

87	Catenella nipae	T
88	Cryptonemia undulata	R
89	Dermonema pulvinata	V
90	Eucheuma gelatinae	T
91	Grateloupia livida	R
92	Gracilaria eucheumoides	V
93	Hypnea cornuta	K
94	Hypnea japonica	V
95	Sargassum tenerrimum	K
	Trees	
96	Barringtonia asiatica	V
97	Lumnitzera litorea	V
98	Rhizophora apiculata	V

2.3.2.3 Major Problems and issues

a) Degradation of coastal ecosystems (tidal flats, estuaries, coral reefs,...):

- Mangrove forest cover decreases from 400,000-500,000 ha in 1943 to 180,000-200,000 ha in 1995 partly by the war, partly by the domestic use and recently by cutting for shrimp farming.
- Coral reef is exploited for making souvenirs, construction material and medicines.

b) Over-exploitation and illegal methods leading to exhausting resources:

- Over-exploitation (including illegal fishing) is common phenomenon in resources exploitation in Viet Nam. Many species are in danger.
- Using explosive materials is conducted almost in every province.

c) Pollution in many areas especially estuaries, ports by oil, pesticides and organic pollutants.

d) Habitat modification due to the reduction in area of mangrove and coral covers and due to erosion of the coast.

2.3.2.4 Economic losses because of over - exploitation

As it has been presented in 2.3.2.1, the overexploitation is a severe problem in Viet Nam. It is because of high concentration of exploiting capacity in the shallow water areas of the depth less than 100m. Apart from this, illegal fishing of Chinese and Thailand vessels in the Viet Nam waters is another reason, the production of which is estimated of 300,000 - 400,000 ton/year.

The overexploitation make the catching became less and less. For example, fishing of Thanh Hoa, Nghe An provinces by light catching is:

	Nghe An	Thanh Hoa
1993 - 1995	200 - 300 ton/unit, year	120-130 ton/unit, year
1996	20 - 25 ton/unit, year	25 - 30 ton/unit, year

Catching productivity in 1996 in both provinces is insignificant:

- Light fishing in Thanh Hoa: 15 tons vessels in year 1970 - 1980 can catch 120 tons/vessel/year, in 1996 it was 15 - 20 tons/ vessels/year only.
- Shrimps grounds from Quang Ninh to Nghe An are in degradation. Among them there are grounds not exploitable (shrimp ground Mi Mieu in Quang Ninh for example, shrimp ground Hon Ne, Hon Me (Nghe An Province) decreases 30 - 40%, at shrimp ground Hau Loc (Thanh Hoa Province) the productivity reduces from 800 - 1,200kg to 300 - 400kg, the exploitation capacity of shrimp ground Dien Chau (Nghe An province) decrease from 100 ton/year to 5 - 6 ton/year nowadays.
- Cuttlefish catching productivity decreases by 50 - 75%. Formerly, it was 200kg/person year, now: 50 - 100/person year.

Apart from this, not allowable catching methods can contribute significantly to the overexploitation and increase with the time:

- In 1992, Thanh Hoa province has 800/1600 vessels using explosion.
- In 1994, it is recorded 40 cases, 23 vessels, 2609 kg of explosion materials.
- During 1992 - 1993, in the whole country, there were 600 cases of 700 vessels using explosion materials. Among them, Thanh Hoa Province - 200 cases, Quang Nam - Da Nang - 58 cases, with 7058 kg of explosion materials, 544 times, 147 vessels.
- Islet-Village Hai Ninh (Qui Nhon City) has 50/62 house holds using explosion for coral exploitation. Daily, the people there use 8kg of explosion materials for 180 m³ of corals. For the last 20 years, this village is still using this method.
- Chinese and Thailand peoples also conduct illegal fishing in Vietnamese waters by using the xianua anaesthesia method

2.3.2.5 Causes including sectoral demands and failures and internal and external market demands

No data showing these causes.

2.3.2.6 Impact of global change

The El-Nino phenomenon seems to affect the living marine resources of Viet Nam in migrant species and may be by increasing the water temperature. Unfortunately there is no data for this.

2.3.2.7 Proposed interventions

The most important measure is the legal interventions. In order to protect the resources of marine products, Viet Nam has promulgated some laws and regulations as described below:

- The State Laws on the protection and management of aquatic living resources approved on 25th of April, 1994.
- The State Decree on the protection and management aquatic living resources approved on 2nd of June, 1990.

- The circular letter number 04TS/TT, guiding the implementation the two listed above State documents, including:
 - Regulations about the protection of aquatic living environment.
 - Regulations about the management, protection and development of aquatic living resources.
 - Regulations about prohibited and temporarily prohibited regions from exploitation.
 - International cooperation in the field of protection and development of aquatic living resources.
 - Guidelines for implementation.
- The Governmental Decree on the regulation for foreign ships and boats fishing in Viet Nam territorial water approved on 22nd of December, 1990.
- Decision of Minister of the Ministry of Fisheries on the registration and permission of involvement if fishery activities approved on 16th of June, 1991.
- Decision of Minister of Ministry of Fisheries signed on 22nd of September, 1993 about the regulation promulgation of the exploitation and management of aquatic living resources of important fishing grounds.
- In order to guarantee successful implementation of the state regulations on the protection and development of the aquatic living resources, Ministry of Fisheries has established an institutional system from central to local levels, which has the function of management and protection of aquatic living resources and the safety control of the fishing equipment and tools, including :
 - National Agency of Fishery Resources and Environment Conservation, belonging to Ministry of Fisheries. This Department has its branches in Hai Phong, Da Nang and Ho Chi Minh city.
 - Local Offices of Fishery Resources and Environment Conservation of Province belonging to Department of Fisheries or Department of Agriculture-Forestry and Fisheries.
 - The domestic offshore fishing must be developed
 - The sea control must be established and enforced to stop illegal and not allowable fishing methods
 - Stop converting mangrove forests into shrimp and other marine products pool farming

Until now, there are 29 local offices and one Committee for the protection of resources, 26 among which, belong to coastal provinces.

2.4 MODIFICATION OF AQUATIC HABITATS

2.4.1 Fresh water habitats

Due to the diverse geographical features, Viet Nam has all conditions favorable for the formulation of various types of fresh water and coastal wetlands. The wetlands in Viet Nam include rivers, springs, large river basins, coastal low lands, natural fresh water lakes, water reservoirs and seasonally submerged areas. They play an important role in the micro-climatic regulation, flood limitation, erosion protection, ground water control and especially the habitat function.

2.4.1.1 Fresh water and coastal wetlands

As described in the previous section, Viet Nam is rich in river-spring network with 2500 big and small rivers and 0.6 km/ km² average density. The river-spring network plays an important role in Viet Nam's economy, that can be summarized as follows:

- It creates large, fertile and populated deltas such as the Red River and Mekong River deltas.
- It creates areas of abundant fish systems with high production rate. For example, the Red River fish system area has more than 110 species of fish and the Mekong one has 155 species, many of which are of high scientific and economic value. Fishing communities livelihood along river banks depends on these resources.
- Large bars are resident grounds for many emigrant birds.
- Rivers, springs supply water for domestic water, agriculture, aquaculture, manufacturing and electric power generation.
- Rivers serve as an important domestic water transportation network supporting communication between different areas of the country. Many river ports are the places for good exchange, especially between high and low-land areas.
- Recently some rivers, springs has been used for tourism purposes.

In the high mountain and midland areas, the socio-economic life is still not developed. To avoid the run-offs, indigenous community are living only around valleys and hill-side where they can cultivate plants suitable for the mountain climate such as cinnamon, wax-tree, tea and opium. They destroy forests for woods, medicines and for cultivating crops. They are provided with the water from rivers and springs for domestic use and partly for agriculture.

The use of rivers, springs in these areas for water transportation is still limited due to the presence of number of waterfalls. Recently, as hydropower stations and water reservoirs have been built, some rivers can be used for local transportation only. At some places, spring flows have been exploited for electric power for local domestic use of small scale.

In opposite to the upstream areas, the socio-economic status in the downstream areas is more abundant and complicated. Due to flat topography, hydraulic networks have been extended for human multi-use activities. In these area, fisherman communities exist and are very poor. Their livelihood is mainly based on catching fish, transporting goods and people across rivers. The families work independently, have a lot of children living all their life on small boats. They discharge all types of waste directly into rivers and are involved in black social activities, such as drinking, drugging. Only on Huong River (Thua Thien Hue Province), there are 887 households with 6218 person living on boats and in "rat-hole" houses at the river banks.

River water generally is turbid, rich in dissolved salt, neutralized in pH and with average mineralized level, which is favorable for multi purposed uses. By the data of the Ministry of Transportation, Viet Nam has about 40,000 km of rives and canals which are potential for water transportation. 10% of them has the depth more than 2.0m; 6.8%: 1.5-2.0m; 7% 1.2-1.5m; 29.2%: 0.9-1.2m and 47%: less than 0.9m. In the South Part of Viet Nam the water transportation is predominant due to the presence of dense river-canal network.

The amount of waterway transported goods can reach 50% of the total one. However up to now only 13,000 km (30%) of rivers are used, in which 6,000 km in the North, 500 km in the Middle Part and 6,500 km in the South.

Deltaic wetland: Viet Nam has 2 big deltas: the Red River and Mekong River. Red River Delta has the area of 1,743,200 ha, and is 0-5m above the mean sea level. 21% of population of the whole country live in the delta, among which 11,477,083 in rural area and population density is 900-1,500 per./km². The land area for agriculture is about 6,000 km² and the water surface area for aquaculture is 237 km². The rice productivity is 9-10 ton/ha, but meets not few difficulties due to storm, flood, drought and northwest monsoon, which result in poor crops, poverty and migration wave to cities.

Biodiversity decreases due to the use of pesticides, pollutants from industrial areas, resource over-exploitation and etc.

The Mekong Delta has an area of about 3,200,000 ha, which comprises of 5 main regions: Tien and Hau river estuaries (flooded), Dong Thap Muoi (closed and flooded), U Minh forest and tidal flat. The delta is a potential area for rice cultivation in the South East Asia and domestic fishery development. It is subjected by saline intrusion and sweeping floods. There are 6 natural protected areas for wetlands and wild animals such as the Cham Chim, Vo Doi, Nam Can forest, Bac Lieu bird ground, Cai Nuoc and Dam Doi.

Seasonally varying wetlands: They are malaleuca forests located in the Mekong Delta, especially, the Dong Thap Muoi and Long Xuyen quadrangle forests which has the area of 800,000 ha and is 0,5-1,5m higher than mean sea level (MSL). In the rainy season, they are submerged by 2m of water, but become dry in dry season, that results in the severe acidification of the soil. In the area, there are about 134 phyto-species be long to 64 families, 160 species of phytoplanktons, 70 species of zooplanktons, 21 species of benthos, 36 species of fish and hundreds of species of birds.

The U Minh malaleuca forest was 142,520 ha large before the Viet Nam war. There are 64 phyto-species. Two natural preservation areas have been established there.

Beside, there are about 5,000 ha of malaleuca forest in the Middle part of Viet Nam, less developed due to nutrient-poor soil.

Tidal flats can be found in coastal areas and estuaries with the depth from 0m (referenced to the chart datum) to the highest tidal level. They occupy the area of about 1 mil. ha. Beside of mangrove forests, they are swampy tidal flats which are the results of natural reclamation. They are grounds for emigrant birds, has high biodiversity and are resources on which the livelihood of local community depends on. Recently, this wetland resources have been reduced due to coastal erosions.

2.4.1.2 Inland lakes and water bodies

Major natural lakes

- Ba Be Lake is in Cao Bang Province, located at the height of 250-350m above MSL, surface area: 450 ha, average depth: 17-23m, maximum depth: 30m. This is the biggest mountainous lake in Viet Nam with surrounding limestone mountain and tropical forests. In the lake, there are about 20 phyto-species of high ranking, over 100 species of phytoplanktons, 24: zooplanktons, 27: benthos, 49 species of fish and some species of reptiles and emigrant (in winter) birds.
- Chu lake, Vinh Phu Province, 30m above MSL, area: 300 ha. It has very poor phyto-community due to extensive exploitation. The lake is used only for irrigation and catching natural fish.
- Western Lake, Hanoi, 3.5m above MSL, 3.5m depth, the area: 413 ha. The lake bottom is covered by thick sludge of 0.8m mainly by organic waste. There are 18 species of big trees, 102 phytoplanktons, 40 zooplanktons, 12 benthos, 33 fish, among which 22 species belong to cyprinidae family. The productivity of natural fish decreases. Catching production is 300 tons/year, mainly from aquaculture.
- Bien Ho Lake, Gia Lai Province, 800m above MSL, the area: 600 ha, maximum depth: 36m, poor in big trees, 122 phytoplanktons, 54: zooplanktons, 15 species of benthos and 27 species of fish. The lake is used for water supply, tourism and fish catching.
- 'Lak' lake, Dak Lak Province, 440 above MSL, the area: 600 ha, maximum depth: 6m, phyto-community is abundant, over 100 species of phytoplanktons, 50: zooplanktons, 20: benthos, 49: fishes. It is the grounds for birds including the emigrants and the place for tourism and water supply.
- Bien Lac, Binh Thuan Province, 100 above MSL, the area in dry season is 240 ha, in wet season: 2000 ha. There are 38 species of fish in it, no data on other species. It is used for aquaculture and irrigation.

Reservoirs: There are 3600 reservoirs in Viet Nam using for water storage in flood season, electric power generation, domestic and aquacultural water supply. Among them, about 460 reservoirs (13%) with capacity of over 1mil. m³. The biggest reservoir is Dau Tieng with the area of 72,000 ha and the one with the highest capacity on electric generation is the Hoa Binh (1920 MW). There are 4 reservoirs being built: Thac Mo (150 MW), Vinh Son (66 MW), Hinh River (66 MW) and Yaly (690 MW).

Like natural lakes, reservoirs play an important role in local climate regulation; they supply fish, electric power and water for local communities. The communities there are still poor and sparse. Their livelihood is based on catching fish and converting forest into agricultural land. Their activities increase the accumulation of sediments in the reservoirs in rainy season, destroys aquatic resources. The Government invests on reservoirs development, but the compensation to the local habitants for their houses and cultivation land is not satisfied them and that leads to the conflict between development and community benefit. Reservoirs contribute to the propagation of some diseases, associated with water through mosquitoes and snails including malaria, intestinal flat worm.

2.4.2 Marine habitats

2.4.2.1 Estuaries and embayments

Estuaries: Along Vietnamese coast, there are estuaries of different types, regularly distributed from the North to the South. In average, there is one estuary for every 20 km of the coastline. Based on the morphology, dynamic conditions, evolution trend and resource potential, the estuaries can be divided in the following groups.

Deltaic River Mouth: It includes two river deltas of Red and Mekong rivers. They are also two big estuaries in the world and are among the biggest at the Pacific Ocean Western Coast. The importance is that these two estuaries are located in the typical tropical climate region and has high habitat value in aquatic resources for the World and the Region.

Red river estuary has its mouth area of 96,000 ha (the area is calculated from the highest tidal level to 6m of depth below the Chard Datum). The area of high tidal flat with mangrove forest is about 25,000 ha and the area of low tidal flat is: 27,000 ha while the area constantly submerged in water is 44,000 ha. With the watershed of $160 \times 10^3 \text{ km}^2$ and length of 1,200 km, the Red River discharges to the sea 120 km^3 of fresh water, 130×10^6 tons of dissolved minerals every year. It creates a typical brackish area of 300,000 ha at the river mouth. It is a really huge habitat and important resource of bioplanktons and fish genders in the Gulf of Tonkin and the South China Sea in general. The area covers a long part of the coast from Do Son (Hai Phong Province) to Lach Truong (Thanh Hoa Province).

Mekong river estuary has a total area of about 600,000-800,000 ha, 60-70% of which is mangrove forest, sea grasses and coastal swamps. With the watershed of $790 \times 10^3 \text{ km}^3$ and the length of 4,500 km, the Mekong river discharges 470 km^3 of fresh water, 160×10^6 tons of alluvia and 57×10^6 tons of dissolved minerals every year. It creates an area of brackish water of 1,000,000 ha. This is a habitat area, 3 time larger than the Red river estuary one.

The deltaic river mouths of Red and Mekong rivers are the accumulated areas, result of the natural coastal reclamation process in Viet Nam. The rate of the natural reclamation in Red river estuary area is about 30-100 m/year and in Mekong river estuary area: 20-70 m/year.

Conic-shape estuaries: Viet Nam has typical conic-sharp estuaries distributed at Tien Yen - Ha Coi, Cua Luc and Bach Dang in the North and at Dong Nai in the South. The total area of the estuaries is 281,500 ha while the area of high tidal flats is 135,000 ha, of low tidal flats: 49,600 ha. Tien Yen - Ha Coi estuary has an area of 74,000 ha and the area constantly submerged of 38,300 ha. Dong Nai estuary has an area of 120,000 ha, high tidal flat: 75,000 ha, low tidal flat: 10,000 ha.

The estuaries of this type have large tidal flats, relatively stable, which are ideal habitats for marine aquatic resource formulation. They are also the ideal places for marine port development (Sai Gon port at Dong Nai river, Hai Phong port at Bach Dang river and Cai Lan port on the Cua Luc embayment).

