REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

Oil pollution and its control in the East Asian Seas region

UNEP Regional Seas Reports and Studies No. 96

Prepared in co-operation with

ASEAMS

UNEP 1988

CONTENTS

PREFACE

The documents compiled in this volume are papers presented at the Meeting of Experts on the Control of Oil Pollution in the East Asian Seas Region held in Bali, Indonesia on 19-23 October 1987. The meeting was convened by the United Nations Environment Programme (UNEP) to bring together scientists from within and outside the region to evaluate the state of the art on oil pollution research and control in terms of knowledge and current activities, and to help determine solutions that would lead to the effective containment of this problem.

The following papers reflect the views and experiences of the region's experts as well as of representatives from recognized international organizations. Such a compilation for Southeast Asia is the first of its kind to date. It is timely in the light of national and international efforts to consolidate and optimize activities aimed at solving this significant environmental problem. The volume should serve as an important reference especially for the Governments of the Southeast Asian countries since it deals with highly relevant issues and covers aspects ranging from scientific and technical to economic and legal.

The editors are indepted to the UNEP Oceans and Coastal Areas Programme Activity Centre for support of this endeavor and to the Interim Chairman of the Association of Southeast Asian Marine Scientists (ASEAMS), Mr. Edgardo D. Gomez, for his coordination and advice. The editors also acknowledge the valuable assistance of Emily Capuli, Teresa Totañes and Samuel Mamauag, all research personnel of the Marine Science Institute.

H.T. YAP
R.M. DE LA PAZ
L.T. McMANUS

INTRODUCTION

The seas of Southeast Asia have become the focus of international concern due to the increasing number and severity of environmental problems affecting them. A major reason for this trend lies in the fact that the region is for the most part comprised of developing countries characterized by relatively large and rapidly growing human populations, and attempts at "shortcuts" to economic and industrial development. A consequence is the tendency to exploit natural resources without due concern for sustained productivity or even protection of the environment.

An important problem confronting the countries of the region is the degradation of natural ecosystems such as coral reefs, mangrove forests and seagrass beds. These resources are crucial for the continued production of food from the coastal zones, particularly in the form of economically-important fisheries. Thus, much of Southeast Asia is confronted with the spectre of diminishing resources with the consequences of reduced production of food and other needed products.

The other significant environmental problems concern pollution from various sources. Sedimentation and domestic sewage have been identified as priority issues. Industrial effluents are a growing problem. Finally, pollution by oil has been recognized to be of increasing severity, requiring urgent concerted action on a regional basis.

The question of oil pollution merits special attention because some countries in Southeast Asia are major producers of petroleum. As a consequence, the danger of leakage of oil into the sea always exists due to natural seepages as well as accidents during production and transport. Furthermore, in the East Asian Seas are located critical routes for oil tanker traffic between the Middle East and the northwest Pacific so that the incidence of spillage from groundings or collisions is relatively high.

In view of the above, the countries of the region recognized the need for a scientific programme involving research with the goal of monitoring, preventing and controlling marine pollution. With the United Nations Environment Programme (UNEP) playing a catalytic role, a series of preparatory projects and meetings led to the adoption in April 1981 of an Action Plan for the Protection and Development of the Marine and Coastal Areas of the East Asian Region by the Governments of Indonesia, Malaysia, the Philippines, Singapore and Thailand 1/. In December 1981, the duly appointed representatives of these countries formed the Co-ordinating Body for the Seas of East Asia (COBSEA) to approve and oversee the implementation of various regional projects addressing what were considered to be the most pressing environmental problems.

To date, the following projects have been implemented in the framework of the Action Plan 2/, some of which have follow-up activities at present:

(i) Co-operative research on oil and oil dispersant toxicity in the East Asian Seas region (EAS-12);

1/ Action plan for the protection and development of the marine and coastal areas of the East Asian Seas region. UNEP Regional Seas Reports and Studies No. 24. UNEP, 1983.

2/ The East Asian Seas Action Plan: Evaluation of its developments and achievements. UNEP Regional Seas Reports and Studies No. 86. UNEP, 1987.

(ii) Study on coral resources and the effects of pollutants and other destructive factors on coral communities and related fisheries in the East Asian Seas region (EAS-13);

(iii) Study of the maritime meteorological phenomena and oceanographic features of the East Asian Seas region (EAS-14);

(iv) Survey and monitoring of oil pollution and development of national co-ordinating mechanisms for the management and establishment of a regional data exchange system (EAS-15);

(v) Assessment of concentration levels and trends of non-oil pollutants and their effects on the marine environment in the East Asian Seas region (EAS-16);

(vi) Implementation of a technical and scientific support programme for oil spill contingency planning (EAs-17);

(vii) Co-operative study into the cleaning-up of urban rivers (EAS-18);

(viii) Development of management plans for endangered coastal and marine living resources in East Asia: Training phase (EAS-19); and

(ix) Assessment of land-based urban, industrial and agricultural sources of pollution, their environmental impact and development of recommendations for possible control measures (EAS-21).

The above activities were a result of a series of deliberations and consultations with scientific experts of the region in co-operation with UNEP and other international organizations. In various meetings, environmental issues were identified in the order of priority, ways and means to address these problems were then outlined given existing resources, expertise and planned financial support from UNEP as well as from the Governments of the region in the form of a Trust Fund. After final approval by COBSEA, the different research projects then went into effect involving scientific institutions in the participating countries who linked up with each other on the basis of regional co-operation.

In December 1986, UNEP started to convene meetings of experts from the region to advise her on the scientific aspects of projects implemented by COBSEA and to make appropriate recommendations. A special activity of this nature was the Meeting of Experts on the Control of Oil Pollution in the East Asian Seas Region held in Bali, Indonesia, on 19-23 October 1987 [3/].

The above meeting was held as a result of a decision by COBSEA to terminate the ongoing projects on oil pollution, to reassess the state of the art in terms of existing knowledge, current activities and priorities, and to determine the most effective approaches to the problem. The following series of papers were presented by participants at that meeting.

H.T. YAP

3/ Report of the meeting of experts on the control of oil pollution in the East Asian Seas region, Bali, 19-23 October 1987 [UNEP(OCA)/EAS WG.1/16].

METEOROLOGICAL PHENOMENA AND OCEANOGRAPHIC FEATURES OF THE EAST ASIAN SEAS REGION RELEVANT TO OIL POLLUTION AND ITS CONTROL

Absornsuda Siripong
Marine Science Department
Faculty of Science, Chulalongkorn University
Bangkok 10500, Thailand

ABSTRACT

The control of pollution by oil in the marine environment is based on the knowledge of the pathways and fate of this substance upon entering the sea. The fate and pathways of oil are largely governed by the physical processes ranging from molecular motion to ocean-wide currents, operating on time scales from seconds to millennia. Depending on the particular forces acting together at a given time, spilled oil will undergo any of a variety of transformations. Physical oceanographic processes are to a larger extent forced by climatic events, so that an analysis of factors determining the extent and degree of oil pollution should start with meteorological phenomena. The most significant of these is surface wind. The East Asian Seas region is characterized by two basic types of wind systems: the monsoons (NE and SW), and tropical cyclones or typhoons. In the oceanic environment, a number of features affect the distribution of oil. These include temperature and salinity profiles, swells and waves, tides and tidal currents, and surface currents. The few attempts to model oil spill trajectories in the East Asian Seas have taken all known meteorological and oceanographic features of importance into account. Recommendations for further action include monitoring of oil pollution, compilation and exchange of all pertinent information, modelling, and involvement of the oil industry in research.

1. Physical processes in the marine environment and oil pollution

1.1 Spatial and temporal scales of physical transport processes

A discussion on the physical processes in the sea that play a direct role in the distribution of oil may be found in works such as those of Weidemann and Sendner (1972). The most important influences on the distribution of pollutants are exerted by motions of any kind. The spectrum of motions in the sea extends from molecular dimensions to oceanwide current systems. Thus, a firm understanding of the dynamics underlying physical oceanographic processes is crucial as a basis for the prediction of oil movement in the sea.

The concept of a space-time spectrum of a given oceanographical quantity is very useful for developing a strategy for oceanographic measurements. The variability of the oceanographical quantities encompasses time scales ranging from seconds at the least to millennia, and spatial scales from centimeters to tens of thousands of kilometers.

The studies of the dispersion of substances should also take into account the lifetime of the substance in question since the lifetime will essentially determine the characteristic time scales of physical processes effecting the dispersion. Knowledge of the dispersion of a short-lived tracer cannot necessarily be applied to the dispersion of a long-lived tracer.

1.2 Fate of oil in the sea

The various factors that determine the fate of oil in the sea including the transformations it undergoes are discussed in Jeffrey (1980) and GESAMP (1977), among others.

Petroleum discharged on the sea surface undergoes physical, chemical and biological alteration. Physical factors have the most significant initial effect upon oil discharged into the marine environment in the form of spreading and movement by winds and currents, evaporation of the volatile components, solution, emulsification, dispersion of small droplets into the water, sedimentation, spray injection into the air and photochemical oxidation. Chemical dispersants have the potential for reducing the known adverse effects.

Oil spilled at a point source can be transported by waves, winds and currents. In most cases, transport by waves may be disregarded. The advective processes are central to oil trajectory analysis.

2. Meteorological phenomena in the East Asian Seas region

An attempt to understand the physical processes that govern the pathways of oil in the sea, and thus the character and extent of pollution, should begin with a treatment of meteorological phenomena. The most important factor is surface wind which generates wind waves and wind-driven currents. These are the main mechanisms of oil transport in the sea. It appears that local meteorological conditions are most likely responsible for the relatively quick removal of spilled oil from the ocean surface.

In this paper, only the prevailing wind systems will be considered, in addition to certain important phenomena which influence oceanographic features of the East Asian Seas. These are the monsoon wind systems and the tropical cyclones which pass through the region.

A comprehensive treatment of meteorological features characteristic of the region may be found in Dobby (1945) and Fisher (1971). These authors also provide diagrams depicting wind conditions throughout the region at different times.

In the northern hemisphere, on the average, the NE monsoon occurs between December and February (cold and dry). A transition between monsoons takes place from March to April, the warmest months. The rainy season is ushered in by the SW monsoon which extends from May to September. Another transition occurs from October to November.

In the southern hemisphere as in the Indonesian region, the SW monsoon season behaves like a northern summer (June-August, dry), and the NE monsoon season like a northern winter (December-February, wet).

Detailed descriptions of meteorological features in specific localities in the region exist, such as the work of Flores and Balagot (1969) on the Philippines, and of Ilahude (1979) and Sutamihardja (1985) on Indonesia.

Data on typhoons in the region have been compiled by Niino and Emery (1961) and Hill (1979). Another useful reference are the records of the Meteorological Department of Thailand.

Most typhoons originate east of the Philippines in the northwest Pacific. Some originate farther west in the South China Sea. The average track displays a seasonal variation, being farthest south in winter and farthest north in summer. Most tracks fall into two main groups:

- move W or NW but later curve towards the N and finally the NE; and

- move W or NW, sometimes SW with recurvature.

The second group affects the East Asian Seas region. The frequency of tropical cyclones is such that September is the peak month and February the month of lowest occurrence.

3. Oceanographic features of the East Asian Seas

The oceanographic parameters which affect the movement of oil in the sea are depth of the mixed layer (Ekman transport), surface waves (Stokes drift), tidal currents and surface wind drift (Langmuir circulation).

3.1 Vertical structure of the sea

Much of the discussion below is drawn from the work of Pinyoporn (1986) who studied the seasonal variation of certain characteristics of water masses in the South China Sea based on observations from nine oceanographic stations during four monsoon seasons.

Three layers have been distinguished in the South China Sea: an upper layer and a deep layer characterized by nearly uniform temperature, salinity and density, separated by a comparatively thin layer of rapidly changing properties, the thermocline in the case of temperature.

The upper or mixed layer extends from the sea surface down to a depth ranging from about 50–200 m. The computed annual variation of the mixed layer depth is the average of all bathythermograph data per month at latitude 15–16^{o}N and longitude 119–120^{o}E. The mixed layer is shallowest in June–July (summer), and deepest in January (winter). Within the mixed layer are found the most intense currents and turbulent motions in the sea.

Sea surface temperature and salinity distributions during the four monsoon seasons were plotted from all historical oceanographic station data and bathythermograph data. During the NE monsoon season or winter, the inflow of high salinity water from the Pacific reaches its maximum and increases the salinity maximum value. But the inflow of oceanic water, owing to mixing and dilution, is displaced to shallower depths and becomes lower in salinity towards the lower latitudes. During this season, oceanic water dominates the whole continental shelf area. The shelf water, which is a body of mixed water, increases its proportion of oceanic water to estuarine water.

During the SW monsoon or summer season, a reversal of hydrographical conditions in the shelf takes place, and the salinity decreases as a result of increasing fresh water dilution. During this period, along the deeper shelf area, there is a general upward sloping of isotherms and isohalines, showing the intrusion of slope water into the coastal area.

3.2 Physical oceanographic processes

3.2.1 Swells and waves

The terms "swell" and "wave" are used to describe processes on the surface of the ocean. The data on these features in the region are sparse. They show high correlation with the surface wind. A coast which faces the wind during a particular season experiences stronger wave action during that season.

For a useful compilation of data, including extensive tables and charts, see U.S. Hydrographic Office (1965), Haslam (1978), Valencia (1978a), and U.S. Defense Mapping Agency (1979).

3.2.2 Tides and tidal currents

Tidal dynamics in the East Asian Seas region have been investigated by Wyrtki (1961), NEDECO (1965), Haslam (1978), U.S. Defense Mapping Agency (1979,1982), and Soegiarto (1981). Such studies also cover the types of tides and their geographical distribution.

Tides in Southeast Asia are cooscillatory tides of the Pacific and Indian Oceans. Because of the extremely strong subdivision of the region the pattern is manifold, and in each sub-basin a different oscillation is primarily stimulated (Wyrtki 1961).

In the open sea, tidal currents are overshadowed by the monsoon wind drifts. Exceptions are channels, inlets and along the coast where current speeds are highest. Data for these are also very sparse. Tidal currents in estuaries are measured and analyzed differently from those in the open sea.

Detailed studies of current regimes at the Bang Pakong River Mouth in Thailand were conducted by Siripong et al. (1984). Siripong and Tamiyavanich (1984) investigated the variation of tidal currents in the offshore area of Ban Laem in the Upper Gulf of Thailand (Figs. 1, 2 and 3).

3.2.3 Surface currents

There are a number of different physical forces which drive sea currents. One such factor, wind shear stress over the ocean surface, is limited, on the average, to shallow depths, characteristically to the upper mixed layer. The wind does not directly affect deep currents.

Surface circulation throughout the region during four seasons was determined using ship's drift and Geomagnetic Electrokinetograph (GEK) data. Surface currents correlated highly with monsoon winds.

3.2.4 Exchange of water between the Indian and Pacific oceans

A significant water flux from the Pacific to the East Asian Seas via the Indonesian Sea has been suggested by various investigators. The predominant pathways are generally believed to be the deep passages north and south of Timor. In transport capacity, the Lombok Strait, between Bali and Lombok Islands, is second only to the Timor passages.

The effect of the regional monsoon wind on the ocean transport in the Indonesian seas has been examined by means of a barotropic primitive numerical model (Pariwono 1986), applying the monthly wind field as the driving force. Realistic bottom topography and linear dissipation were incorporated in the model.

4. Oil spill modelling in the East Asian Seas

There are five published works on oil spill modelling in the East Asian Seas and none of them seem to get satisfactory results.

4.1 Singapore area

Oakley and Cripps (1972) determined if sewage wastes or sludges could be safely discharged into the sea from proposed developments. Consideration was also given to pollution by oil and oil wastes.

Full analysis of the results has not yet been made, but preliminary consideration has been given to the possibilities of marine disposal of sewage from the Telok Blangah development. They concluded that a discharge of untreated sewage would adversely affect waters around some of the islands in the vicinity where tourist development with swimming and boating is contemplated.

4.2 Offshore region of West Sabah

Chua and Mathias (1975) may have been the first to work on oil dispersion in the South China Sea. The movement of an oil slick on the sea surface is defined as the distance that it travels under the influence of three important meteorological and oceanographic parameters: the wind vector, the tidal stream vector and the residual current vector. Their results emphasized the dominant effect of the current on the movement of the bulk of an oil spill (Valencia 1978b).

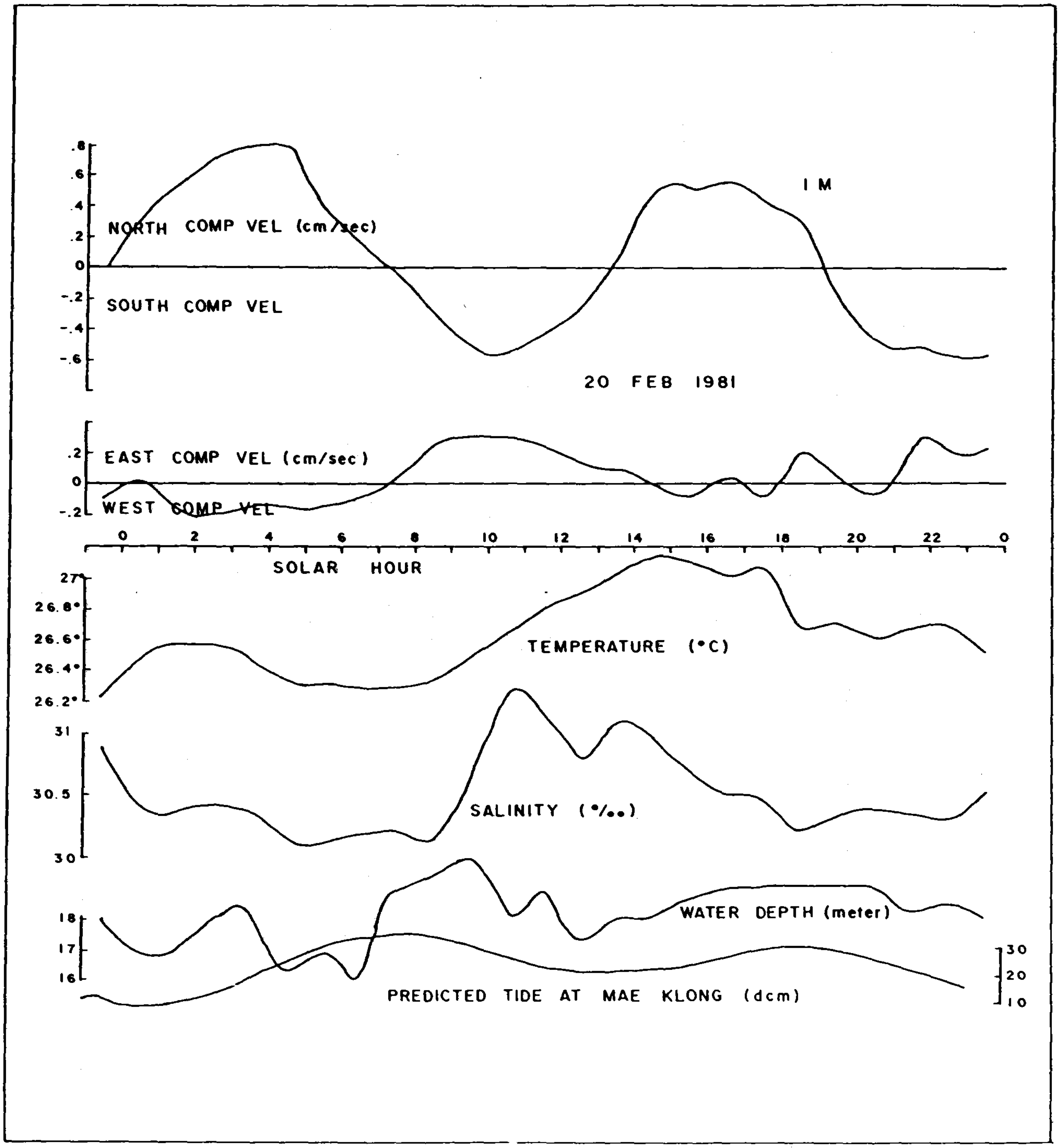


Fig. 1. The variations of some physical properties of sea water offshore of Ban Laem in 25 solar hours at 1 m level (from Siripong and Tamiyavanich 1984).

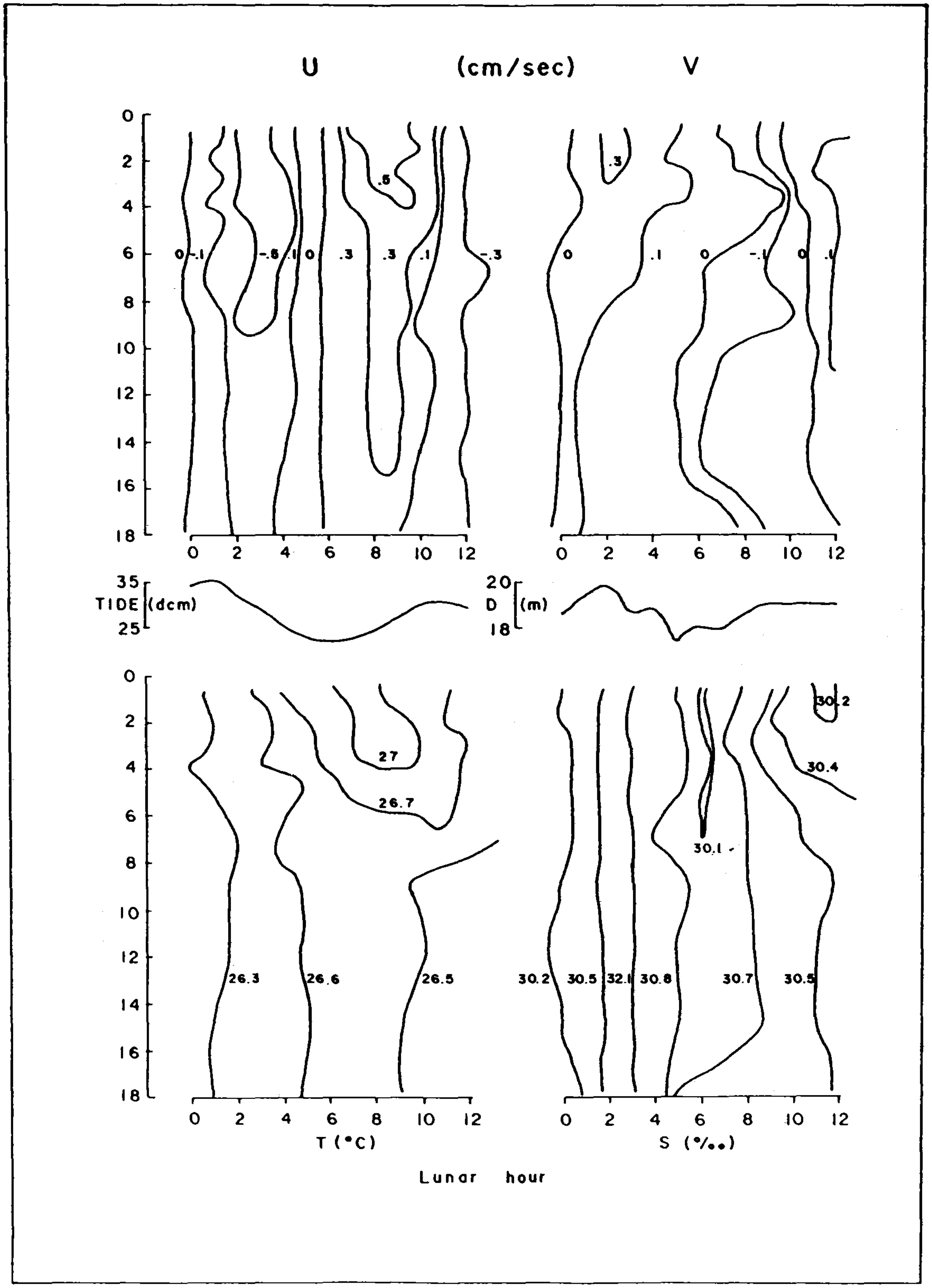


Fig. 2. The variations of some physical properties of seawater offshore of Ban Laem from lunar hour 0 to 12 at various depths (from Siripong and Tamiyavanich 1984).

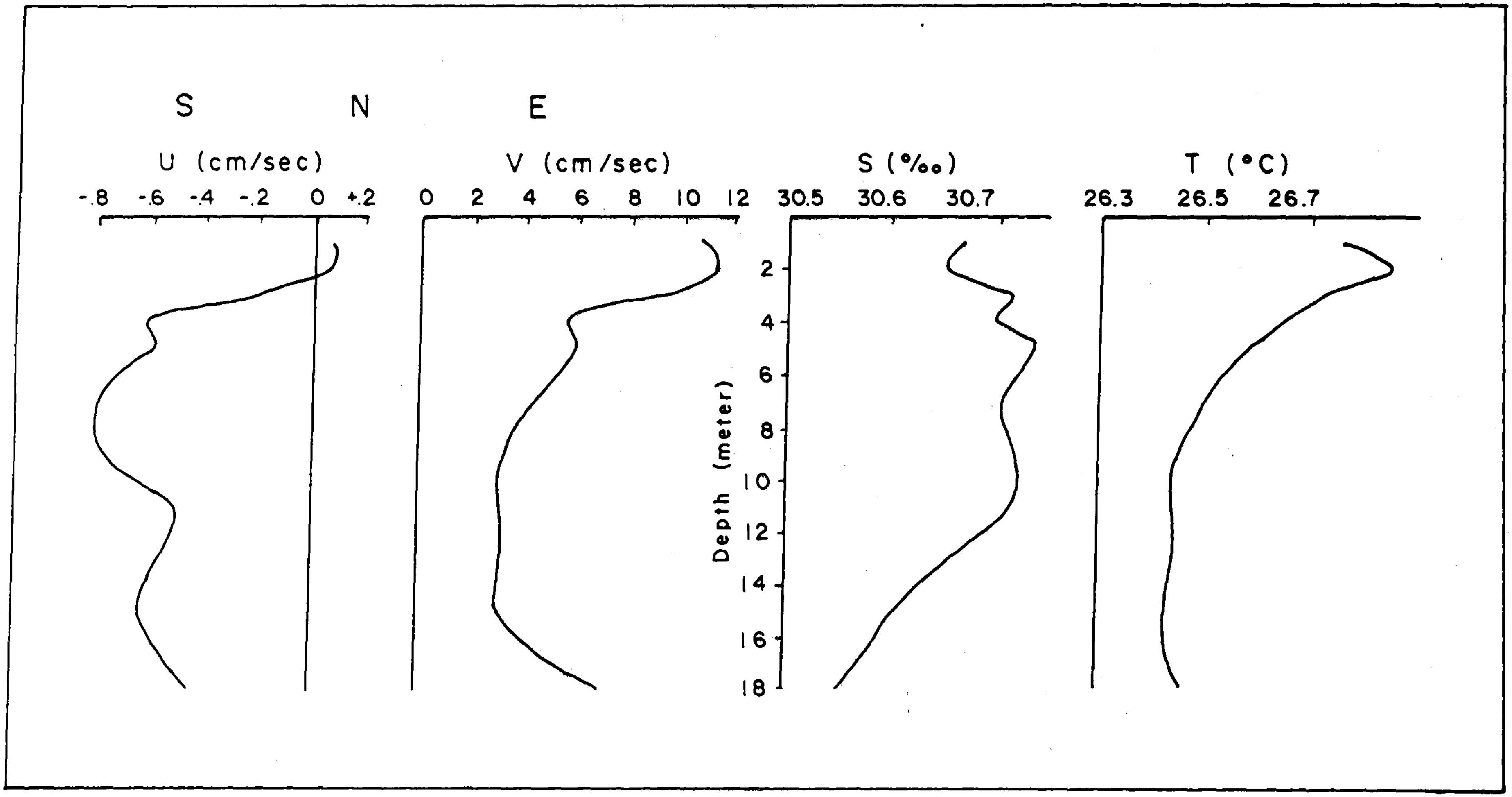


Fig. 3. The variations of some physical properties of sea water offshore of Ban Laem averaged per tidal cycle in a vertical direction.
U (+ = N, - = S component of velocity), V (+ = E, - = W component of velocity)
(from Siripong and Tamiyavanich 1984).

Figure 4 presents the resultant travel paths of an oil spill under the combined influence of the wind and current assuming a spill occurred on the first of each month and continued to exist in some instances through successive months until land was encountered. In the figure, the spill is shown to originate at the Tembungo well site.

4.3 Gulf of Thailand

Vongvisessomjai et al. (1978) constructed a mathematical model (Fig. 5) of an oil spill in the Upper Gulf of Thailand. The hydrodynamic calculations utilise the fresh water flow, tidal current velocity and wind-driven current to obtain a combined vector which determines oil slick movement. They compared the model results with an actual oil spill and concluded that the current system is the dominant hydrodynamic factor affecting the slick movement.

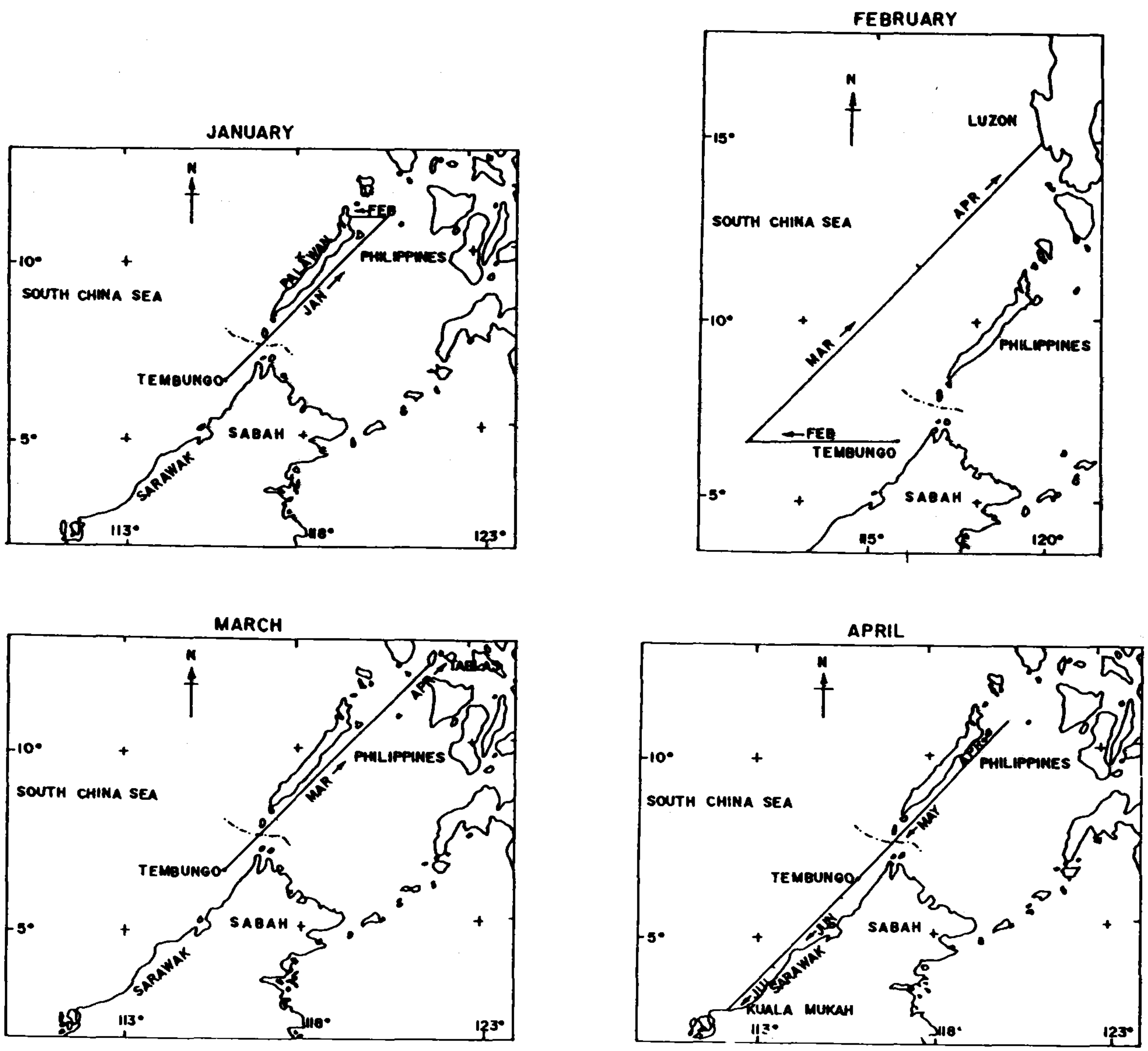


Fig. 4. Combined current and wind transport: monthly travel paths.

(Continued next page)

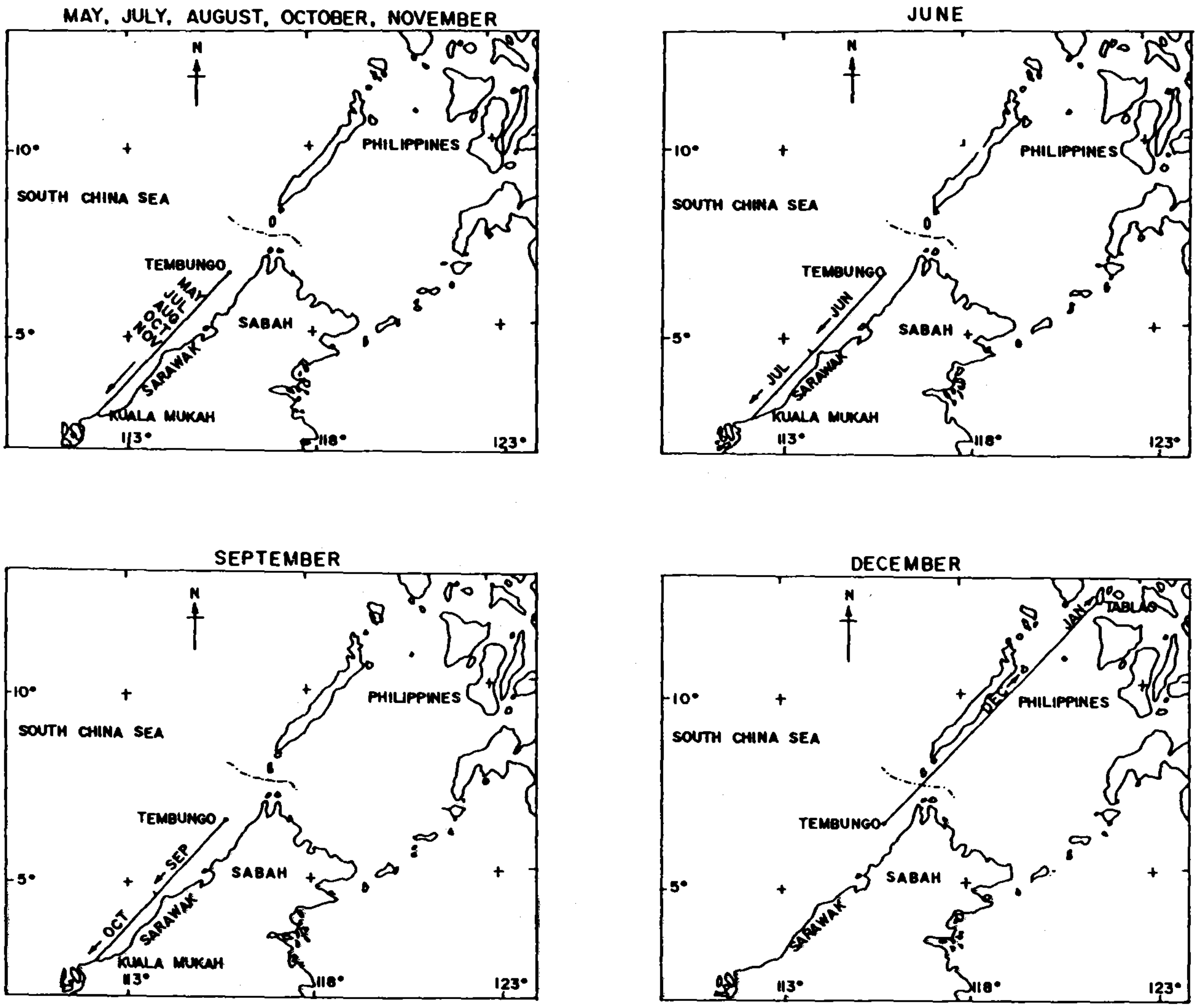


Fig. 4. Combined current and wind transport: monthly travel paths.

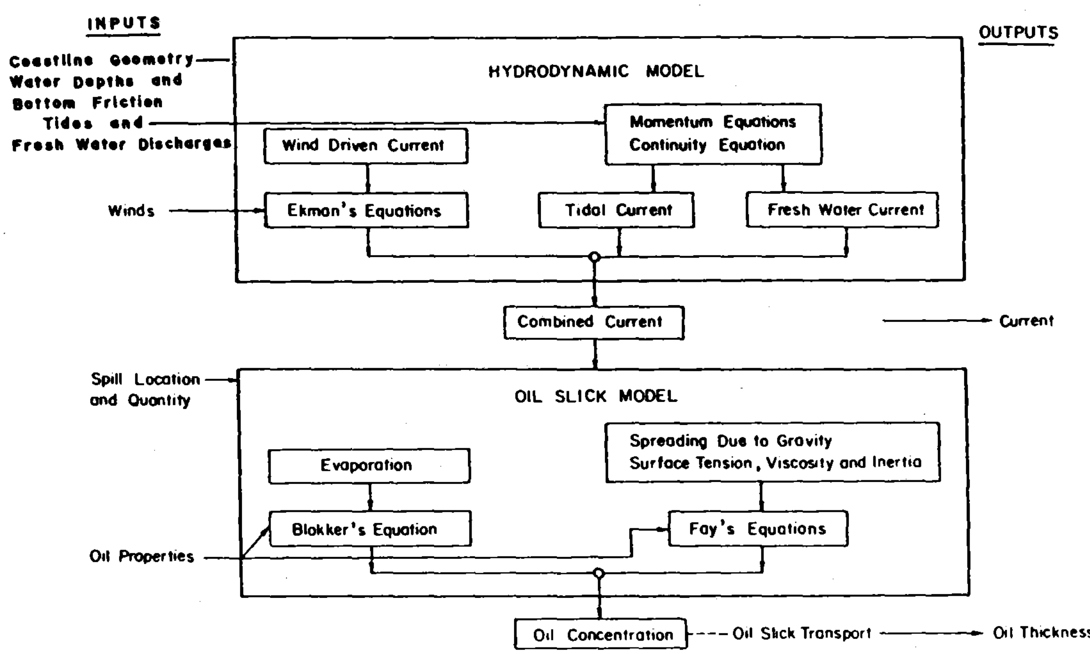


Fig. 5. General formulation of the mathematical model of an oil slick

4.4 The South China Sea

Valencia et al. (1983) presented hypothetical oil spill trajectories for four phases of the monsoons for four well locations in the South China Sea: BACH-HO, off the Mekong Delta (9°40'N, 108°E), NIDO, off NW Palawan (11°N, 118°50'E), CPC F-1 Wellsite off SW China (Taiwan) (18°N, 109°E) and south of Hainan (23°N, 120°E). These trajectories were combined in figures with published trajectories projected from TAPIS off the east coast of Peninsular Malaysia (6°45'N, 114°30'E), TEMBUNGO, offshore of NW Sabah (6°45'N, 114°30'E), and the Upper Gulf of Thailand (Figs. 6 and 7).

The hypothetical oil spill trajectories indicated the distance of travel from the site and included the effects of regional and seasonal currents and winds. Physical processes such as spreading and evaporation were considered.

4.5 Simulation of an oil spill in a mangrove swamp

Lai and Lee (1984) studied the spreading of naturally and chemically dispersed oil in a mangrove environment. Ninety liters of oil were spilled in a 9 square metre mud cubicle 1 - 1/2 hour before highwater. The maximum velocity of the slick was attained 20 - 40 minutes after highwater. Velocity depended almost entirely on tidal flow which was estimated at about 1 - 2% that of tidal currents in open water (Figs. 8 and 9).

5. Recommendations

Considering the background and nature of the oil pollution problem in the East Asian Seas, the following are recommended:

(1) Continuous and systematic monitoring and evaluation of oil pollution in the sea;

(2) Compilation of data, published information, names of scientists and names of institutions connected with oil pollution work to facilitate exchange of knowledge and experience. A newsletter is a good mechanism;

(3) Construction of oil spill trajectory models for areas which are potentially vulnerable;

(4) Invitation of experts on oil spill modelling to serve as consultants; and

(5) Solicitation of the financial support of the oil industry for research on marine oil pollution.

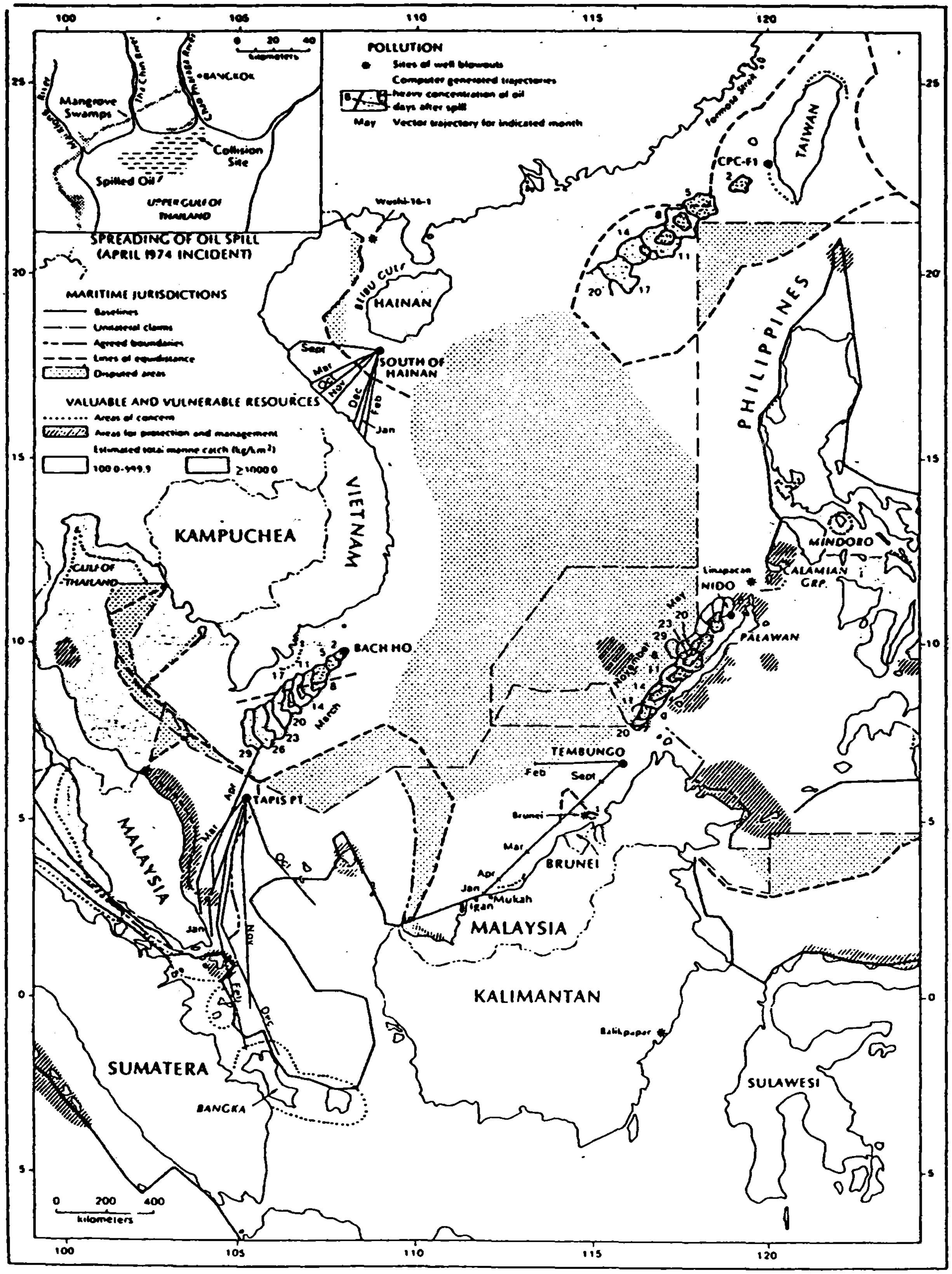


Fig. 6. Hypothetical oil spill trajectories: northeast monsoon (Valencia et al. 1983).

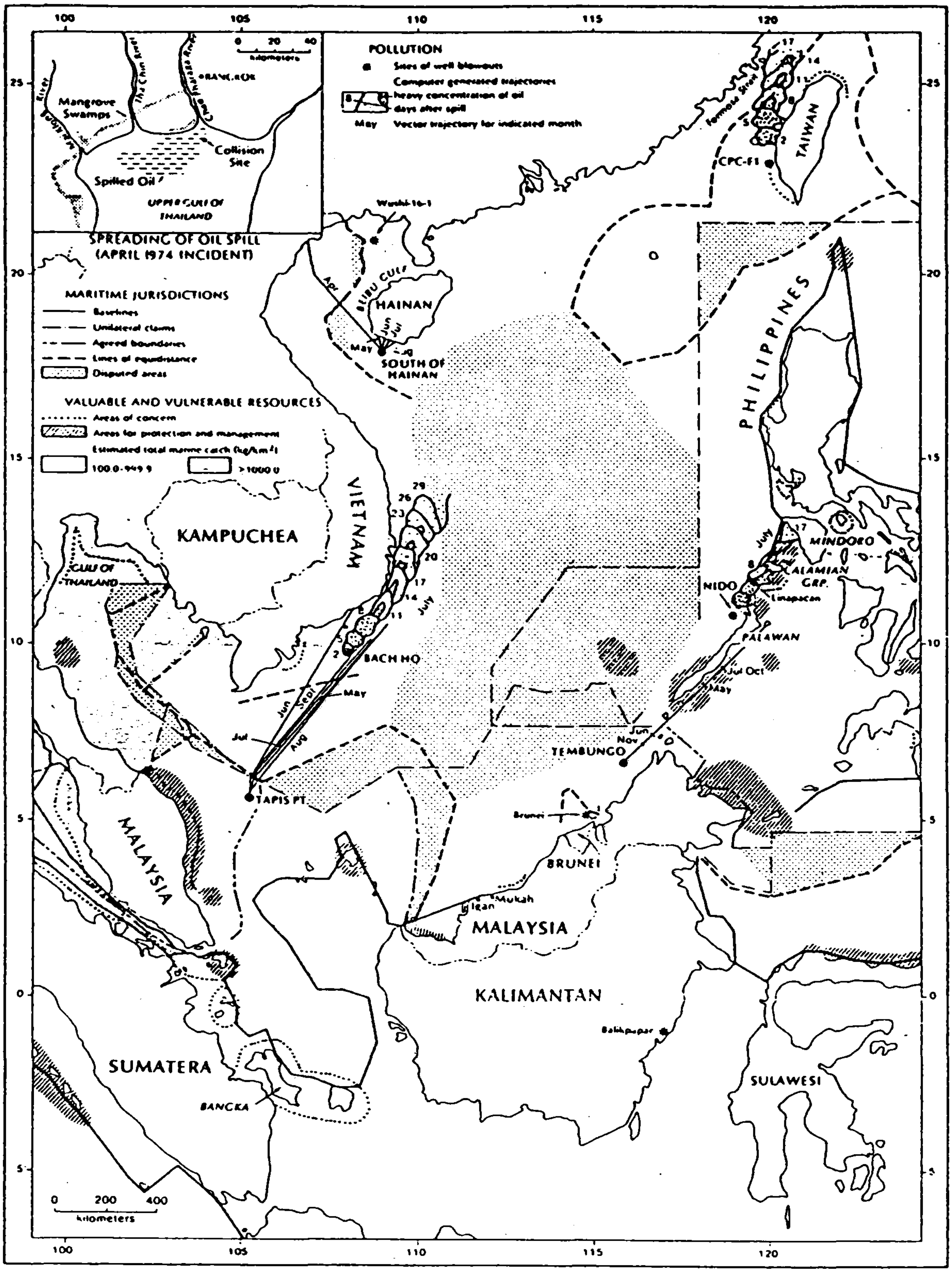


Fig. 7. Hypothetical oil spill trajectories: southwest monsoon (Valencia et al. 1983).

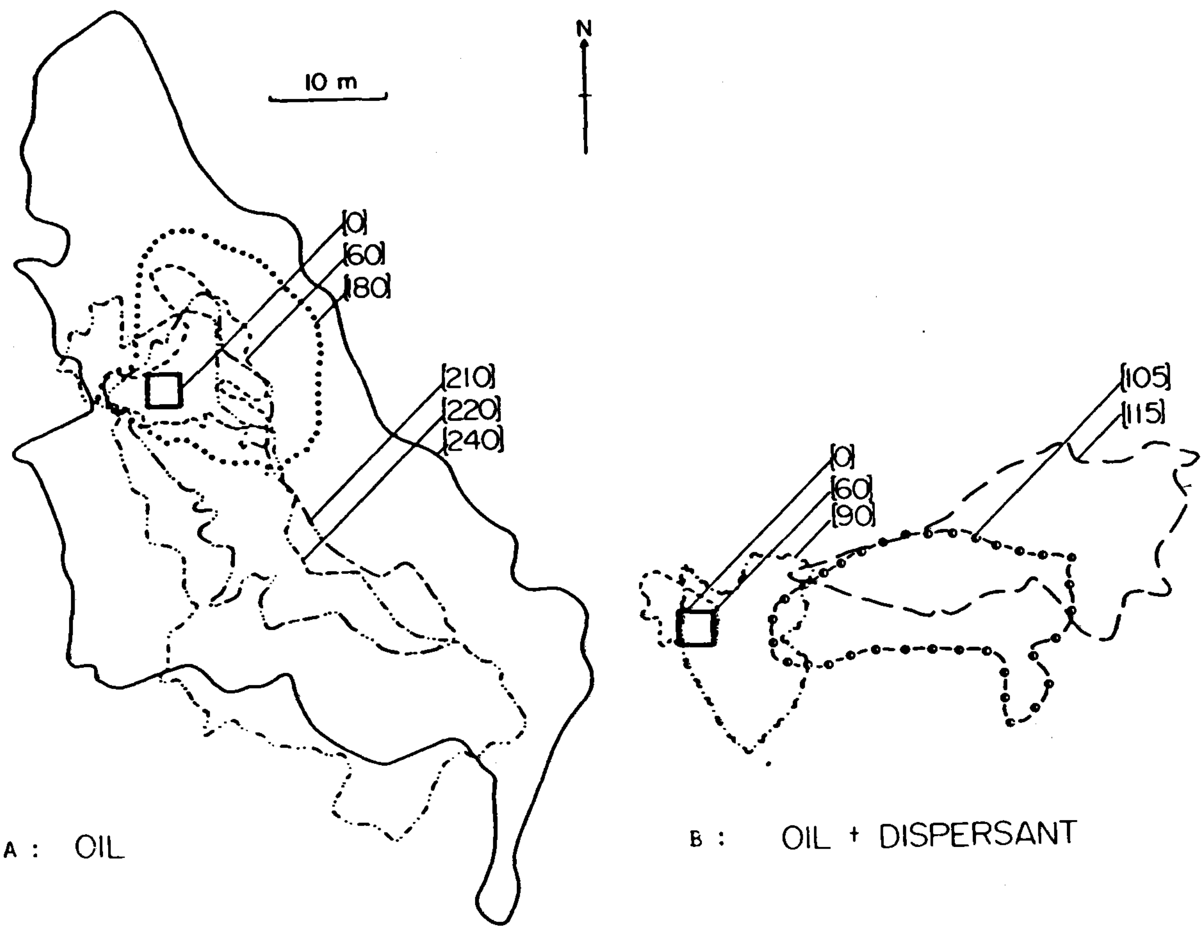


Fig. 8. Oil slick movement in mangrove swamps at Pantai Acheh.
A = undispersed oil. B = dispersed oil. Squares = centers of the spill sites.
Figures in brackets = time in minutes following spillage (from Lai and Lee 1984).

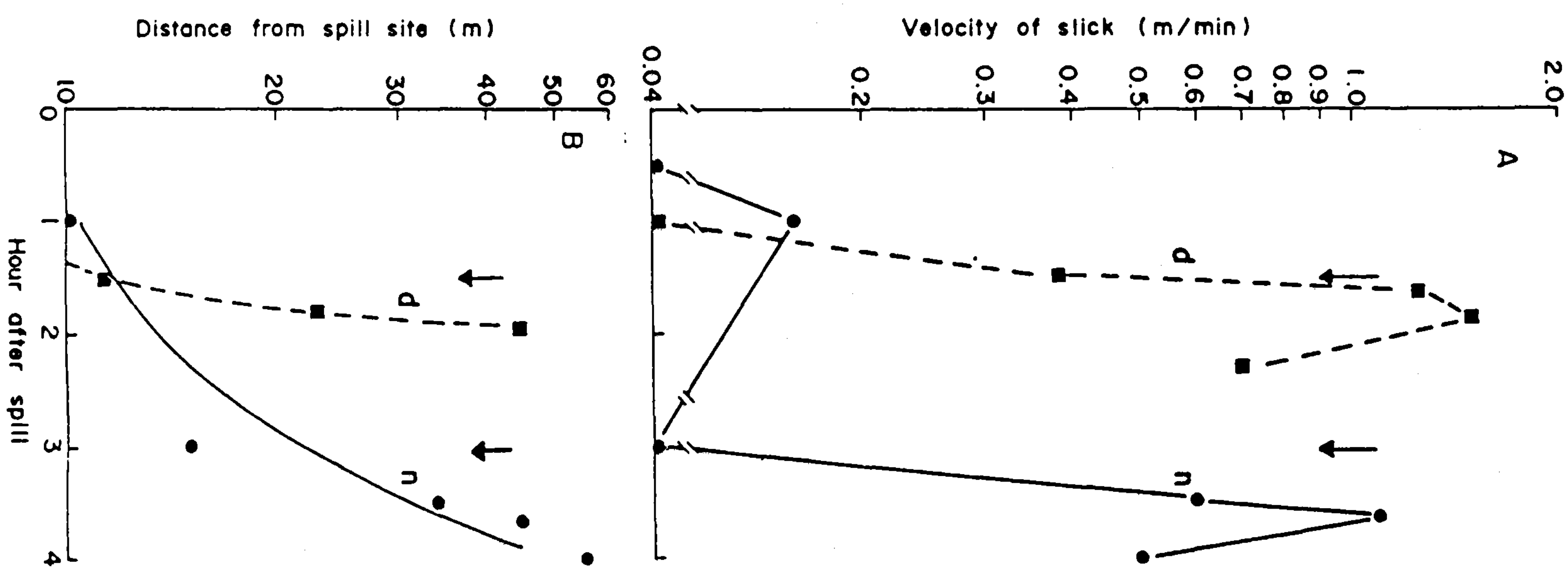


Fig. 9. A: Oil slick velocity. B: Distance from the spill site. d = dispersed oil;
n = undispersed oil. Arrows indicate time of high water
(from Lai and Lee 1984).

REFERENCES

Chua, T. E. and J. A. Mathias, eds. 1975. Coastal resources of West Sabah, a preliminary investigation in relation to oil spill. Penang: Universiti Sains Malaysia.

Dobby, E. H. G. 1945. Southeast Asia. London: University of London Press.

Fisher, C. A. 1971. South-East Asia, a social, economic and political geography. New York: Methuen and Co., Ltd.

Flores, J. F. and V. F. Balagot. 1969. Climate of the Philippines. In H. D. Rakawa (ed.). Climates of Northern and Eastern Asia, World Survey of Climatology, pp. 159-213. Amsterdam: Elsevier.

GESAMP, 1977. Impact of oil in the marine environment. IMCO/FAO/UNESCO/WMO/IAEA/UN Joint Group of Experts on the Scientific Aspects of Marine Pollution. Rept. Studies, GESAMP 6.

Haslam, D. W. 1978. China sea pilot. Vol. 1, N. P. 30, Fourth Ed. England: Hydrographic Dept.

Hill, R. D., ed. 1979. South-East Asia, a systematic geography. Oxford: Univ. Press.

Ilahude, A. G. 1979. The oceanographic features of the coastal region between Jakarta and Cirebon: oceanography. In E. C. F. Bird and A. Soegiarto (eds.). Proceeding of the Jakarta Workshop on Coastal Resources Management, 11-15 Sept. 1979, pp. 31-35. N. Y.: The United Nations Univ.

Jeffrey, L. M. 1980. Petroleum residues in the marine environment. In R. A. Geyer (ed.). Marine Environmental Pollution 1; Hydrocarbons, pp. 163-180. Amsterdam: Elsevier.

Lai, H. C. and K. T. Lee. 1984. Simulation of oil spills in a mangrove swamp. In H. C. Lai and M. C. Feng (eds.). Fate and Effects of Oil in the Mangrove Environment, pp. 139-147. Penang: Universiti Sains Malaysia.

NEDECO. 1965. A study on the siltation of Bangkok Port Channel. Vol. II, The Field Investigation. Delft: W. D. Meinema Ltd.

Niino, H. and K. O. Emery. 1961. Sediments of shallow portions of the East China Sea and South China Sea. Bull. Geol. Soc. Am. 72:731-762.

Oakley, H. P. and T. Cripps. 1972. Marine pollution studies at Hongkong and Singapore. In M. Ruivo (ed.). Marine Pollution and Sea Life, pp. 83-91. Surrey: Fishing News (Books) Ltd.

Pariwono, J. I. 1986. Monsoonally wind-driven transport in the Indonesian waters. Symposium on Marine Science in the Western Pacific, The Indo-Pacific Convergence, Townsville, Australia, 1-6 December 1986.

Pinyoporn, W. 1986. Seasonal variation of characteristic of water masses in the Gulf of Thailand and South China Sea. Bangkok: Marine Science Dept., Chulalongkorn University. M. S. thesis.

Siripong, A., T. Piyakarnchana and S. Tamiyavanich. 1984. The variation of salt flux at Bang Pakong River Mouth. Proceedings of the Third Seminar on Water Quality: The Quality of Living Resources in Thai Waters. Bangsaen: Marine Science Institute.

Siripong, A. and S. Tamiyavanich. 1984. The variation of some physical properties of the sea water offshore of Ban Laem, Petchburi Province per tidal cycle. Proceedings of the Third Seminar on the Water Quality: The Quality of Living Resources in Thai waters. Bangsaen: Marine Science Institute.

Soegiarto, A. 1981. The oceanographic features of the Southeast Asian waters. In Chia Lin Sien and Colin MacAndrews (eds.). Southeast Asian Seas, Frontiers for Development, pp. 20-47. New York: McGraw-Hill.

Sutamihardja, R. T. M. 1985. Water quality in the coastal area, the Jakarta Bay experience. In I. Kato, N. Kumamoto, W. H. Matthews and A. Suhaimi (eds.). Environmental Protection and Coastal Zone Management in Asia and the Pacific, pp. 37-48. Tokyo: Univ. of Tokyo Press.

U. S. Defense Mapping Agency. 1979. Sailing directions (planning guide) for Southeast Asia. 1st ed. Pub. 160. Washington, D. C.: U. S. Defense Mapping Agency.

U. S. Defense Mapping Agency. 1982. Sailing directions (planning guide) for Southeast Asia. 2nd ed. Pub. 161. Washington, D. C.: U. S. Defense Mapping Agency.

U. S. Hydrographic Office. 1965. Atlas of sea and swell charts: the Indian Ocean. Washington, D. C.: U. S. Navy.

Valencia, M. J. 1978a. The physical environment. In Chua T. E. and J. A. Mathias (eds.). Coastal Resources of West Sabah, An Investigation into the Impact of Oil Spill, pp. 3-45. Pulau Pinang: Penerbit Universiti Sains Malaysia.

Valencia, M. J. 1978b. Prediction of oil slick movement. In Chua T. E. and J. A. Mathias (eds.). Coastal Resources of West Sabah, An Investigation into the Impact of Oil Spill, pp. 217-233. Pulau Pinang: Penerbit Universiti Sains Malaysia.

Valencia, M. J., H. L. Kaul and J. Galt. 1983. South China Sea: hypothetical oil spill trajectories and transnational impact. Ocean Management 8: 335-351.

Vongvisessomjai, S., A. Arbhabhirama and Y. Fuh. 1978. A mathematical model of oil spill movement, Upper Gulf of Thailand. AIT Res. Rept. No. 73.

Weidemann, H. and H. Sendner. 1972. Dilution and dispersion of pollutants by physical processes. In M. Ruivo (ed.). Marine Pollution and Sea Life, pp. 115-121. Surrey: Fishing News (Books) Ltd.

Wyrtki, K. 1961. Physical oceanography of the Southeast Asian waters, South China Sea and Gulf of Thailand, 1959-1961. NAGA Report Vol. 2, SIO.

SOURCES AND EXTENT OF OIL POLLUTION IN THE EAST ASIAN SEAS REGION

Ministry of State for Population and the Environment
Jalan Merdeka Barat 15
Jakarta, Indonesia

ABSTRACT

Oil spilled on the sea surface undergoes a variety of transformations as a result of physical processes acting on it, and can cause severe damage to individual organisms and entire ecosystems. Data on contamination in the Southeast Asian seas is scarce. Available information indicates that hydrocarbon concentrations are in the order of 0.01 - 4 ppb, with higher values found in the waters around Japan. Oil in the marine environment originates from a number of sources such as activities on land, natural seepage from submarine reservoirs (relatively abundant in Southeast Asia), and offshore operations. An important cause of oil pollution is linked to shipping and shipping accidents, since the East Asian Seas are a major transit route for oil carriers. Recommendations center around the prevention and control of oil pollution.

1. Introduction

The marine environment in the East Asian Seas region is known as an ASEAN regional common, a fact that has been recognized from the very beginning of ASEAN cooperation. For this reason, among the first cooperative activities to be adopted by ASEAN countries, with the catalytic and supportive role of the United Nations Environment Programme (UNEP), was the Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the East Asian Seas region. Further to that, the marine environment is also recognized not only as a common regional heritage which needs to be conserved and protected, but also as an abundant source of resources which, if used rationally, can help foster economic development and improve the quality of life in the region.

With the increasing number of ships passing practically most sea lanes in Southeast Asia, where substantial quantities of oil are transported and a number of onshore and offshore installations processing crude oil or producing oil are found, the risk of oil pollution is a high one. Consequently, it becomes imperative to give high priority to activities like oil pollution combatting and related countermeasures such as oil spill contingency planning which handles oil spills originating either from onshore and offshore operations or from tanker traffic.

In the Asia-Pacific region, oil and gas deposits are most promising in sedimentary basins, many of which lie in ocean regions delimited by volcanic island chains (Fig. 1). In the case of basins that are located under the sea, their nature cannot be predicted from land data. Recent findings from oil and gas exploration in the offshore areas of Southeast Asia confirm this.

The description of the production and transport pattern for oil gives an indication of actual and possible causes of oil contamination in the marine environment. Oil contamination and accumulation in the form of dispersed oil in water, and floating and stranded tarballs are global phenomena which depend on the geographic and hydrographic features of the region.

Oil pollution of the marine and coastal environment is widely recognized as a problem and have been noted at various regional meetings over the last few years. However, oil pollution and its impact on the environment, particularly in Southeast Asian countries, are difficult to assess because the needed research and survey data are so scarce and fragmentary.

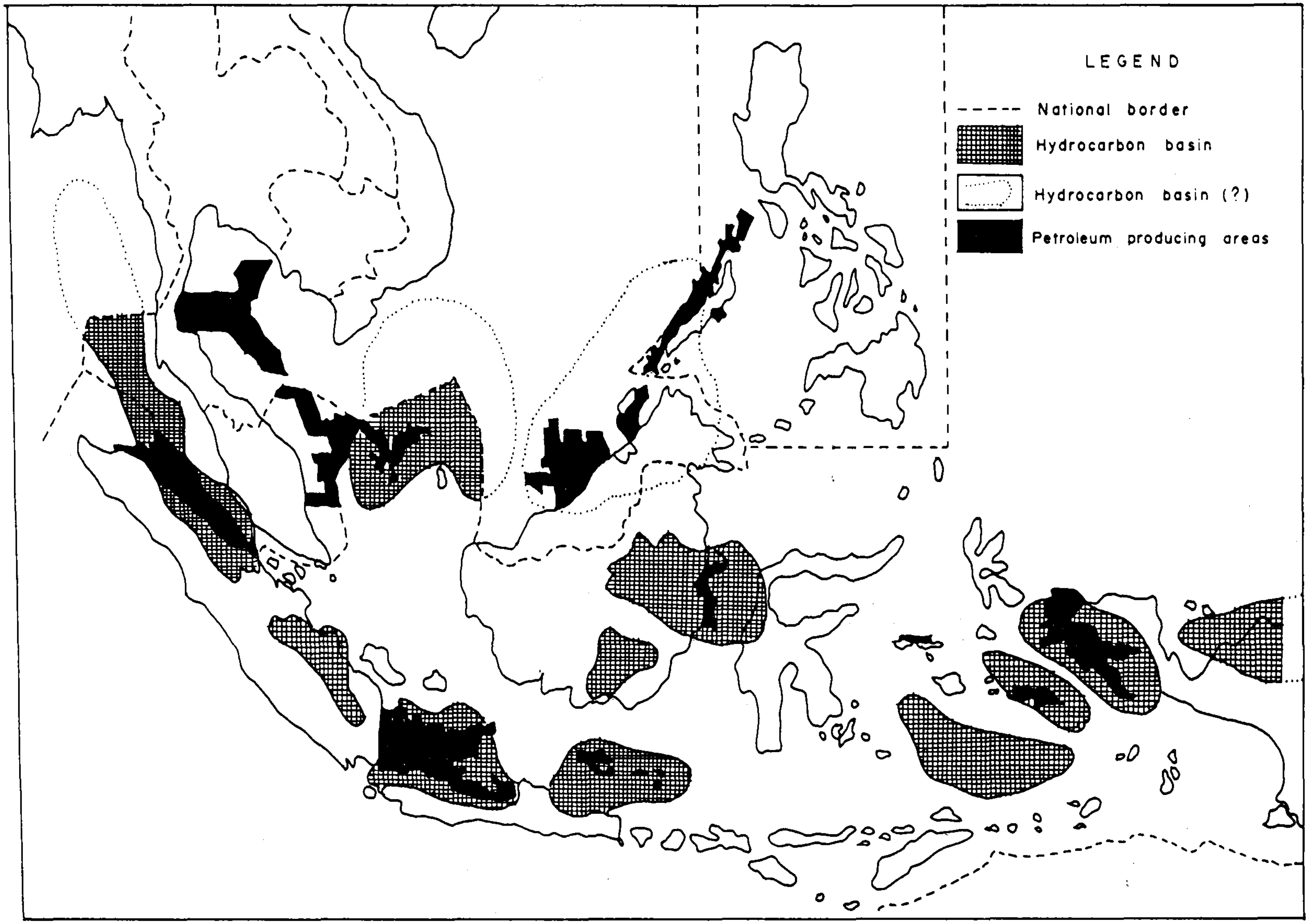


Fig. 1. Prospective hydrocarbon basins and petroleum producing areas (after Petroleum News Southeast Asia 1980, Sigit et al. 1980, BAKOREN 1982)

This paper provides an overview of maritime and terrestrial sources of oil pollution in the East Asian Seas region, the amount of oil reaching the region from these sources, the volume transported from and through the region, and the present levels of oil pollution observed in the marine and coastal environment.

The above mentioned results were derived from the implementation and management of projects of the Coordinating Body for the Seas of East Asia (COBSEA) and other related activities, such as:

- overview of land-based pollution sources in Southeast Asia;

- assessment of oil pollution impact on living aquatic resources in Southeast Asia;

- environmental problems of offshore exploration and exploitation in Southeast Asia; and

- survey and monitoring of oil pollution and development of national coordinating mechanisms for the management and establishment of a regional data exchange system.

An attempt is also made to come up with recommendations on research and monitoring needs, training and equipment requirements, and funding for control of oil pollution in the region, together with detailed descriptions of projects and activities which may be implemented in order to achieve the goals of the recommendations.

2. The impact of oil pollution in the sea

Oil pollution in the ocean can be created by an accident at the drilling site or when oil is being transported. Oil spilled in the ocean, with its various physical and chemical characteristics, will create a negative impact on the environment, living resources, as well as marine related activities such as fishing, culture, mining, transportation, and recreation.

Spilled oil on the sea surface with a volume of one litre will cover an area of about 4,000 square meters when completely spread out. During the time it is spreading, many changes occur in the oil. All types of oil contain volatile components that evaporate readily. Within a few days, about 25% of the volume of a typical oil spill is lost through evaporation. The remaining oil is subjected to emulsification processes which cause oil and water to mix.

In turbulent seas, oil-in-water emulsions tend to form and the resulting oil droplets are dispersed throughout the water. Some oil droplets, especially those weighted down by mineral particles, even reach the bottom.

Water-in-oil emulsions form when water droplets become enclosed in sheaths of oil. The emulsion is stabilised by interactions between the enclosed water droplets and various residues and asphaltic materials found in most crude oil. This type of emulsion shows up as a floating, sticky, viscous mass and sometimes contains enough water to cause the total volume to be greater than that of the original oil.

Most oil that survives the emulsification process is degraded by photo-oxidation and the activity of microorganisms that are naturally present in the water.

By the end of three months at sea, only about 15% of the original volume of an oil spill remains. This is in the form of black, tarry lumps of a dense asphaltic substance and it is these lumps that frequently wash up on beaches.

When massive spills occur close to shore, there is not enough time for the processes described above to affect the total amount of oil involved. The result is that a thick sticky film of oil is deposited on any solid that comes in contact with the spill. Plant life along shorelines would be smothered and sea birds killed.

The toxic effects of oil result from some of the many compounds that make up oil (see Siripong, "Oil and the marine environment", this volume). It was reported that for spills close to shore, massive and immediate destruction of marine life occurs during the first few days after a spill. The species affected include a wide range of fish, shellfish, worms, crabs, and other invertebrates. Bottom-living fish and other creatures are killed and washed ashore. The toxicity is immediate and leads to death within minutes or hours. The long-term and especially low-concentration effects of oil components on living systems are not as clear as short-term effects.

Oil on beaches discourages tourism. Removal of the contaminated sand could be done but this is a laborious and time consuming task. Furthermore, it is unlikely that all oil would be removed as some would be covered by shifting sand and could be re-exposed later on. For a long period, tarry patches could soil the skin and swimming suits of holiday makers. The problem is an unpleasant one even when the oil is present in samll amounts.

2.1 Oil contamination in marine waters

The data from the Marine Pollution (Petroleum) Monitoring Pilot Project (MAPMOPP) of the Integrated Global Ocean Survey System (IGOSS) o hydrocarbons and floating tarballs (oil lumps) (Figs. 2 and 3) provide the only overview of the state of oil contamination in the East Asian Seas. The hydrocarbon concentrations range from 0.01 - 4 ppb with both extremes occurring in the southern part of the South China Sea. The Malacca Straits, eastern South China Sea, Celebes Sea, and northern Philippine Sea have values of 0.06 and 0.07 ppb. Higher values of 0.2 to 0.7 ppb are found in waters around Japan.

Some countries in Southeast Asia conduct surveys and occasional observations of hydrocarbons in coastal waters, but the results and data are scattered, so it is impossible to integrate this information with the MAPMOPP/IGOSS data. Even for an assessment within the region, interpretation is difficult because of the various methods of sampling and analysis used.

The hydrocarbon contamination data given by country represent an effort to compare the available information regardless of the purposes for which this was generated. Concentration of oil pollution is strongly dependent on the hydrographic and geographic features of the region.

The following methods were used for hydrocarbon analyses. MAPMOPP/IGOSS presumably used 5 litre of sample extracted by n-hexane and analysed by fluorescence spectrometry (IOC/WMO 1976). Phang et al. (1980) (Malaysia) used 2.5 litre of water sample extracted in CCl_4 and analysed with an infrared spectrophotometer (Atwood et al. 1972). The Oil and Gas Technology Development Center, "Lemigas" (Indonesia), used 5 litre of water sample, extracted in CCl_4, shaken with Frorisil to remove polar hydrocarbons, and finally analysed by infrared spectrophotometry (CONCAWE 1972). The national Pollution Control Commission of the Philippines analysed water samples by extraction with a solvent and weighing gravimetrically without any separation of the polar and non-polar hydrocarbons. These differences of method make comparisons difficult.

2.2 Chemical effects of oil spills on marine organisms

The degree of biological damage caused by an oil spill in the ocean mainly depends on:

- the type of oil pollutant;
- the characteristics of the open sea towards the coast;
- the characteristics of the movement of sea water off the coast;
- the bottom topography of the sea; and
- the weather conditions when the accident took place.

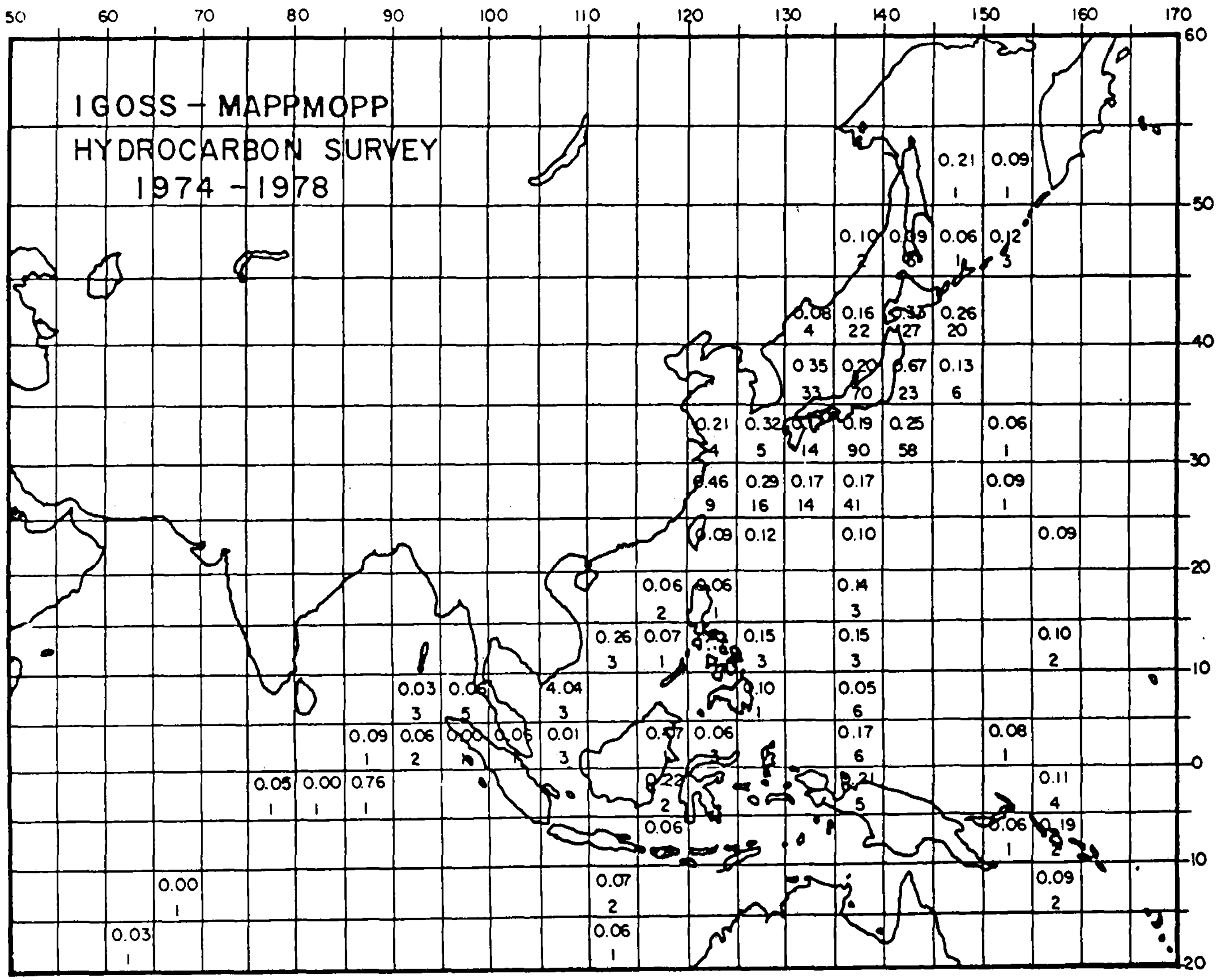


Fig. 2. Regional distribution of the concentrations of hydrocarbons in water (ppb) and number of samples by 5° squares (source: IGOSS-MAPMOPP)

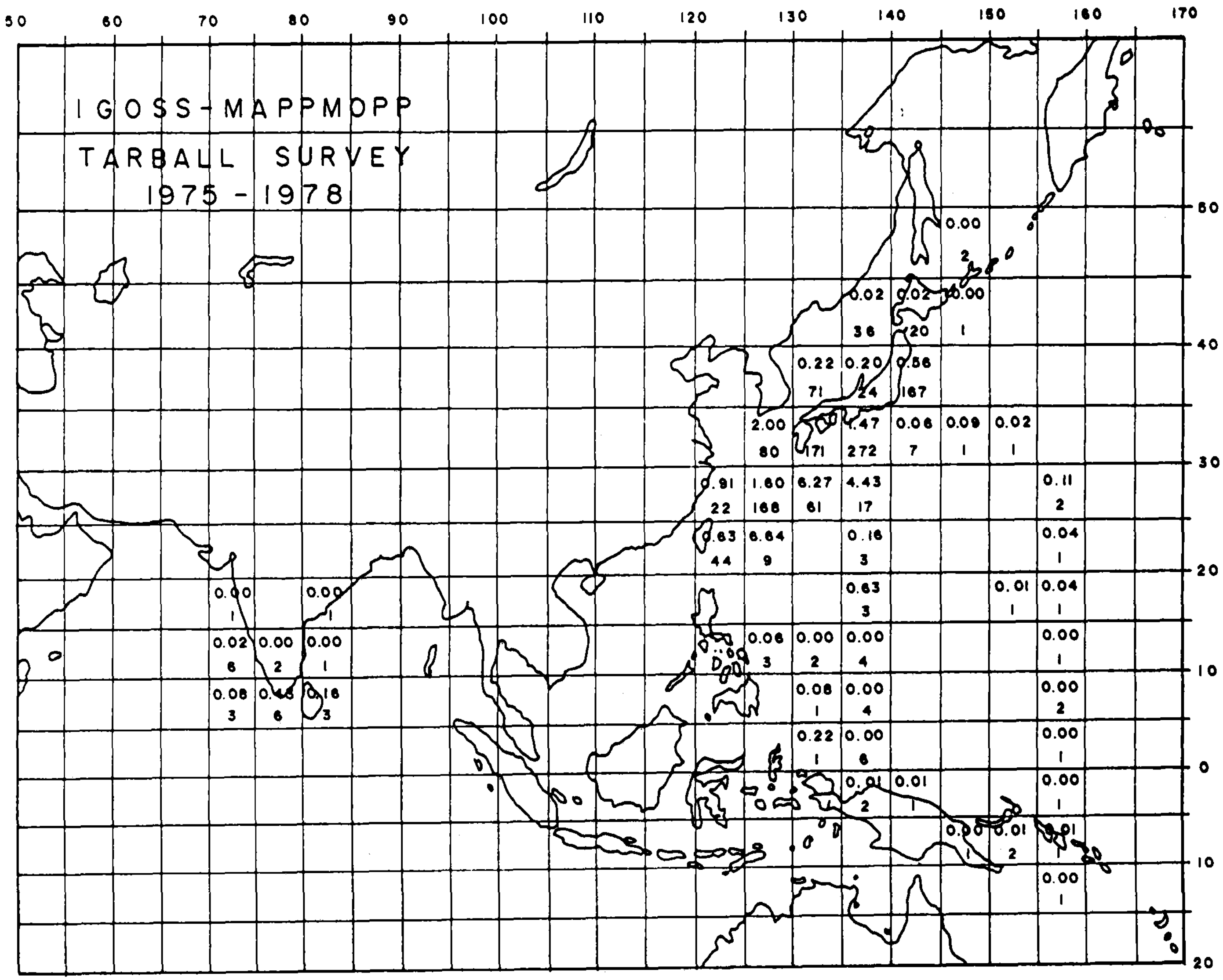


Fig. 3. Regional distribution of tarball concentrations and number of samples by 5^{0} squares (source: IGOSS-MAPMOPP)

2.3 Physical effects of oil spills in the ocean

Oil spills in the ocean, especially of crude oil, will cause deterioration of fishing gear such as nets, traps, and other static fishing tools rendering them useless.

Effects of oil on coastal ecosystems are discussed by Chansang (this volume).

3. Maritime and terrestrial sources of oil pollution

It is our policy that prevention of pollution be an integral part of, and would actually facilitate, oil exploration and production in the region. This is of importance since the problem of pollution is a logical consequence of industrial and technological development, and has become both a national and international issue that requires our special attention.

It is estimated that about 5 - 10 million tonnes of oil are discharged into the world's oceans every year (Lim and Ong 1987). The major sources of discharge are:

- cargo tank washings at sea;
- bilge pumping at sea (ships other than tankers);
- in-port oil losses;
- oil exploration and production; and
- accidents or grounding of tankers.

3.1 Terrestrial sources

Terrestrial sources of pollution in the East Asian Seas region are connected with land exploration and production activities. The mining and energy sector in Indonesia has a very important role and forms the main source of the state income. It also provides the largest part of energy resources, but from another point of view could also be a source or cause of pollution due to technical failure and other reasons.

In Table 1 is a list of important land-based crude oil producers in Indonesia. This provides an indication of production rate in the country (see also Fig. 4).

Table 1. Land-based crude oil producers in Indonesia.

Company	Location	Production (in million barrels)
Pertamina	(see Fig. 4)	30.7
Caltex	Riau province	292.9
Stanvac	Jambi province	12.0
Calasiatic Topco	Central Sumatra	2.5
Lemigas	Central Java	0.3
Petromer Trend	Birds Head (Irian Jaya)	27.7

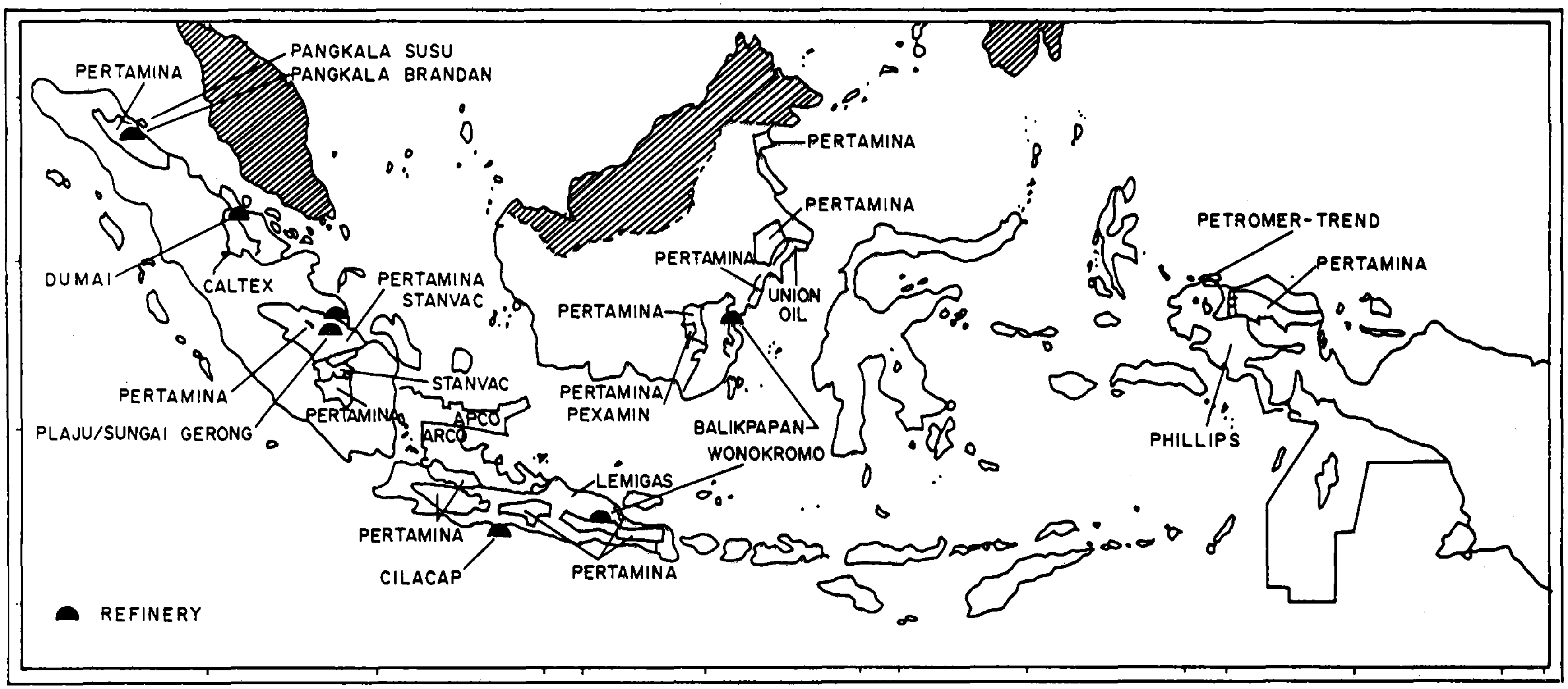


Fig. 4. Land-based and offshore oil fields in Indonesia

3.2 Hydrocarbon producing basins

The actual and potential hydrocarbon producing basins in the Southeast Asian region are found in various geological settings.

In Indonesia, the known basins stretch from Sumatra, including the northern offshore extension into the Straits of Malacca, through Java to Kalimantan, as well as the basins in and offshore of West Irian.

