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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 I
EXECUTIVE SUMMARY

SEPTEMBER 1999

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

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LIST OF VOLUMES

Volume I	Executive Summary
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EXCHANGE RATE

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PREFACE

In response to a request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct a development study on Environmental Management for Ha Long Bay and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr.Yoichi Iwai of Nippon Koei Co.,Ltd. and composed of Nippon Koei Co.,Ltd. and Metocean Co.,Ltd. to Vietnam, three times between February 1998 and July 1999. In addition, JICA set up an advisory committee between February 1998 and September 1999, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Vietnam, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Vietnam for their close cooperation extended to the team.

September 1999

Kimio Fujita
President
Japan International Cooperation Agency

September 1999

Mr.Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

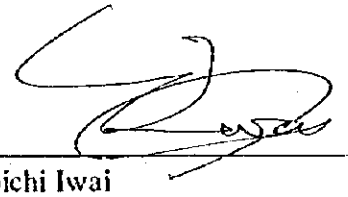
We are pleased to submit to you the Final Report on the Study on Environmental Management for Ha Long Bay in the Socialist Republic of Vietnam. This report presents the results of all works conducted in both Vietnam and Japan during a total period of 20 months from February 1998 through September 1999.

This is an environmental management plan to achieve sustainable development in the Ha Long Bay area for the target year 2010. This management plan also includes the Project of environmental conservation measures for sanitation, mining, tourism, and environmental resources, and enhancement of environmental management capability.

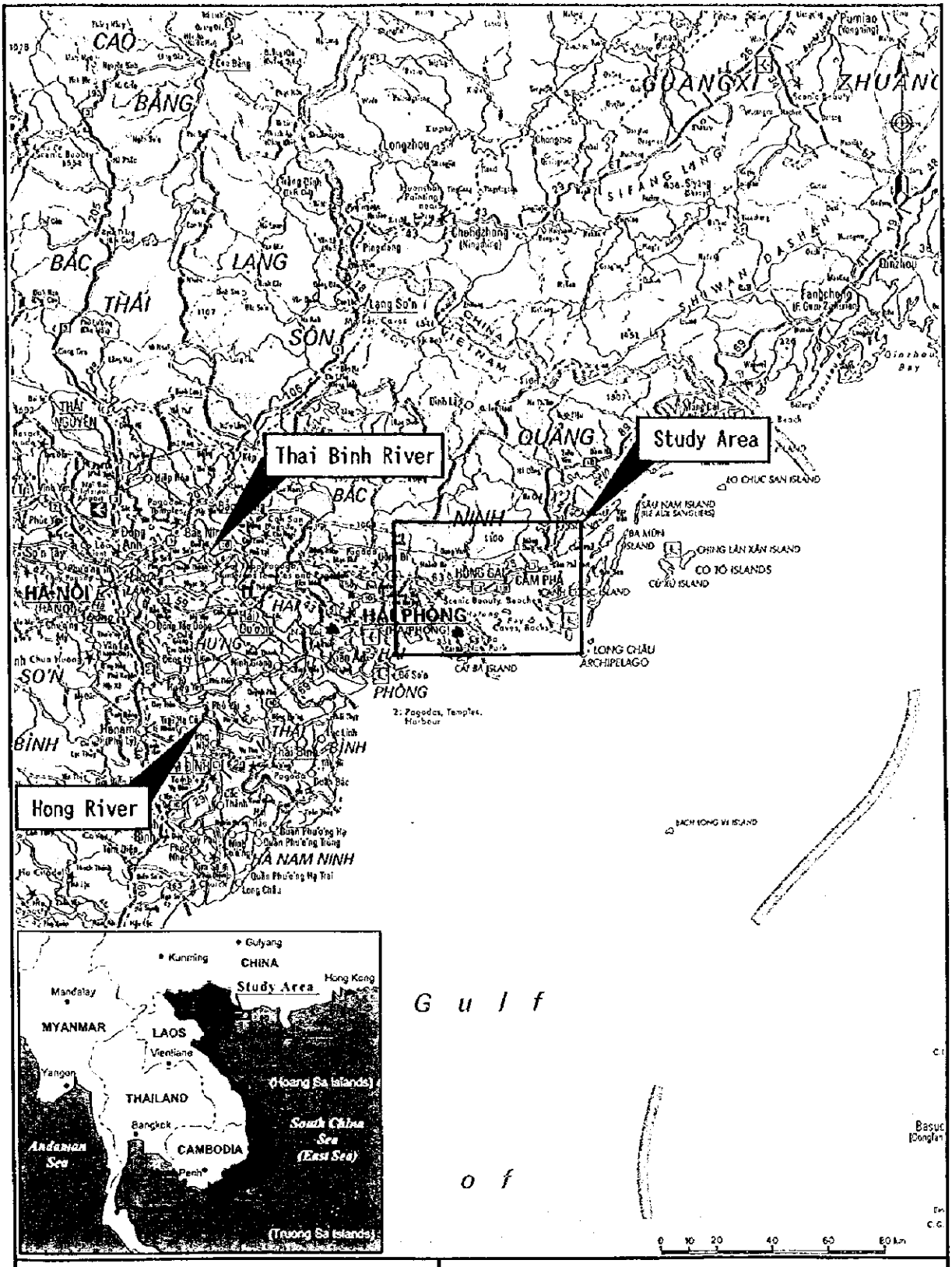
The Project will prevent the serious environmental problems which would be caused by the planned socioeconomic development. We are confident that the Project, once implemented, will greatly help conserve the environment in the Ha Long Bay area. Hence, we recommend implementing the Project as early as possible.

We wish to express our deep appreciation and sincere gratitude to your Agency, the Advisory Committee, the Ministry of Foreign Affairs, the Ministry of Transportation, and the Environmental Agency of Japan for the courtesies and cooperation kindly extended to our team. We also wish to express our hearty appreciation and gratitude to the Government of the Socialist Republic of Vietnam, the Embassy of Japan in Vietnam, and the JICA Vietnam Office for close cooperation and assistance extended to us during our field investigation and study in Vietnam.

Very truly yours,



Yoichi Iwai
Team Leader
The Study on the Environmental
Management for Ha Long Bay



The Study on Enviornmental Management for Ha Long Bay in the Socialist Republic of Vietnam	Location of Study Area
Japan International Cooperation Agency	

OUTLINE OF THE STUDY

1 Background

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. This area is a major sightseeing spot in Vietnam, and was inscribed on the World Heritage List of UNESCO in 1994. With the recent growth of the area, however, environmental destruction, such as water pollution and loss of natural environment, is getting serious.

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

2 Objectives

The objectives of the Study on Environmental Management for Ha Long Bay (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.

3. Environmental Management Plan for Ha Long Bay (EMP)

3.1 Framework of the EMP

3.1.1 Vision and Goals

The fundamental vision of the EMP for Ha Long bay is to be set as follows:

"Environmentally Sound and Sustainable Development of the Ha Long Bay Area".

The goals to attain this vision are to be set as follows:

Goal I : Absolute Protection of the World Heritage

Goal II : Achievement of Environmental Protection for Sustainable Economic Growth

Goal III : Establishment of Enforcement Capability of Environmental Management

3.1.2 Target Area, Year and Managemnet Items

- The target area: i) the bays which are designated for the World Heritage and its buffer area, and
  ii) the hinterland areas which may affect the environment of the bay.
- The target year: 2010
- The target management items : water quality, environmental resources, technical and institutional capacities

3.1.3 Approach and Strategy

In order to attain the vision and goals of the EMP for Ha Long bay, it is necessary to set an administrative approach and strategy that guides actual environmental components and projects of the EMP. Therefore, the following approach and strategy is taken for the EMP.

(1) Absolute Protection of the World Heritage

- Keeping Clean and Clear Water Quality of the World Heritage Area
- Conserving Natural Ecosystem and Seascape of the World Heritage Area
- Managing Solid Wastes Disposal

(2) Achievement of Environmental Protection for Sustainable Economic Growth

- Controlling Area Wide Pollution Load
- Conserving Natural Coast and Tidal Area
- Protecting Forest and Water Resources

(3) Establishment of Enforcement Capability of Environmental Management

- Capacity Building of the Responsible Agency
- Institutional Set up for Enforcement of the EMP

3.2 Environmental Zoning

The EMP area can be broadly divided into four environmental zones, as summarized below.

Principal Distribution of Environmental Zones

Zone	Total area (km^2)	%	Principal distribution
1) Special Conservation Zone (SCZ)	1,080	43	- World Heritage core and buffer areas - national park and forest reserves
2) Conservation Zone (CZ)	720	29	- sub-catchment area - around the World Heritage buffer area
3) Active Management Zone (AMZ)	250	10	- tidal flat along the coastal line - Bai Chay bay
4) Development Zone (DZ)	450	18	- around the planned development area - existing urban and mining area
Total EMP area	2,500	100	-

3.3 Conservation Criteria

The conservation criteria by environmental zones are proposed for water quality, and environmental resources including landscape.

(1) Water Quality Conservation Criteria

Water Quality Conservation Criteria (Sea Area 1)

Environ. zone	Applied area	Transparency (m)	BOD (mg/ℓ)	COD_{Mn} (mg/ℓ)	T-N (mg/ℓ)	T-P (mg/ℓ)	SS (mg/ℓ)
SCZ	Western Part	3.0	1.5	7.0	1.3	0.6	5
	Eastern Part	3.5	1.0	4.5	1.1	0.5	4
CZ	-	3.0	1.0	4.5	1.1	0.5	5
AMZ	Bai Chay coastal	0.5	1.3	7.5	1.6	0.7	15
	Hong Gai coastal	1.5	1.3	7.5	1.6	0.7	5
	Bai Chay bay	1.5	1.3	7.5	1.6	0.7	5
	Cam Pha and Cua Ong	1.5	1.1	5.0	1.6	0.7	7
	Binh Huong estuary	0.5	1.3	7.5	1.6	0.7	15

Water Quality Conservation Criteria (Sea Area 2)

Environ. zone	DO (mg/ℓ)	pH	Oil slick	Floating solid wastes	Fecal coliform (MPN/100 mℓ)
SCZ	5	7.0-8.3	nd	nd	nd
CZ	5	7.0-8.3	nd	nd	nd
AMZ	5	7.0-8.3	nd	nd	1,000

Note: 1) nd shows not detectable.
2) Fecal coliform is applied to sea bathing area.

As for the surface water, the Inland Water Quality Standards of Vietnam (TCVN 5942, 1995) is applied to all environmental zones.

(2) Environmental Resources

1) Natural Environment

Conservation Criteria for Natural Environment

Environ. zone	Forest (green) coverage	Tidal flats	Mangrove swamps	Coral reefs	Fish and shellfish
SCZ	464 km² (94%)	1,120 ha	200 ha	Present conditions	No illegal fishing at fishing grounds
CZ	208 km² (85%)	-	-	-	ditto
AMZ	-	17,300 ha	3,800 ha	-	ditto
DZ	228 km² (52%)	-	-	-	-

Note: Present conditions of coral reefs are distribution, species composition, and living coral reefs.

2) Landscape

Conservation Criteria for Landscape

Environ. zone	Shape and surface of islands	Color and clearness of seawater	View of natural resources	Natural scenery
SCZ	No islands changed artificially	To be controlled as water quality	- No islands having bald spots - To be controlled as tidal flats and mangrove swamps	No cargo ships anchored in the World Heritage core area and deviated from the courses

4 Environmental Measures

The conservation criteria for the EMP should be achieved through an array of environmental measures. The proposed environmental measures and estimated costs are shown in Table S.1.