Coastal estuaries in the Middle part of Viet Nam: The Middle Part of Viet Nam is an area of short and steep rivers, located inside the coastal zone. They include the Ma, Ca, Gianh, Han, Thu Bon, Tra Bong, Tra Khuc, Da Rang and Da Nang river estuaries. The estuaries are located at the sea coast with the depth of 20-50 m where the dynamic wave, current and tidal of low magnitude (1-2.5 m) are in presence. It is a reason of that their area is small, about 500-3,000 ha each. The estuaries are poor in nutrients and fresh water from mainland. The brackish water zones are narrow but tidal flats with mangrove forest cover almost all the banks of estuaries. They are the habitats of high value which supply fish to the Western coastal water of the South China Sea.

The estuarine areas in the Middle part of Viet Nam have a tendency to be naturally accumulated and extended slowly. Sand bars at the river mouths are moving seaward with the speed of 1-5 m/year.

Embayments: Embayments are found at most places along Vietnamese coast. For the whole Vietnamese coastal zone, there are 2 big gulfs including the gulf of Tonkin and Gulf of Thailand. Behind the coast of the Gulf of Tonkin, the Gulf of Thailand and the Middle Part coast, there are numbers of small embayments valuable for economic development of the country.

Coastal lagoons: Coastal lagoons are concentrated mainly at the coast of the Middle Part of Viet Nam from the 11°N to the 16°N. They include Nai, Thuy Truu, O Loan, Cu Mong, Thi Nai, Nuoc Ngot Tra O, Nuoc Man, An Khe, Truong Giang Lang Co and Tam Giang - Cau Hai with the total area of about 448 km². The biggest one (also among the biggest in the world) is the lagoon system Tam Giang - Cau Hai which is 67 km long, 1-10 km wide and has an area of 216 km² (Table 50).

Table 50. Some characteristics of coastal lagoons in the Middle Part of Viet Nam

No	Lagoon	Average sizes (km)		Depth (m)		Area (km ²)
		Length	Width	Mean	Max.	
1	Tam Giang - Cau Hai	67.0	3.2	1.6	4.2	216.0
2	Lang Co	16.1	4.0	1.1	3.0	16.0
3	Truong Giang	14.7	4.0	1.1	2.0	36.9
4	An Khe	2.9	1.1	1.3	2.0	3.5
5	Nuoc Man	2.3	1.2	1.0	1.6	2.8
6	Tra O	6.2	2.1	1.6	2.2	14.4
7	Nuoc Ngot	8.5	3.1	0.9	1.4	26.5
8	Thi Nai	15.6	3.9	1.2	2.5	50.0
9	Cu Mong	17.6	2.2	1.6	3.5	30.2
10	O Loan	9.3	1.9	1.2	2.0	18.0
11	Thuy Trieu	17.5	1.5	-	-	25.5
12	Nai	6.0	3.5	2.8	2.8	8.0

Lagoons in Viet Nam have been formulated mainly by sand bars connected with the headlands of the coast and river mouths. The rivers have created wide tidal flats with the area of 6,500 ha, on 30-40% of which there exist mangrove forests. There are the habitats which are spawning grounds for fish in the South China Sea, in general and for the lagoons themselves, in particular. Regarding the evolution trend, the lagoons have passed their formulation stage to the stage of development and become been filled slowly. They can be opened and closed by seasons or in several years periods with increasing frequency.

Coastal bays: The statistics show that there are 14 big and small bays located along Vietnamese coast from the North to the South. The bay with the largest area is Rach Gia (11,900 km²), which is on the north-east of the Gulf of Thailand. The following is the Ha Long Bay including Ha Long and Bai Tu Long with the total area of 648 km². The others rather big bays are Phan Thiet (368 km²), Van Phong (300 km²), Ca Na (200 km²), Da Nang (187 km²). The rest have the area between 50 and 125 km² which includes Chan May, Dung Quat, Quy Nhon, Song Cau, Binh Giang, Cam Ranh, Phan Rang and Ganh Rai (Table 51).

Many bays are supplied with alluvia by small rivers that results in tidal flats formulation with mangrove forests or huge low tidal flats as in the case of Ha Long, Song Cau, Binh Cang, Cam Ranh, Ganh Rai and Rach Gia bays. Beside, there are many islands in some bays: Ha Long (1960 islands) and Rach Gia (hundreds of islands forming some archipelagoes such as Nam Du, Ba Lua, Hai Tac, An Thoi and Phu Quoc). Thus, tidal flats, mangrove forests, rock reefs are valuable habitats for marine aquatic resources.

Table 51. Size and area of coastal bays of Viet Nam

No	Name	Length (km)	Width (km)	Area (km ²)
1	Ha Long	18	36	648
2	Chan May	8.5	4	34
3	Da Nang	12.5	15	187
4	Dung Quat	12.5	4	50
5	Quy Nhon	16	5	80
6	Song Cau	12.5	6.5	81
7	Van Phong	30	10	300
8	Binh Cang	6	20	120
9	Cam Ranh	15	5.5	83
10	Phan Rang	10	5	50
11	Ca Na	20	10	200
12	Phan Thiet	35	10.5	369
13	Ganh Rai	10	12.5	125
14	Rach Gia	170	70	11,900
	Averaged	26.9	15.3	1,017

Biodiversity

Estuaries and coastal bays are water bodies with the highest bio-productivity and biodiversity. These water bodies are rich in nutrients from mainland transported to the sea, have wide tidal zones, small depth and are rather closed from wind and wave, that results in ideal habitat formulation for marine living organisms.

According to the statistics on the survey results of marine science institutes of Viet Nam and the Ministry of Fishery, the aquatic resources include:

- Phytoplankton: 537 species belonging to 4 branches:

+ Silicoflagelata:	2	species
+ Cyanophyta:	3	-
+ Pyrrophyta:	184	-
+ Bacillariophyta:	348	-

- zooplankton: 657 species of 7 branches:

+ Coelenterata:	102	species
+ Trechelminthes:	6	-
+ Annelida:	20	-
+ Arthzopoda:	398	-
+ Mollusca:	51	-
+ Chaetognatha:	34	-
+ Procordata:	46	-

- Benthos: There are about 6377 species of macro benthos, in which:

+ Mollusk:	2500	species
+ Crustacea:	1500	-
+ Polychaeta:	700	-
+ Coelenterata:	650	-
+ Echinoderonata:	50	-
+ Spongia:	150	-

- Marine fish: There are 2,058 species belonging to 717 genera, 198 families and 32 orders. The coral fish in coastal bays and island includes 455 species belonging to 157 genera, 53 families and 14 orders.

- Reptile: 21 species:

+ Ophidia:	15	species
+Cheloniidae:	5	-
+ Crocodilia:	1	-

- Under water mammal: 12 species of 10 genera, 4 families, 2 orders (Catacea and Sizenia).

- Mangrove: 76 species, 35 of which are living in the estuaries and coastal tidal flats, 41 in high tidal zone.

- Algea: 90 species:

+ Cyanophyta:	1	species
+ Chlorophyta:	11	-
+ Phaeophyta:	27	-
+ Phodophyta:	51	-

- Sea birds: 200 species living in Vietnamese estuaries and emigrant from the countries of Pacific Ocean Western coast.

Change in area, causes and consequences

The change in area of estuaries, lagoons and coastal bays of Viet Nam is significant for recent decades. The area reduction is mainly caused by the natural erosion process and human activities. This modification has posed negative impacts on the habitats, reduced their bio-productivity and destroyed marine ecological environment.

• The change in the area of estuaries lagoon and coastal bays is still less studied. However, based on the results of recent studies of Vietnamese scientists and evolution of water bodies it can be seen the following:

- The deltaic estuaries have the tendency to be accumulated and extended naturally.
- In opposite, the conic-shape river mouths have the tendency to be reduced in area due to the lack of supplying source of alluvia from upstream. The valuable habitats are being vanished and the environment quality is degraded.

- For the coastal lagoons in the Middle part of Viet Nam the volumes of water bodies are reduced by the accumulation process in both the area and depth. In parallel, there is a process of closing the lagoons with an increasing frequency, which will convert them into fresh water lake and the marine habitats into inland-freshwater one.
 - The coast bays of Viet Nam are less changed due to the more stable ecological environment and natural processes.
- The change in area by human activities are remarkable for the estuarine tidal flats and coastal bays. The main causes of this is the reclamation for building coastal aquaculture ponds. In the North of Viet Nam, this change started in 1960-1964 and became intensive from 1985 - up to now. In the South of Viet Nam, the change in area of tidal flats started in 1980 and continues till now. By the inventory results and statistics of the Ministry of Fishery, the area of aquaculture ponds and their production in 1991 - 1993 are as follows:

Table 52. The change of area and production of aquaculture ponds in tidal zone of Viet Nam

No.	Name of tidal zone	1991		1993		Increasing rate (%)	
		Area (ha)	Production (tons)	Area (ha)	Production (tons)	Area (ha)	Production (tons)
1	North zone	17,589	4,139	24,424	6,231	+38.8	+50
2	Middle north zone	4,134	1,549	7,170	5,163	+73.4	+233
3	Middle south zone	4,935	2,025	6,287	2,480	+27	+22
4	Southeast zone	6,794	1,117.5	6,354	2,054	-0.6	+66.7
5	Southwest zone	141,093	30,725	169,138	51,241.7	+19	+66.7
6	The whole country	174,545	39,560	212,373	67,169.7	+21.67	69.7

Note: Positive rate (+): increase, Negative rate (-): decrease

The total area of tidal zone in estuaries and lagoons and coastal bays of Viet Nam have been decreasing. It was reduced on 20% in 1991, 25% in 1993 and could be reduced on 30-35% in future.

The reclaimed area for aquaculture, in general coincides with the area of high tidal flats, where mangrove exists. The mangrove is destroyed at the deltaic river mouths and the conic river estuaries. The reduction in area of estuarine lagoon and coastal bay is increasing resulting in the threat to coastal water bodies. In the Northern area from Mong Cai to Lach Truong, the reclaimed area for aquaculture constantly increases: this area was 17,589 ha in 1991, 24,424 in 1993 and 30,730 in 1997.

The coastal water bodies are reduced not only by the reclamation for aquaculture, but also by the reclamation for agriculture. The total reclaimed area for agriculture and population area development at Vietnamese river mouths is of 150,000 ha (equal to 70% of the reclaimed area for aquaculture). This area is mainly distributed in the North, Southeast and Southwest of Viet Nam and in the estuarine areas of Bach Dang, Red, Dong Nai and Cuu Long rivers.

The reclamation for agriculture and population center development has changed the estuarine habitats into the mainland freshwater one. The change in area both natural and due to human activities causes severe consequences as follows:

- Lost of breeding and nursing grounds for fish, crab, shrimp, ...
- Lost of nutrient balance.
- Reduction in area of some special grounds, for example for mollusk, marine crab and bird, ...
- Reduction of the area for sedimentation, accumulation of pollutants, erosion and degradation of environment and other ecosystems.
- Lost of aquatic resources and influence on the related economic activities.
- Biodiversity degradation and reduction of productivity of valuable species.

Proposed interventions

The interventions are necessary to protect coastal waters and habitats because of the following reasons:

- Viet Nam coastal waters, especially estuaries and lagoons have high economic value for the country, region and the world.
- Viet Nam contributes its effort to world wide effort in the protection of environment, reduction of negative impacts such as sea level rise and Enino effect.

The actions to be taken are as follows:

- Promulgation of policies to eliminate the untidy exploitation of estuaries, lagoons and coastal bays which result in the reduction of their area.
- Improvement and issue of legislative guidelines on the exploitation and protection of fishing resource putting in first priority the community benefit.
- Carrying out the inventory on the integrated planning for the exploitation of coastal waters to protect valuable habitats.
- Renovation and extension of the space of estuarine waters, lagoons to ensure sustainable resource use.

2.4.2.2 Coral reef

Coral reefs are a special ecological and sensitive system, typical for shallow tropical seas. They are habitats for different marine living organisms from planktons, seaweeds to dugongs, among which many precious species have been recorded in the Red Book of Viet Nam and the World.

Coral reefs exist in many places including Quang Ninh, Hai Phong coastal waters, island areas of Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri provinces and along the coast of the Middle Part of Viet Nam. They are found also in the waters of Paracel and Spratley archipelagoes belonging to Da Nang city and Khanh Hoa province respectively.

Coral reefs are in serious degradation of both the covered area and number of species. Other aquatic organisms living in coral reefs are also reduced in number significantly.

In the coastal zone where corals exist, the conflicts appear, especially between fishery, tourism, marine navigation and construction. These conflicts, however, are still not severe and can be solved by the negotiation between sectors.

Coral reef ecosystem, like the tropical forest is very sensitive to the external impacts such as biological, mechanical and human activity.

- Biological impacts are mainly caused by *Acanthaster planci*. In Viet Nam, the *Acanthaster planci* with rather high density has been found in coastal water of Nha Trang, but their impacts are not so significant as in other area of the Pacific Ocean Western coast (Sorokin, 1990).
- Mechanical impacts such as waves, typhoons and saline decrease often occur. They support the process of self-renovation of coral reefs for period of about 5-20 years (Sorokin, 1990). For many reefs, this ability can take 50-100 years.
- Human impacts, if have periodical character, influent on the coral renovation very quickly. However, the human activities such as polluting environment, cutting forests building hydro-constructions, fishing by inappropriate manners, using pesticides and tourism have caused negative impacts on the coral reefs, in particular and on the aquatic resources, in general. Like in other countries in the region, in Viet Nam coral reefs are threaten by direct human impacts such as using dynamites, sweeping nets, poisons and cutting coral for commercial purposes.

Coral reefs are also effected by global impacts, especially the warming effect (Sorokin, 1990). The change in area and nature of coral reefs have caused losses to the fishery and tourism sectors. According to the statistics carried out in the Project KT.03.11 the Abalone production has decreased from 70-130 tons/year to 20-25 tons/year. The loss of coral reefs has also influenced on the livelihood of the coastal communities.

The needed measures for coral reef protection are

1. Controlling the exploitation level and methods by regulations. Experiences of many countries show that it is not necessary to prohibit the exploitation of resources over the coral reefs.
2. Strengthening public awareness on the importance of coral reef habitats.
3. Establishing a network of natural marine protected areas drawing on the coral reef habitats in the whole Vietnamese coastal water.

Coral reef ecosystem is among the most diverse by gene resource. The results of the project KT.03.11 show that there are about 350 species (it will be 5,000 species if other aquatic groups are included). For the offshore reefs the number of species can be 10,000 (Mc Manus, 1994). Co the establishment of MPA and gene resource reservation have an important meaning that is addressed in the Red Book of Viet Nam and the World.

2.4.2.3 Mangrove forest

a. Biodiversity

There are about 95 species of mangrove in Viet Nam distributed mainly in the Northeast and the South Viet Nam, among them:

- 30 species for providing timber
- 14 species giving tannin for dye and leather processing
- 24 species can be use as fertilizer
- 5 species can be used for medicine
- 21 species giving honey
- 1 species used for drinking water production.

Regarding other living organisms in mangrove forests, there are about 200 species of birds, 10 among which are the rare and precious, 391 benthos, 179 mollusk. Biomass of benthos in mangrove forest is very high: 70-200 g/m² in average and 500-1000 g/m² at some places. The zooplankton is also abundant: there are 104 species in mangrove forests of the North of Viet Nam, 70 species in the Middle part and 53 species in the South. The biomass is high: 100-25,000 pieces/m³ and can reach 30,000 pieces/m³ at some places. In the Red river estuary, there are about 185 species of phytoplankton, the Bach Dang: 145 species and Dong Nai: 125 species. The biomass is about 10⁴-10⁸ cells/m³.

Other living beings are also abundant: fish - 63 species, shrimp - 25 species, amphibian - 9 species, reptile - 22 and about 21 wild animals including tigers and panthers.

The biodiversity of Viet Nam mangrove forest is the highest among the countries of the Pacific Ocean west coast and the region such as the Philippines, Singapore, Cambodia, and Hainan Province of China. The high biodiversity creates valuable aquatic resources such as marine crabs, shellfish, ... It can be said that mangrove forests in Viet Nam provides an amount of food to about 30 million of people in the coastal zone where they exist.

b. Change in area, causes and consequences: The area of mangrove forest of Viet Nam has changed significantly since 1943. The biggest change is in the East and West of the South Part. It was 400,000 ha in 1943, became 290,000 ha in 1962 (Rollet 1963) and 252,000 ha in 1982 (Institute of Forest Planning Training). The reduction of the forest area has been caused mainly by toxicants used during the Viet Nam war, from 1962-1972. After the war, mangrove forest have been gradually renovating but also continue to be degraded due to the reclamation.

According to the statistics of Seprodex Co., 1987, the area of destroyed forests for brackish fish and shrimp ponds was 50,000 ha in 1981 and reached 120,000 in 1987 with the average loss rate of 10,000 ha/year. At present, the reclamation process is continuing at all Vietnamese coast. For the Mekong estuary the change in area of mangrove forest is shown in the table 53.

Table 53. Total area (ha) of mangrove forest in Mekong estuary from 1980 to 1995

No	Province	Natural area	Mangrove forest area 1980	Coverage rate (%)	Mangrove forest area 1995	Coverage rate (%)	Reduction rate (times)
1	Ben Tre	113,153	48,000	42.4	5,501	4.8	8.08
2	Tra Vinh	199,990	65,000	54.1	6,678	5.5	9.83
3	Soc Trang	109,656	41,000	37.3	2,989	2.7	13.7
	Total	422,799	154,000	44.6	15,168	4.3	10.5

In the North of Viet Nam mangrove forest area has also been decreased due to the coastal reclamation for agriculture and aquaculture. At the northeast coast of Viet Nam from Mong Cai (Quang Ninh Province) to Do Son (Hai Phong Province), the area of mangrove forests was reduced in 4,236 ha between 1940-1964 and 17,094 ha between 1964-1997 due to the reclamation for aquaculture and in 15,871 ha between 1934-1997 due to the reclamation for agriculture. The coastal area of Red River Delta is still abundant in mangrove forest. However, since 1975 the area of mangrove forest lost is 4,640 ha till 1991, 7,430 ha till 1993 and 9,400 ha till 1997.