In Malaysia and Brunei, the Northwest Borneo basin and its offshore extension are of recent interest as are the Saigon-Brunei basin in the southern part of the South China Sea and the Gulf of Thailand basin.

The Gulf of Thailand basin extends to the north into the land area of Bangkok. Of special interest also is the sedimentary area in the Andaman and Nicobar Islands extending down to the Malacca Straits.

In the Philippines, producing fields have been found in the offshore area of Palawan Island in the South China Sea (Siddayao 1980).

Some recent discoveries in Southeast Asia, particularly in the offshore areas, have greatly changed earlier concepts of estimating hydrocarbon potential based on the projection of land geology.

The prospective hydrocarbon basins and oil and gas producing areas in Southeast Asia, as illustrated in Figure 1, indicate the natural wealth of the region. Data on hydrocarbon resources in the submarine areas are shown in Table 2.

Table 2. Hydrocarbon resources in the ocean waters of Southeast Asia (in barrels per day)

(after Bilal and Kuhnhold 1980, Siddayao 1980, Sigit et al. 1980).

Country	Production 1978		Production 1980	
	Total	Offshore	Total	Offshore
Brunei	209,400	179,100		
Indonesia	1,634,790	545,240	1,576,546	536,876
Malaysia	196,500	196,500		300,000
Philippines	40,000	40,000	40,000	40,000
Singapore	0	0	0	0
Thailand	200	0	200	0

3.3 Marine transport of oil, shipping operations and casualties

Most of the oil shipped through and in Southeast Asian waters is in transit to Japan while the rest goes to the USA and other Asian countries, together accounting for more than 90% of the oil supplied (Fig. 5).

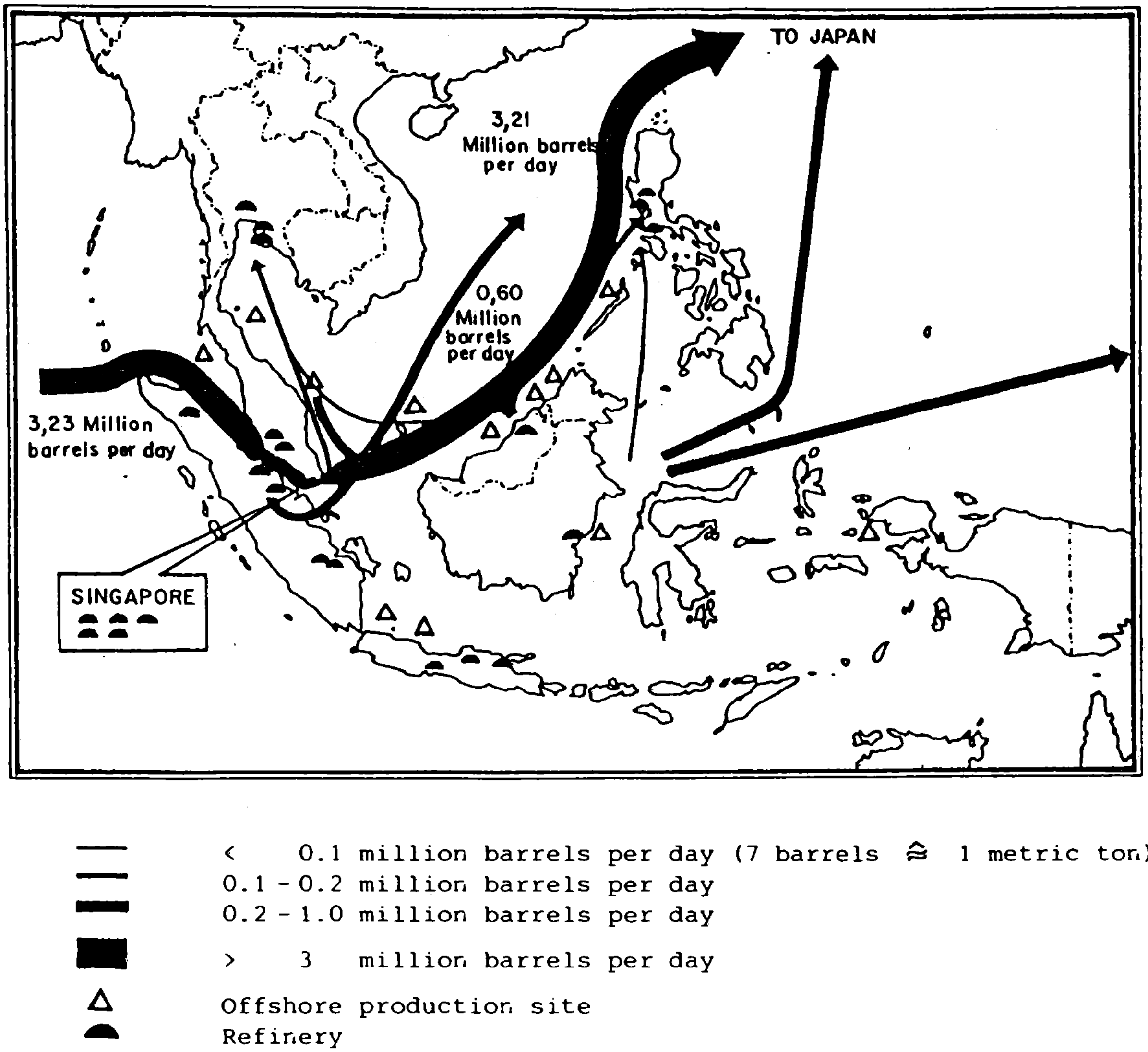


Fig. 5. Transport of crude oil in Southeast Asia (1795) (after Finn et al. 1979)

According to Finn et al. (1979), 3.23 million barrels (bbl), mainly crude, enter this region daily through the Straits of Malacca, while 3.81 million bbl/day (crude and refined products) leave the Macassar Straits for Japan and the Pacific (Bilal and Kuhnhold 1980). The Port of Singapore, situated at the key intersection of major sea routes, ranks as the world's third busiest port. Its strategic location has also contributed to Singapore's emergence as a center for ship repairs and service for oil tankers. Table 3 shows frequencies of tanker movement in Southeast Asia and Table 4 shows the origin, size and numbers of tankers that travel through the Straits of Malacca.

There are many factors that affect or that may affect the pattern of oil shipment in Southeast Asia. For example, unpredictable new resource discoveries within the region, such as offshore of Vietnam and China, may change patterns of supply.

Table 3. Frequencies of tanker movements in Southeast Asia (Valencia 1981).

Destination (Route)	Hypothetical vessel size	Frequency
South Korea and Japan	200,00 DWT	984/yr (1/0.4 d)
Japan (Lombok-Macassar-Sulawesi Sea:- east or west of the Philippines)	VLCCs	140/yr (1/2.6 d)
Sulawesi Sea	VLCCs + Tankers	25-30/yr (1/13.5 d)
Port Dickson, Malaysia	90,000 DWT	40/yr (1/9 d)
Singapore	VLCCs	91/yr (1/4 d)
Singapore Strait	Various	15,336/yr (1/.024 d or 1/34 min)

Table 4. Origin, size spectrum and number of tankers in transit through the Straits of Malacca. Numbers in parentheses show percentage of total Japanese oil imports and percentage of tankers transporting oil to Japan (Finn et al. 1979).

Origin	Tanker size (thousand dwt) 100	100-150	150-200	200-250	250-300	Amount of oil (thousand tons)	Number of tankers
Persian Gulf	284	261	106	321	86	192,830 (73%)	1,058 (58%)
Indonesia	198	30	2	-	-	17,419 (6%)	230 (13%)
Africa	40	13	6	5	-	8,117 (3%)	64 (4%)
TOTAL	522	304	114	326	86	218,355 (83%)	1,352 (74%)

In the Straits of Malacca, the transit of international tankers results in very dense traffic, and accidents can always happen causing oil spills. In 1975, 5,500 tonnes spilled in the Straits of Malacca from the tanker "Diego Silang". There were two major oil spills in the South China Sea from collisions: that of a supply ship with the storage barge "ESSO Mercia" which spilled 500 tonnes of bunker crude oil, and the other between the "M.V. Fortuna" and the "USS Ranger" which spilled 10,000 tonnes of crude oil. Table 5 shows ship casualties in Malaysian waters.

Table 5. Ship casualties in Malaysian waters from 1975 to early 1980 (from Bilal and Kuhnhold 1980).

Name of vessel or incident	Cause	Location	Date	Amount and type of oil
"Tolo Sea"	Grounding due to fire	Penang Harbour	20.05.1975	60 tonnes bunker fuel oil
Oil slick	Unknown Penang	South Channel, bunker fuel oil	03.05.1979	Estimated 10-15 tonnes
"Diego Silang"	Collision with Russian Ship "Vystok"	Malacca Straits	24.07.1976	5,500 tonnes Kuwait crude
"M.V. Asian Guardian"	Rupture of discharge pipe to power station	Malacca Straits	16.05.1977	60 tonnes light fuel oil
"M.V. Montessa"	Accidental discharge due to mechanical failure	Malacca Straits	30.06.1979	Arabian light crude (amount unknown)
Shell Refinery	Accidental discharge due to pipe rupture	Malacca Straits (Port Dickson)	30.11.1979	Arabian light crude (50 t)
"Tesahino Maru"	Leakage of delivery pipeline	Malacca Straits (Port Klang)	20.01.1980	Bunker fuel oil (amount unknown)
"Toan Chuen Chun"	Accidental discharge due to mechanical failure	Johore Straits	10.05.1979	Bunker fuel oil (amount unknown)
"Esso Mercia"	Collision with supply ship "Florence Tide"	South China Sea	30.10.1978	505 tonnes bunker fuel oil
"M.V. Fortuna"	Collision with "USS Ranger"	South China Sea	05.04.1979	10,000 tonnes Kuwait light crude oil

In the southern part of Singapore, oil contamination comes mainly from ships that use the busy sea lane of the Strait of Singapore and from those that anchor at the various designated anchorage areas which occupy practically the whole of the southern territorial waters of Singapore. Because of the heavy traffic, a number of oil spills have occurred through the collision or grounding of tankers. Table 6 gives a list of casualties and oil spills for the period 1975 and 1976.

Menasveta (unpublished) reported that there is a problem of oil contamination due to oil activities in Thai waters, but it is still relatively small. An accidental oil spill occurred in April 1974 when the 5000 tonnes coastal vessel "Visahakit" collided with another ship about 8 km from the mouth of the Chao Phraya river. The spill was estimated at 9000 bbl of oil.

Table 6. Shipping casualties in the Strait of Singapore (after Finn et al. 1979, Kantaatmadja 1981).

Date	Name of ship	Type (Tonnage)	Cause	Location	Comments
06.01.75	"Showa Maru"	Tanker (273,698)	Grounding	Buffalo Rock, off Singapore	7,700 tonnes oil spilled
16.01.75	"Isuzugawa Maru" "Silver Palace"	Tanker (122,233) Tanker (21,226)	Collision	Outside of Singapore Port limits	"Isuzugawa Maru" had cargo of crude oil; no spillage
05.04.75	"Mysella"	Tanker (212,759)	Grounding	1°12'04"N, 103°50'54"E	2,000 tonnes oil spilled
18.04.75	"Tosa Maru" "Cactus Queen"	Tanker (42,790) Tanker (152,035)	Collision	1 mi south of St. John's Island	"Tosa Maru" broke in two and sank
14.06.75	"Kowei Baru" "Monte Cristo"	Freighter Freighter	Collision	Eastern Roads, Singapore	
30.06.75	"Liengku"	Freighter	Collision	Malacca Straits	Ship sank
17.07.75	"Neissei Maru" "Ravi"	Tanker (231,986) Freighter	Collision	1°15'03"N, 104°09'03"E	"Neissei Maru" had cargo of crude oil
24.10.75	"Seatiger"	Tanker (123,693)	Collision, grounding	4.8 km south of St. John's Island	
29.10.75	"Kriti Sun"	Tanker (123,484)	Struck by lightning	Singapore Port	
11.12.75	"Sachem" "Gen. Madalineki"	Tanker (29,908) Bulk Carrier(23,298)	Collision	Eastern anchorage, Singapore	
17.05.76	"Margo" "Georg Hanake"	Freighter Freighter	Collision	Eastern anchorage, Singapore	
26.07.76	"Forresbank" "Mareva A.S."	Freighter Freighter	Collision	Eastern anchorage, Singapore	
06.09.76	"Soyakaze" "Marrita E."	Freighter Freighter	Collision	Off St. John's Island	
26.10.76	"Citta di Savona" "Philippine Star" "Esso Spain"	Tanker (64,805) Tanker Tanker (81,827)	Collision	Eastern anchorage, Singapore	"Savona" and "Star" had cargoes of crude oil; 1,000 t oil spilled

The biggest oil spill in Indonesian waters was in the Strait of Singapore, where a super tanker of 273,698 dwt, "Showa Maru", grounded on treacherous shoals near the Buffalo Rock Beacon. It spilled approximately 54,000 bbl of Middle East crude (Kantaatmadja 1981).

Oil spills due to shipping accidents in the waters of the Philippines have been listed by the National Operation Center for Oil Pollution. The record for 1978 is given in Table 7.

Table 7. Oil spills by shipping accidents in Philippine waters in 1978 (after Gomez 1980).

Name of vessel/company	Cause	Date	Location
AGEP Wood Preserving Div.	Discharge to Pasig River of 3-4 drums bunker oil	12.04.78	Pasig River
William Lines motor vessel	Waste oil spillage	19.05.78	Iloilo River
Compania Maritima vessel	Waste oil spill (20 gal)	20.05.78	North Harbor, Manila
Motorized banca (Samasco)	Waste oil spill (20-30 gal)	22.05.78	Bauan, Batangas
Motorized tank (Las Vivas)	Discharge of waste oil	06.08.78	Shell-Batangas Bay
Barge (Luzon Stevedoring)	Spillage of 4,000 bbl of auto turbo fuel	27.09.78	Bataan Refining Co., Lamao, Bataan
Motorized tank (Las Vivas)	Oil spill due to grounding	27.09.78	Bataan Refining Co., Lamao, Bataan
Barge (Luzon Stevedoring)	Spill of 7,000 bbl of premium gasoline by sinking	27.09.78	Bataan Refining Co., Lamao, Bataan
Barge (Luzon Stevedoring)	Spill of bunker oil (and 20,000 bags fertilizer) due to grounding	09.10.78	Manila Bay
Barge (Luzon Stevedoring)	Bunker oil spill by grounding	09.10.78	Manila Bay
Motorized tank (C. Robles)	Oil spill due to sinking	10.10.78	Bataan Refining Co., Lamao, Bataan
Barge (Sealink Inc.)	Spill of 1,300 bbl lubo oil due to sinking	14.11.78	Pasig River

Aside from oil spills through accidents, discharges of oil occur also from operational shipping activities. These discharges consist of activities such as deballasting, tank cleaning, dry docking, bunkering, cargo loading and unloading. The incidence of operational or deliberate oily waste discharges in the area of the East Asian Seas has been studied by Kurashina (1975) and Nasu et al. (1975). The result is as follows:

	Annual number of dirty ballast discharge and tank cleaning operations	Amount discharged in 1000 t/yr
SE Japan area	74	578
Taiwan area	7	616
South China Sea	392	4,705

Oil released during deballasting operations is in the form of tar lumps and weathering produces tarry residues and tarballs. Figure 6 shows the distribution of oil lumps in relation to eastbound tanker traffic and surface currents.

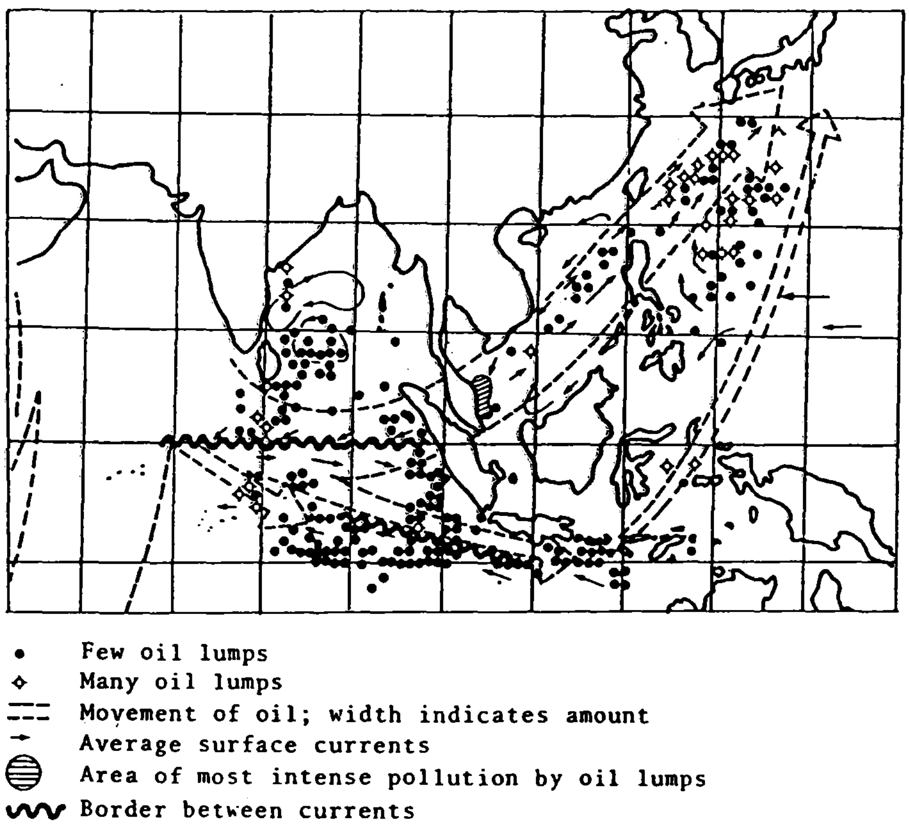


Fig. 6. Surface currents, transport of oil, and distribution of oil lumps in South and East Asia (after Nasu et al. 1975)

The Straits of Lombok, the Straits of Macassar and the Celebes Sea are an alternative route for Ultra Large Crude Carriers (ULCC, over 300,000 dwt) sailing to Japan and the west coast of America, both because of the physical environment in the Straits of Malacca and because of the characteristics of vessels involved in the oil trade between the Western Pacific and the Middle East.

In 1975, three ULCC's, the "Globtik London" (483,960 dwt), the "Globtik Tokyo" (483,684 dwt), and the "Nisseki Maru" (3,372,698 dwt), sailed through these waters in addition to the 25 to 30 Very Large Crude Carriers (VLCC, 200,000-300,000 dwt) and 100 to 150 tankers that transit these waters each month (Hayes 1979).

3.4 Refineries and production fields

There are numerous loading ports, production fields and refineries located along the coast of the Straits of Malacca and adjacent to the Strait of Singapore. Twelve coastal refineries with a total output of over 1,400,000 bbl per stream day are located on the coasts of the Straits of Malacca and Singapore. Port Dumai in east Sumatra is one of the world's biggest crude oil exporting terminals. In 1973 it exported 2.5 milion tonnes of crude oil (Finn et al. 1979).

Along the coast of the southern part of the South China Sea there are eight refineries having a total capacity of 445,000 bbl per stream day.

One refinery is located on the east coast of Kalimantan (Straits of Macassar) with a capacity of 75,000 bbl per stream day. Furthermore, a new refinery center is located on the southern coast of the island of Java. It has a capacity of 100,000 bbl per stream day which is being extended to 300,000 bbl per stream day. The oil terminals, production fields and refineries continuously release oily effluent into the adjacent waters. Sometimes accidental spills have resulted from technical failures and human errors like leaks, overfilling and mismanagement. Table 8 shows a list of refineries with their capacities and Figure 1 indicates the locations of producing and prospective oil fields in Southeast Asia.

3.5 Tarball occurrence

Referring to Figure 3 from MAPMOPP/IGOSS, and Figure 6 from Nasu et al.'s (1975) study on petroleum pollution in the high seas, we obtain the following summary of the tarball status in the East Asian Seas. To the north of Luzon (Philippines), there are 0.63 kg/km2 (= 0.63 mg/m2), and northeast of this area tarball values reach 1.6 kg/km2 (= 1.6 mg/m2). In the direction of Japan the contamination reaches higher values. As stated above, the discharge of tankers' dirty ballast is much more frequent in the South China Sea than in Taiwanese and Japanese waters. Thus the question of tarball contamination in the South China Sea is quite interesting. In the Philippine Sea the plots indicate "only" 0.06 mg/m2.

Stranded tarballs have been observed in some countries in Southeast Asia. In Pulau Pari, where the Indonesian Institute of Oceanology is located, tarballs have been observed regularly for the last four years. Pulau Pari itself is a pseudo-atoll consisting of five small islands, and on three of these, stranded tarballs have been observed. The result of a 1981/1982 survey is given in Figure 7. It shows that the fluctuation of the quantity depends on the monsoon. The lowest value is in August (12.3 g/m^2) and the highest (81 g/m^2) is in November (Toro and Djamali 1982).

In August 1982, Lemigas and the French Centre National pour l'Exploitation des Océans (CNEXO) made a reconnaissance survey in the Riau Archipelago (Strait of Singapore) and the southern part of the West Celebes coast (Straits of Macassar), among other areas. Although this was the month with the lowest concentrations, tarballs were still found in Pulau Pari, Riau Archipelago and the west coast of Celebes.

On the coast around the Gulf of Thailand, tarballs were found during March and April. At Songkhla beach, the highest accumulation was 0.2 to 715 g/m^2. On the beaches of Phuket Island, facing the Indian Ocean and Andaman Sea, such as the beaches of Karon, Patbong, Naiyang and Laem Phanwa, the concentrations ranged from 0.1 to 180 g/m^2. The quantities increased from August onward (Piyakarnchana et al. 1978).

Table 8. Coastal refineries and capacities in Southeast Asia (from Petroleum News Southeast Asia 1980, Bilal, pers. comm.).

Country	Capacity (bbl/d)	Location
BURMA		
Petrochemical Industries Corp., Chauk	6,300	
Petrochemical Industries Corp., Syriam	22,000	Andaman Sea
New Refinery, Maluk, 2,000 bbl/d (1980)		
New Refinery, Mann, 25,000 bbl/d (1982)		
INDONESIA (all owned by the state enterprise Pertamina)		
Cilacap, South Java (1984)	300,000	Indian Ocean
Balikpapan, Kalimantan (1984)	265,000	Straits of Macassar
Dumai, Sumatra (1984)	185,000	Straits of Malacca
Sungai Gerong, Sumatra	79,000	Straits of Malacca
Plaju, Sumatra	111,000	Straits of Malacca
Pangkalan Brandan, Sumatra	4,000	Straits of Malacca
Sungai Pakning, Sumatra	50,000	Straits of Malacca
New Refinery, Batam (planned) 200,000 bbl/d		Strait of Singapore
MALAYSIA		
Esso, Port Dickson	36,000	Straits of Malacca
Shell, Port Dickson	90,000	Straits of Malacca
Shell, Lutong, Sarawak	14,000	South China Sea
Petronas, new refinery, West coast	150,000	Straits of Malacca
Petronas, new refinery, Paka, Trengganu (20,000-30,000 bbl/d on stream by 1984)		South China Sea
PHILIPPINES		
Bataan Refining, Limay	104,000	South China Sea
Caltex, South Luzon	74,000	South China Sea
Pilipinas Shell, Batangas	68,000	South China Sea
SINGAPORE		
British Petroleum, Pasir Panjang	28,000	Strait of Singapore
Esso, Pulau Anyer Chawan	213,000	Strait of Singapore
Mobil, Jurong	180,000	Strait of Singapore
Shell, Pulau Bukom	500,000	Strait of Singapore
Singapore Refining Co., Pulau Merlimbau, (100,000 bbl/d by late 1980)	70,000	Strait of Singapore
THAILAND		
Esso, Si Racha	35,000	Gulf of Thailand
Summit, Bangkok	80,000	Gulf of Thailand
Summit, Fang	1,000	Gulf of Thailand
Thailand Oil Refining, Chonburi (65,000 bbl/d expansion approved)	65,000	Gulf of Thailand

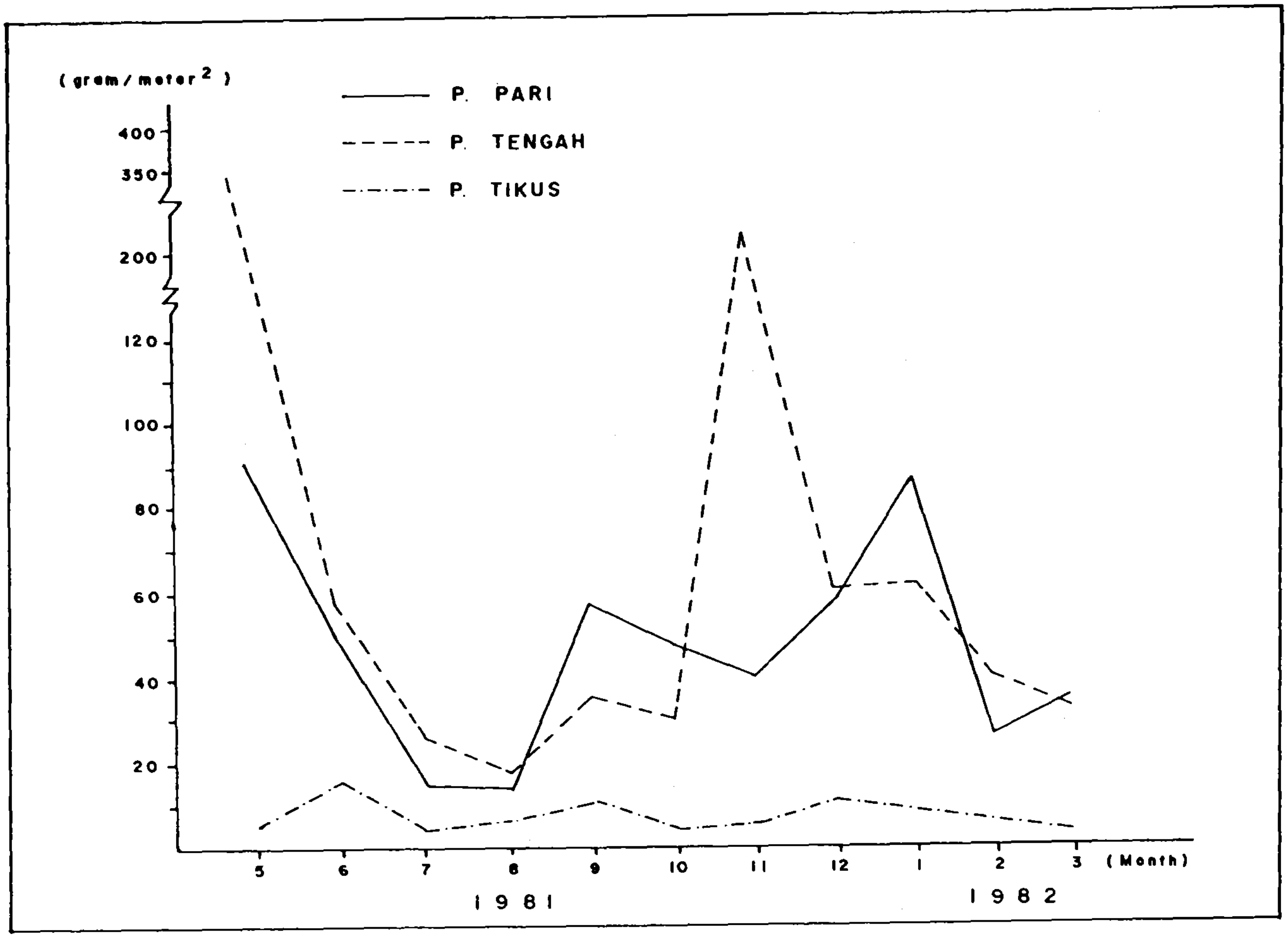


Fig. 7. Mean quantity of stranded tarballs per month (g/square meter) on Pulau Pari, Pulau Tengah and Pulau Tikus (Toro and Djamali 1982)

On the eastern coast of Peninsular Malaysia from Kota Baharu to Mersing, including the offshore island of Pulau Tioman, contamination by oil residues and tarballs has also been found (Maheswaran 1978).

4. <u>Areas vulnerable to oil pollution</u>

The Southeast Asian waters including the South China Sea are at present beset by oil activities such as oil exploration, production, refining and transportation. As a consequence of low level discharge by refining and production processes, spills by shipping casualties, as well as spills due to technical failure or human error in handling of oil, the waters in this region are continuously contaminated by oil. The accumulations of dispersed/dissolved oil in water, floating oil lumps and stranded tarballs are very dependent on such physical factors as the winds, ocean currents and tidal movement. Local currents and seabed topography in the Malacca Straits, the Gulf of Thailand and the Java Sea may influence predicted sites of accumulation.

At present the Straits of Malacca and the South China Sea waters are the most vulnerable areas for oil pollution because of the increasing size and frequency of tankers traversing the area, as well as oil activities and hydrographic and geographic patterns. Before tankers enter the shallow straits thay have to reduce their draft by discharging the ballast water. Whether the deballasting operation occurs in the western or eastern entrance of the straits is a significant question, because these operations lead to oil slicks and tarball formation.

Deballasting in the South China Sea is more probable and frequent, although this depends on the transportation schedule and destination of cargo. Tankers from the Middle East to Japan not only load and unload at the beginning and end of their voyage, but also unload and take on cargo at intermediate ports such as Singapore or Port Dickson.

The Gulf of Thailand receives water from the current circulation in the South China Sea during the yearly monsoon (Wyrtki 1961). This might possibly explain the tarball deposition along the coast of the Gulf and the eastern coast of Peninsular Malaysia. It is interesting to note that the accumulations and their locations vary seasonally, in close relation to the current circulation and tanker routes as suggested by the studies of Kurashina (1975) and Nasu et al. (1975).

In the region of Pulau Pari, currents conform with the general pattern of the Java Sea. Measurements were made during October and November 1970 at Kepulauan Seribu (Seribu Archipelago), north of Pulau Pari. During the transitional period between monsoons, the maximum velocity of the general current was only 0.08 m/sec at low tide. At high tide, rates tended to increase to 1.0 m/sec. This current system, particularly the relative stagnancy of the waters, may explain the deposition of tarballs at the islands.

Surveys and monitoring of oil contamination in the Southeast Asian countries are being conducted to assess the extent of oil pollution, but it is difficult to define the status of pollution in the region because of inadequacies in terms of research and monitoring, and training and equipment requirements.

5. Recommendations

The following measures should be considered for the effective control of oil pollution in the region.

A. Additional programmes to fill existing gaps:

- Studies on the fate and effects of oil in the marine environment, including biodegradation, levels in organisms, etc.;
- Developing a common method of finger-printing oil and its products;
- Developing a common method and procedures for oil spill impact analysis, including quantification of ecological effects, to substantiate claims and determine compensation;
- Studies to establish baseline levels of oil pollution in the region;
- Developing procedures and guidelines for the use of dispersants and especially the selection of suitable equipment for use in cleaning up oil spills in certain locations;
- Prioritizing sensitive resources which are vulnerable to potential oil spills in conjunction with environmental sensitivity index mapping; and
- Identifying regional Oil Spill Impact Assessors who are authorised to decide on disputes in compensation claims.

B. Developing criteria for the following:

I Sensitive areas (may require partial or full protection):

(a) economic effects on, for example, fishing areas, artificial and natural breeding grounds, aquaculture sites, coral reefs, mangroves;

(b) loss of amenities, e.g., diving sports, swimming, etc.;

(c) effects on use of sea water, e.g., for cooling;

(d) effects on safety, e.g., risk of fire and explosions;

(e) protection of fragile ecosystems such as marine life sanctuaries; and

(f) preservation of rare species.

II Selection of suitable dispersants:

(a) low toxicity, i.e., sufficiently low levels of chlorinated hydrocarbons, heavy metals, aromatic hydrocarbons and other carcinogens;

(b) effectiveness;

(c) rapid biodegradability; and

(d) low flammability.

III Siting of technical support system:

(a) Proximity to high risk areas, e.g., refineries;

(b) Availability of communication facilities, e.g., telephone, telex, VHF radio, etc.;

(c) Accessibility for replenishment of supplies such as dispersants and spray equipment;

(d) Security of site;

(e) availability of support facilities for manpower, such as lodging, food, water, etc.; and

(f) Availability of support facilities for equipment, e.g., jetties, aircraft landing facilities.

IV Selection of equipment:

(a) application,considering water depth, weather conditions, wave height, navigational constraints;

(b) cost effectiveness;

(c) availability of maintenance and repair services and spares;

(d) ease of deployment;

(e) durability, e.g., use in tropical climates;

(f) local availability (and if locally manufactured); and

(g) components or materials such as absorbents like hay, woodchips, coconut husks, chicken feathers.

V System of contingency planning: multi-tier system would be applicable depending on the system affected.

C. Further considerations:

I Cooperation in regional contingency plan development:

(a) more even siting of operation centres;

(b) developing a loan and rental scheme for centers in the region;

(c) applying the existing standard operating procedure for the Malacca and Singapore Straits which had worked well with respect to other regional waters; and

(d) regional training and education exercises on oil spill response and clean-up.

II Follow-up action:

(a) developing expertise in relevant areas like risk analysis through training courses;

(b) review meetings;

(c) soliciting of external technical support for trajectory studies on oil spills;

(d) collecting data on specific activities that could be affected by oil spills;

(e) standardization of equipment and chemicals used in the region for better comparability; and

(f) identification of parameters required for monitoring.

REFERENCES

Atwood, H. R., R. W. Hannah and M. V. Zeller. 1972. Determination of oil in water by infra-red spectroscopy. Perkin-Elmer INFRA-RED Bulletin No. 11.

BAKOREN, National Energy Co-ordination Body. 1982. General policies on energy. Jakarta, Indonesia: Dept. of Mines and Energy (in Indonesian).

Bilal, J. and W. W. Kuhnhold. 1980. Marine oil pollution in Southeast Asia. SCS/80/WP/92, April 1980. Manila: South China Sea Fisheries Development and Coordinating Programme.

CONCAWE. 1972. Methods for the analysis of oil in water and soil, 1/72. Stichting, The Hague: CONCAWE.

Finn, D. P., Y. Hanayama, M. J. Meinandi Nejad, T. Piyankarnchana and J. N. Reeves. 1979. Oil pollution from tankers in the Strait of Malacca: a policy and legal analysis. Honolulu, Hawaii: East-West Centre, Open Grants Office.

Gomez, E. D. 1980. The present state of mangrove ecosystems in Southeast Asia and the impact of pollution - Philippines. SCS/80/WP/94c (Revised). Manila: South China Sea Fisheries Development and Coordinating Programme.

Hayes, T. M. 1979. Mission reports: Lombok/Makassar Strait/Celebes Sea shipping route - sub-regional arrangements for combating marine oil pollution. IMCO Report No. A6/A-UNDP/Int/Mar/Poll.

IOC/WMO. 1976. Guide to operational procedures for the IGOSS pilot project on marine pollution (petroleum) monitoring. Manual and Guide No. 7. Paris: UNESCO.

Kantaatmadja, K. 1981. Marine oil pollution international claim. Alumni, Bandung, Indonesia (in Indonesian).

Kurashina. 1975. The present situation of tarballs. Hydrographic Research Bulletin No. 93, Japan.

Lim, Ho Teck and Ong Seng Eng. 1987. Technical support to oil spill contingency planning and related experiences in Singapore. Working paper presented at the "Workshop on the Implementation of Technical and Scientific Support Programme for Oil Spill Contingency Planning in the EAS region", Jakarta, Indonesia, August 1987.

Maheswaran, A. 1978. Marine pollution and its control. Paper presented at the First Marine Science Conference "Our Seas in Perspective", Kuala Lumpur, Malaysia.

Nasu, Kamiyanagi and Kitani. 1975. Petroleum pollution in the high seas. Oceanographic Survey Notes No. 2, Japan.

Petroleum News Southeast Asia. 1980. Oil and Gas Map, Jan., Singapore.

Phang, S., T. K. Hwang and T. T. Ang. 1980. A study of the hydrocarbon content in the coastal water along the east coast of Peninsular Malaysia. In T. E. Chua and J. K. Charles (eds.). Coastal Resources of East Coast Peninsular Malaysia, An Assessment in Relation to Potential Oil Spills, pp. 21-27. Penang: Universiti Sains Malaysia.

Piyakarnchana, T., S. Tamiyavanich, J. Sakarin, T. Suknimit and P. Wootistiraphinyoe. 1978. A survey of the tarballs on the beaches in Thailand in 1977-1978. Proceedings of the Symposium on Marine Pollution Research in Thai Waters, pp. 235-242. Thailand: National Research Council.

Siddayao, C. M. 1980. Submarine hydrocarbons in South-East Asia: resources, environment and policy. GeoJournal 4,5: 393-406.

Sigit, S., Reksosoemitro, S. Sediono and B. Soegito. 1980. Indonesian mining yearbook 1980. Jakarta: Department of Mines and Energy.

Toro, V. and A. Djamali. 1982. Fluctuation of tarball in Pulau Pari, Kepulauan Seribu. Jakarta: LON-LIPI.

Valencia, M. J. 1981. Shipping, energy and environment: South-East Asian perspective for the 1980's. Workshop Report, East-West Environment and Policy Institute. Honolulu: East-West Center.

Wyrtki, K. 1961. Physical oceanography of the Southeast Asian waters. Naga Report, Vol. 2: Scientific Result of Marine Investigations in the South China Sea and the Gulf of Thailand, 1959-1961. La Jolla, Cal., U. S. A.: University of California.

EFFECTS OF OIL POLLUTION ON MARINE AND COASTAL LIVING RESOURCES OF THE EAST ASIAN SEAS REGION

Hansa Chansang
Phuket Marine Biological Center
P.O. Box 60
Phuket 83000, Thailand

ABSTRACT

This paper attempts to update the recent information on oil contamination of the marine environment in Southeast Asia. Information available indicates a low level of oil present in the coastal waters. Data on beach tar show a significant decline in early 1980 from the higher level in the last decade. There is very limited information on the effect of oil pollution on the marine ecosystems within the region. A brief review of the current knowledge on effects of oil pollution and clean-up on ecosystems, especially mangroves, coral reefs and seagrass beds, is made. Several measures are recommended for long term planning to minimize the effect of oil pollution in the region.

1. Introduction

Concern about the effects of oil pollution on the marine and coastal living resources in Southeast Asia is justifiable. Some countries in the region are oil producing and major tanker routes from the Middle East to Japan and the Eastern Pacific are located along their borders specifically in the Straits of Malacca, South China Sea and Java Sea. This is an attempt to review and summarize the status of knowledge on the effect of oil pollution on the marine ecosystems in Southeast Asia, especially the coral reefs and mangroves.

Information on exploration, production and transportation of oil, occurrence of oil spills, level of oil contamination and studies made on oil pollution has been compiled by Bilal and Kunhold (1980). The only study after this is that of Leong et al. (1987) on the effects of oil on the ecosystem. This does not mean that the problem does not exist. The news sections in the 1984 - 1987 issues of "Marine Pollution Bulletin" report at least three oil spill accidents in the area.

2. Status of knowledge on oil pollution in Southeast Asian waters

Recent information on the level of hydrocarbons in ASEAN waters is summarized in Table 1. More information on marine tar and beach tar is also available. Holdway (1986) reported the result of a circumnavigational survey of marine tar during 1978 to 1980 (Table 2). He concluded that the marine tar was found mainly in areas of shipping concentration. Widespread occurrences of < 1 mg/m^2 of tar were observed in the Arafura, Banda, Flores and Java Seas. Fourteen out of twenty stations in this region were found to contain tar with an average value of 0.08 mg/m^2. The Java Sea, which is the site of heavy shipping traffic visiting the ports of Jakarta, Surabaja and Singapore, appeared to be the most polluted of the four seas. The amount of marine tar in this region was higher than in the open Indian Ocean, however still significantly less than in the Mediterranean and Red Seas.

Table 1. Information on hydrocarbon levels in Southeast Asian waters.

Location	Time	Concentration of hydrocarbon	Reference
Gulf of Thailand			
Upper Gulf	April 1985 - September 1986	2.3 ug/l average 0.65–8.3 ug/l range	Wattayakorn 1987
Lower Gulf		1.3 ug/l average 0.07–6.6 ug/l range	Wattayakorn 1987
East coast of Malaysia	April–May 1979	0–130 ug/l	Phang et al. 1980
Jakarta Bay		0.00–0.39 mg/l	Soegiarto 1980
Jakarta Bay		0.5–46 ug/l	Thayib and Thayib 1987
East coast of Sumatra	1976-1978	< 0.1-7.2 mg/l	Soegiarto 1980, after Wasilun 1978
Straits of Malacca (Penang)	February–March 1979	10–120 ug/l	Phang et al. 1980
Coastal Thai waters of the Andaman Sea	1985	0.04–1.21 ug/l	Petpiroon (unpublished data)

Reports on beach tar in this region are also presented. Oostdam (1984) reported spot samples of beach tar in this region as part of the survey of the Indian Ocean, South China Sea and South Pacific in 1978 (Table 3). He reported the highest beach tar concentrations in areas of oil production or near tanker routes such as the Persian Gulf, the Red Sea and the South China Sea and practically none in the South Pacific. It was also concluded that the prevailing wind regime was the dominant factor of seasonal variation in tar stranding. He estimated that beach tar life would be only 30 to 90 days in the tropics.

The effect of the prevailing wind regime is also noted by other investigators (Piyakarnchana et al. 1978, Limpsaichol 1984). Limpsaichol (1984) reported the result of periodic monitoring of beach tar along the Andaman Sea coast during 1977 to 1981. This finding showed the marked monsoon seasonal effect on beach tar stranding. Beaches fronting directly on the Andaman Sea contained higher levels of beach tar than those in protected bays. The data on Karon Beach (Table 4) during the southwest monsoon season are comparable with those of Oostdam (1984) on the same beach during that period. Of interest is the drastic decline in stranded tar during the 1980 - 1981 period. He attributed the decline to the results of the Load-On-Top System practised by tankers passing through the Malacca Straits.

Table 2. Data on marine tar concentrations during November 1978 to November 1980 in various localities (Holdway 1986)

Area and date	Total stations	No.(%) stations + tar	Mean (median) tar (mg m^{-2})	Maximal tar (mg m^{-2})
(1) Plymouth, UK-Canary Islands (North-East Atlantic), Nov. 1978	19	18 (95)	0.86 (0.40)	2.83
(2) Transatlantic Ocean, Dec. 1978	52	15 (29)	0.03 (0)	0.39
(3) Pacific Ocean, May-Sept. 1979	69	10 (14)	0.03 (0)	1.03
(4) Arafura, Banda, Flores and Java Seas, Jan.-April 1980	20	14 (70)	0.08 (0.02)	0.37
(5) Indian Ocean, May-Aug. 1980	46	9 (20)	0.01 (0)	0.11
(6) Gulf of Aden-Red Sea, Aug.-Sept. 1980	18	14 (78)	2.45 (0.07)	42.03
(7) Mediterranean Sea, Sept.-Oct. 1980	44	40 (91)	5.52 (0.74)	47.66
(8) Gibraltar-Bay of Biscay (North-East Atlantic)	7	5 (71)	0.03 (0.01)	0.16
TOTAL	275	125 (46)		

Some information on effects of oil pollution in the coastal waters is available. This reveals a chronic industrial pollution problem. Hungspreugs et al. (1984) reported a low level of polycyclic hydrocarbon compounds in benthic organisms (1.0-8.1 ng/g) in the Upper Gulf of Thailand. Chronic oil pollution from land is another problem which needs to be studied. Discharged used oil products are recognized as potential pollutants in coastal waters. Wattayakorn (1987) also suggested air-borne petroleum products as a source of hydrocarbons within the Gulf of Thailand.

3. The effect of oil pollution on marine ecosystems in Southeast Asia

The only reported damage to marine ecosystems in the region was that due to the accidental oil spill by the "Showa Maru" in January 1975 in the Riau Archipelago as presented in Soegiarto (1980) and Bilal and Kuhnhold (1980). The spill affected several hundred hectares of mangroves in Indonesian waters with stranding of slicks in the intertidal zone. Mangroves in the sheltered bays were seriously affected. After two and a half years, the affected mangroves had yet to recover. However, no other quantitative information was presented.

Table 3. Summary of beach tar survey data in the South China Sea (Oostdam 1984, Table 1)

Nation	Region	Beach profiles No.	% polluted	Length* (m)	Tar concentrations+ Mean ($g\ m^{-1}$)	S.D. ($g\ m^{-1}$)	Remarks
Thailand	N.W. Gulf of Thailand	15	7	54	3.3	12.9	
	S.W. Gulf of Thailand	4	100	32	9.7	3.5	
	N.E. Gulf of Thailand	6	33	61	0.7	1.1	
	Andaman Sea	13	77	32	57.3	151.1	max. 553.3 $g\ m^{-1}$
	Total and regional average	38	54	48	17.8	26.6	(Karon, fresh)
Malaysia	N.E. Gulf of Thailand	7	86	37	287.8	324.4	max. 727.8 $g\ m^{-1}$
	C. Gulf of Thailand	10	80	49	102.8	168.7	(Batu Rakit, near
	S.E. Gulf of Thailand	4	100	148	227.6	296.7	giant turtle
	N. of Malacca	15	73	34	6.2	7.9	nesting beaches)
	S. of Malacca	7	29	8	1.0	2.0	
	Total and regional average	43	74	55	125.1	129.4	
Singapore	Mainland	5	20	23	10.8	24.2	max. 54.2 $g\ m^{-1}$
	Islands	14	93	18	9.1	8.9	(opp. Tiger Balm
	Total and regional average	19	56	21	10.0	1.2	Garden)
Indonesia							
(1) Sumatra	Sibolga and vicinity	12	8	13	1.4	4.7	only one beach
	Padang and vicinity	15	0	19	0	0	29.1 $g\ m^{-1}$
	Total and regional average	27	4	16	0.7	1.0	(Sibuluan)
(2) Java	Jakarta and vicinity	3	67	22	0.6	0.6	
	Parangtritis	5	20	65	0.5	0.7	
	Surabaja and Madura	9	67	38	33.0	62.9	max. 194.4 $g\ m^{-1}$
	Total and regional average	17	51	63	11.4	18.7	(Kendjeran)
(3) Bali	Kuta	5	0	33	0	0	
	Anturram	3	0	23	0	0	
	Total and regional average	8	0	28	0	0	
Overall total and regional average		52	18	36	4.0	6.4	

* Length (m) is the mean distance along the sampled profiles from waterline to highest or furthest part of the beach sampled.

+ Values in $g\ m^{-2}$ may be approximated by dividing the length (m) into the tar concentration ($g\ m^{-1}$).

Table 4. The amount of tar (g/m) deposited on Karon Beach, Andaman Coast, during 1977-1981 (Limpsaichol 1984, Table 4)

Period and amount	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
1977-1978 Amount	60	54	83	79	99	102	275	680	475	827	140	327
1980-1981 Amount	42	2	18	27	25	45	35	16	17	15	11	14

The only scientific investigative report on the effects of oil pollution on an ecosystem in the area is that of Leong et al. (1987) on the chronic effects of the discharge of a crude oil terminal in Brunei. The study indicated a decrease in the populations of macrobenthos in the intertidal zone at the discharge site with less impact in the sublittoral zone.

No quantitative information is available regarding the possible loss of marine products due either to tainting or mortality. Soegiarto (1980) reported the problems of a petrochemical plant in Surabaja fouling the brackish water ponds and tainting the fishery products around the effluent outfall. Thayib and Thayib (1987) also cited tainting as an indication of chronic effects of oil pollution in Jakarta Bay.

4. Status of knowledge on the effects of oil pollution on marine ecosystems (general)

Substantial information is available regarding the effects of oil pollution on marine organisms and ecosystems. GESAMP (1977) provides a comprehensive discussion on the status of and knowledge on oil pollution. Subsequent data have been made available within the last decade especially after the series of major oil spills such as from the "Amoco Cadiz" (1978) and the Ixtoc I blow out (1979-1980). Comprehensive reports in a series of oil spill conferences since 1973 provide better understanding of the effects of oil pollution on marine ecosystems. Although most information available is from temperate regions, it is still very useful in providing insights into the possible effects of this factor in the tropics.

In 1981 the Royal Commission on Oil Pollution issued a report stating that the threat of long-term and irreversible large-scale damage to the sea by oil pollution was less serious than that posed by other pollutants such as heavy metals or other hazardous materials. The existing concerns concentrated on the nearshore systems.

The sources of oil pollution in the marine environment are discussed in Siripong ("Oil and the marine environment", this volume). The major sources are marine transportation and run-off from land. Pollution due to marine transportation includes that due to losses during ship operations, oil spills resulting from accidents at sea and discharges during production and terminal activities. Most information available is mainly on oil spills and blow outs, especially large spills. This may be due to concern regarding large concentrations of pollutants at any one time. Very little is known about the long-term effects on nearshore ecosystems.

In general, it is concluded that crude oil is less toxic to marine organisms than are refined products. However, the effects vary according to different sources of crude oil. Recent data strongly indicate that the most acute toxicity is directly correlated with content of soluble aromatic derivatives. Findings also show that marine organisms vary in their sensitivity to oil. Most of the lethal effects from water soluble fractions of petroleum and petrochemicals on adult animals occur within the range of 1 - 100 ppm, while larval and juvenile life stages are usually more sensitive to oil with lethal concentrations often in the 0.1 - 1.0 ppm range (Neff and Anderson 1981).

To study sublethal effects on the long-term success of a population, understanding the effects on reproductive processes is essential. Increased emphasis has been placed during the last decade on studies on the effects of chronic low level pollutant exposure on parameters such as reproductive success, fecundity, embryonic and larval development rate, growth rate of larvae and juveniles, and production of developmental abnormalities (teratogenesis).

Regarding the effect of a major oil spill, it has been widely acknowledged (Royal Commission on Environmental Pollution 1981, GESAMP 1982) that it can kill large numbers of marine organisms particularly in shallow waters and the intertidal zone. The mortality is restricted to the area immediately affected by the oil spill and causes transient local effects on the populations of marine species. Sea birds are the group of animals that are severely affected by spills. No long-term damage of oil to open sea ecosystems has been detected.

The major problem in evaluating the ecological significance of oil spills includes the lack of information on natural variation in marine ecosystems. Increasing evidence has shown that marine ecosystems can naturally be subject to large perturbations. The Royal Commission on Environmental Pollution (1981) concluded that the effects of oil pollution can be very similar to those of natural phenomena. The composition of the community of flora and fauna established after an oil spill might probably differ from that preceding it but the differences would be within the range of natural variation experienced by the marine ecosystem.

As for the effect on commercial fisheries and risk to human health, both the Royal Commission on Environmental Pollution (1981) and GESAMP (1977) found that there is no evidence that oil pollution has depleted commercial fish stocks in the sea although the tainting of fisheries products has been reported. However, in Southeast Asia this aspect should be carefully considered as coastal aquaculture is becoming increasingly important. The presence of small quantities of potentially carcinogenic substances (PAH's) is not regarded as a risk to human health.

The study on the "Amoco Cadiz" spill of 233,000 t of crude oil off the coast of Brittany in 1978 is one of the best on the effects of an oil spill on the marine ecosystem. Seip (1984) presented a synthesis of a time series on the various aspects of an oil spill including the fate of oil, effects on the various coastal communities, and impacts on fisheries, aquaculture and tourism (Fig. 1). It can be seen that after four years oil residues were still present in the sediment.

The effects of oil on the various coastal communities differed. The marsh area was the most severely affected while sandy beach communities showed quite satisfactory recovery. The effect on sea bird populations was drastic but these showed relatively significant recovery within 4 years. The effect on the open sea fishery was negligible. This finding is also confirmed from other oil spills. However, the oyster culture in the bays was affected.

Gundlach et al. (1981) found a good correlation between the classification based on the Environmental Sensitivity Index Value which ranks shoreline types in terms of increasing oil effects and observations at the Brittany spill site as shown in Table 5. The areas that are likely to be severely affected are protected estuaries which consist of marshes at the intertidal shoreline level and tidal flats. These areas are difficult for clean-up and the oil contamination will persist within the interstitial layer of the sediment. Since marshes and estuarine areas are one of the most productive coastal environments, the long-term effect on the ecosystem should receive special attention. The effect of oil on marsh vegetation can be of significant visual impact (Seip 1984). However, the change in macrofaunal communities due to the oil spill was found to be within the range of natural perturbations such as excessive rainfall and storms. The combined effects of natural factors make it difficult to assess the long-range effect of oil on marsh communities (Alexander et al. 1981, Neff et al. 1981, Thebeau et al. 1981).

Dispersants have been banned from use in nearshore areas due to detrimental effects at high concentrations. The use of dispersants would reduce the long-term exposure and damage to intertidal communities while the water column and nearshore benthic communities would be exposed to relatively high levels of dispersed oil. Recent studies report the effectiveness of dispersants on some nearshore habitats. Gilfilan _et al_. (1983) reported no adverse effects on intertidal benthic communities from exposure to dispersed oil in contrast to the effects from untreated oil. Page et al. (1983) also found that less dispersed oil was incorporated into the sediment in comparison with undispersed oil. However, Rowland et al. (1981) reported that with some dispersant treatment an increased penetration of oil was indicated, so that it may have been retained below the sediment surface. The effect depended upon behaviour of the water table in the sediment, time of treatment in relation to tidal cycle and whether the dispersant was applied to the oil before or after standing. Different environmental conditions and different types of dispersants may influence such variations in results as reported.

The above information is useful in terms of evaluating and predicting the impact of oil spills in the tropics. In the tropics, mangroves occupy the same ecological niche as marshes in temperate zones. More data are available on the effects of oil spills on mangroves since Bilal and Kunhold's (1980) report. Getter et al. (1981) described the effect of oil on mangrove forests in the Gulf of Mexico and the Caribbean Sea. The mangrove trees were affected in various ways ranging from tree mortality, leaf defoliation, deformation and stunting, seedling deformation and mortality, lenticel expansion, adventitious growth of pneumatophores to change in the density and distribution of associated flora and fauna. The stress response of mangrove forests varied due to differences in the physical environment such as the degree of wave exposure, current, sediment types, and geomorphic features of the terrain. These factors greatly influence the distribution and persistence of oil in the forests.

Sediment drainage characteristics were suggested to be the important factors in the survival of _Avicennia marina_ after the oil spill in 1982-1983 in the northern Red Sea (Dicks 1986). Trees that grew in sandy areas could tolerate the stress of oil cover better than those in muddy surfaces. This was due to the availability of oxygen in interstitial waters in sandy sediment to the roots of the mangroves while the pneumatophores were covered by oil.

The responses of different species of mangrove trees to the effects of oil and dispersants also vary. _Avicennia_ seedlings were found to be more sensitive to oil, dispersants and to oil-dispersant combinations than _Rhizophora_ seedlings (Getter et al. 1983). It was suggested that higher resistance of _Rhizophora_ seedlings was due to the ability to exclude oil uptake. Different types of oil also affected the seedlings differently. Lighter substances, especially light Arabian crude oil and No. 2 fuel oil, were more toxic than Bunker C. Dispersed Bunker C was also reported to be less toxic than oil alone. However, the effect was reversed for light Arabian crude and No. 2 fuel oil. In addition, the data reported higher resistance to spilled oil of _Rhizophora_ from chronically oiled areas than trees from unoiled or recently oiled sites. Variations in responses to oil and dispersants are also reported in tropical and subtropical seagrasses (Thorhaug and Marcus 1987).

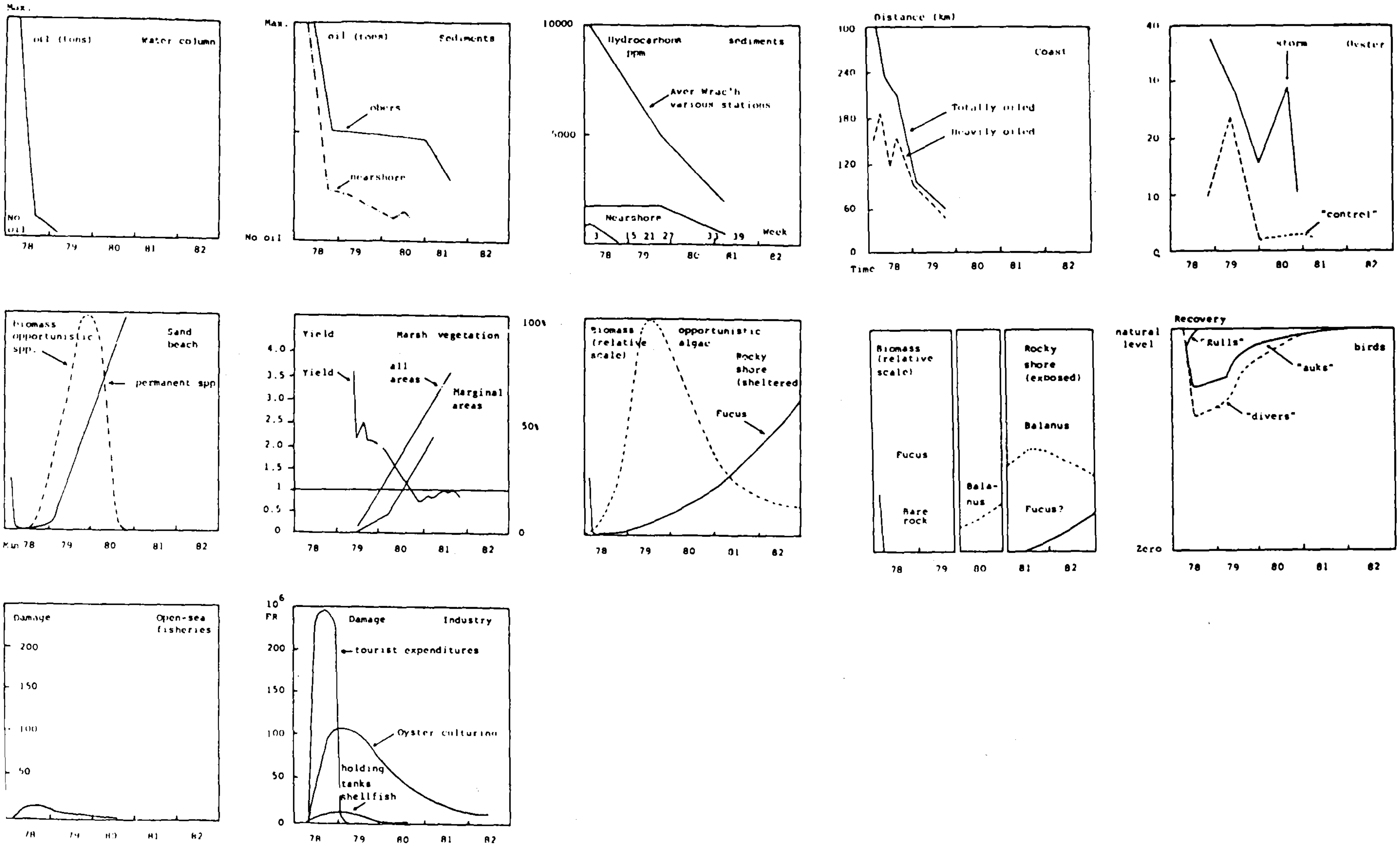


Fig. 1. Synthesis of a time series on oil removal/degradation, community recovery and social impacts. (a) water column, (b) sediments, oil (t), (c) sediments, oil (ppm), (d) coastline, (e) oysters, (f) sandy beach, (g) marsh vegetation, (h) rocky shore, sheltered, (i) rocky shore, exposed, (j) birds, (k) open sea fisheries, and (l) industry. (Seip 1984, Fig. 1).

Table 5. Descriptions of oil persistence after "Amoco Cadiz" oil spill (Gundlach et al. 1981, Table 2).

Sensitivity index value and shore type	Comments (Duration of pollution)	Observed clean-up
1. Exposed rocky headlands	Composed of bedrock with high impinging wave activity; wave reflection kept most of the oil offshore; no clean-up was needed (days or weeks)	Difficult access; natural processes sufficient.
2. Eroding wave-cut platforms	No good example of oil interaction	Usually difficult access.
3. Fine-grained sand beaches	Exposed to moderate-to-high wave energy; little penetration into the beach because of compact sand; thin buried layers commonly persisted in depositional areas (months to 1 year)	Easy access; can be cleaned.
4. Coarse-grained sand beaches	Common in semi-sheltered area in Brittany; greater penetration of oil due to coarser substrate; buried oil common (1 to 2 years)	Easy access; sand removal may cause beach erosion; difficult to use mechanical means.
5. Mixed sand and gravel beaches	Found within some sheltered areas of Brittany; an asphalt pavement formed in some low energy areas of oil deposition (1 to 2 years; more in sheltered areas)	Easy access;generally hard surface permitted some clean -up of surface oil; high-pressure hosing without sediment romoval recommended.
6. Gravel beaches	Showed rapid and deep penetration of oil (1 to 2 years)	Generally easy access; removal of sediment not recommended; high-pressure spraying with mechanical re-working of sediment into surf zone proved most effective.
7. Exposed, compacted tidal flats (moderate to high biomass)	Oil moved rapidly over the flat surface and was deposited along the swashline; varied biological impact: in productive areas, impact was severe (months to 1 of year, oil as sheen evident after 2 years)	Easy access; compact flats cleaned easily mechanically; trenches as part of clean-up may have caused increased oiling interstitial water (visible after 2 years).
8. Sheltered rocky shores	Oil sticks to rocky surfaces; pools of oil between the rocks eventually turned to asphalt (up to 5 years, but most obvious oil effects gone after 2 years)	Access varies, but is often difficult: high-pressure spraying removed algae and organisms as well as the oil; low-pressure washing as the oil comes onshore may be less damaging biologically.

Table 5 (cont'd).

Sensitivity index value and shore type	Comments (Duration of pollution)	Observed clean-up
9. Sheltered tidal flats	In areas of low wave energy, oil persisted on the surface as mixed oil and sediment patches; contamination of interstitial water persisted even if the surface was cleaned (more than 5 years)	Access difficult on soft flats; clean-up very difficult and not usually effective; heavy machinery mixed oil into the sediment.
10. Marshes	Oil pooled on the surface of the marsh, killing most flora and fauna; oil was still very obvious 2 years after the spill (5 to 10 or possibly more years)	Access varies; heavy equipment further destroyed vegetation and natural drainage patterns; manual clean-up not very effective, but necessary in heavily oiled areas.

Listed in terms of the ESI which ranks shoreline types in terms of increasing oil effects. Correlation between this system of classification and observations at the Brittany spill site is good.

The other important ecosystem in the tropics is the coral reef. Information is available regarding the effects of oil on corals and other coelenterates, mainly from laboratory studies and more limited field reports. Loya and Rinkevich (1980) compiled data on the effect of oil on coral reef communities. Subsequent studies presented various effects ranging from none to growth suppression, interference with reproductive development, inhibition of egg and larvae development, to mortality. The results from these observations are difficult to summarize as the studies were done in different areas, on different coral species, and using different assessment techniques with varying oil concentrations and treatment procedures (Dodge et al. 1984, RPI 1985, Knap 1987).

Certain field studies indicate the effect of chronic oil pollution on coral reef communities. A recent investigation on a Caribbean coral reef showed the deterioration of reef structure and absence of certain coral species downstream from an oil refinery (Bak 1987). Loya (1975) cited chronic oil pollution as one of the important factors in preventing recolonization of the reef flat after mass mortality due to extreme low tide in the Red Sea.

Field experiments were conducted to study the effects of oil pollution in intertidal (mangrove) and subtidal (seagrass and coral) habitats (RPI 1985). The results indicated that after 4 months of exposure to oil and dispersed oil, intertidal organisms, primarily mangrove trees, were severely affected at the oil-treated sites. Adult trees were not affected at the dispersed oil site. Resident organisms were affected at both sites with greater impacts in terms of magnitude and duration at the oil site. The study showed drastic effects on subtidal habitats of dispersed oil. These effects included the reduction in terms of abundance and growth rates of several coral species, and mortality of echinoderms and sponges. The abundance of coral species declined at the oil site. Subtidal plants, primarily Thalassia testudinum, were not affected by either treatment.

Thus it can be concluded that dispersants have strong effects on subtidal communities whereas they reduce the effect of oil smothering on intertidal plants. However, other available results indicate that water-based dispersants do not reduce the effect of oil smothering on Rhizophora mangroves (Teas et al. 1987).

In considering the effect of an oil spill within the region based on the information available, the potential areas to experience severe damage would be the shoreline along the main tanker routes. Concern should be given to strategic areas such as the Malacca Straits where heavy traffic passes through narrow, shallow waters. Malacca Straits shorelines are estuaries fringed with mangrove forests. As the productivity of the areas is well recognized, the damage by oil would be severe in terms of both ecological and social aspects, especially given increasing aquaculture expansion within the area and the slow recovery of such sheltered estuarine areas. Contingency plans should be made which prevent spills in such an area to reach the coasts. Identification of sensitive areas should be made as part of the contingency plan. Inventory of coastal resources and drafting of resource maps along the main tanker routes should be done for contingency planning and oil spill prevention.

Attention should focus on the problem of chronic oil pollution impact. Most of the potential sites for chronic oil pollution are in the estuaries or protected coastlines. Lytle and Lytle (1983) reported relatively high concentrations of hydrocarbons in surface sediments in coastal estuaries where petrochemical industries are located. In Southeast Asia, the conflicts of coastal zone land use in estuaries are relevant. Activities involved range from traditional fisheries to highly developed industries. In addition, the areas also act as sinks for sewage from upstream development and communities. Thus, very often these areas are receptacles of various pollutants. This would lead to complications in the study of the impact of chronic oil pollution on living resources and/or human health.

5. Conclusion and recommendations

We have yet to know the extent of the impact of oil pollution on marine ecosystems in Southeast Asia. This is due to the lack of information on this matter. By far, it is fortunate that we have not had any large scale oil spills either from tankers or from blow-outs. It would cost tremendous loss if a large-scale oil spill occurred in a strategic area such as the Malacca Straits. Effective clean-up for prevention of a large spill from reaching the coast would be the only solution to avoid extensive damage.

We still do not know enough regarding the long-term effects of oil spills in tropical estuarine areas to determine whether these impose such a serious threat as in temperate shorelines. Realizing that more studies are needed, it may be unwise to extrapolate from such studies. Prevention seems to be the best solution at this stage. Chronic oil pollution from land run-off or shore activities will have to be considered together with the effects of other pollutants which are the products of industrial development. It would be difficult to be able to establish effects at the community and population levels as being due to one pollutant alone.

According to the information on hydrocarbon levels in sea water as compiled in Table 1, it can be said that on a large scale the region is still relatively free of oil pollution. Problems may arise in localized areas relating to petroleum industry activities or effects from waste discharge. However, most of these are unreported. There are several measures that should be carried out in order to achieve better understanding and effective management to minimize oil pollution in the regional seas. The following are some of these recommendations:

- For large-scale assessment of oil pollution in the regional seas, simple monitoring methods such as periodic beach tar monitoring should be adopted as a standard technique, as it can be carried out without any high technology involved. This will be a pragmatic way to cover the region as a whole. The analysis of hydrocarbon content in sea water or sediment should be concentrated only in certain areas and there should be intercalibration exercises to make the data comparable within the region;

- Effective national and international contingency plans for clean-up activities are the most important solution to prevent damage from oil spills to coastal ecosystems. Plans should be ready especially for strategic areas which have a high risk of being affected by oil spills from tankers as well as blow outs;

- To assess damage from an oil spill, specific components of the ecosystem should be included. To be considered are impacts on fishery and coastal aquaculture resources, marine mammals, birds, other endangered species, and socio-economics;

- Pre-spill baseline data are important to determine the effect of a spill. Coastal resource maps should be available for the contingency plan involving clean-up;

- There are needs to determine the effectiveness and toxicity of dispersants on nearshore communities as these have shown some promising results in treatment of intertidal vegetation;

- The use of bioassay methods for evaluating the toxicity of dispersants or oil on indicator organisms is still necessary to evaluate biological effects. However, the ability of these bioassays to predict accurately the effects in the natural environment depends upon various factors. If a monospecific test such as LC_{50} must be used, the target species or indicator organisms should be representative of the community to be affected;

- There is a need to understand the natural variability of the marine environment , the function and stability of the ecosystem, the role of key species,and the biological significance of the loss of populations of rare species. Although this question is universally applicable, the problem seems to be more acute in the tropics where much less information is available. Such important ecosystems as mangroves, estuaries and coral reefs should receive high priority;

- The fates of oil under different environmental conditions in the tropics are not much known, although it is predicted that oil would degrade faster than in the temperate region. It is worthwhile to demonstrate this fact as this will also have an implication on the clean-up response and assessment of damage to living resources;

- Understanding the circulation patterns of water masses during various seasons in the regional seas would be useful in predicting the movement of spills. However, on a smaller scale, knowledge on coastal water movement and carrying capacity of estuarine areas is needed for evaluating the degree of chronic oil pollution; and

- More studies are needed on chronic oil pollution from land, especially in estuaries. This problem will have to be considered together with the effects from other pollutants such as organic wastes, petrochemicals and other industrial effluents. Monitoring schemes should be established for such important estuaries and coastlines where several industrial activities may interfere with the uses of natural living resources such as fisheries and aquaculture. Standardization of methods and parameters should be done to achieve comparability. Assessment of hydrocarbon accumulation should be accommodated as part of the mussel watch programme.

REFERENCES

Alexander, M. M., P. Longabucco and D. M. Phillips. 1981. The impact of oil on marsh communities in the St. Lawrence River. Proceedings of the 1981 Oil Spill Conference, pp. 333-340. Washington D. C.: American Petroleum Institute.

Bak, R. P. M. 1987. Effects of chronic oil pollution on a Caribbean coral reef. Mar. Poll.Bull. 18(10):534-539.

Bilal, J. and W. W. Kuhnhold. 1980. Marine oil pollution in Southeast Asia - Regional. South China Sea Fisheries Programme, SCS/80/WP/92 (Revised).

Bilal, J., S. Wakya, Mulyono and Abuyurnono. 1975. Inventerisasi data perairan Teluk Jakarta (Inventory of data in the bay of Jakarta). Caraka Lingkungan 1(1):3-6.

Dicks, B. 1986. Oil and the black mangrove, Avicennia marina, in the Northern Red Sea. Mar. Poll. Bull. 17(11):500-502.

Dodge, R. E., S. C. Wyers, H. R. Frith, A. H. Knap, S. R. Smith and T. D. Sleeler. 1984. The effect of oil and oil dispersants on the skeletal growth of the hermatypic coral Diploria strigosa. Coral Reefs 3(4):191-198.

GESAMP. 1977. Impact of oil on the marine environment. Rep. Stud. GESAMP 6.

GESAMP. 1982. The health of the oceans. UNEP Regional Seas Reports and Studies No. 16.

Getter, C. D., G. I. Scott and J. Michel. 1981. The effects of oil spills on mangrove forests: a comparison of five oil spill sites in the Gulf of Mexico and Caribbean Sea. Proceedings of the 1981 Oil Spill Conference, pp. 535-540. Washington D. C.: American Petroleum Institute.

Getter, C. D., T. G. Ballou and J. A. Dahlin. 1983. Preliminary results of laboratory testing of oil and dispersants on mangroves. Proceedings of the 1983 Oil Spill Conference, pp. 533-538. Washington D. C.: American Petroleum Institute.

Gilfilan, E. S., S. A. Hanson, D. Vallas, R. Gerber, D. S. Page, J. Foster, J. Hotham and S. D. Pratt. 1983. Effect of spills of dispersed and non-dispersed oil on intertidal infaunal community structure. Proceedings of the 1983 Oil Spill Conference, pp. 457-463. Washington D. C.: American Petroleum Institute.

Gundlach, E. R., S. Berne, L. D' Ozouville and J. A. Topinka. 1981. Shoreline oil two years after Amoco Cadiz: new complications from Tanio. Proceedings of the 1981 Oil Spill Conference, pp. 525-534. Washington D. C.: American Petroleum Institute.

Holdway, P. 1986. A circumnavigational survey of marine tar. Mar. Poll. Bull. 17(8):374-377.

Hungspreugs, M., S. Silpipat, C. Tonapong, R. F. Lee, H. L. Windom and K. R. Tenore. 1984. Heavy metals and polycyclic hydrocarbon compounds in benthic organisms of the Upper Gulf of Thailand. Mar. Poll. Bull. 15(6):213-218.

Knap, A. H. 1987. Effects of chemically dispersed oil on the brain coral, Diploria strigosa. Mar. Poll. Bull. 18(3):119-122.

Leong, T. S., Y. K. Leong, S. C. Ho, K. H. Khoo, S. P. Kam, S. Hanapi, T. M. Wong, R. S. Legore, W. Deligny and G. T. Tan. 1987. Effects of a crude oil terminal on tropical benthic communities in Brunei. Mar. Poll. Bull. 18(1):31-35.

Limpsaichol, P. 1984. The distribution and variation of tar on beaches along the Andaman Sea coast of Thailand. Phuket Marine Biological Center Research Bulletin 34.

Loya, Y. 1975. Possible effects of water pollution on the community structure of Red Sea corals. Mar. Biol. 29:177-185.

Loya, Y. and B. Rinkevich. 1980. Effects of oil pollution on coral reef communities. Mar. Ecol. Prog. Ser. 3:167-180.

Lytle, J. S. and T. F. Lytle. 1983. Potential damage of oil wastes in coastal estuary sediments. Proceedings of the 1983 Oil Spill Conference, pp. 491-500. Washington D. C.: American Petroleum Institute.

Neff, J. M. and J. W. Anderson. 1981. Response of marine animals to petroleum and specific petroleum hydrocarbons. London: Applied Science Publishers Ltd.

Neff, J. M., M. S. Sharp and W. L. McCulloch. 1981. Impact of the ESSO Bayway oil spill on salt marsh macrofauna. Proceedings of the 1981 Oil Spill Conference, pp. 413-418. Washington D. C.: American Petroleum Institute.

Oostdam, B. L. 1984. Tar pollution of beaches in the Indian Ocean, the South China Sea and the South Pacific Ocean. Mar. Poll. Bull. 15(7):267-270.

Page, D. S., J. C. Foster, J. R. Hotham, E. Pendergast, S. Hebert, L. Gonzalez, E. S. Gilfilan, S. A. Hanson, R. P. Gerber and D. Vallas. 1983. Long term fate of dispersed and undispersed crude oil in two nearshore test spills. Proceedings of the 1983 Oil Spill Conference, pp. 465-471. Washington D. C.: American Petroleum Institute.

Phang, S., T. K. Hwang and T. T. Ang. 1980. A study of the hydrocarbon content in the coastal water along the east coast of Peninsular Malaysia. In T. E. Chua and J. K. Charles (eds.). Coastal Resources of East Coast Peninsular Malaysia, pp. 21-27. Penang: Universiti Sains Malaysia.

Piyakarnchana, T., S. Temiyavanich, J. Sakarin, T. Suknimit and P. Wootistiraphinyoe. 1978. A survey of the tarballs on the beaches in Thailand in 1977-1978. Proceedings of the Symposium on Marine Pollution Research in Thai Waters, pp. 235-242. Thailand: National Research Council.

Research Planning Institute (RPI), Inc. 1985. Technical oil pollution investigations in coastal systems (tropics): technical status report. RPI/R/85-14. Columbia, S. C.: Research Planning Institute, Inc.

Rowland, S. J., P. J. C. Tibbetts, D. Little, J. M. Baker and T. P. Abbiss. 1981. The fate and effects of dispersant-treated compared with untreated crude oil, with particular reference to sheltered intertidal sediments. Proceedings of the 1981 Oil Spill Conference, pp. 283-293. Washington D. C.: American Petroleum Institute.

Royal Commission on Environmental Pollution. 1981. Oil pollution of the sea. Eighth Report, Cmnd. 8358. London: HMSO.

Seip, K. L. 1984. The Amoco Cadiz oil spill - at a glance. Mar. Poll. Bull. 15(6):218-220.

Soegiarto, A. 1980. The present state of mangrove ecosystems in Southeast Asia and the impact of pollution - Indonesia. SCS/80/WP/94a (Revised). Manila: South China Sea Fisheries Programme.

Teas, H. J., E. Duerr and J. R. Wilcox. 1987. Effects of South Louisiana crude oil and dispersants on Rhizophora mangroves. Mar. Poll. Bull. 18(3):122-124.

Thayib, S. S. and M. H. Thayib. 1987. Marine pollution in northern coastal waters of Java, status report. Paper presented at the ASEAN-Canada Workshop on "Pollution and Other Factors in Relation to Living Marine Resources", 23-26 June 1987, Phuket, Thailand.

Thebeau,L. C., J. W. Tunnell, Jr., Q. R. Dokken and M. E. Kindinger. 1981. Effects of the IXTOC I oil spill on the intertidal and subtidal infaunal populations along lower Texas coast barrier island beaches. Proceedings of the 1981 Oil Spill Conference, pp. 467-475. Washington D. C.: American Petroleum Institute.

Thorhaug, A. and J. Marcus. 1987. Oil spill clean-up: the effect of three dispersants on three subtropical/tropical seagrasses. Mar. Poll. Bull. 18(3):124-127.

Wasilun, K. 1978. Monitoring of pollution along the eastern coast of Sumatra in November 1976 and July-August 1978. In Marine Fisheries Report No. 1/1978. Jakarta, Indonesia: Marine Fisheries Research Institute (in Indonesian).

Wattayakorn, G. 1987. Dissolved/dispersed hydrocarbons in sea water from the Gulf of Thailand. The Fourth Seminar on the Water Quality of Living Resources in Thai Waters, 7-9 July 1987. Thailand: National Research Council (In press).

REVIEW OF PAST AND ON-GOING RESEARCH AND MONITORING RELEVANT TO OIL POLLUTION AND ITS CONTROL IN THE EAST ASIAN SEAS REGION

Abu Bakar Jaafar
Department of Environment
Ministry of Science, Technology and the Environment
13th Floor, Wisma Sime Darby
Kuala Lumpur, Malaysia

ABSTRACT

Regional meetings have consistently identified the assessment of oil pollution in Southeast Asian seas as a priority activity. However, no comprehensive monitoring scheme for the region has been undertaken. Globally, the major sources of oil pollution are land-based activities and pollution from vessels. It remains to be established if such is the trend in the ASEAN region where about 4.7 million t/yr of oil are discharged into the South China Sea alone.

Currently, studies on marine oil pollution in the tropics need to be intensified. National efforts to monitor this type of pollution have been under way in Malaysia and Thailand since the late 1970's, and must be realized in other member countries. Specifically, research should focus on an inventory of oil types, a determination of the extent of contamination, and the formulation of a feasible management scheme with provisions for national responsibilities and regional cooperation.

The conflict of interests between an ecologically sound management of the East Asian seas and the economically profitable exploitation of their seabed for oil can impinge on the prospect for active regional cooperation. Unless every member country takes its fair share of responsibility, the hope for a vigilant regional program for the protection of the marine environment is not bright.

1. Introduction

The UNESCO/IOC/FAO(IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters held in Penang in 1976 identified the major types of wastes in the region, established the order of priority and the countries of geographic areas having special concern with particular pollutants (Table 1). The Workshop also indirectly established the order of priority for pollutants for the different countries (Table 2). Oil pollution drew the most attention from all fourteen countries in the region. Disposal of radioactive wastes on the other hand apparently raised little concern. Meetings convened by UNEP related to the adoption of the regional action plan for the East Asian Seas in Baguio (June 1980), Bangkok (December 1980), Manila (April 1981) and Bangkok (December 1981) have consistently endorsed "assessment of oil pollution" as a priority (Table 3).

The intergovernmental efforts in establishing the action plan are in line with Article 204 of the UN Convention on the Law of the Sea of 1982 (UNCLOS) that:

> "... States shall, consistent with the rights of other States, endeavour, as far as practicable, directly or through the competent international organizations, to observe, measure, evaluate and analyze, by recognized scientific methods, the risks or effects of pollution of the marine environment..."

Table 1. Pollutant priorities: Penang meeting, 1976

Pollutant Grouping	Priority	Country area within region having special concern or being affected*
Oil	1	Malacca Straits* (Indonesia, Malaysia, Singapore), South China Sea, Hong Kong, Manila Bay (Philippines)
DDT, pesticides, organochlorines, etc.	1	Philippines, Vietnam, Malaysia, Indonesia, Thailand
Heavy metals	1	Philippines, Hong Kong, Indonesia, Malaysia
Organic and biological pollutants, fertilizers	1	Singapore, Thailand, Hong Kong, Indonesia, Malaysia, Philippines
Silt	1	Malacca Straits* (Indonesia, Malaysia, Singapore), Marinduque and Cebu* (Philippines), Phuket* (Thailand), Hong Kong, Kalimantan dan Java (Indonesia), Sarawak and Sabah (Malaysia)
Heat	2	East Coast of Gulf of Thailand*, Bintulu (Sarawak), Bagac Bay (west coast of Luzon, Philippines), Strait of Johore (Malaysia, Singapore), Hong Kong
Metalloids	2	Indonesia, Malaysia, Philippines
Plastics	3	Hong Kong
Radioactive wastes	3	-
Salt	3	Hong Kong*, Singapore

Note: *Areas specifically identified as high priority areas.

Table 2. East Asian region: wastes ranked according to priority by country

Waste	Country	Priority
Oil	Brunei, Indonesia, Kampuchea, Malaysia, Philippines, Singapore, Thailand, Vietnam, China, Hong Kong, Japan, Taiwan, North Korea, South Korea	FIRST
Organic, biological and agricultural wastes	Indonesia, Malaysia, Philippines, Singapore, Thailand, Australia, Hong Kong, India, Japan, North Korea, South Korea	
DDT, pesticides, organochlorines, etc.	Indonesia, Malaysia, Philippines, Thailand, Vietnam, Australia, India, Japan, North Korea, South Korea	
Silt	Indonesia, Malaysia, Philippines, Thailand, Australia, Hong Kong, India, Japan, North Korea, South Korea	
Heavy metals	Indonesia, Malaysia, Philippines, Hong Kong, India, Japan	
Metalloids (Cu, Zn, Sn)	Indonesia, Malaysia, Philippines, Hong Kong, India, Japan	SECOND
Heat	Malaysia, Philippines, Thailand, Hong Kong	
Salt	Hong Kong, Japan, Singapore	THIRD
Plastics (Vinyl monomers)	Hong Kong, Japan	
Radioactive wastes	Japan	

Table 3. Wastes ranked according to priority: Baguio and Bangkok Meetings, 1980

Draft Action Plan Component	Baguio Meeting Priorities Pollutant	Priority	Bangkok Meeting Priorities Pollutant	Priority
Assessment	Silt and sediment loads.	1	Present:	
			Oil	1
	Organics and nutrients	2	Non oil wastes (metals, organics nutrients, and sediments)	2
	Oil.	3		
	Metals and halogenated organics.	4		
	Heat-thermal wastes	6	Future:	
	Wastes through the atmosphere.	7	Seabed exploitation wastes.	1
			Heat-thermal wastes	2
			Wastes through the atmosphere.	3
Management	Development of principles and guidelines for the disposal of domestic agricultural, industrial, and radioactive wastes	1	Development of principles and guidelines for the disposal of wastes.	1
			Cooperative research on the need for ultimate dumping of hazardous wastes	2
	dentification of the need for, and the delineation of, marine sites for ultimate dumping of hazardous wastes	2		

As a result, two projects on the assessment of oil pollution emerged in the action plan adopted in April 1981 in Manila and reviewed in subsequent documents as:

EAS-15 (previously EAS-2.1) Survey of sources and monitoring of oil pollution; and

EAS-12 (previously EAS-2.2) Cooperative research on oil and oil-dispersant toxicity in the East Asian Seas region.

Under the management component of the action plan, five projects on "oil pollution control" have been identified, but only one, EAS-17 (previously EAS-5.2) on "support programme for contingency planning", has been approved for implementation since 1983.

This paper reviews activities on the assessment of oil pollution under the action plan and highlights the extent of the related research and monitoring activities in the region. It discusses a general framework for the assessment of oil pollution by establishing first the sources of oil pollution; second, the extent of hydrocarbon contamination in the marine environment; and, third, the effects of oil pollution on marine flora and fauna in various ecosystems. Lastly, it outlines future research and monitoring activities.

2. Sources of oil pollution

The UN Convention on the Law of the Sea (1982) establishes inter alia major sources of marine pollution as "pollution from land-based sources", "from sea-bed activities...", "pollution by dumping", "pollution from vessels", and "from or through the atmosphere". A global assessment in 1975 indicated that about 37% of petroleum hydrocarbons introduced into the oceans were from land-based sources. About 44% was from vessels, approximately 10% from the atmosphere through rain, 10% through natural seepage and 2% from offshore oil production (Table 4). The global consumption of oil in the mid-seventies was about 2,800 million M.T. of which about 14 x 10^9 bbl (2.24×10^9 m^3) were transported by sea.

A similar assessment for the East Asian region has yet to be made. However, some estimates can be done by determining both the production and transportation pattern of oil including tanker accidents in the region. As shown in Table 5, about 1.6 million bbl/d were produced in 1980 compared to 2.1 million in 1978, of which slightly over 50% were produced offshore. Table 6 outlines the various capacities of oil refineries throughout the region, amounting to 2.1 million bbl/d in 1980.

Approximately 3.23 million bbl of mainly crude oil are shipped daily via the Straits of Malacca, and about 3.81 million bbl/d leave the region through the South China Sea.

Numerous tanker accidents, though not major, have occurred in the region: 8 accidents in Malaysian waters (Table 7a), 14 in the Strait of Singapore (Table 7b), and 12 in Philippine waters (Table 7c).

About 4.7 million t/yr of oil are discharged during tanker operations in the South China Sea (Kurashina 1975, Nasu et al. 1975). This is the only estimate of oil release made to date.

