UNITED NATIONS ENVIRONMENT PROGRAMME

EAST ASIAN SEAS REGIONAL COORDINATING UNIT

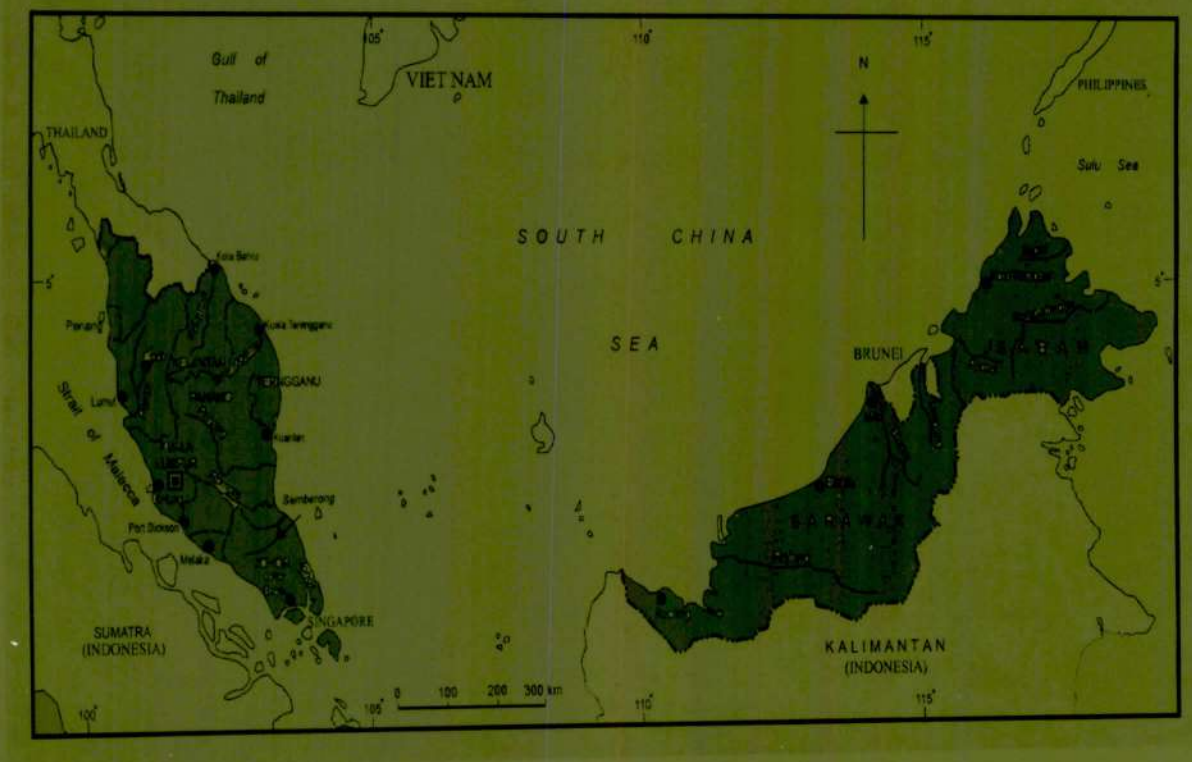
UNEP

UNEP/GEF
Project Coordinating Unit

NATIONAL REPORT OF MALAYSIA

on the

Formulation of a Transboundary Diagnostic Analysis and Preliminary Framework of a Strategic Action Programme for the South China Sea



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1.0 INTRODUCTION

1.1 AIM OF THE NATIONAL REPORT

The primary aim of this report is to provide a description and an analysis of the major water-related problems occurring or affecting the regions of Malaysia which border the South China Sea namely, the states on the east coast of peninsular Malaysia and the states of Sabah and Sarawak.

The analysis of such water-related problems also includes an examination of a number of issues or questions pertinent to these problems, such as the 'root' causes and the actions undertaken to alleviate these problems.

The report is intended as Malaysia's contribution to the formulation of a transboundary diagnostic analysis and a preliminary framework of a strategic action programme for the South China Sea.

1.2 MAJOR WATER-RELATED ENVIRONMENT PROBLEMS

The objective of this section is to provide a general overview of the extent of water-related environment problems in Malaysia. The assessment is based on the monitoring data compiled from the Department of Environment (DOE), government reports on various aspects of water resource management and consultation with various government agencies.

1.2.1 Marine pollution

The extent of marine pollution from land-based activities and sea-based sources is best judged from the monitoring data collected and analysed by the DOE. The DOE database is the result of a monitoring programme began in 1977 and is probably the largest collection of environmental quality data in the country. The monitoring data is made up of four parameters:

- *Escheria coli (E. coli)* – as a measure of organic pollution;
- Oil and grease – as a measure of pollution by hydrocarbons;
- Total suspended solids – as a measure of suspended particulates in the marine environment;
- Heavy metals – the heavy metals which are monitored are lead, copper, mercury, cadmium, arsenic and chromium.

The monitoring data point to organic pollution, oil and grease, and pollution from suspended particulate (question whether it should be plural) as the most chronic pollutants in the marine environment in Malaysia. In overall terms, it can be said that there has been a decline in marine water quality throughout the country. The degree of decline however varies according to the parameters measured (see table 1.1).

Table 1.1 Macro performance indicators for the state of marine water quality (1977–94)

Parameter	Rate of change (percentage)*
E. coli	-1
Oil and grease	-1
Total suspended solids	- 33

Source: Department of Environment, 1994.

* Rate of change is measured based on percentage of compliance to the Interim Standards for Marine Water Quality (annex IV).

Table 1.1 pointed to a significant deterioration of marine water quality as a result of an increase in total suspended solids. This corresponds with the periods of extensive land development beginning with the conversion of some forested areas into agricultural areas, urbanization and increased development in coastal areas.

The international/regional dimension to the problem of marine pollution in Malaysia is represented by the number of intentional and accidental discharges of oil and oily substances into Malaysian waters. From 1976 to 1996, 375 incidents were recorded, most of which occurred in the Straits of Malacca. It is worthwhile to note that while shipping-based pollution constitutes a small portion of all marine pollution, substantial resources are deployed to enforce regulations aimed at preventing and minimizing marine pollution from vessels.

1.2.2 River pollution

In general, rivers in Malaysia have also deteriorated over the years with the overall river water quality index falling by 1 per cent from 1977 to 1994 (table 1.2). However, unlike marine water quality, there is no single major contributor to the deterioration of river water quality in the country. The parameters measured are:

- Total suspended solids – as a measure of suspended particulate in rivers;
- Biochemical oxygen demand – as a measure of organic pollution resulting from agro-based and other industries;
- Ammoniacal nitrogen – as a measure of organic pollution from sewage and animal waste;
- Chemical oxygen demand – as a measure of chemical pollution;
- pH;
- Heavy metals – mercury, lead, cadmium, zinc and copper.

Of the pollutants which enter the Malaysian riverine system, suspended solids resulting from land development and organic waste from domestic sources and animal husbandry are considered to be chronic pollutants.

Table 1.2 Macro performance indicators for the state of the river water quality in Malaysia (1977 – 1994)

Parameters	Rate of change (percentage)*
Overall river water quality index	-1
Total suspended solids	-1
Biochemical oxygen demand	-1
Ammoniacal nitrogen	-2

Source: Department of Environment, 1994.
* Rate of change is measured based on percentage of compliance to the Proposed Interim National Water Quality Standards for Malaysia (annex V).

1.2.3 Decline in marine and coastal biological diversity

Biological diversity is defined as including species diversity, ecosystem diversity and genetic diversity. For the purpose of this study the discussion will be limited to species diversity and ecosystem diversity.

Where species diversity is concerned, there is no single authority on the actual size of marine and coastal biological diversity in the country. Table 1.3 gives an indication of the size of the marine and coastal biological diversity in Malaysia.

Table 1.3 Extent of marine and coastal biological diversity in Malaysia

Marine life	Numbers
Marine fishes	2200 - 4000 (estimates) [a]
Marine food fish	300 [b]
Turtles	4 [c]
Terrapins	1
Coastal birds	127 [d]
Mangroves	104 [e]
Corals	290 [f]
Seagrasses	10 [g]

Source: [a] Zakaria Ismail (1993); [b] Abu Khair Muhammad Mohsin and Mohd. Azmi Ambak (1996); [c] Chan (1991); [d] Economic Planning Unit (1993); [e] Japar (1994);[f] Ridzwan Abdul Rahman (1993); [g] Japar (1994).

As noted, the figures above are by no means authoritative and many more species are yet to be identified and recorded. These include fish species, coral species and invertebrates. The importance of basic taxonomic work in the conservation of biological diversity in Malaysia should not be understated, especially given the various threats to marine and coastal diversity. Norse (1993) identified five major threats to global biological diversity. Within the Malaysian context these threats could be further reduced to three main ones:

- Over-exploitation;
- Alteration and destruction of habitats;
- Pollution.

Little or no effort have been made to study the remaining threats identified as contributing to the decline in marine and coastal biodiversity, such as the introduction of alien species and global climate change. Neither has there been any effort to assess the extent of the decline in marine and coastal biological diversity in Malaysia.

1.2.4 Over-exploitation of resources

Fisheries in Malaysia are generally divided into two basic categories, artisanal or traditional fishery using traditional gear and commercial fishery using trawlers and purse seiners. Fisheries activities are regulated by a licensing system based on gear type, fishing vessel tonnage and distance from shore (table 1.4).

Table 1.4 Zoning system in the fishing grounds for peninsular Malaysia

Zone	Distance	Type of fishing gear
A	5 nautical miles from the shoreline	Restricted to traditional fishing gear
B	Between 5 and 12 nautical miles	Trawler and purse seiner less than 40 GRT
C	Between 12 and 30 nautical miles	Trawler and purse seiner with 40-70 GRT
D	Beyond 30 nautical miles	Trawler and purse seiner greater than 70 GRT

Marine fish landings have increased over the years from around 400,000 metric tonnes in 1975 to 969,000 metric tonnes in 1995 (Department of Fisheries 1996). The increase, which constituted 75 per cent of all landings in 1995, is mostly from the increase in fish landings in peninsular Malaysia. Another important trend is that most of the marine fish landed is from the 'inshore' areas, that is, areas within 30 nautical miles from shore (see table 1.4). This reflects the commonly mentioned fact that the inshore areas of Malaysia's waters have largely been fully exploited (Ong and Lui 1992, Raja Mohamed Nordin 1994). This situation prompted the Government to promote and develop the country's deep-sea or offshore fishing capability.

There are also a number of other factors that reflect the pressure on near-shore fisheries areas. These include a decline in "catch-per-unit-effort" from 130 kilogram per hour (kg/hr) in 1970 to 40 – 60 kg/hr from 1980 onwards on the west coast of peninsular Malaysia. On the east coast of the peninsular the decline is from 90 kg/hr in 1984 to around 72 kg/hr between 1988 and 1990.

1.2.5 Coastal erosion

Coastal erosion is regarded as one of the most pressing areas in the management of Malaysia's coastal areas. The national coastal erosion study commissioned by the Economic Planning Unit in 1985 found that 1,300 of the country's 4,809 kilometres of coastline had been subjected to erosion. Subsequent updates by the Coastal Engineering Section of the Department of Irrigation points to a situation that may be worsening particularly regarding the severity of the threat of erosion to coastal infrastructure and facilities. Table 1.5 provides a picture of the coastal erosion problem in 1985 while table 1.6 illustrates the situation as of 1996. Table 1.7 gives the situation with regard to coastal erosion in the study area. The categorization of the severity of coastal erosion is based on its threat to economic activities and infrastructure. The three categories are listed below:

- Category 1: Critical erosion areas where shore-based facilities and economic activities are in immediate and imminent danger.
- Category 2: Significant erosion areas where shore-based facilities and economic activities are expected to be endangered within 5 to 10 years if no remedial action is taken.
- Category 3: Acceptable erosion areas that are generally undeveloped with consequent minor economic loss if coastal erosion continues unabated.

Table 1.5 Malaysia: Distribution of coastal areas affected by erosion (1985)

Area	Total length of coastline (km)	Category 1 (km)	Category 2 (km)	Category 3 (km)	Total length of eroding coastline (km)
Peninsular Malaysia	1,972	131 41 sites	213 57 sites	651 58 sites	995 156 sites
Sabah	1,802	6 3 sites	10 7 sites	310 14 sites	326 24 sites
Sarawak	1,305	8 3 sites	23 11 sites	14 7 sites	45 21 sites
Total	4,809	145 47 sites	246 75 sites	975 79 sites	1,336 201 sites

Source: National Coastal Erosion Study, 1985.

Table 1.6 Malaysia: Distribution of coastal areas affected by erosion (1996)

Area	Total length of coastline (km)	Category 1 (km)	Category 2 (km)	Category 3 (km)	Total length of eroding coastline (km)
Peninsular Malaysia	1,972	209.4 65 sites	190.8 48 sites	628.5 56 sites	1,028.7 169 sites
Sabah	1,802	13.3 6 sites	7.5 5 sites	326.1 25 sites	347 36 sites
Sarawak	1,305	9 3 sites	22.8 11 sites	13.7 7 sites	45.5 21 sites
Total	4,809	145 47 sites	246 75 sites	975 79 sites	1,647.2 226 sites

Source: Department of Irrigation and Drainage.

Table 1.7 Coastline affected by coastal erosion in the study area (1996)

Area	Total length of coastline (km)	Category 1 (km)	Category 2 (km)	Category 3 (km)	Total length of eroding coastline (km)
Johor	492	18.8 7 sites	53.2 9 sites	165.7 13 sites	237.7 29 sites
Pahang	271	9.6 8 sites	2.8 2 sites	107.8 8 sites	120.2 18 sites
Terengganu	244	20 6 sites	12.8 5 sites	122.4 10 sites	155.2 21 sites
Kelantan	71	5 3 sites	10.9 6 sites	37.6 5 sites	53.5 14 sites
Sabah	1,802	13.3 6 sites	7.5 5 sites	326.1 25 sites	347 36 sites
Sarawak	1,305	9 3 sites	22.8 11 sites	13.7 7 sites	45.5 21 sites
Total	4,809	145 47 sites	246 75 sites	975 79 sites	959.1 118 sites

Source: Department of Irrigation and Drainage.

1.3 COUNTRY BACKGROUND

Geographically Malaysia is made up of two regions, peninsular Malaysia and parts of the island of Borneo which are separated by the South China Sea. Politically Malaysia is made up of 11 states and a federal territory in peninsular Malaysia and the states of Sabah and Sarawak and the federal territory of Labuan in Borneo. Table 1.8 provides the physical dimensions of the country.

Table 1.8 Malaysia – vital statistics

Dimensions	Statistics
Land area	332,800 square km
Total length of coastal area Peninsular Malaysia Sabah and Sarawak	4,490 km 1,737 km 2,753 km
Total sea area Size of exclusive economic zone Size of territorial waters	598,540 km 450,233 km 148, 307 km
Population Population growth	21,700,000 2.4 per cent
GDP per capita (nominal) GDP per capita (PPP)	4,466 9,835*

Source: Maritime Enforcement Coordination Centre (1993); Asiaweek (11/12/97).
* US dollars

Malaysia's climate is equatorial with uniformly high temperatures, humidity and copious rainfall. The general climate is influenced by the north-east monsoons (from November to February) and the south-west monsoons which begin in either April or May and end in September.

Malaysia's coasts are influenced by diurnal, semi-diurnal and mixed tides. The maximum tidal range variation is between 2 to 6 metres. However, a range greater than 5 metres has been observed near Port Klang and Kuching.

The principal environmental protection law for Malaysia is the Environmental Quality Act, 1974 which controls pollution from land-based and vessel-based sources, and controls prescribed development activities as specified under the Environmental Impact Assessment Regulations (1987). The Merchant Shipping Ordinance, 1952 also provides some measure of control over pollution from vessel discharges albeit within the confines of Malaysia's territorial waters. Where marine and coastal resources are concerned two major laws apply, namely, the Fisheries Act, 1985 and the National Forestry Act, 1984. The Exclusive Economic Zone Act, 1984 is an all encompassing piece of legislation which governs all uses of the sea within Malaysia's exclusive economic zone (EEZ) including exploitation of resources and protection of the marine environment.

Table 1.9 Malaysia: Summary of laws and regulations related to the environment and natural resources

Laws/regulations	Year implemented	Brief description
Environmental Quality Act, 1974 (EQA)	1974	Umbrella legislation for the protection of the environment from pollution and impacts of development. Under the EQA any number of environmental regulations or 'Orders' can be established to control specific development or industrial activities. One such regulation is the Environmental Impact Assessment (EIA) Order, 1987.
Fisheries Act, 1985	Superseded the Fisheries Act, 1965 in 1985.	The Fisheries Act is the primary tool for marine and freshwater fisheries resource management. The act regulates resource exploitation by establishing fishing zones, regulating gear types, and issuing licences for fishing vessels. Section 41 of the act provides for the establishment of marine parks. Section 38 provides the necessary powers to state authorities to take action to conserve turtles as an endangered species and to regulate freshwater fisheries.
Exclusive Economic Zone Act, 1984 (EEZ Act)	1984	The EEZ Act establishes the extent of Malaysia's jurisdiction in the EEZ. This includes control over fisheries resources, hydrocarbon exploration, marine scientific research, discharge of sea-based pollutants and dumping at sea. It mirrors Part V of the United Nations Convention on the Law of the Sea.
National Forestry Act, 1984; Forestry regulations in Sabah and Sarawak.	National Forestry Act supersedes earlier forestry regulations.	The body of forestry legislation provides for the establishment of forest reserves for various purposes – selective logging, soil protection, wildlife protection, recreation, communal use etc. The laws also control logging activities by setting rules on practices. Important for protecting mangroves and other wetlands which comes under the jurisdiction of forestry authorities. In peninsular Malaysia the National Forestry Act was promulgated to support the National Forestry Policy.
National Parks Act, 1980; Protection of Wildlife Act, 1972; Sabah Parks Enactment, 1984; Sarawak Wildlife Ordinance, 1984; and various State Parks enactments.	Various years.	In general, this body of laws is aimed at protecting wildlife and habitats by establishing protected areas. Various types of terrestrial (including coastal) protected areas could be established including national parks, wildlife sanctuaries, wildlife reserves, bird sanctuaries and state parks.
Merchant Shipping Ordinance (MSO), 1952; Merchant Shipping Ordinance (Sabah), 1960.	1952, 1960.	Provides for flag-state and port-state control of shipping. Part V(a) of the MSO also controls pollution from ship-based sources within port limits. The two 'MSOs' will be amalgamated under the draft Malaysian Shipping Act which will also incorporate provisions of MARPOL 73/78.
National Land Code, 1965.	1965	Governs administration and alienation of land.
Land Conservation Act, 1960.	1960	Intended to provide protection to hill slopes but never received much needed support from state governments.
Various local government by-laws on earthworks, earth removals, sanitation and solid waste disposal.	Various years.	Important but seldom adequately implemented by-laws for the control of development practices, sewage treatment and disposal of solid waste.