The consequences of the reduction in area of mangrove forest are very significant. First of all they are the reduction of fish resources, environment pollution and unbalance of marine ecosystems. It is due to the following reasons:

- The mangrove forests provide nutrients and food to larvae of marine organisms.
- They are shelter for many valuable species.
- Play role in the protection of the coast from wave, sedimentation and degradation of pollutants from land-based sources.

c. Proposed interventions

- Renovation of mangrove forests along all Vietnamese coast, especially in the swampy tidal flats of large important estuaries. This can cause conflicts with coastal aquaculture, so it need a cost-benefit analyses for the trade-off.
- Renovation of mangrove forests in all deltaic river mouths, extending them seaward.
- Improvement of institutional and legislative arrangements for effective management and protection of mangrove forests.
- Establishment of master plan on mangrove forests, focusing on the their rational use.
- Public awareness of national level on the values of mangrove forests.

2.4.2.4 Seagrass beds

Seagrass belong to the Anthophyta branch, Monocotyledonea group and Helobiac order. Like other plants on land, they have root, body, leaves, flowers, fruit and seed. The difference is that they are submerged in sea water. Study on seagrass has in Viet Nam is in the beginning stage. It was started in 1954 and became more intensive since 1985. This leads to the inadequacy of the related sources of data and information.

Seagrass beds have been found mainly in lagoons, then estuaries and coastal bays of Central Part of Viet Nam. Seagrass growths in the estuary areas of Red and Mekong River Deltas and partly in the estuaries of the Middle Part of Viet Nam. In the island areas, seagrass is more abundant, has high rate of coverage and exist in parallel to coral reefs, especially the dead corals. The conditions in these places are favorable for sea grass:

- The salinity is high: 25-30‰
- The turbidity is less than 5 g/m³
- The bottom material mainly is mud
- Sea water is rich in minerals such as NH₄⁺, NO₂⁻, SiO₃²⁻, PO₄²⁺ and nutrients.

Seagrass are habitats for number of marine organisms, has high biodiversity and productivity. They are spawning grounds for different species such as: benthos, marine fish, marine animals and some algae. The benthos catching amount in seagrasses are higher in comparison with that outside them. (for example, 2.8-6.1 times in Quang Ninh, 2.1 time in Cat Ba and 8.1-110.6 times in Dinh Vu) (Table 54).

Seagrass can serve as the food for fish, shrimp especially Dugong dugon. Dugong dugon is among rare animals recorded in the Red Book of Viet Nam and is a subject to protect. In Viet Nam it has been found in the coastal waters of Quang Ninh, Con Dao and Phu Quoc.

Table 54. Number of species, density and biomass of benthos in seagrasses

Location	Number of species		Density (pieces/m ²)				Biomass (g/m ³)			
	A	B	A		B		A		B	
			1	2	1	2	1	2	1	2
Dam Buon	15	10	434	1226	128	745	169.9	289.3	27.7	128.2
Cat Ba	18	11	3975	1087	3375	949	211.2	423.3	981	202.8
Dinh Vu	15	8	406	1904	164	960	30.98	294.4	0.3	36.3

Note: A: in seagrass bed, B: outside seagrass bed; 1: rainy season, 2: dry season

Bio productivity of seagrass ecosystems varies between 1,230-4,700 gC/m²/year, not less than that of mangrove forest (430-5,000) and coral reefs (1,800-4,200).

a. Change in area, causes and consequences: Seagrass beds in Viet Nam are being intensively exploited for processing fertilizer, animal food and some time destroyed due to the reclamation for agriculture and aquaculture. The use of seagrasses for animal and fertilizers is very popular at the lagoons of the Middle part of Viet Nam. The *Cymodocea rotundata*, *Halodule uninervis*, *Ruppia maritima* are cut to manure rice, while *Valisneria Spiralis*, *Potamogeton malaianus*, *Najasindica* to manure sweet potato, tobacco and serve food for pigs. Reserve of seagrass in lagoons is large (for example, 95,000 tons in the Tam Giang - Cau Hai lagoon). Seagrass in estuaries are used for making mats and other handicrafts. About 50 - 100 thousands tons of rush cut in the estuary of the Red river every year. Many manufacturing sites have been established to support the planting and processing rush in Hai Phong, Thai Binh, Nam Dinh, Ninh Binh and Thanh Hoa provinces.

The reduction in area of seagrass beds in Viet Nam has posed a pressure on its marine ecosystems. The water quality degradation and loss of nutrient balance cause negative impacts on the marine living organism, decrease primary productivity and material resources for many industrial and agricultural activities. It also leads to the loss of eco-balance of the habitats, where seagrass beds exist together with coral reef and mangrove forests.

b. Proposed interventions:

- Reduction and elimination of seagrass exploitation in estuaries, lagoon and coastal bays of Viet Nam.
- Establishment of marine protected area in which seagrasses grow together with corals.
- Conducting comprehensive surveys on the seagrass ecosystems and carrying out appropriate measure on rational use of the ecosystems.
- Strengthening public awareness on the value of seagrass ecosystem.

2.4.3 Critical habitats, ecosystems and species of transboundary importance

a. Habitats associated with fishery Along Vietnamese coast, there are many fish grounds of high productivity. About 95% of the fish caught had undergone the growing stage in coral reefs, estuaries, mangrove forests and seagrass beds. So, for the fishery stable development, the protection and rational use of these ecosystems are needed. For recent years, the fish grounds in coastal zone of Viet Nam has been decreased significantly and this surely has a closed relation with the degradation and ecobalance loss of the mentioned ecosystems. Some species such as Chepanodon, Ilisha, Sciaenidac, Chirocentus, Epinephelus have disappeared.

Coral reefs in Viet Nam has large area and density of distribution among the countries in the region. They provide juvenile shrimps and crabs for the countries of the Southeast Asia and the Pacific Ocean region.

The two deltaic river mouths of the Red and Mekong rivers are huge sources of nutrients and have the favorable conditions to attract fishes and shrimps from South China Sea come in during spawning season.

Mangrove forests and lagoons of Viet Nam are abundant and large in area among the countries along South China Sea and Pacific Ocean coasts.

In brief, the habitats of estuaries, coral reefs mangrove forests, coastal bays and seagrass beds of Viet Nam water are very important for the fishery development and ocean biodiversity reservation of the world.

b. Sensitivity to the threat and economic loss: At present, the marine habitats of Viet Nam such as coral reefs, mangrove forests of estuaries and lagoons and seagrass beds are being threatened and losing their economic value due to human activities.

- Coral reefs are very sensitive to fishing using dynamites and toxicants such as NaCN, and inappropriate nets and their collection for souvenirs.
- The estuary habitats are sensitive to the reduction of the estuary area due to the reclamation for agriculture and aquaculture, fishing by fine nets (1-2 mm) and toxicants.
- Lagoon habitats are threatened by pollution, reduction of fresh water source and wetland area.
- Mangrove forest habitats are threatened by forest destruction for wood, timber and aquaculture, forest land reclamation for industrial and population area development.
- Seagrass bed habitats are sensitive to the threats including the area reduction and coverage decrease due to over-fishing and fishing using bottom sweeping nets in shallow coastal water and island areas.

- The coastal bay are threatened by dynamite fishing over the rock reefs and fishing using electric pulse method, oil pollution from ships and boats, ...

c. Proposed interventions: As the habitats of estuary, mangrove forest, coral reef, seagrass, lagoon and coastal bay ecosystems are valuable for not only Viet Nam but the whole World, the protection measures need to be taken urgently. They are proposed as below:

- Urgent measures to protect and manage the important and valuable ecosystems in Viet Nam sea areas.
 - Improvement of water quality and pollution prevention.
 - Stopping activities that cause the natural area reduction of habitats.
 - Eliminating fishing by inappropriate nets and by using toxicants and dynamites.
 - Encouraging offshore fishing and reducing the fishing ship density in near shore areas.
- Study, planning and establishment of marine protected areas for the ecosystems of estuaries, mangrove forests, coral reefs, seagrass beds and coastal bays to:
 - Protect the source of juvenile fish, shrimp for Viet Nam and the region.
 - Protect biodiversity, gene-resource and rare precious aquatic species.
 - To guarantee the nutrient balance and eco-balance for the marine environment of Viet Nam and the region.
- Cooperation with the countries in the region and the World in the finding measures to renovate and protect habitats of estuaries, mangrove forests, coral reefs, lagoons and seagrass beds:
 - To monitor the transboundary environment parameter for awareness.
 - To plan the rational use of marine resources of Viet Nam, the region and the World.
 - To protect the global biodiversity.
 - To stabilize the fishery sector of the region and the World.

3. ANALYSES OF SOCIAL AND ECONOMIC COST OF THE IDENTIFIED WATER RELATED PRINCIPAL ENVIRONMENTAL ISSUES

3.1 WATER RESOURCES

The shortage and quality degradation of water resources in Viet Nam become more and more evident. Solving the problem has an important meaning for the socio - economic development of the country. On the other hand, it requires great efforts paid not only on financial aspect but also on the improvement of policy and development of an appropriated long-term strategic management plan of the water resources use both for surface and ground water.

In financial aspect, to prevent and treat pollution and increase water quality, it needs to cover some costs including those for field survey, for construction and operation of treatment installations and others in the management and education activities. The detailed financial assessment of such kind of work is still far from the reality in Viet Nam. However it can be estimated for example that the cost for treating 1m³ of surface water can be of some thousands of Vietnamese dong [1USD ~ 12,980VND]. According to the economic expects, the cost to pay for the implementation of the

project "Renovation, rational use and protection of the Cau river water" reaches 200 billion VND for 3 years 1999 - 2002 (Cau river is a branch of Red river system which belongs to the Bac Can, Thai Nguyen and Bac Ninh provinces). The cost would be much higher if the maintenance cost should be included.

In order to compensate for the deficiency and degradation of water, the following expenses will be needed:

Indirect expenses: Indirect expenses include the expenses for working out plans, management, monitoring, education.

- Expenses for working out master plan for water use and exploitation in the whole country: They are not large, comprising mainly the expenditure for a planning committee. This committee will consist of some experts in hydrogeology, water supply planning, environment. On the basis of the collection and assembling of existing data, a master plan will be established for the State for the exploitation and utilization of water resources with the plans for each step up to the year 2010-2020.
- Expenses for working out the law and regulation and related documents on management of water resources and environment, the law on investment to and exploitation of water resources.
- Expenses for the organization and maintenance of water resources management agencies.
- Expenses for the construction and maintenance of monitoring network throughout the country.
- Expenses for the education, propagation to improve the awareness of the community on the matter of exploitation and protection of water resources.

Direct expenses

The water demand is great, but the present status of the clean water production in Viet Nam is still very poor. Actually clean water production receives attention only in some large cities. However, even the large cities, the water supply is still very poor and most of towns still use surface water as the source for domestic water supply. To cover the deficiency of the water supply, large expenses are needed, comprising:

Expenses for the investigation on urban water supply

Within the country there are about 80 cities and towns. By the year 2000, the water demand of each urban area will range from 3,000 to 120,000 m³/day. To meet the water demand in general, the water resources (both the groundwater and surface water) must be investigated and evaluated in more than 100 different areas.

The total water demand for the urban areas by the year 2000 will be 3,466,600 m³/day, by the year 2010 will be 4,855,460 m³/day.

According to the previous data, the expenses for the investigation of one m³ of water is about 150,000 VND. If these expenses are included in the cost of water exploitation in 20 years, each m³ the expenses for investigation of each m³ of water is 20 VND.

Thus the expenses for the investigation of 3,466,600 m³/day will be 520 billion VND (519,990,000,000 VND). The investment in each area must be about 5.2 billion VND.

Expenses for the construction of clean water supply to the urban areas

In general, the water supply systems in the urban areas are very backward, nearly must be constructed from the beginning. According to the present water price, the expenses for the construction of the water supply systems in the urban area is 300 VND/ m³ of water with the pay back period of 20 years. Thus the expenses for construction and exploitation of 1 m³ of water is 3,650,000 VND. The investment for the construction of the water supply system will be 7,800 billion VND.

The expenses for the maintenance and service for the system to operate during 20 years, with the rate of 5 % of the initial investment per year, will be 7,800 billion VND.

Thus the total expenses for the construction and operation of the water supply systems in the urban areas will be 15,600 billion VND.

The total expense for the urban water supply will be 16,120 billion VND.

Expenses for construction of the rural water supply facilities

In 1992, the National Committee for the Drinking Water Supply worked out the plan for rural water supply. According to this plan, by the year 2000, 80 % of the rural population will have access to safe water supply, with the norm of 40 - 60 l/day/capita in plain area, 40 - 60 l/day/capita in midland area, 20 - 30 l/day/capita in mountain areas, 30 - 40 l/day/capita in the coastal areas. Thus, the investment for the rural water supply will be 183,000,000 USD or about 2,020 billion VND.

The facts of the recent years have shown that the water demands in the rural areas are different from the plan. The mode of groundwater exploitation by small drilled wells with hand pumps installed at public places for 10 - 15 families have proved not to be suitable. Therefore the expenses estimated above are far from the actual situation.

If only 10% of villages will have common water supply facilities, the number of these facilities would reach tens thousands. If by the year 2010 there will be 20,000 villages having centralized water exploitation systems for water supply at village scale with 1,000 - 8,000 inhabitants, the discharge of each such system will be 100 - 800 m³/day.

For such water supply, according to the present cost estimates and prices, each water supply system will coast in average 500,000,000 VND (covering only the well, treatment facility, and pipeline to the public terminals.) If counting the cost of the pipelines to houses, the cost will be 700,000,000 800,0005000 VND. The total cost will be 10,000 - 15,000 billion VND.

For the remaining 90% of villages, if they use individual small wells with hand pumps, the investment will be about 50,000 billion VND. If so, the total investment for rural water supply will be 65,000 billion VND.

The total expenses for the water supply will be about 80,000 billion VND.

The indirect expenses constitute 10% of the above expenses (8,000 billion VND), comprising mainly the construction of the national monitoring network, its operation and maintenance, expenses for scientific research, information, education.

With the availability of clean water supply, the diseases will be decreased. Thus, the State will save tens of thousand VND from the expenditure for medicines. In the mean time, every year, tens of millions man-days will be saved from being sick and tending the sick. Thus, in total, tens of billion VND will be saved.

Due to the close control, the State will not fail to collect taxes relating to the production of clean water, which are relatively large amount of money. If for 1 m³ of water the State collects 100 VND of various taxes, every year the State will collect:

$$100\text{VND} \times 4,000,000 \text{ m}^3 \times 365 \text{ days} = 114 \text{ billion VND.}$$

The expenses related to the manufacturing and agriculture activities can not be assessed due to the lack of data and information and appropriate methods.

3.2 FRESH WATER LIVING RESOURCES

It is mistaken if we calculate the loss of freshwater living resources in term of production yield. Annual production of freshwater living resources is one hundred thousands tons, but these natural resources are renewable. With full evaluation of these resources, it can be assessed in its other roles such as:

- Support to the existence of aquatic ecosystems.
- Genetic resources for the different socio-economical sectors, firstly for aquacultural and agricultural sectors.
- Livelihood of 20 thousands of professional fishermen.

Beside, it needs to add the followings:

- The far mountainous regions such as West-North, East-North, Central Highlands from now could not be supplied with freshwater living resources.
- Many fish and other aquatic species with good tasting meats are lost.

The degradation of freshwater living resources is not avoidable.

3.3 MARINE LIVING AQUATIC RESOURCES

The statistics show that:

- Catching productivity by some main methods tends to be decreased, especially for those used in coastal waters with the depth of less than 20m , for example :
 - + Light fishing using lift nets in the North Viet Nam had the productivity of 100 tons/unit trawl/year before; now it is 30 - 40 tons/unit trawl/year only.
 - + Encircling fishing using trawl in the Central Viet Nam had the productivity of 60 -70 tons/unit trawl/year before. Now it's 35 -45 tons/unit trawl/year only.
- Exploitable productivity of premature species is rather high, especially that of shrimp and fish, which have high economic value. For example:
 - Shrimps of the first and second categories at Vung Tau and Con Dao are in 20 - 30% of each catch in 1980, but only 3 - 5% in 1990.

- The average weight of comb in the Gulf of Tonkin was 1,5 - 2 kg in 1989. It became 0,5 - 0,6 kg in 1991. Beside, some species are in danger of extinction.
- Traditional shrimp and fish grounds are radically changed and tend to slowly decrease.

