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JAPAN INTERNATIONAL COOPERATION AGENCY

MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT
PEOPLE'S COMMITTEE OF QUANG NINH PROVINCE
THE SOCIALIST REPUBLIC OF VIETNAM

THE STUDY ON ENVIRONMENTAL MANAGEMENT FOR HA LONG BAY

FINAL REPORT

VOLUME II MAIN REPORT

SEPTEMBER 1999

NIPPON KOEI CO., LTD.
METOCEAN CO., LTD.

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LIST OF VOLUMES

Volume I	Executive Summary
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Volume V	Data Book

EXCHANGE RATE

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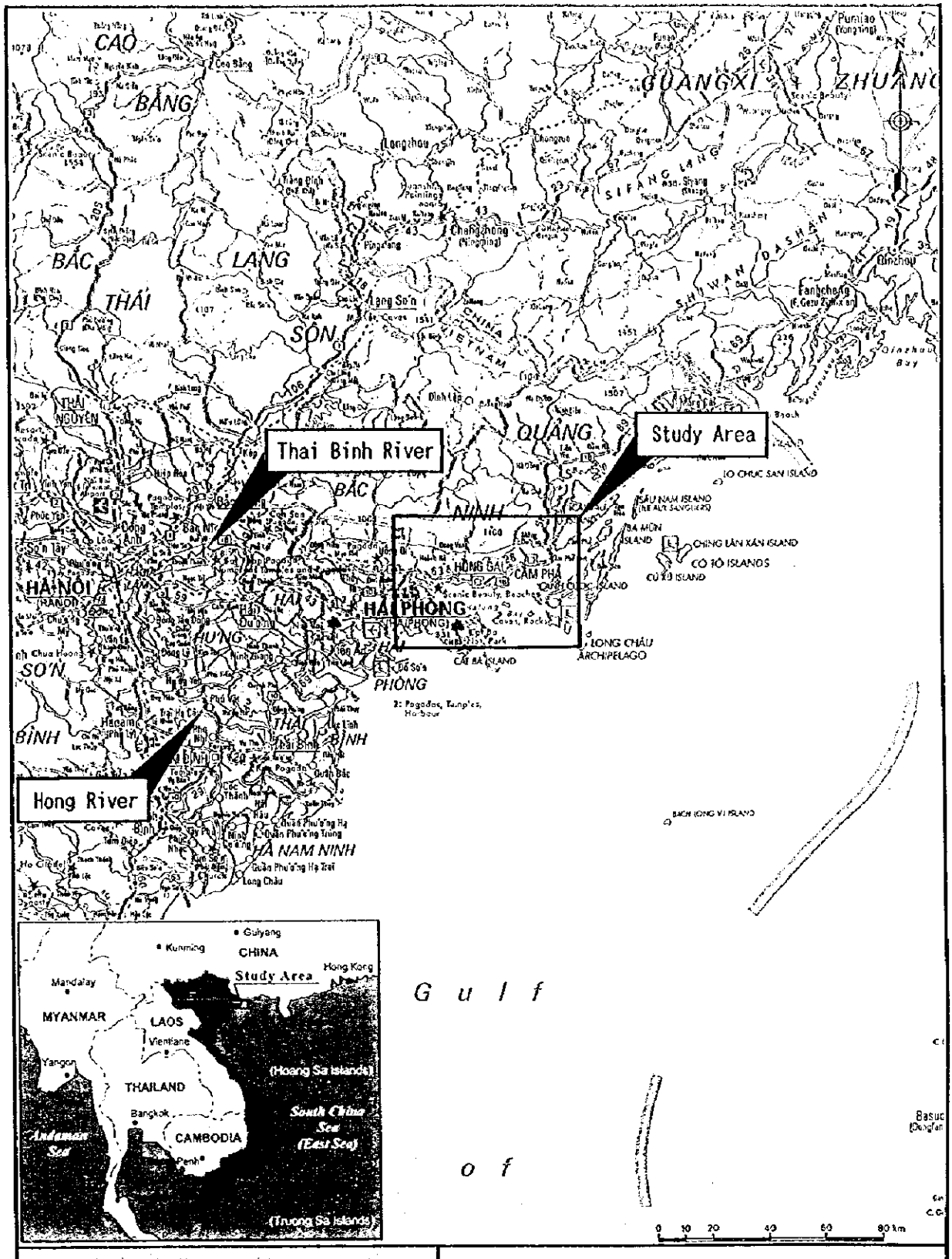

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THE STUDY
ON
ENVIRONMENTAL MANAGEMENT
FOR
HA LONG BAY

FINAL REPORT

Volume II Main Report

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ABBREVIATIONS

<Organization>

ADB	Asian Development Bank
BTFD	Board of Tourist Ferry Dock
CBI	Carl Bro International
CEETIA	Center for Urban and Industrial Area Environment Technique
CIDA	Canadian International Development Agency
CMESRC	Center for Marine Environment Survey, Research & Consultation
CP	Counterpart
CP/T	Counterpart Team
CPUEC	Cam Pha Urban Environment Company
DANIDA	Danish International Development Agency
DARD	Department of Agriculture and Rural Development
DOC	Department of Construction
DOF	Department of Fisheries
DOI	Department of Industry
DOMAP	Department of Architecture Management and Planning
DOSTE	Department of Science, Technology and Environment
DOTOUR	Department of Tourism
DOT	Department of Transportation
DPI	Department of Planning and Investment
E/C	Executive Committee
EMD	Environmental Management Division
EU	European Union
FPA	Forest Protection Agency
GEF	Global Environmental Fund
GOV	Government of Vietnam
HIO	Haiphong Institute of Oceanology
HLESC	Ha Long City Environmental Sanitation Company
HLMB	Ha Long Bay Management Board
IAEA	International Atomic Energy Agency
ID	Inspection Division
IFIP	Institute of Forestry Investigation and planning
IMSAT	Institute of Mining Science and Technology
ITDR	Institute of Tourism Development and Research
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
MOI	Ministry of Industry
MOSTE	Ministry of Science, Technology and Environment
MPI	Ministry of Planning and Investment
NACM	National Agency of Conservation and Museum
NEA	National Environmental Agency
OCDI	Overseas Coastal Development Institute
OECD	Organization for Economic Cooperation and Development
OECF	Overseas Economic Cooperation Fund
PA	Port Authority
QNPC	People's Committee of Quang Ninh Province
S/C	Steering Committee
SAN	Sanitation Company
SIDA	Swedish International Development Agency
STAD	Science, Technology and Administrative Division
STAMQ	Standards, Metrology and Quality Division
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization

UNICEF	United Nations International Children's Emergency Fund
UNIDO	United Nations Industrial Development Organization
QNEMA	Quang Ninh Environmental Management Authority
QNWSC	Quang Ninh Water Supply Company
VINACOAL	Vietnam National Coal Corporation
WB	World Bank
WHO	World Health Organization
WTO	World Trade Organization

<Plan and Project>

BAP	Biodiversity Action Plan
HLMP	Development Master Plan of Ha Long City for 1994-2010
EMS	Environmental Management System
HWSSP	Ha Long City Water Supply and Sanitation Project
NCS	National Conservation Strategy
NPESD	National Plan for Environment and Sustainable Development for 1991-2000
REPR	Resources and Environment Research Program
UNCED	United Nations Conference on Environment and Development
VCEP	Vietnam-Canada Environmental Project
VNNEAP	Vietnam National Environmental Action Plan

<EMP term>

AMZ	Active Management Zone
DZ	Development Zone
EMP	Environmental Management Plan
ERMU	Environmental Research and Monitoring Unit
IC	Implementation Committee
IPCU	Industrial Pollution Control Unit
CZ	Conservation Zone
SCZ	Special Conservation Zone
TFPU	Tidal Flats Protection Unit

<Economic term>

B/C	Benefit-cost ratio
BOT	Build, Operate and Transfer
CVM	Contingent Valuation Method
EIRR	Economic Internal Rate of Return
FDI	Foreign Direct Finance
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Products
L.S	Lump Sum
NPV	Net Present Value
ODA	Official Development Assistance
OVA	Objective Valuation Approach
SVA	Subjective Valuation Approach
TCM	Travel Cost Method
WTP	Willingness to Pay

<Chemical term>

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
IL	Ignition Loss
I-N	Inorganic Nitrogen

I-P	Inorganic Phosphorus
NH_4-N	Ammonia Nitrogen
NO_2-N	Nitrite Nitrogen
NO_3-N	Nitrate Nitrogen
O-N	Organic Nitrogen
O-P	Organic Phosphorus
PO_4-P	Phosphate
SPM	Suspended Particulate Matter
SS	Suspended Solids
TDS	Total Dissolved Solids
T-N	Total Nitrogen
T-P	Total Phosphorus
TSS	Total Suspended Solids

<Others>

CSP	Coal Shipping Port
EIA	Environmental Impact Assessment
GPS	Global Positioning System
F/S	Feasibility Study
LEP	Law on Environmental Protection
M/M	Minutes of Meeting
O&M	Operations and Maintenance
PPP	Pollutant Pay's Principle
TCVN	Vietnam Standards
R&D	Research and Development
QN	Quang Ninh Province
SBR	Sequencing Batch Reactor
SOE	State Owned Company
S/W	Scope of Work
TOR	Terms of Reference
QA/QC	Quality Assurance and Quality Control
WWTP	Wastewater Treatment Plant

MEASUREMENT UNITS

Length

mm	millimeter
cm	centimeter
m	meter
km	kilometer

Extent

m^2	square meter
km^2	square kilometer
ha	hectare

Volume

m^3	cubic meter
l	liter

Weight

kg	kilogram
ton	metric ton

Time

sec	second
min	minute
hr	hour
yr	year

Currency

VND	Vietnamese Dong

Others

%	percent
‰	permill
°C	degree centigrade
10^3	thousand
10^6	million
10^9	billion
CV	cylinder volume
DWT, dwt	dead weight ton
GRT	gross ton
KV, KVA	kilovolt-ampere
MPN	most probable number

PART I

INTRODUCTION

CHAPTER 1

PART I INTRODUCTION

CHAPTER 1 SCOPE OF THE STUDY

1.1 Background

Socialist Republic of Vietnam has a population of approximately 76 million and a land area of 332,000 km^2. The per capita Gross National Product (GNP) in 1995 was US$240, according to the Asian Development Bank, so Vietnam may be characterized as one of the less developed countries. However, since the 6th National Convention of Communist Party in 1986, Vietnam is moving towards an open market economy with the policy known as "Doi Moi", and the economy is surging. Vietnam designates three regions that support this rapid economic growth as North, Central, and South Focal Economic Areas.

Ha Long city (population approximately 130,000 and land area 122.5 km^2), is the largest city in Quang Ninh province. Together with Hanoi city and Hai Phong city, it forms the North Focal Economic Area, or Triangle. To satisfy the need for port facilities in this region, the rehabilitation project of Cai Lan port, located in the Bai Chay bay north of Ha Long city, is under way with financial aid from the Overseas Economic Cooperation Fund (OECF). Upon the completion of this port project, even greater social and economic development of the area is anticipated. Ha Long bay is located south of the rapidly growing Ha Long city and Cam Pha town, and is famous for the numerous islands and islets with peculiar geological characteristics. For the aesthetic seascape of these islands and islets, they are a major sightseeing spot in Vietnam, and this was inscribed on the World Heritage List of UNESCO in 1994.

Ha Long bay and its surrounding area are, thus, precious in terms of both natural environment and economic development. With the recent growth of the area, however, environmental destruction, such as water pollution and loss of natural environment, is getting serious. In particular, the pollution of water with domestic sewage, industrial wastewater, mining wastewater, and pesticides is progressing rapidly in the Bai Chay and Cua Ong areas. With the anticipated growth of

industry and tourism, and accompanying increase in urban area, the environmental conditions of Ha Long bay are expected to deteriorate rapidly in the future.

Therefore, the development of a comprehensive Environmental Management Plan for Ha Long Bay is acutely needed to achieve environmentally sound socioeconomic growth.

1.2 Objectives

The objectives of the Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam (the Study) are:

a) to formulate an environmental management plan for Ha Long bay to be compatible with nature conservation and human activities, and
b) to transfer technology to the counterpart personnel in the course of the Study.

1.3 Study Area

In accordance with the Scope of Work (S/W), the study area for macro analysis is defined as i) Ha Long bay, where the area designated for the World Heritage and its buffer zone exist, and ii) the hinterland area which may affect the environment of the bay. Thus, the study area for macro analysis includes Ha Long bay, Bai Chay bay, the Cua Ong area, and the eastern side of Cat Ba island as shown in Figure 1.3.1.

1.4 Framework of the Study

The Study was conducted over a total period of 20 months from February 1998 to September 1999 in two phases. The first phase was completed in December 1998. The second phase was started in January 1999 and completed in September 1999. The Study framework is shown in Figure 1.4.1.

