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Marine pollution of the Sudanese coast

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MARINE OIL POLLUTION ON THE SUDANESE COAST

by

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SUDAN

A paper submitted to the Faculty of the World Maritime University in partial satisfaction of the requirements for the award of a

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

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BY

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1987

بسم الله الرحمن الرحيم

"IN THE NAME OF ALLAH, THE BENEFICENT, THE MERCIFUL."

A C K N O W L E D G E M E N T S

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ABSTRACT

The increase of heavy traffic in transporting oil along the Red Sea, causes a serious threat of oil pollution in Sudanese waters. This threat has mainly increased after the second stage of the Suez Canal Development Project which was carried out and completed in 1985.

To some extent, marine pollution by substances other than oil already exists along the Sudanese coast and most of it comes from shore-based sources which are located on the coast north and south of Port Sudan town.

This thesis will provide an overal review of the physical characteristics of the Red Sea and the Sudanese coast in particular. It also identifies and provides suitable means of monitoring, controlling and combating the existing marine pollution and any pollution resulting from a major disaster, with regard to the establishment of a MARITIME SAFETY ADMINISTRATION in SUDAN.

A B B R E V I A T I O N S

ALECSO	Arab Leage Educational, Cultural and Scientific Organization
BOD_5	Bio-Chemical Oxygen Demand
COD	Chemical Oxygen Demand
CRISTAL	Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution
DDC	Direct Data Collection
DO	Dissolved Oxygen
FAO	Food and Agriculture Organization of the United Nations
FW	Fresh Water
GESAMP	Group of Experts on the Scientific Aspects on Marine Pollution (IMO, FAO, UNESCO, WMO, WHO, IAEA, UN)
GMRD	Geological Mineral Resources Department
GPC	General Petroleum Corporation
G & O	Grease and Oil
IAEA	International Atomic Energy Agency
IMF	International Monetary Fund
IMCO	Intergovernmental Maritime Consultative Organization
IMO	Internatinal Maritime Organization
ILO	International Labour Organization
IOI	International Ocean Institute - Malta
ICOD	International Centre for Ocean Development
INMARSAT	International Maritime Satellite

ITOPF	International Tanker Owner Pollution Federation Ltd.
IUCN	International Union for Conservation of Nature and Natural Resources
MARPOL 73/78	International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978
MEPC	Marine Environment Protection Committee
MT	Metric Tonnes
M/T	Motor Tanker
M/V	Motor Vessel
NCE	National Committee for Environment
ODA	Overseas Development Assistance
OSC	On-Scene Commander
PSC	Port State Control
SCA	Suez Canal Authority
SPC	Sea Port Corporation
SPCS	Sea Port Corporation Statistics
SS	Suspended Solid
SDR	Special Drawing Right
SMCC	Sudan Marine Conservation Committee
SSL	Sudan Shipping Line Ltd.
SW	Sea Water
T/h	Ton per hour
TOVALOP	Tanker Owner Voluntary Agreement for Liability for Oil Pollution
UN	United Nations

UNDP	UN Development Programme
UNEP	UN Environment Programme
UNCLOS	UN Conference of the Law of the Sea
UNESCO	UN Educational, Scientific and Cultural Organization
WHO	World Health Organization
WMO	World Meteorological Organization
WMU	World Maritime University

TABLE OF CONTENTS

Page

Page

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDIXES

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

The Arabian Gulf countries are considered as the major oil exporting area in the world. (Fig. 1, a map showing by arrows the oil movements)

At the same time the European countries are considered as the major import area for Arabian Gulf oil.

In 1975 the Suez Canal re-opened again thus playing an important role in increasing the number of vessels using the Red Sea.

In 1983 the first stage of the Suez Canal Development Project was completed which increased its cross sectional area to 3,600 square meters and the permissible draught to 53 ft. allowing the sailing of ships of up to 150,000 DWT and tankers of up to 370,000 DWT in ballast condition.

The second stage of the Suez Canal development project is to deepen and widen the Canal to increase its wet sectional area to 5,200 square meters and permissible draught to 67 ft. so as to handle loaded tankers of 250,000 DWT and bigger units either partially loaded or in ballast condition (See tables 1 and 2 , traffic through Suez Canal and oil quantity).

In this way there is a tremendous increase in heavy traffic in the transportation of oil along the Red Sea. Due to the geographical location of the Sudanese coast, there is an ever existing hazard of oil spill due to marine accidents. In addition to that, the daily operations of this traffic along the coast and in ports results in a regular input of oil into this area. The cleaning of oil tanks through the tanker's ballasting voyage is particularly important. Also, as stated by Couper 1983, pollution is becoming critical in the Red Sea off Jeddah with the development and industrialisation of Saudi Arabia.

Moreover, on the Sudanese coast there are shore based installations such as oil terminals, oil refineries, heavy industrial areas at Port Sudan, electrical power stations, etc. which also contribute to a regular source of marine pollution by oil and other substances.

Table 1

Oil Quantities Transported Through the Suez Canal
Years 1976/86

Year	Quantity in 10^6 m tons
1976	187
1978	248
1980	281
1982	363
1984	410
1986	442

Source: SCA Report 1986.

Table 2

Traffic Figures 1985/86 of Suez Canal

	1986	1985
Number of transits	18403	19791
of which tankers	3659	3374
other vessels	14744	16417

Source: Lloyd's List, August 3/1987.

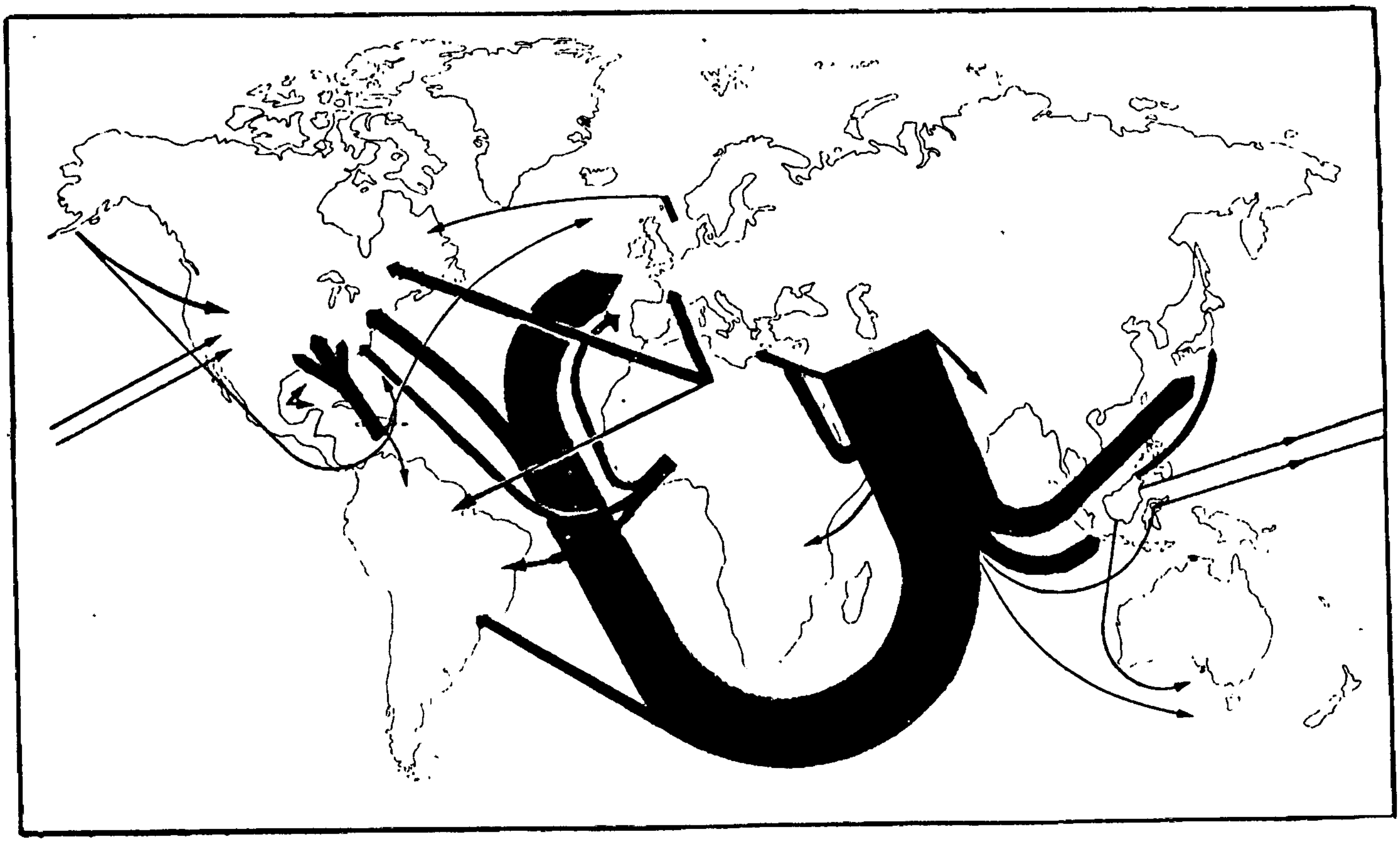


Fig. 1: The Major Oil Movement at Sea

CHAPTER 2

THE NATIONAL ENVIRONMENT THREATENED BY MARINE OIL POLLUTION

اسفنج وسمك عجل الفراشة ـ شعب سنقنيب ـ السودان
Sponge with butterfly perch (Anthias squamipinnis)
Sanganeb Reef, Sudan. Photo & C Leni Riefenstahl

الشعب المرجانية في الساحل السوداني جميلة. احميها
ممنوع جمع الشعب او الاصداف او استعمال رماح الصيد
لجنة السودان للمحافظة على البيئة البحرية
ص.ب ٢٤ بورتسودان ـ السودان

Sudanese reefs are beautiful : Protect them.
Spear fishing, coral and shell collecting are prohibited
Sudan Marine Conservation Committee,
P O Box 24, Port Sudan, SUDAN

CHAPTER 2

THE NATIONAL ENVIRONMENT THREATENED BY THE MARINE OIL POLLUTION

2.1 INTRODUCTION:

The strategies for coastal development of marine resources and control of marine pollution, must be discussed with the background of the local geographical, biological oceanographical and man-made influences.

There are two main biological features of the open Red Sea which distinguish it from the Indian Ocean and the other seas. The first one is that the epipelagic zone from the surface to 100 meters is relatively poor in nutrients. The second is that the region has a relatively low phytoplankton and zooplankton diversity. This is probably due to the lack of fresh water input and associated run-off of nutrient rich soil material. Generally the Red Sea is limited in the number of higher animals that the open sea can support, i.e. fish, turtles, mammals.

Most of the 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 explains in general the decrease in phytoplankton and zooplankton diversity on moving up the Red Sea as the influence of Indian Ocean flora and fauna is diluted (UNEP 1985 - No. 64).

2.2 GENERAL GEOGRAPHY:

Sudan is the largest country in area in Africa covering 2,505,800 square kilometers, with a population of about 21,000,000. It is bordered by 8 countries, Egypt and Libya in the North, Chad and Central Africa in the West, Zaire, Uganda and Kenya in the South, and Ethiopia in the East. On the eastern edge it is bordered by the western coast of the Red Sea. This coastline extends from South to North for 750 Km., (SPC data), however, the coastline of Sudan is more than that due to embayments and headlands.

2.3 THE SUDANESE PORTS:

2.3.1 Port Sudan:

Is the only major port of Sudan and is owned and operated by the Sea Ports Corporation (SPC). It lies in a naturally sheltered harbour. There are two anchorage locations available; the Wingate reef anchorage and the Towartit reef anchorage. Ships not anchoring within these areas float at a safe distance from the port whilst awaiting entry.

The port is divided into two sections, the Main Quays, (berths 1 to 11) and the South Quays, (berths 15 to 18).

The crude oil and petroleum products are handled at berths 17 and 18, which are not ideal berths as they are designed for a container terminal. Some petroleum products are handled at berth 16.

Plans are in preparation for a dedicated new oil tanker/gas carrier jetty at berth 14 between the grain berth and the pilot look-out point. This is a much preferred location for tankers and will greatly improve safety in the port and solve a number of problems presently encountered at berths 16 and 17-18. (Source of information GPC)

2.3.2 New Saukin Port:

A new port at Mersa Kuwai (8 Km. north of the existing old port of Saukin) is under construction. The present project for building a new container and passenger harbour is at a very advanced stage, and oncompletion, will be of a considerable size and serve seaborne trade as well as inland trade. This new port will, in the future expansion schemes, include an oil traffic zone.

On the Sudanese coast there are many small ports mainly known as Mersas, (i.e. Mersa Halot, Mersa Wiai, Mersa Darur....) which are used for Sanbuk trade and small wooden Faluka fishing boats.

2.4 CHARACTERISTICS OF THE RED SEA:

The Red Sea is a lush oasis of coral life surrounded by vast tracts of desolate mountains and plains. It extends in a northwest-southwest direction for about 1930 Km. in length and approximately 360 Km. across at its widest point. In the northern end it forks to form the shallow Gulf of Suez and the deeper Gulf of Aqaba. At its southern end, it narrows to the strait of Bab-el-Mandab, 26 Km. wide and less than 200 meters deep (Marcos 1970), where it joins the Indian Ocean via the Gulf of Aden. The central channel plunges from 1000 meters in depth to more than 2000 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.

2.5 OCEANOGRAPHY OF THE RED SEA:

2.5.1 Salinity:

One of the major oceanographical features of the Red Sea is its high salinity with dissolved salts in the surface water up to 41 parts per thousand along the Sudanese coastline. This value is unusually high compared to 35 parts per thousand in the open oceans. This high salinity is due to the hot climate, which increases the rate of evaporation, and the absence of any rivers adding fresh water.

2.5.2 Temperature:

The surface sea temperatures range in the northern part of the Red Sea from approximately 20^{o}C to 26^{o}C. At Port Sudan, depending on the time of the year, this range is approximately between 26^{o}C to 30^{o}C.

2.5.3 Tides:

The Red Sea is a long body of water with a low tidal range. On the Sudanese coast only at one point in the western part of Port Sudan harbour one can find a tidal gauge. As stated in UNEP 1985-64, the average spring tide range is about 50 cm. but decreases from both ends towards the centre, where at the latitude of Port Sudan there is no applicable diurnal tide. In addition to this there is a seasonal change in the sea level which is low in summer and relatively high in winter during December and January (Schroeder, 1982). The Gulf of Aden has a rather greater tidal range due to the influence of tides within the Indian Ocean.

2.5.4 Wind:

There are two major types of winds affecting the Red Sea region. The trade winds are caused by rising equatorial temperatures, which create depressions into which the tropical air masses flow thus causing winds that blow permanently towards 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 to the south (UNEP 1985-64). At Port Sudan the average velocity range of the NNW wind is from 7 to 11 Km./h, but during winter the maximum speed of the wind can be approximately 120 Km./h. In winter the monsoons, which are recurring winds that change direction with the seasons, blow from high-pressure zones over the land out toward the ocean, and in summer they draw breezes into low-pressure zones of overheated air over the land masses. The NW monsoons account for the winter and spring high tides by pushing water into the Red Sea through the strait of Bab-el-Mandab, and the SW monsoons create an eastward-moving current that draws water out of the Red Sea. (UNEP-No. 64-1985)

2.5.5 Currents:

The currents of the Red Sea are more easily influenced by local and monsoon winds than those in large bodies of water. This is due to its narrowness, only 306 Km. wide, and its irregular coastline. Surface currents from November to April flow northward and for the rest of the year flow southward (Schroeder 1982).

2.5.6 Transparency:

The clarity of the water is one of the Red Sea's known features. At Sangeub Reef, a transparency of 46 meters was measured in June 1979, which is an unusually high value. However in coastal waters the transparency may be less than one meter. Generally a range of 20 to 30 meters is normal (Schroeder 1982).

2.6 LIVING MARINE RESOURCES:

2.6.1 Fish:

The coastal population of Sudan has increased in the last few years by 2.9% (WHO - Rep. 85/86) due to refugees from Ethiopia and the expansion of Port Sudan city which is already overburdened. This has increased the food needs and intensified the problem of protein supply not only to the coastal region but also for the whole country.

In the past, the development of fisheries in Sudan has been directed towards open sea fisheries and shrimp trawling (Reed 1962 b).

Fishery statistics at Port Sudan are not up-to-date and the estimates on total catch taken, vary between 300 and 600 tons per year (Schroeder 1982).

In Sudan fishing is mostly performed at low technological scale. Recently two aid projects have been working on supporting the fishermen and the Fisheries Department to obtain better catches and to supply more fish on the market. These are the British ODA project and the UN-FAO project. Both projects are providing technical assistance to local boatbuilders, mechanization of boats, training of fishermen for fishing and carpentry, trucks for transporting the fish and cold-stores. Also surveys studying the potential of various fish and shell fish are being covered by these projects.

2.6.2 Shrimps:

Shrimps are mainly caught by local fishermen in very limited quantities using cast nets in coastal lagoons and shallow waters. In the Saab Shubuk area a survey carried out by the British ODA indicated that water trawling shrimps with small boats has commercial potential.

2.6.3 Shellfish:

Shells and Beche-de-mer are confirmed as having commercial potential by a number of the British ODA fisheries teams (Kane-cited in Schroeder).

The most important types of shellfish being cultivated are Mother-of-pearl, Trochus, Dufra and Cowries.

At present a research project, using various culturing methods in Dongonab Bay, is being carried out by the Sudanese Fisheries Research Centre.

2.6.4 Sea Birds:

The seabirds of the Red Sea are divided into three separate groups. The widespread tropical group is the first one. The second group is the northern Indian Ocean species which can be found in the northern part of the Red Sea and coasts of Arabia. The white-eyed gull is the best example of this group. The third group, of which the Caspian tern in the best example, is a widespread, though not necessarily common, species occurring in both temperate and tropical zones. Gallagher and Woodcook (1980) found that the white-eyed gull breeds only in the Red Sea and Gulf of Aden.

Furthermore, Simmons and Cramp (1983) reported that the white-eyed gull is a candidate for future Red Data Book treatment. Its endemism to the area is worth emphasising.

The sooty-gull reported by Ormond et-al, 1985, is fairly common in the north Red Sea especially in the waters of Saudi Arabia around Al Hala Island in the Farasan Bank (Fig.2). Calpham (1964) reported colonies of the sooty-gull from the Dahlak archipelago in Ethiopia.

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

Moore & Balzarotti 1983 (cited in UNEP - 64) reported 280 to 500 breeding pairs in the Egyptian Red Sea coasts and islands.

The crab plover nests by burrowing into the ground and 20 to 40 pairs are reported breeding on the islands of Hurghada in the Egyptian Red Sea (Heathcote-e-al 1984).

The spoonbill is recorded as breeding in the Red Sea (UNEP - 64 - 1985).

Large numbers of resident and migrant waders are supported by the coastal wetlands along the Red Sea and may well have an international significance for a number of species. Finally a number of birds of prey follow passerines through the Red Sea on their annual migration.

A number of birds breed in the mangroves of the Red

Sea, most notably the pink backed pelican. And greater number roosting and sheltering in the mangroves. Several of these birds found in the area have international significance and efforts should be made to protect them, even if they have relatively little commercial value.

2.7 COASTAL VEGETATION:

2.7.1 Mangroves:

The mangroves are halophytic plants that live in the intertidal fringe of the tropical shallow waters. They cover a wide variety of species of tree which belong to a number of effectively unrelated families, but are found growing together along the edge of brackish or seawater shores in tropical regions. In the UNEP, 1985 - 64, it is reported 60 or so mangroves.

Only three species of mangroves are reported in the Red Sea.

- The Avicennia found throughout the area.

- The Rhizophora Mucronata, found in a few different, restricted locations.

- The Bruguriera Gymnorhiza, which is recorded in Sudan.

The functions of the mangrove plants are surprisingly varied. Where mangroves are extensive, the trees are often of considerable economic importance.

Wood is used as fuel, making excellent charcoal due to its high caloric value (Morton 1965 - cited in William & Johannes). It is also used in house and boat construction, in the manufacture of fishing nets, as a source of plywood glue and various dyes and stains. Leaves have been used as livestock feed and are also used in various medicinal purposes for humans and livestock. The Nigerians harvest salt excerted by the leaves of the black mangrove. The flowers are a source of honey and the roots are often planted for erosion control.

The mangrove in the Red Sea area is grazed particularly by camels, used for building materials (net stands, shacks and bird traps) and for cooking and heating. At the same time the mangroves in this area are important bird breeding areas (UNEP - 1985 - 64).

In addition, and in a desert environment with little green vegetation, the mangrove stands have a landscape value that should not be underestimated. They also act as a focus for wild life which can be viewed by visitors.