3.4 AQUATIC HABITATS

3.4.1 Economic lost due to the reduction in area of habitats

The reduction in area of habitats is typical in Viet Nam. It is due to the transformation of mangrove forests, sea grass beds and estuarine tidal flats in to reclamation area for agriculture, aquaculture and industrial and population area development.

a. Coastal reclamation for agriculture This form of activities converts the marine ecosystems into agricultural land resulting in the loss of marine biological resource value and scenery damage. According to the general assessment of many projects associated with the estuarine tidal flats, swampy tidal flats with seagrasses and mangrove forests, the benefit from the aquatic resources of the tidal flats is estimated of 10 million VND/ha/year. The economic value related to the environment, scenery, tourism, biodiversity and others is about 50% of the direct aquatic resource exploitation value (5 mil. VND/ha/year). As the rice production for the acidic and saline soil is about 5 tons/ha, which is valued of 2 mil. VND/ha/year, the economic loss due to reclamation for agriculture is about 13 million VND/ha/year (equal to 1,000 \$US/ha/year).

b. Reclamation for aquaculture: Annual production of aquaculture is about 5-70 kg/ha for shrimp, 80-100 kg/ha for fish and 10-20 kg/ha for crab. As estimated, the alternative benefit is of 20-30% from aquaculture (which is about 4,000,000 VND/ha/year (equal to 8,500 \$US/ha/year).

c. Reclamation for industrial and population area development: The area lost due to this activity is not significant. The economic loss is about 70% of the average benefit from tidal areas which is approximately 15,000,000 VND/ha/year. So, it become 10,500,000 VND/ha/year (equal to 8,000 \$US/ha/year).

d. Damage to port and marine transportation economy: Port and marine transportation is an important sector for Vietnamese economy. Due to the reduction of the tidal areas, many navigation channels have the problem with sedimentation. For example, the channel to the Hai Phong port on the Bach Dang river was 9-18 m deep and could receive ships of 10,000 tons in 1960-1964 while at present, its depth is 4-5 m which can accept ships of 3,000-5,000 tons only. The economic loss associated with marine transportation is about 50-60% of the value of channel system and the cost of its maintenance (dredging volume is 4-5 million m³/year).

3.4.2 Habitat destruction

The habitat destruction in Vietnamese coastal water by dynamite fishing over the coral reefs, mangrove forest cutting, fishing using bottom sweeping and rake nets,... has changed the value of habitats of wetlands of different forms. Dynamite fishing over the coral reefs and rock reefs in Viet Nam has caused a loss of 20-30% of their value. Following the results of some projects, the mangrove forest cutting has converted 40% of the thick forest into the sparse one and degraded its soil quality. The reduction of forest coverage causes an economic, environmental and ecological damages, which is as estimated, 20-30% of their value. The use of bottom sweeping nets over the sea grass beds has reduced their area in Vietnamese coastal shallow waters and island areas of the depth less than 6 m. This loss is estimated of 10-20% of their natural value.

3.4.3 Destructive exploitation of aqua resources of wetlands

The destructive exploitation is mainly associated with using fine nets for catching both juvenile and adult fishes, catching the rare and precious aquatic species. These activities can reduce the catching amount in coastal zone of Viet Nam by 30-40% of the natural productivity of habitats. The catching of rare and precious species happens at anywhere along Vietnamese coast. This decreases their productivity on 20-90%. For example, the production of abalone at Bach Long Vi is 1 ton/year at present while it was 20-30 tons/year before 1985.

The aquatic resources of tidal area in estuaries, such as oyster, shellfish, ... are being exploited destructively. Some species disappear and their grounds area decreases by 50-60% in comparison with that before 1975.

4. ANALYSIS OF THE ROOT CAUSES OF THE MENTIONED ISSUES

4.1 POLLUTION

Pollution state of the country has the following root causes:

- The people are, in general, very poor. They put the first attention to the daily needs, but not to the environment.
- Industry is backward with no treatment for waste water. Even imported technology in many cases is the second hand one which does not meet the environment standard. Solid waste is collected partly only and is not treated. Urban areas are developed very fast, the sewersystem for which is not adequate.
- In the rural area, the use of chemical fertilisers and pesticides is uncontrolled.
- Deforestation make the natural pollution including sediment easy entering the river flows and then the coastal water.
- Warning of environment protection to people is low.
- Legislation aspects are still new, under the law documentation is needed to be developed. Enforcement of these legislations is still weak. Environment management system from the central to local levels is weak.

4.2 SURFACE WATER

Major causes of the shortage and quality degradation on fresh water resources of Viet Nam can be listed as bellow:

a. *Natural causes*

- The water resources are distributed unevenly in both space and time.
- Rain fall distribution is different in space and time.
- The climate change and sea level rise increase the salinity intrusion process into river systems.
- The El-Nino effect cause the drought.

b. *Impacts of human activities*

- Industrial development, urbanization and population increase are major causes of pollution to water resources and their reserve reduction.
- Upstream activities such as deforestation, dam and reservoir construction lead to the degradation of river water quality and the reduction of ground water reserve.
- The use of chemical toxicants (in the war time) and in agriculture nowadays such as herbicides and pesticides also cause the degradation of the water quality.
- Especially, the existing law and regulation, management, policy and institutional arrangements and public awareness are not sufficient to meet the increasing requirements on the use of water resources in Viet Nam for its socio – economic development at this stage.

To protect the water resources from its shortage and quality degradation many problems need to be solved. As discussed above, the shortage and quality degradation of water resources are the results of multisectional activities. It can be summarized in the following table:

Sector	Impact
Agriculture and Industry	Pollution (to both fresh water and marine water) Eutrophication in water bodies, which is dangerous for human and other aquatic living species
Mining	Pollution of water bodies, habitats damage, air pollution
Forestry	Soil and ground water pollution, turbidity and sedimentation in river water
Urbanization and economic development	Pollution in lakes, rivers estuaries and coastal zone Eutrophication of water bodies, habitats loss, threat to human and other aquatic living species.

4.3 GROUND WATER

Within the territory of Viet Nam, the exploitation and utilization of water resources is still not well controlled. There are already some indications of depletion and quality degradation of water in many places.

The causes of these phenomena are difficult to identify. The main phenomena and their causes include:

Salinity intrusion

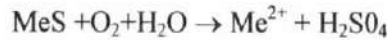
It affects not only on the surface water resources for irrigation and domestic and industrial uses but also on the ground water. In Ho Chi Minh city in the past the groundwater abstraction was 80,000 m³ per day. In 1986 the abstraction was increased by two time, i.e. 160,000 m³ /day. Over a few year saline water had invaded most of Gia Dinh and a part in the west of old Saigon. Many wells had to be closed. Over 20 years the saline-fresh boundary had retreated only 1 - 1.5 km away. Saigon had to move to the use of surface water from Dong Nai river. Similar phenomena have happened in Hai Phong, Vinh and many other localities.

Decline of ground water level

The decrease of water level have been observed in some locations: Hanoi, Xuan Loc, Buon Ma Thuot, etc. In Xuan Loc, the water level in 1993 and 1994 was observed to be declined by over 1 m compared to 1992. The main cause is the over exploitation. The decline in the water level in Hanoi occurs intensively. On the other hand, due to the rapid urbanization, every year tens thousands square meters of land become houses and roads, preventing the rain water from percolating and recharging the groundwater.

Mining

Degradation of water quality due to mining occurs intensively in mining areas. Within the territory of Viet Nam, the main mineral being mined is coal. Coal mines are mainly concentrated in Quang Ninh and Bac Thai. The mining facilitates the oxidation of metal sulfides which are common in the waste rocks from the mines, with the following reaction:



This reaction increases the concentration of SO_4^{2-} in the water, decreases the pH values of the water. Therefore the surface water and groundwater in many mining areas of Quang Ninh, Na Duong (Lang Son), Thai Nguyen have been acidified.

Industrial activities in large cities and industrial zones

In large cities, every day tens to hundreds thousands of cubic meter of waste water is discharged. Actually nearly no factory, industrial enterprise, hospital in Viet Nam have waste treatment facilities. All the waste waters are discharged to the canals and rivers. Therefore most of rivers in the cities are very dirty. For example, in Hanoi everyday about 500,000 m³ of untreated wastewater is discharged. This has made the To Lich, Kim Nguu, Set, Lu rivers seriously polluted. This waste water is conducted to the lakes and ponds in Thanh Tri, thus polluting also the water there. In Ho Chi Minh City, the rivers and canals are also seriously polluted. This also caused the pollution of the upper aquifer. Similar phenomenon also occurs in Hai Phong, Da Nang and other cities. One of the pollution sources to the water environment is the garbage dumping without treatment.

Agricultural activities

In order to increase the yield of the crops, the farmers in Viet Nam are using more and more chemical fertilizers and insecticides. In suburban areas of large cities (in the vegetable belts), the amount of insecticides used is very large, usually 10 times greater than the mean level in the country. Part of the insecticides enters the water environment and degrades its quality.

Deforestation in the mountain area

Due to the deforestation, the rain water cannot percolate to the groundwater and thus reducing the groundwater reserve. Many springs have been dried up such as those in the Quang Ninh mining area, in areas with karst development. Due to the deforestation, the rain water carries soil into caves, blocking them. The water flowing from springs which used to be clear, becomes muddy. Such springs have been observed in Son La.

Lack of law and regulation

There is still either no effective management agency for control well the natural resources and environment in general and water resources in particular.

Education and awareness

The education and awareness on the water resources is still limited and not uniform, especially in the coastal, isolated and remote areas.

4.4 LIVING FRESHWATER AQUATIC RESOURCES

The degradation of the freshwater living resources was in relation to two main factors:

- Over- and irrational exploitation, which decreases the population.
- Socioeconomic activities that have destroyed the habitats and ecological niches of the living freshwater organisms.

Over- and irrational exploitation includes the exploitation that passes over the recovery capacity for the population, fishing in the spawning grounds, migratory lines and feeding grounds of the fingerlings. The catching fish and fingerlings in the lower courses of the big river such as Red, Thai Binh, Tien and Hau has caused the loss up to billiard of fingerlings of natural freshwater fish species annually. The impacts of fishing gears and tools to the living resources are too big. The fine fishing nets (lifting nets, catching nets, trawlers...) have captured all size of fish species. The bottom dredges have captured all living gastropods. Particularly, the use of dynamites, toxic chemical matters and electric pulse method for fishing is so popular everywhere. Only in the Thuy Phuong village (Tu Liem, Hanoi) there are 20 fishermen using electric methods for catching fish. Many accidents in electric fishing have occurred to people.

Socio-economic activities have seriously destroyed the habitats and ecological niches. Deforestation in some past decades has reduced the forest coverage from 46% to 27%. This activity causes heavy erosion of soil, flood or drought disasters to many regions. Many mountainous rivers and streams have no water in the dry season. Deforestation of mangrove forests, Melaleuca forests,... has caused negative impacts to the living resources.

The remained natural wetlands, especially those of the two big deltas of the Red and Mekong rivers, are continuously reclaimed and converted into agricultural lands. The total surface area of wild wetlands of the Red river delta is 50,000 ha and of the Mekong river delta: 300,000 ha.

There is a large surface of swamps, ponds, lakes which are reclaimed for agriculture and converted into rural, urban and industrial lands. For example, Hanoi city has lost many lakes due to human settlements.

The construction of dams prevents the migration of fishes. Up to now, in Viet Nam, there are around 400 dams of middle and big sizes. The big dams such as Hoa Binh, Thac Ba, Tri An, Dau Tieng, Phu Ninh and Yaly have posed many negative impacts to the living organisms.

The activities of the industrial sectors such as chemical industry, energy industry, construction and transportation have caused pollution to many water bodies. The water bodies of major cities such as Hanoi, Ho Chi Minh, Viet Tri, Thai Nguyen, Hai Phong and Da Nang are being polluted.

Regarding the agricultural activities, a lot of inorganic fertilizers, pesticides, herbicides has been used making water polluted. Each year, the agricultural sectors have used 600 thousands tons of nitrogen fertilizers and 20 thousands tons of herbicides. There are some residues of heavy metals have been found in the meat of fishes.

The chemical war in the South of Viet Nam during the year 1965-1970 has destroyed 2×10^6 ha of forest.

The aquaculture activities also give the pressure on the natural living organisms. The introduction of the exotic fish or invertebrate species for culture makes the competition between the exotic and the local species. There are many cases which have posed serious negative impacts to the local species. Example is the Golden snail.

All of the natural water bodies have their own productivity in living resources. If we use these water bodies in aquaculture, the natural living resources must be decreased.

The root causes of the negative effects may be:

- The high rate of population growth including fishermen households which results in high exploitation level for living.
- The improvement of catching tools in both number and effectiveness.

4.5 LIVING MARINE AQUATIC RESOURCES

There are many causes leading to this situation. The main of them are as follows:

- a) The country is backward, living conditions of population are very low, that leads to mangrove forest cutting, coral reef exploiting and using illegal method of fishing.
- b) The invest to and improvement of fishing methods and equipment in recent years are quickly increased. In ending years of 1980, there were 40,000 boats all over country. But in 1994, there were over 90,000 boats all over the country. Most of them is small boats used for fishing only in the nearshore areas. In the southeastern area, fishing density is high: 30 - 50 boats/km². The density increase is not the same for different areas.
- c) Using catching methods, which damages or exterminates the recovering ability of fish communities like using explosives, strong light and fine nets in order to catch premature fishes. Pulling trawl is a traditional fishing tool in Viet Nam.
- d) Lift net, fish traps are used very popularly in the coastal areas and estuaries. In some areas, there are hundreds of these units used in every square kilometer.
- e) Law enforcement is still weak point. Lack of proper policy to manage coastal zone.
- f) Environmental and ecological pollution firstly by oil, industrial waste and the waste from ships and boats. The results of survey in 1990 show that the content of oil in the sea water at the South Hon Mat and Mui Ron was 0.09 mg/l, at East Vung Tau was 0.07 mg/l, at Nhat Le and Thuan An was 0.06 mg/l, in the Red River and at the East Hon Me was 0.05 mg/l. The amount of waste tends to be increased with the increase in number of industrial areas. Beside, the other human activities such as deforestation and destruction of coral reefs also degrade resources.
- g) Illegal exploitation by foreign ships in the last years of the 80th decade increases. Many Chinese and Taiwanese ships entered Vietnamese sea in the North and many Thai ships in the South have conducted illegal fishing, which also degraded resources. Beside, since the implementation of the open-door policy by Vietnamese Government, many sea products such as comb, oyster, arca have been exported to China and Cambodia with no control and this also degrades the resources.

4.6 AQUATIC HABITATS

The root causes of the modification of habitats include:

- Under the pressure of low economic level and the food shortage before 1985, all Vietnamese country has conducted the land reclamation campaign for agriculture and aquaculture. It was the decision of the Government.
- Regarding the environment and natural resource protection, there is a lack of scientific basic in policy and institutional arrangements of the Government. Different sectors at different localities exploit the resources by their own way without regard on the integrated management for the sustainable use.
- The level of knowledge and living standard in many coastal rural areas are still very low.
- There is a lack of technical, institutional and legislative tools for Government to control the resource use in the wetlands.
- The benefit of coastal communities is not properly integrated into the coastal economic development and resource exploitation. Therefore, there is a lack of support from local communities in resource and ecosystem protections.
- The public awareness some time, some where is incorrect and without scientific basis. It leads to the damage of habitats and ineffective participation of stakeholders.
- Lack of laws and regulations on the wetland management.

The socio-economic root causes and also the impacts and transboundary effects of the main concern environmental problem/issues in Viet Nam are reviewed in the Tables 55, 56 and 57.

KEY TO THE SOCIO-ECONOMIC ROOT CAUSES OF IDENTIFIED ISSUES AND PROBLEMS

<p>Legal (L) Inadequate legal and institutional framework</p>	<p>L1- Inadequate cooperation at regional level L2- Inadequate cooperation and coordination at national level L3- Inad legislation and regulation L4- Common property issues-no clear access policy, equity issues L5- Lack of enforcement, non-clarity in enforcement</p>
<p>Management (M) Inadequate planning and management</p>	<p>M1- Poorly coordinated intersectoral planning and management M2- Lack of integrated planning (ICZM etc.) M3- Inappropriate harvesting techniques M4- Inadequate or inappropriate technology use, need for alternatives technology use (alternative energy sources, waste water treatment etc.) M5- Inadequate monitoring M6- Poor general management (need for management alternatives-alternative energy, waste water treatment etc.)</p>
<p>Human (H) Inadequate Human and Inst. Capacity development</p>	<p>H1- Lack of research-management orientated science-monitoring, evaluation and integration with policy development H2- Education development-incorporation of alternative management and valuation in intergeneration and transboundary aspects H3- Lack of trained personnel to develop and implement policies</p>
<p>Stakeholders (S) Insufficient involvement</p>	<p>S1- Lack of awareness S2- Poor identification of stakeholders S3- Lack of adequate participation</p>
<p>Financial (F)</p>	<p>F1- Lack of total cost accounting and internalization of environmental costs (low value of environmental systems-buffer zones, erosion, fisheries etc.) F2- lack of effective economic funding/mechanisms (subsidies, grants etc.) F3- Economic incentives-national (subsistence driven, shrimp farming) F4- Economic incentives-national (export-foreign currency driven, tourism, shrimp farming etc.) F5- Economic incentives from foreign investment</p>

Table 55. Major concern habitat loss in Viet Nam

Habitat	Site	Causes of issues/problems	Impact	Socio-Economic Root causes	Transboundary Aspect
Mangrove	Mekong Delta, Quang Ninh	Alternative landuse - shrimp farm, industrial urban development, cutting for cooking, sedimentation	148,000 ha lost during 1943-1982	Poverty in coastal zone (S) Poor management (M1, L5)	Reduction of biological biodiversity Reduction of breeding grounds-fisheries
Coral reef	Vung Tau, Nha Trang, Ha Long Bay, Con Dao Island and Hon Khoai Island	Destructive fishing, Exploitation for building material Sediment, Tourism	Increase of death coral. 15-20% reduction in the Central part	L5, M6, H1, S1, M5	Biodiversity loss Fisheries reduction Reduction in tourism
Sea grasses	Lagoons in Central Viet Nam	Exploitation for fertilizer and animal food sedimentation from logging, mining	Loss of area (no data)	M6, H1, S1, S2, F1	Reduction in fisheries production Biodiversity loss
Estuaries and wetlands	Red River	Sedimentation-logging/mining. Loss due to reclamation Dredging from port development	Loss of wetlands Reduction of area for fisheries. Social and economic impacts	Irrational reclamation land demand for construction	Biodiversity loss Loss of spawning grounds