1.5 Organization of the Study

1.5.1 Steering Committee, Executing Committee, and Counterpart Team

Through the initial Steering Committee (S/C) held on 26 February 1998 for discussion of the Inception Report (IC/R), the overall organization of Vietnam side was set for the actual implementation of the Study as follows:

a) The People's Committee of Quang Ninh Province (QNPC) is the main counterpart of the Study. The Ministry of Science, Technology and Environment (MOSTE) coordinates support for the implementation of the Study at the national level, and

b) The Steering Committee (S/C) consists of relevant ministries and organizations was set up based on the Minutes of Meeting on Scope of Work for the Study signed on 19 September 1997. A list of S/C members is shown below.

Position in S/C		Name	Organization
1	Chairman	Mr. Ngo Dinh Tho	Deputy Chairman of QNPC
2	Deputy Chairman	Dr. Truong Manh Tien	Vice Director of National Environment Agency in MOSTE
3	Deputy Chairman	Mr. Vu Van Thanh	Director of DOSTE in QNPC
4	Member	Mr. Nguyen Dinh Hai	Deputy Division Head of M. of Industry
5	Member	Dr. Pham Trung Luong	Vice Director of ITDR in General Board of Tourism
6	Member	Mr. Bui Duc Nhuan	Vice Director of National Maritime Agency in M. of Transportation
7	Member	Mr. Nguyen Quoc Hung	Vice Director of NACM in M. of Culture and Information
8	Member	Mr. Nguyen Van Thai	Expert of DOMAP in M.of Construction
9	Member	Mr. Pham Quang Tho	Vice General Secretary in UNESCO Vietnam
10	Member	Mr. Nguyen Thi Thanh Ha	Ministry of Finance

Note: QNPC: People's Committee of Quang Ninh Province
MOSTE: Ministry of Science, Technology and Environment
DOSTE: Department of Science, Technology and Environment
ITDR: Institute of Tourism Development and Research
NACM: National Agency of Conservation and Museum
DOMAP: Department of Architecture Management and Planning

c) The Executing Committee (E/C) consists of relevant departments and organizations in QNPC, and was organized to coordinate activities in QNPC. A list of E/C members is shown below.

Position in E/C		Name	Organization
1	Chairman	Mr. Vu Van Thanh	Director of DOSTE in QNPC
2	Deputy Chairman	Dr. Tran Hong Ha	Expert of NEA in MOSTE
3	Deputy Chairman	Mr. Vu Quang Mon	Vice Director of Dept. of Planning and Investment
4	Member	Mr. Nguyen Van Long	Vice Director of Dept. of Finance
5	Member	Mr. Nguyen Van Tuan	Head of Ha Long Bay Management Board
6	Member	Mr. Dao Xuan Dan	Vice Director of Dept. of Construction
7	Member	Mr. Le Dinh Tram	Vice Director of Dept. of Agriculture and Rural Development
8	Member	Mr. Cao Tuy	Vice Director of Dept. of Fishery
9	Member	Mr. Nguyen Duc Long	Vice Director of Dept. of Industry
10	Member	Mr. Nguyen Minh Hien	Vice Director of Dept. of Tourism
11	Member	Mr. Phung Anh Dai	Deputy Chairman of People's Committee of Ha Long City
12	Member	Mr. Pham Toan	Head of Technology Division of Dept. of Transportation
13	Member	Mr. Do Dang Duong	Head of Cultural Specialty Division of Dept. of Culture and Information

d) The Counterpart Team (CP/T) was set up for actual activities of the Study and consists of the following 16 members mostly from QNPC:

Position in CP/T		Name	Organization
1	Chief CP	Mr. Vu Van Thanh	Director of DOSTE in QNPC
2	Member	Mr. Nguyen Van Thanh	Dept. of Planning and Investment
3	Member	Mr. Nguyen Duong Thuat	Dept. of Finance
4	Member	Mr. Nguyen Manh Hai	Dept. of Construction
5	Member	Mr. Vu Quang Cu	Dept. of Construction
6	Member	Mr. Pham Quang Trung	Dept. of Agriculture and Rural Development
7	Member	Mr. Hoang Danh Son	DOSTE
8	Member	Mr. Pham Quang Vinh	DOSTE
9	Member	Mr. Vu Nam Phong	DOSTE
10	Member	Mr. Nguyen Quang Hao	Ha Long Bay Management Board
11	Member	Mr. Do Dang Duong	Dept. of Culture and Information
12	Member	Mr. Pham Toan	Dept. of Transportation
13	Member	Ms. Dang Thi Kim Van	Dept. of Tourism
14	Member	Mr. Le Duy Ky	Dept. of Fishery
15	Member	Ms. Bui Thi Cuong	People's Committee of Ha Long City
16	Member	Mr. Bui Khuynh	Dept. of Industry

1.5.2 JICA Study Team

The JICA study team comprises 15 members consisting of the team leader and 14 experts including one coordinator as listed below.

	Designation / Work Assignment	Name
1	Team Leader / Environmental Management Plan	Yoichi IWAI
2	Hydrology / Water Pollution Analysis	Toshiyuki UJIIE
3	Regional Development / Land Use	Mamoru OSADA
4	Water Quality Analysis	Donald MEISNER
5	Tide and Water Quality Simulation	Ikuro MITSUMOTO
6	Monitoring Plan	Kazuhiko DOHI/Yosiharu KON
7	Environmental Database	Tomoo AOKI
8	Sanitation (Sewage and Waste)	Michael GRAY
9	Pollution Control (Mining and Tourism)	Itaru OKUDA
10	Natural Environment / Landscape	Takashi SATO
11	Port Engineering	Kiyoshi MIZUTANI
12	Satellite Image Analysis	Kenichi SHIBATA/Fumiko Makita
13	Organization and Institution	Robert EVERITT
14	Economic and Financial Analysis	Hiroshi HASEGAWA
15	Coordinator	Seiji KIKUCHI/Ritsuko SATO

Note: Members in charge of Monitoring Plan and Coordinator were changed in the First Work in Vietnam (Part 2), and those in charge of Satellite Image Analysis were changed in the Second Work in Japan.

FIGURES

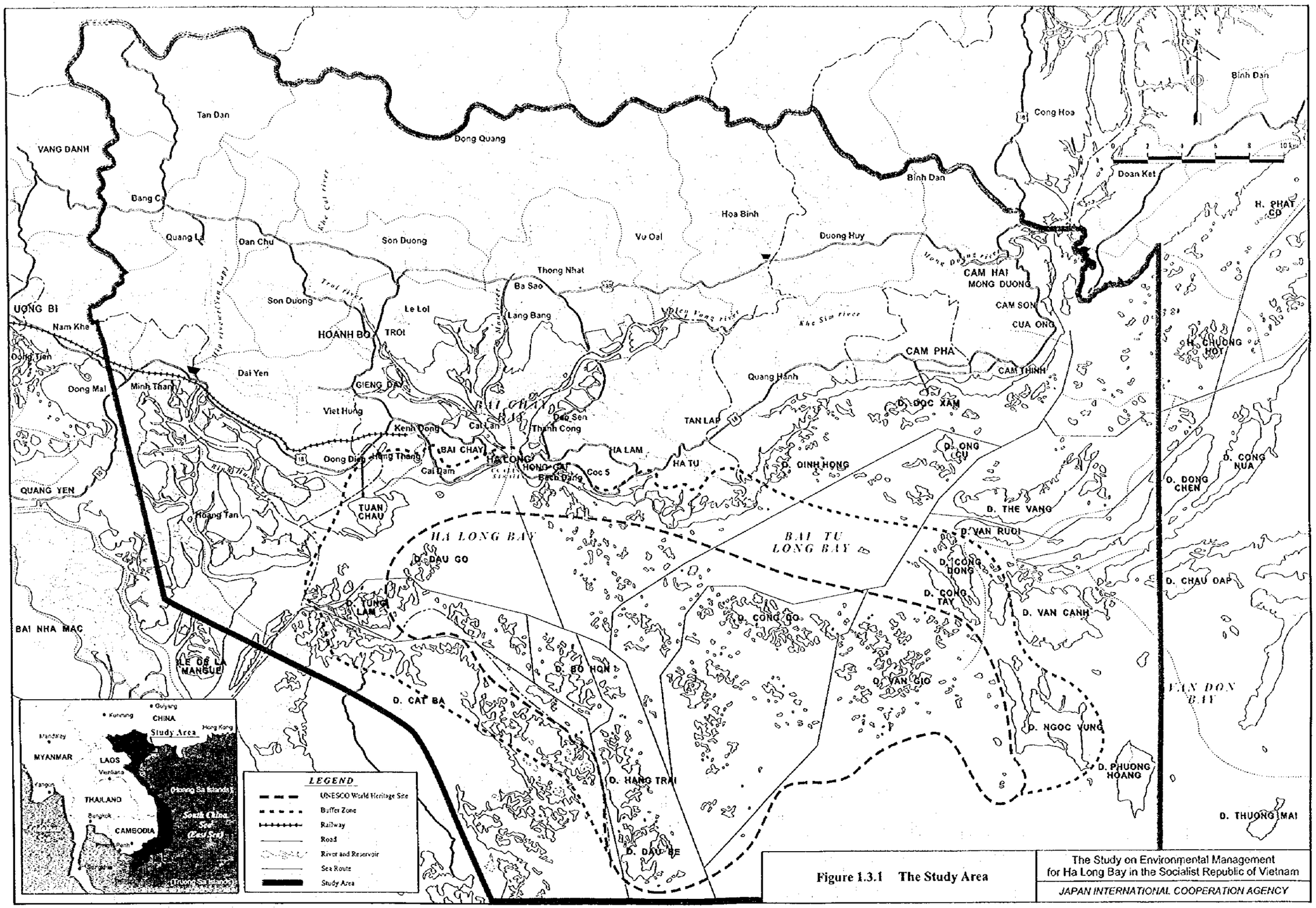
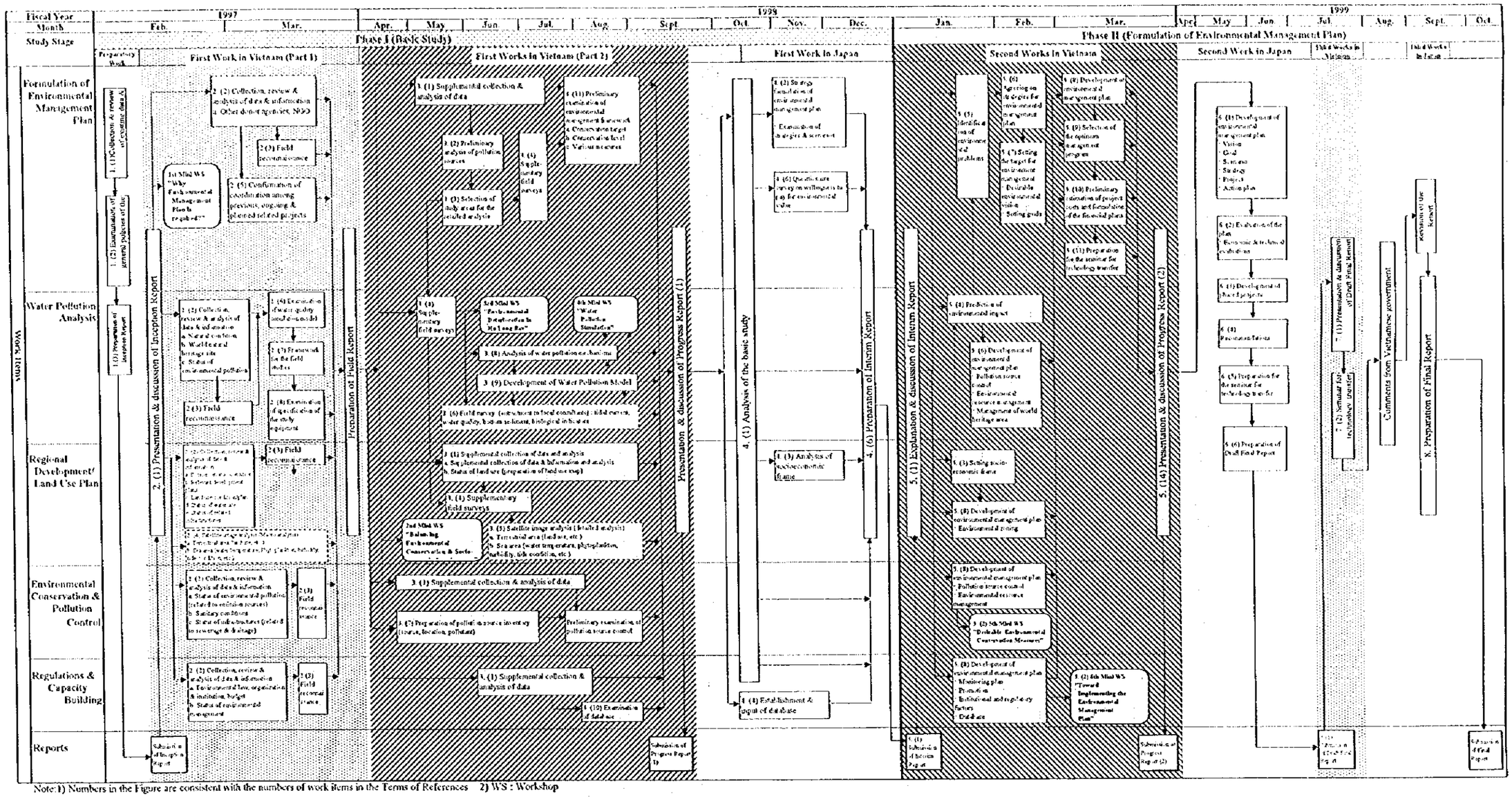