2.7.2 Seagrasses:

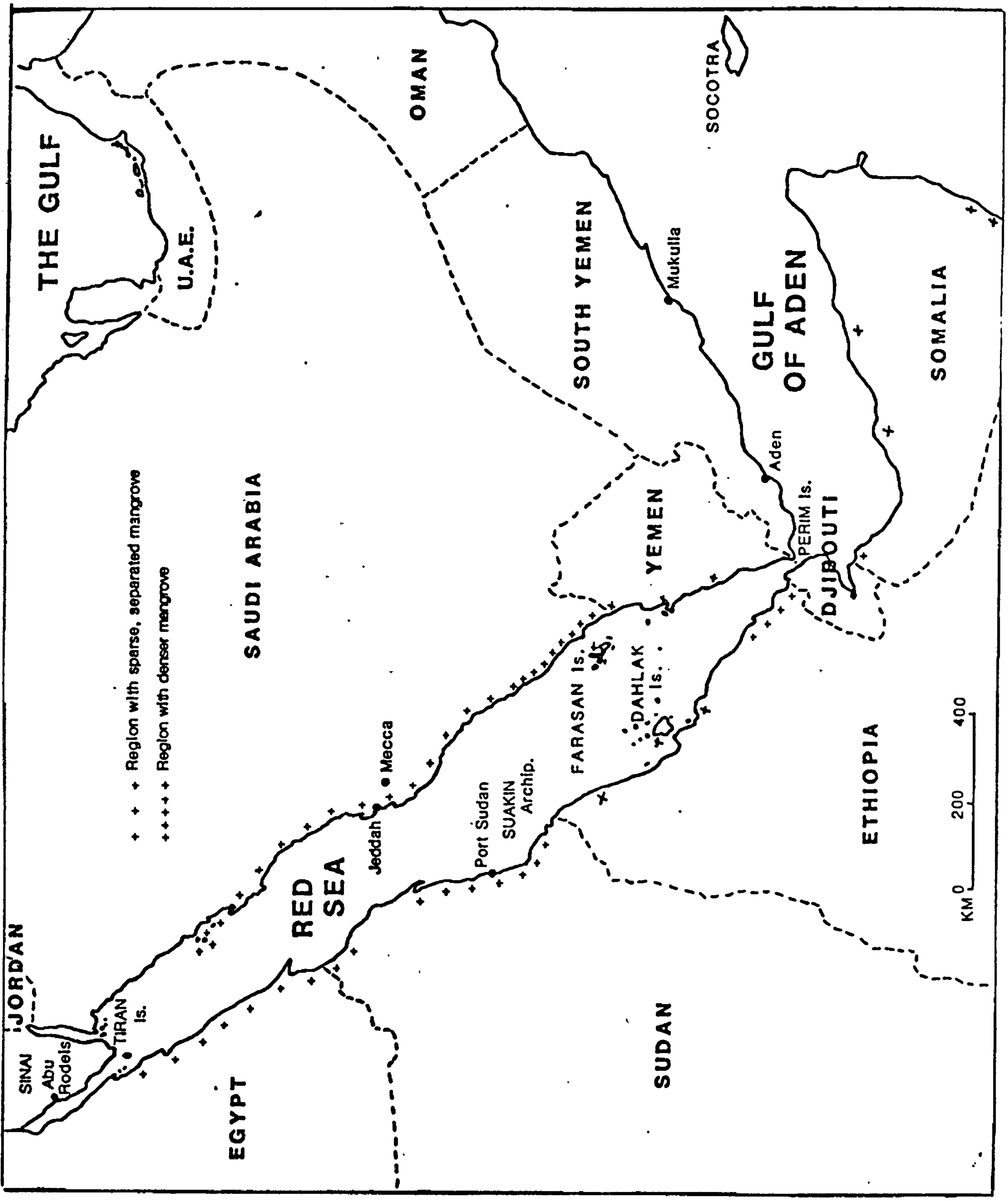
Seagrasses are unique in their features among submerged marine and estuarine plants, because of their extensive root and rhizome system.

The functions of the seagrasses in the marine ecosystems can be summarized as follows:-

- They have a rapid rate of growth and high productivity.

- They act as a shelter for fish.

Fig. 2: Distribution of Known Mangrove Stands in the Red Sea and Gulf of Aden Region.



Source: UNEP No. 64/1985

- The leaves support large numbers of epiphytic organisms, which under favorable conditions, may by comparable in biomass to the seăgrass leaf weight and which are grazed extensively.

- They give substrate consolidation.

- Nutrient recycling occurs.

In the Red Sea most of the species are found throughout the region. (UNEP-1985-64)

Direct destruction of the seagrass bed in the region is limited. However, relatively limited areas of seagrass in the Red Sea show an indication of having been harmfully impacted by man.

2.8 CORAL REEFS:

Coral reefs are probably the most extensive shallow marine communities on earth and among the most biologically productive of all natural communities, marine terrestrial.

In the shallow waters of the Red Sea the extensive coral reefs fringe much of the coastline and often extend offshore for many kilometers.

The clarity of the water plays a great role for the maximum depth to which the corals normally live. Those algae symbiotically associated with corals must have light to convert CO_2 and H_2O into food substances.

The distribution of reefs through out the Red Sea can be related to tectonic movements and block faulting making suitable foundations for reef growth.

Several types of reef can be encountered:

- The fringing reefs which are adjacent to the shore along most of the coastline.

- The patch/platform reefs which are groups of reefs typically lying between 13-15 Km., offshore and arranged in "Q" series called the barrier system. An example is the Suakin Archipelago.

- The pillar reefs/atolls which are found much further offshore (15-20 Km.) and arise from much deeper water. Examples are the deep water reefs of Sanganeb Atoll off Port Sudan.

The clarity of the Red Sea water increases the beauty of coral reefs in these regions.

Sheppard (1983) and Ormond-et-al 1985 reported that over 150 species of coral are recorded from the northern and central Red Sea. The coral species diversity is the highest in the central Red Sea.

The coral reef communities are almost certainly the most economically significant of the marine habitants in the Red Sea. The significance of the reefs for fisheries related in part to their very high primary productivity. As reported in UNEP - 1985 - 64 the result of the diversity of reefs represents a major genetic resource. Many reef animals have been found to contain pharmacologically active compounds which may be of medical value or lead to advances in medical research.

Moreover, the coral reefs are generally found to be of considerable economic and social value for recreation and tourism.

Due to the research of many different experts (Shinn 1972, Birkelland-et-al 1973, cited in Johannes - 75) it is safe to conclude that crude oil spills do not pose a significant threat to coral reefs. However, Cohen (1973) and Lewis (1971) observed the effect of oil dispersants on tropical marine organisms. Tests run during the Ocean Eagle oil spill in Puerto Rico indicated that dispersants (emulsifiers) created more damage than they prevented by dispersing the oil through the water column and by causing serious beach erosion through reduction in the physical attraction of sand grains to one another.

The waste discharge in the sea may be of enormously hazardous to coral reefs as they are particularly sensitive to alterations of water quality and air.

It is reported that the reef at Sanganeb and Umbria wreck in Sudan are suspected to undergo great damage through high tourist pressures.

See Fig.3: Distribution of major coral reef areas in the Red Sea.

2.9 NON-LIVING RESOURCES:

2.9.1 Salt:

Salt is extracted from sea water by the natural evaporation method in large shallow artificial ponds. The largest plants are located south of Port Sudan up to the New Suakin Port. Mainly ordinary table salt is obtained and the annual production exceeds 100,000 tons, mainly consumed locally.

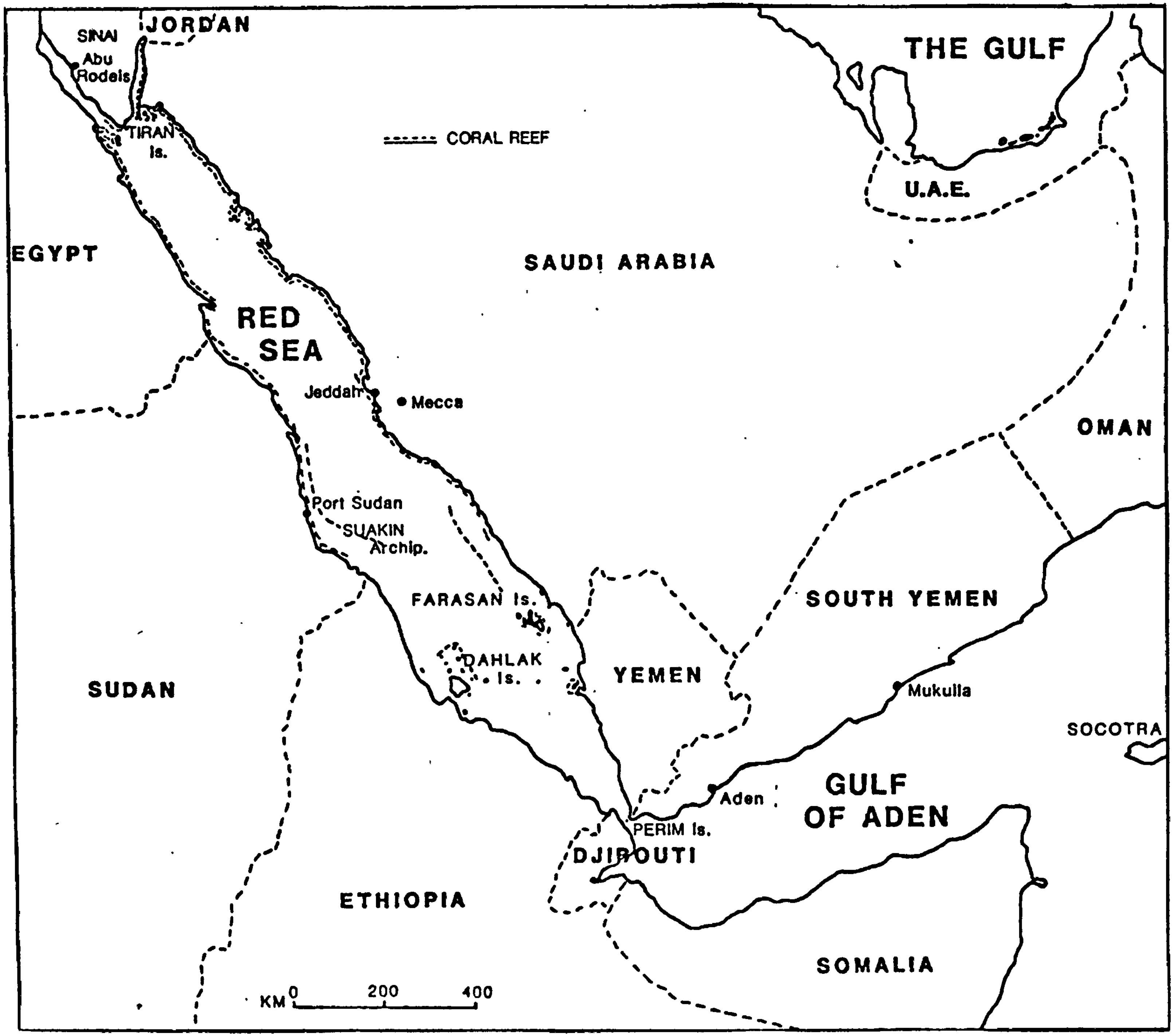


Fig. 3: Distribution of Major Coral Reef Areas in the Red Sea and Gulf of Aden Region.

Source: UNEP No. 64/1985

2.9.2 Minerals:

In the central part of the Red Sea, some of the deep basins contain metalliferous muds of different compositions.

The efforts of the Saudi-Sudanese Commission for the Development of Red Sea Resources have been concentrated on a basin located between Mohamed Qol and Jeddah. This basin has an area of 60 square Km. and a maximum depth of 2170 meters, with a flat bottom layer of mud having a thickness of 10 to 30 meters. Besides iron and lead, other metals of commercial interest are zinc (2,5 million tons), copper (0.5 million tons) and silver (9000 tons). A prepilot mining test was carried out successfully in 1979 (Schroeder 1982).

Along the Red Sea coast metalliferous minerals derived from weathering rocks on land have been accumulated by the currents and waves. Such deposits in a length of 15 Km. beach have been found on the Sudanese coast near Trinkitat (about 120 Km. south of Port Sudan). Minerals of commercial interest in these deposits are ilmenite and rutile. (Information of GMRD)

2.9.3 Oil and Gas:

Several different foreign oil companies (Agib, Chevron Total and others) were involved in exploration at various Sudanese shore and offshore sites. Gas, mainly methane, has been found in commercial quantities near the Suakin Archipllago.

2.9.4 Freshwater:

Obtaining freshwater along the coast of Sudan, especially in Port Sudan, is given top priority today. Building desalination plants is one of many options which exist for supplying fresh water to the Red Sea province. The first plant is already in operation at Port Sudan tyre factory (ITMD), and another one is planned for the tourist village of Arus (40 Km. north of Port Sudan).

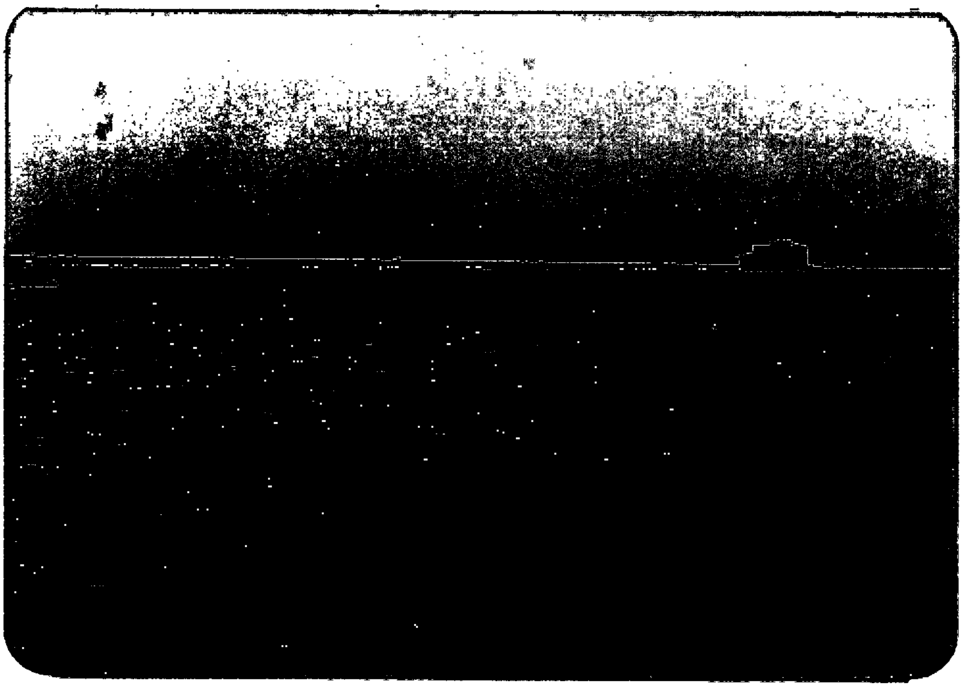
2.9.5 Tourism:

The Sudanese Red Sea offers special attractions for foreign tourists, namely diving among some of the world's most beautiful reefs (Schroeder). The improvement of the diving tourism in the coral reefs will be of a commercial interest.

For citizens of Port Sudan, recreation centres along the coast are increasing year by year. For visitors from inland, the sea offers a unique attraction and new experience.

CHAPTER 3

SOURCES OF MARINE OIL POLLUTION



S.W. Pump Station of Tyre Factory - Port Sudan

CHAPTER 3

SOURCES OF MARINE OIL POLLUTION

3.1 INTRODUCTION:

As we know that marine pollution implies a degrading of environmental quality as perceived by society, it becomes necessary to assess its impact from scientific, economic and policy perspectives. In order to assess the magnitude of marine environment, to identify areas and activities of high risk that require regulations and management, this chapter identifies the major source of marine pollution and estimates the amount of pollution from each source.

In this project two types of marine pollution on the Sudanese coast will be discussed:

1. Oil pollution from ships.
2. Oil pollution from coastal industry.

3.2 OIL POLLUTION FROM SHIPS:

3.2.1 The Fate of Spilled Oil:

When liquid is spilled onto the sea, the first observed phenomenon is the tendency of the oil to spread over the surface of the water to form a thin film - an oil slick. Certain crude oil and heavy residual fuel oils are excepted, which have a high specific gravity causing them to solidify or sink. As a general rule the oil slick spreads relatively quickly immedately following a spill. The rate of spreading and the thickness of the film depends on the sea temperature and the nature of the oil. The light oil spreads faster than a heavy waxy oil.

An oil slick does not remain in one place, but moves downwind at 3-4% of the wind speed (Fig. 4) except in enclosed waters where tides and water currents have a greater influence on the movements of the slick. 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.

The composition of the oil changes from the time it is spilled. (Fig. 5). As the oil is spreading and moving over the sea surface a number of processes will occur which give rise to changes in the physical and chemical properties of the oil. 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. The most significant initial weathering processes for oil spills on the sea in evaporation. The light fractions of an oil are lost within the first few hours. Thereafter, the rate decreases and the less volatile components will form a residue which has a higher specific gravity and viscosity than the original oil.

The other important mechanism affecting the natural fate of il on the sea surface is dispersion or the formation of oil-in-water emulsions. The water soluble components dissolve in the water column, and the immiscible components become emulsified as small droplets. This is the incorporation of small particles or globules of oil from five micrometers to several milimeters diameter into the water column (Bishop, 1983).

The rate of dispersion is a function of the sea´s state

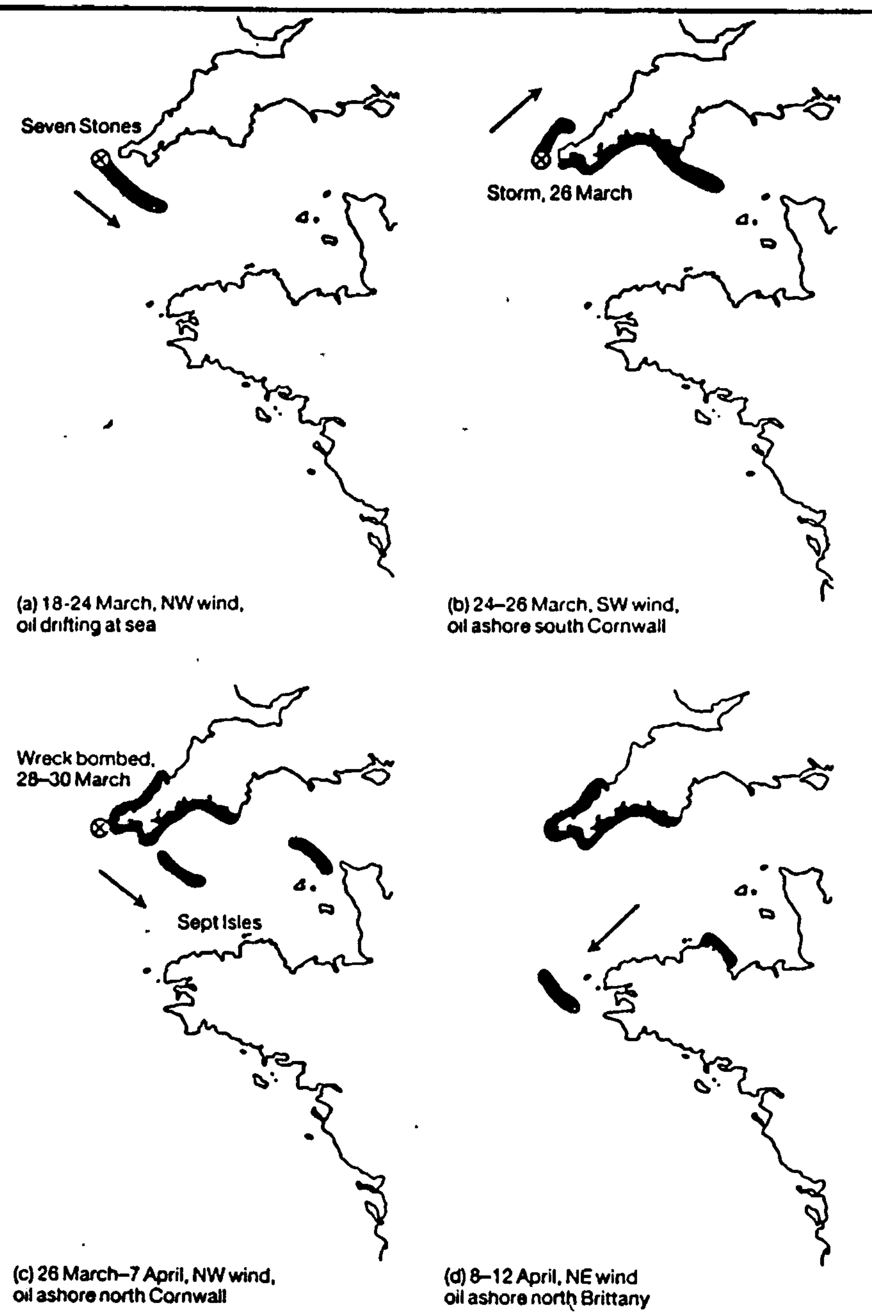


Fig. 4. Movement of oil from the wrecked tanker *Torrey Canyon* in response to changing wind direction.