Table 56. Major concern water related issues

Issue	Site	Causes of issues/problems	Impact	Socio-Economic Root causes	Transboundary Aspect
Freshwater shortage	Middle Part of Viet Nam, nearshore islands	Climate change, deforestation, salinity intrusion, irrational exploitation of groundwater	Human health Reduced agricultural production	Population growth, industrial development	Loss of waterfowl
Fresh water quality degradation	Sai Gon-Dong Nai River, Red River, downstream of Thai Binh River, groundwater of big cities (Hanoi, Hai Phong, Quang Ninh, Ho Chi Minh City)	Industrial waste water, domestic waste from cities, mining activities, salinity intrusion, fertilizers, liter	Health hazards. Loss of aesthetic value. Cost of water treatment	Non-existent treatment facilities, lack of law enforcement. Low awareness of people to protect their environment.	Minimal because of self-cleaning. The impacts are localized
Over-exploitation of freshwater living resources	Anywhere	Degradation of water quality Illegal fishing methods	Loss of biodiversity. Low production	Lack of enforcement of law, poverty low environmental awareness	Almost everywhere, most acute in the Red River and Mekong River Deltas threatened endemic species.
Over-exploitation of marine living resources	All of the coastal zone	Increase of fishing facilities, use of illegal fishing methods, foreign poaching	Loss of biodiversity. Low production	Poverty, lack of law enforcement, lack of control of foreign fishing, lack of facilities for deep sea fishing	Loss of biodiversity. Reduced productivity

Table 57. Major concern pollution issues

Issue	Site	Impact	Root causes	Transboundary Aspect
Solid waste	Coastal cities	Decline in water quality. Lost of aesthetic value, public health hazards	M2, M3, M4, F1, F2, S1	Localized groundwater problems, tourism decline
Domestic waste	Ho Chi Minh, Hai Phong, Ha Long, Qui Nhon, Nha Trang, Da Nang Vung Tau	Water quality deterioration in rivers and coastal waters, public health hazard	L1, L5, M2, M3, M4, M5, H3, S1, F1, F2, F5.	Mainly to sea via Red and Mekong Rivers, Migratory fish deterioration
Agricultural/rural waste	Red River and Mekong deltas	Water quality	L4, L5, S1, S2, M4, M5	Marine biodiversity loss
Oil pollution	At almost all Viet Nam coastal water	Suffocation of marine life, chronic toxicity, loss of aesthetic value	L2, L3, L5, M3, S1, S2, F2, F3, F5	Oil spills, loss of biodiversity
Industrial waste	Ha Long, Hai Phong, Ho Chi Minh, Vung Tau	Acute and chronic toxicity, Anoxia, suffocation of marine life	L1, L5, M2, M3, M4, M5, H3, S1, F1, F2, F5	Suspended chemical and heavy metal transport
Sedimentation and erosion	Tonking Gulf, Red and Mekong Rivers	Benthic community, coral reef, sea grasses suffocation	L3, L5, M3, H3, S1, S2, F1, F2, F5	Sediment transport
Shipbased pollution	Tonkin Gulf and Shelf of the South of Viet Nam	Chronic and acute toxicity, suffocation of marine life, alteration of fauna / flora	L1, L5, M3, M5, H3, S1, S3, F1, F2, F5	Shipping lanes offshore lanes
Atmospheric inputs	Coastal zones of Red river and Mekong river deltas	Chronic toxicity	L1, L2, L3, L5, M3, M5, H1, H3, S1, F2, F4,	Transboundary transport - with China and Thailand

5. CONSTRAINS TO ACTION

5.1 INFORMATION, SCIENTIFIC UNCERTAINTIES AND PUBLIC AWARENESS

Information on the state of pollution is inadequate: In general, the pollution matters are serious problem only since the last years. Methodologies of sampling and analyses in many cases are arbitrary, so the quality assurance is still a problem also.

Information on living resources meets the following difficulties:

- Statistics on the production and so on are provided only when the fishing and aquaculture cooperatives exist. Nowadays, the private fishing can not supply such a like figures (number)
- Economic evaluation is still weak point in the management

The information on Viet Nam aquatic resources and habitats are inadequate, incomprehensive, unsystematic and sometime contradictory. There still not exists the baseline data of national level on wetland. Therefore, the information on the wetland modification can not be assessed or quantified. The confidence of the information and data is low. There is also a lack of scientifically understanding about the resources that leads to the untidy use of the areas, resulting in the environment degradation, resource reduction and human life and health damages.

Public awareness on the environment is very low. Daily, existence needs are in the first attention of people, the environment matters are in the second one only. Beside, the low education level, especially in the mountainous regions does not give them enough knowledge of environmental issues and their consequences. Beside, awareness of the decision makers are different. It can be said that only the people who are in direct consideration of environment are concerned of the negative environment impacts. The others do not make it serious.

The local communities do not consider themselves as the resource stakeholders but only beneficiary of nature. This conception has resulted in the conflicts between different users and sectors.

5.2 FINANCIAL ECONOMIC

- Viet Nam is the poor country and its financial capability is very limited to cover all urgent problems of environment.
- Economic benefit is always the first concern of many projects, development is always more important than environmental protection.
- Up to now, there is no environment tax system and no foundation for environment protection, which are determined by the Environmental Law (1993).

Due to the lack of information and understanding of national level, there still not exist a multi-sectoral action programme on the development and protection of aquatic resources. The invest from the Government is focused on the exploitation of these resources but not on their protection and development.

5.3 LEGAL, INSTITUTIONAL AND MANAGERIAL

Almost all natural resources are under the jurisdiction of the Government. Local communities rarely take part in their management. In some cases, they are not the beneficiary of the resources and the benefit from the wetland, where they live. Up to now, there still not exist a national agency, which is responsible for the management of all aquatic resources. For example, wetlands are managed by different agencies from different sectors mainly from the Ministry of Agriculture and Rural Development. The mechanism of cooperation between sectors is unclear, which often causes overlaps and conflicts.

The environmental law of Viet Nam was promulgated in 1993, but there is a lack of regulations and guidelines for the resources protection and development including the policies on the environment protection investment, ownership, commitment, international cooperation, etc.

There is a lack of underlaw documentation on its financial aspect. The enforcement of law is in initial stage.

6. ONGOING AND PLANED ACTIVITIES, RELEVANT TO THE IDENTIFIED ISSUES

6.1 POLLUTION

On-going activities:

- A national preliminary monitoring network has been established and is functioning. This network composes of 3 land side region stations for the North, the Middle and the South of Viet Nam, acid station at Lao Cai city, and baseline meteorological station at Cuc Phuong Forrest, 4 marine regional stations for the coastal waters of the North, the Middle and the South of Viet Nam and offshore waters. Monitoring is conducted quarterly with chosen parameters and methodology. Due to this network, the data for assessment of present state of Environment are derived and presented in annual reports to submit to the National Assembly.
- Improvement of the legislation is urgently needed, including National oil spill response plan, Environment tax legislation preparation.
- Environment Impact Assessment for any significant new project.
- Strengthen the capacity of environment management for Department of Science Technology and Environment (DoSTE) for each province or city by various training courses, equipment supply and organisation matters including the international assistance in term of projects CEP, CIDA, UNEP,...
- Present Environment state report of each province or city prepared by DoSTE.
- Research for making Scientific base for decision makers such as:
 - The carrying capacity of important water bodies (Sai Gon - Dong Nai and Red rivers)
 - The environment problems of demonstration principal zones for economic development in the North, the Middle and the South of Viet Nam.
 - A number of other pollution problems such as assessment of unidentified sources oil pollution at the shore line and auditing of solid waste for the whole country...

6.2 SURFACE WATER

In Viet Nam, the survey and exploitation of ground water resources are undertaken by different ministries:

- The General Department of Geology and Minerals is responsible for the investigation and assessment of the ground water resources.
- The Ministry of Agriculture and Rural Development is to manage the water resources. However there are some agencies of the Ministry undertaking the activities related to the exploitation and use of ground water such as "Ground water Exploitation companies I and II" and " Center for clean water and rural sanitation" (from the central to provincial levels).
- The Ministry of Health has some agencies working on the water supplying.
- The MOSTE is responsible for the water environment management.
- There exists the National Committee for Clean Water and Environment Sanitation, some centers belonging to which also undertake the water resources exploitation works.

Toward this real situation, the coordination and cooperation between sectors and agencies is extremely important. By the point of view of the relevant experts, it is time to have radical reform in the management and institutional arrangements to address the exploitation and protection of the water resources. There may needs to form an organization of ministerial level, which is responsible for the survey, investigation, monitoring and management of water resources. The units undertaking the water exploitation and supply work could be the enterprises of the type of the 'Company for Clean Water Commerce' or the 'Company for hydrology and water supplying'.

The Government should:

- Promulgate and improve related laws and regulations,
- Carry out the policy which encourages the clean water production for communities and manufacturing.
- Cooperate with neighboring countries in the field of investigation, assessment and exploitation of water resources.
- Manage and implement in good manner the related projects with the funds from international organization and other Governments.
- Coordinate the water resources exploitation activities of sectors, areas and solve the conflicts in jurisdiction between the sectors and communities.

For the local Government: to conduct the related activities according to the existing laws and regulations, especially those on the assessment of the water demand of its area for the Central Government coordination.

For the management line agencies (Department or General Department):

- To determine the existing situation and variation of the water resources and give the consultation to the Government on the longterm strategy of water resources use.
- To conduct the survey on water resources and the beneficiaries of the resources, based on which to carry out a long-term plan for the resources exploitation.

The ministries and sectors should submit their water demand to the Government.

The science and technical associations are responsible to gather the experts and scientists to carry out the consultations for the Government in the investigation, assessment, exploitation and management of the water resources.

6.3 GROUND WATER

The plan for implementation may be divided into three stages suitable with the development of the country and the awareness of the community, in particular as follows:

Stage 1: From 1998 to 2000 In this stage the following works will be implemented:

- Establishment and perfection of the data base for the centralized and unified management of the information within the whole country.
- Working out the master plan for the whole territory, the important economic areas (Bac Bo plain, Nam Bo plain and central plateau, Hanoi, Ho Chi Minh city, key economic areas of Central region).
- Finalizing and promulgating the laws and subordinate legal documents related to the exploitation and protection of the groundwater resources within the territory of the whole country.
- Promulgating the regulations on investment into the production of and doing business in clean water.
- Strengthening the organization of the supervising and managing agencies and promulgating the regulations on the activities of those agencies.
- Supplementing and maintaining the operation of the national groundwater monitoring network.
- Carrying out the investigation and evaluation of the water resources to serve water supply to some important urban areas, working out feasibility study for the water supply to some typical cities and towns.
- Experimental research of new water supply solutions, application of scientific advances to speed up the investigation, promptly put into the exploitation and utilization the groundwater sources which have been evaluated.
- Experimental construction of centralized water supply facilities at village scale in areas with various natural conditions, to serve as the basis for general application throughout the country.
- Launching a propagation campaign to the community about the exploitation and protection of the groundwater resources.
- Strengthening and expanding international corporation to speed up the exploitation and protection of the groundwater resources and the environment in the whole territory of Viet Nam.

Stage 2: From 2001 to 2005

- Continuing the planning of the groundwater exploitation in the remaining areas.
- Continuing collection of information from the national monitoring stations, local and monitoring stations and correlating with the regional monitoring stations.
- Carrying out the investigation of water sources for urban areas, continuing establishment of feasibility study for water supply to the remaining 50 % of urban areas.
- Working out the water supply programs of the urban areas.

- Developing the centralized rural water supply at village scale-in large areas.
- Checking, amending and supplementing the laws and subordinate legal documents to meet promptly the changes of the actual socioeconomic conditions, strengthen the organization of the management agencies, enhancing the efficiency of those agencies.

Stage 3. (From 2006 to 2010) The following works will be implemented:

- Complete the construction of the national groundwater monitoring network, Increasing the efficiency of the network in the prediction of the variation of the groundwater due to the impacts of economic activities in the country and the region.
- Perfecting the laws and subordinate legal documents, consolidating those laws and documents.
- Accomplishing the investigation of water resources to serve the water supply for the remaining urban areas. By the year 2010: putting all the wellfields into operation for stable water supply to urban areas.
- Accomplishing the rural water supply.
- Working out plans for the development of clean water production and business sector to the year 2050.

6.4 AQUATIC LIVING RESOURCES

Ongoing activities:

- The Government and Ministry of Fisheries have launched decrements on 25 April 1989 and 02 June, 1990, 30 August, 1990 which determine in particularity the species, regions, time period allowable for catching, the size of nets of each catching method.
- Establishment of a network for aqua resources protection from the Department of Aquaresouces Protection as the Ministry of Fisheries to the Subdeperment of Aquaresouces Protection at local level.
- Strenthening the fishing control teams in the coastal zone.
- Prohibition from the use of exploisive and electric methods.
- Investment of 400 bil. VND to develop the offshore fishing vessels.
- The cicular letter of the Ministries of Finance and Fisheries 10 January, 1998 deceres the resources tounover taxes by 50% for the offshore fishing for 3 years.
- Environment impact assessments for aquaculture projects are required.

6.5 AQUATIC HABITATS

Recognizing the importance of wetlands in economic, social and environment aspects, the Government of Viet Nam has conducted activities mainly during the 5 years plan 1996-2000 and up to 2010. They can be listed as below:

- Action plans for the protection of biodiversity
- Establishment of national strategy on the protection of wetlands
- Conduction of surveys in the coastal and island areas for development planning

- Study, establishment and management of marine/coastal protected areas
- Establishment of RAMSAR in the lagoons of the Middle Part of Viet Nam
- Assessment of seagrass ecosystem in Viet Nam
- Proposal of initiatives on the integrated management of Viet Nam coastal zone
- Study on the environment changes due to the socio economic development planning and interventions for the Red and Mekong river deltas
- AUSTRALIA-ASEAN Programme on the management of Viet Nam coastal resources
- IUCN/GEF Programme on marine protected areas
- CANADA - ASEAN Environment Programme
- SIDA Programme for coastal zone management

7. SPECIFIC ACTION PROPOSED FROM EACH IDENTIFIED ISSUES

7.1 POLLUTION

- Improvement of environmental institutions at the central and local levels. Change from present Department to General Department or higher in order to fulfil the management tasks.
- Enlargement of monitoring network in both number of stations and the frequency of monitoring (to monthly period).
- EIA for existing industrial units.
- Waste standards for urgent areas, first of all the Sai Gon - Dong Nai, the Red river and the Thai Binh river.
- Treatment facilities for water and solid waste: in the big cities such as Ha Long, Hai Phong and Vung Tau... (It is planned to build the waste water treatment plant there, for Hanoi and Ho Chi Minh City: the solid waste treatment factories).

7.2 AQUATIC LIVING RESOURCES

- To follow up, enforce the above mentioned documents
- To operate the above mentioned network of resources protection
- To strengthen the activity of the fishing control teams

7.3 GROUND WATER

The main solutions for the problems set out include:

Updating the regional and international information The regional and international information on the related issues such as climate change, production, exploitation and utilization of groundwater, etc. should be regularly updated through exchange of publications, scientific seminars, Internet systems. The exchange of information will help avoid unnecessary actions.

Strengthening the scientific research This is to find and apply the scientific advances in the investigation and exploitation of groundwater. This will help rapidly solve the problems set out.

Intensifying the education and propagation to improve the awareness of the community Measures must be taken to make everybody, every agencies and authorities of various levels recognize fully the water supply, including the use of groundwater which is of special importance in the development of the national economy in the years to come. It is only when the role and importance of the groundwater is recognized that there can be great changes and the problems set out can be solved.

Allowing and creating all favorable conditions for the private organizations and collectives in the country and abroad to invest their capital in the production and sale of clean water, especially in the production of clean water from the groundwater. At present the clean water production in Viet Nam is still small and poor. In fact there are many private groups carrying out unorganized drilling of wells. But there still no companies registered for producing and doing business in clean water for urban areas, except the clean water business companies which formerly were water supply companies of some cities. Due to many objective reasons, these clean water business companies have difficulties in their business and suffer losses. Policies should be adopted to give privileges to the clean water production and business companies so that they may be established and operate efficiently.

Investment by the State to the clean water business as being made in Hanoi, Hai Phong and Ho Chi Minh City

Calling for humanitarian aids to solve the rural water supply problems, especially in the remote and isolated areas

Borrowing foreign funds for investment into the production and doing business in clean water.

Raising funds from the population according to "the State and the people work together" mechanism for construction of water supply facilities.

Finalizing and promptly promulgating laws: To facilitate the rational exploitation of the groundwater resources and protection of the environment, to encourage the investment into the production and doing business in clean water, the State of Viet Nam must promulgate promptly the laws and subordinate legal documents in this aspect. This is a difficult but urgent task. An organization must be established and strengthened for effective management and control of the groundwater and the environment. This organization must extend to the local level and must issue its regulations for activities.

The above measures have close interrelationships and support each other. But the most important element is the awareness of the authorities, especially the ministries and sectors at the central level.

