it to a certain place or time.

- The State has the right to impose certain measures technical standards to prevent the occurrence of damage, or minimize it, or restrict it to the least and narrowest scope possible and with the least possible impact. Experts and specialists are to undertake this task, each in his own field.

9. The State has the right to take all necessary measures and actions associated with the elimination of actual damage, repair of its effects and provision of indemnity for it in application of the rules that "Damage or mischief should be eliminated and removed", "Damage or mischief should not be removed through similar damage or

mischief", "Look for and resort to alternatives in case the original becomes impossible" and "Obligation or necessity does not annihilate or delay the rights of others".

- The State, for instance, has the right to hold individuals, organizations, establishments and companies responsible for the elimination and removal of damage resulting from their activities, enterprises and projects which are needed for the welfare of the whole community and which may result in, or lead to damage to, the environment and the natural resources or elements. The rule in this connection is "Damage or mischief should be removed as much as possible".

- The State has the right to impose moratoria on certain projects or enterprises if it realizes that such projects or enterprises will lead to, or result in, real damage to the environment that is in excess of the benefits thereof. The elimination of mischief should be given preference and priority to the fulfilment and achievement of interests. If, however, the community is in urgent need of some action that may result in certain damage, the need in this case should be considered a necessity in so far as it permits the forbidden. Excuses and pretexts for such actions should, in this case, be carefully and precisely assessed each time, according to its own circumstances and situation. If, however, the need for such harmful actions vanishes, the authority should stop these actions or impose moratoria on them for "Whatever is permissible for a certain reason or pretext becomes null and void when that reason pretext vanishes or becomes irrelevant".

- The State has the right to hold individuals, organizations, establishments and companies responsible for the cost of eliminating the damage resulting from unlawful activities in violation of the terms of licences, charters, permits or contracts. The juristic rule is "The user or executor is a guarantor even if his act is not deliberate or intentional". Nevertheless, individuals, organizations, establishments and companies should not be held responsible for any damage or mischief that may result from exercising their lawful and legitimate or licensed rights, within the usual and legitimate limits and in accordance with common practices. "For legal permission annihilates indemnity and guarantee" according to the juristic rule.

- The State has the right to claim damages or indmnity from individuals, organizations, establishments and companies for avoidable damage to the physical or natural environment, resulting from unlawful activities which can not be eliminated or recovered.

- The State has the right to censure or blame individuals, or the owners of organizations and establishments or their designees, should they infringe or violate the terms of licences, charters, permits or contracts intentionally or deliberately or through evident negligence or violation of the general policies and instructions set forth by the State for the conservation of the natural environment, its elements and its resources, (4).

INTERNATIONAL LAW OF MARINE POLLUTION

As far as the framework of international law relating to marine pollution is concerned, there are now some 40 international conventions and related instruments which, in one way or another, address the problem. Some of these instruments are of direct interest to the shipping industry whilst others are more peripherally related to the problem. Nevertheless, it is quite clear today that all of them have contributed to the international legal regime of marine pollution prevention which exists today. Accordingly, they must be viewed as a total "package" rather than as separate rules. In the past the shipping industry has often concentrated its efforts only on those rules which had a functional and direct impact on its operations. That appears to be short-sighted as it does not address the problem as perceived by the regulatory process. This is even reflected in the international conventions and instruments themselves which, until recent years, have concentrated more on liability and compensation than on prevention, (5).

Although, the point being made can best be illustrated by a closer examination of the various international conventions and instruments, there is little need to give very much detail here. However, some of the most important ones, particularly those concerned with oil pollution prevention, liability and compensation will be examined very briefly.

-The United Nations Convention on the Law of the Sea,1982

This Convention was the result of the most ambitious-ever attempt by the United Nations to reform international law. The Third U.N. Law of the Sea Conference (UNCLOS III) originated in 1967, when the mineral resources of the deep seabed where first debated in the U.N. General Assembly. This resulted in the establishment of the U.N.Seabed Committee, Which became a preparatory committee for a full-scale law of the sea conference very soon after. The inconclusive result of the Geneva Law of the Sea Conferences made a new conference almost inevitable. In particular, the limit of national jurisdiction, undecided after Geneva, would become one of the central UNCLOS III issues. Much of this had very considerable implications for the shipping industry.

As could be expected, shipping had been somewhat uneasy about UNCLOS III, particularly as the thrust for the Conference had come very much from the Third World. However, in addition, the possibility of extended national maritime jurisdiction in the oceans, raised the spectre of new regulatory measures aimed at shipping in maritime areas up to 12 miles and, possibly 200 miles, from coasts. Furthermore, after the Stockholm UNCHE, UNCLOS III was also charged with drawing new international rules for the protection of the marine environment.

UNCLOS III held sessions from 1973 to 1982 and became much more than an international conference. It was a "law reform movement" which attempted to redistribute ocean resources and ocean uses. In general, this attempt was successful despite the fact that serious problems continue to exist in the area of deep seabed mining which has caused problems for the U.S. and several other advanced industrial states. Nevertheless the Conference produced a massive new convention of over 300 articles most of which have already gained acceptance. In addition, it is the general view that even though the new convention is unlikely to enter into effect for a few years, many of its provisions have already become customary international law. In any case, for shipping the Convention provides "umbrella" legislation in a variety of areas. It provides:

a. new jurisdiction for coastal states in 12-mile Territorial Seas; 24-mile Contiguous Zones; 200-mile Exclusive Economic Zones; Archipelagic Waters, and especially environmentally endangered waters.

b. extensive new provisions for the protection of the marine environment in Part XII of the Convention which gives coastal states considerable powers to protect their marine environment in the new jurisdictional areas. The Stockholm UNCHE state obligation to protect the environment is fully and clearly incorporated.

c. new provisions regarding the rights and responsibilities of coastal, flag and port states concerning vessels in ports, inland waters, territorial seas, economic zones and archipelagic waters and on the high seas.

In addition, the Convention also provides for dispute settlement, as well as technical assistance to developing states in aspects relating to shipping and environmental protection. The International Maritime Organization (IMO) is clearly designated as the "competent international organization" and its treaties are thus further legitimized by the U.N.Convention on the Law of the Sea.

There is no doubt that the new U.N.Convention on the Law of the Sea is of great significance to world shipping. Maritime transportation is now reduced to one of many competing ocean uses. At the same time, shipping is addressed basically as a polluting industry and the rules relating to shipping are almost all environmentally-oriented. This appears to have lost sight of the "real" commercial purpose of shipping and emphasises the need for a maritime transit convention which will provide much-neede regime for international sea transport which is presently regulated in a very fragmented manner,(6).

-International Convention for the Prevention of Pollution of the Seas by Oil,1954. (OILPOL'54) Ammended in 1962 and 1969.

OILPOL'54 has now been succeeded by MARPOL'73/78 and is, therefore, strictly speaking, no longer applicable. However, as MARPOL only became in force in October 1983, the OILPOL provisions will remain effective for many sates until they ratify MARPOL and/ or denounce OILPOL.