5 Evaluation and Development Program of the EMP

5.1 Economic and Financial Evaluation of the EMP

The EMP has an Economic Internal Rate of Return (EIRR) of 7.1%, which is more than the discount rate recommended by the Japanese government at least. It can be justified that the EMP implementation is economically feasible and acceptable from social viewpoint of the study area, because intangible benefits of the EMP such as scientific, ecological and educational values have not been counted in the cost-benefit analysis.

The Financial Internal Rate of Return (FIRR) resulted in 0.54%. Since the measures and projects proposed under the EMP are for environmental

conservation hardly generating monetary and implemented by non-profit public agencies, the EMP is considered financially feasible as its FIRR is over 0 % at least.

In addition, comparing cash outflows in the cost recovery schedules with the potential revenues, the revenues through 2000 to 2050 is enough to cover the cash outflow as a whole, summing up to a surplus balance. Therefore, the proposed financial plan is appropriate to realize a sound financial management for the EMP.

5.2 Implementation Schedules

The implementation schedules for the proposed projects and programs of the EMP were developed incorporating a phased plan. The schedules were developed considering necessary time of capacity building and consistency with the planned socioeconomic development. The developed implementation schedules are shown in Table S.1.

5.3 Investment Program

The yearly costs of each project and program of the EMP were calculated, and then an investment program was developed. The developed investment program of the EMP is shown in Table S.2, including annual O&M costs. The total reduction cost during 2000 to 2010 is about US$ 168 million.

6 Recommendations

The EMP is prepared for provincial environmental management of the Ha Long bay area. This means that the People's Committee of Quang Ninh Province (QNPC) has the primary responsibility for implementation of the EMP. Although QNPC will be confronted with a lot of difficulties, it should be noted that an actual challenge could break current problems of environmental management. In order to pave the way for execution of the EMP, QNPC is strongly recommended:

(1) To incorporate the EMP into the Development Master Plan of Ha Long City for 1994-2010

(2) To establish the Implementation Committee (IC) of the EMP

(3) To cooperate with State Owned Enterprises (SOE)

(4) To control pollution loads from ships

(5) To reinforce actual activities of the EMP

(6) To tackle the environmental impacts from outside of the EMP area

(7) To reinforce emergence response against environmental accidents

7 Conclusion

The Ha Long bay area is planned to be developed as the North Focal Economic Area in Vietnam. Without proper countermeasures, however, environmental deterioration caused by the socioeconomic growth has gradually become serious, so that the negative impacts will fall on the economic growth. Therefore, environmentally sound and sustainable development should be recognized as one of the important issues in this area.

In the course of the Study, the current environmental problems were identified and also the possible environmental problems which would be caused by the future development projects were predicted. The Study presented a vision, namely "Environmentally Sound and Sustainable Development of the Ha Long Bay Area", for the target year 2010, and three goals were set to attain this vision. In addition, the environmental conservation criteria by environmental zones were examined, together with necessary counter and preventive measures. Consequently, total 32 projects and programs consisting of both hard and software components were proposed. The Environmental Management Plan for Ha Long Bay (EMP) was developed by systematizing the proposed projects and programs.

Realization of the EMP surely contributes to absolute protection of the World Heritage area and the achievement of environmental protection for sustainable economic growth in the Ha Long bay area. The EMP plays an important role as a guidepost for not only environmental protection but also sustainable development in the Ha Long bay area. Although the realization of the EMP would need much time, costs, and endeavors by all organizations concerned, the commencement of the concrete measures as early as possible toward the target year 2010 is strongly recommended.

Table S.1 Proposed Environmental Measures and Estimated Costs of the EMP up to 2010

Category	No.	Projects and Programs	Costs (million US$)
1. Sanitation			
1.1 Domestic Wastewater Management	1	Don Dien WWTP including collection system in Dong Dang area	31.2
	2	Deo Sen WWTP	36.9
	3	Bach Dang WWTP	11.1
	4	Cam Pha WWTP	7.5
		Subtotal	86.7
1.2 Industrial Wastewater Management	5	Cai Lan Industrial WWTP (collection and convey system)	13.2
	6	Hoanh Bo Industrial WWTP (collection and convey system)	
	7	Lang Bang Industrial WWTP	1.7
		Subtotal	14.9
1.3 Domestic Solid Wastes Management	8	Procurement of solid wastes collection vehicles and equipment	8.3
	9	Extension of Quang Hanh landfill site	4.3
	10	Clinical solid wastes incinerators	1.2
		Subtotal	13.8
1.4 Industrial Solids Wastes Management	11	Procurement of solid wastes collection vehicles and equipment	1.7
	12	Extension of landfill sites	1.0
	13	Hazardous solid wastes incinerators	2.0
		Subtotal	4.7
		Total	120.1
2. Measures for Mining	14	Development of environmental plan for mining	0.9
	15	Pilot project on rehabilitation	1.8
	16	Measures for mine wastewater	2.2
	17	Measures for coal processing plants	1.7
	18	South Deo Nai dumping site rehabilitation	3.4
	19	Rehabilitation of river basins (Mong Duong, Dien Vong, Ha Tu , Hong Gai, Cam Pha, and Cua Ong)	11.5
	20	Dredging	13.3
		Total	34.8
3. Measures for Tourism	21	Development of environmental plan for tourism	0.1
	22	Improvement of sanitation condition-Phase 1	1.5
	23	Improvement of sanitation condition-Phase 2	1.2
	24	Reinforcement of patrolling capability	1.0
		Total	3.8
4. Measures for Environmental Resources	25	Reforestation in bare areas	1.5
	26	Rehabilitation of mangrove swamps	1.0
	27	Fishing activity management program	0.1
	28	Measures for landscape	0.1
		Total	2.7
5. Environmental Monitoring	29	Environmental monitoring (water quality, environmental resources)	0.8
	30	Environmental inspection	0.1
		Total	0.9
6. Institutional Development	31	Reinforcement of environmental management capability (staff, training programs, procurement of equipment)	2.5
	32	Establishment of Visitor Center	3.0
		Total	5.5
Grand Total			167.8

Notes: 1) WWTPs include accompanied collection systems including pump stations and local collector sewers in deosely populated areas.
2) Costs include those of O&M during 2000-2010.

Table S.2 Implementation Schedules for Projects and Programs of the EMP

Category	Type	No.	Name of Projects/Programs	Phase I			Phase II				Phase III			
				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Sanitation Measures	Domestic Wastewater Management	1	Don Dien WWTP											
			Dong Dang Area (wastewater collection and convey system)											
		2	Dxo Son WWTP											
		③	Bach Dang WWTP											
		4	Cam Pha WWTP											
	Industrial Wastewater Management	5	Cai Lan WWTP (wastewater collection and convey system)											
		6	Hoanh Bo WWTP (wastewater collection and convey system)											
		7	Lang Bang WWTP											
	Domestic Solid Wastes Management	8	Procurement of Solid Wastes Collection Vehicles and Equipment											
		9	Extension of Quang Hanh Landfill Site											
		10	Clinical Solid Wastes Incinerator											
	Industrial Solid Wastes Management	11	Procurement of Solid Wastes Collection Vehicles and Equipment											
		12	Extension of Landfill Sites											
		13	Hazard Solid Wastes Incinerator											
Measures for Mining		14	Development of Environmental Plan for Mining											
		⑮	Pilot Project on Environmental Rehabilitation											
		16	Environmental Measures for Mine Wastewater											
		17	Environmental Measures for Coal Processing Plants											
		18	South Dxo Nai Dumping Site Rehabilitation											
		19	Environmental Rehabilitation of River Basins											
		20	Dredging											
Measures for Tourism		21	Development of Environmental Plan for Tourism											
		㉒	Improvement of Sanitation Condition-Phase1											
		23	Improvement of Sanitation Condition-Phase2											
		24	Reinforcement of Patrolling Capability for Tourism Activities											
Measures for Environmental Resources		25	Reforestation in Bare Area											
		㉖	Rehabilitation of Mangrove Swamps											
		27	Fishing Activity Management Program											
		28	Measures for Landscape (Landscape Management Guideline) (Reinforcement of Patrolling Capability for Shipping Activities)											
Environmental Monitoring		㉙	Environmental Monitoring (water quality and environmental resources)											
		30	Environmental Inspection											
Institutional Development		31	Reinforcement of Environmental Management Capability											
		㉜	Establishment of Visitor Center											

Note: 1) ▭ Design, ▬ Construction, ▨ Equipment Procurement, ▭ Operation and Maintenance (O&M) or Training
2) ○ means priority project.