Malaysia's development planning is governed by a series of five-year plans known as the Malaysia Plans. The country is currently implementing the Seventh Malaysia Plan (7MP). The thrust of these plans is the economic, social and physical development of the country. The initial plans are sectoral in nature, but emphasis has since shifted towards a more integrated approach in development planning. The 7MP for example, typifies this new approach to incorporate environmental considerations into development planning at the macro level, complementing the environmental impact assessment regulations which are site specific environmental management tools. This approach benefited greatly from a number of documents considered to be pivotal in promoting integrated development planning, namely the National Conservation Strategy and the draft national policy on environment.

1.4 GEOGRAPHIC DIVISIONS USED IN THE ANALYSIS

This section is divided into two parts. The first part describes and illustrates the actual geographical division used in the management of river water quality in the study area. This division is used as the basis for delineating water quality monitoring areas in the country and is divided along the catchment areas of each river. The discussion on the administrative division is important to give an overview of the different levels of government involved in environmental and development management in Malaysia, particularly in relation to water-related issues.

1.4.1 Geographic division

The geographic division used in this report is based on the DOE Water Quality Region maps based on the delineation of the catchment of a particular river. The rationale for selecting such an arrangement is that most if not all of the data on water quality as collected by the DOE are organized into water quality regions. Similarly the arrangement also allows for data from the National Water Resource Study to be correlated to the water quality data. The Water Quality Region maps are given as figures 1 (a), (b) and (c).

1.4.2 Administrative division

The study area covers six states in Malaysia which border the South China Sea, namely, Kelantan, Terengganu, Pahang, Johore (eastern seaboard), Sabah and Sarawak (figures 1 and 2). In planning terms the states are often treated as separate entities from one another particularly where land use planning is concerned. On the other hand, there is also merit in treating the study area as one unit or entity given the relative homogeneity of their development profiles and environmental characteristics. The states concerned are the least industrialized of the states in Malaysia and emphasize marine and coastal tourism as a major income earner. The lack of industrial development also means that these states experience less industrial pollution or pollution from related infrastructural activities such as port development (this will be discussed in detail in the following sections).

The smallest unit of administration in Malaysia is the municipality which is administered by local authorities responsible for providing basic sanitary services such as waste collection and sewage treatment and disposal. The sizes of these municipalities vary from small towns to big provincial capitals. Municipal authorities are responsible for controlling physical development activities, in particular construction works and related activities. The next level of administration is the district level where decisions on land use are implemented based on decisions made at the state or provincial government level. Table 10 gives the geographic and administrative distribution by state, river catchment areas and population.

Table 1.10 Geographical divisions/subdivisions used in the analysis

Subregion	Provinces/ states in the subregion	Major cities	Names of watershed areas/rivers	Total area of watershed (km^2)	Total area of subregion (km^2)	Total population of the subregion/year (1991 census fugure)
Malaysia's states which border the South China Sea.	Kelantan	Kota Bharu	Golok Kelantan Kemasin	15,015	14,922	1,207,684
	Terengganu	Kuala Terengganu	Besut Keluang Setiu Terengganu Ibai Dungun Paka Chukai/ Kerteh Kemaman	12,970	12,995	808,556
	Pahang	Kuantan	Balok/ Cherating Kuantan Pahang Bebar/ Merchong Rompin	42,245	35,966	1,081,148
	Johor	Johor Baru	Endau Mersing Sedili Kecil/Besar	7,440	18,986	2,162,357
	Sabah	Kota Kinabalu	Mengalong Labuan Padas Membakut Kimanis Papar Putatan/Mo-yong Damit/Tua-ran Kadamaian Bingkongan Rakit	31,306	73,620	1,808,848

Table 1.10 (continued)

Subregion	Provinces/ states in the subregion	Major cities	Names of watershed areas/rivers	Total area of watershed (km^2)	Total area of subregion (km^2)	Total population of the subregion/year (1991 census fugure)
	Sarawak	Kuching	Kayan Sarawak Sadong Lupar Saribas Kerian Rajang Oya Mukah Balingian Kemena Similajau Suai Niah Sibuti Miri Baram Limbang Lawas	122,449	123.985	1,718,380

2.0 DETAILED ANALYSIS OF MAJOR WATER-RELATED CONCERNS AND PRINCIPAL ISSUES

2.1 POLLUTION

2.1.1 Sources of pollution

2.1.1.1 Rivers

The study area consists of many major tributaries and numerous smaller rivers. In general terms, the rivers in the study area are cleaner than those on the west coast of peninsular Malaysia. Of the 42 rivers classified as 'clean' in 1996, 22 are located in the study area while only 5 are located on the west coast of peninsular Malaysia (DOE 1997). The rest are rivers in Sabah which empty into the Sulu Sea and the Sulawesi Sea. River pollution is a reflection of the industrial and agricultural developments in the study area as well as the population density and access to sewage treatment facility. A listing of rivers in the study area and industrial sources located within their tributaries is given in annex III.

Rivers in the study area are essentially multiple-use resources. The primary use of these rivers is the supply of freshwater for domestic, industrial and irrigation purposes. Secondary uses vary from one state to another and include riverine transportation in Sabah and Sarawak and locations of settlements in Sabah, Sarawak and Kelantan. Besides beneficial uses rivers are often used as a convenient dumpsite for domestic and industrial sewage. The ambient water quality and pollution loads of rivers in the study area are provided in annex II of the report.

Table 2.11 Transportation of pollution – rivers, streams and canals

Subregion	Number of rivers, streams, canals, etc and total water discharge (ton/y)	BOD (ton/y)	Total AN (ton/y)	Total P (ton/y)	Suspended solids (ton/y)	Oil (ton/y)	Other pollutants, please specify in appropriate units per year
Kelantan	3	27,443	4,258		25,202	0.315	
Terengganu	9	10,515	9,771		15,078	0.120	
Pahang	5	27,545	5,125		29,791	0.120	
Johor	3	16,030	1,638		4,969	0.138	
Sabah	12	No data available	No data available	No data available	No data available	No data available	
Sarawak	20	No data available	No data available	No data available	No data available	No data available	

Source: Department of Environment.

2.1.1.1 (a) Total suspended solid (TSS)

The pollution load for these rivers consists primarily of silt from land development activities. Table 2.12 lists the number of rivers which exhibited deterioration in TSS load in the study area. Note that for Sabah and Johore the data do not differentiate between rivers which empty into the South China Sea and those which empty into the Sulu and Sulawesi Seas and the Singapore Straits.

The silt deposited in rivers within the study area often originates from activities in upland areas such as logging and land clearing. This is particularly true during the phase of extensive land clearing for agricultural purposes during the early 1970s to the mid-1980s. More recently, and to a lesser certain extent development or construction activities in riparian areas have also resulted in the siltation of rivers throughout Malaysia.

Table 2.12 Number of rivers in study area exhibiting deterioration in TSS

State	Number of rivers showing increase in TSS load
Johore	14
Sarawak	14
Sabah	9
Terengganu	2

Source: Department of Environment, 1997.

2.1.1.1 (b) Biological oxygen demand (BOD)

The limited extent of industrial pollution load in these rivers is a reflection of the relative underdevelopment of the industrial sector in the study area compared with the west coast of peninsular Malaysia. In 1993 the number of major stationary industrial sources of water pollution in the study area totalled only 1163 compared with the national total of 3741 sources (table 2.13).

Table 2.13 Distribution of the major stationary industrial sources of water pollution in the study area, 1993

State	Number of sources
Kelantan	65
Terengganu	109
Pahang	140
Johore	689
Sabah	168
Sarawak	nil
National total	3741

Source: Department of Environment, 1994.

None of the rivers in the study area are classified as being heavily polluted by pollution from agro-based and manufacturing based industry.

2.1.1.1 (c) Ammoniacal nitrogen

Ammoniacal nitrogen content in river water reflects the level of pollution from domestic and animal husbandry sources. Lower population density and the absence of large animal husbandry activity (most notably pig farming) means that rivers in the study area made up only 25 per cent of rivers badly affected by ammoniacal nitrogen. This, however, does not reflect the true nature of the problem as most states in the study area still lack a comprehensive sewage management system. This is the result of the systemic failure of local authorities to provide adequate sewage treatment facilities. Table 2.14 illustrates the overall picture of public access to sewage treatment facilities at the end of 1993. Table 2.15 provides an indication of the agricultural sources of pollution.

Table 2.14 Malaysia – access to sewage treatment facilities in large and small local authority areas at the end of 1993

Local authority size	Access to sewage treatment facilities (percentage)		
	Connected service	Septic tank	No access
Large	45	44	11
Small	10	52	38

Source: Indah Water Konsortium, 1997.

Table 2.15 Agricultural sources of pollution

Subregion	Rice field (ha)	Other seasonal crops (ha) please specify (vegetables)	Plantations such as rubber, oil palm, fruit trees etc (ha)	Number of pig farms only	Aquaculture area (ha) includes freshwater and brackishwater ponds, ex-mining pools, cages.
Kelantan		2,595	385,337	0	208.7
Tereng-ganu		1,328	269,311	0	144.1
Pahang		4,448	895,958	9	3,854.5
Johore		15,382	1,011,729	93	778.3
Sabah		data not yet available	data not yet available	no data	1,751
Sarawak		ditto	Ditto	no data	326.8

Source: Agriculture Department, peninsular Malaysia, *Crop Hectarage Statistics 1996.*

2.1.1.2 Ports and harbours – maritime transport

There are five major ports in Malaysia's South China Sea region namely Kemaman, Kuantan, Kuching (Pending-Biawak), Bintulu and Kota Kinabalu. Of these Kemaman and Bintulu are specialized ports serving the petroleum industry. Kemaman is a supply base for the offshore petroleum exploration and exploitation activities while Bintulu is Malaysia's premier liquefied natural gas (LNG) port facility.

Table 2.16 Ports and harbours in the study area and types of cargo handled.

Port/harbour (1993)	**Number of vessel calls/ visits per year**	**Major cargo type transported (e.g. oil, fish, farm produce, waste)**	**Volume of cargo transfer per year (freightweight tonne ,000/y)**
Kuantan	1,217	Palm oil, processed timber, iron/steel	3,401
Bintulu	2,838	Palm oil, petroleum, fuel oil, processed timber, logs, chemicals	14,698
Kuching	1,944	Palm oil, palm kernel waste, petroleum, fuel oil, processed timber, logs, grains, rubber, latex	3,396
Miri	1,744	Petroleum, processed timber, logs, steel, latex	7,109
Rajang	2,036	Palm kernel waste, processed timber, logs, ore and minerals	5,543
Ports in Sabah	10,033	Palm oil, palm kernel waste, petroleum, fuel oil, processed timber, logs, latex, cement, klinker	13,168
Kemaman	312	Liquified petroleum gas (LPG), iron/steel	2,542

Source: Ministry of Transport, *Transport Review 1993.*

Port and shipping operations are inherently hazardous to the marine environment. Fortunately, there has been no significant pollution incident recorded at the major ports listed above. From 1995 to 1996 there was only one reported oil spill incident which occurred at the Kemaman Supply Base involving the spillage of 12 litres of fuel oil.

Besides major ports, there are also numerous riverine ports serving the interiors of Sabah and Sarawak. There is probably less control over the discharges of oils and other pollutants that could result in pollution incidents at these ports than the major ports. However no data are currently being collected to accurately assess the impact of riverine port operations on the marine and coastal environment.

In addition to pollution from ports and harbours, the study area is also subject to oil pollution from shipping activities. From October 1995 to April 1996, a total of 27 incidents of oil pollution were detected in the South China Sea. These incidents involved intentional discharges by vessels and spillage as a result of accident or operational failures. Most of the incidents, however, happened as a result of direct and intentional discharge of oil and oily wastes. The single biggest incident during the period was the spillage of 4,530 barrels of oil at the Bintulu Crude Oil Terminal which happened as a result of a leaking floating pipe (DOE 1997).

Fortunately for Malaysia the impact of these pollution incidents has been minimal, partly because of the small volume of spillage and discharges, and partly because these incidents occurred in the open sea therefore facilitating natural dispersion. The most common problem in coastal areas associated with oil pollution is the occurrence of tar balls that appear regularly throughout the country. The lack of incidents, however, is not an accurate representation of the possibility of pollution occurring from sea-based activities. An illustration of the potential sea-based pollution sources is given in figures 3 and 4. Table 2.17 indicates the number of spills in the study area from 1987 – 1997.

Table 2.17 Records of oil spills (accidental and operational discharges and other marine disasters, 1987–97 (by subregion)

Subregion	Number of occurrences	Total oil spilled (tons)
Kelantan	6	Spills were not measured using a standard measurement
Terengganu	64	
Pahang	33	
Johor	17	
Sabah	11	
Sarawak	34	

Source: Department of Environment.

2.1.1.3 Red tide

Within the study area and within Malaysia in general, Sabah is the most affected by red tide outbreaks. Between 1976 and 1991 there have been seven incidents of red tide outbreak in Sabah resulting in 12 fatalities from paralytic shellfish poisoning (PSP) and over 200 cases of red tide related poisoning. During that period only one incident was recorded in the South China Sea area bordering the east coast of peninsular Malaysia, off the coast of the state of Terengganu (Choo 1994).

Choo (1994) noted that based on work throughout Asia and the Pacific the sporadic outbreaks in Sabah and the single outbreak in Terengganu could be classified as not relating to industrial pollution. These incidents occurred in isolated areas away from industrial activities. The same could not be said for the red tide incidents recorded off the west coast of peninsular Malaysia which are associated with industrial pollution.

2.1.1.4 Coastal cities and population centres

There are five major cities in the study area with populations of more than 100,000. These cities are Kota Bharu, Kuala Terengganu, Kuantan, Kuching and Kota Kinabalu. The population for these cities and population with access to sewerage treatment and disposal facilities are given in tables 2.18 and 2.19. Annex I provides detailed information on actual pollution discharges for Kota Bharu, Kuala Terengganu and Kuantan. No data are available for Kuching and Kota Kinabalu.

Table 2.18 Cities with populations of more than 100,000 and population growth rate

Subregion (Population)	BOD (ton/y)		Total AN (ton/y)		Total P (ton/y)		Solid waste (ton/y)
	To river/canal	Direct to the sea	To river/canal	Direct to the sea	To river/canal	Direct to the sea	
Kelantan	27,283.7	No data	27,802	No data	No data	No data	Data not yet available
Terengganu	1,044.2	No data	9,698	No data	No data	No data	Ditto
Pahang	26,546.4	No data	4,821.6	No data	No data	No data	Ditto
Johor	8,997.2	No data	1,576.8	No data	No data	No data	Ditto
Sabah	No data	No data	No data	No data	No data	No data	Ditto
Sarawak	No data	No data	No data	No data	No data	No data	Ditto

Table 2.19 Major coastal cities – percentage of population with access to basic sewerage facilities (1997)

State (City)	Population	Population with access to sewerage facilities	Number of non-central-ized waste treatment plants (1998)	Number of central/ non-central waste treatment plants (2003)
Kelantan (Kota Bharu)	257,792	0	0	7/7
Terengganu (KT)	268,294	23,000	34	34/0
Pahang (Kuantan)	232,738	55,750	75	75/0
Sarawak (Kuching)	497,000	n.a	n.a	1/1
Sabah (Kota Kinabalu)	271,000	n.a	n.a	1/14
Total	1,526,824	78,750		117/22

Source: Department of Sewerage Services.

Table 2.19 provides a worrying picture of the systemic failure of local authorities to provide basic sewerage services to key coastal cities in the study area. To correct this situation would require vast investment in establishing and operating sewerage facilities. This is discussed later.

2.2 FRESHWATER SHORTAGE AND DEGRATION OF ITS QUALITY

2.2.1 Surface water

2.2.1.1 Sources of surface water and current status

The primary source of surface water in the study area is rainfall. In general Malaysia receives fairly heavy rainfall annually. The average rainfall is 2,420 mm in peninsular Malaysia, 2,630 mm in Sabah and 3,850 in Sarawak. This translates to a total annual rainfall of 990 billion cubic metres (cu. m). Table 2.20 provides a breakdown of the total rainfall.

Table 2.20 Water balance in Malaysia

Type	Amount (billion cu. m)
Evaporation	360
Surface runoff	556
Groundwater recharge	64
Total	990

Source: Nather Khan, I., 1992.

Surface water resources are harvested or captured using two primary methods, impoundment and direct extraction at intake points along rivers. In the rural areas of Sabah and Sarawak, gravitational methods are also used to capture rainfall for domestic consumption.

2.2.1.2 Demand for use (by sector)

2.2.1.2(a) Irrigation

Irrigation by far is the heaviest user of surface water in the study area. In Kelantan, for example, almost all harvested surface water is used for irrigation purposes (Kelantan depends almost exclusively on groundwater for its domestic water supply). On average irrigation activities consume 72 per cent of harvested surface water, albeit in untreated form.

Irrigation water demand is expected to increase to an annual 10,734 million cu.m by the year 2000 from the present level of about 9,000 million cu.m. Within the study area the highest increase in demand is expected in the state of Kelantan which presently consumes 1,252 million cu.m of water for irrigation purposes. The figure is expected to increase to 1,635 million cu.m by the year 2000.

2.2.1.1 (b) Domestic and industrial consumption

Treated water supply is used exclusively for domestic and industrial purposes. This amounted to 28 per cent nationally and for the states in the study area, demand from this sector is expected to increase given the increase in population, increased industrialization and increased coverage of the treated water supply reticulation system. The increased demand is also expected because of the government policy to provide a water supply to all Malaysians by the year 2000.

The demand for domestic and industrial consumption is projected to grow by about four times in the year 2000 from the 1980 levels. Table 2.21 gives the historical and projected demand for industrial and domestic consumption by state.

Table 2.21 Historical and projected domestic and industrial water demand by state (1980-2000) x 000,000 m^3/y

State	1980	1985	1990	2000
Perlis	7	9	16	37
Kedah	49	82	113	260
Pulau Pinang	124	169	236	343
Perak	145	216	327	596
Selangor	470	658	787	1201
N.Sembilan	62	102	131	197
Melaka	30	43	61	112
Johor	159	258	338	578
Pahang	49	116	193	455
Terengganu	31	53	82	222
Kelantan	34	60	99	311
Sabah	58	82	103	259
Sarawak	59	92	124	273
Raw water to Singapore	198	250	319	414
Total	1475	2190	2926	5258

Source: Department of Irrigation and Drainage, National Water Resource Study (1982). Updated 1997.

2.2.2 Groundwater

2.2.2.1 Groundwater supply, use and extraction

Unlike some countries, Malaysia has yet to feel the pressure to resort to groundwater. Of the six states in the study area only Kelantan is heavily dependent on groundwater. Prior to 1982, Kelantan depended almost exclusively on groundwater for public water supply purposes. The proportion of treated water from rivers had however increased steadily to about 32 per cent of total average supply by 1985. Groundwater is being used for domestic supply in areas where there is a lack of suitable surface water. According to the Geological Survey Department (GSD), these areas apart from Kota Baru include a few coastal villages in Sarawak and Sabah. Table 2.22 gives an indication of the present status of groundwater resources in Malaysia.