So far, no comprehensive or current assessment of oil released into the region from all possible sources has been done. The available reports are far from adequate in establishing the significant sources of oil pollution in the region. Furthermore, there has been no specific objective under any of the action plan projects to carry out such an assessment.

If the 1975 global assessment could be a guide, pollution from vessel sources is more serious than that from land-based sources since about 44% of oil released into the marine environment was due to vessels and 37% to land-based sources. Other sources from or through the atmosphere and through dumping were not as significant.

Table 4. Input of petroleum hydrocarbons into the marine environment, 1975

Source		Input Rate, Million Metric Tons/Year	
		Best Estimate	Probable Range
Natural Sources (8%)			
Marine seeps		0.2	0.02 - 2.0
Sediment erosion		0.05	0.0005 - 0.5
Offshore Production (2%)		0.05	0.04 - 0.07
Transportation (44%)			
Tanker operations		0.7	0.4 - 1.5
Drydocking		0.03	0.02 - 0.05
Marine terminals		0.02	0.01 - 0.03
Bilge and fuel oils		0.3	0.2 - 0.6
Tanker accidents		0.4	0.3 - 0.4
Non-tanker accidents		0.02	0.02 - 0.04
Atmosphere (8%)		(0.3)*	0.05 - 0.05
Municipal and Industrial Wastes and Runoff (37%)			
Refineries		0.2	0.1 - 0.6
Municipal wastes		0.7	0 - 1.5
Non-refining industrial wastes		0.2	0.1 - 0.3
Urban runoff		0.03	0.01 - 0.2
River runoff		0.1	0.01 - 0.05
Ocean Dumping (1%)		0.02	0.005 - 0.02
TOTAL	100	3.32	1.3 - 7.9

* A value of 0.3 was used for the atmospheric inputs in the calculations, although the atmospheric panel did not wish to give a best estimate for this input.

(Source: IMCO. Petroleum in the Marine Environment; Inputs of Petroleum Hydrocarbon into the Ocean due to Marine Transportation Activities. November 1981).

Table 5. **Hydrocarbon resources in the ocean waters of Southeast Asia (in bbl/d) (after Bilal and Kuhnhold 1980, Siddayao 1980, Sigit et al. 1980)**

Country	Production Total	1978 Offshore	Production Total	1980 Offshore
Brunei	209,400	179,100		
Indonesia	1,634,790	545,240	1,576,546	536,876
Malaysia	196,500	196,500	300,000	
Philippines	40,000	40,000	40,000	40,000
Singapore	0	0	0	0
Thailand	200	0	200	0
TOTAL	2,080,890	960,840	1,616,746	876,876

Table 6. Coastal refineries and capacities in Southeast Asia (from Petroleum News Southeast Asia 1980)

Country	Capacity (bbl/d)	Location
BURMA		
Petrochemical Industries Corp., Chauk	6,300	
Petrochemical Industries Corp., Syriam	22,000	Andaman Sea
New Refinery, Maluk, 2,000 bbl/d (1980)		
New Refinery, Mann, 25,000 bbl/d (1982)		
INDONESIA		
(all owned by the state enterprise Pertamina)		
Cilacap, South Java (20,000 bbl/d extension by 1986)	100,000	Indian Ocean
Balikpapan, Kalimantan	75,000	Straits of Macassar
Dumai, Sumatra	100,000	Straits of Malacca
Sungai Gerong, Sumatra	79,000	Straits of Malacca
Plaju, Sumatra	111,000	Straits of Malacca
Pangkalan Brandan, Sumatra	4,000	Straits of Malacca
Sungai Pakning, Sumatra	50,000	Straits of Malacca
New Refinery, Batam, 200,000 bbl/d (planned)		Strait of Singapore
MALAYSIA		
Esso, Port Dickson	36,000	Straits of Malacca
Shell, Port Dickson	90,000	Straits of Malacca
Shell, Lutong, Sarawak	14,000	South China Sea
Petronas, new refinery, West coast	150,000	Straits of Malacca
Petronas, new refinery, Paka, Trengganu (20,000-30,000 bbl/d on stream by 1984)		South China Sea
PHILIPPINES		
Bataan Refining, Limay	104,000	South China Sea
Caltex, South Luzon	74,000	South China Sea
Pilipinas Shell, Batangas	68,000	South China Sea
SINGAPORE		
British Petroleum, Pasir Panjang	28,000	Strait of Singapore
Esso, Pulau Anyer Chawan	213,000	Strait of Singapore
Mobil, Jurong	180,000	Strait of Singapore
Shell, Pulau Bukom	500,000	Strait of Singapore
Singapore Refining Co., Pulau Merlimbau (100,000 bbl/d by late 1980)	70,000	Strait of Singapore
THAILAND		
Esso, Si Racha	35,000	Gulf of Thailand
Summit, Bangkok	80,000	Gulf of Thailand
Summit, Fang	1,000	Gulf of Thailand
Thailand Oil Refining, Chonburi (65,000 bbl/d expansion approved)	65,000	Gulf of Thailand
TOTAL	[illegible]	

Table 7a. Ship casualties in Malaysian waters from 1975 to early 1980
(from Bilal and Kuhnhold 1980)

Name of vessel or incident	Cause	Location	Date	Amount and type of oil
"Tolo Sea"	Grounding due to fire	Penang Harbour	20.05.1975	60 t bunker fuel oil
Oil slick	Unknown	South Channel, Penang	03.05.1979	Estimated 10-15 t bunker fuel oil
"Diego Silang"	Collision with Russian Ship "Vystok"	Malacca Straits	24.07.1976	5,500 t Kuwait crude
"M. V. Asian Guardian"	Rupture of discharge pipe to power station	Malacca Straits	16.05.1977	60 t light fuel oil
"M. V. Montessa"	Accidental discharge due to mechanical failure	Malacca Straits	30.06.1979	Arabian light crude (amount unknown)
Shell Refinery	Accidental discharge due to pipe rupture	Malacca Straits (Port Dickson)	30.11.1979	Arabian light crude (50 t)
"Tesahino Maru"	Leakage of delivery pipeline	Malacca Straits (Port Klang)	20.01.1980	Bunker fuel oil (amount unknown)
"Toan Chuen Chun"	Accidental discharge due to mechanical failure	Johore Straits	10.05.1979	Bunker fuel oil (amount unknown)
"Esso Mercia"	Collision with supply ship "Florence Tide"	South China Sea	30.10.1978	505 t bunker fuel oil
"M. V. Fortuna"	Collision with "USS Ranger"	South China Sea	05.04.1979	10,000 t Kuwait light crude

Table 7b. Shipping casualties in the Strait of Singapore (after Finn et al. 1979, Kantaatmadja 1981)

Date	Name of Ship	Type (Tonnage)	Cause	Location	Comments
06.01.75	"Showa Maru"	Tanker (273,698)	Grounding	Buffalo Rock, off Singapore	7,700 t oil spilled
16.01.75	"Isuzugawa Maru" "Silver Palace"	Tanker (122,233) Tanker (21,226)	Collision	Outside of Singapore Port limits	"Isuzugawa Maru" had cargo of crude oil; no spillage
05.04.75	"Mysella"	Tanker (212,759)	Grounding	1°12'04"N, 103°50'54"E	2,000 t oil spilled
18.04.75	"Tosa Maru" "Cactus Queen"	Tanker (42,790) Tanker (152,035)	Collision	1 mi south of St. John's Island	"Tosa Maru" broke in two and sank
14.06.75	"Kowei Baru" "Monte Cristo"	Freighter Freighter	Collision	Eastern Roads, Singapore	
30.06.75	"Liengku"	Freighter	Collision	Malacca Straits	Ship sank
17.07.75	"Neissei Maru" "Ravi"	Tanker (231,986) Freighter	Collision	1°15'03"N, 104°09'03"E	"Neissei Maru" had cargo of crude oil
24.10.75	"Seatiger"	Tanker (123,693)	Collision, grounding	4.8 km south of St. John's Island	
29.10.75	"Kriti Sun"	Tanker (123,484)	Struck by lightning	Singapore Port	
11.12.75	"Sachem" "Gen. Madalineki"	Tanker (29,908) Bulk Carrier (23,298)	Collision	Eastern anchorage, Singapore	
17.05.76	"Margo" "Georg Hanake"	Freighter Freighter	Collision	Eastern anchorage, Singapore	
26.07.76	"Forresbank" "Mareva A.S."	Freighter Freighter	Collision	Eastern anchorage, Singapore	
06.09.76	"Soyakaze" "Marrita E."	Freighter Freighter	Collision	Off St. John's Island	
26.10.76	"Citta di Savona" "Philippine Star" "Esso Spain"	Tanker (64,805) Tanker Tanker (81,827)	Collision	Eastern anchorage, Singapore	"Savona" and "Star" had cargoes of crude oil; 1,000 t oil spilled

Table 7c. Oil spills by shipping accidents in Philippine waters in 1978. (after Gomez 1980)

Name of Vessel/Company	Incident	Date	Location
AGEP Wood Preserving Div.	Discharge to Pasig River of 3-4 drums bunker oil	12.04.78	Pasig River
William Lines motor vessel	Waste oil spillage	19.05.78	Iloilo River
Compania Maritima vessel	Waste oil spill (20 gal)	20.05.78	North Harbor, Manila
Motorized banca (Samasco)	Waste oil spill (20-30 gal)	22.05.78	Bauan, Batangas
Motorized tank (Las Vivas)	Discharge of waste oil	06.08.78	Shell-Batangas Bay
Barge (Luzon Stevedoring)	Spillage of 4,000 bbl of auto turbo fuel	27.09.78	Bataan Refining Co., Lamao, Bataan
Motorized tank (Las Vivas)	Oil spill due to grounding	27.09.78	Bataan Refining Co., Lamao, Bataan
Barge (Luzon Stevedoring)	Spill of 7,000 bbl of premium gasoline by sinking	27.09.78	Bataan Refining Co., Lamao, Bataan
Barge (Luzon Stevedoring)	Spill of bunker oil (and 20,000 bags fertilizer) due to grounding	09.10.78	Manila Bay
Barge (Luzon Stevedoring)	Bunker oil spill by grounding	09.10.78	Manila Bay
Motorized tank (C. Robles)	Oil spill due to sinking	10.10.78	Bataan Refining Co., Lamao, Bataan
Barge (Sealink Inc.)	Spill of 1,300 bbl lubo oil due to sinking	14.11.78	Pasig River

3. Oil in the marine environment

A considerable amount of literature on the fate and effects of oil in the temperate marine environment, but not in the tropics, is available, and none on a comprehensive assessment of the extent of oil contamination in marine biota. Nonetheless, GESAMP (1977) provides a comprehensive review on the impact of oil pollution in the marine environment. Physical effects have been established to be the most significant initial consequence of oil discharge into the sea. Chemical and photochemical processes such as oxidation, photolysis and polymerization are next in importance. Biological impact becomes significant only after a period of weeks. However, the report points out various data gaps such as oil toxicity, carbon dioxide transfer through oil and thorough documentation of analytical procedures, among others. Thus, the group recommends the following:

(i) Common and specific terms describing various types of oil should be established at an international level;

(ii) Comparative studies should be made on the fate and rate of degradation of heavy oil fractions in sea water and bottom sediments, under both simulated and field conditions;

(iii) Reference materials should be used to establish the validity of the methods, especially the effectiveness of the isolation and separation stages and the suitability of the measurement technique;

(iv) Effects of oil should be studied at the ecosystem level, rather than by single species bioassay. Attention should be paid to chronic and sublethal effects using, for example, histopathological techniques. Genetic alterations and other effects on single species should not be ignored;

(v) There should be intergovernmental efforts to report on the extent of marine produce rendered unavailable to consumers due to official closures of fisheries or banning of sales of marine plants and animals;

(vi) Systematically obtained data should be gathered on the contents of specific carcinogenic polynuclear aromatic hydrocarbons (PNAH's) in marine produce taken from clean and polluted waters using standardized methods of tissue sampling and analysis; and

(vii) To evaluate the impact of oil on the marine environment, a technique should be developed to allow the relative comparison of one oil type and its source with another.

The only significant activity relating to oil pollution monitoring under the action plan was the joint survey near Pulau Sambu in the Straits of Malacca in August 1986. The one-week survey, based on the IOC/WMO Marine Pollution (Petroleum) Monitoring Pilot Project (MAPMOPP) (IOC Manuals Guide No. 7), involved the determination of particulate petroleum residues (tar balls) in surface waters and on beaches, and dissolved and dispersed hydrocarbons in water columns 1 m below the surface. This survey was essentially similar to one conducted in Jakarta in August 1983. The total tar density was determined to be 0.157 to 0.635 g/m^2, whereas dissolved and dispersed hydrocarbons ranged from 0.1 to 20.9 ppb. Similar estimates have not been made for other parts of the region.

3.1 Oil from ships

Numerous studies and monitoring activities have been carried out in the region but not as part of the action plan. In Malaysia, almost all of the recent and current research on marine pollution is related to mineral oil exploration, as most of the work is largely funded by the local oil companies, namely, PETRONAS, SHELL and ESSO. Monitoring pollution of the environment rests on government and is carried out by the Department of Environment. A marine pollution monitoring programme has been initiated by the Department since 1978 covering 98 coastal stations, each station being monitored once every three months. The results of this study show higher concentrations of oil and grease in open waters than in the nearby river estuaries, implying that the contribution of oil and grease through vessel sources is more significant than that of river discharges. The results also show high concentrations of oil and grease in rich fishing areas, indicating that fishing boats are a significant source of oil pollution.

In Thailand, the IGOSS Marine Pollution Monitoring Programme has been implemented since 1976. Beach tar was monitored all along the Thai coastline until 1980. Dissolved petroleum hydrocarbons were also investigated. In 1977, a baseline survey of petroleum-derived n-pariffins in sea water and sediments was made. Another study on petroleum hydrocarbons in sea water, sediments, fish and bivalves was also made in the Upper Gulf of Thailand and the Eastern Seaboard in 1983 (Hungspreugs 1985).

3.2 Oil in the biota

There has been an increase in the relative number of studies on hydrocarbon/oil dispersants using marine biota from 3 in 1977 to 11 in 1982. A similar increase in the relative number of marine pollutant studies using molluscs was seen from 13 in 1977 to 14 in 1982. Current research gives little emphasis on fish.

3.3 Oil in the sediments

The fate of oil in the marine environment is determined by certain "weathering" processes which occur at different time scales:

Time period	Predominant Process(es)
Hour	Evaporation, Dispersion, Emulsification and Spreading
Day	Spreading
Week	Sedimentation
Month-Year	Biodegradation

Two minor processes, dissolution and oxidation, take place but cease within two to four weeks. Evaporation, dispersion and emulsification are greatly diminished within a week. Thus, sedimentation and biodegradation determine the ultimate fate of discharged oil. For instance, much higher concentrations of hydrocarbons are found in the sediments than in the water column of the Japan Sea (Table 8).

To date, hardly any emphasis on the need to assess persistent oil in sediments and in macrobenthos has been made under the action plan. An environmental baseline study of the macrobenthos was carried out for PETRONAS and SHELL Companies in the vicinities of the Crude Oil Terminals in Sabah (Labuan) and Sarawak (Bintulu and Lutong), and around selected offshore platforms. The study showed that benthic communities were least dense at a discharge site where the highest levels of hydrocarbons occurred. High levels of hydrocarbons were obtained from samples taken from the old discharge site where there has been an accumulation of hydrocarbons over a longer period of time than in a recent discharge point (Leong et al. 1985). Thus, it is important that determination of hydrocarbons in the sediments be made specially in areas long affected by oil discharges or oil spills.

Table 8. Hydrocarbons in Japan Sea, 1981

Medium	Average	Maximum (ppb)*	Minimum (ppb)*	No. of samples	S.D.
Embayed Water	0.069	0.20	0.04	35	0.031
Sea Surface	0.109	0.20	0.05	30	0.047
Deep Layer	0.138	0.35	0.05	13	0.095
Sediments	16 ppm	89 ppm	0.31 ppm	-	-

* Except where indicated

(Source: Japan, Environment Agency, Water Quality Bureau, February, 1983).

3.4 Oil in coastal and offshore waters

Another study carried out annually by the Universiti Pertanian Malaysia in the South China Sea showed that the hydrocarbon level in offshore waters was much lower (range: 9.49-65.56 ppb) than that found in the coastal waters off the Trengganu River Estuary (range: 110-1750 ppb). The same pattern was also observed in the sediments. Over 50% of the sampled coastal sediments had more than 100 mg hydrocarbon/kg dry sediment, whereas the hydrocarbon contents in the offshore sediments fell below this value.

The results of this study also reflected the fact that research and monitoring programmes need to be intensified more in the coastal waters and enclosed bays than in offshore waters. This does not imply that oil contamination in the open seas should be ignored. Relatively high concentrations of hydrocarbon ranging from 0.011 ppb (1 mg/l) to 4 ppb (MAPMOPP of IGOSS study for the East Asian region 1974-1978) occurred in the southern part of the South China Sea. Similar research should have been continued into and throughout the eighties.

Among coastal habitats, mangroves and coral reefs are vulnerable to spills and chronic discharges of oil. A study on the fate and effects of naturally and chemically dispersed oils in the marine environment by Lai and Feng (1984) showed that oil was most toxic to mangrove saplings in static conditions, less in flow-through systems, and least in situ. Furthermore, the impact of undispersed oils was greater than that of dispersed oil over time. Of the 3 oil types tested, Malaysian crude was most toxic to mangrove, followed by Arabian light crude and Bunker C fuel. Mangrove fauna appeared more susceptible to oil toxicity than did saplings by 2-3 orders of magnitude.

These results suggest that if mechanical means of oil recovery fail, the immediate application of dispersants on freshly spilt oil would help mitigate the impact of oil spills on mangroves. A protocol to screen various types of dispersants that are suitable for use in the region needs to be developed. Preliminary results of dispersant toxicity testing conducted in Malaysia by the Fisheries Research Institute suggest the following rating:

48h.LC50 (μl/l)	Description	Rating
5,000	Practically non-toxic	1
5,000 - 500	Slightly toxic	2
500 - 50	Moderately toxic	3
50 - 5	Toxic	4
5	Very toxic	5

(The study shows that both Corexit 8667 and Corexit 9527 (diluted 1:9) are slightly toxic, whereas other tested dispersants, namely Hydrosol SE-4, Hydrosol DN-40, Shell LTX, and Servo CD-2000 (diluted 1:9) are practically non-toxic (UNEP/IG.77/INF.6, 27 April 1987).

Furthermore, the non-trivial effects of oil in mangrove habitats indicate the need to map these areas, showing sapling height, species-specific sensitivity to spilt oil and the distribution of fauna which collectively seem more vulnerable than the flora. Lastly, the study indicates higher risk in the production and transportation of local crude than in that of Arab crude. This is crucial in assessing risks attributed to various oil-related activities in the region.

4. Assessment relevant to control

The Working Paper on Marine Oil Pollution in Southeast Asia prepared by Bilal and Kuhnhold (1980) serves as a basic document in the initial assessment of oil pollution in the region. It needs to be updated, including some data gaps that should be filled in. The tasks could have been easily accomplished throughout the implementation period of EAS Project 15 (Previously EAS 2.1).

Information on the extent of oil contamination, particularly in coastal sediments, will provide the basis for establishing affected areas. Critical areas would deserve the most immediate attention and action for the control of all pollution from possible sources at the national, regional and international levels. Enforcement measures should be jointly undertaken through a regional protocol. Otherwise, an assessment programme remains an expensive exercise that does not lead to any form of regulatory action.

Lastly, the scientific assessment component of the action plan must lead to a management scheme, preferably through a protocol, in order to ensure regulatory action at the national level. To develop such a scheme, common analytical methods need to be adopted, a rigorous intercalibration program should be implemented, and exchange of pollution data bases needs to be done on a regular basis.

5. Oil pollution control and outstanding issues

According to Article 192 of the new Convention, "Nation states have the obligation to protect and preserve the marine environment," although countries, particularly developing ones, "have the sovereign right to exploit their natural resources pursuant to their environmental policies..." (Article 193). Issues which arise regarding the extent to which the marine environment is protected and preserved, or that natural resources are exploited to the detriment of the total environment, vary from one state to another. The logical responses would be for all states to "cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organizations, in formulating and elaborating (uniform) international rules, standards and recommended practices and procedures..." (Article 197). In this case, should the formerly five ASEAN countries agree to cooperate on a regional basis, questions of allocation of responsibility and liability need to be resolved:

(i) What is considered socio-economically reasonable in the exploitation of each state's natural resources (including estuaries, mangroves, and coral reefs) or in the production of each state's renewable resources (including brackish water culture and marine culture of fish in cages and of seashells on suspended racks)?; and

(ii) What is considered technically rational in the use of the Southeast Asian seas for the disposal of wastes of both land-based and vessel-source discharges?

The first difficulty arises because the productivity of the environment of each state is dependent upon the well-being of the total environment which is beyond national boundaries. An over-exploitation of natural resources by one state may be a threat to another's living resources. An over-production of a state's renewable resources may constrain another's economic activities.

The second difficulty arises because the states have now assumed that the marine environment has its limits and that loosely regulated disposal of untreated or partially treated wastes assists industrial growth on the short-term. Therefore, an over-generation of wastes by one state is perceived by another stateas a reduction in its own prospects for rapid growth with necessarily minimal environmental protection, if both states have initially agreed, with other states as well, to maintain a predetermined environmental quality.

Nonetheless, the position of every state concerned in matters relating to the protection and preservation of the marine environment, particularly from the impact of oil pollution, is a simple function of two troubling factors: resources that are at risk because of over-exploitation and adverse modification of the environment, and the impact of pollution generated within and transported beyond a state's jurisdictional limits.

5.1 Resources at risk

Resources that are at risk vary from one country to another because national jurisdictions do not necessarily coincide with the many oceanographic features of the region. Oil spills owing to tanker collisions or groundings have occurred and are more likely to occur in the narrow, shallow and congested entrance to Singapore Strait from the Malacca Straits than in other areas (Bennett 1977, Finn et al. 1979, Bilal and Kuhnhold 1980, Chia 1981). Similar spills owing to gas blow-outs are more likely to occur on the Indonesian side, in Selat Panjang, than in other places of the region. Because of prevailing northwesterly currents, tanker spills are more likely to hit the west coast of Peninsular Malaysia first than the east coast of Sumatra, as demonstrated in 1976 when the "DIEGO SILANG" spilled its oil after a triple collision with two other vessels off Pulau Pisang near the western entrance to Singapore Strait. Singapore is least likely to be affected, as it was truly so in 1975 when the "SHOWA MARU" grounded off Buffalo Rocks and spilled its oil in Singapore Strait (Bennett 1977). In both incidents, oil reached the coastline of Peninsular Malaysia, "but no serious attempts were made to assess the extent of ecological damage" (Jothy 1982).

Valuable resources including fisheries are exposed to both oil spills and other pollutants. They are considered vulnerable in the case of oil spills (Jothy 1982). Generally, these resources are highly productive estuaries and mangroves, thriving natural and artificial reefs, and dense shallow-sea communities.

5.2 Pollution and its sources

Countries in the region do not necessarily place the same degree of environmental value on the seas of Southeast Asia. Malaysia has always regarded the Straits of Malacca, for instance, as its front yard; to Indonesia, the straits are more backyard. It is ironic, however, that Malaysia generates the largest load of pollution, as shown in Table 9. About 80% of the waste is of domestic origin. This suggests that a low proportion of the population is served by sewage treatment systems.

Table 9. The Straits of Malacca and Singapore: land-based sources of organic pollution and pollution load

(Thousand t of biochemical oxygen demand per year)

Origin	Indonesia	Malaysia[b] South	Malaysia[b] West coast	Singapore South coast
Domestic	3[a]	73	6	4
Industrial	negligible	16	5	-
TOTAL		89	11	4[c]

Note: [a] The load is estimated solely from the population figure of the province of Riau. It is assumed that 0.01 lb of Biochemical Oxygen Demand (BOD) is generated per capita. The estimated population of Riau is 2 million.

[b] See WHO-PEPAS (1981) for the detailed estimates of pollution load by locality and by specific industry.

[c] A very high proportion of industrial wastes is admitted to domestic sewage treatment plants. Thus, no amount of pollution of industrial origin is indicated here.

Pollution load alone is not truly a total measure of the problem of the environment as the environment itself has the inner capacity to assimilate organic wastes including oil, to transform inorganic compounds to simple organic compounds, or even dilute the non-assimilative wastes to lower concentrations. Pollution levels in various environmental compartments — water, sediments, plants, and animals — are useful indicators whether or not the environment is in stress.

Oil pollution is more prevalent in areas where oil tankers are discharging their cargoes of oil than in areas where there are no oil terminals or refineries. High concentrations of oil were found along the coast of Negeri Sembilan, where the only oil refineries in Peninsular Malaysia are located (Morgan and Valencia 1983). Oil pollution is not as serious in other areas including the vicinities of the oil port of Dumai and the busy Port of Singapore.

Indonesia and Singapore have the facilities for receiving and treating oily wastes or dirty ballast waters installed in Dumai and in Pulai Sebarok respectively. The absence of such infrastructure in Malaysia leaves vessels serving in-country ports, particularly Port Dickson, no alternative but to discharge their wastewaters in the straits. The frequent fines imposed so far on vessels caught polluting do not deter most vessels from discharging their wastes in that part of the region or even while anchored in ports. Without such facilities, it is difficult for Malaysia to enforce the existing rules or to expect most vessels to refrain from discharging their oily wastewaters. Thus, Malaysia does little to curb the problems of marine pollution arising from vessel discharges in ports as well as in other areas beyond port limits. Such enforcement as there is occurs only in port areas.

5.3 Prospects

Cooperation in the protection and preservation of the marine environment is not difficult to achieve. As long as the countries concerned exercise care in further exploiting the depleting natural resources within their respective sovereignties or in polluting the waters in their immediate environment, they may yet succeed in protecting and preserving the environment to sustain their development needs.

Countries in the region tend to exploit their natural resources more than they preserve or protect. But the extent to which they exploit or conserve varies from country to country. Singapore means to be very clear and decisive in its purpose. Implicit in its plan and action is that every part of its territorial waters or coastal zones is designated only for a single, specific purpose. First, the area designated only for shipping and related activities extends from Tuas in the west to Changi point in the east; neither is fishing allowed nor are vulnerable resources left protected in this area[1]. Second, fishing and mariculture are limited to the north-east side of the main island of Singapore. The lands immediately adjacent to this area are kept rural for limited horticulture and intensive animal husbandry. Third, the northwest part of the island is reserved for water-supply storage. (Mariculture may not be an attractive venture there as the estuaries are now cut off from tidal influence, and the nutrients from land run-off and river discharges are trapped in the recently built estuarine reservoirs. However, cage-culture is encouraged there by the Primary Production Department of Singapore's Ministry of National Development). Fourth, no matter how little the area is now left to be protected, Singapore has been the most effective state in the region in regulating all types of wastes that reach the marine environment. If not helping to ensure the health of the surrounding ocean, Singapore has at least maintained a sanitary environment for its own sake.

Malaysia, although it has quite comprehensive legislation to regulate the release of wastes from land-based sources, continues to have problems of pollution arising from activities that are largely beyond the mandate of the Department of Environment, a federal government agency which has general responsibility for the protection of the environment. Its mandate is limited to pollution arising from factories and sewage treatment plants, but not sewage that includes oil wastes. Sewage is a local and state government problem.

Even within the federal government, other forms of pollution remain under the general responsibility of resource-development and other regulatory agencies: the Marine Department for merchant shipping, the PETRONAS for exploration and exploitation of oil and gas, the Mines Department for mining of other minerals; agencies within the Ministry of Agriculture for the use and abuse of pesticides, livestock and related veterinary services, and for drainage, irrigation, river and coastal maintenance; and the Forest Department for mangrove and other forest-related management. To address systematically and comprehensively all forms of pollution is a difficult task because of the sharing of responsibilities between federal and state authorities.

1 The Sentosa mishap in January 1983, when seven tourists were killed as their cable cars plunged into the Singapore Channel after the aerial cables across the channel had been hit by under-passing oil rigs which drifted away and beyond the control of the towing tug boats, illustrates the extent of a practical problem that is likely to arise again whenever there is an attempt to introduce too many activities in a busy shipping area.

Indonesia has not yet developed supporting regulations to make the existing environmental laws effective. This shortcoming should not yet be taken as a problem since the level of development and the extent of activities on the Indonesian side do not necessarily warrant measures as stringent as required on the Malaysian side. Oil pollution seems to be under control, although silt is increasingly becoming a problem.

Similar observations could be made in the case of the Philippines and Thailand. In short, the prospects for regional cooperation in the protection and preservation of the marine environment would not be bright unless every country of the region takes its fair share of responsibility, in proportion to the area under its national jurisdiction.

6. Recommendations

Future research and monitoring activities related to oil pollution must lead to regulatory action at both national and regional levels. It is, thus, proposed that:

(i) A comprehensive and regular assessment of all types of oil released in the region from all possible sources be carried out in order to establish the most significant source of oil pollution for regional action;

(ii) A comprehensive monitoring programme, with the necessary prerequisites of common methods, standards, and regular intercalibration exercises, be carried out at the national level, and collected data be exchanged on a regular basis for a comprehensive regional assessment of oil contamination in the region;

(iii) Marine water quality criteria and standards for major types of oil in the region be developed using results of baseline studies established under the regional monitoring programme; and

(iv) A protocol be developed for the control of the most significant source of oil pollution.

REFERENCES

Bennett, E. J. C. 1977. The legal enforcement of anti-pollution conventions. Spec. Publ. Bermuda Biol. Stn. 14: 65-68.

Bilal, J. and W. W. Kuhnhold. 1980. Marine oil pollution in South-East Asia. Manila: South China Sea Fisheries Development and Coordinating Programme.

Chia L. S. 1981. The Straits of Malacca and Singapore: navigational resource and environmental considerations. In Chia L. S. and C. MacAndrews (eds.). Southeast Asian Seas: Frontiers for Development, p. 239-276. New York: McGraw-Hill.

Finn, D. P., Y. Harayama, M. J. Meinandi-Nejad, T. Piyakarnchana and J. N. Reeves. 1979. Oil pollution from tankers in the Straits of Malacca, a policy and legal analysis. Honolulu, Hawaii: East-West Center, Open Grants Office.

GESAMP. 1977. Impact of oil on the marine environment. Rep. Stud. GESAMP 6.

Gomez, E. D. 1980. The Philippine marine environment - 1978: marine pollution and degradation of ecosystems. In The Kuroshio IV, p. 506-531. Proceedings of the Fourth Symposium for the Cooperative Study of the Kuroshio and Adjacent Regions, 14-17 February 1979. Tokyo: Saikon Publishing Co., Ltd.

Hungspreugs, M. 1985. Marine pollution by heavy metals in the East Asian Seas region. In A. L. Dahl and J. Carew-Reid (eds.). Environment and Resources in the Pacific, p. 239-248. UNEP Reg. Seas Rep. Stud. No. 69.

IOC/WMO. 1976. Guide to operational procedures for the IGOSS pilot project on marine pollution (petroleum) monitoring. Manual and Guide No. 7. Paris: UNESCO.

Jothy, A. A. 1982. The fate of fisheries and aquaculture in the wake of a deteriorating aquatic environment in Malaysia. Proceedings of the Symposium "The Malaysian Environment in Crisis", September 16 - 20, 1978, Penang, Malaysia.

Kantaatmadja, K. 1981. Marine oil pollution international claim. Bandung, Indonesia: Alumni (in Indonesian).

Kurashina. 1975. The present situation of tarballs. Hydrographic Research Bulletin No. 93, Japan.

Lai, H. C. and M. C. Feng (eds.). 1984. Fate and effects of oil in the mangrove environment. Penang: Universiti Sains Malaysia.

Leong, T. S., L. Y. Kwong, H. S. Chye, K. K. Huat, K. S. Pheng, S. Hanapi, W. T. Meng and R. S. Legore. 1985. An environmental baseline study of the macrobenthos in the vicinities of the crude oil terminals in Sabah (Labuan) and Sarawak (Bintulu and Lutong) and selected offshore platforms. Penang: Universiti Sains Malaysia.

Morgan, J. R. and M. J. Valencia (eds.). 1983. Atlas for marine policy in South-East Asian Seas. Berkeley: University of California Press.

Nasu, Kamiyanagi and Kitani. 1975. Petroleum pollution in the high seas. Oceanographic Survey Notes No. 2, Japan.

Petroleum News Southeast Asia. 1980. Oil and gas map. January 1980, Singapore.

Siddayao, C. M. 1980. Submarine hydrocarbons in South-East Asia: resources, environment and policy. GeoJournal 4,5: 393-406.

Sigit, S., Reksosoemitro, S. Sediono and B. Soegito. 1980. Indonesian mining yearbook 1980. Jakarta: Department of Mines and Energy.

UNEP. 1987. Report of the Sixth Meeting of the Co-ordinating Body for the Seas of East Asia (UNEP/IG. 77/6, 27 - 29 April 1987).

WHO - PEPAS. 1981. Preliminary assessment of land-based sources of pollution in the East Asian Seas. PEPAS, FP/0503-79-10, Malaysia.

MARINE AND COASTAL AREAS OF THE EAST ASIAN SEAS REGION PARTICULARLY SENSITIVE AND VULNERABLE TO OIL POLLUTION

Coastal and Marine Programme
International Union for Conservation of Nature
and Natural Resources (IUCN)
Avenue du Mont-Blanc
CH-1196 Gland
Switzerland

ABSTRACT

This paper aims to identify marine and coastal areas and associated renewable resources of the East Asian Seas region that are sensitive and vulnerable to oil pollution. It begins with a brief review of the region's major marine natural resources. The overall distribution of each major resource is mapped which, taken together, constitute the region's concentrated key resource areas.

From information on the distribution of various kinds of oil pollution, as well as activities that may result in oil pollution, the most vulnerable marine and coastal areas are determined. Concentrated key renewable resource areas that overlap with the areas most vulnerable (directly or indirectly) to oil pollution denote the resource areas of immediate concern.

The paper is concluded by several recommendations. These include mapping of certain critical marine habitats and other resources whose distributions in the region are not yet known in detail (e.g., seagrasses). Periodic upgrading of existing databases, and distributional maps of resources and the extent of oil pollution are seen as key elements of any coastal zone management programme. The analysis presented can also be used to identify conflicts between renewable marine resources and other activities (e.g., coastal infilling and dredging), whose impact on marine environments of the East Asian Seas region may be equally, if not more serious, than the effects of oil pollution.

1. Introduction

Oil pollution in the East Asian Seas region is potentially a serious threat to the coastal and marine environment as a result of the extensive activity in drilling, transportation and refining taking place or planned in the region (Morgan and Valencia 1983). Oil spillages from several tanker accidents since the 1970's (see, for example, Soegiarto and Polunin 1982, Couper 1983) have undoubtedly highlighted the problem. However, oil in the marine environment also originates from activities inland, natural seeps and from other sources.

Coastal and marine habitats occupy virtually the entire intertidal and subtidal zones within the East Asian Seas region. Together with their associated plant and animal species, these habitats represent a renewable resource base of appreciable magnitude and value. The biota in the region is also among the richest found anywhere in the world, although the reasons for this are still not completely clear (see Soegiarto and Polunin 1982). Knowledge of the nature and distribution of local marine habitats and associated species is therefore of fundamental importance to oil spill contingency planning and coastal resource management. In the context of the present meeting, emphasis is given to marine and coastal areas and habitats of the East Asian Seas region that are particularly sensitive and vulnerable to oil pollution.

Certain coastal and marine habitats are considered to be "critical" (IUCN 1976), and may be more important than others in sustaining renewable natural resources. Examples of critical marine habitats are mangroves and other coastal vegetation, coral reefs and seagrass beds. The attributes of critical marine habitats include: high productivity, or source of nutrients and productivity for adjacent areas, the feeding, breeding or nesting areas for marine and other animals, areas particularly rich in species and areas essential for the survival of marine species that are of commercial or conservation interest, and areas of special scientific interest. Critical habitats and associated resources are also among those that are particularly sensitive and vulnerable to oil pollution (see IUCN 1983).

This paper aims to provide a simple analysis as a tool for identifying areas encompassing critical marine habitats and associated resources in the East Asian Seas region that are sensitive and vulnerable to oil pollution. The analysis provides the context and setting for determining oil spill contingency requirements.

2. Methodology

The distribution of critical marine habitats, principal fishery areas and other key resources was determined from information available for the East Asian Seas region (Morgan and Valencia 1983, IUCN/UNEP 1985). Included are mangroves, coral reefs, high fishing catch areas, major mariculture production areas and selected species or species groups (turtles, crocodiles, seabirds, dugongs, whales and dolphins). These different resources are mapped and, taken together, constitute the region's total critical habitats/resources. These are considered to represent the principal resources of economic, conservation or scientific importance.

Information on the distribution of tanker routes, commercial ports, oil terminals and other actual or potential sources of oil pollution was also analyzed. This was taken from maps from existing sources (Morgan and Valencia 1983, Ministry of State for Population and the Environment, this volume). Information from these maps, taken together, indicates the areas most vulnerable to oil pollution. Concentrated key resource areas that overlap with the areas most vulnerable to oil pollution denote the resource areas of greatest concern.

It is not the intention of this paper to give complete details of all the different renewable marine resources and threats from oil pollution in each country. Instead, emphasis is given to the methodology and analysis used for identifying coastal areas and habitats that are sensitive and vulnerable to oil pollution at a broad, regional level. The analysis illustrates an approach and methodology for evaluatingthe conflicts and compatibilities of resource conservation and resource use. As more site specific information on particular resources or threats from oil pollution (e.g., from land-based activities) becomes available, a more detailed picture for the region will emerge. The analysis can also be supplemented by the use of models that predict oil spill trajectories (see Morgan and Valencia 1983). Similar analyses can be used for identifying areas most at risk from other impacts (e.g., coastal infilling, dredging) which may represent environmental problems of equal or even greater significance than oil pollution (see IUCN/UNEP 1985).

3. Results and discussion

3.1. Importance of renewable and coastal marine resources

3.1.1. Critical marine habitats

The overall importance of critical marine habitats has been highlighted above. Many of these habitats are of both direct human value and ecological significance. Mangroves yield a great variety of useful products. They serve as shelter and provide food which is utilised by numerous animals including shrimps, crabs, shellfish and fish. The nursery function of mangroves is of particular significance. Mangroves are often favoured sites for mariculture production. They also reduce sedimentation and act as environmental buffers through the protection they afford to coastal areas (e.g., from hurricanes).

Coral reefs represent the most spectacular marine habitat in terms of structural complexity and the diverse biota which they support. A major value in the region is their associated artisanal and commercial fisheries which largely reflects the habitat's high primary productivity. In some areas, parts of the reef flat are utilised for aquaculture (e.g., algae, molluscs and fish). Coral reefs are a source as well of limestone for building materials, and a variety of other products including fish and other ornamental or souvenir species. Exploitation of these products has often also been accompanied by reef degradation. Coral reefs are of considerable value for tourism and education, underwater tourism being well developed in the Philippines and Indonesia. In addition, coral reefs are of appreciable importance by functioning as wave buffers, and may be considered as "self-repairing breakwaters" (Johannes 1975).

Seagrasses are another example of highly productive marine habitats which function as coastal food factories occurring both intertidally and in the shallow subtidal zone. Epiphytic algae on the surface of the blades make a substantial contribution to primary productivity. The leaves and roots of seagrasses provide a direct food source for several animals of conservational or local importance (e.g., adult green turtles, juvenile hawksbill turtles, dugongs and rabbitfish). However, the important food source to most organisms is decomposing seagrass which becomes available through detrital food chains. Seagrass beds also provide a refuge for a variety of commercially important molluscs, crustaceans and fish. For many animals (e.g., commercial penaeid shrimps) seagrasses also harbour juvenile stages, thereby serving as nursery areas. An additional function is that dense stands of certain species reduce current velocities. This allows increased sedimentation and enables the development of an epifauna and infauna that could otherwise not survive.

3.1.2 Fisheries and mariculture

The fisheries clearly represent the coastal and marine resources of the East Asian Seas region that are of most direct human value. They are based on pelagic and demersal fisheries, the latter including commercially important penaeid shrimps. The fisheries throughout the region are characteristically highly diverse (i.e., multi-species catches), particularly in the demersal sector. Of the pelagic fisheries, the main target species groups are coastal tunas (Euthynnus thunnus and Auxis spp.), mackerels (Rastrelliger spp.), king mackerels (Scomberomorus spp.), scads (Decapterus spp.), anchovies (Stolephorus spp.), sardines (Sardinella spp.) and carangids. Apart from tuna and shrimps, most of the marine catch in the region is consumed locally.

Mariculture operations are also of considerable significance in the region. Organisms produced by mariculture include algae, penaeid shrimps, mussels, oysters, cockles and fish. Production rates vary considerably from area to area. In the Philippines, for example, production rates of 706 kg/ha/yr have been recorded for milkfish, 950 kg/ha/yr for Penaeus monodon (penaeid shrimp), and 78,250 kg/ha/yr for Perna viridis (shellfish) (Morgan and Valencia 1983). Further details of mariculture operations and the fisheries in the region are available in the literature (e.g., Morgan and Valencia 1983, IUCN/UNEP 1985).

3.1.3 Other marine habitats and resources

During resource assessment studies, attention often focuses on critical marine habitats. However, all habitats and species must contribute in some way to the overall ecological integrity of a region. Future research may well reveal some ecological or other value of these seemingly less "critical" habitats (e.g., sand beaches, subtidal sand and mud and even artificial structures). Accordingly, these resources should be safeguarded for possible future use.

In addition to habitats and the fisheries, there are certain species or species groups that are sensitive to oil pollution and need to be highlighted on account of their commercial, conservational or other importance. Among these are turtles, other reptiles, seabirds, dugongs, whales and dolphins. In some cases (e.g., turtles and dugongs) species are classified as either "vulnerable" or "endangered", emphasizing their precarious conservation status.

3.2 Identification of critical habitats and other key resource areas in the East Asian Seas region

3.2.1 Mangroves

Mangroves are well developed in the region, occurring in estuaries, deltas, on the mainland coast or on islands, often adjacent to fringing coral reefs. In the Indonesian areas alone, 38 species of mangrove have been recorded. The distribution of principal mangrove areas in the region is shown in Figure 1. The estimated areas of intact or relatively undisturbed mangrove are as follows:

Thailand	312,714	ha	(IUCN/UNEP 1985)
Malaysia	652,219	ha	(IUCN/UNEP 1985)
Singapore	1,800	ha	(IUCN/UNEP 1985)
Indonesia	3,806,119 (77% in Irian Jaya)	ha	(IUCN/UNEP 1985)
Philippines	100,564 (representing 22% of mangrove forested area in 1918)	ha	(Howes 1987)

3.2.2 Coral reefs

Coral reefs are extensively developed in several parts of the region (Fig. 1). In the Philippines, more than 400 species of hard coral are thought to occur, compared with approximately 360 species reported for another coral-rich area in Australia (the Great Barrier Reef) (IUCN/UNEP 1985). Most coral reefs in the East Asian Seas region are represented by fringing reefs, although barrier reefs, bank reefs and patch reefs also occur. Coral reefs are commonly associated with the coastal and offshore islands that are so widespread and numerous in the region.

3.2.3 Seagrass beds

Seagrasses occur primarily in sandy and silty substrata, often in coastal shallows bordering lagoons and mangroves,or associated with reef flats. Stands may be dense or occur in widely scattered areas. Details of the location and extent of seagrass beds for all areas of the East Asian Seas region are not yet available. However, the distribution of all seagrass species known for certain areas (e.g., the Philippines) has been determined and mapped (Menez et al. 1983).

3.2.4 Fishing and mariculture areas

Fishery resources are easily tainted or contaminated by oil, even if not impacted directly. Hence the location of the main fishery areas is of considerable significance, particularly in view of their direct food and economic value. Areas associated with estimated total marine fish catches exceeding 11 kg/km^2 are shown in Figure 2. These have been divided into areas where catches range from 100-1000 kg/km^2 and those where catches exceed 1000 kg/km^2. The map indicates that extensive tracts of coastline around Malaysia, the Philippines, as well as some other localities (e.g., Indonesia, Brunei), yield high fishery catches. The location of the main shrimp exploitation areas is also shown. Further details on the fisheries, including a breakdown of the demersal and pelagic fishery areas by species, or species groups, are provided by Morgan and Valencia (1983).

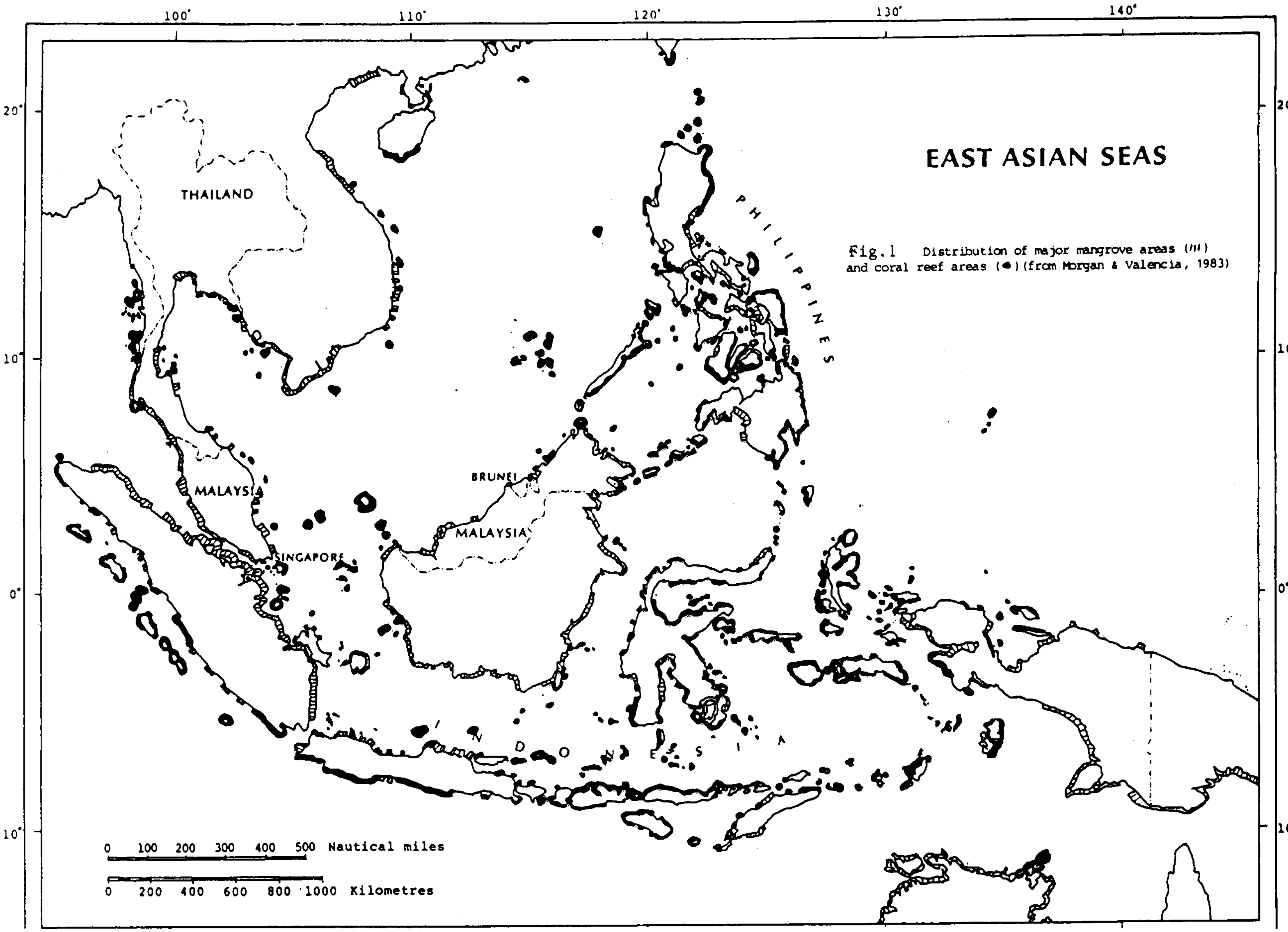


Fig.1 Distribution of major mangrove areas (///) and coral reef areas (●) (from Morgan & Valencia, 1983)

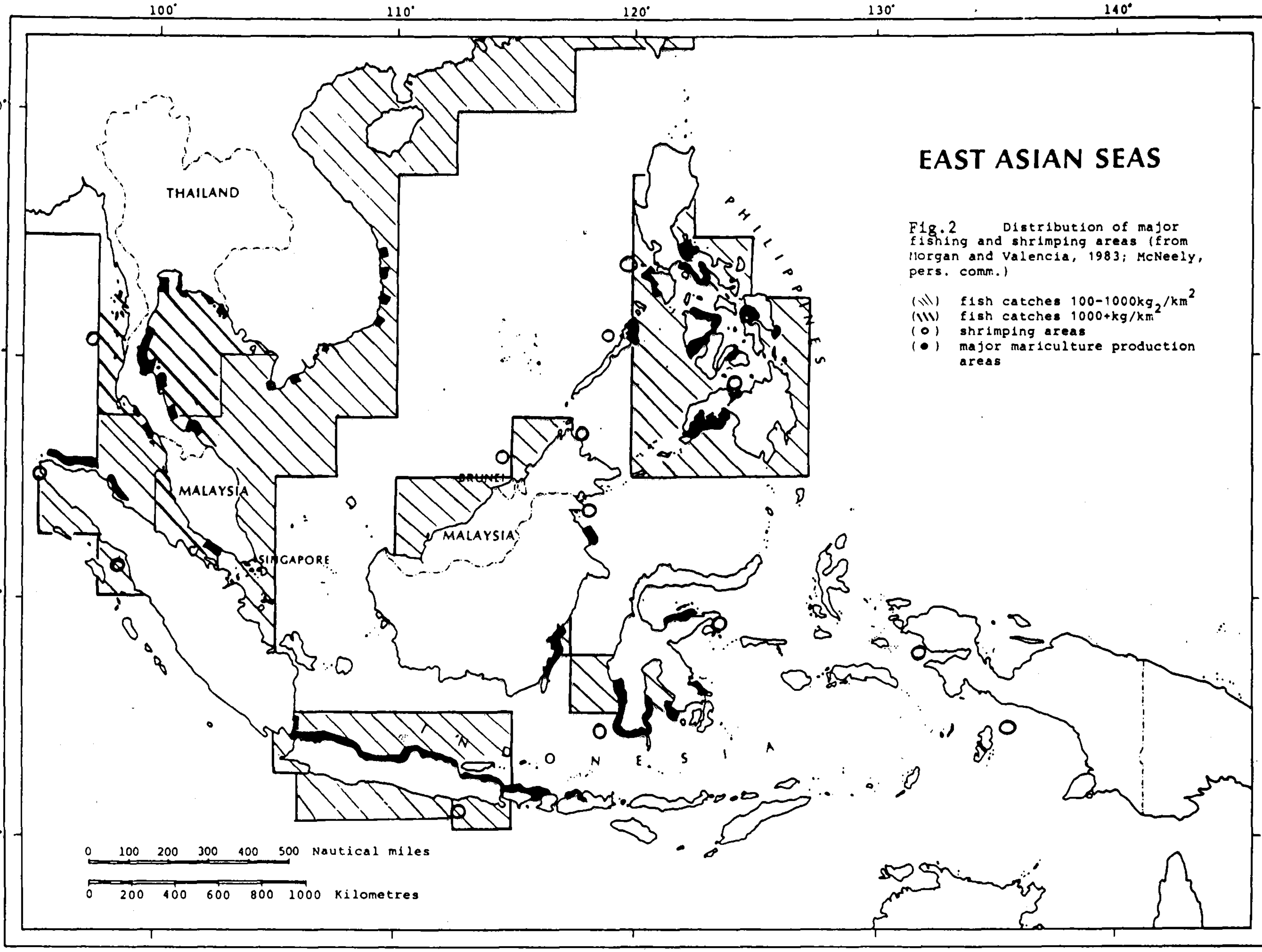


Fig.2 Distribution of major fishing and shrimping areas (from Morgan and Valencia, 1983; McNeely, pers. comm.)

It would also be of value to determine and map the main nursery and spawning grounds of major groups, since larvae and juvenile stages are known to be particularly sensitive to oil pollution. Brackish water lagoons surrounded by mangroves, tidal forests and wetlands are among the habitats used as shrimp nurseries in the region (IUCN/UNEP 1985). Shrimp larvae also appear to be more abundant in coastal than offshore waters (IUCN/UNEP 1985).

The principal mariculture production areas in the region are indicated in Figure 2. These are sited intermittently along the coast, but are particularly extensive in the Philippines and Indonesia (e.g., Java). Additional information on mariculture facilities (i.e., hatcheries, research stations, pilot and demonstration farms) is given by Morgan and Valencia (1983).

3.2.5 Species of special conservation significance

The distribution of selected species (or species groups) of conservational importance is shown in Figure 3 using the data of Morgan and Valencia (1983). Included are the locations of known turtle nesting sites (data available for the different species, but not shown), probable sites of occurrence of crocodiles, occurrence of sea bird colonies, probable occurrence of dugong, and sightings of whales and dolphins. Morgan and Valencia (1983) classify these animals according to the types of habitats occupied. The range of the latter group (whales and dolphins) extends to open deep-water, and migrations within and outside the East Asian Seas region are also undertaken. Animals comprising the former groups frequent or depend heavily on coastal habitats such as beaches, mangroves, estuarine areas, reef environments, and many species also undergo migrations. Of particular significance is that all the species at times inhabit surface waters and thereby easily face direct exposure to oil slicks and other surface contaminants.

3.2.6 Concentrated key resource areas

The above distribution maps (Figs. 1-3) of selected critical marine habitats, fishery resources and species of conservational importance are combined on a single map in Figure 4 to delineate concentrated key resource areas. Areas of greatest overlap signify the greatest concentrations of key renewable resources. These areas are located along extensive tracts of coastline and open water in all countries of the region. A large component of these concentrated key resource areas is made up of major fishing areas (catches exceeding 11 kg/km^2).

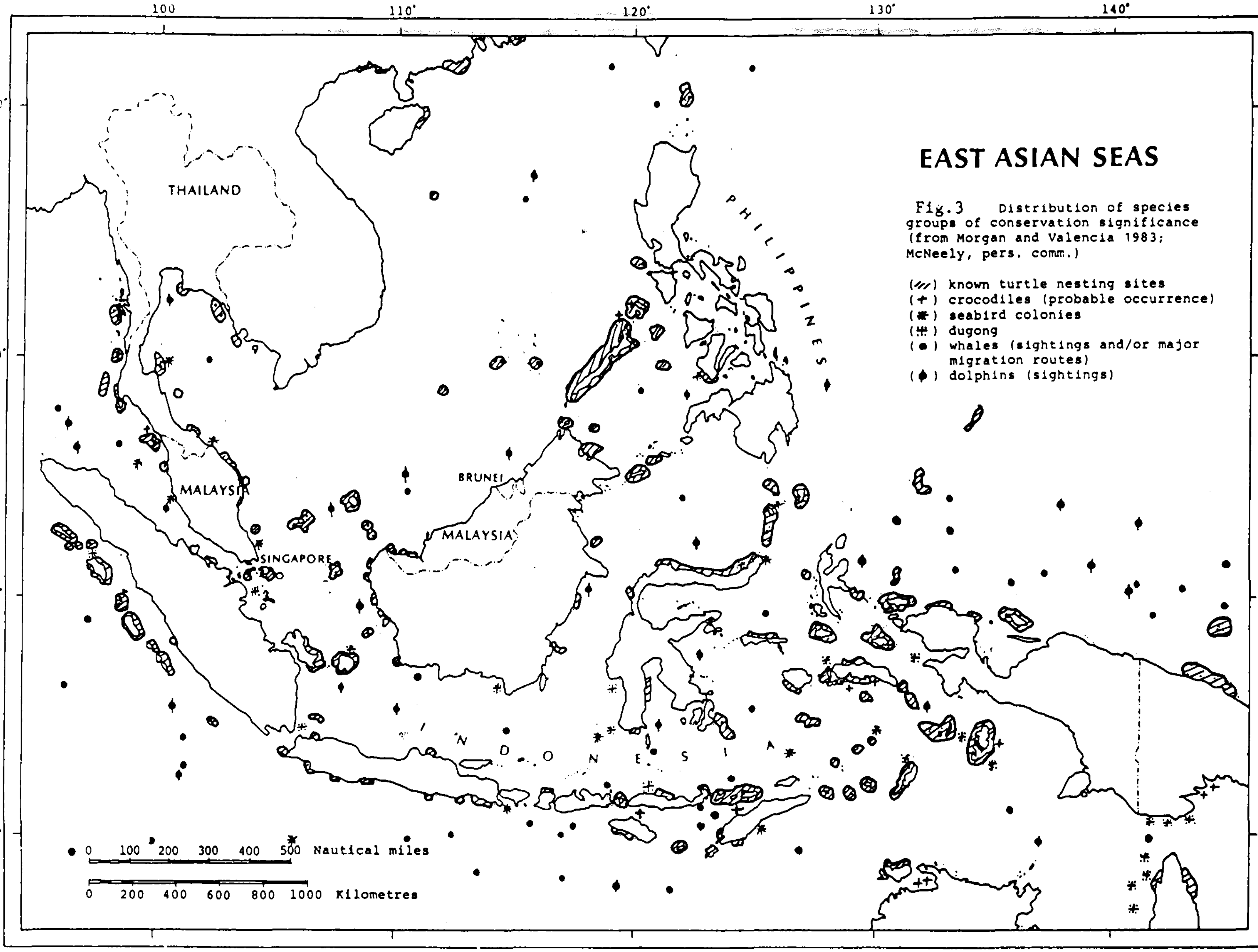
3.3 Threats from oil pollution

The purpose of this section is not to provide a detailed review of the impact of oil pollution on living resources in the East Asian Seas region, as this is considered in a companion paper (Chansang, this volume). General reviews on the subject are also available in the literature (e.g., IUCN 1983). Rather, it aims to identify in a general way areas that may be particularly susceptible to oil pollution from various sources or activities. Areas that overlap with concentrated key resource areas will be of most immediate concern for management. This does not mean that other areas should be disregarded, as oil spill trajectories predict that oil spilled in one area will probably drift to another (Morgan and Valencia 1983).

Sources of oil pollution are discussed in detail in another paper (Ministry of State for Population and the Environment, this volume) which includes maps indicating their locations. Only a brief overview is given below.

3.3.1 Commercial ports

In the vicinity of ports accidental spillages of oil and other petroleum products are not uncommon. Renewable resources around these areas therefore often experience chronic exposure to oil, if only in low concentrations. In South East Asian waters there are an estimated 536 ports ranging from some of the largest in the world to mere harbours capable of handling only local crafts (Morgan and Valencia 1983).


EAST ASIAN SEAS
Fig.3 Distribution of species groups of conservation significance (from Morgan and Valencia 1983; McNeely, pers. comm.)
(///) known turtle nesting sites
(+) crocodiles (probable occurrence)
(*) seabird colonies
(#) dugong
(●) whales (sightings and/or major migration routes)
(♦) dolphins (sightings)
THAILAND
PHILIPPINES
BRUNEI
MALAYSIA
MALAYSIA
SINGAPORE
INDONESIA
100
110°
120°
130°
140°
20°
10°
0°
10°
0 100 200 300 400 500 Nautical miles
0 200 400 600 800 1000 Kilometres

3.3.2 Tanker traffic

Tanker routes represent another obvious potential hazard with respect to accidents and subsequent oil spills. Tanker and shipping routes in the East Asian Seas region are among the busiest in the world. Tankers passing through the region carry oil from the Middle East and Far East mainly to Japan and the Pacific coast of North America. The Malacca Straits represent a bottleneck of tanker and shipping traffic where at least 6 tanker spillages of more than 50,000 bbl occurred between 1970-80 (Couper 1983).

3.3.3 Oil terminals

Oil terminals occur in all countries constituting the East Asian Seas region. Coastal areas and resources in these areas may therefore be subject to persistent, generally low-level spillages.

3.3.4 Offshore moorings

Offshore moorings are strung along the coast in several parts of the East Asian Seas region, particularly in Malaysia. Chronic oil spillages are likely to occur in these areas, particularly during the unloading and loading of tankers.

3.3.5 Tar balls and oil slicks

The occurrence of tar balls and oil slicks provides overt evidence of oil pollution in an area. In such cases, there is therefore at least the potential for impact on renewable resources by oil. Tar balls are particularly prevalent around the Malaysia/Indonesia vicinity. The data available (Ferrari 1983) suggest that these are also areas containing oil slicks, although the site most severely affected by oil slicks appears to be around Bangkok.

3.3.6 Extensive drilling

Extensive drilling or exploitation of oil inevitably carries the risk of blow-outs and other sources of spillages (IUCN 1983). The discharge of drilling muds can also affect habitats and fauna (e.g., corals). The principal areas occur around Malaysia and Indonesia. Considering the already appreciable tanker traffic in the region, the risk of serious pollution is further increased by ongoing programmes for oil and gas exploration (IUCN 1983).

3.3.7 High hydrocarbon content of sea water

Concentrations of hydrocarbons in the region vary from place to place, but are generally considerably higher in coastal waters than in the open sea. Areas with greatest reported concentration occur around Indonesia, Malaysia and Singapore. Critical habitats and associated resources in these localities are therefore at particular risk with respect to the immediate or long-term consequences of oil pollution.

3.3.8 Overall threats from oil pollution

The areas and associated resources probably at greatest risk from oil pollution can be determined by combining on a single summary map information on the different activities or sources leading to oil pollution (see Ministry of State for Population and the Environment, this volume). This summary map is shown schematically in Figure 5, from which it is apparent that several marine and coastal areas in all the countries comprising the East Asian Seas region are either at risk, or actually affected by oil pollution. The main areas include: a) a large band extending south-east from Thailand to the east coast of the Malaysian peninsula/Singapore area, and also extending north-east into the South China Sea reaching the Philippines; b) a large band extending from the south-east Philippine area in a south-west direction to Borneo; c) a series of smaller areas around the coasts of Indonesia and Brunei. However, as mentioned previously, it may also be necessary to make use of oil trajectory models to determine the movements of spilled oil from the sources to adjacent areas.

3.4. <u>Sensitivity and vulnerability of renewable coastal resources to oil pollution</u>

The areas containing coastal resources that are particularly sensitive and vulnerable to oil pollution are shown in Figure 6. This was derived by overlapping the map showing concentrated key resource areas (Fig. 4) with the map showing the areas facing greatest overall threat from oil pollution (Fig. 5). Based on the analysis, the following areas and resources appear to be particularly sensitive and vulnerable to oil pollution in the East Asian Seas region:

a) a large band extending south-east from Thailand into the Gulf of Thailand as well as to the east coast of the Malaysian peninsula;

b) a number of areas on the west coast of the Malaysian peninsula, including Singapore and the Malacca Straits;

c) an area off the coast of Brunei/Malaysia;

d) several bands around the Philippines;

e) several bands around Indonesia.

The following information on the sensitivity and vulnerability of renewable coastal and marine resources is also of significance to oil spill contingency planning.

Mangroves typically occur in low energy sedimentary environments and are among the habitats that are most vulnerable to oil spill damage (see Gundlach and Hayes 1978, IUCN 1983). Similarly, sheltered coastal environments, even if not colonised by mangroves, are often comprised of intertidal mud (and sand) flats. These habitats and associated blue-green algal mats are also highly productive, and may be at great risk, too, following an oil spill (IUCN 1983). However, the distribution of intertidal flats in the East Asian Seas region is not yet known in detail.

Coral reefs may be adversely affected in several ways by exposure to oil hydrocarbons (Loya and Rinkevich 1987). Sheltered parts of the reef in shallow water, for example, reefal lagoons and back reefs, are generally more at risk than more exposed parts (e.g., the reef slope) which occur in deeper water.

Seagrasses have not been studied extensively in the region, and even their overall distribution has not yet been determined (see IUCN/UNEP 1985). However, seagrass beds, together with their epiphytic algae and other associated biota, may be particularly susceptible to oil pollution in shallow, sheltered waters where the habitat reaches its greatest development.

Fishery resources are clearly at greater risk from the effects of oil pollution in coastal waters than in areas further offshore. Young stages usually occur in greater abundance in coastal areas, and are also the stages most susceptible to the effects of oil. Fish traps and mariculture production areas are usually sited in intertidal or shallow subtidal areas and are therefore at great risk from nearby oil spills. Both the gear and catch/production may become oiled and tainted, thereby rendering the product unfit for consumption.

Species of special conservation significance often frequent the sea-air interface and are at risk from oil pollution in spill areas, as discussed previously. Heavily affected beaches may be a serious problem for animals such as turtles which use beaches as nesting sites.

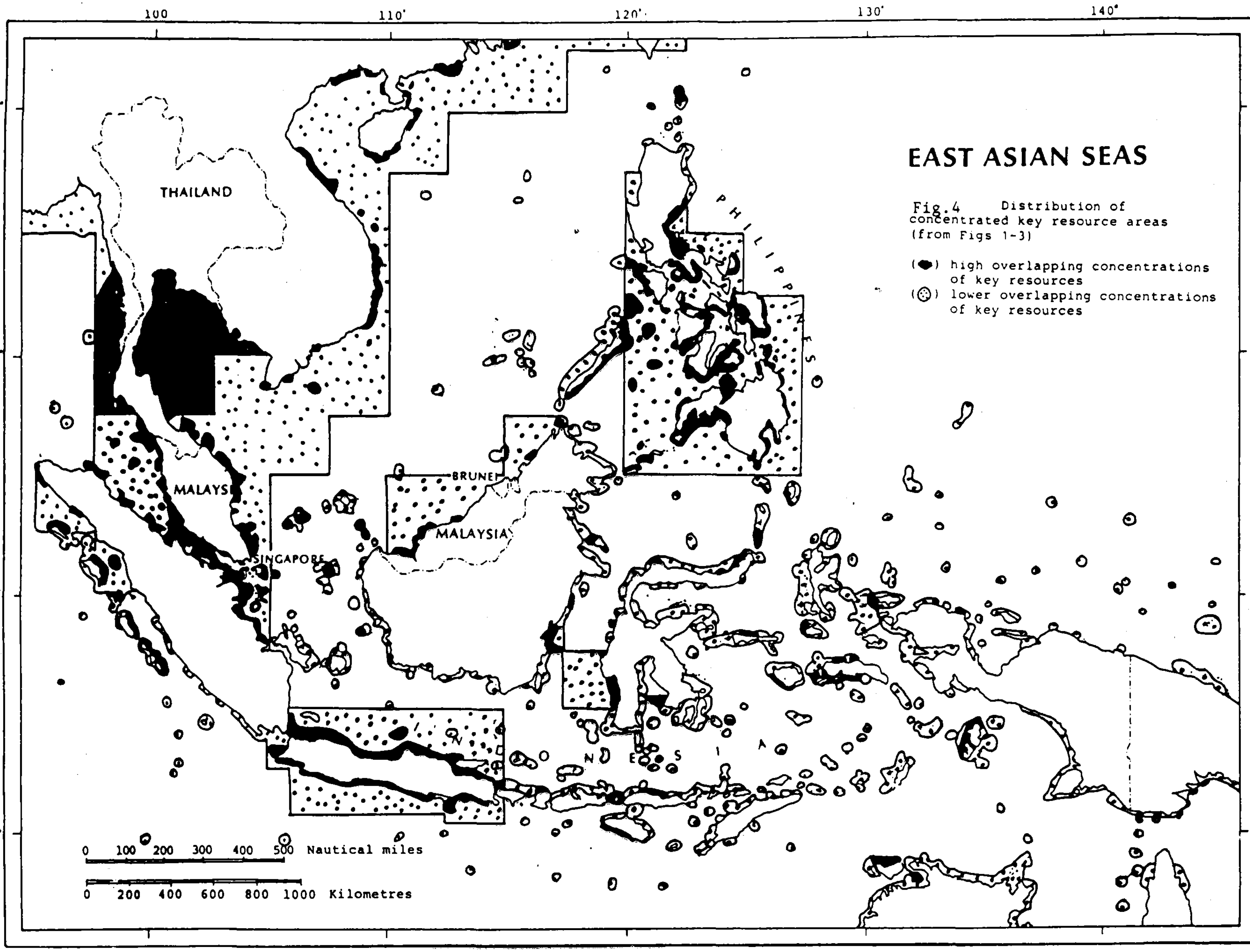


Fig.4 Distribution of concentrated key resource areas (from Figs 1-3)

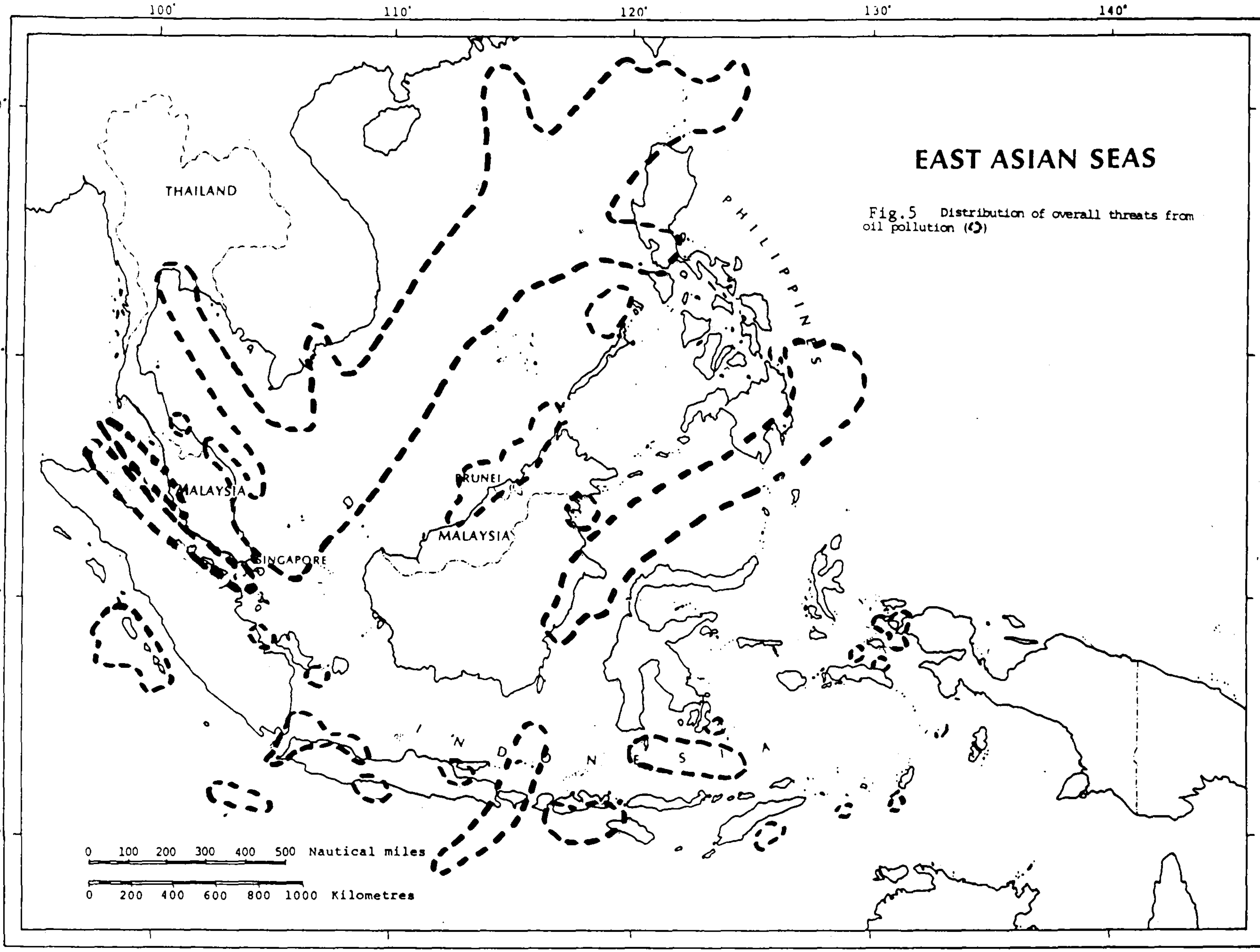


Fig.5 Distribution of overall threats from oil pollution (◌)

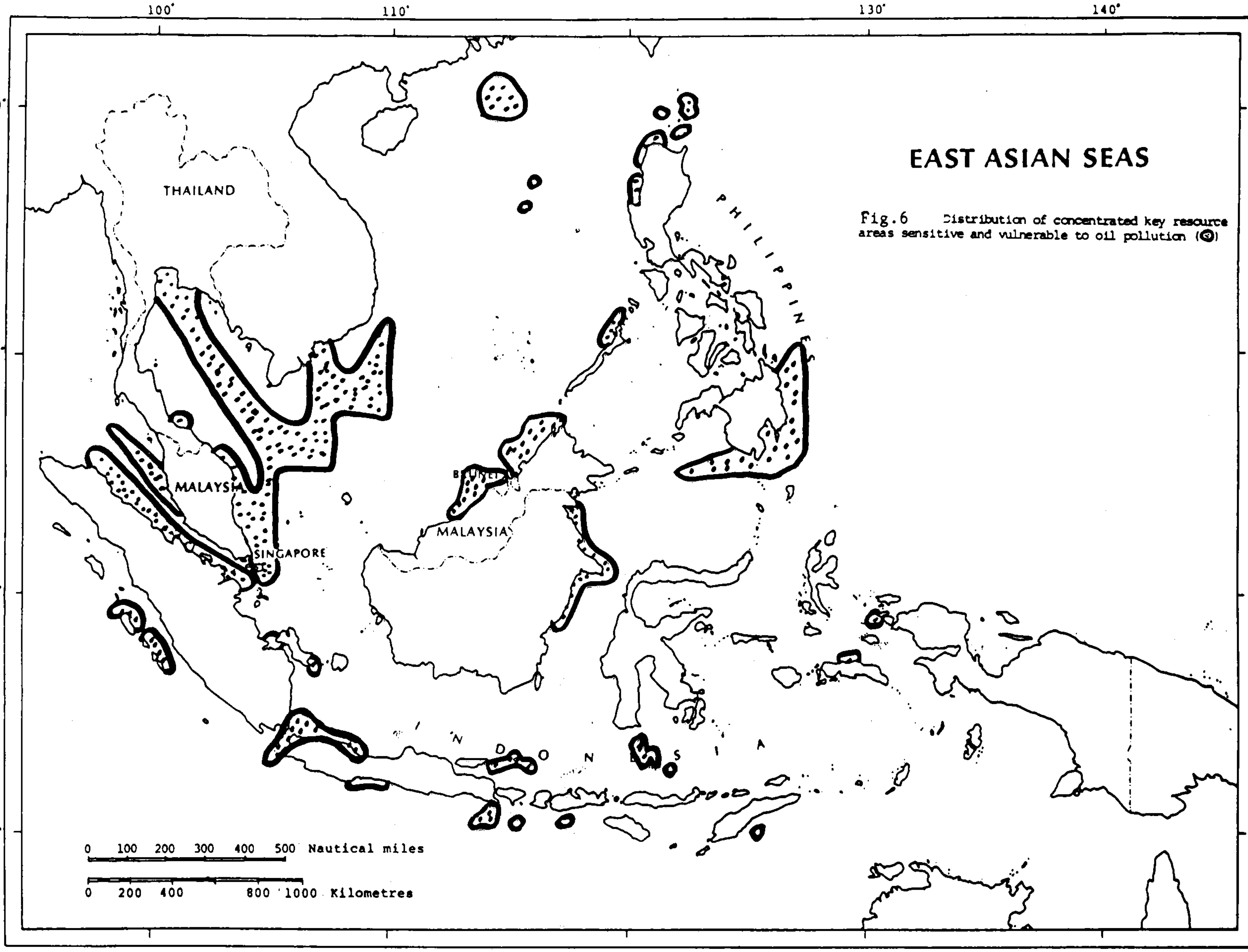


Fig.6 Distribution of concentrated key resource areas sensitive and vulnerable to oil pollution

Finally, it should perhaps be stressed that the coastal and marine environment in the East Asian Seas region is already subject to a variety of major impacts in addition to oil (Soegiarto and Polunin 1982, Morgan and Valencia 1983, IUCN/UNEP 1985). It is quite conceivable that areas already under stress from other impacts (e.g., heavy metals, dredging, infilling, heavy fishing) may require little further impact to result in serious environmental degradation.

4. Further research needs and recommendations

It is suggested that major renewable marine resources be identified and mapped in detail by each East Asian Seas country. These resources should include mangroves, coral reefs, seagrass beds, mudflats, coastal swamp forests and continental shelf areas. In addition detailed information on the threats from oil (and other) pollution should be collected and mapped by each country. On the basis of the information integrated in this way the main areas of conflict or compatibility of uses and resources can be identified for each particular country. The detailed information thus obtained would provide the basis for national and regional oil spill contingency planning as well as coastal zone management programmes. Sensitivity mapping is discussed in the paper presented by the Intergovernment Maritime Organization (this volume).

5. Acknowledgments

This paper was prepared by Drs. A.R.G. Price and D.L. Elder of the Coastal and Marine Programme of IUCN. The information on which the paper is based originates almost entirely from existing work as duly acknowledged in the text. The authors also wish to thank Helen Nicolaou and Nikki Meith for preparing the illustrations.

REFERENCES

Couper, A., ed. 1983. The Times atlas of the oceans. Times Books.

Ferrari, J. 1983. Oil on troubled waters. Ambio 12(6): 354- 357.

Gundlach, E.R. and M.O. Hayes. 1978. Vulnerability of coastal environments to oil spill impacts. Mar. Tech. Soc. J. 12: 18-27.

Howes, J.R. 1987. Rapid assessment of coastal wetlands in the Philippines. Kuala Lumpur: Asian Wetland Bureau.

IUCN. 1976. An international conference on marine parks and reserves. IUCN Publ. News Series No. 37.

IUCN. 1983. Impact of oil pollution on living resources. IUCN Commission on Ecology Papers No. 4.

IUCN/UNEP. 1985. Management and conservation of renewable marine resources in the Kuwait Action Plan region. UNEP Regional Seas Reports and Studies No. 63.

Johannes, R.E. 1975. Pollution and degradation of coral reef communities. In E.J. Ferguson Wood and R.E. Johannes (eds.). Tropical Marine Pollution, pp. 13-51. Amsterdam, Oxford, New York: Elsevier Publishing Co.

Loya, Y. and B. Rinkevich. 1987. Effects of petroleum hydrocarbons on corals. In B. Salvat (ed.). Human Impacts on Coral Reefs: Facts and Recommendations, pp. 19-102. French Polynesia: Antenne Museum, EPHE.

Menez, E.G., R.C. Phillips and H.P. Calumpong. 1983. Seagrasses from the Philippines. Smithsonian Contributions to the Marine Sciences No. 21.

Morgan, J.R. and M.J. Valencia. 1983. Atlas for marine policy in South-East Asian Seas. Berkeley, Los Angeles,London: University of California Press.

Soegiarto, A. and N. Polunin. 1982. The marine environment of Indonesia. A report prepared for the Government of the Republic of Indonesia under the sponsorship of IUCN and WWF.

PETROLEUM INDUSTRY AND THE ENVIRONMENT IN ASEAN

Ismail Ahmad
ASCOPE Environment and Safety Program
c/o PETRONAS
Menara Dayabumi, P. O. Box 12444
Jalan Sultan Hishamuddin 50778
Kuala Lumpur, Malaysia

ABSTRACT

This paper attempts to present an overview of the current petroleum related activities and their potential impacts on the marine environment in the ASEAN region. The potential natural environmental hazards in the development of offshore petroleum resources and the various sources of oil pollution from these activities are reviewed. The paper elaborates on the current petroleum industry's cooperative efforts, particularly those of ASCOPE and other related programmes, in the mitigation of marine oil pollution in the region. It concludes with a call for a consolidated regional programme within the scope of the East Asian Seas action plan for the prevention of marine oil pollution.

1. Introduction

Oil in the marine environment is not a foreign compound. It has been naturally introduced for millions of years by oil seeps on land and in the sea. This form of natural "oil pollutant" is estimated to contribute 0.3 million M. T., about 7 - 9%, of an estimated total of 3.2 million M. T. of oil which enters the world's marine environment annually. About the same amount is estimated to come from atmospheric sources (National Research Council 1985).

Oil seepage and domestic use of crude oil for medicinal purposes and later for lighting lamps and for resin mixtures were recorded as far back as the 8th century in the Southeast Asian region, particularly in Indonesia and Malaysia. However, commercial oil exploitation and production began in the late 19th century.

The Southeast Asian region was one of the first areas in the world to produce oil commercially, with an initial production of about 150 l daily from Sumatra, Indonesia in 1885 (Petromin 1985). The Royal Dutch started to operate the first refinery in 1892 and exported crude oil from Indonesia in 1893. Subsequently, oil was struck in commercial quantities in Sarawak, Malaysia in 1910, and the first refinery started its operation in 1917. Brunei discovered its Seria field in 1929. Following the rapid development of the offshore oil and gas industry in the early 60's in the United States, Indonesia, Malaysia and Brunei started to explore offshore areas in the same period. Indonesia started its offshore production in 1969 in the Java Sea, and Malaysia in 1968 in offshore Sarawak.

Currently, the ASEAN region produces daily an average of 2 million bbl and 5 billion std cu ft of crude oil and natural gas, respectively. About 45% of the current oil and gas in the region is produced from offshore fields. In Malaysia, 100% of the current production is from offshore fields. There are currently more than 20 refineries in the region with a total daily utilised capacity of 2 million bbl. It is estimated that the region consumed 1 million bbl of various petroleum products in 1985 and will continue to consume about 1.3 million bbl through 1995.

In addition to abundant petroleum resources, the seas bordering the ASEAN countries (Fig. 1) are richly endowed with a wealth of other marine resources. The ASEAN marine environment and related ecosystems support diverse and unique tropical species of flora and fauna. Mangroves cover about 4.8 million ha which represent 1.6% of the total land area of the region (ASEAN Experts Group on the Environment/UNEP 1983). The coastal areas, beaches and islands are attractive for public amenities and tourism development. The regional seas also support one of the world's most productive fisheries. Total annual catch from the region in recent years was approximately 7 million M. T. or roughly 11% of the world's total marine catch (Valencia 1981). These abundant fishery resources have been an important source of food and employment for many of the region's coastal populations.

The waters of Southeast Asia occupy a crossroad position between the Indian and Pacific Oceans along the trade routes of Europe, Africa, the Middle East, Japan and the other Far Eastern nations. They thus serve as major transportation routes for oil.

The current extensive exploration and exploitation of petroleum resources in the ASEAN region and continued dependence on crude oil and products from the Middle East and Africa will undoubtedly place oil and marine related pollution and safety of navigation as major concerns in the years to come.

Offshore and coastal pollution by petroleum hydrocarbons in the ASEAN region have been identified in the last decade. The seriousness of this type of contamination on a regional scale has been pointed out at, among others, the IOC/FAO (IPFC)/UNEP International Workshop on Marine Pollution in East Asian Waters held in Penang, Malaysia in April 1976 and at the FAO/UNEP Experts Consultation Meeting on Assessment of Oil Pollution and Its Impact on Living Aquatic Resources in Southeast Asia, Manila, Philippines in February 1980. Since the Penang Workshop, remedial and preventive steps have already been taken on several fronts in the region.

A number of regional programmes on the prevention and control of marine pollution have been undertaken involving the ASEAN littoral states, international agencies (particularly those in the U.N. system), oil and service companies [particularly the association of national oil corporations in ASEAN (ASCOPE)*], and a few other institutions outside the region.

2. The oil scene in ASEAN: discoveries, production and consumption

The current predominant offshore discoveries and production are from the sedimentary basins of the continental shelf and its slope. The West Sumatra, Sunda, West Java, Kutei, the Malay, Sabah-Sarawak-Brunei, and Northwest Palawan basins are potential sources of oil. The Gulf of Thailand, Andaman Sea, Central Luconia, offshore of Sarawak and North Sumatra may contain gas. Most reserves are associated with the Miocene and Pliocene sands and substantial amounts of gas is contained in Miocene carbonates (Figs. 2 and 3).

The region is estimated to have recoverable reserves of 13 billion bbl of oil and 106 trillion std cu ft of gas. About 45% of the current oil and gas is produced from offshore fields (Tables 1 and 2).

Oil and gas are the most vital of all the marine resources of the region and by far the most important product exported (Table 3).

ASCOPE* The ASEAN Council on Petroleum, founded by the state/national petroleum corporations/agencies on October 15, 1975 as a regional instrument for cooperation in all facets of the petroleum industry among ASEAN countries. The current members of ASCOPE are PERTAMINA (Indonesia), PETRONAS (Malaysia), the Philippine National Oil Company, Singapore National Oil Company and the Petroleum Authority of Thailand.

