UNITED NATIONS ENVIRONMENT PROGRAMME

EAST ASIAN SEAS REGIONAL COORDINATING UNIT

UNEP/GEF
Project Coordinating Unit

NATIONAL REPORT OF THAILAND

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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PREFACE

The project GF /ES/FP/1100-97-03 : Formulation of a Transboundary Diagnostic Analysis and Preliminary Framework of a Strategic Action Programme for the South China Sea is funded to a large extent by GEF through a Project Development Facility Grant. It has been developed at the request of the National Focal Point for the East Asian Seas Action Plan at the meeting in Bangkok, 22-26 July 1996. It has been approved by the Twelfth Meeting of the Coordinating Body on the Seas of East Asia (COBSEA) held in Manila, 3-5 December 1996.

The project addresses the transboundary environmental concerns of the South China Sea and especially aims to undertake a large-scale Transboundary Diagnostic Analysis for the South China Sea leading to the future development of a strategic action programme including a cluster of related projects in the fields of marine biodiversity protection; protection of the South China Sea against degradation, particularly pollution from land-based activities; and management of multi-country freshwater basins such as the Mekong and Hong-he Rivers that drain into the South China Sea. Transboundary Diagnostic Analysis needs to be based on available secondary information in the South China Sea region and the causal linkages explaining the extent of the sources and impacts of identified issues will need to include consideration of likely trends in terms of changes in economic development and demographic characteristics.

To prepare for this national report, the Office of Environmental Policy and Planning (OEPP) contracted the Southeast Asia Global Change System for Analysis, Research and Training Regional Center, an affiliation of Chulalongkorn University, to conduct literature survey, interviews, and drafting of report. Two national workshops were conducted during the course of preparation of this report to gather information and action plans of prospect participating agencies in the future. OEPP would like to express thanks to all agencies and individual that made contributions to this national report.

OEPP realizes that the most important obstructions in term of prevention of transboundary environmental problem is due to the lack of awareness in different sectors and the lack of proper legal and institutional instruments. It is hoped that with additional support from UNEP and GEF in the future, some of the key obstruction will be resolved.

1.0 INTRODUCTION

Thailand as coastal country of the South China Sea has fully aware of the transboundary pollution in this marginal sea and realize that the problem must be solved by a regional cooperation effort and not by individual countries. Preparation of this national report is an effort of the country to show the willingness to participate in such a program.

1.1 AIM OF THE REPORT

This national report is aimed to review existing information in Thailand related to transboundary environmental concerns in the South China Sea. Information from published reports, in-house documents and interviews had been compiled according to the outline given by the First Meeting of National Coordinators for the Formulation of a Transboundary Diagnostic Analysis and Preliminary Framework of a Strategic Action Programme for the South China Sea, Bangkok, Thailand 31 March - 4 April 1997. However much of information required by the outline could not be obtained, mainly because of the lack of information and past emphasis of environmental agencies in Thailand had been on local effects of pollution and environmental degradation rather than transboundary. Information concerning economic aspect and cost analysis of issues are also substantially lacking.

1.2 MAJOR WATR-RELATED ENVIRONMENT PROBLEMS

Major environmental problems related to water in Thailand are

- Freshwater shortage
- Freshwater quality degradation
- Marine and coastal environmental quality degradation
- Over exploitation of marine and freshwater living resources
- Destruction of coastal and marine ecosystem
- Threats to endangered species

These problem will be reviewed and discussed in this national report in terms of history, present status, forecasting, causes, economic valuation, policy, past/present/future actions and plans.

1.3 COUNTRY BACKGROUND

Thailand is situated on the South-East Asian mainland, between latitudes 5o 37' N and 20o 27' N and longitudes 97o 22' E and 105o 37' E. The land area of the country is bound to the north by Myanmar and the Lao People's Democratic Republic, to the east by the Lao People's Democratic Republic and Cambodia, to the west by Myanmar, and to the south by Malaysia. The total land area is 513,115 square kilometres, extending about 2,500 kilometres from north to south and 1,250 kilometres from east to west. The total length of coastline is about 2,705 kilometres, 1,840 kilometres in the Gulf of Thailand and 865 kilometres in the Andaman Sea (Indian Ocean). The total inland water area is 45,450 square kilometres, among this 2,050 square kilometres are man-made reservoirs, 2,150 square kilometres are natural lakes, 1,250 square kilometres are rivers, and about 40,000 square kilometres are other types of freshwater bodies.

The country has a population of approximately 59.1 million (1994), of which around 6 million live in the capital city, Bangkok. The most important ethnic minority are Chinese. Other minority groups include Malays, Cambodians, Indians, non-Thai hill tribes, and some Vietnamese. Immigration is controlled by a quota system. The population growth rate was 1.4 per cent in 1990. Over 25 per cent of the population lived in urban areas.

The gross domestic product (GDP) of the country is shown in the table below.

Table 1.1 Annual gross domestic product in millions of US dollars (by sector)

Sector	1990	1991	1992	1993	1994
Total	74,138	85,680	98,151	110,064	107,918
Agriculture and forestry	6,520	7,401	8,037	6,934	8,473
Fisheries	1,260	1,690	2,193	2,324	2,398
Other	66,358	76,589	87,921	100,806	97,047

Source: SEAFDEC 1997.

In 1987 the infant mortality rate was 35 and the under-five mortality 45 per 1,000 live births. Life expectancy was 63 and 68 years for males and females respectively in 1990.

Thailand's industries have traditionally been closely linked with agriculture. From the post-war years up to the late 1950s, the major processing facilities were rice mills, sawmills, sugar mills, ice factories, tobacco leaf curing plants and cottage or household industries, such as fabric weaving and basketry, to supply local needs. All these industries grew up as a result of free market forces and with limited government assistance.

Modern industrialization started in the early 1960s. Although the first Industrial Promotion Act was promulgated in 1954, it was only implemented in 1960 with the establishment of the Board of Investment. This Act was revised in 1962 to promote investment in specific activities, mainly through tariff protection, tax holidays and reduction of taxes on imported goods in 1972 in accordance with the Government's shift in policy from an import substitution to an export oriented economy.

Growing at an annual average rate of approximately 10 per cent since 1960, in 1988 manufacturing accounted for more than 26 per cent of the national income; employed 8 per cent of the entire labour force; and accounted for 90 per cent of exports and 71 per cent of imports, making it the nation's largest sector.

In 1960, industrial activity concentrated on food processing, which accounted for over one third of total manufactured products. Other significant products were beverages, tobacco, garments and chemical compounds. From 1960 to 1969, the fastest growing was the petroleum products industry, averaging 103.1 per cent a year. However, between 1980-1988 the average growth rate declined to only 3.4 per cent a year as a result of the diversification of the industrial sector.

Intermediate products, among them machinery, electrical machinery, iron and steel, metal products and non-metallic products, also expanded rapidly. As a result of the relatively high growth rates of these industries structural change took place in this sector. Instead of concentrating on a few industries, the manufacturing sector's activities broadened to encompass several new groups of industries. Thus, in 1970 more intermediate products were manufactured, for example, electrical machinery transportation equipment, textiles and garments not only to substitute for imported products, but also for exported products.

In the current phase of Thailand's industrial development, dating from the realignment of the Japanese yen and other major currencies, the country is benefiting from a major regional restructuring of manufacturing. Production of a new range of intermediate manufactures is being fuelled by a wave of foreign investment and industrial relocation from Japan, Taiwan Province of China and other Asian newly industrializing economies (NIEs), in addition to the United States of America and other countries.

On the whole, the manufacturing sector's performance has been impressive. With its ability to expand and adapt to world market conditions, the country can look forward to further diversification and growth and increased prosperity.

Taking into consideration the availability of resources and the potential of projects already under way, one may expect the following industries to grow in significance over the next decade.

Agro-based industries. At present Thailand has abundant supplies of farm produce. The advantage of establishing additional food processing industries is, therefore, apparent. Large-scale commercial livestock production offers unlimited growth potential. Other agro-based industries with good prospects include palm oil, vegetable oil, canned fruit and paper pulp.

Non-ferrous construction materials. Thailand's cement industry reputedly was a net exporter. But during the uncertain period following the oil crises, the Government took measures to control inflation by freezing the prices of major commodities including cement. As a result, investment in this industry was delayed and the country became a net importer of cement. By mid-1979, however, with government encouragement, a massive expansion of capacity was under way which turned Thailand back into a net exporter of cement by 1982. Other construction materials with strong potential are aluminum, glass and ceramics. The economic boom of 1987-89 led to another surge in the construction sector.

Light machinery and equipment. Effective 1 January 1987, the Government in July 1986 advised local passenger car assembly plants that they must use not less than 54 per cent of locally-produced components. This measure has helped to accelerate the production of automotive components. This prospect has been further enhanced by cooperation among the Association of South East Asian Nations (ASEAN) countries to expand intra-ASEAN trade, thus enlarging the market for individual countries. Other activities include the production of agricultural machinery, diesel engines, drilling and welding machines.

Chemical products. With current market demand, the chemical products industry is expected to expand rapidly over the next few years. Items in this group include herbicides, acetylene black, glue gelatin and cellulose acetate.

Mineral processing industries. Developments in this sector point to future expansion of zinc, rock salt and gypsum processing facilities.

In summary, Thailand's prospects for industrial exports in the near future appear bright. This assessment is based on five major factors: capable producers who now have a strong and flexible agricultural base; much closer contact with world markets than before; low-cost skilled labour capable of producing advanced industrial products; the dynamism of East Asian trade and investment growth, and a relatively well-functioning economic system free from distortion by high levels of protection or rapid inflation.

1.4 GEOGRAPHIC DIVISIONS USED IN THE ANALYSIS

Generally Thailand may be divided into five geographic regions, north, north-east, east, central and south. Definition of the region and provinces included, however, depends on the purpose. In this report, the division system for water resource management (National Water Resource Committee) will be used.

Because rivers and streams in the north-east region drain in to the Mekong River, which is an international water eventually discharging through Viet Nam into the South China Sea, it will be excluded from this report which will strictly adhere to the national level of status of aquatic resources in Thailand. In addition, provinces along the Andaman Sea coast which is a part of the Indian Ocean, which is beyond the scope of the South China Sea project, will also be excluded.

The four geographic regions to be covered in this national report will be defined as follows:

Table 1.2 Geographic regions of Thailand

Region	Provinces
North	Mae Hong Son, Chiang Mai, Lumpoon, Lumpang, Chiang Rai, Payao, Phrae, Nan, Tak, Utaradit, Sukhothai, Petchaboon, Pichit, Kumpangpetch, Nakorn Sawan, Uthai Thani and Pitsanulok
Central	Saraburi, Lopburi, Ayuthaya, Singh Buri, Angthong, Chainat, Bangkok, Nonthaburi, Patumthani, Nakorn Pathom, Samut Prakarn, Samut Sakorn, Kanchanaburi, Ratchburi, Petchburi, Supan Buri and Samut Songkram
East	Cholburi, Rayong, Chantaburi, Trad, Chachoengsao, Prachinburi, Nakorn Nayok and Sakaew
South (Gulf of Thailand only)	Prachuab Kirikhan, Chumporn, Surat Thani, Nakorn Sri Thammarat, Pattalung, Songkhla, Pattani, Yala and Narathiwat

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

Most municipalities, industries and agriculture in Thailand discharge wastes into nearby waterways or reservoirs and usually not directly into the sea, not even large coastal cities such as Bangkok and Cholburi. The wastes, however, will eventually reach the sea as a part of loading by rivers.

Table 2.1 Major pollutant loading (tons per year) into water bodies connected to the Gulf of Thailand divided by region (data from 1995)

Region	BOD Generated (Ton/Year)				
	Urban	Industry	Shrimp farm	Agriculture	Total
North(1)	32,635	n.d.	n.d.	110,164	142,799
East(2)	5,204	1,508,467	6,237	23,354	1,543,262
Central and Suburb(3)	160,378	146,249	n.d.	49,143	355,770
South(4)	35,540	237,193	7,341	126,867	406,941
Total BOD generated	>233,757	>1,891,909	13,578	309,528	2,448,771
Region	BOD Discharged (Ton/Year)				
	Urban	Industry	Shrimp farm	Agriculture	Total
North(1)	21,297	n.d.	n.d.	33,049	54,346
East(2)	4,027	301,693	6,237	7,006	318,963
Central and Suburb(3)	129,601	29,249	n.d.	28,122	186,972
South(4)	19,474	11,377	6,566	12,719	50,136
Total BOD discharged	174,399	>342,319	>12,803	80,896	610,417
	Total P Generated (Ton/Year)				
	Urban	Industry	Shrimp farm	Agriculture	Total
North(1)	n.d.	n.d.	n.d.	4,393	4,393
East(2)	n.d.	n.d.	n.d.	n.d.	n.d.
Central and Suburb(3)	n.d.	n.d.	380	8,523	8,903
South(4)	869	n.d.	219	4,307	5,395
Total P generated	>869	n.d.	>599	>17,223	>18,691
	Total P Discharged (Ton/Year)				
	Urban	Industry	Shrimp farm	Agriculture	Total
North(1)	n.d.	n.d.	n.d.	1,432	1,432
East(2)	n.d.	n.d.	n.d.	n.d.	n.d.
Central and Suburb(3)	n.d.	n.d.	380	6,392	6,772
South(4)	585	n.d.	219	1,273	2,077
Total P discharged	>585	n.d.	>599	>9,097	>10,281
	Total N Generated (Ton/Year)				
	Urban	Industry	Shrimp farm	Agriculture	Total
North(1)	12,576	n.d.	n.d.	27,454	40,030
East(2)	n.d.	n.d.	n.d.	6,907	6,907
Central and Suburb(3)	n.d.	n.d.	n.d.	31,009	31,009
South(4)	5,032	8,582	1,787	49,830	65,231
Total N generated	>17,608	>8,582	>1,787	115,200	143,177
	Total N Discharged (Ton/Year)				
	Urban	Industry	Shrimp farm	Agriculture	Total
North(1)	n.d.	n.d.	n.d.	8,955	8,955
East(2)	n.d.	n.d.	n.d.	5,180	5,180
Central and Suburb(3)	n.d.	n.d.	n.d.	23,256	23,256
South(4)	3,037	414	1,787	8,208	13,446
Total N discharged	>3,037	>414	>1,787	45,599	50,837

Although the data are incomplete, it is likely that by the year 2000 the total BOD loading by all rivers into the Gulf of Thailand could reach the order of one million tons a year. The four major rivers at the head of the upper Gulf account for about 50 per cent of the total loading. The loading of other pollutants, such as metals, has not been quantified by the national authorities.