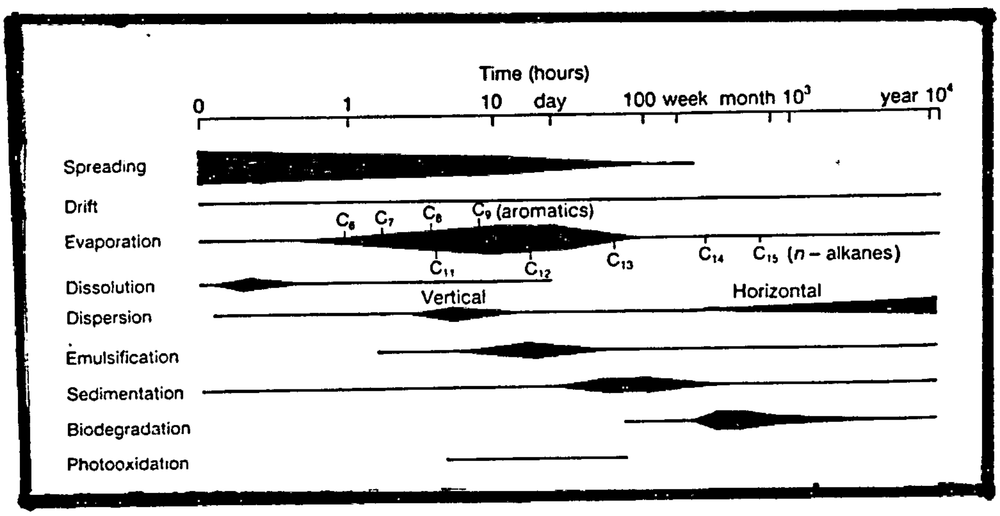


Fig. 5: Factors Affecting Oil Spilled on the Sea

and of the nature of the oil. Emulsification of the oil in the water depends on the mixing provided by waves and water turbulence. They heavy residues of crude oil form tar balls, ranging in size from less than 1 mm to 100-200 mm in diameter (Clark, 1986).

3.2.2 The Input of Oil Into the Sea:-

With the enormous increase in the use of oil and its production from 272×10^6 metric tons per annum, the United States Academy of Science estimated 6.1×10^6 metric tons of oil entering the oceans in 1975 while a reduction to 3.2×10^6 metric tons had occurred by 1985 but was still about 0.1% of the total world oil production. The table below shows the input of oil from various sources:

Table 3

Sources	Quantity 1975	Quantity 1985
1. Tanker and ship operations	1.93	1.10
2. Municipal and industrial	1.90	1.00
3. Oil refinery wastes	0.80	0.10
4. Natural seeps	0.60	0.25
5. Atmosphere fallouts	0.60	0.30
6. Tanker accident	0.20	0.40
7. Offshore drilling etc.	0.80	0.05
TOTAL MTA	6.11	3.20

Source: (US National Academy of Science Magazine)

Transportation does not represent the only, or even the major source of petroleum hydrocarbons entering the sea, nor is crude oil the only form the inputs take. Petroleum hydrocarbons are organic compounds and are degraded by bacterial activity to inorganic and products. Like sewage discharges, spilled oil is damaging when the quantity is excessive. But oil has other properties which provide additional environmental hazards. Some five million tonnes of petroleum hydrocarbons reach the world's seas and oceans each year. (Clark - 1986)

The table below shows the relative importance of the principal sources:

Table 4

Sources	Oil industry	Other	Total
Transportation:			
Tanker operations	0.60		
Tanker accident	0.30		
Dry docking	0.25		
Other shipping operations		0.12	
Other shipping accident		0.10	
TOTAL	1.15	0.22	1.37
Fixed Installations:			
Offshore oil production	0.060		
Coastal oil refineries	0.060		
Terminal loading	0.001		
TOTAL	0.12		0.12
Other Sources:			
Industrial waste		0.15	
Municipal waste		0.30	
Urban run-off		0.40	
River run-of		1.40	
Atmospheric fallout		0.60	
Natural seeps		0.60	
TOTAL		3.45	3.45
GRAND TOTAL	1.27	3.67	4.94

Source: Clark R.B. 1986.

The total amount of oil which gets into the sea from all sources is the subject of many estimates. As stated by Wardby-Smith in 1983, this total may differ from author to author. He found that for almost the same sources of oil in the marine environment, Jeffery estimated in 1970 a total of 1.9×10^{6} MT, the US Coast Guard in 1973 with a further study gave a total of 3.81×10^{6} MT, which greatly exceeds Jeffery's total. The major difference in the US Coast Guard figures is found in the waste oil from land based discharges which are based on extrapolating world figures from measurements of the oil contents of American rivers. Other authors in 1975 estimated a total of 3.60×10^{6} MT. In 1977 E.B. Cowell estimated a total of 5.33×10^{6} MT of oil being discharged into the sea. From the above results there seems to be no doubt that at least 2×10^{6} MT, oil, and probably a good deal more, enters the sea each year.

3.2.3 Accidental Oil Pollution:-

In general terms, the major oil producing countries are not the major users of oil products, so that a great deal of oil has to be transported by sea (Fig. 1).

The increasing use of oil has led to an increase both in the number, and more especially, in the size of tankers.

During the transportation of oil in tankers, oil pollution may result from either tanker accidents or operational oil discharges.

Oil pollution of the sea attracts great public attention because it is visible and most people encounter it, either at first hand on bathing beaches or on second hand from pictures on television or in the press whenever there is a spectacular accident.

With the increasing numbers of tankers on the sea more accidents have occurred, and as tankers have increased in size so large ones have also been involved. The first major tanker accident, that of the Torrey Canyon, was in 1967 when it ran grounded on the Seven Stones Rocks off the southwest coast of England (Fig. 6). The vessel was a complete wreck and 100,000 tons of crude oil was lost. This was the world´s largest spill until in March 1978 when the supertanker Amoco Cadiz ran aground off the north-west coast of Brittany, France, and lost its cargo of 223,000 tons of crude oil, causing enormous pollution of the beaches there.

Because shipping hazards are greatest close to the shore and in narrow waterways or at the entrances to ports where the density of shipping is high, most tanker accidents take place close to shore, and when oil is spilled, shore pollution almost invariably results.

The latest example of this hazard happened on 30th of May 1987 when M/T Skyron, with 137000 tonnes of crude oil, collided with the general cargo m/V Hel in the English Channel and burst into flames. The quick action of the rescue and fire officials of the region´s countries saved the north-east coast of Kent from a major pollution threat, as well as succeeding in saving both the ships with their oil cargoes, leaving only light fuel oil extending for ten kilometers from the bunker tanks of the general cargo ship. (Lloyd´s Weekly Report Vo. 268 - June 1987)

Three weeks later, on 23rd of June 1987, in the River

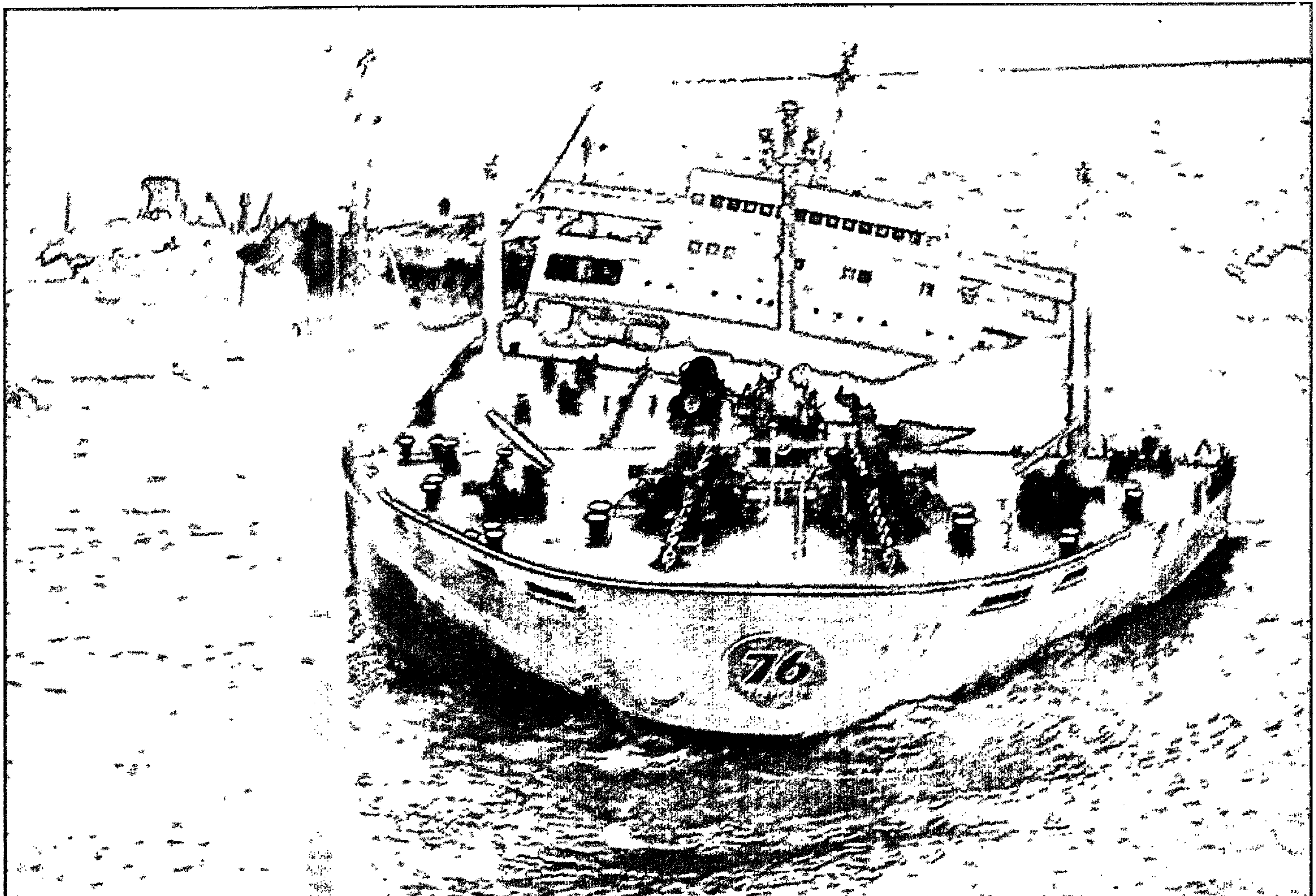


Fig. 6: The Torrey Canyon

Seine of France, the M/T Fuyoh Maru had steering problems and collided with the M/T Vittoria which exploded and split into two due to the failure of a gas-free in the empty cargo tanks, causing river pollution after the fuel tanks started leaking. (Lloyd's Weekly Report Vol. 268 - June 1987)

These cases can be applied to the Red Sea and the Gulf of Sue, where traffic density varies daily with the Suez Canal convoy cycle. The narrow passages and emmersed coral reefs are the main features of the elongated narrow Red Sea and Gulf of Suez. The wide range of vessels operating in this area includes, VLCC, OBO ships, bulk carriers, container vessels, Ro-Ro ships, fishing craft, passenger ships and many other types. Additionally, there are oil-rigs with supply vessels which contribute to the congestion of waterways in the Gulf of Suez.

The results of major shipping accidents in this area would not be less disastrous than such accidents in any other congested waterways where a large proportion of shipping consists of tankers. The unpleasant consequences of any major accident involving a crude oil tanker would include beach pollution and adverse effects on fishing and marine life.

It is important, therefore, that measures should be taken without any delay to forestall the occurrence of shipping accidents in the Red Sea and Gulf of Suez.

With a quick look to the statistical data of marine accidents in the last five years in Port Sudan harbour, we can see an increase in different types of accidents, including the type of accidents which have been involved in the manoeuvring and berthing of oil tankers. (Table 5)

Table 5

Marine Accidents in Port Sudan Harbour

	1981/82	1982/83	1983/84	1984/85	1985/86
Ships	15	13	12	19	13
Tugs & Lanuchs	14	17	18	30	25
Pontoon	4	2	4	2	2

Source: SPC

This increase is mainly due to lack of up-to-date equipment and trained personnel on these tugs.

M/T "SATTITE", 1200 DWT, is a supply tanker for fuel oil owned by the Sudan Shipping Line Ltd. This tanker, according to SSL reports and from an economical point of view, solved a real problem regarding the bunkering of the national company's ships especially when there is a lack of fuel oil in Port Sudan which occurs frequently, as it is used as a storage tank. However from safety point of view and antipollution precautions, I think there needs to be more control because:

- It has no proper permanent crew who are trained to work on board tankers.

- It is usually without a watchkeeper during night hours. It is sometimes even berthed with a full load in the tanks.

- It moves in many cases from the bunkering terminals to supply ships along the main quays of the harbour, where there is more traffic thus increasing the risk of accident.

A good example occurred in the port of Karachi in Pakistan on the 8th of July 1985, when the bunker supply tanker "AL-AKBAR II" capsized, spilling about 900 metric tons of fuel oil with a specific gravity of 0.92 into the port area. Although the spilled oil could have been easily contained and recovered due to the location of the spill, the absence of any proper equipment such as booms, skimmers etc. meant that all the efforts to contain and recover this oil proved furtile. Thus, the spilled oil polluted the whole Karachi harbour area, and due to the south-westerly winds, it flowed all along the jetties and extended to the beaches as well as to the outer sea with the change of tide (Lloyd's List - 9th July 1985). In this case the whole port was affected for many days and the oil remained in the area and degraded by natural processes in time.

In Port Sudan harbour, there is no contingency plan to deal with such accidents. Also there is an absence of any proper antipollution equipment such as booms, skimmers etc. They control oil spills by using dispersant fluids which are often toxic to marine organisms.

Although the Gulf of Suez is 400 miles from Sudanese waters, the spilled oil will move under the influence of wind, tide and currents. As the Red Sea and especially the Gulf of Suez, is almost totally enclosed by land, it is probable that although the tide and sea currents play a role in the movement of floating oil, the major influence on the destination of an oil spill is the force and direction of the wind.

A study carried out by the Egyptian Institute of Oceanography and Fisheries found that the high levels of pollution recorded in the southern part of the Gulf of Suez are related to the presence of the offshore oil fields. The levels of oil pollution to be found in the southern part of the Gulf of Suez have been described by the researchers as bands of oil tar, several centimeters thick and several meters wide, which coat many of the shores along the tide line, while at some sites more extensive accumulations of tar balls and oil occur. The oil pollution in the Gulf of Suez appears to come from the offshore oil fields and largely from illegal discharges of dirty ballast water from tankers, due to the lack of supervision and surveillance.

There is more evidence that oil pollution on the Egyptian Red Sea Coast is increasing, with an increase in the concentration of tar on different parts of that coast, and this oil pollution is carried southwards by the prevailing current and wind.

3.2.4 Oil Tanker Operations:

During the load voyage of oil tankers some of the heavier components of crude oil settle or cling to the internal surfaces of the tank structure. This material, known as clingage, remains in the tanks after the cargo has been discharged. This may be 0.3 to 0.5% of the cargo carried in that particular tank, which in the case of large tankers may amount to 1000 metric tons (Stubberud, 1986). Plus this amount some hundred tons of oil may remain in the pumps and pipelines.

In the ballast voyage the oil tanks are required to be cleaned. Previously, sea water was used through special machines for cleaning and washing the oil tanks. These oily residues with sea water used to be discharged overboard, which contributed to the oil pollution at sea. This quantity can only be reduced or eliminated either by providing reception facilities ashore or retaining this quantity temporarily on board in the slop tanks.

Although all the necessary restrictions and provisions are explained in the International Convention for the Prevention of Pollution from ships 1973/78, a large quantity of oil is still discharged from oil tankers in the Red Sea enroute to Gulf Ports.

The Red Sea is considered as one of the special areas indicated by IMO. These special areas are:

- The Mediterranean Sea
- The Baltic Sea
- The Black Sea
- The Red Sea
- The Gulf Area

The requirements for the first three areas have been in effect since MARPOL 73/78 entered into force in 1983, and the other two will take effect from the date established by IMO.

The oil tankers, after passing the Suez Canal, continue their ballast voyage southwards to the production ports. Oil slicks are common all along the ship traffic routes within a 50 nautical miles range of the Sudanese Coast. These are clear indications of oil tanks cleaning residues from oil tankers enroute to loading fresh cargo. Under MARPOL 73/78, the discharge of oil from cargo tanks is prohibited except for clean or segregated ballast (See Appendix A and B).

Moreover, the oily wastes produced in the machinery spaces of all types of vessels, are also discharged into our area due to the lack of proper legislation and control.

3.2.5 Oil Pollution From Ships at Port Sudan:

3.2.5.1 Ship's Operations:

At present the most polluted areas on the Sudanese Coast are concentrated in the waters close to Port Sudan. (See Fig. 7) Since Port Sudan is the major and only operated port now, almost all foreign trade is conducted through it.

Table 6

Number of Ships Calling Port Sudan

Year	No. of Ships
1977	1253
1978	1172
1979	1272
1980	1110
1981	1214
1982	1262
1983	1378
1984	1336
1985	1201
1986	1371

Source: SPC

Referring to table No. 6 above we can see that the number of ships calling at Port Sudan is

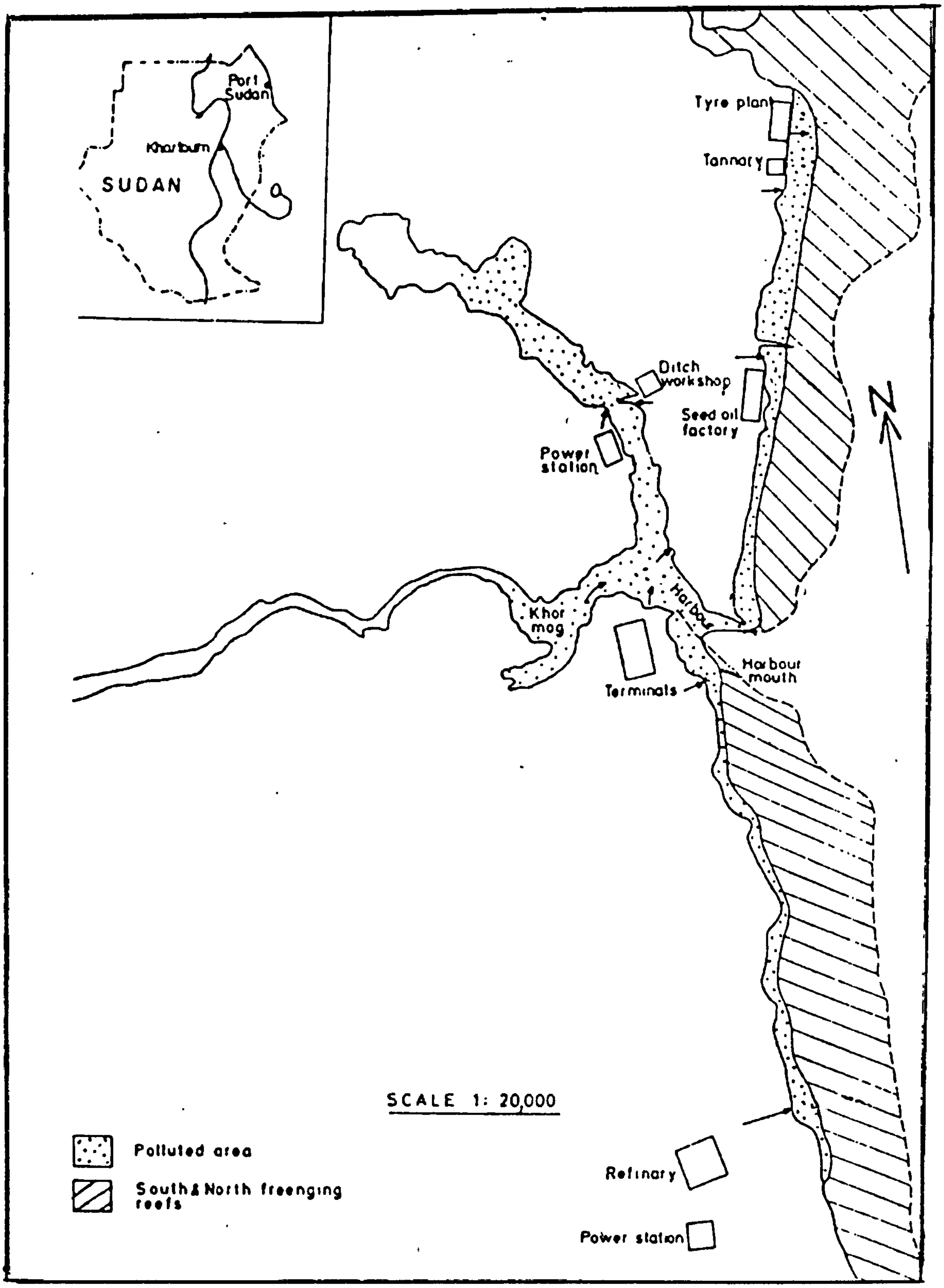


Fig. 7: The Polluted Areas Around Port Sudan Harbour

increasing. In 1985/86 more than 1370 ships visited the harbour, of which 93 were oil tankers of up to 50,000 DWT (SPC, statistic report 1985/86).