Table S.3 Investment Schedules for Projects and Programs of the EMP

Unit:US$ × 10³

Category	Type	No.	Name of Projects/Programs	Stage	Phase I			Phase II				Phase III				Total
					2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Sanitation Measures	Domestic Wastewater Management	1	Don Dien WWTP	Design & Construction			2,000	3,500	3,500				2,452	3,000		14,452
				O&M						200	200	200	238	250	250	1,338
			Dong Dang Area (wastewater collection and convey system)	Design & Construction				2,500	3,600	3,945	4,000					14,045
				O&M								200	200	449	449	1,298
		2	Deo Sen WWTP	Design & Construction			3,000	5,600	5,600			6,000	6,583	7,000		33,783
				O&M						490	490	490	490	580	580	3,120
		③	Bach Dang WWTP	Design & Construction	1,000	1,800	1,800				1,600	2,294	2,294			10,158
				O&M				90	90	90	90	90	90	200	201	941
		4	Cam Pha WWTP	Design & Construction					2,000	2,300	2,552					6,852
				O&M								158	158	158	158	632
			Subtotal	Design & Construction	1,000	1,800	6,800	11,600	14,700	6,245	7,552	8,294	11,359	10,000	0	79,350
				O&M	0	0	0	90	90	780	780	1,158	1,176	1,637	1,638	7,329
	Industrial Wastewater Management	5	Cai Lan WWTP (wastewater collection and convey system)	Design & Construction	1,200	1,602						1,200	1,602			5,604
				O&M			80	80	80	80	80	124	160	160	160	1,004
		6	Hoanh Bo WWTP (wastewater collection and convey system)	Design & Construction						1,200	1,602			1,200	1,602	5,604
				O&M								251	251	251	251	1,004
		7	Lang Bang WWTP	Design & Construction						600	805					1,405
				O&M								63	63	63	63	252
			Subtotal	Design & Construction	1,200	1,602	0	0	0	1,800	2,407	1,200	1,602	1,200	1,602	12,613
				O&M	0	0	80	80	80	80	80	438	474	474	474	2,260
	Domestic Solid Wastes Management	8	Procurement of Solid Wastes Collection Vehicles and Equipment	Equipment Procurement				801	801	801	801	801	801	801	801	6,408
				O&M					165	192	224	262	306	357	417	1,923
		9	Extension of Quang Binh Landfill Site	Design & Construction				1,000	1,723							2,723
				O&M					135	158	185	216	252	294	343	1,583
		10	Clinical Solid Wastes Incinerator	Design & Construction		407	500									907
				O&M				29	32	35	38	39	39	39	39	290
			Subtotal	Design & Construction	0	407	500	1,801	2,524	801	801	801	801	801	801	10,038
				O&M	0	0	0	29	332	355	447	517	597	690	799	3,796
	Industrial Solid Wastes Management	11	Procurement of Solid Wastes Collection Vehicles and Equipment	Equipment Procurement				196	196			400	400			1,192
				O&M				18	23	31	41	55	81	120	129	498
		12	Extension of Landfill Sites	Design & Construction		270	300									570
				O&M				17	22	29	39	52	76	112	121	468
		13	Hazard Solid Wastes Incinerator	Design & Construction				450	911							1,361
				O&M						51	65	83	106	146	173	624
			Subtotal	Design & Construction	0	270	300	646	1,107	0	0	400	400	0	0	3,123
				O&M	0	0	0	35	45	111	145	190	263	378	423	1,590
Measures for Mining		14	Development of Environmental Plan for Mining	Design	203	374	259				86					921
																0
		⑮	Pilot Project on Environmental Rehabilitation	Design & Construction	675	727	261									1,663
				O&M				38	40	44	44					166
		16	Environmental Measures for Mine Wastewater	Design & Construction				58	360	720	720					1,858
				O&M								90	90	90	90	360
		17	Environmental Measures for Coal Processing Plants	Design & Construction		58	58	53	55							224
				O&M						226	238	250	250	250	250	1,464
		18	South Deo Nai Dumping Site Rehabilitation	Design & Construction		144	2,736									2,880
				O&M				62	62	62	62	62	62	62	62	496
		19	Environmental Rehabilitation of River Basins	Design & Construction		173	173	997	1,034	1,928	958	861	898	1,130	976	8,228
				O&M				133	171	311	383	449	528	608	711	3,292
		20	Dredging	Design & Construction	1,315	1,315	1,315	1,315	1,315	1,315	1,075	1,075	1,075	1,075	1,075	13,265
																0
			Subtotal	Design & Construction	2,192	2,791	4,802	2,423	2,764	3,063	2,839	1,936	1,973	2,205	2,051	29,039
				O&M	0	0	0	233	273	643	725	853	930	1,010	1,113	5,778
Measures for Tourism		21	Development of Environmental Plan for Tourism	Design	50						25					75
																0
		㉒	Improvement of Sanitation Condition-Phase I	Design & Procurement	29	241	241									511
				O&M				125	125	125	125	125	125	125	125	1,000
		23	Improvement of Sanitation Condition-Phase2	Design & Construction				14	176	224	257					671
				O&M								108	108	108	108	432
		24	Reinforcement of Patrolling Capability for Tourism Activities	Design & Procurement			67									67
				O&M				60	73	85	98	110	124	136	149	835
			Subtotal	Design & Construction	79	241	308	14	268	224	314	0	32	0	32	1,452
				O&M	0	0	0	185	198	210	223	343	357	369	382	2,267
Measures for Environmental Resources		25	Reforestation in Bare Areas	Construction		122	124	125	125	125	155	155	150	150	150	1,381
				O&M				5	6	10	10	12	13	14	16	86
		㉖	Rehabilitation of Mangrove Swamps	Design & Construction	92	81	81	88	81	81	81	88	81	81	81	916
				O&M				8	10	11	12	13	16	17	18	105
		27	Fishing Activity Management Program	Equipment Procurement		32										32
				O&M		6	6	6	6	7	7	7	7	7	7	66
		28	Measures for Landscape (Landscape Management Guideline)	Design		50						25				75
																0
			(Reinforcement of Patrolling Capability for Shipping Activities)	Equipment Procurement				32								32
				O&M				4	4	5	5	5	5	5	5	38
			Subtotal	Design & Construction	92	285	205	245	206	206	236	268	231	231	231	2,436
				O&M	0	6	6	23	26	33	34	37	41	43	46	295
Environmental Monitoring		㉙	Environmental Monitoring (water quality and environmental resources)	Equipment Procurement	30			79	24	108	90					331
				Monitoring	72	11	32	24	37	64	40	23	42	25	87	457
		30	Environmental Inspection	Equipment Procurement	30							30				60
				Inspection	4	4	4	4	4	4	4	7	7	7	7	55
			Subtotal	Design & Construction	60	0	0	79	24	108	90	30	0	0	0	391
				O&M	76	15	36	28	41	68	44	30	49	32	94	513
Institutional Development		31	Reinforcement of Environmental Management Capability	Equipment Procurement	134					74					74	282
				Training	350	572	452	22	391	11	412	10	10	10	10	2,250
		㉝	Establishment of Visitor Center	Design & Construction	200	235	2,236									2,671
				O&M			40	40	40	40	40	40	40	40	40	360
			Subtotal	Design & Construction	334	235	2,236	0	0	74	0	0	0	0	74	2,953
				O&M	350	572	492	62	431	51	452	50	50	50	50	2,610
Total	Design & Construction + Equipment Procurement				4,957	7,631	15,151	16,808	21,533	12,521	14,239	12,959	16,398	14,437	4,791	141,395
	O&M + Training				426	593	614	765	1,516	2,561	2,930	3,594	3,937	4,683	5,019	26,438
	Grand Total (Design & Construction + Equipment Procurement + O&M + Training)				5,383	8,224	15,765	17,573	23,049	14,882	17,169	16,523	20,335	19,120	9,810	167,833

Note: ○ means priority projects.

THE STUDY
ON
ENVIRONMENTAL MANAGEMENT
FOR
HA LONG BAY

FINAL REPORT

Volume I Executive Summary

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ABBREVIATIONS

<Organization>

ADB	Asian Development Bank
BTFD	Board of Tourist Ferry Dock
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
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
FPA	Forest Protection Agency
GOV	Government of Vietnam
HIO	Haiphong Institute of Oceanology
HLESC	Ha Long City Environmental Sanitation Company
HLMB	Ha Long Bay Management Board
ID	Inspection Division
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
MOSTE	Ministry of Science, Technology and Environment
MPI	Ministry of Planning and Investment
NEA	National Environmental Agency
OECF	Overseas Economic Cooperation Fund
QNPC	People's Committee of Quang Ninh Province
S/C	Steering Committee
SIDA	Swedish International Development Agency
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
QNEMA	Quang Ninh Environmental Management Authority
VINACOAL	Vietnam National Coal Corporation
WB	World Bank

<Plan and Project>

HLMP	Development Master Plan of Ha Long City for 1994-2010
HWSSP	Ha Long City Water Supply and Sanitation Project
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
CVM	Contingent Valuation Method
EIRR	Economic Internal Rate for Return
FDI	Foreign Direct Finance
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Products
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
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
T-N	Total Nitrogen
T-P	Total Phosphorus

<Others>

EIA	Environmental Impact Assessment
IC/R	Inception Report
F/S	Feasibility Study
LEP	Law on Environmental Protection
M/M	Minutes of Meeting
O&M	Operations and Maintenance
QA/QC	Quality Assurance and Quality Control
R&D	Research and Development
SOE	State Owned Company
S/W	Scope of Work
TCVN	Vietnam Standards
TOR	Terms of Reference
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

PART I INTRODUCTION

CHAPTER 1 SCOPE OF THE STUDY

1.1 Background

Ha Long city (population approximately 130,000 and land area 122.5 km^2), is the largest city in Quang Ninh province. Since it forms the North Focal Economic Area together with Hanoi city and Hai Phong city, 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 spectacular geological characteristics. For the aesthetic seascape of these islands and islets, they are a major sightseeing spot in Vietnam, and this area 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, and mining wastewater 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 if they are not managed properly.

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, the study area for macro analysis is defined as i) Ha Long bay, where the area designated for the World Heritage and its buffer area 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 Study Schedule

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.

1.5 Organization of the Study

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.

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.

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

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

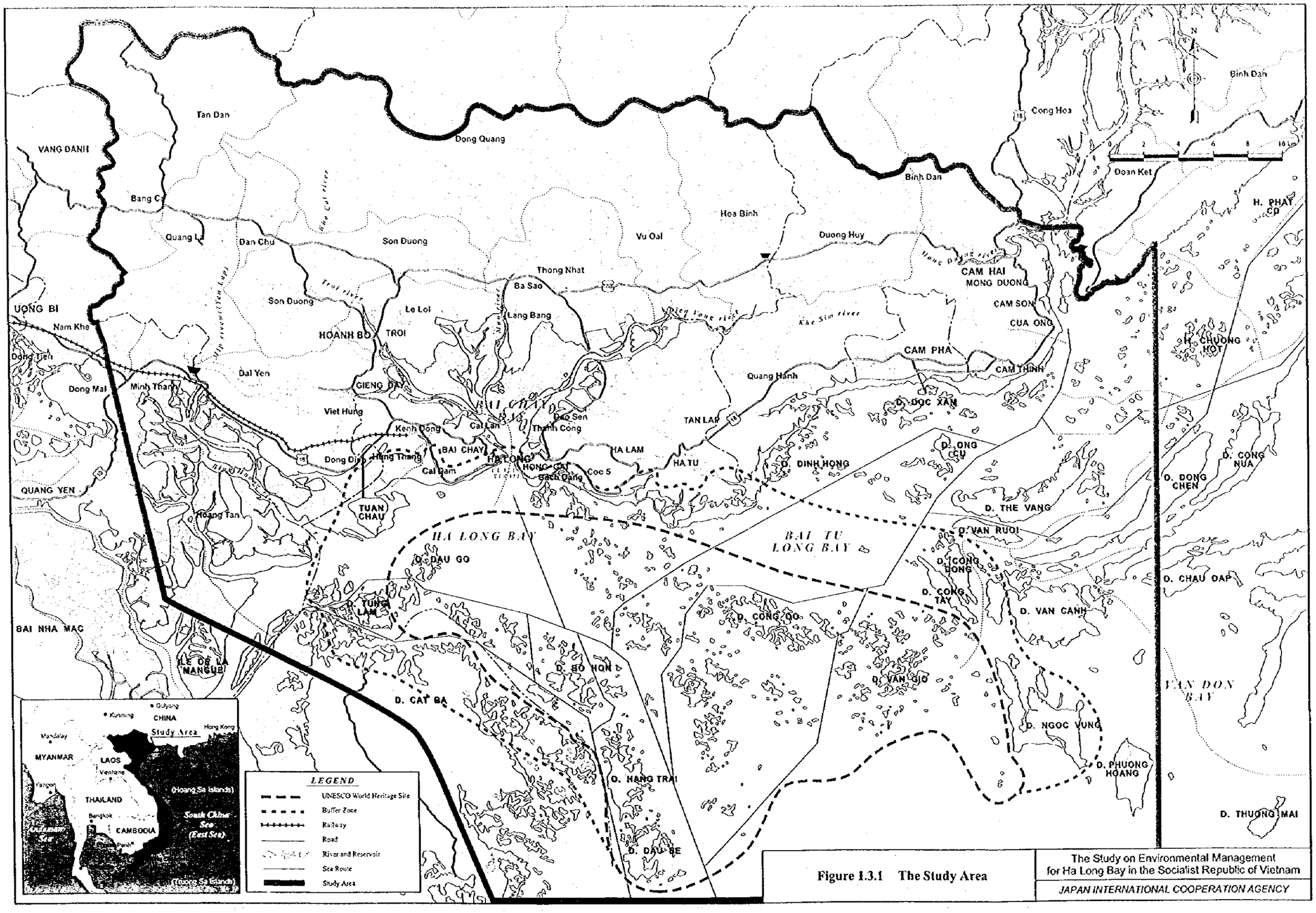


Figure 1.3.1 The Study Area

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

JAPAN INTERNATIONAL COOPERATION AGENCY

PART II

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

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

CHAPTER 2 GENERAL FEATURE OF THE STUDY AREA

2.1 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. Mining activities are carried out in the range of hills which stretch parallel with the coast from Ha Long city to Cam Pha town. The northern portion of the study area is mountainous and has limited opportunities for development. The coastal area is relatively narrow which has led to extensive coastal land reclamation.