The north-east monsoon brings heavy rains to the east coast of the peninsula, west and north Sabah and south Sarawak from November to February. Kelantan although relatively well endowed with water resources, faces shortages in meeting irrigation needs during dry periods. The coastal region of Sarawak puts up with a shortage of fresh water resources during the dry months as the estuaries are affected by saline intrusion.

Table 2.22 Status of groundwater resources in Malaysia in billion m^3

Region	Storage	Recharge	Safe yield limits
Peninsular Malaysia	63	20	5.7
Sabah	14	14	2.2
Sarawak	22	30	3.9
Total	69	64	11.8

Source: Department of Irrigation and Drainage, National Water Resource Study (1982).

Groundwater is pumped extensively in the coastal areas of Sarawak to supply water to villagers. Other states which utilize groundwater to supplement surface water supply are Pahang, Terengganu, and the Federal Territory of Labuan and Sabah (mainly in Sandakan). Apart from these localities, groundwater is a vital resource for those living in Malaysia's outlying rural districts.

Presently, the Geological Survey Department records show that groundwater is pumped chiefly for public and domestic use (65 per cent) with smaller amounts going to industry (30 per cent) and agriculture (5 per cent). Industrial use of groundwater is concentrated mainly in the major industrialized zones. In Kelantan, the groundwater resource is also used in conjunction with surface water to irrigate tobacco-growing areas.

The use of groundwater brings with it a number of advantages and problems. The main advantage of groundwater use is that, in many instances, groundwater is sufficiently clean and could be made available to the public without prior treatment. The resource is available in many areas that do not have dependable surface water supplies because the groundwater has been stored by nature through many years of recharge. Equally importantly, groundwater supplies are not seriously affected by short droughts. Finally, for irrigation purposes, groundwater is preferable to surface water because it contains nutrients that could promote plant growth.

However, groundwater quality could be affected by a number of natural and man-made problems. Usually, the problems affecting groundwater quality and its suitability for human consumption are inherent in the water itself, such as high iron content which often leads to encrusted piping and pumps. The other constraint in the development of groundwater is associated with high chloride content especially for parts of the alluvial aquifers near the sea, for example, the Kota Baru areas. In Sarawak, the quality of groundwater in the shallow coastal aquifers is poor except along some narrow strips of higher beach ridges. It is characterized by low pH, high iron content, fairly high manganese content, water coloration and high organic content (especially in peat areas), fairly strong odour and turgidity.

Man-made pollution often results from improper disposal of industrial and domestic waste and sewage. Because groundwater is partly recharged by seepage from the surface, it is highly probable that surface water pollution may affect the quality of groundwater. The presence of *E. coli* has been detected in some dug-wells in east coast of the peninsula, particularly in the rural areas and in wells exploiting shallow unconfined aquifers. A joint study by the Malaysian Agricultural Research and Development Institute (MARDI) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Western Australia, has pointed out contamination in the drinking wells of several areas in the Kelantan plain.

Another issue is over-pumping of groundwater for aquaculture purposes. The eel farm, Song Cheng Sdn. Bhd., which is located in Nenasi, Pekan (Pahang), has more than 400 tube wells (each 100 metres deep) to pump groundwater 24 hours a day (Raman 1996). This massive extraction of groundwater has caused groundwater shortages in adjacent areas. According to Raman (1996), the Pahang Public Water Department revealed in 1993 that the water treatment plant in Nenasi was having difficulties in extracting enough water for 15,000 residents in the district of Bebar. Four hundred villagers from the same area also complained that their wells were drying up.

2.2.3 Issues

2.2.3.1 Water shortage

At present, parts of peninsular Malaysia, in particular the Klang Valley is experiencing a shortage of treated water supply. The shortage is caused by a combination of natural and man-made causes. The prolonged dry season has depleted water reserves in dams and reduced river water levels creating a shortage of supply to water treatment facilities. While states in the study area are yet to experience any shortage in water supply for domestic and industrial purposes, irrigated areas in

Kelantan have started to experience shortages of water for rice fields prompting the relevant authorities to reschedule planting seasons and to artificially raise river water levels at intake points.

Malaysia loses up to 43 per cent of its treated water supply to a variety of man-made causes. The losses, termed "non-revenue-water-losses", happen as a result of leakages, damage to the reticulation system, meter under-registration, fire fighting and thefts. While steps have been taken to address non-revenue-water-losses, the figure remains high because leakages and thefts are difficult to detect (EPU 1993).

2.2.3.2 Pollution

Issues relating to the pollution of freshwater resources have been discussed at length in the preceding sections.

2.2.3.3 Water resource planning

Because water is a state matter under Malaysia's constitutional arrangement, no national level policy or body exists to coordinate water resources development. This is despite the fact that water is often a shared resource with many states sharing the same catchment areas for their rivers. The notion of a "National Water Policy" and a "National Water Council" is an issue that has long been discussed but has not been implemented. The most recent shortage in the Klang Valley has again brought the question of national level water management to the forefront of discussions on water resources development. It is imperative that the discussions over the establishment of a national water council and the formulation of a national water policy be expedited in order to alleviate water shortage in parts of the country. National level coordination is needed to facilitate inter-state water transfer – one of the solutions proposed for areas experiencing water supply deficits.

An important element that has until now been neglected in water resources planning in Malaysia is water conservation. Because water is an abundant resource in Malaysia, water conservation techniques have not been thoroughly explored. In planning for future development, authorities should give due consideration to water conservation methods such as recycling and the capture and use of rainwater in residential and industrial areas for non-human consumption purposes.

2.3 EXPLOITATION OF LIVING AQUATIC RESOURCES

2.3.1 Living marine resources

2.3.1.1 Fisheries resources

2.3.1.1.1 Status of fisheries resources

In Malaysia, fisheries are important for local consumption, export and recreation. Fish provides a relatively significant and healthy part of the diet. Presently, the average per capita consumption of fish in Malaysia is estimated at about 40 kg.

In 1995, the total landing from marine capture fisheries was 1,108,436 tonnes. Of these, 52 per cent (579,618 tonnes) came from the east coast states (Kelantan, Terengganu, Pahang, and east Johor), Sarawak and Sabah. From 1991 to 1995, the fisheries landing from these states was quite constant (table 2.23). This was mainly due to full exploitation of fisheries resources in water within the 12 nautical miles.

During the same period, the landing of Grade 1 fish and prawn (except east Johor) decreased (table 2.24). However, trash fish showed an increase in landing (except Pahang). These are the signs of over-fishing. Table 2.25 shows the exploitation level of various fisheries resources in the South China Sea.

Table 2.23 Marine fisheries landing (tonnes) from the east coast of peninsula Malaysia, Sarawak and Sabah

STATE	1991	1992	1993	1994	1995
Kelantan	25,706	24,035	38,262	33,086	25,446
Terengganu	101,457	87,443	113,292	109,509	80,556
Pahang	108,860	111,452	126,667	111,538	126,002
East Johor	71,664	70,607	66,882	70,644	58,632
Sarawak	86,607	88,241	81,924	95,624	99,255
Sabah	115,739	167,743	173,808	184,882	189,717
TOTAL	510,033	549,521	600,835	605,283	579,618

Source: Annual Fisheries Statistics (1991-1995).

Table 2.24 Marine fisheries landing according to grade from the east coast of peninsula Malaysia, Sarawak and Sabah

STATE	1991	1992	1993	1994	1995
KELANTAN					
Grade I	1,085	867	694	471	406
Grade II	298	326	269	466	653
Grade III	20,385	19,184	23,570	20,976	17,055
Prawn	692	265	318	676	563
Trash fish	3,244	3,393	13,400	10,490	6,761
TERENGGANU					
Grade I	2,620	2,779	2,769	2,379	1,733
Grade II	1,932	1,947	2,110	3,794	1,991
Grade III	85,047	68,204	96,801	94,175	71,160
Prawn	1,034	995	1,575	1,122	563
Trash fish	10,824	13,518	10,037	7,499	6,761
PAHANG					
Grade I	2,555	4,128	3,696	2,698	1,936
Grade II	1,841	2,347	1,840	2,906	1,701
Grade III	46,401	55,009	59,116	48,869	51,368
Prawn	1,853	2,101	2,545	2.770	2,579
Trash fish	56,210	47,867	59,470	54,295	68,418

Table 2.24 (continued)

STATE	1991	1992	1993	1994	1995
EAST JOHORE					
Grade I	1,229	6,088	5,681	1,220	6,416
Grade II	1,213	3,448	4,007	2,128	4,523
Grade III	30,168	52,146	45,156	27,670	50,942
Prawn	3,440	14,256	10,397	2,924	10,198
Trash fish	35,614	12,232	16,562	36,702	27,121
SARAWAK					
Grade I	5,714	6,088	5,681	5,292	6,416
Grade II	4,640	3,448	4,007	3,244	4,523
Grade III	47,589	52,146	45,156	45,659	50,942
Prawn	14,822	14,256	10,397	16,084	10,198
Trash fish	13,685	12,232	16,562	25,169	27,121
SABAH					
Grade I	16,581	26,023	21,758	16,899	17,864
Grade II	10,782	11,338	10,460	9,697	10,611
Grade III	67,093	99,430	113,093	123,966	131,335
Prawn	13,550	19,747	14,788	14,159	13,228
Trash fish	5,536	19,654	9,898	19,649	16,035

Source: Department of Fisheries (1991-1995).

Table 2.25 Exploitation level of fisheries resources in the South China Sea

Fishing zone	Resource category	East coast of peninsular Malaysia	Sarawak	West coast of Sabah
12 nautical miles from coastline	Prawn	OE	OE	OE
	Coral reef fishes	?	UE	OE
	Pelagic fishes	OE	OE	OE
	Demersal fishes	OE	OE	UE
Exclusive economic zone (EEZ)	Small pelagic fishes	UE	UE	UE
	Demersal fishes	UE	UE	UE
	Tuna	UE	UE	UE

Source: Department of Fisheries (1987, 1995), Biusing (1996), Gambang (1996), SEAFDEC (1996).

Note: OE = Over-exploited; UE = Under-exploited; ? = Status not available

2.3.1.1.2 Economic losses

Economic losses within Malaysia's fisheries sector have been attributed to a number of factors. One of the most potentially damaging causes is over-exploitation of the resource itself. While Malaysia's fisheries have yet to suffer a collapse of a particular species or stocks, there is evidence that over-exploitation has resulted in the degradation of landing quality (grade) as illustrated in table 2.24. Increased landings of lower quality or grade fish often translates into lower income for fishing communities (Raja Mohammed Noordin 1994). However, no empirical analyses have been done to examine the true extent of losses caused by over-exploitation.

There has been no recorded loss in the fisheries sector as a result of pollution in the South China Sea. However, incidents in the Straits of Malacca indicate that losses from oil pollution can be substantial. The most recent spill on the coast of Selangor, for example, resulted in the loss of livelihood among coastal fishermen. This loss was compensated for by the state government at a rate of RM 20 per day for up to 14 days. The figure however was arbitrary as there is no reliable benchmark to be used to calculate such losses. To facilitate compensation in cases of oil spills, the Malaysian Government has since 1995 ratified the Convention on Civil Liability (CLC).

2.3.1.1.3 Impacts of global change

While the impact of global climactic change (most notably global warming) on the fisheries sector could be devastating, no effort has been made to assess how global climatic change will affect the fisheries sector in Malaysia. Kennedy (1990) however has noted a number of possible impacts that global warming may have on tropical fisheries. These impacts include a net decrease in the productivity of fish as a result of a decreased supply of phytoplankton.

2.3.2 Sea turtles and painted terrapin

2.3.2.1 Status of turtles and painted terrapin

Of the marine turtles, four species breed regularly on Malaysia's beaches. They are the Leatherback Turtle (*Dermochelys coriacea*), Green Turtle (*Chelonia mydas*), Hawksbill Turtle (*Eretmochelys imbriata*), and Olive Ridley Turtle (*Lepidochelys olivacea*). The Loggerhead Turtle (*Caretta caretta*) which was occasionally reported by fishermen in Malaysian waters in the 1970s, has not been seen over the last 10 years. All species have evidently been more abundant in the past. Currently, the population of these turtles is critically threatened. The number of leatherback landings have decreased by more than 99 per cent since the 1950s, while green turtles have decreased by at least 60 per cent since the 1960s. All five turtle species mentioned above are listed under The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and The International Union for the Conservation of Nature and Natural Resources (IUCN) threatened or endangered categories.

Table 2.26 shows the major nesting sites and breeding season of sea turtles in Malaysia. On the east coast of peninsula Malaysia, the leatherback is only known to nest in Terengganu, mainly on beaches in Rantau Abang. The other three species, green turtle, hawksbill and olive ridley, have been observed to lay eggs on beaches in Kelantan, Terengganu, Pahang, and Johor.

Currently, only the green turtle and the hawksbill turtle are known to nest in Sabah. Turtle eggs were mainly collected in Turtle Islands Parks (north of Sandakan), and a few from Pulau Tiga, Pulau Gaya, Tanjong Nosong in Kimanis Bay to Kota Kinabalu, and Pulau Sipadan. In 1964, five loggerhead turtles were observed swimming in the water nearby the Turtle Islands Park (Phillips 1988). Since then, no observations have been made in the Sabah waters.

Three species of sea turtles, green turtle, hawksbill turtle and olive ridley turtle are known to nest regularly on the Turtle Islands of Sarawak (Talang Talang Besar, Talang Talang Kechil and Satang Besar Island). Green turtles were also reported to nest on the beach between Semantan and Sungai Semunsan, and Tanjong Similajan north of Bintulu. The loggerhead (*Caretta caretta*) was reported to nest in small numbers in Sarawak (Leh 1985; cited in Chan 1991). More information is needed to confirm the occurrences of loggerhead turtle in the South China Sea.

Based on tagging recoveries and migration data, *Chelonia* from Sabah and *Dermochelys* from Terengganu have been recovered mostly in the Phillipines and Indonesian waters. Chelonian tagged at Talang Talang Besar (Sarawak) was recovered in Sabah and Indonesia.

Painted terrapin (*Callagur borneoensis*), locally known as "Tuntung Laut", reside along rivers and tidal estuaries, and are mainly found on the east coast of peninsula Malaysia. However, there is no reliable information available about this animal for Sarawak and Sabah. It is protected under the State Fisheries Enactments of Kelantan, Terengganu, Pahang and Johor. It can be found in large numbers in the Setiu, Chalok and Paka river systems in Terengganu. Although the painted terrapin is primarily a freshwater reptile, it prefers ocean-facing beaches that are not far from the home river mouth for nesting purposes. Nesting is seasonal for painted terrapins and takes place from early April to late August on the east coast of peninsula Malaysia. The major nesting sites are between Kampung Fikri and Kampung Telaga Papan.

2.3.2.2 Principal threats

Threats to sea turtles and painted terrapin are listed below:

(a) High demand for eggs;
(b) Intentional catches by local fishermen for food consumption;
(c) Unintentional catches causing drowning in trawls and gill nets;
(d) Unintentional kill by destructive fishing methods (i.e., dynamiting);
(e) Marine pollution (mainly oil spill and tar-ball);
(f) Decreased nesting areas owing to habitat degradation, coastal erosion, and excessive coastal development for tourism.

Table 2.26 Major nesting sites and breeding seasons of turtles on the east coast of peninsular Malaysia, Sarawak and Sabah

Species	Major natural landing sites	Nesting season
Leatherback Turtle *(Dermochelys coriacea)*	Terengganu (Merchang, Rantau Abang, Dungun, Paka, Pulau Kapas)	April-August
Green Turtle *(Chelonia mydas)*	Kelantan (Pantai Chinta Berahi) Terengganu (Penarek, Merchang, Rantau Abang, Dungun, Paka, Kemaman, Pulau Kapas, Pulau Perhentian, Pulau Redang) Johor (Pulau Sibu, Pulau Simbang, Pulau Pemanggil) Sarawak (Talang Talang Besar, Talang Talang Kechik, Satang Besar Island, Semantan) Sabah (Turtle Islands National Park, Pulau Tiga, Pulau Gaya)	April-August

Hawksbill Turtle *(Eretmochelys imbriata)*	Terangganu (Penarek, Dungun, Paka) Johor (Pulau Mertang, Pulau Sibu, Pulau Simbang) Sarawak (Talang Talang Besar, Talang Talang Kechik, Satang Besar Island) Sabah (Turtle Islands National Park, Pulau Tiga, Pulau Gaya)	January-September
Olive Ridley Turtle *(Lepidochelys olivacea)*	Terengganu (Penarek, Dungun, Paka, Kemaman, Cherating, Pulau Redang) Sarawak (Talang Talang Besar, Talang Talang Kechik, Satang Besar Island)	January-September
Painted Terrapin *(Callagur borneoensis)*	Terengganu (Setiu, Penarek, Dungun, Paka, Kemaman)	April-August

Source: Chan 1991.

2.3.3 Marine mammals

2.3.3.1 Status of marine mammals

There are no data in terms of species of marine mammals and their numbers in Malaysia. Fishermen or boatmen occasionally report the occurrence of marine mammals. In Malaysia, dolphins are usually found in shallow coastal waters and estuarine or mangrove areas. The bottlenose dolphin (*Tursiops truncatus*) and the Indo-pacific humpbacked dolphin (*Sousa chinensis*) are quite common in major river mouths of the east coast of peninsula Malaysia and Sarawak, mainly in Pahang River, Terengganu River and Rajang River. According to Sabah Parks, five species of dolphin have been identified in Sabah waters: Malayan dolphin (*Proelphinus malayanus*); Pacific common dolphin (*Tursiops catalania*); Irrawaddy dolphin (*Praella brevirostris*); plumbeous dolphin (*Sotalia plumbea*) and white dolphin (*Sotalia borneensis*).

Dugong (*Dugong dugon*) is frequently observed in shallow coastal waters off the east coast of peninsular Malaysia, Sarawak and Sabah where seagrasses are abundant. The population size is believed to be very small. Dugong is under threat and its population is expected to decline because of the gradual loss of seagrass beds in Malaysia.

2.3.3.2 Principal threats

Threats to marine mammals are listed below:

(a) Bycatch in fisheries (incidental catch);
(b) Entanglement in gill nets;
(c) Unintentional kills by destructive fishing methods (i.e., dynamiting);
(d) Habitat loss (seagrass ecosystem);
(e) Marine pollution (mainly oil spill);
(f) Displacement by boat traffic (river mouths).