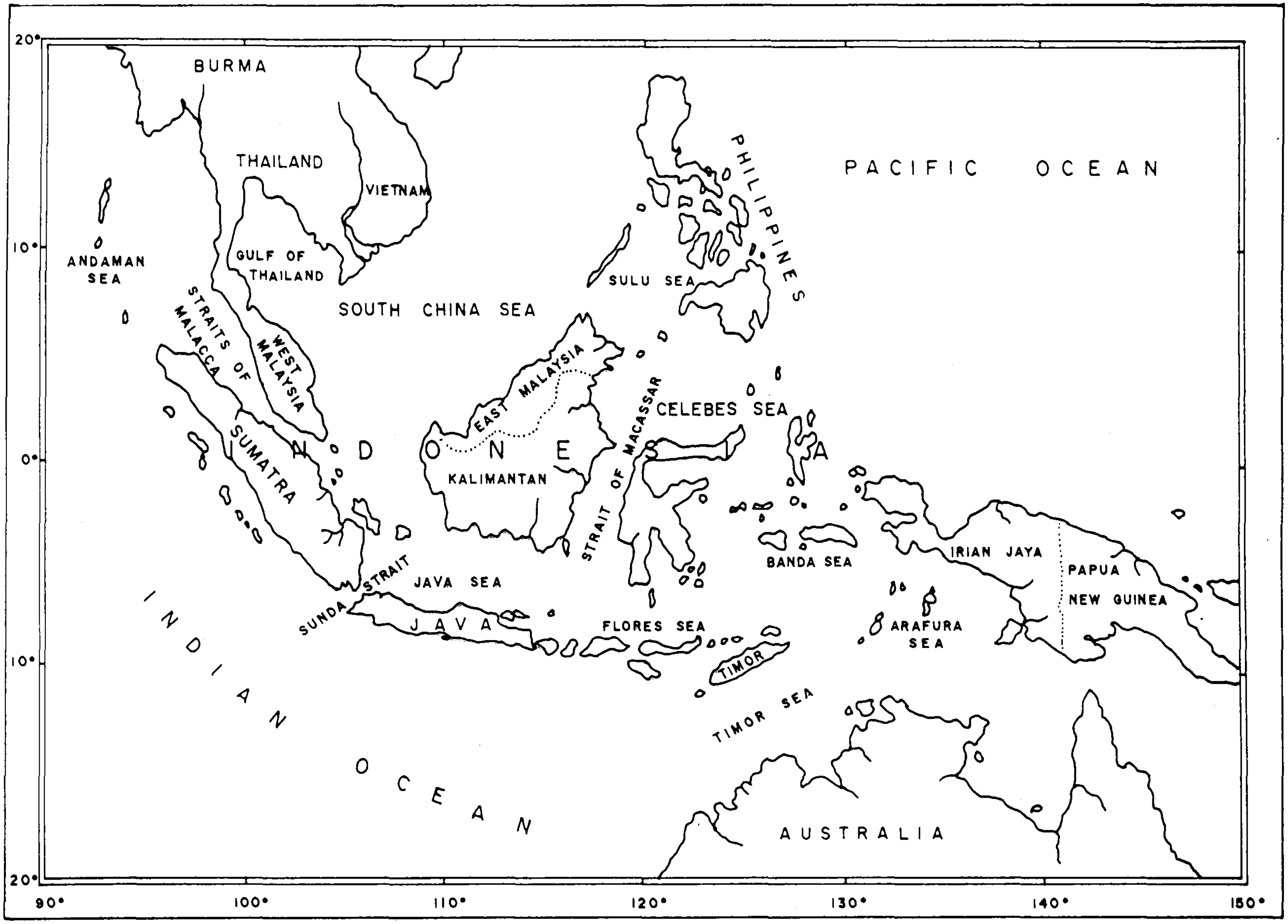


Fig. 1. Map of the Southeast Asian Seas

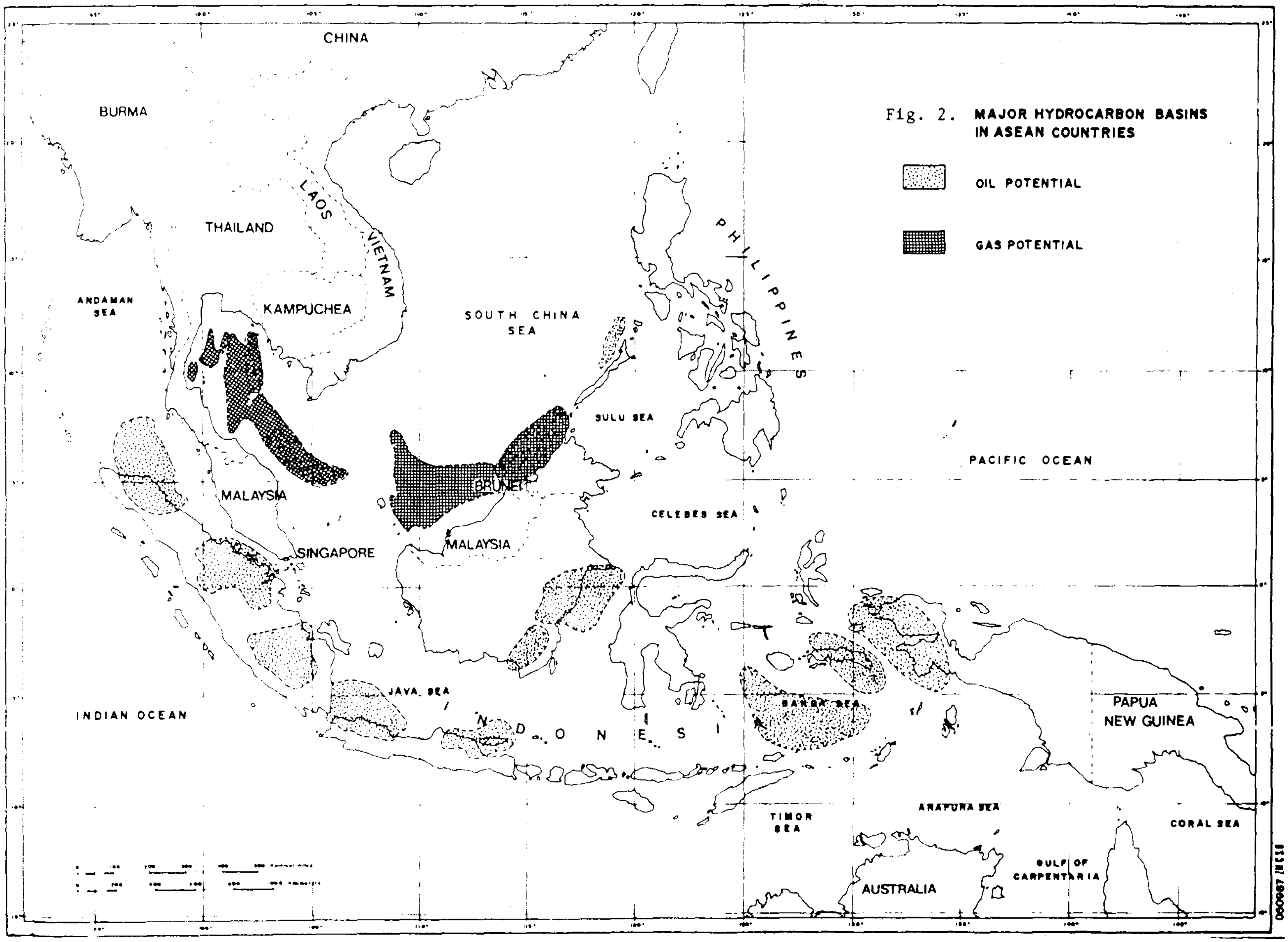


Fig. 2. **MAJOR HYDROCARBON BASINS IN ASEAN COUNTRIES**

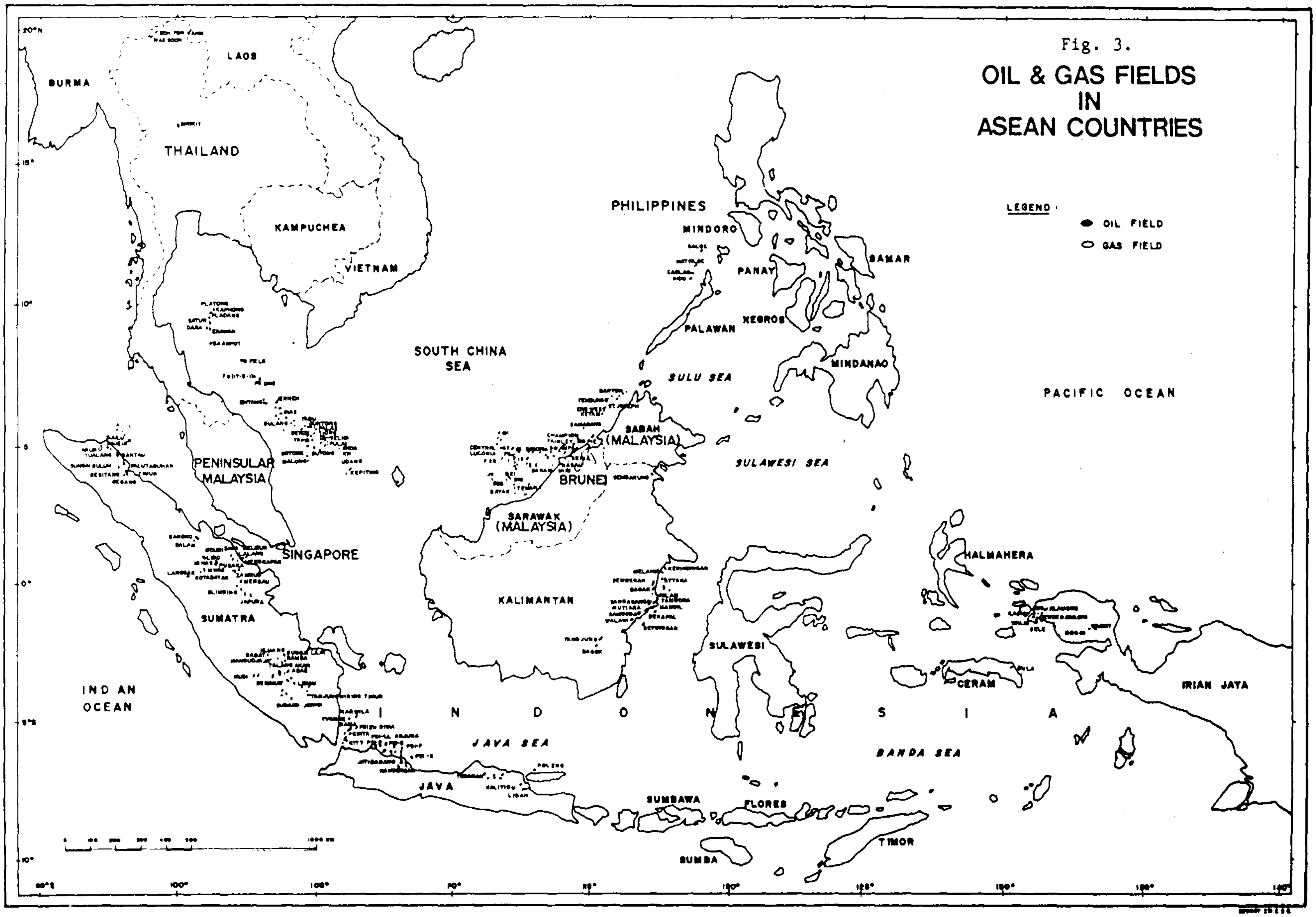


Fig. 3.
OIL & GAS FIELDS IN ASEAN COUNTRIES

Table 1. ASEAN crude oil reserves and production

Country	Production (million bbl/d) 1986	1984	1983	Reserves as at January 1, 1987 (billion bbl)
Indonesia	1.24	1.47	1.29	8.3
Malaysia	0.503	0.47	0.38	2.9
Philippines	0.006	0.012	0.015	0.017
Singapore	-	-	-	-
Thailand	0.036	0.019	0.011	0.10
Brunei	0.17	0.16	0.16	1.42
TOTAL	1.955	2.121	1.856	12.837

Source: Oil and Gas Journal, December 1986.

Table 2. ASEAN gas reserves and production

Country	Production (Billion cfd) 1986	1984	1983	Reserves as at January 1, 1987 (Trillion cu ft)
Indonesia	3.2	1.5	1.3	49.4
Malaysia	0.6	0.1	0.1	52.2
Philippines	-	-	-	0.010
Singapore	-	-	-	-
Thailand	0.3	0.2	0.15	7.4
Brunei	0.75	0.86	0.87	7.1
TOTAL	4.85	2.66	2.42	105.912

Source: Oil and Gas Journal, December 1986 and March 1986.

Table 3. ASEAN primary energy demand (1983-1995)
(Unit: Thousand bbl/d of Oil Equivalent (BDOE))

	1983	1984	1985	1995
Solid fuels	83	140	227	357
Natural gas	174	240	343	441
Hydro	85	98	152	208
Nuclear	-	4	17	17
Geothermal	20	24	36	41
Oil 1250	1089	1123	1259	
TOTAL	1612	1595	1898	2323

Source: Minutes of the 29th Meeting of the ASCOPE Economic Committee, November 22-24, 1985, Singapore.

Indonesia, Brunei and Malaysia are the current major oil and gas producers and net exporters. Indonesia accounted for an average of 72% of the total production of oil from 1981 - 1985, and Malaysia, an average of 18% for the same period. The remaining production is accounted for by Brunei, Thailand and the Philippines.

It was estimated that the region consumed 1 million bbl/d of various petroleum products in 1985, with a projected demand of 1.3 million bbl/d through 1995 (Table 4). Singapore, a well-known petroleum refining center in the world, accounted for an average of 44% of the total oil consumption by the region in the period 1981 - 1985, followed by Indonesia with an average of 30% over the same period.

Consumption of natural gas increased from an average of 11% from 1976 to 1980, to about 13% from 1981 to 1985. Indonesia accounted for about 65% of the total gas production in the region (1981 - 1985), Brunei 32%, and the balance accounted for by Malaysia and Thailand. There are currently more than 20 refineries in the region with a total daily design capacity of 2.6 million bbl/d and utilised capacity of 2 million bbl/d (Table 5).

3. Energy cooperation in ASEAN

ASEAN activities on energy cooperation arose in response to the energy crisis of the 1970's. Countries were heavily dependent on oil for about 95% of their energy requirements and when the oil crisis worsened, they felt they had to reduce their dependence on oil and develop their indigenous non-oil resources. Cooperation in energy has been discussed within ASEAN as early as 1976 and was embodied in the Declaration of ASEAN Concord.

Energy cooperation is presently being pursued through a two-pronged approach: a) in the short term, by evolving arrangements to guarantee the supply of oil and, b) in the long term, by developing and utilizing new energy sources.

Table 4. Total ASEAN product consumption (1983-1995)
(Unit: Thousand bbl/d)

	1983	1984	1985	1995
LPG	26	35	55	77
Gasoline	177	184	210	248
JPI/Kerosene	222	202	214	218
Gas/Diesel Oil	394	390	404	434
Fuel Oil	407	258	213	250
Other Products	24	23	27	32
TOTAL	1250	1089	1123	1259

Source: Minutes of the 29th Meeting of the ASCOPE Economic Committee, November 22-24, 1985, Singapore.

Table 5. ASEAN refining capacity
(Unit: Thousand bbl/d)

Country	Design Capacity		Effective Capacity		Utilised Capacity
	1987	1984	1987	1984	1987
Indonesia	846	826	795	750.5	719
Malaysia	207	207	186.3	186.3	165.6
Philippines	287	289	258	260.1	167
Singapore	976	1,087	752.2	748.3	
Thailand	193	175	183	166	182
Brunei	9.4	9.4	9.4	9.4	9.4
TOTAL	2,599	2,584	2,123.3	2,124.5	1,991.3

Source: Minutes of the 33rd Meeting of the ASCOPE Economic Committee, June 24-25, 1987, Chiangmai, Thailand.

Recently, member countries signed an Energy Cooperation Agreement to serve as the framework for cooperation in the efficient development and use of all forms of energy, whether commercial, non-commercial, renewable or non-renewable in modalities that may be appropriately designed for the purpose of strengthening economic resilience. Cooperative programmes for energy undertaken in the fields of planning, development, manpower training, information exchange, efficiency and conservation, and supply and disposal will all fall under the framework of this Agreement. An ASEAN Petroleum Security Agreement was signed on 24 June 1986 which embodied the emergency sharing scheme for crude oil and/or petroleum products.

A number of mechanisms have evolved in the pursuit of energy cooperation in the region. The first mechanism to arise as an immediate response to the energy crisis in the 1970's was the ASEAN Council on Petroleum (ASCOPE). In October 1975, the heads of the national oil companies of the member countries agreed to set up ASCOPE to provide a forum and a mechanism for implementing the petroleum-sharing scheme and to pursue regional cooperation in all facets of the petroleum industry, including the safety of petroleum operations in the region and prevention of oil pollution.

In addition to ASCOPE, there are other ASEAN Committees, namely the ASEAN Committee on Industry, Minerals and Energy (COIME) and the ASEAN Committee on Science and Technology (COST) which are currently involved in energy cooperation in the region.

4. Environmental and geological hazards

Geologic characteristics and climate impose constraints on oil and gas exploration in Southeast Asia. A seismically active region, its submarine topography features landslides and slumps, subsidence basins, active faults, shallow gas pockets, and subsurface and overpressure zones. Earthquakes and typhoons are common occurrences.

Volcanic activity is concentrated in 3 areas of the region: the Indonesian territory from Sumatra to Ceram, the western Pacific Ocean from New Guinea to the Philippines and Taiwan, and the southern coast of Vietnam which features submarine volcanism.

Associated with volcanic activity, submarine landslides and earthquakes are long-period waves called tsunamis. From AD 416 to 1965, there were 78 recorded tsunamis, 20 of which occurred from 1900 to 1965 at a frequency of one every 3.25 years.

Typhoons are intense tropical cyclonic storms in the Western Pacific and are the most destructive, periodically-occurring natural hazards in Southeast Asia. The typhoon season lasts from July to November, and peaks in July and September. An average of 9 typhoons pass through the South China Sea each year.

Consideration of these natural hazards and thorough technical and economic feasibility studies are imperative to ensure the success and safety of offshore oil and gas development. Potential sites of shallow gas concentrations and seeps need to be identified prior to actual drilling. The stability of the seafloor should be ascertained before development structures are placed. Submarine landslides and slumps can dislocate drilling and production platforms, possibly causing blowouts and spills. Areas of high erosion and sediment accumulation should be determined so that pipelines and other structures will not be buried or undermined. The probability of seafloor settling after fluid extraction needs to be established to prevent distortion and consequent instability of platforms and other installations.

Despite the intensive offshore drilling and production activities during the past decade, the region has had a relatively good safety and environment record (Rioux et al. 1980). However, there have been a few blowouts and rig mishaps. These include accidents in Arjuna field, Indonesia in 1972, in offshore Brunei during the early 70's and in offshore Sarawak, Malaysia. They occurred in virgin offshore areas during the pioneering years of exploration when "wild-catting" operations were still in the early stages of assessing the potential environmental and geological hazards. But none of these incidents have resulted in serious environmental pollution at a magnitude approaching that of the IXTOC-1 blowout off Mexico in 1979.

Available information and data such as maps, navigational charts, etc. on the natural, physical, geological and navigational hazards in the region are relatively good. However, oil prospectors are not taking chances and normally would conduct high-resolution and continuous seismic reflection and oceanographic surveys, and seafloor sediment and core sampling to ascertain potential hazards prior to drilling and installation of structures.

5. Transportation

Movement of petroleum from the oil field to the consumer may require 10 to 15 transfers, about 6 different transportation modes including tankers, pipelines, trains and tank trucks, as well as storage facilities such as permanently anchored offshore tankers and onshore terminals. Oil and gas produced offshore (Fig. 4) are mostly transported via submarine pipelines from the production platforms to onshore terminals and refineries for further processing in the region. Processed crude and products are loaded for export via fixed anchor loading systems such as the offshore Single Buoy Mooring (SBM) and conventional loading hoses from the shoreline. It is generally accepted that pipeline transshipment of oil and gas is the safest way of transportation of such products (Figs. 5 and 6).

Much of the world's petroleum trade passes through the Southeast Asian Seas. Manufactured goods move in both directions while petroleum and other bulk commodities move primarily from west to east and from south to north (Fig. 7). It was estimated that 3.2 million bbl of mainly crude oil are shipped through the Southeast Asian waters daily via the Straits of Malacca and about 3.8 million bbl/d leave this region through the South China Sea, most of it in transit to Japan. Another 0.6 to 1.2 million bbl/d leave the Makassar Strait for Japan and the Pacific (Finn et al. 1979).

The route through the Malacca and Singapore Straits is one of the most heavily travelled waterways in the world. Traffic of all types and sizes, at an average of more than 150 vessels including at least 10 VLCCs, passes through the Straits of Malacca and Singapore daily. The economic and strategic significance of these straits has long been recognised and their vulnerability to pollution has become a major concern in the region. Being dangerously shallow in certain stretches and with narrow deepwater channels, the straits have seen numerous tanker accidents resulting in major oil spills. The groundings of the "Showa Maru" in 1975 and "Diego Silang" in 1976 in the Singapore and Malacca Straits which caused massive transfrontier oilspills were the real "eye-opener" for the littoral states as to the imminent need to institutionalise regional agreements in combating transfrontier oil spills and the prevention of marine pollution in the region.

5.1 Navigational hazards

Ships use the Southeast Asian seas to gain access to the many ports of the region and to navigate between the Indian and Pacific oceans. The physical hazards to navigation include such environmental characteristics as shallow water, swift currents, meteorological conditions like squalls and poor visibility, and, for some areas, a great density of transit traffic.

On May 1, 1981 the Traffic Separation Schemes for the Malacca-Singapore Straits, recommended by the International Maritime Organization (IMO), went into effect. The Malacca-Singapore Straits route is the most important and frequently used passage from the Indian Ocean to the South China Sea. It is also one of the most difficult navigational passages in the world. New charts are now available and improved navigational aids have been established. An under-keel clearance of 3.5 m (11.5 ft) is now mandatory, thereby restricting passage to vessels drawing less than 19.8 m (65 ft) as originally recommended in the Sailing Directions. Despite these improvements, the straits remain naturally hazardous.

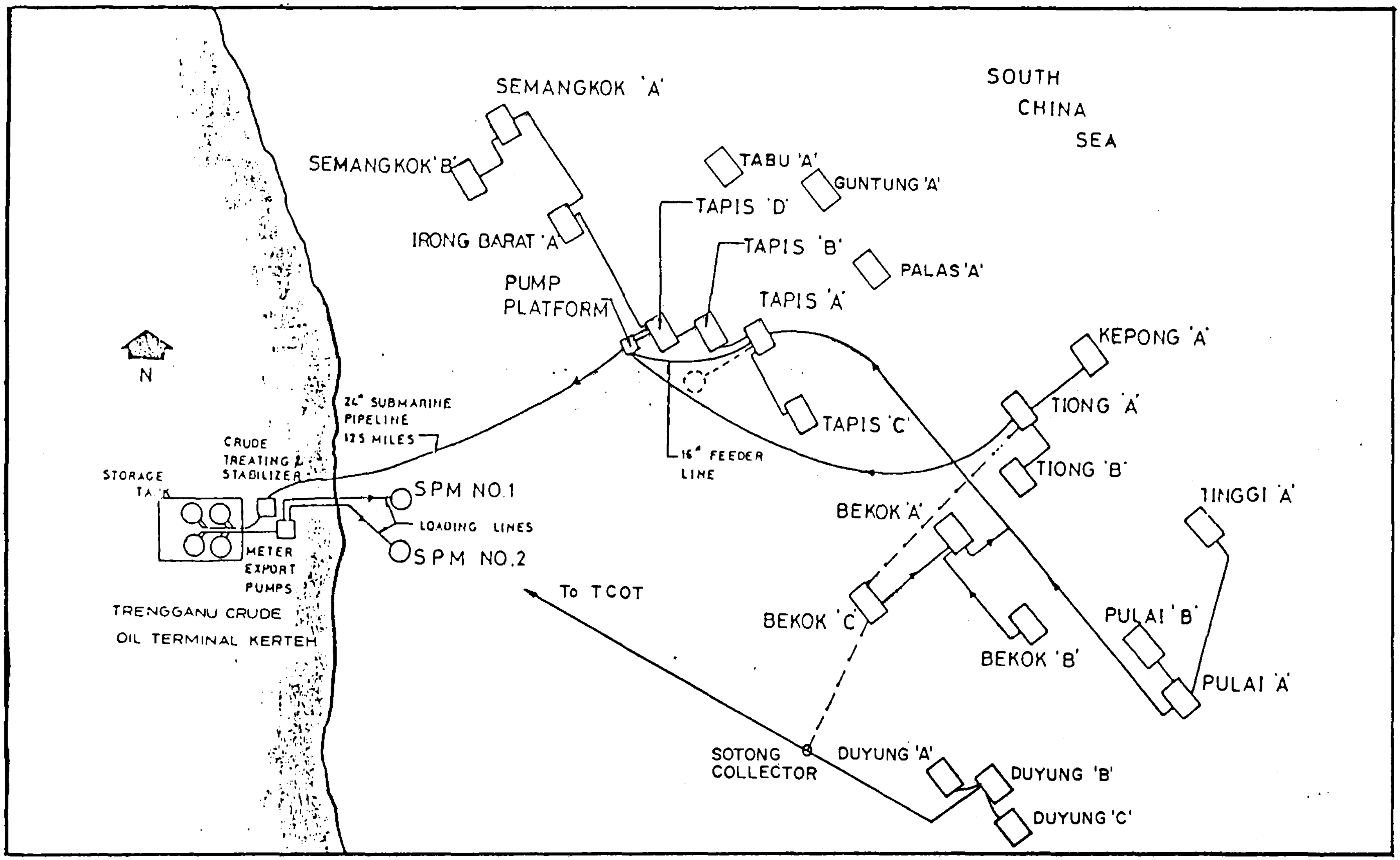


Fig. 4. Schematic layout of production platforms - offshore Trengganu, Malaysia.

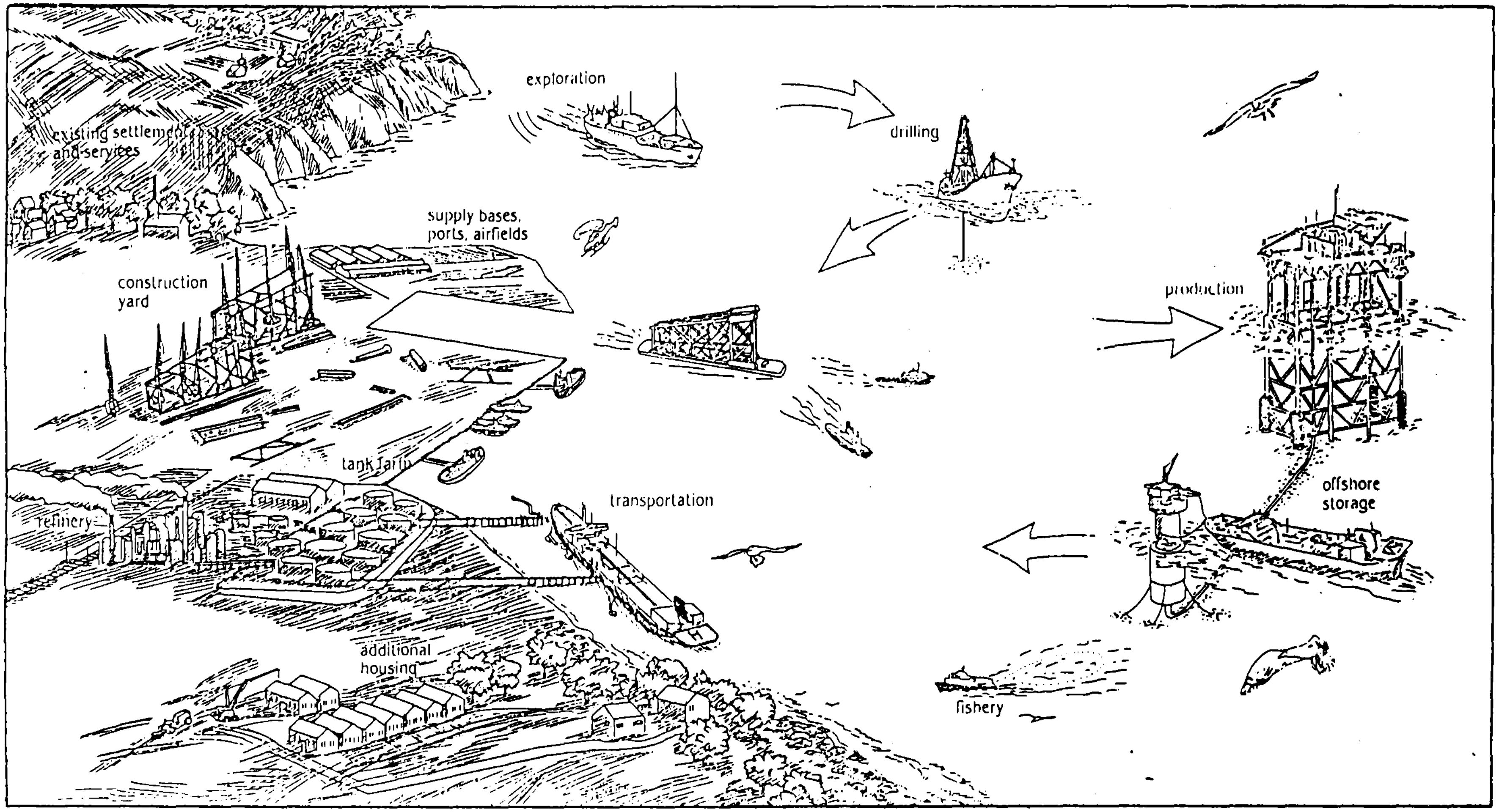


Fig. 5. General overview of petroleum activities (from Gilbert 1982).

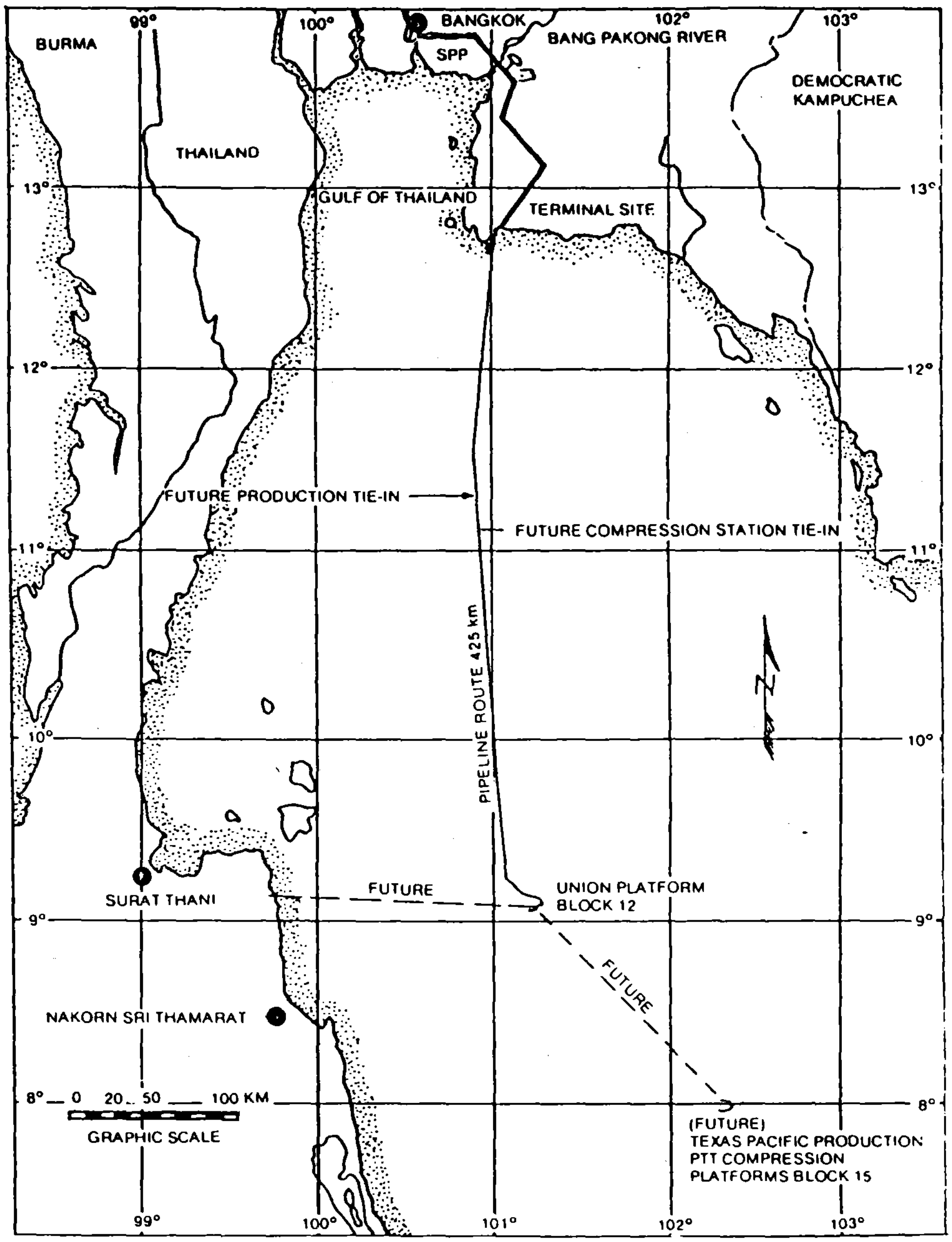


Fig. 6. PTT natural gas transmission system in the Gulf of Thailand.

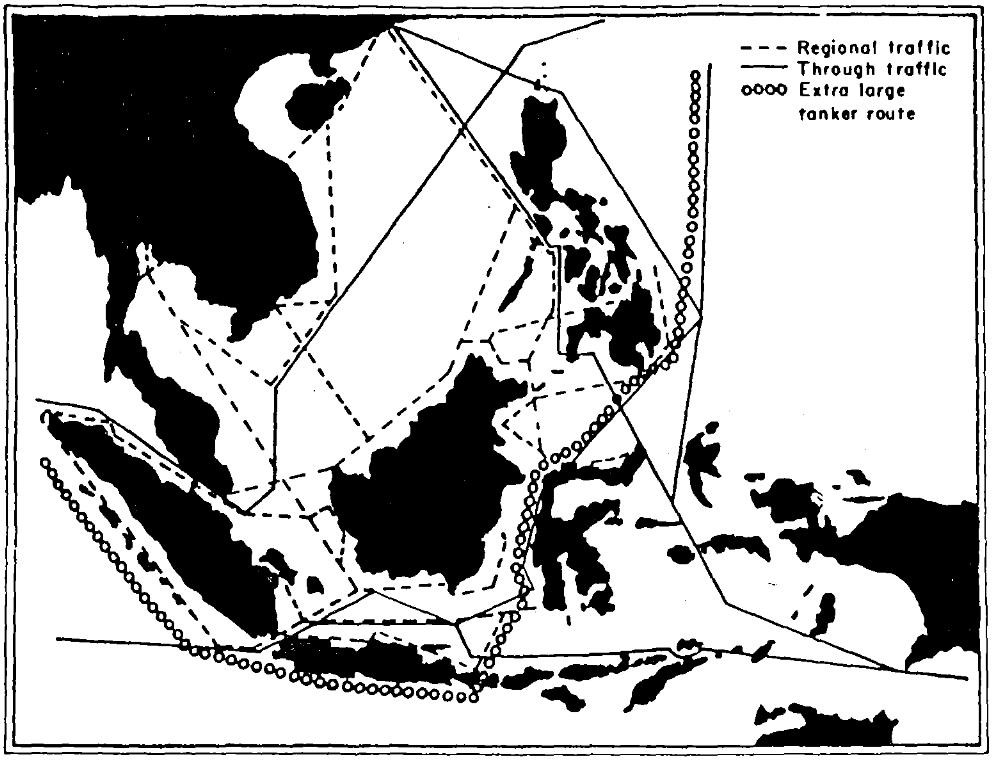


Fig. 7. Main shipping routes in Southeast Asia (after Finn et al. 1979).

Alternatives to the Malacca-Singapore Straits route are the Sunda and Lombok Straits. The former is deep and wide enough for deep-draft vessels but has limited water depths to the northeast. Selat Lombok is the safest route for vessels of over 200,000 dead weight tons (DWT) and is wide and deep enough for the largest tankers. Yet this strait also has its navigational hazards. In the narrower portions, there are tidal currents of up to 6 kn, and even in the broader regions of the passage speeds of up to 3.5 kn have been encountered (Sailing Directions 1979). The Selat Lombok route is used only by the largest vessels that cannot navigate the Malacca-Singapore Straits since the route entails a major detour and increased travel time and fuel costs.

Tidal currents affect navigation in Southeast Asian waters. Although tidal range is generally not great throughout the region, tidal currents can be strong, reaching up to 2.5 - 3 kn in some inshore areas. Occasional Sumatras (strong squalls from the southwest) are additional hazards. They are accompanied by thunder, lightning and rain, and greatly reduce visibility. Poor night visibility is frequently exacerbated by burning associated with shifting cultivation at the end of the dry season in southern Sumatra and by volcanic fallout.

6. Environmental aspects of petroleum offshore operations in ASEAN

Since oil business is international in nature and involves multinational oil companies, the industry's current practices and standards, in terms of its operations, are relatively uniform within a country or a region. In addition to operations carried out by the national oil corporations, majority of the current offshore fields in the region are operated by multi-national oil majors.

Pollution aspects, from seismic survey and exploration to production and transportation involved in offshore operations, are regulated by each country. An Environmental Impact Assessment (EIA) study is required on major offshore oilfield development by Malaysia, Indonesia, Thailand and the Philippines. Oily discharges such as the wastewater, drilling muds and cuttings, as well as oil spills are also regulated in all countries in the region.

Figure 8 depicts a typical wastewater treatment system of an offshore production platform in Malaysia and, generally, a similar system is installed in other countries in the region (Ahmad 1983).

Produced-water is treated both onboard the offshore platform and piped via submarine pipelines for further treatment at the storage terminal onshore. It is treated by a combination of coalescing and gravity separation techniques. The water passes through various gravity separators into the Corrugated Plate Interceptors (CPI) and sometimes further into air flotation separators. Onboard the platform, it is finally discharged to the subsea caisson for further separation.

At the storage terminal, treated water from the offshore platform is further treated in skimmer pits, dissolved air floating units, CPI/TPI and oxidation ponds prior to discharge to the sea via outfalls (Fig. 9).

Table 6 shows the monthly average of wastewater discharge quality at some offshore platforms in Malaysia for 1980. It is estimated that most of these platforms discharge within the limit of 100 mg/l (oil and grease content) as set by the Malaysian Exclusive Economic Zone Act, 1984. Table 7 reflects the discharge quality for a crude oil terminal in Malaysia. It is estimated that 270,000 m^3/mo of produced-water are discharged from offshore production platforms and 566,344 m^3/mo from the four crude oil terminals in Malaysia.

During drilling, special fluids normally called muds are used to contain well pressures, remove the drilled rock cuttings on the surface and to stabilise the borehold. These fluids have to be uniquely mixed to cope with the particular geological conditions encountered.

Many wells are drilled with water-based muds. However, certain geological formations (e.g., shales and salts) swell or dissolve in water,leading to a variety of problems of which borehole instability and borehold collapse are the most serious. Under such circumstances, it has been proven that a mud in which oil is the continuous phase (oil-based mud) appreciably reduces these drilling problems, increases drilling rates and reduces costs. An oil-based mud is an emulsion of water in light oil, typically 3 parts diesel to 1 part water, together with some of the other normal components that make up a water-based drilling mud. Table 8 shows the typical chemical composition of water-based mud in Malaysia's offshore operations. Use of oil-based mud in Malaysia requires prior approval of PETRONAS.

Normally during the drilling process, rock cuttings are carried from the hole by the drilling mud and then separated from the fluid. When water-based muds are used, the cuttings are disposed of without treatment. However, cuttings from wells drilled with oil-based muds have a film of oil adhering to their surface. The muds are so formulated that the oil fully wets the solids. This factor results in most of the oil being bound with the cuttings and falling with the solids to the sea-bed. Depending on the characteristics of the oil, the cuttings may require cleaning prior to disposal. Cuttings from the solids separation system are passed over vibrating screens or shale shakers where they are sprayed with washfluid. The cleaned cuttings are discharged and the underflow from the screens may be passed through hydrocyclones and centrifuges to separate the fines from the liquid. These fines which are a small proportion of the bulk are discharged and the liquid is returned to the wash system.

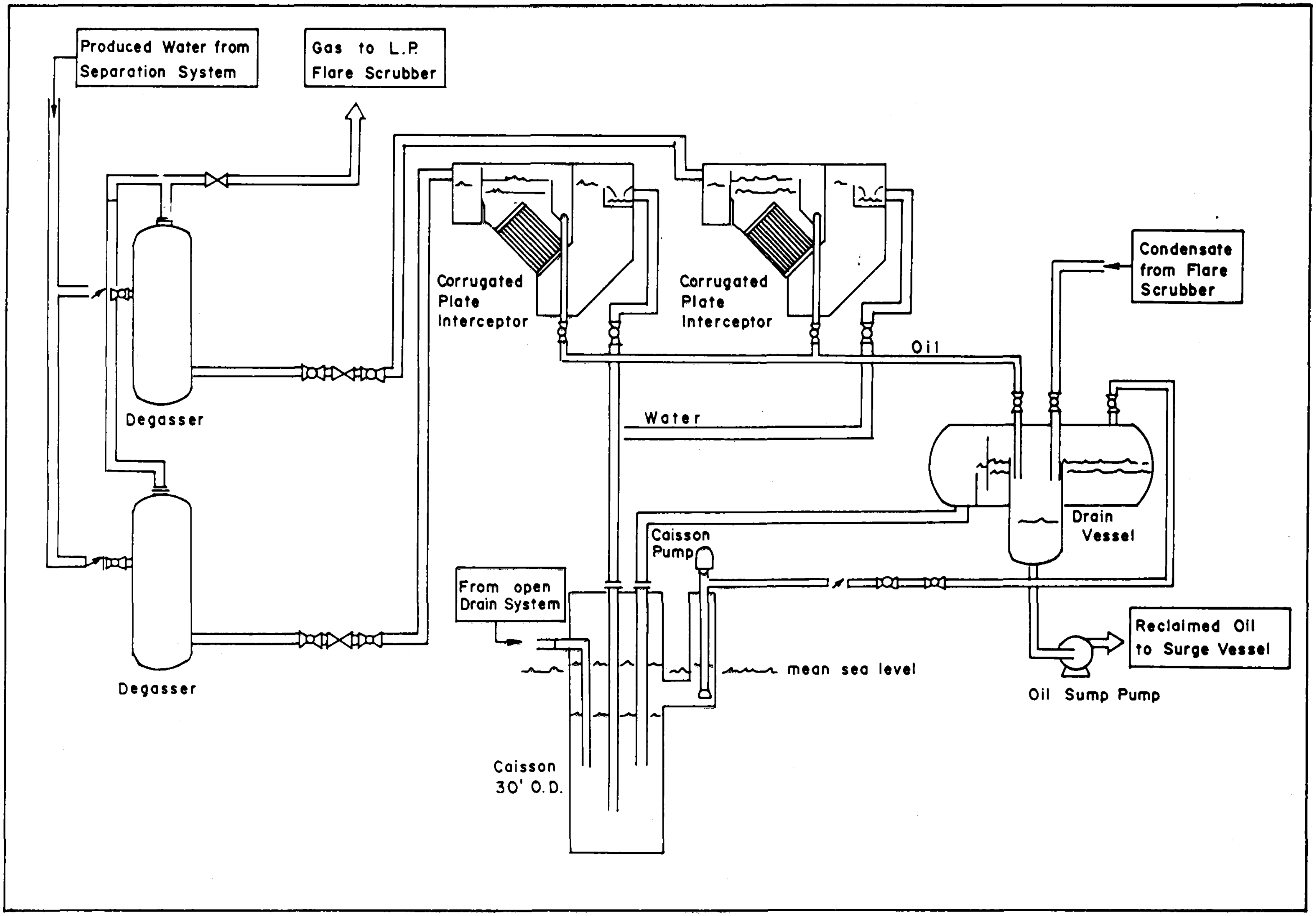


Fig. 8. A typical wastewater treatment system of an offshore production platform in Malaysia.

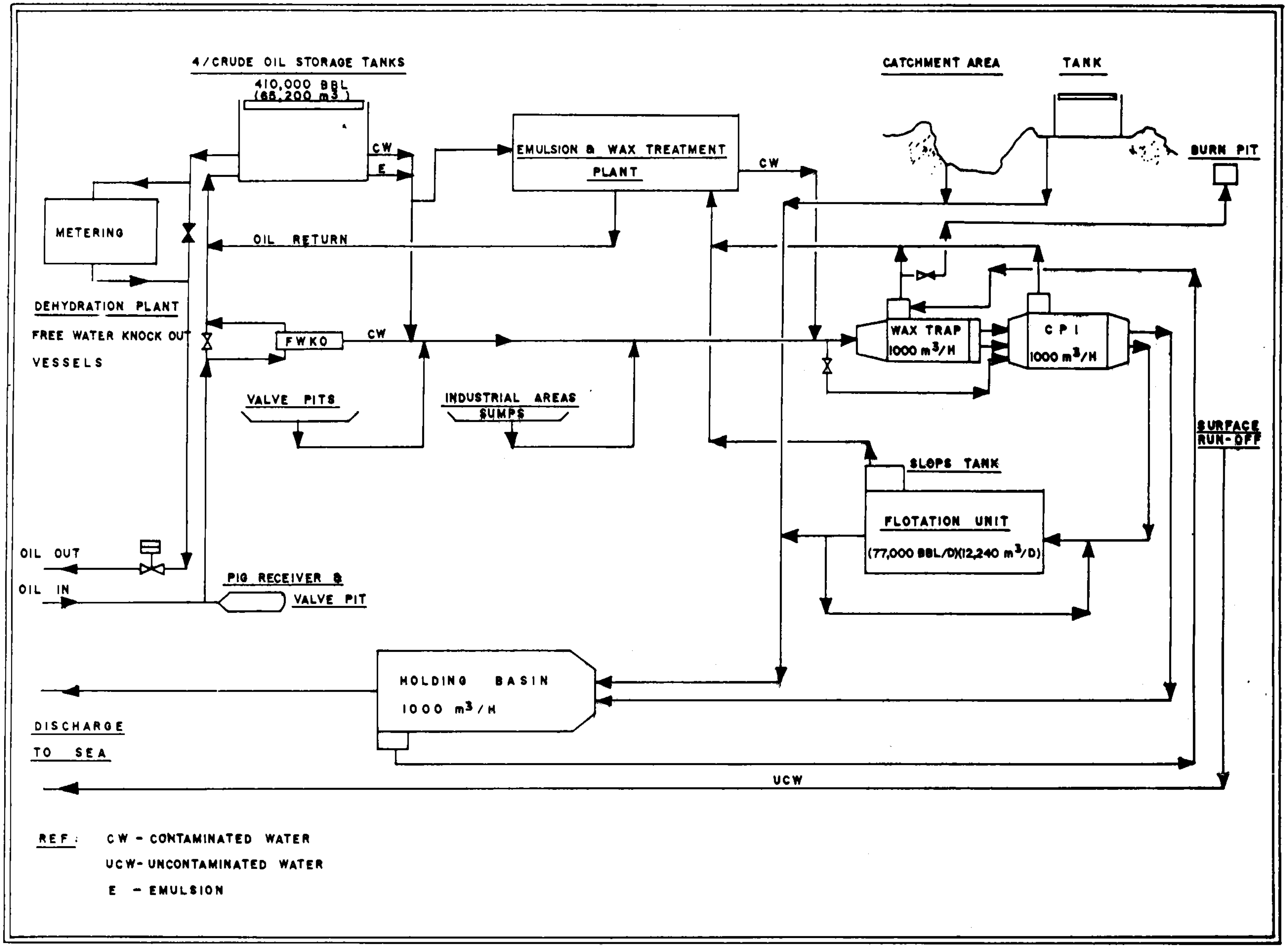


Fig. 9. A typical wastewater treatment system of a crude oil terminal in Malaysia.

Table 6. Monthly average of wastewater discharge quality at offshore production platforms, Malaysia: oil content (mg/l)

Month (1986)	Platforms					
	Pulai A	Tapis D	Tapis A	Tinggi A	Bekok A	Bekok C
January	36	29	11	10	21	11
February	36	8	6	57	9	68
March	30	8	0	54	61	11
April	31	29	24	46	25	58
May	33	1	-	35	21	37
June	34	13	1	101	18	6
July	29	6	15	249	9	19
August	29	12	37	139	24	27
September	33	20	37	45	152	-
October	33	3	102	46	162	-
November	32	9	57	61	189	-
December	0	0	720	-	-	-

Source: Exploration and Production Division, PETRONAS.

Table 7. Typical discharge-water quality from a crude oil terminal in Malaysia

Month: July 1987 — Sample Point: DAF Surge Tank Outlet

pH			Temperature °C			BOD_5 (mg/l)			COD (mg/l)			TSS (mg/l)			Oil and grease, ppm Infrared: Freon extractable			Oil and grease, ppm Infrared: Free oil		
AV.	MAX.	MIN.	AV.	MAX.	MIN.	AV.	MAX.	MIN.	AV.	MAX.	MIN.	AV.	MAX.	MIN.	AV.	MAX.	MIN.	AV.	MAX.	MIN.
7.4	7.9	6.6	36	40	31	1109	1702	440	2198	4340	790	44	70	11	56	102	21	6	14	2

Total volume of effluent discharged that month 18354 KL

Table 8. Typical chemical composition of water-based drilling mud used in Malaysia's offshore operations

Product/Chemical Name	Description and Chemical Composition
1. Barite	Barium Sulphate (inert). $BaSo_4$
2. Bentonite	Sodium Montmorillonite clay (reactive)
3. Caustic Soda	Sodium Hydroxide flake (toxic). NaOH
4. Soda Ash	Sodium Carbonate powder. Na_2Co_3
5. Lime	Calcium Hydroxide powder. $Ca(OH)_2$
6. Aldacide	Paraformaldehyde powder (toxic). $(CH_2O)_x$
7. Dextrid	Stabilised partially destrinised polysaccharide powder (toxic)
8. Salt	Sodium Chloride granular (non-toxic). NaCl
9. Pac-R	Polyanionic cellulose
10. Desco	Modified tannin
11. Surflo W-300	Alcohol base defoamer
12. Condet	Water solution of anionic surfactants
13. XCD Polymer	High molecular weight X anthum gum
14. O-Broxin	Modified Ferrochrome Lignosulfonate
15. EZ-SPOT	Oil mud concentrate of blended emulsifiers, lubricants and gellants
16. TORQ-TRIM	Blended liquid triglycerides and alcohol
17. Wall-nut	Granular nut hulls
18. Bicarbonate of soda	Sodium Bicarbonate powder. $NaHCO_3$

Other forms of discharges, such as deck drainage and sanitary wastes are properly treated onboard offshore platforms prior to disposal to the sea. Solid wastes (domestic and industrial) are normally transported to shore.

With regards to contingency planning for oil spills,all operators have their Response Plans with the necessary equipment onboard offshore platforms, onshore terminals and supply bases. Some of the oil majors have their regional plans among their Affiliates in the region and share in the Tiered Area Response Capability (TARC)'s stockpile of equipment based in Singapore.

6.1 Oil pollution in the ASEAN marine environment

Sources and the extent of oil pollution in the ASEAN marine environment are also discussed in the paper by the Ministry of State for Population and the Environment, Indonesia (this volume).

Oil enters the marine environment by a number of different routes as a result of human activities and natural processes. Environmental problems from oil operations can arise at any stage from exploration to transportation, and more acutely during consumption of petroleum products.

The various sources of both land-and marine-based oil pollution of the ASEAN marine environment have been studied, among others, by WHO's Western Pacific Regional Centre for the Promotion of Environmental Planning and Applied Studies (PEPAS) (Malaysia), by the Marine Pollution (Petroleum) Monitoring Pilot Project (MAPPMOPP) of the Integrated Global Ocean Survey System (IGOSS) and by Bilal and Kuhnhold (1980). The current East Asian Seas Program on the survey and monitoring of oil pollution is expected to further probe into the state of oil pollution in the ASEAN region. Water quality monitoring which is normally carried out by oil operators can supplement baseline regional dataon oil pollution. However, these data are not being fully tapped for incorporation into a regional analysis.

Marine oil pollution in the ASEAN region is caused mostly by:

(a) the utilization of petroleum-related products such as fuel and lubricating oils for transportation, industrial activities and power generation;

(b) the direct discharge of untreated municipal and industrial wastes containing refined and partly weathered oils through sewers and rivers;

(c) the discharge of effluents generated in the production and processing of crude oil from offshore platforms and refineries; and

(d) oil spillages arising from tanker accidents, tank washings, deballasting operations, oil terminals, ports and supply bases.

It should be noted that contamination from the discharge of oily bilge waters and spillage of gasoline from large vessels and small craft used by fishermen is felt on an increasing scale in various coastal waters.

The phenomena of oil pollution occurs mostly in waters off densely populated areas, like big cities, major ports and locations with oil activities. In the open seas, the Straits of Malacca and the South China Sea region might presently be the areas most endangered by oil pollution. Considering that the biggest contributions of hydrocarbons entering the marine environment come from terrestrial sources, Table 9 may give some insight on the major polluting industries in the region.

Existing hydrocarbon concentrations in ASEAN waters have been measured in the open seas and coastal waters. Concentrations vary widely in the region, but in coastal areas they are generally more than 1000 times higher than the baseline measurement in the open sea.

Southwest of Singapore in the Riau Archipelago, hydrocarbon quantities ranged from 1 to 11.5 ppm. In waters off Indonesia, concentrations ranging from 0.3 to 1.1 ppm were found north of Jakarta, in the vicinity of the Cinta and Arjuna oil terminals. Hydrocarbon levels of 0.4 - 1.2 ppm were measured in Pangkalan Susu, and concentrations of 1.2 - 1.5 ppm off Dumai (Table 10, Fig. 10). In the Philippines, hydrocarbon pollution is most evident in Manila Bay (Table 11).

Table 10. Hydrocarbon contamination in harbours and terminals, Indonesia (Muchtisar and Muluk 1977)

Various waters			
Vicinity	Av. ppm	Year	Location
Cilacap (Refinery, Terminal, Harbour)	0.2	1977	Estuary
	11.9	1977	
	0.5	1977	
Pangkalan Susu (Terminal)	0.8	1978	Coastal/Shore
	0.9	1978	
	0.6	1978	
Pangkalan Brandan (Refinery, Lubrication Oil Plant)	0.5	1978	Estuary
	0.4	1978	
	1.2		
Sorong (Irian Jaya, Terminal)	0.2	1978	Coastal/Shore
	2.6	1978	

Table 11. Petroleum hydrocarbon in Philippine waters (after Gomez 1986).

Location	Year	Oil content, ppm
South Harbor, Manila	1978	1.76 - 5.11
		0.20 - 14.50
North Harbor, Manila	1978	2.27 - 5.47
		0.25 - 8.00
Cavite	1978	1.89 - 5.62
		0.14 - 6.00
Cebu	1978	0.66 - 5.05
Davao	1978	1.24

Table 9. Major polluting industries in some ASEAN countries

Location	Water Pollutants				Air-borne pollutants from fuel burning sources						
	Total BOD[c] (10^3 t/yr)	Domestic (%)	Indus-trial (%)	Major polluting industries	Total (10^3 t/yr)	Power genera-tion (%)	Indus-trial (%)	Domestic (%)	Transport (%)	Wood burning (%)	Petroleum refineries (%)
1. Manila	130.0	75	25	Food and beverage; textile; paper mills	447	30.0	8.6	negligible	61.4		
2. Jakarta	43.2	74	26	Food and beverage; textile; detergent; paper mills	545	11.7	10.9	6.2	72.2		
3. East Java	129.7	58	42	Food and beverage; textile	249	7.0	24.4	8.9	59.7		
4. Penang	9.5	64	36	Food and beverage; textile; pig farming	30.6	-	30.0	0.5	69.5		
5. West Coast, Peninsular Malaysia	133.8	61	39	Palm oil; rubber; textile; food and beverage; pig farming	876.7	47.4	10.2	negligible	24.0	15.8	2.6
6. South Coast, Peninsular Malaysia	10.7	40	60	Palm oil; rubber; food and beverage; pig farming	76.9	30.6	5.9	negligible	51.8	11.6	
7. East Coast, Peninsular Malaysia	25.0	85	15	Palm oil; rubber; food and beverage; pig farming	65.5	-	35.1	0.5	52.8	11.6	
8. East Malaysia	30.7	66	34	Palm oil; rubber; food and beverage	65.0	7.0	34.0	0.5	53.2	5.3	
9. Bangkok[a]	83.0	93	7	Breweries; food manufacturing	304	11.6	31.2	0.4	56.8		
10. Coastal area around Upper Gulf, Thailand[b]	92.6	10	90	Tapioca starch; pulp and paper mills	250	65.6	14.1	0.1	20.2		

Source: WHO/PEPAS, FP/05 03-79-10, 1981.

Note: a The low percentage for industrial water pollution is due to the fact that the majority of discharges from industrial premises are upstream of the Bangkok Metropolitan Authority area and are therefore not included.

b The high percentage for industrial water pollution is due to the high industrial load from the East Coast.

c Based on 300 working d/yr for industrial load and 365 d/yr for domestic load.

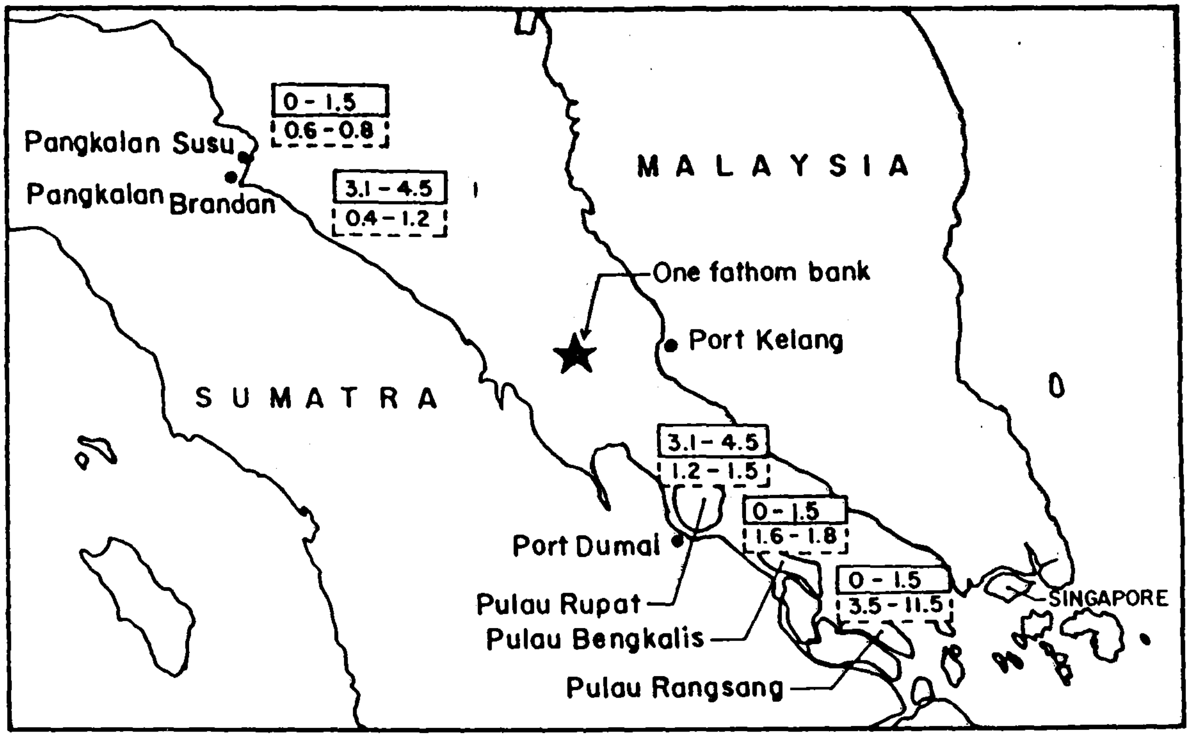


Fig. 10. Hydrocarbon concentrations (ppm) in the waters of the Straits of Malacca. Figures in solid boxes represent concentrations in surface samples, in dotted boxes, of sub-surface samples (LEMIGAS 1975).

In Peninsular Malaysia, concentrations are on the order of 0.1 to 0.2 ppm for the eastern coast waters, while at Penang (west coast), the measured level is 0.12 ppm. During the period 1980 - 1983, the degree of pollution (mainly from oil and grease) on the Malaysian side of the Johore Strait was more serious compared to the Singaporean side, although it was found to be increasing on an alarming trend for both sides. The high level of pollution particularly on the east side of the strait was associated with the relatively high intensity of shipping activities in the port of Johore. In 1984, due to concerted efforts to control oil pollution from vessels, the quality of waters in the Strait of Johore improved considerably, although much of the improvement took place on the Singaporean side.

However, in 1985 oil contamination on the Malaysian side was reportedly less compared to Singapore (DOE 1986).

The mean oil and grease concentration from the Singapore side decreased significantly from 5.1 mg/l in 1980 to 2.0 mg/l in 1985, on the east side of the strait. On the western side of the strait, the mean concentration remained at 2 mg/l for the same period. Notable also is the significant reduction of the mean concentration of oil from 4.2 mg/l to 1.0 mg/l and of grease from 4.8 mg/l to 2.0 mg/l, in the west and east coasts of Singapore during the period 1980 - 1985. It should be noted, however, that part of the contamination was contributed by discharges from land-based industries (Gomez 1986).

A large volume of oil discharge also comes from normal shipping operations like tank cleaning, dry-docking, bunkering and cargo loading and unloading in the region. Oil released during deballasting operations is in the form of tar lumps and weathering produces tarry residues and tar balls.

Monitoring of tar on the beaches and of dissolved petroleum hydrocarbons in the Gulf of Thailand was initiated by the Department of Marine Science, Chulalongkorn University in 1976 in relation to its participation in the MAPMOPP (Marine Pollution Monitoring Petroleum Programme). Recently, at the request of the National Environment Board of Thailand, the Department conducted a one-year survey of petroleum hydrocarbons in sea water, sediments and other selected marine organisms. Petroleum hydrocarbon levels in selected marine organisms are shown in Table 12.

Table 12. Petroleum hydrocarbons in marine organisms in Thailand (μg/g dry weight)

Organism	Concentration, ppm
Threadfin fish	0.117
Flounder	0.598
Black pomfret	0.415
Short-necked clam	0.462
Green mussel	0.059
Cockle or blood clam	2.376

Bilal et al. (1982) reported some areas in the region that had quite significant contamination with tar balls. Concentration of tar balls in Northern Luzon, Philippines was around 0.630 kg/km^2 but reached as much as 1.6 kg/km^2 northeast of this area in 1978. For Indonesia, there were reports of stranded tar balls in two beaches: Pulau Putri in 1970 and Pulau Tidung in 1972. Density of stranded tar balls could reach about 2,000 g/m^2. Stranded tar balls were also found on the south coast of Java and on a few beach areas in Malaysia.

With regards to impacts of oil pollution on marine resources, numerous studies have been conducted in the region. These include works on tainting of beach clams in the Gulf of Thailand (Piyakarnchana et al. 1977), pollution of mangroves in Southeast Asia (Gomez 1980), and effects of oil on mangroves (Mathias 1978, Baker et al. 1980, Soegiarto and Polunin 1981). Research on hydrocarbon utilization by marine bacteria (Thayib et al. 1977), and on the effects of oil on fish and shrimps (LEMIGAS; University of Science, Malaysia) has started.

Recent studies on macrobenthos in the vicinities of crude oil terminals and offshore platforms in Malaysia by Leong et al. (1985) indicate that the impact of discharges was localised and was hardly detectable beyond 200 m from the discharge point (Table 13). This and similar studies were commissioned by the National Oil Company (PETRONAS), Malaysia. Coastal resources vulnerable to oil spills in Malaysia have been identified by various studies. Portions of sensitive coastlines in the east coast of Peninsular Malaysia have been mapped in the form of an Environmental Sensitivity Index (ESI) Map.

Oil spill trajectory and dispersion models have been made for some offshore locations in Malaysia by Chua and Mathias (1978) and Chua and Charles (1980).

Table 13. A summary of various parameters for Bintulu, Labuan and Miri intertidal study sites and West Lutong, Temana and control offshore sites (after Leong et al. 1985)

Site	Bintulu		Labuan			Miri		West Lutong	Temana	Control
Parameters	Control	Discharge	Control	Discharge	Intermediate	Control	Discharge			
TOE	14 ppm	43 ppm	107 ppm	5972 ppm	74 ppm	16 ppm	371 ppm	129 ppm	215 ppm	87 ppm
AL + AR	0.14 ppm	2.6 ppm	7.7 ppm	1348 ppm	20 ppm	4.1 ppm	117.4 ppm	2.79 ppm	2.0 ppm	-
Vanadium	10 ppm	10 ppm	20 ppm	20 ppm	20 ppm	10 ppm	10 ppm	61 ppm	47 ppm	25 ppm
Nickel	1 ppm	2 ppm	3 ppm	3 ppm	3 ppm	3 ppm	3 ppm	23 ppm	23 ppm	13 ppm
Chromium	2 ppm	2 ppm	6 ppm	36 ppm	6 ppm	2 ppm	2 ppm	17 ppm	18 ppm	8 ppm
Total number of organisms	588 ± 389	185 ± 70	36 ± 43	71 ± 129	620 ± 250	2546 ± 5194	508 ± 727	188	308	882
Total number of species	11 ± 3	6 ± 2	1.8 ± 1.8	1.3 ± 1.0	3.4 ± 2.5	13 ± 7	8 ± 3	40	34	28
Total number of crustaceans	331 ± 229	47 ± 48	21 ± 31	69 ± 131	61 ± 116	322 ± 281	161 ± 224	50	36	501
Total number of molluscs	180 ± 150	80 ± 73	0	0	0	2118 ± 5189	402 ± 704	56	180	191
Total number of polychaetes	74 ± 118	46 ± 53	15 ± 12	0	559 ± 130	97 ± 120	40 ± 43	69	45	178

7. Cooperation in marine pollution combatting among ASEAN countries

The ocean is a continuous fluid medium. Environmental pollutants and their impacts can be transmitted across national boundaries as they inevitably spread under the influence of winds and currents.

In recognising that marine oil pollution cannot be contained within political boundaries, ASEAN countries have emphasized the need for close cooperation in the protection and conservation of the coastal and marine environment in the region. The need is greatly felt in the ASEAN region because of geographical proximity of neighbouring states, the similar characteristics of their coastal and marine environment, and the common environmental problems they face.

Regional cooperation in the prevention and control of marine pollution in ASEAN actively started as a result of the decision of the UNEP Governing Council in 1977 (Decision 88 (v), Oceans), although initiatives were taken much earlier by the countries of the region in preparation for the Stockholm Conference in 1972. Prior to the implementation of the action plan for the protection and development of the marine and coastal areas of the East Asian Seas in 1981 by the ASEAN countries and UNEP, there were several regional arrangements already established. The Council on Safety of Navigation and Control of Marine Pollution in the Straits of Malacca/Singapore or the Tripartite Committee was formed in 1971. Under the umbrella of the ASEAN, its Marine Pollution Experts Group was formed in 1973 and subsequently this group formulated the ASEAN Contingency Plan for combatting oil spills in 1975. In the same year, ASCOPE was formed and is currently one of the most active groups dealing with oil pollution as a consequence of petroleum activities in the region.

The ASEAN regional environmental programs have reached ministerial level at the First Ministerial Meeting on the Environment of ASEAN in 1981. At this meeting the "Manila Declaration on the ASEAN Environment" and the "ASEAN Environment Programme (ASEP) - I" were endorsed. Priority areas were established in accordance with the common interests of the region, viz., marine environment (East Asian Seas action plan), environmental management, nature conservation, industry and environment, environmental education, and training and information exchange. The implementors of ASEP are members of the ASEAN Experts Group on the Environment (AEGE) established in 1978 under the umbrella of the ASEAN Committee on Science and Technology (COST).

With regard to the ASEAN marine environment program, the East Asian Seas action plan was adopted at inter-governmental meetings in 1981 and subsequently a Coordinating Body on the Seas of East Asia (COBSEA) and an EAS Trust Fund were established in cooperation with the United Nations Environment Programme (UNEP). The EAS program includes assessment of oceanographic phenomena, oil pollution, toxicity of oil dispersants, non-oil pollutants, coral ecosystems, and land-based pollution sources, among others.

7.1 ASCOPE cooperation on environment and safety in the ASEAN petroleum industry

Besides focusing its efforts towards achieving an energy independence in the region, ASCOPE has been instrumental in promoting collaborative programmes in the technical, economic and legal aspects of the ASEAN petroleum industry. Through a joint and integrated effort among its three main Working Committees (Technical, Economic and Legal) some of the areas of cooperation that are being actively undertaken since 1976 are in the field of environment and safety of petroleum operations.

ASCOPE cooperation on environment and safety has been one of the major and regular agenda and work programmes of the ASCOPE Technical Committee. Within the Technical Committee, there is a specialised group, the "ASCOPE Study Group on Environment and Safety" (ASGES) which implements approved work programmes. ASCOPE programmes are not exclusively for member countries only. These are generally open to participation by multinational oil companies, government agencies or other interested parties in and outside the region. ASCOPE cooperative programmes on environment and safety include routine exchange of information and data, training, organization of technical workshops, seminars, etc. (Table 14) and formulation of guidelines, standards, contingency plans and conventions.

Table 14. Major environment and safety-related workshops, conferences, seminars, etc. organised by ASCOPE or jointly with its collaborators.

1. 1st ASCOPE Conference and Exhibition, October 11 - 13, 1977, Jakarta (various sessions).
2. Workshop on "Oil Spill Prevention and Control", October 13 - 17, 1980, Singapore.
3. Course on "Oil Pollution Control", September 8 - 10, 1981, Kuala Lumpur.
4. Workshop on "Industrial Safety in Petroleum Industry", June 8 - 10, 1981, Manila.
5. 2nd ASCOPE Conference and Exhibition, October 7 - 11, 1981, Jakarta (various sessions).
6. Joint ASCOPE/EAST-WEST CENTER ENVIRONMENT AND POLICY INSTITUTE Workshop on "Environmental Planning Guidelines for Offshore Oil and Gas Development", September 27 - 30, 1982, Jakarta.
7. Workshop on "Technical Aspects of Geological and Natural Environmental Hazards", March 20 - 30, 1983, Jakarta.
8. 2nd EAPI (EWC)/ASCOPE/CCOP/IOC Workshop on "The Geology and Hydrocarbon Potential of the South China Sea and Possibilities of Joint Development", August 22 - 26, 1983, East-West Center, Honolulu.
9. Joint ASCOPE/E & P Forum Regional Seminar on "Technical Aspects of Oily Water Discharges from Offshore Operations", November 3 - 4, 1983, Jakarta.
10. Joint CCOP/ASCOPE/NECOR Workshop on "Offshore Safety", March 5 - 9, 1984, Jakarta.
11. Joint NECOR/ASCOPE/CCOP Workshop on "Offshore Safety Regulation", October 7 - 11, 1985, Bangkok.
12. 3rd ASCOPE Conference and Exhibition, December 2 - 5, 1985, Kuala Lumpur (various sessions).
13. Joint CCOP/ASCOPE/NECOR Seminar on "Regional Cooperation on Oil Spill Contingency Planning Response", August 4 - 8, 1986, Kuala Lumpur, Malaysia.
14. Joint CCOP/ASCOPE/NECOR Workshop on "Quality Assurance/Control of Offshore Petroleum Industry", September 21 - 26, 1987, Manila.

A number of ASCOPE programmes have been undertaken jointly with collaborators, such as the Committee for Coordinating of Joint Prospecting for Mineral Resources in Asian Offshore Areas (CCOP), Norwegian Engineering Committee on Oceanic Resources (NECOR), International Exploration and Production Forum (E & P Forum) and East-West Center, Environment and Policy Institute (EAPI). ASCOPE has been closely following the development of the East Asian Seas programs, especially those relevant to the petroleum industry in the region, by attending several COBSEA meetings since 1984.

Among the current major programmes on environment and safety are the following:

ASCOPE Environmental Information and Data Bank (AEIDB)

ASCOPE member countries have been regularly exchanging and updating among themselves, and other interested parties, relevant information and data in the field of petroleum. To further enhance and facilitate continuous and open communication, a Memorandum of Understanding on Exchange of Petroleum Information and Data was adopted by the ASCOPE Council in 1978 (ASCOPE Secretariat 1980).

One of the existing "banks" is the ASCOPE Environmental and Safety Information/Data Bank. Current developments on this programme include systematising the acquisition, collation, updating, retrieving and production of existing information and data. An AEIDB manual was published in October 1987.

ASCOPE Plan for the Control and Mitigation of Marine Pollution (APCMMP)

A regional oil spill contingency and response plan called APCMMP was formulated by ASCOPE, among others, to enhance and augment national capabilities and effectiveness of response to combat oil spills. The APCMMP was adopted by member-countries in 1980, and its operational features and institutional arrangements are continuously being updated.

The APCMMP aims to contain spills resulting from petroleum exploitation, production, and coastal refining and terminal activities since the ASEAN Contingency Plan and others cater to spills resulting from shipping activities and other sources. The APCMMP currently has no common stockpile of equipment. The available resources of in-country oil companies will be tapped and mobilised for this programme. The plan's Operational Handbook is continually updated to ensure currency.

Presently, ASCOPE is refining the operational capabilities of the APCMMP and is devising ways to establish equipment and resource stockpiles in strategic locations in ASEAN. Considering that there are other similar plans in the region, APCMMP ultimately aims to integrate and pool existing capabilities into one to strengthen regional capabilities in responding to a major oil spill.

Drafting of technical guidelines/convention for "An Agreement on Equal Right of Access and Non-Discrimination for Damage Claims Relating to Transfrontier Pollution Resulting from Offshore Operation"

Although there are contingency plans on cooperation and assistance with respect to transfrontier marine pollution in the region, the institutional, diplomatic, and legal arrangements on the right of access of one nation to a neighbouring country, as well as mechanisms for the application and settlement of damage claims, etc. are currently inadequate. There are international liability funds such as CRISTAL, and conventions, such as the International Convention on Civil Liability for Oil Pollution Damage which only cover liability for spillage from tankers.

With regards to similar arrangements for pollution resulting from offshore exploration and production activities, there is a liability agreement called the "Offshore Pollution Liability Agreement (OPOL) (1974)", which is currently restricted to the North Sea operations. Realising that a liability arrangement similar to OPOL does not exist in the ASEAN region, ASCOPE has taken the initiative to establish an appropriate legal instrument. Based on detailed studies conducted by both the ASCOPE Technical and Legal Committees, a convention on "An Agreement on Equal Right of Access and Non-Discrimination for Damage Claims Relating to Transfrontier Pollution Resulting from Offshore Operations" has been drafted. Although the draft is still in the preliminary stages, it has been transmitted to relevant government agencies in the region for review and comment.

A series of dialogues with all concerned parties in the region is a prerequisite for further development of this proposed convention. The draft has also been deliberated on at previous COBSEA meetings. It is ASCOPE's intention to ensure an expeditious adoption of the convention by the governments in the region.

Guidelines for common regulations on safety and environmental protection for offshore drilling, production activities and marine transportation

Although environment and safety records of petroleum activities in this region are relatively good, ASCOPE does not remain complacent. It is continuously ensuring that its own activities, and those of others, maintain high safety standards. In order to suit local and/orregional conditions, ASCOPE has developed regulations on safety and environmental protection for offshore drilling, production activities and marine transportation.

Part I of the ASCOPE guidelines on the "Essential Elements in Operational Planning" was adopted by member countries in 1981. Part II on "Offshore Oil and Gas Environmental Guidelines" was adopted in 1983. These guidelines cover environmental and safety aspects from the early development stage of offshore operations to production and transportation. They are also being field-tested in each member country prior to consideration of the practicality of adopting common guidelines on environmental and safety standards in the region.

Formulation of energy conservation policies and strategies

Guidelines on energy conservation have been jointly formulated by the Technical and Legal Committees which may serve as policy-makers of ASCOPE member countries in drawing up policies and programmes so as to fit the priorities set in each country. With regards to petroleum handling, all members recorded progress by subscribing to standard methods toward minimising loss of petroleum in processing, storage and tank cleaning. On utilization of waste energy, some member countries have undertaken R and D projects on agri-based alcogas, methanol and recycling of lube oil (ASCOPE Secretariat 1980).

Cooperation on environment and safety research and studies

In the ASCOPE AEID Bank, a list of environment and safety related research and studies of the region's petroleum industry is being continuously updated. In addition to the application of useful information available in the AEIDB, ASCOPE is also planning to conduct joint research/studies among member countries. A joint mapping work in connection with the Environmental Sensitivity Index of Coastal Resources Vulnerable to Hydrocarbon Pollution and Oil Spill Trajectory Modelling is being considered. This type of joint research will provide the opportunity for member countries to share their expertise and to pool their resources. Joint studies with external collaborators are also being considered.

7.2 Cooperation of oil companies

In addition to ASCOPE cooperation directly among the state oil corporations in the region, the resident major multi-national oil companies in each ASEAN country are also cooperating among themselves, particularly in the area of oil spill contingency planning and response. However, it should be mentioned that these oil companies are taking part in some of the ASCOPE programmes.

At the local level, most oil companies including the state-owned ones belong to a group or committee which deals collectively with, among others, environmental and safety aspects of their operations. In Malaysia, this group is called the Oil Industry Committee on Environmental Conservation. In Thailand, a parallel group is the Oil Industry Environmental Safety Group, and in the Philippines, the Oil Industry Emergency Mutual Aid Organisation. These groups represent the industry in government meetings which address environmental affairs of the petroleum industry. In Malaysia, the National Oil Company (PETRONAS) represents the oil industry in the National Environmental Quality Council (EQC) which is the highest environmental body and advisor to the Minister of the Environment. It should be mentioned here that most resident oil companies form Oil Spill Cooperatives which pool stockpiles of equipment at major centers of petroleum operations.

At a regional level, major oil companies such as ESSO, Shell, etc. cooperate on the environmental aspects of their activities. The most notable demonstration of the oil industry's cooperation recently in the region is the establishment of the TARC's (Tiered Area Response Capabilities) stockpile of oil spill equipment in Singapore in 1983. The stockpile, worth US $2 million, is shared by BP, Caltex, Esso, Mobil and Shell and is supposed to cater to spills of up to 10,000 t in the Malacca and Singapore Straits.

Resident oil companies are also very active in conducting and sponsoring studies and research related to their activities. For instance, in 1982 Exxon sponsored the University of Science of Malaysia in studies on the fate and effect of oil and dispersed oil on the tropical marine environment. PETRONAS (Malaysia) and its affiliates and contractors have conducted numerous studies relevant to the local petroleum industry (Tables 15 and 16).

7.3 Regional contingency and response planning for oil spills in ASEAN

Regional cooperative efforts in navigational safety and combatting transfrontier oil pollution were initiated by the establishment of the Council on Safety of Navigation and Control of Marine Pollution in the Straits of Malacca/Singapore (Tripartite Committee) in 1971 and followed by the formation of the Marine Pollution Experts Group in 1973. While these groups were deliberating a regional oil spill contingency plan, the region was hit by a massive oil spill in 1975 and again in 1976, both in the Straits of Malacca and Singapore. In fact, prior to these spills, there was a major spill of 9,000 bbl reportedly due to a vessel collision at the mouth of Chao Phraya river, Thailand in 1974.

Table 15. EIA studies conducted by PETRONAS, its operators, subsidiaries and joint ventures.

Completed

1. Trengganu Crude Oil Terminal
2. Dulang Oil Field Development Project, 1987
3. Gas Terminal (Slugcatcher) Project Phase II, 1986
4. Socio-Economic Impact Assessment Study of Petroleum Industries in Trengganu, 1984
5. Refinery, Kerteh, 1982
6. Gas Processing Plant, Kerteh
7. Malaysia LNG Plant
8. ASEAN Bintulu Fertilizer Plant

On-going

1. Environmental Impact Assessment Study on PETRONAS 2nd Refinery, Malacca
2. EIA Study on Peninsular Gas Utilisation (PGU) Stage II Project
3. Expansion of Gas Processing Plant and LPG Export Terminal

Source: Corporate Environmental Services, PETRONAS.

The major spills which affected the littoral states bordering the straits, caused by the grounding of the "Showa Maru" off Buffalo Rock, Singapore in 1975 (4,000 t Kuwait crude) and the collision of the "Diego Silang" in the Malacca Straits in 1976 (5,500 t Kuwait crude), brought home the reality of the region's vulnerability to oil pollution. These incidents also initiated efforts to tighten up navigational rules and the development of oil spill contingency planning and response plans in the region. After the "Showa Maru" spill, no less than 10 additional spills occurred in these straits in 1975.

Recently, three spills occurred in June and July 1987 in the Malacca and Singapore Straits. A Libyan-registered tanker (Elhani) ran aground on July 22 spilling about 2,000 M. T.of crude oil. An earlier grounding of a Liberian-registered tanker (Stolt-Advance) was reported on July 11 off Singapore waters. An extensive slick was sighted between the 2nd and 17th of June 1978 off Johore coast, Malaysia.

Table 16. EIA support studies conducted by PETRONAS, its operators, subsidiaries and joint ventures

<u>Completed</u>

1. Coastal Resources of West Sabah - An investigation into the impact of oil spill (1975).

2. Oil Residue Survey of East Coast Peninsular Malaysia (1977).

3. Coastal Resources of East Coast Peninsular Malaysia. An assessment of potential oil spills (1980).

4. Environmental Sensitivity Index Mapping of Dungun-Chukai Coastline (1983).

5. An Environmental Baseline Study of the Macrobenthos in the Vicinities of the Crude Oil Terminals in Sabah (Labuan) and Sarawak (1985).

6. Coastal Resources of Sarawak (conducted together with No. 5) (1985).

7. Biodegradation of Crude Oil in Sabah and Sarawak Marine Environment (1986).

<u>On-going</u>

1. Soil Erosion Study for Peninsular Gas Utilisation (PGU-Stage II) Project

2. Environmental Sensitivity Index (ESI) Mapping for Chukai-Kuantan Coastline

Source: Corporate Environmental Services, PETRONAS.

The major source of oil spills in Singapore waters were the shipping activities and their casualties (Table 17). Other spills occurred during bunkering operations. While vessel spills accounted for 47% to 55% of the spills observed in 1975 to 1977, spills from bunkering activities accounted for 33% to 41%.

Table 18 shows spill incidents (1984 - 85) from offshore operations in Malaysia. It could be seen that the amounts are environmentally insignificant, with the exception of the Bayan field spill of 7,065 bbl in 1984. Most of these spills were caused by minor leakages and instrumentation malfunction.

Considering the region's repeated experiences in oil spills, numerous contingency plans have been developed.

The ASEAN Oil Spill Contingency Plan was formulated in 1975, followed by the ASCOPE Plan (APCMMP) in 1980. On May 1, 1981, the Traffic Separation Schemes (TSS) for the Malacca-Singapore Straits recommended by IMO went into effect. Two major sub-plans were also developed, namely, for the Lombok/Makassar Straits and Sulawesi Sea, centered at Davao, Philippines, and the Tripartite Plan among Malaysia, Indonesia and Singapore to cater to spills in the Malacca and Singapore Straits in the early 1980's. A Revolving Fund worth 400 million yen was allocated for operational expenditures for spills involving Japanese tankers in the Malacca/Singapore Straits.

Table 17. Statistics of sources and causes of reported oil spill cases in Singapore during 1975 - April 1977 (Rahman *et al*. 1979).

Source	1975				1976				1977			
	Number of Incidents				Number of Incidents				Number of Incidents			
	Minor*	Medium*	Major*	Total	Minor*	Medium*	Major*	Total	Minor*	Medium*	Major*	Total
1. SEA AND COAST	44	3	3	50	52	2	1	55	39	4	1	44
<u>Vessels</u>	36	2	3	41	44	2	1	47	36	4	1	41
a) Bunkering	25	-	-	25	38	2	-	40	30	3	-	33
b) Oil/slop transfer	3	1	-	4	2	-	-	2	-	-	-	-
c) Bilge oil pumping	3	1	-	3	-	-	-	-	2	-	-	-
d) Ballasting	2	1	1	2	3	-	-	3	2	-	-	2
e) Collision, grounding (mostly tankers)	-	-	3	3	-	-	1	1	-	1	1	2
f) Leaks/accidents on board (including damaged vessel discarding oil)	3	1	-	4	1	-	-	1	2	-	-	2
<u>Coastal facilities</u>	5	-	-	5	8	-	-	8	3	-	-	3
a) Tank, pipe, drain leaks	2	-	-	2	8	-	-	8	3	-	-	3
b) Coastal runoff/overflow (mostly due to rain)	3	-	-	3	-	-	-	-	-	-	-	-
<u>Offshore facilities</u>	3	1	-	3	-	-	-	-	-	-	-	-
2. LAND/URBAN RUNOFF	-	-	-	-	-	-	-	-	-	-	-	-
3. UNIDENTIFIED	22	2	-	24	43	-	-	43	39	-	-	39
TOTAL	66	5	3	74	95	2	1	98	78	4	1	83

*Minor: 1 t oil spill
*Medium: 1-100 t oil spill
*Major: 100 t oil spill

Table 18a. Oil spill incidents from offshore operations in Malaysia (1984 - 1985): Trengganu

Time	Date	Name of facility	Location of spill	Estimated amount of spill	Spillage	Source of spill	Cause of spill
1100 h	27/1/84	TOOT SALM 2	Kerteh Lat 4^{o} 33' 26.53"N Long 103^{o} 30' 44.95"E	20 l	Crude oil	SALM 2	Leakage of the noise string of SALM 2
1730 h	7/3/84	Tapis 'D'	Lat 5^{o} 31' 47.05"N Long 104^{o} 57' 28.42"E	10 bbl	Crude oil	Tapis 'D' Flare Boom	Malfunction of SDV valve on Tapis Pumping Platform causing surge vessel to carry over crude to Tapis D' flare
0600 h	26/3/84	Tapis 'A'	Lat 5^{o} 32' 07.34"N Long 105^{o} 01' 36.80"E diameter	1/2 bbl or 500 ft	Crude oil	Tapis 'A' Caisson N/A	
1325 h	18/3/84 SALM 2	TOOT	Kerteh Lat 4^{o} 33' 26.53"N Long 103^{o} 30' 44.95"E	25 l	Crude oil	SALM 2	Minor leakage at SALM 2
2145 h	16/7/84	Pulai 'A'	Lat 5^{o} 19' 46.74"N Long 105^{o} 29' 34.9"E	300 l	Crude oil	Caisson	Overflow from Caisson due to control valve malfunction on the 1st stage separator
1248 h	23/10/84	Tembungo SALM	Lat 6^{o} 38' 105"N Long 115^{o} 46'E	10 bbl	Crude oil	10" loading hose of SALM	Rupture of 10" loading hose between the SALM and the ESSO castellion
1530 h	23/12/84	Tapis 'A'	Lat 5^{o} 32' 07.34"N Long 105^{o} 01' 36.80"E	25 bbl		Caisson	Oil sump pump P 315 and P 305 failure

Source: E & P Division, PETRONAS.