2.2 Socioeconomic Conditions

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 total population of the study area was around 370,000 in 1996. Unlike most areas of Vietnam, the provincial economy is dominated by service and industrial activities, not by agriculture. Per capita GDP (1995) of Ha Long 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 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

At present the coal mining and its relating industries have been playing a dominant role in the study area. 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.

2.3 Infrastructure Development

2.3.1 Transportation

Ports in the study area are broadly categorized into coal ports, oil ports, and general ports. Major ports which have been under operation are Hong Gai floating port, Hong Gai coal port, Cot 5 coal port, Nam Cau Trang port, B12 oil port, Cai Lan port, Vung Duc coal port, Cua Ong coal port, and Hon Net floating port. The total length of urban road in Ha Long city is 480 km. National Highway 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.

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 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 maximum production capacity of the present system is estimated to be about 15,000 m^3/day.

2.3.3 Sewage

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, while 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 directory, and wastewater from tourist boat is discharged into the sea without treatment.

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).

2.3.4 Solid Wastes

It was estimated 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. HLESC and CPUEC are responsible for collection and disposal of domestic solid waste, but both companies are short of resources. 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

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. Electricity is also supplied from small-scale hydroelectric plants in the districts of Quang Hanh, 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.

2.4 Coastal and Aquatic Ecosystem

2.4.1 Wetland Ecosystem

Most of tidal flat 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. 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.

2.4.2 Aquatic Ecosystem

(1) Phytoplankton and Zooplankton

According to the Field Survey in the rainy season, 166 species of 6 phytoplankton phylums were identified. The species composition showed that flora of phytoplankton has the characteristics commonly observed in coastal waters of the temperate and subtropical zone. As for zooplankton, the result of samples collected at 10 survey points shows 47 species, and Copepoda has the highest number of species.

(2) Zoobenthos

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.

(3) Seagrass and Seaweed Bed

According to the existing data about seagrass, six species have been identified in Cat Ba island and Ha Long bay. Before the 1970s, 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.

(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 HIO's survey from 1993 to 1995, there are no corals around Hong Gai and Bai Chay in the mainland and near islands 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.

(5) 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 were recorded in Ha Long bay. There were three spawning areas and seven main fishing grounds in the study area.

2.5 Legal and Institutional Conditions of Environmental Management

Much of Vietnamese environmental policy is articulated in the "National Plan for Sustainable Development and Environment". 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.

The Ministry of Science, Technology and Environment (MOSTE)/National Environmental Agency (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.

LEP also refers to the responsibilities of the Provincial People's Committees regarding the protection of the environment. Department of Science, Technology and Environment (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 an eager appeal by DOSTE, no periodic monitoring station has been set up mainly due to budget constraint of the province.

CHAPTER 3 WATER POLLUTION MECHANISM

3.1 Oceanographic Conditions

3.1.1. Coast and Sea Bed Topography

The seabed in the bays is flat and shallow, only a few meters in depth in Bai Chay bay and near Hong Gai and Cam Pha. The depth is 1.0-1.5 m adjacent to the coastline, sloping gently toward the southeast, extending 2 m deep on average. However, there are narrow deep depressions up to 30 m deep, which allow the large cargo ships to approach the coastline. Since a geometrical closed level index of the bays is 4.9 for Bai Chay bay, the bay has a high potential of eutrophication from the viewpoint of coastal topography.

The tidal flat in the Ha Long bay area covers the whole Bai Chay bay, about 210 km^2. An extensive tidal flat with mangrove is found around the estuary of the Mip river with an area of about 9 km^2 and in Bai Chay bay about 5 km^2. Tidal flat has a water purification function as well as preservation of biodiversity and nursery ground of fishery resources. Land reclamation works and dike constructions in the tidal flat have been affecting water quality of the bays. The biggest land reclamation so far was carried out near Hung Thang for tourism development with about 30 ha.

3.1.2 Sea Bed Sediment

The sediment in the bays shows a typical grading shoreline with coarser-grained sediments near shore and finer-grained sediment offshore. Bottom sediments are dominated by mud, silt, and clay, but those of Bai Chay bay contain sand, gravel and even cobbles as well as organic maters and settled detritus.

3.1.3 Tides and Tidal Currents

(1) Rainy Season

In the study area, the high water tide occurs once a day for most of the days, occasionally twice a day in a month. Tides are being observed at the Hong Gai station, and the average tidal amplitude is about 2 m and the maximum is 4.7 m. The noticeable current direction is wholly towards the north from the open sea in the south of Ha Long bay in the dry season. On the other hand, the open sea and coastal waters generally flow in different patterns in the rainy season, so that they are not mixed up in the Ha Long bay area.

Currents were measured by the JICA study team in July 1998. The main objective of the measurement was to provide 15-day continuous data series necessary for harmonic analysis at three stations (Cua Luc, Cam Pha – Cua Ong, and Cua Dua) for upper and lower layers.

The results of the Field Survey revealed that a) the current velocity of the upper layer was higher than those of the lower layer especially at the Cua Luc strait, b) long term driving forces such as fresh water from rivers affected the upper layer mainly, c) diurnal constituents dominated, and d) the current velocity during the spring tide is far higher than that during the neap tide. Although the southern wind dominated during the survey period, the averaged currents of the upper layer at the Cua Luc strait clearly showed southward direction. This suggests that the freshwater from rivers to Bai Chay bay would be transported mainly in the upper layer.

(2) Dry Season

The current measurement for the dry season was conducted for 24 hours during the spring tide at Cua Luc and Cam Pha – Cua Ong in November 1998, by DOSTE. The north-southward component of the velocity dominated at the Cua Luc strait and the east-westward component dominated in Cam Pha – Cua Ong. These were the same characteristics as in the rainy season. Although the northern wind dominated at Cua Luc during the survey period, the southward component of the upper layer was lower than that in the rainy season. This suggested that the

major cause of the southward currents of the upper layer at the Cua Luc strait was not the wind but the freshwater inflow to Bai Chay bay.

3.1.4 Water Mass Structure

From the observed drastic change of water color and measured salinity distribution, there is a salt wedge type stratification in the bays and a tidal front of which two kinds of water bodies confront each other. One comes from freshwater from the catchment area, the other is seawater in the bays itself. The constant current is weak near the tidal front, and water body between coast and tidal front is regarded a stagnant condition. The results of the Field Survey and satellite image analysis revealed that there is a water body having relatively high water temperature and low salinity at the southern part of the study area. This water body flows from southwest to east and meanders in some places.

3.1.5 Water Exchange in the Bay

The volume of water of Bai Chay bay and Ha Long bay is estimated about 60×10^6 m^3 and $6{,}300 \times 10^6$ m^3, respectively. Assuming that the exchange of the bays' water is only caused by the fresh water flows, a retention time of the bays' water is about one month for Bai Chay bay and more than six years for Ha Long bay including Bai Tu Long bay.

3.2 Water and Sediment Quality

3.2.1 Overview of Historic Water Quality Data

Existing data suggest that the water quality of Bai Chay bay is affected by untreated domestic and industrial effluents from Ha Long city compared with water quality in outer Ha Long bay near the Cat Ba island. Nearshore water quality of the bays falls within the eutrophic or the mesotrophic states which are typical of coastal estuarine environments. The influence of land-based pollution on offshore water quality adjacent to Cat Ba island appears to be minimal.

3.2.2 Water Quality of the Rainy Season

(1) Water Quality in the Rivers

Dissolved Oxygen (DO) was essentially uniform across all rivers during dry and rainy conditions with about 6-7 mg/ℓ. Biochemical Oxygen Demand (BOD) was ranging from nil to 8 mg/ℓ, Total Nitrogen (T-P) was from 2 to 13 mg/ℓ. Total Phosphorus (T-P) concentrations show a greater difference between rainy (0.4 ~ 2.1 mg/ℓ) and dry (0.3 ~ 1.4 mg/ℓ) conditions. During the rainy day, T-P concentrations are generally high in the rivers.

There is a significant range in Suspended Solids (SS) among the rivers. The rivers showing the higher SS concentrations with 1,000 mg/ℓ on rainy day were a part of the Dien Vong river and its tributaries in Hong Gai quarter.

(2) Water Quality in the Bays

The concentration of BOD of 1.2 mg/ℓ on average did not exceed the Coastal Water Quality Standard in Vietnam (20mg/ℓ, TCVN). However, most measured transparency (2.1m on average), DO saturation (55% on average), inorganic nitrogen (0.14 mg/ℓ on average), and chlorophyll-a (2.6 mg/ℓ on average) correspond to the Eutrophic Water Classification (OCDI).

The Field Survey results show relatively high SS concentrations (22-37 mg/ℓ), partially exceeding TCVN (25 mg/ℓ) especially near estuary of the Mip river and in the Cam Pha area. These indicate that this water body was influenced by land-based sediment runoff and/or stirred bottom sediment.

The oil was measured in the whole study area, and levels nearshore area were relatively high compared with TCVN (2 mg/ℓ).

3.2.3 Water Quality of the Dry Season

The water quality of the dry season is rather good compared with that of the rainy season. Measured BOD was about 0.5 mg/ℓ, COD was 2.6 mg/ℓ, SS was 3.5 mg/ℓ

on average, respectively. Transparency of the dry season was ranging from 2 to 4 m with almost uniform distribution in the bays. In terms of salinity, in the dry season it was about 30 ‰, higher than in the rainy season. Transparency was ranging from 2 to 4 m.

3.2.4 Bottom Sediment Quality in the Bays

The T-N concentrations in the bottom sediments adjacent to Ha Long city and Cam Pha town (about 2-3 mg/g) are higher compared to sediments in offshore areas (less than 1 mg/g). This indicates that the bottom sediments in inshore area in the bays were influenced by a land-based sediment runoff. On the other hand, T-P levels in sediments were uniform across all sampling sites, with almost 0.3 mg/g.

3.2.5 Influence by Offshore Water Body

Relatively lower values of salinity with less than 15 ‰ were measured offshore area in July 1998. Lower salinity indicated that this water body was influenced by fresh water. This offshore water body showed also relatively high concentrations of COD (7.7 mg/ℓ), SS (6.5 mg/ℓ), and nutrients (T-N: 1.46 mg/ℓ, T-P: 0.81 mg/ℓ) compared with those in the center of Ha Long bay (COD: 6.4 mg/ℓ, SS: 2 mg/ℓ, T-N: 0.78 mg/ℓ, T-P: 0.56 mg/ℓ). The origin of this water body is explained by the satellite image analysis of water temperature in June 6, 1997 and in July 11, 1998. The water body having a relatively higher water temperature was seen in the southern outskirts of the study area, and it flew from southwest to northeast. Normally the tidal current of the Gulf of Tonkin flows from south to north during the rainy season. Northward prevailing currents in the western Gulf of Tonkin during the rainy season support a hypothesis on influence of the Thai Binh river and the Bach Dang river.

3.3 Pollution Load

3.3.1 Setting Sub-catchments

The catchment of the bays was divided into 14 sub-catchments for estimation of pollution loads, except for Cat Ba island and other islands. The sub-catchments having main rivers (No.1, 4 to 6, and 14) are located in the northern part of the catchment from the east to the west. The others (No.2, 3, 8 to 13) are located in along the coast line of the bays, these gradient varies from 12 to 20%.

The land use pattern of each sub-catchment was analyzed by satellite image analysis. The amount of freshwater flowing into the bays from each sub-catchment was estimated based on the hydrological data and analyzed land use pattern. The estimated total freshwater inflow is about 980 million m^3/year, 82% of which is discharged from the main rivers (Mip, Troi, Man, Dien Vong, Mong Duong rivers).