2.4 MODIFICATION OF AQUATIC HABITATS

2.4.1 Freshwater habitats and coastal wetlands

The main types of coastal wetlands in the study area are mangroves, freshwater swamp forest, nipah and peat swamp forests. Mangroves are particularly dominant in Sabah and Sarawak whereas in peninsular Malaysia mangroves are largely confined to estuaries. Much of the non-mangrove wetlands in the study area has been depleted especially the peat swamp areas in peninsular Malaysia. In Sarawak peat swamp forest is protected and representatives of this type of forest can be found in a number of national parks. The true extent of the loss of these types of freshwater and coastal wetlands has yet to be assessed. However, representatives of non-mangrove wetlands need to be given immediate protection to prevent further losses. Table 2.27 gives the status of freshwater and coastal wetlands.

Table 2.27 Natural freshwater and other wetlands

Subregion	Total area (ha) at present/location	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of fish, other vertebrates such as amphibians, reptiles, birds; molluscs, other invertebrates/ remarks
Kelantan	Semerak FR (4)	FR	Melaleuca swamp
	Sungai Golok Catchment Reserve (6400)	Catchment reserve area	Swamp forest
	Sungai Golok *melaleuca* swamp	Stateland proposed for FR	
	Telong *melaleuca* swamp	Stateland/alienated land proposed as WR	
Terengganu	Belara FR (11431)	FR	Lowland swamp forest
	Bukit Terendak FR (10592)	FR proposed VJR site	Peat swamp forest
	Kuala Kemaman FR (2962)	FR	Lowland swamp forest
	Merchang FR (9301)	FR proposed VJR site	Swamp forest and lowland dipterocarp forest (LDF)
	Paya Mengkuang FR (1722)	FR	Swamp forest
Pahang	Kedondong FR (3147)	FR	Freshwater swamp forest
	Resak FR (2290)	FR	Freshwater swamp forest
	Tasik Bera FR (40038)	FR	Freshwater swamp forest, LDF. Lake ecosystem.
Johor	Ulu Sedili FR (31293)	FR	Freshwater swamp forest
	Sungai Sedili CR	CR	Freshwater swamp forest, LDF, mangroves

Table 2.27 (continued)

Subregion	Total area (ha) at present/location	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of fish, other vertebrates such as amphibians, reptiles, birds; molluscs, other invertebrates/ remarks
Sabah	Klias FR (3630)	FR	Last remaining sizeable tract of peat swamp forest in West Sabah
	Sungai Binsuluk FR (12106)	FR	Last remaining sizeable tract of mixed coastal forest in West Sabah
	Sugut FR (32007)	FR	Freshwater swamp forest, LDF
	Kampung Hindian FR (580)	Amenity FR	Swamp forest
	Padas Damit FR (9027)	Amenity FR	Swamp
	Kota Belud – Tempasuk Plain Bird Sanctuary (12000)	Gazetted as bird sanctuary	Beach dune, grassland, freshwater swamp
	Balembangan	Proposed extension to existing FR	
Belansat FR (170)	FR	Swamp forest	
Balingian FR (26905)	FR	Swamp forest	
Beluru FR (40350)	FR	Peat swamp forest	
Binatang FR (135)	FR	Swamp forest	
Buan FR (17928)	FR	Swamp forest	
Daro FR (15890)	FR	Swamp forest	
Ensengai FR (867)	FR	Freshwater swamp forest	

Table 2.27 (continued)

Subregion	Total area (ha) at present/location	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of fish, other vertebrates such as amphibians, reptiles, birds; molluscs, other invertebrates/ remarks
Entulang FR (1833)	FR	Swamp forest	
Kanowit East FR (155)	FR	Swamp forest close to Sungai Rajang	
Kayangeran FR (5497)	FR	Swamp forest	
Kemena FR (5787)	FR	Swamp forest	
Kubud East FR (6115)	FR	Swamp forest	
Kubud West FR (1329)	FR	Swamp forest	
Lemai FR (7321)	FR	Swamp forest	
Lower Baram FR (75244)	FR	Swamp forest	
Majau FR (169)	FR	Best peat swamp forest in Sarawak	
Maludam FR (15563)	FR	Swamp forest	
Marudi FR (7121)	FR	Peat swamp forest	
Naman FR (7655)	FR	Swamp forest, has good potential for transfrontier reserve	
Rimbas FR(2367)	FR	Swamp forest	
Sadong FR (427500)	FR	Swamp forest	
		Peat swamp forest	

Table 2.27 (continued)

Subregion	Total area (ha) at present/location	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of fish, other vertebrates such as amphibians, reptiles, birds; molluscs, other invertebrates/ remarks
Sedilu FR (10703)	FR	Peat swamp forest	
Selezu FR (2064)	FR	Peat swamp forest	
Setuan FR (10001)	FR	Swamp forest	
Simunjan (19055)	FR	Peat swamp forest	
Stabar FR (3569)	FR	Swamp forest	
Sundar FR (1740)	FR	Swamp forest	
Sungei Bawan FR (13669)	FR	Swamp forest	
Sungei Segan FR (3561)	FR	Swamp forest	
Tahu FR (2566)	FR	Swamp forest	
Batang Lassa Protected Forest (PF 37529)	PF	Swamp forest	
Igan PF (3238)	PF	Swamp forest	
Kenyana PF (20106)	PF	Swamp forest	
Ikut-Mudan PF (7892)	PF	Swamp forest	

Table 2.27 (continued)

Subregion	Total area (ha) at present/location	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of fish, other vertebrates such as amphibians, reptiles, birds; molluscs, other invertebrates/ remarks
Lemiting PF (85722)	PF	Swamp forest	
Lepah PF (5931)	PF	Swamp forest	
Loba Kabang North PF (12536)	PF	Swamp forest	
Loba Kabang South PF (34399)	PF	Swamp forest	
Oya-Mukah PF (46665)	PF	Swamp forest	
Pulau Bruit PF (25149)	PF	Swamp forest	
Retus PF (33732)	PF	Swamp forest	
Sawai PF (52554)	PF	Swamp forest	
Sebuyau PF (26281)	PF	Swamp forest, MDF	
Tatau PF (27256)	PF	Peat swamp forest	
Telang Usan (86693)	PF	Swamp forest	
Triso PF (33904)	NP	Peat swamp forest	
Loagan Bunut National Park (NP 10736)		Peat swamp forest	

2.4.2 Marine habitats

2.4.2.1 Coral reefs

2.4.2.1.1 Status of coral reefs

There are three types of coral reefs in the study area, platform reef, fringing reef and atoll reef (Zainuddin and others 1995). The patches of reefs occur mostly as fringing reefs associated with the islands on the east coast of peninsular Malaysia as well as Sabah and Sarawak. Numerous atoll reefs are also found further into the Malaysian EEZ in the South China Sea. Zainuddin and others provided a comprehensive review of coral reefs in Malaysia but also noted that there has been no attempt to quantity the extent of coral reef coverage in Malaysia.

In general the reefs in the study area have been rated between fair and good. The coral reefs on the east coast of peninsular Malaysia have between 56 to 69 per cent live coral cover and are categorized as in 'good' condition. However, it was noted that there is also a high percentage of dead corals and coral rubble (Zainuddin and others 1995). The reefs in Sabah have been categorized as 'fair' having 43 – 52 per cent live coral cover but with more variation between the reefs fringing the coast and those on the outer islands such as Pulau Layang Layang (Swallow Reef). There are fewer reefs in the waters of Sarawak, but the percentage of live coral cover at 60 per cent is higher than peninsular Malaysia and Sabah.

2.4.2.1.2 Principal threats to coral reefs

Coral reefs in the study area are adversely affected by a number of natural and man-made phenomena. Recorded natural causes of coral reef degradation include crown of thorn (COT) infestations particularly on the east coast of peninsular Malaysia and storm damage which causes stresses to coral reefs in east Malaysia (Sabah and Sarawak).

Anthropogenic threats are more damaging to coral reefs and include damage from fishing activities, sedimentation from land development, industrial pollution, tourism activities, dredging and to a limited extent coral mining. Zainuddin and others (1995) produced an analysis of causes of coral reef degradation in Malaysia, including the study area, which is reproduced below as table 2.28.

Of the man-made threats, two deserve special mention in this report. First, coral damage as a result of fishing activities, in particular fish blasting, and second, sedimentation from development activities. Coral reef damage from fishing activities warrants a mention because it illustrates the relationship between coral reefs and the fish communities they support. The importance of coral reefs to fisheries activities should not be understated because coral reefs in Malaysia are known to support 326 fish species from 40 families. As such any threat to the coral reefs may also have adverse effects on the economy of fishing communities.

Sedimentation from development activities while not a major threat in itself, highlights the problems posed by the present system which separates the management of marine protected areas from the land mass they surround. Two often-cited cases are the damage to coral reefs caused by development on land in Pulau Redang in Terengganu and on the coastal area adjacent to the Tunku Abdul Rahman National Park in Sabah.

Table 2.28 Causes of coral reef degradation and destruction in Malaysia's South China Sea region.

Causes of reef degradation	East coast of peninsular Malaysia	Sabah and Sarawak
	Scale of damage	
Storm	2	3
Coral bleaching	1	1
Disease/predation	4	2
Fishing intensity	3	5
Fishing damage	3	5
Fish blasting	2	4
Gleaning	1	3
Sedimentation	3	3
Domestic and agricultural pollution	2	4
Industrial pollution	1	1
Oil spill	1	2
Dredging	1	2
Coral mining	1	3
Tourist activities	2	2
Boat scouring	3	5

Source: Adopted from Zainuddin and others, 1995.

Key to scale values:

1 = None to rare; very low occurrence
3 = Some damage; some stress
5 = Medium to high; damaging
7 = Very high; high stress; very damaging

2.4.2.2 Mangroves

2.4.2.2.1 Status of mangrove resources

Within the study area most mangroves are found in Sarawak and on the east coast of Sabah. Total mangrove hectarage in these two states stood at 160,000 hectares and 316,400 hectares respectively (EPU 1993). The figures show a decrease in mangrove coverage from the 1980 figure of 173,614 hectares for Sarawak and 365,345 hectares for Sabah. Like peninsular Malaysia, Sarawak has lost a significant amount of mangrove forests over the years. The primary reason being the conversion of mangrove forests to other uses such as agriculture and infrastructure development. In Sabah, since the introduction of regulations against wood chipping in 1985, mangroves have been left undisturbed and consequently have contributed to the abundance of wildlife and fisheries resources. Table 2.29 shows the mangrove areas in peninsular Malaysia. The east coast of the peninsula has few mangrove areas compared with the west coast. Data compiled by Japar (1994b) showed that there are 104 mangrove species in Malaysia.

Table 2.29 The current extent (ha) of mangrove forest reserves and stateland mangroves in peninsula Malaysia

State	Mangrove forest reserves [a]	Stateland mangroves [b]	Total mangrove area
Perlis	0	100	100
Kedah	7,949	100	8,049
Penang	451	100	551
Perak	43,502	2,600	56,102
Selangor	15,090	4,000	19,090
Negeri Sembilan	233	0	233
Melaka	238	0	238
Johor	16,659	8,000	24,659
Pahang	2,483	450	2,933
Terengganu	1,295	0	1,295
Kelantan	0	20	20

Sources: [a] Annual Report of Forestry Department (1995)
[b] Chan and others (1993)

Table 2.30 Distribution of mangroves in the study area

Subregion	Total area (ha) at present	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of mangrove tree species/remarks	Number of associated species (birds, fish, invertebrates) (specify)
Kelantan	Kuala Besar mangrove forest	Stateland forest proposed as forest reserve (FR).		
Terengganu	Kuala Kemaman Forest Reserve (2962 ha) Pulau Redang	FR Proposed as forest reserve.	 Some has been cleared for the development of a resort	

Table 2.30 (continued)

Subregion	Total area (ha) at present	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of mangrove tree species/remarks	Number of associated species (birds, fish, invertebrates) (specify)
Pahang	Bakau Pontian FR (159)	FR		
	Bakau Rompin FR (195)	FR		
	Balok FR (100)	FR		
	Bebar FR (436)	FR. Proposed as Virgin Jungle Reserve (VJR)		
	Cherating FR (264)	FR. Proposed as VJR		
	Kuantan FR (512)	FR		
	Tanjong Agas mangrove forest	Stateland, proposed as FR.	Some aquaculture activities.	
	Kuala Rompin	Stateland	Good example of insular mangrove ecosystem	
	Kuala Endau	Stateland		
	Pulau Seri Buat	Stateland		
Johor	Kuala Sedili Kecil FR (443)	FR.	Some degradation as a result of infrastructure project. Example of mangrove-freshwater transition.	
	Sungai Sedili Besar FR	FR.		
	Mersing FR (6169)	FR. Proposed as Wildlife Reserve (WR).	Degraded as a result of development.	

Table 2.30 (continued)

Subregion	Total area (ha) at present	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of mangrove tree species/remarks	Number of associated species (birds, fish, invertebrates) (specify)
Sabah	Abai FR (1396)	FR		
	Bengkoka Peninsula FR (13263)	FR		
	Kudat and Marudu Bay FR (13636)	FR	Alienated land proposed for nature reserve.	
	Mengkabong FR (2363)	FR	Sandy beach and mangroves. Important for *Clupeid* fishery.	
	enumbuk FR 5710)	FR		
	Pulau Banggi FR (11504)	FR		
	Sulaiman Lake FR (2635)	FR		
	Tambisan FR (6500)	FR		
	Tanjung Butan FR (600)	FR		
	Tawau FR (39018)	FR		
	Likas Swamp			

Table 2.30 (continued)

Subregion	Total area (ha) at present	Area lost per year during last 5-10 years or other indirect indication of loss/legal status	Number of mangrove tree species/remarks	Number of associated species (birds, fish, invertebrates) (specify)
Sarawak	Kenalian FR (1153)	FR		
	Lawas FR (2275)	FR	Important for threatened primates	
	Rajang FR (12343)	FR	Degraded as a result of wood chippping.	
	Sarawak FR (8726)	FR		
	Sibuti FR (950)	FR		
	Terentang FR (6420)	FR		
	Kabong FR (1012)	Communal FR	Communal forest reserve.	
	Batang Jemoreng FR (25952)	Protected Forest Reserve.	Peat swamp forest and mangroves.	
	Loba Pulau FR (9272)	Protected Forest Reserve.		
	Paloh FR (8302)	Protected Forest Reserve.	Peat swamp forest and mangroves.	
	Samunsam Wildlife Sanctuary	Wildlife Reserve (WR).	Mixed habitat – mangrove, nipa, heath forest.	
	Trusan Sundar	Proposed FR		
	Limbang	Proposed WR.		
	Tanjung Datu	Proposed as National Park (NP)		

2.4.2.2.2 The role of mangrove ecosystems

The connection between mangroves and fisheries has been well documented. It is widely recognized that mangroves play an important role in sustaining the productivity of coastal fisheries (Chong and others, 1990; Day and others, 1989; Hamilton and others, 1989; Japar, 1994; Jothy, 1984; Little and others, 1988; Khoo, 1989; Pinto, 1988; Robertson and Duke, 1990; Sasekumar and others, 1992). Generally, mangroves provide ideal nursery, breeding and feeding areas for many economically-important species of fish and prawn, as well as being a permanent habitat for mud crabs (*Scylla serrata*) and oysters (*Crassostrea* spp.). In fact, many fish and prawn are dependent on mangrove forests for the completion of their life-cycle, mostly during their juvenile stages. It is also believed that mangroves export a substantial amount of nutrients, enriching coastal areas. Mangrove forests thus have important ecological functions for near coastal and offshore fisheries.

2.4.2.2.3 Principal threats to mangroves

The single biggest threat to mangroves in the study area is the conversion of mangrove forests to other forms of land use. This includes the clearing of mangroves for aquaculture, land reclamation for development purposes and clearing of mangroves for agricultural purposes. Within the study area the Sarawak River mangroves were reported to be under immediate threat of conversion (EPU 1993).

2.4.2.3 Seagrass ecosystem

2.4.2.3.1 Status of seagrass resources

There is a lack of information on the status of seagrass resources in Malaysia. Based on the data compiled by Japar (1994), Malaysia has 13 species of seagrass belonging to 7 genera. Currently, the east coast of peninsula Malaysia, Sarawak and Sabah have seven, one and nine species of seagrasses respectively (table 2.31). Figures 2 and 3 show the distribution of seagrasses in peninsular Malaysia and Sabah. The distribution and species composition of seagrass resources in Sarawak is poorly known.

Table 2.31 Occurrence of seagrasses species, the east coast of peninsular Malaysia, Sarawak and Sabah

Family and species	East coast of peninsular Malaysia	Sarawak	West coast of Sabah
Hydrocharitaceae			
• *Enhalus acoroides*	X		X
• *Halophila beccari*		X	
• *Halophila ovalis*	X		X
• *Halophila minor*	X		X
• *Thalassia hemprichii*			X

Table 2.31 (continued)

Family and species	East coast of peninsular Malaysia	Sarawak	West coast of Sabah
Cymodoceae			
• *Cymodocea rotundata*			X
• *Cymodocea serrulata*	X		X
• *Halodule pinifolia*	X		X
• *Halodule uninervis*	X		X
• *Syringodium isoetifolium*	X		X
Total	7	1	9

Source: Data compiled by Japar (1994).

2.4.2.3.2 The roles of seagrass

Seagrass is one of the essential foods for the dugong (*Dugong dugon*) and many herbivorous fishes (i.e., rabbitfishes and wrasses). Apparently, the seagrass resources are very poor along the coasts of states bordering the South China Sea. This also partly explains the very low population of dugong in the South China Sea. Seagrass beds are also widely recognized as feeding, breeding and nursery grounds for many commercially important fishes.

2.4.2.3.3 Principal threats

Threats to the seagrass ecosystem are as below:

(a) Coastal reclamation projects for port and tourism facilities (mainly in Pahang and Johor);
(b) Land-based marine pollution (sewage, industrial and agricultural effluent);
(c) Marine pollution (mainly oil spill).

2.5 SUMMARY OF THE PRINCIPAL THREATS TO LIVING RESOURCES IN THE SOUTH CHINA SEA

Table 2.32 provides a summary of the impacts of human activities on living marine resources. Some of the impacts, particularly from land-based marine pollution and oil spill are difficult to quantify or classify because of a lack of reliable information or studies, although these two sources are believed to have had an adverse impact on living marine resources and marine habitats.

2.6 COASTAL EROSION

The threat posed by coastal erosion to Malaysia's coastline in general is considered significant from economic, social and political perspectives. Economic losses as a result of coastal erosion have affected the livelihood of coastal communities, destroyed agricultural areas and damaged infrastructure such as roads, human settlements and tourism facilities. Shahrizaila (1992) identified natural and man-made causes of coastal erosion in Malaysia:

(a) Movement of littoral currents;
(b) Intensified wave movements during monsoon seasons;
(c) Inappropriate siting of coastal structures such as seawalls, revetments, groynes and breakwaters;
(d) Degradation of coastal habitats (mangroves, coral reefs and seagrass beds) resulting in the loss of natural protection against wave action.

At the same time, it is also recognised that some coastal infrastructure (in particular resorts and roads) have been constructed in areas which are affected by natural decretion of shorelines. This is turn has made the facilities vulnerable to the threat of natural erosion.