2.1.1.2 Coastal cities and coastal population

There are no coastal cities or municipalities in Thailand with a registered population over 100,000 (based on UNEP criteria) that discharge waste directly into the sea. All of them discharge waste into rivers or canals, and therefore are considered part of loading by rivers in this report. However, non-point loading into the sea is very likely even though it could not be quantified.

At present there is no large-scale sewage outfall in Thailand but they are planned for the suburb cities of Bangkok, such as Samut Prakarn. The construction of these outfalls is expected to begin within the next few years.

2.1.1.3 Industrial pollution from coastal installations

The available data are only for small factories while the data for large factories, including several large coastal industrial estates, are unknown even to the officials of the Pollution Control Department. The data indicate that BOD loading by these small coastal installations is quite insignificant compared with that being discharged by rivers.

Table 2.2 Direct BOD loading into the Gulf of Thailand by coastal factories

Type of industry	Number of factories	BOD Load (t/y)
Food processing	65	1937
Textile	26	578
Other	9	90
Total	100	2605

2.1.1.4 Discharge from uplands to lowlands

BOD is again possibly the best indicator for the relative contribution of pollutants by upland and lowland rivers. In general pollution transferred from the upland areas to the lowland is smaller than pollution generated within the lower sections of rivers near the mouth.

Table 2.3 Proportion of BOD loading in the lower sections of some major rivers

River	Total length (km)	Length of lower sections (km)	BOD loading in lower sections (%)
Chao Phraya	376	62	71
Ta Chin	318	82	62

2.1.1.5 Ports, harbours and maritime transport

Under normal operations, most cargo and oil/gas ports are not major sources of pollution. Only in fishing ports, where regulations on pollution control are difficult to implement on small boats, is oil pollution from fuel/lubrication oil dumping and bilge water discharge seen. Fishing ports exist in every coastal province and they are usually near to major urban areas, thus making it difficult to separate the contribution from the two sources. There are probably over 10,000 fishing boats of various sizes registered and operating in the Gulf of Thailand. These boats use between 20 - 1000 litres of lubricating oil a year. All of the discarded oil is believed to be discharged into the sea. In addition, leaks and spills of fuel (diesel) oil during filling and transfer occur but this cannot be estimated. Maritime accidents, although still low in frequency, could release significant amounts of oil into the sea.

Table 2.4 Maritime accidents between 1973-1996 involving oil leaks

Area	Number
Chao Phraya River	23
Bang Pakong River	1
Cholburi Coast	6
Rayong Coast	4
Samut Songkhram	1

2.1.1.6 Sea bed exploration and exploitation

Seismic survey

Seismic surveying could interfere with marine mammals and other animals. However, the frequency and extent of seismic surveying in the Gulf of Thailand decreased from 15 times (38,946 kilometres) in 1992 to only 4 times (9,636 kilometres) in 1996 (Department of Mineral Resources.1996).

Well drilling

Drilling activity creates and disperses a large amount of drilling mud and cutting to the environment. In 1996 alone 179 wells were drilled to a total depth of 597,580 metres. Roughly about half a million cubic metres of drilling muds and cutting could be produced and possibly discharged annually into the sea near drilling sites.

Processed water

Processed water in oil and gas production contains substances such as mercury, arsenic and hydrocarbon. It is estimated that for wells in the UNOCAL concession area alone in 1996 5 kg of mercury, 79 kg of arsenic and 24 tons of petroleum hydrocarbon were generated. The numbers are expected to increase to 16 kg, 251 kg and 78 tons respectively a year within the next few years. However, public concern about this issue has been raised in Thailand and various efforts have been proposed by major oil companies to treat this water. The ultimate goal is the zero discharge of all contaminants into the sea.

2.1.1.7 Marine dumping

At present, there is no known significant direct dumping of any kind into the marine environment. However, local dumping of garbage and other waste has been frequently observed but we do not know of any official records of these activities.

2.1.1.8 Atmospheric input into the aquatic environment

There have been no known reports about atmospheric flux into marine and coastal systems in Thailand.

2.1.2 Pollution hot spots

Freshwater

There are six systems where the water quality index frequently reaches level 5: the lower Chao Phraya River, Pasak River, Petchburi River, Bangpakong River, Rayong River and Songkhla Lagoon. All of the hot spots, except the Pasak River, are within 100 kilometres from the sea coast indicating that it is the estuaries that actually suffer from pollution. Low water quality is usually found between May-July, the period when runoff is small. Low oxygen, high BOD and high coliform bacteria are major causes of pollution, indicating that domestic as well as industry origins produce organic wastes. Trace and/or heavy metals have been found in high concentration in some rivers occasionally, but there is still no conclusive evidence about metal pollution in Thai rivers.

Marine system

Water quality

All marine hot spots, in terms of water quality degradation, are related to river mouths. Usually seawater within tens of kilometres from polluted rivers, such as the Chao Phraya, are always in poor quality. However, seawater away from river mouths is usually of acceptable quality.

Eutrophication

Eutrophication, mainly *Noctiluca*, occurs everywhere in the upper Gulf of Thailand, especially during the high river runoff period. Eutrophication was also found near other river mouth areas such as Ban Don Bay and off Songkla Lagoon, possibly because of nutrient input from the land. The extent of phytoplankton bloom is usually limited to few tens of kilometers from major riverine discharge points. Physical transport processes play a very important role in controlling the extent of eutrophication in the Gulf of Thailand.

2.1.3 Sensitive and high risk areas

Most of the nearshore areas in the Gulf of Thailand are considered sensitive because they are usually spawning grounds for several marine and brackish water species. They are also important for small-scale local fisheries which operate subsistence fishing practices. Many of the areas are prime tourist spots which generate high income at local and national levels.

The head of the upper Gulf of Thailand

About 50 per cent of all contaminants discharged into the Gulf of Thailand comes from four rivers, the Chao Phraya, Ta Chin, Mae Klong and Bang Pakong. The standing wave and strong front in the upper Gulf limit the exchange of coastal water with offshore water and thus contaminants accumulate in nearshore sediments. In addition the navigational channels in the river mount area are usually treacherous and prone to accident, for example the Bangkok Bar Channel, where thousands of cargo ships and tankers navigate annually, has a navigational lane which is only a few hundred metres at its narrowest point.

Ban Don Bay

Although contaminant loading by Tapi-Pum Duang River system is still small compared with the major rivers in the upper Gulf of Thailand, the bay is more open and contaminants can be transported far offshore. Despite shell fish culture in the bay, there are many well developed coral reefs and Seagram communities around nearby islands as well as spawning grounds for Indo-Pacific mackerel, the most important marine fish in Thailand, which are sensitive to degraded water quality.

Rayong

Petrochemical and other industries have been developed in this Eastern Seaboard area. Although in the past major accidents and contaminated spill were rare occurrences, the Pollution Control Department is keeping a close watch of this area. Coral reefs and seagrass have been found.

Songkhla Lagoon

The brackish water in the lagoon near the city of Songkhla is constantly contaminated by high BOD and coliform bacteria, possibly because of the restricted exchange between lagoon water and seawater.

2.2 FRESHWATER SHORTAGE AND DEGRADATION OF ITS QUALITY

2.2.1 Surface water

In Thailand rainfall is the only source of freshwater. Freshwater from the Mekong River, which originates from ice melt in the Sino-Tibetan Plateau, could be important for the north-eastern region of the country but it is beyond the geographic coverage of this report.

2.2.1.1 Surface water demand and supply

Table 2.5 Water demand by different sector in million cubic metres per year

	Northern	Central	Eastern	Southern	Total
Seasonal rice	26,141	1,354	6,155	7,694	41,344
Off-season rice	2,281	1,524	994	5,600	10,399
Other crops	1,823	18,208	5,600	16,800	42,431
Domestic	241	946	110	176	1,473
Industry	7		95	78	180
Other		16	24	60	100
TOTAL DEMAND	30,493	22,048	12,978	30,408	95,927
Rainfall	221,600	83,500	78,200	118,900	502,200
Demand:Rainfall (%)	14	26	17	26	19

Rice farming is by far the largest water user in the northern region while other crops are the largest water users in the central and southern regions. Domestic and industrial uses are much smaller users than the agricultural sector. In terms of supply from rain, even though it seems water demand is only a small fraction of rainfall, because evaporation, evaporotranspiration and groundwater recharge data are not well estimated, no conclusions about water shortages can be drawn from table 2.5. However, it is well known that on a local scale water shortage occurs in the dry season, especially the rain shadow areas such as in Prachinburi-Sakaew in the east and Uthaithani-Tak in the north-west.

2.2.1.2 Problems and causes

Thailand is now facing a water shortage problem caused by several factors:

(a) The decrease of forested area reduces the quantity of water absorbed by trees during the rainy season and later gradually released in the dry season which could to a certain extent prevent flood and drought;

(b) The water has been used not only for domestic consumption but also for leisure, golf courses, off-season rice-growing, industry, power production, navigation and seawater intrusion prevention;

(c) There have been ideological conflicts concerning water storage systems among water resources developers, public officials and environmentalists. One line of thought believes that in order to solve the water shortage problem, large dams or reservoirs should be built since the water could benefit from economies of scale, could be used very efficiently and for multipurposes. Small reservoirs and weirs should not be unsystematically built upstream because they may not be economically feasible or could adversely affect the operation of large-scale projects downstream. The other group of people, particularly environmentalists and workers from non-governmental organizations, say the opposite. They believe that the construction of weirs or small reservoirs would not damage limited forested areas and benefit directly local people living nearby. It should be pointed out that despite high economical benefits from large-scale water development projects as agreed by most engineers and economists, the beneficiaries so far have seemed to be people in the cities, not people in the countryside. It is therefore proposed that large water development projects could be implemented so long as the benefits from such projects are equitably shared by people adversely affected by the implementation of the projects;

(d) Uneconomical use of water is another cause of water shortage. For example, farmers themselves sometimes do not apply good farming methods to contain water on their land, water is used for golf courses, and modern water-flushed toilet bowls are used instead of traditional toilets;

(e) The organization for water resources management in Thailand is not complete. Users can freely bring surface water from outside the irrigation area, resulting in an uneconomical use of water under the present laws, the rights for water uses are not clear. The current administrative system allows those with high technology or political power uncontrollable use. Therefore, the water management system creates problems concerning efficiency and fairness;

(f) The organizations related to water management cannot solve the water crisis. The Royal Irrigation department should have a right to water allocation instead of water procurement. Conflicts between upstream and downstream users have been increasing. The existing mechanisms cannot allocate supply in one place and demand in the other. Therefore, water shortages and uneconomic water use always occur;

(g) The many laws and water management organizations have created overlapping problems in the scope of work. For example, there are different standards from different organizations to control water pollution;

(h) Response to the water crisis in Thailand currently consists of improving coordination between organizations. A Ministry of Water Resources has been proposed to gather together all the organizations relating to water resources management but it has not yet been established. However, a water allocation mechanism is definitely needed to determine water permits for both the government and private sectors;

(i) Central command and control is probably worthwhile for the initial stage of water resources management. When the number of water users is widely increased, local organizations should be responsible for water allocation and maintenance. Protests from users may be possible as they prefer to use free irrigation water;

(j) According to the existing laws and regulations relating to water resources, the State does not have adequate powers to effectively control water use. The first legal issue is that not all types of use and water sources are subject to legal control. Although several pieces of legislation have been passed to control water utilization, their application is limited to certain water sources or cases as discussed below:

(i) The Public Irrigation Act (B.E. 2485) empowers the Government to control water use, mainly for agriculture, in the so-called "irrigation area". Water users in such an area are required to obtain permission from officials and to pay for the use of water from the designated "irrigation canal". The Private Irrigation Act (B.E. 2482) subjects all kinds of private irrigation systems to government control except those undertaken on a temporary basis or for an area not larger than 200 rai. In spite of the extensive powers of the State authorized by these Acts to control or manage water use, there are some large areas subject to no laws;

(ii) Underground water is also taken for agricultural use during the dry season in the areas outside the application of the Underground Water Act, B.E. 2520. Such abstraction could affect water levels in public surface water sources;

(iii) There is no legal control of large-scale water use. Section 1355 of the Civil and Commercial Code stipulates that a riparian landowner is entitled to utilize water in a waterway only for the reasonable needs of his land. This means that the amount of water allowed to be used depends on the size of the land and activities thereon. This approach creates problems of competing use between upstream and downstream, particularly in the densely populated areas and for large-scale water uses;

(iv) The present laws have not prioritized water use. During water shortages, the upstream water users seem to have priority over their downstream counterparts.