7.4 AQUATIC HABITATS

For the aquatic resources, the following actions are needed:

Watershed management

- Initiatives on the flood control in the Red and Mekong river deltas
- Master plans for areas rich in wetlands
- Revision of the strategy on wetland to 2010 under the Resolution on the Environment Protection in the period of industrialization and modernization of Viet Nam
- Preparation guidelines for EIA of area development
- Strengthening public awareness and participation in the wetland area management
- Policy to stimulate fishery, especially the offshore fishing
- Policy on tax regulation and land use

8. IMPLICATIONS OF THE PROPOSED ACTIONS BY SECTORS

8.1 FINANCE

- Keeping 1% GDP for the budget for science technology and environment and nowadays preparing all needed matters for rising up this budget to 2% by 2000.
- Preparation of laws on the environment tax, including environmental foundation and others.
- Favour of the tax to encourage offshore fishing and coastal aquaculture.
- Loan for offshore fishing and coastal aquaculture.
- Invests in projects of water treatment, solid waste dumping, firing and composite fertilising.

8.2 ECONOMIC DEVELOPMENT

- Conducting environmental based master-planes at regional (3 economic development zones for the whole country) and provincial levels.
- Giving favourable conditions for foreign investment in environment projects (clean water, waste water treatment, rehabilitation of mining area, solid waste treatment, et...)

8.3 FISHERIES

- Favour of offshore fishing, technology transfer and assistance.
- Favour of coastal aquaculture, technology transfer, supply of breed and young species.
- Enforcement of fishing control to stop fishing with too fine nets, in not allowed seasons, using explosive materials and electric power and illegal fishing of Chinese and Thailand peoples.
- Stop cutting mangrove forest for making shrimp ponds.
- Establishment of aquatic natural reserves including marine parks.
- Education, propaganda and awareness to fisherman on environment protection.

8.4 AGRICULTURE

- Control of chemical fertilisers and pesticides.
- Accomplishment of clean vegetable programme and clean water programme for rural areas.
- Propaganda and education to the rural people on environment protection.

8.5 FORESTRY

- Accomplishment of greencover programme for bar hills and mountains replanting the damaged mangrove forest.
- Establishment of natural reserves.
- Accomplishment of programme for individual forest management.
- Technology transfer and assistance in forest protection, planting and natural reservation.
- Enforcement of forest control.
- Propaganda and education to the people on environmental protection.

8.6 MINING

- Rehabilitation of old mining areas and areas of mining solid waste discharge.
- Treatment of waste water before discharging in to the environment.
- Control of coastal mining. Stopping the mining causing erosion and mining of living corals for building materials.
- Environment Impact Assessment for any significant mining projects.
- Propaganda and education to mining people on environmental protection.

8.7 MANUFACTURING

- Environment Impact Assessment for any new projects
- Environment Impact Assessment for existing factories for improving the environment around them by the treatment of air, water and solid waste, in the case of necessity, to stop the production or move the factories to new places.
- Applying clean technology.
- Ensuring that the waste discharge meets the standards of waste.
- Propaganda, education to workers in environmental protection.

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APPENDIXES

**MUNICIPAL DISCHARGES AND
DISCHARGES FROM RIVERS
(HOT SPOTS)**

MUNICIPAL DISCHARGES

			Country:	Viet Nam
			City:	Ha Long
1.	Permanent population:	255,000	(last census taken: 1995)	
2.	Average seasonal increase:	470,00		
	(months of tourist season):	June - September		
3.	Population served by municipal sewer system:	725,000		
4.	Main industries (individual or group) served by municipal sewer system:	Only mining is significant, 7,000,000 tons of waste water discharge.		
5.	Sewage treatment plant:	5.1	Existent	NO
		5.2	Non-existent:	YES
		5.3	Planned to be constructed on:	1998
6.	Wastewater flow to the treatment plant	0 m³/day		
6.1	Type of final treatment before discharge:			
		• Primary:	NO	
		• Secondary:	NO	
		• Tertiary:	NO	
7.	Total wastewater treated:	0 m³/day		
8.	Total wastewater discharged (into the marine environment) (for the entire city)			
		8.1	Treated	0 m³/day
		8.2	Untreated	10,000 m³/day
9.	Type and location of discharge: (when more than one, specify for each one)	Direct discharge of industrial and domestic waste water into the Ha Long and Cua Luc bays		
10.	Quality of receiving environment (Coastal water of Cua Luc Bay and Bai Chay swimming area)			
10.1	BOD5:	0.85, 2.37	(mg/L)	
10.2	COD	2.94, na	(mg/L)	
10.3	Total-N	0.047, 0.027	(mg/L)	
10.4	Total-P	0.12, 0.34	(mg/L)	
10.5	TSS	21.97, na	(mg/L)	

10.6	Oil (Petroleum Hydrocarbons):	0.35, 0.46	(mg/L)
10.7	Heavy metals		
10.7.1	Zn :	0.011, 0.027	(mg/L)
10.7.2	Pb:	0.014, 0.005	(mg/L)
10.7.3	Cu:	0.012, 0.010	(mg/L)
10.8	Organochlorines		
10.8.1	Lindan:	0.0005 - 0.002	(mg/L)
10.8.2	DDT:	0.0 - 0.003	(mg/L)
10.9	Faecal coliforms	1000 - 4600	(MNP/100 mL)

11. When a sewage treatment plant and/or sewer system are non-existent, give estimation of the cost needed for the construction (secondary treatment will be included):

SUS 22,000,000

12. Additional information regarding the disposal of solid wastes that may affect the receiving waters:

Coal dust and coal mine solid discharge are almost everywhere in the area.

13. Remarks:

In 10.1 - 10.7, the first number is the data collected by the Sub-Institute of Oceanography Hai Phong, the second one is the survey results of CMESRC

MUNICIPAL DISCHARGES

Country: **Viet Nam**

City: **Hai Phong**

1. Permanent population **500,000**..... (last census taken.....**1997**.....)
2. Average seasonal increase: **503,000 (1996)**
3. Population served by municipal sewer system: **300,000**
4. Main industries (individual or group) served by municipal sewer system:

Name of enterprise	Type of activity	Size (/year)	Population equivalent
Building material			
Chinhphong Cement Factory	Cement production	600 tons	2330
Kien An Brick Factory	Brick production	300-600 tons	1030-2060
Go Cong Brick Factory	Brick production	2000 m³	4550
Third Military Region Brick Factory	Brick production	300-600tons	1030-2060
Building Material Company	Other building materials	500 m³	1140
Chemistry			
Trang Kenh Chemical Factory	Calcium Carlid production	100-300 tons	340-1020
Minh Duc Chemical Factory	Chemical production	3000 m³	6820
Hai Phong Ion Enamel Factory	Ion enamel goods production	240 tons	820
Machinery and Ship Building			
Duyen Hai Machinery Factory	Machines production	2360 tons	8080
Pha Rung Ship Repairing Factory	Ship repairing	2000 tons	6850
VSC POSCO Steel Company	Steel production	2160 tons	7400
Song cam Shipping Factory	Ship building	30 tons	100

Estimate: **0.8 kg/person/day (292kg/per/year)**
1.2dm³/person/days (0.44m³/person/year)

5. Sewage treatment plant: 5.1 Existent**No**.....
5.2 Non-existent ... **Yes**.....
5.3 Planned to be constructed on: **na**
6. Wastewater flow to the treatment plant.....**0** (m³/day)

6.1 Type of final treatment before discharge:

- Primary NO
- Secondary NO
- Tertiary NO

7. Total wastewater treated0 (m³/day)

8. Total wastewater discharged (into the marine environment)
(for the entire city)

8.1 Treated0.....(m³/day)

8.2 Untreated ...72,000 - 88,000....(m³/day)

9. Type and location of discharge: (when more than one, specify for each one):

Direct discharge, domestic and industrial waste water

10. Pollution loads at the discharge point:

10.1 BODS2,842-3,630..... (t/y)

10.2 COD4,006-4,660..... (t/y)

10.3 NH₃ 188-232..... (t/y)

10.4 PO₃ 221-1396..... (t/y)

10.5 TSS4,439-5640..... (t/y)

10.6 Oil (Petroleum Hydrocarbons)...na

10.7 Heavy metals: na

10.8 Organochlorines: na

10.9 Coliform24,000..... (MPN/100 mL)

11. Quality of receiving environment (**Marine coastal water**)

11.1 NO₃ : 0.138 (mg/L)

11.2 PO₄³⁻ : 0.142 (mg/L)

11.3 TSS: na

11.4 Oil (Petroleum Hydrocarbons) 0.55 mg/L

11.5 Heavy metals

11.5.1 Cu: 11.5 µg/L

11.5.2 Zn: 12.2 µg/L

11.6 Faecal conforms 1500 (col/100 mL)

12. When a sewage treatment plant and/or sewer system are non-existent, give estimation of the cost needed for the construction (secondary treatment will be included):

40,000,000\$US

13. Additional information regarding the disposal of solid wastes that may affect the receiving waters: **Domestic waste water is discharged without treatment directly to the sea and through Cam river mouth and Lach Tray River**

MUNICIPAL DISCHARGES

Country: **Viet Nam**

City: **Da Nang**

1. Permanent population **667,200**.....(last census taken.....**1997**.....)
2. Average increase: **23,000**
3. Population served by municipal sewer system: **530,000**
4. Main industries (individual or group) served by municipal sewer system:
(data on waste discharge are not available)

Name of enterprise	Type of activity	Size (/year)	Population equivalent
Brewery	Beer production		
Drinking water	Drinking water production		
Food processing	Fish processing, slaughter houses		
Textile and dye factories			
Construction materials	Cement, steel, concrete, granite		
Chemicals'	glass, plastics, fertilizers, pesticides		
Mechanics	shipbuilding, automobile and motobyke production, paper and wooden plank production		

5. Sewage treatment plant: 5.1 Existent**No**.....
5.2 Non-existent
5.3 Planned to be constructed on: **no data**
6. Wastewater flow to the treatment plant.....**0** (m³/day)
6.1 Type of final treatment before discharge:
 - Primary **NO**
 - Secondary **NO**
 - Tertiary **NO**
7. Total wastewater treated**0** (m³/day)
8. Total wastewater discharged (into the marine environment)
(for the entire city)
 - 8.1 Treated**0**.....(m³/day)
 - 8.2 Untreated*....(m³/day)

9. Type and location of discharge: (when more than one, specify for each one):

Domestic and industrial waste water, to Han River and Da nang Bay

10. Pollution loads at the discharge point:

10.1	BOD	.....Data not available	
10.2	COD	.....3,236	(t/y)
10.3	NO ₃ -N.....	2,475	(t/y)
10.4	PO ₃ -P	36.3	
10.5	SiO ₂	..... 6,204	(t/y)
10.6	Organic N ...	4,126	(t/y)
10.7	Organic P	.....26.1	(t/y)
10.8	TSS	.....194,136	(t/y)
10.9	Heavy metals:		
	Fe	1,782	(t/y)
	Mr	126	(t/y)
	Cu	37.5	(t/y)
	Pb	15.9	(t/y)
	As	27.8	(t/y)
	Zn	79.5	(t/y)

11. Quality of receiving environment (**Da Nang Bay**)

11.1	NO ₃ :	0.443	(mg/L)
11.2	PO ₄ ⁻³ :	0.142	(mg/L)
11.3	TSS:	100	(mg/L)
11.4	Oil (Petroleum Hydrocarbons)	1.5 - 3.3	mg/L
11.5	Heavy metals		
	11.5.1 Fe:	0.314	mg/L
	11.5.2 Zn:	0.141	mg/L
	11.5.3 Hg:	0.002	mg/l
11.6	Coliform	1,500 - 110,000	(col/100 mL)

12. Additional information regarding the disposal of solid wastes that may affect the receiving waters:

- **Domestic wastes from many residence aareas along the coast of Da nang Bay are discharged without treatment directly to the Bay.**
- **The solid waste at some dumping sites are burned for its reduction in amount but the resulting smoke badly pollutes the air quality in the areas. Beside, the waste water generated from the dumping sites (normally not isolated) comes to springs the reaches to the Han River and Da Nang Bay**

MUNICIPAL DISCHARGES

Country: **Viet Nam**

City: **Vung Tau**

1. Permanent population**154,505**... (last census taken **1995**)
2. Average seasonal increase ...**2,624,000**.....
(months of tourist season)**Round the year**.....
3. Population served by municipal sewer system **90%**
4. Main industries (individual or group) served by municipal sewer system:

Name	Type of activity	Size
Oil and gas industry	Services	8.8 x 10⁶ tons/year
Vung Tau Port operation	Receiving commercial ship from both domestic and international navigation lines	330,000 tons/year
Special Port for oil and gas industry		na

5. Sewage treatment plant: 5.1 Existent**No**..... since when
5.2 Non-existent**Yes**.....
5.3 Planned to be constructed: **na**
6. Wastewater flow to the treatment plant..... **0** (m³/day)
(When more than one exists, specify for each one) **0** (m³/day)
6.1 Type of final treatment before discharge:
 - Primary **NO**
 - Secondary **NO**
 - Tertiary **NO**
7. Total wastewater treated**0**..... (m³/day)
8. Total wastewater discharged (into the marine environment)
(for the entire city)
 - 8.1 Treated ...**0**.....(m³/day)
 - 8.2 Untreated**30,000**.... (m³/day)
9. Type and location of discharge: (when more than one, specify for each one)
.....**Domestic waste water/ Vung Tau coastal water**

10. Pollution loads at the discharge point:

10.1	BODS	.....4,788.....	(t/y)
10.2	COD	.....4,884.....	(t/y)
10.3	Total-N.....	1.39.....	(t/y)
10.4	Total-P.....	28.0.....	(t/y)
10.5	TSS	.....8,867.....	(t/y)
10.6	Oil (Petroleum Hydrocarbons).....	0.438.....	(t/y)

11. Quality of receiving environment (coastal water)

11.1	NO ₃ ⁻ :	0.02 - 0.87.....	(mg/L)
11.2	NH ₄ P	0.01 - 0.57	(mg/L)
11.3	Total-P	.....0.05.....	(mg/L)
11.4	TSS	.....18.....	(mg/L)
11.5	Oil (Petroleum Hydrocarbons)	.....1.006.....	(mg/L)
11.5	Heavy metals		
11.5.1	As:	0.013.....	(mg/L)
11.5.2	Zn:	0.029.....	(mg/L)
11.5.3	Cu:	0.014.....	(mg/L)
11.5.4	Σ Fe:	0.38	(mg/L)
11.6	Organochlorines:	0.02 x 10 ⁻³	(mg/L)
11.7	Coliforms	.....1800.....	(MNP/100 mL)

12. Additional information regarding the disposal of solid wastes that may affect the receiving waters:

Solid waste are not treated, they are buried or use for levelling land for building construction

DISCHARGES FROM RIVERS AND CANALS INTO THE SEA

Country: **Viet Nam**

Name of River/Canal: **Red River**

1. Discharge site (geographical position): **The Gulf of Tonkin
(Ba Lat is the main river mouth)**
2. Average daily flow: **325,760,000 m³/day**
3. River water quality and pollution loads at point of discharge:

		River water quality (mg/L)		Pollution loads (tons/year)
		At Phu Hao St.	In coastal water	
3.1	BOD	0.8		96,000
3.2	COD	2.1		252,000
3.3	NO3	0.517	0.085	24,600
3.4	Po4	0.284	0.03-0.077	14,800
3.5	TSS	1,000		120,000,000
3.6	Heavy metals			
	Cu:	0.04985	0.0057-0.0192	2,816.7
	Zn:	0.05530	0.0228-0.0533	2,014.6
	Cd	0.0037	0.0029-0.0041	117.8
3.7	Persistent Organic Pollutants			
	DDT	0.004		400
3.8	Oil (petroleum hydrocarbons)			
		0.12		14,268

DISCHARGES FROM RIVERS AND CANALS INTO THE SEA

Country: **Viet Nam**

Name of River/Canal: **Dong Nai- Sai Gon**

1. Discharge site (geographical position): **Ganh Rai Bay**
2. Average daily flow: **164,380,000 m³/day**
3. River water quality and pollution loads at point of discharge:

		River water quality mg/L)		Pollution loads (tons/year)
		At Nha Be St.	In Ganh Rai Bay	
3.1	BOD	5-8	0.085	300,000-400,000
3.2	COD	na	na	na
3.3	Total N	0.5-1.9	0.2-0.5	79,570
3.4	Po4	0.2-0.32	na	10,220
3.5	TSS	137-170	na	8,220-10,220 x 10³
36	Heavy metals			
	Pb:	0.003225	0.005-0.020	102.2
	Zn:	0.02-0.05	0.001-0.01	77000
3.7	Persistent Organic Pollutants			
	DDT	0.00054		432.85
3.8	Oil (petroleum hydrocarbons)			
		0.12 (At Vung Tau)		28.800

4. Other remarks: **The Sai Gon River's water is affected by the industrial and domestic waste from Ho Chi Minh City, by oil and gas industry on the shelf of the South of Viet Nam.**

DISCHARGES FROM RIVERS AND CANALS INTO THE SEA

Country: **Viet Nam**

Name of River/Canal: **Mekong**

1. Discharge site (geographical position): **The South China Sea,
Dinh An is the main river mouth**
2. Average daily flow: **1,369,863,000 m³/day**
3. River water quality and pollution loads at point of discharge:

Pollution	Water quality		Pollution loads
	My Tho cross section	Coastal water	
	(mg/l)	(mg/l)	(x10 ³ tons/year)
BOD			
COD	5-24		2,500-12,000
NO ₃ -N	0.11-0.45	0.003-0.004	55-225
PO ₄ ²⁻	0.02-0.07	0.06-0.08	10-35
	(µg/l)	(µg/l)	(x10 ³ kg/year)
Pb	2-3		1,000-1,500
Zn	21	10	10,500
Cu	30	20	15,000