OILPOL was adopted in London in 1954 and was a significant convention at that time. It was the first international treaty exclusively designed to deal with the oil pollution problem. It prohibits the international operational discharge of oil and oily mixtures by certain ships in specified areas of the oceans. Thus ballast discharges have to be confined to permitted areas and all loading and discharging operations must be recorded in an "oil record book", which is inspected at regular intervals. Amendments to the Convention, in 1962 and 1969, expanded its scope modestly, mainly by narrowing the "permitted areas" for pollutant discharges. The 1969 amendment was in response to the TORREY CANYON disaster which had illustrated some of the weaknesses in OILPOL. An amendment in 1971 was designed to deal with the environmentally vulnerably waters of the Great Barrier Reef of Australia, but has not entered into force. It is now doubtful if it will. A second 1971 amendment attempted to deal with the tank sizes of tank-ships. It was felt that smaller tank sizes might result in less pollution, particularly due to collision and stranding. There was considerable opposition from the ship construction industry and this amendment has consequently also not entered into force.

Thus whilst OILPOL has now been superseded it will, nevertheless, continue to be a part of international marine pollution law for some time to come.

-International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution, 1969 (INTERVENTION 1969).

The Intervention Convention was another result of the TORREY CANYON disaster. It gives coastal states limited rights to take preventive measures on the high seas against vessels which are considered to present grave and imminent danger to coastlines and other coastal interests from oil pollution as a result of a maritime casualty.

There is no question that this Convention caused very considerable debate as it was a real departure from the traditional international legal principle which allowed no interference in the ligitimate operations of vessels on the high seas. Thus, for the first time, states other than flag states, were permitted to take preventive and mitigating action against foreign vessels provided that there was a realistic concern that oil pollution might result in major harmful consequences.

The Convention has been criticized both for allowing too much descretion to coastal states and for limiting the rights of such states to take action. It has been in effect since 1975 and has been accepted by a large number of states. In 1973 a Protocol covering substances other than oil was added. It entered into effect in 1983.

-International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL'73).

MARPOL is the most important international marine pollution convention to enter into effect in maritime history. MARPOL was concluded by an international conference held under IMCO auspices in London in 1973 and attended by delegations from 77 states. The Convention, for the first time, addressed the total problem of marine pollution and thus considered not only oil pollution. There had, of course, been concern that polluting substances other than oil might, in some circumstances, be even more harmful to the marine environment than oil. In addition, the new Convention also attempted to regulate other polluting sources such as sewage and garbage from ships. MARPOL also contains Annexes which deal with noxious liquid substances in bulk, and harmful substances carried in packaged form or in containers.

MARPOL consists of a Preamble, the main body of the Convention of 20 articles, two Protocols and five Annexes. As already indicated, the Annexes set out actual preventive regulations. The Convention took ten years to enter into force. Furthermore, it would have probably taken longer if it were not for the 1978 Protocol which allows states to adopt the Convention while only accepting Annex I (Oil Pollution Regulations). As a result the Convention is presently in effect only with Annex I.

The 1978 Protocol, generally known as the "Tanker Safety and Pollution" Protocol, as it was brought about by the series of shipping disasters which had occurred in the winter of 1977/78, also entered into effect in October 1983. Although it purports to be a simple amending protocol, it stands on its own and is basically a separate convention. Accordingly, MARPOL is often titled "MARPOL'73/78", (7).

-<u>International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC 1969).</u>

This important convention was another direct result from the TORREY CANYON disaster. That accident had shown that the traditional liability aspects of maritime law could not deal satisfactorily with claims arising out of oil polltion. As a result, a separate oil pollution liability regime had to be created.

The purpose of the Convention is, of course, to provide a uniform set of international rules and procedures for determining liability and, as a consequence, provide compensation to those who noted that only oil is covered under the Convention. Furthermore, only oil carried in bulk as a cargo is included. Vessels in ballast are thus not covered.

Liability for damage from pollution is placed on the shipowner and is "strict". In other words, there is no need to prove negligence. The shipowner has to prove that certain exceptions exist if he wishes to avoid liability. Exceptions are limited to war, natural phenomena of an exceptional nature, wrongful acts and negligence of the victim, as well as the failure of authorities in maintaining navigational aids.

However, in most cases where the shipowner can not avail himself of such exceptions, and where he is not held to be at fault, he can limit liability to approximately USD 160 per ton with a ceiling of approximately USD 17 million per incident. An amending protocol to the Convention, which entered into force in 1981, replaces the original gold standard of compensation calculation with the Special Drawing Rights (SDR) of the International Monetary Fund.

In order to be covered under the Convention the ship must carry commensurate insurance. Under the Convention ships must also carry certificates confirming the existance of such liability insurance. Such certificates are demanded by many states as evidence of adequate coverage.

The Convention only applies to damage caused in the territory and territorial sea of states which are parties to the Convention, although the flag state and the shipowner's state need not be parties to the Convention. Action against those liable under the Convention must be brought in the state where the damage occurred, and the shipowner wishing to limit liability must establish his fund similarly to the method used in other limitation proceedings. The court which assumes jurisdiction over such a fund will have sole responsibility for apportionment and distribution of the fund.

A Protocol was developed during 1984 at the IMO in response to concerns that the CLC convention was no longer able to fully meet the demands of major pollution incidents.

The CLC Protocol raises liability limits for ships up to 5,000 GRT to about USD 3.1 million (in SDR funds). For larger vessels, the limit is increased by tonnage-based formulas to a maximum of about USD 62 million for vessels of 140,000 GRT and above. If proven damages exceed the shipowner's liability the 1984 Fund Protocol would provide additional compensation.

-International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971 (FUND 1971).

Even before the CLC entered into force in 1975, marine insurance underwriters relized that for very large-scale pollution incidents the CLC limits might be inadequate. As a result a supplementary convention-FUND 1971- was concluded to provide cover for catastrophic pollution incidents. FUND 1971, as its name implies, consists of a fund financed from levies on the import and export of oil in contracting states. Once again, only oil (cargo or bunkers) carried in bulk by vessels is covered. Parties to the FUND must also be parties to the CLC and, the flag state of the vessel which caused the damaged, must also be a party to the FUND if the shipowner is also seeking compensation. In approximate terms the FUND allows cover of about USD 54 million maximum aggregated with any available CLC cover. The administration of the FUND has the power to increase the maximum to USD 72 million. The available defences of the FUND are: where and hostilities; negligence of the claimant, and lack of proof that the oil was split from the vessel in question. Claims against the FUND are brought in the applicable courts of contracting states.

Like the CLC, the SDR was also introduced as the unit of account for liability calculations. This was done in the 1976 Protocol of the Convention. However, this Protocol has not entered into force so far.

The FUND Protocol 1984 revises the FUND Convention by raising the ceiling to a maximum of USD 208 million, providing the aggregate quantity of oil imported in three of the contracting states totalled at least 600 million tons in the preceding calendar year.

Both new Protocols also:

a. extend the geographical scope of the parent conventions to contracting states' exclusive economic zones up to 200 miles from the coast;

b. follow the 1976 Limitation Convention (1976 LLMC) very closely. This would indicate that the breaking of limitation would be more difficult.

c. simplify the procedure for future amendments on liability limits, (8).