Table 2.6 Issues in freshwater shortages

Principal issues	Sub-issues
Uneven distribution of rainfall (temporal and spatial)	• El Nino • Different Asian-Australian monsoon • Different storm patterns
Insufficient/inappropriate storages and reservoirs	• High cost associated with reservoir construction in sandy area • Conflicts between reservoir construction and natural resource conservation
Insufficient irrigation/water supply network	•
Overuse of water by some sectors	• Lack of water conservation awareness • Lack of regulation • No regulation on types of industries with respect to water demand in each zone • Luxury consumption in urban areas • Inappropriate agriculture practices with respect to water supply in some zones

2.2.1.3 Surface water quality: issues and causes

A study of the water quality in all the rivers in Thailand conducted by the Pollution Control Department has indicated that some portions of some rivers have deteriorated. The causes of low quality freshwater resources are as follows:

(a) Major sources of pollution come from households, hotels, restaurants and hospitals. These domestic wastes without treatment or not efficient treatment are rich in organic matter and therefore mainly affect the dissolved oxygen level in water and the level of nutrients. A study by the Pollution Control Department in 1997 indicated that 75 per cent of wastewater discharged into the lower Chao Phraya basin from Patum Thani to the river mouth of the Chao Phraya is from domestic waste;

(b) The major categories of water-borne pollution include BOD, COD and other standard industrial pollutants (such as total suspended solids, ammonia, phosphorus, sulfide, nitrate, sulfate, chloride, oil and grease). The major industrial sources of these pollutants include fertilizer plants, refineries, pulp and paper mills, metal plating factories and chemical and metallurgical industries. In terms of the more organic waste load (BOD), the major polluting industry subsectors are food industries, alcohol distilleries, tanneries, pulp and paper mills, oil and fat processing and pharmaceutical plants. In Thailand, approximately 20,000 of the factories registered with the DIW are classified as water-polluting industries. The industrial contribution of BOD pollutants is estimated at approximately 25 per cent in Bangkok;

(c) The settlement of communities near public water sources, which is the old Thai way of life, has caused water pollution because wastewater could be directly discharged into public water sources. One way to solve this problem is to prohibit the settlement of houses or buildings near public water sources but it seems to be impractical and would raise strong public resistance because substantial parts of river banks have been occupied by a large number of dwellers. Thus, it should prohibit only new settlements. Section 43 of the ECNEQ Act, B.E.2535 empowers the MOSTE to proclaim protected areas along the rivers within which a regulation may be issued to ban building construction;

(d) There is an overlapping power between the pollution control official and the official under the Factory Act. This Act, however, the cooperation between the Pollution Control Department and DIW have provide better authorization; (question?)

(e) The Factory Act (B.E. 2535) and the ECNEQ Act (B.E. 2535) focuses only on the control of pollution discharges to meet effluent standards but fails to examine the possible carrying capacity of water sources at a particular point in time in absorbing pollution discharges which are not harmful to the public;

(f) Penalties in some acts are minimal, such as the Water Hyacinth Eradication Act, B.E. 2456, which stipulates a fine not exceeding 10 baht or imprisonment not exceeding seven days. This was not considered to be severe. This Act controls water pollution in the agricultural sector requiring those within whose land water hyacinth grows to destroy such water hyacinth and also empowers the authorities to order persons to collectively eliminate water hyacinth for the common interest;

(g) Section 28 of Royal Irrigation Act, B.E.2485 prohibits the dumping of garbage or the discharging of polluted water or chemicals into irrigation canals. However, the area covered by this Act is limited to irrigation canals and not other water sources. Besides, the prohibition does not include chemicals used in agriculture, such as pesticides. To fill the gap in the Royal Irrigation Act, the Hazardous Substance Act, B.E. 2535 can authorize the relevant authorities to control hazardous substances in certain areas under Section 16 and Sections 22-24. Another problem for Section 28 of the Royal Irrigation Act is the implied requirement that the waste discharged must be in an amount that can cause substantial damage to the water of the irrigation canal. This Act and the ECNEQ Act, B.E. 2535 do not cover cases where pollution discharge is minimal or no specific source of pollution can be traced;

(h) The principal legislation for controlling pollution from households or communities is the Public Health Act, B.E.2535 which authorizes local officials or public health officials to control the dumping of garbage or refuse into water sources and the contamination of water sources which may be harmful to human health. Such officials may prescribe local ordinances controlling the disposal of garbage by designating the place for disposal to prevent people from littering with toxic substances (Section 237) or clogging the

sewerage system (Section 375). However, the Code does not provide penalties for a single disposal of a small quantity of articles in the waterway even though the resulting accumulation could be harmful;

(i) Lack of subordinate laws is another obstacle for effective law enforcement. Legislation provides for measures to control water pollution in the form of Ministerial Regulations and Notifications. In practice, however, such necessary subordinate laws have not been prescribed. For example, effluent standards of wastewater from households do not appear in the Ministerial Regulation, No.33 (B.E.2535) prescribed pursuant to the Building Control Act, B.E.2522. The rationale behind such absence seems to be the ever-increasing cost of wastewater treatment. An elected government may not wish to impose such a burden on the people for fear that such an imposition would affect its support in the next election;

(j) Effective enforcement of law is essential to the protection and control of water pollution. Although the law requires the installation of wastewater treatment systems in factories, such systems are not operated by the factory owners in order to save production costs. As a result, the discharge of waste and wastewater is common. This is exacerbated by the shortages of manpower on the part of responsible government bodies as compared with the soaring number of factories, especially within Bangkok and its provincial areas. Law enforcement is ineffective because of corruption on the part of government officials and the unscrupulous influence of some politicians who intimidate or use their power over responsible officials who are subsequently discouraged from performing their duties;

(k) Direct public control of consumption may impose some difficulty, particularly with respect to the collection of evidence against the offenders and the financial requirements for legal action as well as the time spent on such action. Moreover, insufficient collection of evidence may result in the dismissal of an action by the court and such action cannot be brought again by the public prosecutor against the same offenders for the same offence (Criminal Procedure Code, Section 39(4). This could cause the dismissal of any relevant civil action on the ground that it involves both criminal and civil matters and as a result an injured person may not receive compensation (Criminal Procedure Code, Section 46). Non-governmental organizations, such as water users organizations which are keen on environmental protection and equipped with legal experts, should therefore be allowed to bring a criminal action in their own right against offenders. This approach is new to Thai legislation. So far the ECNEQ Act, B.E.2535 has allowed registered non-governmental organizations to bring legal action into court only when authorization from an injured person has been obtained which is in fact a well-recognized principle under the Criminal Procedure Code as reflected in several Supreme Court decisions;

(l) Laws for water pollution control tend to adopt more severe punishment in terms of imprisonment and fines. However, compliance with the law does not only depend upon the imposition of a severe penalty but also upon strict enforcement with no discrimination against any particular group of people;

(m) Administrative fines are a new kind of sanction which has been proposed as distinct from fines as criminal sanction. This sanction is a strategy for the administrative officials to enforce the law which bypasses the criminal process. However, this strategy needs to be introduced clearly to officials who are used to the old concept of criminal fines and still enforce criminal fines in the other laws. The concept of administrative fine is similar to that in Sections 37-38 of the Criminal Procedure Code of some environmental protection acts which has not been clearly defined as an administrative fine. Thus, the introduction of administration fines may confuse the official who does not understand this concept;

(n) A person causing environmental damage may be held liable under the Civil and Commercial Code which adopts the concept of fault liability in Section 420 and strict liability in Sections 433-437. Compensation awarded under this Code, however, is not adequate since it does not include environmental clean-up costs spent by the Government. Recognizing this problem, the ECNEQ Act, B.E. 2535, Section 96 and 97 stipulates that clean-up costs for damage caused by pollution spent by the Government can be recovered and in cases where natural resources were unlawful damaged, compensation will be for the total value of the natural resources damaged. Nevertheless, the compensation provided by the ECNEQ Act, B.E. 2535 does not cover some items which should pay for restoration, for example, costs of damage assessment and actual costs of water quality restoration. In the case of no-rehabilitation, compensation should include future benefits which, for instance, the State would have directly received from the natural resources destroyed as well as for their lost natural beauty. In addition, the real expenses for claiming in court should be recoverable. All these costs are recognized by the Water Law Draft;

(o) Administrative sanction is clearly specified by law. However, in practice it has not been always enforced for fear of uncertainty of its scope or influence of offenders who may have close connections with local politicians or House representatives.

2.2.1.4 Proposed interventions

1. Official permission should be obtained before the utilization of water except for household use.

2. Both private water users and government agencies or state-owned enterprises wishing to use water are required to apply for a water permit so that all water use can be recorded.

3. A Basin Commission should be assigned to issue water permits within its basin since it is in a position to know the demand and supply of water.

4. A water permit should be valid for five years and because of the decrease of rainfall in some years its issuance does not guarantee a permit-holder the amount of water specified in the permit.

5. In times of water shortage, the Government may declare a Water Shortage Area where water would be equitably allocated by a Basin Commission and household use would come before other types of water use.

6. The permit system would apply not only to runoff but also to underground water regardless of its depth.

7. Water charges would be varied depending on, among other things, the water user's ability to pay, and costs in constructing, operating and maintaining water distribution systems.

8. Water permits would be transferable and considered as property rights which would certainly cause water users to protect their right to use water.

9. Permit issuers would monitor compliance with conditions in a permit and if non-compliance is found, such a permit could be revoked.

10. The construction of dams is to store upstream resources in order to control the downstream flow. The dams can be large-scale, small-scale and control dam. The small-scale dam would benefit the local community. No such coastal dams have been constructed anywhere in Thailand. Environmental conflicts might be expected. An advantage of this approach is the additional water storage during the dry season and reduced flooding in downstream areas. However, the disadvantages are high cost and economical and political conflicts.

11. A diversion water project should be suitable for water allocation. Currently, there is project for the irrigation area of the Bang Pakong and Mae Klong area. This will minimize the water shortage problem.

12. Mixing the use of surface water and groundwater should be considered. The surface water will be the main use while the groundwater is sustainably used for the high demand of water use. The disadvantage is that the groundwater needs to be well managed.

13. Recycling of water would be costly and risky when a 100 per cent treatment of wastewater could not be achieved. At the present, the chemical industry and pulp and paper industry initiate the recycling of wastewater.

14. Enhancement of efficiency in water use would reduce the quantity of water use by improving the technique or economical incentives for reducing water loss.

Table 2.7 Water loss in different sectors

	Transport	**Use**	**Return to same water source**	**Water loss**
Irrigation purpose	100%	35-70%	10-25%	20-400%
Consumption purpose	100%	15%	50%	35%
Industrial purpose	100%	10%	60%	30%

15. The following approaches could provide a sustainable water use strategy:

    (a) Rights to water use: This provides the right to water use for the industrial sector. The agricultural sector could apply for the right to water use in relation to irrigation. The advantage would be to improve efficient water use. However, strict control of raw water transport is needed;

    (b) Water fee/ land cost: A water fee principal would equally benefit all types of water users. Water fees should be applied to the agricultural sector so that efficient water use would save water quantity. This approach will help the farmer select the plants that need less water during the dry season;

    (c) Change in the crop system: This is to encourage the farmer to grow crops that need less water. Mixing crops might be an alternative approach to reduce the quantity of water use for agricultural proposes.

16. Dredging the natural water sources such as ponds, canals should be considered.

17. Construction of water protection dikes to increase water storage should be undertaken.

18. Punishment of offenders may be difficult because of bribery or pecuniary benefits offered to responsible officials by some factory owners. One solution to such problems is to allow the public to take part in law enforcement, such as direct action against the offenders. At present, some legislation provides for such an approach, for example the Factory Act, B.E.2535, and the Building Control Act, B.E.2522 which allows a person sustaining damage or whose living condition is affected to bring action against the offenders. This approach should also be incorporated in other legislation as it would allow the public to check the performances of government officials.

19. Severe penalty of imprisonment and fine will have a psychological effect on the prospective offenders not to violate the laws. However, a key factor in preventing violation of the law is prompt law enforcement with no discrimination against any particular group of people in society regardless of outlaw influence or bribery. Light sentences or parole measures should not be imposed by court only upon rich offenders but upon all people whether rich or poor as they are equal before the law.

20. The power to issue, suspend or revoke a licence is essential for the optimization of water resources, for other natural resources utilization and the control of pollution as supported by the concept of sustainable development. Suspension and revocation of licences are administrative powers to deal with the licensees who violate conditions and requirements of their licence. These powers will take immediate effect on the licensees. However, appeal against such suspension or revocation may be made to the Minister taking charge of such laws for further review.

21. The concept of licence should apply not only to the utilization of water but also the discharge of pollution into public water sources. A licence is required even where such discharge meets an effluent standard.

22. An existing licence could sometimes be revoked without fault for the benefit of a new licence which could yield more benefits or be used in a multi-purposes project. However, revocation could be made only after the hearing of testimony and just compensation specified by the issuer of licence is offered to the original licensee by the new licensee.

2.2.2 Groundwater

The groundwater system in Thailand is mainly recharged by rainfall and some influent seepages streams. It is generally available in most rock types, except solid granite and its equivalents. Alluviums are so far the best aquifers while the solution channels or opening of limestone also yield a considerable quantity of water to wells in those areas. In sedimentary, metasediment, metamorphic and volcanic rocks, groundwater occurs only in cracks, joints bedding planes and other fractured systems. The recoverable quantities of water from these rocks depends largely on size, shape, and continuity of the fissures.

Except for the eastern region, aquifers in the other three regions produce a relatively high yield of water. Groundwater is an essential source of clean water for many rural areas. Currently there are over 200,000 wells in the country.

Although groundwater extraction takes place all over the country, only in the vicinity of Bangkok is detail data available. In 1990 about 1.4 million cubic metres of groundwater was drawn a day in six provinces in the central region including Bangkok.

2.2.2.1 Environmental concerns

In addition to land subsidence at a rate of up to 5 cm a year in the vicinity of Bangkok because of groundwater withdrawal, contamination from natural and man-made causes has been reported.

Table 2.8 Known areas with contaminated groundwater in Thailand

Contamination	Location	Cause
Northern Region		
Fluoride	Chiangmai	Hot springs
Nitrate	Agricultural areas	Fertilizer
Northeastern Region		
Sulphate		Natural gypsum and anhydrite
$CaCO_3$	Limestone aquifer	Natural
Salt		Natural rocksalt
Iron		Natural lateritic soil
Nitrate	Agricultural areas	Fertilizer
Central Region		
Nitrate	Agricultural areas	Fertilizer
Aldrin, Dieldrin	Agricultural areas	Pesticides
Salt	Coastal	Seawater intrusion
Nitrate	Agricultural areas	Fertilizer
Sulphate		Seawater?
Eastern Region		
Salt		Seawater intrusion
Southern Region		
Arsenic	Nakorn Sri Thammarat	Natural arsenopyrite
Iron	Sedimental rocks	Natural
Other trace metals		Natural mineral deposits, mining, dressing

Source: Summarized from Chufamanee and Tridech, unpublished.