These ships, during routine operations, produced waste oil and dirty ballast water. Due to the lack of supervision and strict regulations most of these ships pollute the harbour and territorial waters from illegal discharges of dirty ballast and machinery space bilges. The tides and waves created by manoeuvring the vessels in the harbour help in drifting and accumulating oil up on to the beaches.

Another problem originates mainly from the various types of small ships sailing freely around the Red Sea ports, which also contribute to polluting the coastal waters with waste oil and rubbish. These ships are very old and have no antipollution equipment, beside which they are mostly operated by uncertified personnel who have no basic knowledge of the question of marine pollution.

In fact there is no estimation to the amount of oil entering our waters from this source, but it can be imagined from the heavy traffic shown.

3.2.5.2 Oil Terminals:

With regard to table No. 7 we can see a continuous increase in imported goods into the country with a total of more than 41×10^5 tons during 1985/86 (SPC - Report 1985/86).

More than 30% of this total is crude oil and petroleum products with a total of 14×10^5 tons in 1985/86 (See Table 8). These quantities were transported by 93 oil tankers, almost two tankers per week (Table 9).

As mentioned before, under 2.3.1, crude oil and petroleum products are handled over berths No. 16 and 17/18 which are not ideal berths as they are designed for container terminals.

These discharge terminals are connected to many petroleum storage tanks, owned by some of the petroleum companies, by a number of over ground pipelines. There are 40 storage tanks situated along the southern part of the harbour, with a storage capacity of 50,000 tons oil/tank. Elsafi, 1982, found that handling losses for every unit of 250 tons of crude oil, was one ton, i.e. one ton remains in the tanker during unloading. It is estimated that 200 tons/tank of slope oil were discharged through a drainage system extending 2 Km. into the sea, with a flow rate of 2080 m^3/day and a total of more than 8×10^3 t/y combined pollutant load. The combined pollutant load per capacity of terminals for storage was estimated as 16.3 Kg./ton. This estimation contains a high percentage of G & O (46.8%) and an SS of 45.8%, while high concentrations of Pb are produced from terminals with a high load.

Present safety distances around berth 16, which is designed as a dry cargo/passenger terminal only, are too short. Moreover, uncontrolled activities take place near to the

Table 7: Quantities of Cargo Through Port Sudan Harbour

Year	Imports	Exports
1976/77	2381200	1418213
1977/78	2507405	1154359
1978/79	2528890	1026809
1979/80	2821978	1259194
1980/81	2880940	1103136
1981/82	2849517	0996461
1982/83	3218688	1014079
1983/84	2953505	0962695
1984/85	3206545	0520667
1985/86	4108879	0479806

Source: SPCS

Table 8: Quantities of Crude Oil & Petroleum Product Imported

Year	Crude Oil	Petroleum Products	Total
1976/77	1140297	084556	1224853
1977/78	1044109	174612	1218721
1978/79	0795011	429042	1224053
1979/80	1038721	234834	1273555
1980/81	0859920	392461	1252381
1981/82	0643627	553494	1197121
1982/83	0624341	634590	1258931
1983/84	0537289	679932	1217221
1984/85	0324368	822552	1146920
1985/86	0725224	704818	1430042

Source: SPCS

Table 9: Types of Ships Calling Port Sudan

Type of Ships	Year						
	1980	1981	1982	1983	1984	1985	1986
General Cargo	878	826	836	754	701	551	553
Container	-	-	-	55	132	122	134
Live Stock	-	15	13	99	111	166	154
Oil Tanker	59	69	58	65	96	93	93
Roll on/Roll off	114	178	220	184	124	66	58
Car Carrier	-	-	-	30	24	39	41
Passenger	-	35	41	64	97	96	267
Molasse Tanker	-	-	-	6	7	6	14
Bulk Carrier	-	-	-	13	6	41	39
Vegetable Oil Tanker	-	-	-	-	4	7	5
Other Ships	59	91	94	107	34	14	33
TOTAL	1110	1214	1262	1378	1336	1201	1371

Source: SPCS

tanker/gas carrier berth, including the unloading of grain carriers with vacuum machines, container handling, truck traffic and sometimes the berthing of passenger ferries.

As we can see from the above-mentioned statistical figures and the situation around the unloading oil terminals, there is a continuous hazard and threat to the marine environment in the harbour. Oil pollution is likely to occur in the event of damage, or tanker accidents due to equipment failure or careless handling which neglects the precautionary measures.

3.3 OIL POLLUTION FROM COASTAL INDUSTRIES:

Oil pollution from this source is still concentrated near Port Sudan. The reason is the industrial plants which discharge their waste directly into the sea. Industry, with demands for large volumes of water for cooling or effluent disposal, has tended to be located on the coast.

Although the level of pollution from this source is not yet very high, they are considered as the main and only source for the existing pollution around Port Sudan Town. Relevant to the expansion of the industrial area around this town, the hazard from waste oil pollution will also increase.

The plants mostly contributing to this type of pollution are:

- The Seed Oil Factory
- The Main Electric Power Station
- The Repair Dock Yard

3.3.1 The Seed Oil Plant:

This is located in the area of Abu Hashish. It produces about 33 x 10^3 t/y of oil, extracted from ground nuts and sesame, at 95% of full capacity.

This plant discharges 25.2 x 10^3 m^3/day of processing liquid waste directly into the sea. This discharge has a temperature of 50^oC with an ambient temperature above the sea of 24^oC, which contributes to thermal pollution of this area. This thermal pollution can completely damage and destroy the natural marine communities (Zeiman, 1975, cited in Elsafi, 1982).

The total waste load is calculated as 77000 Kg./y and the load of production per plant is found to be about 2.3 Kg./ton (Elsafi, 1982).

The measurement of oil pollution along the coast shows a high concentration in excess of 600 mg./L of G & O at this plant. These concentrations of G & O, measured along the coast, were above the permissible limit (Osman, 1980, and Laws, 1981, cited in Elsafi, 1982).

the strong relationship between G & O and SS has increased the Chemical Oxygen Demand (COD) which has reduced the DO in the sea water, while the strong reversible correlation between G & O, pH and salinity implies that when G & O increase in the surface water pH and salinity might be reduced.

3.3.2 The Main Electrical Power Station:

This is located on the western side of the harbour. It is the main supplier of electric power to Port Sudan Town, and has been renewed with the building of four new generators using blended-fuel oil. This plant has been discharging the waste oil directly into the sea for quite a long time. There is no specific quantitive estimation for this waste load, but it can be seen clearly from the Figures No. 8-12 how the beach and harbour side is polluted. Elsafi, 1982 stated that the combined waste at that area contained a high level, 55% of COD.

Furthermore, the coolant water discharge from this plant, which has a temperature of 36^{o}C, helped in limiting the distribution and prevalence of marine vegetation on that side of the harbour (Nasr et al, 1986). "Heated water is known to damage natural communities in the ecosystem" (Zieman, 1968/75 cited in Nasr et al 1986).

3.3.3 The Dock Yard:

The dock yard is owned by the SPC, located at the north coast end of the harbour. It has one slipway for dry-docking the harbour tugs and crafts, and commercially accepts ships of up to 1500 DWT.

This yard is not provided with any reception facilities to receive tank cleaning residues. Thus in the absence of any strict rule and surviellance, most of these oily residues are disposed off into the port area resulting in oil pollution of the marine environment. This yard has seemed to be a source of used oil pollution for a long time. Furthermore, in the event of an oil slick occurring it was cleaned by using chemical dispersants which are considered as a source of another type of marine pollution.

3.4 SUMMARY:

There is more direct evidence that the existing oil pollution around Port Sudan and along the Sudanese Coast results from the sources mentioned in this chapter.

In 1986, a study carried out by the Sudanese Institute of Oceanography at Port Sudan in the water areas of the harbour found that:-

- The areas adjacent to the shore line are heavy polluted and seemed to be devoid of organisms except for large numbers of free-living nematodes which were observed in this area.

  This could be taken as direct evidence as to existence of oil pollution since these nematodes have a great resistance to oil.

  "The palychaete worm, Capitella Capitela has been found to occur in very large numbers after oil spills. It was thought that it benefited from the absence of other organisms which normally prey upon it or compete with it for food resources" (Blumar et al 1971, cited in Nasr et al 1986). This argument has been accepted by the researchers which apply to the situation of nematodes in Port Sudan harbour.

- The heavy sedimentation in the area of study which is coated with floating oil had some effect on most marine plants such as interference with photosynthesis.

- The dead coral in the area of study is affected by oil and sediments. "Although the prevailing north-east winds moved the floating oil to the sourth-western shore, a considerable amount of oil was absorbed by the suspended sediments and sank to the bottom where both sediments and oil affected the corals."

- "The live coral which was observed in the study area was a species of Porites which seemed to be resistant to oil pollution and sedimentation."

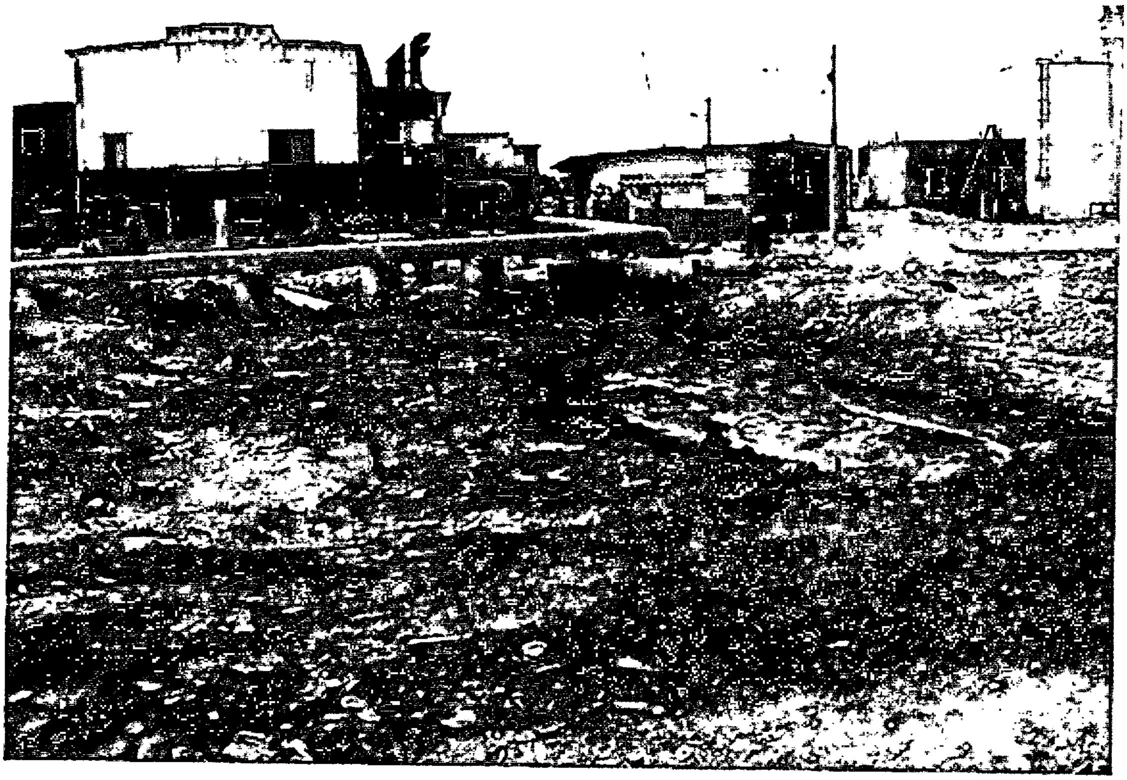


Fig.8.

Figs.8&9 show how the waste oil is drained from the electric power station directly into the sea.

Fig.9.

Figs.10-12,Polluted coast inside PortSudan Harbour.

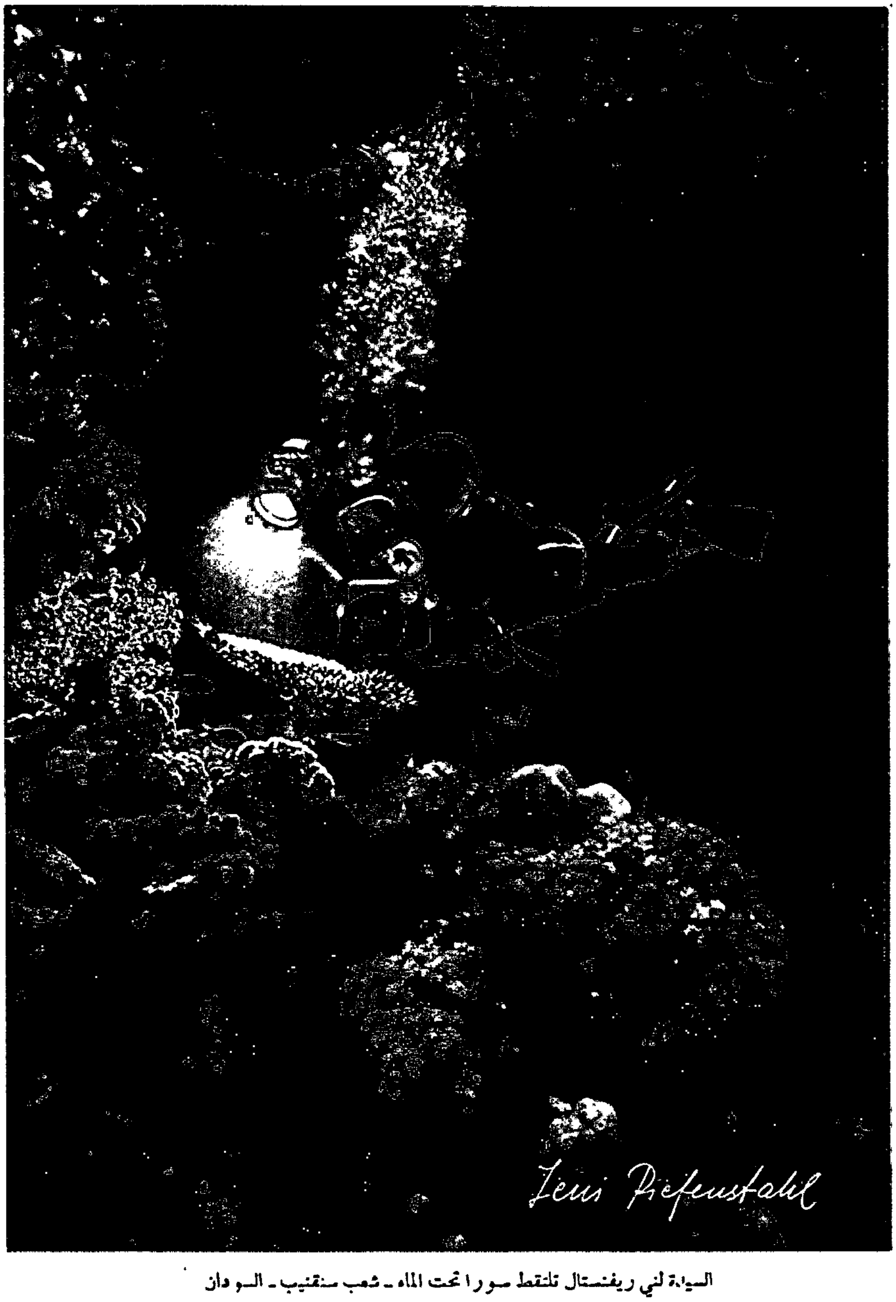
Fig.10.

Fig.11.

Fig.12.

CHAPTER 4

THE IMPACT OF MARINE POLLUTION ON THE ENVIRONMENT



السيدة لني ريفنستال تلتقط صورا تحت الماء ـ شعب سنقنيب ـ السودان

Leni Riefenstahl taking underwater photographs
Sanganeb Reef, Sudan, Photo & C. Leni Riefenstahl

Sudanese reefs are beautiful : Protect them .
Spear fishing, coral and shell collecting are prohibited!
Sudan Marine Conservation Committee,
P. O. Box 24, Port Sudan, SUDAN

CHAPTER 4

THE IMPACT OF MARINE POLLUTION ON THE ENVIRONMENT

4.1 INTRODUCTION:

There is no doubt that marine pollution has a deleterious effect on all marine life. It is important to emphasize the need to understand not only what pollutants do to the environment but also the natural processes occurring in order to assess the impact of pollution on man and the environment. It would be useful to know the costs of this effect on the environment and on man and to compare these with the costs to eliminate this pollution.

The impact of oil pollution depends 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.

The behavior of synthetic organic chemicals, from shore-based sources, which have tended to accumulate in the sediments of shallow waters, are important as marine pollution affects not only the environment but also, to a significant degree, man's further utilization of the marine environment.

4.2 THE 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 a short life duration (Clark, 1986).

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.

Any sample of crude oil or refined petroleum product may contain several thousands of different compounds in varying proportions which begin 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 components 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 change, there may be long-term effects resulting from sub-lethal doses of the toxins to eggs and the 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 different types in different circumstances.

4.3 EFFECT OF PETROLEUM HYDROCARBONS ON MARINE COMMUNITIES:

The result of damage from oil contamination may be either from single spills or from low-level continuous discharges. In the first one 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 oil, and the marine communities will recover. This recovery may take only a matter of weeks for rocky shores where the area can be cleaned rapidly, or it may take up to several years for soft-bottom or marsh areas where the oil may persist for long periods of time. Continuous, low-level contamination from ports, refineries, or waste water 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 sub-lethal effects of oil.

4.4 EFFECT ON HUMAN HEALTH:

"Some petroleum hydrocarbons are toxic to human beings and there are a few cases on record or children being made seriously ill or even dying after inadvertently swallowing Kerosene (Paraffin). There is a risk of humans unknowingly receiving measurable doses of these toxins from contaminated food or drinking water.

Oil includes polycyclic aromatic hydrocarbons (PAH) some of which are known as Carcinogens (Clark, 1986)." A report from GESAMP (1985) concluded that when Carcinogens in marine organisms were not metabolized or destroyed by cooking, some risk of cancer induction existed 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.

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 (Sami, 1985).

4.5 COMMERCIAL DAMAGE FROM OIL POLLUTION:

Fixed installations where fish or shellfish are held in intensive mariculture are particularly vulnerable to damage from accidental oil pollution as the animals cannot escape. A slick of oil drifting through such an installation may inflict commercial damage quite incommensurate with the size of the spillage. Such unfortunate experiences have happened in Japan, where mariculture is more varied and more advanced than in most other countries.

Although the fishery industry in Sudan is not very large, very advanced projects and plans are underway in the Fisheries Departments in Port Sudan and Suakin.

A known case in which an oil spill appears to have had a perceptible impact on fish stocks was that which followed the wreck of the Amoco Cadiz on the Brittany coast in 1978, and the devastating pollution that resulted.

On theoretical grounds, it has been calculated that a major oil spill at the time and in the place of the main fish spawning in the North Sea would at least cause a slight reduction in the overall catch for one year.

Clark, 1986, stated that most of the harmful effects of oil on fisheries refer to shellfisheries, either intertidally or in shallow water, and the damage may persist for years.

As serious as the losses are, resulting in the death of fish and shellfish, the most important commercial damage is from tainting.

Light oils and the middle boiling range of crude oil distillates are the most potent source of tainting but all crude oils, refined products refinery effluents, wastes from petrochemical complexes, the exhaust from outboard motors burning an oil-petrol mixture, and a host of other sources can impart an unpleasant flavour to fish and seafood which is detectable at extremely low levels of contamination.

Unlike most other organisms in the sea, sea birds are harmed through the physical properties of floating oil. 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 the skins which reduces buoyancy and thermal insulation.

Discharge of oil bilge and dirty ballast water in the North Sea caused the death of 150×10^3 sea birds (Hickling, 1975, cited in Elsafi 1982).

During the acute phase of oil spills off the north and west coasts of Bahrain in 1980, about 1000 birds were found dead and a considerable number that had been affected were observed (UNEP 44, 1984).

Evidence that oil damages corals has been inclusive in studies where crude oil floated above natural reef outcrops and experimental specimens. There is little evidence of any significant deterioration of the reefs due to oil pollution in the Red Sea. But 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 sub-littoral coral growth, or through their own chemical toxicity pollute the water column and damage, or kill, the corals growing in that column (UNEP No. 64, 1985).

4.6 EFFECT OF OIL DISPERSANTS:

Chemical dispersants were used for the first time on a very extensive scale to fight crude oil pollution when the Torrey Canyon became stranded in the English Channel in March, 1967.