Figure 1.3.1 The Study Area

The Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam

JAPAN INTERNATIONAL COOPERATION AGENCY



Note: 1) Numbers in the Figure are consistent with the numbers of work items in the Terms of References 2) WS : Workshop

Figure 1.4.1 The Study Framework

PART II

CURRENT SITUATION OF THE HA LONG BAY AREA AND SIMULATION MODEL DEVELOPMENT

CHAPTER 2

PART II CURRENT SITUATION OF THE HA LONG BAY AREA AND SIMULATION MODEL DEVELOPMENT

CHAPTER 2 GENERAL FEATURE OF THE STUDY AREA

2.1 Natural Conditions

2.1.1 Topography

The study area covers Ha Long bay, and farther, Ha Long city, Cam Pha town, Hoanh Bo district, the eastern part of Yen Hung district, and the eastern part of Cat Ba island, all of which are located around Ha Long bay. The bay is situated directly south of Ha Long city and is renowned for hundreds of scenic limestone islands. The islands stretch along the coastline to the Chinese border. Cam Pha has its own bay called Bai Tu Long which is also included in the study area. Mining activities are carried out in the range of hills which stretch parallel with the coast from Ha Long city to Cam Pha town. Furthermore, this area is at present the most important coal mining area in Vietnam. Although flat coastal lands are limited in the study area as a whole, there are good flat lands around the Bai Chay estuary. The northern portion of the study area is mountainous and has limited opportunities for development. The coastal zone is relatively narrow which has led to extensive coastal land reclamation.

2.1.2 Land Use

(1) Existing Conditions

A relatively small portion of land is used for agriculture, i.e. about 2-7% except Yen Hung district, most of which is not included in the study area. The agricultural land is mostly used for annual crops such as rice, and very little is used for perennial crops. Special use land which is for building, transport, irrigation, and mineral exploitation has a substantial share of the land use in Cam Pha (33%) and Ha Long (43%). Most of special land in Cam Pha is coal mining area. In the case of Ha Long, the land seems to be used not only for coal mining,

but also urban facilities. Forestry and the not used lands account for over 90% in Hoanh Bo district. So, it is the least developed district in the study area.

Existing Land Use Pattern in the Study Area In 1996

Category (Unit: ha)	Ha Long	Cam Pha	Hoanh Bo	Yen Hung	Total	Quang Ninh
Agricultural land	870	1,197	4,123	12,784	18,974	55,492
Farming land	276	703	2,233	5,971	9,183	32,851
Paddy field	150	434	2,050	5,701	8,335	28,154
Forestry land	2,482	13,560	49,327	2,114	67,483	196,958
Special use land	5,242	16,174	1,678	1,656	24,750	35,683
Residential area	981	760	408	1,118	3,267	7,244
Not used land	2,711	16,932	35,573	14,094	69,310	298,480
Total land area	12,286	48,623	91,109	31,766	183,784	593,857
Category (Unit: %)	Ha Long	Cam Pha	Hoanh Bo	Yen Hung	Total	Quang Ninh
Agricultural land	7.1	2.5	4.5	40.2	10.3	9.3
Forestry land	20.2	27.9	54.1	6.7	36.7	33.2
Special use land	42.7	33.3	1.8	5.2	13.5	6.0
Residential area	8.0	1.6	0.4	3.5	1.8	1.2
Not used land	22.1	34.8	39.1	44.4	37.7	50.3
Total land area	100.0	100.0	100.0	100.0	100.0	100.0

Note: 1): Special use land is for transportation, irrigation, mineral exploitation, etc.
2): The sum of farming land and paddy land is not equal to agricultural land.
3): Forestry land includes only the natural forest. Besides, the reforestation area is 40,000 ha and the other secondary forestry land is 151,873 ha. The total land for forest is 387,873 ha. (63% of the provincial land)
Source: Statistical Year Book of Quang Ninh Province, 1996

(2) Land Use Change by Macro Analysis

In the macro analysis of the land including the study area, whole land use map was made using "LANDSAT" data of 1988, 1992, and 1997. The analyzed area of 5,600 km^2 in total was classified into five main land types, as shown in the next table.

Classified Area in 1988, 1992, and 1997

Classification	1988		1992		1997	
	Area (km^2)	Ratio (%)	Area (km^2)	Ratio (%)	Area (km^2)	Ratio (%)
Forest	1,985	35	1,871	33	1,784	32
Farm & Grass	253	5	297	5	328	6
Urban	377	7	415	7	437	8
Mine	193	3	225	4	259	5
Water Body	2,792	49	2,792	49	2,658	49
Total	5,600	100	5,600	100	5,466	100

Note: Water body includes seawater area.

The macro analysis shows that forest land has been exploited for agriculture urbanization, and mining activities. The forest land has decreased by about 10%

from 1988 to 1997. Also, the water-body area has been decreased recently due to reclamation.

The next table shows changes of principal categories such as mangrove forest, tidal land, and coal mining areas in 1989, 1992, and 1996.

Changes of Mangrove Swamps, Tidal Flats, and Coal Mining Areas

(Unit: ha)

Land Category	1989	1992	1996	1996 / 1989
Mangrove Swamps	2,987	4,080	3,483	1.2
Tidal Flats	7,648	5,573	3,583	0.5
Coal Mining	3,256	4,084	5,418	1.7

Between 1989 and 1996, the coal mining area increased continuously. On the other hand, the tidal land decreased by 50%. The mangrove forest increased in 1992, but then decreased in 1996. The figure of 1989 for mangrove forest was supposedly underestimated, because the satellite data was taken during high tide. These recent land use changes imply that environmental impacts on the natural ecosystem in the study area are gradually becoming bigger.

(3) Results of Detailed Analysis

Focusing on the river basins flowing into Ha Long bay which was investigated in the macro analysis, the land use maps of 1:100,000 scale were drawn on the basis of multiple "SPOT" data between 1986 and 1996. Figure 2.1.1 shows the latest land use map and the table below presents the land use of the study area in 1996.

Land Use of the Study Area in 1996

No.	Land Use Category	Area (ha)	%
1	Natural Forest	14,400	13.9
2	Secondary Forest	37,100	35.9
3	Trees on Limestone	4,400	4.3
4	Scrub Land	16,600	16.0
5	Grass Land	7,000	6.7
6	Bare Land	800	0.8
7	Agricultural Land	6,200	6.0
8	Coal Mining	5,400	5.2
9	Residential Area	3,800	3.7
10	Water Body	7,600	7.4
Total		103,300	100.0

Note: The seawater area and islands are excluded.

The whole area covered by the detailed analysis is 1,033 km^2. The first major category is forest (natural forest, secondary forest, and trees on limestone)

occupying 54% of the total land area. Coal mining and residential area respectively account for 5% and 4% of the whole. Their shares are rather small for their possible large impacts on the environment. Surface water area of 7,600 ha accounts for 7% of the total land area.

2.1.3 Climate

The climate of the study area is dominated by a relatively dry northeast "winter" monsoon (October/November to March/April) and a wetter "summer" monsoon (May/June to September/October). The annual rainfall is about 1,800-2,000 mm. Highly intensive rainfalls can occur in some areas, leading to high erosion rates in logged watersheds and to high pollution loading runoff events, especially during the start of the wet season, when dry canals and river beds are flushed. The temperature of the study area has a range of 25-29°C from May to October, and 15-23°C for the other months. The monthly average humidity is relatively steady and ranges from 75-90%. Low winter temperatures and rainfalls limit some types of agricultural production. Typhoons and associated storm surges can cause significant flooding and damage, especially to coastal areas.

2.1.4 Geology and Soil

Ha Long bay is surrounded by limestone islands in the sea and rock hills toward the land. The seabed is covered with 1.5-2.0 m deep fine grain sediments. The coast is characterized by tidal flats and hills of terrigenous rocks of the early Mesozoic age. The tidal flats, most of which are covered by mangroves, are engraved by a system of digitate shaped tidal creeks and channels. Also, some rocky benches and beaches are found on Bai Chay and Tuan Chau coasts.

The sea beds and tidal flats are mostly covered with three major sediments: sands (0.1-1.0 mm in diameter), coarse silt (0.05-0.1 mm) and pelitic (0.01-0.05 mm) sediments. Beaches in Bai Chay, the low tide flats in Bai Chay bay and in northern Tuan Chau island are covered with terrigenous sands. Shelly sands are seen on small beaches of limestone islands in the southern Ha Long bay, on the banks surrounding coral reefs, and on Cua Van inlet bed.

Coarse silts are found in most of the areas in Bai Chay bay and from Cai Dam-Tuan Chau through the northern Cat Ba-Cua Van-Dau Be to the border of Bai Tu Long bay. Pelitic mud widely covers an area of Ha Long bay and Lan Ha bay (southeast of Cat Ba island). The tidal flats with mangroves in the east coast of Bai Chay bay is also covered with this sediment.

2.1.5 Hydrologic Conditions

There are five large rivers in the catchment, namely, the Mip, Troi, Man, Dien Vong and Mong Duong rivers (the Main rivers). The Dien Vong river drains the eastern basin of Bai Chay bay. Total surface water runoff is extrapolated using empiric relationship between basin area and effective rainfall which is calculated by multiplying amount of precipitation and discharge ratio. The estimated surface runoff is 980 million m^3/year (30m^3/s) in total catchment area. The surface runoff from the Main Rivers is estimated at 806 x $10^6 m^3$/year, which accounts for 82% of the total.

The deforestation caused by coal mining, intensive agriculture, and other human activities such as exploitation for limestone or cement, housing construction in the hill slopes result in increase of soil erosion. Assuming concentration of suspended solids (SS) in the waters flowing into the bays is 2,000 mg on rainy days and 20 mg on dry days, the amount of sediment runoff as SS is estimated at 150 tons/day.

2.1.6 Vegetation and Forest Resources

The distribution map of the original vegetation shows that the land area in the study area originally belonged to "semi-evergreen hill forest" and Cat Ba island belonged to "forest on limestone". According to the Field Survey, 1,027 species were recorded in the study area. Most of them belong to Magnoliophyta with 43 families, 951 species. The species distribution showed that mainland community consisted of 475 species and Cat Ba islands community consisted of 749 species. Many species on Cat Ba island are endemic to this island. The vegetation map made on the basis of the Field Survey is shown in Figure 2.1.2.

In Quang Ninh province, the Department of Agriculture and Rural Development (DARD) is in charge of management of forests. The data of DARD shows that Quang Ninh province has a total land area of 593,800 ha of which 66% was composed of forest area in 1996. In the forest area, 186,949 ha is covered by forests and 203,934 ha is bare land. The forest vegetation in Quang Ninh province accounted for 31.5% in 1996.

DARD has classified natural forests into three grades of forests, namely "rich forests", "intermediate forests", and "poor forests", and has managed forests to get compliance with the standard of the wood volume that is set for each grade of forests. DARD has the plan to raise the forest vegetation with a goal of up to 40% increase by the year 2000. To achieve the target forest vegetation, DARD has controlled deforestation mainly caused by collecting for firewood and coal mining, and promoted reforestation projects. Owing to them, 5,500 - 5,800 ha of bare land has been reforested per year from 1996 to 1998, and 6,500 ha of reforestation is planned in 1999.

2.1.7 Mineral Resources

There are extensive mineral resources in the study area, but they are primarily limited to coal and resources for building materials such as limestone, clay and kaolin. Metals are not found in significant quantities. Coal is undoubtedly the most important mineral in the study area. In Quang Ninh province, a coal deposit has been found in a 10 km wide faulted trench area stretching east-west for 150 km. Coal occurs in sediments that are up to 4,500 m thick, containing some 61 seams with an aggregate coal thickness of up to 150 m. Coal types in Quang Ninh include anthracite, semi-anthracite, bituminous, and others. In Cam Pha town there are six major mines: three are underground (Thong Nhat, Mong Duong and Khe Cham) and three are open pit mines (Deo Nai, Coc Sau and Cao Son). In Ha Long city major open pit mines are in Ha Tu and Nui Beo. Two underground mines are located in Ha Lam and Tan Lap.