Table 18b. Oil spill incidents from offshore operations in Malaysia (1984 - 1985): Sabah and Sarawak

Time	Date	Name of facility	Location of spill	Estimated amount of spill	Spillage	Source of spill	Cause of spill
0745 h	5/1/84	Barge 'AB-1' and vessel 'Mesra 7'	Temana Field	1 gal	Fuel oil	Barge's Starboard side	Minor collision between the vessel 'Mesra 2' and barge 'AB-2'
0930 h	9/7/84	Labuan Crude Oil Terminal	Labuan	40 bbl	Crude oil	FWKO vessel	Leakage of gasket at Semarang incoming EDV No. 213, 313, 414
2030 h	16/9/84	Bayan Production Station	Bayan Field, Bintulu	7065 bbl	Crude oil	Crude overflow through vent stack	Malfunction of pumping instrument
N/A	25/9/84	Temana 'B' Platform	Temana Field	15 bbl	Crude oil	Drain valve of Temana 'B' Platform	Leaking drain valve on incoming Scraper of Temana-B
1350 h	6/11/84	Lutong Crude Oil Terminal	Lutong	200 bbl	Crude oil	Tank 79	Overflow of tank 79
0719 h	3/4/85	SBM No. 2	Lat 7° 28' 48.88"N Long 113° 56'33.03"E (West Lutong)	Less than 100 bbl	Crude oil	Loading line 2B of SBM No. 2	Leakage of loading line 2B of SBM No. 2
0237 h	1/5/85	Bintulu SBM	Bintulu SBM	20-30 bbl	Crude oil	Cargo tanks of tanker 'Bunga Kemboja'	Overflow from cargo tanks of tanker 'Bunga Kemboja'

Source: E & P Division, PETRONAS.

It should be noted that most of the above regional and sub-regional plans, with the exception of the TARC (see Sec. 7.2) and Davao Plans, have no collective equipment stockpile. The ASCOPE Plan depends on the equipment and resources of national oil companies in the various countries. The Japanese Revolving Fund has not been spent on equipment by the Tripartite Committee. It is very encouraging to note, however, that the Tripartite Plan went into action at Pulau Sambu, Indonesia in 1986 and the TARC recently also commissioned its equipment. The ASCOPE Plan has been exercised on several occasions with respect to the aspects of its reporting and communication procedures.

Considering that the current regional plans are lacking in equipment and resources, the development of each country's national plans is a prerequisite to an effective regional arrangement in combatting oil spills. After all, the regional plans are meant to be supplemental to national plans and their resources.

Each country in the region has a national plan for its territorial waters but at various stages of development. Malaysia is currently developing her national plan for the South China Sea areas, in addition to an existing plan for the Straits of Malacca. Indonesia, Singapore and the Philippines are all improving the management and operational features of their plans. Because these national plans are still inadequate in terms of equipment, it is anticipated that these countries will further increase their stockpiles in the future.

Besides the inadequacy in equipment and resources, current regional plans are also lacking in legal and institutional provisions as well as in technical and scientific supports. Institutional and legal arrangements on the following aspects are necessary to ensure that regional plans are feasible:

i. Obligation to report oil spill/oil pollution

ii. Commitment in rendering assistance

iii. Exchange of information

iv. Common procedures on:

- reporting and calling for assistance
- trans-boundary mobilisation of equipment, vessels and aircraft, spraying of dispersant, workers vis-a-vis immigration, customs and airspace clearance, etc.

v. Financial arrangements on assistance rendered in terms of loan of equipment, manpower, reimbursement, stockpile sharing of equipment, etc.

vi. Legal procedures on damage claims and compensations, insurance, etc.

Presently, the aforementioned linkages are loosely provided for in the region. ASCOPE members have existing broad arrangements and obligations within the spirit of the "ASCOPE Declaration" (October 15, 1975, Jakarta) on mutual assistance in all aspects of the petroleum industry, including oil spills, which have to be formalised.

It is also important to note that most ASEAN countries have yet to implement relevant international conventions such as the MARPOL 73/78 and similar agreements which are related to the prevention of marine pollution.

It should be mentioned that other regions within the UNEP's Regional Seas Program have addressed essential institutional and legal provisions by adopting appropriate protocols, conventions, agreements, etc. like the 1969 Bonn Agreement for the North Sea, the 1971 Copenhagen Agreement for the Nordic area, the 1978 Barcelona Emergency Protocol for the Mediterranean region and the 1985 Jeddah Emergency Protocol for the Red Sea and Gulf of Aden region. The ASEAN member countries should seriously consider similar agreements to further enhance current regional arrangements. This is in line with the recommendation of the Joint CCOP/ASCOPE/NECOR Seminar on "Regional Cooperation on Oil Spill Contingency Planning and Response" held on 4 - 8 August 1986 in Kuala Lumpur, Malaysia.

7.4 Technical and scientific support requirements

ASCOPE is currently considering a regional Environmental Sensitivity Index Mapping of selected vulnerable coastal areas, particularly in the vicinity of petroleum installations and centers of activities in the region. Partial ESI mappings have been completed by some countries. In collaboration with the Norwegian Engineering Committee of Oceanic Resources (NECOR), a computer programme on Regional Oil Spill Trajectory/Dispersion Modelling, Oil Spill Risk and Impact Analysis will be developed by the end of the first quarter of 1988. ASCOPE is also undertaking a comprehensive study on the need to establish a common equipment stockpile, at strategic locations, in addition to available resources within the custody of member countries. An inventory of currently available equipment and capabilities in the region will be thoroughly reviewed prior to making any decision.

In addition, the following supportive research is being considered:

i. Fate and effect of oil in the marine environment in the region, including studies on biodegradation, hydrocarbon levels in benthic organisms, etc.

ii. Development of a common method of finger-printing of oil and its products.

iii. Development of a common method and procedure for oil spill impact analysis,including qualification and quantification of ecological impacts, etc. to substantiate claims and compensations, etc.

iv. Establishment of a "baseline" level of oil pollution in the region.

v. Formulation of procedures and guidelines for the use of dispersants in cleaning up oil spills.

vi. Prioritization of sensitive resources vulnerable to potential oil spill in conjunction with environmental sensitivity index mapping.

Another essential step to consider is the designation of Spill Impact Assessors or Adjustors from scientists and oil experts in the region who can be authorized to settle disputes in compensation claims in the case of oil spills.

Other existing regional programmes should also be tapped for support of a regional oil spill contingency plan. These include ASEAN Environment Programmes (ASEP II) on nature conservation, marine environment, remote sensing, environmental information/data exchange, among others. Programmes of the International Maritime Organization (IMO) should also be considered. Recently, a COBSEA Workshop on the Implementation of a Technical and Scientific Support Programme for Oil Spill Contingency Planning in the East Asian Seas Region was held in Jakarta in August 1987. Its recommendations can be incorporated in the current contingency plan.

8. Integration

It is apparent that considerable efforts on a regional scale have been done to mitigate marine pollution. However, it also appears that results, data, information, etc. are not effectively shared and synthesised. This has resulted in seemingly scanty documentation of available data on marine pollution in the region, and may lead to possible duplication of efforts if unchecked.

Current available data from the various programmes may be quite sufficient to establish a "baseline level" of oil pollution and its impact in the region through coherent documentation. Further documentation of these data can be done after consolidation.

The level of oil pollution in the East Asian Seas should be established from the various papers presented in this meeting.

Additional work within the framework of the action plan should be done. This consists of 4 major components: environmental assessment, management, coordination, and establishment of linkages, and is aimed at achieving the following:

- assessment of the effects of the marine, coastal and other land-based activities on environmental quality;

- management of marine and coastal development activities which may have an impact on environmental quality or on the protection and use of renewable marine resources on a sustainable basis;

- development of suitable coordination measures for the successful implementation of the action plan.

It should be noted that unlike most of the other 13 regional action plans, the current East Asian Seas programme does not include a legal component nor does it have a framework for regional cooperation in combatting marine pollution. This shortcoming may inherently affect the practicality of implementing the action plan. For instance, the oil companies' TARC equipment in Singapore cannot be made accessible for mobilisation in neighbouring states without a legalised modus operandi agreed upon by the ASEAN nations involving immigration, customs,airspace clearance (for spraying dispersant), etc. Damage claims and compensations with respect to the "Showa Maru" spill (1975) are still outstanding and payments made so far were far below actual claims. This legally noncommittal state of affairs in the region has prompted ASCOPE to draft its Convention of Damage Claims (RC).

The region's petroleum industry is very much under control of its operations with regard to environmental management and pollution control. A considerable number of studies and research related to petroleum activities have been sponsored by oil companies in the region. Collectively, the industry has quite adequate resources to handle their own oil spills. With regards to the current ASCOPE programmes, they are mainly technical and operational in nature. Considering that ASCOPE is the regional authority in the ASEAN petroleum business, it is most appropriate that it should play an active role in providing the technical and operational expertise in all matters related to the prevention and control of oil pollution in the region.

9. Recommendations

i. It is widely recognised that in order to develop an effective regional plan, a national plan of each country should be operational first. A regular exercise should be conducted to improve operational and management features of national plans.

ii. The following COBSEA programmes related to regional oil spill contingency planning should be continued:

- Oil and Dispersant Toxicity

- Meteorological and Oceanographic Studies

- Oil Pollution Monitoring

- Marine Database

- Technical and Scientific Support Programme for Oil Spill Contingency Planning

The completion of the above programs should be expedited.

iii. Some programmes which are being undertaken by ASCOPE, IMO and the ASEAN Experts Group on the Environment (AEGE) are relevant and complementary to a regional oil spill contingency planning effort. Joint activities for some of these programmes should be considered.

iv. Considering that there are at least 5 current arrangements related to regional oil spill contingency planning, it is essential that these plans should be harmonised and integrated into a consolidated and unified regional plan.

v. In addition to technical, operational and management requirements, a regional plan should have institutionalised arrangements for the following mechanisms:

- procedures on pollution reporting and calling for assistance from neighbouring countries.

- procedures on transfrontier mobilisation of equipment, vessels andaircraft, spraying of dispersant, workers vis-a-vis immigration, customs and airspace clearance, etc.

- procedures on claims, compensations and insurance.

- assistance in terms of loan of equipment, manpower, stockpile-sharing, etc.

Ideally, these mechanisms should be institutionalised through adoption of regional protocols and conventions. Currently, there is no such instrument in the ASEAN region.

ASCOPE's Draft Convention for "An Agreement on Equal Rights of Access and Non-Discrimination for Damage Claims Relating to Transfrontier Pollution Resulting from Offshore Operations" could be used as a model for further development of other institutionalised regional arrangements.

10. Conclusion

Marine pollution cannot just be the concern of one nation as it is naturally transfrontier in nature. Most problems of marine pollution are unique to a particular region and as such their solutions are best sought on a regional cooperative basis.

As the seas of the region are one of the world's major trade passageways, they have been victims of pollution as a result of oil spills from tanker collisions, groundings and deliberate discharges of oil wastes. Because of this vulnerability, ASEAN nations should seek to strengthen their current arrangements in the mitigation of marine pollution in the region within the spirit of the "Bangkok Declaration" (1967) and the "Manila Declaration on the ASEAN Environment" (1981).

REFERENCES

Ahmad, I. 1983. Treatment and disposal of liquid discharges of offshore oil and gas operations in the East Coast of Peninsular Malaysia. Paper presented at the Joint ASCOPE/E & P Forum Regional Seminar on the Technical Aspects of Oily Water Discharges from Offshore Operations, Jakarta, Indonesia.

ASCOPE Secretariat. 1980. ASCOPE-ASEAN Council on Petroleum - The First Five Years: 1975 - 1980. Jakarta: ASCOPE.

ASEAN Experts Group on the Environment/UNEP. 1983. The Phase II of the regional collaborative programme on environment of the ASEAN countries. ROAP/ASEAN/83/2. UNEP-ASEAN Environment Programme Series.

Baker, J. M., M. Suryowinoto, P. Brooks and S. Rowland. 1980. Tropical marine ecosystems and the oil industry, with a description of a post-spill survey in Indonesian mangrove. Paper presented at the International Conference and Exhibition "Petromer '80", Monaco.

Bilal, J. and W. W. Kuhnhold. 1980. Marine oil pollution in Southeast Asia - Regional. SCS/80/WP/92 (Revised). Manila: South China Sea Fisheries Development and Coordinating Programme.

Bilal, J., E. Legowo, B. Prasetyo, G. Bodennee and L. Loubersac. 1982. Occurrence of tar pollution along shores in Indonesia. In LEMIGAS and CNEXO. French-Indonesian Research Cooperation in Oceanography.

Chua, T. E. and J. K. Charles, eds. 1980. Coastal resources of east coast Peninsular Malaysia, an assessment in relation to potential oil spills. Penang: Universiti Sains Malaysia.

Chua, T. E. and J. A. Mathias, eds. 1978. Coastal resources of West Sabah, an investigation into impact of oil spill. Pulau Pinang: Penerbit Universiti Sains Malaysia.

Department of Environment of Malaysia (DOE). 1986. Comparative analysis of marine pollution in the Strait of Johore 1985. Kuala Lumpur: DOE.

Finn, D. P., Y. Hanayama, M. J. Meinandi Nejad, T. Piyakarnchana and J. N. Reeves. 1979. Oil pollution from tankers in the Strait of Malacca, a policy and legal analysis. Honolulu, Hawaii: East-West Centre, Open Grants Office.

Gilbert, J. T. E. 1982. Environmental planning guidelines for offshore oil and gas development. Hawaii: East-West Center, University Press.

Gomez, E. D. 1980. The present state of mangrove ecosystems in Southeast Asia and the impact of pollution - Philippines. SCS/80/WP/94c. Manila: South China Sea Fisheries Development and Coordinating Programme.

Gomez, E. D. 1986. Preliminary regional report on the state of the marine environment in the East Asian Seas region. UNEP/WG. 154/4 (Draft).

LEMIGAS. 1975. Laboratory Report No. 352/TR/RPK/1975 (Unpublished).

Leong, T. S., L. Y. Kwong, H. S. Chye, K. K. Huat, K. S. Pheng, S. Hanapi, W. T. Meng and R. S. Legore. 1985. An environmental baseline study of the macrobenthos in the vicinities of the crude oil terminals in Sabah (Labuan) and Sarawak (Bintulu and Lutong) and selected offshore platforms. Penang: Universiti Sains Malaysia.

Mathias, J. A. 1978. The effect of oil on seedlings of the pioneer mangrove, Avicennia intermedia, in Malaysia. Marine Research in Indonesia 18:17 (abstract only).

Muchtisar, D. P. and C. Muluk. 1977. Air limbah industri minyak. Studi kasus tentang aspek teknologi dan ekologi (Oil industry effluent. A case study from the aspect of technology and ecology). Proyek Study Lingkungan Hidup, PPTMGB "LEMIGAS" (in press).

National Research Council (NRC). 1985. Oil in the sea. Inputs, fates and effects. Washington, D. C.: National Academy Press.

Petromin. 1985. Supplement. October 1985. Singapore: Petromin Publishing Co. (ASIA) Pte. Ltd.

Piyakarnchana, T., S. Temiyavanich, J. Sakarin, T. Suknimit and P. Wootistiraphinyoe. 1977. A survey of the tar balls on the beaches in Thailand 1977-1978. Proc. Symp. on Marine Pollution Research in Thai Waters, pp. 235-242. National Research Council of Thailand.

Rahman, A., L. S. Chia and D. S. P. Chung. 1979. Pollution of water by hydrocarbons and heavy metals around Singapore. Paper presented at the Second Symposium "Our Environment". Inst. Nat. Sci. Nayang University, Singapore (unpublished).

Rioux, R. L. E., T. Edgar and F. F. H. Wang. 1980. Preliminary report on environmental problems of offshore exploration and exploitation in Southeast Asia. UNDP/CCOP/RAS/80/003, Bangkok.

Sailing Directions, U. S. A. 1979. Sailing directions (enroute) for the Straits of Malacca and Sumatera. Publication 174 (1st edition, 1978).

Soegiarto, A. and N. Polunin. 1981. The environment of Indonesia. A report prepared for the Government of the Republic of Indonesia, under the sponsorship of the International Union for Conservation of Nature (IUCN) and the World Wildlife Fund (WWF).

Thayib, S., A. Irwandi and W. Kastoro. 1977. Penelitian isolasi dan evaluasi bakteri pemecah minyak serta pengaruh macam-macam dispersant pada bakteri laut tropika (Isolation and evaluation of hydrocarbons utilizing bacteria and the effect of dispersants on tropical marine bacteria). Proyek Study Lingkungan Hidup, PPTMGB "LEMIGAS", Jakarta.

Valencia, M. J., ed. 1981. Proceedings of the Workshop on Coastal Area Development and Management in Asia and the Pacific, Manila, Philippines, 3 - 12, December 1979. Honolulu: University of Hawaii Press.

WHO/PEPAS. 1981. Preliminary assessment of land-based sources of pollution in the East Asian Seas. PEPAS,FP/0503-79-10, Malaysia.

OIL POLLUTION CONTROL MEASURES AND ARRANGEMENTS IN INDONESIA

Ministry of State for Population and the Environment
Jalan Merdeka Barat 15
Jakarta, Indonesia

ABSTRACT

Being at the crossroads of ASEAN maritime traffic and because of her varied oil exploration/production activities, Indonesia has taken a lead role in clean-up operations in Indonesian waters and the limits of adjoining ASEAN waters. She subscribes to the conventions and protocols of MARPOL and SOLAS. However, due to limited capability, it becomes necessary to participate within the framework of an ASEAN regional programme. Both the government and industry sectors are involved in arrangements to combat/abate oil spills. A National Contingency Plan (SISNAS-PDPL) taps existing government institutions at the national, provincial and local levels, depending on the severity of the pollution. The plan makes use of the Index of Environment Sensitivity to determine the level of activity required to overcome an oil spill. In addition, the oil industries follow an Industrial Oil Spill Contingency Plan (IOSCP) under the coordination of the state-owned PERTAMINA. The policy, scope, purpose and objectives of the IOSCP are clearly stated and the plan is reviewed periodically to accommodate changes. Specific oil spill control measures are enumerated.

1. Introduction

Indonesia is an archipelago two-thirds of the area of which comprises oceanic waters (Fig. 1). The seas and marine resources play a very important role in national development. However, with the increasing number of ships passing through Southeast Asian waters - where most sea lanes are located - and oil exploration/production activities going on nearshore and offshore, it becomes imperative to give high priority to oil pollution control measures and related arrangements in order to protect the marine environment.

Although efforts are being made to combat and control oil spills, there is still limited capability in the East Asian region, including Indonesia, to be able to cope with oil pollution. It becomes, therefore, necessary to undertake numerous activities that are integrated within the framework of an ASEAN regional programme in order to meet the requirements of future guidelines for oil pollution control and clean-up measures.

Indonesia, together with other Southeast Asian governments, has conducted several activities to implement the East Asian Seas Action Plan, with the support of the United Nations Environment Programme (UNEP) and the Co-ordinating Body on the Seas of East Asia (COBSEA). Specific activities geared towards oil pollution control include:

- implementation of a technical and scientific support programme for oil spill contingency planning;
- survey of sources and monitoring of oil pollution; and
- cooperative study on oil and oil dispersant toxicity testing.

2. Sources of oil contamination and incidents of oil pollution

Oil spills in the sea can be traced to the following sources:

- ship accidents;

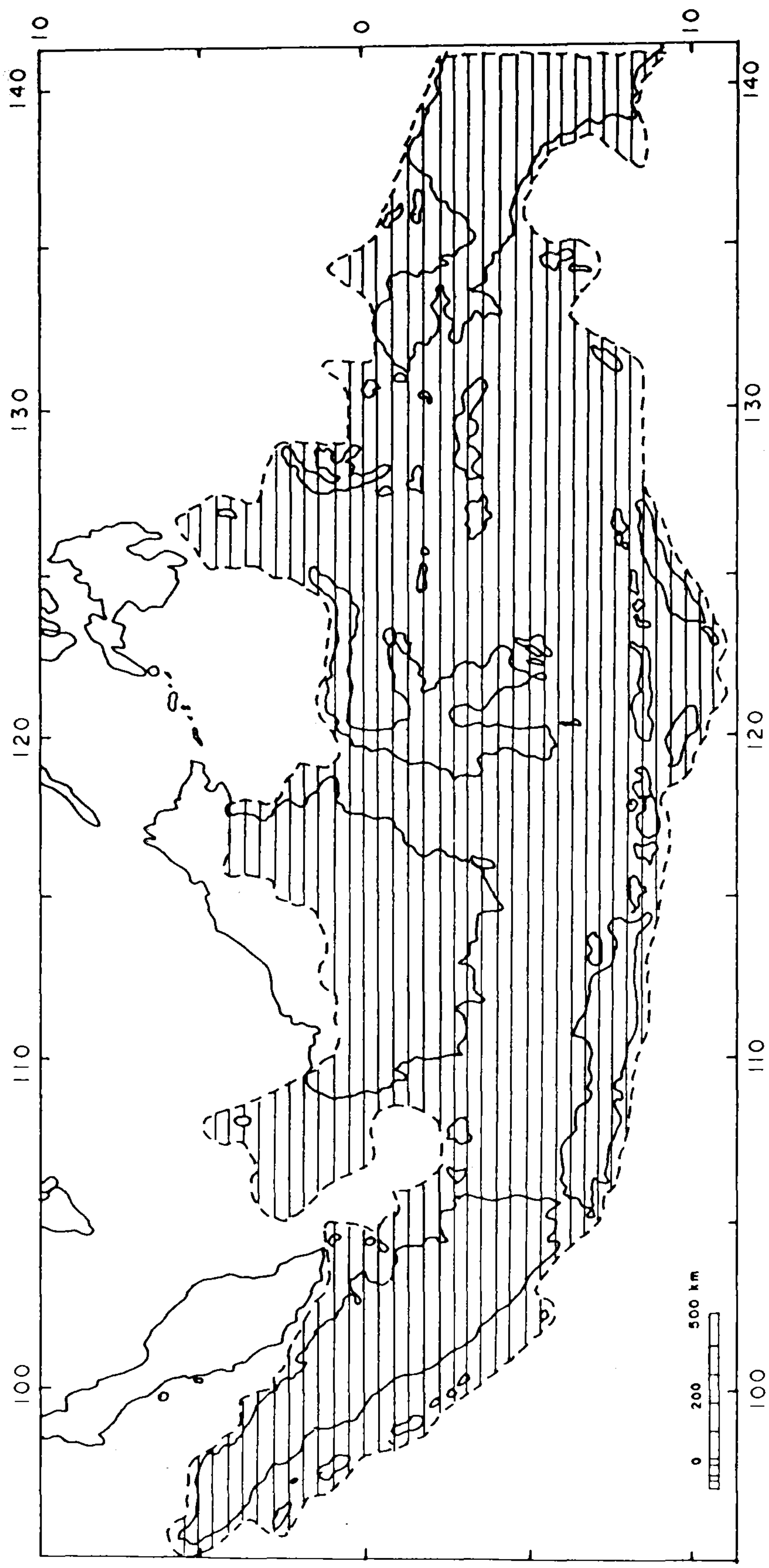


Fig. 1. Indonesian territory, land and sea within the 12 nautical mile limit.

- tanker operations;

- bunkering of ships;

- offshore exploration and production (E and P) activities;

- offshore operations at coastal terminals and refineries; and

- undersea and coastal pipelines.

Oil pollution can cause serious economic damage to coastal activities. More than ten years ago, the oil tanker "SHOWA MARU" grounded in the Malacca-Singapore Straits, releasing some 5,000 tonnes of crude oil. This is the first concrete example of the type of environmental damage that an oil spill can create in the marine environment.

Although precautions have been taken to prevent the occurrence of such accidents, these nevertheless are difficult to prevent. Just recently, another oil tanker was stranded near Tekong Island in the waters of Riau Archipelago - just within the border limits of the three coastal states in the region - causing a variety of stresses in the marine environment.

The current extensive exploration and exploitation of petroleum resources in the region and the continued dependence on the oil resources of the Middle East and Africa will undoubtedly focus great concern on oil and marine related pollution and safety in the ASEAN region.

Marine and coastal pollution by petroleum hydrocarbons has been identified as a problem in various meetings in the region in the last decade. Recognizing that oil pollution knows no natural nor political boundary, ASEAN countries have emphasized the need for close cooperation in the protection and conservation of the marine environment, pollution control, and safety of petroleum operations.

3. Areas sensitive to oil pollution in Indonesia

For centuries, the seas have been an important source of food for the Indonesian people, in view of the rich and diversified living resources they contain. Non-living resources such as minerals and hydrocarbons form part of the resources of the marine and coastal zones. The seas also sustain other types of activities, such as inter-island, regional and international trade and communication, recreation and tourism. Unfortunately, as a result of the strong economic development trends in almost all sectors, the marine and coastal resources have been subjected to severe pressures, both direct and indirect. Areas that are sensitive to oil pollution can be classified as follows:

3.1 Conservation areas (parks and reserves)

Conservation areas include marine reserves and national parks. Fifteen marine conservation areas have been identified (Table 1) by virtue of an announcement of the Minister of Agriculture on June 14, 1957. Up to the present, these areas have no legal status as marine reserves. However, they are managed in accordance with the regulation of land conservation areas, as provided in Forestry Legislation No. 5 of 1957.

There are 8 national parks, some of which are sea parks (Table 2).

In line with the future development of marine conservation areas under the support of the FAO/UNDP Nature Conservation Programme, some 179 areas have been nominated as conservation areas (Salm and Halim 1984) based on specific criteria. These areas are classified in Table 3.

Table 1. List of marine conservation areas in Indonesia.

Name of marine park/reserve (ha)	Area (ha)	Government statement	Location	Dominant component
Pombo	1,000	Mentan No. 327/ Kpts/Um/7/73	Middle Maluku, Maluku Province	land
Banda	2,500	211/Kpts/Um/4/ 77	Middle Maluku, Maluku Province	sea
Kasa	1,100	653/Kpts/Um/10/ 78	Middle Maluku, Maluku Province	land
Seribu Islands	108,000	527/Kpts/Um/7/ 82	Jakarta Bay, Jakarta Special Territory	sea
Sangalaki	280	604/Kpts/Um/8/ 82	Berau, East Kalimatan Province	land
Semama	220	604/Kpts/Um/8/ 82	Berau, East Kalimatan Province	land
Weh	2,600	923/Kpts/Um/12/ 82	Sabang, Aceh Special Territory	land
Cape Keluang	2,000	046/Kpts-II/84	Serang, West Java Province	land
Sangiang	700.35	122/Kpts-II/84	Kwai	land
Karimata	77,000	381/Kpts-II/85	Ketapang, West Kalimantan Province	land
South of Moyo Island	6,000	308/Kpts-II/86	Sumbawa, West Nusa Tenggara	sea
Karimun, Java Island	111,625	123/Kpts-II/86	Jepara Central Java	sea
Arakan Wowontulap	13,800	328/Kpts-II/86	Minahasa, North Sulawesi	land
Bunaken Manado Tua	75,265	328/Kpts-II/86	Minahasa, North Sulawesi	sea
Maumere Bay	59,450	126/Kpts-II/86	Sikka, East Nusa Tenggara Province	sea

Table 2. List of national parks with marine areas in Indonesia

Name of national park	Location	Area of national park (ha)	Area of sea (ha)
South Barisan	Bengkulu/Lampung	365,000	21,600
Ujung Kulon	West Java	78,619	28,500
Seribu Island	Jakarta Special Territory	108,000	100,000
Baluran	East Java	25,000	2,500
West Bali	Bali	77,727	5,000
Komodo	East Nusa Tenggara	75,000	275,000
Tanjung Puting	Central Kalimantan	300,000	355,000
Kutai	East Kalimantan	200,000	10,000

Table 3. Nominated areas for marine conservation in Indonesia.

Type of area	Numbers
Strict Nature Reserve	68
Marine National Park	7
Natural Monument	8
Wildlife Reserve	47
Marine Resource Reserve	11
Anthropological Reserve	13
Multiple Use of Marine Reserve	1
Marine Park	24
Biosphere Reserve	1
World Heritage Site	1

Source: Salm and Halim (1984)

By the end of Pelita IV (Fourth Stage of Development Program) some 10 million hectare are targeted to have been declared as marine conservation areas, of which only 5% have been developed. By the year 2000, some 30 million hectare would have been projected in 200 locations in Indonesian waters. These will comprise about 10% of Indonesian territorial waters in the long term. Table 4 shows the development plan for marine protected areas in Indonesia.

Table 4. Development plan for protected marine areas in Indonesia

Geographical location	Total number of sites	Number of sites established as marine reserve/park	Size (ha)
Indian Ocean	41	1	425,325
Pacific Ocean	24	-	1,339,000
Java Sea	32	2	490,480
Bali Strait	2	2	10,000
Sunda Strait	2	2	38,000
Malacca Strait	11	1	198,365
Karimata Strait	14	1	267,010
Flores Sea	19	2	809,000
Sulawesi Sea	13	4	453,000
Tomini Bay	7	-	223,500
Maluku Sea	8	-	350,000
Makassar Strait	15	-	600,000
Tolo Bay	5	-	215,000
Bone Bay	1	-	5,000
Seram Bay	7	-	503,000
Sawu Sea	1	1	60,950
Timor Sea	2	-	21,500
Banda Sea	12	3	260,500
Arafura Sea	11	-	279,000
Lombok Strait	3	-	2,500
Buru Sea	1	-	4,000
Total	231	19	6,555,630

3.2 Marine fishery areas

The marine fishery areas, with special reference to prawn, are indicated in Figure 2. The potential production of the Indonesian marine fishery (including the EEZ) has been calculated for each category of fishery resources as follows:

Pelagic	3,520,110 t/a
Demersal	2,546,410 t/a
Tuna	166,302 t/a
Cakalang (Skipjack)	275,405 t/a
Shrimp	69,050 t/a
Coral fish	400,976 t/a

3.3 Coral reefs

Coral reefs are vital to marine fisheries because of their high levels of productivity and the diversity of their biota. Coral reefs are very sensitive to oil spills; the latter can damage the reef ecosystem through:

- decrease in genetic sources;
- decrease in primary productivity;
- damage to the habitat; and
- evacuation of particular reef organisms to other areas.

Coral reefs in Indonesia are indicated in Figure 3.

3.4 Mangrove forests

Mangrove forests protect coastal areas and provide breeding sites for shrimps and nursery grounds for fishes. Oil spills can damage mangrove forests through:

- clogging of the pores of pneumatophores of mangroves;
- increased temperature and decreased oxygen;
- accumulation of hydrocarbon on the mangrove biota; and
- actual physical damage.

Figure 4 shows the distribution of mangroves in Indonesia.

3.5 Seagrass beds and estuarine areas

These areas are also important for marine fisheries because of their high productivity. In addition, they function as habitats for some organisms of high economic value.

4. Oil pollution control measures and arrangements

Under the coordination of PERTAMINA, the state-owned oil enterprise, and the Directorate General for oil and gas, the Indonesian Department of Mining and Energy, fixed oil installations within oil and gas industries, whether onshore or offshore, are normally required to develop oil spill response capability and a contingency plan. Ships crossing frontiers from one jurisdiction to another and plans dealing with oil spills at sea must take this fact into account.

Fig. 2. Potential areas for juvenile prawn in Indonesia.

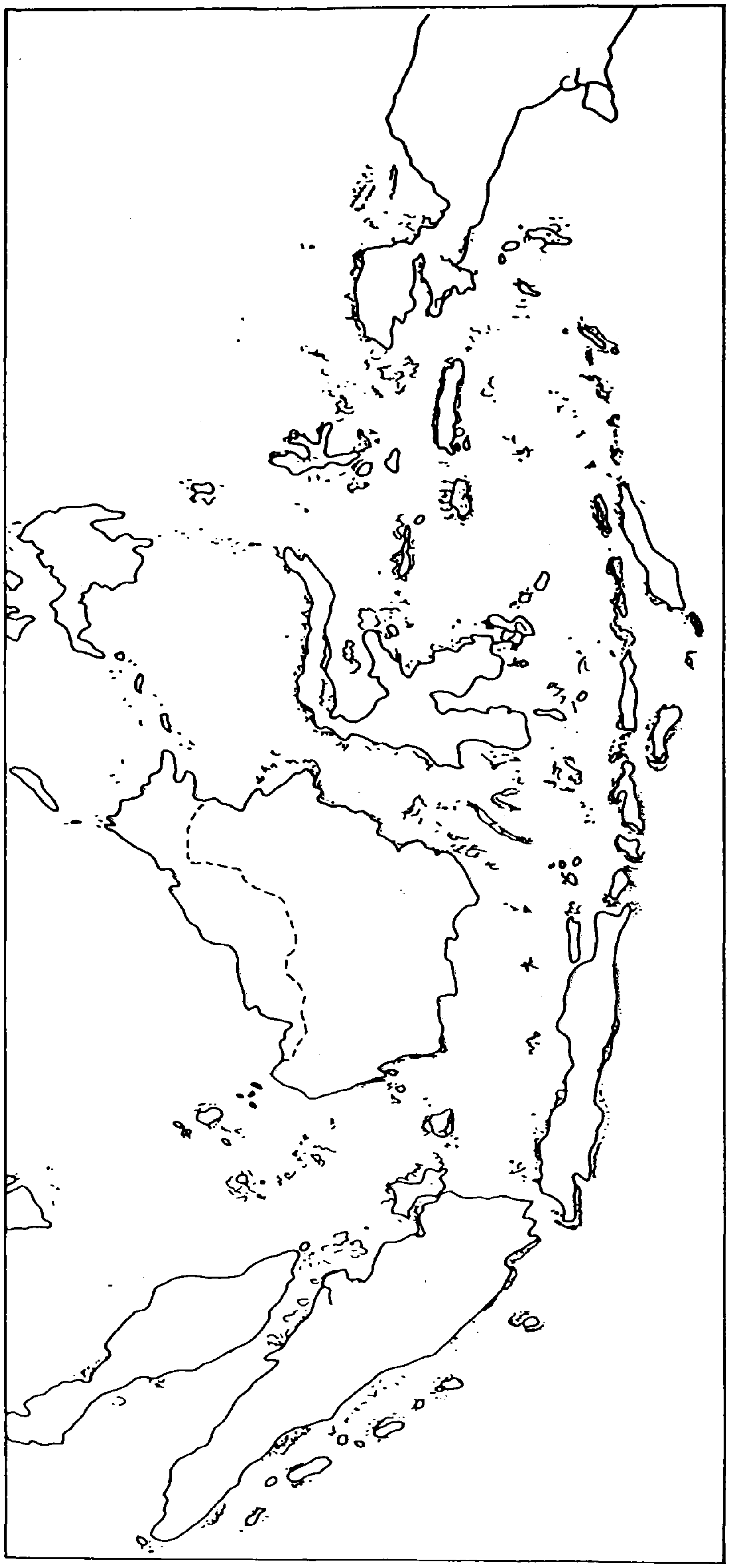


Fig. 3. Approximate distribution of coral reefs in Indonesia (Molengraaf 1929).

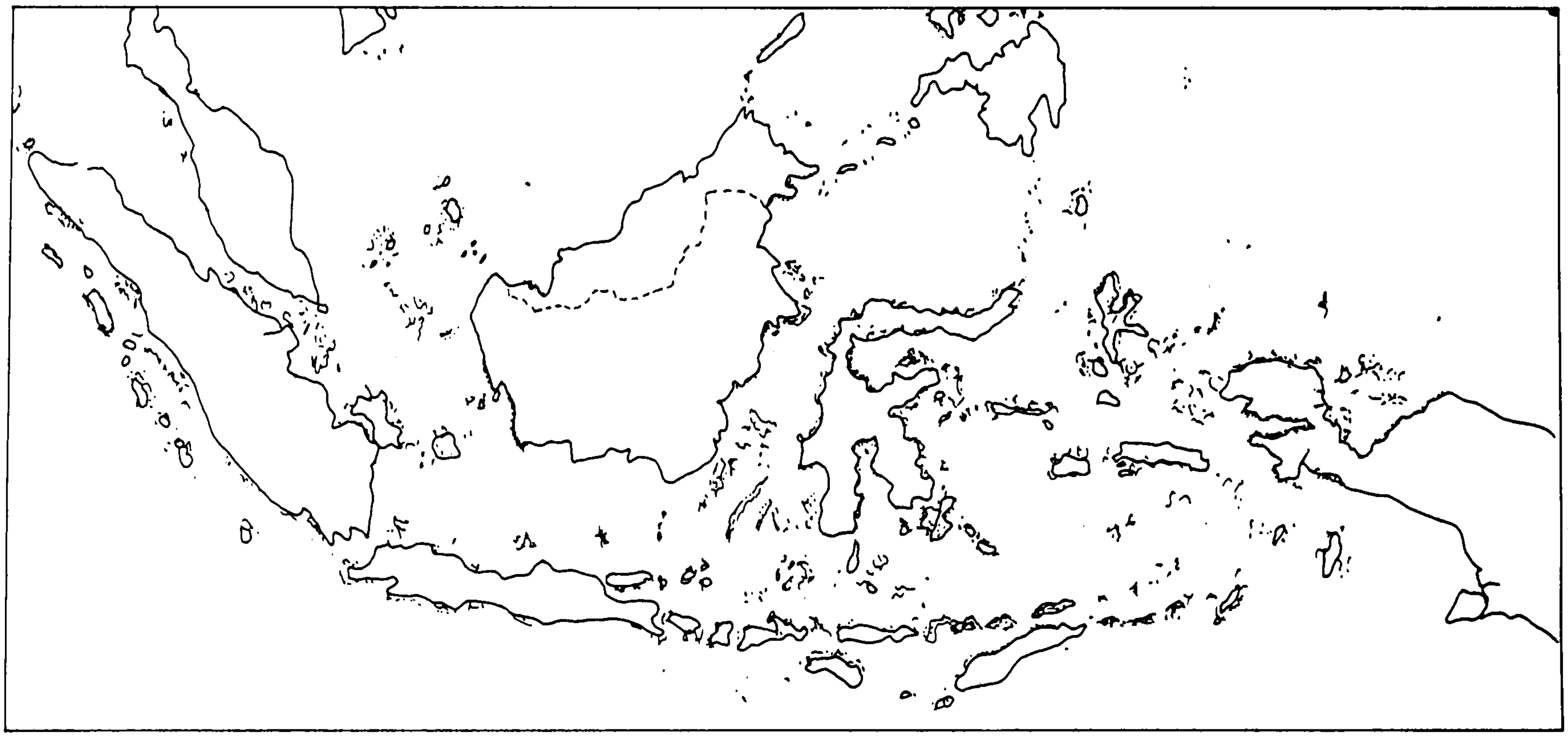


Fig. 4. Approximate distribution of mangrove communities in Indonesia
(Van Steenis 1958, Chapman 1977, Wiroatmodjo and Judi 1979).

Ships are subject to a complex set of requirements as dictated by international conventions and protocols implemented through national laws. The MARPOL and SOLAS conventions and protocols are now in force. Consequently, the emphasis is no longer one of ratification but effective implementation.

To ensure effective results in any effort to clean up oil spills, the Indonesian government is presently in the processing stage to master the art of clean-up technology with the help of a well-planned contingency plan and related arrangements.

The Government of Indonesia similarly takes the lead and plans to oversee clean-up operations in Indonesian waters as well as waters within the limits of neighboring ASEAN countries. For effective contingency planning, the following information is made available:

- clear, prior definition of roles/responsibilities and effective communication;

- effective clean-up techniques;

- inventory of equipment and materials available within the industry or on a country to country basis, if this involves a sub-regional plan, such as the Regional Plan for the Malacca-Singapore Straits among the three coastal states and the Sulawesi Sea between the Philippines and Indonesia; and

- shoreline sensitivity information (as mentioned above and more hereunder),spill tracking and trajectory projection techniques (still in the development stage).

For activities involving damage control, salvage or well-capping, the owner or the operator normally takes the lead role in the total operation, in collaboration with the relevant government agencies.

A multi-disciplinary and cross-sectoral approach to operation is emphasized to cope with the problems of marine pollution. This involves the participation of various institutions integrated into a system and ever alert to take action:

- if the pollution occurs as a result of routine activities at sea or other places, routine action is expected to be performed;

- if the pollution occurs as a result of accident at sea or other places, emergency action shall be applied with; and

- the conceptual system called Emergency National System to protect against Marine Pollution (SISNAS-PDPL), otherwise called the National Contingency Plan.

4.1 The SISNAS-PDPL or National Contingency Plan

Implementation of the SISNAS-PDPL operational scheme does not require the forming of a new institution but makes use of existing institutions. Two lines of action are involved:

- physical prevention, which operation is coordinated by the Department of Transportation, under the direction of the Directorate General of Sea Transport, while the Head of the Regional Office of Sea Transport is responsible for field activities; and

- protection of the marine environment from the negative impact of pollution and rehabilitative action.

The State Minister of Population and Environment, Chief Coordinator of activities, deals mainly with the framework of the Strategy Plan. He sets the guidelines for the Operational Plan and identifies the sensitive areas that should be guarded from oil pollution.

Emergency action to combat marine pollution may be carried out within the national (including local or provincial)plans, depending on the ability of the regional office.

The SISNAS-PDPL thus copes with different degrees of oil pollution:

- small or routine spills that should be overcome locally by the local industry; or

- a larger one that may be difficult to overcome locally and which, therefore, should be tackled on a higher policy system at the provincial level; or

- very large spills of about 5,000 tonnes which should be overcome at the national or SISNAS-PDPL level.

At all levels of the contingency plan, the procedures for reporting, communication, control, coordination and clean-up are clearly stated so as to respond effectively and without delay thus preventing further discharge of oil or to prevent the oil spill from entering sensitive areas.

Several possible methods can be used singly or in combination to combat oil spills making use of:

- mechanical containment and oil recovery (e.g.,booms, skimmers);

- chemical agents like oil dispersants;

- absorbent materials; and

- natural degradation

The selection of method(s) depends largely on the available resources, the circumstances at the oil spill site and the size of the oil spill. At-point-source prevention methods are encouraged at certain sites (e.g., industrial sites, platforms, etc.) as they prove to be the best in minimizing oil pollution. Ecology experts are tapped in every oil pollution control operation to measure the extent of contamination and its impact on the environment.

Water territory is distinguished into open sea and coastal areas for purposes of setting priorities in an emergency situation. The level of sensitivity of a coastal area is indicated by an Index of Environment Sensitivity, the rank of which is determined by an ecological approach (Table 5). This index is used to estimate the level of activity required to overcome the oil spill. A high index value of 8 indicates high sensitivity or low tolerance to oil spill, hence, with the slowest speed of recovery. The government is presently examining the legal aspect of combatting oil spills in accordance with the development of science and technology.

4.2 The industrial oil spill contingency plan

Aside from the SISNAS-PDPL or the National Contingency Plan, the oil industries follow certain prevention and control procedures under the coordination of PERTAMINA, Directorate General of Oil and Gas/Department of Mining and Energy, in conformity with the policy or firm belief that the protection of the environment from undesirable, accidental discharge can be achieved through sound engineering and industrial practices. In line with this policy is the assumption that every industry employee and member, together with the surrounding community, has the right to live and work in a pollution-free and healthy environment.

Table 5. Index of environment sensitivity adopted in Indonesia.

Index of sensitivity	
1	Type of coast: Stony Remarks: Movement of water distinctive due to wave action, flow of water and ebb tide; oil cannot concentrate as water movement carries oil to other directions or movement of water breaks the oil elements into small pieces, causing the speedy recovery of water quality; typical inhabitants either burrowers or those with strong tentacles.
2	Type of coast: Sandy Remarks: Tidal wave movements carry oil to upper part of intertidal area; oil can either stay, penetrate or be carried out in other directions, depending on water current, the size and texture of sand grains; benthic animals usually scarce in soft sandy areas because of sand movement.
3	Type of coast: Out-welling area Remarks: Area where river-borne sediments border on benthos which originally exist in this place.
4	Type of coast: Upwelling Remarks: Also called fertile waters due to abundance of nutrients on the surface when upwelling occurs along offshore areas, hence area is rich in biota; protection of area from oil spills should be done according to the types and dynamics of water in the affected area.
5	Type of coast: Mangrove area Remarks: Area specifically characterized by mangrove species; substratum variable depending on elevation/speed of water current which determines the fate of an oil spill (whether it will stay, adhere or flow); although primary productivity is high, the inhabiting organisms are not so many; detritus with dominant impact on surrounding littoral zone.
6	Type of coast: Seagrass area Remarks: Area generally located in subtidal zone; production of carbon high, organisms living or surrounding the area many; impact of oil spill in area prevents photosynthesis.

Index of sensitivity	
7	Type of coast: Mud flat
	Remarks: Area formed due to minimum water movement; contains considerable number of organic elements; area generally flat; oil penetrates and stays, the recovery is slow.
8	Type of coast: Coral reef
	Remarks: Area with high productivity and of greatest concentration of marine life; oil floating on the water surface and dispersing to the bottom easily destroys the sensitive organisms living in this area; its production and primary productivity will greatly influence the productivity of the surrounding waters.

The policy, scope, purpose and objectives of the Industrial Oil Spill Plan are as follows:

4.2.1 Policy

The management of the industry shall make a concerted effort to protect the environment from sources of pollution through sound design, supervision, training and pre-planning of abatement.

4.2.2 Scope

The plan includes all employees and contractors involved. Geographically, the plan includes all industry property and any surrounding (land and sea) area that can be affected by pollution as a result of the industry operation.

4.2.3 Purpose and objectives

In addition to providing guidance in abating pollution and in order to minimize ecological damage to the environment, every effort is made to prevent accidental sources of pollution from escaping the confines of the plant area. However, the plan is also designed to combat any pollution arising from the industry operation.

The plan is to be reviewed and updated periodically to incorporate procedures and equipment not envisaged originally or to accommodate necessary changes in design or equipment.

4.3 Spill control measures

Spill control is effected according to the following scheme:

(i) All pipings, valves, hose and related equipment for any leaks or damage in the system shall be inspected monthly. All information relating to these inspections is to be kept in the files of the Marine Department;

(ii) Ships receiving products shall be inspected by the Marine Department personnel to check on potential sources of pollution before loading begins;

(iii) Spill control and clean-up equipment for offshore purposes shall be stored and maintained by the Marine Department;

(iv) Training of personnel for offshore spill control shall be the responsibility of the Marine Department under the direction of the spill control team.

(v) Any dispersant used shall be in accordance with the prescription of the Directorate General of Oil and Gas (MIGAS);

(vi) Lines of communication and chain of command for the Marine Department personnel are in accordance with the chart shown in Figure 5; and

(vii) It shall be the responsibility of the Senior Marine Official in Site to notify the General Manager and Manufacturing Manager of any offshore pollution.

5. Conclusion

From the foregoing, it can be concluded that both the government and the industry sectors are involved in the oil pollution control measures and arrangements in Indonesia. They are currently:

- developing national or regional oil spill response plans;

- establishing strong liaison with the local and international industry organizations to develop a complementary oil spill response tool for the existing system; and

- drawing upon the appropriate expertise and technical advice from ASEAN, UNEP, IMO and other relevant international organizations in order to develop the Oil Spill Contingency Plan.

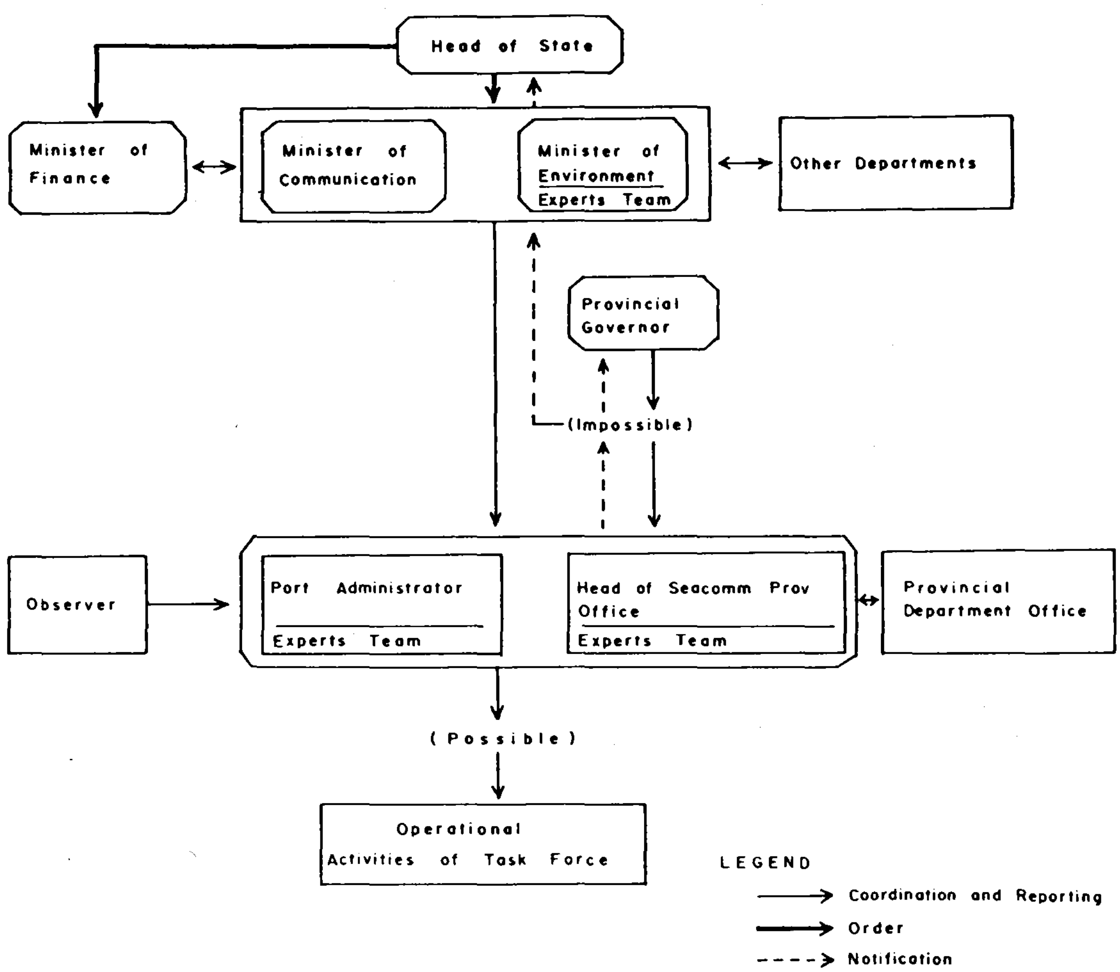


Fig.5. Flowchart of the NCP of Indonesia or SISMAS-PDPL.

REFERENCES

Chapman, V. J., ed. 1977. Ecosystems of the world. I. Wet coastal ecosystems. Amsterdam: Elsevier Scient. Publ. Co.

Molengraaf, G. A. F. 1929. The coral reefs in the East Indian archipelago, their distribution and mode of development. Proceedings of the Fourth Pacific Science Congress, Batavia-Bandoeng.

PPPTMGB "LEMIGAS". 1986/1987. Oil spill trajectory prediction in Cilacap area (in Indonesian - unpublished).

Salm, R. V. and M. Halim. 1984. Marine conservation data atlas. Bogor, Indonesia: Directorate General of Forest Protection and Nature Conservation.

Soegiarto, A. 1980. The present state of mangrove ecosystems in Southeast Asia and the impact of pollution. SCS/80/WP/94a (Revised). Manila: South China Sea Fisheries Development and Coordinating Programme.

Steenis, C. G. G. J. van. 1958. Ecology of mangrove. In Rhizophoraceae. Flora Malesiana 1,5: 431-441.

Uktolseya, H. 1984. Hydrodynamical system in Cilacap area. Paper presented at the Symposium on Living Environment in Cilacap, Indonesia (in Indonesian).

Uktolseya, H. 1985. Some notes on coastal resourcesmanagement in the Malacca Straits. Paper presented at the Symposium on Environmental Research and Coastal Zone Management Problems in the Straits of Malacca.

Uktolseya, H. 1987. Physical conditions of the Indonesian waters. Paper presented at the ASEAN-EEC Seminar-Workshop on Marine Sciences, Manila, Philippines, 13 April 1987.

Wiroatmodjo, P. and D. M. Judi. 1979. Pengelolaan hutan payau di Indonesia (The management of brackishwater forest in Indonesia). In S. Suemodiharjo, A. Nontji and A. Djamali (eds.). Prosiding Seminar Ekosistem Hutan Mangrove (Proceedings of a Seminar on the Mangrove Forest Ecosystem). Jakarta: Lembaga Oseanologi Nasional.

OIL POLLUTION CONTROL MEASURES AND ARRANGEMENTS IN MALAYSIA

Department of Environment
Ministry of Science, Technology and the Environment
13th Floor, Wisma Sime Darby
Kuala Lumpur, Malaysia

ABSTRACT

To safeguard the national interest, Malaysia has formulated various strategies and developed action plans to prevent and minimize oil pollution. Six major marine environment related legislative acts are in force: Merchant Shipping Ordinance 1952, Continental Shelf Act 1966, Petroleum Mining Act 1966/72, Environmental Quality Act 1974/85, Exclusive Economic Zone Act 1984, and Fisheries Act 1985. Two major contingency plans are being implemented to combat major oil spills: the Straits of Malacca Contingency Plan (SOMCP) and the South China Sea Contingency Plan (SCSCP). The SOMCP (1975) has been regularly updated (1981, 1984) to incorporate improvements while maintaining the essential features. The SCSCP was developed, cognizant of the need to maximize resources and take advantage of existing regional/sub-regional cooperation programmes. Aside from these, there are also local plans to cope with minor spills.

Since the EXERCISE MALACCA '84, the Department of Environment (DOE) has pursued further administrative and technical developments to strengthen the current capability. Chief among these concern: (1) the establishment of a national trust fund for oil spill clean-up; (2) further arrangement for a comprehensive contingency plan for all types of maritime casualty; (3) reappraisal of the use of chemical dispersants; (4) possible use of oil trajectory models to predict oil slick movements and cope with large sensitive areas; (5) further study, identification and documentation of environmentally sensitive areas; (6) recognition of Environmental Impact Assessment (EIA) as an effective tool for the sound management of a project. Malaysia is also participating in regional arrangements, most important of which are the Traffic Separation Scheme and Oil Scheme Revolving Fund for the Straits of Malacca and Singapore. Finally, she is prepared to work out any form of regional or international arrangements and relies on the assistance of agencies like the IMO and UN-CCOP to realize a common plan for the region.

1. Introduction

Oil enters into the sea as a result of natural seepage as well as man's activities. While nature plays its part by degrading the hydrocarbons, man tries to contain and clean up the spilled oils when his efforts at prevention have failed.

Marine oil pollution became apparent in Malaysia in the early fifties when villagers found tar balls on beaches. Although the sources of such oil pollutants are better understood today, the exact contributions by tanker operations/accidents, transportation activities, river and urban runoff, etc., are not exactly ascertained. Nevertheless, based on the analysis of oil spill incidences in Malaysian waters (Table 1) and other studies and as inferred from Figure 1, it is quite clear that pollution originates largely from vessels and other marine sources and less from river discharges and other land-based sources.

Protection of the Malacca Straits from oil pollution and disposal of wastes from passing ships is vital in order to safeguard the marine fisheries and beaches. The Malaysian coastal waters bordering the South China Sea, though relatively less important in terms of fishes, are similarly endowed with marine resources that need protection. More than 45 oil fields and 47 gas fields operate in the areas.

Table 1. Oil spill incidences affecting Malaysian waters

Year	Ship	Where	Why	How Much	Of What
1975	Showa Maru Strait	Singapore	Grounding	4000 t	Crude
	Tolo Sea	Penang Port	Collision	60 t	Fuel Oil
1976	Diego Silang	Malacca Straits	Collision	5500 t	Crude
1977	MV Asian Guardian	Malacca Straits	Collision	60 t	Fuel Oil
1978	Esso Mercia	South China Sea	Collision	505 t	Fuel Oil
1979	MV Fortune	South China Sea	Collision	10000 t	Crude
1980					
1981	MT Ocean Treasure	Malacca Straits	Operational	1050 t	MFO
1982					
1983					
1984	Bayan Platform	South China Sea	Operational	700 t	Crude
1985					
1986	Bright Duke & Pantas	Malacca Straits	Collision	Diesel	
1987	MT Stolk Adv MT Elhani	Singapore Strait	Grounding	2000 t	Crude

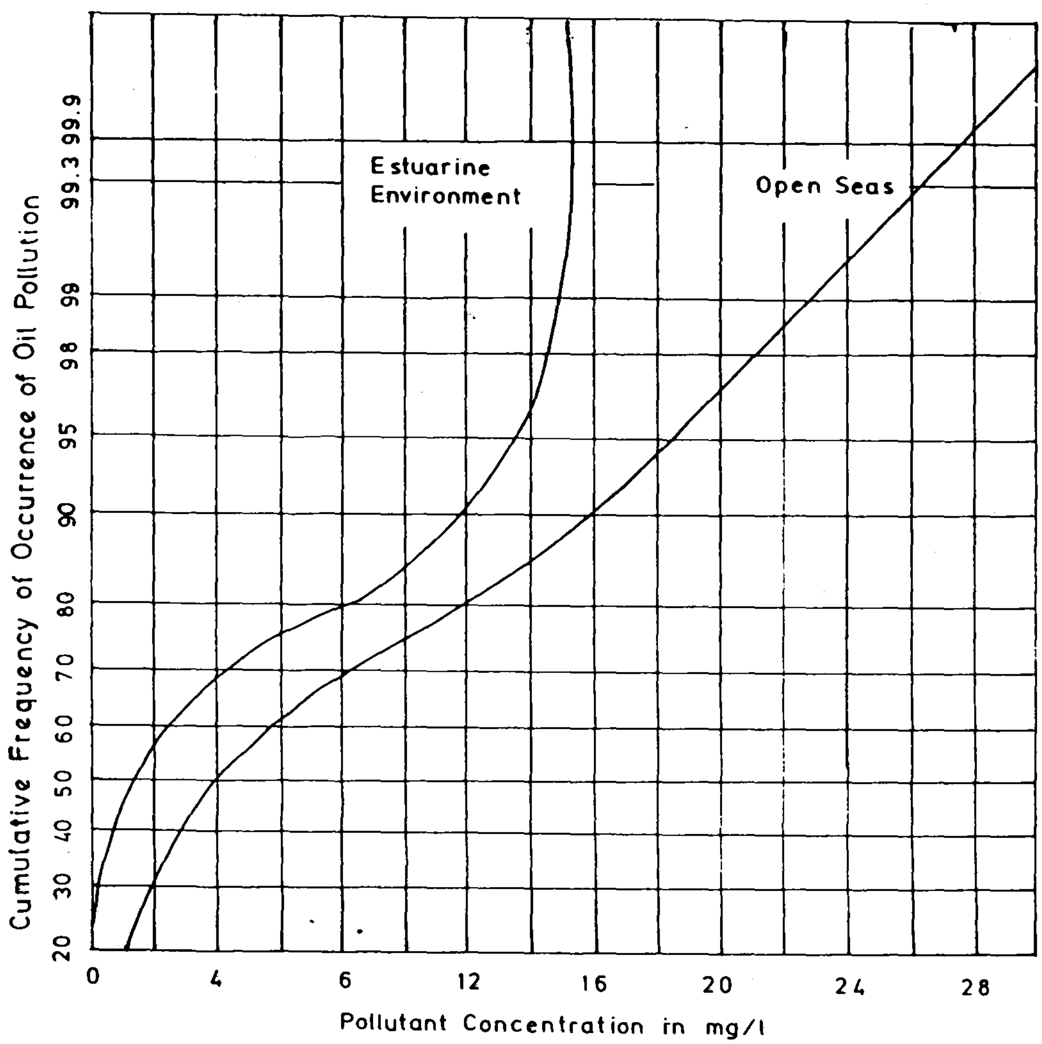


Fig. 1. Distribution characteristics of oil pollution in the estuarine environment and in the open coastal waters, 1979 - 1982 (Jaafar 1985).

To safeguard the national interest, Malaysia has formulated various strategies and developed action plans with the end in view of preventing or minimizing oil pollution.

2. Oil pollution control legislation

Malaysia has six major marine environment related legislative acts as follows:

2.1 Environmental Quality Act

The Act represents the most comprehensive pollution control instrument ever introduced, covering all aspects of the environment, including the seas. It was later amended in 1985. Salient provisions of the Act are contained in the following sections:

- Section 22, limits atmospheric discharge/fallout to acceptable conditions, as spelled out in the 1978 Environmental (Clean Air) Regulations;

- Section 26, prohibiting discharging or spilling of oil outside the territorial waters of Malaysia (as defined by Emergency Ordinance No. 7, 1969) if such would result in carrying/washing of oil into Malaysian waters, under pain of fine or imprisonment;

- Section 27,(as amended in 1985), prohibiting any discharge of oil in contravention of acceptable conditions;

- Section 47 (1), providing for the recovery of costs and expenses incurred in any pollution combating operations. [Note, however, that Malaysia has yet to be a contract party to the International Convention on Civil Liability for Oil Pollution Damage (CLC 1969) and the International Compensation Fund for Oil Pollution Damage (FUND 1971)];

- Section 34 A, which was amended to include the requirement for major projects to undergo environmental impact assessment (EIA). [Note that this section materially affects activities such as siting and construction of marine ports, exploration and exploitation of seabed resources, refineries, crude oil terminals, oil and gas field development and other major petroleum processing/handling facilities.]

2.2 The Exclusive Economic Zone Act

This Act, which came into force in 1984, empowers the Malaysian Government to specify measures in relation to the EEZ. Part IV of the ten parts Act is totally devoted to the protection and preservation of the marine environment.

2.3 The Continental Shelf Act

This Act empowers the King to make regulations for the safety of navigation, protection and conservation of the living resources and the protection of the marine environment.

2.4 The Petroleum Mining Act

This Act empowers the Petroleum Authority to stipulate conditions such that the licensee shall maintain facilities in good repair and condition, take steps to prevent escape of wasted oil or petroleum in the exploration area, and prevent damage to petroleum bearing strata.

2.5 The Merchant Shipping Ordinance

The Ordinance contains provisions which deal with safety of ships at sea, carriage of dangerous goods, collisions, wrecksand salvage. An amendment bill has been tabled to include oil pollution control and abatement at sea, thus enlarging the provisions of the Ordinance.

2.6 The Fisheries Act

Gazetted in 1985 to replace that of 1963, the Act still retains the original intent of regulating maritime and estuarine fishing. A completely new set of provisions (Part IX) empowers the Minister of Agriculture to establish marine parks andmarine reserves in line with the current concern for the conservation, management and development of marine fisheries.

3. Linkages with international conventions

In addition to the national legislations, Malaysia subscribes to the provisions of international conventions, such as MARPOL 73/78. However, she has problems with the existing provisions of the 1958 Geneva Convention with respect to the interpretation of the right of innocent passage, such that any pollution act whether deliberate or accidental does not constitute an act prejudicial to peace, good order or security.

In this regard, Malaysia, together with Indonesia and Singapore, has succeeded in including an article in the Informal Composite Negotiating Text (ICNT) in the Law of the Sea Conference (Par. 6, Art. 220), thereby authorizing a coastal state to take enforcement measures against a foreign ship violating the laws concerning damage to the marine environment. If successfully applied, such provisions would strengthen the capability of a littoral state to combat oil pollution at sea.

4. Oil spill contingency planning

The Malaysian Government formulated its first oil spill response plan, then known as the "National Oil Spill Contingency Plan," for the Straits of Malacca in 1975. It was subsequently reviewed to integrate search and rescue elements and data on environmentally sensitive areas. Another contingency plan is being formulated in the South China Sea coastal waters. It is anticipated that the two plans shall ultimately become integrated to become the National Oil Spill Contingency Plan.

4.1 The Straits of Malacca Contingency Plan (SOMCP)

The need for a contingency plan for the Straits of Malacca has arisen largely from the hazardous nature of the narrow and shallow waterway compared to other areas. In the two major incidents involving the grounding of the two tankers "SHOWA MARU" (1975) and "DIEGO SILANG" (1976), spills were noted to hit the west coast of Peninsular Malaysia rather than the east coast of Sumatra due to the prevailing northwesterly currents.

Valuable resources including fish, which forms over 75% of animal protein supply to the local populace, are exposed to both oil spills and other pollutants of daily occurrences. Generally, these resources are the highly productive estuaries, rapidly propagating mangroves, thriving coral reefs, and densely populated shallow sea bottoms. Without proper safeguard against oil spills, damage to most of the Malay Peninsula's valuable resources in the western coast can be substantial.

The SOMCP has been geared primarily to provide a mechanism of coordinating governmental response systems for the effective containment and recovery of oil spills. The plan similarly provides direction to the industries in handling oil spill incidents. Malaysia has, since 1975, invested a total sum of 33 million Ringgit for the acquisition of the relevant equipment and materials, as shown in Table 2. SOMCP has the following features:

4.1.1 Response area and response arrangement

The plan covers the Malaysian waters in the Straits of Malacca, as well as part of the South China Sea, i.e., that portion of the waters lying between North latitude one degree thirty minutes (1°30'N) and approximately North latitude seven degrees (7°N) (Fig.2). The necessary clean-up capability is presently developed in two centres for on-scene coordination, namely Johore Bharu and Port Klang. The other centre (Penang) is under review with respect to its most critical area.

The Plan can be activated in either minor or major oil spills. In the former case, the nearest Area Coordinator initiates the corrective measures prior to the clean-up operation. In the latter case, resources from all marine-related agencies, including the Royal Navy, shall be deployed by the Committee under the aegis of the Department of Environment.

4.1.2 Organizational arrangements then and now

In the original plan (1975) the Oil Spill Control Committee consisted of members from the key agencies such as the Ministries of Home Affairs, Foreign Affairs, Defence, Communications and Public Works, and representatives of the ship-ownersconcerned. The functions of the committee are as follows:

a) To coordinate the activities of the various agencies involved in the operation;

b) To expedite action with minimum red tape;

c) To direct the work of the Area Coordinator;

Table 2. Major oil spill combat equipment acquired for the Straits of Malacca Contingency Plan

Type		Description		Quantity
1. Workboat	(i)	Fitted with communication equipment, cyclonet skimmers and fire fighting equipment		2
	(ii)	Storage tank capacity:		
	(a)	Cargo	= 500 t	
	(b)	Dispersant	= 10 t	
	(c)	Foam	= 10 t	
	(iii)	Maximum speed	= 10 kn	
	(iv)	Horsepower	= 2 x 285 HP	
	(v)	Size:		
	(a)	Length	= 48.4 m	
	(b)	Breadth moulded	= 10.5 m	
	(c)	Depth moulded	= 4.3 m	
	(d)	Draft loaded	= 3.3 m	
2. Tugboat	(i)	Fitted with communication, dispersant spray and fire fighting equipment		4
	(ii)	Storage tank capacity:		
	(a)	Dispersant	= 1 t	
	(b)	Foam	= 5 t	
	(iii)	Maximum speed	= 12 kn	
	(iv)	Horsepower	= 2 x 1020 HP	
	(v)	Size:		
	(a)	Length	= 28.0 m	
	(b)	Breadth moulded	= 8.5 m	
	(c)	Depth moulded	= 4.0 m	
	(d)	Draft loaded	3.0 m	
	(vi)	Bolland Pull	= 20	
3. Oil Barges	Storage capacity is 200 t			6
4. Oil Booms	RFD 30A Rubber inflatable type		1500 m	
5. Oil Skimmers	Cyclonet 100 Dynamic type of skimmers fitted to the workboats			2 pairs

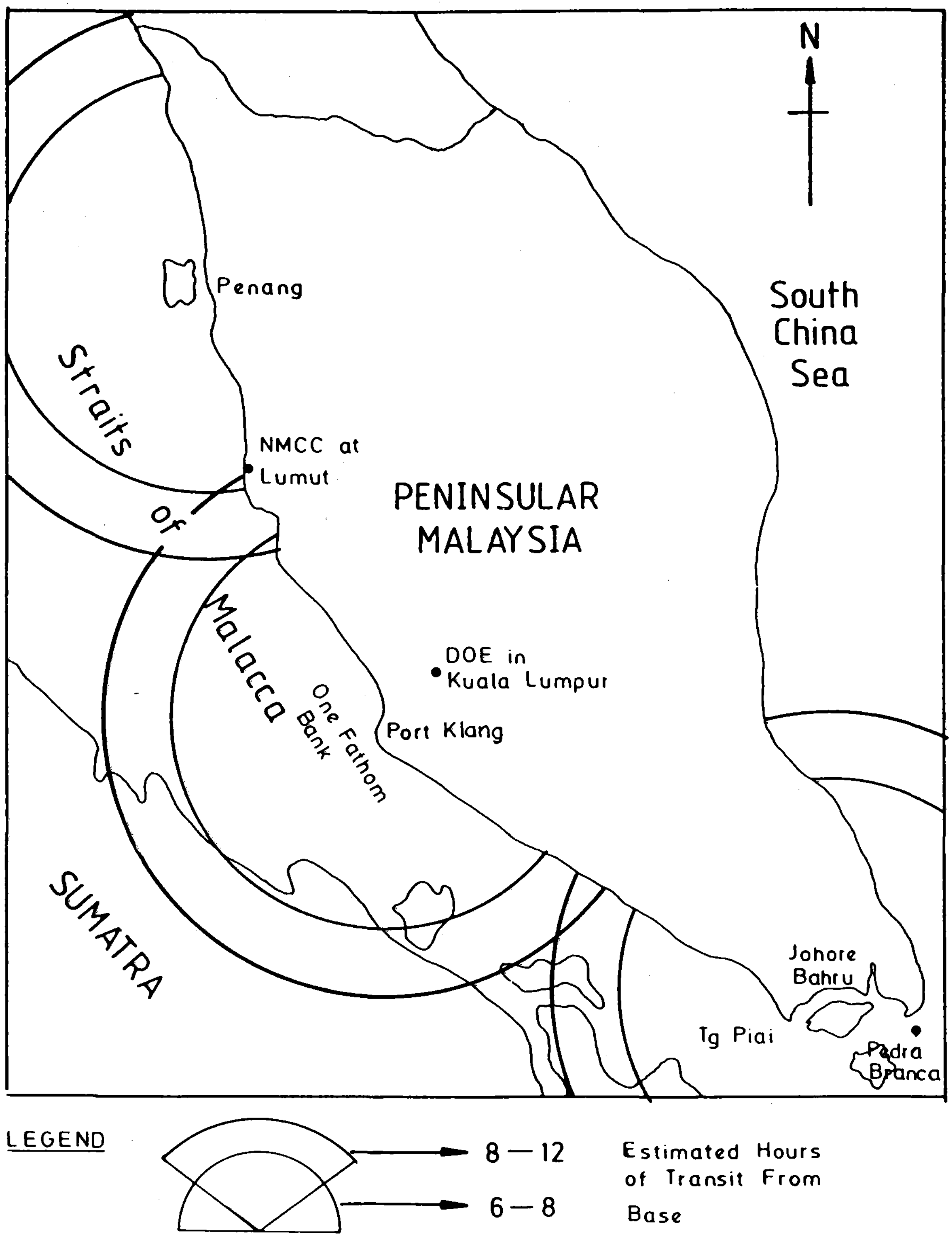


Fig. 2. The geographical scope of the National Contingency Plan to Combat Oil Spills in the Straits of Malacca with its 3 operational centres in Penang, Port Klang and Johore Bahru.

d) To keep an overview on the alertness of other Area Coordinators;

e) To coordinate, through the Foreign Affairs representative, inter-country contacts;

f) To deal with any other matters referred by the Area Coordinator or other relevant agencies for action or decision; and

g) To declare the degree of emergency: minor, major, or national disaster.

The Area Coordinator appoints the On-Scene Commander who in turn shall be responsible for the actual clean-up operation. The functions of the other agencies (Navy, Air Force) are predesignated. Areas of responsibility are defined for agencies in communication, air support, and deployment of vessels, skimmer, booms, etc., procurement and transportation of dispersants and other supplies, and movement of personnel. Information on distances between operation bases and travel-times, reporting format, communication networks, list of required communication equipment, vessels, and combat equipment for the operational base, and inventory of relevant equipment in the oil industry are also relevant.

The updated plan (1981, 1984) maintains the essential features of the original but has the following important changes:

a) Restructuring of the Plan Organization (Fig. 3) such that the National Committee has been expanded to include agencies identified to have critical roles in implementing the plan; role of the Navy is no longer seen as central in the new structure;

b) Increase in the number of officials designated as Area Coordinators from 3 to 12, including the Harbour Masters in Perak, Kuala Trengganu as well as the Marine Officers in Labuan, Kota Kinabalu, Kuching, Sibu and Miri;

c) Role of On-Scene Commander made more explicit , i.e., to support the Area Commander;

d) Necessity for sample collection introduced; role of the Chemistry Department in analyzing collected samples emphasized;

e) The Area Coordinator has the additional function of securing an approved waiver against liability, e.g., letter of guarantee from the owner, agent or operator of the source of spill;

f) Strict procedure is established in spill investigation, record keeping and reporting, as well as maintenance of a detailed account of the cost/expenses of the clean-up operations;

g) Inclusion in the new procedure of names of officials/key personnel in the oil industry together with their office address and residence telephone numbers, forms for handling of oil samples for chemical analyses and for analytical reports, sample Note of Indemnity, and updated list of anti-pollution equipment available throughout the country and existing stocks of chemical dispersants.

4.2 The South China Sea Contingency Plan (SCSCP)

The accelerated development and exploitation of Malaysia's offshore petroleum resources and those of her neighbours in the South China Sea introduces a greater element of risk as a result of the increase in tanker traffic in and out of the region (Fig. 4). Several incidents of oil spills resulting from tanker accidents have been recorded (see Table 1).

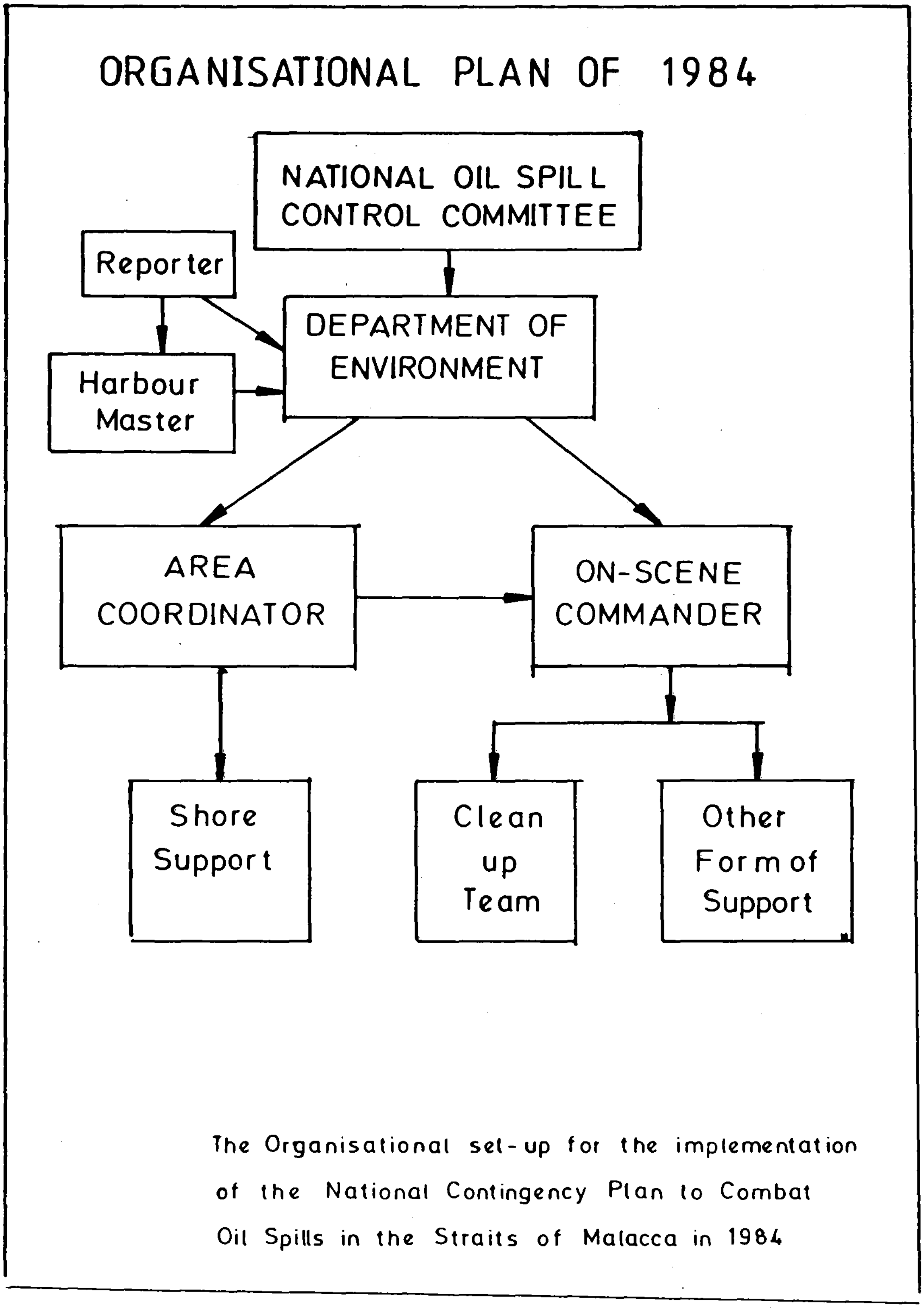


Fig. 3. The organisational set-up for the implementation of the National Contingency Plan to Combat Oil Spills in the Straits of Malacca in 1984.

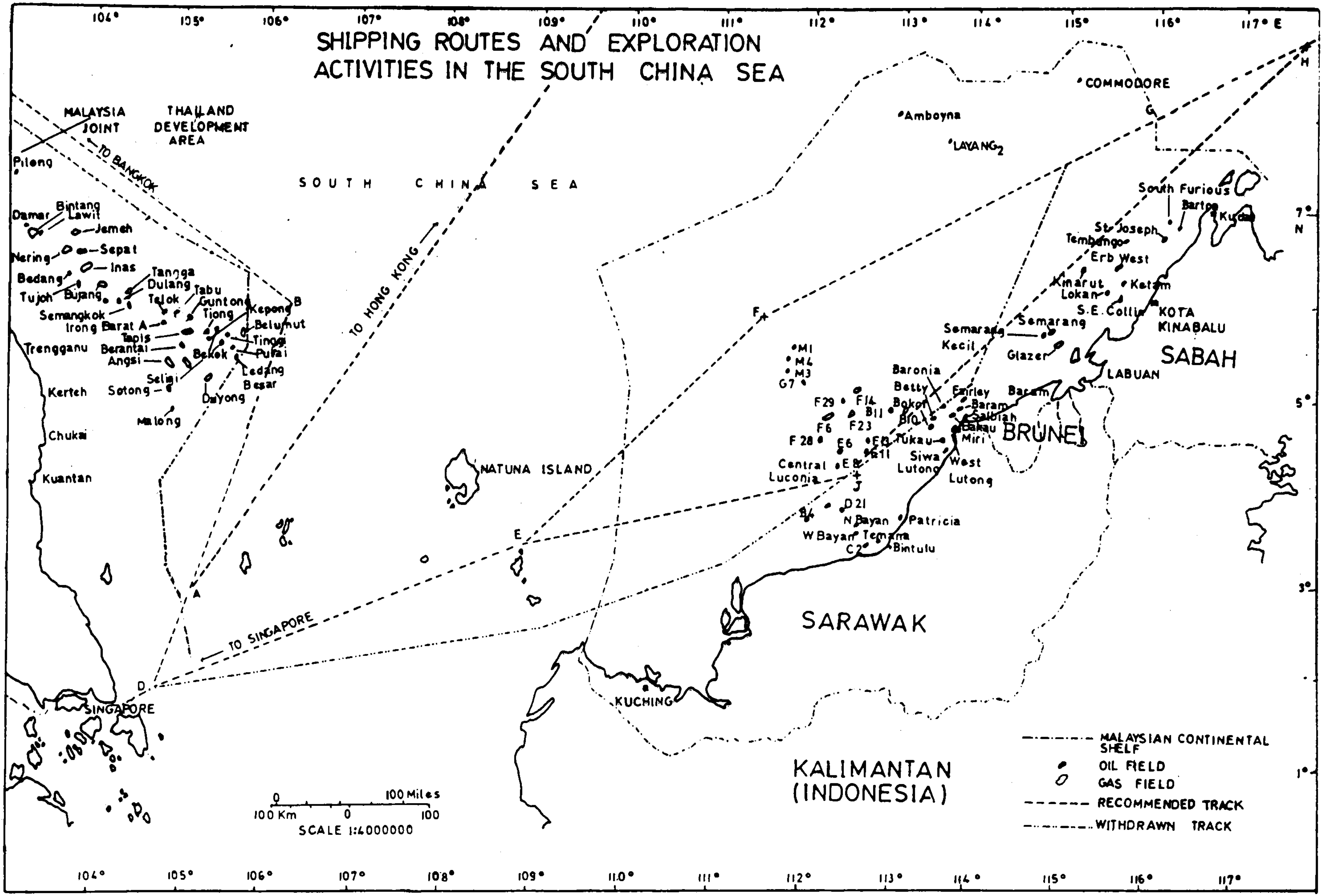


Fig. 4. Shipping routes and exploration activities in the South China Sea.

The need to develop a contingency plan for the South China Sea cannot be over-emphasized. The current economic recession and advances in oil spill combating technology have necessitated modification of the original approach adopted for the Malacca Straits, with greater emphasis hereto on the pooling of resources and maximizing the usage of available resources. Five sub-committees have been formed and are currently working on the contingency plan for the South China Sea.

The Malaysian coastline bordering the South China Sea includes five sections: East Johore, Pahang, Trengganu/Kelantan, Sabah and Sarawak. Each section is represented by one of the five committees, which in turn formulates a local contingency plan. The concept of cooperative support and joint response action is built into each plan. It is envisaged that the five local plans shall be integrated to form a national contingency plan for the South China Sea area. Figure 5 shows the elements of the Plan. The draft plans are now ready.

In developing the SCSCP, the need to maximize available facilities and to plan for effective deployment of resources is perhaps clearer than ever at this time of economic difficulties. The concept of an ASEAN Contingency Plan has been considered and existing sub-regional arrangements (e.g., Sulawesi Network) have been taken advantage of (cf. Figure 5). Other items that receive attention are the concept of coordinated even location of operation centers and the possibility of sharing equipment and chemicals, whether nationally or regionally, thus avoiding duplication of capital outlay.

4.3 Other oil spill response plans

In addition to the two aforementioned Plans, there are also local plans developed by port authorities and the petroleum industry, such as the PETRONAS Joint Refinery/TCOT Oil Spill Contingency Plan at Trengganu and the SHELL/ESSO Refinery Oil Spill Contingency Plan at Port Dickson. These local plans are supplementary to the National Contingency Plan.

5. Administrative and technological developments

Since the EXERCISE MALACCA '84, the Department of Environment (DOE) has established two sub-committees (one on communication and another on response capability) to identify gaps in the existing arrangements and make recommendations to the DOE.

Under the fifth Malaysia Plan, the DOE is upgrading the existing communication network among at least 21 government agencies and non-governmental institutions. Some allocation of development funds has also been set aside to further develop and strengthen the current capability.

Other developments are as follows:

a) National Trust Fund for oil spill clean-up. The Malaysian Government has approved a small trust fund (with initial allocation of 2 million Malaysian Ringgit) to be used strictly for emergency oil spill clean-up.

b) Contingency Plan for Maritime Casualty. A single communication network and unified response procedure has been proposed for all types of maritime casualty in the Straits of Malacca and South China Sea (with the special role to be played by the Maritime Enforcement and Coordination Centre (MECC) which is based in Lumut, Perak). Further, a comprehensive plan to respond to maritime disasters is being worked out.

c) Use of Dispersants

- The Malacca Straits Plan calls for extensive utilization of mechanical means while the use of chemical dispersants is greatly discouraged in view of their toxicity. However, with the new and improved generations of dispersants, the DOE has reconsidered their use for combating oil spills.