3.3.2 Specific and Non-specific Pollution Sources

(1) Database

An inventory of pollution sources was taken to develop a database. The various data especially on the land-based specific pollution sources in the study area were collected by conducting questionnaire survey by the JICA study team in 1998. The established database was provided to DOSTE by the JICA study team. It is recommended that database should be updated in appropriate timing to provide users latest data and information, to accumulate data, and to analyze time series changes of the data. Pollution source inventory data should be updated as soon as possible when new factory or any change of existing factory concerned as a pollution source is registered of informed.

(2) Pollution Sources

For pollution load estimation, specific pollution sources in the study area are largely classified into three groups, namely, domestic wastewater including

tourism, industrial wastewater including coal mining activities, and livestock wastewater based on the types and/or activities.

While normally non-specific pollution sources are classified into two groups, land runoff and precipitation. Land runoff in the study area consists of pollution loads from forest, agricultural area, bare areas including denuded area by coal mining, and urban areas.

3.3.3 Runoff Pollution Load to the Bays

The pollution loads flowing into the bays are calculated based on the generated pollution loads and runoff ratios. Domestic and livestock pollution loads are estimated by each population and pollution load units. Pollution loads from industries are estimated by volume of wastewater data obtained by the questionnaire survey for inventory and the Field Survey, and a typical water quality of each type of factory in Vietnam and Japan.

Runoff ratio depends on land use, type of pollution sources, distance between location of sources and the bays, and intensity of rainfall. In order to obtain the runoff ratios in the rivers, calibration is to be considered between water quality taken by the Field Survey and estimated runoff pollution loads. The pollution loads generated in the sub-catchments locating along the coastline, flow into the bays directly or via streams with relatively high runoff ratio.

A runoff pollution load is estimated by means of parameters such as runoff ratio and pollution load units which are set based on the result of the Field Survey. The pollution loads of BOD, COD, SS, T-N and T-P flowing into the bays are estimated as shown below.

Pollution Loads Inflow

(Unit: ton/day)

Items	Domestic	Industries	Livestock	Non-specific	Total
BOD	3.0	0.3	1.9	1.9	7.2
COD	4.9	1.9	2.8	12.3	21.9
SS	8.5	22.1	16.3	194.0	241.1
T-N	2.7	0.5	2.5	9.7	15.5
T-P	0.3	negligible	1.5	4.2	6.1

Notes: Domestic pollution load includes that of tourism.

3.4 Mass Balance of Pollutants in the Bays

Material circulation and balance in the bays should be taken into consideration for the analysis of organic pollution mechanism in the bays. For the analysis of mass balance of pollutants in the bays, four representative calculation areas were set, namely, Bai Chay bay, Bai Chay and Hong Gai, Cam Pha and Cua Ong, and Ha Long bay and Bi Tu Long bay. The box mixing method was used for calculation. This method is that once pollution loads poured in each area, the water and pollutants are mixed one tidal period (assumed 24 hours), and pollutants is conveyed to the outsides with same water volume as inflow. In order to simplify the calculation, exchange of water between outside of each area was not considered. BOD was used as an indicator of pollutants.

Primary production, decomposition, settlement, and elution are key components for clarification of organic pollution mechanism in the bays. These parameters are used to carry out the material balance calculation as well as to establish water quality simulation model in the bays. In order to obtain the values of these pollution mechanism parameters of the bays, the JICA study team implemented tests *in situ* and laboratory.

The results of calculation for the present condition (1996) are shown below. Standing stock in the table means BOD left in each line. The results of this mass balance analysis indicate that the organic pollutant represented by BOD is mainly brought by the primary production.

Mass Balance of Pollutants

(Unit: BOD ton/day)

Items / Areas	Contribution on increase in pollutants			Contribution on decrease in pollutants		Standing Stock
	Pollution Load Inflow	Primary Production	Elution	Self- * purification	Outflow	
Bai Chay bay	2.9	45.3	0.6	42.4	6.3	0.1
Bai Chay and Hong Gai	7.6	62.3	0.6	65.0	5.3	0.2
Cam Pha and Cua Ong	2.0	1,234.2	21.3	1,255.1	1.1	1.3
Ha Long bay	10.3	2,004.2	13.5	2,009.7	10.7	7.6

Notes : 1) * Self-purification includes decomposition and settlement.
2) Pollution load inflow in Bai Chay and Hong Gai area includes that from the Cua Luc strait.

3.5 Water Pollution Mechanism of the Bays

3.5.1 General Conditions of Water Quality in the Study Area

The results of the Field Survey indicate that the bays' water, on the whole, had mesotrophic or slightly eutrophic conditions and little deterioration. However, the water and sediment quality inshore along Ha Long city and Cam Pha-Cua Ong areas was comparatively influenced by land-based effluent discharges. It is obvious that run-off pollution loads from the catchment was limited to the inshore areas, mainly close to untreated effluent discharge points. The only pollution variable that appears to influence offshore areas was oil, due to the presence of shipping activities throughout the bays.

SS and iron (Fe) were the only problematic variables in some rivers. The rivers experience high SS loads of more than 1,000 mg/ℓ, which is likely a result of erosion from past and present denuded areas by urbanization, coal mining, and agricultural activities. The relatively higher Fe levels, for example more than 20 mg/ℓ, in some tributaries are likely caused by mine waste in concert with low pH of 2~4.

The concentrations of heavy metals in water and sediment of the bays were lower than the coastal water quality standards in Vietnam or international standards. The almost uniform distribution of zinc (Zn) and cadmium (Cd) concentrations throughout the bay sediment suggests that the their concentrations are considered to be natural.

3.5.2 Water Quality Distribution in the Bays

(1) Rainy Season

As observed in the Field Survey in July 1998, land-based fresh water together with pollutants is stagnated inshore from the Cua Luc strait to Ha Long bay. Besides, the water in the bays is stratified wedge-wise by land-based fresh water and is intruded offshore water which shows relatively higher values of COD, SS, and nutrients than those in the center of the Ha Long bay.

Observed water quality distribution in the rainy season is consistent with this water mass structure. Namely, relatively higher values of pollutants are observed inshore and offshore (COD: 8~11 mg/ℓ), while lower values in the center of Ha Long bay (COD: 5~6 mg/ℓ). Some parameters such as SS are the highest (about 7 mg/ℓ, except for the areas influenced by stirred up bottom sediment) at the front of the salt wedge, so-called null point, where run-off pollutants tend to be settled.

(2) Dry Season

Observed water quality distribution in the dry season was a little different from that in the rainy season. Salinity in the dry season was higher than in the rainy season due to little precipitation. Stratified water in the rainy season disappeared in the dry season, so that offshore water intruded into the inner part of bays. Accordingly, little differences of the water quality such as transparency was observed throughout the bays in the dry season.

3.5.3 Water Quality in the Rainy and Dry Seasons

The observed bays' water quality parameters of BOD, COD, and SS were around twice as high in the rainy season than the dry season. One possibility is that land based pollution loads into the bays in the rainy season are higher than in the dry season. This is mainly due to a high percentage of the pollutants washed out to the bays by the higher rainfall.

Another possibility is an effect of primary production. Chlorophyll-a values are around twice as high in the rainy season than in the dry season. This means that photosynthetic rate, namely generated organic matters by a primary production, in the rainy season is higher than in the dry season. This relatively active primary production in the rainy season is caused by the higher land based nutrients washed out by the precipitation, light intensity, and water temperature compared with the dry season.

3.6 Simulation Model Development

3.6.1 Structure of the Model

The objective of developing a numerical simulation model is to estimate changes in key water quality parameters for the different environmental scenarios derived from the socioeconomic frame. The model was first developed for the current conditions based on the data obtained by the Field Survey and the existing data for its validation. The model simulated three processes: hydrodynamics, diffusion, and nutrient cycling in the study area.

The hydrodynamic model was run to provide hydrodynamic conditions to be used in the water quality modeling. The period of the run was chosen to correspond to the Field Survey period. Four major tidal constituents were used as tidal forces rather than the single dominating constituent because of the large range of the amplitudes for tidal current velocities depending on the time.

Pollutant variables of the diffusion model were SS, and it was simply treated as a single variable. The diffusion model was run based on the results of the hydrodynamic model. The nutrient cycling model was also run based on the results of the hydrodynamic model. Pollutant variables addressed by the model were COD, inorganic nitrogen (I-N), organic nitrogen (O-N), inorganic phosphorus (I-P), organic phosphorus (O-P), and DO.

3.6.2 Validation of the Simulation Model

To validate results of the models, the simulated results were compared to the measured data obtained by the Field Survey.

The tidal current ellipses extracted from the simulated results were compared to the measured data for the validation of the tidal components of the simulated currents. The simulated results rather met with the measured data. The averaged velocities of the simulated results were also compared to the averaged velocities of the measured data. The simulated results roughly met with the data.

The simulated results of the diffusion model and the nutrient cycling model were compared to the measured data. The Field Survey data of SS, COD, T-N, and T-P

decreased from the load points to offshore and then increased toward the south and southeast. The simulated results showed such trend.

On these grounds, it is concluded that the developed numerical simulation model can be used for the projection of future water quality in the bays.

CHAPTER 4 FUTURE SOCIOECONOMIC FRAME

4.1 Review of National, Provincial, and City Development Master Plans

4.1.1 National Development Master Plan

The two key policy documents presented at the Eighth Party Congress in June-July 1996 were "Political Report of the Central Committee" and "Orientation and Tasks of the 1996-2000 Five-year Plan for Socio-economic Development". The key economic theme of the developments is to promote industrialization and modernization, and the overall goal is to develop Vietnam into an industrialized economy by 2020. The Political Report indicates that Vietnam would continue to develop a mixed economy, and that the State economic sector together with the cooperative sector should constitute the foundation of the economy, while the private sector would account for a considerable proportion. The following three basic economic objectives were identified for the period through 2000:

- High, sustainable, and efficient economic growth,
- Macro-economic stabilization,
- Long term development of human resources, infrastructure, technology, and institutions.

4.1.2 Development Master Plan of Quang Ninh Province

The basic planning goal of the Development Master Plan of Quang Ninh Province 1995-2010 is to develop the province into an industrial and tourism province and to become one of the growth poles in the Northern Growth Triangle. The industrial priorities will change drastically between in 1996-2000 and in 2001-2010. A shift of industrial structure from the traditional industrial sectors to new urban industrial sectors is expected to achieve the goal. The Urban Development Master Plan of Quang Ninh province for 1995-2010 (August, 1995) identifies major development projects in urban and suburban areas in the province. The development direction of the study area which includes two major provincial urban centers is determined by the Urban Development Master Plan.