2.1.8 Tourism Resources

Quang Ninh province has a lot of tourism potential which has been strengthened further by the designation of Ha Long bay to the World Natural Heritage site in 1994. Ha Long bay is considered as one of the areas with the highest tourism potentials in the country. Its spectacular karst seascape is recognized throughout the world. Ha Long bay is also culturally and historically important, as it contains a lot of archeological sites of national significance. In the study area, Cat Ba park is the only national park and it has the highest biodiversity of any coastal and marine site in northern Vietnam. In addition, Quang Ninh province has a lot of scenic beaches along the 250 km coastline such as Bai Chay, Tra Co, Minh Chau, Quan Lan, Vinh Trung, and Vinh Thuc. But deforestation has limited the opportunities for eco-tourism in the study area. Mountainous areas, in particular the road corridor of No.18B from Hoanh Bo to Mong Duong may offer significant potential for mountain-oriented tourism development for the future.

However, due to the insufficient infrastructure of the country and of Quang Ninh province, the present tourism activities are still limited only to short stay activities, such as bay cruise for international and local tourists and bathing on the beaches for the local population. The key tasks for successful tourism promotion are to attain well-organized tourism management and environmental protection as well as the related infrastructure development. The relatively low sunshine hours in Ha Long bay can be regarded as one of the disadvantages for a beach resort, however.

2.1.9 Water Resources and Water Use

Water resources in the catchment area of the bays contain rivers, and reservoirs. The biggest dam is the Yen Lap dam with total storage volume of 130 x 10^6 m^3 whose water is utilized for domestic and industrial water supply of 3,000m^3/day and irrigation purposes of 70 x 10^6 m^3/year in Yen Hung district. The largest river is the Dien Vong river whose water is being used as a raw water source of domestic and industrial water supply. The water in is taken by the Da Bac dam with capacity of 15,000 m^3/day.

The water of the bays is used for various purposes such as transportation by ships and ferry boats including floating ports, bathing and other recreational uses. There are nine main ports in the study area which can be categorized into three types; namely coal ports, oil ports, and general ports. The passenger car-ferry is operated in the Cua Luc strait, while there are two berths located on the Bai Chay and Hong Gai sides.

Recreational uses are also other main activities on the sea. A lot of people enjoy bathing or boat tour on the sea. According to Ha Long Bay Management Board (HLMB), there are about 1,500 tourist boats in this area. Most tour boats sail from Bai Chay new tour boat harbor and go around the world heritage site.

2.1.10 Landscape

Landscapes in the study area can be classified into four types, namely, Rural landscape, Urban landscape, Seashore landscape, and Marine landscape, based on the topography, vegetation, and land use.

The value of landscape depends on perceptive impressions of human being for environments including lithosphere, hydrosphere, atmosphere and biosphere, it can be evaluated objectively by the quality of landscape elements classified into several landscape grades. The main landscapes of the study area are listed as follows according to the landscape value.

- Landscape of global value: Ha Long bay area (World Natural Heritage)
- Landscape of national value: Cat Ba national park, other protected area
- Landscape of provincial value: Landscape of natural resources

(1) World Heritage Area

The landscape of the World Heritage can be appreciated from the seashore on mainland and from boats on the sea. The landscape from mainland is the photographic scene from fixed viewpoints and the landscape from boats is the sequence scenes from a moving viewpoint in the sea. Typical landscapes from the mainland and the sea are shown in Figure 2.1.3 and 2.1.4.

The value of landscape can be evaluated from the following aspects that may be proposed as the main value items for evaluating landscape: Diversity, Naturalness, Beauty, Prominence, Peculiarity, and Visibility.

Each value item depends on the landscape elements. The important landscape elements that produce the high value of the World Heritage are: a) Shape and surface of islands, b) Color and clearness of seawater, c) View of natural resources, and d) Natural scenery.

(2) Tourism Spots

The tourism spots which are popular among tourists in Ha Long bay are shown in Figure 2.1.5 based on the guide map issued by HLMB. The main tourism spots are the Dau Go island and its surrounding waters, the waters from the Chan Voi island to Van Boi island, Bo Hon island and its surrounding waters, Dau Be island, and Dao Van Gio island. The main tourism spots are located in the western area of the World Heritage area.

(3) Other Valuable Landscape

The landscapes of the Cat Ba national park and Reserves such as Bai Chay forest and Don Song Ky Tung forest that have been designated as a protected area by the Government are listed as the landscape of national value. Natural resources and natural environment held in good conditions can form valuable landscape. In the study area, the landscapes around the natural resources such as riversides of the Mong Duon, Dien Vong, and Troi rivers, mangrove swamps of Bai Chay bay, Yen Hung, Quang Hanh, tidal flats along Cam Pha, Hung Thang and Bai Chay bay are listed as the landscapes of provincial value in the study area.

2.1.11 Cultural Assets and World Heritage

The Quang Ninh province has a lot of historic and cultural sites such as Yen Tu (home of Vietnamese Buddhism), Long Tien (temple), Bai Tho (ruins of old town), Tra Co (ruins of archaic building), Bach Dang (a battlefield in the Middle Ages), and Cua Ong (temple).

Ha Long bay including Cat Ba island holds over 1,900 islands and islets forming a spectacular seascape of limestone pillars. Because of their precipitous nature, most of the islands have been uninhabited and unaffected by human activities. The exceptional esthetic values of this site are complimented by its great biological interest. Accordingly, UNESCO designated Ha Long bay as the World Natural Heritage in December, 1994. Recent surveys of the Cat Ba national park have counted 745 plant species, five of which are rare and endangered.

2.2 Socioeconomic Conditions

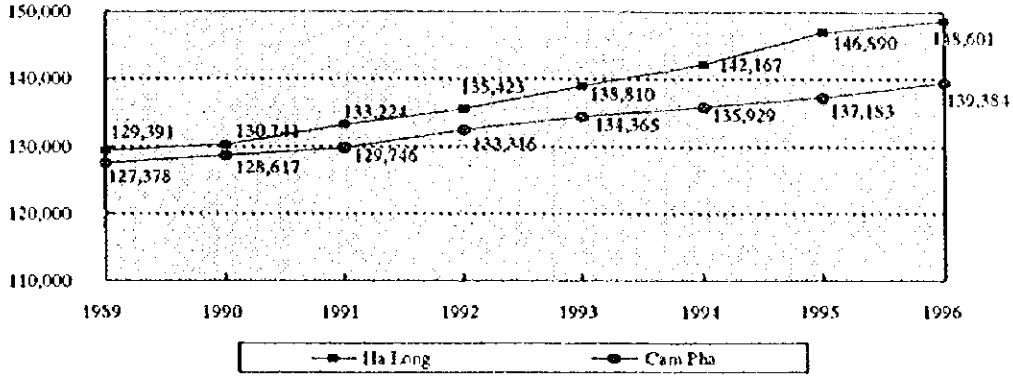
The study area covers Ha Long city, Hoanh Bo district, part of Cam Pha town, Yen Hung district, and Cat Hai district (Cat Ba island). The administrative units included there are presented in the table below.

District/City/Town	No. of Units	Names of Administrative Units
1) Ha Long city	16 quarters	Hong Gai, Bach Dang, Yet Kieu, Tran Hung Dao, Cao Xanh, Cao Thang, Ha Lam, Ha Trung, Ha Tu, Ha Phong, Ha Khanh, Hong Ha, Hon Hai, Bai Chay, Gieng Day, Ha Khau
	2 communes	Hung Thang, Tuan Chau
2) Hoanh Bo district	1 small town	Troi
	14 communes	Dai Yen, Son Duong, Viet Hung, Le Loi, Thong Nhat, Vu Oai, Dan Chu, Quang La, Bang Ca, Tan Dan, Duong Lam, Duong Son, Ky Thuong, Hoa Binh
3) Cam Pha town	11 quarters	Cam Thinh, Cam Dong, Cam Son, Cam Phu, Cua Ong, Cam Tay, Cam Thuy, Cam Thanh, Cam Thach, Cam Trung, Mong Duong
	3 communes	Quang Hanh, Cam Binh, Duong Huy
4) Yen Hung district	4 communes	Hong Tan, Minh Thanh, Ha An, Tie An
5) Cat Hai district	-	-

Source: DOSTE, 1998

2.2.1 Population and Human Settlement

The national census held every ten years provides the most reliable data on demographic characteristics. According to the latest census data held in 1989, the population of Ha Long city was 129,391 and that of Cam Pha town was 127,378. The figure below shows the population growth of the two major urban centers in the study area, Ha Long city and Cam Pha town.



Source: Provincial Population and Family Planning Committee, 1998

Population Growth of Ha Long City and Cam Pha Town

The population of Hoanh Bo, Yen Hung, and Cat Hai districts are 52,464 (1997), 125,972 (1996), and 15,741 (1994), respectively. The eastern part of Yen Hung district is mostly a wetland in river estuaries where only a few inhabitants are living, however. The total population of the study area was around 370,000 in 1996.

The coastal strip along National Highway No. 18 in the study area has been settled for a long period of time as well as the northern part of the Red river delta. Most population in the study area today are still concentrated in the coastal strip along the National Road No. 18, particularly in the two urban centers, Ha Long and Cam Pha. The distribution pattern is unequal because of its complicated topographical conditions. The human settlement will expand along the coastal area the same as before.

2.2.2 GDP and Investment

The tables below shows the share of GDP by economic sector. Unlike most areas of Vietnam, the provincial economy is dominated by service and industrial activities, not by agriculture. Around 80% of the provincial GDP comes from the industry & construction and service sectors. Particularly Ha Long city, the main urban center in the study area, is largely based on the industry and service activities. It should be noted that there are big income gaps among the districts in the study area. Per capita GDP (1995) of Ha Long city is over twice the national

average. On the other hand, those of Hoanh Bo and Yen Hung districts are just less than half of the national average.

GDP Share of Districts in the Study Area in 1994

GDP Share (%)	Ha Long	Cam Pha	Hoanh Bo	Yen Hung
Industry	47.0	9.3	3.6	2.8
Construction	1.4	12.6	11.5	3.7
Agriculture, Forestry	0.1	43.9	47.8	52.7
Service	5.4	4.1	2.4	5.3
Business	12.7	4.7	2.9	4.5
Tourism & Other Services	23.4	5.2	6.3	5.7
Government	10.0	20.2	25.5	25.3
Total	100.0	100.0	100.0	100.0

Note: Industry includes mining
Source: Coastal and Marine Environmental Management for Ha Long Bay, ADB, 1995

GDP of Study Area in 1995

Area	GDP (VND billion)	GDP per capita (VND million)	Average Annual Growth Rate (1990-1994) (%)
Ha Long	950	6.53	18.9
Cam Pha	409	2.96	2.8
Hoanh Bo	66	1.29	2.6
Yen Hung	144	1.17	3.9
Vietnam	222,840	3.01	10.4

Source: Statistical Year Book of Vietnam, 1996 and UNDP & DSI, Sustainable Development Planning For Road No. 18 Corridor, 1997

The recent rapid economic growth has been largely dependent on Foreign Direct Investment (FDI). In Quang Ninh province 36 FDI projects have been approved by August, 1997 since 1989. The investment capital tends to become larger in recent years. Major sectors of FDI are hotel construction and tourism services as well as industry such as food processing and building materials.

2.2.3 Industry

At present, coal mining and its relating industries have been playing a dominant role in the study area. Besides them, mechanical engineering, shipbuilding, construction materials, food-processing industries are located there. The major industrial facilities are state-owned and have been protected from either domestic or international competition until recently. Accordingly the lack of competition have resulted in minimal or no additional investment in plant renovation, even for the recurrent costs of basic operation and maintenance. As a result of this, some of the industrial facilities in the area are or will be facing difficulty to be competitive

on the international markets and to reserve necessary financial resources for pollution prevention.

Coal resources in Quang Ninh Province has been exploited since before French rule, and the historical production is estimated to be over 200 million tons. VINACOAL's current production in Quang Ninh province is about 10 million tons per year, and about 8.4 million tons are produced in the study area. The estimated annual sales are in the order of 3 trillion VND, and the industry contributes to about 24% of the total provincial GDP. It provides jobs to about 80,000 people in the Province. Most mines use out-dated mining technology and their productivity is low, however.

2.2.4 Tourism

Tourism is an important growth sector in the study area. It has a potential to provide diversity and balance to the industrial structure of the area. The number of visitors has been steadily increasing in the 1990s, in particular the increase of foreign visitors is remarkable. Local visitors are drawn to traditional festivals and famous pagodas as well as Ha Long bay. In the last several years the tourism activities have been undergoing considerable changes which were reflected in not only the number of visitors but also the development of infrastructure, the number of tourism enterprises, incomes and types of tourism activity.