In order to avoid contamination of the beaches, which were important for holiday-makers, during a period of one month approximately 22,000 tonnes of dispersants were used. The widespread use of disperants resulted in the damage and death of plants and animals, particularly on the shore. This incident led to a generally held belief that the environmental effects of dispersants were worse than the efect of the oil, and due to this many national authorities decided to ban the use of dispersants.

The important consequences of using oil dispersants are:

- The dispersants can exert their own toxic effect on plants and animals in the water or on the shore.

- They may modify the form and availability of the oil to exert its effects.

- They may react with the oil to produce more harmful effects.

Generally dispersants increase the amount of oil in the water column and therefore increase the risk of effects from this type of pollution (Wilson, 1984, UNEP No. 44).

Consequently, care must be taken to limit or avoid the use of dispersants where environmental impact might be greater for the dispersed oil than for the undispersed surface oil.

Despite the negetive results of toxic dispersants used during the Torrey Canyon incident, in the UK it is still firmly believed that dispersants have an optimum role in combating oil spills. This optimum can be reached when following the method below:

- Define where and when dispersants could or should be used, how they should be applied and in what quantities. This method is known as environmental control.

- Identify under laboratory control the composition, safety, effectiveness and toxicity of the dispersants. This method is known as laboratory control.

These two methods have now been adopted more widely in the world.

CHAPTER 5

PREVENTION OF OIL POLLUTION

CHAPTER 5

PREVENTION OF OIL POLLUTION

5.1 INTRODUCTION:

For many years it has been recognised that the amount of oil being pumped into the sea is too great for the ocean to absorb, and a variety of methods have been introduced in an attempt to eliminate the problem of what is normally termed "operational pollution".

In the last fifteen years a great deal of work has been carried out on the effect of oil pollution on the marine environment, on means of preventing the escape of polluting oil and on equipment and methods to deal with the oil after it has been released.

The same question keeps arising: What measures are to be taken so that an oil spill does not occur, be it a tanker collision, a harbour mishap, or drilling rig accident? Better technical precautions, better development in shipbuilding, but above all better navigation are the most effective measures for preventing accidental oil pollution.

After the "Amoco Cadiz" accident in 1978, there were discussions in all coastal nations as to what could be done to prevent oil accidents.

Various methods and measures designed to reduce operational pollution and prevent tanker accidents have been introduced by individual governments and tanker operators. Such measures against the risk of oil pollution can be organized without world-wide conventions, on a national or regional basis. But it is well recognised that shipping is essentially international in character. So rules and standards relating to maritime safety and pollution prevention should be discussed, agreed upon and implemented at that international level.

There is no doubt that the international instruments will provide a solid regulatory umbrella for the protection of the marine environment. But the implementation of these instruments depends on the existance of appropriate national legislation.

The United Nations Convention on the Law of the Sea was a result of the most ambitious project ever attempted by the UN to reform an International Law.

This chapter will very briefly examine the various international conventions which concern oil pollution prevention, liability and compensation.

5.2 INTERNATIONAL MARITIME ORGANIZATION (IMO):

In 1958 the Intergovernmental Maritime Consultative Organization (IMCO) was formed, since 1982 known as the International Maritime Organization (IMO).

It is the United Nations Maritime Agency, with 131 member states and one associate member.

The main two objectives of IMO are to improve the safety at sea and to eliminate marine pollution from ships (Safer Shipping and Cleaner Oceans).

More than 30 treaty instruments covering many aspects of maritime safety and pollution prevention have been adopted by this organization.

The existence of IMO enables the maritime nations to meet regularly and adopt measures which are of mutural benefit.

In the field of Marine Environment Protection, the work programme of IMO is directed as follows:

I. To develop and adopt the highest practicable standards for the prevention and control of deliberate and accidental pollution from ships and other equipment operating in the marine environment.

II. To encourage governments in the effective implementation and enforcement of internationally accepted standards and other related measures.

III. To promote co-operation among governments, particularly at regional level, for combating pollution in cases of emergency.

IV. To provide assistance to developing countries in order to meet the objectives mentioned in II and III above.

5.3 THE INTERNATIONAL AGREEMENTS:

5.3.1 The Law of The Sea:

The third UN Law of the Sea Conference (UNCLOS III) originated in 1967, when the mineral resources of the deep seabed were first debated in the UN General Assembly. This resulted in the establishment of the UN Seabed Committee, which became a preparatory committee for a full-scale Law of the Sea Conference very soon after. The inconclusive result of the General Law of the Sea Conference made a new conference almost inevitable. In particular, the limits of national jurisdiction, undecided after Geneva, would become one of the central UNCLOS III issues. Much of this had considerable implications for the shipping industry. As could be expected, shipping has 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 means aimed at shipping in maritime areas up to 12 miles, and possibly 200 miles, from coasts.

The UNCLOS III held sessions from 1973 until 1982 and became much more than an international conference. It was a "Law reform movement" which attempted to redistribute ocean resources and ocean uses. 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 the shipping industry the convention provides "umbrella" legislation in a variety of areas, such as:

1. New jurisdiction for coastal states in the 12-mile territorial waters, 24-mile continguous zones, 200-mile Exclusive Economic Zones, Archipelagic waters, and especially environmentally endangered waters.

2. 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.

3. New provisions regarding the rights and responsibi-

lities of coastal flag and port states concerning vessels in ports, inland waters, territorial seas, economical zones and on the high seas.

The convention also provides for dispute settlement, as well as technical assistance to developing states in aspects relating to shipping and environmental protection.

There is no doubt that the new UN 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 emphasis the need for a maritime transit convention which will provide much-needed regime for international sea transport which is presently regulated in a very fragmented manner (Gold, 1985).

5.3.2 The International Convention for the Prevention of Pollution of the Sea by Oil, 1954, as Amended in 1962 and 1969:

The 1954 Oil Pollution Convention (OIlPOL 54) was the first major attempt by the maritime nations towards the international control of oil pollution. This convention was a result of a conference held in London that year. The convention was provisionally deposited with the United Kingdom Government until IMCO was established in 1958, when the depositary functions were taken over by the Organization.

The principal object of OILPOL 54 was the protection of the seas from oil pollution. It prohibits the international operational discharge of oil and oily mixtures by certain ships in specified areas of the ocean, extending to at least 50 miles from the nearest land. This convention entered into force on 26 July 1958.

The OILPOL 54 was amended in 1962 to include ships of lesser gross tonnage and to narrow the permitted zones for oil discharges. This amendment entered into force for its Parties on 28 June 1967.

The 1969 amendment was in response to the "Torrey Canyon" disaster which had illustrated some of the weaknesses in OILPOL 54. This amendment entered into force for its parties on 20 January 1978.

The 1969 amendment prohibited oil discharged through the normal operation of a ship except under the following conditions:

1. The total quantity of oil which a tanker may discharge in any ballast voyage must not exceed 1/15,000 of the total cargo carrying capacity of the vessel.

2. The rate at which oil may be discharged must not exceed 60 litres per mile travelled by the ship.

3. No discharge of any oil whatsoever must be made from the cargo spaces of a tanker within 50 miles of the nearest land.

In 1971, two further amendments were designed. One was to deal with the protection of the Great Barrier Reef Area of Australia and the other to deal with tank sizes of tank-ships (Stubberud, 1986).

Although the 1971 amendments did not enter into force, it was recommended that they be put into effect nationally and they were observed in several maritime countries. OILPOL 54 has now been succeeded by MARPOL 73/78 and is therefore no longer applicable. However, as MARPOL only came into force in October 1983, and is not yet ratified by many states, the OILPOL 54 provisions will remain effective for many states until they ratify MARPOL and or denounce OILPOL 54.

5.3.3 The International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978, (MARPOL 73/78):

In 1973, IMO convened a major conference to discuss the whole problem of marine pollution from ships. It resulted in the adoption of the most important and comprehensive anti-pollution convention to enter into effect in maritime history. The convention deals not only with pollution by oil, but also pollution from chemical and other harmful substances, garbage and sewage, except disposal of land generated wastes into the sea by dumping which is covered by a separate convention.

MARPOL consists of the main body of the convention of 20 articles, two protocols and five annexes which set out the actual prevention regulations as follows:-

Annex I:	Pollution by oil
Annex II:	Pollution by noxious liquid substances carried in bulk
Annex III:	Pollution by harmful substances carried in packages, portable tanks, freight containers or rail tank wagons, etc.
Annex IV:	Pollution by sewage from ships
Annex V:	Pollution by garbage from ships

The first and second Annexes are compulsory, while the remaining Annexes are optional.

The MARPOL Convention greatly reduces the amount of oil which can be discharged into the sea by ships, and bans such discharges completely in the main special areas, covered in the previous chapter. It gives statutory support for such operational procedures as "Load on top" (which greatly reduces the amount of mixtures which have to be disposed of after tank cleaning) and segregated ballast tanks.

The series of serious tanker accidents in the winter of 1976/77 led to demands for further action. IMO responded to these demands and took rapid steps to convene the Conference on Tanker Safety and Pollution Prevention in 1978. This Conference adopted a Protocol known as the "Tanker Safety and Pollution" which introduced further measures, including requirements for such operational techniques as crude oil washing "COW", which is considered as a development of earlier "Load-on-top" system; and a number of modified constructional requirements such as protectively-located segregated ballast tanks. (Pub. 5)

The convention and other protocol entered into force in October 1983 and is often titled as "MARPOL 73/78".

5.3.4 The International Convention Relating to Intervention on High Seas in Cases of Oil Pollution Casualties, 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 has 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 realistic concern that oil pollution might result in major harmful consequences.

The convention has been criticized both for allowing too much discretion 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 which entered into effect in 1983.

5.3.5 The International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC 1969):

This is the Convention which deals with the civil liability of the ship or cargo owner for damage suffered as a result of an oil pollution casualty.

The purpose of the Convention is to ensure that adequate compensation will be readily available to victims of oil pollution, and places the obligation for paying such compensation on the shipowner. Furthermore, only oil carried in bulk as a cargo is included. Vessels in ballast are thus not covered.

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 failure of authorities in maintaining navigational aids.

However, in most cases where the shipowner cannot 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 calculations with the Special Drawing Right (SDR) of the International Monetary Fund (IMF).

In order to be covered under the convention the ship 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 to be parties to the Convention. Action against those liable under the Convention must be brought in the state where 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 concern that the CLC was no longer able to fully meet the demands of major pollution incidents. The CLC Protocol raises liability limits for ships up to

5000 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.

5.3.6 TOVALOP and CRISTAL

The world's tanker owners appreciated that oil spills, no matter what the cause, were giving the oil industry a very bad public image and were also likely to encourage governments to introduce legislation which might hamper trade, without doing very much to reduce the number of oil spillages. The tanker owners, therefore, decided to combine and make agreements so that they could pay the clean-up costs resulting from a spill in which a tanker was concerned. This would be done if the tanker was negligent, regardless of the degree of fault. This payment would be either to the owner of the tanker who has incurred expenses by cleaning up the oil, or to the government concerned who has incurred expense in removing the oil, or by taking measures because the escaping oil presented a grave and imminent danger of damage by pollution to the coastlines of the country concerned.

This agreement, which has been signed by the owners of 97% of the world's tankers, is called the (Tanker Owners Voluntary Agreement Concerning Liability for Oil Pollution - TOVALOP). It has now been in existance for over fifteen years, and it is administered by an office in London called the International Tanker Owners Pollution Federation Ltd.

The tanker owners, like owners of other types of ships, combine into mutual aid groups (called P & I Clubs) who share their incurred costs under the heading of "Protection and Indemnity". These Clubs now include the oil spill clean-up costs. The maximum amount which can be paid out is based on the tanker size, being USD 100 per gross registered ton of tanker with a maximum of USD 18.6 million.

The major oil companies have also set up a fund known as "CRISTAL" which stands for Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution. In the event of the cost of a TOVALOP incident exceeding the limit given before, and if the cargo belongs to a member who has paid into the fund, then the CRISTAL fund may add to the total, up to a maximum of USD 36 million. (Wardley-Smith, 1982).

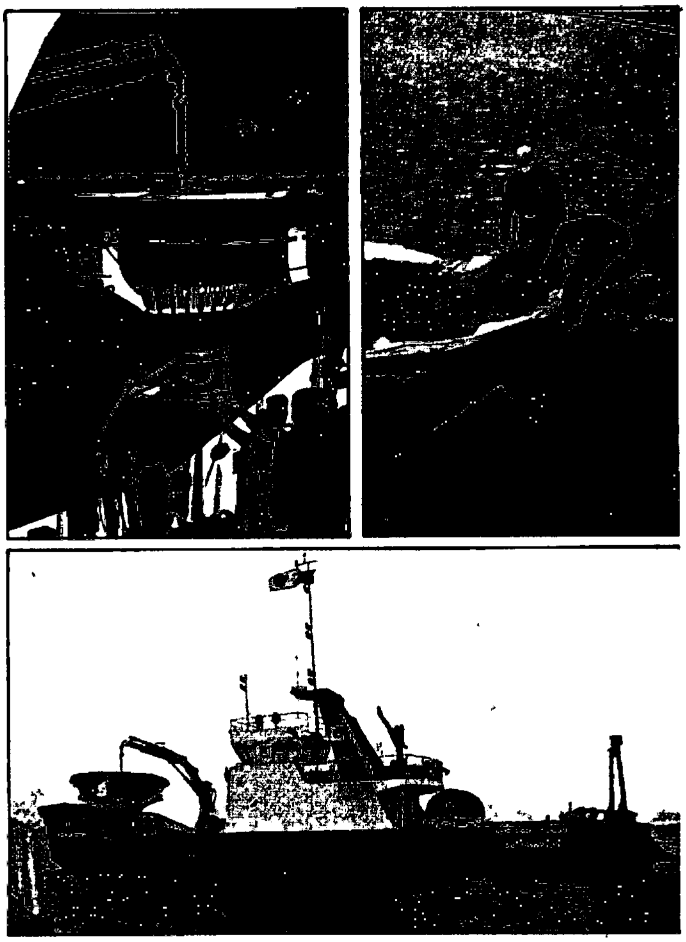
5.3.7 The International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971 (FUND 1971):

This convention was adopted by IMO in 1971 as a result of feelings by some delegates to the conference that the liability limits established by the previous conventions were too low, and that the compensation made available could in some cases, therefore, prove to be inadequate. The convention came into force in 1978.

Unlike the CLC, which puts the onus on the shipowner, the Fund is made up of contributions from oil importers. The purpose of the Fund is to provide additional compensation to victims where an accident results in pollution damage which exceeds the compensation available under the CLC. Thus the burden of compensation is spread evenly between the shipowners and the cargo interests. The Fund is operated by an International Oil Pollution Compensation Fund Organization in London. 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 damage, must also be a party to the Fund if the shipowner is also seeking compensation (IMO Publication 003/85). (See Appendix C)

C H A P T E R 6

TREATMENT OF OIL POLLUTION



New advanced oil spill control and clean-up equipments

CHAPTER 6

TREATMENT OF OIL POLLUTION

6.1 INTRODUCTION:

Unfortunately, from past experience, many oil spills have occurred close to coastal areas which are 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 causes serious damage.

Because oil spill on water spreads naturally it is desirable to try to confine a spill to a point near to its source. Clearly, oil spilled in a dock or harbour basin may be confined by the walls of the basin, but it will also be concentrated, to some extent, by wind blowing over the area, and individual pockets will sometimes be formed. If the total area over which the oil has spread can somehow be reduced, then its thickness will be increased, and there will be a better chance of physical recovery. Everyone now agrees that the physical removal of oil is to be preferred whenever possible.

As it has been mentioned in the previous chapter, many measures against the risk of oil pollution have been organized under the worldwide conventions. But the question is when oil is spilled, what is to be done? This question is taken seriously by all the countries with a merchant marine fleet and by the scientific community.

It is wishful thinking to expect that oil may be recovered from the water surface under any conditions. If this were so, it would be possible for considerable amounts of oil to be salvaged. Unfortunately, the areas where successful containment of oil on the water surface can be achieved are limited by wind, waves and current conditions to the relatively calm waters, usually only found in some rivers and estuaries.

If the oil slick moves toward a coast, the oil should be fought. Unfortunately the many different measures to fight oil on the sea have not been completely successful in rough weather on the open sea. One reason for this may be the lack of convincing technical concepts, but another reason is certainly the lack of funds needed to really build up effective oil-fighting units and oil recovery devices. However, a cost benefit calculation is difficult because even with effective oil spill fighting precautions there is no 100% safety, and after certain oil spills some oil will reach the coast on spite of all the efforts. In the last ten years the price to remove 1 ton of oil from the sea, chemically or mechanically, has been between USD 10 and 50 (Holmes 1977, cited in Sebastain 1983).

The main purpose of this chapter is to review the available offshore and onshore cleaning-up techniques with particular emphasis on those which have found measures to combat oil pollution at the regional level.

6.2 ANALYSIS OF DIFFERENT CLEAN-UP METHODS:

6.2.1 Dispersing Oil:

Dispersants are surface-active substances which enhance the formation of small, 1-5 μm diameter droplets of oil suspended in seawater, so that the oil slick disappears from the surface of the sea. At the beginning of the use of dispersants for fighting oil spills, about one ton of dispersants was necessary to disperse one ton of oil. Modern concentrates can be used 1:30 (Sebastain, 1983). Further, it is no longer necessary to provide good mixing of dispersants, as modern types are rather self-mixing so that some may be applied from airplane or helicopter. To avoid the risk of evaporation of the chemical it is rather reasonable to allow the light, volatile fractions of the oil to evaporate before dispersal; then the risk of explosion is avoided during operations. The spraying should be done before the water in oil emulsion, the "chocolate mousse" is formed.

The dispersal of oil following an oil accident is done not only by chemicals, but to a fairly large degree, depending on the weather, by natural processes too, and under favourable conditions small oil spills may be dispersed by the stirring effect of a motor boat's propeller (Moss 1971, cited in Sebastain 1983).

Types of Dispersants:

The dispersants used at the time of the wreck of the "Torrey Canyon" accident in 1967, were fairly poisonous. Detergents were used in large quantities. 10,000 t of dispersants and detergents were used to combat approximately 14000 t of weathered oil. Biologically, more damage was done by the dispersants applied than would have been done by the oil. The type used was the "BP 1002" which was a product with 12% nonionic detergents and 3% stabilizers in an aromatic solvent. The toxicity of "BP 1002" for subtidal organisms is 0.5-5 mg/L expressed as 24 hLC50, the concentration which kills half of the experimental animals within 24 hours. Toxicity for intertidal animals is 5-100 mg/L. In practice all animal life was killed where beaches had been cleaned with such types of dispersants (Southward 1978, cited in Sebastain, 1983).

In the meantime, however, the question of chemicals for fighting oil spills is again under discussion. Dispersants have been developed which are only about 1/1000th as toxic as "BP 1002". For example "BP 1100" and

"Corexit 7664" and for some of them the 48 hLC50 is as low as 10g/L.

In Great Britain such dispersants are licensed for sea use which have a 48 hLC50 of above 3.3 g/L, and the toxicity of an oil-dispersant mixture must not be higher than the toxicity of oil alone.

It is absolutely essential that, to achieve good results, oil slick dispersants be applied as recommended by the manufacturers. Many dispersants have, in the past, been wasted by incorrect usage and this has, no occa- sions, given dispersants a bad name.

Dispersants have proved to be an effective and practical method of dealing with large and small oil spillages both at sea, in shore and on beaches. It is important that they be applied correctly. It is not sufficient simply to have supplies of dispersants and equipment available at the right place at the right time, but trained personnel must also be available. It must also be borne in mind that it is much easier to disperse oil whilst it is still at sea and every effort should be made to do this before it comes ashore.

6.2.2 Sinking Method:

Oil floats as a layer on the surface of water. It would therefore, appear to be possible to get rid of the floating oil by making it heavier, that is, by distri- buting over it some powdered or granular solid so that the combined density of the solid, together with the oil, would be sufficient to make the oil sink. Simple experiments were carried out and showed that this is indeed possible. The powder used should be oleophilic so that it will attach itself firmly to the oil. It should also be of high density to minimize the amount of material required.

In practice different types of material were used such as a mixture of dense sand and cement, finely powdered chalk treated with a small quantity of surface active agent, and a mixture of sand and water as a slurry as introduced by the Royal Dutch Shell Company (R. Farn cited in Wardley - Smith 1983).

This method of disposing of an oil slick has been tested experimentally. Although it is satisfactory it can only be used where suitable sand is available within a reasonable distance from the site of the incident.

The main disadvantage of this method is that much of the oil later returns to the surface, or if it stays on the seabed, it is transported to the 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.

These conclusions have forced the British Government to draw up a number of working rules:

- Oil should not be sunk where there are currents likely to move the sunken oil either in the direction of amenity beaches or shellfish grounds.

- Oil should not be sunk where the bottom is likely to be trawled.