ELEMENTS OF MALAYSIA'S NATIONAL CONTINGENCY PLAN
& ITS LINKAGES WITH REGIONAL PLANS

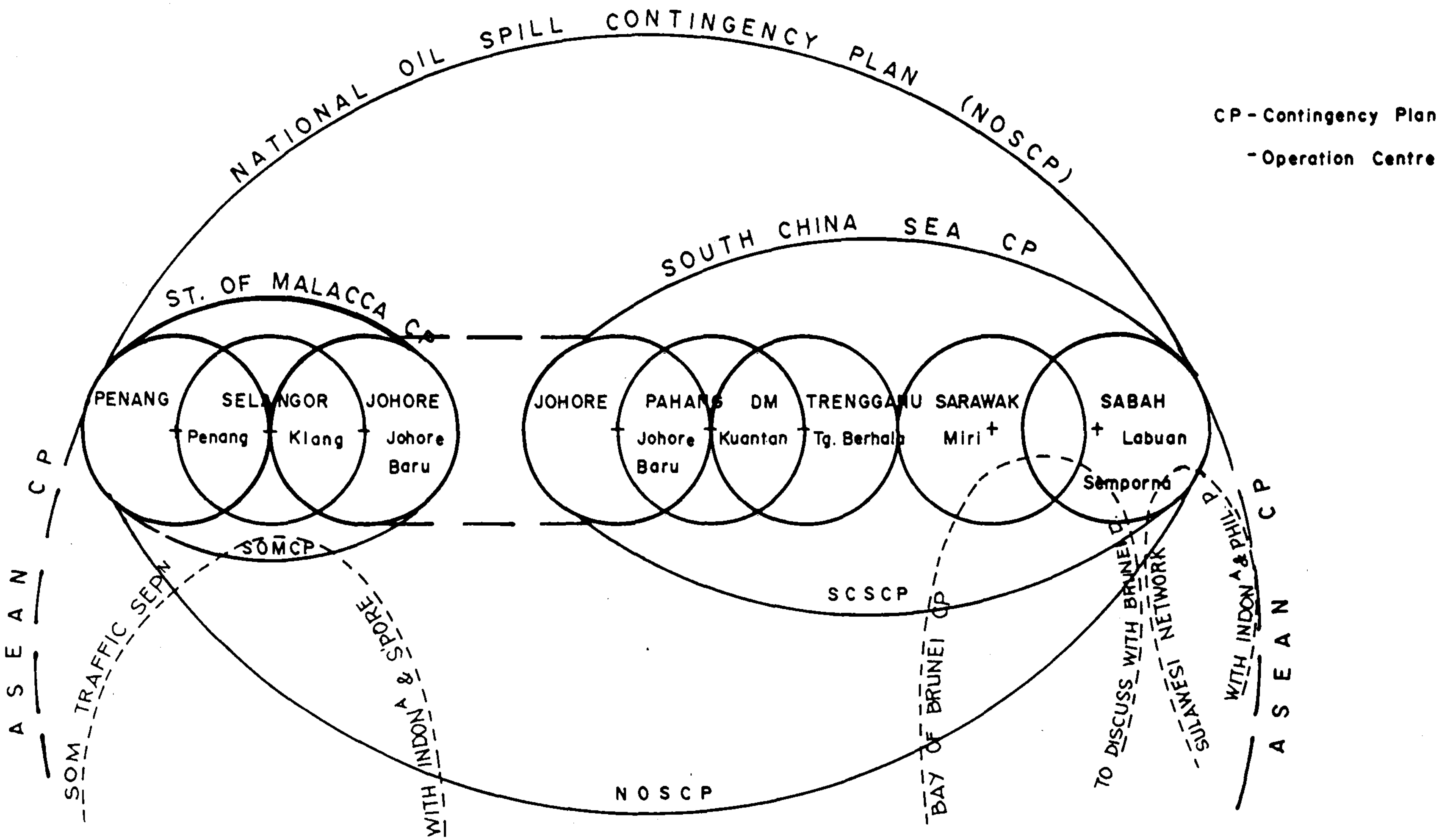


Fig. 5. Elements of Malaysia's National Contingency Plan and its linkages with regional plans.

- While awaiting the results of toxicity reports under the COBSEA project (EAS 12), the DOE is now drafting a set of guidelines on the use of dispersants.

- A provisional list of oil dispersants that may be used in Malaysian waters has been prepared. However, their use is still restricted to the conditions permitted by the proposed guidelines.

- The Malaysian Committee on Contingency Plan has (on 7 May 1987) provisionally accepted the results of the dispersants tested in the COBSEA project. (It will be noted however that the project concentrates on the toxicity aspect. It would be useful if effectiveness could also be included as a parameter, as is the general world trend now).

d) Oil spill trajectory

- The prediction of oil slick movement is very important especially when resources for combating oil spill are limited and the areas requiring protection are vast.

- Most of the coastal resources in Malaysia that are particularly "vulnerable" to oil pollution have been more or less identified. However, Malaysia has difficulties in prioritizing the areas for protection in the event of a major oil spill.

- Oil trajectory modelling is thought to be an invaluable tool where the time of response is of the essence. Computer software is available for modification but still the relevant data concern the currents, tides and winds.

e) Environmentally sensitive areas. It is recognized that the identification and accumulation of data for these areas would be a long continuous process, and local as well as international assistance and joint efforts are much needed.

f) Environmental Impact Assessment (EIA). The procedures and methodology in conducting EIA's prior to project implementation are now more well known and widely practised. However, post-spill project assessment procedures and methodology are yet to be defined and practised and universally accepted. This is especially important if assessment and evaluation results are to be compared and to be of use for future analysis. Cooperative regional efforts are much needed if after-spill impact analysis is to gain significant progress.

6. Regional arrangements

The need for regional cooperation in holding down the hazards to the marine environment has been well recognized by the Malaysian Government. Among the more important arrangements are the Traffic Separation Scheme for the Straits of Malacca and the Straits of Malacca and Singapore Oil Spill Revolving Fund.

6.1 Traffic separation scheme for the Straits of Malacca

This scheme is geared towards the orderly flow of traffic in the Straits of Malacca thus reducing the risk of collision in congested and converging areas. It has the following important provisions:

- two one-way routes for opposing east-bound and west-bound traffic;

- constant speed of twelve knots to prevent in-line collision;

The scheme was adopted by Indonesia, Singapore and Malaysia and was endorsed by the IMO. It states the rule, among others, that:

> "Deep draught vessels and VLCC's shall allow for underkeel clearance (UKC) of at least 3.5 m at all times during the entire passage through the Straits of Malacca and Singapore."

The scheme came into force on 1 May 1987. It is an important measure that has contributed much to the reduced number of ship collisions in the Straits.

6.2 The Straits of Malacca and Singapore oil spill revolving fund

After a series of dialogues, a Memorandum of Agreement was signed on 11 February 1981 between the Governments of Malaysia, Indonesia and Singapore on the one part and the Malacca Straits Council for the Japanese Non-Governmental Associations on the other part, establishing a revolving fund of four hundred million yen (Y 400,000,000) to combat oil pollution from ships in the Straits of Malacca and Singapore. This fund is specifically intended to enable the three coastal states to take immediate action, either independently or jointly, against any spill caused by ships, whether accidental or intentional.

Figure 5 shows the linkages of the National Contingency Plan with other regional plans.

7. Conclusion

In line with changes and current developments, the Malaysian Government has reviewed its objectives and strategies in implementing the legal, administrative and technical measures relating to the protection of the marine environment and of its neighbours.

Specifically, the Malaysian Oil Spill Contingency Plan is undergoing modification to take into account:

- Additional environmentally sensitive areas being exposed to oil pollution threats;

- The need to provide for sub-regional response plans and other regional cooperative efforts;

- Scientific data and technical innovations resulting from local and international cooperation programmes;

- More cost-effective deployment of combating facilities and continual joint efforts in sharing equipment and chemicals;

- More exact oceanographic and meteorological data for more accurate forecast of spill movements and more speedy counter-measures

Malaysia is not only concerned with the rapid development and integration of its own contingency plan but is prepared to work out any form of regional or international arrangements. The assistance of agencies like the IMO and UN-COOP shall be of great help to realize a common plan within the region.

REFERENCES

Jaafar, A. B. 1985. The state of environment in Malaysia. Seminar on Malaysian Environmental Quality, 8-11 July 1985, Kuala Lumpur.

OIL POLLUTION CONTROL MEASURES AND ARRANGEMENTS IN THE PHILIPPINES

Environmental Management Bureau
Department of the Environment and Natural Resources
6th Floor, Philippine Heart Center Building,
East Avenue, Diliman, Quezon City,
Philippines

ABSTRACT

Marine pollution is a major concern in the Philippines in view of the country's archipelagic configuration. Marine pollution-related legislation includes Presidential Decree (P.D.) 600 (Marine Pollution Decree of 1974), P.D. 601 (Revised Coast Guard Law of 1974), P.D. 602 (National Oil Pollution Operations Center Decree of 1976), and P.D. 1979 (Revised Marine Pollution Decree of 1976). Memo Circulars 02-77, 02-80, and 05-83 implement the provisions of the law. Oil pollution control contingency plans exist at both the national and sub-regional levels. The National Contingency Plan has well defined components including objectives, implementing units, operational procedures, and inventory of pollution control resources. Operational procedures include discovery and notification, evaluation and initiation of action, containment and other measures, mitigation and disposal, and documentation and cost recovery. A subregional arrangement exists with the governments of Indonesia and Malaysia to counter oil spills in the Lombok/Makassar Straits and the Sulawesi Sea. The Philippines is also a signatory to the ASEAN Contingency Plan and ASCOPE Plan.

1. Introduction

Marine pollution is a major concern in the Philippines in view of the country's archipelagic configuration and its heavy dependence on the marine environment for food, livelihood opportunities, communication and navigation. As projected in the Philippines Development Plan, by the year 2000, commercial fisheries will become the most important sector in the natural resource category with its vast export potential; hence, strategies to enhance commercial fisheries yield are being adopted. These strategies include the abatement of marine pollution.

Contaminants in the marine environment could destabilize the marine food chain and disrupt vital process in coastal/marine ecosystems. Philippines waters are recipients of contaminants in the form of organic wastes, nutrients, trace metals, organochlorines, pathogens, and oil in varying amounts and frequency of discharge. To date, heavy pollutant inputs are noted in coastal areas adjacent to major cities and major development activities. Oil pollution in particular is growing to be a significant threat as oil exploration/exploitation activities and sea transportation in the country have intensified.

2. Extent of oil pollution

Oil contamination in marine waters is traceable to the following:

- Natural seepages in the ocean floor. These account for about 10% of the over six million metric tons of petroleum hydrocarbons entering the oceans of the world every year (Berbano 1979).

- Industrial discharges. Examples of industrial sites in the country which are potential oil sources are metallurgical and engineering works, garages and service stations, oil refineries, depots and trade centers (Pecache 1979). Figure 1 shows the location of crude oil terminals, refineries and major refined petroleum product depots in the country.

- Loss from offshore oil production (Pham 1979). As of 1986, the country's three oil fields (Figure 1) had a cumulative production of about 31.8 million bbl while for 1986 alone, the aggregate production was about 2.5 million bbl (Lozano and Berbano 1986). The amount of oil lost to the marine environment during the production period was not quantified.

- Deballasting operations and tank washing (Pham 1979).

- Shipping accidents (Pham 1979). Oil spill incidents for the period 1975-1986 are presented in Table 1. It should be noted that over 60% of incidents are ship-related; about 13% occurred in refineries and depots, and only 2 incidents were factory-related. The highest amount of oil spilled was 2,225,580 l while the lowest reported was less than 100 l. Bunker oil is the oil type frequently spilled. Accidents - e.g., rupturing of hoses or pipes, malfunctions or explosions - accounted for 26% of the spills and sinking of vessels was responsible for 24% of the oil spill incidents. Areas where relatively frequent oil spill incidents have occurred are in the Pasig River and the coastal areas of Batangas and Negros Occidental. The latter was the site of the major oil spill incident in 1986. Oil spill incidents occur most frequently in August-October, the "typhoon months" in the Philippines.

The Philippines still relies heavily on sea transportation in the conveyance of people, goods and services among its numerous islands. In addition, the country lies at the crossroads of the major shipping lanes (Figure 2) through which over 3.21 million bbl of crude oil alone are conveyed on a daily basis (Bilal 1985). The presence of these routes is a potential threat to the country's marine environment in terms of accidental discharges/spillage of energy materials and other hazardous cargo.

Limited data are available on the quality of Philippine marine waters in terms of oil contamination. Table 2 shows the oil and grease levels in selected marine waters. Some oil levels at South Harbor exceeded the National Pollution Control Commission (NPCC) criteria for class SE waters, i.e., watersbest suited for navigational use. In some instances, oil and grease levels at South Harbor, North Harbor, Cavite, and Cebu exceeded the NPCC criteria for marine fisheries propagation.

In Batangas Bay, where two refineries are located, hydrocarbon readings were of the range 0.8-5.5 ppm (Bilal 1985). An analysis of the 1985 Manila Bay monitoring results shows that higher levels are found in stations adjacent to Metro Manila. Except for one station which yielded a reading of 0.01 ppm, the nearshore stations registered oil and grease levels in the range of 1.45-11.32 ppm. Offshore stations yielded concentrations of 0.02-0.11 ppm (NPCC 1986).

Oil contamination is also manifested in Philippine beaches at aic (Cavite), and Sual and San Fabian (Pangasinan).

A number of Philippine coastal zone/marine resources are vulnerable to low-level or massive oil spillage. These include the following: coral reefs, mangrove areas, fishing grounds, beach resources, seashores and marine parks (Figures 3, 4, 5 & 6). Most of these resources are already under stress from non-oil contaminants and destructive exploitation activities.

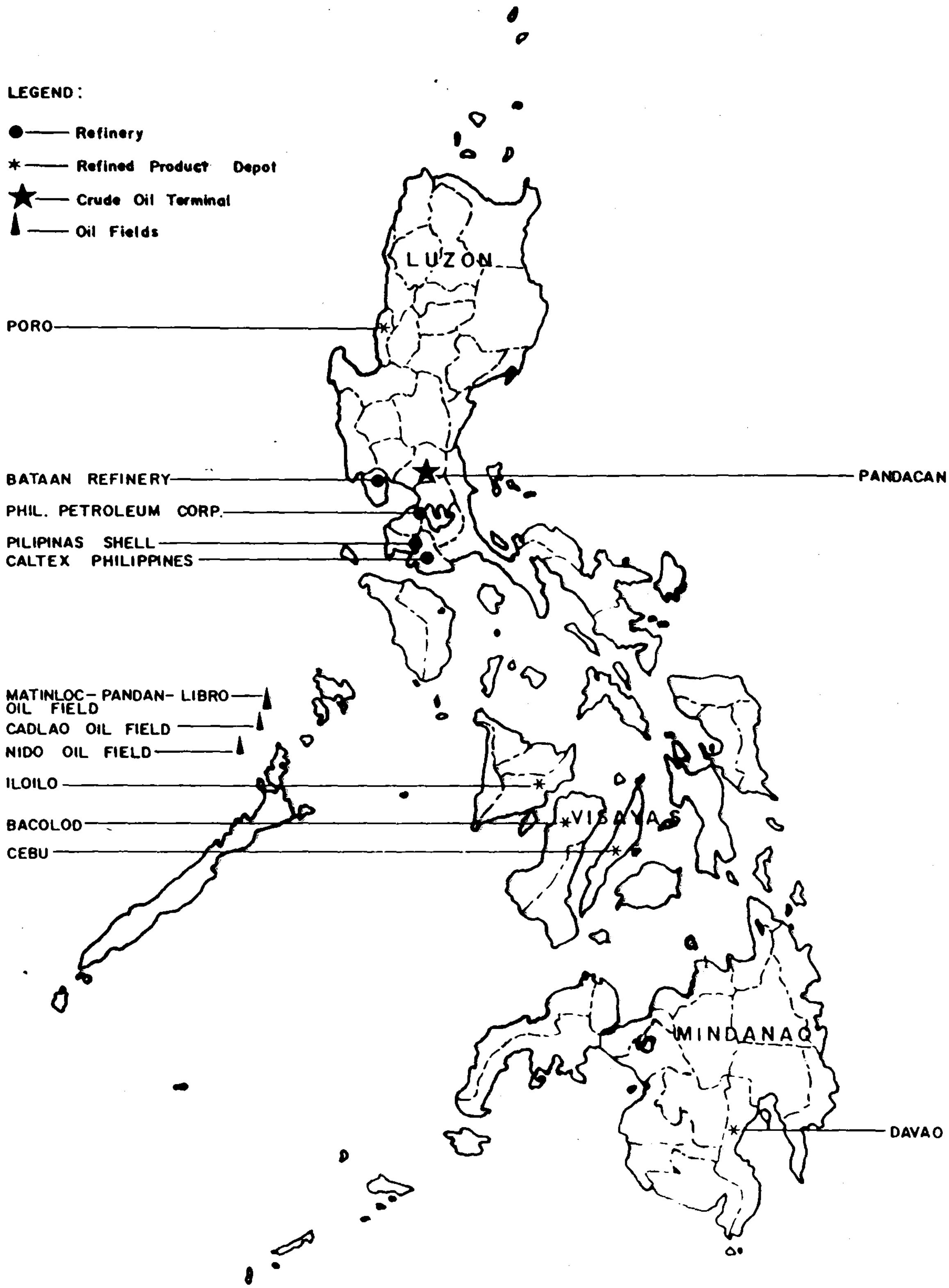


Fig. 1. Location of refineries, crude oil terminals, refined product depots and oil fields in the Philippines (MOE 1982).

Table 1. Oil spill incidents in the Philippines

Name of vessel/company	Place	Date	Quantity (1)	Type of oil	Cause
1. L-1909 Lusteveco	Pasig River	03 Aug. 1975	5,284	Fuel oil	Barge sinking
2. L-235 Lusteveco	Manila Bay, vicinity of Cavite	03 Aug. 1975	9,247	Fuel oil	Grounding
3. M/S Shotuko Maru	Off Escalante Point, Negros Occidental	17 Oct. 1975	Not specified	Fuel oil	Collision/sinking
4. Filoil Refinery	Wawa, Rosario, Cavite	13 April 1976	1,590-3,180	Waste/sludge oil	Accident; oil-water separator opened
5. Mobil Depot	Sasa, Davao	18 Aug. 1976	1,680	Fuel oil	Leakage due to broken pipe
6. LSCO Lumberjack	Caltex Pier, Batangas	21 Sept. 1976	840	Fuel oil	Grounding
7. LSCO Petrochem	San Fernando, La Union	11 Oct. 1976	1,470	Fuel oil	Grounding
8. M/T Raja Sulayman	Bataan Refining Corp., Bataan	06 Nov. 1976	4,200	Crude oil	Leakage
9. M/S San Diamond	Vicinity of Cape San Agustin to Santa Ana, Davao	10 Dec. 1976	Not specified	Fuel oil	Sinking
10. M/V Gen Santos	Manila Bay, vicinity of San Nicolas	27 Dec. 1976	8,450	Fuel/diesel oil	Sinking
11. M/V Maya	Mariveles Harbor, Bataan	23 Feb. 1977	Not specified	Fuel/lube oil	Sinking
12. Petrophil	Banago, Bacolod City	04 June 1977	68,000	Gasoline	Damaged cargo line
13. M/T Phil Star	Banago, Bacolod City	22 Aug. 1977	2t	Oil	Leakage in pipeline
14. Shell Refinery	Tabangao, Batangas	22 Aug. 1977	2,310	Crude oil	Accidental rupturing of vessel's hose
15. Caltex/Petrophil	Banago, Bacolod City	01 Sept. 1977	147,376	Diesel oil	Leakage in pipeline
16. Two unidentified vessels	Pasig River	09 Sept. 1977	Not specified	Fuel oil	Collision involving two vessels
17. M/V Insular de Cebu	Dumaguete Pier, Dumaguete City	15 Sept. 1977	10,000	Diesel oil	Crack in fuel tank
18. M/T Apokia	Malasibomanoc Island, Batangas	16 Oct. 1977	7,962-8,957	Fuel oil	Vessel went aground
19. AG & P Wood Preserving Div.	Pasig River	12 April 1978	625-833	Bunker oil	Factory discharge

Table 1 (cont'd).

Name of vessel/company	Place	Date	Quantity (l)	Type of oil	Cause
20. M/V Don Jose		19 May 1978	Not specified	Oil	Discharge
21. M/V Guimaras		20 May 1978	75.7	Oil	Discharge
22. M/V Tamarao		22 May 1978	288-432	Oil	Discharge
23. M/T Peathray G-III		06 Aug. 1978	Not specified	Fuel oil	Spillage
24. LB 603		27 Sept. 1978	635.80	Turbo oil	Sinking
25. LB 607		27 Sept. 1978	1,112,790 - 1,208,304	Premium gasoline	Sinking of barge due to typhoon
26. M/T Peatheray G-III	Malasibomanoc Island, Batangas	27 Sept. 1978	5,500	Bunker oil	Vessel went aground
27. Unidentified vessel	BRC, Bataan	27 Sept. 1978	1,112,911	Bunker oil	Sinking of vessel due to typhoon
28. LB 1008		27 Sept. 1978	476,910	Oil	Spillage
29. Unidentified barge	BRC, Bataan	09 Oct. 1978	476,962	Bunker oil	Sinking of barge
30. Unidentified barge	Manila Bay	09 Oct. 1978	114,471	Fuel oil	Barge went aground
31. M/T Charlie		10 Oct. 1978	280,000	Bunker oil	Sinking
32. Unidentified vessel	BRC, Bataan	10 Oct. 1978	1,059,915	Bunker oil	Sinking of vessel due to bad weather
33. M/T Feoso Sun		08 Nov. 1978	Not specified	Bunker and crude oil	Spillage due to explosion
34. Barge CCI-I	Pasig River	14 Nov. 1978	49,205 - 206,683	Lube oil	Sinking of barge
35. Unidentified vessel		28 Nov. 1978	30,000	Diesel oil	Sinking of vessel
36. Unidentified vessel	Pasig River	28 Nov. 1978	40,000	Automotive/diesel oil	Sinking of vessel
37. M/T San Roque		10 May 1979	6,558	Oil	
38. Unidentified vessel	Calapan, Oriental Mindoro	10 May 1979	111,291	Automotive/diesel oil	Accidental parting of hose nipple during cargo
39. Unidentified vessel	Calapan, Oriental Mindoro	02 June 1979	63,595	Automotive/diesel oil	Accident
40. M/V HSIN Pioneer	Bauan, Batangas	05 July 1979	2,082 - 3,123	Bunker oil	Accident; crack in forward tank

Table 1 (cont'd).

Name of vessel/company	Place	Date	Quantity (1)	Type of oil	Cause
41. SMC Glass Corp.	Pasig River	12 July 1979	2,082	Bunker oil	Accident; hose pipe ruptured
42. Unidentified vessel	Anajawan, Sipalay, Negros Occ.	July 1979	625	Not specified	Vessel went aground
43. M/T Phil Hero		08 Aug. 1979	200	Oil	
44. Shell	Shell Refinery, Batangas	04 Sept. 1979	625	Not specified	Accident
45. Unidentified vessel	Lubang Island, Mindoro	29 Nov. 1979	30,000	Diesel oil	Sinking of vessel
46. Caltex	Caltex Refinery, Batangas	06 Jan. 1980	18,527 - 22,712	Bunker oil	Not specified
47. Caltex	Caltex Refinery, Batangas	17 Jan. 1980	18,937	Oil-water mixture	Discharge to nearby river; overflow of oil-water separator due to malfunction of desalter
48. M/T Phil Hero		08 Aug. 1980	200	Oil	
49. LB 1010		08 Oct. 1980	200	Oil	
50. M/T Delsan VI		12 March 1981	10,500	Oil	
51. M/T Insular de Negros	24 April 1981	477	Oil		
52. M/V Lorenzo Con II		21 July 1981	100	Oil	
53. M/R Delsan VI	Caltex Oil Depot, Iloilo City	03 Dec. 1981	1,050	Crude oil	Worn-out hose
54. M/T Gulf Ace	Poro entrance, San Fernando, La Union	19 Dec. 1981	127,190-158,987	Bunker oil	Vessel went aground
55. PNOC	Calumpang, Gen. Santos City	28 April 1982	10,410-14,573	Bunker oil	Storage tank pipe ruptured
56. M/T Camrahn	Calumpang, Gen. Santos City	28 April 1982	10,500	Bunker oil	Submarine pipeline leakage
57. NPC Storage Tank		28 April 1982	7,948-11,128	Oil	Leakage
58. Caltex Oil Depot	Lapu-lapu City, Cebu	28 April 1982	352,000	Bunker oil	Bottom hose of storage tank #5 ruptured
59. Caltex Oil Depot Cebu	Lapu-lapu City,	15 June 1982	346,674	Bunker oil	Ruptured tank valve

Table 1 (cont'd).

Name of vessel/company	Place	Date	Quantity (l)	Type of oil	Cause
60. M/T Anthony Jr.	Vicinity of Bgy. Lapaz, San Narciso, Zambales	27 Aug. 1982	Not specified	Bunker oil	Grounding
61.	Aringay, La Union	26 Nov. 1983	Not specified	Fuel/diesel/bunker oil	Sinking of tanker after catching fire
62. M/S La Carlota and MIS Hortencia	Iloilo Anchorage	15 Dec. 1983	497,597	Fuel oil	Collision involving two vessels
63.	Pandacan, Metro Manila	01 Sept. 1984	8,000	Bunker oil	Sinking of vessel
64. M/T Regina Gracia	Mobil, Pandacan, Metro Manila	21 Sept. 1984	140,000	Bunker oil	Loading
65.	Baliwasan, Zamboanga City	27 Sept. 1985	625	Bunker oil	Bunker oil tank of coco oil factory cracked
66.	Sual, Pangasinan	26 Oct. 1985	Not specified	Petroleum oil products	Sinking of vessel due to typhoon
67. M/V Dona Josefina	Isabel, Leyte	10 May 1986	30,000	Bunker oil	
68. Iloilo City		26 May 1986	1,041	Bunker oil	Torn hose
69.	Iloilo City	30 June 1986	477	Bunker oil	Sudden rupturing of discharge hose
70. M/T Maysun	Negros Occ.	16 Aug. 1986	2,225,580	Bunker oil	

Source: NOCOP-PCG

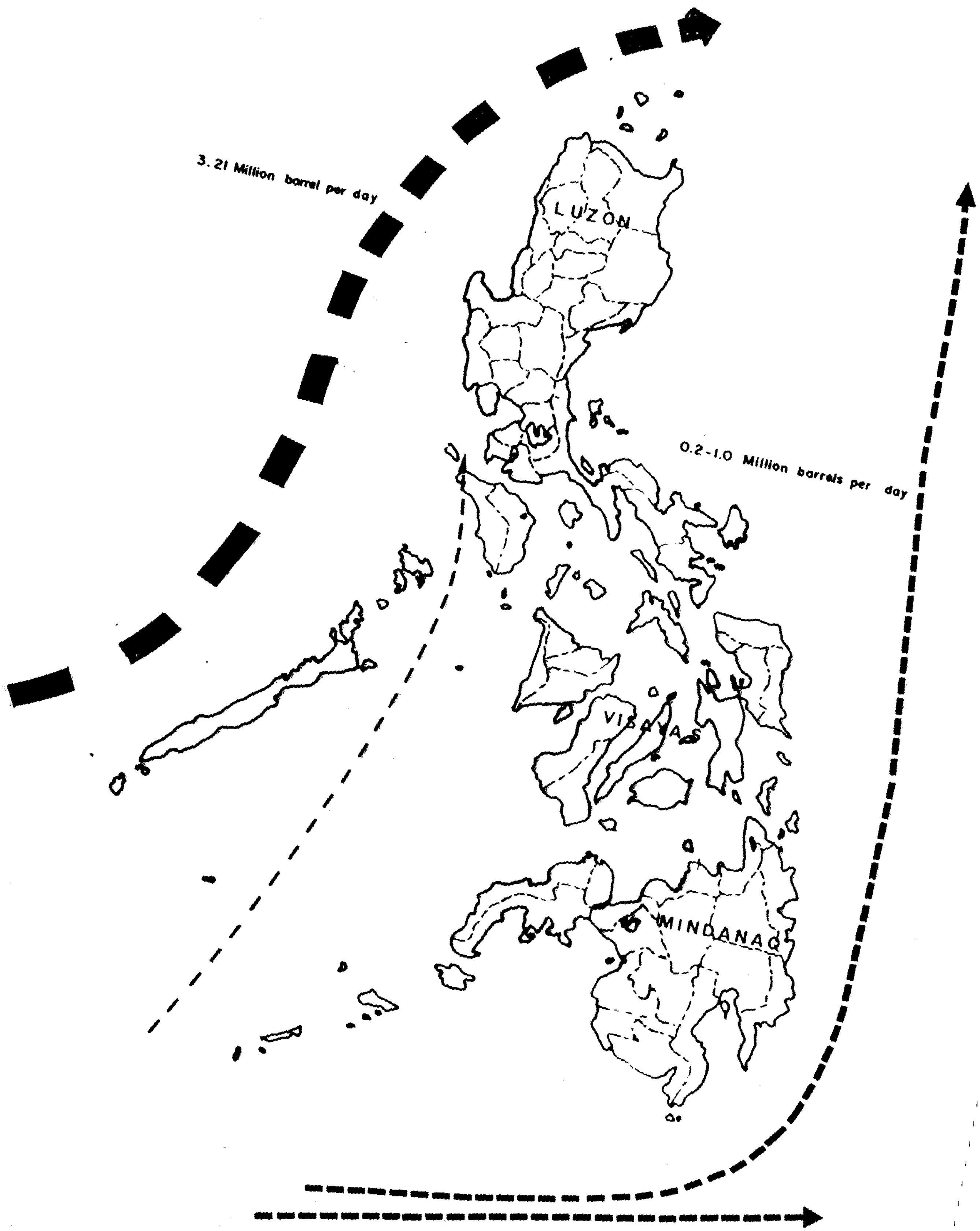


Fig. 2. Major shipping lanes.

Table 2. Oil levels in Philippine marine waters (NOCOP, *NPCC 1986)

	Location (Range,ppm)	Date	Oil content
1.	South Harbor	1978	1.76 - 5.11 0.20 - 14.50
2.	North Harbor	1978	2.27 - 5.47 0.25 - 8.00
3.	Cavite	1978	1.89 - 5.62 0.14 - 6.00
4.	Cebu	1978	0.66 - 5.05
5.	Davao	1978	1.24
6.	Manila Bay*	1985	0.01 - 11.32

3. Oil pollution control legislation

It is the policy of the government, as expressed in Presidential Decree (P.D.) 1151, to provide for an environment that is conducive to the health and well-being of its citizens and harmony between man and his environment. This is echoed in the Philippine Environment Code (P.D. 1152) where the various concerns, e.g., water quality management, air quality management, the strategies to be adopted and the institutional mechanisms for each are identified. In particular, the marine pollution-related legislative acts are the following:

3.1 P.D. 600 - Marine Pollution Decree of 1974

The decree declares it a national policy to prevent and control the pollution of the seas within the territorial jurisdiction of the country. For this purpose, the Philippines Coast Guard (PCG) is empowered to prescribe the pertinent rules and regulations. Moreover, the PCG is authorized to develop capability for containment and recovery of spilled oil in island waters and high seas. This legislation was later amended by PD. 979 in 1976 (see below).

3.2 P.D. 601 - Revised Coast Guard Law of 1974

The decree organizationally modifies the PCG and empowers its members to act as law enforcement agents of the Bureau of Fisheries and Aquatic Resources (BFAR) and the National Pollution Control Commission (NPCC).

3.3 P.D. 602 - National Oil Pollution Operations Center Decree of 1974

The decree creates the National Operations Center for Oil Pollution (NOCOP) in the PCG Headquarters. The Center is empowered to negotiate/co-ordinate with oil companies, government instrumentalities and national operations centers of ASEAN in combating and containing oil pollution.

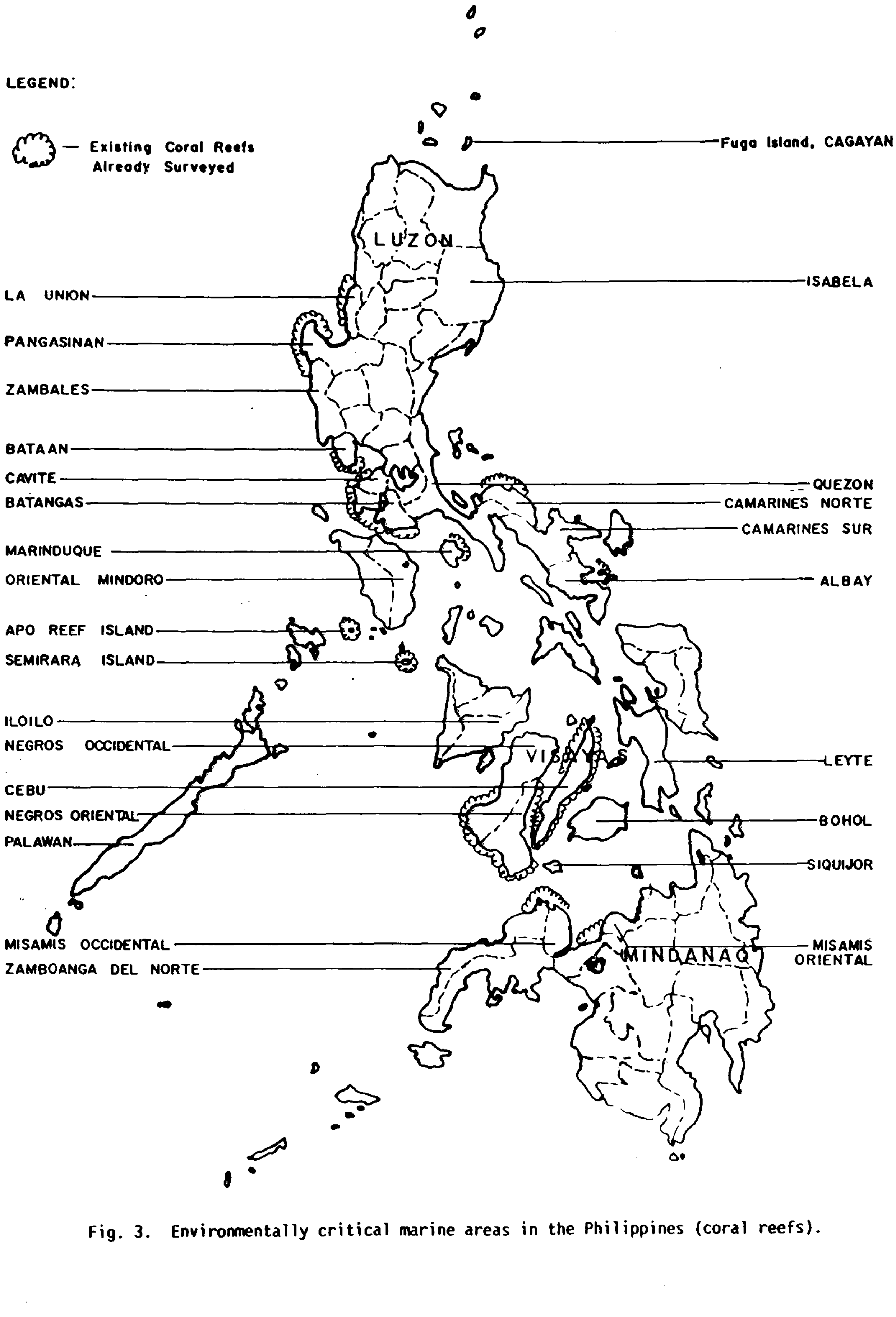


Fig. 3. Environmentally critical marine areas in the Philippines (coral reefs).

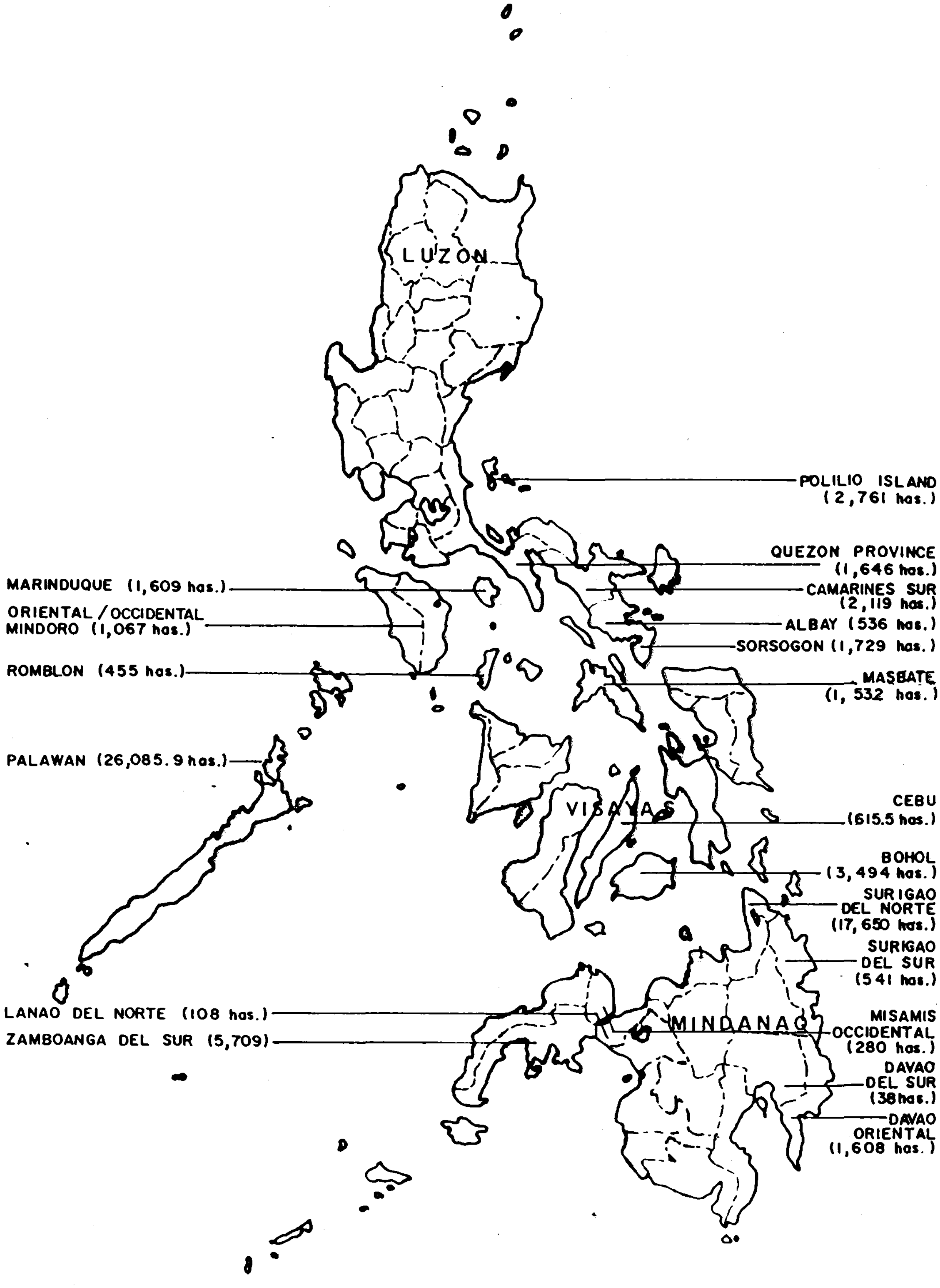


Fig. 4. Environmentally critical marine areas in the Philippines (mangroves).

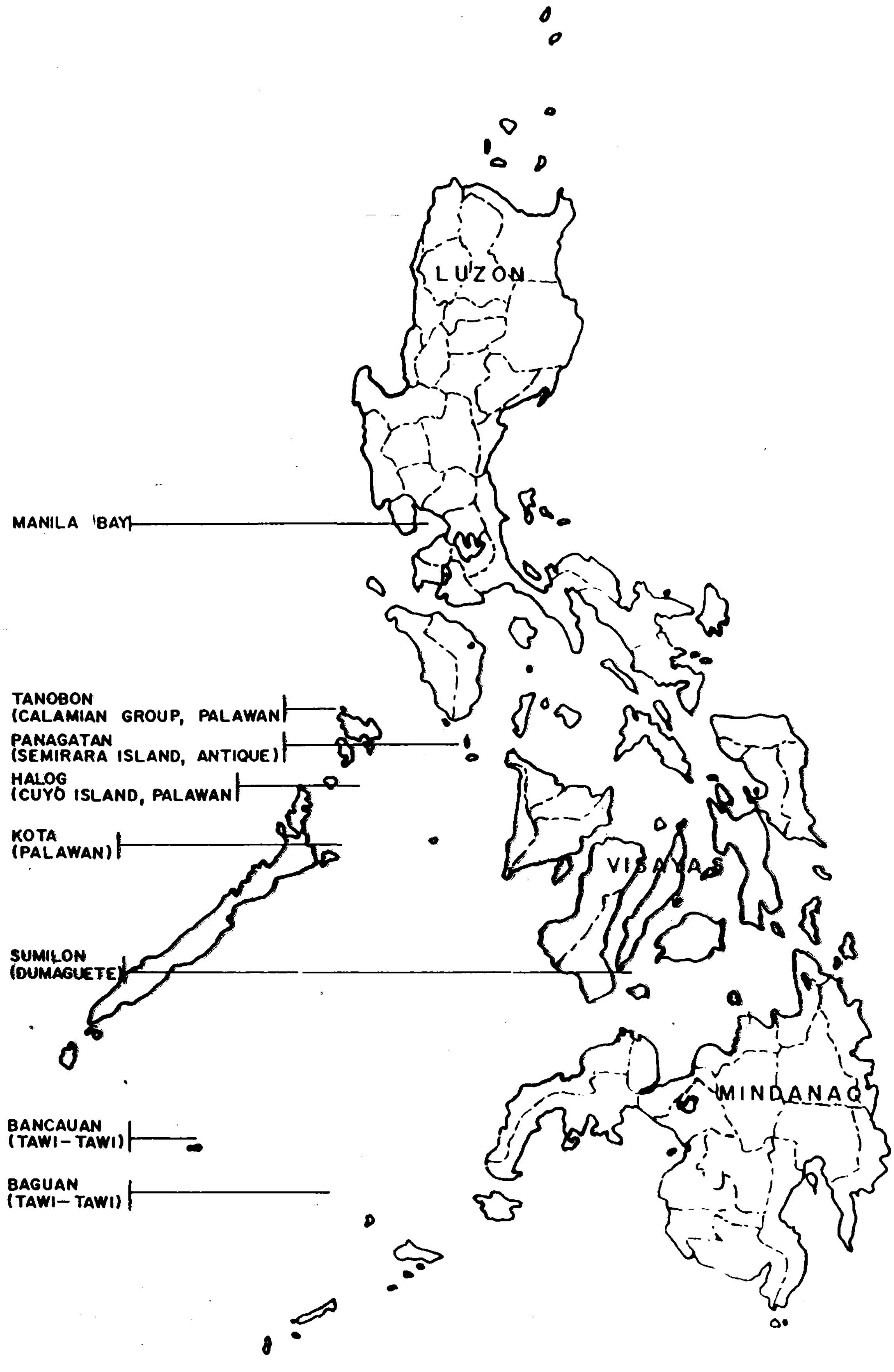


Fig. 5. Environmentally critical marine areas in the Philippines (fishing grounds).

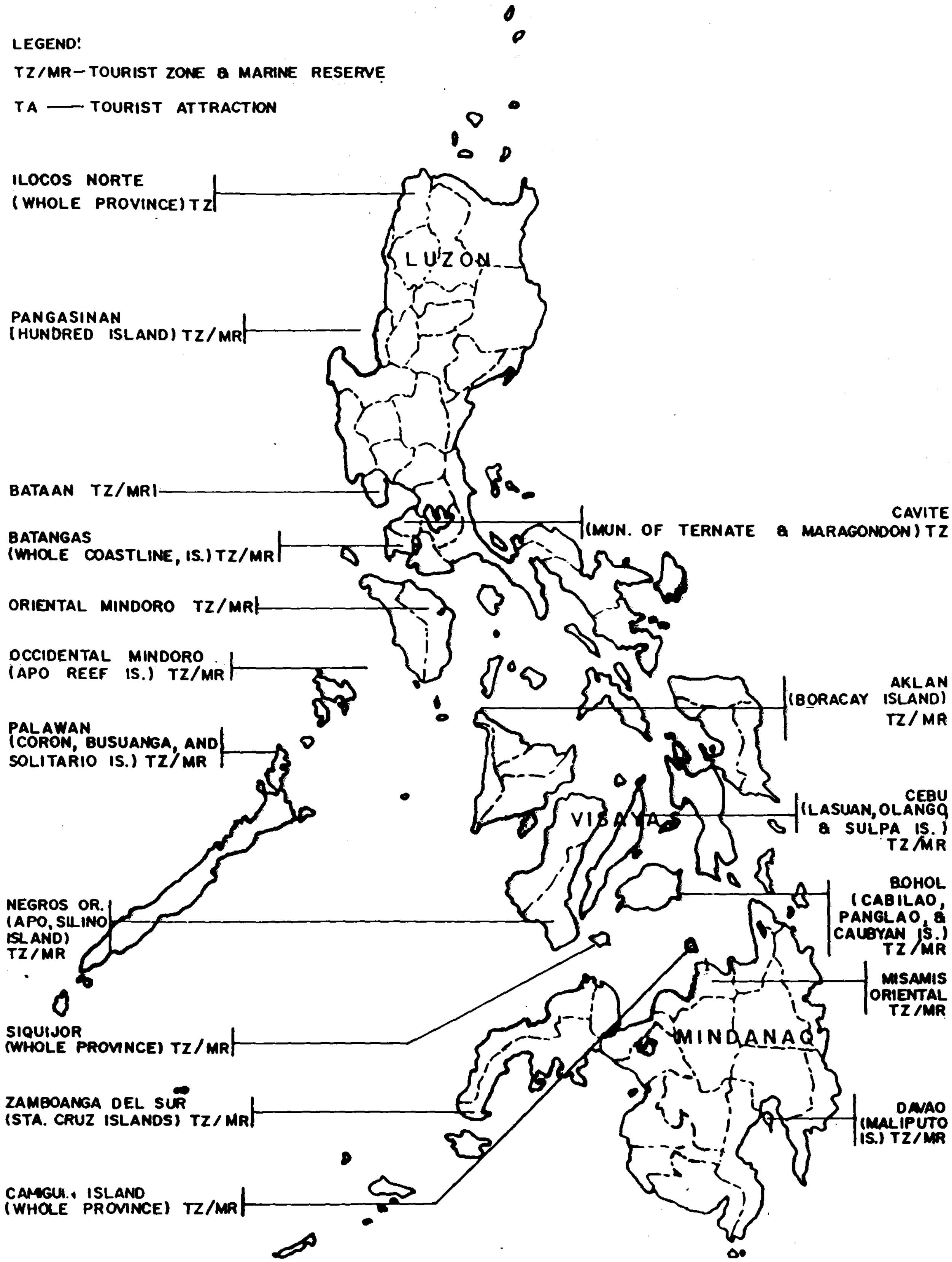


Fig. 6. Environmentally critical marine areas in the Philippines (beach resorts/tourist zones).

3.4 P.D. 979 - Revised Marine Pollution Decree of 1976

The decree empowers the NPCC to promulgate national rules and policies governing marine pollution. The PCG is likewise tasked with the promulgation of its own rules and regulations on marine pollution in accordance with NPCC's guidelines.

Regulation of oil pollution in the Philippines is effected through habitat protection and control of waste discharges at source. For instance, receiving bodies of water in the country are classified according to their best usage. The maximum allowable oil and grease limit for class SC and SE are 5 mg/l and 10 mg/l, respectively. The best usage for class SC is fisheries propagation and for class SE, navigation. Regulations are also enforced on the degree of treatment of wastes from industries and other point sources prior to disposal into the environment. The quality of effluents is also specified prior to discharge into protected coastal areas and open seas. In addition, the Environmental Impact Assessment (EIA) system is currently implemented to predict and minimize the adverse effects of development projects on vulnerable organisms and ecosystems. The system covers both environmentally critical projects and environmentally critical areas (Table 3).

To implement the provisions of P.D. 600 and P.D. 979, the PCG formulated and approved the rules and regulations on marine pollution control. These are reflected in the following circulars:

(i) Memo Circular 02-77. This contains the rules and regulations for prevention, containment, abatement and control of marine pollution.

(ii) Memo Circular 02-80. This provides for the accreditation of oil-water separators, oil containment, recovery and disposal equipment, as well as chemical dispersants. It aims to ensure that all oil-water separators, chemical dispersants and other related equipment in vessels, oil refineries and such other places as required shall meet the standards of the PCG.

(iii) Memo Circular 05-83. This prescribes the rules for the issuance of International Oil Pollution Prevention Certificates to vessels of Philippine registry in consonance with the provisions in the international convention on marine pollution, MARPOL 73.

4. Oil pollution control contingency plans

There are a number of oil spill contingency plans adopted in the country. The overall framework is contained in the National Marine Pollution Control Contingency Plan (1975) while site-specific arrangements are implemented by oil companies and barging companies. There exists a sub-regional co-operative network for oil spills involving Indonesia and Malaysia, while the Philippines is also a signatory to the ASEAN Contingency Plan and the ASCOPE Plan.

4.1 The national contingency plan

The National Contingency Plan aims to coordinate and integrate response by the Government and private sectors at the national and local levels in dealing with oil spills. The Plan covers ports and harbours, and offshore, coastal and inland waters, including the tributaries and adjoining shorelines. The Plan has the following major components:

4.1.1 Objectives

- to develop appropriate preventive and ready measures and effective systems for discovering and reporting the existence of a pollution spill;

- to institute prompt measures to restrict the spread of pollutants;

- to ensure that the public health and welfare are provided adequate protection;

Table 3. Environmentally critical projects and environmentally critical areas in the Philippines

---

A. Environmentally Critical Projects

1. Heavy Industries

   a. Non-ferrous metal industries

   b. Iron and steel mills

   c. Petroleum and petro-chemical industries including oil and gas

   d. Smelting plants

2. Resource Extractive Industries

   a. Major mining and quarrying projects

   b. Forestry projects

      1) Logging

      2) Major wood processing projects

      3) Introduction of fauna (exotic animals) in public/private forests

      4) Forest occupancy

      5) Extraction of mangrove products

      6) Grazing

   c. Fishery Projects

      - Dikes and fishpond development projects

3. Infrastructure Projects

   a. Major dams

   b. Major power plants (fossil-fueled, nuclear-fueled, hydro-electric or geothermal)

   c. Major reclamation projects

   d. Major roads and bridges

B. Environmentally Critical Areas

1. All areas declared by law as national parks, watershed reserves, wildlife preserves and sanctuaries;

2. Areas set aside as potential tourist spots;

Table 3 (cont'd).

3. Areas which constitute the habitat for any endangered or threatened species of indigenous Philippine wildlife (flora and fauna);

4. Areas of unique historic, archaeological or scientific interest;

5. Areas which are traditionally occupied by cultural communities or tribes;

6. Areas frequently visited and/or hard-hit by natural calamities (geologic hazards, floods, typhoons, volcanic activity, etc.);

7. Areas with critical slopes;

8. Areas classified as prime agricultural lands;

9. Recharge areas of aquifers;

10. Water bodies characterized by one or any combination of the following conditions:

    a. tapped for domestic purposes;

    b. within the controlled and/or protected area declared by appropriate authorities;

    c. support wildlife and fishery activities.

11. Mangrove areas characterized by one or any combination of the following conditions:

    a. with primary pristine and dense young growth;

    b. adjoining the mouth of a major river system;

    c. near or adjacent to traditional productive fry or fishing grounds;

    d. act as natural buffers against shore erosion, strong winds and storm floods;

    e. on which people are dependent for their livelihood.

12. Coral reefs characterized by one or any combination of the following conditions:

    a. with 50% or greater live coralline cover;

    b. spawning and nursery grounds for fish;

    c. act as natural breakwaters of coastlines.

- to apply techniques to clean-up and dispose of the collected pollutants; and

- to institute actions to recover clean-up costs.

4.1.2 <u>Implementing units</u>

- The central figures are the National Operations Center for Oil Pollution (NOCOP) Director based at the South Harbor, Manila who assumes the overall responsibility and the On-Scene Commander (OSC), who is the Philippine Coast Guard (PCG) Commander in whose jurisdiction the oil spill occurs.

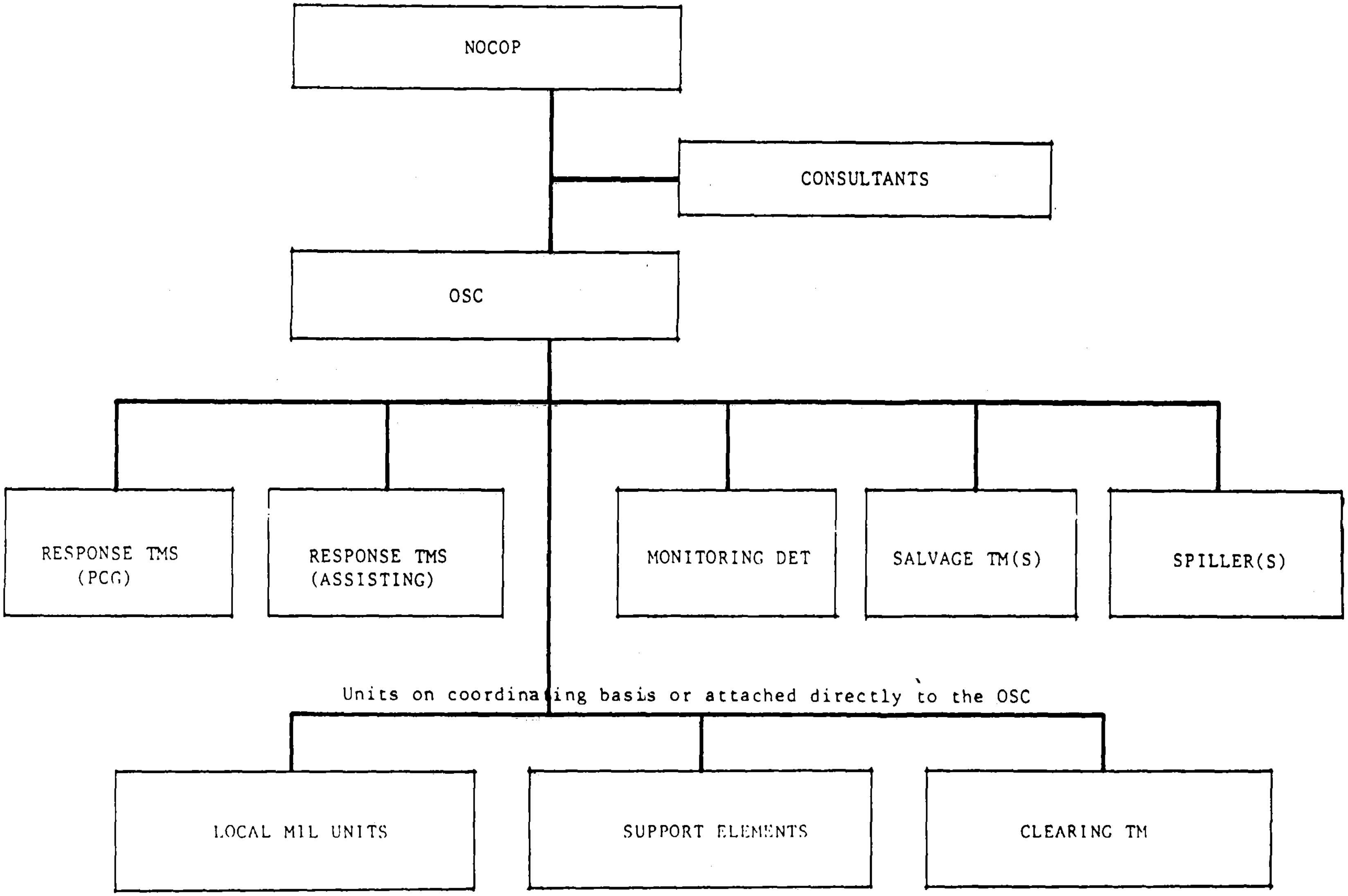


Fig. 7. Philippines National Oil Contingency Plan: organizational chart.

- Assisting units include the response team, the support elements, the salvage company, the clearing team, and oil refineries/terminals/depots and other entities discharging industrial wastes into the sea.

- Each implementing unit has clearly defined duties and functions.

The organizational chart in Figure 7 presents a summary.

4.1.3 Operational procedures

The procedures concern chiefly the following operations: (i) discovery and notification; (ii) evaluation and initiation of action; (iii) containment and other measures; (iv) clean-up, mitigation and disposal; (v) documentation and cost recovery.

(i) Discovery and notification:

- An oil discharge may be discovered through (a) a report submitted by a discharger; (b) deliberate searches by vessel controls and aircraft; and (c) random or incidental observations by government entities or the general public.

- In all these cases, the discovery of pollution spills should be reported immediately to the NOCOP and/or nearest PCG station (Table 4) by wire or telephone or by any means with the least possible delay.

- The alerting or initial report to the NOCOP/OSC should provide utmost information so that the NOCOP/OSC can evaluate the degree of severity of the spill and thus indicate the type and degree of mobilization needed. Such a report should try to provide the following information:

(a) type of pollutant (e.g., diesel, crude oil, etc.);

(b) name of water course, the location where the spill occurred and/or its present position;

(c) cause of spill and name of spiller, if possible;

(d) time and date spill occurred if known or when first observed;

(e) indication if any concerned offices have been notified and if they have responded;

(f) any other pertinent information; and

(g) name, address and telephone number of caller.

(ii) Evaluation and initiation of action:

- The OSC ensures that an oil spill report is immediately acted upon. He shall evaluate the magnitude/severity of the spill, determine the feasibility of removal and type/degree of mobilization, and assess the effectiveness of removal actions based on the available information.

- The OSC sends the initial and subsequent Pollution Reports (POLREPS) to the NOCOP at least twice daily at 0800 H and 2000 H, according to the prescribed format and, after receiving an alerting report, advises the latter of the need for further response actions, depending on circumstances. He is responsible for adequate surveillance of the ongoing activities.

- The OSC ensures that constant communication is maintained according to the scheme shown in Figure 8. The voice radio call signs, list of centers with radiophones, and list of salvors are shown in Tables 5, 6 and 7, respectively.

(iii) Containment and counter measures:

These are defensive actions to be initiated as soon as possible after the discovery and notification of a discharge. They may include public health and welfare protection activities, evacuation activities, source control procedures, salvage operations, placement of physical barriers to halt or slow the speed of a pollutant, emplacement or activation of booms or barriers to protect specific installations or areas and the employment of chemicals and other materials to restrain the pollutant and its effects on water-related resources.

(iv) Clean-up, mitigation and disposal:

- This includes actions to recover pollutants and monitoring activities to determine the scope/effectiveness of removal actions.

Table 4. List of Philippine Coast Guard Stations

Commandant Headquarters, Philippine Coast Guard 25th Street, Port Area, Manila Tel. No. AFP 63-48 PLDT 48-32-07	Station Commander Coast Guard Station, Legaspi Pier Site, Legaspi City
Director National Operations Center for Oil Pollution (NOCOP) c/o Headquarters, Philippine Coast Guard 25th Street, Port Area, Manila	Station Commander Coast Guard Station, Lucena Cotta, Lucena City
Commander Shore Facilities Command Fort Santiago, Intramuros, Manila Tel. No. 40-52-58	Station Commander Coast Guard Station, Manila Pier 8, North Harbor Manila
Commander Headquarters, First Coast Guard District Farola Compound, Muelle de la Industria Binondo, Manila Tel. No. 49-27-39	Station Commander Coast Guard Station, Puerto Real Puerto Real, Quezon
Station Commander Coast Guard Station, Aparri Aparri, Cagayan	Station Commander Coast Guard Station, San Fernando Poro St., San Fernando, La Union
Station Commander Coast Guard Station, Batangas Santa Clara, Batangas Cit	Station Commander Coast Guard Station Bacolod, Negros Occidental
Station Commander Coast Guard Station, Cagayan de Oro Cagayan de Oro	Station Commander Coast Guard Station, Surigao Surigao City

Table 4 (cont'd).

Station Commander
Coast Guard Station, Cebu
Quezon Boulevard, Cebu City

Station Commander
Coast Guard Station, Dumaguete
Dumaguete City

Station Commander
Coast Guard Station, Catbalogan
Catbalogan, W. Samar

Station Commander
Coast Guard Station, Iloilo
Iloilo City

Station Commander
Coast Guard Station, Masbate
Masbate, Masbate

Station Commander
Coast Guard Station, Maasin
Maasin, Leyte

Station Commander
Coast Guard Station, Roxas
Culasi, Antique

Station Commander
Coast Guard Station,
General Santos City

Station Commander
Coast Guard Station, Bislig
Bislig, Surigao

Station Commander
Coast Guard Station, Butuan
Butuan, Agusan

Station Commander
Coast Guard Station, Margosatubig
Margosatubig, Zamboanga del Sur

Station Commander
Coast Guard Station, Tacloban
Tacloban City

Station Commander
Coast Guard Station, Tagbilaran
Tagbilaran City, Bohol

Commander
Headquarters, Third Coast Guard District
Zamboanga City

Station Commander
Coast Guard Station, Batu-Batu
Batu-Batu, Tawi-Tawi

Station Commander
Coast Guard Station, Cotabato
Cotabato City

Station Commander
Coast Guard Station, Davao
Sasa, Davao City

Station Commander
Coast Guard Station, Jolo
Jolo, Sulu

Commander
General Santos Headquarters, Fourth Coast Guard District
25th Street, Port Area, Manila

Station Commander
Coast Guard Station, San Jose
San Jose, Mindoro Occ.

Station Commander
Coast Guard Station, Puerto Princesa
Puerto Princesa, Palawan

Station Commander
Coast Guard Station, Coron
Coron, Palawan

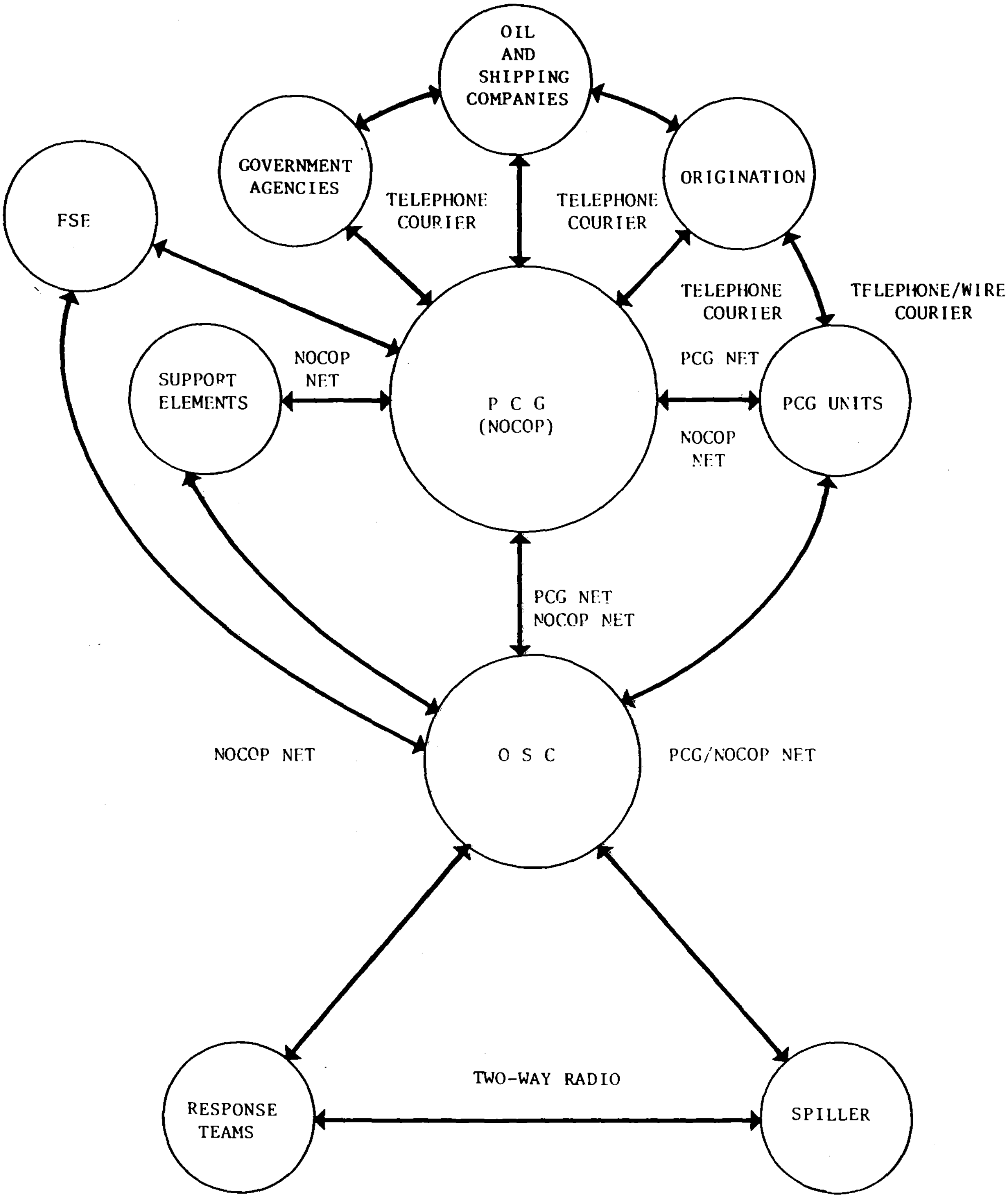


Fig. 8. Pathway of communication during an oil spill control operation in the Philippines.

Table 5. Call-signs used in the voice radio procedure during oil spill control operations in the Philippines

Unit	Call-sign
Director, NOCOP	GREEN POND
OSC	WATERCOOLER (The station name after the call-sign completely identifies the OSC being addressed, i.e.,"WATERCOOLER DUMAGUETE THIS IS GREEN POND BREAK...").
Response Team (First)	CASCADE ONE
Response Team (Second)	CASCADE TWO
Succeeding Response Team	CASCADE ___ (The number depends on the sequence such response teams joined the scene and as designated by the OSC).
Support Elements	
Air Surveillance/Transport	SUNSHINE (or regular call-sign assigned if known).
WATER SUPPORT Craft	ROCK BOTTOM (or regular call-sign assigned, name or bow number of vessel if known).
Beach/Shore Element	SANDBAR
Spiller	BLACK GOLD (or regular call-sign assigned if known).
Search and Rescue Unit	WATCHER (or assigned call-sign, name of vessel if known).
Salvage Team	WELDER
Clearing Team	PAPERCLIP

Table 6. Office of Civil Defense regional centres and sub-stations with SSB and AM radiophones

OCD Central Office:

National Disaster Control Center
Camp Gen. E. Aguinaldo, Quezon City
Tel No. 79-21-02

Region I
OCD Regional Center No. I
Sevilla, San Fernando, La Union
Tel. No. 23-84

Region II

OCD Regional Center No. II
Carenah Bldg., College Ave.
Tuguegarao, Cagayan

Region III

OCD Regional Center No. III
MacArthur Highway, San Fernando,
Pampanga
Tel. No. 37-01

Region IV

OCD Regional Center No. IV
Legaspi City
Tel. No. 806

Region VI

OCD Regional Center No. VI
Iloilo City
Tel. No. 7-66-71

Region VII
OCD Regional Center No. VII
4th Floor, Ma. Cristina Bldg.
Jones Ave., Cebu City
Tel. No. 8-22-74

Region VIII

OCD Regional Center No. VIII
186 J. Zamora St., Tacloban City

Region IX

OCD Regional Center No. IX
Macatulad Bldg., La Purizima St.
Zamboanga City
Tel. No. 23-61

Region X

OCD Regional Center No. X
JPR Borja St., cor Pabayo St.
Cagayan de Oro City
Tel. No. 38-60

Region XI

OCD Regional Center No. XI
599 F. Bangoy St., Davao City
Tel. No. 7-76-41

Table 6(a). SUB-STATIONS

Region	Location
1. VI	Capitol Bldg., Roxas City, Capiz (AM)
2. VIII	Capitol Bldg., Catbalogan, Samar (AM)
3. VIII	Capitol Bldg., Tacloban, Leyte (AM)
4. IX	PC Hq., Bongao, Tawi-Tawi (SSB)
5. IX	PC Hq., Jolo, Sulu (SSB)
6. IX	PC Hq., Camp Abelon, Pagadian City (SSB)
7. IX	Lapu Pula, Cagayan de Sulu (SSB)
8. X	Capitol Bldg., Butuan City (SSB)
9. X	ISMI Resthouse, Iligan City (SSB)
10. XI	PC Hq., Kidapawan, N. Cotabato (SSB)

N.B. Under the COWS Agreement, OCD can tap any or all communication systems whenever necessary.

Table 7. List of salvors

1. Luzon Stevedoring Corporation
   Tacoma & Second Street, Port Area, Manila
   Tel. No. 48-16-31/39 & 49-21-31/39

2. United Salvage & Towage (Phils.) Inc.
   Rm 42 Paris Apts., Paris St., Malate, Manila
   Tel. No. 59-82-51

3. Blue Green Waters Inc.
   751 Ongpin St., Binondo, Manila
   Tel. No. 49-88-11 loc. 518

4. A. D. S. Salvors
   5429 Sampaguita St., Makati, Rizal

5. Bag (Phils.) Inc.
   Subic, Zambales
   Tel. No. 23-50-17

6. M G H Salvage Services
   57 Cabatuan St., Quezon City

7. Antonio Asprec
   Agoo, La Union

8. Benedicto Vicencio
   360 Gen. Luna St.
   Malabon, Rizal

9. Roger G. Gernale
   Cumicat Trading, 1359 Gomez St.
   Paco, Manila
   Tel. No. 50-34-30 & 58-37-04

10. Subic Marine Services
    26 Luna 11, Malabon, Rizal

11. Floating Marine Repair Services Inc.
    1451 San Marcelino St., Manila
    Tel. No. 50-92-32

12. Mr. Dasad Ussam
    3003 D Kakarong St., Makati, Rizal

13. Oriental Salvage Corporation
    122 M Acosta St., Pasay City

14. Capco Marine Salvage Corporation
    8066 D. Silva St., Sto Nino, Paranaque, Rizal
    Tel. No. 47-60-71/79 loc. 263; PLDT: 40-02-19

15. Cebu Salvage Corporation
    Opon, Mandaue, Cebu

16. V. R. Mateo Enterprises
    81 Malumanay St., Teachers Village
    Diliman, Quezon City
    Tel. No. [illegible]

Table 7 (cont'd).

17. Eduardo Calixto Enterprises
    142 Fortune St., Pasay City

18. F. Llanes, Hauler-Contractor
    Suite 402, Puzon Bldg.
    E. Rodriguez Ave., Quezon City
    Tel. No. 78-89-11 loc. 112

19. E. Dacu Marine Salvage Services
    210 Dalisay St., Bacood, Sta. Mesa, Manila

20. Cardinal Products, Inc.
    Suite 402, Puzon Bldg.
    E. Rodriguez Ave., Quezon City

21. Orobuena Enterprises
    307 Calvo Bldg., Escolta, Manila

22. Albagon Marine Salvage Services
    2384 Espiritu St., Singalong, Manila

23. J. Silverio Marine Salvage Services
    21 Niugas, Malabon, Rizal

24. Medina-Pogoy Trading Incorporated
    411 Goiti Bldg., Plasa Lacson
    Sta. Cruz, Manila
    Tel. No. 40-26-10

25. Demetrio Delfinado
    Jose Panganiban, Camarines Norte

26. Saludes Enterprises
    Jose Panganiban, Camarines Norte

27. New Triton Enterprises
    626 Downtown Center Bldg., Rosario, Manila
    Tel. No. 49-49-51/55 loc. 626 & 98-35-51

28. Antonio Camanag Salvage Operation
    Dra. Salamanca Road, Cavite City

29. Super Island Timber Development Corp.
    271 Roosevelt Ave., Quezon City

30. POL Enterprises
    531 P. Pio St., Cavite City

31. A. C. Travel Corporation
    Phil. Village Hotel, Pasay City
    Tel. No. 80-74-19 & 80-74-53

- Actions may include use of sorbent, suction devices, skimmers and belt devices, devices for floating pollutants, use of burning, dispersion and sinking to remove oil, use of mechanical removers, powder, burning and non-toxic dispersants, etc.

- The use of dispersants is limited to certain cases and there are provisions for disposal/storage of pollutants/contaminants during clean-up operations.

(v) Documentation and cost recovery:

For documentation purposes, the NOCOP and the PCG Station/OSC maintain a journal of communication received and transmitted. Aside from the POLREPS, a written post-operations report of the OSC should reach the NOCOP not later than five (5) days after the termination of an operation. The collection of scientific and technical information of value to the NOCOP and scientific community may be considered in this phase. The collection of samples and data must be performed at the proper time during the operation to fix liability and for other purposes.

With regard to recovery of removal cost and recovery for damage to state property, the principle of having the polluter pay for the costs of damage incurred is generally followed. The Plan states that the sending or sponsoring company or unit shall be responsible and provide for the administrative and logistical requirements of personnel and equipment deployed at the scene of the action. However, the units or groups of volunteers incurring expenses in the operation should maintain a true account of the expenses incurred and, whenever possible, all bills must be accompanied by a statement of accounts. The settlement of bills shall depend on the circumstances of individual cases of operations and also upon the results of legal action that normally determine the liability of the offender or spiller. There are, however, no provisions for damages claimed by a Third Party.

4.1.4 Inventory of pollution control measures

The ownership, type and location of oil containment, recovery and clean-up equipment and materials are shown in Table 8.

4.2 Other contingency plans

On a national scale, there are existing arrangements among oil companies and barging contractors on their respective contributions in terms of manpower, equipment and financial resources in the event of an oil spill. These arrangements are normally site-specific and are as follows:

- the Mutual Aid Agreement on oil spills along Pasig River and other areas arising from the operational scope of the Pandacan Terminal;

- the Memorandum of Agreement among oil companies on an oil spills co-operative for Poro, Bacolod, Iloilo and Davao; and

- the Standing Agreement among oil companies and barging companies operating in the Laguna Lake area to pool resources in the event of an oil spill in the lake.

There is an existing sub-regional arrangement among the Governments of Indonesia, Malaysia and the Philippines on the formation of a Co-operative Network for Oil Spill Countermeasures in the Lombok/Makassar Straits and the Sulawesi Sea. This involved, among others, the stockpiling of oil pollution control equipment in Davao in 1984. The facilities are to be utilized in training exercises and are for deployment in case of an oil spill in the Lombok/Makassar Straits and the Sulawesi Sea.

Table 8. Ownership, type and location of oil containment, recovery and clean-up equipment and materials in the Philippines

1. Luzon Stevedoring Corporation (LUSTEVECO)

   a) Port Area Manila Salvage Office

      1,000 ft boom
      2 skimmers
      2 dispersant applicators
      2 VHF portable transceivers for communications

   b) Pandacan Terminal (Manila)

      2 80 ft booms
      1 VHF portable transceiver

   c) Batangas City Terminal

      2 15 ft dispersant booms with 6 nozzles each
      1 drum Gamosol oil dispersant
      2 VHF portable transceivers for communication

   d) Limay, Bataan Terminal

      5 drums Corexit dispersant
      1 dispersant applicator
      2 VHF portable transceivers for communication

   e) Subic Naval Base

      2,000 ft boom
      1 skimmer
      1 oil/water separator
      1 oil transfer pump

2. Caltex (Philippines) Inc.

   a) Pandacan Terminal (Manila)

      2 2 1/2 dispersant pick-up tubes or eductors
      2 drums Corexit dispersant
      1 1 1/2 dispersant pick-up tube or eductor
      5 drums oil dispersant
      1 Portable Oil Recovery System consisting of slurp, pump water/oil separator
      1 portable storage tank and hoses
      500 ft "Hutchinson" oil barrier boom, 12 inch

   b) Batangas Refinery (San Pascual, Batangas)

      1 oil barrier boom, 1,500 ft
      20 drums dispersant, Jansolv, BG-1100 and Corexit
      1 motor boat, 20 ft, fiber-glass
      2 Soxal Standard Oil Skimmers
      1 truck load of hay

Table 8 (cont'd).

30 sacks of corn cobs
4 hand sprayers for dispersants
2 2 1/2 dispersant pick-up tubes or eductors
1 deballast tank, 20,000 bbl capacity
2 air-operated floating skimming pumps
2 vacuum pumps and 2 rafts with oil containers
1 dinghy boat
5 vehicles with GE panel mounted mobile radios
3 units portamobil radios
4 units walkie-talkies
11 message rates (receiver only)
100 drums non-toxic oil dispersant
1 pollution control and fire boat equipped with 500 gpm pump, capable of carrying 15-20 people and pulling 1,500 ft of 12-inch oil barrier boom and spraying dispersants on oil spills.
5 100 ft straw booms

3. Philippine Shell Petroleum Corporation

a) Pandacan Terminal (Manila)

1 Michael Lighter equipped with diesel pump, 2 sprayers and surface breakers for the application of Shell Dispersant LT (Low Toxicity)
14 drums Shell Dispersant (LT)

b) Tabangao Refinery (Batangas City)

1 floating boom (plastic), 500 ft
1 floating skimmer with 100 ft hose
28 drums Shell Dispersant (LT)
5 portable dispersant sprayers
8 eductor (air/water driver)
2 ballast container with pump (fixed at jetty)
2 mobile radio sets
1 raft with submersible pump
Absorbents
Fire pump and hoses

4. Mobil Oil Philippines, Inc.

Pandacan Terminal (Manila)

1 "Gamlet" floating boom barrier (300 ft)
1 oil skimmer, 150 GPM x 75 ft with 10 ft discharge hose, electric motor driver (explosion proof)
1 oil skimmer, 300 GPM, air driven pump
1 monitoring, Cannon type wheel used for spraying dispersant
8 2 1/2 portable branchpipes with variable inductors for spraying dispersant
2 drums, Corexit dispersant
10 sacks, absorbent, Tinilate Perlit (GA-2)

Table 8 (cont'd).

5. Petrophil Pandacan Terminal

60 drums Corexit 7664 dispersant
1 Marathon Hose (4 inches x 500 ft)

6. Bataan Refining Corporation

1 Kawa-kah Boom, 2000 ft
15 drums Corexit 7664 dispersant

7. Philippine Petroleum Corporation

a) Pililla

1 electric driven oil skimmer
2 spill booms 270 ft long with 12 inch skirt
2 motorized bancas (contracted)
1 spare spill boom, 270 ft long (with LSCO)
1 100 ft skimmer discharge hose
8 walkie-talkies (used inside the refinery only)
1 telephone (shore mounted)
(Hay available)

b) Sucat Terminal, Sucat, Muntinlupa, Rizal

1 electric motor driven oil skimmer, floating saucer type
1 spill boom, 125 ft long with 12 inch skirt
1 motorized banca (contracted)

On the regional level, the Philippines is a signatory to the ASEAN Contingency Plan and the ASCOPE Plan for the Control and Mitigation of Marine Pollution.

5. Conclusion

Marine contamination in the Philippines in terms of oil could be said to be still in the manageable stage. This is manifested in the results of oil measurement activities in coastal waters adjacent to major cities and ports in the country. However, this information and the effective dispersing capacity of the monsoons should not prevent the authorities from implementing a vigorous oil pollution monitoring programme to cover all potential oil pollution sources for the purpose of detecting problem areas and demanding action from polluters. One aspect of oil spill contingency planning that requires special attention is the need for a revision of the eleven year old National Plan. This concerns the following points:

- updating of information on the available resources, manpower and equipment for oil spills;

- inclusion of new technologies and practices in oil spill control and containment;

- inclusion of changes in the operating procedures and mechanisms based on current conditions;

- inclusion of provisions for response to offshore oil operations and transfrontier oil spills;

- inclusion of clear-cut provisions on damage claims and compensation; and
- consideration of linkages between the Plan and sub-regional/regional arrangements on oil spill control entered into by the Philippines.

Another important aspect of oil pollution control is the effective implementation of the Plan. Towards this end, training of the personnel concerned on a regular and continuous basis is a must. Said training courses should focus not only on the actual operations in case of a spill but also on equipment maintenance and the rehabilitation of oil-pollution damaged ecosystems. In as much as contingency planning and response have already taken a regional dimension, regular exercises at the national and regional levels should be carried out.

There also exists the need for strengthening the scientific support for oil pollution assessment and control. To date, more information is needed on the appropriate oil pollution control and disposal technologies, effects of oil pollutants on tropical organisms and ecosystems, methodologies for predicting oil slick transport and dispersion, oil pollution risk analysis and rehabilitation of degraded ecosystems.

The efficiency and effectiveness of a regional marine pollution contingency planning and response system is dependent upon the soundness of local/national and sub-regional arrangements as well as scientific support.

REFERENCES

Berbano, M. C. 1979. Environmental aspects of offshore oil exploration and production: an overview. Paper presented at the ESCAP-SEPS-PCG National Seminar on the Protection of the Marine Environment and Related Ecosystems, Manila, Philippines.

Bilal, J. 1985. The state of hydrocarbon pollution in the East Asian Seas based on studies in the South-East Asian Seas Region. In A. Dahl and J. Carew-Reid (eds.). Environment and Resources in the Pacific, pp. 217-234. UNEP Regional Seas Reports and Studies No. 69.

Lozano IV, J. P. and M. C. Berbano. 1986. The Philippines: National Plan for Oil Spill Contingency Planning and Response. Paper presented at the Joint UN-CCOP/ASCOPE/MECOR Seminar on Regional Co-operation on Oil Spill Contingency Planning and Response, Kuala Lumpur, Malaysia.

Ministry of Energy. Report for 1982. Metro Manila: Ministry of Energy.National Pollution Control Commission (NPCC). 1986. Manila Bay Monitoring Program 1985, pp. 26-27. Manila: National Pollution Control Commission.

Pecache, G. 1979. The new dimension of marine pollution in the Philippines. Paper presented at the ESCAP-SEPS-PCG National Seminar on the Protection of the Marine Environment and Related Ecosystems, Manila, Philippines.

Pham, N. K. 1979. Oil discharges - chemical and physical effects. Paper presented at the ESCAP-SEPS-PCG National Seminar on the Protection of the Marine Environment and Related Ecosystems, Manila, Philippines.

OIL POLLUTION CONTROL MEASURES AND ARRANGEMENTS IN SINGAPORE

Ministry of the Environment
40 Scotts Road
Singapore 0922
Singapore

ABSTRACT

Pollution in Singapore originates either from land-based sources or from ships along the main shipping lanes. The Port of Singapore Authority (PSA) is responsible for coordinating all oil spill response and clean-up operations. A number of sensitive or priority areas have been identified. Risk of collision or grounding of oil tankers is significantly high at three bottlenecks that constrain navigation in Singapore waters. Two major legislative acts aimed to control oil pollution at sea are the Prevention of Pollution of the Sea Act (1976) and the Merchant Shipping (Oil Pollution) Act (1981). The Water Pollution Control & Drainage Act and Environmental Public Health Act (1987) aim to control oil pollution from land-based sources. Various oil pollution control measures are prescribed. An Oil Spill Response Plan is in force to handle all pollution at sea. Singapore also participates in a regional arrangement involving the resources of the Tiered Area Response Capability (TARC) Committee as well as subscribes to a Tripartite Agreement with Malaysia and Indonesia to combat oil spills in the Straits of Malacca and Singapore. She is also a party to the ASEAN Contingency Plan and expects to accede to MARPOL 73/79 in 1989.

1. Introduction

In a world that is dependent on oil as an energy source and raw material for a host of petrochemicals, it is not surprising that oil pollution of the sea poses a real and significant problem. Oil being a complex mixture of hydrocarbons, some of which are toxic, can cause severe environmental and economic damage when discharged into the ocean in large quantities.

It is estimated that 5-10 million tonnes of oil is discharged into the world's oceans every year. The main sources of discharge are:

(i) Cargo tank washings;

(ii) Bilge pumping (ships other than tankers);

(iii) In-port oil losses;

(iv) Offshore oil and petroleum production;

(v) Accidents or grounding of tankers;

(vi) Natural seepage;

(vii) Coastal facilities (e.g., refineries, terminals,etc.); and

(viii) River and urban run-off (land-based sources).

Although it is reported that oil discharges from sea-based sources amount to about 46% of the estimated total discharge as compared to 44% from land-based sources, it is generally recognized that the impact of a single incident of a large spillage from a sea-based source (e.g., a tanker accident) can be far greater than those from land-based sources.

In Singapore, the Port of Singapore Authority (PSA) is responsible for coordinating all oil spill response and clean-up operations of spillages that occur in the sea. The PSA maintains a continuous surveillance over the coastal waters to ensure that there are no unauthorized discharges and to alert all parties when an oil slick is sighted. To assist the PSA, oil companies and tugboat owners are required by law to maintain a minimum level of anti-pollution equipment stockpile and materials. A supplementary stockpile of equipment and materials has been required by the oil companies to handle oil spills on a regional basis of up to 10,000 tonnes of oil. This stockpile is presently being funded by five major oil companies in Singapore, viz., British Petroleum, Caltex, Esso, Mobil and Shell.

2. Extent of problem in Singapore and susceptible areas

Singapore has no off-shore oil exploration and production facilities because there is no crude oil. There are, however, major oil refineries and industries. Oil being the main source of energy, substantial quantities of it are transported in the seas around Singapore. Seaborne cargo throughput the PSA gateway and Jurong Port in 1986 totalled 44 million t. Number of ship arrivals during the period was more than 33,350, totalling 324.6 million gross registered tons. On any one day, there are about 600 ships in port.

The proximity of the major sea lanes used by oil tankers travelling between the Middle East oil producing countries and the Far East oil consuming countries further aggravates the risk of occurrence of an oil spill.

Thus the marine oil pollution problem can be broadly grouped into two major areas:

(i) Pollution from sources within the territory of Singapore (including land-based sources); and

(ii) Pollution from ships along the main shipping lanes.

Being a small island republic, practically the whole shoreline of the main island and offshore islands is susceptible to damage caused by an oil spill. A number of sensitive or priority areas have been identified as follows:

(i) Power stations' cooling water intake points;

(ii) Recreational beaches and parks;

(iii) Oil installations' cooling water intake points;

(iv) Wharfs and anchorages areas; and

(v) Aquaculture/fish farms.