Major hotels including a few international-class accommodations are currently concentrated in Bai Chay. Accommodations in Cam Pha are only guesthouses mainly serving for professionals and government employees on business trips. The two existing hotels in Cat Ba island are state-owned hotels. However, the quality of rooms and services is regarded as low and doesn't meet tourists' demand yet. In addition, in Bai Chay there are a large number of mini-hotels which are privately operated. They often lead to chaotic development which can spoil locations through poor design and offering low quality accommodation.

Transportation facilities for tourists are also concentrated in Bai Chay area. The number of boats and cruise ships has increased rapidly, from only 10 units in 1990, to 35 in 1991, 70 in 1993, and 105 in 1995. There are at present 140 boats and

cruse ships with average capacity of 30 passengers per unit. Approximately 5,000 tourists per day enjoy a cruise in Ha Long bay. In addition, there are 90 tourist buses in the province.

2.2.5 Agriculture, Fishery, and Forestry

(1) Agriculture

There is about 55,500 ha of agricultural land in Quang Ninh province. The three major agricultural zones in the province are Dong Trieu, Yen Hung, and Quang Ha. The three districts, Ha Long, Cam Pha, and Hoanh Bo composing the major part of the study area are not included above.

The GDP share of agriculture, fishery and forestry in Ha Long accounts for only 0.06% in 1994 and that implies that it doesn't have a dominant role of agricultural production in the province at all. However, the other two districts as well as Yen Hung still show the high GDP shares from 43 to 53%. The major agricultural products are rice, maize, sweet potato, cassava, peanut, soybean, vegetables and livestock farming.

(2) Fishery

According to the interview survey to the Department of Fisheries (DOF) of Quang Ninh province, the fish production of the Ha Long bay area is about 4,000 to 5,000 tons per year in total, and it occupies 25% of the total production in Quang Ninh province. The main species are groupers, seabasses, seabeams, prawns, and small shrimps in Ha Long bay and tunas and mackerels offshore. The fishery production has a tendency to decrease mainly because of overfishing, degradation of water quality, and the decrease of coral reefs that are the breeding grounds for fish resources.

(3) Forestry

The total forest land in the study area is over 67,000 ha in Ha Long city (20%), Cam Pha town (28%), Hoanh Bo district (54%) and Yen Hung district (7%). The

proportion of forest land in the study area is around 37% which is higher than that of the national average, 28%. Terrestrial forests in the study area generally include sub tropical lowland evergreen/semi-evergreen broadleaf forests, sub tropical hill evergreen/semi-evergreen broadleaf forests, and limestone associated forests. Deforestation is a key problem in the study area. In Quang Ninh province, for instance, about 507,000 ha of forested land in 1943 decreased to only 208,000 ha in 1985. Furthermore, the area has continuously been decreasing to 196,958 ha in 1996.

Also, the study area has had relatively few coastal forests in comparison with other parts of Vietnam. This is largely due to the climatic conditions which are marginal for tropical wetland species such as mangroves. Quang Ninh province as a whole had more than 35,000 ha of mangrove, although most of this consisted of bushes and shrubs on newly deposited alluvium.

2.3 Infrastructure Development

2.3.1 Transportation

(1) Port and Harbor

1) Hong Gai Floating Port

The Hong Gai port is situated in the Hong Gai basin and known as a "floating port". The port is a part of the Quang Ninh port system though it has no quay facilities. The water basin area of the Hong Gai port is 787.5 ha with a depth of 8.1 m. The current navigation channel is 11.0 km long and 6.8 m wide. Four tugboats are used for the Hong Gai port being shared with the Cai Lan port. Capacity of boats is from 150 to 1,000 CV (cylinder volume). Cement is the largest cargo handled in this port (about 40,000 tons/month).

2) Hong Gai Coal Port

The Hong Gai coal port is located at the tip of the Hong Gai Peninsula, just opposite to the B12 oil port across the Cua Luc strait. It has a berth length of 200 m, water depth of 7.5 m (depth at toe: 13 m), being used only for loading coal. This coal port is under the Ministry of Energy, with 52 staffs and 72 port workers

of the Hong Gai coal processing plant. It has a port operation system for 24 hours a day.

3) Cot 5 Coal Port

The Cot 5 coal port is located 5 km (Coc 5) from Hang Ha commune in Ha Long city. It has a 47 m long berth and water depth is 4 m. The applicable ship size ranges from 100 to 200 tons, many of which are transferring ferry boats and barges.

4) Nam Cau Trang Port

The Nam Cau Trang port is located 8 km (Coc 8) from Hong Ha commune of Ha Long city. There is one berth of 200 m in the inter tidal area. The navigation channel extension is about 4 km from Nam Cau Trang to Hong Gai bay. Ferries transporting coal are of ship sizes ranging from 200 to 250 tons. This port is now managed by a team from the Hong Gai coal processing plant.

The following upgrading is planned to increase exporting volume from 200,000 to 500,000 tons/year. The ferry sizes are expected to have capacity of 400 tons after dredging.

5) B12 Oil Port

The B12 oil port located in the entrance of Bai Chay bay is under the control of the Petroleum Company B12. The oil cargo tankers' sizes range from 400 DWT to 36,000 DWT. Major ship nationalities are Chinese, Malaysian, and Panamanian. Five buoys exist offshore to allow tankers to moor and unload cargo up to 30,000 DWT. Oil is piped to the shore from these buoys and stocked in a storage tank.

6) Cai Lan Port

The Cai Lan port is located in Bai Chay bay, which is about 100 km apart from the Hai Phong port. In 1995, the Berth No.1 was opened on an experimental basis. There was a small cargo flow in 1995 and 1996. The port is connected to the open sea by an access or navigation channel, which passes from Bai Chay bay through Ha Long bay and into the Gulf of Tonkin. In 1999, the F/S Report of the Cai Lan port construction project was reviewed including an environmental study as a part of detailed design of the project components.

7) Vung Duc Coal Port

The Vung Duc coal port is located south of Cam Pha town, and 10 km from Cua Ong coal port. The Duyen Hai Company under QNPC manages this port, and some coal mine companies use stockyards and handling systems of the port. There are two cranes for cargo handled in the port area. About 200,000 to 300,000 tons per year of coal is handled.

8) Cua Ong Coal Port

The Cua Ong coal port is located in 10 km away from Cam Pha town. This port is called "Cam Pha port". It has two berths for loading coal. Length of the main berth is 300 m, and water depth is 9 m (depth at toe is 9.5 m). Type of the structure is revetment of concrete. Water basin area of this berth is 400 m × 400 m with depth of 9.5 m. Other interior berth has length of 45 m, water depth of 2 m, and basin area of 100 m × 200 m. The size of ship is from 10,000 to 50,000 DWT.

9) Hon Net Floating Port

The Hon Net Facility Project was approved by the Ministry of Communication & Transport in 1997, and the Quang Ninh Port Authority (PA) manages the Hon Net floating port. At present about 150,000 tons are handled per year based on the data from the Quang Ninh Port Authority. In statistics, almost 95% of the ship size are 400 DWT or less. The major cargoes are oil exported to China and rubber for domestic purpose. Other freights including cement and steel are loaded in the Hon Net floating port.

(2) Road

The total length of urban road in Ha Long city is 480 km of which 153 km is asphalt road and the remaining 327 km is macadam road. National Road No. 18 going through the study area is one of the most important infrastructures for the region. It connects the Ha Long bay area westwards with Hanoi and eastwards with a Vietnamese-Chinese border town, Mong Cai. The section of the National Road No. 18 belonging to the study area is about 60 km, the road width is 7-12 m and the vehicle density is 1,600-2,000 vehicles/day. In addition, the National Road No.18B goes through for 50 km in the study area from Hoanh Bo district and

Mong Duong in Cam Pha town. The width is 5-7 m. The vehicle density is at present low, as most of the section hasn't been asphalted and is not in good condition.

The rehabilitation and improvement of highway No. 18 is rather urgent and crucial to the socioeconomic development of not only the Ha Long bay area, but also the Northern Growth Triangle area as a whole. In addition, a ferry at Cua Luc makes trips slower than necessary and may become a stumbling block for future economic development. A pre-feasibility study was carried out for the bridge on the National Highway No.18 over the Cua Luc straits by the Ministry of Transport, and it proposed to construct the bridge. A construction plan of the new bridge over the Cua Luc strait was approved by the Prime Minister recently in 1998.

(3) Railway

The railway from Hanoi at present ends in Bai Chay 4 km west of the Cai Lan port. The used capacity of the railway lines is at present very limited, however, because of different track sizes and low speed of trains. The section from Hanoi to Kep is double tracked with gauges of 1 m and 1.435 m. The section from Kep to Bai Chay (100 km) is 1.435 m gauge. Besides, the section between Hanoi and Hai Phong is 1 m gauge. As the 1 m gauge is dominant in Vietnam, the track with 1.435 m gauge from Kep to Bai Chay will be changed to the 1 m gauge track and be integrated to the interregional railway network. The extension of the line from Bai Chay to Cai Lan port (5 km) is also planned. In addition, there are several coal transport railway lines in the study area.

2.3.2 Water Supply

The water resources in the study area comprise both groundwater and surface water. Groundwater can be found in three aquifers in the coastal area and there are two surface water sources that can be utilized for public water supply: the Dien Vong river and the Dong Ho river.

The shallow groundwater resources can be exploited by shallow dug wells and these are found all over the study area. However these wells are very susceptible

to surface pollution and season variations in water level and are not generally suitable for supplying water to the public distribution system. Seven deep wells are currently in use for public water supply but the yield is limited. The main sources for public water supplies are thus the Dien Vong and the Dong Ho rivers.

(1) Water Treatment and Distribution

The Quang Ninh Water Supply Company is responsible for the operation of the treatment and distribution system. The main facilities comprise the Dien Vong intake and treatment plant from which water is distributed to both Hong Gai and Cam Pha, and the Dong Ho intake and treatment plant from which water is distributed to the Bai Chay area. The theoretical supply capacity of the original Dien Vong dam and treatment plant is 60,000 m^3/day but this capacity has never been realized in practice. The maximum production capacity of the present system is estimated to be about 15,000 m^3/day. The amounts of water actually reaching consumers are further reduced due to the condition of the supply pipes and the poor reliability and condition of pumps, treatment, and electrical equipment. The actual sales in 1997 to Hong Gai and Cam Pha were only 6,285 and 2,836 m^3/d, respectively.

Virtually all the public water supply to Bai Chay is from the Dong Ho intake and treatment plant, which has a supply capacity of 20,000 m^3/day. The reliability of supplies is better than in Hong Gai and Cam Pha. However, sales in 1997 were still only 2,835 m^3/day.

(2) Present Plans for Development of the Water Supply System

A World Bank funded rehabilitation contract for water supply and distribution to Bai Chay, Hong Gai, and Cam Pha was awarded in Spring 1999. The construction period is expected to be three years. The first stage rehabilitation works are primarily designed to make the supplies more reliable and, in the case of the Dien Vong river source, improve water quality by changing the supply point to the newly constructed Cao Van dam. This will provide a reliable yield from this source of 60,000 m^3/day for the first phase and there are plans to double the supply in the future to 120,000 m^3/day. The target for the water supply

rehabilitation project is to increase the percentage of the population served to 40% by the year 2002 and, in the long term, to 80%.

(3) Water Consumption

According to the Quang Ninh Water Supply Company, the average per capita consumptions for piped supplies are 87 ℓ/day in Hong Gai, 100 ℓ/day in Cam Pha, and 110 ℓ/day in Bai Chay. The average consumption of water from other sources is much lower and is probably in the region of 20 ℓ/c/day. The Ha Long City Water Supply and Sanitation Project (HWSSP) has based demand forecasts on overall per capita consumptions of 110 ℓ/day in 2003 and 150 ℓ/day in 2015.

2.3.3 Sewage

(1) On-site Sanitation

Some 85% of households have their own latrine or toilet, the most common being pit latrines, double vault composting latrines, and pour flush toilets. A number of surveys have been carried out in the last few years by various organizations and these allow the following conclusions to be drawn:

i) There is a rapid conversion of properties in commercial centers and particularly along main roads to flush toilets with septic tanks, dry latrines are still prevalent in areas remote from main roads,
ii) Almost all new developments near main routes are constructed with septic tanks and the tanks are connected to the sanitary drainage channels in adjacent streets, older septic tanks and those remote from main roads generally have soakaways, and
iii) There are about 3,000 people living on the sea, and their wastewater is released into the sea directly.