2.2.2.2 Cause of problems

Overuse of groundwater in the vicinity of Bangkok was caused by an insufficient supply of surface water and piping system, for example in Samut Prakan where heavy industries and urban areas have been rapidly developed since the 1960s. However, recently this problem has been much alleviated.

Prior to the Groundwater Act B.E. 2520 (A.D. 1977), groundwater was considered a free resource. The first groundwater controlled area, Bangkok and vicinities, where the act was implemented was pronounced in 1978 and but it was only in 1994 when the act could be implemented throughout the country.

The problem of groundwater contamination came from many sources, mainly:

Agriculture: fertilizer and pesticides especially in the northern and central regions;
Natural: Fluorine in the north and arsenic in the south;
Mining: Still not clear but it was mentioned in the south;
Saltwater: Natural (eastern) and over-extraction (central).

2.3 EXPLOITATION OF LIVING AQAUTIC RESOURCES

2.3.1 Living freshwater resources

2.3.1.1 Status with respect to fishing pressure

There are only two man-made freshwater reservoirs in Thailand where MSY is known (Pranburi and Rajaprapa). Both are in the south and both appeared to be underfished. However, for most natural water resources, such as rivers and streams, it is quite apparent that fishery resources are in a very poor condition.

Table 2.9 Inland fishery production by species

Species	1992		1993		1994	
	Weight (MT)	Value (1,000 US$)	Weight (MT)	Value (1,000 US$)	Weight (MT)	Value (1,000 US$)
Total	132,053	117,509	175,400	176,961	198,053	176,920
Carps, barbels and other cyprinids	27,714	23,643	31,810	37,170	30,700	37,830
Tilapia and other cichlids	40,860	21,607	53,950	51,330	63,400	49,730
Catfishes	7,553	6,725	9,200	14,580	9,850	14,970
Eel (Flutidae)	-	-	470	40	4,400	90
Eel (Anguillidae)	-	-	-	-	-	-
Gouramis	6,118	6,458	8,800	6,410	5,240	4,240
Snakehead	13,086	23,471	18,590	35,750	21,410	36,450
Milkfish	-	-	-	-	-	-
Misc. freashwater fishes	36,629	35,568	52,400	31,070	60,250	31,820
Freshwater Crustaceans	93	37	50	0	2,800	1,790
Other	-	-	130	611	-	-

2.3.1.2 Endangered/transboundary/migratory species

Several freshwater animals in Thailand are migratory. However, because the freshwater system under examination in this report is not international water, the problem of transboundary is irrelevant. The only concern is the migration of species between up and down stream, for example the Giant Prawn which is known to spawn in brackish water and migrate to freshwater zones. The construction of dams that completely block the waterway with no appropriate fish passage could cause the disappearance of prawns in the northern region.

2.3.1.3 Major problems/issues

(a) Overfishing
(b) Illegal fishing methods
(c) Water quality degradation
(d) Habitat destruction

2.3.1.4 Proposed interventions

(a) Restocking
(b) Fish ladders
(c) Strict enforcement of the law against illegal fishing methods
(d) Restoration of environmental conditions, water quality, habitat

2.3.2 Living marine resources

2.3.2.1 Status of living marine resources with respect to fishing pressure

According to SEAFDEC (1997) marine species in the exclusive economic zones (EEZs) of Thailand can be divided into three groups as follows:

(a) Pelagic species

Pelagic species are those that dwell and feed near the sea surface. They consume phytoplankton and zooplankton and gather in schools. Usually they are fusiform of body and fast swimming. Several of the pelagic species that are economically important are photophile and migrate between the Thai EEZ and contiguous waters. The pelagic species mainly caught in Thailand are Indo-Pacific mackerel (*Rastrelliger brachysoma*), Indian mackerel (*R. Kanagurta*), Faughnis (*R. faughni*), Barred Spanish mackerel (*Scomberomorus commerson*), Indo-Pacific Spanish mackerel (*S. guttatus*), Lined Spanish mackerel (*S. lineolatus*), Longtail tuna (*Thunnaus tonggol*), Kawa Kawa (*Euthynnus affinis*), Frigate tuna (*Auxis thazard*), Round Scad (*Decapterus spp.*), Sardine (*Sardinella gibbosa*), Anchovy (*Encrasicholina heteroloba*), Hardtail Scad (*Megalaspis cordyla*), Black pomfret (*Parastromateus niger*), Silver pomfret (*Pampas argenteus*), Banded crevalle (*Atule mate*), yellow stripe trevally (*Selaroides leptolepis*), and Bigeye Scad (*Selar cruminopthalmus*) etc.

(b) Demersal species

Demersal species have their habitat near the sea bottom. They are carnivorous having strong and sharp teeth. Their major food is fish, shrimp, squid etc. The demersal species which are economically important and mainly caught are Lizard fish (*Saurida elongata*, *S. undosquamis*, and *S. tumbil*), Threadfin bream (*Nemipterus mesoprion*, *N. nematophorus*, and *N. marginatus*), Bigeye (*Piracanthus tayenus*), barracuda (*Sphyraena obstusata* and *S. langsar*), red snapper (*Lutjanus* lineolatus and *L. malabaricus*) and yellow goatfish (*Upenus sulphureus*). These species move slowly, some are in the EEZs of other countries and some straddle between the Thai EEZs and contiguous waters.

(c) Others species

These species are invertebrate such as squid (*Loligo chinensis, L. duvauceli, L. edulis, L. singhalensis,* and *Sepioteuthis lessoniana*), cuttle fish (*Sepia pharaonis, S. lycidas, S. aculeata, S. esculenta* and *S. brevimana*), octopus (*Octopus spp.*), and mairne shrimp (*Penaeus semisulcatus,* and *P. monodon*). Squid and cuttle fish are fast-moving species which may straddle between the EEZs of Thailand and neighbouring countries. Octopus and marine shrimp are slow-moving, living in coastal areas and EEZs. These two species may straddle between the EEZs of Thailand and neighbouring countries or migrate between an EEZ and the high seas for reproduction and spawning..

Table 2.10 Catch of marine species from major fishing gear in the Gulf of Thailand, 1971 to 1992

Year	Indo-Pacific mack.	Indian mack.	Spanish mack.	Small tuna	Round Scad	Sardine	Anchovies	Lizard fish	Threadfin bream	Bigeye
1971	38.3	5.4	0.0	3.3	0.5	2.1	7.2	10.2	12.1	10.1
1972	33.4	9.3	1.6	4.1	0.7	8.0	12.8	14.9	18.6	13.8
1973	41.4	12.7	3.6	5.9	14.7	21.7	22.3	11.4	16.1	10.8
1974	34.7	14.0	2.3	6.9	33.3	46.3	19.5	9.8	15.4	11.4
1975	58.9	16.3	5.5	8.0	25.0	49.0	14.7	10.0	17.1	13.3
1976	49.6	19.0	6.2	7.4	82.5	91.8	15.3	9.6	14.5	10.9
1977	26.1	30.3	8.9	11.2	129.8	203.4	9.9	11.3	17.0	16.9
1978	42.3	33.7	6.2	7.1	106.3	133.6	8.5	11.8	20.3	12.8
1979	82.6	24.8	7.4	13.3	27.0	136.3	14.1	9.8	17.0	10.8
1980	47.3	24.9	7.8	12.5	30.2	96.4	16.7	9.5	14.9	15.2
1981	66.1	17.1	9.7	20.0	34.4	129.2	12.1	7.6	16.0	14.0
1982	71.2	18.3	6.9	39.4	32.1	87.9	23.1	7.7	14.4	8.8
1983	60.2	50.6	7.2	82.0	24.5	97.7	38.1	8.5	12.8	10.3
1984	99.6	29.8	8.0	69.4	27.5	83.8	88.8	8.7	12.1	9.3

1985	97.9	32.9	8.4	81.2	25.7	68.4	103.1	8.5	14.8	10.9
1986	88.8	38.8	11.0	90.2	23.9	92.5	58.0	13.3	22.6	17.3
1987	92.2	36.3	11.9	96.1	41.8	83.6	55.5	16.5	29.5	24.1
1988	88.8	18.7	12.1	141.3	14.0	89.1	66.7	16.2	26.5	21.9
1989	92.7	26.5	9.2	124.9	17.3	114.3	94.3	17.2	29.7	21.7
1990	68.2	20.8	9.2	156.3	10.7	90.8	118.7	13.2	26.0	21.2
1991	55.2	16.3	6.1	137.9	22.7	114.2	110.0	19.8	33.8	25.3
1992	88.3	29.3	6.7	157.2	42.5	141.4	120.2	31.8	51.3	36.2

*Purse seine, trawls, push nets, gill nets, and stake traps

Table 2.11 Present annual catch and MSY of some important species in the Gulf of Thailand

Species	Average catches (tons)	MSY (tons)	State of exploitation
Decapterus macrosoma	28,326	29,280	O
Megalaspis cordyla	16,373	18,433	O
Selar crumenophthalmus	19,981	18,500	F
Atule mate	37,392		?
Parastromateus niger	3,165		?
Chirocentrus dorab	4,655		?
Sardinella gibbosa	104,651	110,457	F-O
Encrasicholina heteroloba	97,274	106,118	F
Lutijanus sebae	4,764		?
Liza vaigiensis	3,585		?
Nemipterus	34,994	21,697	F
Eleutheronema tetradactylum	1,979		?
Priacanthus tayenus	27,309	55,916	M
Pennahia macrophthalmus	6,303		?
Rastrelliger brachysoma	97,489	94,791	F
Rastrelliger kanagurta	32,105	34,282	D
Scomberomorus commerson	10,599	14,599	U
Thunnus tonggol	65,240	86,000	O
Euthynnus affinis	62,284	86,000	M
Epinephelus areolatus	2,386		?
Spyraena jello	3,120		M
Sauridda undosquamis	21,455	21,303	D
Trichiurus lepturus	3,221		?

Source: Saikleang, 1997.

Remarks:

R: Recovering. Catches are again increasing after a collapse from a previous high;
D: Depleted. Catches are well below historical levels, irrespective of the amount of fishing effort exerted;
O: Over-exploited. The fishery is being exploited at above a level which is believed to be sustainable in the long term, with no potential for further expansion and a higher risk of stock depletion/collapse;
F: Fully exploited. The fishery is operating at or close to an optimal yield level, with no expected room for further expansion;
M: Moderately exploited, exploited with a low level of fishing effort. Believed to have some limited potential for expansion in total production;
U: Under-exploited, undeveloped or new fishery. Believed to have a significant potential for expansion in total production;
?: Not known or uncertain. Not much information is available to make a judgment.

2.4 MODIFICATION OF AQUATIC HABITATS

2.4.1 Freshwater habitats

According to the first inventory of wetlands in Thailand, major freshwater and coastal wetland areas in Thailand may be grouped according to Table 2.12.

Table 2.12 Selected freshwater habitats in each region

Northern region (9)	Area (ha)/length (km)
Chiang San Basin	10,000 ha
Tha Ton Marsh	6,000 ha
Nong Luang	2,000 ha
Nong Hang	740 ha
Nong Leng Sai	1,050 ha
Kwan Phayao	2,300 ha
Yom River Floodplain	50,000 ha
Bueng Si Fai	810 ha
Bueng Boraphet	13,000 ha

Central Region (2)	Area (ha)/length (km)
Kwae Yai River System	403 km
Lower Central Plain	1,900,000 km

Eastern (0)	
N.A.	

Southern Region (5)	Area (ha)/length (km)
Khao Sam Roi Yot National Park	13,000 ha
Tapi River and Nong Tung Tong Non Non-Hunting Area	6,450 ha
Thale Noi Non-Hunting Area	45,000 ha
Pa Phru (Phru Toh Dang)	34,636 ha

In 1997, the Office of Environment Policy and Planning initiated and funded a national programme to make a systematic directory and database of all wetlands in the country. The final result is not yet finished at the time of writing, but so far a lot more wetlands have been registered and entered into the database (table 2.13).

Table 2.13 Preliminary survey of freshwater wetlands in four regions

Type	North	Central	East	South
River, canals, streams, waterfalls	144	256	176	1712*
Lakes, ponds, reservoirs	512	637	557	41
River floodplains	3	?	?	13
Flooded marshes, swamps, grasslands	2	?	?	101

Source: Compiled from internal documents of the Office of Environmental Policy and Planning

2.4.2 Marine habitats

2.4.2.1 Estuaries and embayments

Estuaries and bays in the Gulf of Thailand have been modified by several causes, the major ones are dredging, coastal and nearshore construction, and pollution.

2.4.2.1.1 Dredging

Most dredging for sea lanes takes place in estuaries. Each year the Harbour Department dredges and maintains up to about 40 channels in the Gulf of Thailand. Up to 4 million tons of sediments are dredged annually (Harbour Department 1995). The Port Authority of Thailand is responsible for the dredging of the main Chao Phraya Channel, the largest single dredging activity in Thailand. Each year over a million cubic metres of sediment are dredged and disposed of a few kilometres downstream of the dredging site. Private companies can also dredge navigational channels after obtaining permission from the Harbour Department. In Rayong province, three companies, Rayong Refinery, Start Petroleum and Rayong Olefin, have permission to dredge in front of their piers and dispose of material at designated locations offshore.

2.4.2.1.2 Coastal construction

Construction in estuaries is for navigation as well as for other purposes. The main construction categories are breakwaters, pier and jetties. Some important principles in the Navigation in Thai Waters Act, B.E. 2456 that regulate dredging and coastal construction are:

(a) Construction of any kind that extends in or over or below any public water bodies must obtain permission from the Harbour Department;

(b) Dumping or discharge of any solids, sewage, liquids or chemicals into any public water bodies must obtain permission from the Harbour Department;

(c) Dredging or changing navigational channels must obtain permission from the Harbour Department.

2.4.2.2 Coral reefs

2.4.2.2.1 Change in area and species composition

Although most of the areas away from river mouths in the Gulf of Thailand are suitable for coral growth, dense coral communities are found only around islands, even though reliable information from elderly people indicated that in the past extensive coral communities and coral reefs could be found at many mainland locations. This might indicate the disturbance caused by human activities on coral reefs for at least 50 years in the Gulf of Thailand. Yet there are very few systematic and repetitive studies of the changes in coral communities in the Gulf of Thailand and if they are available they cover only short periods, i.e., a few years.