There are three bottlenecks that constrain navigation in Singapore waters. The closest and worst of these is between Raffles Lighthouse, Peak Island and the surrounding Indonesian islands. The channels are narrow with sharp bends challenging the skills of ship masters. The western bottleneck is between Tanjong Piat and the Karimun Island and the eastern one is located at the approaches to the Horsbrug Lighthouse between the south-eastern coast of the Johore Straits and the Bintan Island of Indonesia. The risk of collision or grounding of oil tankers in these sites is significantly high.

3. Legislation on oil pollution

There are two major regulating acts which the government can enforce to control oil pollution of the sea, namely:

(i) The Prevention of Pollution of the Sea Act, 1976 (Cap 243)

(ii) The Merchant Shipping (Oil Pollution) Act, 1981 (Cap 180)

The 1976 legislation makes it a criminal offence to discharge oil or mixtures containing oil into the sea indiscriminately and stipulates preventive measures against pollution. The maximum penalty for the indiscriminate discharge of oil or mixtures containing oil is Singapore $500,000 or imprisonment for a term not exceeding two years or both.

The 1981 legislation holds the owner of the ship that causes an oil spill to be liable for any damage caused by the spill and for all costs incurred as a result of pollution abatement measures taken against it. It further requires that all ships carrying a bulk cargo of more than 2,000 tonnes of oil must be covered by insurance against liability for oil pollution.

The PSA and the marine police carry out surveillance patrols of the Singapore territorial waters. Any offender caught shall be either fined or prosecuted, depending on the seriousness of the offence.

The 1976 Regulation requires oil companies and tugboat owners to maintain a minimum level of oil spill combating equipment and dispersants and to render any services or assistance that may be required of them.

The use of dispersants is also governed by legislation. Only dispersants which could meet the specified criteria of dispersion capacity, flash point, biodegradability, toxicity and maximum content of total aromatic and halogenated hydrocarbons are allowed to be used.

The main legislative acts for the control of oil pollution from land-based sources are:

(i) The Water Pollution Control and Drainage Act, Chapter 348

(ii) The Environmental Public Health Act, 1987

The Water Pollution Control and Drainage Act and the Environmental Public Health Act are enforced by the Ministry of the Environment while the Prevention of Pollution of the Sea Act is enforced by the PSA.

4. Control measures

At source, preventive and control measures are important to reduce the risk of oil spillage or to minimize oil discharge into the sea. The oil industry and the PSA prescribe the following measures:

(i) Implementation of IMO-adopted routing system for the Straits of Malacca and Singapore;

(ii) Provision of slop reception and disposal facilities;

(iii) Restrictions on ship-to-ship transfer of oil at night;

(iv) Use of segregated ballast tanks;

(v) Use of on-board oil-water separator;

(vi) Improved oil terminal facilities;

(vii) Crew training and improved operation;

(viii) Better tanker design; and

(ix) Adoption of LOT (Load On Top) and COW (Crude Oil Washing) procedures.

5. Oil spill response plan

Preventive measures can only reduce the risk of an oil spill occurrence but they cannot totally eliminate it. An effective response procedure is thus necessary to reduce the potential damage.

The PSA has an emergency response procedure to handle an oil spill at sea. The procedures for reporting, communication, control, coordination and clean-up are spelled out clearly, the objective of which is to respond effectively in as short a time as possible to stop further discharge of oil and to combat the oil spill so as to prevent it from being washed ashore. The decision on how the oil spill should be handled depends on the characteristics of the oil, the extent of discharge, and the existing environmental factors.

Methods of combating oil spills used in Singapore include mechanical recovery by booming and skimming and the use of dispersants. The type of oil involved, weather and sea conditions, and the location of the spill site are factors that determine the method to be employed. The resources that would be mobilized depend on the extent of the oil spill. Tables 1 - 5 enumerate the available resources of companies or offices for combating oil spills.

Additional manpower and vessels from the Ministry of Defense can be mobilized in a major oil spill. If the oil hits the shoreline, manpower from the Ministry of Environment would be mobilized to clean up the affected beach. To give an indication of the operational cost involved, the "EVERGRAND" accident which spilled 400 tonnes of oil took 20 craft, 10,000 gal of dispersant and 300 men to work continuously for 180h to contain the damage.

All oil refineries and shipyards have basic items of spraying equipment, slick booms, etc. to control oil pollution within their respective areas. In the event of a major accident, the PSA may activate its emergency plan to control the situation.

6. Regional arrangement and international conventions

In addition to the national resources, there is a supplementary stockpile of oil spill combating equipment and material belonging to the Tiered Area Response Capability (TARC) Committee intended for regional use. The committee, which was set up in 1983, comprises one representative each from BP, Caltex, Esso, Mobil and Shell.

To date, the TARC committee has acquired about US$ 2 million of oil spill response equipment and material (Table 6). The equipment that could be deployed by sea vessels is kept at a salvage company whereas airborne application equipment is stored at an air base. The target set by the TARC committee was to effectively deal with a major oil spill of up to 10,000 tonnes which is about the amount of oil that could be released from a damaged wing tank of a very large crude carrier or from an offshore production platform. The TARC equipment serves Indonesia, Malaysia and Singapore.

Singapore is also a party to the Tripartite Agreement among Malaysia, Indonesia and Singapore where a revolving fund is managed by a committee. This arrangement provides for financial assistance to combat an oil spill in the Straits of Malacca and Singapore. The Japanese Government similarly provides a revolving fund to facilitate speedy action in combating oil spills in the Straits.

In 1973, the ASEAN Experts Group on Marine Pollution was formed. After a number of meetings, an ASEAN Contingency Plan for the control and mitigation of marine pollution was formulated with the following basic objectives:

(i) effective reporting to alert member countries;

(ii) keeping each other up-to-date on individual antipollution capabilities; and

(iii) rendering mutual assistance in combating pollution, wherever possible.

The International Convention for the Prevention of Pollution from Ships, which was adopted by the IMO during the International Conference on Marine Pollution in 1973, was subsequently modified by the Protocol of 1978, and is now known as MARPOL 73/78. Singapore is drafting legislation to incorporate the requirements stipulated in the said convention.

7. Programmes on oil pollution : conclusion

There are various programmes and support programmes on oil spill control in the East Asian Seas (and other regions) developed by UN bodies, the oil industry and governments. If these programmes can be coordinated and clearly spelled out, much more can be achieved.

Table 1. List of anti-pollution equipment in Singapore

1. BP REFINERY SINGAPORE PTE. LTD.

Equipment:

1 "Komara" hydraulically operated oil recovery skimmer
1 Launch fitted with 100 gpm water pump, eductor and spraying equipment
1 Contractor launch
3 Dispersant spray pumps with spray guns and spray booms
12 Knapsack sprayers
300m "Whittaker" barrier boom
3 Portable VHF radios with frequency of 150.50 MHz

2. CALTEX (ASIA) LTD.

Equipment:

500m oil boom "Slickbar MK 9"
1 Steel launch "Tristar" fitted with one 500 gpm fire pump and 818 l dispersants carried in both wing tanks
1 "Komara" hydraulic mini-skimmer
12 20 l capacity knapsack sprayers
2 Rotary hand pumps
1 Megator twin pump set forconcentrated oil dispersant sprays
2 MH-70 "Handi-Com" portable VHF transceivers
2 "Shinwa" portable VHF transceivers with direct contact with Port Operations Centre

3. ESSO SINGAPORE PTE. LTD.

Equipment:

1 Komara skimmer
1 Mooring boat with high pressure spray booms
2 Slurp pumps
12 Knapsack sprayers (10 l capacity)
300m American Boom Barrier Mark II
2 Portable VHF radios on 155.3 MHz and 150.5 MHz frequency
3 Mooring launches
2 Yokohama fenders (2m x 3.5m)

Table 1 (cont'd).

4. MOBIL OIL SINGAPORE PTE. LTD.

Equipment:

2 Vacuum trucks
1 Anti-pollution vessel OSPAC - fitted with two booms for spraying dispersants into the sea
1 Sea truck
2 Contractor mooring boats
1 Warren spring laboratory dispersant equipment
1 Komara mini-skimmer
2 Kebab floating skimmers
1 Slickskim oil recovery system
2 Eductors, nozzles and hoses
12 Knapsack sprayers
2 Stirrup pumps
3 VHF radio sets
1 Dunlop dracon - flexible floating container
600m slickbar MK-6 and MK-9 series
1 Portable dispersant eductor system for spraying dispersants into the sea

5. SHELL EASTERN PETROLEUM PTE. LTD.

Equipment:

65 Knapsack sprayers
6 "Slurp" skimmers complete with 2 "Wilden" pumps
2 "Acme" floating skimmers
1 Komara mini-skimmer
1 Spiltrol harbour skimmer
1 Dunlop dracone (5000 gal capacity)
1800 ft Bennett oil boom
1000 ft Sobar oil boom
20,000 ft Conwed absorbent blanket
3 sets (spare) WSL offshore dispersant spray equipment
2 sets (spare) WSL inshore dispersant spray equipment
8 Walkie talkie radios (150.50 MHz)
2 Harbour tugs fitted with WSL offshore dispersant spray equipment and tankage for 16,000 l dispersant
2 Mooring boats fitted with WSL inshore dispersant spray equipment and tankage for 1,800 l dispersant

6. SINGAPORE REFINING CO. PTE. LTD.

Equipment:

3 Mooring boats
1 Speed boat
1 Vacuum truck
13 Knapsack sprayers (20 l capacity)
2 Portable motorised dispersant spray pumps (96 l/min)
1 Eductor with hoses
1 Rotary hand pump
1 Komara mini-skimmer with hydraulic set
2 VHF/FM portable walkie talkies (150-50 MHz)
580m "Kappa" boom (24") with zipper connections

Table 1 (cont'd).

7. PORT OF SINGAPORE AUTHORITY

a. Oil Recovery Craft:

EC 1 - with fixed oil skimming device and ancillary oil spill control equipment
free running speed - 7 kn
oil skimming speed - 2 to 4 kn
oil collecting rate - $15m^3$/h/mm oil thickness
storage capacity - 50 t
dispersant tank - 1230 l

EC 7 -2 units komara oil skimming device
EC 8 oil recovery rate - 10 t/h/skimmer

EC 7A, -barges with storage capacity for recovery
EC 8A recovered oil - 10,986 l/barge

b. Appliances:

1) Craft

<u>11 Voith Schneider Tugs</u>

VST 1	Victory (V5)	Valour (V9)
VST 2	Vigilant (V6)	Vertex (V10)
VST 3	Valiant (V7)	Viking (V11)
VST 4	Vanguard (V8)	

<u>5 T-Class Tugs</u>

Tambat
Tegoh
Tekun
Tenaga
Teman

<u>1 Fire Boat</u>

API API

2) Land Units

6 Fire units with major pumps
5 Portable pumps
1 Emergency tender

c. Equipment:

4 50m inflatable oil booms
2 50m "Trygve Thune" oil booms (TT)
20 16m Bennett oil booms
12 t Trailer with ancillary equipment
15 units FB 5X - self-inducing type
10 units Technoma sprayer pump - manual
20 units Stirrup pump - manual
5 Rotary pumps (manual transfer pump)
5 Inductors
20 Shovels
9 Rakes

Table 1 (cont'd).

10 Changkols
26 "Punkis" (rattan baskets)
15 Plastic containers
12 Pails
150 Gunny sacks
12 "Miracle" lights
1 25 HP Johnson Outboard Engine
8 sets of spray boom for VST 1, 2, 3 and 4; and V8 (Vanguard), V9 (Valour), V10 (Vertex) and V11 (Viking) - 3m span
12 Drum openers
3 sets drum sling
1 set spray boom for Api Api - 3m span
1 set spray boom for VS Tugs - 3.6m span
2 units Maruyama super pump sprayer

d. Radio Communications:

All launches and Fire and Safety Department vehicles fitted with VHF radio sets

5 sets Walkie Talkie

e. Chemical Dispersant:

1) PSA Dispersant Stock

Tug Victory	-9,100 l
Tug Valiant	9,100 l
Tug Viligant	7,000 l
VST 1	7,000 l
VST 2	7,000 l
VST 3	7,000 l
VST 4	7,000 l
EC 1	1,230 l
Pasir Panjang Fire Station	200 l
	56,730 l

2) Dispersant stock on consignment to PSA

Api Api	4,000 l
Tug Vanguard	9,000 l
Tug Valour	9,000 l
Tug Vertex	9,000 l
Tug Viking	9,000 l
Tug Tekun	400 l
Tug Tenaga	400 l
Tug Tambat	400 l
Base	6,000 l
	47,200 l

Table 1 (cont'd).

3) Dispersant stock held by supplier
Messrs. Chemutreat Pte. Ltd. (Telephone - 7470211)

Emergency Stock	30,000 l
On receipt of order (every 2 hours)	20,000 l

Name	Residence Tel. No.
Mr. Harry Yeo	474950
Mr. Albert Yeo	4797723/629834
Mr. Willie Yeo	671552
Mr. Ron Yeo	7692407
Mr. Siow Weng Kiong	4467362
Mr. Peter Loh	660937
Mr. Mohd Nor bin Buang	7763875

8. SEMBAWANG SHIPYARD LTD.

Equipment:

2 Mooring launches
1 Portable fire pump
400-ft long "Bennet" oil boom
2 FB 5 X
2 10 l knapsack sprayers

Table 2. Stocks of dispersant in Singapore

OIL COMPANIES

1. BP Refinery Singapore Pte. Ltd.

10,000 l BP-1100X

BP Singapore Pte. Ltd.

6,000 l BP-1100X
2,000 l BP-1100WD concentrate

Replenishmentsof BP-1100X and BP-1100WD (dispersant concentrate) are available from BP Sales Stock in Jurong.

2. Caltex (Asia) Ltd.

2,418 l BP-1100X
2,000 l Chemkleen Osda-NY
800 l BP-1100WD concentrate dispersant which can be diluted to 10 times making a total of 8,000 l

3. Esso Singapore Pte. Ltd.

10,000 l dispersant (Corexit 8667/9517)

4. Mobil Oil Singapore Pte. Ltd.

2,000 l BP-1100WD concentrate dispersant which can be diluted to 10 times making a total of 20,000 l

5. Shell Eastern Petroleum Pte. Ltd.

70,000 l Shell SDLTX dispersant

6. Singapore Refining Co. Pte. Ltd.

9,693 l Seaclean

Table 3. Suppliers of dispersant and equipment in Singapore

LIST OF SUPPLIERS

Firm	Stock	Officer on call	Residence Tel. No.
Chemitreat Pte. Ltd. 131 Kallang Way 2 Singapore 1334 Tel. 7470211	250 x 200 l drums Chemkleen OSDA-NY	Mr. Harry Yeo Mr. Willie Yeo Mr. Ron Yeo Mr. Peter Loh Mr. Albert teo Mr. Mogd Norb Buang Company's Quarters (Mr. W.K. Siow)	4749750 671552 7692407 660937 4797723 7763875 4467362
Neos Chemical (S) Pte. Ltd. 35 Gul Drive, Jurong Singapore 2262 Tel. 2641277/2657758	80,000 l NEOS AB3000	Mr. S. Iwagishi Mr. Y. Amada Mr. Bob Lee	4691736 2351071 2203892
Vecom Singapore Pte. Ltd. No. 6 Third Lok Yang Road Singapore 2262 Tel. 2652801/2653262	3,000 l VECOM B 1425 GL 4 airdriven spraying pumps	Mr. P.T. Levitt Mr. A.J. Kraayeveld Mr. Seah Hang Kim	7774639 670353 2712033
Gamlen (Australasia) Pty. Ltd. Units 15-16, Block 6 55 Ayer Rajah Road Singapore 0513 Tel. 7759229/7753015	20,000 l OSR-LT	Mr. M.S. Baveja Mrs. C. Gribben Mr. James Tay	2544041 4813172 4445570
Rochem Singapore Pte. Ltd. c/o Singapore Warehouse Co. Block B, Unit BG 5 Ground Floor 60 Martin Road Singapore 0923 Tel. 2355692	20,000 l oil spill dispersant; 2,000 l oil spill dispersant concentrate (10%/ 90% water) sufficient concentrate to locally blend further 20,000 l	Mr. C.R. Clifton Mr. P. Wee Mr. S. Leong Mr. C.B. Chua	2826409 413105 2709193 7777768

Table 4. List of salvage contractors in Singapore

1. Firm:

Singapore Salvage Engineers

Tel. 77535972/7759919/7757653
Tlx. RS23287 AERTIN

Equipment:

Pyrene FB Foam making and Chubb Fire Security - 8 sets

Numerous deck cargo and oil tank barges, floating cranes barge and variety of diesel and electrical submersible pumps

About 100 drums of oil dispersant

2. Firm:

Smit International SEA Pte. Ltd.

Tel. 2229866
Tlx. RS23456 SALVORS

Equipment:

Salvage tugs/vessels:		Storage barge:
SMIT SINGAPORE	6000 HP	EASTERN SALVOR
SMIT MANILA	6000 HP	Ample stock
MISSISSIPPI	4000 HP	Chemkleen OSDA-N
ORINOCO	4000 HP	
HUDSON	4000 HP	Barges:
SMIT MUARA	1800 HP	
SMIT BALI	1200 HP	CEBO GIANT
SMIT MALACCA	400 HP	SMIT BREEZE

Floating sheerlegs:

SMIT CYCLONE	500/1000t lifting capacity
SMIT MONSOON	400t lifting capacity
SMIT TYPHOON	250t lifting capacity

3. Firm:

Selco (Singapore) Pte. Ltd.

Tel. 2650177 (20 lines)
2650692 (emergencies only)

Tlx. RS21964/21352/23393

Table 4 (contd').

Equipment:

Numerous deck cargo/oil tank barges (195 t DWT to 3,000 t DWT)

Several salvage tugs permanently fitted with pollution dispersant spraying equipment

Salviper (2600 IHP)

Salviking (2750 IHP)

Salvenus (5500 IHP)

Floating cranes up to 300 M.T. capacity

Wide variety of diesel and electrical submersible pumps with capacity up to 1000 m^3/h each

Portable inert gas generator 1000 m^3/h capacity for inerting vessel compartments

2850 ft Sobar Inshore Oil Boom (36")

6 Nos Yokohama/Dunlop pneumatic fenders (2750 mm O 10.00m long) for use in ship-to-ship transfer operations

Oil cargo hoses (various sizes) complete with fittings

Two Nos STOPS hydraulically driven submersibles, oil cargo discharge pump systems c/w hoses, power units, etc. for pumping oil, slops or bunkers from damaged tankers

Table 5. List of contract clean-up services in Singapore

ESSO SINGAPORE PTE. LTD.

Contractor: Through Esso Singapore Pte. Ltd.
San Centre, Chin Swee Road
Singapore 0316

Mr. Kong On Let	Office Tel. No. 7339100 ext 4437
Mr. Loo Teong Heng	Office Tel. No. 7339100 ext 4345

MOBIL OIL SINGAPORE PTE. LTD.

Contractor: R.A. Kunju and Co.
87G, Block 66
Yung Kuang Road
Singapore 2261

Tel. 2656282

30 labourers during normal office hours
20 labourers on 24 hours' notice

Loh Chwee Chew Co.
125 Telok Ayer Street
Singapore 0106

Tel. 2228022 (Office)
2729896 (Residence)

10 men on short notice
20 men on 24 hours'notice

VECOM SINGAPORE PTE. LTD.

6 Third Lok Yang Road
Singapore 2262

Tel. 2652801/2653262

6 labourers on short notice

Table 6. List of TARC equipment

Type	Manufacturer	Quantity
Multi-purpose hydraulic power packs - "PH 35"	PHAROS MARINE	6
Viscous material/debris skimmers - "Seawoolf"	VIKOMA	2
Light/medium oil skimmers - "Seaskimmer 50"	VIKOMA	2
Light/medium oil skimmers - "GT 185"	PHAROS MARINE	2
Ship-mounted sweeping arm skimmers - Marflex Type 8"	MARFLEX	2
Dispersant spray sets: "Spillspray" Boatspray	FRANK AYLES	6
Dispersant spray set: aerial delivery - Hercules 130 a/c	BIEGERT	1
Dispersant spray sets: aerial delivery - helicopter	TRANSLAND	3
Oil boom, open sea - "Troilboom 1.5m heavy duty"	AB TROILBOOM SYSTEMS	20 X 60m
Ship-to-ship transfer pump systems	FRAMO	2 sets
Collapsible oil/ debris tanks	FASTANK	10
Flexible storage tanks, dispersant - 500 IG	DUNLOP	10
Transportable Communications Unit - satellite communications	EB COMMUNICATIONS	10
Dispersant Type 3 - VDC	SHELL	500 drums

REFERENCES

Ang, H. C. and L. Martin. 1980. Oil industry's contribution to marine pollution prevention and control. Paper presented at the National Seminar for the Protection of the Marine Environment and Related Ecosystems, Singapore, 26 - 28 March 1980.

Kuttan, C. 1980. ASEAN Contingency Plan for Marine Pollution. Paper presented at the National Seminar for the Protection ofthe Marine Environment and Related Ecosystems,Singapore, 26-28 March 1980.

Lim, H. T. and S. E. Ong. 1987. Technical support to oil spill planning and related experiences in Singapore. Paper presented at the COBSEA Workshop, Jakarta, Indonesia, 6 - 13 August 1987.

OIL POLLUTION CONTROL MEASURES AND ARRANGEMENTS IN THAILAND

Office of the National Environment Board
60/1 Soi Pracha Sumpun 4
Rama VI Road
Bangkok 10400, Thailand

ABSTRACT

Thailand is now becoming an oil and gas producing country such that oil spill incidents have become commonplace. Existing regulations that deal with the oil spill problems are the Law on Navigation, Petroleum Act, Shipbreaking Regulations, and the National Environmental Quality Act. Both the private and government sectors try to cope with oil spills. The Industrial Environment Safety Group (IESG) combines the effort of the major petroleum companies in combating oil spills. The National Environment Board (NEB) draws the guidelines for the prevention or abatement of oil pollution which are directly implemented by the Harbor Department (HD).

A National Oil Spill Contingency Plan (NOSCP) has been approved for implementation for six years, effective 1987. Its major components include the administrative framework, procedures and communication, combating strategy and equipment inventory/distribution.

The NOSCP is also supplemented by oil spill-related projects such as the Oil Spill Model, with financial assistance from the Canadian government (CIDA), and the Environmental Impact Assessment (EIA) Approach specifically with respect to tankers. Present administrative and management problems related to oil spills are expected to be solved by the NOSCP.

1. Introduction

Thailand has a total coastline of about 2,600 km which is very important to the nation's economy and the people's welfare. The area is rich in natural resources including fisheries, coral beds, mangrove forests, recreational areas, and mineral deposits. However, the rapid increase in population and human activities along the coastal areas has resulted in the degradation of these valuable natural resources. With the Royal Thai Government's (RTG) growing concern with the rational utilization of marine resources and protection of the marine environment, continuing efforts have been made to conduct an inventory of natural resources, monitor the marine environment and determine the effects of human populations and activities on them.

During the last decades consumption and transportation of crude oil and oil products have increased considerably. Furthermore, Thailand is now an oil and gas producing country such that oil spill accidents, concomitant with oil exploration, have become a source of marine pollution, apart from causes due to discharge of industrial and community waste water.

The RTG has deemed it necessary to strengthen precautions on a national level to overcome the damages of oil pollution. A National Oil Spill Contingency Plan is being considered to prevent and combat oil pollution.

2. Sources of oil contamination and incidents of oil pollution

Oil contamination of marine waters in Thailand may originate from the following sources:

2.1 Tanker and ship transportation

The monthly traffic of international tanker and ship vessels, including coastal tankers, is estimated to include a total of 308 vessels. When the proposed Chabang Deep Sea Port and Map Ta Phut Deep Sea Port in the Eastern Sea Board Area begin to operate, the number of vessels landing on both parts is estimated to be in the order of about 180 and 151 vessels/mo, respectively. Figure 1 shows the shipping routes in Thai waters.

2.2 Refineries

Three oil refineries are presently in operation in Thailand, namely, Thai Oil Refinery (TORC), Esso Refinery and Bang Chark Refinery (Fig. 2). These refineries are located near river mouths or along the coastal shore and are involved in the importation of crude oil from the Middle East, China and ASEAN countries which later on is shipped to Bangkok and other parts of the country in refined form. The amount of crude oil delivered to the refineries at Si Racha varies from 270,000 to 300,000 t/mo and at Bangkok from 230,000 to 360,000 t/mo. Transportation of crude oil is normally via 60 and 90 MDWT tankers, except to the Chao Phraya River where smaller vessels (5,000 DWT barge) are used due to the draft limitation of the river.

2.3 Oil depots

Numerous oil depots lie along the Chao Phraya River and other rivers in southern Thailand. Loading and unloading of oil products, which are intensified in these areas, are risky resulting in incidents of spillage during handling and collision of vessels.

2.4 Oil exploration in the gulf and continental shelf

With the rapid increase of oil/gas exploration in Thailand the probability of oil spills in the marine environment is increased. However, no such incident has been reported so far.

2.5 Shipbreaking industry

This is one major source of oil pollution because of oil spills associated with the demolishing processes of the said industry. The lone shipbreaking industry is located in the Upper Gulf; however, the Eastern Sea Board Committee has recently prohibited its operation there and recommended its translocation to the east and south of Thailand.

2.6 Other sources

The discharge of waste water and oily waste from fishing boats and industries constitutes another source of oil pollution.

Several incidents involving oil spills have been recorded for the past ten years (Table 1). Most of them were the result of accidental discharge or sinking of a cargo ship during accidental collisions between tankers or ships.

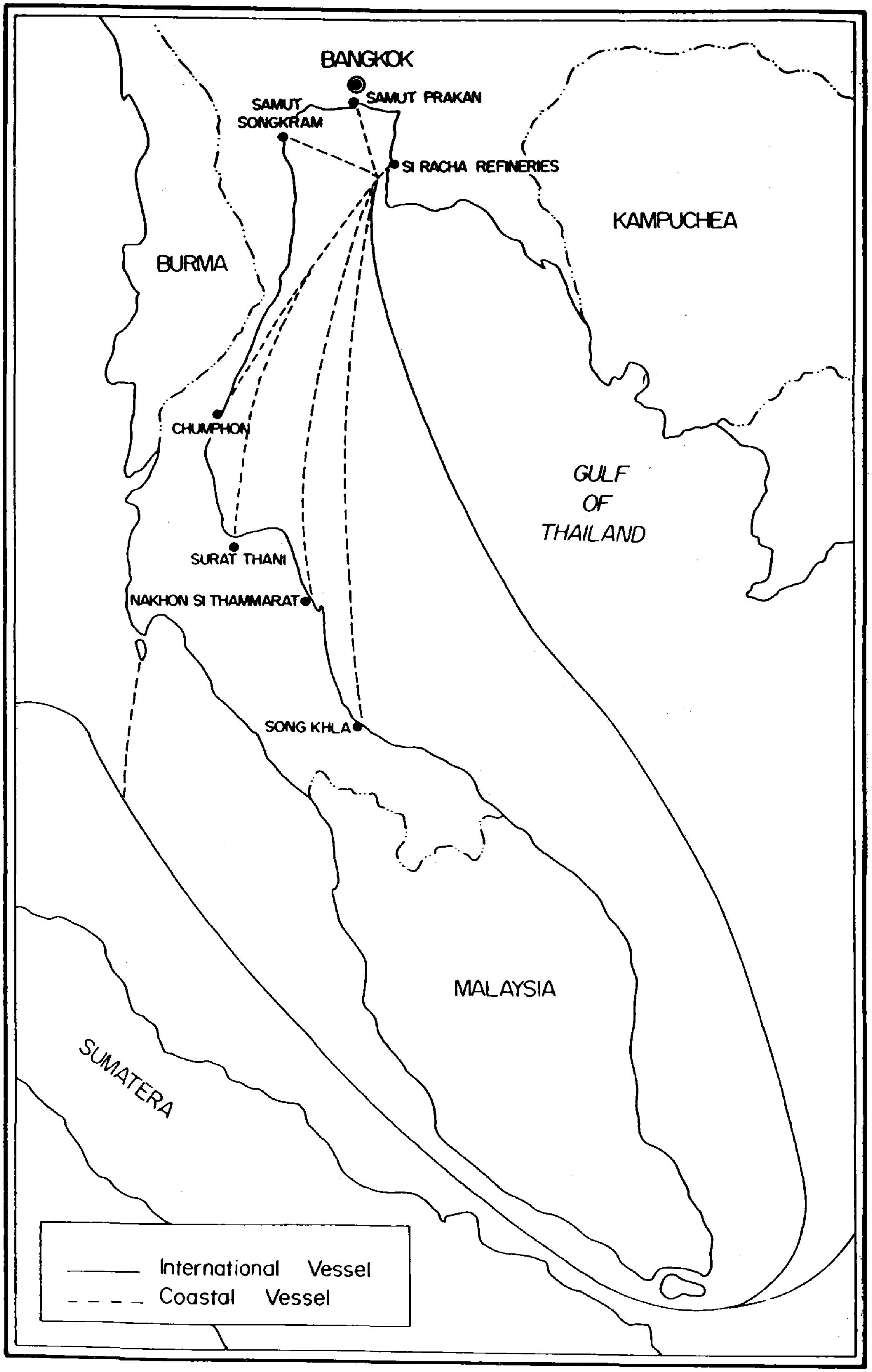


Fig. 1. Port and shipping routes

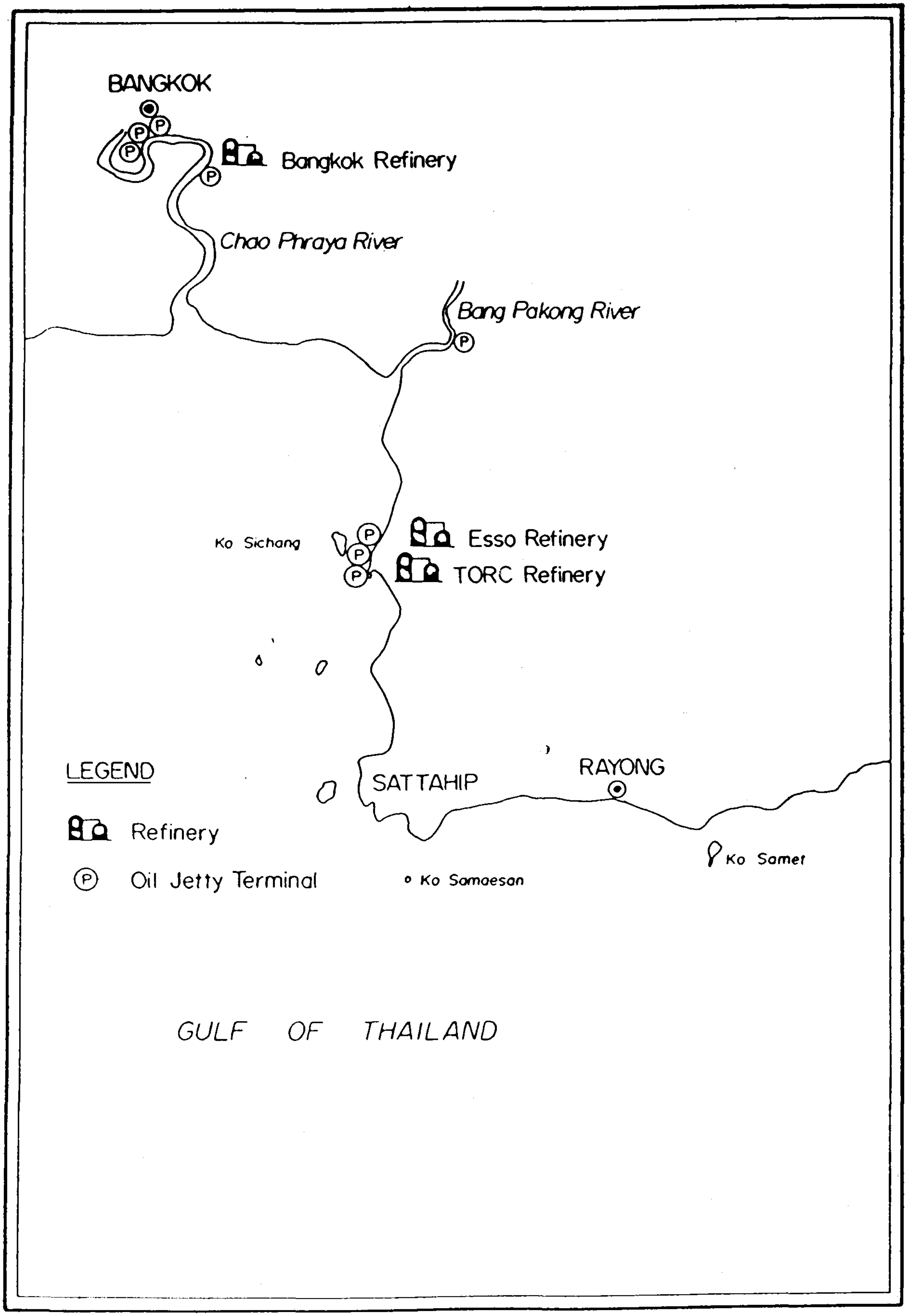


Fig. 2. Oil refineries and oil jetty terminals

Table 1. Record of major oil spill incidents in Thailand

Date/Location of the incidents	Causes of the incidents	Amount of oil released (1)	Remarks
1973; Sattahip Port	Fire accident of a Thai coastal tanker	no record	
April 10, 1974; near the Chao Phraya River Mouth	Accidental collision between a Thai coastal tanker "VISAHAKIT" and a Mexican tanker "TOLVIA"	2,234,400	Damaged the fishery resources at Samutprakar Province
May 29, 1977	Accidental collision between a Thai coastal tanker "VACHIRA" and a Japanese ship	300,000	
April 16, 1978; Chao Phraya River Mouth	Accidental discharges from a cargo ship "DELTA SIGMA PI"	no record	
1979; near Ko Sichang	Sinking of a tanker "SUNFLOWER"	no record	Spillage of oil
July 5, 1981	Sinking of a cargo ship "GOTA GAJA"	no record	Spillage of oil and dispersant
November 1985; Chao Phraya River	Accidental discharges from a cargo ship (unidentified)	1 km wide 2 cm thick	

3. National development plan for regional management of oil pollution

The RTG has prepared a regional development plan essential for guiding community and industrial growth in the future, in a manner consistent with the country's natural resource base. At present, two regional development projects, namely, the Eastern Seaboard Development Project (ESB) and the Songkhla Lake Basin Planning Study (SLB), are being implemented in Thailand. These projects aim to develop an integrated coastal zone management plan suitable for each designated area. Locations of these development projects are shown in Figure 3.

The ESB Project is located along the eastern shore of the Upper Gulf plus an extension along the coastline of Rayong province. Two refineries, three marine terminals, and several other industries have been located along the coast, plus a number of important beach resorts including Pattaya. The SLB planning study represents a different approach from ESB. The approach to ESB planning was primarily economic development, with limited attention to the environmental parameter, with the detailed REMP being produced as a second step of the study.

For the SLB, located in the southeastern part of Thailand, both the economic and environmental parameters are established by the terms of reference (TOR) for the study as equal and integral aspects of the overall planning process. The SLB planning study, being administered jointly by (NESDB) the National Economic and Social Development Board and NEB, is Thailand's first use of the "Economic-cum-Environmental" approach to regional planning. Thus the SLB project will produce a Regional Environmental Plan along with a Natural Resources Development Plan and a Socio-Economic Development Plan as integrated outputs.

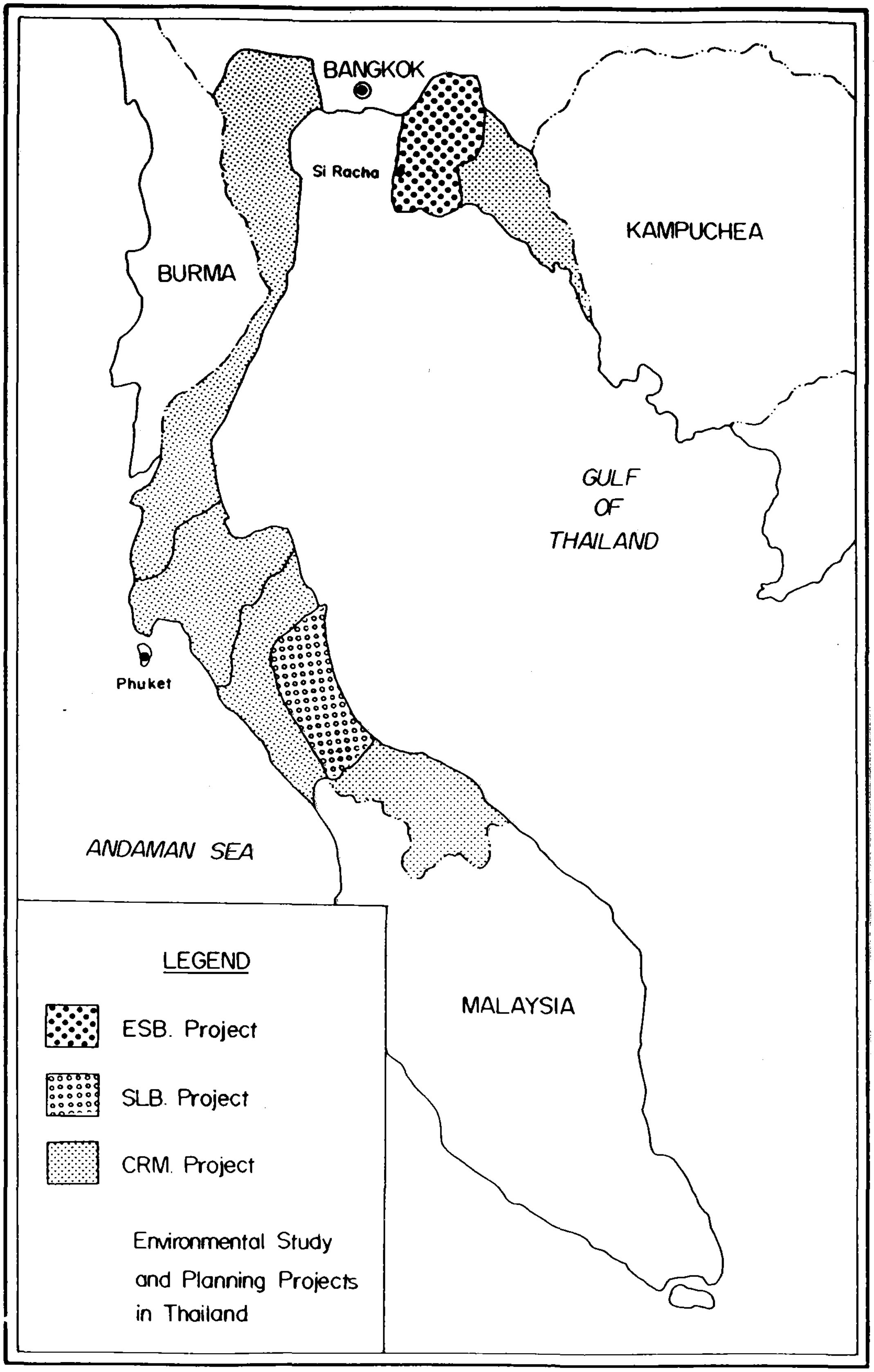


Fig. 3. Environmental study and planning projects in Thailand

4. Oil pollution control legislation

The existing regulations that deal directly or indirectly with the oil spill problem are found in various acts, such as:

4.1 Law on navigation

The main intent of this law is to ensure a safe ship traffic in Thai waters. Section 204, e.g., states that "No discharge of petroleum whether mixed with water or not shall be permitted into the harbor or river from any tank ship or licensed premises."

4.2 Petroleum Act

This act aims to regulate petroleum operations, including the exploration, production, storage, transport, sale or disposal of petroleum. Certain provisions of the Act are concerned with the protection of the marine environment, such as:

Section 74, which states that "in conducting petroleum operations in offshore areas, the concessionaire shall not cause any unjustifiable interference with navigation, aviation, the conservation of the living resources of the sea, or scientific researches, and shall not undertake any operation which hinders the laying of submarine cables or pipelines or cause damage to the submarine cables or pipelines."

Section 75, which states that "the concessionaire shall take appropriate measures in accordance with good petroleum industry practice to prevent pollution of any place by oil, mud or any other substances and shall take immediate action to combat such pollution, if accident occurs."

4.3 Shipbreaking regulations

Local harbor masters are empowered to require the observance of the following measures on the part of operators of the shipbreaking industry:

- provision of net and other equipment to contain left-over material of shipbreaking, as well as transfer of these materials by such means that do not involve throwing in water;

- adequate provision of fire-fighting equipment, oil dispersant, and other oil-combating equipment;

- provision of a "Gas Free System" to avoid explosion;

- clearing of all tanks in ships to avoid pollution;

- deployment of permanent booms around the ship to control oil spill within its boundary; and

- strict observance of other relevant laws/regulations.

4.4 Environmental Act

Section 20 of the Environmental Act states that "if there is an emergency arising from the environmental pollution which, if left unremedied, will be dangerous to life, or will cause personal injury or damage to the properties of the people or the state, the Prime Minister shall have the power to issue an order prohibiting the person from causing such damage in order to stop or reduce the severity of the environmental pollution."

5. Administrative arrangements and management activities for combating oil spill incidents

The problem of oil spills in Thailand has received increasing attention from both the RTG and private sector.

The Industry Environmental Safety Group (IESG), a private voluntary organization, was set up in 1970 as a combined effort of the major petroleum companies in Thailand (Fig. 4). The IESG aims to provide cooperation and sharing of available resources to combat oil spills.

Various government agencies have been assigned responsibilities to cope with the oil spill problem, such as the National Environment Board (NEB) and the Harbour Department (HD). The NEB provides the recommendations and guidelines, whereas the HD assumes the direct responsibility of preventing and abating marine pollution by oil. However, due to the lack of equipment, qualified personnel and budget, its task is handicapped.

To minimize the adverse impact of oil spills, the NEB commissioned the Asian Institute of Technology (AIT) to study the natural conditions affecting the fate and behavior of oil spills in Thai waters and prepare a mathematical model for predicting the spread and movement patterns of oil spills in the Gulf waters. This model can be used in planning monitoring programs.

The IESG, which has been operative for more than a decade, has adopted three important measures for combating oil spills, viz.:

5.1 Readiness of physical and personal resources through:

- monthly inventory of oil spill clean-up equipment, chemicals, fire-fighting equipment, etc. and circulation of the result of the inventories to IESG members;

- assumption of secretarial responsibility by the chairman of each company and provision of key personnel for supervision activities of oil spill incidents; and

- maintenance of an own team by each company to cope with overall operation.

5.2 Readiness for operation

- each company notifies the others whenever an oil slick is discovered;

- each company agrees to assist the others, if requested, furnishing manpower, equipment, and materials; and

- each company informs the others regarding equipment and supplies available on a day to day basis.

5.3 Operations during emergency

An oil spill contingency plan has been adopted for the Si Racha area, but the plan is insufficient to cope with a major disaster or a particularly complex operation.

In general, the expenses incurred in combating or abating an oil spill are charged against the polluter. However, when the polluter is not clearly identified, the members of the IESG shall share the cost of the expenses. The IESG is estimated to spend about 750,000 baht each year on this basis.

Table 2 is a summary list of the equipment and chemicals at the disposition of the IESG. It will be noted that the capacity of equipment is limited to approximately 50 t/h, whereas a dispersant is estimated to clean up about 1,500 t oil slick.

6. Towards a national oil spill contingency plan

The NEB and HD have been developing plans to help meet the growing demands for better regulation of oil transportation and better means of coping with the oil spill problem.

A national "Committee for Combating and Abatement of Oil Pollution" (CAP) was established in 1982 to meet this end. The Committee includes key representatives from the NEB (Secretary General), the HD (Director General) and the private sector.

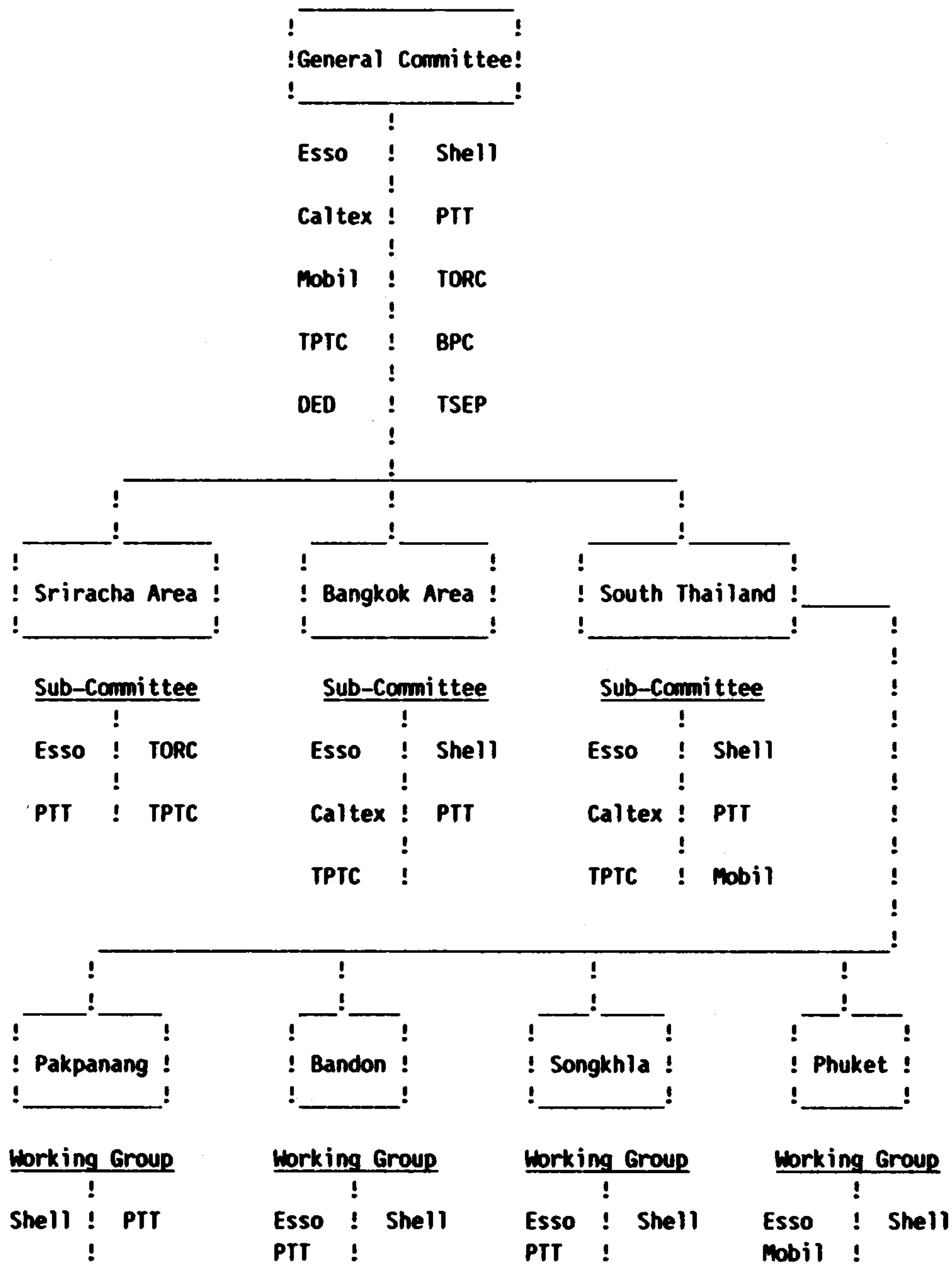


Fig. 4. Organizational Chart of the Industry Environmental Safety Group (IESG) Thailand

Table 2. List of oil spill response equipment and chemicals of Thailand as of September 1986.

	BCP	CALTEX	ESSO	MOBIL	PTT	SHELL	THAI OIL	TPTC	TSEPCO
BOOM (ft) Type 36" 30" 24" 12"	River 24" = 500 ft 100 ft Oil Boom MK-1		36" 1000 ft 30" 500 ft 24" 500 ft 18" 100 ft 12" 600 ft	12" 120 ft		25" 6 Booms 660 ft 25" 120 ft 25" 480 ft 25" 480 ft	36" 400 ft (Being kept ESSO Refinery part of IESG)		
DISPERSANT Type COREXIT SHELL OTHERS	Corexit 9600 35 drums	Corexit 7664 20 D x 200 Oil slick Dispersant 3 D x 200	Corexit 9527 146 D x 200 Corexit 7664 16 D x 200 Corexit OC - 5 7 D x 20	Corexit 9527 8 D x 200 BP-1100 WP 6 pails 25 l	Corexit 46 D x 200 Coast guard 1 D x 200	Shell Dispersant (conc.) 27 D x 200 LTX 7 D x 200	Corexit 9527 55 D x 200 LTX shell 21 D x 200	Shell Dispersant (conc.) 10 D x 200	
SPRAY BOOM	Back Pack 10 sets		Oceangoing 1 set Inshore Warren Spring 2 sets Back Pack Sprayers 13 sets	5 sets Back Pack Sprayers		2 sets of spray booms fixed on flat bottom boat 14 spray guns	1 set Oceangoing 3 sets Jet nozzle 8 sets back pack	5 sets back pack	
SKIMMER (Unit) Slurp Weir Skimmer Floating Skimmer Catamaran Type Skimming Barge	Slurp Weir 2 sets		5 sets Slurp Weir Skimmer 1 set Catamaran		Floating Skimmer 16 sets	2 sets with a vacuum truck	1 set Slurp Weir Skimmer 6 sets Floating Skimmer		

Table 2 (cont'd).

	BCP	CALTEX	ESSO	MOBIL	PTT	SHELL	THAI OIL	TPTC	TSEPCO
<u>WORK BOAT</u> (Unit)	Work boat From Contr.		2 work boats (Contr.)			1 wk/boat bottom boats 5.25 x 2.25 m	1 wk/boat		
<u>PUMP</u>	1 set Hale Type Pump 2 sets Electric Motor Driven 3 sets Air Comp. Electric	1 unit 3" Air- Driven 1 set Air Comp. 1 set Diaph Pump 1 set Slimplite	1 unit Blackmer		1 Brigg 7 HP	1 Petter Diesel Engine 5 HP			
<u>OTHERS</u>	1 unit Double Diaphragm Pump		Generator 1 x 2 kw 1 x 38 kw			2 plastic containers fixed on workboats			
<u>TRUCK</u> (Unit) Vacuum Truck Mobil Unit Oil/Water separation Tank Truck	Vacuum Truck 1 unit Oil/Water Separator		Vacuum Truck 1 unit 1 Mobil unit 1 oil/water Sys. tank truck			1 vacuum truck	2 vacuum trucks 3 x 5 m^3 capacity		2 vacuum trucks cap. 11,000 l

Table 2 (cont'd).

	BCP	CALTEX	ESSO	MOBIL	PTT	SHELL	THAI OIL	TPTC	TSEPCO
<u>COMMUNICA-</u> <u>TION</u> Walkie Talkie Band: Radio FM	8 sets Citizen Band	6 sets	6 sets WIT Citizen Band 15 sets FM Radio 2 sets Marine Band 5 sets UHF Radio		2 sets (S'kla) 2 sets (Sattahip)	1 Base set 7 W/Ts CNS 10 W/Ts VHF/AM at seafed depots	4 W/T Marine Band 10 W/T VHF sets	15 sets W/T 6 sets SSB 6 sets VHF 1 megaphone	8 sets VHF in Lan Krabu
<u>OIL</u> <u>ABSORBENT</u> (ft)	Sorb Oil 3M 19 x 19 100 pcs	Sorb Oil Mini Paks @ 20 ft 3 sets 1 set Wrigger	Synthetic 3M/Sorb Oil Mini = 2,300 ft						

Two subcommittees were established on an interim basis in 1983. One is responsible for developing, implementing and managing a National Contingency Plan (NCP), while the other is responsible for drafting laws and regulations concerning the prevention and combating of oil pollution.

In 1984, the NEB assisted the HD in drafting a National Oil Spill Contingency Plan (NOSCP), together with a request for financial assistance from the Danish International Development Agency (DANIDA). The final report, which was submitted to the Committee on April 15, 1987, contains the terms of reference (Phases I and II) (Annex I) and the recommendations for oil spill management according to the following scheme:

(a) Administrative framework

(b) Procedures and communication

(c) Combating strategy

(d) Equipment inventory and distribution of equipment

The approved draft plan is quite vast in scope and will involve high investment. Even with the Danish government's offer of a soft loan, it was not deemed possible to implement the whole plan at the same time. The implementation was, therefore, divided into two phases of 3-years duration each, as follows:

(a) Phase I (1987-1989). With the Upper Gulf of Thailand as the area of high priority, activities include improvement of the organizational structure of the responsible authority, preparation of manpower, training, and establishment of oil spill bases; and

(b) Phase II (1990-1992). Extending the operation to the whole of Thai waters. Oil spill bases shall be established in the Lower Gulf (Songkhla Province) and Andaman coast (Phuket Province), as well as in Don Muang Airport, for storage and quick transport of equipment and personnel in all 23 coastal provinces.

7. <u>Oil spill contingency plan-related projects (oil spill model)</u>

In 1984, the NEB similarly submitted a project for financial assistance by the Canadian International Development Agency (CIDA) entitled "Pollution Prevention and Control Management System for Oily and Hazardous Wastes" which is an important tool for the protection of the marine environment for oil pollution.

The completed project, which was submitted on March 5, 1986, has the following accomplishments:

- identification of major problem areas and sources of pollution;

- advice on methods of preventing pollution;

- advice on methods of mitigating the effects of oil pollution;

- advice on methods of controlling clean-up and disposal of oil and hazardous materials;

- determination of methods of training personnel to cope with problems;

- advice on the organizational requirements for a National Oil Spill Contingency Plan;

- production of a computerized sensitivity mapping system (see, e.g., Sensitivity Map of Eastern Seaboard Area, Figure 5); and

- assurance of availability of computer hardware to carry out an ongoing program.

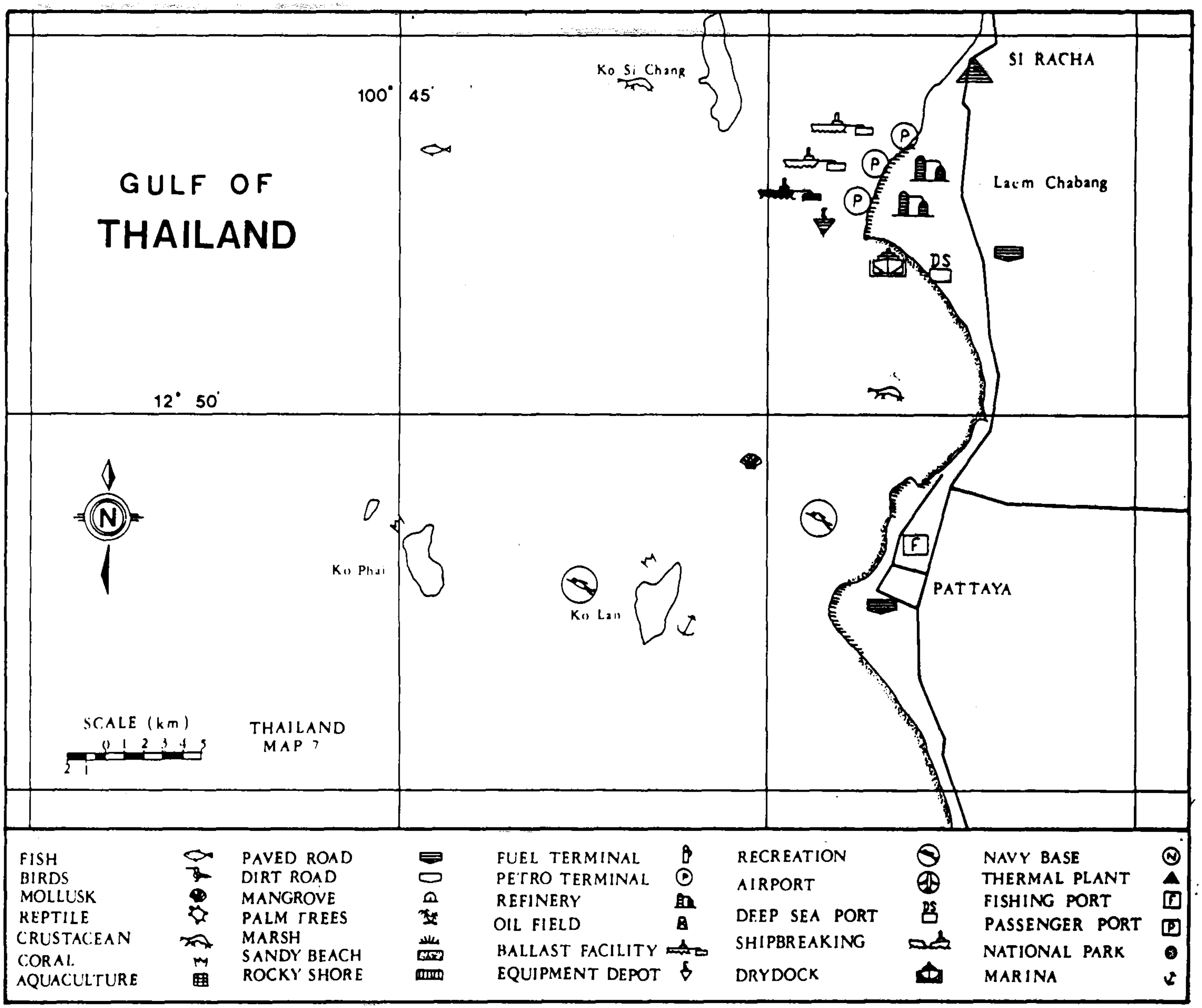


Figure 5. Sensitivity map of Thailand

It will be noted, however, that the Oil Spill Model developed is particularly suited for the Gulf of Thailand only and cannot be used in other areas like the Andaman Sea.

8. Environmental Impact Assessment (EIA) approach to oil pollution control

The EIA Report, in accordance with the National Environment Quality Act (NEQA) of 1975, as amended in 1978, specifies the "Types and Sizes of Projects Requiring Environmental Impact Assessment" and recommends preventive measures to remedy the adverse effects on environmental quality, specifically those caused by oil tankers.

The NEB proclamation includes commercial ports and harbors with berthing capacity for vessels greater than 500 t gross weight. The EIA focuses on mitigation measures and monitoring programs, thus serving as a management tool for the prevention of environmental degradation resulting from oil spill incidents.

To assist the government and private sectors in the preparation of documents, the NEB has published and distributed a Manual of NEB Guidelines. Among others, these guidelines include:

- precautions during the loading and unloading of crude oil products; and
- suggestions to port operators to provide reception facilities that will receive waste water from tankers (including ballast and bilge waters) as well as treatment procedures within acceptable limits before waste water is discharged in waterways.

9. Conclusion

Thailand is beset with problems of coping with oil spill management due to the following causes:

(a) lack of coordination among agencies concerned with the control of pollution from industrial activities;

(b) lack of expertise/technical knowledge for the management and control of pollution;

(c) insufficient equipment to combat oil spills; and

(d) insufficient budget to combat or abate oil pollution.

It is expected, however, that upon the implementation of the NOSCP, these problems can be solved with the cooperation of various government agencies and the private sector, and aid from international agencies.

ANNEX I

Terms of reference for the preparation of the National Oil Spill Contingency Plan in Thailand

PHASE I (19 January - 15 February 1985): collection of preliminary data and coordination with various agencies concerned with preparation of work plans; terms of reference for phase I as follows:

1. Assess the probability of oil spills in Thai waters.

2. Recommend priorities on the basis of identification of areas sensitive to oil spill.

3. Assess available existing resources and equipment.

4. Recommend organization and management (central/local) including communication, reporting and alarm procedures.

5. Recommend full scale equipment list (including cost estimates).

6. Recommend action plan for implementation including recommendations for training and exercises.

7. Prepare the terms of reference for phase II.

PHASE II (1 September 1985 - 1 March 1986): terms of reference as follows:

1. Collect and analyze information concerning all oil related activities in Thai waters.

2. Collect data resulting in the identification of all areas sensitive to oil pollution.

3. Provide a risk analysis of ship and off shore movement.

4. Identify areas of priority in Thai waters.

5. Recommend a national oil combating policy.

6. Review and incorporate all existing contingency plans and facilities affecting Thai waters.

7. Review existing surveillance facilities.

8. Recommend the location and contents of equipment facilities.

9. Recommend organization and management.

10. Identify public and privately owned ships and aircraft suitable for oil combating.

11. Identify the need for dedicated pollution control vessels.

12. Prepare an oil spill combating manual.

13. Detail training and exercise programmes.

14. Provide a budget forecast for the total project.

15. Set up an action plan.

GLOBAL AND REGIONAL OIL POLLUTION CONTROL MEASURES AND ARRANGEMENTS RELEVANT TO THE EAST ASIAN SEAS REGION

International Maritime Organization
4 Albert Embankment
London SE1 7SR
UK

ABSTRACT

There is a considerable amount of work under way at present at the national, regional and global level of relevance to the control and combating of oil pollution in the East Asian Seas region. The single most ambitious international treaty in existence concerning marine pollution is the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78). This Convention is considered to provide the keystone for international environmental regulation of shipping. On a regional level, the International Maritime Organization (IMO), the United Nations Environment Programme (UNEP) and other international and regional organizations have for many years actively cooperated in encouraging the development of regional arrangements for combating marine pollution in emergencies. It is to be borne in mind, however, that the fundamental building blocks for regional co-operation are well developed and operational national contingency plans which provide the basis for possible joint oil spill response operations and mutual assistance. Finally, with respect to the East Asian Seas region, serious consideration should be given to the formulation and adoption at the ministerial level of a regional oil spill contingency plan which could incorporate the substance of a legal instrument as well as operational arrangements for co-operation in combating oil pollution.

1. Introduction

The Sixth Meeting of the Co-ordinating Body on the Seas of East Asia (COBSEA), in considering the recommendations of the meeting of experts on the East Asian Seas Action Plan (Bangkok, December 1986), decided to terminate the on-going projects related to monitoring and control of oil pollution and requested UNEP to convene a meeting of experts on the control of oil pollution with the following terms of reference:

(a) "to determine the state of knowledge on the extent and sources of oil pollution in the region; review the existing and on-going research, management and legislative activities relevant to control of oil pollution; and

(b) to advise COBSEA on activities to be undertaken in the framework of the action plan in order to impose effective control on oil pollution in the region" (UNEP/IG.77/6).

The present meeting, co-hosted by the Ministry for Population and Environment of Indonesia and the ASEAN Council on Petroleum (ASCOPE), is being convened by the Executive Director of UNEP in accordance with this decision of COBSEA. The recommendations of the meeting are expected to result, subject to the approval of the Seventh Meeting of COBSEA, in more effective measures for the control of oil pollution in the region.

IMO along with other United Nations organizations was active in the development of the East Asian Seas Action Plan and has expressed its readiness to assist designated national authorities upon request in the implementation of COBSEA projects which deal *inter alia* with co-operation in combating major incidents of marine pollution. There are in the East Asian Seas region several intergovernmental and industry-sponsored and funded oil spill contingency plans and related activities. The IMO Secretariat therefore suggested to the Sixth Meeting of COBSEA (Bangkok, 27-29 April 1987) that it may be appropriate at some stage to tie together existing national and regional governmental and industry plans into a consolidated region-wide plan or arrangement to ensure optimal and timely oil spill reporting and deployment of existing resources available to governments and industry and to facilitate provision of assistance from outside the region.

The purpose of this document is to provide a succinct overview of oil pollution control and combating measures and arrangements relevant to the East Asian Seas from the perspective of IMO. The document also identifies possible future activities which may usefully be undertaken by COBSEA to enhance the capability of the States participating in the East Asian Seas Action Plan to combat and control oil pollution in the region.

2. Background

The coastal zones of the ASEAN countries are heavily populated with about 75% of the population living near the coast. Many of these people rely on coastal resources for a living, including some 2.2 million fishermen and an estimated further 50 million people for whom the sea is the primary source of livelihood. The development of coastal cities, ports and harbours, as well as other industrial and agricultural activities, all lead to an increased stress on the marine environment. A balance therefore has to be maintained between the demands of developing economies and protection of the marine environment necessary to sustain both the traditional activities, such as fishing and aquaculture, and the more recently developed tourist industry which takes advantage of the region's natural beauty and tropical climate. ASEAN Member States are amongst the world's principal producers of fish and major exports include shrimp and tuna, while tourism has become an important source of foreign exchange for many of the countries.

The potential for marine pollution from ships, due to either operational discharges or accidental spills of cargo or bunkers, becomes very evident from even a cursory examination of the marine traffic flows both generated within the region itself and from goods in transit. Table 1 shows the number and tonnage of tankers under the flags of ASEAN member countries and Table 2 gross ship tonnage and oil production in the East Asian Seas region.

The East Asian Seas region is at the crossroads of international trade routes with petroleum and other bulk commodities moving primarily west to east and south to north while manufactured goods move in both directions. For east-west traffic, chiefly oil moving from the Middle East to Japan, the favoured route is through the Malacca and Singapore Straits into the South China Sea. However, due to under-keel clearance restrictions, loaded tankers of more than about 220,000 dwt are unable to follow this route. These larger vessels and ore carriers from Western Australia use the deeper passage through the Lombok and Makassar Straits and the Sulawesi Sea.

During the 1980 IMO/UNEP meeting on the Development of Sub-regional Oil Spill Contingency Arrangements for the Sulawesi Sea, it was noted from a previous study, (Document OSC/INF.2) that 25 to 30 VLCC tank vessels transited the Lombok/Sulawesi Sea seaway per year. In addition, approximately 110 to 150 smaller tank vessels transited the area per month. The statistics were compiled prior to the enactment of the under-keel clearance of 3.5m agreement for the Straits of Malacca and Singapore passage.

Indonesia's Department of Sea Communications estimates that the VLCC tank vessel traffic in the Sulawesi Sea/Lombok Straits passage has increased to approximately 18 VLCC tank vessels per month while the number of smaller tank vessels transiting the area has remained the same. The dramatic increase in tank vessel traffic, where all are fully loaded, has taken place because of the 3.5 m clearance rule for the Malacca Straits. Light VLCC return by the shorter route via Singapore.

The US National Academy of Sciences (1975) estimated the quantities of oil released to the sea by operational ship discharges on a global basis in 1973 to be 1.833 million t. As a result of the progressive introduction of the provisions of MARPOL 73/78 it was re-estimated (Cormack and Fowler 1986/87) in 1978 to be 0.981 million t. The comparison with a detailed breakdown of the figures is shown in Table 4 which also includes more recent estimates for total tanker operations, bilge and bunkers by IMO for 1980.

From Table 4 it can be seen that the estimated amounts have decreased from 1973 to 1980 but that the IMO estimates of the 1980 input are more conservative than those for 1978.

Table 1. Analysis of ASEAN tankers by principal types (Lloyd's Register of Shipping 1986).

Country	Oil Tankers		Oil/Chemical Tankers		Chemical Tankers		Bulk/Oil Carriers (Including Iron Ore)	
	No.	Gross Tonnage	No.	Gross Tonnage	No.	Gross Tonnage	No.	Gross Tonnage
Brunei Darussalam	1	382	-	-	-	-	-	-
Indonesia	193	603,394	2	13,833	3	2,442	-	-
Malaysia	73	273,514	-	-	4	57,572	1	89,178
Philippines	74	646,514	2	9,256	9	9,003	12	572,542
Singapore	121	1,604,411	4	48,553	9	66,278	7	271,995
Thailand	60	59,315	1	3,139	-	-	-	-
World Total	5,985	124,140,186	505	4,285,627	861	3,560,321	348	21,266,832
China	179	2,215,865	-	-	3	4,307	9	604,818
Vietnam	15	39,619	-	-	-	-	-	-

Table 2. Gross ship tonnage and oil production in the East Asian Seas region.

Country	Gross Tonnage and Percentage Gross Tonnage	Percent World's Tonnage	Oil Production in Million T 1985	1986	Change 1986 Over 1985
Brunei Darussalam	1,973	0.0	7.4	7.5	+ 1.3%
Indonesia	2,085,635	0.52	63.9	67.3	+ 5.3%
Malaysia	1,743,629	0.43	21.3	24.8	+ 16.1%
Philippines	6,922,499	1.71			
Singapore	6,267,627	1.55	9.2	9.2	- 0.7%
Thailand	533,138	0.13			
World Total	404,910,267	100	2,806.1	2,932.8	+ 4.5%
China	15,839,767	3.92	124.9	130.6	+ 4.6%
Vietnam	338,668	0.08			

The main exports of crude oil and natural gas are chiefly to Japan, while imports include crude oil and chemicals. The principal tanker ports are listed in Table 3. Singapore remains the main refining centre although intra-regional exchange of crude and petroleum products has declined in recent years as individual countries have developed their own energy resources and refining capacity. An indication of the movement of chemicals in the region is given by the results of a MARDATA search which showed 25 chemical tanker movements in Bangkok for the first two months of 1987.

In order to apply these global figures to the estimation of operational discharge rates to the East Asian Seas, it would be necessary to consider the percentage of global shipping operating in the East Asian Seas, the nature of these ships and the details of their trading characteristics. It is interesting to note, for example, that about 28,860 t of oil enter the North Sea per year from an estimated 5,016 ships operating in the North Sea, i.e., assuming that deballasting discharge is normally deferred until the tanker has left the North Sea (Cormack and Fowler 1986/87). On the other hand, about 24,000 ships per year are estimated to transit the Malacca Straits. Using the same reasoning it can be assumed that at least 150,000 t of oil enter the East Asian Seas per year.

3. Prevention and control measures of oil pollution from ships

Operational discharges of oil arise from the mixing of oil and water. Sources of such mixtures from the machinery spaces of ships include: water included with bunkers, residue of water ballast in oil tanks which have been ballasted, water leaks from machinery into oil systems, oil leaks into bilges, and leakage of steam from heating coils in bunker and settling tanks. In oil tankers, mixtures arise primarily from water washing of cargo oil tanks and the carriage of water ballast in cargo tanks.

Table 3. Principal ASEAN tanker terminals (from Drewry Shipping Consultants Limited "Asian Oil Traders and Tanker Demand Report No. 110, March 1983").

Country	Port	Maximum dwt	Function
Brunei	Seria	200,000	Crude Loading
Indonesia	Ardjuna Terminal	200,000	Crude Loading
	Balikpapan	40,000	Products Discharging
	Cilacap	35,000	Crude Discharging, Products Loading
	Cinta	175,000	Crude Loading
	Pangkalan Susu	100,000	Crude Loading
	Seniphah	125,000	Crude Loading
	Sungai Pakning	80,000	Crude Loading
Malaysia	Labuan	250,000	Crude Loading
	Hari	100,000	Crude Loading
	Port Dickson	90,000	Crude and Products Loading, Products Discharging
	Port Kelang	25,000	Products Load/ Discharging
Philippines	Batangas	120,000	Crude Discharging
	Bauan	300,000	Crude Discharging
	Cebu	20,000	Products Discharging
Singapore	Pulau Bukom	325,000	Crude Discharging, Products Loading
	Singapore	350,000	Crude Discharging, Products Loading
Thailand	Bangkok	35,000	Products Discharging
	Sriracha	90,000	Crude Discharging

Table 4: Estimated annual inputs of oil into the oceans from operational ship discharges for 1973, 1978 and 1980.

Source	Estimated annual amount (million t)		
	1973	1978	1980
Load on top tankers	0.31	0.11	
Non-load on top tankers	0.77	0.50	0.71
Bilgers and bunkering	0.50	0.12	
Technical operations	0.003	0.001	0.32
Dry docking	0.25	0.25	

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78), aims to limit operational pollution by: specifying construction and equipment standards, establishing discharge criteria, prescribing operational procedures, designating areas where permitted discharges are lower than in the open sea, and requiring the provision of reception facilities. These matters are dealt with in Annex I of the Convention which applies to <u>all</u> ships, i.e., of any size on either local or international voyages. However, the survey and certification requirements apply only to oil tankers of 150 t gross tonnage and over and other ships of 400 t gross tonnage and above. Furthermore, the requirements vary according to the size of vessels.

MARPOL 73/78 is considered as the most ambitious international treaty concerning marine pollution ever adopted. In addition to oil pollution, the subject of this meeting deals with all forms of marine pollution from ships except disposal of land-generated waste into the sea by dumping which is covered by the London Dumping Convention.

Most of the technical measures are included in five Annexes to the Convention which deal respectively with the following:

Annex I - Oil
Annex II - Noxious liquid substances carried in bulk (e.g. chemicals)
Annex III - Harmful substances carried in packages (e.g. tanks and containers)
Annex IV - Sewage
Annex V - Garbage

MARPOL 73/78 entered into force on 2 October 1983. To date, the instrument has been ratified by 43 countries. Annex II, as amended, entered into force on 6 April 1987. Annexes III, IV, and V are optional and to date, 28 countries whose combined merchant fleets represent 48.02% of the world gross tonnage have ratified Annexes II and V and 26 countries representing 42.87% of world tonnage have ratified Annex IV. The status of ratification of MARPOL 73/78 and other IMO Conventions related to marine pollution by States in the wider East Asian Seas region is shown in Table 5.

Table 5. Status of conventions and protocols related to protection of marine environment (as of 20 September 1987).

Country	Convention Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Brunei Darussalam	X												
Indonesia	X							X			X		
Malaysia													
Philippines					X								
Singapore								X	X				
Thailand													

Country	Convention Number												
	1	2	3	4	5	6	7	8	9	10	11	12	13
China	X				X			X	X				
Vietnam													

1 MARPOL ANNEX I/II
2 MARPOL ANNEX III
3 MARPOL ANNEX IV
4 MARPOL ANNEX V
5 LDC 72
6 INTERVENTION 69
7 INTERVENTION PROTOCOL 73
8 CLC 69
9 CLC PROTOCOL 76
10 CLC PROTOCOL 84
11 FUND 71
12 FUND PROTOCOL 76
13 FUND PROTOCOL 84

4. Control procedures

The effectiveness of any international treaty instrument is dependent on the extent to which the instrument is given effect by the promulgation and enforcement of national laws and regulations. The primary responsibility for ensuring that ships meet the requirements laid down in IMO conventions rests with the flag State - that is, the government of the country whose flag the ship is entitled to fly. When a State accepts an IMO convention it makes the provisions of that convention part of its own national law and in effect agrees to ensure that all ships flying its flag meet the convention's requirements. This is done by surveying and inspecting the ship and then issuing a certificate (or a number of certificates, depending upon the convention) as proof that the requirements have been met. Surveys generally have to be carried out subsequently at stated intervals to ensure that the ship and its equipment still meet convention requirements.

The SOLAS 1974, Load Line and MARPOL 73/78 Conventions contain provisions that ships must be surveyed during construction and periodically thereafter. The Survey requirements in these Conventions vary according to the type of ships and items to be surveyed, but the following is the general concept:

1. passenger ships and radio installations should be surveyed annually;

2. structures and associated equipment of cargo ships should undergo major surveys (i.e. periodical surveys) at five-year intervals, with additional surveys; and

3. life-saving appliances and other safety equipment should be surveyed at two-year intervals, with additional surveys, if necessary.

The survey of ships must be carried out by officers of the Administration, i.e. the government of the flag State, which may, however, entrust the surveys either to surveyors nominated for the purpose or to organizations recognized by it. Many countries, particularly developing countries, which do not have sufficient qualified surveyors, authorize classification societies to carry out surveys and issue certificates on their behalf.

Whilst the primary responsibility for ensuring that any particular ship complies with MARPOL 73/78 rests with the Administration of the flag State in some cases, in particular with respect to ship operations, it will be difficult for such an Administration to exercise full and continuous control over some ships entitled to fly the flag of its State. Such ships for instance may not sail regularly from ports or offshore terminals under the jurisdiction of the flag State.

The problem can be and has been overcome partly by appointing inspectors at foreign ports or authorizing classification societies to act on behalf of the flag State. In addition, MARPOL 73/78 includes a number of provisions for States other than the flag State to exercise control over foreign ships visiting ports or offshore terminals under their jurisdiction.

Aside from viewing port state control as a means of assisting the flag State in ensuring compliance of its ships with MARPOL 73/78, there is the obvious vested interest of port and coastal States in protecting the marine environment under their national jurisdiction in conformity with existing international law by ensuring that ships comply at all times with the marine pollution standards prescribed by MARPOL 73/78.

IMO has adopted Procedures for the Control of Ships under MARPOL 73/78* which contain guidelines for port States and, where appropriate, for coastal States to ensure that a ship continues to comply with the relevant provisions of Annex I of MARPOL 73/78. A number of factors may cause the condition of a ship to be considered as posing a threat to the marine environment rendering the ship involved a pollution risk. These factors fall into categories which include:

---

* Resolution A.542(13) published by IMO under Sales No. 601 86.19E. (Note: This publication also includes resolution MEPC.26(23) in Control Procedures under Annex II of MARPOL 73/78).

1. non-compliance with the construction or equipment requirements of the Convention;
2. inoperative or malfunctioning equipment; and
3. non-compliance with the operational requirements of the Convention.

The control procedures aim to identify such a pollution risk and to provide the basis for remedial action.

Of necessity these control procedures have been divided into different categories each of which is dealt with in a separate chapter. It must, however, be kept in mind that one category may involve another so that for a certain ship more than one chapter of this document may be applicable.

Chapter 2 contains guidance aimed at ascertaining whether a ship holds a valid International Oil Pollution Prevention (IOPP) Certificate and is built, equipped and operating in compliance with the relevant provisions of MARPOL 73/78.

Chapter 3 contains guidance on the gathering of evidence of violation of the discharge provisions contained in Annex I.

Chapter 4 contains guidance on in-port inspections of crude oil washing operations.

Chapter 5 contains guidance on control measures for ships of non-Parties to MARPOL 73/78.

Chapter 6 contains guidance on the dissemination of information obtained as a result of exercising port State control and, if appropriate, coastal State control.

In five appendices, detailed guidelines are given for officials charged with carrying out the control procedures referred to above.

5. International co-operation

It is universally accepted that shipping, being an international activity, must be regulated at the international level with internationally agreed standards applicable to all ships. As mentioned above, it is primarily the responsibility of the flag State to ensure compliance with the agreed standards; however, the role of the port and coastal State is vital in assessing that sub-standard ships are eliminated and the marine environment is protected from the consequences of sub-standard operations.

Where ships are calling at a number of ports in neighbouring countries, there is considerable scope for co-operation among such countries to increase the effectiveness of control on foreign ships in their ports. The Memorandum of Understanding on Port State Control (MOU), agreed among fourteen European States, provides a good example of such regional co-operation.

The text of the MOU was approved in January 1982 and came into operation in July of the same year. Under the Memorandum, fourteen European States (Belgium, Denmark, Finland, France, the Federal Republic of Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom) agree to inspect 25% of all foreign flag merchant vessels visiting their ports each year. Inspections are carried out and deficiencies reported to other participating countries. The purpose of the Memorandum is to co-ordinate the activities of maritime authorities in relation to port State control and to ensure that the ships entering the region comply with the international standards set out in the following conventions:

LOAD LINES 66
SOLAS 74 and 78 PROTOCOL
MARPOL 73/78
STCW 78
COLREG 72
ILO 147

Inspection reports are entered from remote terminals to the SIRENAC information system at the Centre Administratif des Affaires Maritimes (CAAM) in France. The inspections are carried out by surveyors employed by the central government departments responsible for marine transportation in each country. At present it is these departments that have direct access to the individual ports. However, as the system is developed it is envisaged that the ports will have direct access to this information. Figure 1 shows the overall organization for the operation of the MOU.

Initially, the inspections were mainly concerned with vessel safety and crew conditions, but more recently emphasis has been placed on the inclusion of MARPOL 73/78 deficiencies in survey reports.

The MOU programme has been generally welcomed not only by governments but also by shipping organizations, trade unions and others who have an interest in ensuring that maritime standards remain high or are raised even higher. Several other major shipping countries have drawn up their own inspection programmes and others are reported to be following suit. As these programmes are implemented it will be increasingly difficult for sub-standard ships to operate and present a risk to the marine environment.

Several East Asian Seas countries have expressed an interest in establishing an MOU system in the region in the context of the Datalink project described below. The raison d'être of the MOU is to ensure vessel compliance with existing international standards. The ratification of MARPOL 73/78, in particular, should be considered a prerequisite for establishing a formal MOU system. However, an increased level of co-operation between governments in efforts to control and prevent oil pollution from ships in such fields as data exchange and surveillance should not be viewed as a substitute for ratifying international conventions.

6. Assistance in organizing a databank on pollutants from ships (RAS/81/055 - Sub-project 4)

IMO is currently implementing an ASEAN/UNDP project the purpose of which is to provide the ASEAN countries with advice on an information system or database to support measures for the prevention and control of pollution from ships. This first report examined some of the approaches followed and information systems in use in Western Europe and North America to illustrate the scope for possible applications of such systems.

The report covers, but is not limited to, the possible applications set out in the project document as follows:

(a) Data on pollutants carried by ships, e.g.:

- properties of crude oils determining their behaviour when discharged into the marine environment.

- characteristics of other hazardous substances carried by ship, e.g. aquatic toxicity, bioaccumulation, degradability.

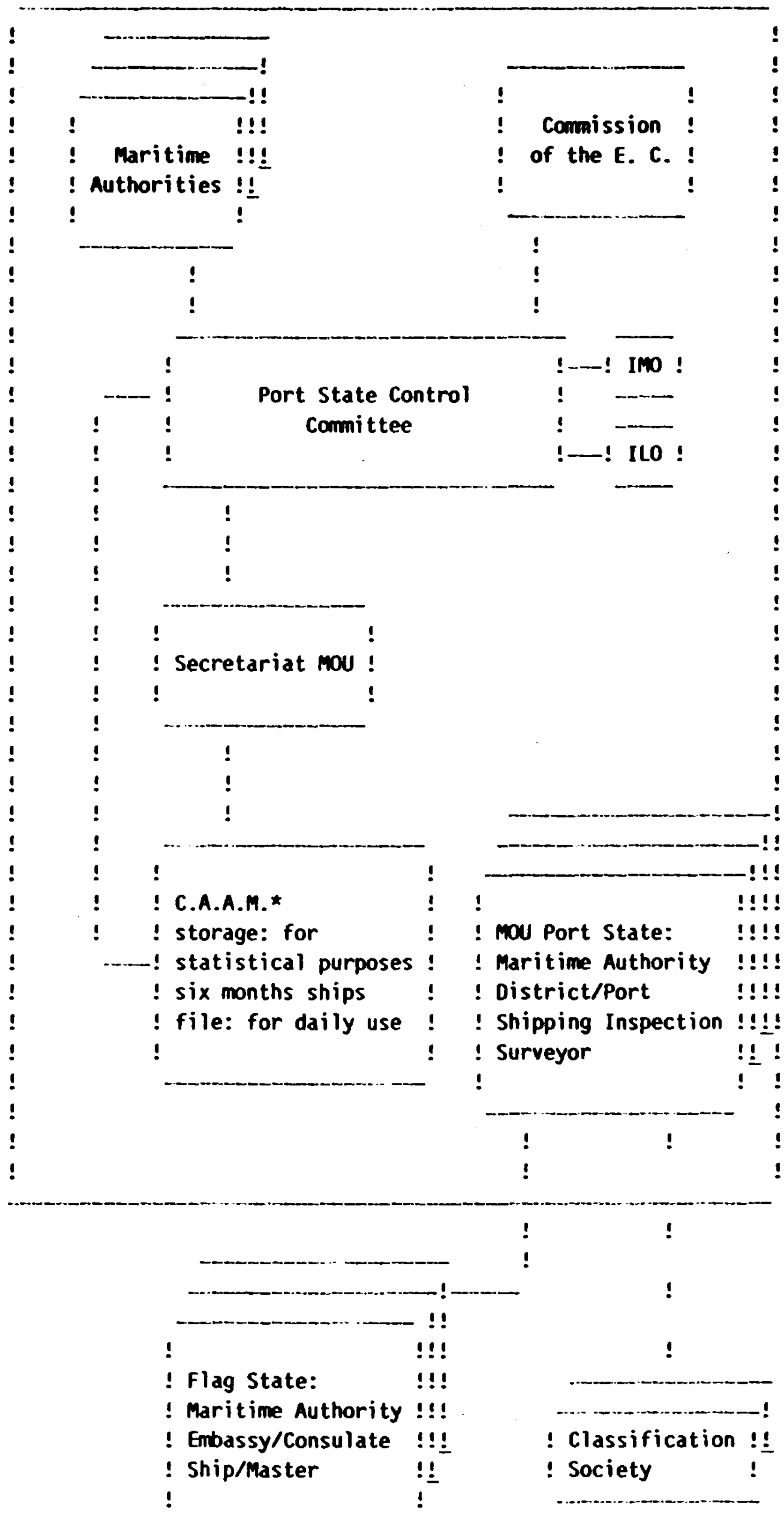
- information on response procedures in case of spillage.

(b) Data on anti-pollution resources, e.g.:

- inventories of equipment, aircraft and vessels which are available for spill surveillance and response.

(c) Storage of shipping statistics (volume and type of traffic) and records of accidents and spillages.

(d) Data on dangerous cargoes, e.g. International Maritime Dangerous Goods (IMDG) Code.



* Centre Administratif des Affaires Maritimes (CAAM)

Fig. 1. Organisational structure under the Memorandum of Understanding on Port State Control

(e) Data on substandard tankers derived, for example, from the exercise of port State Control Procedures called for by SOLAS and MARPOL Conventions.