(2) Present Sewerage System

Hong Gai, Bai Chay, and Cam Pha are served by drainage channels, which for the most part are relatively short and carry runoff from a series of small catchments

along the narrow coastal strip and discharge to the sea. Originally the channels were intended only for rain water but there has been a trend for households to connect wastewater outlets to the drainage channels with the result that, in densely inhabited areas, they now act as a combined system.

The only treatment facilities are in Bai Chay, where a collection and treatment system has been constructed to alleviate the problems associated with wastewater discharges near bathing beaches.

(3) Tourism Development and Wastewater Discharges

Ha Long bay is a resort area that attracts significant numbers of foreign and Vietnamese visitors. The tourist resort is centered on a narrow strip of development along the south coast of Bai Chay and nearly all visitors stay in this area. The main areas of tourist accommodation are the large state and private hotels that are mostly located near the coast to the west of Vuon Dao. There are also a substantial number of mini-hotels, mainly in Vuon Dao and also on higher land above the large hotels. Almost all hotels are served by septic tanks that discharge to drainage channels.

An additional source of pollution associated with tourism is discharges from tourist boats in Ha Long bay. Nearly all tourists who visit Ha Long bay will go on a trip to the islands on the 140 or so tourist boats. The toilets on these boats discharge directly to the sea.

(4) Industrial Wastewater

The proportion of public water supplies used by industry varies from 14% in Bai Chay to 43% in Cam Pha. However, much of the water supplied to factories is for toilet and canteen use rather than process use. The questionnaire survey carried out by DOSTE for the Study indicates that, despite national legislation requiring treatment onsite, industrial wastewater is frequently discharged without treatment. Where there is treatment, it normally comprises septic tanks for domestic rather than process wastes. However, analyses of industrial wastewater discharges carried out in 1998 for the Study show that most discharges are weak and that the

present pollution load from industry, excluding coal mining and coal processing, is small.

In Bai Chay all major industry is, or is planned to be, concentrated in industrial complexes on the north side of Bai Chay. The area immediately to the north of Gieng Day is the center of the local brick industry, while a new industrial area is planned to be developed around a new deep water port at Cai Lan. It is understood that QNPC intend that a developer for the industrial complex will provide the infrastructure including wastewater collection and treatment.

The two main industrial polluters in Hong Gai at present are the Quang Ninh Brewery on the north coast, which discharges effluent into Bai Chay bay and the Quang Ninh Fishery Export Factory in central Hong Gai, which discharges into Ha Long bay.

The present situation in Cam Pha is dominated by the coal industry, although there are plans for other major industries including a steel mill, a cement factory and a thermal power station to be established in the future. The discharges from coal mining activities have a significant influence on groundwater quality as well as river quality.

(5) Operation of Existing Sewerage Facilities

Sanitation services in the study area are provided by two state owned enterprises: the Ha Long City Environmental Sanitation Company (HLESC) and the Cam Pha Urban Environment Company (CPUEC). Currently both companies are under the control of the Municipal People's Committee with their directors reporting directly to the chairman of the respective People's Committee. However, the status of the companies is to change under the Law on State Enterprises, 1995, and proposals have been prepared for both companies to be 'Public State Owned Enterprises' which will have powers to collect revenue and will be part self funded. At the time of writing this report, these proposals were awaiting approval by QNPC and the status of the companies had not changed.

The main responsibilities of the companies are to maintain the sanitary drainage system and to collect and dispose of solid waste. However, they carry out many

other functions including, road sweeping and washing, maintenance of public street lighting, maintenance of public toilets, maintenance of parks and verges, provision of funeral services, and maintenance of cemeteries. The companies are not responsible for design and construction of new facilities but may undertake relatively small works if budgets are made available.

2.3.4 Solid Wastes

(1) Domestic Solid Waste Collection and Disposal

It was estimated by Kampsax in the Feasibility Study for the sanitation component of HWSSP that the 280,000 inhabitants within the built up areas of Ha Long city and Cam Pha generate about 65,000 tons of solid waste annually. Not all of this waste is disposed of, as some materials such as bottles, metal cans and the like are separated and sold by householders or collected by scavengers. On the other hand, waste is also generated from other sources including street sweeping, markets, hotels, industrial and commercial concerns, government offices, schools, and hospitals.

HLESC and CPUEC are responsible for collection and disposal of domestic solid waste but, as previously described, the companies are short of resources and they do not have the capability to collect all waste generated. The coverage by percentage of population that is achieved for various types of collection in the main regions of the study area is summarized below.

Coverage of Collection Service

Collection System	Hong Gai (%)	Bai Chay (%)	Cam Pha (%)
Door to door collection	10	0	15
Collection point	42	42	15
Overall coverage	52	42	30

Source: HWSSP, Sanitation Feasibility Study, Main Report Annexes, 4 Solid Waste Collection and Disposal, 1998

The waste collected in Hong Gai is taken to a landfill at Deo Sen in the north of Hong Gai. This is an uncontrolled landfill that is located beside a cemetery and has been in operation since November 1994. The landfill is uncovered and does not have a liner. There is no treatment for the leachate and, since permeability of

the soils is relatively high, there is potential for contamination of the ground and groundwater in the area.

Waste from Bai Chay is now disposed at Ha Khau, which is the site for a new landfill site proposed by Kampsax. The site, which is about 13 km from the ferry, is at the head of a valley and has an area of some 6 ha. A liner system and leachate treatment will be required at this site but have not been implemented yet.

Waste from Cam Pha is taken to a dump site located at Vung Duc, an island south of the city connected to the mainland by a causeway. Waste is tipped in an area between the island and the causeway and bulldozed from the tipping front to the bay on the north side. The area is subject to flooding at high tide and waste can be flushed into the sea causing littering of the shoreline. In addition, leachate from the landfill discharges directly to the sea. These conditions are environmentally unacceptable but tipping is continuing at this site in the absence of a suitable alternative at present.

(2) Industrial and Other Waste Collection and Disposal

HLESC and CPUEC collect waste from markets, commercial institutions, industries, government institutions and hospitals as well as domestic waste from households. The amount collected from industry is not quantified separately by the companies but is thought to be small and generally limited to ordinary canteen and office waste rather than industrial waste. Industrial companies are generally responsible for making their own arrangements to transport their process waste to landfills. No surveys have been undertaken by the companies of the amount of industrial waste transported to solid waste landfills but it is generally little industrial waste apart from building rubble is found in landfills.

The questionnaire survey carried by DOSTE included questions on solid waste quantities, characteristics and disposal methods. The 23 factories that responded to these questions estimated that they produced a total of approximately 42 tons of waste per day. The present methods of disposal include collection by the Environmental Companies, tipping at the municipal landfill sites, tipping on vacant land or river banks, burial, burning, and sale or reuse for various purposes.

The survey also indicates that relatively little hazardous or toxic waste is produced by major industries at present.

The questionnaire survey was also sent to hospitals and of the 10 that responded, 7 gave estimated quantities of medical wastes produced. These estimates total just over 76 ton per year. The methods of treatment and disposal quoted include incineration, sterilization, chemical treatment, burial, and collection and disposal to dump sites. The Environment Companies estimate that they collect just over 40 tons of hospital waste annually in Ha Long city and Cam Pha.

2.3.5 Electric Energy Supply

Electricity for Quang Ninh province is supplied from the national power grid through the Uong Bi thermal power plant and the six substations of Gieng Day, Giap Khau, Cam Pha, Mong Duong, Tien Yen, and Mong Cai. There are other sources from small-scale hydroelectric plants in the districts of Quang Ha, Tien Yen, Binh Lieu, Hoanh Bo and Dong Trieu. Electricity for Ha Long city is supplied by two substations of Giap and Gieng. The total capacity is 66,000 KVA. These two substations also supply the neighboring areas, namely Cam Pha town and Dong Dang in Hoanh Bo district.

The local distribution network in Ha Long city which is about 280 km long is currently operated under 3 voltage levels: 35, 6, 3 KV. The 35 KV grid line is used for transmission as well as distribution through 35/0.4 KV transmission substations. Electricity for households and public users is mainly supplied by the 6 KV grid lines through 6/0.4 KV substations. The 3 KV grid line mainly supply the coalmines. The losses in the local distribution including transformer and line losses are pointed out to be very high, about 22% on average.

In Cam Pha town power is supplied by the two 110 KV Cam Pha and Mong Duong substations through 35 KV distributing lines. In Hoanh Bo district power is supplied by the 35 KV lines: Bieu Nghi-Dong Dang-Hoanh Bo, Bieu Nghi-Yen Cu, Dong Dang-Hong Gai, Dong Dang-Yen My lines and other supplementary lines.

2.4 Coastal and Aquatic Ecosystem

2.4.1 Wetland Ecosystem

In the study area, wetlands spread widely along the seashore of Bai Chay, Ha Long and Bai Tu Long bays as shown in Figure 2.4.1 because the slope of seabed is gentle in general and the tidal range is large. Shallow waters mostly less than 20 m in depth widely extend off the wetland.

(1) Mangrove Swamps

The Quang Ninh province has a long coastline with a lot of islands suitable for the formation and development of mangrove swamps. Most of tidal flats in the study area were formerly covered by mangrove swamps, but now the dense mangrove areas are limited to Binh Hung estuary, Mong Duong estuary, the inlet of Quan Hanh area, and the seashore area of Bai Chay bay.

The Field Survey by the JICA study team in July 1998 revealed that 19 mangrove species are present, 16 species in Binh Huong estuary and 13 species in Bai Chay bay. The vegetation coverage in Binh Huong estuary reaches 75 - 100% on high tidal area and 70 - 90% on middle tidal area. Dominant species in Binh Huong estuary are *Aegiceras corniculatum*, *Avecinnia lanata*, *Rhizophora stylosa* and *Kandelia candel*. The mean height of *Aegiceras corniculatum* ranges from 1.0 to 1.6 m, *Avecinnia lanata* from 0.6 to 2.9 m, *Rhizophora stylosa* from 0.8 to 2.3 m, and *Kandelia candel* from 1.6 to 2.6 m.

According to the data of the Department of Agriculture and Rural Development (DARD), mangrove swamps covered 39,400 ha in Quang Ninh province in 1972 when reclamation and dike construction for aquaculture had not been carried out. Since then the mangrove swamp areas have reduced because of these activities, and was 12,670 ha in 1996. The reforestation of mangrove swamps by replanting in the destroyed and newly formed swamps is a matter of urgency and necessity for Quang Ninh province at present, and a program of reforestation has been carried out by a project of Red Cross. In 1997, 40 ha in Hai Ninh district and 200 ha in Yen Hung district were reforested.

(2) Fauna in Mangrove Swamps and Tidal Flats

Mangrove swamps and tidal flats form the specific ecosystem. Fish living in mangrove swamps and tidal flats of the study area can be divided into "resident" or "migrant" group based on behaviors. The resident fish group is composed of species digging holes into the bottom under the mangrove canopy or beneath dike stones of nearby pond gates. Typical species are as follows.

- *Boleophthalmus pectinirostris* (goby)
- *Periophthalmus cantonensis* (goby)
- *Trypauchen taenia* (goby)
- *Glossogobius giuris* (goby)
- *Bostrichthys sinensis* (goby)
- *Arius sinensis* (sea catfish)

The migrant fish group is composed of species living in water layers which intrude into mangrove swamps and tidal flats with flood tide and leave with ebb tide. Common species which belong to this group are as follows:

- *Mugil affinis* (mullet)
- *Zebrias quagga* (sole)
- *Platycephalus indicus* (flathead)
- *Leiognathus rivulatus* (pony fish)
- *Gerres filamentosus* (mojarra)
- *Pardachirus pavoninus* (sole)
- *Sparus latus* (porgy)
- *Terapon jarbua* (tigerperch)
- *Pomadasys hasta* (grunt)
- *Pseudorhombus assius* (citharid)
- *Sparus macrocephalus* (porgy)

Shellfish composed of Crustacean and Molluscs are distributed in both mangrove swamps and tidal flats. Among shellfish living in mangrove swamps and tidal flats, many species have high economic value. Important species from the economic viewpoint are as follows:

- *Scylla serrata* (mud crab)
- *Macrophthalmus simdentatus* (littoral crab)
- *Uca arcuata* (wind crab)
- *Penaeus merguiensis* (white shrimp)
- *Squilla* sp. (horse shrimp)
- *Arca granosa* (blood clams)
- *Cylina sinensis* (blood clams)
- *Sanguinolaria diphos* (gallop clams)

(3) Seagrass and Seaweed Bed

According to the existing data about seagrass, 6 species have been identified ; *Cymodocea rotundata, Halophila ovalis, H.beccarii, Zostera japonica, Ruppia maritima, Najas indica* in Cat Ba island and Ha Long bay. Before the 1970's, Dau

Go cave and Tuan Chau island were the major distribution area of seagrass beds in Ha Long bay, but the distribution of seagrass beds has diminished severely since then.