NATIONAL LEGISLATION OF MARINE POLLUTION

Saudi Arabia have no legal regimes within its national laws and legislations for combating the pollution, resulting from the exploration and exploitation of the continental shelf. But there are some articles in the contracts of concession which obligate the companies doing the exploration and exploitation work to prevent pollution of the area of the sea by oil, (9).

The legal source, which regulate the marine environment protection in Saudi Arabia is in the form of Laws and Regulations not specially related to prevention and control of marine pollution but contain some provisions in this respect. e.g. Seaport and Lighthouses Law issued in accordance with the Royal Decree No. M/27 dated 24/6/1394, corresponding to July, 1974. The provisions for Non-Pollution of Seawater with Oil, are found under Articles 311-332 in Chapter One of Section Twelve of the above mentioned law, (10).

This law was enacted after Saudi Arabia ratified the International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL 54/62) and in compliance with third article of the same stipulating that party states shall undertake to promulgate all laws, decrees, orders and regulations which may be necessary to give convention full and complete effect.

-Recent Environmental Regulatory Developments

As outlined in Royal Decree No.7/M/8903, dated 21/4/1401 (25 Feb.1981), which approved Decision No. 86, dated 20/8/1399 (14 July 1979), of the Supreme Committee for

Administrative Reform, the Meteorology and Environmental Protection Administration (MEPA) is responsible for the control of pollution and protection of the Kingdom's environment. MEPA has established a set of Environmental Protection Standards to protect air and water quality by limiting the emission of pollutants from sources. Further standards are planned on land pollution, noise pollution and toxic and hazardous substances. Present standards apply to all existing and planned facilities. The application of such standards on the coast will obviously be an important factor in its long-term environmental protection. The establishment of protected areas and the optimum management of fisheries is valueless unless marine water quality can be maintained, ($_{11}$).

As also outlined in the same Royal Decree No. 7/M/8903, the Environmental Protection Coordinating Committee (EPCCOM) is responsible for the coordination of the activities of the Ministries and governmental agencies involved in environmental protection. EPCCOM, a powerful body whose members are at the level of Deputy Minister under the chairmanship of His Royal Highness the Minister of Defence and Aviation. EPCCOM's functions include "Studying whatever regulations the MEPA submits in connection with environmental protection affairs and approve and present the same to the Council of Ministers", as well as "Approving rules and regulations that must be adopted and applied by Government Agencies in various parts of the Kingdom and presenting same to the Council of Ministers for ratification".

EPCCOM, at its first meeting, on 29 April 1984 adopted several decisions, after endorsement by the Council, will be considered official government policy. The Minister of

Finance would then be required to address the budget needs resulting from the decisions, and the various ministries and agencies affected by the decisions would be obliged to act. As yet, the Council has not endorsed the decisions made by EPCCOM, nor is it known when this may occur.

The major decisions of EPCCOM which relates to combating of marine pollution are the:

1. The approval of the Regional Agreement for Conserving the Environment of the Red Sea and the Gulf of Aden, and its Protocol.

2. Requesting MEPA to take all the measures necessary to insure that authorities concerned in the Kingdom abide by the provisions of both the Kuwait Regional Agreement for the Protection of the Marine Environment and Regional Agreement for the Conservation of the Environment of the Red Sea and the Gulf of Aden, and by their Protocols.

3. The approval of the National Plan for the Control of Pollution by Oil and Other Harmful Substances in Emergencies and the Regulations appertaining thereto, and that legal formalities be taken for their enforcement.

4. The approval of designating marine protectorates in the Red Sea and the Arabian Gulf where there would be a general moratorium on development pending the preparation of detailed conservation plans for the areas.

5. The approval of the prohibition of new coastal infilling, dredging and solid waste disposal without environmental impact assessment.

6. The approval of the delegation to the Coast Guard, in coordination with MEPA, of responsibility for prohibiting disallowed activities.

7. The approval of setting up a permanent committee comprising the Ministry of Education, the Ministry of Higher Education, the Directorate General of Girls Education, and MEPA to study means of promoting and developing the elements of environmental education in the curricula at all levels. And setting up of a permanent committee comprising the Ministry of Information and MEPA, in conjunction with the authorities concerned, to develop environmental awareness programs.

8. The approval of obtaining fixed posts to monitor pollution.

9. The approval of setting up a committee to examine the overlapping jurisdiction of MEPA and the Saudi Arabian Standards Organization (SASO), (12).

THE ROLE OF OIL INDUSTRY FOR THE PREVENTION OF OIL POLLUTION: ARAMCO'S PROGRAMME

ARAMCO has long recognized the need for a comprehensive oil spill strategy. From the moment a drilling operation starts to the departure of the laden tanker from the terminal, prevention of spills has been a guiding principle of the Company. The comprehensive prevention programme has proved largely successful. During the last 30 years, there have been only two offshore oil well blow-outs in Saudi Arabia and only one of these caused significant oil pollution. This enviable record is due to the preventive measures taken. For example, in all the drilling operating undertaken by ARAMCO, crews are highly trained in carefully defined procedures. The crew on all ARAMCO contract rigs are required to attain certain personnel experience levels. In addition, there is an ARAMCO engineer on each contract rig whose job is to see that the drilling is carried out in a safe and reliable manner that meets Company specifications for pollution control, inspection of safety equipment and overall supervision of operations. The drilling is all carefully planned prior to moving the rig on site, and this planning includes a review of seismic data and other geological information to predict potential problems.

It has been and cotinues to be an ARAMCO policy that every precaution be taken to ensure that a well remains under control at all times. This strict maintenance of well control often slows down drilling operations and increases costs. But the dividends in decreased risk of pollution and of costly blow-outs make it worth while. A vivid illustration of the impacts and costs associated with a blow-out was the recent Ixtoc-1 blow-out in

Mexican waters. At ARAMCO all efforts are being made to ensure that such an incident does not occur in Saudi Arabia. For example, in addition to the strict well control procedures mentioned earlier, ARAMCO completes all wells above the surface, that is, on a pltform. This has distinct advantages. In the event of a blow-out there is a good chance that the well can be ignited and the oil and gas burned instead of spilled into the water. This was demonstrated recently in the Berri oil field where a blow-out on a six-well platform resulted in only a small amount of oil on the water during the two months it took to quench the well. A subsurface completion, such as the Ixtoc well, spills oil directly into the water when it blows and thus is inherently a much greater pollution threat than the above-surface completions.

However, even with the best possible preventive measures, there is always the chance of a blow-out, as happened with the Ekofisk well in the North Sea, the Ixtoc-1 well in the Bay of Campeche and the Hasbah-6 well in the Arabian Gulf. In order to react to such a situation, ARAMCO has carefully logged each well, pinpointing both the surface and down-hole locations. ARAMCO has also noted each well's performance characteristics and formulated a plan for the placement of relief wells. Thus, when the Berri Well No.34 went out of control, two rigs were immediately rushed to the scene and within 60 days were able to kill the well. This could not have been accomplished without forward planning and an accurate knowledge of the down-hole location of the well. It should be borne in mind that it took more than eight months to cap Ixtoc-1 and only after millions of barrels of oil had been spilled.