- Oil should not be sunk if it is likely to fall on shellfish beds or fish spawning grounds.

6.2.3 Burning Methods:

Some hydrocarbon products, for example, crude oil and kerosene, gasoline, petrol, etc. are highly flammable. The suggestion is frequently made that when oil is spilt on the surface of the sea and floats in a large slick, it should be disposed of by burning. This, unfortunately, has many practical disadvantages:

- The light fraction of crude oil which is the easiest to ignite rapidly evaporates. The rest is unlikely to be fired without great difficulty.

- If the oil is light quickly after discharge on the sea surface it may well be tantamount to lighting the vessel itself.

- When the oil spreads out over the sea, rapidly a thin layer is cooled by the sea, and that presents another difficulty in burning the oil, since a considerable amount will be left unburnt.

In 1969 experiments on the burning of oil on water were carried out in the United Kingdom by a working group of the Institute of Petroleum. In these experiments, a concrete lined pond, 100 sq. ft. in area, was filled with water. Two thicknesses of fresh Kuwait oil, half-an-inch and one-eighth of an inch thick, were floated on the water. Both ignited readily on the application of the flame and burnt fiercly for four minutes and one-and-a-quarter minutes respectively, and then went out quite suddenly. When, however, a layer of fuel oil was used, or crude oil was allowed to weather for twenty four hours before ignition, it was found to be very much more difficult to ignite the layer of oil. In all cases, a residue was left amounting to 15-20% of the oil originally applied (Wardley-Smith, 1983).

On the whole,burning is not a realistic method of disposing of oil spilled on the sea as air pollution by smoke is generated.

6.2.4 Booms:

Oil booms are floating barriers, used to prevent the spreading of oil on water, and sometimes to thicken the layer of oil by reducing the area into which it has spread. In its simplest form, an oil boom may be described as a floating fence supported by one or more bouyancy units.

There are many variations in design and attempts have been made to elaborate the system by incorporating weirs to skim off, and so remove, the entrapped oil.

Commercially-made booms are usually one of two types called "fence" or "certain" booms which constitute at least 80% of all known commercial types.

The Fence Booms:

It is made of rigid or semi-rigid material, presenting a vertical screen against the oil floating on the water (Fig. 13)

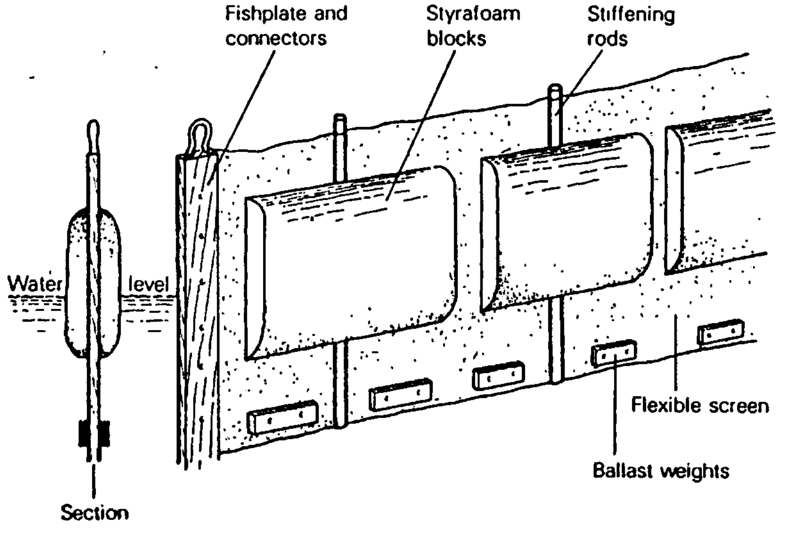


Fig. 13 Typical 'fence' type boom

The screen is kept afloat by plastic-filled bouyant compartments or blocks of plastic foam and is usually ballasted by weights attached to the base of the screen.

Some manufacturers offer booms of this type in "kit" form in which the main component, or screen, may be rolled-up and compactly stored. (Newman, 1983).

The Curtain Boom:

This type of boom is made up of long and usually continuous buoyancy tubes carrying a pendant skirt with chains or metal weight attached to the base (Fig. 14).

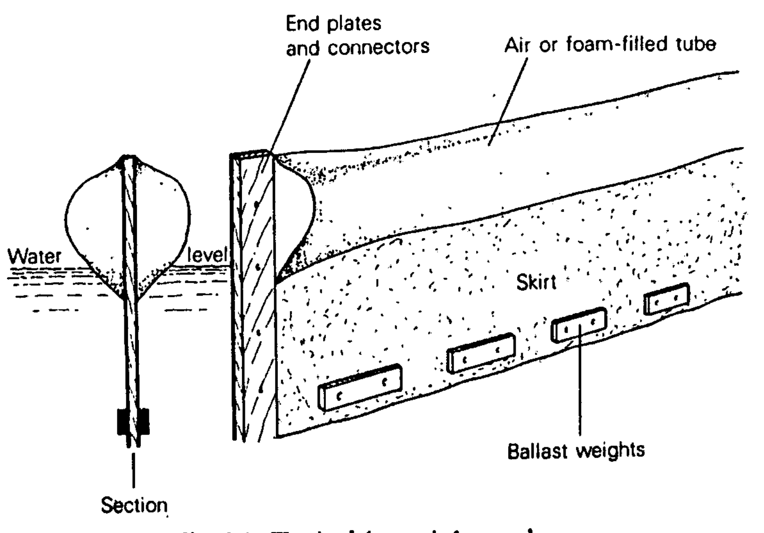


Fig. 14 Typical 'curtain' type boom

Often such booms are air-inflated before deployment and deflated after use. Thus bulk in storage saved, but some sort of inflation device has to be carried as additional equipment.

It is easier to inflate this type of boom than to assemble the many parts of which some "fence" type booms are composed.

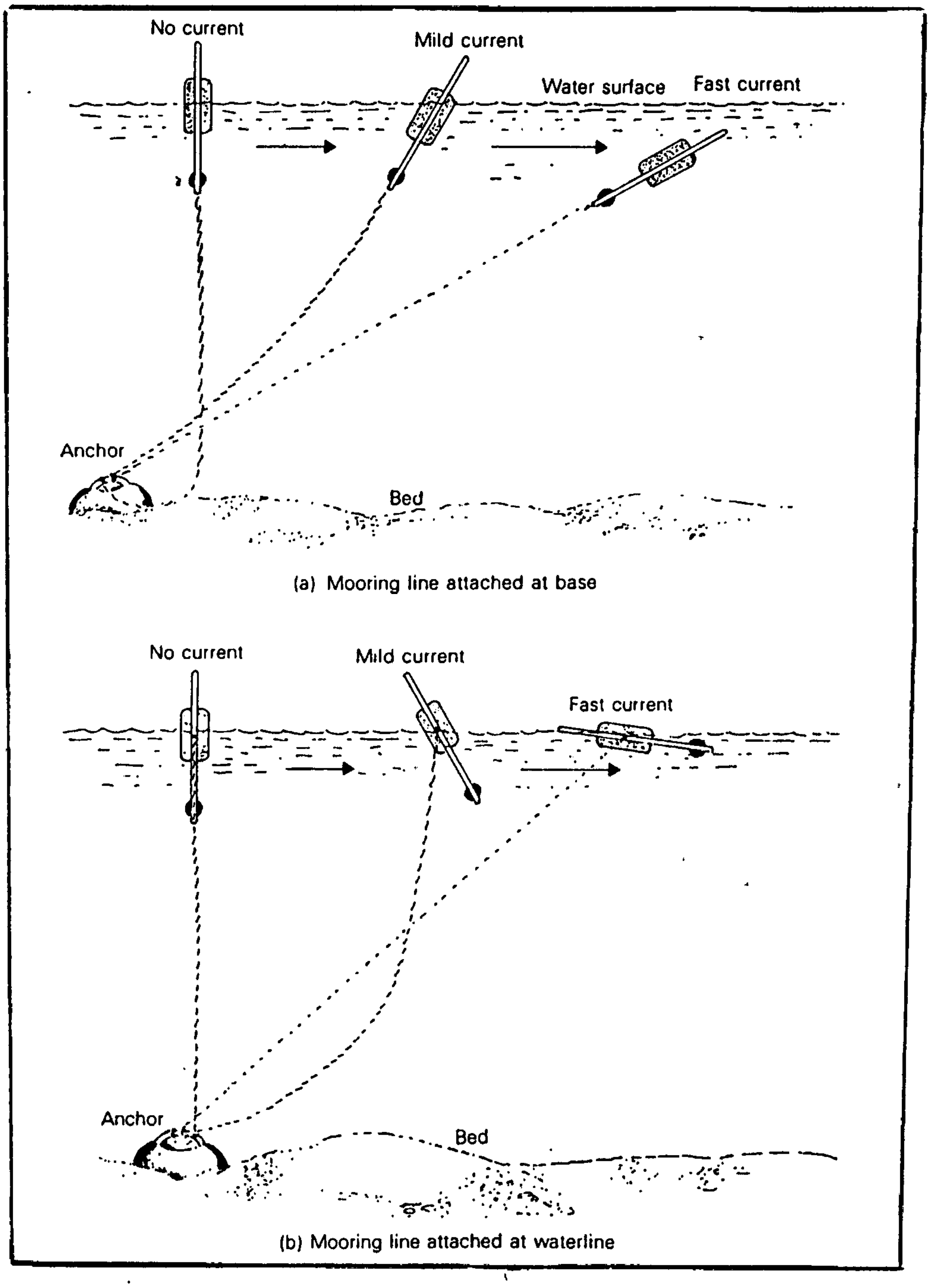


Fig. 15 "Fence" type boom

(a) mooring line attached at base.

(b) mooring line attached at water line.

Oil Mop:

This device has recently appeared on the market. It consists of a rope made of oleophilic fibres carefully woven into a polypropolane core thus forming an efficient oil absorbing device with a density of 0.9.

Although primarily designed as a pick-up device, intended to be passed between rollers to expel the oil, it may also be described as a floating absorbent boom, and the principle could be applied to the removal of oil from small streams, accidentally polluted, possibly a factory discharge. Fig. 16 shows a simple layout that could be applied to such a case.

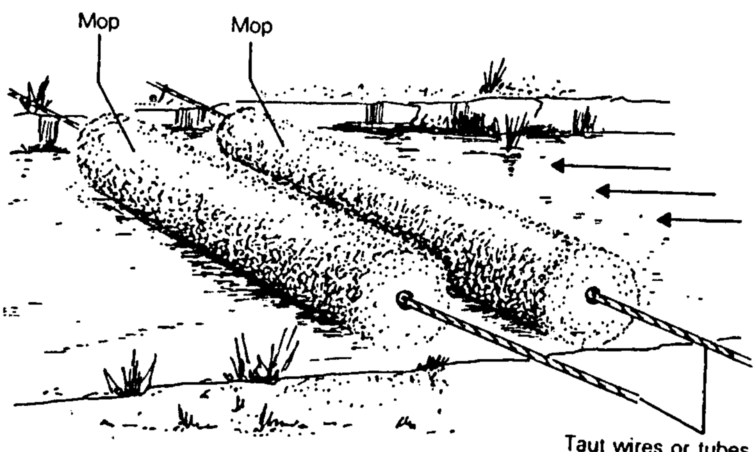


Fig. 16 Cylindrical mops of oleophilic fibres

6.2.5 Mechanical Clean-up Method:

Collecting oil, as distinct from sinking or dispersing it, has generally been seen as the most desirable way of dealing with spilt oil, at least in theory.

In any case the best method to fight oil on the sea surface is mechanical clean-up. There are plenty of devices on the market, and many of them have been efficient with oil spills on inland waters, in sheltered coastal regions, or on calm days.

These devices are known collectively as "Skimmers", and form a central part of an overall system for recovering oil from the surface of rivers, canals, lakes, harbours and open sea.

A disadvantage of this method is that the skimming of oil takes time to organise, and to carry out. During this time, the oil may move, spread and also absorb water.

Both the movement and spreading of oil are affected by the incorporation of water with oil. This may proceed rapidly, and in some instances the character of the discharged oil will change markedly within hours.

Even with the most effective boom system to confine and concentrate the oil layer, the thickness seldom exceeds a few inches. At this thickness, any high capacity skimmer will rapidly clear the oil from an area around it.

The performance of the skimmer will then be determined, not by its own pick-up capability, but by the rate at which new oil can be brought to the skimmer, or how rapidly the skimmer can be moved to successive new patches of oil.

The optimum performance of skimmers is rèlated to the properties of the oil being collected, and particularly to its viscosity which changes rapidly as water pick-up occurs.

Skimmers relying on the use of absorptive belts are more effective with lighter oils, while the disc skimmers deteriorates with both light and heavy oils.

A skimmer of any kind is likely to be ineffective if waves break over it (Wardley-Smith, 1983).

At the "Amoco Candiz" accident, the ship "Chandis" was at hand and equipped for mechanical oil recovery. Within 2 hours 80 t of oil were sucked up, but later rough sea made further operations impossible (Sebstain, 1983).

In principle, one of the following methods could be applied for mechanical oil recovery:

- Adhesion:
  Oil adheres to surfaces, especially if they are oleophilic. Apparatuses with rotating disks or drums or with continuous bands etc, have been invented, from which the oil is mechanically stripped off.

- Sill:
  A narrow surface layer of seawater and oil runs down over a sill; oil and water must subsequently be separated further.

- Cyclones:
  A circular water movement is created which has a

depression in the middle; oil is pumped from the depression.

- Suction:
  The sea surface layer is sucked in, water and oil are subsequently separated.

In principle, all these methods work in connection with barriers or other devices to concentrate the oil at the sea surface before recovering it, and with separators to separate oil from surplus water recovered. (Fig. 17)

Equipment Maintenance:

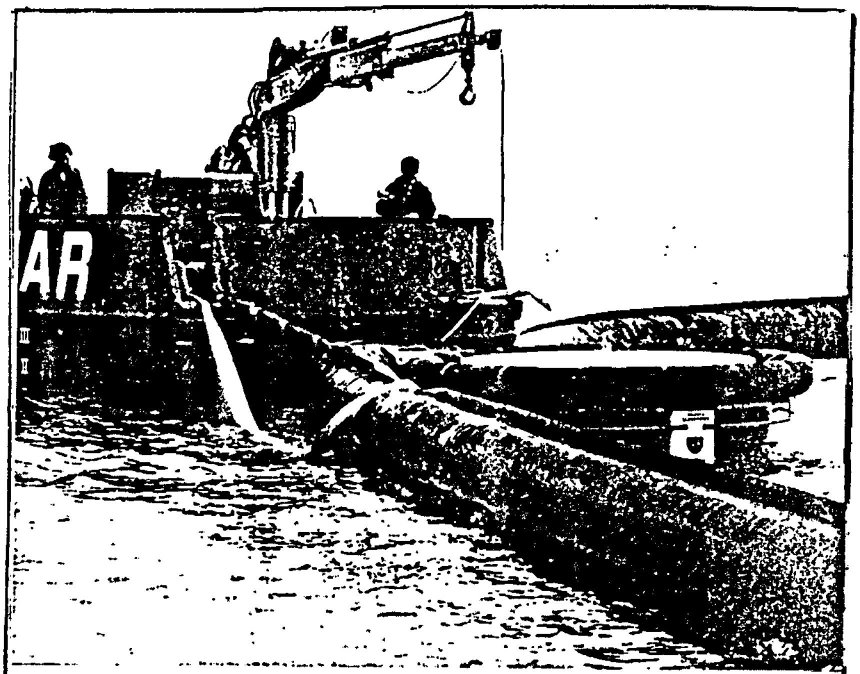
One of the major recurring problems encountered during an oil spill incident is the failure of the equipment, which can have a devastating effect on controlling the incident.

Measures should be taken to avoid circumstances leading to failures.

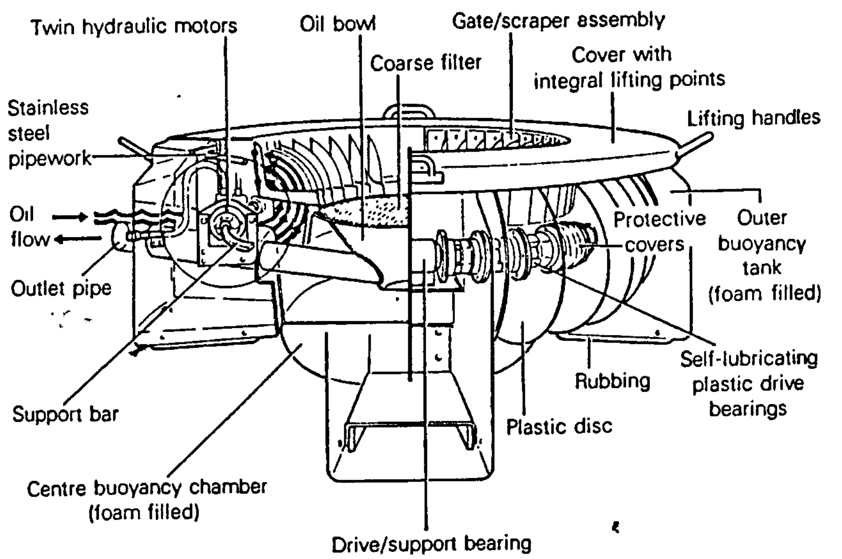
Experience has shown that failures can be caused by three prime reasons:

- poor maintenance of equipment,
- untrained operators, and
- badly designed equipment.

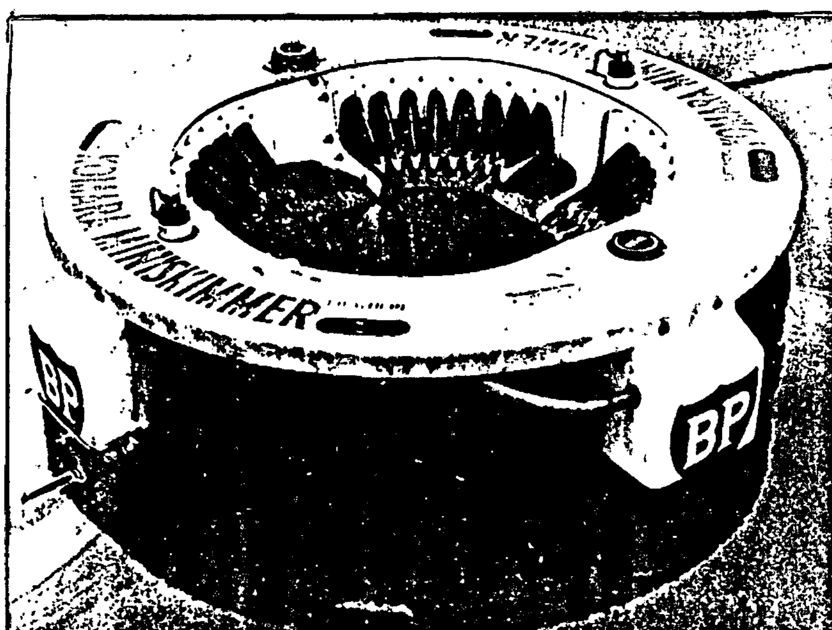
Fig. 17



Vikoma skimmer deployed within a boom



Komara skimmer and pump



Komara skimmer floating

CHAPTER 7

CONTINGENCY PLANNING AND THE ORGANIZATION OF A CLEAN-UP RESPONSE

CHAPTER 7

CONTINGENCY PLANNING AND THE ORGANIZATION OF A CLEAN-UP RESPONSE

7.1 INTRODUCTION:

The risk of an oil spill will continue as long as transported oil is the major source of energy.

Although all possible preventive safety measures are being adopted to prevent any discharge of oil into the sea, the operational and accidental discharge cannot be avoided due to human error, failure of equipment and other factors.

The heavy marine traffic in transportation of oil off the Sudan coast presents a high degree of risk of oil pollution due to collisions, strandings and other accidnts. Accidents of such nature can cause potential damage to the national environment.

Therefore, attention must be directed towards the development and maintenance of oil spill combat capabilities at local, national, regional and international levels.

Spill response teams and strategies must be organised in advance if the risk of environmental damage or potential disaster are to be minimized.

Contingency planning is frequently carried out at both the national and local levels. Particular attention is usually devoted to areas where the likelihood of an oil spill is greatest with an attempt being made to predict the maximum possible and the most probable size of a spill and the types of oil that could be involved. This is particularly the case for static installations such as terminals, refineries, etc. Where the threat cannot be assessed realistically, an arbitrary spill size is often selected in an attempt to ensure that all facets of the contingency plan are related to a common goal.

The responsibility for preparing contingency plans for response to major spillages rests with government, since it alone can determine policy. It is also in the best position to achieve the necessary co-operation between the many government departments, local authorities, industrial and other interests involved, and to resolve the conflicts of interests that will inevitably occur.

The contingency plans define the action which must be taken in response to a spill before the event occurs. Also the training programmes are designed to ensure that properly infermed and equipped crew are prepared to move into action as soon as the spill is reported.