Priority is given to protecting areas affected by category 1 erosion and to a lesser extent areas under category 2. Since 1985 RM 200 million has been spent on coastal protection work. A number of guidelines have also been prepared by government agencies such as the Department of Irrigation and Drainage (DID) and the Department of Town and Regional Planning. In 1987 the Government issued a general circular which requires all development in the coastal area to be referred to the Coastal Engineering Division of DID for evaluation and technical inputs.

Table 2.32 Summary of the impacts of human activities on living marine resources

Living marine resources and impacts of human activities	East coast of peninsular Malaysia	Sarawak	West coast of Sabah
(1) Fisheries resources			
• Overfishing (Inshore fisheries)	+++	+++	+++
• Destructive fishing methods	0	0	+++
• Illegal fishing by foreign vessels	+	+	+
• Ecosystem degradation	+	+	++
• Coastal development	+	+	+
• Land-based pollution	NS	NS	NS
• Marine pollution (oil spill)	NS	NS	NS
• Red tide bloom	+	0	+
(2) Sea turtles	+++	+++	+++
• Excessive egg-harvest	+	+	+
• Intentional/accidental catch	0	0	++
• Destructive fishing methods	++	+	+
• Marine pollution (tar-ball)	NS	NS	NS
• Land-based pollution	+++	++	+++
• Excessive coastal development (mainly for tourism)	+	+	+
• Coastal erosion (beach)			
(3) Mangrove ecosystem			
• Conversion for urban development	+	+	+
• Conversion for agriculture	+	+	+
• Conversion for aquaculture	+*	+*	+
• Exploitation for forestry	+	+	++
• Marine pollution (oil spill)	NS	NS	NS
• Land-based pollution	++**	NS	NS
• Mining	NS	NS	NS

Table 2.32 (continued)

Living marine resources and impacts of human activities	East coast of peninsular Malaysia	Sarawak	West coast of Sabah
(4) Coral reef ecosystem			
• Destructive fishing methods	0	0	+++
• Intensive recreational use	+++	+	+++
• Land-based pollution	?	?	?
• Marine pollution (oil spill)	+	+	+
• Coral and sand mining	NS	NS	++
(5) Seagrass ecosystem			
• Coastal reclamation	+++	+++	+++
• Marine pollution (oil spill)	?	?	?
• Land-based pollution	NS	NS	NS

Note: +++ = adverse impact; ++ = moderate impact; + = low impact;
0 = not reported; NS = status not classified
* inclusive future development of coastal aquaculture that involved clearing of mangroves.
** information based on work carried out by Ibrahim and Japar (1991) in Pulau Redang where dumping of silt caused mangrove die-back.

3.0 ANALYSIS OF THE SOCIAL AND ECONOMIC COSTS OF IDENTIFIED WATER-RELATED ISSUES

The full social and economic costs of the water-related problems described earlier are not yet apparent in Malaysia. However, there are indications or symptomatic manifestations of what the social and economic costs could be if the water-related pollution problems are not adequately addressed. These include:

- Sporadic outbreaks of waterborne diseases, for example, cholera particularly in the state of Kelantan where rivers are being used for domestic consumption and waste disposal (table 3.33);
- Higher cost of providing safe water supply for domestic consumption;
- The application of the polluter-pays principle in wastewater treatment (this will be discussed later).

Table 3.33 Incidents of diseases related to water quality in the study area

[1]Subregion, watershed area	Average number of reported cases for each disease in the last 5-10 years; Indicate if increasing or decreasing over this period (1992-1996)	Average number of deaths for each disease over a specified period; Indicate if increasing or decreasing over this period (1992-1996)
Kelantan		
1. Cholera	48	0.5
2. Typhoid incl. Paratyphoid	437	1.2
3. Food poisoning		
4. Hepatitis A	170	0
5. Dysentery	245.6	0
	15.8	0

[1] Data obtained from the Public Health Division, Ministry of Health Malaysia.

Table 3.33 (continued)

Terengganu		
1. Cholera	2.8	0
2. Typhoid incl. Paratyphoid	51.8	0.4
3. Food poisoning		
4. Hepatitis A	117.4	0.2
5. Dysentery	136.8	0
	9.4	0
Pahang		
1. Cholera	0.6	0
2. Typhoid incl. Paratyphoid	22.6	0.2
3. Food poisoning		
4. Hepatitis A	74.6	0
5. Dysentery	29.4	0
	6.6	0
Johor		
1. Cholera	2.8	0
2. Typhoid incl. Paratyphoid	28.6	0
3. Food poisoning		
4. Hepatitis A	208.6	0.2
5. Dysentery	24.2	0
	4.2	0.2
Sabah		
1. Cholera	723.6	9
2. Typhoid incl. Paratyphoid	291.2	4.2
3. Food poisoning		
4. Hepatitis A	113.8	0.2
5. Dysentery	161.2	0
	52.6	0
Sarawak		
1. Cholera	39.2	0.2
2. Typhoid incl. Paratyphoid	98.8	0.4
3. Food poisoning		
4. Hepatitis A	104.2	0.4
5. Dysentery	15.2	0
	61	0

There are numerous examples overseas of the result of fish stock failures. However, there has been no collapse of fisheries stocks in Malaysia. Table 2.25 illustrates the threat of over-exploitation in the coastal fisheries while resources in the EEZ remain largely untapped. The steps taken to alleviate the stress on coastal fisheries include promoting fisheries activities in the EEZ and promoting alternate livelihoods for coastal fishing communities. However, these actions are not necessarily directly related to fish stock status but may have come about as a result of the decline in the fishermen's income.

The economic costs of correcting or addressing water-related problems are not explicitly mentioned in the national budgets. These costs are considered as part-and-parcel of the development budget and are 'hidden' within the national annual budgets and the Malaysia Plan allocations. There have, however, been direct allocations to address water-related issues. These include the RM 200 million spent since 1985 to address coastal erosion problems.

4.0 ANALYSIS OF THE ROOT CAUSES OF THE IDENTIFIED WATER-RELATED ISSUES

There are a number of generic and specific causes of the water-related problems in Malaysia's South China Sea region. This section identifies both the generic and specific problems at the national, state and local government level. The nature of the problems discussed in section 2 of this report is linked to the root causes by the "causal-chain-analysis" method and is shown in table 4.34.

4.1 GENERIC/NATIONAL LEVEL PROBLEMS

4.1.1 Land use planning and land use

Within the Malaysian context, land use planning and land use practices have significant impacts on the country's environment in general and more specifically on the state of the riverine, marine and coastal environment and resources. Many of the problems discussed under section 1.2 originated directly and indirectly from weaknesses in adhering to land use planning policies and procedures, particularly at state and local government levels.

There are a number of planning and legislative tools available for land use planning and development. The primary legal instruments for this are:

- The National Land Code, 1965;
- The Land Conservation Act, 1960;
- The Sarawak Land Ordinance, 1948;
- The Sabah Land Ordinance, 1930;
- The Environmental Quality Act 1974;
- The National Forestry Act, 1984;
- The Street, Drainage and Building Act, 1976.

In principle, these instruments provide authorities with adequate tools for controlling land development activities. However, these instruments are national laws and because the powers to regulate land use are vested with state authorities and local governments, the implementation of this body of legislation has not always been satisfactory. The problem of the "Federal-State dichotomy" is a widely discussed issue in Malaysia, and was the subject of a recent study commissioned by the Ministry of Science, Technology and Environment.

The primary land use planning tools are the Land Capability Classification (LCC), the structure planning process, and the DOE's guidelines for siting industrial facilities. However, none of these instruments are legally binding and their implementation and interpretation are left very much to the discretion and capabilities of local authorities. The lack of capacity to implement these tools at local government level has sometimes created a situation in which the effects of pollution from land-based activities are exacerbated. The 1993 National Conservation Strategy study identified these problems as improper citing of factories and animal husbandry activities within water catchment areas, and the proliferation of development activities on steep slopes. The extent of this problem is illustrated in annex III which provides the present distribution of industrial pollution sources in the study area.

4.1.2 Land use planning and modification of habitats

Deficiencies in the present land use planning system are often cited as a major cause of habitat modification and loss. Because the land use planning system accords little or no value to the protection of habitat for conservation or environmental purposes, particular habitats such as mangroves and peat swamp are often subjected to conversion for agricultural and industrial purposes.

This has led to the decline in mangrove areas as discussed in section 2.4.2.2. The loss of other wetlands habitats cannot be calculated as these areas are state land outside the Permanent Forest Estate (PFE) system and their hectarage has not been recorded.

Habitat degradation and loss as a result of poor land use planning are compounded by poor land development practices resulting in habitat loss and degradation as a result of soil erosion. As mentioned in section 2.4.2.2.1 and 2.4.2.1.2 mangroves and coral reefs have been degraded and lost as a result of smothering and die-back caused by soil erosion. The situation is also illustrated in table 1.1 which shows suspended solids as the main cause of marine water quality degradation in Malaysia.

4.2 INSUFFICIENT ACCESS AND PROVISION OF CENTRALIZED SEWAGE TREATMENT FACILITIES AND IMPROPER DISPOSAL OF SEWAGE

From 1977 to 1984 organic pollution contributed more to the decline in river water quality than any other pollutants. The problem with organic pollution is the result of two interrelated factors:

- Insufficient domestic or household access to centralized sewerage treatment system;
- Inadequate provision of centralized sewerage facilities.

The two factors resulted from the lack of investment made into developing sewerage infrastructure. During the period from 1980 to 1995 investment into the development of sewerage infrastructure amounted to RM 328 million compared with the RM 7.7 billion spent on developing water infrastructure. The coverage of the various methods of sewerage treatment and disposal in 1995 stood at 52.7 per cent of all households (Seventh Malaysia Plan, 1996 – 2000). The resulting situation was such that growth in water consumption and wastewater discharge outpaced the growth of wastewater treatment facilities development, therefore aggravating the problem of organic pollution from domestic sources.

Part of the cause of the problem is the fact that local authorities and private developers responsible for the development and upkeep of sewerage facilities lack the financial resources to develop expensive sewerage treatment facilities and the technical expertise to maintain existing facilities. The state of affairs is illustrated in the fact that more than 80 per cent of the 3,600 or so public sewage treatment plants under the jurisdiction of local authorities did not meet the discharge standard or are not operational (Information Malaysia Yearbook, 1997). The situation is worse in the study area compared with the west coast of peninsular Malaysia and even with the proposed investments up to the year 2003, the provision of centralized sewage treatment facility remains inadequate (tables 2.18 and 2.19).

4.3 LACK OF CAPACIITY TO IMPLEMENT POLICIES AND ENFORCE REGULATIONS

One of the most pressing problems faced by the lower tiers of government (the local authority level) is the lack of capacity to implement policies on development control and enforce regulations under local authority jurisdiction. As noted earlier, there is no lack of legislation on environmental matters. The local authorities, for example, are responsible for enforcing bylaws regarding sewage treatment and disposal, earthworks, solid waste collection and disposal as well sanitary regulations. However, in Malaysia local authorities are often small and do not possess the necessary professional staff to undertake the tasks assigned. Similarly, the financial resources available to local authorities are also small and are often insufficient for them to undertake activities such as the provision of centralized sewage treatment facilities. There is therefore a need for an extensive capacity-building exercise at local authority level. Already there is discussion about strengthening the capacity of local authorities by increasing its professional strength in areas such as environmental management, development planning and engineering.

4.4 INAPPROPRIATE ECONOMIC INCENTIVES IN THE FISHERIES SECTOR

Inappropriate economic incentives given to the fisheries sector is one of the reasons why pressure remains high on the fisheries resources. The system that includes a wide range of subsidies and low licensing fees allows many fishermen to remain in the industry even when there is diminishing return as discussed earlier. It also contributed to a situation in which there is almost an open access to the fisheries resource in the South China Sea. Given the large number of coastal fishermen and a declining resource base, it is important that the present system of economic incentives given to fishing communities be considered. Besides eliminating inappropriate economic incentives, it is also crucial that the ongoing efforts to offer alternative sources of income to fishing communities be intensified.

Table 4.34 Malaysia – Causal chain analysis table

Major problems	Location	Source	Causal chain			Socio-economic impacts	Action
			Immediate	Intermediate	Root cause		
1. Nitrate-domestic (sewage)[2]	Kuantan, Kuala Terengganu Kota Bharu, Kota Kinabalu, Kuching	Sewage	Untreated discharge	Lack of centralized sewage systems &/or treatment facilities	Financial constraints	Human health problems from microbial contamination Eutrophication & loss of fisheries production.	Develop alternative treatment method. Build central sewage treatment system
2. Phosphate-domestic (sewage) note: phosphate based detergent has been banned in Malaysia	Kuantan, Kuala Terengganu Kota Bharu Kota Kinabalu, Kuching	Sewage	Untreated discharge	Lack of centralized sewage systems &/or treatment facilities	Financial constraints	As above	Develop alternative treatment method. Build central sewage treatment system

[2] *Refer to Annex 1*

Table 4.34 (continued)

Major problems	Location	Source	Causal chain			Socio-economic impacts	Action
			Immediate	Intermediate	Root cause		
3. Sediments (rural)[3] Increase in Sediment load	Sedili Kecil (4) River Endau River (1) Rompin River (1) Pahang River (1) Kuantan River (4) Cukai River (2) Kelantan River (1) Padas River (1)	Logging (1) Mines (2) Agriculture (3) Urban (4) development/ construction	Soil erosion Tailings discharge Soil erosion Sediment mobilizati-on	Inadequate enforcement of policies and regulations Absence of policies regarding mine waste /EIA management Poor land use practices and poor implementation of land use plans	Lack of capacity No capacity to enforce/implement	Degradation of aquatic habitats. Loss of recreational value. Loss of fisheries revenue.	Adoption of integrated watershed management plans. Review laws pertaining to mining. Regulations Capacity-building for enforcement Capacity-building
4. Organics domestic	Sedili Kecil Endau River Rompin River Pahang River Cherating River Cukai River Pengkalan Chepa River Kelantan River	Sewage Industries	Untreated discharge	Lack of centralized sewage systems &/or treatment facilities Failure to treat industrial waste waters	Financial constraints. Lack of implementation of policies regarding waste water treatment	Eutrophication and loss of aquatic production Human health problems resulting from chronic toxicity	Develop alternative treatment method. Build central sewage treatment system
5. E. coli	See 1	See 1	See 1	See 1	See 1	See 1	See 1

[3] *Refer to Annex II*

Table 4.34 (continued)

Major problems	Location	Source	Causal chain			Socio-economic impacts	Action
			Immediate	Intermediate	Root cause		
6. Over-fishing **Competition between artisanal and commercial subsectors**	Along the coast		Increase demand for fisheries resource (per capita consumption now 40 kg/year)	Too many boats Too many fishermen	Open-access Over-capitalization Inappropriate economic policy at state level.	Competition over coastal fisheries resource. Decreased income of artisanal fishermen	- Amend economic policy to eliminate "incentives" for fishing.
7. Habitat loss **a) Mangroves**	Rajang Sandakan Tawau Sedili		Woodchip-ping (unsustain-able use) Aquaculture (conversion) Aquaculture/ Infrastructure	Poor implementation of forestry policies Export income	Inadequate regulation, under-evaluation of mangrove goods and services	Loss of fisheries as a result of loss of spawning and nursery grounds. Loss of biodiversity.	Develop and apply policies for sustainable extraction of mangroves for woodchips. Woodchipping stopped in 1989 Regulate conversion of mangroves for aquaculture and infrastructure purposes.

Table 4.34 (continued)

Major problems	Location	Source	Causal chain			Socio-economic impacts	Action
			Immediate	Intermediate	Root cause		
(b) Corals	Redang Tioman Layang-Layang (Swallow Reefs) Tunku Abdul Rahman Park Sarawak	Construction Constructiion Construction Reclamation for urban development	Direct runoff of sediments Coral Mining Blast fishing	Poor construction practices Extension of airstrip and reclamation	Resort development National territorial claim Over capacity of tourism activities Reclamation Inadequate enforcement of laws	Loss of fisheries as a result of loss of spawning ground and nurseries. Loss of diversity Loss of tourism and recreational opportunities	Improve implementation of existing regulations and policies regarding coastal and resort development. Enhance enforcement Education
8. Decline in turtle landings	Rantau Abang,		Tourism development High demand for eggs Pollution		There is a lack of information to determine the root cause		Better regulation of turtle egg collection. TED Research
9. Coastal erosion		Coastal engineering structures (groins & wavebreakers) Dams	Construction of inappro- priate coastal structure. Construction of dams. Natural causes.	Disruption of sediment flow Decreased sediment transportation to coastal areas	Lack of integrated planning. Lack of understanding of sediment transport processes	Damage to coastal settlements	Better coordination between agencies.

5.0 CONSTRAINTS TO ACTION

5.1 INFORMATION AND PUBLIC AWARENESS

5.1.1 Information

Information is one of the most crucial assets in environmental management efforts. Within the Malaysian context information on the environment is collected by the sectoral agencies responsible for environment and natural resource management. For example, the Department of the Environment collects environmental monitoring data, the Department of Forestry collects data on forest resources and the Department of Fisheries collects data on fisheries resources. The main agency responsible for the collection of social and economic statistics is the Department of Statistics which also serves as the depository for such data. However, environmental data remain the domain of respective line agencies and are not deposited with the Department of Statistics.

There is an abundance of environmental data in Malaysia, many environment and resource management agencies regarding data collection as a primary function. However, for data and information to be truly an asset in environmental management, data collection needs to be followed by quality data storage, collation, analysis and dissemination. The national conservation strategy study identified several stages in the information collection chain which could be improved on:

- Data and information handling and usage;
- Sectoral data collection and storage;
- Definitions of terms and divisions;
- Data processing;
- Dissemination.

The two main bodies of environmental data collected in Malaysia are the environmental quality data collected by the Department of Environment and the statistics relating to the fisheries sector collected by the Department of Fisheries. While researchers from universities also collect data, such data does not constitute a 'time-series' as it is collected on a project basis depending on the availability of research funds and location of research areas.

The environmental quality data are sufficient for the planning and management purposes of the Department of the Environment, but lacking where municipal discharge data are concerned. This is the direct result of the lack of attention paid to such matters by local authorities. It is envisaged that this area of data collection can be improved given that municipal sewerage facilities are now operated by a single entity.

The fisheries statistics are sufficient for managing the industry but not the resource. While catch level data and data on the various types of gear used are comprehensive, data on resource productivity, demographics and availability are lacking. The last major resource survey in Malaysia's exclusive economic zone was conducted in 1987. However, such data have continuously been used to extrapolate allowable catch levels.

Where habitats are concerned, the only substantial body of data available is on forested areas within Malaysia's Permanent Forest Estate system. Forest habitats outside this system have not been surveyed and are not part of the national forest inventory work. This has made tracking habitat loss difficult especially in relation to wetlands.