The preventive measures do not stop with drilling. Each completed well is protected with two failsafe valves. The platforms are designed to meet more severe weather conditions than are likely to occur in the area, and both the platforms and pipelines are cathodically protected from external corrosion. ARAMCO's pipeline specifications are the most stringent in the world when wet or sour service is anticipated. In fact, when these specifications, were first laid down, no supplier would bid on the pipe contracts. Even the specifications for normal crude service are stricter than those set by the American Petroleum Institute (API). With 855 km. of offshore production pipeline, ARAMCO has to be rigorous.

At the same time, the Company is looking ahead, anticipating the possibility of new pollution hazards. For example, as the oil fields begin to go wet, the potential for internal corrosion will increase, so steps are being taken now to respond to this new problem. Designs are being made for corrosion control chemicals to be injected at the well head. New flowlines and pipelines in severe service areas will be required to have an internal coating of polyurethane or epoxy.

ARAMCO's preventive measures continue when the oil comes ashore from the offshore wells and production platforms. Many spills are caused in and around marine terminals; cosider, for instance, the Bantry Bay incident, the tank failure at the Shell terminal in Nigeria or the many smaller spills of 100 to 200 barrels that occur each year in terminals all over the world. As the world's largest terminal operator, ARAMCO is well aware of the potential for spills in these areas.

The tankage capacity for the ARAMCO terminals can be up to 37 million barrels of oil stored within one kilometer of the shoreline. Where there is oil stored there is the potential for a spill, so again prevention is the key. Each tank is individually diked and the diked area is drained to an impoundment area. The system is designed to hold the contents of the terminal's largest tank, thus preventing an oil release into the sea.

From the tanks the oil must be transferred to the tankers, and it is during this operation that there is an increased danger of oil spill. At the Juaymah Terminal, oil is pumped at up to 130,000 barrels per hour so that even a small leak could result in a large quantity of oil being released. In order to reduce this risk as much as possible very strict operational and inspection standards are maintained. To begin with, all hoses are regularly inspected and overhauled. Currently, the surface hose string on SBM's is changed every 12 months and the subsurface string is changed every 24 months (though this may soon be reduced to 12 months also). During an overhaul, the hose string is subjected to a bend or stiffness test, a visual inspection, a vacum test at 630 mm Hg. and a 100 percent pressure test. Divers also carry out regular inspections on the hose couplings and flanges while in service so that small leaks can be detected before they grow larger. Similar inspections and tests are carried out at the Sea Island terminals.

Preventive measures are in force at both the Juaymah Terminal, where the SBM's are located, and the Ras Tanura Terminal, where the Sea Island and Piers are situated. A loading plan is established during discussions between terminal personnel and the offtaking vessel personnel.

This loading plan covers the critical loading rates that are to be used and the topping off rates that can be expected. Actual loading operations are carried out with every care normally associated with terminal operations, (13).

CHAPTER V- REFERENCES

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CHAPTER VI

CONCLUSIONS

&

RECOMMENDATIONS

CHAPTER VI

CONCLUSIONS & RECOMMENDATIONS

This final chapter presents a summarization of ideas and conclusions relative to the important aspects of marine oil pollution in Saudi Arabia, followed by recommendations based on each conclusion.

1) On the physical and biological characteristics of the Saudi Arabian marine environment and the national resources threatened by oil pollution:

Saudi Arabia is blessed with a unique marine environment both on the Red Sea and the Arabian Gulf. The Red Sea is famous for the richness and diversity of its coral reefs and associated marine life, which rank it as the only enclosed coral sea in the world. As such, the Arabian Gulf is almost entirely enclosed shallow sea, its shrimp fishery has been of long-standing commercial importance.

The length of Saudi Arabian coastline is approximately 2,250 kilometers, of which 1,800 km extends along the eastern side of the Red Sea and 450 km stretches along the western side of the Arabian Gulf. Along this lenghth, the coastline varies significantly from mangrove marshes; offshore islands; mudflats; coral reefs; muddy sand; to rocky and sand beaches. This long and varied coastline gives rise to a considerable diversity in the nature and relative importance of the resources threatened in the various regions.

The coastal zones of Saudi Arabia displays a rich and varied selection of marine organisms whose potential economic, scientific, educational and aesthetic value is not yet fully exploited or even, perhaps, widely appreciated.

The diversity and abundance of marine life in coastal marine communities of the Red Sea and the Arabian Gulf are remarkable. More than 1000 species of fish, 150 species of corals, 450 species of molluscs, 170 species of echinoderms and 484 species of algae have been recorded along the Red Sea coast of Saudi Arabia. Marine habitats along the Arabian Gulf coast of Saudi Arabia do also exhibit considerable diversity. From sublittoral soft bottoms alone more than 167 species of polychaete, 125 species of gastropod mollusc and 73 different bivalves, over 39 different amphipod crustaceans and 66 species of decapods have been recorded. Important breeding colonies of seabirds also occur in the Saudi Arabian coastal zones and offshore islands.

Marine habitats such as coral reefs are the richest, most diverse and most productive natural biological communities within the Kingdom. Coastal waters of Saudi Arabia provide 24,000 to 28,000 tonnes of fisheries' produce annually. Coastal waters are used in the Kingdom's desalination plants providing more than 2.2 million cubic meters of water per day. The attractions of the shoreline are a focus for recreation by Saudi Arabians as shown by the crowds enjoying the Corniche shoreline and beaches in weekends.

Considering the significant resources occurring in the Saudi Arabian marine environment, and considering the economic, scientific, educational, and aesthetic importance of this environment for the benefit of the present and future generations, the protection of this environment should deserve high priority in Saudi Arabia.

<u>2) On the sources of oil pollution in the Saudi Arabian marine environment:</u>

We have identified the major sources of oil pollution in the Saudi Arabian marine environment and have estimated the volume of oil that is likely to spill from each source. According to our estimates, approximately 61,240 tonnes of oil spilt into the Saudi Arabian marine environment during 1982. Although Saudi Arabian marine environment comprises only 0.052 per cent of the surface area of the world's marine environment, our estimates indicate that it contributes 2.1 per cent of the world's marine oil pollution, which is 40 times the average estimated amount for a marine environment of a similar surface area.

The estimates for Saudi Arabia show that 36.7 per cent of the total comes from tanker transport and 26.1 per cent from offshore production. This high percentage of pollution from tanker transport and offshore operations in Saudi Arabia is consistent with the high concentration of oil production and transportation activities in the Saudi Arabian marine environment.

We have found a major discrepancy between our estimates and the available spill data. This discrepancy will probably decrease with improvements in both the technology for monitoring oil spills and the legal system for enforcing spill reports, and also with improvements in the model for estimating oil pollution.