4.2 Future Development Plan

The Development Master Plan of Ha Long City for 1994-2010 (HLMP) provides the orientation of long term socioeconomic and spatial development of Bai Chay, Hong Gai and Cam Pha-Cua Ong in the period of 1994-2010 and further. The major planning goal is to realize a well balanced region harmonizing with various sectors such as urban development in Bai Chay - Hong Gai area, the coal mining activity, tourism development, and industrial development. The development of Ha Long is divided into the following three phases:

(1) First Phase from 1993 to 2000

- to upgrade Hong Gai town to Ha Long city
- to expand the city boundary to Viet Hung and Dai Yen communes (Hoanh Bo district)
- to improve and construct the urban infrastructure
- to promote the construction of tourism infrastructure
- to promote the expansion of the Gieng Day industrial area (construction material factories and the shipyard)
- to expand the deep-sea port of Cai Lan gradually

(2) Second Phase from 2000 to 2010

- to expand the city boundary to the north and west of Cua Luc, Troi small town and part of the following communes, Le Loi, Thong Nhat, Vu Oai, Son Duong (Hoanh Bo district) and Minh Thanh (Yen Hung district)
- to build Cua Luc export processing area (at present, Cai Lan concentrated industrial development area) and the high tech industrial area
- to construct the urban infrastructure, in particular, relating to transportation, water supply, sanitation and environment protection
- to continue constructing the tourism infrastructure

(3) Third Phase after 2010

- to expand the city boundary farther to the east, Cam Pha (excluding Cong Hoa and Cam Hai communes) and Bai Tu Long bay
- to concentrate the coal mining industry in Cam Pha area

The major development projects have been identified and some of them have already been implemented based on the general direction defined by the master plan. Generally speaking, however, the implementation schedule is delayed and, furthermore, the project sizes have become smaller in some cases because of the recent international and, consequently, domestic economic turmoil.

4.3 Setting Future Socioeconomic Framework

The socioeconomic development frame defines the fundamental conditions of the environmental management plan. At the beginning stage of the study, the development frame planned by QNPC was granted to be a given condition for the EMP preparation. However, it is revealed that the existing development frame needs to be partly adjusted, responding to the current change of investment circumstances, and results of the EIAs of the concrete projects. In particular, the frame concerning the major development projects were adjusted, i.e., their development scales and schedules (see Table 4.3.1).

4.3.1 Population, Employment and Land Use

The future total population of Ha Long city and Cam Pha town and the change of administrative boundary in the study area are directly adopted from HLMP. The population of sub-districts is forecast based on each sub-district's recent growth rate. In addition, the following items are also adopted from HLMP.

- employment change by development phase
- economic potential, future production and labor force demand by major industry, and
- future demand for urban development land in Ha Long city

4.3.2 Tourism

The tourism development frame of Quang Ninh province is adopted as a basic frame for the EMP preparation, such as the number of international visitors to Ha Long. The average share of domestic visitors in the study area recently accounts for 67.2 % of the visitors to the province. This figure is used for the estimation of domestic visitors to Ha Long.

4.3.3 Estimation of Sizes of the Major Industrial Development Projects in the Study Area

The industrialization and relevant infrastructure development are regarded as one of the possible environmental threats in the study area. The size of the major industrial development projects is one of the crucial factors determining their degree of environmental impacts. For the further steps of EMP preparation, the sizes of the major projects are estimated by using the data on location unit per site area of factory building by industry. As data on location unit is currently not available in Vietnam, the Japanese data are substitutionally adopted for the estimation.

4.4 Environmental Impacts by Future Socioeconomic Development

4.4.1 Present Progress of Countermeasures

The following environmental measures were set for the future water quality projection, namely "without an Environmental Management Plan" (Scenario I, see Chapter 5.5). The measures were selected from the current progress of environmental controls including planned measures which will have been done by 2010.

- Sewage construction and management project in the Bai Chay area,
- First stage of Ha Long City Water Supply and Sanitation Project (HWSSP),
    - Construction of Gien Day and Deo Sen wastewater treatment plants,
    - Drainage improvement in Hong Gai area,

- Upgrade of solid wastes collection up to 65% in Ha Long city and 50% in Cam Pha town,

- Present practices of sanitation improvement,
- Wastewater treatment to attain effluent standards for new industrial development projects including mining,
- Present reforestation activities, and
- Present pollution control for coal mining activities by VINACOAL.

4.4.2 Future Environment in the Ha Long Bay Area

The projected future water quality "without an Environmental Management Plan" by the developed simulation model is shown in Figure 4.4.1.

In case of COD_{Mn}, it was estimated to increase from 4 mg/ℓ to 5 or 6 mg/ℓ at the upper layer in Bai Chay bay. The increase in COD_{Mn} will be most pronounced in the coastal area form Tuan Chau to Hong Gai areas, and it will extend out to the World Heritage core area.

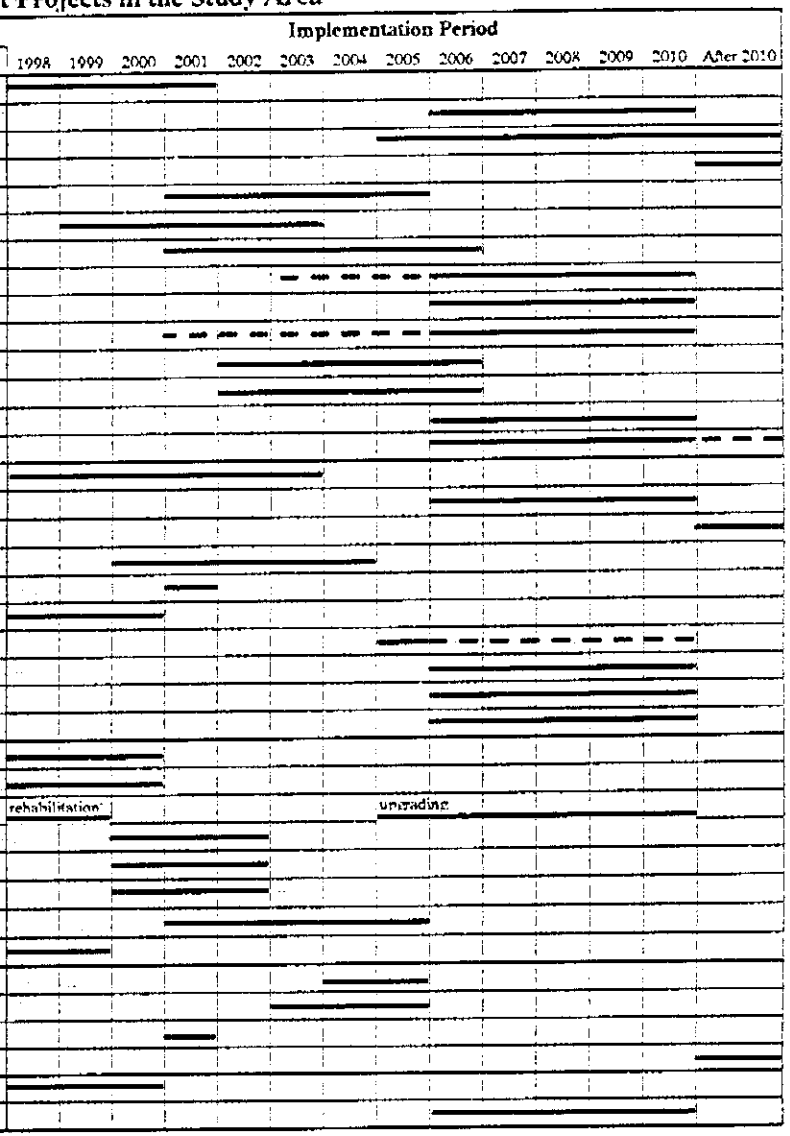
Solid wastes generation in the Ha Long bay area in 2010 is expected to be four times as much as that of the present. The generated solid wastes can not be collected and disposed well by the present progress of countermeasures in the future. This situation will result in deterioration of water quality as well as sanitation condition, and destruction of landscape.

The increased bare areas by the development activities will lead to increase in SS runoff and soil erosion. Land reclamation will decrease in tidal flats and/or mangrove swamps. It is likely that the losses of tidal flats and mangrove swamps will decrease water purification capacity and habitats for fish and shellfish in the bays.

Therefore, the present progress of environmental controls are not enough to prevent water quality deterioration, destruction environmental resource in the Ha Long bay area. Without proper countermeasures, it is possible that the future socioeconomic development would have negative impacts upon the development itself (see Figure 4.4.2).

Table 4.3.1 Adjusted List of Major Development Projects in the Study Area

Sector		project	Location	Area (ha)	Implementation Period From	To
Industry	1	Cai Lan Concentrated Industrial Park Phase I	Cai Lan	78	Ongoing	2001
		Cai Lan Concentrated Industrial Park Phase II	Cai Lan	300	2005	2010
	2	Hoanh Bo Industrial Park (renamed from Dong Dang IZ)	Dong Dang, Troi	300	2005	
	3	High-tech Industrial Park	Le Loi - Hoanh Bo	300	After 2010	
	4	Expansion of brick and tile factory	Gieng Day, Hoanh Bo		2001	2005
	5	Expansion of ship building factory	Gieng Day		1999	2003
	6	Coal burned thermal power station (300MW), BOT by OXBOW	Vu Oai - Hoanh Bo		2001	2006
	7	Coal burned thermal power station (300MW)	Bridge no. 20 - Cua Ong	50-60	2006	2010
	8	Steel refinery (1.5mil. t/year)	Bridge no. 20 - Cua Ong		2006	2010
	9	Steel mill (0.5mil. t/year)	Cai Lan		2006	2010
	10	Hoan Cau - Taiwan cement	Lang Bang - Hoanh Bo		2002	2006
	11	Hai Long - South Korea cement	Lang Bang - Hoanh Bo		2002	2006
	12	Cement Factory	Thong Nhat - Hoanh Bo		2006	2010
	13	Cement Factory	Quang Hanh - Cam Pha		2006	2010
Transport	14	Cai Lan port Phase I Stage1 (3 berths)	Cai Lan		1998	2003
		Cai Lan port Phase I Stage2 (4 berths)	Cai Lan		2006	2010
		Cai Lan port Phase II	Cai Lan		After 2010	
	15	Bai Chay Bay bridge	Cua Luc		2000	2004
	16	Relocation of Hong Gai port	Hong Gai		2001	2001
	17	Improvement of B12 oil port	Bai Chay		Ongoing	2000
	18	Relocation of B12 oil port			2005	
	19	Nam Cou Trang coal port	Nam Cou Trang		2006	2010
	20	Dien Vong River bridge	Ha Khanh		2006	2010
	21	Bieu Nghi air port	Bieu Nghi		2006	2010
Road	22	Improvement of 18A (Hong Gai - Cua Ong)			Ongoing	2000
	23	Improvement of 18A (Chi Linh - Bai Chay: 35km-118km)			Ongoing	2000
	24	Improvement of 18A (Cua Ong - Mong Cai)			Ongoing	2010
	25	Improvement of 18B (Dong Dang - Lang Bang)			2000	2002
	26	Improvement of Troi - Lang Bang (Hoanh Bo)			2000	2002
	27	Improvement of Hong Gai - Ha Khanh (Dien Vong River)			2000	2002
	28	Highway (Noi Bai - Ha Long)			2001	2005
	29	Causeway and Bridge to Tuan Chau Island	Tuan Chau		Ongoing	1999
Railway	30	Extension (Ha Long - Cai Lan, 4km)	Bai Chay		2004	2005
	31	Improvement (Kep - Ha Long)			2003	2005
	32	Removal of Coal Transport Railway (Hong Gai - Ha Tu)			2001	2001
	33	Coal Transport Railway (Mong Duong - Lang Bang)	along Road 18B		After 2010	
Others	34	Land Reclamation Hung Tang I	Hung Tang	30	Ongoing	2000
	35	Land Reclamation Hung Tang II	Hung Tang	170	2006	2010



Note: The dotted line indicates a possible advanced or delayed implementation peoriod.