DISCHARGES FROM RIVERS AND CANALS INTO THE SEA

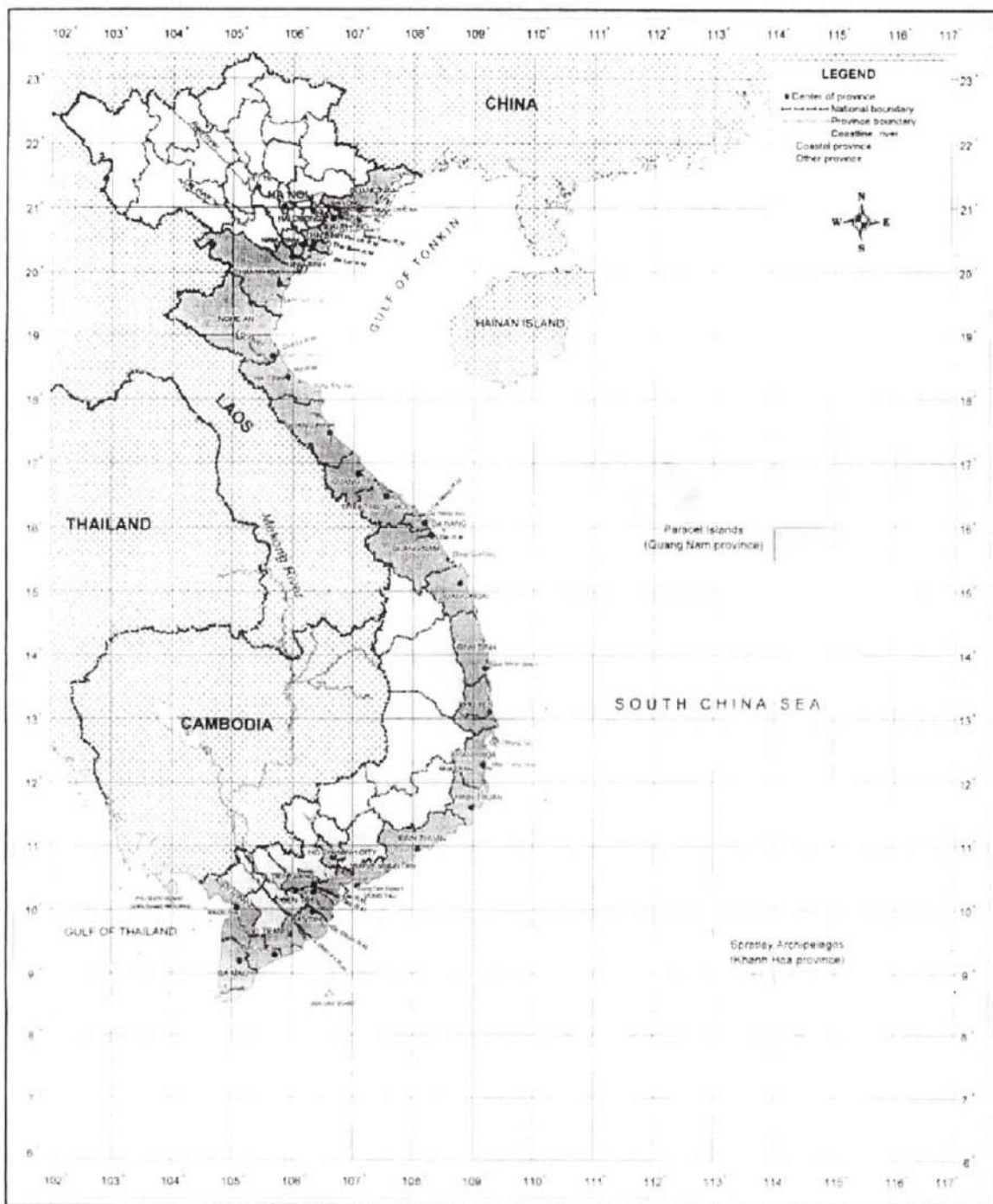
Country: **Viet Nam**

Name of River/Canal: **Thai Binh**

1. Discharge site (geographical position): **Thai Binh river mouth, The Gulf of Tonkin**
2. Average daily flow: **95,890,000 m³/day**
3. River water quality and pollution loads at point of discharge:

Pollution	Water quality		Pollution loads
	Riverine mouth cross sections	Coastal water	
	(mg/l)	(mg/l)	(x10 ³ tons/year)
BOD	0.5-0.6		20-30
COD	0.88-0.92		44-46
NO ₃ -N	0.03-0.05	0.098-0.177	1.2-1.5
PO ₄ ²⁻	0.05-0.10	112-210	1.5-3.0
TSS	225		9
	(µg/l)	(µg/l)	(x10 ³ kg/year)
Pb	2.7	2.2-2.3	154.3
Zn	56.7-57.9	40.8-54.7	3,352
Cu	71.0-80.8	54.6-66.0	3,974.2
Oil	na	250	8,750

Figure 1 Administrative map of Viet Nam with special reference on the coastal provinces



Digitized, edited and printed in Centre for Marine Environment Studies, Research and Consultation (CMESRC), 224 Truong Khanh Hoi, Hanoi, Vietnam. Tel: 84 4 8326195, April 1997.
 Date sources: 1. Vietnamese Administrative Map, General Department of Land Management 1:1,000,000, 1992.

Figure 2 Main river system of Viet Nam and their watersheds

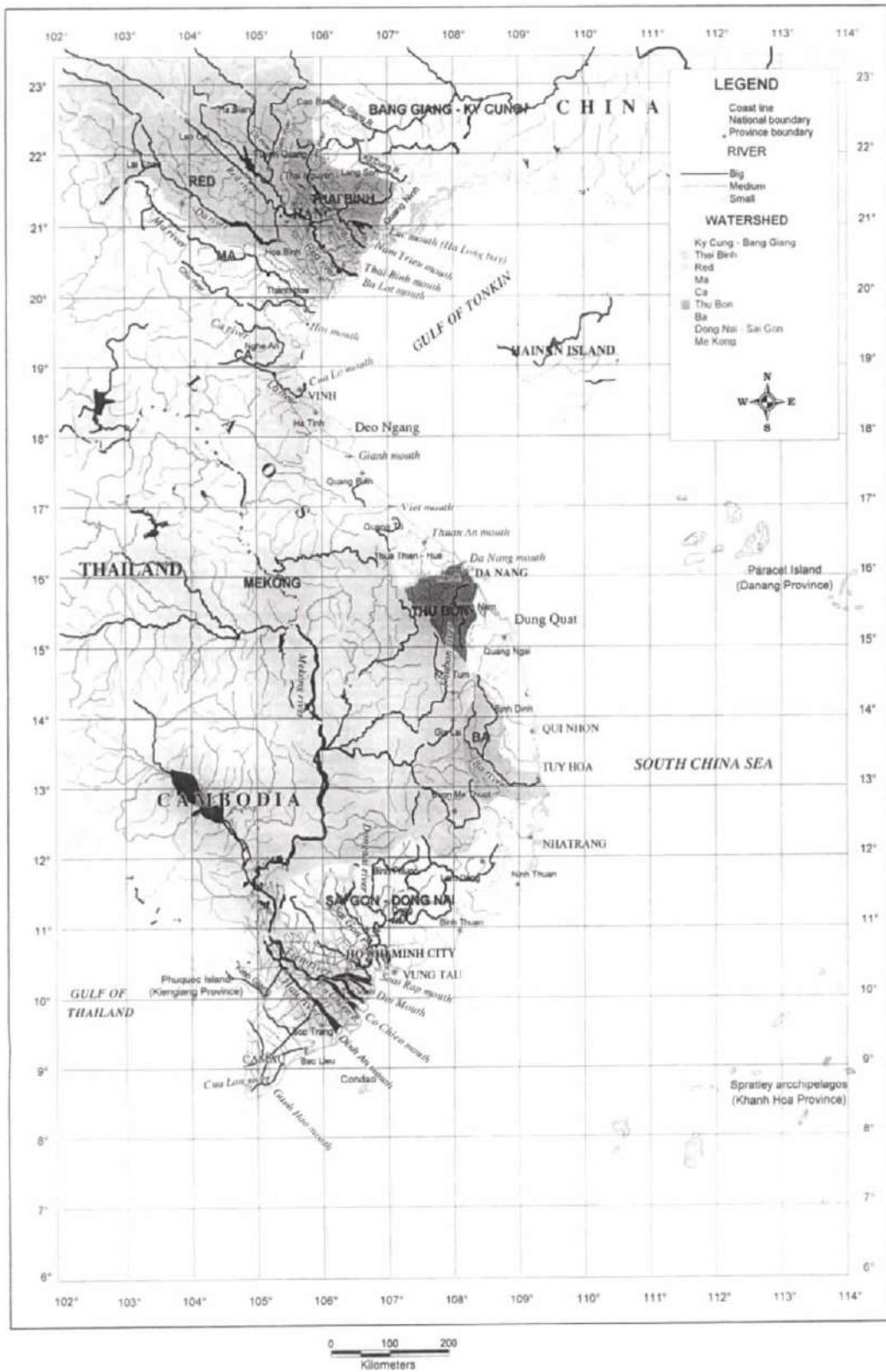


Figure 3 Petroleum activities and marine navigation lines

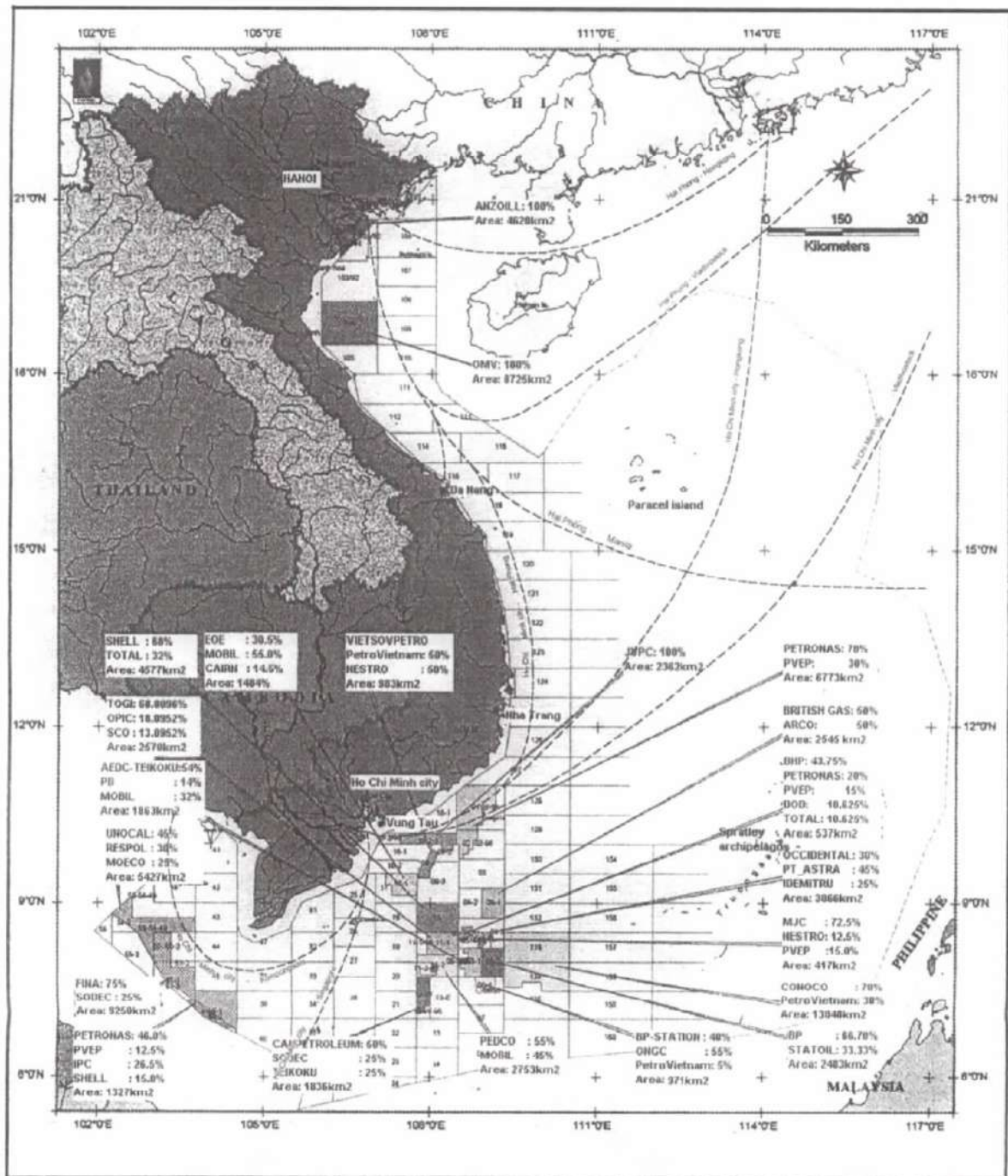
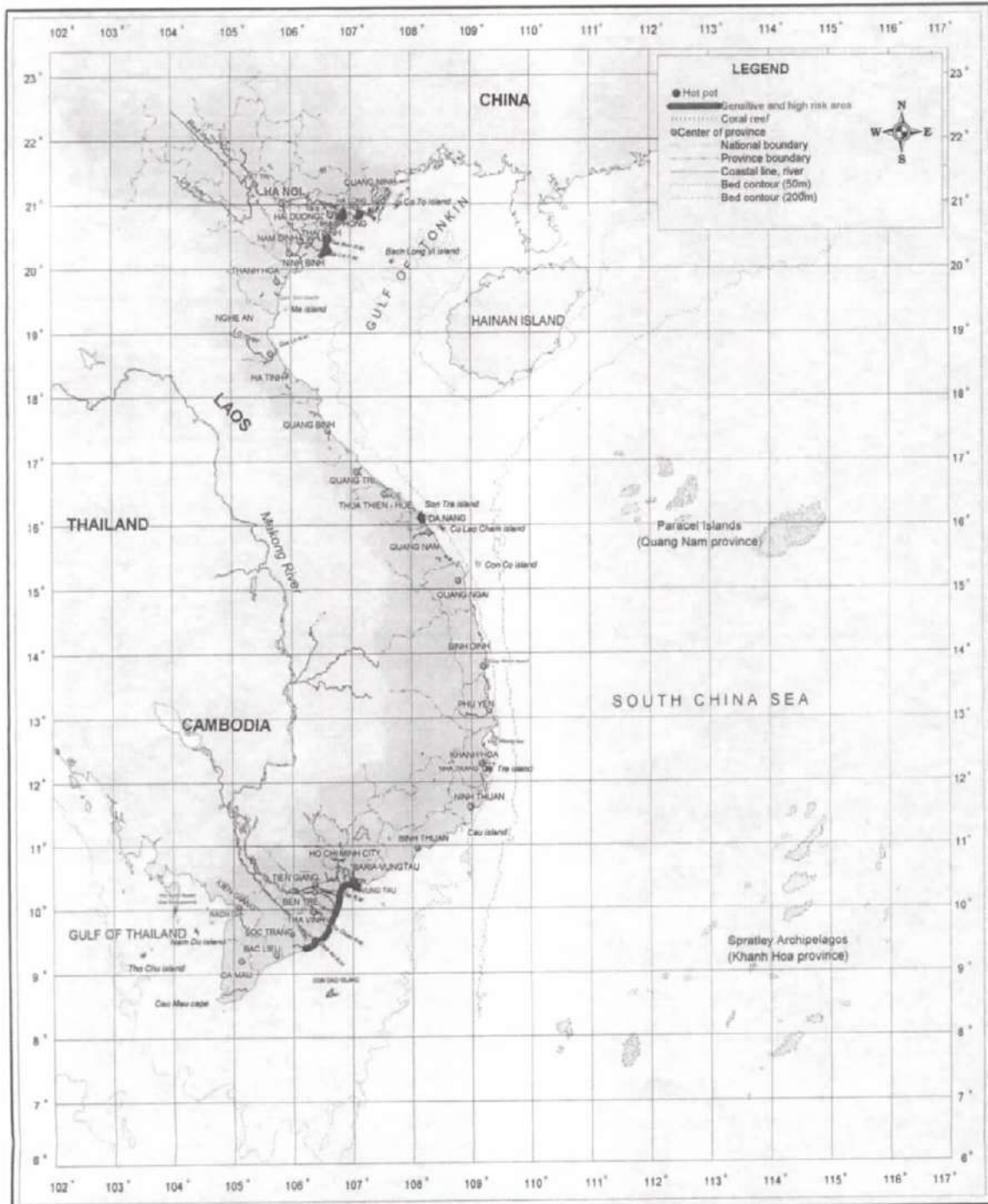


Figure 4 Hotspots, high risk areas and coral reefs



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224 Doan St., Hanoi, Vietnam, Tel. 84 4 829198, April 1997

0 100 200
Kilometers

Figure 5 Industrial and population centers and the state of land environment pollution