(f) Data in support of vessel traffic control systems; such systems would most probably relate to the passage of vessels through exceptionally hazardous areas, e.g., Malacca Straits, but could ultimately form part of an integrated vessel traffic service.

In May 1987 IMO Consultants, International Tanker Owners Pollution Federation Limited (ITOPF) visited Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand. As a result of the mission it was possible to narrow down the choice of applications which might realistically form an ASEAN database on ship source pollutants. It was felt that a port State central information system could be established on a sub-regional basis between countries with a more advanced maritime administrative infrastructure. Experts from the above-mentioned countries met with the IMO Consultants in Bangkok from 21 - 25 September 1987.

The meeting of ASEAN experts, after consideration of a number of options for the application of a regional database, agreed to establish a Maritime Incident Reporting System for the ASEAN Region (MIRSAR). The Consultants' conclusions and recommendations follow this section.

It is proposed that information on all marine casualties occurring in the ASEAN Region involving vessels larger than 75 grt should be entered. The intention is primarily to capture data on all incidents where there was a risk of pollution, either from cargo or bunkers, whether or not pollution actually occurred. The database would also include reports on spills from offshore installations such as pipelines and platforms, but pollution from onshore sources is to be excluded. Also excluded is information on crew injury and minor damage while loss of life would be recorded. The detailed interpretation of which types of incidents should be entered in the database is to be left to the users. It is proposed that a small working group should be set up to agree on the final data format.

After consideration of the likely data storage requirements, it was determined that the computer system necessary to support MIRSAR should be based on micro-computers using commercially available database software. The initial configuration proposed is for each country to have one micro-computer connected via telephone lines to a dedicated host micro on which the master database would be stored. In the first instance, the systems would only be available to the nominated maritime agency in each country, but in the longer term, it was anticipated that the system would become accessible to each of the major ports. The system can be upgraded easily by the addition of a mini-computer if, at some time in the future, the data storage requirements exceed the capacity of the host micro. In addition, this configuration permits other applications such as an equipment and personnel database to support the ASEAN Regional Contingency Plan to be added at a later date.

Many of the delegates had expressed the concern that individual countries would face difficulties meeting the on-going and operating costs of a database, but agreed that the proposed configuration represents minimal expenditure in this regard: simply the cost of leasing a telephone line and inter-ASEAN telephone call charges when updating or interrogating the system. Subject to Government approval, Malaysia offered to host the dedicated micro-computer.

7. Airborne surveillance of the East Asian Seas

Regional co-operation for the technical and operational improvement of systems of airborne surveillance to detect oil spills can be an important factor in policing of illegal discharges from ships.

At this stage of development the continual use of commercially available UV/IRLS, SLAR and microwave radiometry (MR) systems provides a potential for improving the ability to collect evidence for prosecution purposes in cases of illegal operational discharge.

Work in this field has been under the auspices of the Bonn Agreement (Belgium, Denmark, France, Iceland, the Federal Republic of Germany, Netherlands, Norway, Sweden, and the United Kingdom) and there is continual co-operation among these States in relation to the management of a response to a major oil spill incident. They have concluded that with regard to the policing of operational discharge offences, however, much remains to be done before a complete mutually agreed surveillance coverage of common sea areas can be established. This could most profitably be done in consultation with the relevant international bodies. The results of such investigations when carried out by those countries now possessing the necessary equipment should provide a satisfactory basis for discussion of possible needs and best means for the introduction of common aerial surveillance of the whole North Sea area at the operational level.

There is potential for developing a similar approach in the East Asian Seas region with IMO implementation of a US$ 255,000 ASEAN sub-project providing for the installation of a remote sensing package using an aircraft supplied by the Malaysian Government. It is hoped that after operations begin, agreement can be reached on exchange of information and on placing the aircraft at the disposal of other ASEAN States. In the long term it would be desirable to agree on surveillance cover of all high density traffic areas of the region using compatible equipment and establishing mutual data exchange. Information generated from a common surveillance programme would interface with the aforementioned data bank.

8. Global co-operation in combating oil pollution

IMO activities are not limited to the development of international standards aimed at the prevention and control of marine pollution from ships. IMO also provides a forum for wide ranging discussion of problems related to combating marine pollution and oil spill response and contingency planning. A comprehensive Manual on Oil Pollution has been published by IMO which consists of four sections dealing with prevention, contingency planning, salvage, and practical information on means of dealing with oil spillage. The last mentioned section is currently being revised. Guidelines on Oil Spill Dispersant Application and Environmental Considerations have also been published and will be revised in the near future.

IMO has also recently given increased attention to the problems of countries faced with the threat of major marine pollution from spills of oil and other hazardous substances. The Secretary-General of IMO convened an advisory group composed of experts from 11 countries and 15 intergovernmental and non-governmental organizations in April 1986 at IMO Headquarters in London.

One of the actions arising from the recommendations made by the advisory group is that IMO will now undertake the preparation of a "Guide to Assistance in Marine Pollution Emergencies" that will contain information provided by governments, international and regional intergovernmental and nongovernmental organizations, and industry. The Guide will describe the type of assistance that might be made available in the event of a major marine pollution incident, and specify how a request for such assistance should be made. This Guide will briefly cover the roles and functions of the various entities which could be involved in a marine emergency and its aftermath, such as shipowners, coastal States, flag States, cargo owners, marine insurers, and salvors. It will also include valuable information provided by potential requesting States such as the identification of a national focal point and arrangements for receipt of material resources and personnel which would facilitate the provision of assistance in an emergency.

A questionnaire has been sent to IMO Member States to determine the nature and extent of the assistance which they might be able to make available, and to obtain information from potential users of such assistance which would facilitate its provision and use. A similar request will be addressed to international and regional organizations to determine the precise way in which they can assist a country faced with a major marine pollution emergency. It should be noted that there certainly will be no attempt to develop a global inventory of equipment available for oil spill response - a task of Herculean proportion and dubious value. To date, of the East Asian Seas countries, only Singapore has replied to the questionnaire.

9. Regional co-operation

The International Maritime Organization (IMO), the United Nations Environment Programme (UNEP) and the other international and regional organizations have for many years actively co-operated in encouraging the development of regional arrangements for combating marine pollution in emergencies. This co-operation has resulted in the development of intergovernmental regional agreements which commit groups of States to co-operate in responding to major incidents of marine pollution which are likely to affect more than one State. This commitment is reinforced in several regions by the establishment of regional and sub-regional contingency plans; in two regions by a regional centre, and in one sub-region by an equipment base. To date there are 11 regions in the world where a regional intergovernmental agreement on co-operation in combating marine pollution incidents is either in effect or under active consideration.

The East Asian Seas Action Plan does not at present include a legal instrument on regional co-operation in the combating of marine pollution. There are, however, a variety of government- and industry-sponsored regional and sub-regional arrangements dealing with oil spill response. The following is a summary of the status of these arrangements.

9.1 Establishment of a sub-regional centre for shipping pollution countermeasures at Davao, Philippines

In 1980 UNEP sponsored a meeting to consider the development of marine pollution protection for the Lombok and Makassar Straits and the Sulawesi Sea. The Governments of the Philippines, Indonesia, and Malaysia recognized the need for pollution prevention capability in this area and, with the help of an IMO project funded by the United Nations Development Programme (UNDP), a number of actions were initiated to resolve the concerns of the Governments, as described below.

UNDP Project Document number RAS/81/057/1/01/19 was authorized on 7 July 1983 for the "Establishment of a Sub-regional Centre for Shipping Pollution Countermeasures" at Davao, Philippines. In August of 1983, the Project Document was revised and retitled "Strengthening of the Network for Oil Spill Countermeasures in the Lombok/Makassar Straits and Sulawesi Sea".

The revised Project Document called for an on-scene co-ordinators workshop meeting for the establishment of an operating plan for the Centre and a financial management scheme to make the Centre and on-going training financially self-sufficient after the equipment was used on an actual oil spill. An agreement in principle was reached as to the management of the Centre and the oil pollution abatement equipment was ordered.

The revised Project Document authorized a hands-on training course to be held at Davao, Philippines when all of the pollution equipment had arrived at the Centre. On 28 January 1985, the training course was conducted with 28 trainees from Indonesia, Malaysia and the Philippines in attendance. At the conclusion of the training session, the member countries scheduled three consultative meetings to be held within the year to finalize the management scheme agreed to in principle at the workshop meeting in April of 1984.

The first of the Consultative Meetings was held on 5 February 1985 and developed an outline of the subjects to be finalized during the next two meetings. Due to scheduling difficulties,the second and third meetings were combined into a Final Consultative Meeting held in Jakarta, Indonesia on 28 July 1987.

The objective of the Final Consultative Meeting was to reach a working accord between member countries for the operation of the Sulawesi Oil Spill Response Network by finalizing the management plan agreed to in priciple at the 1984 workshop meeting.

The Sulawesi Sea Oil Spill Network action plan developed at the meeting is to be incorporated into the contingency plan of the three member countries and into the ASEAN contingency plan.

9.2 Action Plan for the Sulawesi Sea Pollution Network

Geographic boundaries were discussed in depth by the member countries and were agreed to encompass the territorial waters of the three member countries and their respective tributaries with the exclusion of the area already covered by the Straits of Malacca and Singapore Contingency Plan. The scope of area increases the possible use of the equipment far beyond the Lombok/Sulawesi Sea area.

Identification of environmentally sensitive areas has been completed by all three member countries and the information is contained in their respective national contingency plans. This appears to be the most practical approach to the issue of environmentally sensitive areas as the information has little value outside of the individual country's area of responsibility.

Inter-country routing for direct lines of communications was completed and information exchanged between member countries.

A base fee for non-member use of the equipment was not resolved. Use of the equipment within the expanded geographic area of response is well defined, but how rental rates would be applied to non-members needs more discussion. It was agreed that, under the concept of maximum utilization of the equipment, third party use of the equipment should be encouraged to generate revenue for the future operation of the equipment centre.

Use of the equipment when the identity of the spiller is unknown was discussed but was not fully resolved. In the event that the equipment is put into operation by a member country to clean up a spill where there is no identified responsible party presents a unique problem. Areas that need to be discussed would be whether the country that uses the equipment would be responsible for the rental fee normally generated and would the country be responsible for lost or damaged equipment. As the Sulawesi Sea Oil Spill Network Action Plan is fully developed, these issues can be addressed and resolved.

9.3 Inter-country Management Committee

During the 1984 workshop meeting, the formation of an Equipment Committee was discussed and agreed to in principle. It was recognized that after the equipment was used on an oil spill where revenue was generated, a committee should be convened to evaluate the equipment and authorize the expenditure of funds for repair or replacement of equipment.

Member countries in attendance at the Final Consultative Meeting in July 1987 agreed that the Equipment Committee concept should be expanded into the formation of an Inter-country Management Committee, the reason being that as UNDP/IMO input diminishes, there will be a need for an Inter-country Management System to resolve on-going administrative matters.

It was agreed that rental use of the equipment could be a source of revenue and that if a major oil spill does not occur in the Lombok/Sulawesi Sea, there will be no funds generated from this source.

9.4 Revolving fund concept

A proposed solution for future funding would be that the three member countries approach the tank vessel owners/operators and offshore oil drilling operators that use the Sulawesi Sea seaway to establish a revolving fund to support the project. An incentive for participation could be a subscription plan where the participating vessel owner/operator would receive a reduced charge for the use of the equipment from the Center in the event they were involved in an oil spill. The establishment of a Sulawesi Sea revolving fund from private sources would be similar to the Malacca Strait revolving fund which is currently administered in respect of Malaysia, Indonesia and Singapore.

9.5 Nucleus of trained operators

It is apparent that the nucleus of trained operators from Malaysia and Indonesia is rapidly decreasing. The concept of inter-country movement of equipment has never been tested and its effectiveness is not known. To strengthen the number of qualified operators and test inter-country movement of equipment, it is recommended that a training course be scheduled where equipment is moved to a neighbouring member country.

9.6 Five year plan

The seaway between the Lombok and Makassar Straits and the Sulawesi Sea is a vast and remote area which has experienced an approximate 769% increase in VLCC traffic since 1980. The establishment of the Davao Centre is justified and necessary as an initial step to provide protection for the seaway. However, it is recognized that the amount of equipment presently at Davao is not sufficient for protection from a sizeable spill. The long range concept for an improved protection plan would be for the establishment of two or more pollution stations strategically located along the seaway. The concept would be the same as a fire department in a large metropolitan city where fire houses are located at a number of locations, all prepared to come to the assistance of one another.

Multiple pollution equipment centres should all contain the same basic equipment which, when moved to a distant site, would physically match up with other equipment while the operating personnel would be familiar with the operation of equipment from other centres. The operating principle would be that the closest centre would respond and request additional equipment and personnel from other equipment centres as needed.

Geographically, the most prudent location for a second station would be in the Lombok Strait area. Protection would then be provided at each end of the seaway and the assistance offered by the combined use of equipment and personnel would strengthen the protection of the entire area.

As mentioned above, the equipment procured for the additional centre would be compatible with the equipment at the Davao Centre. Hose sizes should be the same, oil containment booms should have matching connectors and skimmer/hydraulic power packs should be from the same manufacturer and of the same design so as to be interchangeable, etc.

Using the same equipment design is essential when cross training operating personnel. Training procedures will be simplified and the efficiency of the equipment operators will be enhanced.

To increase the scope of the equipment at the Davao Centre, the project should include a smaller version of the equipment now stationed at the Davao Centre. The smaller version would be ideally sized for use in shallow or confined water and also for use in training personnel in member countries. An airborne pollution equipment package would test the logistical support envisioned by the Sulawesi Sea Oil Spill Network and, at the same time, have a functional role in the protection of the area.

10. Conclusions and recommendations of the IMO consultant

The formation of an Action Plan for the operation of the Sulawesi Sea Oil Spill Network was achieved during the Final Consultative Meeting. Some additional work on a few details will be required, but these details can be resolved by the Inter-country Management Committee at their first meeting. It is suggested that each member country should include the Sulawesi Sea Action Plan in their own country's Oil Spill Contingency Plan as it relates to the operation of the Sulawesi Sea Oil Spill Network.

The conclusions and recommendations are those of the Consultant and do not necessarily represent the views of UNDP or IMO.

Each member country should review the long range goals and objectives of the Sulawesi Sea Oil Spill Network and determine its continuing interest in the project in view of the fact that eventually the operational funding for the Network will be the combined responsibility of the Governments of Indonesia, Malaysia and the Philippines.

The three member countries should actively pursue the establishment of a revolving fund system, contributed to by the owner/operators of VLCC's and offshore drilling operators who use the Lombok and Makassar Straits and Sulawesi Sea area. The fund should be used to offset any cost for the maintenance of equipment and periodic hands-on training. Further, the revolving fund should be supplemented by fees derived from the rental of the equipment when it is used on an oil spill as defined in the Sulawesi Sea Oil Spill Network Action Plan.

UNDP/IMO should continue to fund the project for a period of two years until the member countries can develop a revolving fund to perpetuate the operation of the network.

After the member countries have formulated a sound funding programme for the on-going operation of the Network, UNDP/IMO should give favourable consideration to increasing the capabilities of the Network by purchasing equipment and establishing a second equipment centre in the Lombok Strait area.

The two-year funding of the project by UNDP/IMO should include the purchase of an airborne harbour equipment package and during the two-year support period, one hands-on training course in a neighbouring country should be conducted. It is recommended that the course be held in Manado, Sulawesi, Indonesia. Further, it is recommended that part of the exercise be to determine if the equipment and personnel can be moved internationally on quick notice without hindrance by administrative formalities. To test this part of the operational plan, no prior notice to local authorities should be given. Notification for the training course should follow the inter-country communication routing established at the Final Consultative Meeting and included in the Sulawesi Sea Oil Spill Network Action Plan.

10.1 Overview of IMO Mission for the Development of a Co-operative Action Plan for Oil Pollution Combat (South China Sea) currently underway

The output of the project is envisioned to be the consolidation of the regional area national contingency plans and sub-regional activities into a master document entitled the ASEAN Action Plan. Included in the plan will be the following subjects which will be used as a ready reference during oil pollution emergencies. Action will be initiated by the lead ASEAN agency as deemed appropriate and when requested by a member country.

(a) location of equipment including a detailed description of the equipment at each site;

(b) information concerning the use of the equipment at a distant site including any restrictions;

(c) fees and tariffs for the equipment when used outside the primary operating area. Penalty or charges if used by non-member third parties;

(d) the availability of equipment operators to accompany specialized equipment. Time retrictions as to how long equipment operators can be used;

(e) detailed wind and current information to predict the movement of oil on the surface of the sea;

(f) detailed communication information for each member country. Listings will include, but not be limited to, title of person to contact, address and other pertinent information such as location of communication centres, hours of operation, frequencies of radio equipment and telex numbers;

(g) where feasible, a general overview of the environmentally sensitive areas. This information will be illustrated on maps and charts, but will be limited to information already available in each country during the time of the mission;

(h) notification procedures on how the affected country will request assistance through the ASEAN Action Plan. The notification scheme will place equipment on stand-by and if requested immediately, mobilize the equipment. The decision to request assistance will remain with the affected country;

(i) the plan will include information on the procedures for requesting aid from outside the Region; and

(j) information on communications and equipment centres, oil terminals and environmentally sensitive locations will be illustrated on maps and charts of the area. The mapping concept will give the users of the Action Plan a quick, concise view of the resources and limitation for any action anticipated.

10.2 Malacca Straits Contingency Plan (Revolving Fund)

The Revolving Fund Committee was formed in 1981 as a result of major oil spills in the Malacca Straits in the 1970s involving tankers carrying crude oil to Japan. A revolving Fund of 1.9 million US dollars was established under a Memorandum of Understanding between Japan and the Governments of Malaysia, Indonesia and Singapore. The purpose of the Fund was to enable the Governments of the three littoral States, either jointly or separately, to take immediate action against oil pollution from a ship in the Malacca Straits irrespective of its type or flag. The Fund, which is managed on a five year rotation by the three littoral States, is reimbursed when compensation is received from the polluting vessel's owners. In 1986 the management of the fund was passed from Indonesia to the Government of Malaysia. The operation of the revolving fund is now guided by a Contingency Plan which at present is in the draft form.

10.3 The Tiered Area Response Capability (TARC)

TARC was established in 1985 by five major oil companies operating in Singapore: BP, Caltex, Esso, Mobil and Shell. Their purpose was to acquire and administer an oil spill response equipment stockpile to supplement existing local oil industry and government capabilities in Singapore, Malaysia and Indonesia. These countries border the Malacca and Singapore Straits which are perceived as the TARC primary area of interest.

TARC equipment can be mobilized beyond the primary area provided it is available and can be returned to the equipment base within 24 hours (12 hours for the Airborne Dispersant Delivery System - ADDS). The stockpile is based in Singapore with three contractors appointed to store, inspect, maintain, repair and mobilize the equipment. The actual operation of the equipment is the responsibility of the user.

Associate membership (at US$ 40,000 per annum) gives priority access to the stockpile at preferential rates. At the discretion of the TARC Trustee/Administrator, most items from the stockpile can be made available, but at twice the participant tariff. Equipment is otherwise available on a first come - first served basis.

10.4 ASCOPE Plan for the Control and Mitigation of Marine Pollution (APCMMP)

The ASCOPE Plan was adopted by member countries in 1980 and its operational features are continuously being updated. The main intent of the ASCOPE Plan is not to duplicate national and other existing plans in the region, but to coordinate and integrate the efforts of member countries. The plan provides for an effective reporting procedure, creating awareness of the anti-pollution capabilities of member countries, and rendering assistance in operations where and when necessary. The capabilities established within each country are included in the plan so that information can be disseminated rapidly and requests for assistance dealt with efficiently. Potential pollution problem areas are described, together with production centres, coastal tourist and recreational areas, fish spawning areas and fishing grounds. The plan also records the location of resources for marine oil pollution control and shore reception facilities, as well as information on winds, currents, tides, etc. It also describes operational procedures.

The current development of the ASCOPE Plan is to exercise its operational capabilities and consider the possibilities of establishing equipment and resources stockpiles in strategic locations. Considering that there are other similar plans in the region, it is the ultimate aim of ASCOPE to integrate and avoid duplication of efforts, and to pool resources together in order to further strengthen the region's capabilities.

11. Status of national contingency planning

The fundamental building blocks for regional co-operation are well developed and operational national contingency plans which provide the basis for possible joint oil spill response operations and mutual assistance. As an extension of the UNDP/IMO project on the Sulawesi Sea Oil Spill Network mentioned above, an IMO consultant is currently visiting the countries of the region in connection with the development of a co-operative action plan for the South China Sea.

The consultant will visit all six ASEAN member countries and hold consultations with the relevant authorities including Departments of Fisheries, Marine Departments, Meteorological Departments, National Oil Corporations and multinational oil companies operating in the region, and Telecommunication Departments. He will then prepare a report which will form the basis of the "Action Plan" and will include his findings and recommendations in respect of the following:

(a) Assessment of the extent and magnitude of oil pollution risk in the South China Sea.

(b) Review of indigenous capabilities for combating oil pollution.

(c) Extent to which areas and resources sensitive to oil pollution have been surveyed and mapped, or where this is pending.

(d) Inventories of anti-pollution equipment and materials in each Member State.

(e) Assessment and verification of communication channels for anti-pollution operations.

(f) Formulation of a Co-operative Action Plan for oil pollution combating in the South China Sea.

The total duration of the consultancy will be about eight weeks in two split missions.

Pending the completion of the missions, the following is a brief summary of the status of national contingency planning in the region based on information currently available to IMO.

11.1 Brunei Darussalam

Brunei Darussalam is currently using an Oil Spill Contingency Plan developed by Brunei Shell Petroleum Company Sendirian Berhad (BSP) for dealing with major oil spills in territorial waters of Brunei.

An Oil Spill Emergency Team consisting of senior personnel in BSP has been appointed. The team will be directed by the Emergency Contingency Manager (Operations Manager). Duties of each member of the team (and all supporting personnel) are defined. In the event of a major spill, the team will assemble at the Emergency Control Centre (ECC) in Seria.

The Emergency Control Centre is linked to the BSP Communications Centre (VSL) which is manned 24 hours of the day and is also linked to the National Air/Sea Rescue Centre in Bandar Seri Begawan.

All emergencies arising out of BSP activities are reported to the BSP Emergency Communications Centre and specific personnel are notified as required by the instructions contained in the BSP Emergency Procedures Guide.

In the event of a well blowout, the Oil Spill Emergency Team will coordinate their activities with the Blowout Task Force defined in the BSP Blowout Contingency Plan. BSP has adequate resources to handle an oil spill offshore up to 5,000 bbl/d for three days. In excess of this, the assistance of regional Shell Companies is required.

11.2 Indonesia

It is understood that the National Contingency Plan is not yet in force. There does exist a "Standing Operating Procedure for the Prevention and Abatement of Marine Oil Pollution in the Straits of Malacca and Singapore" agreed to in 1981 between the Director-General, Sea Communications, and the Director-General, Oil and Gas.

Pertamina has developed contingency plans to deal with their operations related to offshore activities and vessel operations and holds oil spill response equipment and material in strategic locations around the country. The Pertamina Contingency Plan is integrated into the ASCOPE plan described above.

11.3 Malaysia

Malaysia introduced and implemented the National Contingency Plan to Prevent and Combat Oil Spills in the Straits of Malacca (NCOP-SOM) in October 1975 with the following objectives:

- to provide the mechanism for a coordinated and speedy response to oil spill accidents within the area covered by this Plan;

- to develop an adequate clean-up capability for oil spill accidents; and

- to mitigate the harmful effects of oil spills on the aquatic and marine environment through preventing or controlling the spread of such spills.

This Plan covers the Malaysian waters in the Straits of Malacca as well as part of the South China Sea which, for this purpose, is defined as that portion of the waters which lies approximately between 1°30'N and 7°N. To date the necessary clean-up capability has been developed to cover only two of the three designated centres for on-scene coordination, namely, Johor Bharu and Port Kelang. The other centre in Penang is under review since the most critical area is that from One-Fathom Bank through Tanjung Piai to the Horsburgh Light-Horse at Pulau Batu Putih (Pedra Branca).

It is proposed that the existing organisational plan for the Straits of Malacca be extended to the South China Sea, particularly on the development of a single communication network and unified response procedure for all types of maritime casualty. Special mention should be made of the increasing role to be played by the Maritime Enforcement and Co-ordination Centre (MECC) based in Lumut, Perak and established recently under the auspices of the Secretary to the National Security Council.

To date, the Government of Malaysia has invested approximately 17.3 million Ringgit in oil spill combating equipment, vessels and material.

11.4 Philippines

A National Marine Pollution Control Contingency Plan was promulgated in June 1975. The Plan seeks to protect the environment from the damaging effects of oil spills and other hazardous waste substances by providing a coordinated response mechanism for combating oil spills using the combined resources of the private sector and the government. It also promotes the coordination and direction of national and local response systems and the development of local government and private capabilities to handle such spills. The Plan covers all the sea, ports, harbours, inland waters and their tributaries, and their adjoining shorelines within the territorial jurisdiction of the country.

The Plan, which has not been revised since its promulgation, serves to unify the various local spill response mechanisms in the country. At the same time, it supplements the various decrees, rules and regulations concerning the prevention of marine pollution by addressing the issues and problems spawned by an unplanned or sudden, and usually accidental, discharge of oil or any hazardous substance that poses a threat to the public health or welfare. The Plan clearly defines the objectives and the roles of the implementing units.

11.5 Singapore

The Port of Singapore Authority (PSA) is responsible for controlling marine pollution in Singapore waters and coordinates all activities pertaining to prevention, control and combating marine pollution.

PSA has prepared contingency plans to deal with incidents that are likely to result in serious pollution. A comprehensive Marine Emergency Action Procedure has been promulgated by the PSA which includes procedures to deal with a major oil pollution incident.

11.6 Thailand

In 1986, an oil contingency plan was developed for Thailand. The plan includes several aspects, such as:

- Important fishing grounds, and breeding areas for species of fish, shellfish, and crustaceans of commercial value.

- Aquaculture and mangrove forest areas along the coast of Thailand.

- Distribution of coral reefs.

- Areas with rare and endangered reptiles and mammals.

- Socio-economic information, i.e. amenity beaches and other tourist areas, marine parks, seabird colonies, and industrial sites.

- Description of wind patterns, surface currents, seawater temperatures and hydrocarbon levels in water and sediments.

- An assessment of the risk of oil pollution in Thai waters, including an evaluation of the frequency and size of a range of possible hydrocarbon releases.

The results of a DANIDA study cover an evaluation of the existing oil spill control capabilities in Thailand as well as recommendations for a national oil spill contingency plan including organization, staffing, reporting, alarm and communication arrangements, oil spill control equipment, recommendations for training and exercises, and a cost estimate for the implementation. A separate manual for oil spill combating operations has been developed as well.

The final report was submitted to a national committee for consideration on 15 April 1987.

Implementation of the Plan will take at least three years. The Harbour Department will act as a lead agency during the implementation period. The steps of implementation are as follows:

(a) Approval of the Draft Contingency Plan;

(b) Preparation of the passing of a new Marine Pollution Prevention Act;

(c) Formation of the permanent Organization;

(d) Completion of the Contingency Plan;

(e) Design of facilities and procurement of equipment;

(f) Training; and

(g) Commissioning.

12. East Asian Seas Action Plan

In 1981 a Co-ordinating Body on the Seas of East Asia (COBSEA) was established to serve as the overall authority to determine the contents of the Action Plan, to review its progress and approve its programme of implementation through periodic meetings of governments.

There have been six such meetings at which programme activities have been reviewed and therefore it should not be necessary in the context of this meeting to describe in detail that part of the programme relevant to oil pollution prevention and control and combating. The following, extracted from the report of the sixth meeting of COBSEA (Bangkok, 27-29 April 1987), is indicative of the project status and possible interrelationships with other project actions being undertaken in the region.

EAS 12: Oil-dispersant toxicity

The output of this project would have an obvious application to national and regional oil spill contingency planning and could be incorporated as well into regional guidelines on oil-spill dispersant applications and environmental considerations, the development of which has been called for by the workshop on the technical and scientific support programme described below.

EAS 15: Survey and monitoring of oil pollution and related activities

Survey and monitoring of oil pollution and establishment of a regional data base and the proposed establishment and management of a marine data base and information system may interface with the two ASEAN/UNDP projects described above: "Databank on Pollutants" and "Airborne Surveillance".

EAS 17: Implementation of a technical and scientific support programme for oil spill contingency planning

In August 1987 a workshop was held in Jakarta, Indonesia on the subject of this project. The workshop report has been circulated (COBSEA 87/EAS 17/Rpt 1) and the following are recommendations put forward by the extracts from workshops of particular relevance to this paper.

Activity	Timetable	Responsibility
EAS 12: Co-operative research on oil and oil-dispersant toxicity in the East Asian Seas region. Project to be terminated and followed up by new activity.	Continuing until December 1987 (with budget allocated in revision 5 of project)	Ministry of Science, Technology and the Environment, Government of Malaysia, in co-operation with national institutions of the region
EAS 14: Study of the maritime meteorological phenomena and oceanographic features of the East Asian Seas region. Project to be extended until December 1988, and reformulated so that it includes the (1) development and testing of predictive models for physical transport processes in selected deep sea areas and (2) indication on how and by whom such models can or will be used in the context of the action plan (based on proposal 2 in Annex IV of UNEP/WG.154/6).	Continuing until December 1988	National Environment Board, Government of Thailand, in co-operation with national institutions of the region.
EAS 15: Survey and monitoring of oil pollution and development of national co-ordinating mechanisms for the management and establishment of a regional data exchange system. Project to be terminated and followed up by new activities.	Continuing until October 1987 (with budget allocated in revision 5 of project)	Office of the State Minister for Population and the Environment, Government of Indonesia, in co-operation with national institutions of the region.
EAS 17: Implementation of a technical and scientific support programme for oil spill contingency planning. Project to be terminated and followed up by new activity.	Continuing until October 1987 (with budget allocated in revision 5 of project)	Office of the State Minister for Population and the Environment, Government of Indonesia, in co-operation with national institutions of the region.

13. Conclusions and recommendations

13.1 General remarks

In addition to the above COBSEA programmes, activities which are being undertaken by ASCOPE, IMO, and the ASEAN Experts Group on the Environment (AEGE) are relevant and complementary to the regional oil spill contingency planning efforts.

All concerned parties should closely monitor the development of these programmes and their potential integration with COBSEA's programmes can be further elaborated at the present meeting.

To fill up the "gaps", the following programme should be considered for regional implementation:

(i) Study on the fate and effects of oil in the marine environment of the region, including biodegradation, hydrocarbons in benthic organisms, etc.

(ii) Study to establish "baseline" levels of oil pollution in the region (in conjunction with EAS 15).

(iii) Developing procedures/guidelines for the use of dispersants in cleaning up oil spills (in conjunction with EAS 13).

(iv) Prioritizing sensitive resources which are vulnerable to potential oil spills in conjunction with Environmental Sensitivity Index Mapping.

(v) Developing a common method of finger-printing of oil and its products.

(vi) Developing a common method and procedures for oil spill impact analysis, including quantification of ecological and other impacts, to substantiate claims for compensation.

(vii) Establishing in the region an independent panel of Oil Spill Impact Assessors (Adjusters), among others, to qualify and arbitrate disputes in claims for compensations.

Considering that there are at least 5 current arrangements related to regional oil spill contingency planning, it is essential that these plans should be harmonized and integrated into a consolidated and unified regional plan.

In addition to its technical operational and management features, and the necessary equipment and trained personnel, a regional plan requires institutionalized arrangements on the following essential elements:

- procedures on pollution reporting and calling for assistance from neighbouring countries.
- procedures on transfrontier mobilisation of equipment, vessels, aircraft, workers, spraying of dispersant, etc. vis-a-vis immigration, customs, airspace clearance, etc.
- procedures on claim, compensations and insurance.
- financial arrangements on assistance in terms of loan of equipment, manpower, reimbursement, sharing of stockpiles, etc.

The above essential elements should ideally be institutionalized through an adoption of regional protocols and conventions. Currently, there is no such institutional arrangement in the ASEAN region.

13.2 Conclusion

From the above overview of activities being carried out under the auspices of IMO/UNEP/ASEAN/COBSEA, the oil industry, national administrations and bilateral aid agencies, it should be obvious that there is a considerable amount of work under way at the national, regional and global level of relevance to the control and combating of oil pollution in the East Asian Seas region. Although these activities are not subject to any centralized institutional control or co-ordination by one designated international or regional organization, there is no clear evidence of any wasteful duplication of efforts. The organization of work at the international and regional level invariably reflects the institutional arrangements and sectoral responsibilities established at the national level. It is, therefore, extremely difficult and perhaps counter-productive to attempt to systematically impose institutional co-ordination through international or regional organizations. However, there is a need and clear justification for periodically conducting sectoral overviews of all global, regional and national activities related, e.g., to oil pollution prevention control and combating measures and arrangements relevant to the East Asian Seas region. Such overviews would enable the countries of the region to monitor activities undertaken by the different sectoral ministries in co-operation with the different international and regional organizations. It is through such monitoring and periodical review that duplication can be avoided. However, there is no substitute for national co-ordination and the establishment of inter-disciplinary national committees dealing with such matters as marine pollution prevention control and combating. The Governments of the region cannot hope to achieve international co-ordination solely through participation in meetings convened by international or regional organizations primarily because, as is well known, the focal points for these organizations are different.

As can be seen from the above, the principal means by which the control and prevention of oil pollution from ships is effected is the implementation of the MARPOL 73/78 Convention by flag and port States. This Convention provides the keystone for international environmental regulation of shipping and the international maritime community is resolved that every effort should be devoted to the widest possible acceptance and implementation of it. IMO and the World Maritime University have devoted considerable energies in enhancing the technical capabilities of countries to carry out the inspection, certification, and control requirements of MARPOL 73/78. The extent to which any country can implement an international treaty of such nature is of course dependent on the technical and financial capabilities of that country. However, less than optimum capability should not serve as a barrier to acceptance as it is considered preferable from a purely technical point of view to accept the Convention and then work towards its full implementation. Acceptance of MARPOL 73/78 by all East Asian Sea States would contribute greatly to the control of oil pollution from ships operating in the region and should therefore be encouraged within the COBSEA programme.

There appears to be a widespread recognition of the desirability of adopting some form of agreement on co-operation in combating marine pollution which would inter alia provide a framework for mutual co-operation and assistance in dealing with major marine pollution incidents. Such a framework would apply to all major marine pollution incidents whatever the source which adversely affect the marine and coastal environment and related interest of one or more of the East Asian Seas States. It could include elements of exchange of information, timely notification of oil and chemical spill incidents, mutual assistance, operational measures, sub-regional arrangements, and institutional arrangements including meetings of focal points.

The question of whether or not to adopt a treaty instrument, i.e., a convention for the protection and development of the marine environment of the East Asian Seas region with associated protocols was discussed at the time of adoption of the East Asian Seas Action Plan and it was agreed that for the time being, such legal instruments would not be developed. However, the Sixth Meeting of COBSEA in April 1987 included in its long term strategy for 1987-1996 the exploration of the feasibility of the development and adoption of a suitable legal framework [a convention and relevant protocol(s)] for the plan. The IMO Secretariat, in co-operation with UNEP, has prepared draft protocols on co-operation in combating marine pollution emergencies in most of the UNEP Regional Seas areas as well as regional and sub-regional contingency plans, and stands ready and able to assist the countries of the East Asian Seas in this regard. As the long term strategy still does not indicate that the States of the region have firmly decided to develop legal instruments, serious consideration should be given to the formulation and adoption at the ministerial level of a regional oil spill contingency plan for the East Asian Seas region which could incorporate the substance of a legal instrument as well as operational arrangements for co-operation in combating oil pollution. The format for such a plan has been developed by IMO in the context of regional contingency plans adopted in other regions and is available.

As can be seen from the above description of the on-going IMO/ASEAN/UNDP project for the development of the co-operative action plan for combating oil pollution in the South China Sea, it would appear that this project, which is currently underway, could provide the framework by which the first draft of such a regional contingency plan could be developed. In view of the existence of the ASEAN Contingency Plan and ASCOPE Plan, it would also appear more desirable for such a plan to be adopted under the framework of this project rather than to expend the limited resources of the COBSEA programme on such an endeavour at this stage. However, the input from COBSEA focal points through reviews of the draft plan would be extremely useful.

The principle underlining the COBSEA project EAS 17 that technical and scientific support is required for national and regional oil spill contingency plans is still valid. Continued implementation of this project could serve as a useful conduit by which the expertise of all the countries in the region combined with external advisory input as required can be directed to solving specific technical and scientific problems which would enhance oil spill response capability in the region. The aforementioned workshop held in Jakarta in August 1987 on the implementation of a technical and scientific support programme for an oil spill contingency plan usefully identified several "gaps" which could be filled by future activities under this project; for example, the further development of environmental sensitivity index mapping, the development of regional guidelines for the use of oil spill dispersants, and the development of guidelines on methods and procedures for oil spill impact analysis are all potential projects which should attract positive consideration by the meeting of experts.

13.3 Recommendations

The following are activities which may be undertaken in the framework of the East Asian Seas Action Plan which would contribute to the control and combating of oil pollution in the region.

13.3.1 Legal/technical regional workshop on MARPOL 73/78

Indonesia is one of the two countries of the region which has ratified MARPOL 73/78 and would be well placed to host a workshop aimed at discussing the experiences gained by, e.g., Indonesiain preparation for acceptance and subsequent implementation of MARPOL 73/78. Problems which are perceived as obstacles to acceptance and implementation of MARPOL 73/78 in the region would be examined with participation of IMO experts from outside the region who have faced similar problems.

13.3.2 Development of a practical field guide for oilspill response that focuses on tropical marine and coastal environments of the East Asian Seas region

A great many manuals, guidelines, technical notes and other publications exist on the methods and equipment used to deal with oil spills. By and large, these publications are either intended to be generally applicable for all conditions and environments or focus on temperate or polar regions so that little or no information is provided that deals with warm-water coral, mangrove, lagoon or sea-grass habitats.

This is not surprising since most of the research and experience gained has been in dealing with oil spills in the northern latitudes, although recent major spills in the Gulf of Mexico and the Persian Gulf have increased the knowledge base on how oil behaves and can be treated in sub-tropical waters.

This is not to say that much of the advice in these existing publications is not of equal relevance to all marine and coastal environments. This is particularly true for advice on contingency planning, salvage at sea measures to prevent or reduce the amount of oil spilled, techniques for containment and mechanical recovery of spilled oil, and oil spill dispersant application. The output of EAS 12 "Co-operative research on oil and oil-dispersant toxicity in the East Asian Seas region" would be particularly relevant. However, a field manual for oil spill response strategies that focuses on tropical marine and coastal environments or which uses the specific characteristics of the East Asian Seas region as a reference point is not readily available.

Another feature of many of the existing guidelines is an emphasis on the use of specialized equipment for oil containment and recovery which may not be readily available in the region. The proposed guidelines would focus on the use of indigenous materials and practical means likely to be available in many of the countries of the region. Also in keeping with the recognition that the region is particularly vulnerable to damage resulting from significant oil pollution, emphasis will be placed on the problems of oil spill clean-up and restoration.

The proposed manual's format and content would be practical and user-orientated and will rely to a great extent on diagrams and illustrations rather than lengthy texts. Specifically, the manual would deal with marine and shoreline habitats, shoreline type, protection methods, clean-up methods, decision guidelines for on-scene co-ordinators, and restoration of shoreline aspects in tropical environments. Particular attention would be given to the behaviour of oil in tropical environments including rates of spreading, evaporation, photo-oxidation, dissolution and biodegradation, and the impact of oil pollution and oil clean-up activities on corals, mangroves, lagoons, and seagrass habitats as well as use of dispersants in the tropics. Specific experience gained in dealing with spills in the tropics could be included as case studies.

Duplication of detailed information contained in existing publications which are already widely available, such as the IMO Manual on Oil Pollution and the recently published IMO/UNEP Guidelines on Oil Spill Dispersant Application and Environmental Considerations, will be avoided and a bibliography or reference list will be included to assist users in finding other more detailed information on oil spill combating which is known to be currently available.

13.3.3 <u>Behaviour of oil in tropical environments</u>

As an input to the abovementioned project, a study would be carried out by one of the marine science institutions in the region on the behaviour of oil in tropical waters including rates of spreading, evaporation, photo-oxidation, dissolution, etc.

13.3.4 <u>Development of environmental sensitivity index (ESI) maps and their integration into national and regional contingency plans</u>

Several countries in the region have developed environmental sensitivity index maps in conjunction with oil spill contingency planning. The experience gained by these countries could form the basis of a model workshop on the development of ESI maps and their integration into national and regional contingency plans.

13.3.5 <u>Regional Workshop on Chemical Spill Countermeasures</u>

Although the subject of this meeting is oil pollution control, it would be unwise to ignore the fact that in recent years, the transport and storage of hazardous substances which may present a danger to both the public and the environment, if not handled in a proper way, have increased greatly. Public concern over hazardous materials has justifiably grown and both governments and industry have taken steps to prevent and respond to incidents involving hazardous substances.

IMO has given increased attention to this matter and has recently published a Manual on Chemical Pollution and organized workshops on chemical spills. It is suggested that it would be timely to organize a workshop in the region dealing with the following aspects:

- Methods for identification and assessment

- Remote detection

- Measurements of atmospheric concentrations

- Phases of hazard evaluation

- Response
    - on board ships
    - classification of spillage
    - methods of response
    - control of operation at response work areas
    - disposal

- Personal safety and health
    - toxic hazard awareness
    - standardized operating procedure
    - response organization and training.

REFERENCES

Cormack, D. and D. Fowler. 1986/1987. Operational Oil discharges from ships: impact on the North Sea. Oil and Chemical Pollution 3:307-325.

National Academy of Sciences (NAS). 1975. Petroleum in the marine environment. Washington, D.C.: NAS.

UNEP. 1987. Report of the Sixth Meeting of the Co-ordinating Body on the Seas of East Asia (UNEP/IG.77/6, 27-29 April 1987).

OIL AND THE MARINE ENVIRONMENT

Absornsuda Siripong
Marine Science Department
Faculty of Science, Chulalongkorn University
Bangkok 10500, Thailand

ABSTRACT

An understanding of the composition and basic properties of petroleum is essential for the successful control of oil pollution in the marine environment. Petroleum is composed primarily of hydrocarbons which may be classified into five groups: paraffins, naphthenes, arenes, alkenes and cycloalkanoarenes. In addition, other organic compounds exist in petroleum in the form of hydrocarbon derivatives containing sulphur, nitrogen, oxygen, or trace metals such as vanadium and nickel. The composition of oil largely determines its toxicity to organisms. Among physical properties of petroleum that should be considered are density, refractive index, viscosity, surface tension, specific heat, latent heat, distillation range, boiling point and vapor pressure. Oil in the marine environment occurs in a variety of forms. Sources of oil entering the ocean include natural seeps, precipitation from the atmosphere, terrestrial run-off, and activities involving production, transport and use.

1. Introduction

It was agreed at the international convention on marine pollution held in London in 1972 that oil and oil products should be considered the most widespread pollutants affecting the world's oceans. The seas, like the atmosphere, know no national boundaries; pollution originating in one nation is not the problem of just that nation but of all the nations of the world (Simonov 1974).

All oils are a complex of components with differing physical, chemical and biological properties. When oil is spilled onto the surface of the sea it undergoes a number of changes, some of which enhance its natural dissipation while the others cause it to persist. The fate and effects of an oil type and the clean-up requirements will depend primarily, therefore, upon the combined physical and chemical properties of its components (White and Nichols 1981). Thus, light refined products, such as gasoline, kerosene and some light crude oils which are highly volatile materials with low viscosities do not persist on the surface of the sea for any significant length of time due to rapid evaporation and natural dispersion. Spills of these materials therefore do not normally require clean-up. Heavy crude and residual fuel oils, on the other hand, may be expected to persist on the sea due to their greater proportion of nonvolatile components and high viscosity. Such oils are also resistant to many clean-up techniques and large spills frequently cause widespread contamination of coastlines, requiring extensive and costly clean-up operations.

The nature of the damage caused will also vary according to the type of oil spilt. The location of a spill can have a considerable bearing on the costs since it will determine the resources threatened and the clean-up response required (White and Nichols 1981).

The following discussion on the properties of oil and the sources of oil entering the marine environment summarizes information drawn from the existing literature. The various pertinent publications are cited throughout the text. A significant source of material is the work of Banks and King (1986).

2. The natural oil

2.1 Introduction

The term "petroleum" is derived from the Latin words petra (rock) and oleum (oil). It is natural organic material composed principally of hydrocarbons which occur in the gaseous or liquid state in geologic traps. The liquid part, after freed from dissolved gas, is commonly referred to as crude oil. Underground reservoirs adopt various forms, and the oil is usually associated with natural gas and brines.

In a typical dome-shaped formation, the fluids occupying the interstices in the rock are arranged in order of increasing density with ill-defined boundaries between zones.

Uppermost is the gas zone or cap which contains so-called associated (i.e., with oil) natural gas. This comprises low molecular weight alkanes -- methane (predominantly) plus its C_2-C_7 homologues (ethane, propane, butanes, pentanes, hexanes and heptanes) — together with inorganic gases (carbon dioxide, nitrogen, hydrogen sulphide and sometimes helium). The intermediate zone contains oil saturated with dissolved gas under the conditions of temperature and pressure prevailing in the reservoir rock. The bottom zone is occupied by "connate" or "interstitial" water, traces of which are also present in the pores of reservoir rock in the oil and gas zones.

Oilfield waters (or "brines") contain relatively large amounts (frequently more than 10^4 ppm) of dissolved inorganic salts, principally chlorides and sulphates of sodium, potassium, calcium and magnesium (Banks and King 1986).

2.2 Origin of petroleum

The majority of geochemists believe that petroleum originates from buried sedimentary organic matter derived from biopolymers produced by plants and animals (lignin, carbohydrates, lipids and proteins). Diagenesis, which is the biological, physical and chemical alteration of this organic matter prior to a pronounced effect of heat, results in complex geopolymers known collectively as kerogen which is the main organic constituent of ancient sediments.

Two main types of kerogen are recognized: a "coaly" type which does not contribute to petroleum and a "sapropelic" type which does. Thermal conversion of sapropelic kerogen into oil and gas occurs as temperature rises during burial of sediments. Once formed in dense fine grained source rocks, oil and gas undergo primary migration into more permeable coarse grained sedimentary reservoir rocks where movement (so-called secondary migration) of the fluids within the pores eventually leads to their segregation into accumulations.

Oil bearing formations range in age from the early Palaeozoic era (500 x 10^6 yr) to the late Cenozoic (10^6 yr). Particularly prolific oilfields belong to the Cenozoic and Mesozoic periods (reaching back 225 x 10^6 yr).

2.3 Characteristics of crude oil

Physically, crude oils can vary from light, mobile, straw-coloured liquids containing a large proportion of easily distillable material to highly viscous, semi-solid black substances from which very little material can be removed by distillation before the onset of thermal decomposition. Densities generally lie in the range 0.79–0.95 g/cm^3 under surface conditions, and viscosities vary widely, from about 0.7 to more than 42,000 centipoise. In general, crude oils are flammable under ambient conditions and their odours can vary from an almost pleasant aromatic bouquet to the distinctly unpleasant smell often associated with sulphur derivatives.

Despite the wide differences in the physical aspects of different crude oils, their ultimate or elemental compositions are remarkably consistent. Thus, the percentages by weight of the elements present in a "crude" fall within the narrow limits quoted in Table 1.

Table 1. Elemental composition/wt (%) : ranges for crude oils (from Banks and King 1986)

Carbon	83.90	-	86.80
Hydrogen	11.00	-	14.00
Sulphur	0.06	-	8.00
Nitrogen	0.02	-	1.70
Oxygen	0.08	-	1.82
Metals*	0.00	-	0.14

* The most abundant "trace" metals are vanadium and nickel. Numerous others (e.g., iron, magnesium, aluminum, copper, silver) have been detected, but no systematic analytical work seems to have been carried out, and it is difficult to evaluate whether their occurrence is common or not.

2.4 Constituents of crude oil

As indicated by the analytical data listed in Table 1, the main constituents of crude oils are hydrocarbons (HC), compounds composed solely of hydrogen (H) and carbon (C), and these can account for over 75% of the material. Of the other elements present, sulphur (S), nitrogen (N) and oxygen (O) appear as heteroatoms in hydrocarbon derivatives, some of which occur as petroporphyrins, i.e., complexes involving traces of metals [notably vanadium (V) and nickel (Ni)] present in petroleum.

Metals may also be combined as salts of carboxylic acids, but much remains to be learned about the structural affiliations of metallic and metalloidal elements in crude oil. Inorganic sulphur can be present as the element or as hydrogen sulphide (H_2S) dissolved in the oil. Heavy crudes of the younger formations, for instance Venezuelan crudes, have a low hydrocarbon content of the order 35-38%, the remainder comprising compounds with molecules containing at least one heteroatom. Non-hydrocarbon components are concentrated mainly in the heavy residues (residuum) from the distillation of crudes.

Organic compounds may be classified according to the basic scheme set out in Figure 1. All the classes shown are represented in petroleum.

Three basic types of hydrocarbons (paraffinic, naphthenic and aromatic) occur naturally in crude petroleum. These hydrocarbons range from simple, highly volatile substances to complex waxes and asphaltic compounds which cannot be distilled. A fourth type may be created by "cracking" during the refining process. The characteristics of many crude oils (Marcinowski 1970) will fall within the ranges shown in Table 2 (see also Table 3).

2.4.1 Paraffins or alkanes

The first type of compound (the paraffins or alkanes) has a chainlike structure, either straight or branched, in which each C atom is linked to four other C or H atoms. All the available bonds of the C's are thus used, and the compound is "saturated". The names of the

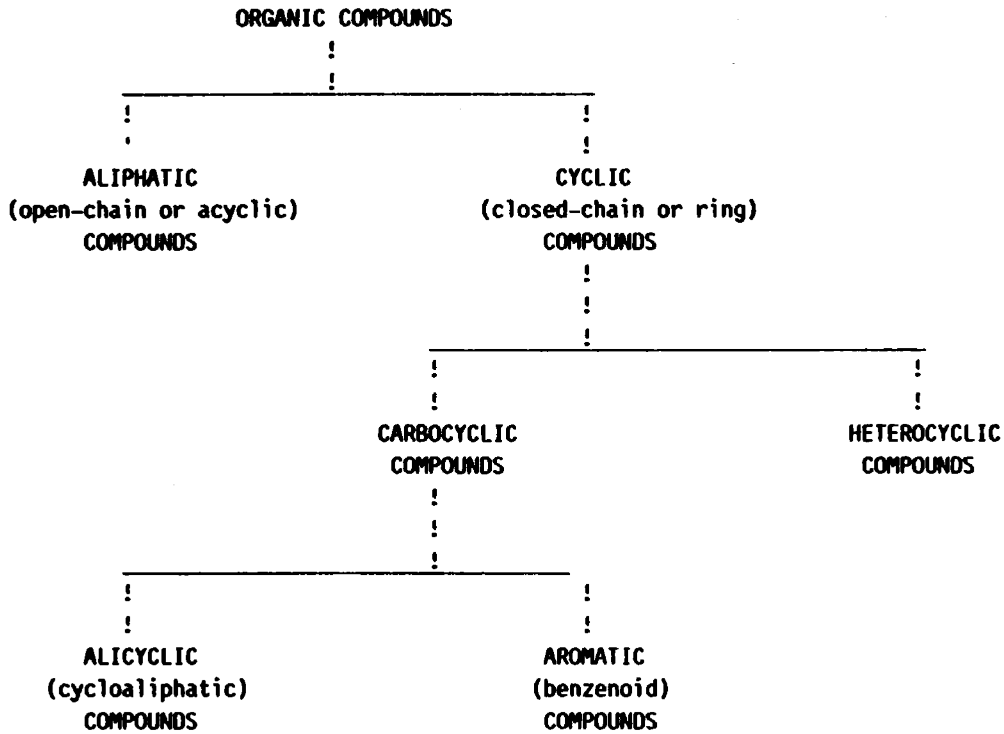


Fig. 1. Classification of organic compounds in petroleum.

simplest members of the straight chain series are familiar: methane, ethane, propane, butane, pentane...octane, etc. Straight and branched-chain hydrocarbons of this type constitute a large fraction of crude petroleum and predominate in gasoline and some fuels. Beginning with octane, the eighth member of the series, their solubility in water is negligible. This does not mean, however, that they do not mix with sea water. Through wind and wave action they may be dispersed as tiny droplets in the sea, or they may even hitch a ride to the bottom on clay or other particles and thus contaminate the bottom sediments.

2.4.2 Alicyclic compounds or naphthenes

In the second type of compound, which is also saturated, some of the C atoms are joined into rings of 5–7 members. These are the alicyclic compounds — "cyclic" because of the rings. The simplest compounds of the group are cyclopentane, cyclohexane and cycloheptane, with 5, 6 and 7 C's in the rings, respectively. Other chemical groups may be substituted for the H's in these molecules.

2.4.3 Aromatic compounds or arenes

The third type of compound, like the alicyclic, contains one or more rings. The C atoms in these rings share their bonds with only 3 other atoms, rather than four. The simplest compound of this type is the familiar benzene. Other common organic solvents chemically related to benzene are toluene, ethylbenzene and xylene. Many of the larger molecules have been implicated as potent carcinogens in experimental animals. A number are known to be acutely toxic to man or other animals.

Table 2. The range of properties of some crude oils (from Marcinowski 1970)

Specific gravity	15/15°C	0.80–0.988	Sulphur	%wt	0.80–5.00
Initial boiling point	°C	30–125			
Kinematic viscosity	cS	4–25	Wax	%wt	5–12
Pour point	°C	-35 to +7.0	Asphaltenes	%wt	0.05–3.00

2.4.4 Olefins or alkenes

The fourth type of compound is a class of unsaturated, straight or branched-chain compounds called olefins or alkenes. They are produced during the refining process, when, through "cracking," large molecules are broken down into smaller ones that make up the more desirable light petroleum fractions.

2.4.5 Cycloalkanoarenes

These "mixed" polycyclic hydrocarbons, referred to as naphthenoaromatics, possess structures involving fusion of aromatic with alicyclic rings, and may carry aliphatic side-chains. When they do they contain all three types of C/H molecular "building blocks." As a class they begin to appear in the kerosene fraction, increasing in concentration in the higher-boiling distillation cuts and residues.

Examination of several crude oils has shown that bicyclic naphthenoaromatics (one aromatic and one alicyclic) — indane, tetralin and their alkyl derivatives — are relatively abundant in kerosene and light gas oils. The tricyclic compound 1,2,3,4-tetrahydrophenanthrene and its derivatives are also common. Of particular importance to studies on the origin of oils is the presence in heavier gas oils or lubricating oil fractions of tetra- and pentacyclic naphthenoaromatics related to steroid and triterpenoid structures.

2.4.6 Other organic compounds

Crude oils contain appreciable amounts of organic compounds with structures incorporating one or more (the same or different) atoms of S, N or O in addition to C and H.

As a class, these organic non-hydrocarbon compounds are distributed throughout the whole boiling range of a crude oil, but appear mainly in the heavier distillation fractions and the non-volatile residue.

Although concentrations of non-hydrocarbons in any one fraction may be relatively small, their influence can be important. For example, acidic components such as thiols (sulphur-containing compounds) and carboxylic acids (oxygen-containing compounds) promote corrosion of metal equipment. Reforming catalysts employed in the production of motor gasoline are seriously deactivated by sulphur compounds. Trace metals (V, Ni) become deposited on, passivate and/or poison catalysts employed in desulphurization of fuel oil or catalytic cracking of heavy distillates.

The colour and odour of crude oil stems mainly from the NSO compounds that are concentrated in the lubricating oil (C_{26}–C_{40}) and residuum (>C_{40}; asphaltic bitumen) fractions.

Crude oil may also contain relatively minor amounts of suspended inorganic salts (mainly chlorides) and of dissolved elemental sulphur and hydrogen sulphide (H_2S). Arrangements are normally made at the wellhead to remove H_2S (along with light hydrocarbon gases) and "salt" associated with oil accumulations. Even small quantities of salt remaining in crude or picked up during shipping can lead to serious problems in the refinery owing to its deposition in distillation plants or conversion there into corrosive acids. Its concentration is best reduced, therefore, to less than 0.001 wt-% by washing crude with water at ca. 120°C under pressure before distilling it.

Very high molecular weight NSO-compounds are present in the asphaltic residuum which remains after removal of distillable material from crude oil, and are referred to as resins and asphaltenes. The residuum mainly comprises very heavy oils, resins, asphaltenes and high molecular weight waxes. Addition of liquid propane at temperatures below 21°C causes the resins and asphaltenes to precipitate, and these can then be separated by dissolving the resins in n-pentane.

The asphaltenes are dark brown-black amorphous solids, and the resins may be light- to dark-coloured thick fluids or amorphous solids. Resins always seem to be more abundant than asphaltenes, and their ratio varies considerably depending on the crude oil source.

About half of the total combined N and S present in crude oil appears as resins and asphaltenes, most of these elements being present in the form of heterocyclic groups. The probability of all molecular species present containing one or more heteroatoms (N,S or O) is high.

2.4.7 Organometallic compounds

Numerous "trace" elements have been detected in crude oils besides N, O and S. Of the many metals listed (aluminum, barium, calcium, chromium, copper, gold, iron, lead, magnesium, manganese, nickel, silver, titanium, vanadium, etc.), Ni and V are the most abundant and, in the form of petroporphyrins and related complexes, appear to be present in all crudes.

Their concentrations vary from source to source, total amounts ranging from <1ppm to in excess of 1300 ppm. Average abundances, determined by analysis of 64 crude oils from various parts of the world, are 18 ppm Ni and 63 ppm V, and a good correlation exists between sulphur, asphaltene and metal content. Some metals, particularly iron, may be derived from pipework and other equipment used to extract and transport oil. Other sources of inorganic material are finely divided clays and related mineral matter taken from reservoir rocks along with crude and petroleum brines.

2.5 Crude oil classification

A method of classifying crude oils is necessary to provide a guide to the quality and hence, value, of the oil. In the very early days, the kerosene fraction used for lighting purposes was the most valuable product. With the introduction of the internal combustion engine, gasoline became the most valuable fraction in crude oil. The specific gravity of crude oil provided a rough measure of the amount of the lighter fraction present. The lower the specific gravity (or the higher the API gravity which is an inverse scale) the greater was the yield of light fractions by simple distillation, and hence the higher the price of the crude.

In 1937, Lane and Garton of the US Bureau of Mines put forward a general scheme for the classification of crudes based on the specific gravity of 2 fractions (key fractions) produced by a standardized method of fractionation of the crude. Although this classification is not completely satisfactory, it is now universally employed. The main advantage lies in the wide coverage since practically all known crude oils have been analysed and classified by this method and the information is kept up to date by the periodic publication of new analyses by the US Bureau of Mines.

The method involves fractionation of the crude, starting by a distillation at atmospheric pressure, during which the fraction boiling between 250 to 275°C is collected (Key fraction No. 1), and continuing with a distillation at 40 mm Hg during which the fraction boiling between 275 and 300°C is collected (Key fraction No. 2). The specific gravity of both fractions is determined, and from the specific gravity (or API gravity) of the fractions, the crude is assigned to 1 of the 9 classes shown in Table 3 (Banks and King 1986).

Table 3. Classification of crude oils accordingto the US Bureau of Mines (from Banks and King 1986)

Class	Key fraction No. 1		Key fraction No. 2	
	Sp gr 60/60°F	°API	Sp gr 60/60°F	°API
Paraffinic	<0.825	≥40	<0.876	≥30
Paraffinic-Intermediate	<0.825	≥40	0.876–0.934	20–30
Intermediate-Paraffinic	0.825–0.860	33–40	<0.876	≥30
Intermediate	0.825–0.860	33–40	0.876–0.934	20–30
Intermediate Naphthenic	0.825–0.860	33–40	>0.934	≤20
Naphthenic Intermediate	>0.860	≤33	0.876–0.934	20–30
Naphthenic	>0.860	≤33	>0.934	≤20
Paraffinic-Naphthenic	<0.825	≥40	>0.934	≤20
Naphthenic-Paraffinic	>0.860	≤33	<0.876	≥30

2.6 Physical properties of petroleum fractions

In the case of mixtures, particularly complex multi-component mixtures, the behaviour of the individual pure compounds does not normally correlate simply with the behaviour of the complete mixture. Thus, when dealing with the complex mixtures of hydrocarbons normally found in petroleum fractions, knowledge of the average properties of the mixture are often of greater importance than an understanding of the exact chemical composition and of the physical properties of the individual compounds.

The discussion in this section has been drawn from Banks and King (1986).

2.6.1 Density (d)

The SI unit of kg/m^3 is related to the petroleum industry units as follows:

1 lb/ft^3 = 16.019 kg/m^3
1 lb/UK gal = 99.776 kg/m^3
1 lb/US gal = 119.830 kg/m^3

Since the calculation of the volume depends on the mass of the same volume of standard fluid and the appropriate density/temperature relationships, it is quite normal to dispense with the absolute density measurement and quote the result in terms of specific gravity.

Other ways of expressing liquid densities are used in particular industries and in the oil industry reference is often found to API gravities. This is derived from the specific gravity by use of the relationship

$$\text{Degrees API} = \frac{141.5}{\text{Sp gr } 60/60^{o}\text{F}} - 131.5$$

There is thus no simple relationship between absolute densities and API gravities, and it is usual to consult tabulated information for such conversion.

Vapour densities are defined in the same way as liquid densities, but are very much smaller, so they are often expressed as gravities relative to air at a particular temperature. Unlike liquid densities, vapour densities are very dependent on pressure and it is very important that the pressure involved is accurately reported.

Vapour densities are usually expressed in terms of specific volumes, that is, as volume per unit mass (m^3/kg or ft^3/lb). In the oil industry, vapour density is sometimes reported in ft^3/gal liquid.

The main use of density is to permit the mass of a given volume of liquid or gas to be determined for use in subsequent calculations. Knowledge of density is also a guide to chemical composition. Although it is only rarely that density on its own can be used to determine composition, it is often used in combination with other properties to characterize a mixture. In general, paraffinic hydrocarbons have comparatively low densities, naphthenic and olefinic hydrocarbons intermediate densities, and aromatic hydrocarbons comparatively high densities.

2.6.2 Refractive index (n)

This can be measured easily with a number of instruments since n is numerically equal to the ratio of the sine of the angle of incidence to the sine of the angle of refraction when light passes obliquely from a vacuum into the substance.

The value of n varies with the wavelength of the light used, and also with temperature, and both must be quoted. The "D line" of the sodium spectrum (wavelengths of 5890 and 5896 A) is usually used for n measurements with hydrocarbons.

Refractive index alone can be used to give information on the composition of hydrocarbon mixtures. As with density, low values are associated with paraffins and higher values with aromatics.

The combination of n and d is a more powerful tool, and several authorities proposed the use of such combinations as

"refractivity intercept": $n - \frac{d}{2}$

and "specific refraction": $\frac{(n^2 - 1)}{(n^2 + 2)} \times \frac{1}{d}$

as indicative of the chemical composition of hydrocarbon mixtures.

2.6.3 Viscosity

Dynamic viscosity (u) may be defined as the force per unit area which is required to maintain a unit velocity gradient in the fluid. If the ratio of the force to the velocity gradient remains constant with increasing velocity (rate of shear) the liquid is said to be Newtonian, and many of the liquids encountered in the petroleum industry do behave in this manner.

The unit of dynamic viscosity is force x time/(length)^2 and in SI units is N s/m^2.

Temperature has a marked effect on viscosity. The effect is different for liquid and gas. With gas, the effect of a temperature increase is to increase the viscosity; with liquid, the effect is to reduce it. The temperature relationship, although not well understood, is important in connection with lubrication since as a lubricating oil heats up in use, the viscosity decreases, and this may render the oil useless for its purpose.

An indication of how temperature affects viscosity is given by the Viscosity Index, an empirical number which effectively compares values of viscosity at two different temperatures. In recent years, by the addition of suitable additives, lubricating oils with remarkably flat viscosity/temperature gradients have been developed. These oils possess a suitably low viscosity at start-up to enable satisfactory flow and lubrication, and still possess a sufficiently high viscosity at high working temperatures to maintain a safe oil film.

Pressure also has some effect on the viscosity of oils. A pressure of about 7 MN/m^2 (about 1000 psi) will increase the viscosity by about 15%.

Viscosity is important as a measure of the resistance to flow of a fluid, and hence in the calculation of power requirements to move fluids from one part of a system to another. Its importance in lubricating problems is discussed above. When combined with other properties such as density, it can be used to give valuable information concerning the composition of petroleum fractions. For example, the Viscosity-gravity Index is based on specific gravity and Saybolt viscosity. It is of particular value in identifying a predominantly paraffinic or aromatic material. The lower the value of the index, the more paraffinic the fraction.

2.6.4 Surface tension

This force is measured either in J/m^2 or N/m

A rise in temperature leads to a fall in surface tension and the higher the molecular weight of the hydrocarbon material, the higher the surface tension.

The main importance of surface tension is that it controls the ease of formation and the stability of emulsions and foams. It also governs the detergent properties of an oil. It may, in addition, together with viscosity, control the amount of oil recoverable from a crude oil reservoir.

2.6.5 Specific heat

This quantity is measured in J/kg K. It is not related to the heat capacity of water. The more common units of Btu/lb^{o}F or cal/g^{o}C (which are numerically equal, being effectively the ratio of the heat required to heat the substance to that required to heat water) are related to the SI unit by

$$1 \text{ Btu/lb}^oF = 1 \text{ cal/g}^oC = 4.1868 \text{ kJ/kg K}.$$

For most hydrocarbons, specific heat is almost a linear function of temperature (increasing as temperature increases). It decreases as the density increases. A knowledge of the specific heat of a fraction is important in determining net heat fluxes in all heating and cooling problems.

2.6.6 Latent heat

Heat of vaporization is perhaps the most important latent heat in petroleum engineering. It decreases as the temperature rises and becomes zero at the critical temperature (this phenomenon forming, in fact, a useful indication of the critical point).

As with specific heat, values of latent heat are needed in order to calculate heat effects, particularly for distillation equipment.

2.6.7 Critical properties

A study of the pressure (P), volume (V) and temperature (T) relationships of a pure component reveals a particular unique state where the properties of a liquid and vapour become indistinguishable from each other. This state is called the critical state and the appropriate parameters of state are termed the critical pressure (P_c), critical volume (V_c) and critical temperature (T_c). It is an important characteristic of the critical state for a pure component that with values of P or T greater than either P_c or T_c, the vapour and liquid states cannot coexist at equilibrium, and thus P_c and T_c represent the maximum values of P and T at which phase separation can occur.

From a knowledge of P_c, T_c and V_c, many predictions can be made concerning the physical properties of substances. These predictions are based on the Law of Corresponding States according to which substances behave in the same way when they are in the same state with reference to the critical state. The particular corresponding state is characterized by its reduced properties, i.e.,

$$T_r = T/T_c, \quad P_r = P/P_c, \quad V_r = V/V_c.$$

The use of this concept permits generalized plots in terms of reduced properties to be drawn which are then applicable to all substances (which obey the law) and can be important in determining thermodynamic relationships. It is rare in petroleum engineering to have to deal with pure substances, and unfortunately the application of the Law of Corresponding States to mixtures is complicated by the fact that use of the true critical point for a mixture does not yield correct values of reduced properties for accurate prediction from generalized charts. For a mixture the critical state no longer represents the maximum T and P at which a liquid and vapour phase can coexist, and phase separation can occur under retrograde conditions.

For engineering purposes, this difficulty is resolved by the use of pseudo-critical conditions which are based on the molal average critical T's and P's of the compounds of the mixture. Although use of pseudo-reduced conditions for mixtures of hydrocarbons is generally satisfactory, this is not true for states near the true critical, nor, in general, for mixtures of vapour and liquid.

2.6.8 PVT relationships

Knowledge of the P, V and T of a system forms the basis for the calculation of the thermodynamic relationships of the system. A simple treatment of a mathematical model of a gas based on kinetic theory yields the relationship

$$PV = nRT,$$

where n is the number of moles of gas and R is a universal constant equal to 8.314 kJ/kmol K.

This mathematical model is called the Perfect Gas, and real gases which behave in this way are called Ideal Gases. Most light petroleum gases, air, flue gases, etc. may be treated as ideal up to pressures of about 1.5 to 2 MN/m^2 (250-300 psi) provided the temperature is well above the critical.

For heavier vapours and for lower temperatures a more accurate equation of state is needed. Sufficient accuracy is normally obtained for engineering purposes by the use of the compressibility coefficient ($\underline{Z}$), where

$$\underline{PV} = \underline{ZnRT}.$$

The $\underline{Z}$ is a function of T, P and the nature of the gas, but values can be obtained from generalized charts by use of reduced temperatures and pressures (pseudo-values in the case of mixtures).

2.6.9 Distillation range and boiling point

The temperature at which a pure component boils at atmospheric pressure is an invariable property of the substance and is in fact a useful guide to the identity of the material. Mixtures do not have a single boiling point, but they "boil" over a range of temperature depending on pressure, composition and the nature of the apparatus used to carry out the experiment.

For the very complex mixtures of hydrocarbons met with in petroleum fractions, the nature of the apparatus used is of great importance. Relatively simple apparatus which gives a general idea of the distillation range (such as that in the IP or ASTM standard method) yields very little information about the composition of the fraction, and may not give an indication of the presence of low- or high-boiling components. More sophisticated apparatus which gives a high degree of fractionation yields a "true boiling point" curve which gives much more information, and may even, in the case of relatively simple mixtures, permit composition to be determined.

Distillation range is of value in assessing the suitability of petroleum fractions for various applications, particularly with respect to volatility. Such information is also needed for the design and control of distillation columns. It is also useful, usually in conjunction with some other physical property such as density, in characterizing petroleum fractions to permit prediction of other properties.

2.6.10 Vapour pressure

At moderate pressure, the total vapour pressure of a mixture is equal to the sum of the partial vapour pressures of all the components (Raoult's law). Provided a hydrocarbon mixture obeys Raoult's law, knowledge of the composition of the liquid phase and the vapour pressure of each of the components permits the composition of the equilibrium vapour to be calculated. In practice, deviation from Raoult's law is common, particularly at high pressures, and even at moderate pressures with the higher boiling hydrocarbons. In these cases, equilibrium vapour and liquid composition may be calculated by the use of the liquid-vapour equilibrium of K charts which take such deviations into account.

Because of its use in the calculation of equilibrium vapour liquid compositions, vapour pressure is of prime importance in the design of distillation, evaporation and condensation equipment. It is also important in the safe design of storage vessels and any equipment subject to high pressures.

2.7 Oil composition and biological effects

An assessment of the biological effects of oil pollution should take into account the composition of crude oil and the relative toxicity of its fractions.

Because different types of compounds are concentrated in the various petroleum fractions, much has been written about the relative toxicity of different petroleum products. Volume for volume, crude oil appears to be less toxic than, for example, fuel oil. However, with the exception of the few compounds created by the refining process, all of the chemical constituents in the refined parts are also found in the unrefined whole. If the part can be deadly, so can the whole (Steinhart and Steinhart 1972).

The composition of crude oil is related to toxicity as follows:

a) The low boiling saturated hydrocarbons have, until recently, been considered harmless to the marine environment. However, it has now been demonstrated that these hydrocarbons produce at low concentrations anaesthesia and narcosis and at greater concentrations cell damage and death in a wide variety of lower animals, and that they may be especially damaging to the larval and other young forms of marine life.

b) Higher boiling saturated hydrocarbons naturally occur in many marine organisms and are probably not directly toxic though they may interfere with nutrition and possibly with the reception of the chemical clues which are necessary for communication between many marine animals.

c) Olefinic hydrocarbons probably are absent from crude oil, but they are abundant in oil products, e.g., in gasoline and in cracking products. They are also produced by many marine organisms, and may serve biological functions such as in communication. However, their biological role is poorly understood.

d) Aromatic hydrocarbons are abundant in petroleum and represent its most dangerous fraction. Low boiling aromatics (benzene, toluene, xylene, etc.) are acute poisons for man as well as for other organisms. It was the great tragedy of the "TORREY CANYON" accident that the detergents which were then used to disperse the oil spill had been dissolved in low boiling aromatics. Their application multiplied the damage to coastal organisms. However, poisoning of marine life will occur even with non-toxic detergents or dispersants which are applied in non-toxic solvents because they disperse the toxic materials of crude oil. Organisms are exposed to these poisons through contact and ingestion.

e) The high boiling aromatic hydrocarbons are suspected as long term poisons. Current research on the carcinogenic hydrocarbons in tobacco smoke has demonstrated that the carcinogenic activity is not limited to the well known 3,4-benzopyrene. A wider range of alkylated 4- and 5-ring aromatic hydrocarbons can act as potent tumor initiators. However, the direct carcinogenicity of crude oil and crude oil residues has not yet been conclusively demonstrated. Oil and residues contain alkylated 4- and 5-ring aromatic hydrocarbons similar to those in tobacco tar.

f) In their behavior and toxicity the nonhydrocarbons of crude oil (N, O, S and metal compounds) closely resemble the corresponding aromatic compounds (Blumer 1971).

2.8 Forms of oil

Oil in the sea appears in six different forms:

a) Large particles such as tar balls
b) Microparticles (fine droplets)
c) Colloidal particles
d) Adsorbed onto particulate matter such as silt, detritus and phytoplankton
e) Dissolved in seawater
f) Water-in-oil emulsions

3. Sources of oil entering the ocean

3.1 Major sources

Oil enters the marine environment mainly from four different sources (GESAMP 1977):

a) Accidental and intentional release during production, transportation and use,

b) Advection through land run-off, domestic and industrial sewage,
c) Precipitation from the atmosphere,
d) Natural submarine seeps.

Perhaps the most important aspect of oil pollution is its ubiquitous and sometimes invisible presence in harbours, coastal regions, along oil tanker routes, and in the offshore oilfields.

It is necessary to examine the major sources of pollution. In 1973 the world oil production was over 2800 x 10^6 t, and over the previous five years it increased at the rate of nearly 7.5% per year. However, the increase in oil prices reduced the use of oil, leading to a temporary fall in production in 1975. Production thereafter increased again to over 3000 x 10^6 t in 1979.

3.2 Natural seeps

Oil seeps which occur beneath the sea are a direct source of pollution. Wilson et al. (1974) estimated 0.2-6.0 mta (million tons per annum). This is not uniformly distributed, as some 45% comes from a few high seepage areas of the world. Their best estimate for an annual figure is 600,000 t.

3.3 Precipitation from the atmosphere

The contribution of oil from the atmosphere is less well understood, but is probably largely in the form of short-chain low-boiling hydrocarbons and compounds produced from them by oxidation. The atmospheric contribution of hydrocarbons is thought to have increased water solubility compared to other sources of hydrocarbons. Figures ranging from 0.1 to 10 mta have been mentioned. The higher estimates are generally derived from an arbitrarily chosen figure based on the percentage of evaporated hydrocarbons that "ought to return". The alternative method of measuring oil in precipitation and multiplying by overall precipitation over the oceans generally gives a lower figure. NAS (1975) estimated 0.6 mta.

The distribution patterns resulting from evaporation, atmospheric transport and washout is such that high local concentrations are unlikely to occur (GESAMP 1977).

3.4 Rivers and terrestrial run-off

Oil from rivers and terrestrial run-off mostly reaches the coast in a comparatively dilute form, adsorbed on suspended material, and it has been subjected to weathering so that part of the more acutely toxic compounds has been lost. On the other hand, in estuaries, the hydrodynamics is rather complex and most of the suspended material is deposited.

The pollution from land-based activities and sources is the largest and accounts for more than 50% of the total.

3.5 Production, transportation and use

3.5.1 Offshore exploration and production

It is not easy to make accurate estimates of the amount of oil entering the sea, particularly from drilling and exploration offshore. The extension of exploration and production into deeper and deeper water in areas much less favourable for drilling increases the hazards so that accidental spills are more likely. On a worldwide basis, losses from this source are estimated to be between 100,000-150,000 t/yr. Figures of this kind are highly tentative because a single major oil well incident can release as much oil as minor incidents will in the course of a whole year (Wardley-Smith 1983).

3.5.2 Discharge from tankers

One of the largest sources of oil is the regular or routine discharge from tankers (Table 4).

Table 4. Summary of operational oil discharges from tankers (tons per typical round trip voyage)

	Vessel Size (dwt)											
	35,000		50,000		120,000		200,000		250,000		350,000	
Operation	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.	Max.	Typ.
1. Deballasting of unwashed tanks (non-segregated ballast; not LOT)	21	10	30	14	72	33	120	56	150	70	210	97
2. Deballasting of water washed tanks (non-segregated ballast)	6	2	9	3	22	7	36	11	45	14	63	19
3. Deballasting of crude oil washed (with a water rinse) tanks (non-segregated ballast)	2	0.7	3	1	7	3	12	4	15	5	21	7
4. Deballasting of segregated ballast*	0	0	0	0	0	0	0	0	0	0	0	0
5. Tank water cleaning (non-segregated ballast, not LOT)	113	76	162	10	388	261	648	435	810	543	1134	760
6. Tank water cleaning (LOT)	34	15	49	22	117	52	194	87	243	109	340	152
7. Tank water cleaning (LOT and segregated ballast*)	17	7	24	11	58	26	97	43	122	53	170	75
8. Tank crude oil washing with a water rinse (LOT)	6	3	9	4	22	10	36	17	45	21	62	29
9. Sludge removal**	-	14	-	20	-	48	-	80	-	100	-	140

10. Bilge pumping (varies only slightly with vessel sizes)

a. Direct discharge overboard; maximum: 3 t/voyage; typical: 2.5 t/voyage
b. Use of oil/water separator; maximum: 1 t/voyage; typical: neg.
c. Discharge from setting tank; maximum: 2 t/voyage; typical: 1.5 t/voyage

* It is assumed that all vessels have adequate segregated ballast for all ballast voyages.
** The performance of this operation at sea is being phased out.

Source: Science Applications, Inc. et al. 1978. Development of environmental criteria and guidelines to assess the environmental plan submitted as part of the oil purchase/transport contract (Prepared for U.S. Department of Energy)

Consider a complete round trip of a tanker, starting from arrival at its unloading or discharge port. After unloading, a tanker is so high out of the water that it could be very difficult to handle, particularly in confined waters. Because of this, as soon as the tanks are empty, a sufficient number of them are ballasted with water, between 25 and 30% being usually enough. If nothing is done until the tanker gets to its loading point when the ballast water is pumped out to be replaced by oil, a great deal of very oily water will be discharged at the loading terminal.

When a tanker is unloaded, it cannot be completely clean as some oil is left on the bottom and sides of the tank and also on the cross members which are almost always present. This oil, called clingage, amounts to about 0.2% of the tank contents. The exact amount depends on the type of oil, the geometry of the tank and the temperature. In addition, some oil is left in the pipe lines of the tanker, so that the entire amount retained after unloading is about 0.3% of the total cargo. When the tank is ballasted with water, some of this oil mixes with the water.

In the normal cleaning process, the whole contents of the tank are pumped overboard and then the tank is further washed by means of rotating jets of water under high pressure which can be heated or mixed with an emulsifying chemical. The whole of this oily water is then pumped over the side.

It will be seen that the discharge of the 0.3% of the tank capacity represents 0.3% of the world volume of oil carried by sea — in total a very large amount. The major oil companies developed the method of tank cleaning called load-on-top or LOT (see Wardley-Smith 1983). In this process, oil is still discharged into the sea. However, the amount is under 100,000 t compared to 500,000 t discharged by the remaining 15% which do not use the LOT system.

3.5.3 Tanker accidents

The increasing use of oil has led to an increase both in the number and the size of tankers. In Table 5, the number of tankers in each of three size groups is given for 1960 to 1979. There has been over a four-fold increase in tankers over 150,000 dwt between 1970 and 1979 whereas there were none of this size in 1965.

Table 5. Tanker sizes in world fleet (numbers of ships)
(from Wardley-Smith 1983)

As of 31 December	Below 70,000 dwt	70,000 to 150,000 dwt	Over 150,000 dwt	Total
1960	2319	21	-	2340
1965	2654	128	-	2782
1970	2521	416	165	3102
1975	2449	482	634	3565
1976	2131	672	740	3543
1977	1999	684	788	3471
1978	1826	646	783	3255
1979	1770	687	744	3201

NB: Tankers below 10,000 dwt and also government and non-commercial tonnage are excluded.

The first major tanker accident, that of the "TORREY CANYON", was in 1967 when it ran aground on the Seven Stones Rocks off the southwest coast of England and 100,000 t of crude oil were lost. This was the world's largest spill until 12 years later when the "AMOCO CADIZ" grounded off Brittany in March 1979 and lost 220,000 t of crude oil. Earlier in 1974 the "METULA" grounded in the Straits of Magellan while carrying 220,000 t of crude, though only some 50,000 t were lost. The remainder was salvaged and the ship safely removed.

In autumn of 1969 three very large crude oil carriers (VLCC) suffered unexplained explosions at sea. After that there have been some more explosions on tankers.

The amount of pollution on the shore which results from accidents of this kind depends on local circumstances, such as tides, winds, etc. Although fortunately not frequent, explosions and fire are the greatest hazards to which tankers are subject.

By far, the greatest number of spills occur during loading and unloading operations. Data from over 6500 accidental spillages all over the world have recently been published (International Tanker Owners Pollution Federation Ltd. 1980).

The analysis shows:

(a) Most spills are small, 89% being less than 50 barrels (bbl), 9% falling in the range 50-5000 bbl and only 2% being greater than 5000 bbl.

(b) Most spills (92%) occur during normal operations such as loading, discharging and ballasting, rather than from accident situations.

(c) 83% of all spills of over 5000 bbl are the result of collision or grounding.

(d) Most spills (74%) resulting from grounding or collision occur in port, port approaches or restricted waters.

(e) Most spills are from smaller vessels. Many of these are engaged in short runs from refinery to consumer, whereas larger tankers are usually involved in the long haul crude traffic.

An attempt was made to identify the reasons for these spills. Wardley-Smith (1975) found that of a rather smaller number of incidents nearly half could be attributed to human error. The US Coast Guard attributes human error to 50 to 70% of all spills (Wardley-Smith 1983).

3.6 Total amount of oil entering the marine environment

The total amount of oil which enters the sea from all sources is the subject of many estimates. Wardley-Smith (1983) prepared a summary based on the assessments made by various authorities (Table 6). His own estimate includes seepage of 0.6 million t. However, his 3.6 million t total does not include the possible additions of hydrocarbons discharged from motor cars, oil-fired furnaces, power stations, industrial furnaces and domestic central heating. The total is large but the transfer from the atmosphere by rainfall and from land run-off into the sea has been neglected. There seems no doubt that at least 2 million t, and probably a good deal more, of oil enters the sea each year (Wardley-Smith 1983).

Table 6. Sources of oil in the marine environment ($x10^6$ t)
(from Wardley-Smith 1983)

Sources	Jeffery 1970	Charter et al. 1973	Author's Estimate	E.B.Cowell 1977
From Undersea Sources			0.6	0.6
Natural seeps	0.15	0.12		
Offshore production			0.15	0.06
From Atmosphere				0.6
Atmospheric fallout				
From Land Sources (other than Oil Refining)				0.3
Municipal wastes	0.5	1.97[a]		
Industrial wastes			1.3	0.15
Urban run-off				0.40
River run-off				1.40
From Oil Refining	0.3			0.06
Effluent from coastal refineries				
From Ocean Transportation				
Load on top tankers	0.1			0.11
Non load on top tankers	0.6	1.07	1.0	0.5
Tanker accidents		0.35	0.35	0.3
Terminal operations	0.2			0.001
Bilges and bunkering	0.05	0.3	0.3	0.5
Dry docking	-			0.25
Non tanker Accidents	-			0.1
TOTAL	1.90	3.81	3.6	5.331

[a] All land-based discharges.

REFERENCES

Banks, R.E. and P.J. King. 1986. Chemistry and physics of petroleum. In G.D. Hobson (ed.). Modern Petroleum Technology,Part I, pp. 279-328. N.Y.: John Wileyand Sons.

Blumer, M. 1971. Oil pollution of the ocean. In T.R. Detwyler (ed.). Man's Impact on the Environment, pp. 295-301. N.Y.: McGraw-Hill.

GESAMP. 1977. Impacts of oil on the marine environment. Reports and Studies GESAMP 6. International Tanker Owners Pollution Federation Ltd. 1980. Measures to control oil pollution, a report. London: Graham and Trotman.

Marcinowski, H.J. 1970. Removal of oil from water surface - literature survey. Report No. 27/70, Stichting Concawe, The Hague, December, 1970.

National Academy of Sciences (NAS). 1975. Petroleum in the marine environment. Washington, D.C.: NAS.

Simonov, A.I. 1974. Scientific problems of the systems for global monitoring and investigation of oil pollution in the world ocean. Proc. Mar. Poll. Monitoring, NBS 409: 9-14.

Steinhart, C. and J. Steinhart. 1972. Blowout; a case study of the Santa Barbara oil spill. Reading, U.K.: Duxbury Press c/o Van Nostrand Rheinhold.

Wardley-Smith, J. 1975. Oil spills from tankers. Paper presented at the Conference on Marine Ecology and Pollution, Institute of Petroleum and Field Studies Councils, Aviemore, Scotland, April 1975.

Wardley-Smith, J., ed. 1983. The control of oil pollution. London: Graham and Trotman Publishers.

White, I. C. and J.A. Nichols. 1981. The cost of oil spills. Mar. Poll. Bull. 12(11): 363-367.

Wilson, R.D., P.H. Monagham, A. Osanik, L.C. Price and M.A. Rogers. 1974. Natural marine oil seepage. Science 184(4139): 857-865.