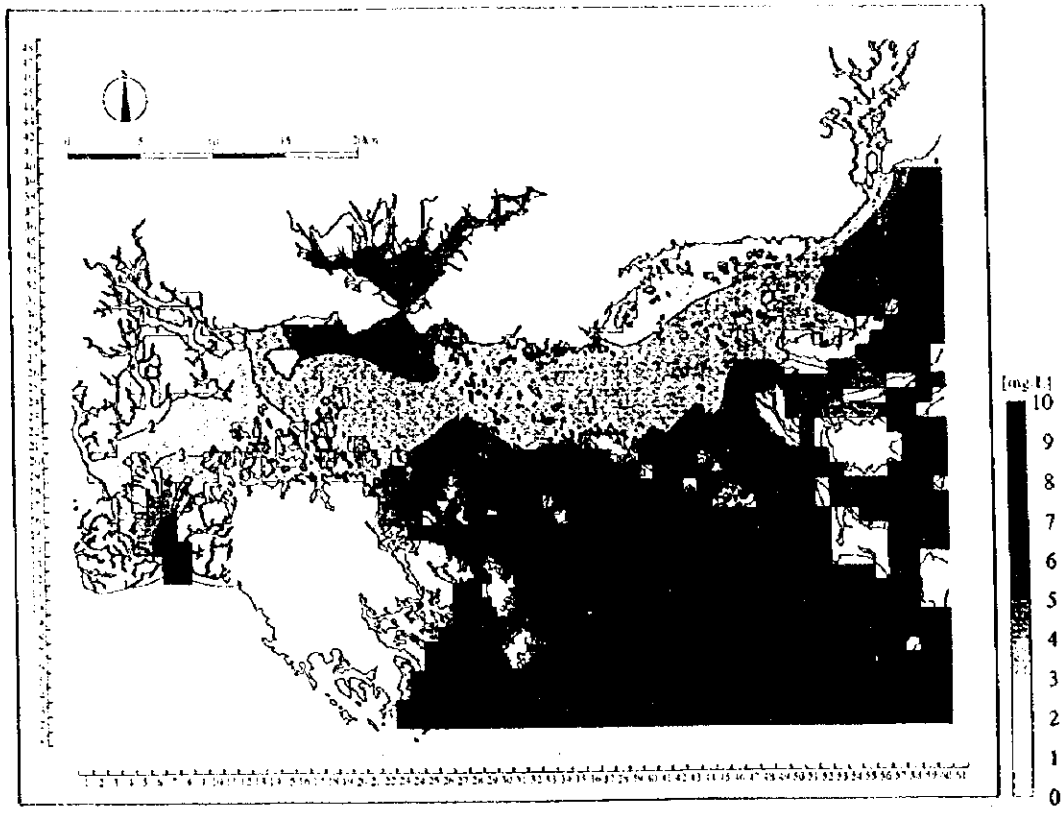


Figure 4.4.1 (1) Projected Future Water Quality "Without Environmental Management Plan" (COD, Upper Layer)

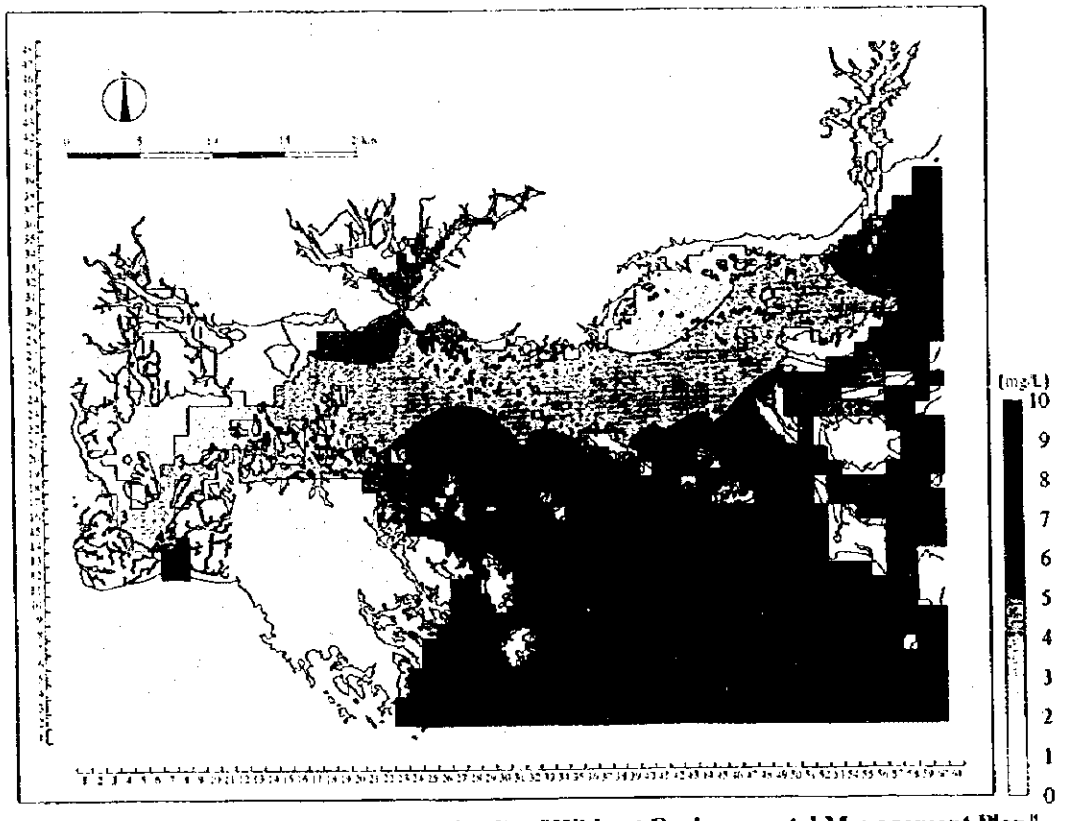


Figure 4.4.1 (2) Projected Future Water Quality "Without Environmental Management Plan" (COD, Lower Layer)

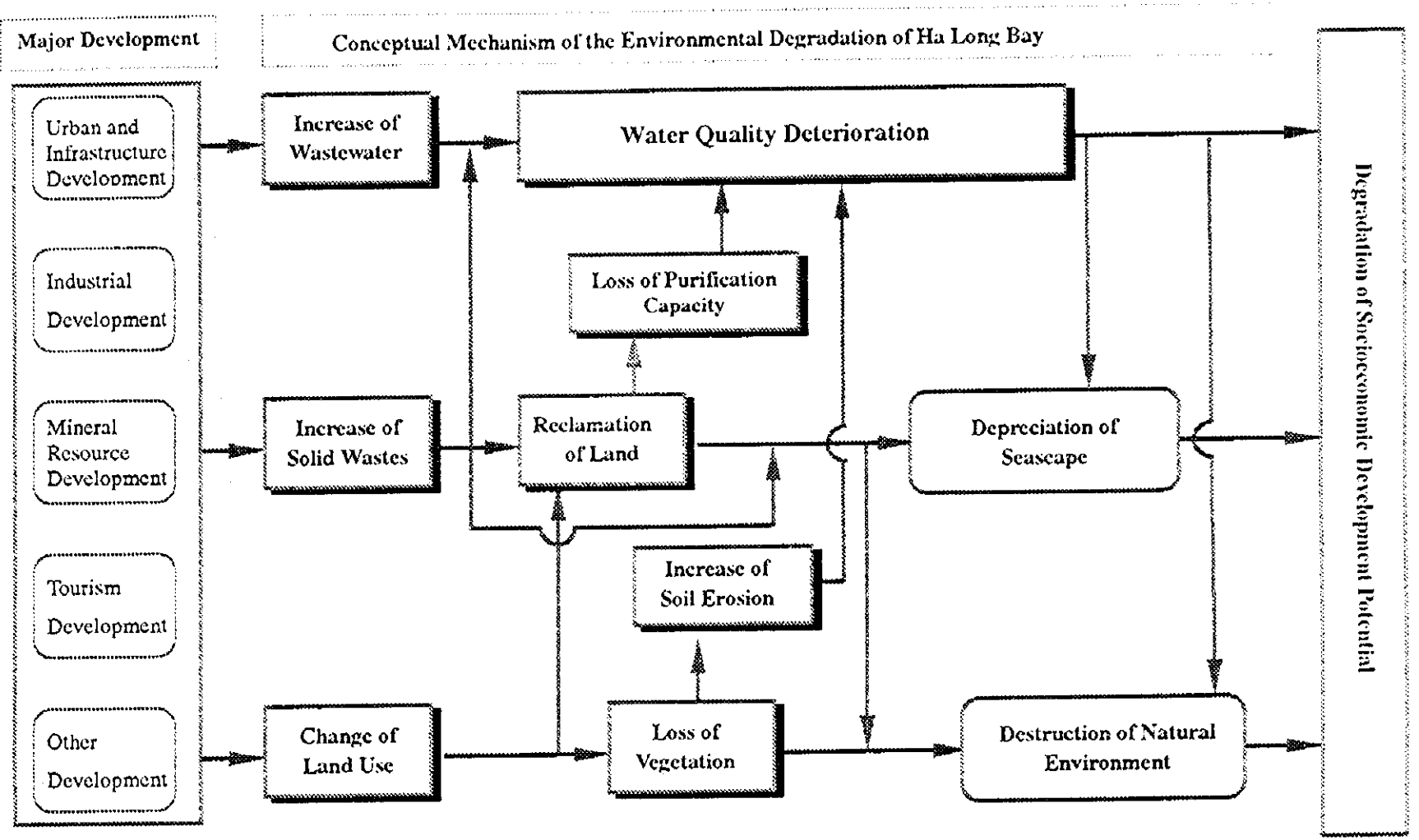


Figure 4.4.2 Environmental Degradation by Future Socioeconomic Development in the Ha Long Bay Area

PART III

ENVIRONMENTAL MANAGEMENT PLAN FOR HA LONG BAY

PART III ENVIRONMENTAL MANAGEMENT PLAN FOR HA LONG BAY

CHAPTER 5 FRAMEWORK OF THE ENVIRONMENTAL MANAGEMENT PLAN (EMP)

5.1 Necessity of Environmental Management Plan

Ha Long bay area has the following environmental problems caused by untreated domestic and industrial wastewater, and solid wastes. Without the proper countermeasures, environmental destruction caused by the future economic growth is expected to get serious.

- Possible of water quality deterioration by land based and offshore pollution
- Environmental degradation by tourism activities
- Pollution loads from shipping activities
- Deforestation together with increase in SS and soil erosion by land use changes
- Decrease of tidal flats and mangrove swamps by disordered land reclamation
- Decrease of coral reef by robbing and/or water quality deterioration
- Depreciation of landscape by cargo ships or tankers

Problems on environmental management are as follows:

- Unclear demarcation of responsibilities
- Poor environmental monitoring
- Lack of trained staff for environmental management
- Poor public awareness

To solve the current environmental problems and prevent the possible future problems, and also achieve environmentally sound socioeconomic development, a comprehensive environmental management plan consisting of hard and software types of measures are actually needed. The wise use and protection of environmental resources are essential to develop the regional socio-economy such as tourism industry.

It should be noted that in case of environmental accidents, enterprises of the projects and owners of ships are responsible for the emergency remedial measures to deal with such accidents.

5.2 Vision and Goals

5.2.1 Vision

The fundamental vision of the Environmental Management Plan for Ha Long bay (EMP) is to be set as follows:

"Environmentally Sound and Sustainable Development of the Ha Long Bay Area".