Generally there are three types of coral community found in the Gulf of Thailand:

(a) Porites communities are usually found in protected bays or coves where water circulation is weak. The communities are strongly dominated, up to 100 per cent, by the massive *Porites lutea* which is a fast growing species (up to 2 cm a year) owing to its porous skeleton. This species can tolerate high suspended solids, fluctuating salinity and temperature, and can be exposed in the air for a longer time than most other corals. Other corals that are fast growing can tolerate stress quite well and frequently coexist with *Porite lutea* are *Goniopora spp.*, *Pavona spp.* and *Pocillopora*

damicornis. *Porites lutea* will be less dominant in areas where the environment is more favourable to other corals, and in such cases more species could be found. This type of community is found in areas with sediment and freshwater runoff from rivers, such as the communities around Sichang and nearby islands in the upper Gulf of Thailand, those around Man Nai and Man Klang island in Rayong province, communities around nearshore islands in Chumporn Bay area, and communities in the southern zone of the Ang Thong National Park;

(b) Acropora communities usually exist in deeper water, being submerged all the time. The area must also have strong water circulation but not breaking waves. Acropora communities may be subdivided into those with non-consolidated substrate and dominated by the open branching form such as *Acropora formosa* and those with solid substrate and dominated by table forms such as *Acropora hyacynthus*. Acropora communities, especially the opening branching form, are highly dynamic and can disappear or reappear within a few years;

(c) Cliff communities are found along the rocky cliffs exposed to wind and wave actions. Usually corals grow at least a few metres below the lowest water line but the community can extend to a very deep depth, for example, up to 20 metres. Coral colonies are usually small but the species diversity can be quite high. Many of the coral species found in this environment cannot be found in the other two communities.

2.4.2.2.2 Cause of habitat change

(a) Tropical cyclones

Coral communities along the west coast of the Gulf can possibly be hit by tropical cyclones from the South China Sea. An example was in November 1989, when Typhoon Gay hit southern Thailand and caused significant damage to the coral reef communities of Tao island north of Mae Haad Beach, Tian Bay and Nang-Yuan island, Surat Thani province (Sudara and others 1992a). Although tropical cyclones rarely enter the Gulf, offshore barriers composed almost entirely of old coral blocks found along the north, east and south sides of Ko Samui and Ko Pa-ngan are evidence that heavy storms did occasionally hit these islands.

(b) Siltation and sedimentation

Some coral communities in the Gulf have been exposed to sediment and river runoff, and therefore have adapted to the poor conditions. However, some communities were established under a more favourable environment but when they are disturbed by anthropogenic sediment, they are highly susceptible to drastic changes or are even wiped out completely. Some examples are the coral communities around Ko Saket, Rayong province which have been subjected to high turbidity and siltation from the nearby land reclamation for Map Ta Pud Port (Sudara and others 1992b).

Naval operations have also impacted coral communities at some islands off the Pattaya resort town, such as Phai Island (Sirirattanachai 1994). By using islands as practice targets for bombardment, it increases erosion and smothering effects on nearby corals.

(c) Dynamite fishing

Dynamite fishing is illegal but has been widely practiced by some fishermen for over 20 years. This activity has now diminished in some localities but it has changed the community composition of many reefs. In Chumporn area which has been heavily blasted, the density and diversity of coral have changed. Only the big massive corals such as *Porites lutea* have survived (Sudara and others 1991). Dynamite fishing has damaged the coral communities around Samet islands as revealed in the study of Sirirattanachai and Manthachitra (1992) during the period 1988-1991.

(d) Anchoring of boats

Owing to the rapid expansion of tourism in the Gulf of Thailand, particularly at Samui island, many boats bring tourists for diving and fishing. Moored boats caused heavy damage to the reefs. More than 24 boats drop their anchor at Haad Sai Lee at Tao island daily resulting in the very low cover of hard corals around this area (Sudara and others 1991).

2.4.2.3 Mangroves

Change in area and species composition

The mangrove area in Thailand has gradually decreased. From the first assessment using LANDSAT images in 1975 to the latest data for 1996, about 86, 71, 58 and 73 per cent of the mangrove areas have been destroyed in the inner Gulf, the Gulf east coast, the peninsular west coast, and over the whole of the Gulf of Thailand respectively (table 2.14).

Table 2.14 Mangrove area (in hectares) in Thailand based on LANDSAT data

	Year*						
Region	1975	1979	1986	1989	1991	1993	1996
Inner Gulf	42,772	36,528	3,109	2,106	853	5,951	5,981
Gulf of Thailand East Coast	42,200	38,512	25,743	19,092	10,567	12,420	12,083
Peninsular East Coast	39,500	34,112	19,788	17,191	14,050	16,465	16,614
Gulf of Thailand Total	124,472	109,152	48,640	38,389	25,470	34,835	34,678
Country Total	312,700	287,308	196,429	180,559	173,821	168,683	167,582

Year 1993 - 1996 based on LANDSAT 1:50,000 images
Source: Data from the Royal Forestry Department, and Charuppat and Ongsomwang 1995

Good and diverse mangroves are usually found along the seaward edge of the area. The substrate there is usually fine grain muds. When the mangrove is disturbed, usually the substrate will be harder and contain a larger proportion of sand size particles. The species composition of tree will change to those preferring harder substrate, such as Acrostichum aureun, Melaleuca leucadendron and Acanthus illicifolia (table 2.15). In addition, the number of certain species and individuals of mud skippers and fiddler crabs which are restricted to mangroves will also be reduced.

Table 2.15 Arbitrary definition criteria for natural (primary) and disturbed/deformed (secondary) mangrove in Thailand

Criteria	Natural mangrove	Disturbed mangrove
Number of tree species	>20	<20
Average tree height	>20 m	<20 m
Substrate texture	Soft and muddy	Hard and more sandy
Indicating species		• Prong Tha-le (*Acrostichum aureun*) • Samet (*Melaleuca leucadendron*) • Ngueak Pla-mhor (*Acanthus illicifolia*)

Source: Pitiwong Tantichodok, personal communication.

Conflicting uses of the area

During the early 1980s when shrimp farming in mangrove areas began to develop, conflicts between shrimp farmers and charcoal makers, the most important human activity in mangroves at that time, occurred occasionally. However it is apparent that at present shrimp farming is the clear winner in terms of land use in the mangroves.

Recently there have been complaints from small-scale fishermen around some mangrove areas that the catch has drastically declined. Although part of the problem might be due to overfishing, breeding and recruitment of mangrove dependent animals, such as white or banana shrimp (*Penease merguiensis*), could have substantially declined. However, most of the complaints were from the Andaman Sea, for example, Phangnga, where mangrove destruction is still in the early phase, while in the Gulf of Thailand fertile mandgrave have been gone for a long time and so local fishermen have become used to the low catching rate. At present studies are being carried out in the Gulf of Thailand, for example by Chulalongkorn University, to evaluate the importance of mangroves and recruitment of some important marine animals.

There are a few case studies on the conflict between different sectors or occupations in mangroves in the Gulf of Thailand, which can be summarized as:

Table 2.16 Some conflicts between different sectors in mangrove areas in the Gulf of Thailand

Conflicting parties	Issues	Location	Ref
Shrimp farms vs rice farms	• Salination of freshwater resource used for agriculture and domestic use • Deterioration of water quality due to organic riched mud disposed from ponds	Songkhla	Watanyoo (1995)
Shrimp growout ponds vs shrimp hatcheries	Deterioration of water quality due to organic riched mud disposed from ponds	Songkhla	Watanyoo (1995)
Shrimp farms vs small scale coastal fisheries	Decline of coastal fisheries production by 36% which could not be explained by overfishing	Chantaburi	Srethasirote (1995)

2.4.2.3.2 Causes of habitat changes

Table 2.17 Major causes and root causes of mangrove destruction summarized from reports from all coastal provinces

Causes of destruction	Root causes
Conversion of land into tiger prawn farms (general)	• Expansion in shrimp especially tiger prawn export • Overpromotion and lack of coordination among government agencies • Department of Fisheries uses the shrimp export figure/value as a success criteria of the department • Mangrove area is convenient for shrimp culture, easy access to seawater etc. • Lack of awareness • Lack of effective local resource management programmes
Conversion of land into tiger prawn farms (public land)	• Lack of patrolling and enforcement • Corruption • Not clearly marked/defined boundary • Approved land development concessions
Conversion of land into tiger prawn farms (private land)	• Cabinet resolution on 15 Dec 1987 does not cover private land

Clearing to make way for construction, urbanization, factories, and other types of land development	• Lack of awareness • Lack of patrolling and enforcement • Corruption • Not clearly marked/defined boundary • Approved land development concessions • Development projects by government agencies can be exempted from laws and regulations • Housing to accommodate increasing population and immigration • Lack of effective local resource management programmes • Lack of coordination among government agencies
Restriction of water exchange with the sea	• Construction of infrastructure like roads, piers, dams etc. • Lack of awareness and understanding • Difficulty to predict indirect effects of construction on mangrove • Lack of effective local resource management programmes • Lack of coordination among government agencies
Illegal logging for firewood, charcoal, timber	• Lack of awareness • Lack of patrolling and enforcement • Corruption • Not clearly marked/defined boundary
Hardening of substrate prohibits replantation of true mangrove trees	• Subsequent effects of land development
Coastal erosion	• Subsequent effects of mangrove clear cutting
Garbage dumping and waste water discharge from domestic use and aquaculture	• Lack of awareness • Lack of patrolling and enforcement • Not clearly marked/defined boundary • Lack of effective local resource management programmes • Lack of coordination among government agencies • Lack of economical alternatives for waste treatment
Dredging for cockles and other benthic animals along the outer edge of mangrove	• Lack of awareness • Lack of patrolling and enforcement • Not clearly marked/defined boundary • Lack of effective local resource management programmes
Insufficient information for national and local level decision makers	• Lack of practical researches for conservation • Lack of coordination among government agencies • Most researches are descriptive and not prescriptive

Table 2.18 The status of land uses (ha) in 1993 in the 3 zones defined for national mangrove by Cabinet Resolution on December 15, 1987

	Conservation Zone	Economic Zone A	Economic Zone B	Total
The Gulf East Coast				
Mangrove	1,437	8,935	2,676	13,048
Shrimp ponds	1,241	17,711	7,033	25,984
Urban areas	56	113	2,316	2,486
Other/unclassified	440	3,445	9,443	13,328
Total	**3,174**	**30,203**	**21,468**	**54,845**
Central				
Mangrove	438	18	4907	5,363
Shrimp ponds	883	44	13,230	14,157
Urban areas	119	178	1,452	1,749
Other/unclassified	2,467	732	42,514	45,713
Total	**3,907**	**972**	**62,103**	**66,982**

Peninsular East Coast				
Mangrove	1,569	12,245	2,610	16,425
Shrimp ponds	1,244	2,638	17,020	20,902
Urban areas	54	188	329	572
Other/unclassified	3,319	4,140	11,092	18,551
Total	**6,186**	**19,212**	**31,051**	**56,449**
Gulf of Thailand Sub-Total				
Mangrove	3,444	21,198	10,193	34,836
Shrimp ponds	3,368	20,393	37,283	61,043
Urban areas	229	479	4,097	4,807
Other/unclassified	6,226	8,317	63,049	77,592
Total	**13,267**	**50,387**	**114,622**	**178,276**
Country Total				
Mangrove	23,206	130,597	14,880	168,683
Shrimp ponds	4,472	22,940	37,580	64,992
Urban areas	272	561	4,128	4,961
Other/unclassified	14,729	45,591	73,492	133,813
Total	**42,678**	**199,689**	**130,081**	**372,448**

Source: Charuppat and Ongsomwang, 1995.

Table 2.19 Identifiable shrimp farms in Conservation Zone and Economic Zone A, where shrimp farms are prohibited

Region	Identifiable shimp farms (ha) in Conservative and Economic A Zones	Percentage of identifiable shrimp farms in "shimp farm prohibited" area
Gulf of Thailand East Coast	18,952	52
Central (Upper Gulf)	927	19
Peninsular East Coast	3,882	15
Gulf of Thailand Sub-Total	23,761	37
Country Total	27,412	11

Source: Charuppat and Ongsomwang, 1995.

2.4.2.3.3 Impacts of global change

Sea level rise will push both the inner and outer margins of mangroves toward the land. For the natural coastline, the gradual increase in sea level will basically shift mangroves more inland. However, most mangrove forests in Thailand are now backed by rising ground or developed areas which restrict landward migration of the mangrove inner margin. Thus the width of mangrove will be reduced, or even completely destroyed (Boonprakob 1996). However, at some exceptional areas where sediment supply from rivers is accumulated, for example the western side of the Maeklong River mouth, mangroves in those areas may be able to keep up with sea level rise. However, sediment supply by river depends very much on rainfall in the watershed which may be reduced by global changes. Because of the complex relationship among different environmental factors, it is therefore impossible to speculate accurately on the effects of global change on the mangrove ecosystem without sufficient basic information.

2.4.2.3.4 Economic aspects of mangroves

A study on the cost and benefit of mangrove forest plantation in the upper Gulf of Thailand (Kamlang-ek 1995) estimates that the total cost (direct money from timber plus other indirect costs) over 15 years is 26,610 baht/rai while the total benefit (direct plus indirect) is 61,741 baht/rai. The net benefit would be 35,121 baht/rai over 15 years. The monetary benefit from shrimp farming was estimated by Watanyoo (1995) for the Songkhla area at 159,954 baht/rai/year at the moment. However it is still questionable how long the benefit could be sustained, possibly less than 10 years. In contrast, the instantaneous benefit from rice fields for the same general area is only 186 baht/rai/year.

The Royal Forestry Department had estimated for 1996 that it takes six years to replant and nurse mangrove trees from bare land at a cost of 12,870 baht per rai (approximately US$ 1,800 per hectare). Based on this figure, it will take US$25.6 million to restore mangrove forests back to the level of 1975 (table 2.20).