Marine habitats are studied and recorded only by university researchers and to a lesser extent non-governmental organizations. The lack of continued monitoring means that data on changes in species composition, ecosystem health and area coverage are not available. Of the major coral reef

areas only the reefs off Pulau Redang have been observed for a relatively longer time between 1991 to 1994. The results from these observations have since been used to illustrate the effects of land development on corals in Malaysia.

There has been no attempt to hypothesize or quantify the effects of global climate change on marine and coastal ecosystems in Malaysia.

5.1.2 Public awareness

The lack of public awareness is considered a major hindrance to the effort to address problems related to the proper disposal of household waste, in particular in areas where access to public sanitary services is limited. In Kelantan and Sabah communities living on rivers and coastal fronts sometimes use rivers and coastal waters as a convenient means of disposing household waste.

However, there has been an overall increase in public awareness on environmental matters as noted in a survey conducted by a Malaysian daily last year (The New Straits Times 11/07/97).

5.2 LEGAL, INSTITUTIONAL AND MANAGERIAL

5.2.1 Legal

There is no lack of environmental protection and resource management law in Malaysia. The laws are supported by existing as well as proposed policies on environmental protection, forestry, agriculture and biological diversity. It is commonly accepted, however, that there is room for improved the enforcement of these environmental regulations and implementation of the various policies. Causes contributing to deficiencies in enforcement efforts include, among others, the lack of enforcement assets (including manpower and equipment); lack of awareness of environmental laws among industries and the public; insufficient environmental databases to support enforcement activities; and the existence of legal loopholes in environmental legislation.

5.2.2 Institutional and managerial

There are a number of issues that determine the conditions under which environmental protection work is carried out in Malaysia. The most important is the constitutional arrangement which gives state governments control over land, forestry, mineral and water resources. This plays a key role in determining the relationship between the federal and state authorities where environmental and natural resources management is concerned. Apart from land use planning the situation has also impacted on areas such as development of sound land use practices; provision of sewerage services; pre- and post-privatization; and conservation of habitats.

At the federal level, the institutional structure for managing certain activities sometimes does not contribute to resolving environmental problems. For example, the management of the sewerage services is divided between the Department of Sewerage Services of the Ministry of Housing and Local Government and the DOE of the Ministry of Science, Technology and Environment. The former is the supervisory agency where service quality is concerned but has no control over discharge standards. The DOE on the other hand controls discharge standards but has no control over the quality and quantity of sewerage treatment facilities.

At the same time there are examples of good inter-agency cooperation in implementing environmental protection measures and in enforcing environmental laws. One of the most visible examples is the combined effort to detect, apprehend and prosecute vessels that intentionally discharge oil, oily wastes and other pollutants into Malaysia's waters. The enforcement activity typically involves agencies with enforcement authority delegated by the DOE such as:

- The Royal Malaysian Air Forces (in surveillance role);
- The Royal Malaysian Navy (in surveillance, monitoring and in apprehending offenders);
- The DOE as lead agency and prosecuting agency;
- The Marine Department as the agency responsible for controlling maritime transport.

To further enhance enforcement efforts a common procedure for arresting ships found contravening Malaysia's marine environment protection law has been developed and workshops held to promote cooperation.

Another example of inter-agency cooperation in controlling marine pollution is the implementation of the National Oil Spill Control Contingency Plan. In addition to the agencies mentioned above the plan also involves local authorities in clean-up operations once oil spills have reached beaches or shore areas.

6.0 ONGOING AND PLANNED ACTIVITIES RELEVANT TO THE IDENTIFIED ISSUES

6.1 POLLUTION

6.1.1 River pollution

Various measures are being undertaken and planned to address the problems associated with river pollution. And while the full impact of river pollution is yet to be seen in Malaysia, existing problems indicate that if it is not adequately addressed river pollution could impact severely on the social and economic well-being of communities depending on rivers for water supply and other services. The effort to address the problem of river pollution largely hinges on the ongoing government initiative to privatize the treatment of domestic sewage. The exercise, which began in 1993, is aimed at significantly improving the present sewerage system. Over the next few Malaysia Plans the concessionaire (Indah Water Konsortium) will spend over RM 7 billion to develop new sewerage infrastructure as well as to maintain and improve existing ones. It is unlikely that the result of this exercise will be seen in the immediate future, and given the lack of projection it is difficult to predict the contribution this exercise will make to improve river water quality. The numerical objectives of the project are as follows:

- In 49 large local authority areas – 85 per cent of customers will be connected to main sewerage services while the remainder will be served by septic tanks;
- In 95 small local authority areas – 30 per cent of customers will be connected to main sewerage services while the remainder will be served by septic tanks.

No statement has, however, been made regarding pollution level related objectives.

Equally importantly is the fact that the privatization of sewage treatment means that the public is paying for environmental protection for the first time. And while the notion of "polluter-pays" is not new in environmental circles, the Malaysian public (unlike industry) has hardly been introduced to the principle. This has created some initial problems related to the rates imposed with some municipalities unilaterally deciding against paying the treatment rates. However after further consultation, improved publicity and revised rates, the project appears to have met with public approval and support.

Industry-related programmes are expected to continue to be based on existing regulations provided under the Environmental Quality Act. One of the features of the present industry regulation programme is the success achieved in controlling pollution from the rubber and palm oil manufacturing sectors. The success based around industry specific compliance standards combined with generous subsidies for the development of indigenous waste treatment and recycling processes should be expanded to include other industries which have been identified as major polluters, for example the electroplating and food industries.

River pollution by sediment will continue to be a problem unless authorities are prepared to abide by the many land use guidelines and land protection regulations and undertake much needed activities such as establishing riverine or riparian reserves and restricting or prohibiting development in highlands or steep areas.

6.1.2 Marine pollution

The continued effort to address marine pollution problems can be summarized into three important areas:

- Continuous and long-term efforts to address land-based pollution;
- Continued surveillance and monitoring of vessel-based pollution;
- Preparedness to counter oil spills.

The problem with marine pollution from land-based activities is similar to the problems of river pollution in that much depends on sound land use planning and development and treatment of sewage and other domestic and industrial discharges. In recognizing the problem, Malaysia has endorsed the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). At the same time national efforts to address the problem are continuing.

As part of the effort to strengthen marine environment protection efforts Malaysia has also ratified a number of important international maritime conventions pertaining to marine pollution prevention and compensation for marine pollution damage. The most important of these instruments is the International Convention for the Prevention of Pollution from Ships, 1973 and the Protocol of 1978 (MARPOL 73/78) which Malaysia ratified on 28 January 1997. The ratification of MARPOL 73/78 is crucial as it provides Malaysia with a useful flag state control instrument for Malaysian flagged vessels while protecting Malaysia from pollution by vessels of other member States.

To address the possibility of pollution from oil spills, Malaysia established a National Oil Spill Contingency Plan (NOSCP) in 1978. The plan was subsequently revised in 1993 to improve coordination between related agencies. The programme consists of a tiered response programme based on responses at spill site (Tier 1); at national level (Tier 2); and at regional level (Tier 3).

The National Oil Spill Contingency Plan combines the efforts and resources of the public sector (headed by the DOE) and the private sector. The private sector effort and resources are coordinated by the Petroleum Industry of Malaysia Mutual Aid Group (PIMMAG) headed by the national oil corporation Petronas. Some assistance has also been received from the Government of Japan and the Japan Petroleum Association for the purchase and stationing of oil spill control equipment stockpiles and the training of personnel.

6.2 FRESHWATER SHORTAGE AND QUALITY

There is no serious water shortage problem in Malaysia or in the study area. But as noted earlier, the issue of water supply concerns more than just water quantity but is dependent also on water quality or the availability of clean water for treatment and supply. Given the general decline in

river water quality in Malaysia, it is foreseeable that unless river water pollution is controlled, pollution may contribute to future shortages in water supply for the country's treatment plants. This could result in the need to install expensive water treatment technology and increased water prices for domestic and industrial consumption.

The effort to improve the water supply quality is closely linked to pollution control efforts and has been described above. The problem of freshwater quantity however requires coordination at the national level – a move which the state authorities have resisted for fear that state revenue from water resources might be lost. The most recent shortage has again brought the questions of a national water policy and a national water council to the discussion table. The idea which was first mentioned in the National Water Resource Study of 1982 needs to be reviewed and addressed as a matter of urgency to avoid localized shortages which often result in expensive short-term solutions.

Most states have resorted to privatization as a means for ensuring water supply quality and quantity. In states where privatization has been carried out, it is too early to judge whether privatization has improved water supply quality or quantity. But without a national body to supervise and monitor the status of freshwater supply in Malaysia, it would be extremely difficult to develop national standards for water quality and quantity.

6.3 EXPLOITATION OF RESOURCES

The most pressing issue that needs to be addressed with reference to resource conservation in the study area is the pressure on coastal fisheries resources. A number of actions have been taken to alleviate the problem. First, since 1984, the Government has been promoting offshore fisheries as an alternative to coastal fisheries. The approach has not been entirely successful and most of fish landed (over 80 per cent nationally) still originates from near-shore areas within 30 nautical miles from shore. However, statistics for offshore fisheries are reportedly inaccurate as some fishing boats declared lower catch figures than the actual catch while some others are known to land fish in non-Malaysian ports. Problems affecting the deep-sea fishing sector include the lack of interest among locals to work on deep-sea fishing boats and problems in getting start-up capital from local financial institutions. Of the 646 deep-sea fishing licences offered, corporations and individuals have taken up 572.

The other alternative that is being implemented is income substitution. Fishing communities are encouraged to develop new skills or participate in economic activities such as downstream processing of fish produce (mostly as cottage industries), agriculture or new employment in the manufacturing sector.

Nevertheless, the approaches mentioned above are indirect and are essentially long-term measures. In the immediate term the Department of Fisheries has also implemented methods aimed at improving the fisheries stock such as deploying artificial reefs. Stock enhancement is also one of the objectives of establishing marine parks besides ecosystems protection and marine biological diversity conservation. Enforcement of licensing conditions is also carried out to ensure the use of proper equipment and prevent the encroachment of large fishing boats into inshore fishing zones. Even more drastically, the Department of Fisheries has imposed a moratorium on new inshore fishing licences since 1982.

A more direct approach is the zoning system shown in table 1.4. The intention of this arrangement is to ensure that coastal fisheries resources are protected from industrial fishing activities. Enforcing these zones, however, is difficult because larger fishing boats regularly encroach into coastal fishing areas. The Department of Fisheries is presently exploring other means of enforcing the zoning regulations including local community participation.

The success of these programmes needs to be monitored and evaluated to ensure that resources are being used in an optimal manner. To this end regular trawl surveys are conducted by the Department of Fisheries to monitor stock conditions and levels. Miles (1995) however commented on the lack of trend data for offshore and EEZ areas – the only survey being conducted in 1987.

6.4 HABITAT MODIFICATIONS

Where habitat protection is concerned, Malaysia depends almost exclusively on the existing system of marine and terrestrial protected areas established under key legislation namely, the Fisheries Act, the Forestry Act, the National Parks Act and the Protection of Wild Life Act. In Sarawak, protected areas are established under the National Parks Ordinance while in Sabah the principal legislation for habitat conservation is the Park Enactment although protected areas can also be established under the Forest Ordinance. Besides direct protection through the establishment of protected areas, these laws also accord indirect protection to habitats. For example, although certain seagrass beds are not located within marine park boundaries, the Fisheries Act protects these beds by prohibiting trawling in inshore areas where seagrass beds are.

To date, the marine protected area system in Malaysia comprises 38 marine parks which protect the waters of 38 islands in peninsular Malaysia and the Federal Territory of Labuan. Additionally, Sabah has also gazetted three islands as state national parks. Some mangroves in Sabah and Sarawak are protected as forest reserves.

The combination of these laws provide for the establishment of protected areas which include representatives of most if not all of the habitat types found in Malaysia. On the other hand, coastal and freshwater wetlands are not represented within this system. Zainuddin and others (1994) however recommended that the existing protected areas be expanded to include representative habitats not already included or under-represented.

7.0 IMPLICATIONS OF THE PROPOSED ACTION BY SECTOR

7.1 FINANCE

The most significant investment is expected in two areas, in the provision of sewerage services and freshwater supply. The projected investment needed to improve the national sewerage system totals RM 7 billion as opposed to the RM 328 million already spent by the public sector to provide for sewerage treatment. The impact of the present economic downturn on this investment is yet to be analysed. In comparison the Government has already spent RM 7.8 billion ringgit in providing water supply to Malaysians and is spending another RM 4.03 billion during the Seventh Malaysia Plan (7 MP) period. Again the present economic downturn may have an impact on this spending but the impact will only be known after the mid-term review of the 7MP is completed later this year.

In addition to the long-term investments, the country's financial resources are also sometimes used to finance short-term or stop-gap measures to address pressing water-related issues. The present water shortage, for example, has imposed an additional burden on the Government's finance. Similarly the water crisis in Malacca in 1990 resulted in a RM 250 million investment to install a water pipeline from the Muar River to Malacca. Such stop-gap measures will continue to burden the country's finances if longer term solutions are not explored.

No significant investments have been proposed for environmental management projects during the Seventh Malaysia Plan.

7.2 ECONOMIC DEVELOPMENT

The proposed interventions do not require any modification to the country's economic development policy at the national or macro level. State level development, however, would need to be realigned to shift the focus from a resource intensive economic base to one that is geared towards industrialization. This is particularly true if land use planning and land development practices are to be improved particularly where habitat modification and loss are concerned. Such realignment would be difficult to achieve as most state revenues comes from resource exploitation, in particular water, mineral and forestry resources.

Imposing a national coordination mechanism for water supply, for example, might be a boon or a bane to the state authorities at it may deprive them of a revenue generating resource. At the same time the national mechanism may also contribute towards state revenue by encouraging inter-state water transfer or purchases.

7.3 FISHERIES

The income replacement programmes and the programmes to limit the number of fishermen in coastal areas may have direct effects on stock size and availability. Without time-series data, however, it would be difficult to confirm whether such improvement is indeed occurring. Similarly no attempt has been made to assess the contributions made by the establishment of marine parks on fisheries stock and marine biological diversity. The establishment of marine parks, however, has created a tension between the authorities and local fishing communities who claim that they are being deprived of their traditional fishing grounds.

7.4 AGRICULTURE AND FORESTRY

The call for the protection of representative wetland habitats would significantly improve the country's Permanent Forest Estate system as most non-mangrove wetlands are located on state land. Such a move however would deprive the agriculture sector of what is considered to be a readily available resource for agricultural purposes. Again the solution lie partly in the realignment of state level development policies towards those which are more industry intensive rather than those which are resource intensive.

7.5 MANUFACTURING

The effects of the proposed interventions on the manufacturing industry can be both good and bad. An improved water supply assists the development of the industrial sector. However, given that there are many industries located near the country's rivers, investment needs to be made to improve their environmental performance. In an ideal situation these factories would need to be relocated away from rivers, and indeed many have been relocated. Specific industry related programmes have also been developed and have been successful in the case of the rubber and palm oil industry. These programmes, however, do need commitment from the public and private sector to improve industry practices and install pollution control equipment.

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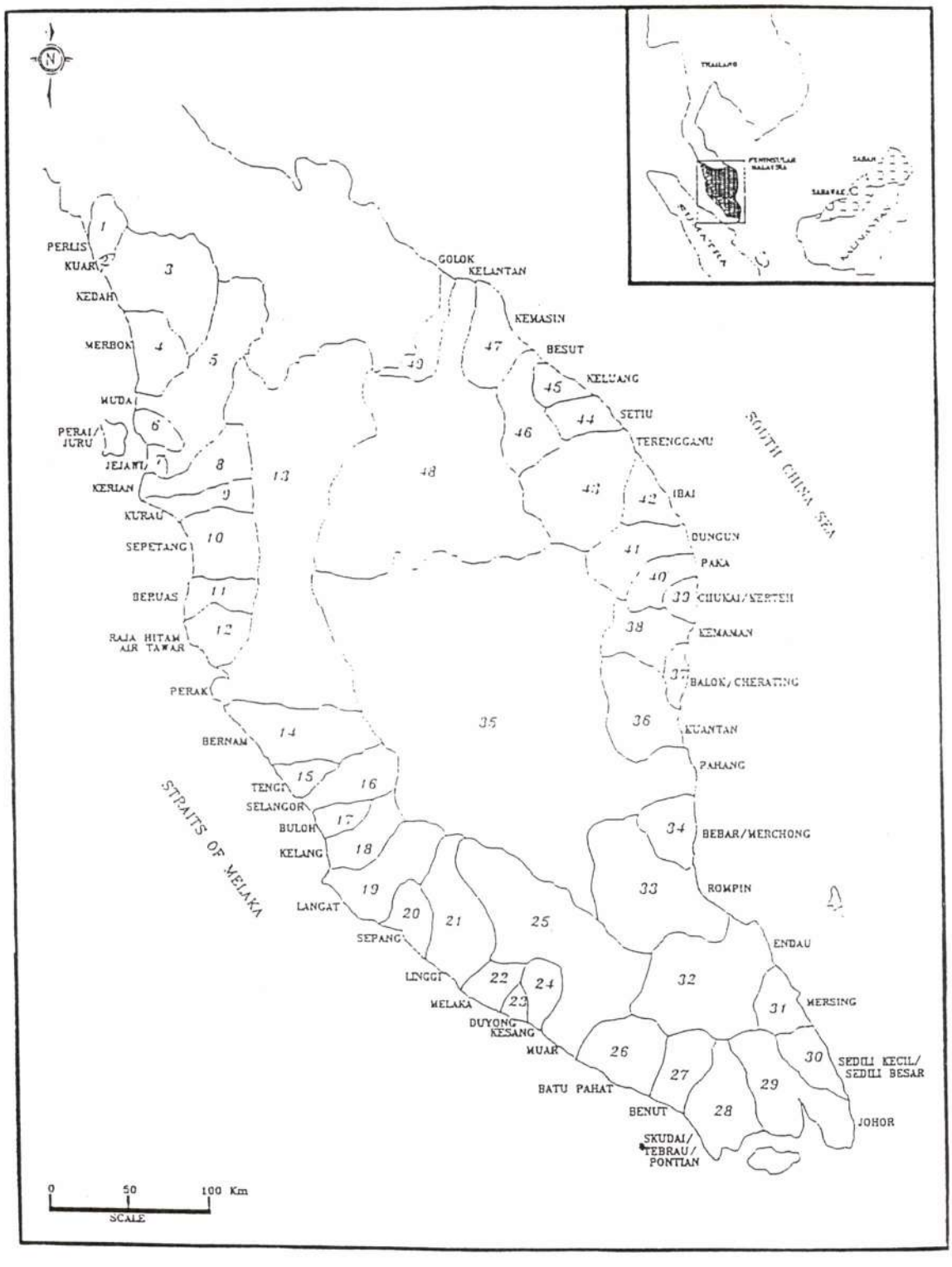