Our estimates demonstrate the need for assessing the magnitude of oil pollution in the Saudi Arabian marine environment and for developing baseline studies to identify trends in oil pollution and to pinpoint areas and activities of high risks. An active spill incident reporting system would enable the Government to accumulate information on spill incidents, to identify activities that require regulations, to pinpoint areas of high spill frequency, and to develop compensation schemes for spill damages.

If our estimates portray accurately the magnitude of oil pollution in Saudi Arabia, then these estimates justify the introduction of strict preventive legislation by ratifying the existing international conventions relating to pollution prevention, and the effective enforcement of such legislations. These estimates also justify the creation of monitoring programmes to detect and monitor oil spills and to notify authorities about the location and movement of spills.

These estimates was not intended to be as an academic exercise in future forecasting but rather as a basis for action to reduce the amount of current and future oil pollution in Saudi Arabia.

3) On the impact of oil pollution on the Saudi Arabian marine environment:

The biological effects of oil in the marine environment are extremely varied and depend on the organisms involved, the nature and severity of the oil presence and environmental factors. Biological responses may range from immediate mortalities due to smothering and the actuely toxic effects of light petroleum hydrocarbon fractions to long-term and sublethal alterations in physiology, fecundity and community structure due to chronic but low-level oil pollution. Effects are particularly severe in shallow water and at the air-sea interface and intertidal zone. The prevailing weather conditions and the type of remidial action taken all influence the ultimate biological effects that are detectable.

In the tropical and subtropical marine environments, biological activity is greater than in any other area and therefore the damage caused by oil spills is proportionately of larger dimensions. It is especially worth noting that most available methods for containing, collecting, dispersing or deflecting spilt oil were developed in the temperate zone. Toxicity testing leading to recommendations for world-wide use is normally carried out in laboratories there, using the common species of that zone under typical conditions of temperature, salinity, etc., and most observations of the ecological effects both of spilt oil and clean-up treatments have been made around its shores. It should not be assumed that such methods or data, even when they originate from the most reliable sources, are automatically applicable to other regions. The development of special techniques for tropical and subtropical waters, togather with the aquisition of relevant biological data, seem generally to be much more neglected.

There would appear to be a strong case for considerable expansion of scientific investigation of the marine environment in Saudi Arabia, both fundamental and applied to problems such as oil pollution. This could probably be handled by the marine science centres already existing or going to be established in Saudi Arabia.

To date the Saudi Arabian marine environment has proved to have sufficient capacity to withstand the stresses. However, in view of increasing hydrocarbon background concentrations in remote marine sediments, an awareness of the limitations of current techniques for detecting subtle changes in biota should be retained. Locally, biological effects may be severe, depleting population numbers and altering community structures. Such effects may be detectable for over a decade in the worst-affected sites and thus warrant governmental concern and every preventive effort.

4) On the combating of oil pollution in the Saudi Arabian marine environment:

The basis of effective clean-up response to oil spills is a combination of good contingency planning, organization and control. No amount of sophisticated equipment will compensate if one or all are lacking. However, an event as unpredictable as a major oil spill will always cause severe problems even in the best prepared countries in view of the extent of the potential impact on the population and resources of a country and the lack of a complete technological solution.

A comprehensive National Contingency Plan for Combating Pollution by Oil and Other Harmful Substances has recently been developed and is currently before the Saudi Council of Ministers for endorsement. The overall authority and responsibility for implementation of the Plan is vested in the Environmental Protection

Co-ordinating Committee (EPCCOM) whose members are drawn from all the Government Ministries likely to be involved in any incident involving major pollution. The working secretariat for EPCCOM is the Meteorology and Environmental Protection Administration (MEPA). The Plan allows for the creation of two main centres, one for each coast, with smaller centres covering the principal ports in each of the main areas. Responsibility for operational aspects mainly fall on the Saudi Arabian Port Authority (SAPA) and the Ministry of Petroleum with its associated oil companies in the first instance, but it is possible that eventually the Royal Saudi Navy and Coastguard will also play an active part in oil spill clean-up activities.

Saudi Arabia holds the largest stock of oil pollution control and clean-up equipments in the Arabian Gulf and the Red Sea, most of it being owned by the Arabian American Oil Company (ARAMCO) which alone holds sufficient equipment to contain and control oil spill of up to 70,000 barrels under favorable conditions. however, a major percentage of the Kingdom's combat capability against oil spill is centred around the use of dispersants. ARAMCO now maintains a continuing training programme for the large numbers of oil spill response personnel needed to operate this equipment. Saudi Arabia also a party to regional agreements for combating oil pollution both on the Arabian Gulf and the Red Sea.

To conclude this section, a number of specific aspects have been identified as requiring attention by the Government in order to improve the effectiveness of the response to future oil spills. These include the need for:

1. Endorsement of the National Contingency Plan by the Council of Ministers. MEPA through its charter, should make concientious efforts to put both the above Plan and related various EPCCOM resolutions into practice with continual revision and improvement of the Plan at national and local level;

2. Central data bank, maintaining up-to-date information on all matters relating to marine pollution, including developments in oil spill control technology, current materials and equipment available, contractor response agencies available etc. The application of computer system to operational situations should be further developed to cover tracking, weathering, surveillance, training, inventory update, beaching, clean-up operation, simulated scenarios and backtracking;

3. Central testing and evaluation body for spill equipment, materials, etc., probably at a regional level within the Arabian Gulf, to evaluate new and existing equipment/materials for effectiveness under conditions prevailing in the region;

4) An improved level of organization, coordination and cooperation between the various agencies responsible for clean-up, both at national and regional level, in order to achieve a better control of all operations;

5) Provide training facilities in oil spill control and clean-up techniques specifically tailored to the needs of the country, probably using the existing facilities at ARAMCO or the Regional proposed facilities at MEMAC. Those responsible for the control of oil spill clean-up

to be further persuaded to seek technical advice both at the planning and operational stage. Effective participation in seminars, workshops on pollution combating at national, regional and international levels.

6) Realistic and comprehensive oil spill exercises and the trial deployment of booms and equipment, especially in inshore waters and on shorelines, not neglecting disposal problems;

7) The provision of airborne oil pollution monitering and coastal surveillance system to carry out regular long-range reconnaissance in order to verify predictions of oil movement, to determine the effectiveness of the response and to direct the clean-up operations. In addition, the system can be configured for many other applications, such as fishery and customs inspection, search and rescue, sea traffic surveillance, mineral exploration and remote sensing research.

5) On the prevention of oil pollution and related legislative aspects in Saudi Arabia:

In view of Saudi Arabia's position as the cradle of Islam and as the only nation to use the Holy Quran as a State Constitution, we had immediately to consider of prime importance the Islamic religion as a factor which is the ultimum guiding influence in Saudi Arabia, we had to consider the Islamic principles for the conservation of the natural environment.

The conclusion derived at was, that Islam welcomes any regional or international endeavour in the field of conservation and invites all concerted, joint, and cooperative efforts in all fields to establish a balanced and planned international system for the protection and conservation of man and his environment and for the maintenance and perpetuation of a suitable, prosperous life for the present and future generations.