Table 2.20 The cost to replant mangrove trees in 1996 back to the level of 1975

Region	Million US$1986
Inner Gulf	10.5
Gulf of Thailand East Coast	8.6
Peninsular East Coast	6.5
Gulf of Thailand Total	25.6
Country Total	41.5

Since 1995, the Royal Forestry Department had replanted 7,816 hectares (Havanond 1995). During the programme, several problems were encountered. For the afforestation on newly formed land strips the common problems are:

(a) Waves;
(b) Fouling barnacles;
(c) Grazing by hermit crabs and other animals;
(d) Boat propellers;
(e) Push netters;
(f) Exposure to sunlight.

Reforestation of degraded mangroves faces these problems:

(a) Grazing and damage by crabs and crab-eating macaques;
(b) Hardening and acidification of the substrate;
(c) Conflicts with local residents.

2.4.2.3.5 Major impact areas

Most mangroves in the Gulf of Thailand have been wiped out, with a few exceptions in Nakorn Sri Thammarat, and possibly in Chantaburi and Trad. The remaining forests, moreover, are severely suffering from the pressure from shrimp farms and other land development, both in terms of clear cutting of trees to make space available for different activities and from wastes and pollutants discharged from aquaculture and domestic sources.

2.4.2.4 Seagrass beds

2.4.2.4.1 Species composition and distribution

Seagrass can be found in abundance along the east and west coasts of the Gulf of Thailand but they are rare in the upper (inner) Gulf, at least since the mid-1970s when systematic surveys of sub-tidal resources such as coral reefs and seagrass began. In 1997, the Office of Environment Policy and Planning conducted an intensive inventory survey of seagrass beds in Thailand and data from literature and field observations were reviewed (OEPP 1997). From this report, most of the data on seagrass in the Gulf of Thailand are dated after 1990 and repeated surveys of the same site are rarely available. Seasonal fluctuation, possibly naturally because of monsoons, is also very strong in many areas so it is not possible to make a scientific comparison for changes in the species composition and area coverage. However, some qualitative estimation will be reviewed and discussed.

Along the east coast of the Gulf of Thailand, from Cholburi to Trad provinces, there are at least nine major seagrass beds. Most of them, except those in Rayong province, fringe around islands. Disturbance from human activities could be an explanation for the absence of seagrass along many mainland coasts even though the general environment appears to be suitable.

Most of the surviving seagrass beds along the east coast are patchy and smaller than one square kilometre except for the one from Ao Makampom to the Prasae River mouth in Rayong. From the review by Lewmanomont and Okawa (1995), a total of nine species of seagrass have been found.

2.4.2.4.2 Causes of habitat change

Because seagrasses usually grow in soft substrate, they can be easily eradicated by human activities and natural causes, such as storms, without any traces being left. This makes it difficult for the survey teams to evaluate the past extent and the causes of destruction. Frequently information had be obtained from interviews with local people who are sometimes inaccurate.

Nationwide (including the Gulf of Thailand and Andaman Sea), there are five causes for the deterioration of seagrass communities:

(a) Natural

Inappropriate substrate, strong waves and currents, and oscillating monsoons limit growth and the survival of seagrass. In the Gulf of Thailand, seagrasses are usually found in clam protected bays, or near river mouths with clayey sand substrate, or on remote islands which are little affected by humans.

(b) Fisheries

Bottom scraping fishing gear that operate near the shore, such as small trawlers, push netters and beach seiners, can extensively damage seagrass communities.

(c) Collection/harvesting

Seagrass may be used in the paper pulp industry, chemical extraction, and as fertilizer and animal feeds. The collection of seagrass does take place in some areas in Thailand.

(d) Land reclamation

Although this cause is strongly put forward as the major cause of seagrass destruction in Thailand, there are only a few areas where land reclamation and land development are quoted as the causes of destruction (Table 2.21). However, it is highly likely that many more beds have been destroyed without any record since the first systematic survey of seagrass in Thailand began only in the mid-1980s.

(e) General deterioration of seawater quality.

The effect of suspended particles in the water is particularly important because of smothering and light shading. Many activities on land and in the sea can increase the concentration of solids in the water and stunt the growth of nearby seagrass.

Table 2.21 Outstanding causes of destruction of some seagrass beds in the Gulf of Thailand

Cause	Where
Waste disposal • Domestic • Aquaculture	 • Ao Makampom, Rayong Prasae River Mouth, Rayong • Klong Huahin, Rayong Ao Kungraben, Chantaburi
Fisheries (e.g. push net, bottom gill net)	Klong Huahin, Rayong Ao Pattani, Pattani
Collection (for traditional medicine)	Ao Kungraben, Chantaburi
Expose to monsoon	Exposed areas in Trad and Sura Thani Provinces
Land reclamation	Pradae River mouth, Karnchanadit, Surat Thani Ao Pattani, Pattani
Land development	Had Sai Kaew, Songkhla

Source: From OEPP (1997)

2.4.2.4.3 Existing laws, regulations and policies concerning seagrass

(a) Environmental Quality Promotion and Control Act B.E. 2535

This act enables the Ministry of Science, Technology and Environment to declare conservation areas and protected areas to protect the natural habitat and specie diversity.

(b) National Policy and Plan for Promoting and Protecting the Environment B.E. 2540 - 2559

Under this policy the seagrass problem is well recognized, marine seagrass and macroalgae are aquatic plants essential for marine ecosystem, about 30 per cent are now under severe condition and may be completely disappeared. Direct actions under this plan are:

1. To declare virgin and diverse seagrass and algal beds as plant protection areas according to the Fisheries Act B.E. 2490;
2. To establish an action plan to restore seagrass and algae;
3. To allow small-scale fisheries in degraded seagrass and algal beds.

Moreover there are also indirect actions, such as:

1. To promote practical research to conserve endangered plants and animals, such as dugong, dolphins and sea turtles;
2. To promote and build awareness on the conservation of rare plants and animals, and marine environments;
3. Fifteen provincial plans to manage the environment.

Among all the 15 coastal provinces, not one is directly concerned with seagrass.

(c) Cabinet Resolution (17 February 1992) on Policy, Measures and Action Plans for Coastal Resources and Environmental Management

This is the overall umbrella for all activities by government agencies regarding coastal resources and environments.

(d) Cabinet Resolution (3 March 1992) on a National Master Plan to Manage Coral Reefs The principles of this resolution are:

1. To maintain quality, density and diversity to match with the level of uses;
2. To balance priority development between national economic development and local utilization;
3. To encourage local communities to be involved and supportive of coral management;
4. To maintain balance between punishment and encouragement as the approach to managing coral reefs;
5. To promote cooperation among the national government, local administrations, non-government organizations, users and academics in the management of coral reefs;
6. To make decisions based on the accurate status of coral reefs, resource utilization, and capacity of the ecosystem, with support from appropriate data and information systems.

This cabinet resolution also defines coral reefs into three categories based on resource utilization: (1) zones for local control, (2) zones for tourism and recreational uses, including intensive tourism and eco-tourism, and (3) zones for conservation.

(e) Fisheries Act B.E. 2490

This act empowers the Director General of the Fisheries Department to declare protected areas for aquatic organisms.

Proposed interventions

Management of the coastal habitat/ecosystem in Thailand, which has suffered from similar pressures to other marine coastal resources, must be based on four principles:

(a) Restoration, mainly to:
- Limit or prohibit destructive fishing practices, such as bottom trawls, push nets and beach seines, while encouraging non-destructive gear, such as surface drift nets, traps, casting nets, hook and line;
- Limit or prohibit the collection of seagrass for commercial purposes;
- Limit or prohibit land reclamation;
- Maintain seawater quality especially with respect to suspended solids.

(b) Research on:
- Species composition and quantitative ecology of animal and larvae in seagrass beds;
- Appropriate restoration and conservation approaches.

(c) Build public awareness by:
- Educating the general public, fishermen, coastal communities;
- Encouraging local participation;
- Conducting seminars among fishermen on seagrass conservation.

(d) Monitoring to:
- Encourage non-government organizations and local communities to monitor and patrol seagrass beds;
- Develop appropriate and up-to-date information systems.

Zoning

At the moment (1997) a zoning system has not been applied to seagrass communities in Thailand, except for those in Trang province in the Andaman Sea which is the last large habitat for Dugongs where certain fishing practices are prohibited.

According to OEPP (1997), two zones were proposed, the conservation zone and the restoration zone (table 2.22).

Table 2.22 Zoning of seagrass communities (OEPP 1997)

Zone type	Criteria	Prohibited activities	Closely watched activities
Conservation	• Good to very good ecological condition • Few to very few fishing pressure • Less potential for development	• All kind of fishing • Disposal of land filled materials • Anchoring • Mining • Dredging • Sewer and waste disposal	• Any activities that has potential to impact the seagrass ecosystem
Restoration	• Good to poor ecological condition • With fishing activities • Has potential for development	• Bottom trawls and push nets • Disposal of land filled materials • Anchoring • Dredging	• Commercial harvesting • Waste water from domestics and aquaculture • Coastal aquaculture nearby • Fisheries activities nearby • Constructions nearby

Table 2.23 Proposed seagrass areas for zoning (OEPP 1997)

Province	Zone	Location	Area (km^2)
Gulf of Thailand East Coast			
Cholburi	Conservation	Ko Kram	
Rayong	Restoration	Ao Makhampom to Prasea River Klong Huahin	2.5
Chantaburi	Restoration	Pangrad River	
	Conservation	Ao Kungkraben	large
Trad	Restoration	Ko Kud Ko Kradad Khao Lan to Laem Klad	 0.12
	Conservation	Laem Thamachat	
Gulf of Thailand West Coast			
Petchburi			
Prachuab Kirikhan	Conservation	Ao Manao	
Chumporn			
Surat Thani	Restoration	Ban Hua Thanon, Ko Samui Haad Nathon, Ko Samui Laem Chon Kram, Ko Samui Haad Chaweng, Ko Samui	1.5 0.5 0.2
		Channal between Ko Samui and Ko Madlang Ko Pangan	1.0 3.0
Nakorn Srithammarat			
Songkhla	Restoration	Laem Chak	
Pattani	Restoration	Klong Tayamu	1.5
	Conservation	Ao Pattani	2.7

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

Only three issues will be discussed in their scientific and technical aspects although there are several more issues.

3.1 WATER USES

The data from 1987 indicate that the total cost of freshwater was 7948 million baht (4253 million baht went to natural water). The Government subsidized about 6293 million baht, about 79 per cent. To encourage a more efficient use of water TDRI proposed that all the government subsidies should be removed. It was estimated that by doing so the real net GDP could be increased by 0.5 per cent while the agriculture output would be increased by 0.06 per cent while using 7.4 per cent less water.

A joint analysis by NESDB, RID and PCD (1997) reveals that in the agricultural sector, vegetables, fruits and tobacco are the most efficient cash crop as far as water use is concerned, 4-20 baht per cubic metre. Sugar cane and sweetcorn yield 0.50-1.50 baht per cubic metre while other field crops, such as rice, yield less than 0.50 baht per cubic metre. Off-season rice yields 0.03 to 0.38 baht per cubic metre.

Other sectors besides agriculture are willing to pay a higher cost for water. The survey found that the domestic and industrial sectors are willing to pay 3.75-11.00 and 5.00-17.75 baht per cubic metre respectively. After correcting for water not fully utilized by consumers, NESDB, RID and PCD (1997) suggested that the appropriate water usage fee for the domestic and industrial sectors should be 4.33-12.69 and 7.95-28.24 baht per cubic metre respectively.

Based on the cost/benefit analysis, NESDB, RID and PCD (1997) recommended that the priority for water use in the dry season should be given to:

(a) The industrial sector which yields more than 8 baht per cubic metre;
(b) Cash crops that yield more than 4 baht per cubic metre, such as vegetables, fruits and tobacco.

For crops that yield less than 4 baht per cubic metre, such as rice, some fee system should be established in order to encourage farmers to grow other crops that gain more money than the existing crops. For example, off-season rice growing in the dry season should be discouraged because of the very low return and because the main rice crop can sufficiently supply the demand. At present, the agricultural sector receives water free of charge.

In addition agricultural practices in the lower part of the river basins where several other activities are available cause the workforce to lose other job opportunities. Therefore, priority for water use in the dry season should be given to the agricultural sector in the central and upper parts of the basins.

3.2 FISHERIES RESOURCES

Based on statistics released by the Department of Fisheries, marine and freshwater fish products from capture have been continuously increasing both in terms of mass and unit value. From this it may be concluded that even though over-exploitation is well known for both marine and freshwater resources, the fisheries sector has not suffered any economic losses. However, the economic loss in terms of environmental and aesthetic values has not been estimated.

3.3 INDUSTRIAL WASTE

It is estimated that the cost of treating all industrial waste in Thailand in 1991, 1996 and 2001 would be 428, 900 and 1600 million baht respectively. Oils and non-halogenated solvents were the most expensive to treat. Heavy metal and infectious wastes posed the highest risk to humans. However in terms of risk reduction effectiveness (risk factor reduction per million of baht), heavy metal and photo wastes ranked first and second respectively. The total cost to treat organic waste (BOD) from industry was estimated to be 1,032 million baht a year in 1986. This was about 2.6 per cent of the GDP of the BOD generating industry of the country.

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

Th analysis of the socio-economic root causes of major environmental issues in Thailand will be presented in the table form designed by by UNEP EAS/RCU. Information obtained in the following table were obtained from literature review as well as interviews with experts and officials from government and private sectors.