The Field Survey which was carried out at 13 sites shown in Figure 2.4.2, records 11 species of sea algae in the study area.

(4) Coral Reef

The distribution of coral reef in the study area is limited to the southern part of Ha Long bay. According to the survey by the Haiphong Institute of Oceanology (HIO) survey from 1993 to 1995, there are no corals around Hong Gai and Bai Chay in the mainland and near islands such as Vung Oan, Gieng Coi, Vung Chua, Hon Deu, Tuan Chau, due to muddy bottom and high turbidity. The nearshore sites such as Cap De, Bui Xam and Co Ngua have smaller number of species compared with the far offshore sites that have higher number of species and abundance. The living coral coverage ranged from 15% to 55%, and most of reefs belong to "poor reefs" (the cover is lower than 25%) and "fair reefs" (cover ranged from 25 to 49%), and only the reefs at Soi Van, Vung Ha, Dau Be and Hang Trai belong to "good reefs " (cover ranged from 50 to 74%). There are no "excellent reefs" with cover over 75% in the study area. Among the species, dominant species belong to families Faviidae, Poritidae, Oculinidae and Agariciidae which are more tolerant to turbidity of seawater.

As a result of the Field Survey, which was carried out in the sites shown in Figure 2.4.3, 122 species belonging to 41 genera of Scleractinians were identified. The number of species and coral cover are shown in Figure 2.4.4. Among 17 survey sites only 2 sites belong to "excellent reefs", 2 sites belong to "good reefs", 6 sites belong to "fair reefs" and 4 sites belong to "poor reefs". Among them, one site (No.15) is all covered with dead corals and no coral has been observed at two sites (No.13, 16). High percentage of dead coral was observed at sites No.1, 2, 5, 7 and 8 and especially all of the corals are dead at No.15.

2.4.2 Aquatic Ecosystem

(1) Phytoplankton

1) Rainy Season

According to the Field Survey in the rainy season, 166 species of 6 phytoplankton phylums were identified. Of them Bacillariophyta has the highest number of species with 128 species (occupying 77% of total number), followed by Dinophyta with 33 species (20%), Cyanophyta with 2 species (1%), and 3 other phylum, Chlorophyta, Euglenophyta and Chrisophyta with one species each (1%). The cell number of phytoplankton varied in different survey points as shown in Figure 2.4.5. The species composition showed that flora of phytoplankton has the characteristics commonly observed in coastal waters of the temperate and subtropical zone.

The cell number of surface layer ranges from 14,040 to 77,100 cells/ℓ and bottom layer from 33,170 to 157,020 cells/ℓ. The range of cell number shows the level commonly observed in coastal waters where eutrophication has not progressed severely. The number of species of bottom layer is mostly higher than surface layer, because benthic algae such as *Navicula*, *Pleurosigma* and *Amphora* are distributed more in bottom layer compared to surface layer. Of Dinophyta, 10 species belong to harmful algae, but their density is low, the highest number is 800 cells/ℓ belonging to *Dinophisis caudata*.

2) Dry Season

According to the analyzed result of phytoplankton samples collected at 10 survey points, 126 species of 4 algae have been identified. Of them, Silic Bacillariophyceae has the highest number of species with 98 species (occupied 77.8% of total number), followed by Dinophyceae with 26 species (20.6%). Most species in the dry season are composed of the species living in seawater and brakish water, and the species living in freshwater are few. In comparison with the rainy season, there were few freshwater species in the dry season. The surface layer had the higher number of species than the bottom layer, though the

difference was not so large. On the contrary, in the rainy season the surface layer had the lower number than the bottom layer.

The cell number of surface layer ranges from 8,960 to 146,280 cells/ℓ, and that of the bottom layer ranges from 3,720 to 145,000 cells/ℓ. In comparison with the rainy season, the average cell number in the dry season is higher in surface layer and lower in the bottom layer.

(2) Zooplankton

1) Rainy Season

The result of samples collected at 10 survey points shows 47 species. Copepoda has the highest number of species with 25 species, followed by Crustacean larvae with 10 species, Cladocera and Molluses larvae with 3 species each, Chaetognatha with 2 species. Besides them Coelenterata, Ostracoda, Tunicata and fish larvae, has one species only, respectively.

The number of species and individual number at each survey point are shown in Figure 2.4.6. The number of species at each survey point varied from 6 to 28 species. The species composition showed that fauna of zooplankton had the characteristics which are commonly observed in coastal waters of the temperate and subtropical zones as seen in phytoplankton. At survey point No. 14 and 15 located at the southern end of the study area, oceanic species were comparatively abundant. It suggests that the waters in this area are affected by oceanic waters. The individual number of zooplankton is 140 ind./m^3 on the average of all survey points with a range from 6 to 429 ind./m^3 at each survey point.

2) Dry Season

In the dry season, 46 species of zooplanktons have been identified. The number of species at each survey point varied from 9 to 30 species. The average number of species in the dry season is 20 and it is higher than in the rainy season. The individual number of zooplankton is 491 individuals/m^3 on average for all survey points and varies from 90 to 878 individuals/m^3 at each survey point. The average individual number in the dry season was higher than in the rainy season.

(2) Zoobenthos

The Field Survey was carried out to understand the current condition of zoobenthos on main habitats as shown in Figure 2.4.7.

According to the result of the Field Survey, 208 species of zoobenthos were identified. Among them, molluses has the highest number of species with 92 species, followed by crustaceans (Crustacea) with 23 species and echinoderm has the lowest number with only 15 species. The counting in various habitats shows that there are 169 species in littoral zone in mangrove swamps, 104 species in soft bottom in sublittoral zone and 99 species in hard coral reef. The individual number of zoobenthos varies in different habitats : 110 to 4,242 individuals/m^2 in the littoral zone in mangrove swamps, 85 to 530 individuals/m^2 in the soft bottom in sublittoral zone. Zoobenthos counts 9 to 98 individuals/kg dead corals in hard coral reef.

Zoobenthos in the mangrove swamps were surveyed at 6 survey points in the littoral zone at Hoang Tan, Dai Yen and Cua Luc inlet. From samples collected, 58 species of zoobenthos were recorded. Number of species, individual number and biomass at each point are shown in Figure 2.4.8. Number of species at each survey site ranges from 1 to 9. It suggests that the fauna of zoobenthos in mangrove swamps has low diversity. However, individual number and biomass show a high value. In comparison with the result of benthos in soft bottom in sublittoral zone surveyed concurrently in the study area, the benthos in mangrove swamps shows higher individual number of four times and biomass of more than ten times. Dominant species in terms of the individual number are *Ostrea* sp., *Cerithidea cingulata*, *Septifer* sp. and *Pagurus* sp. Abundant molluses characterizes the benthic fauna in mangrove swamps.

Zoobenthos in the sublittoral in the soft bottom were surveyed at 10 survey points in Ha Long bay. From samples collected, 96 species of zoobenthos were recorded. Number of species, individual number, and biomass at each point are shown in Figure 2.4.9. Number of species at each survey point ranges from 9 to 29. Dominant species in terms of individual number are *Terebellides stroemi*, *Dentalium aprium*, *Nepthys polybrranchia*, *Dentalium longitrorsum* and

Cuspidaria nobilis. These species can be widely observed in the coastal waters of the temperate and subtropical zones.

Zoobenthos in the coral reefs were surveyed at 10 survey points. From samples collected, 89 species of zoobenthos were recorded. Number of species, individual number and biomass at each point are shown in Figure 2.4.10. Number of species at each point ranges from 12 to 26. Dominant species in terms of individual number are *Lithophaga malaccana*, *Eunice siciliensis*, *Sipunculus* sp. and *Lithophaga teres*.

(3) Fish and Shellfish

An interview survey to fishermen and local agencies was carried out to understand the habitats of main fish and shellfish and fishing activities in the study area. According to the survey, 189 species belonging to 124 genera, 66 families were recorded in Ha Long bay. There are five types of important habitats for fish, i.e. mangrove swamps, coral reefs, rocky reefs, bays and embayment, and sand-mud bottom areas. Every habitat is characterized by some typical species. Also it was found that there were three spawning areas in the study area: Cua Luc-Tuan Chau-Dau Be (for pelagic fishes), coral reefs and nearby waters (for bottom fishes) and Ngoc Vung-Cong Do (for groupers and snappers). There are seven main fishing grounds in the study area: Dau Be, Dau Go, Hon Soi Den-Ngoc Vung, Cua Dua-Cong Do, Tuan Chau, Cong Dong-Cong Tay and Hon Net-Hon Ong Cu as shown in Figure 2.4.11.

2.5 Legal and Institutional Conditions

2.5.1 Policy and Legal Conditions on Environmental Management

(1) Policy

Much of Vietnamese environmental policy is articulated in the "National Plan for Sustainable Development and Environment". In general, its policy aims at:

a) satisfying the basic material, spiritual, and cultural needs of the current and future generations of Vietnamese people by wisely managing the country's natural resources, and

b) establishing and enforcing policies, action plans and institutional frameworks to ensure sustainable use of natural resources that are closely connected to all aspects of the process of socioeconomic development in Vietnam.

The basic objectives of the policy include:

a) preserving those key ecological processes and ecosystems that influence the well being of the Vietnamese people,

b) conserving the abundance and genetic diversity of domestic and wild animals and plants for current and future generations,

c) ensuring the long term sustainable use of natural resources by fostering efficient use and monitoring actual use,

d) maintaining basic environmental quality, and

e) attaining a population growth level and distribution that is consistent with Vietnamese natural capacity and ensuring adequate living standards for the people.

(2) Law on Environmental Protection

A large number of environmental protection laws and regulations have been promulgated over the past few years. The Law on Environmental Protection (LEP, 1993) provides the basic framework for the environmental protection and management in Vietnam. LEP mandates the Central Government overall responsibility for environmental protection. In general, LEP stipulates:

a) that polluting activities are strictly prohibited,

b) that EIA of new projects and existing facilities are required,

c) that the introduction of new technologies or alien species is controlled,

d) that the government may demand financial contributions for those causing damage to the environment,

e) inspection procedures to ensure compliance with LEP, and

f) procedures for dealing with environment accidents.

Basic laws in other economic sectors have provisions relating to environmental protection. As such the legal framework for environmental protection in general is well developed, but there remains a need for clarification of the responsibilities for environmental management.

MOSTE has published Vietnamese environmental standards. In Quang Ninh province, there appear to be no local standards. The general policy dictates that the national standards are to be followed.

(3) Inspection

Circular No. 1485-Mtg, December 12, 1998 of MOSTE provides guidance on the structure, responsibility, and scope of the activity of environmental inspection. The inspection agency within MOSTE is responsible for state inspection for environmental protection. The inspection agencies at the provincial level carry out inspection on behalf of the Provincial People's Committee. In Quang Ninh province, the Inspection Division of DOSTE undertakes the following inspection:

a) to assess the implementation of the regulations on environmental protection in all departments and branches of the provincial government,
b) to assess the implementation of State's management function of the People's Committees of provinces, districts, wards, and communes,
c) to determine compliance with the regulations in the Law on Environmental Protection by organizations and individuals within their localities,
d) to determine violations of the Law on Environmental Protection that may occur during activities of organizations and individuals, and
e) to coordinate with inspection of other departments and branches.

(4) Enforcement

Decree No. 26/CP dated April 26th, 1996 of the Government "Regulation on Punishment for Administratively Violating Environmental Protection Legislation" outlines the forms of punishment and the responsibilities and authority for enforcement. The various articles provide for warnings and fines for violations of:

a) prevention of pollution and environmental regulation and of protection of biodiversity and natural resources,
b) prohibitions on exploitation and trading of rare and precious animals and plants, and of use instruments and methods of mass killing and catching,
c) infringement of regulations on environmental protection of soil resources,
d) regulations on exports and import of wastes, hazardous substances, radioactive materials, and genetic material,
e) regulation on disposal of radio-active waste and waste contaminated with viruses and other pathogens,
f) regulations on noise and vibration detrimental to human health and affecting the daily life of the people, and
g) regulations on burning and destruction of forests and exploitation of mineral resources.

The authority for dealing with violations is delegated to environmental inspectors and the chief inspector of DOSTE, Director, Vice Director, and Chief Inspector of NEA and Chairman of the People's Committee.

(5) Current Constraints in Implementation

Vietnam has made good progress in developing a set of laws and regulations to define the legal framework for environmental management. The establishment of an environmental management system operated by trained staff and effective institutions is now in progress. There is much to be done to clarify the responsibilities between MOSTE and other national ministries. Each of these national ministries must set policies and delegate responsibility to the provincial authorities. At the provincial levels, there is also a need to clarify the responsibilities between the provincial DOSTE and the departments of other ministries.