It must be emphasized that the setting up of a national response organisation is not only a matter of holding in stock a certain quantity of pollution abatement equipment.

Response organisations differ from one country to another, but generally are common in:

- providing, or arranging for the provision of appropriate equipment, ships and manpower and associated resources,
- conducting the necessary training and liaison,
- preparing the contingency plans, and
- operating these plans.

In most countries both civil and military authorities are requested to encourage reporting and to transmit reports to a designated central government authority.

7.2 THE SCOPE OF A RESPONSE ORGANIZATION:

As stated in the IMO Manual on Oil Pollution Section II, "The aim of a contingency plan is to provide a timely and adequate response when pollution incidents occur, so as to minimize in the public interest the extent of their damage."

I agree that one of the most important functions of the government is to ensure that adequate plans and resources, whether of their own or of some other organization, exist to cover all areas of activity from which pollution may arise.

The government should consider making the maximum use of the existing organisations since these will be a source of personnel, may already contain the expertise required, and are likely to have contacts with industry already established.

A fundamental principle of contingency arrangements is that spheres of responsibility within and between various organizations must be clearly defined and understood.

The response structure and mechanism should have the necessary flexibility so that it can be made appropriate to the scope and complexity of a particular operation.

Thus the plan should cover low level responses for small, localized spills, as well as major, high impact spills requiring highly co-ordinated responses with the appropriate level of command a large operations team and the relevant resources.

During the planning stage most countries establish the framework of an organization and command structure (including a designated On-Scene Commander) that can be brought together rapidly when an incident occurs in order to ensure that the agreed policies are implemented and that co-ordination between various agencies, authorities and interests is achieved.

Although in most cases the organization is geared towards the most probable size of spill, the best plans have a measure of flexibility built in to allow for expansion in dealing with a much larger or more difficult spill than previously anticipated.

The extent of the On-Scene Commander's (OSC) authority for making decisions will depend upon many factors, including the circumstances of the particular incident.

In most countries the OSC will have the authority to make and implement most decisions during a major incident.

Clearly, however, this will depend upon the implications of the decision.

This is often reflected in the contingency plans themselves, which allow for the implementation of a national plan where the incident proves beyond the resources and capability of the regional authority.

With the implementation of a national plan may also come a change in the chain of command with central government and Ministers assuming an active role.

Regardless of the extent or geographical features of the area covered, a contingency plan includes:

- a list of persons and agencies that must immediately receive the report of an oil spill,
- a list of jobs that must be done when oil is spilled,
- the identification of a chain of command and the assignment of qualified personnel to specific oil spill response tasks,
- a communications network to assume co-ordination of efforts and efficient response,
- reference materials and other technical data that will be helpful to those who are responsible in action,

- an inventory of the type and location of all available oil response equipment, and
- data which identify probable oil movement patterns under a range of climatic conditions.

The development of response capabilities in an organization should be delegated to one individual or to a special committee.

The tasks assigned to this person or team should include:

- an analysis of potential spill location;
- the evaluation, procurement and maintenance of essential supplies and equipment;
- the establishment of training programmes and regular drills in clean-up procedures.

A good contingency plan should designate one individual as the OSC of response operations in the area covered by the plan.

The OSC must immediately take the overall responsibility for co-ordination of response action.

The OSC may be a representative from private organization (e.g. oil company), a governmental official, or an independant oil spill clean-up contractor.

He is responsible in the event of an oil spill, for the decision on actions to take throughout each phase of the clean-up operation.

He has to maintain close liaison with the concerned agencies for support and to provide progress reports of all emergency decisions and actions.

After the OSC is designated, he has to form a response team from various available resources he feels necessary.

The OSC should be supported by a fully trained staff (response team), whose functions are clearly defined in the contingency plan.

When dealing with a medium-to-large oil spill, the response team generally includes a number of supervisors to oversee specific facets of operation, a public information officer and numerous work crews.

In the event of serious spills, the OSC has to find cooperation with respect to legal, financial, logistical and technical matters as stated in the contingency plan.

7.3 THE NATIONAL SUDANESE CONTINGENCY PLAN:

7.3.1 Aims and Objectives:

As stated before the main aim of the national contingency plan is to provide timely and adequate response in case of pollution incidents occur, so as to minimize the damage to the marine environment.

The contingency plan therefore establishes the procedures whereby all agencies, whether government or private, capable of making a contribution, can marshal their resources for a rapid response, commanded and coordinated by the designated authority.

There are many factors which are taken into account in considering the nature and scope of the national contingency arrangements. These include the following:

- Assessment of the nature and size of the threat to which the state is likely to be subjected.
- The geographical features of the state.
- The environmental impact due to any pollution.
- The structure of government and national subdivision.

- The availability of suitable existing organizations including those in the industry and neighbouring states.

I believe the situation on the Sudanese coast dictates an urgent need for a national contingency plan capable of dealing with oil spills of any volume.

The vital reasons which necessiate the designating of a national contingency arrangement are:

- As stated in Chapter 1, the increase in heavy traffic after the reopening and developing stages of the Suez Canal, especially the traffic of large size tankers.

- The quantity of imported crude oil and petroleum products in the country are increasing as discussed in Chapter 3.

- The existance of oil refinery and other industries around Port Sudan town.

- The offshore mining and oil exploitation in the Red Sea. Moreover the export of inland exploited oil is expected to become a reality in the near future and will increase oil traffic in national waters.

Considering all the above reasons, and in order to fulfill the aims and objectives, a national contingency plan must be formed in order to protect the marine environment.

The main sources of oil pollution are discussed in Chapter 3 and on the basis of such activities, the areas of pollution incidents are thus identified.

Accidents do not occur frequently. Since there has been no major tanker accident in this area, we can take warning from the historical spill records around the world, such as the disasters of Torrey Canyon and Amoco Cadiz which provide sufficient relevant information and data.

The record of the grounding and stranding of various vessels on the national coast can be considered to predict an oil spill risk record.

The offshore accidents as in the North Sea and the terminal operation accident such as at Nawroze in the Arabian Gulf are both worth mentioning.

I think that due to lack of finance, manpower, and equipment plus other constraints, it is only possible for the time being to deal with a limited oil spill at the national level.

It should be emphasized that a complete contingency plan can rarely be formed all at once. In most cases it will be more appropriate to form it step by step as resources covered by the plan are available or being developed (IMO-manual).

"Combatting pollution especially from large spills, will always require coordination and control at the highest level. No state can afford to set up an autonomous organization solely for this purpose," (Wardley-Smith, 1983).

In the case of Sudan as we started from the beginning, we have had to make use of the existing organizations (safety department in SPC, port fire brigade, police and armed forces, etc.).

For further application, the co-operation from various regional states is identified.

This regional cooperation can be borne through the Jeddah conference, which will be discussed later in this paper.

7.3.2 Organization:

When you are organising an oil pollution contingency plan, it is essential to arrange all the different units to be centrally controlled and coordinated, so that in case of major incident, all the resources can be utilised to best advantage.

Wardley-Smith, in 1976 through the IMCO symposium at Acapulco, divided the oil spills, from the point of view of clean-up operations, into three groups:

1. Chronic Pollution:
   The tarry lumps and occasional patches of viscous semi-liquid oil found on almost all coasts and particularly on windward ocean shores.

2. Medium Spills:
   Mostly produced by ships during handling of their bunkers and/or cargo and almost always occurring during transfer operations. This is located in harbours and adjacent waters.

3. Large Spills:
   Resulted from a major incident involving a tanker. Although this type is infrequent, approximately 3% of all spills, these can cause serious pollution.

Combatting pollution requires complementary planning at all of these three levels.

basic requirements for the fast and easy, controlled and coordinated reaction from properly trained staff using the right equipment.

Time is the most vital factor in responding to spills.

In formulating the plan it is essential to ensure that the clean-up of each and every spill, whatever its size, is efficient with the least damage to the environment and at the least cost. (Fig. 18)

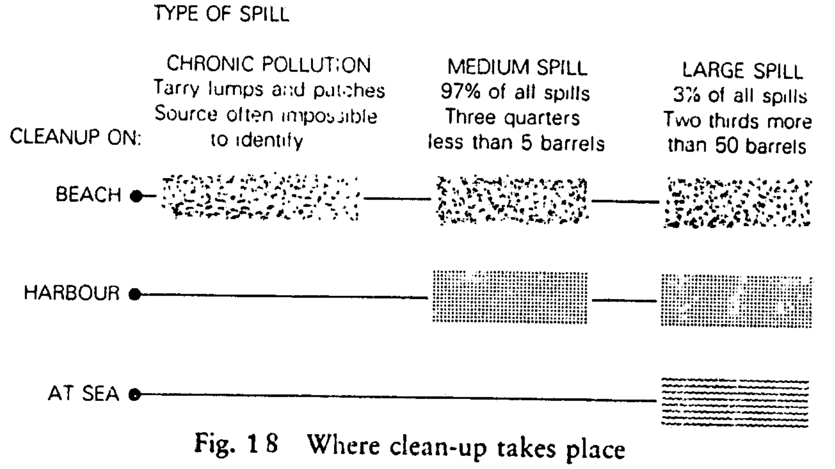


Fig. 18 Where clean-up takes place

7.3.3 Training and Excercises:

Training, in all its aspects and at all levels, is very essential for the success of any operation, especially when the question of safety and effectiveness is required.

The organization that deals with an oil spill is not simple and depends on the cooperation and inter-relation of a number of individuals.

Persons operating particular pieces of equipment must know how to handle them. This will be achieved by regular excersises to increase the skill of the operator.

Since special types of equipments are used for oil spill operations, the staff for maintenance should be trained in maintaining and repair them to avoid any malfunctions of the equipment during emergency operations.

The controller and his staff must also be thoroughly experienced, and it is very important that after the organization has been set up, a number of regular exercises are carried out to see that everything works smoothly and that everybody knows what is to be done.

The training programmes should be developed at all levels and include theoretical as well as practical instructions related to oil spill incident operations.

The training centre of SPC can play a big role in arranging these types of courses.

Advantage should be taken of the various courses which already exist in some organizations and arrangements are required to be made for their further improvement.

These courses for the training of personnel responsible for handling pollution incidents can easily be conducted by the training centre of SPC, the oil companies, the Institute of Oceanography and the National Council for Research.

It can be also arranged for training abroad at Singapore Malta, Southampton or other countries which have facilities for training such personnel.

7.3.4 Communications:

Adequate communications, strict command and coordination functions are a vital part of any contingency arrangements for the deployment of all oil combating resources, as well as for handling operational information and documentation necessary for planning and feedback.

Quick, close contact is very essential between the sectoral commander, central headquarters the forward bases, the afloat commander, other anti-pollution agencies and all agencies concerned with other emergency aspects.

It is very important to have a communications centre with an efficient network linking all the transportation systems. This centre must be capable of providing ship-to-ship, ship-to-shore, ship-aircraft and vice versa at all time.

The INMARSAT system is an advantage for parties establishing a contingency plan.

The existing shore station in SPC could with a little more improvement, be adapted for use in combating oil pollution incidents.

The facilities of harbour tugs and pilot boats which are equipped with a VHF capability plus the portable units available could all be utilized in the event of a major oil spill.

7.4 THE RED SEA AND GULF OF ADEN CONFERENCE:

A conference held in Jeddah, Saudi Arabia, in February 1982, adopted a Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment. This conference was prepared under the auspecies of the Arab League Educational, Cultural and Scientific Organization (ALECSO).

Besides the Convention, a Protocol was adopted concerning Regional co-operation in Combating Marine Pollution and an Action Plan formulated to protect the marine environment of the region. (See Appendix D)

The protocol is similar to that of the Kuwait Action Plan. It consists of all the basic elements of regional agreements. It stipulates the establishment of a Regional Commission for the Conservation of the Red Sea and Gulf of Aden and a Subsidiary Marine Emergency Mutual Aid Centre to strengthen the capacities of the contracting. However, it is unknown when such a centre will be set up. (See Appendix E)

The Red Sea and Gulf of Aden Environment Programme (PERSGA), an arm of (ALECSO), in Jeddah, provides the secretariat support and technical backing for the implementation of the Protocol as well as the Convention and Action Plan.

The Democratic Yemen indicated its interest in establishing a sub-regional marine pollution combating centre in Aden serving coastal states on the Gulf of Aden.

UNEP agreed to support this centre by holding a government

experts meeting and the UNDP will support the fund needed when the agreement of the other coastal states is obtained.
(D. Edwards, 1986)

7.5 MARINE ENVIRONMENT PROTECTION COMMITTEE (MEPC):

In the early seventies the National Committee for Environment (NCE) was established in Sudan, and mainly considered the problem of sand-movements in the western and northern parts of the country.

At that time the Sudan Marine Conservation Committee (SMCC) was formed by the efforts of a number of national enthusiastic individuals in Port Sudan. The SMCC late in 1979 became a subcommittee of the NCE.

The SMCC is now considered as the response for marine conservation in Sudan. It consists of representatives from many government departments such as:

- Sea Ports Corporation.
- Fisheries Department.
- Fisheries Research Centre.
- University of Khartoum, Marine Biology Laboratory.
- Institute of Oceanography.
- Navy.
- Commissioner of the Red Sea Province.
- Regional and Town Planning Office.
- Geological and Mineral Resources Department.
- Health Authorities.
- Tourism and Hotels Corporation.

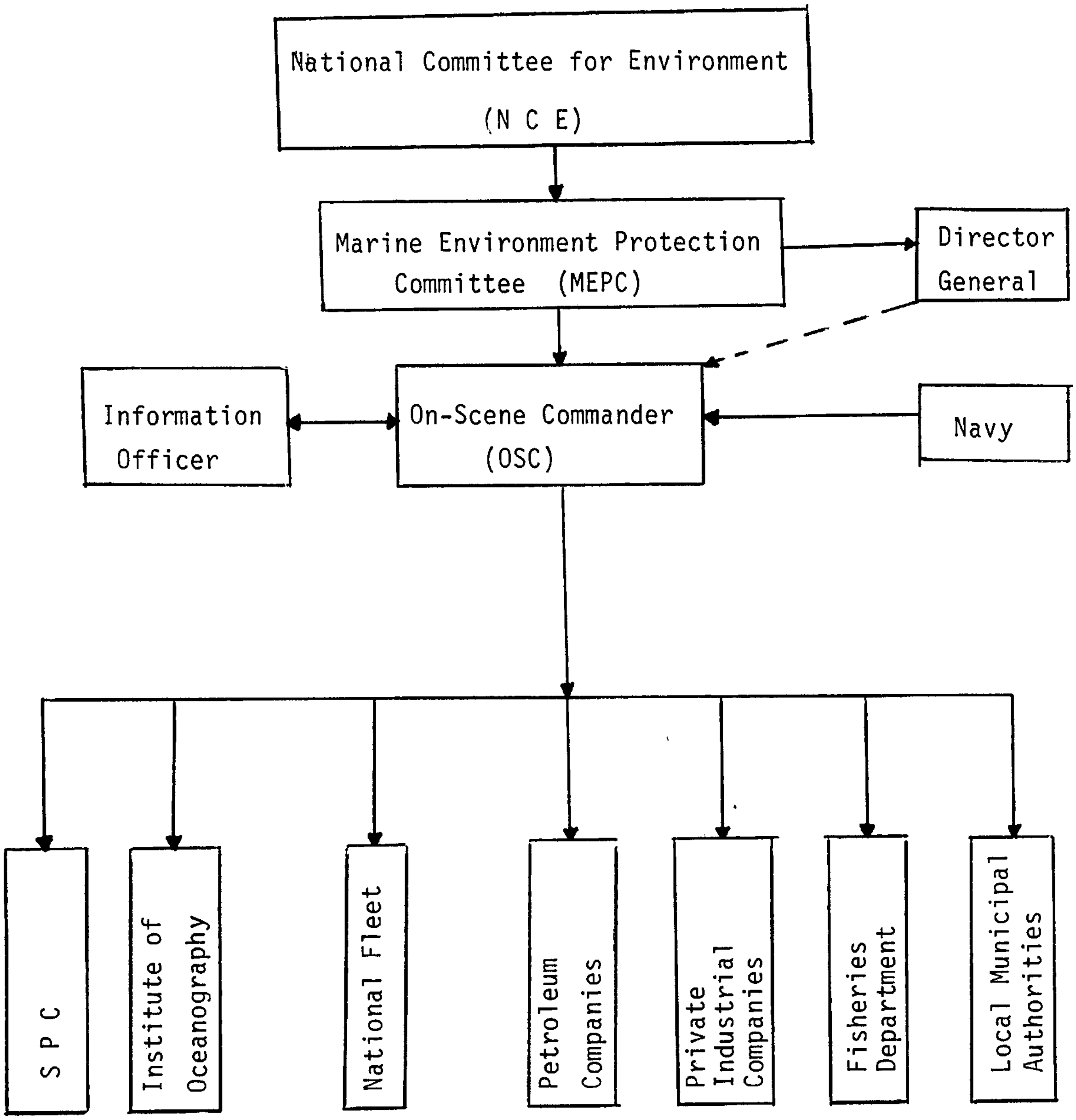
The SMCC seems to be powerless and has no active programme yet. I think the reason for this is because it has no legal support, which is due to the lack of maritime legislation in the country. However, this committee can still be considered as the nucleus of a new Marine Environment Protection Committee (MEPC).

The MEPC can take its legal support through the National Maritime Law which is supposed to be in revision during the preparation of this thesis.

Moreover, the establishment of the new Maritime Administration in the Ministry of Transport, which is about to become a reality will mean that it can support, adopt and implement the MEPC's activities.

The MEPC, in addition to the representatives mentioned before, will, I suggest, include representatives from the National Shipping Company, the private industrial sector, and the oil companies. This will help the effective contingency plan, as it should establish the procedures whereby all agencies, whether government or private, capable of making contributions, can marshal their resources for rapid response, commanded and co-ordinated by the designated authority.
(See Figure 19: Recommended National Oil Spill Response Organization)

FIG.19 : RECOMMENDED NATIONAL OIL SPILL RESPONSE ORGANIZATION



CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 8

CONCLUSION AND RECOMMENDATIONS

8.1 CONCLUSION:

1. Due to the geographical location of Sudan, and due to a tremendous increase in heavy traffic in the transportation of oil along the Red Sea, the marine environment is threatened from operational and accidental pollution.

2. Diving tourism, which is more attractive to foreign tourists will suffer enough from the increase of oil and marine pollution around Port Sudan.

3. There is no strong link between the public and marine research and administrative activities.

4. The imported quantities of crude oil and petroleum products are increasing each year as the demand of energy increases especially with the extension of industrial areas on the coast and inland.

5. There is an increase in marine accidents in Port Sudan harbour which can be noticed from the SPC annual statistics.

6. The oil terminals in Port Sudan harbour from berth 16 - 18 are not ideal berths as they are designed for container terminals. The safety distances and uncontrolled activities around these berths increase the hazards to the marine environment into the harbour.

7. There is more evidence that the industries around Port Sudan are polluting the sea with oil and other substances.

8. The ships berthing and anchoring at Port Sudan harbour are polluting the harbour waters due to the absence of inspections and controls.

9. Research into the existing oil pollution in the harbour and the effect of oil and sediments upon the dead coral in the Port area, were carried out and proved by the Institute of Oceanography.

10. There are no training courses in the field of marine pollution.

11. No antipollution combating equipment is available in Sudan which can be used in the event of marine oil pollution.

12. There is no contingency plan presently in existence for any oil spill in the country.

13. The harbour has no local contingency plan in the event of an oil spill in the Port.

14. The chemical dispersants used in the harbour dockyard are not controlled for their toxicity on the living marine community.

15. The legal situation with aspects to marine conservation and protection is very weak, or almost not existent in the proper way.

All these problems are mainly due to the lack of any National Maritime Law.

There is only a Maritime Act of 1961 which is considered as the legal instrument providing the registration of Sudanese ships and general regulations and control of merchant shipping. This Maritime Act has no regulations regarding marine pollution.

There is another marine regulation belonging to the Marine Fisheries Department. This Regulation was amended in 1975 to make certain that no waste in any form which may be harmful to humans or animals shall be discharged into the sea or near to the coast. It also forbids the use of spearguns as well as coral and shell collecting. (Appendix F)

The Port Sudan harbour uses the 1937 Port regulations which touch upon pollution matters to a very limited degree concerning waste within the port's waters.

16. Sudan has been a member of IMO since the 15th of July 1974.

Unfortunately the government has not ratified any sort of convention or agreement through this organization.

The reason for this is clear due to the total absence of an independant Maritime Administration which suppose to be responsible for these functions.

In the Ministry of Transport there is no direct control or supervision of Maritime Administration.

Until now all maritime activities are combined within the port management, and carried out through the Division of Marine Services of SPC in Port Sudan.

A mission report was written and handed to the Sudanese Government in 1978 by an expert from IMCO who advised the immediate establishment of a Maritime Administration under the direct responsibility of the Ministry of Transport.