Table 4.1 Causes, root causes and socio-economic causes of freshwater shortage

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Freshwater Shortage	East Coast (Rayong) Upper West Coast (Prachuab Kirikhan)	Drought	• Natural (possibly reinforced by global change/ENSO)	
		Uncontrol use	• No regulation on types of industries with respected to water demand in each zone • Luxury consumption in urban areas • Inappropriate agriculture practices with respected to water supply	• Out-date and too rigid laws and regulations • Lack of incentive/regulation for water recycling in all sectors • Lack of a fair classification and privilege for water users in different sectors
		Insufficient reservoirs	• Sandy soil (seepage) • Conflict between dam construction and "conservationists"	• High cost to construct reservoirs in sandy substrate • Some large irrigations projects could not satisfy local people in terms of short and long term benefits • Some irrigation projects are not "transparent"
		Insufficient groundwater supply	• Natural?	•

Table 4.2 Causes, root causes and socio-economic causes of freshwater quality degradation

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Freshwater quality degradation	Near major communities	Domestic waste water (BOD, nutrients, low oxygen)	• Insufficient treatment facilities • Lack of funding for investment and operation	• People feel unfair to be charged for water treatment service
		Sewer (Coliforms)	• Many septic tanks are in water saturated soil near waterways • Lack of central treatment facility	• Insufficient money • Lack of "polluter pays" concept among people
		Suspended solids	• Erosion	•
		Industrial wastes—small factories	• Insufficient capital of the factories • Lack of central treatment facilities	• Unplanned permission for factories • Lack of zoning policy for small factories • No estimation of the cost that polluters have to pay • Lack of available low cost technology for waste treatment
		Industrial wastes—large factories	• By-passing of wastes from the treatment units • Zoning system in the industrial estate is not followed	• Insufficient resources of the enforcement units • Corruption by government officials • Pressures from politics and labour unions complicate the operating licence suspension • The industrial estates relax the zoning regulation in exchange for more income from the organization
		Industrial wastes—government factories	• Lack of appropriate treatment facilities in some factories	• Government "custom" prohibits government agencies to sue each other
Groundwater quality deterioration	Central plain (shallow aquifers)	Saltwater intrusion	• Insufficient recharge	•
		Other pollutants ??	•	•
Flooding and dispersion of pollutants and deseases	Lower central/coastal plains (especially in suburban areas)	Cannot stop growth of major cities, especially Bangkok	• Bangkok is the centre of business, industry, convenience and wealth	•

Table 4.3 Causes, root causes and socio-economic causes of coastal erosion

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Coastal erosion	Widely	Coastal construction	• Lack of local study of sediment transport • Impropriate engineering design	• Reduction of construction and consultation costs by investors • Lack of technical knowledge and may be corruption by government officials and consultants concerned with coastal construction • Lack of public involvement in large construction projects
		Dredging for navigational uses	•	•
Marine/coastal habitat destructions	Mangroves	Conversion into aquaculture uses (especially shrimps)	• Fast cash return from aquaculture	• Outdated laws and regulations, especially the loophole that allows "degraded" forests to be converted for other uses • Corruption by government officials in charge • Involvement by "influential" people in the business
		Conversion into urban areas	• Unplanned and unregulated expansion of coastal cities and towns	• Outdated laws and regulations, especially the loophole that allow "degraded" forests to be converted for other uses • Corruptions by government officials in charge • Involvement by "influential" people in the business
		Effect of pollution?	•	•

Table 4.4 Causes, root causes and socio-economic causes of marine and coastal habitats destruction

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Marine/coastal habitat destructions	Coral reefs	Smothering	• Coastal erosion and other anthropogenic sources of suspended solids	• Coastal development and dredging without taking marine resources into consideration
		Chemical pollutions	• Domestic wastes from nearby human settlements, ships etc.	• Development without taking marine resources into consideration • Lack of enforcement on waste from ship and tourism boats
		Tourism and recreational uses	• Uncontrolled and unmanaged quantity and quality of visitors • Irresponsible divers and tour operators • Conservation zoning system is not fully implemented	• Insufficient resources (budget, personnal etc.) of local enforcers • Lack of awareness by many visitors and tourists
		Irresponsible fisheries	• Destructive fishing methods, including dynamite, trawl nets and certain traps	• Insufficient enforcement • Political issue when dealing with small scale fisheries
		Landfill	• Insufficient land area for development and expansion of coastal activities	• Inappropriate advance planning • Desire for "cheap" coastal land
		Coastal erosion and transformation	• Coastal construction that affects sediment transport • Dredging	• Unawareness • Unplanned development
	Seagrass beds	Smothering	• Coastal erosion and other anthropogenic sources of suspended solids	• Coastal development and dredging without taking marine resource into consideration
		Chemical pollution	• Domestic wastes from nearby human settlements, ships etc.	• Development without taking marine resource into consideration • Lack of enforcement on waste from ships etc.
		Dredging	• Navigational development	• Lack of awareness
		Irresponsible fishing	• Nearshore bottom trawling	• Lack of enforcement

Table 4.5 Causes, root causes and socio-economic causes of deterioration of coastal seawater and sediment quality

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Deterioration of coastal seawater and sediment quality	Mainly near river mouth and brackish water areas but occasionally in marine areas	Domestic waste (mainly oxidizable organic and nutrients)	• Insufficient treatments	• Lack of funding • Lack of awareness • Overestimation of the carrying capacity of coastal ecosystem
		Sewers	• Inappropriate sewer system	• Unawareness/ignorance
		Aquaculture wastes (mainly oxidizable organic and nutrients)	• Over feeding (especially high protein feeds) • Insufficient treatment of pond sludge	• Lack of low cost alternatives to treat sludge • Ignorance, especially among non-local investors
		Coastal industries	•	•
		Maritime (mainly oil)	• Operational leakage • Illegal discharge from tankers • Accidents (collision, grounding, and during transfer)	• Lack of resources for enforcement and patrol • Political pressure especially when dealing with small boats • Negligence
Deterioration of offshore seawater and sediment quality	No conclusive evidence yet found but needs close monitoring	Oil	• Operational leakage • Illegal discharge by tankers • Accidents (collision, grounding, and during transfer)	• Lack of resources for enforcement and patrol • Political pressure especially when dealing with small boats • Negligence
		Trace metals	• Accidental leak of processed water?	•
Deterioration of quality of aquatic food products	Still rare but needs constant monitoring	Persistent pollutants	• Uncontrolled discharges from domestic, agriculture and industrial sources	• Same as those for water quality deterioration
		Coliforms and other pathogens	• Domestic and sewer discharges	• Same as those for water quality deterioration
		Other chemicals (such as antibiotics)	• Excess usage in aquaculture industry	• To maintain intensive culture

Table 4.6 Causes, root causes and socio-economic causes of deterioration of the decline in fishery resources

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Decline in fishery resources	Widely	Overfishing	• Failure to manage fishing pressure • Non-selective fishing gear, especially trawlers	• High demand for domestic consumption and export • Lack of national and regional management policies that are effective and implementble • Lack of reliable data and statistics • Influences from politics and interest groups
		Habitat destruction/modification	• Shoreline modification • Destruction of natural submerged habitats • Interference with migration	
		Reduced recruitment	• Reduced number of spawners • Failure to protect nursing areas, e.g. 3 km from shore • Pollution effects on spawning and survival of larvae	
		Changing in ecological food chain	• Succession by low value or non-edible species	

Table 4.7 Causes, root causes and socio-economic causes of deterioration of eutrophication

Issue	Impact zone	Cause	Root Causes	Socio-Economic Causes
Eutrophication	Coastal area, mainly in the upper Gulf of Thailand	Nutrient enrichment	• Degradation of organic loading from land (mainly domestic and aquaculture) • Nutrient regeneration in sediments	

5.0 CONSTRAINTS TO ACTION

There is a huge number of government agencies, local administrations, state enterprises, international organizations, private businesses, non-profit and non-governmental activity groups involved in environmental programmes in Thailand. Each of them has unique problems and constraints that would be very long to list here. As far as the objective of this national report is concerned, the constraints will be summarized to produce a natural picture of the problem.

5.1 PERSONNEL CONSTRAINTS

5.1.1 Shortage of qualified personnel in government offices

There are insufficient numbers of qualified environmental scientists and analysts working in government units because of the infamous bureaucratic system full of red tape and corruption. In addition, government jobs offer low compensation, non-competitive salary ranges and occupational promotion is often based on seniority and connection rather than performance and achievement.

Many devoted officials become disheartened. The government system discourages officials, especially those in junior positions, from being critical or offering opinions in their work. Instead of voicing their opinions in public or at a meeting, officials have to approach their superiors in a closed door discussion. And very likely, their opinions and ideas will be rejected or simply ignored. Because the majority of government officials lack drive and creativity, those young energetic and innovative minds turn away from bureaucracy and seek careers in the private sector where there are more opportunities for intellectual growth in a democratic environment.

5.1.2 Hiring foreign experts in environmental projects

In spite of the availability of Thai environment experts both in the government and private sectors, western experts are hired for several projects. Many times this is done only to boost the image and credibility of the project because western countries are seen as superior in professionalism and technological advancement. Not only is the hiring of foreign experts very costly, their western framework can also be detrimental to environmental management in Thailand as the western approach is often unsuitable in the Thai context. As an example, the earlier National Economic and Social Development Plans under foreign advisors put much emphasis on export promotion without recognizing the significance of the traditional economic base and socio-cultural background. Therefore, they produced a host of social, economic and environmental problems after implementation.

5.2 INSTITUTIONAL CONSTRAINTS

5.2.1 Centralized government system exerts top-down approach

Local administration units still lack decision-making power concerning crucial environmental management issues. This is because the central Government is over-concerned with their ability to successfully carry out self-governance without being dominated by local influential figures. More effort should be made to encourage a decentralized system while minimizing the influence from local interested groups that do not represent the majority.

In government provincial offices, many officials in key positions are sent from central units. These officials do not have strong ties or commitment toward the local community because one day they will be transferred to some other office. Thus, they are often negligent in tackling local environmental problems.

Probably the worst part of centralized administration is the tedious hierarchical line of command. The policy and activities of each unit are usually made by a person, the unit leader, rather than a committee. Not only is this conducive to corruption, the use of "line of command" instead of "brainstorming" also results in complex environmental problems being tackled from a single perspective whereas a multidisciplinary and multiple angles approach would be more beneficial. The lack of implementable and effective national and regional management policies, the unplanned and unregulated expansion of urban centres, the inappropriate zoning of industrial sites, inadequate research and development (R and D), and a myriad other problems have stemmed from the short-sighted leadership of centralized administration.

Thailand is characterized by top-down administration and bottom-up resource exploitation. In other words, natural resources have been used to serve urban elites, often for their pleasure and not for real needs.

5.2.2 Lack of public involvement in decision-making on mega projects

In the past the conception, design and contract of most mega projects was done without public input. Consensus has been limited to high-level government officials and executives of large businesses. Only after the initial phase of construction do the public realize a project has been approved. Public hearing generally occurs much too late, thus highlighting rather than mitigating the conflict. The Petroleum Authority of Thailand's project on the gas pipeline in Kanchanaburi is a case in point; protest and counter-protest are being organized, worsening the situation. Therefore, public hearings should be mandatory before all costly projects take shape. In addition, there should be a strict procedure to assure transparency in such work initiated by the Government and big businesses.

5.2.3 Lack of cooperation among government offices and between government offices and non-governmental organizations

It is unquestionable that strong territorialism exists in the government system in terms of physical logistics, budget and responsibilities. This contributes greatly to ineffective management because it is a major obstacle to any means of cooperation, even the exchange of information, among government offices. Duplicated work and redundant duties continue because each unit distrusts the others in terms of performance as well as distrusting competitors. In addition, it is a tradition among administrators in the government system to take the magnitude of the allocated budget to be the indicator of their success, the fatter the budget, the higher praise they receive for their "effectiveness". This leads to a lack of cooperation and no delegation of duties to appropriate agencies since that may entail a loss of budget. The top administrators, at the ministry level for example, are not always strong enough to make decisions and therefore compromises are made so that the departments involved are satisfied while the overall effectiveness of the programme is given a lower priority.

Cooperation between the government offices and environmental non-governmental organizations is woefully lacking. They often consider themselves to be on the opposite side of the fence, developmentalists versus conservationists. Eventually, their work is against each other instead of complementing each other. It should be mentioned here also that some non-governmental organizations do have a reputation for representing particular interest groups and not sincerely devoting themselves to the national environment. Whether or not this is true, it points out a complex situation with the probability that a large amount of money may be involved.

5.2.4 Lack of reliable data and versatile information on environmental conditions

Data collection on environmental conditions and management is done regularly by several government agencies. However, most of the datasets have been designed to describe the general environment situation or status. They usually lack specific objectives set before the monitoring programmes started. Moreover, the data obtained are rarely utilized and analysed to the full extent. Whenever environmental information is needed by decision makers, for example when a megaproject is proposed, existing data are frequently not sufficient because the data are for descriptive and not prescriptive purposes. More studies and data collection are usually required.

The quality of data is also another problem. In Thailand, there has not been a mandatory quality control/quality assurance system for environmental data. Thus despite a long-term effort to collect environmental data, no one can really guarantee the correctness of those data.

5.2.5 Overemphasis on certain industries for the sake of incoming money and development

There are several industries which were promoted out of proportion in an attempt to "develop" the country, tourism being the latest one. It is true that the tourist industry will bring in much-needed foreign currencies but concerned offices usually ignore the negative consequences or fail to anticipate problems which will stem from certain businesses or operations; for example, jet skis and substandard tourist boats cause oil pollution as well as disturbing marine life and human activities, yet they are seen around many popular beaches in Thailand. Tourism, as well as other promotions, should only be made after appropriate environmental impact assessments and adequate protection measures have been implemented, including the carrying capacity, efficient conservation zoning system etc.

5.2.6 Policy makers insensitive to socio-economic dynamism

It is important that environmental policies be well-suited to the current situation. Yet some policy makers do not realize the connection between environmental problems and socio-economic dynamism which needs fast and smart reactions. The government regulation on budget spending is a good example. The management of the Environmental Fund should be more flexible; rigid spending regulation results in the lack of advance money to cope with emergencies.

The allocation of budget and authority for each local administration, such as municipalities and sanitation districts, depends on the number of "registered" residents. For some, this does not represent the actual size of the population at all since the number of transients such as visitors and temporary workers far exceeds the residents. Therefore, this number should be under consideration for the allotment of budget and authority.