We found that, the existing national law has not addressed the protection of the marine environment exclusively, except some provisions in respect to prevention and control of marine pollution within the Saudi Ports Law and Regulations. Noting that this legislation is an old one which is not in compatability with the new developments in the field of protection of the marine environment. The formulation of these provisions was based on OILPOL Convention which is the only convention been ratified by Saudi Arabia.

Recently, in 1981, owing to the increasing awareness of the environmental problems, a Royal Decree designated the responsibility for the control of pollution and protection of the environment to MEPA. Furthermore, an inter-ministrial committee (EPCCOM) was established for the coordination of the activities of the Ministries and governmental agencies involved in the protection of the environment. Several resolutions were adopted in its first meeting in 1984, if approved by the Council of Ministres, a detailed coastal zone management plan will be developed during the period of the moratorium.

Presently, the Government is assessing the impact that ratification of (MARPOL 73/78) will have on affected companies and ports within Saudi Arabia. The main obstacle for early ratification of the convention is the provision for providing port reception facilities.

It is concluded on the basis of this study, which has ranged over environmental assessment, pollution risk assessment, pollution impaçt assessment, response capabilities, and legal preventive measures, that a comprehensive oil pollution preventive legislation and its effective enforcement can be neglected only at the cost of, possibly, further deterioration of the Saudi Arabian marine environment.

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APPENDIX 1

THE SAUDI ARABIAN NATIONAL CONTINGENCY PLAN.

AAAAM.TXT Translation from EPCCOM Arabic 22/7/84

AAAAM.TXT Translation from EPCCOM Arabic 22/7/84

KINGDOM OF SAUDI ARABIA
NATIONAL CONTINGENCY PLAN FOR COMBATTING POLLUTION BY OIL AND OTHER HARMFUL SUBSTANCES

ARTICLE 1

TITLE

This plan shall be called The National Contingency Plan for Combatting Pollution by Oil and Other Harmful Substances and is hereinafter referred to as "The Plan".

ARTICLE II

GENERAL POLICY AND OBJECTIVES

(a). General Policy

It is the policy of the Kingdom of Saudi Arabia that the exploration for oil and the handling and transportation of oil and other harmful substances is to be carried out in such a manner as to minimise the risk of environmental and economic damage or threat to public health. In the event that a spillage does occur, swift and effective action will be taken to minimise the environmental and public health and welfare risks resulting from that spillage.

(b). Objectives

The Plan aims to provide for co-ordinated and swift action to protect the marine environment and coasts of the Kingdom from the effects of spills of oil and other harmful substances by establishing mechanisms that maximise the use of available resources and ensure proper response at the scene of any discharge of oil or harmful substance including the mobilising of equipment, manpower and expertise at a level appropriate to combat such a spill.

The Plan also fulfils the Kingdom's regional obligations expressed in the Protocols Concerning Regional Co-operation in Combatting Pollution by Oil and Other Harmful Substances in Cases of Emergency of the Kuwait Regional conference (April 1978) on the Protection and Development of the Marine Environment and the Coastal Areas or any other similar Regional or International obligations in the future.

AAAAM.TXT Translation from EPCCOM Arabic 22/7/84

ARTICLE III

LEVELS OF RESPONSE

(a). National Oil Spill Response

MEPA will plan and co-ordinate response activities to control pollution by oil and other harmful substances in the Kingdom and will:

- formulate national policy in oil pollution control in the Kingdom's marine environment;
- act in accordance with the Kuwait Protocol Concerning Regional Co-operation in Combatting Pollution by Oil and Other Harmful Substances in Cases of Emergency (April 1978) or any other similar regional or international obligation in the future;
- undertake surveillance, monitoring and studies necessary for the tracking of oil spills and the determination of oil spill pollution impacts;
- provide national management, administration and co-ordination for the implementation and operational functioning of The Plan;
- co-ordinate protection of facilities and sensitive areas against oil spills; and
- provide operational co-ordination in the event of a national spill emergency.

Where the President of MEPA considers that an oil spill requires a national response he shall, with the agreement of the Chairman of the Environmental Protection Co-ordinating committee,)hereinafter referred to as EPCCOM) have power to take control of the response activity and he may direct the allocation of resources from any Government or Government controlled agencies, as he sees fit, to assist in surveillance, protection, combat or cleanup activities or stepping up of such activities.

(b). Area Oil Spill Response

The activities required to plan for and co-ordinate an Area response to an oil spill will be undertaken within the Western (Red sea) and Eastern Arabian Gulf) Regions by MEPA. Staff of these Regions include a Regional Co-ordinator for oil spill response activities in the Region for the supervision of protection and combat activities and co-ordination in the event of spills requiring an Area spill response.

The functions and duties of MEPA's Regional Co--ordinators in respect of oils spills include:

- review and evaluation of Local Contingency Plans for marine and coastal facilities (see Article IV (b) hereunder);

- preparation and development of a comprehensive Area Plan to include the necessary complementary and co-ordination measures to ensure integration and mutual support of local capabilities and to provide additional support from the region;
- area response program management, administration and co-ordination;
- invoking response to an Area Spill;
- review of spill event reports in the Area;
- conducting spill response exercises and co-ordination of training programs;
- coastal and offshore spill surveillance and regulatory compliance monitoring;
- evaluation of combat, surveillance and protection equipment; and
- identification of relevant monitoring programs to be carried out by the coastal and marine facilities.

In the following cases the MEPA Regional Co-ordinator will assume responsibility to co-ordinate spill prevention, protection and combat activities:

- in coastal areas outside the boundaries of coastal facilities;
- where the nature of the action required is beyond the capabilities of the local coastal facility; and
- where the magnitude of the spill is classified as "Major" (see Annex 1).

In such cases, and as required, the MEPA Regional Co-ordinator may seek, and will be provided with, necessary manpower and equipment from any one or more of the following:

- the Frontier Forces;
- the Saudi Ports Authority;
- any coastal Municipality; and
- any organization having a coastal or marine facility or installation.

(i). Area Operations Committees

To assist MEPA Regional Co-ordinators in planning area response programs and the allocation and Western Regions with the following membership:

- the MEPA Regional Co-ordinator for the Region (as Chairman);

- all On-Scene-Commanders from the Region (see Article III(c) hereunder) or representatives of the organizations responsible for these local facilities;

- locally based representatives of:-

  the Ministry of Transport
  the Ministry of Petroleum and Mineral Resources
  the Ministry of Municipal and Rural Affairs
  the Saudi Frontier Forces
  the Royal Saudi Navy
  the Saudi Ports Authority
  the General Directorate of Civil Defence
  the Royal Commission for Jubail and Yanbu
  the Saline Water Conversion Corporation; and
- any experts, consultants or observers designated by the Chairman of EPCCOM.

(c). <u>Local Oil Spill Response</u>

The following organizations having coastal facilities will undertake spill prevention, protection and combat activities within the coastal and marine area affecting the efficient operation of their facility:

- Ministry of Petroleum and Mineral Resources and the associated oil companies;

- Ministry of Industry and Electricity;

- Saline Water Conversion Commission;

- Saudi Frontier Forces;

- Royal Saudi Navy;

- Saudi Ports Authority;

- Royal Commission for Jubail and Yanbu; and

- any other organization having marine or coastal facilities which is designated by MEPA.