It is quite clear that there are many obstructions in the Ministry of Transport in creating this new Maritime Administration.

Actually in this Ministry, there is no enthusiastic official in marine affairs and this can be seen in the long delay in the work of foreign experts who are at present assisting in the establishment of a Maritime Administration in Sudan.

17. Most of the import and export cargo in Sudan is transported by sea. There is no proper international road link with other countries, and the international railway with Egypt is mainly used by passengers. Thus sea transport must be considered more seriously in the Ministry of Transport, and marine affairs should be supported in their development and improvement.

8.2 RECOMMENDATIONS:

1. The state should intensify the exploration of living and non-living resources in the territorial waters.

2. The marine scientific research work is very important. This research is now carried out, under very poor and limited facilities, by the Institute of Oceanography in Port Sudan and the Fisheries Research Centre in Saukin. These two centres should have more support from the government and the future Maritime Administration.

3. The information centres in the Sea Port Corporation, Sudan Shipping Line and Scientific Research Centres, should increase their activities towards public basic understanding of the sea.

4. Courses and training programmes in the marine pollution field should be organised within the state or arranged abroad. The training centre in SPC can play a large role in organizing the theoretical part of these courses.

5. All difficulties in establishing a Maritime Administration should be solved so as to create an adequate organization which can be responsible for the adoption, implementation and development of marine affairs in the country.

6. The Maritime Legislation in Sudan should be revised, updated and collected to form the National Maritime Law.

7. A clean-up policy has to be developed to give guidance as to when and how to deal with spills and in what circumstances it should be left to disperse and degrade by natural means.

8. A Good communications system will add greatly to the efficiency of any operation. Thus the existing communication

facilities should be improved and developed according to internatinal requirements.

9. A local marine oil pollution contingency plan should be formed within the harbour zone.

10. Regional cooperation to combat any major oil pollution should be given great consideration.

11. The Port Regulations should be revised and up-dated to include strict rules against the discharge of any oil/oily water in the harbour and penalties must be stated for the offenders.

12. Port State Controls (PSC) should be encouraged in order to achieve the safety and seaworthiness of vessels calling at Sudanese ports.

13. The structure of SMCC is to be improved by accepting more members representing the national shipping companies, the oil companies and the private industrial sector.

    The committee should have legal support through the new National Maritime Law. Moreover, I suggest changing its name to the Marine Environment Protection Committee (MEPC) which is a stronger and more powerful title than Conservation Committee.

14. The shore-base sources of oil pollution which were discussed in Chapter 3, have to be stopped immediately from discharging any percentage of oil into the sea.

15. The ratification of IMO conventions and protocols, regarding maritime safety and the prevention of marine pollution, should be prepared and implemented immediately by the new Maritime Administration.

I recommend, among the marine pollution conventions, that the following should have priority in being ratified:

1. The International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (CSI), 1969.

   a. This Convention will not result any additional financial cost to the government.
   b. The translation of this convention in Arabic language, which is needed to the Parliament, has already been in Egypt. This will help to save time and money.
   c. The Sudanese ships, when sailing in foreign countries, who ratified this convention, are subjected to intervention from those countries in the event of any oil pollution done by our ships. So, why do we not practice the same convention on foreign ships who pollute our coast.

2. MARPOL 73/78:

   MARPOL 73/78 is the major act in the international field against marine pollution.

   a. The Sudanese ships are all constructed and equipped according to the requirements of this convention, thus, the ratification of this Convention will not add more cost on to the National Fleet.
   b. The translation into the Arabic language is already done which will make it easy for the Sudanese Parliament to adopt it.
   c. The Convention is divided into 5 Annexes, and the Government can ratify parts of these Annexes.
   d. The only high cost in ratifying this Convention is

the building of "Reception Facilities" for waste oil and dirty ballast water. However even this can be solved by financial assistance, without the payment of interest, from IMO, UNDP, etc.

3. The International Convention on Civil Liability for Oil Pollution Damage, (CLC) 1969. (Appendix "C")

16. National and international liaison should be maintained with such international organisations such as, IMO, UNEP, ILO, WHO, FAO and other relevant organizations on all matters concerning marine pollution.

Active participation in seminars and conferences regarding marine pollution should be encouraged.

17. In Sudan, as we are starting from scratch, we should make maximum use of existing organizations (e.g. ship survey and inspection organizations, armed forces, local municipal departments).

We should identify a certain responsible or lead agency for the establishment of a national marine pollution response organization with the authority of overall planning and co-ordination of national efforts in this field.

APPENDIXES

Appendix " A "

CONTROL OF DISCHARGE OF OIL UNDER MARPOL 73/78

Control of Discharge of Oil from Cargo Tank Areas of Oil Tankers

<table>
<tr><th colspan="2">Sea Areas</th><th>Discharge Criteria</th></tr>
<tr><td colspan="2">Within a SPECIAL AREA*</td><td>NO DISCHARGE except clean** or segregated ballast</td></tr>
<tr><td rowspan="2">Outside a SPECIAL AREA</td><td>Within 50 nautical miles from land</td><td>NO DISCHARGE except clean or segregated ballast</td></tr>
<tr><td>More than 50 nautical miles from land</td><td>NO DISCHARGE except either:
(a) clean or segregated ballast; or
(b) when:
(1) the tanker is en route; and
(2) the instantaneous rate of discharge of oil does not exceed 60 litres per nautical mile; and
(3) the total quantity of oil discharged does not exceed 1/15,000 (for existing tankers) or 1/30,000 (for new tankers) of the total quantity of cargo which was carried on the previous voyage; and
(4) the tanker has in operation an oil discharge monitoring and control system and slop tank arrangements as required by Regulation 15 of Annex I of MARPOL 73/78.</td></tr>
</table>

* Special area requirements take effect in the Mediterranean Sea, Black Sea and Baltic Sea areas from the day of entry into force of MARPOL 73/78 and for the Red Sea and Gulfs areas from the date established by IMO.

** "Clean ballast" is the ballast in a tank which has been so cleaned that the effluent therefrom does not create a visible sheen or the oil content exceed 15 ppm (for the precise definition of "clean ballast", see Regulation 1(16) of MARPOL 73/78.

Regulation 16

Oil Discharge Monitoring and Control System and Oily-Water Separating Equipment

(1) Any ship of 400 tons gross tonnage and above shall be fitted with an oily-water separating equipment or filtering system complying with the provisions of paragraph (6) of this Regulation. Any such ship which carries large quantities of oil fuel shall comply with paragraph 2 of this Regulation or paragraph (1) of Regulation 14.

(2) Any ship of 10,000 tons gross tonnage and above shall be fitted:

(a) in addition to the requirements of paragraph (1) of this Regulation with an oil discharge monitoring and control system complying with paragraph (5) of this Regulation; or

(b) as an alternative to the requirements of paragraph (1) and sub-paragraph (2)(a) of this Regulation, with an oily-water separating equipment complying with paragraph (6) of this Regulation and an effective filtering system, complying with paragraph (7) of this Regulation.

(3) The Administration shall ensure that ships of less than 400 tons gross tonnage are equipped, as far as practicable, to retain on board oil or oily mixtures or discharge them in accordance with the requirements of Regulation 9(1)(b) of this Annex.

(4) For existing ships the requirements of paragraphs (1), (2) and (3) of this Regulation shall apply three years after the date of entry into force of the present Convention.

(5) An oil discharge monitoring and control system shall be of a design approved by the Administration. In considering the design of the oil content meter to be incorporated into the system, the Administration shall have regard to the specification recommended by the Organization.* The system shall be fitted with a recording device to provide a continuous record of the oil content in parts per million. This record shall be identifiable as to time and date and shall be kept for at least three years. The monitoring and control system shall come into operation when there is any discharge of effluent into the sea and shall be such as will ensure that any discharge of oily mixture is automatically stopped when the oil content of effluent exceeds that permitted by Regulation 9(1)(b) of this Annex. Any failure of this monitoring and control system shall stop the discharge and be noted in the

* Reference is made to the Recommendation on International Performance Specifications for Oily-Water Separating Equipment and Oil Content Meters adopted by the Organization by Resolution A.233(VII).

Oil Record Book. The defective unit shall be made operable before the ship commences its next voyage unless it is proceeding to a repair port. Existing ships shall comply with all of the provisions specified above except that the stopping of the discharge may be performed manually.

(6) Oily-water separating equipment or an oil filtering system shall be of a design approved by the Administration and shall be such as will ensure that any oily mixture discharged into the sea after passing through the separator or filtering systems shall have an oil content of less than 100 parts per million. In considering the design of such equipment, the Administration shall have regard to the specification recommended by the Organization.*

(7) The oil filtering system referred to in paragraph (2)(b) of this Regulation shall be of a design approved by the Administration and shall be such that it will accept the discharge from the separating system and produce an effluent the oil content of which does not exceed 15 parts per million. It shall be provided with alarm arrangements to indicate when this level cannot be maintained.

Regulation 17

Tanks for Oil Residues (Sludge)

(1) Every ship of 400 tons gross tonnage and above shall be provided with a tank or tanks of adequate capacity, having regard to the type of machinery and length of voyage, to receive the oily residues (sludges) which cannot be dealt with otherwise in accordance with the requirements of this Annex, such as those resulting from the purification of fuel and lubricating oils and oil leakages in the machinery spaces.

(2) In new ships, such tanks shall be designed and constructed so as to facilitate their cleaning and the discharge of residues to reception facilities. Existing ships shall comply with this requirement as far as is reasonable and practicable.

Regulation 18

Pumping, Piping and Discharge Arrangements of Oil Tankers

(1) In every oil tanker, a discharge manifold for connexion to reception facilities for the discharge of dirty ballast water or oil contaminated water shall be located on the open deck on both sides of the ship.

(2) In every oil tanker, pipelines for the discharge to the sea of effluent which may be permitted under Regulation 9 of this Annex shall be led to the open deck or to the ship's side above the waterline in the deepest ballast condition. Different piping arrangements to permit operation in the manner permitted in sub-paragraphs (4)(a) and (b) of this Regulation may be accepted.

* Reference is made to the Recommendation on International Performance Specifications for Oily-Water Separating Equipment and Oil Content Meters adopted by the Organization by Resolution A.233(VII).

Appendix " C "

Compensation for tanker spills

The four compensation arrangements are complex and the table below offers a simplified description of each.

Industry Agreements

International Conventions

Basic Compensation provided by Shipowners

If basic compensation not enough, supplementary compensation provided by Cargo Owners

	TOVALOP	CLC	CRISTAL	FUND CONVENTION
	Tanker Owners Voluntary Agreement concerning Liability for Oil Pollution	International Convention on Civil Liability for Oil Pollution Damage 1969	**Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution**	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971
When does each apply?	When persistent oil from a tanker covered under TOVALOP, either threatens to cause or does cause pollution damage to the territory of a state where CLC does not apply	When persistent oil escapes from a laden tanker causing pollution damage to the territory of a state party to the CLC	When persistent oil owned by a CRISTAL member and carried in a tanker covered under TOVALOP threatens to cause or does cause pollution damage to the territory of a state not party to the FUND Convention	When persistent oil escapes from a laden tanker, causing pollution damage to the territory of a state party to the FUND Convention
What is the maximum compensation available per incident?	Up to $16·8 million depending on vessel size	Up to $18 million depending on vessel size	Total made up to $36 million	Total made up to $58 million

PROTOCOL CONCERNING REGIONAL CO-OPERATION IN COMBATING POLLUTION BY OIL AND OTHER HARMFUL SUBSTANCES IN CASES OF EMERGENCY

The Contracting Parties,

Being Parties to the Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment (hereinafter referred to as "the Convention"),

Conscious of the ever-present potentiality of emergencies which may result in substantial pollution by oil and other harmful substances, and of the need to provide co-operative and effective measures to deal with them,

Being aware that appropriate measures for responding to pollution emergencies need to be enhanced on a national and regional basis to deal with this problem in a comprehensive manner for the benefit of the Red Sea and Gulf of Aden environment,

Have agreed as follows:

Article I

For the purposes of this Protocol the following terms and expressions have the meanings indicated below, except when otherwise inferred from the text:

1. "Appropriate Authority": either the "National Authority" defined in article I of the Convention, or the authority or authorities within the Government of a Contracting Party, designated by the National Authority and responsible for:

(*a*) Combating or otherwise operationally responding to marine emergencies;

(*b*) Receiving and co-ordinating information on marine emergencies;

(*c*) Co-ordinating available national capabilities for dealing with marine emergencies in general within its own Government and with other Contracting Parties.

2. "Marine Emergency": any casualty, incident, occurrence or situation, however caused, resulting in substantial pollution or imminent threat of substantial pollution to the marine environment by oil or other harmful substances and includes collisions, strandings and other incidents involving

ships, including tankers, blow-outs arising from petroleum drilling and production activities, and the presence of oil or other harmful substances arising from the failure of industrial installations.

3. "Marine Emergency Contingency Plan": a plan or plans, prepared on a national, bilateral or multilateral basis, designed to co-ordinate the deployment, allocation and use of personnel, material, resources and equipment for the purpose of responding to marine emergencies.

4. "Marine Emergency Response": any activity intended to prevent, mitigate or eliminate pollution by oil or other harmful substances or threat of such pollution resulting from marine emergencies.

5. "Related Interests": the interests of a Contracting Party directly or indirectly affected or threatened by a marine emergency such as:

(*a*) Maritime, coastal, port or estuary activities, including fisheries activities;

(*b*) Historic and tourist attractions;

(*c*) The health of the coastal population and the conservation of living marine resources and of wildlife;

(*d*) Industrial activities which rely upon intake of water, including distillation plants, and industrial plants using circulating water.

6. "Convention": the Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment.

7. "Council": the organ of the Regional Organization for Conservation of the Red Sea and Gulf of Aden Environment established under article XVI of the Convention.

8. "Centre": the Marine Emergency Mutual Aid Centre established under article III, paragraph 1, of the present Protocol.

Article II

1. The Contracting Parties shall co-operate in taking the necessary and effective measures to protect the coastline and related interests of one or more of the Parties from the threat and effects of pollution due to the presence of oil or other harmful substances in the marine environment resulting from marine emergencies.

2. The Contracting Parties shall endeavour to maintain and promote, either individually or through bilateral or multilateral co-operation, their contingency plans and means for combating pollution in the Red Sea and Gulf of Aden by oil and other harmful substances. These means shall include, in particular, available equipment, ships, aircraft and manpower prepared for operation in cases of emergency.

2..

Article III

1. The Contracting Parties hereby establish the Marine Emergency Mutual Aid Centre.

2. The objectives of the Centre shall be:

(*a*) To strengthen the capacities of the Contracting Parties and to facilitate co-operation among them in order to combat pollution by oil and other harmful substances in cases of marine emergencies;

(*b*) To assist Contracting Parties, which so request, in the development of their own national capabilities to combat pollution by oil and other harmful substances and to co-ordinate and facilitate information exchange, technological co-operation and training;

(*c*) 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. This possibility should be submitted for approval by the Council after evaluating the results achieved in the fulfilment of the previous objectives and in the light of financial resources which could be made available for this purpose.

3. The functions of the Centre shall be:

(*a*) To collect and disseminate to the Contracting Parties information concerning matters covered by this Protocol, including:

- (i) Laws, regulations and information concerning appropriate authorities of the Contracting Parties and marine emergency contingency plans referred to in article V of this Protocol;
- (ii) Information available to the Contracting Parties concerning methods, techniques and research relating to marine emergency responses referred to in article VI of this Protocol and
- (iii) List of experts, equipment and materials available for marine emergency responses by the Contracting Parties;

(*b*) To assist the Contracting Parties, as requested:

- (i) In the preparation of laws and regulations concerning matters covered by this Protocol and in the establishment of appropriate authorities;
- (ii) In the preparation of marine emergency contingency plans;
- (iii) In the establishment of procedures under which personnel, equipment and materials involved in marine emergency responses may be expeditiously transported into, out of, and through the territories of the Contracting Parties;
- (iv) In the transmission to the Contracting Parties of reports concerning marine emergencies; and
- (v) In promoting and developing training programmes for combating pollution;

(*c*) To co-ordinate training programmes for combating pollution and prepare comprehensive anti-pollution manuals;

(*d*) To develop and maintain a communication/information system appropriate to the needs of the Contracting Parties and the Centre for the prompt exchange of information concerning marine emergencies required by this Protocol;

(*e*) To prepare inventories of the available personnel, materials, vessels, aircraft, and other specialized equipment for marine emergency responses;

(*f*) To establish and maintain liaison with competent regional and international organizations, particularly the Inter-Governmental Maritime Consultative Organization, for the purposes of obtaining and exchanging scientific and technological information and data, particularly with regard to any new technology which may assist the Centre in the performance of its functions;

(*g*) To prepare periodic reports on marine emergencies for submission to the Council; and

(*h*) To perform any other functions assigned to it either by this Protocol or by the Council.

4. The Centre may fulfil additional functions necessary for initiating operations to combat pollution by oil and other harmful substances on a regional level, when authorized by the Council, in accordance with paragraph 2 (*c*) above.

Article IV

1. The present Protocol shall apply to the Sea Area specified in paragraph 1 of article II of the Convention.

2. For the purposes of dealing with a marine emergency, internal waters, including ports, harbours, estuaries, bays and lagoons, may be treated as part of the Sea Area if the Contracting Party concerned so decides.

Article V

Each Contracting Party shall provide the Centre and the other Contracting Parties with information concerning:

(*a*) Its appropriate authority;

(*b*) Its laws, regulations, and other legal instruments relating generally to matters addressed in this Protocol, including those concerning the structure and operation of the authority referred to in paragraph (*a*) above;

(*c*) Its national marine emergency contingency plans.

Article VI

Each Contracting Party shall provide the other Contracting Parties and the Centre with information concerning:

(*a*) Existing and new methods, techniques, materials, and procedures relating to marine emergency responses;

(*b*) Existing and planned research, their results and development in the areas referred to in paragraph (*a*) above.

Article VII

1. Each Contracting Party shall direct its appropriate officials to require masters of ships, pilots of aircraft and persons in charge of offshore platforms and other similar structures operating in the marine environment and under its jurisdiction to report the existence of any marine emergency in the Sea Area to the appropriate national authority and to the Centre.

2. Any Contracting Party receiving a report pursuant to paragraph 1 above shall promptly inform the following of the marine emergency:

(*a*) The Centre;

(*b*) All other Contracting Parties;

(*c*) The flag State of any foreign ship involved in the marine emergency concerned.

3. The content of the reports, including supplementary reports where appropriate, referred to in paragraph 1 above should conform to the form to be adopted by the Centre.

4. Any Contracting Party which submits a report pursuant to paragraphs 2 (*a*) and 2 (*b*) above, shall be exempted from the obligations specified in paragraph 2 of article IX of the Convention.

Article VIII

The Centre shall promptly transmit information and reports which it receives from a Contracting Party pursuant to articles V, VI and paragraph 2 of article VII of this Protocol to all other Contracting Parties.

Article IX

Any Contracting Party which transmits information pursuant to this Protocol may specifically restrict its dissemination. In such a case, any Contracting Party to which this information has been transmitted, or the Cen-

ملحق التشـــريع

لغازيتة جمهورية السودان الديمقراطية رقم ١١٧٥

بتاريخ ١٥أبريل ١٩٧٥

لائحة مصائد الاسماك البحرية (تعديل) لسنة ١٩٧٥ •
(تشريع نمرة ٨ لسنة ١٩٧٥)

عملا بالسلطة المخولة له بمقتضى المادة ٩ من قانون مصائـــد الاسماك الـــبحرية لسنة ١٩٣٧ اصدر وزير الزراعة والاغذية والموارد الطبيعية اللائحة الاتى نصهـــا :

اسم اللائحة وبدء العمل بهـــا

١ـــ تسمى هذه اللائحة "لائحة مصائد الاسماك البحرية (تعديل) لسنة ١٩٧٥ " ويعمل بها من تاريخ نشرها فى الجريدة الرسمية •

تعديـــــل

٢ـــ تعدل لائحة مصائد الاسماك البحرية لسنة ١٩٣٧ على النحو الاتى :

(١) بعد المادة سبعة تضاف المادة الجديدة الاتية :

"حظر استعمال البنادق المائية وصيد احياء مائية معينــــة وحظر تلوث البيئـــة •"

أـــ لا يجوز لاى شخص :ـــ

١) استعمال اى بندقية مائية لصيد الاسماك الا بتصريح من الســـلطة المختصة •

٢) صيد او جمع اى مرجانه او شعب مرجانية او حيوان صدفى او صدفة او اى سمكه للزينة الا بتصريح من السلطة المختصة •

٣) القاء اى نفاية او غيرها فى مياه الساحل او بالقرب منه ويكون من شأنها احداث تلوث فى البيئة او الاضرار بالثروة السمكية •

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-----T H E E N D -----