5.3 LEGAL CONSTRAINTS: LAWS, REGULATIONS AND ENFORCEMENT

5.3.1 Loopholes in laws and regulations

There is a laxity in Thai legal control because of loopholes allowing grafters to rake in profits; for instance, the law granting issuance of land ownership documents to villagers who work on the land designated as "degraded forests". The usual practice is for influential figures to hire local villagers to clear the forest. After it has been categorized as "degraded", then land ownership papers are issued to these "entrepreneurs". Rampant encroachment causes deforestation, soil erosion, watershed destruction and fat bank accounts for the grafters.

Up to 1997 there has not been a law which prohibits or controls the imports of second-hand machinery regarding the model, type, year, condition and number. Some outdated machinery lacks oil containment or oil filtering systems so the discharge is released into the surface and underground water sources.

Certain laws deter private enterprises from providing specific services such as operating treatment plants for the proper disposal of toxic or hazardous waste. At present, domestic hazardous waste is usually mixed with household garbage while waste in factories is managed by different standards. Some goes to land fills, while some is still kept in the factories awaiting appropriate disposal facilities.

Several laws and regulations are outdated. The environmental situation changes rapidly, new problems arise, yet the legal framework is inadequate to deal with such changes and legal amendment takes an awfully long time. In addition, apart from environmental laws, other laws are made without much consideration of the environment. Environmental scientists or analysts have not usually been included or consulted in the drafting process.

5.3.2 Legal emphasis on punishment instead of rewards or incentive-building

The emphasis of environment-related laws is on punishment. Instead, positive actions should be encouraged through rewards and incentive-building, for example, the Government should promote water recycling in all sectors by providing rewards for those who have successfully managed to do so, and the Government should give compensation to people or businesses which carry out environmental friendly activities for their costs.

5.3.3 Lack of an appropriate law for government agencies to control and manage beyond territorial waters

Thailand is among last countries in the world that has not ratified to the UN Convention on Laws of the Sea. Yet, there are several signs from government and legislatives that the country may do so soon. This UNCLOS allows coastal states to issue laws and other legal instruments to control and manage resources and environmental in the EEZ and continental shelf.

While neighbor countries, such as Malaysia has had an effective laws that empower government agencies to control and manage environmental and natural resource in its EEZ, officers in Thailand do not enjoy the privileges. Thus several activities that can cause transboundary consequences could still be active in Thailand'EEZ only few kilometers from neighboring countries' EEZ.

5.4 CULTURAL CONSTRAINTS

5.4.1 The Thai worldview: fatalism, tolerance and apathy

The Thai people have been described as lighthearted, tolerant and fatalistic. This is not far from the truth. Thailand is the land of plenty, and natural resources are abundant so the people tend to "take it easy". In the recent past, it was very difficult for a Thai to imagine that fresh clean water would be one of the scarce resources and a lot of Thai people would have to drink bottled water at a cost of over 10 baht per litre - a higher price than the same amount of imported gasoline.

Basically an agrarian people whose lifestyle and production depends mostly on uncontrollable natural forces, the Thais do not worry so much about their "tomorrows". Furthermore, Buddhism emphasizes "karma" or past deeds which also prescribe the present. Since life has been somewhat pre-determined, why the struggle? It is much easier to leave everything up to destiny; this is reflected in the two familiar phrases, "mai pen rai" (never mind) and "chang mon" (let it be). As a result, attempts to raise environmental awareness are met with failure. The people have not been responsive to programmes such as pre-sorting household garbage, separating hazardous waste such as containers of pesticide and dry batteries, and installing kitchen grease receptors.

The Thais are friendly and tolerant. Conflict and potential encounters are avoided. Consequently, the people ignore and withdraw from problems and conflicts. In this way, the Thais seem to be apathetic and the problems are perpetuated or become intensified instead of being tackled or solved.

5.4.2 Love of enjoyment, entertainment, consumerism and conspicuous consumption

The Thais love "sanuk" or enjoyment and fun, and they are willing to pay whatever cost (to the environment) to have fun activities. The lantern floating ceremony of the twelfth lunar month is an excellent example. The traditional purpose of this ceremony is to pay respect to the goddess of the river, but recently it has become a mere entertainment and causes pollution in urban waterways. Another case in point is the governor of Uthai Thani who organized a drinking party in Huay Kha Khaeng National Park, UNESCO Natural World Heritage Site, in order to entertain his friends.

There are many entertainment businesses which use water wastefully. Among these are massage parlors which often secure priority of water resource over the agricultural sector because they are located in elite centres or urban areas and not in the remote countryside.

Many of the Thais have fallen victim to consumerism and conspicuous consumption. A person's worth is seen by his/her spending and owning. Teenagers are following western consumption patterns: eating junk food in disposable wares. More and more natural resources are exploited and turned into non-degradable wastes.

As mentioned, the Thais are not future-oriented, thus they would rather spend money on immediate enjoyment than invest in environmental preservation. According to the survey commissioned by the Waste Water Management Authority, the residents think it is unfair to be charged for water treatment service. As in a myriad other environmental problems, the residents fail to recognize that each one of them contributes to the problems. It is easy to point the finger at factories or large industrial estates which are point source polluters, but small-scale non-point source polluters are an even larger part of the problem.

5.4.3 Patron-client relationship and system of dependency

Many of the unsolvable environment problems in Thailand stem from the fact that there are influential figures (ranging from politicians, high-level military or police and super-rich business men to district and village heads) behind most insidious schemes or activities. These people and their followers are capable of being uncompromising and even violent in order to safeguard their own profits. Threat, violence and death are a common requital for those who disrupt their schemes or activities.

These influential people act as "patrons" and their followers are "clients" under the patrons' protection and support. While the patrons secure power as well as huge material or monetary profit, clients receive their partial share. This system of dependency is ingrained in the Thai tradition and mutual benefit keeps perpetuating the bond. A large part of natural resources are exploited for the benefit of these select groups. Thus, the "Tragedy of the Commons" does not occur only to the common property, but also to the common people who do not have power or influence.

5.3.4 "Wrong" type of environmental education

The Thai traditional education system is "learning by observing and doing". Learners gain experience from the real situation and develop a practical and holistic approach to life. Nevertheless, the new mode of formal education both in school and university has alienated students from practicality; students "learn" in order to pass the exam rather than to think creatively. Thus, many Thais lack environmental awareness; they were taught that the value of the natural environment lies in its economic potential. They also fail to understand that environmental cost is actually "paid" (albeit gradually) by every single person on earth.

6.0 ONGOING AND PLANNED ACTIVITIES RELEVANT TO THE IDENTIFIED ISSUES

6.1 SURFACE FRESHWATER QUANTITY AND QUALITY MANAGEMENT

6.1.1 National Policy for 1997-2000 concerning freshwater resources in Thailand

In the past, Thailand did not have a national water policy. Previous Governments emphasized water development to meet the increasing water demand. National water resources management therefore was broadly proposed in the NESD plan. In 1996, the water resources policy was a part of the long-term policy and plan for enhancement and conservation of national environmental quality (1997-2016) which aimed at the systematic development, conservation and rehabilitation of surface water and groundwater resources in all watersheds in order to maintain an adequate quantity and suitable quality for sustainable use. The National Policy for 1997-2000 aimed to:

(a) Enhance raw water production;
(b) Coordinate between government and private sectors to manage and maintain existing water resources especially for agriculture;
(c) Encourage the private sector to invest in tap water production;
(d) Enhance the efficiency of water resources management to reduce the uncontrolled runoff by at least 25 per cent;
(e) Modify water fees to be based on the real production value and production yield;
(f) Enhance water use efficiency in all sectors;
(g) Create a central agency for water resources development, policy and management.

Water Resources Management Guideline

(a) Implement organization and mechanisms for water resources development at national and watershed levels;
(b) Implement a water allocation system based on priority and fairness;
(c) Improve water transport efficiency and reduce loss;
(d) Realize the value of water.

Water quality

(a) Reduce and control water pollution from agriculture and industry;
(b) Set up approach and emergency plans for pollution dispersion;
(c) Support wastewater treatment.

The important issues indicated in the eighth NESD plan (1997-2001) are:

1. To enhance social stability for family and community
    1.1 To provide and improve basic infrastructure including wastewater treatment

2. To effectively plan land use
    2.1 To provide areas for runoff management

3. To expand agricultural areas for sustainable agriculture
    3.1 To modify to a natural agricultural structure, using organic materials and promoting the use organic matter instead of chemical fertilizers by farmers
    3.2 To support water resources allocation for small agriculture areas

4. To develop water resources
    4.1 To develop raw water in many levels
    4.2 To coordinate with the government and private sectors in order to manage and maintain the existing water resources, especially for agriculture
    4.3 To support the private sector for tap water investment
    4.4 To enhance efficiency in water resources management to reduce the losses to less than 25 per cent
    4.5 To modify the water fees by determining the ratio of the production value and use
    4.6 To coordinate the government and private sectors for more efficient water use
    4.7 To create a central agency responsible for water resources development in formulating policy coordination and management

5. To monitor water quality so it does not deteriorate below surface water quality standards
    5.1 To reduce and control water pollution from agricultural and industrial activities
    5.2 To set the approach and emergency plan for pollution dispersion
    5.3 To support wastewater treatment
    5.4 To promote long-term investment in wastewater implementation in economic centres

6. To set up guidelines for systematic water resources management especially at the watershed level
    6.1 To implement organization and mechanisms for water resources development in natural and watershed levels for accuracy in the work of each organization
    6.2 To implement suitable allocation systems at all levels among all types of users according to priorities and fairness
    6.3 To collect the raw water fee from industries, farmers and household users
    6.4 To improve the transport and location system to the farmers and the households to minimize the loss of the water as quickly as possible
    6.5 To realize the water value

Important legislative instruments for environmental protection

(a) The Environmental Fund;
(b) Conservation and environmental protected areas;
(c) Pollution control areas;
(d) Environmental impact assessments;
(e) Polluter Pays Principle;
(f) Duty reduction for pollution control equipment.

The Thai Government has provided a large budget for water resources development, not less than two hundred million US dollars a year. At least 30 agencies under eight ministries are assigned responsibility directly and indirectly. Generally, the mandate of water resources management has been identified according to the political area not at the watershed level. Most of the policies and plans are under the responsibility of many ministries. Currently, water management organization at all levels is under crisis.

6.1.2 Overlapping mandates

Mandates in water resources management overlap. At the national level, there are three committees: the NESD Committee, the National Environmental Committee, and the Natural Resource Management Committee. Following is a list of the organizations under six ministries relating to water resources management:

1. Ministry of Agriculture and Cooperatives: The Royal Irrigation Department, The Royal Forestry Department, The Land Development Department, Department of Fisheries, Office of Agricultural Economics, The Agricultural Land Reform Office, Department of Agricultural Extension;
2. Ministry of Transport and Communications: The Harbour Department;
3. Ministry of Industry: Department of Mineral Resources, Department of Industrial Works;
4. Ministry of Interior: Department of Town and Country Planning, Public Works Department, Office of Accelerated Rural Development, Department of Lands;
5. Ministry of Public Health: Department of Health;
6. Ministry of Science, Technology and Environment: Department of Environmental Quality Promotion, Pollution Control Department, Department of Energy Affairs, Office of Environmental Policy and Planning.

At the regional level, the organizations at provincial, district and local levels are Office of Provincial Administration, Office of District Administration, Provincial Administration Organization, municipality, sanitary, and chamber.

At the implementation level, important issues indicated in the five-year environmental plan of MOSTE (1997-2001), are the 25 watershed management plans, 2000 small-scale projects, investment in 8000 natural water resources rehabilitation projects, and underground and surface water resources management mechanisms to reflect water true value. The plan only indicates adjustment of the water fee in the non-agricultural sectors to meet the changing situation.

Below are some of the important agencies involved in water resources management in Thailand:

(a) **NESDB** is responsible for setting the direction and framework of the natural resources and environmental development. The framework sets the criteria for budget allocation and investment for all development projects in Thailand.

(b) **NEB** is formulated under the ECNEQ Act (B.E. 2535) in which the Prime Minister is the chairman. In 1996, NEB proposed the long-term policy and plan for enhancement and conservation of national environmental quality (1997-2016) and also established a subcommittee and working group to screen the projects. The mandate and direction of the NEB are varied according to the Prime Minister and Ministerial Cabinet of each Government. Therefore, attempts to improve water management organization depend on the understanding and communication with the administrators from the election.

(c) **The National Hydrological Committee** has been established since 1993 but was reformulated in 1997.

(d) **The Natural Water Resource Committee** was established in 1989 according to the Prime Minister's Regulation (B.E. 2532). The Committee is comprised of 19 agencies and 5 experts with the Deputy Prime Minster as chairman. This Committee is under the Office of the Prime Minister. It has the following duties:

1. To collect general data on water resources in Thailand and other countries;
2. To submit natural resource development and conservation policy, action plans and measures to the cabinet for approval;
3. To propose plans relating to the conservation of water resources;
4. To supervise construction plans or water resources development of other agencies;
5. To study problems and barriers to government work;
6. To consider and propose water allocation and control priorities;
7. To monitor, assess and make summary reports of construction work or water resource development;
8. To consider and propose amendments to the law relating to the improvement and conservation of natural water resources;
9. To propose public relations campaigns and disseminate information on administrative and problem solutions;
10. To coordinate the assistance and support of education and research activities;
11. To be the focal point to cooperate and propose measures for such problems as water shortage and flooding.

While the committee has broad and important duties, it was formulated under the Prime Minister Regulation (B.E. 2532) not by any law or act. In addition, there is no direct budget to support the continuity of any activities. Committee members are only representatives from involved ministries. The Committee lacks academic and political experts. At present, they are in the process of recruitment to establish the organization and are waiting for the announcement of the National Water Resource Act which is being drafted by NRC.

(e) The Royal Irrigation Department (RID)

RID is responsible for obtaining water to store, control, transport, drain or allocate for agriculture, energy, public utilities or industry including protection against damage from water and water transportation within the irrigation areas. In the past, the Operation and Maintenance Division under RID was responsible for flood and drought problems. The drought crisis in 1993 resulted in the