Each organization will appoint an On-Scene-Commander who will be responsible for oil spill response within the local facility's area.

Each coastal facility must develop a local oil spill response plan and must maintain a properly trained and equipped Task Force capable of responding to the type and size of spill assessed as appropriate to the spill risk and sensitivity of that locality in consultation with the Regional Co-ordinator.

AAAAM.TXT Translation from EPCCOM Arabic 22/7/84

ARTICLE IV

AREA & LOCAL PLANS

For the development and implementation of The Plan, Area (Arabian Gulf and Red Sea) and Local Plans shall be developed and implemented as follows:

(a). Area Plans

An Area Plan provides the standard operational response guidelines and procedures for a Region. The Regional Co-ordinator must develop the plan and submit it to the President of MEPA for approval. The Area Plan should detail the action the Regional Office will take if a spill occurs requiring an Area response. The Area Plan shall include the following:

- a compilation of the Area's Local Plans;
- a surveillance and monitoring system for discovery of oil spills in Saudi waters and the coasts of the Region and for notification of such spills to MEPA;
- a detailed command and communications structure;
- a notification system for alerting members of the Area Operations Committee and MEPA headquarters;
- specific job descriptions for each key position in the response organization;
- identification of local support organizations involved in spill response and key personnel within those organizations;
- up-to-date inventory of spill response resources within the Area including Government, private and commercially held manpower and equipment;
- communications and logistic procedures for the allocation of resources and manpower from one coastal facility to another;
- listing of critical water use facilities and ecologically sensitive areas and methods to be used to protect them; and
- a survey of potential spill sources and a determination of the maximum credible spill from each;
- instructions for obtaining oceanographic and marine meteorology data and estimating spill trajectories;
- data collection worksheets and instructions on spill event data collection and documentation procedures; and
- description of acceptable containment, cleanup and disposal techniques including instructions for obtaining necessary approvals in particular cases.

(b) Local Plans

A Local Plan provides the standard operational response guidelines and procedures for a coastal facility. It is prepared by the facility in consultation with the Regional Co-ordinator. The Local Plan should detail the action the facility will take if a spill occurs involving facilities or vessels within its area.

The Local Plan shall include the following:

- local organization command and communications structure, including individual names, telephone numbers, radio frequencies and other means of notification of key personnel;
- specific job descriptions for each key position in the Facility;
- communication and logistic procedures for deploying manpower and equipment; and
- procedures for notification of the Regional Co-ordinator.

ARTICLE V

RESPONSIBILITIES

The various activities associated with the response to an oil spill are allocated to MEPA and those organizations having responsibility in the area or activity.

(a) Implementation

MEPA, in addition to its responsibilities of implementing and co-ordinating The Plan, will publish policies, regulations and procedures in respect of prevention, control, clean-up and disposal of spills of oil and other harmful substances.

All facilities shall carry out their activities outlined in this Plan from their own budget, except in emergency cases which require capabilities beyond those available in the individual or combined facilities. In these cases use can be made of the emergency funds specified in Article VII(c).

In emergencies MEPA may conclude agreements and contracts with individuals, establishments, companies and organizations, Saudi or foreign, local or international, connected with the purposes of The Plan, to provide immediate support, as required, for surveillance, monitoring, protection and combat and assessment and impact studies. Such agreements and contracts must be approved by the Chairman of EPCCOM.

(b) Co-ordination

MEPA will co-ordinate the activities of all other organizations in so far as their activities relate to oil spill response including determining the adequacy of manpower and equipment resources held by the various participating organizations.

(c) Surveillance and Monitoring

MEPA will undertake and co-ordinate surveillance and monitoring of the marine economic zone and coastal areas of the Kingdom using its own resources and funds available under Article VII (a). As required, assistance shall be provided by the Ministry of Petroleum and Mineral Resources, the Saudi Ports Authority, the General Directorate of Civil Defence and the Saudi Frontier Forces.

Surveillance will include:

- aerial observation;
- marine observation;
- coastal observation;
- remote sensing;
- oportunistic reports received from military, civil and private aircraft and shipping; and
- any other practicable means available.

MEPA shall identify all relevant monitoring activities required to be carried out under The Plan by the appropriate organizations.

(d) Protection

All organizations having marine or coastal facilities (Article III(c)) shall provide adequate manpower and equipment to protect themselves from any type of spill which may be expected to arise from their own or other nearby activities. This equipment shall be continuously maintained so as to be immediately deployable in the event of a spill.

(e) Combat

Subject to the environmental specifications and measures provided by MEPA, all organizations having marine or coastal facilities (Article III(c)) will undertake combat of oil spilled within their areas and shall provide and maintain adequate equipment to undertake that task. Outside these areas the Frontier Forces shall be responsible under the supervision and co-ordination of MEPA's Regional Co-ordinator.

(f) Cleanup

Subject to the environmental specifications and measures provided by MEPA, all organizations having marine or coastal facilities (Article III(c)) will undertake cleanup of oil spilled within their areas and shall provide and maintain adequate equipment to undertake that task. Outside these areas the appropriate Municipality and the Frontier Forces shall be responsible under the supervision and co-ordination of MEPA's Regional Co-ordinator.

(g) Disposal

In consultation with affected organizations, MEPA will identify appropriate sites and methods for the disposal of collected oil and oiled debris.

(h) Studies

MEPA will undertake, supervise or co-ordinate the conduct of appropriate scientific and other studies relevant to the above activities with a view to facilitating government decisions on matters related to a major spill and increasing the state of knowledge to improve the effectiveness of oil spill response in addition to the assessment of environmental impacts.

ARTICLE VI

OPERATIONAL PROCEDURES

The actions taken to respond to a spill of oil or other harmful substance depend upon many factors including the magnitude and location of the spill.

Response actions in the event of a spill involve the following five phases.

(a) Phase I - Discovery and Notification

All organizations having marine or coastal facilities or marine activities such as the Frontier Forces and fishing companies, and all ship captains and aircraft pilots, should report any oil spill observed.

Reports by these organizations, those obtained through search or surveillance and incidental observations should be notified to MEPA's Regional Co-ordinator where the observer is aware of the procedure, otherwise discoveries should be notified to local On-Scene-Commanders or to port authorities, police, radio or television stations, telephone operators, airtraffic control towers or any available public authority. Personnel at such facilities will be instructed to relay the report promptly to MEPA's Regional Office.

Insofar as possible, spill discovery reports and notifications should include the following:

- general description of the spill event;
- identification of the source of the spill;
- geographic position, time and date of the incident or observation;
- quantity and type of substance spilled;
- oceanographic and meteorological conditions prevailing in the area; and
- any other pertinent information.

The operator of a coastal facility shall immediately notify MEPA's Regional Co-ordinator if a report is received indicating a major spill event as indicated in Annex 1.