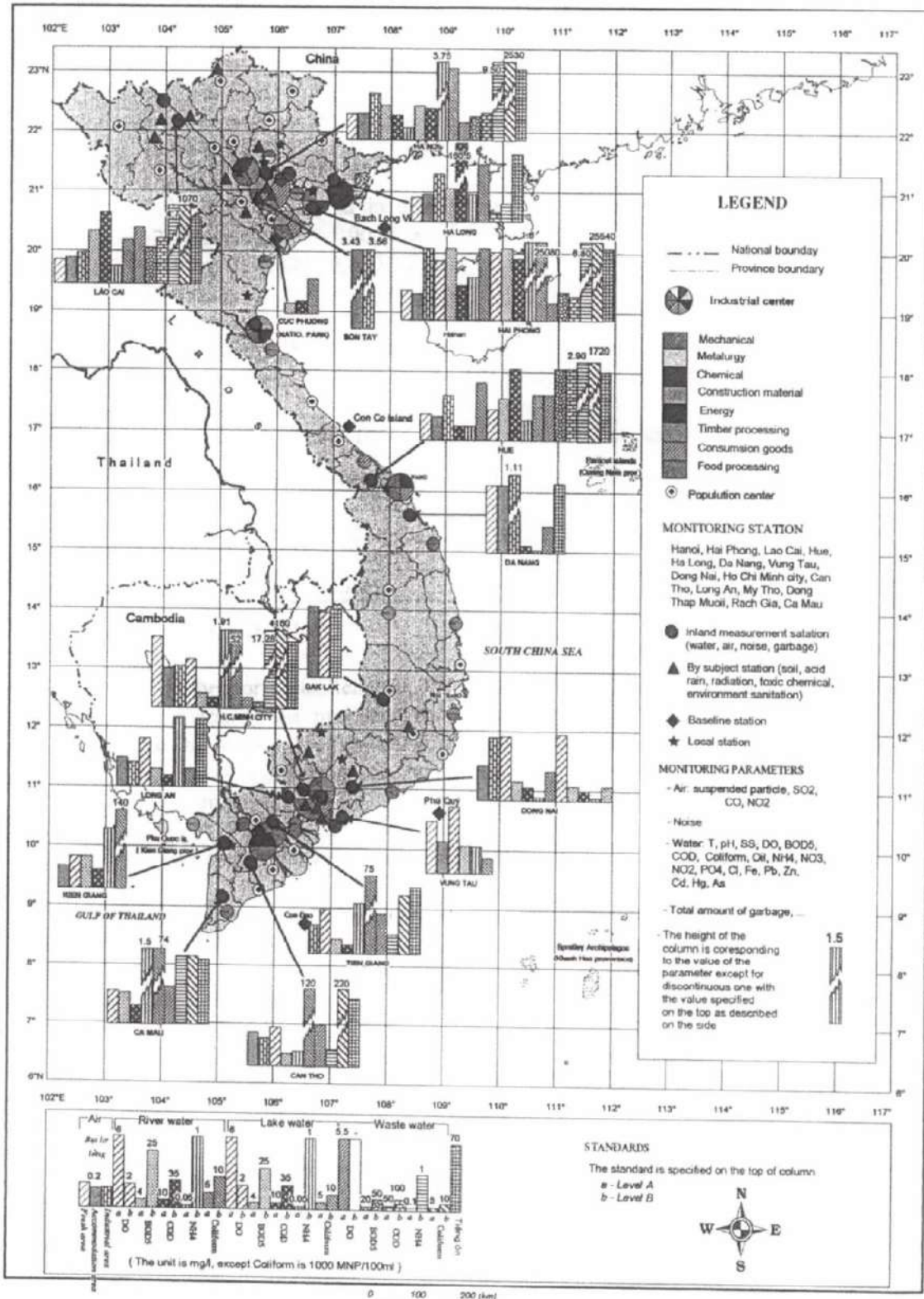


Figure 6 The surface current in January

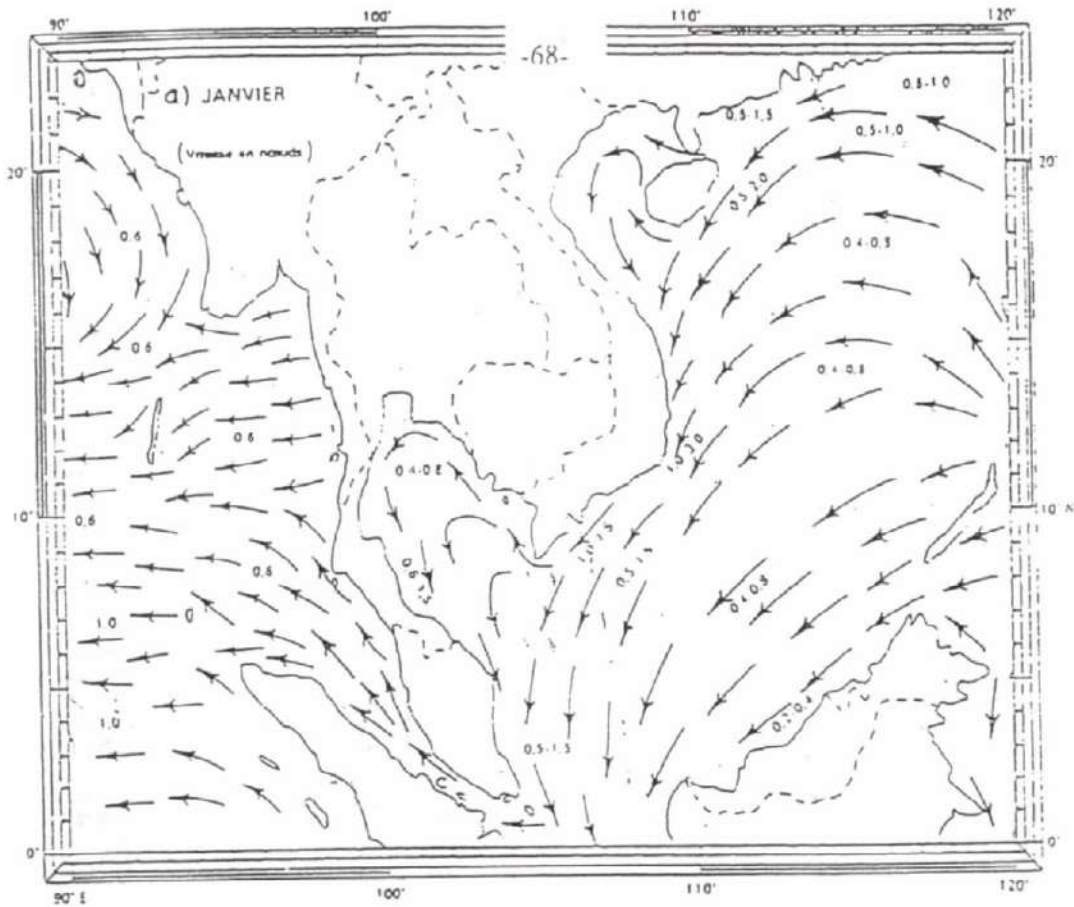


Figure 7 The surface current in July

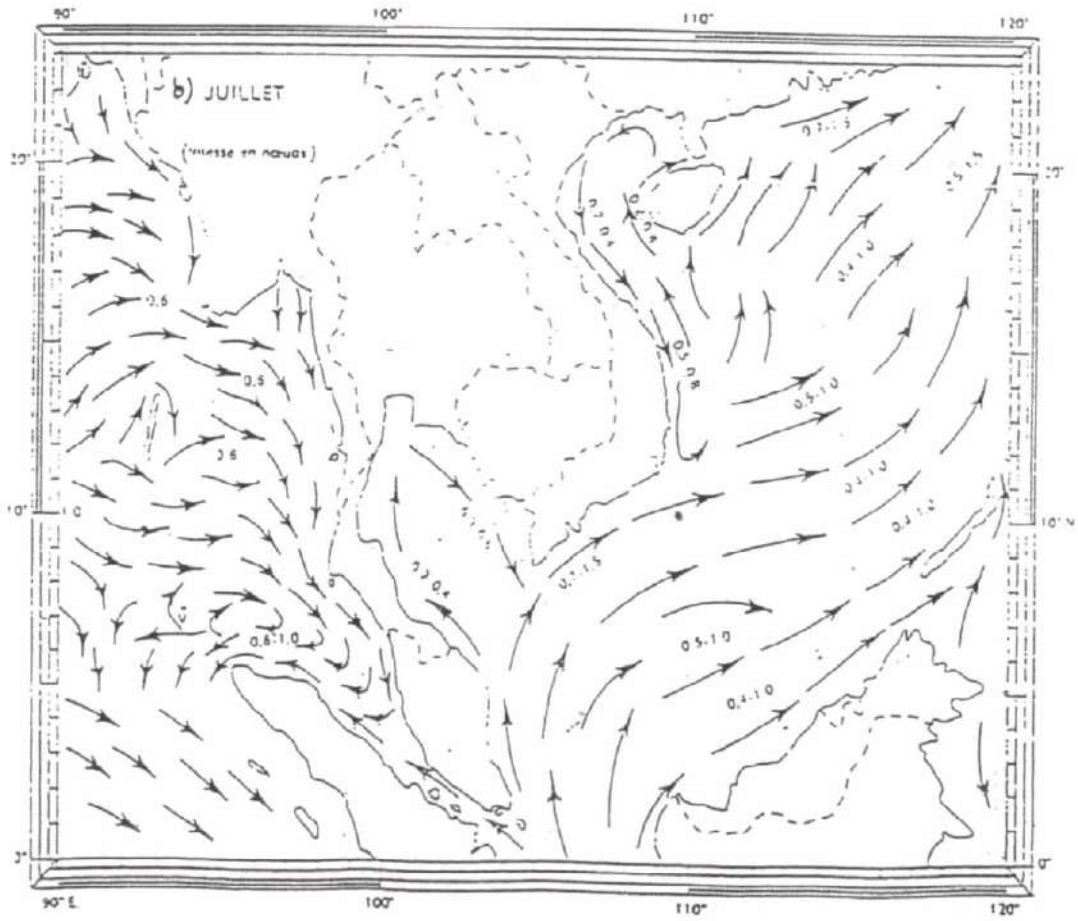
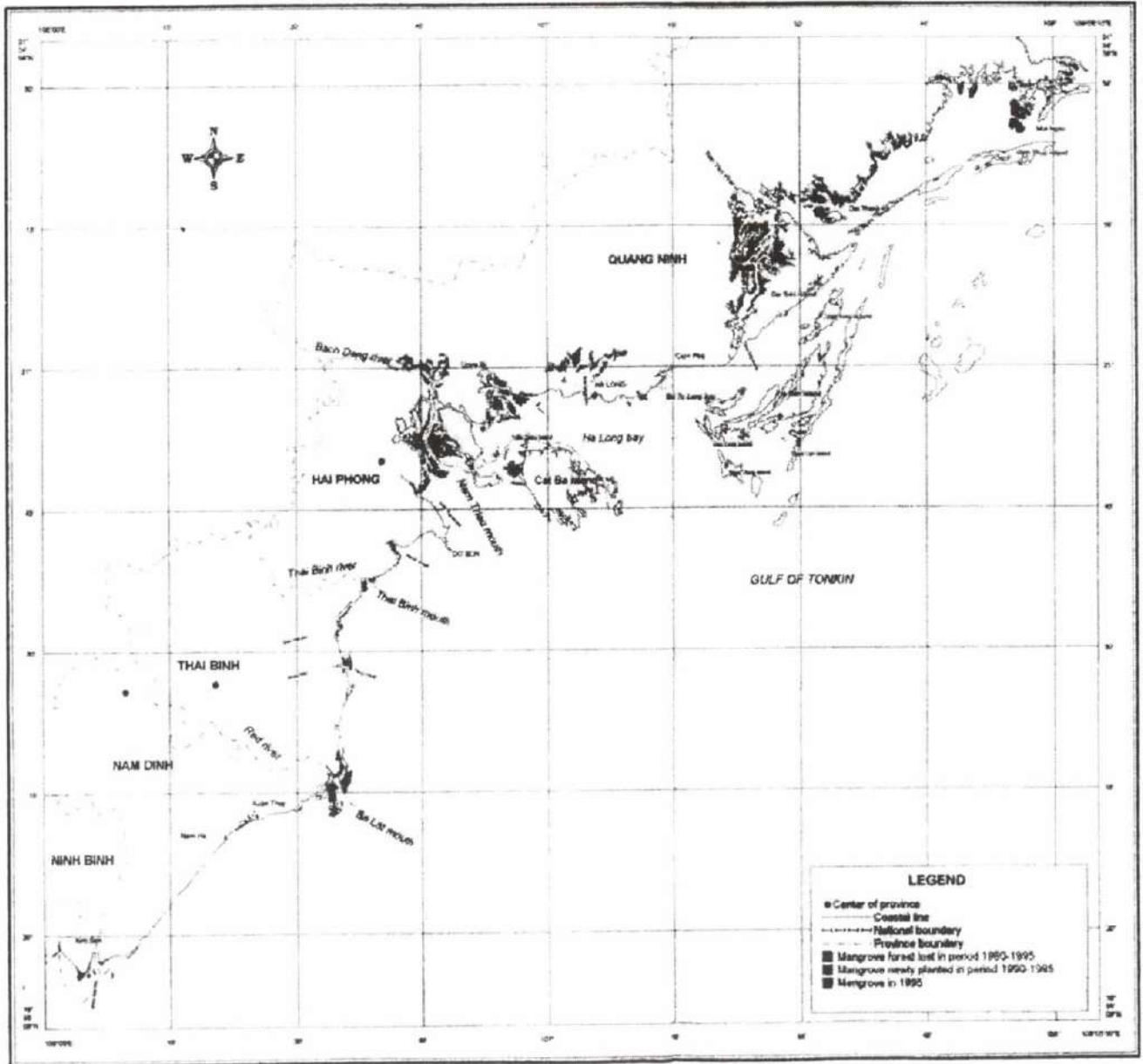


Figure 8 Mangrove forest in the northern part of Viet Nam

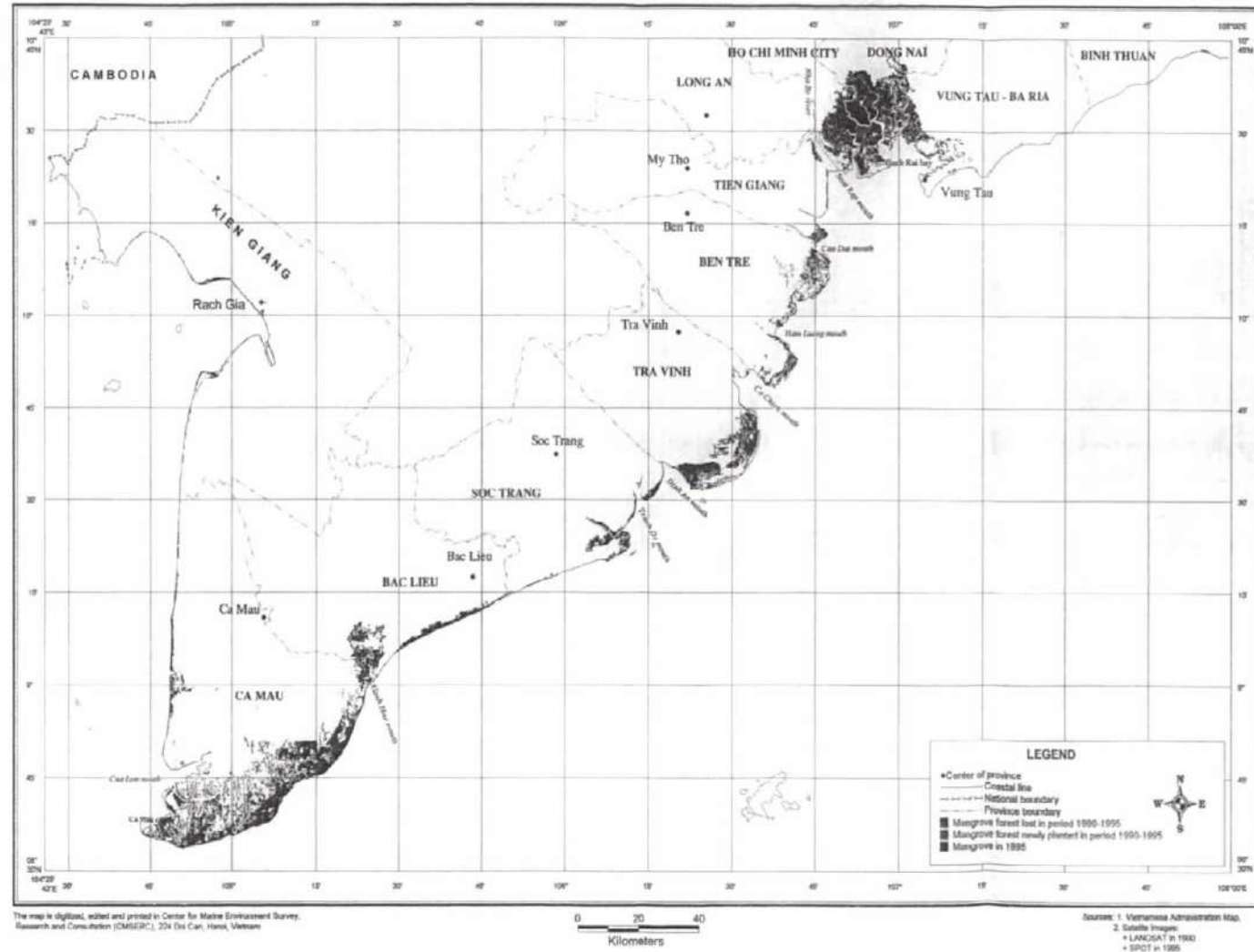


The map is digitized, edited and printed in Center for Marine Environment Survey, Research and Consultation (CMERC), 224 Doi Can, Hanoi, Vietnam

0 10 20
kilometers

Sources: 1. Vietnamese Administrative Map.
2. Satellite Images:
• LANDSAT in 1980
• SPOT in 1995

Figure 9 Mangrove forest in the southern part of Viet Nam



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