Figure 1(a). Peninsular Malaysia Water Quality Region

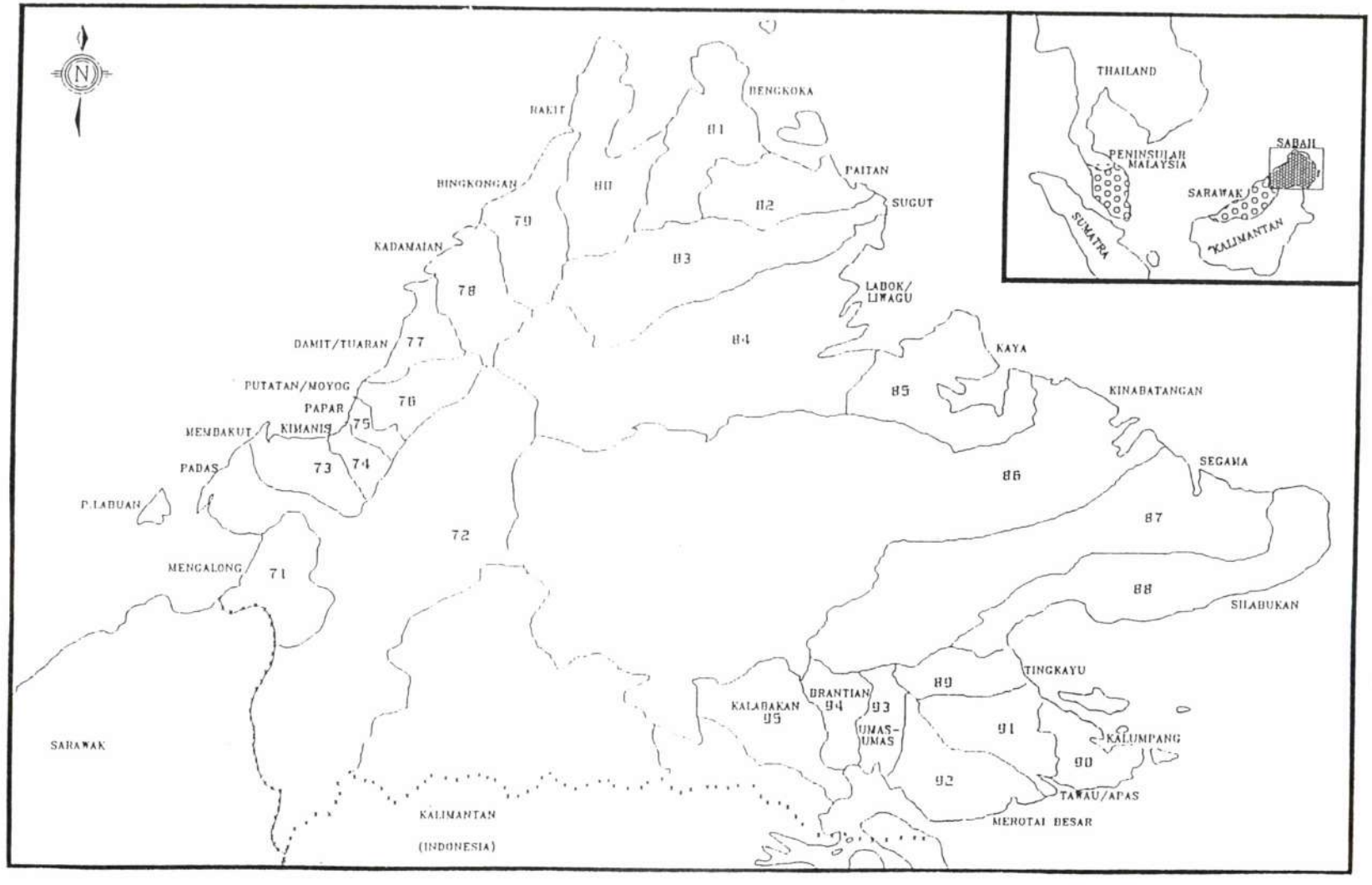

Figure 1(b). Sabah Water Quality Region

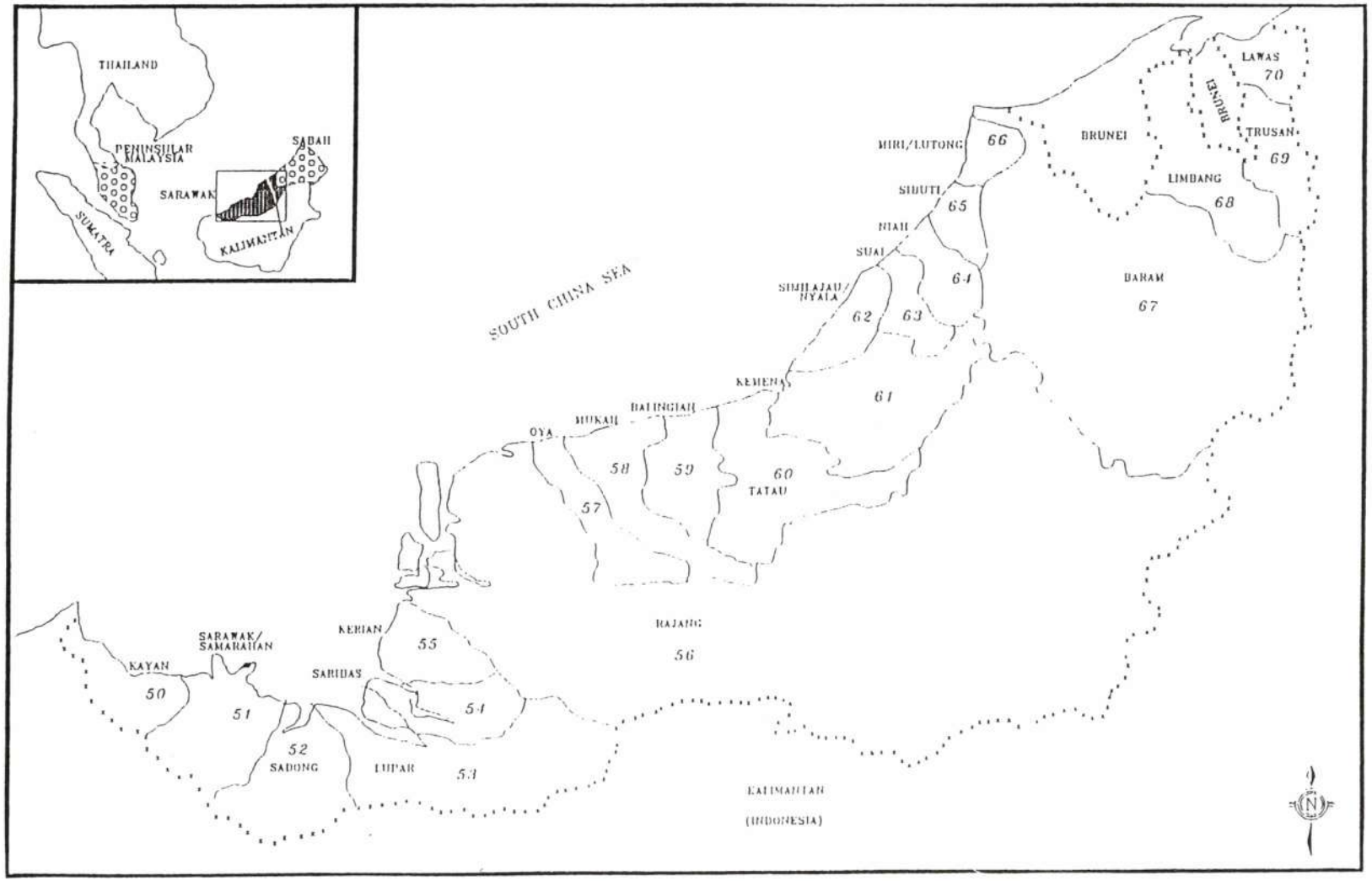

Figure 1(c). Sarawak Water Quality Region

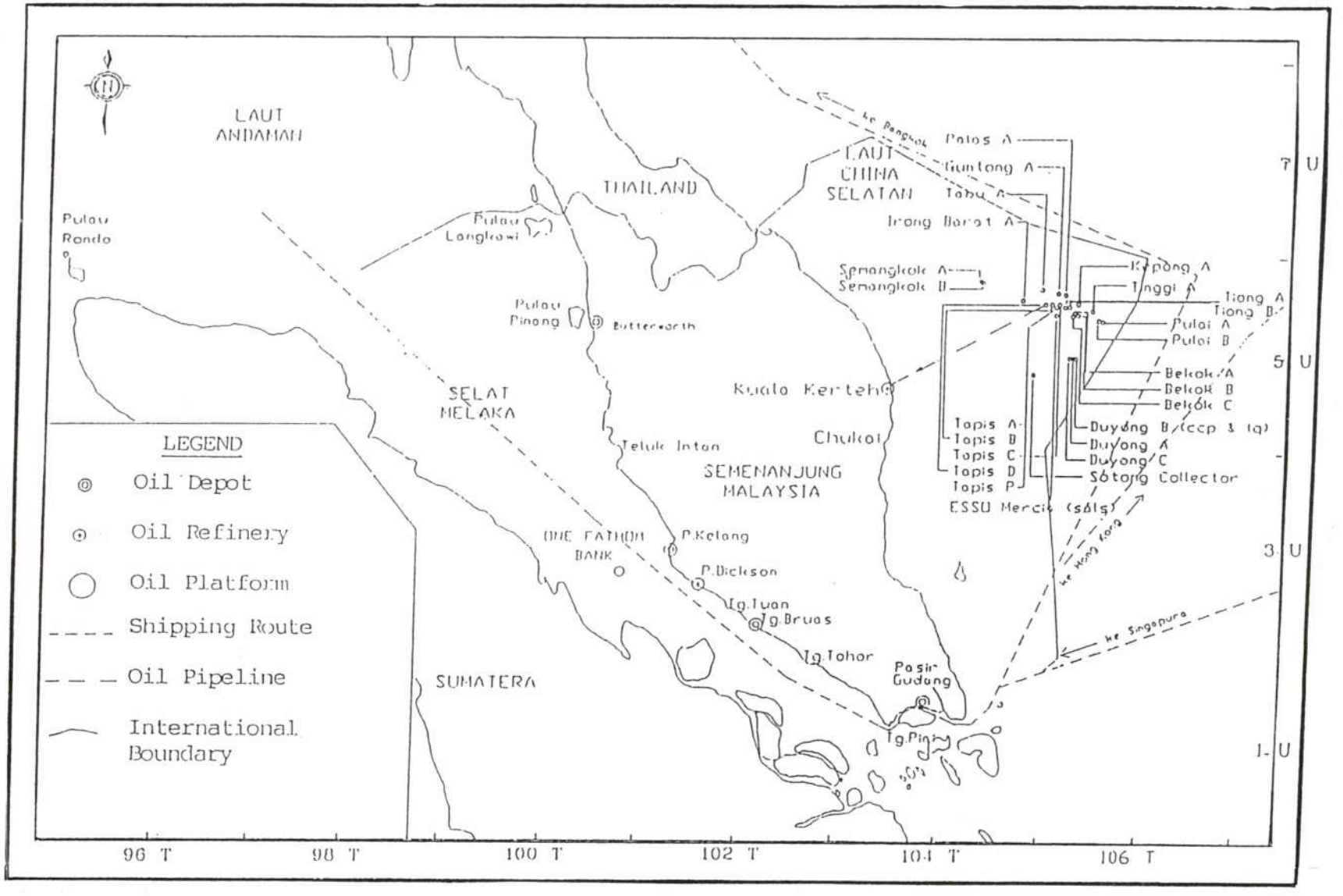

Figure 2. Oil Spill Risk Areas – Peninsular Malaysia

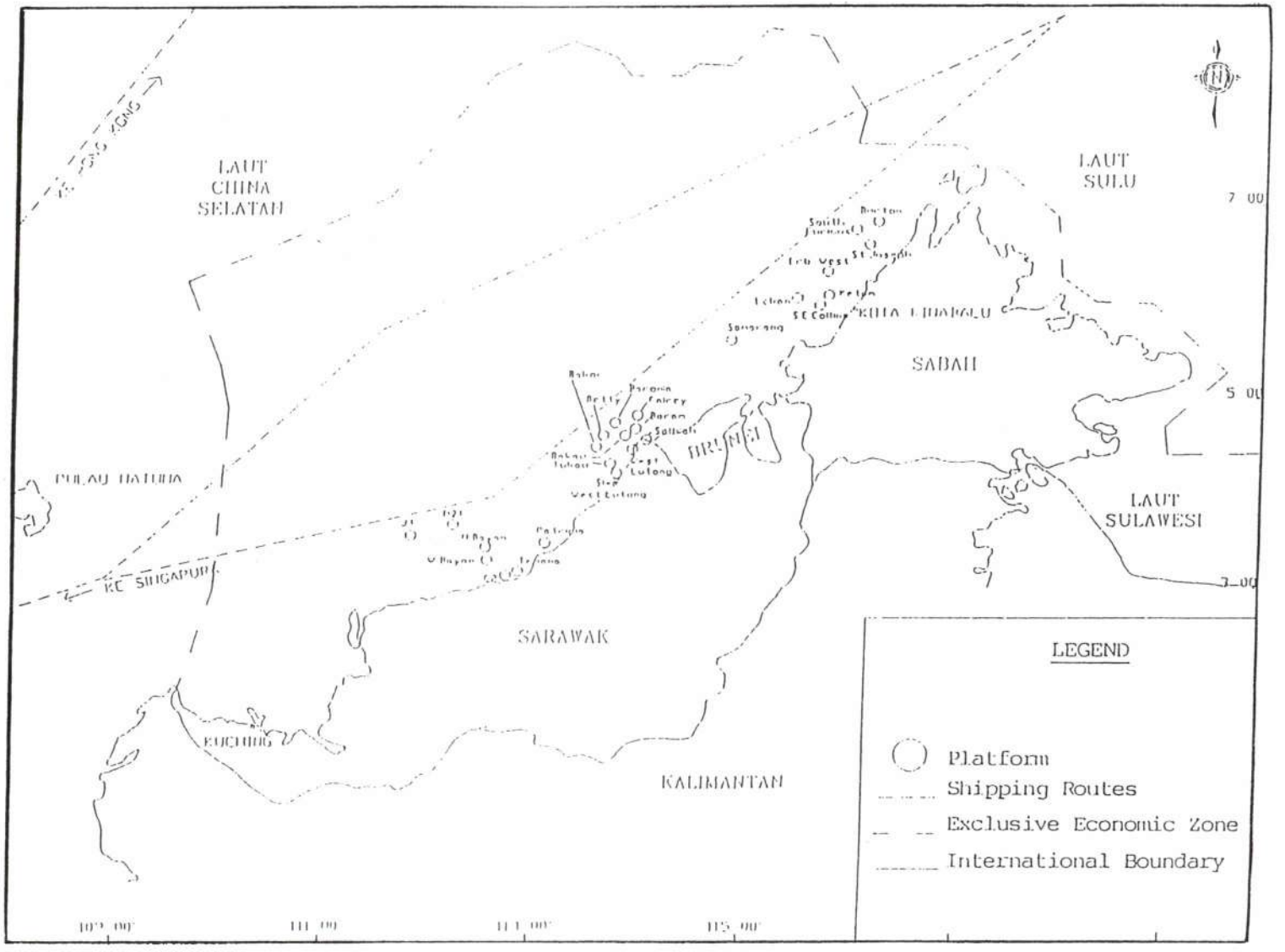

Figure 3. Oil Spill Risk Areas – Sabah and Sarawak

FIGURE 4:

AREA OF CONCERN: THREAT OF POLLUTION TO COASTAL ZONE

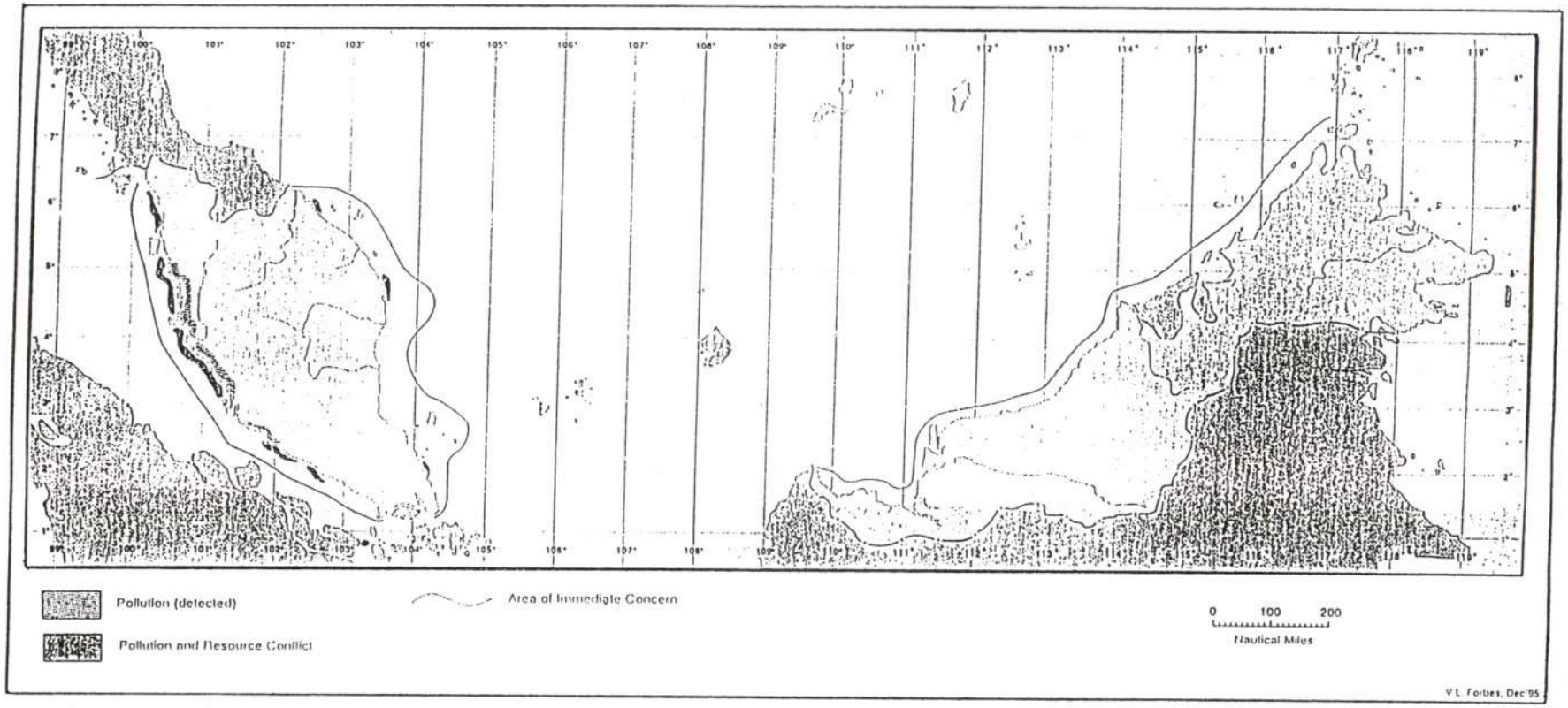

Figure 4. Area of Concern: threat of pollution to coastal zone

FIGURE 5:

VULNERABLE MARINE ECOSYSTEMS - MANGROVE FOREST AND CORAL ISLANDS

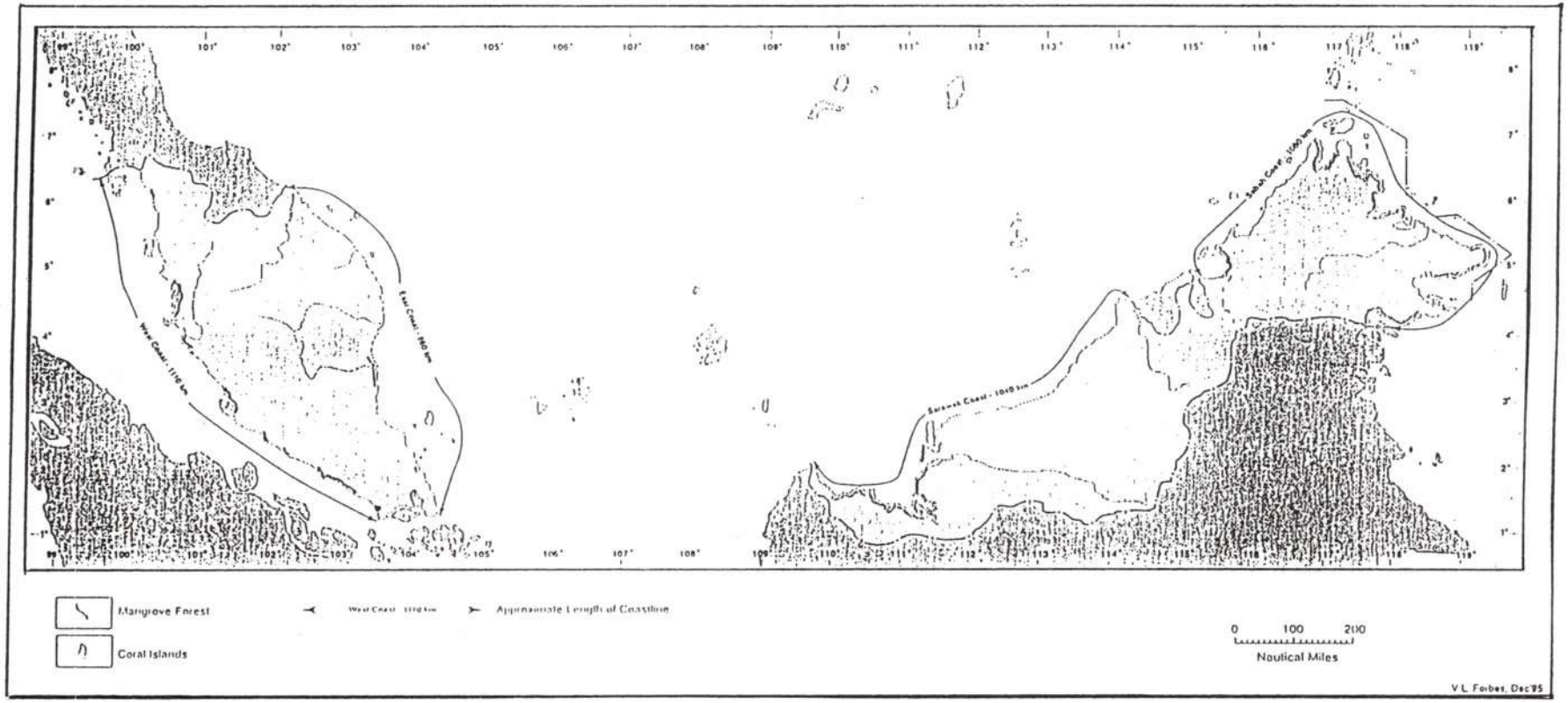

Figure 5. Vulnerable Marine Ecosystems – mangrove forest and coral islands

FIGURE 6:

VULNERABLE MARINE ECOSYSTEMS SEAGRASS BED

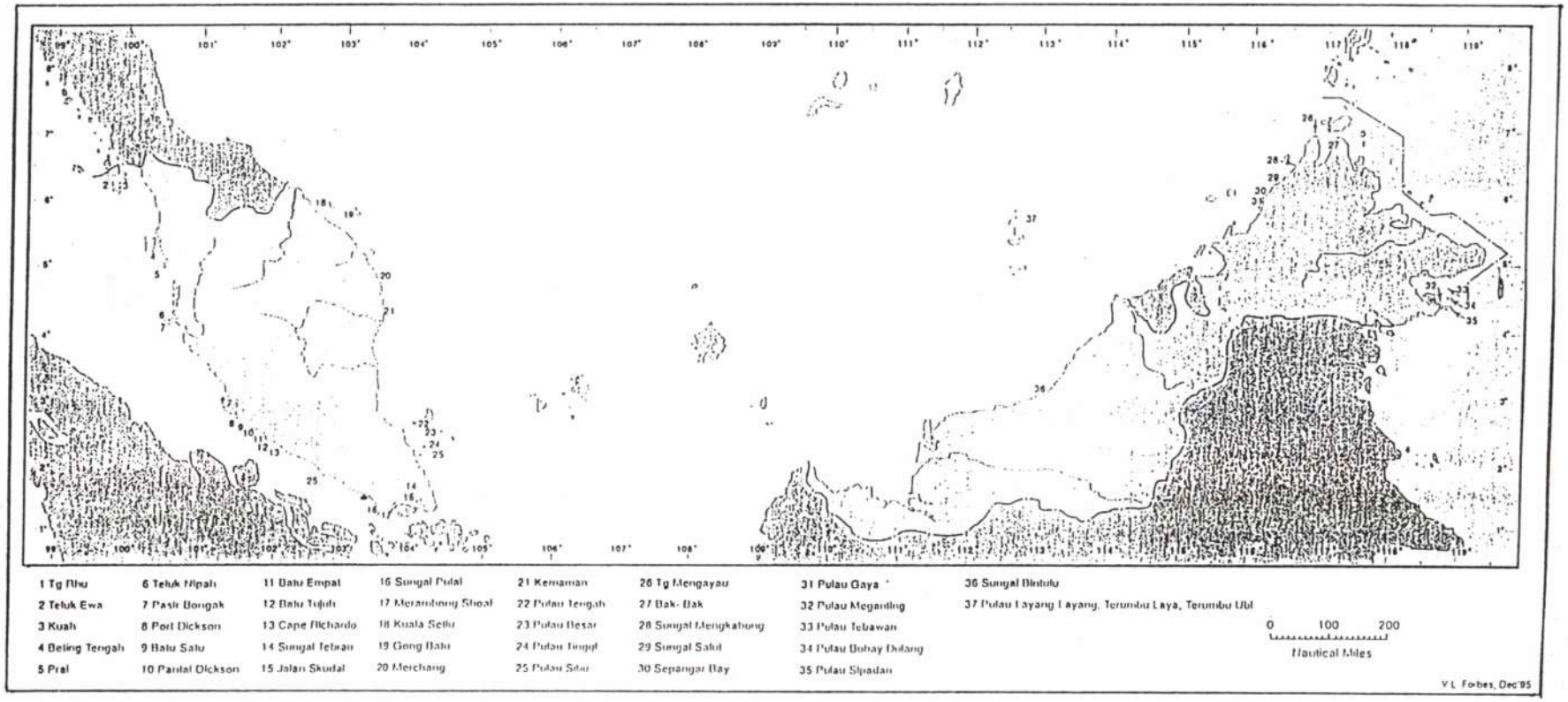

Figure 6. Vulnerable Marine Ecosystems – seagrass bed

FIGURE 7:

KNOWN TURTLE NESTING SITES

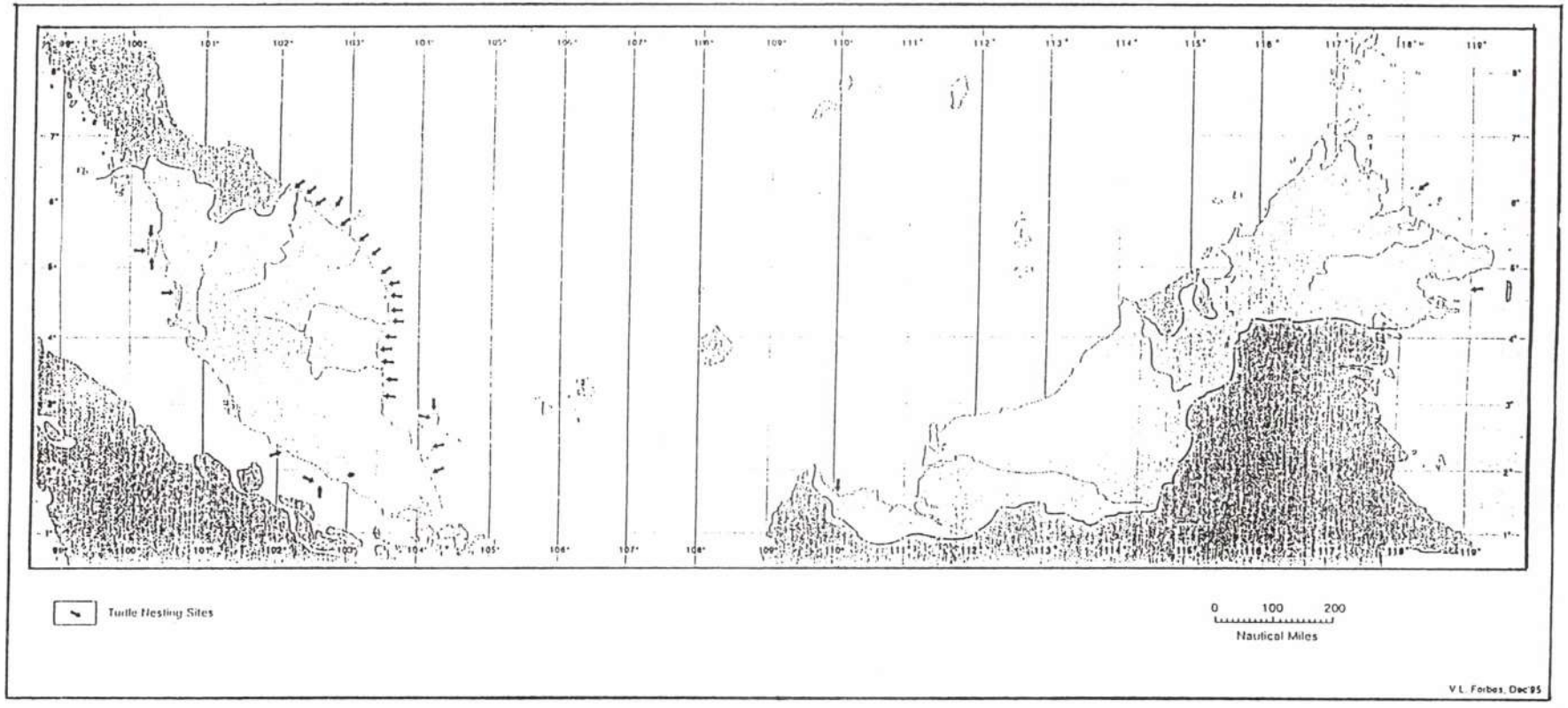

Figure 7. Known Turtle Nesting Sites

FIGURE 8:

SEA-SURFACE CURRENTS: JULY

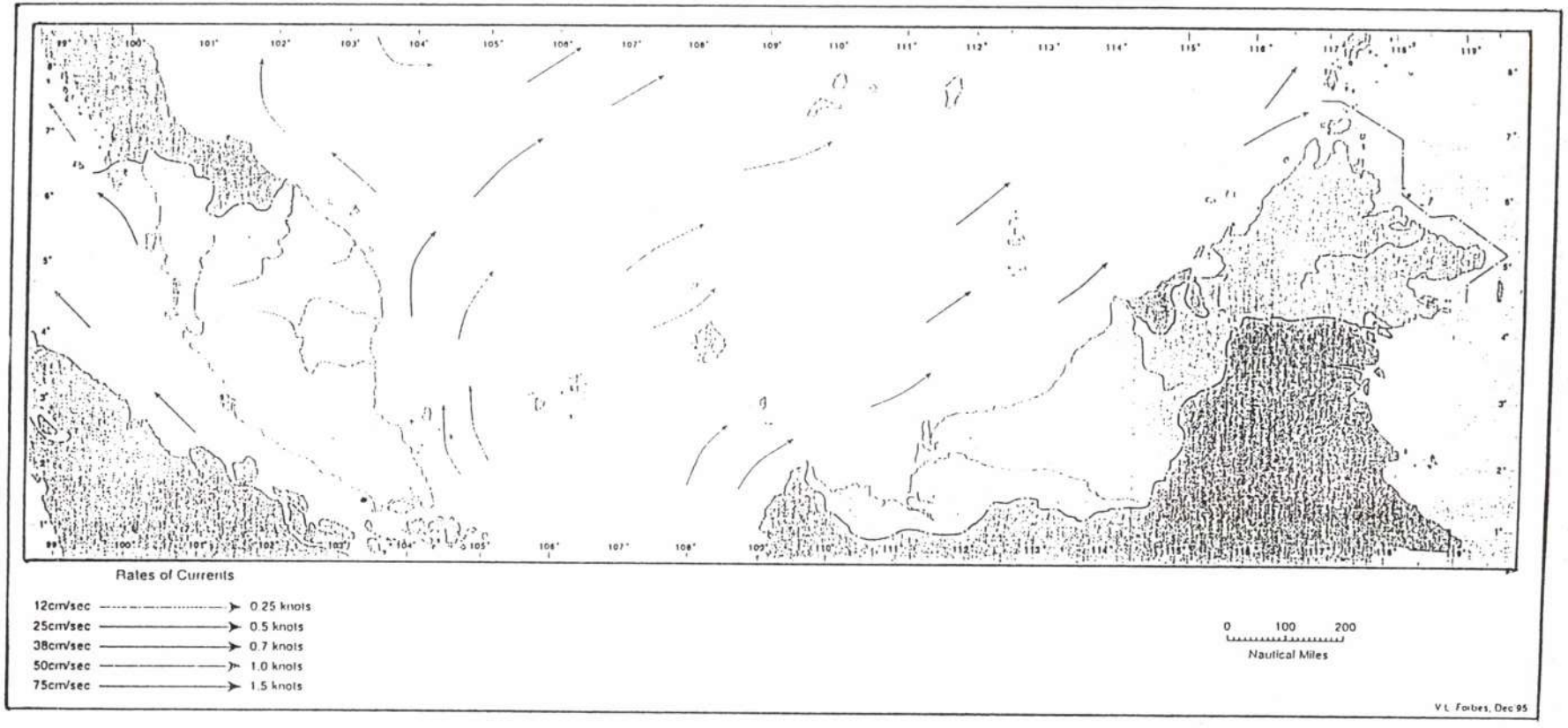

Figure 8. Sea Surface Currents: July

FIGURE 9:

SEA-SURFACE CURRENTS: JANUARY

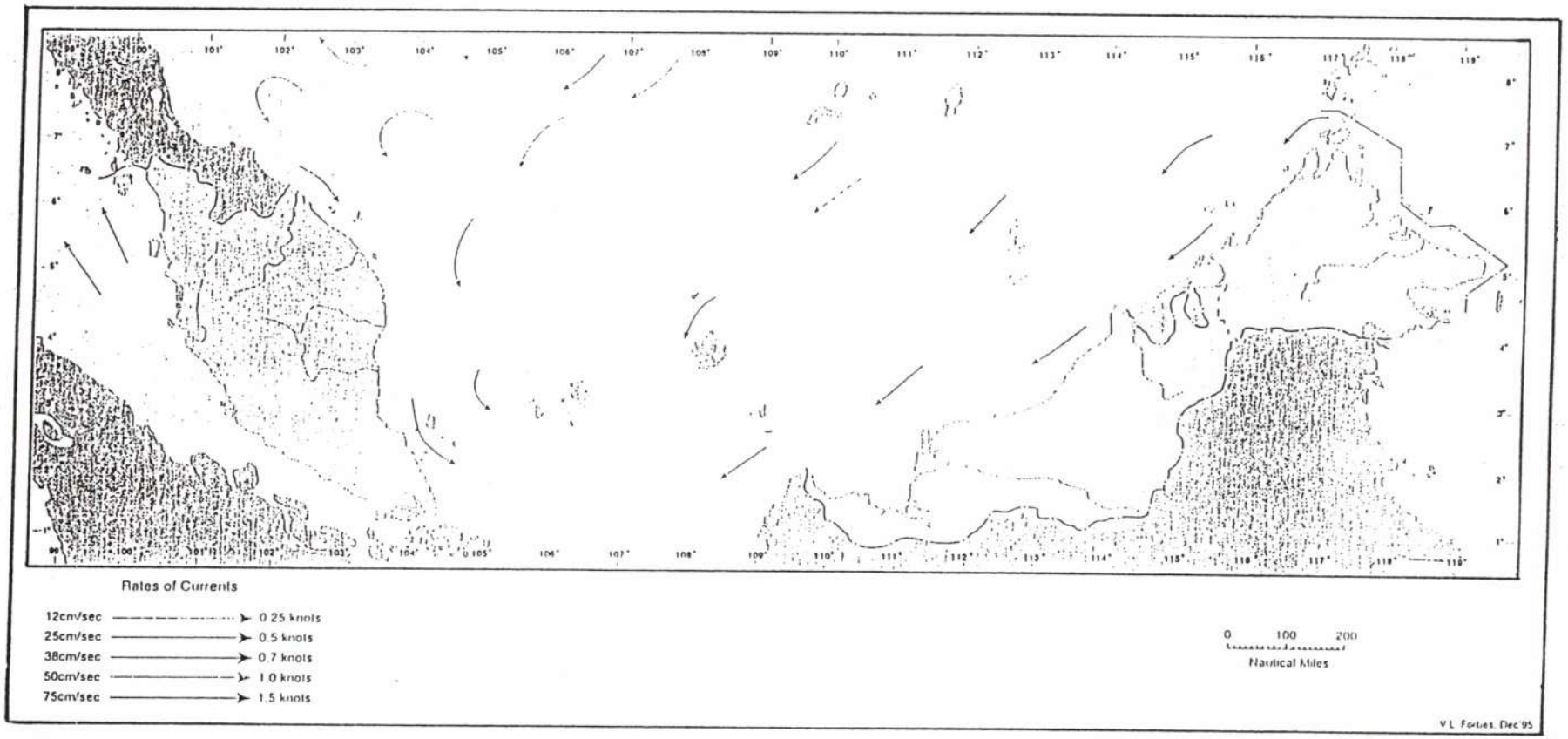

Figure 9. Sea Surface Currents: January

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