(b). Phase II - Evaluation and Initiation of Action

The On-Scene-Commander or operator of a coastal facility shall promptly investigate all spill reports and shall:

- classify the size of the spill, as indicated in Annex 1;
- evaluate the necessity for containment or cleanup action;and
- evaluate the feasibility of various containment or cleanup options.

The MEPA Regional Co-ordinator shall be notified in all cases and immediately if:

- the spill is classified as moderate or major;
- the necessary response is likely to exceed the resources of the facility; or
- the spill is likely to have regional or international implications.

MEPA's Regional Co-ordinator will notify MEPA National Headquarters in all cases and immediately if:

- the spill is classified as major;
- the necessary response is likely to exceed the resources of the Region or
- the spill is likely to have regional or international implications.

The On-Scene-Commander or operator of a coastal facility shall endeavour to identify the party responsible for the spill and determine whether that party is taking appropriate steps to control and clean up the spill. If appropriate steps are not being taken he shall:

- endeavour to prevent further discharges from the source;
- advise the discharger of the proper spill response actions and warn of the liability for spill response costs and consequential damages;
- collect appropriate data for cost recovery proceedings and spill response assessment; and
- collect appropriate data to define the proper response procedure.

(c) Phase III - Containment and Countermeasures

If the discharger neglects or refuses to take appropriate action or if such action is insufficient to properly combat the oil spill then containment and countermeasure action shall be taken by the On-Scene-Commander. The first priority in such action is to ensure the safety of those involved in the spill, in the response action and the general public. Spill response then includes:

- control of discharge at source, where possible;
- placement of physical barriers to prevent spread of spill and to protect specific installations or locations;
- damage control and salvage operations; and
- use of chemical agents to disperse or restrain spread of the spill in areas where their use is not prohibited by MEPA.

The On-Scene-Commander of a coastal facility may request the MEPA Regional Co-ordinator to provide assistance from other coastal facilities, various Government and private organizations and the MEPA Regional Office staff, if necessary.

(d) Phase IV - Cleanup and Disposal

The On-Scene-Commander of a coastal or marine facility shall as soon as practicable begin operations to recover the spilled oil or harmful substance from the water or shore areas using such methods as skimmers, sorbents, dredges and earth moving equipment, and other appropriate means. The Local and Area Plans will guide the On-Scene-Commander or operator in determining priority areas for cleanup and locations for disposal of recovered material.

(e) Phase V - Documentation

During all phases of a spill response the On-Scene-Commander or operator shall ensure that appropriate data and documentation are collected for later identification of responsible parties, cost recovery, evaluation of spill response effectiveness, and research into environmental impacts. Documentation should include films and photographs, statements of witnesses, completed forms, letters, telexes, contracts, field notebooks, sample collection and analysis data, news releases and reports, communications logs etc.

As soon as possible after conclusion of a moderate or major spill response, and no longer than thirty days after, the On-Scene-Commander or operator shall submit a complete report to the MEPA's Regional Office describing the development of the spill event, the actions taken, resources committed, costs incurred and problems encountered.

(f) Escalation of Response

Where the On-Scene-Commander or operator considers that a spill requires action beyond the resources of his facility, he shall so advise MEPA's Regional Co-ordinator who shall notify members of the Area Operations Committee and convene the Committee if necessary.

MEPA's Regional Co-ordinator may allocate resources from other coastal facilities, and from various Government and private organizations, to assist the On-Scene-Commander or operator in combating the spill. At his discretion, and as conditions warrant, MEPA's Regional Co-ordinator may designate a substitute On-Scene-Commander who will assume the full responsibilities and authority of the On-Scene-Commander.

MEPA's Regional Co-ordinator shall keep MEPA informed of any aspects of the spill event which may have regional or international implications.

MEPA's National Headquarters shall determine whether the spill constitutes a "Marine Emergency" under the Protocols of the Kuwait Regional Agreement or any similar regional or international obligations and, if so, shall notify the appropriate Regional Marine Emergency Mutual Aid Centre and keep that Centre properly informed of developments.

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ARTICLE VII

FUNDING

Funds for the implementation of The Plan will be provided from the Kingdom's General Treasury, in consultation with the Agencies concerned, and shall include:

(a) MEPA Allocation

An operational allocation provided within the annual budget of MEPA.

(b) Other Allocations

Allocations within the budgets of various government agencies identified by The Plan as required to participate in oil spill response activities; it being the responsibility of each such agency to seek is own allocation.

(c) Emergency Funds

An emergency budget of SR100 million maintained continuously at the disposal of His Royal Highness the Chairman of EPCCOM to be used for response activities outlined in Articles III(a) and V(a) of The Plan.

ARTICLE VIII

GENERAL

Manpower and equipment necessary to be brought into the Kingdom to assist during the combat of a spill shall be exempted from visa and customs procedures as the case may be, other than customs security checks, on the written request of the President of MEPA. The Ministry of Foreign Affairs, the Ministry of the Interior and the Department of Customs shall issue instructions to ensure that delays are eliminated in such circumstances.

ARTICLE IX

REVIEW AND UPDATING

As The Plan must cover evolving and new conditions, it may require variations or modifications from time to time. MEPA shall be responsible for periodic review, and shall make such recommendations as it considers necessary for approval of the Chairman of the EPCCOM who shall have the power, duty and responsibility at any time to approve any ammendments or additions to The Plan other than an ammendment to Article VII (c), which will require the prior approval of the Prime Minister.

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ARTICLE X

INTERPRETATION

The interpretation of The Plan lies with the Chairman of the Environmental Protection Co-ordinating Committee.

ANNEX 1.

CLASSIFICATION OF SPILLS

The following classification of spill magnitude provides a guide to the appropriate level of response.

(i) Minor Spill

A minor spill is a discharge to sheltered port or nearshore waters of less than 5,000 litres (25 bbl) of oil; or a discharge to offshore waters of less than 50,000 litres (250 bbl) of oil; or a discharge of a harmful substance in a quantity less than that defined by MEPA as reportable.

(ii) Moderate Spill

A moderate spill is a discharge to sheltered port or nearshore waters of 5,000 to 50,000 litres (25 to 250 bbl) of oil; or a discharge to offshore waters of 50,000 to 500,000 litres (250 to 2500 bbl) of oil; or a discharge of a harmful substance in a quantity equal to or greater than that defined by MEPA as reportable.

(iii) Major Spill

A major spill is a discharge to sheltered port or nearshore waters of more than 50,000 litres (250 bbl) of oil; or a discharge to offshore waters of more than 500,000 litres (2500 bbl) of oil; or a discharge of a harmful substance that poses a significant threat to public health or welfare or results in widespread concern.

In the above classifications, nearshore waters means within 20 kilometres of any mainland or island shoreline.

These classifications are not intended to directly correspond to associated degrees of hazard to public health or welfare, nor as a direct measure of potential environmental damage. Any discharge that poses a significant threat to public health or welfare, or to ecological systems of substantial biological, economic or aesthetic value, shall be classed as a major spill irrespective of the quantities released. Furthermore, any spill likely to give rise to regional or international implications shall be classified as a major spill.