Most ministries do not have sufficient financial and human resources to fulfill their environmental management responsibilities. Considerable effort and funding are required to increase the capacity of the existing agencies. More environmental staff is needed in most branches of the government. New and existing staff will require considerable training and retraining. Capacity building is needed to put

monitoring and laboratory systems in place. These systems are necessary to provide decision-makers with reliable information about the changes occurring in the environment as a result of human activity. Environmental research and development to find new solutions and technologies must complement training and capacity building.

Economic instruments (e.g., pollution charges, environmental taxes, environmental funds) may be used to create a disincentive to pollute or otherwise cause environmental damage. To date, this is one of the least used of the regulatory instruments available to Vietnam, due in part to a transition economy. This will mean introducing a completely new program, because, a number of problems can be anticipated in obtaining agreement from industrial facilities and other polluters.

Despite continuing efforts of GOV, the general level of environmental awareness within the people is relatively low. Because of the pressure for socioeconomic development for those people lacking in environmental awareness, it may seem better to follow a "pollute now, pay later" approach to development. Unfortunately, the experience in other parts of world has shown that the costs of cleaning up the environment after harmful effects is more expensive than planning for environmentally sound development. There are also numerous examples where life sustaining environmental resources have been destroyed and lost forever. It may be difficult for Vietnam to choose any other path to development, unless the range of options for development is expanded.

2.5.2 Institutional Framework for Environmental Management

(1) MOSTE and DOSTE

Government Decree 175/CP, which provides guidance on the implementation of law, delegates to and assigns the responsibilities for environmental protection to MOSTE, other ministries, People's Committees, State agencies and organizations, and business and production institutions. MOSTE also has broad responsibilities for international activities related to environmental protection, and participation in international environmental organizations.

In general, the Environmental Management Division (EMD) of provincial DOSTE has been delegated the following responsibilities:

a) to prepare and submit a provincial environmental protection plan to MOSTE for approval and follow-up implementation;
b) as assigned by MOSTE, to carry out appraisal of EIA of investment projects and provincial socioeconomic master plans;
c) to implement environmental monitoring, pollution control, and waste control;
d) to propose solutions to environmental protection problems in the provinces;
e) to cooperate with the inspection agency of DOSTE in carrying out environmental inspection; and
f) to disseminate environmental protection activities, organize and conduct propaganda campaigns for environmental protection and cooperation with concerned agencies in enhancing, training and improving environmental awareness.

Most environmental management divisions in DOSTEs do not have sufficient staff with adequate training to fulfill these responsibilities. Current capacity building efforts by international agencies are focusing on environmental monitoring, EIA, pollution control, and waste management.

In implementing environmental monitoring, pollution control, and waste management, DOSTE will need scientific and technical information. This may require setting up institutions such as new laboratories, monitoring stations, and environmental research centers. However, currently MOSTE has set up national and regional institutions to fulfill these functions.

(2) Economic Development Regulation and Administration

The following six main economic activities in Quang Ninh province are regulated and administered by central government agencies. These economic activities have potential to create serious pollution problems and/or to degrade valued environmental resources. Specific measures must be put in place to ensure the environmental protection.

a) The Department of Science, Technology and Environment within the Ministry of Industry is responsible for advising on the formulation of regulations and procedures governing coal mining operations.

b) The Vietnam General Department of Tourism administers tourism development and management. Tourism is viewed as the industry with the greatest immediate growth potential.

c) The Ministry of Transportation and Communication administers transportation including ports, harbors, and sea transportation generally.

d) The Ministry of Agriculture and Rural Development administers agriculture.

e) The Ministry of Fisheries controls fisheries.

f) Oil imports/export are administered by PETROLIMEX, which is attached to the Ministry of Trade.

(3) Ha Long Bay Management Board (HLMB)

The Ha Long Bay Management Board (HLMB) was established in 1995 to care for the World Heritage in Ha Long bay. HLMB is responsible for:

a) conservation of the World Heritage site,

b) management of tourist facilities within the World Heritage site,

c) maintenance of environmental quality in the World Heritage site, and

d) protection of the environmental resources within the World Heritage site.

HLMB intends to add a new division responsible for tourism and guiding in 1999. It cooperates with the Ministry of Transportation and Communication and DOSTE with respect to licensing of tourist boats. It also cooperates and seeks advice of DOSTE on issues and problems of environmental degradation of the World Heritage site. HLMB makes an annual report on general management of Ha Long bay to QNPC, the Ministry of Culture and Information, and National UNESCO Committee. HLMB, however, is facing two major difficulties, a lack of public awareness of laws and regulations and limited funds to prevent illegal activities.

(4) Sanitation and Wastes

There are two main agencies for sanitation management, the Ha Long Environmental Sanitation Company and the Cam Pha Urban Environment Company. Both companies are under control of their respective Municipal People's Committees and the director of the companies report to the chairman of the People's Committees.

The current staff and budget shortages of these companies make it difficult to conduct activities specifically directed at environmental management and to provide basic services that they are responsible for. However, planned upgrading and the drainage and sanitation system will reduce the number of point sources discharges of domestic wastewater and storm runoff to Bai Chay and Ha Long bays.

2.6 Current Environmental Monitoring Conditions

2.6.1 Legal and Institutional Aspect

(1) Environmental Monitoring System in Vietnam

Natural disasters, rapid demographic growth, and the impacts of human activity have resulted in serious environmental problems in Vietnam. The most significant environmental issues include deforestation, degradation of soil and freshwater, deterioration of the coastal environment and wetlands, over-exploitation of biological resources and loss of biodiversity, increasing environmental pollution and long-term environmental effects of war.

In 1981, the Ministry for Higher Education and the State Committee for Sciences and Technology (now MOSTE) received a proposal from Vietnamese scientists and launched the proposal as the national "Resources and Environment Research Program" (RERP). Through the implementation of eighteen research projects integrated in RERP, with technical assistance from IUCN, "National Conservation Strategy" (NCS) for Vietnam was prepared in 1985.

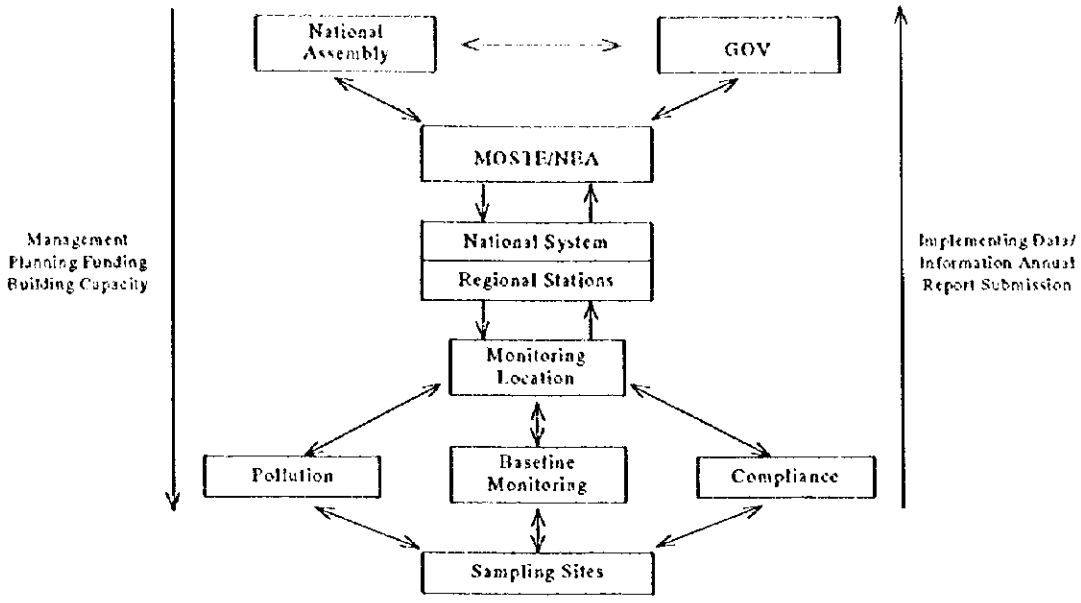
An international conference on environment and sustainable development held in Hanoi in December 1990 in cooperation with UNDP, SIDA and IUCN accelerated

the provision of "National Plan for Environment and Sustainable Development 1991-2000" (NPESD), taking the issues raised in NCS as its foundation. NPESD was officially approved in 1992. This gave an actual departure point to the systematic environmental monitoring in Vietnam, because the framework of NPESD involved a wide variety of components including environmental monitoring.

In implementing the national plan, the government prepared "Law on Environmental Protection" (LEP), that was then enacted in December 1993. In LEP, environmental monitoring is addressed as an indispensable activity in order to manage the environment effectively and ensure a healthy environment for human life (Item Four, Article 37, Chapter IV of the LEP). Environmental inspection is also required to MOSTE by the LEP in Article 40.

(2) MOSTE/NEA (National Environmental Agency)

MOSTE/NEA has a responsibility to establish a national system on coastal/marine environment monitoring, named "coastal pollution monitoring system". This monitoring system has done its task since 1995 in the northern part of Vietnam and was expanded its scope throughout the coast and offshore waters in 1996. This monitoring system is a result of a cooperation between MOSTE/NEA and other sectors/institutes such as Natural Centre for National Science and Technology (Institute of Oceanology), Ministry of Fisheries (Institute of Sea - Product Research) and NAVY (Department of Chemistry). The coordinated mechanism of the system is presented below:



Source: Coastal Pollution Monitoring in Vietnam/Ha Long Bay Case Study 1997, IHO,

Coastal Pollution Monitoring System

(3) DOSTE in Quang Ninh Province

LEP also refers to the responsibilities of the Provincial People's Committees regarding the protection of the environment in each province. This responsibility has actually been handed over to DOSTE of the province. MOSTE/NEA are responsible for offering DOSTE technical guidance and providing training for DOSTE staff.

DOSTE has been enhanced with the environmental monitoring activity, because of the need to conserve Ha Long bay as "World Natural Heritage" and the threat of coal mining activity. However, despite of an eager appeal by DOSTE, no periodic monitoring station has been set up mainly due to budget constraint of the province.

2.6.2 Human Resource Aspect

The Quang Ninh DOSTE has 5 divisions and only 19 staff in total, and most of the administrative budget is given by the QNPC while the Ha Long Bay Management Board (HLMB) has many staff for the care of caves and grottos in World Heritage Area, as shown in the next tables. Other provincial organizations

such as Department of Transport and Fisheries have very poor numbers of staff for environmental conservation activity.

Human Resource of DOSTE

Division	Staff No.
a) Science and Technology division	3
b) Environmental Management division	5
c) Inspection and Control division	2
d) Information and Industry License division	3
e) Administrative division	6
Total	19

Source: DOSTE, 1998

Human Resource of HLMB

Section/Unit	Staff No.
Management Section	
- Administration & Personnel Unit	4
- Profession & Research Unit	4
- Patrol Team	4
- Accounting Unit	3
Profession Activity Section	
- Cave an Grotto Management Unit	76
- Tourists an Guidance Unit (to be established soon)	0
Total	91

Source: HLMB, 1998

2.6.3 Technical Aspect

Based on the literature studies and interviews with relevant organizations, the following problems concerning environmental monitoring in Vietnam are suggested:

a) National laboratories on marine environmental monitoring are being developed with newly added equipment, but the staff of these laboratories have not yet been skilled enough;

b) Quality assurance and control procedures are often inappropriately applied in the steps of the monitoring program;

c) Linkage between marine pollution monitoring and management strategy is hardly highlighted; and

d) Experience in designing of monitoring programs is limited.

Local observation on the actual practice and report preparation concerned with the study area has further clarified these deficiencies. Some instances of the past environmental analysis reports submitted by Vietnamese organizations indicate an

inadequate technical level for chemical analyses, data processing and data checking. Extraordinary values sometimes appeared in water/sediment-quality data, which would never appear in the usual natural environment. These must have resulted from some poor techniques during sampling, storage, data-check or analysis practices. Well-educated personnel on sea/fresh water quality have not been employed for data-quality control.

More basically, biological data have included frequent errors, such as miss-spelling of taxonomic names, disorderly listing of taxonomic groups and wrong summing-up of data. This may be attributed to lack of reliable taxonomic literature for species identification and careless data processing.

A component of the technical transfer and capacity development in environmental monitoring is assistance with the development of a field laboratory facility in which basic analyses will be conducted. DOSTE has provided space in an adjacent building in which it plans to develop a basic laboratory, and where field equipment can be stored. Equipment provided in the course of UNDP and World Bank projects has been stored there.

For development of the laboratory facilities and preparation for the technical training courses, some of the procured field equipment was calibrated. The Horiba multi-parameter meter, the pH meter, and the turbidity meter were calibrated for operation. The Van Dorn water sampler, the Ekman Grab, and the plankton tow were rigged with graduated lines and required weights. All equipment was field tested on Ha Long bay prior to the survey.