5.2.2 Goals

The goals to attain this vision are to be set as follows:

- Goal I : Absolute Protection of the World Heritage
- Goal II : Achievement of Environmental Protection for Sustainable Economic Growth
- Goal III : Establishment of Enforcement Capability of Environmental Management

5.3 Target Area and Year

Considering the invaluableness of the World Heritage area in Ha Long bay, the target area for the EMP is principally defined as i) the bays where the area designated for the World Heritage and its buffer area, and ii) the hinterland areas which may affect the environment of the bay. Thus, the area of the EMP can be delineated as the watershed of the Mip, Troi, Man, Dien, and Mong Duong rivers in the north, the river mouth area of the Mong Duong river in the east, the Binh Huong estuary in the west, and the World Heritage area in the south as shown in Figure 5.3.1. The total area of the EMP is about 2,500 km^2 including 1,300 km^2 of sea area. As for the environmental impacts from the outside of the EMP area, they are considered as boundary conditions.

Since the EMP is prepared basically subject to the socioeconomic development framework of HLMP prepared by QNPC, the target year of the EMP is set as 2010 same as that of HLMP.

5.4 Target Management Items

The target management items for Goals I and II can be categorized into two groups, namely, water quality and environmental resources, while management items for Goal III consist of technical and institutional capacities. Target items will be selected for formulating the EMP as follows.

5.4.1 Water Quality

Although there are many kinds of environmental factors in the EMP area, water quality is considered a key integrated factor from an environmental managemnet viewpoint in the EMP area considering the mechanism of environmental degradation of Ha Long bay. Therefore, the EMP was developed putting high priority on water quality management.

5.4.2 Environmental Resources

Normally, forests and fishes are defined as renewable natural resources. In addition, tidal flats, mangrove swamps, and coral reefs are playing important roles in maintaining good environment including ecosystem. Thus, they were selected as target items of environment resources.

Keeping the beautiful landscape of the World Heritage area is the essential element of the EMP. Landscape in the EMP area is composed of shape and conditions of islands, water conditions surrounding islands, the elements of landscape in the World Heritage area were selected as target for the EMP.

5.4.3 Technical and Institutional Capacities

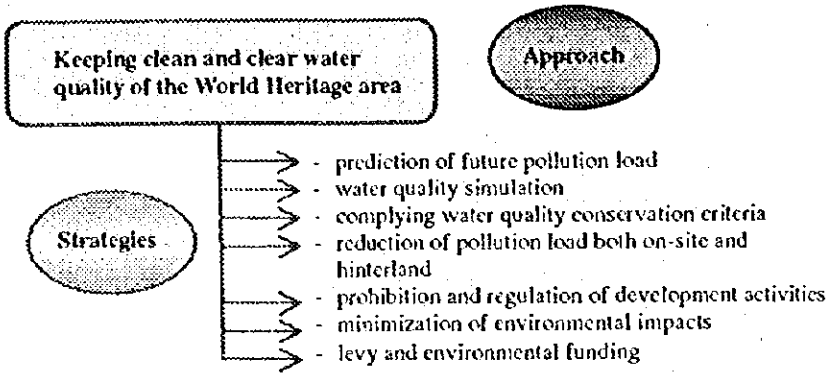
To implement the EMP certainly and steadily, it is essential to strengthen the technical and institutional capacities of responsible and executing agencies. Thus, the target items were selected for each component of capacity building.

5.5 Approach and Strategy

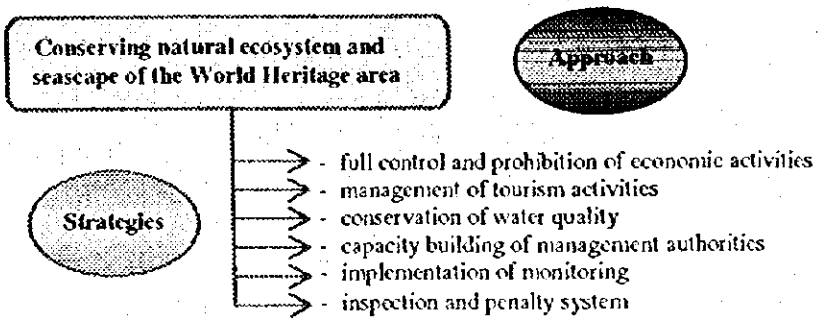
In order to attain the vision and goals of the EMP for Ha Long bay, it is necessary to set an administrative approach and strategy which guides actual environmental components and projects of the EMP. Therefore, the following approach and strategy is taken for the EMP.

5.5.1 Absolute Protection of the World Heritage (Goal I)

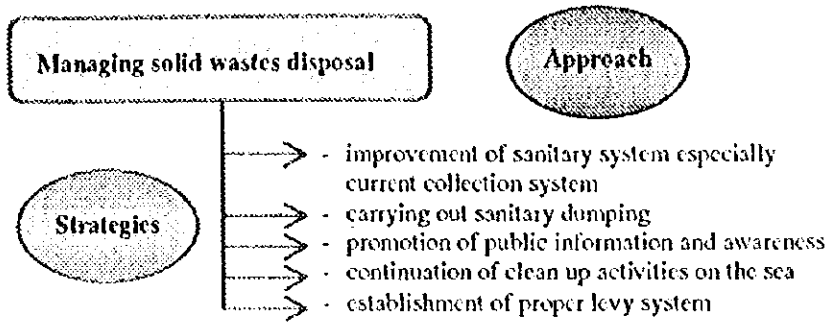
(1) Keeping Clean and Clear Water Quality of the World Heritage Area



(2) Conserving Natural Ecosystem and Seascape of the World Heritage Area

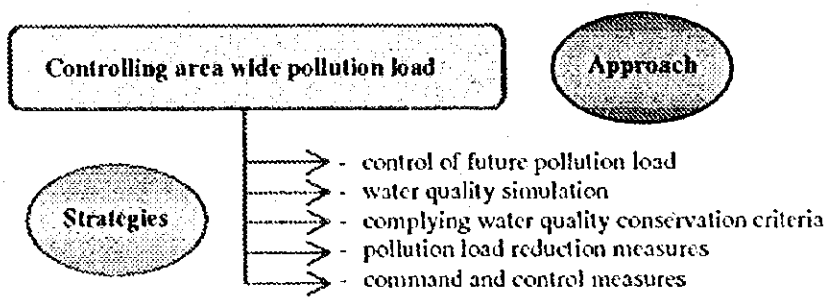


(3) Managing Solid Wastes Disposal

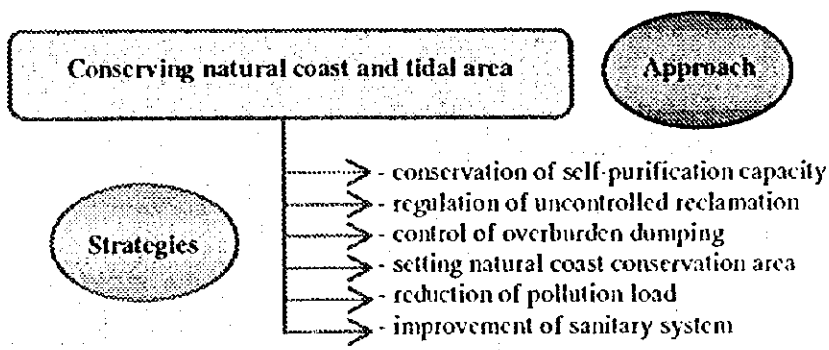


5.5.2 Achievement of Environmental Protection for Sustainable Economic Growth (Goal II)

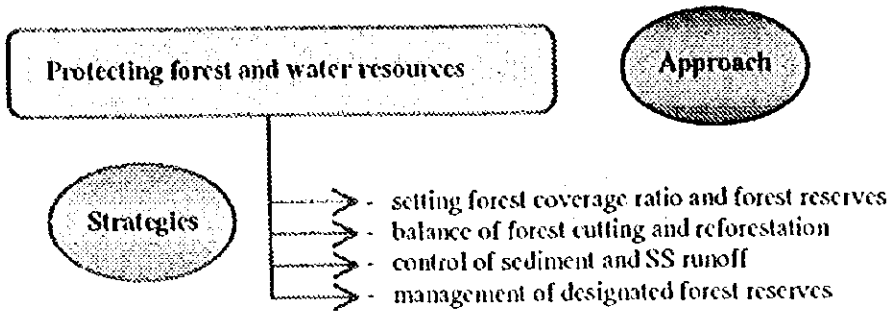
(1) Controlling Area Wide Pollution Load



(2) Conserving Natural Coast and Tidal Area

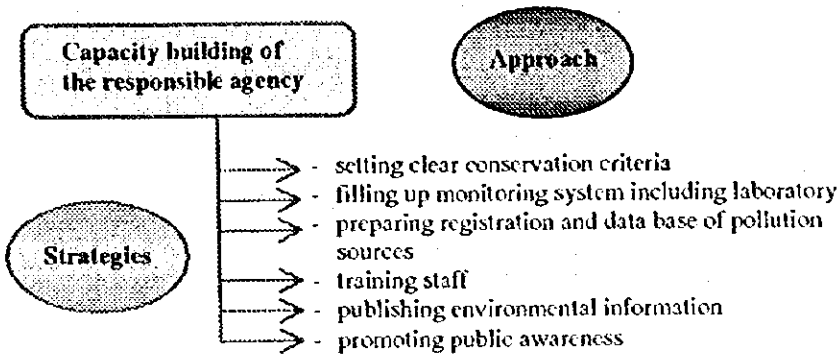


(3) Protecting Forest and Water Resources

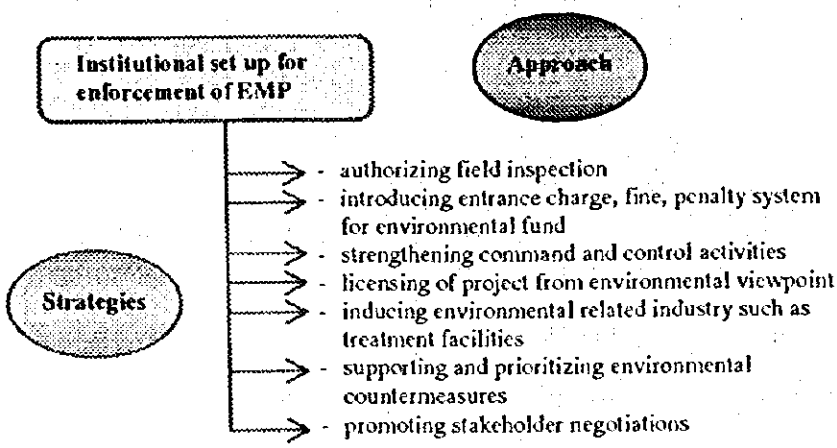


5.5.3 Establishment of Enforcement Capability of Environmental Management (Goal III)

(1) Capacity Building of the Responsible Agency



(2) Institutional Set up for Enforcement of the EMP



5.6 Environmental Zoning

The EMP area can be broadly divided into four environmental zones, namely, 1) Special Conservation Zone (SCZ), 2) Conservation Zone (CZ), 3) Active Management Zone (AMZ), and 4) Development Zone (DZ) as summarized below. The location of each zone is shown in Figure 5.6.1.

Principal Distribution of Environmental Zones

Zone	Total area (km^2)	%	Principal distribution
1) Special Conservation Zone	1,080	43	- World Heritage core and buffer areas - national park and forest reserves
2) Conservation Zone	720	29	- sub-catchment area - around the World Heritage buffer area
3) Active Management Zone	250	10	- tidal flat along the coastal line - Bai Chay bay
4) Development Zone	450	18	- around the planned development area - existing urban and mining area
Total EMP area	2,500	100	-

5.7 Conservation Criteria by Environmental Zones

5.7.1 Examination of Environmental Conservation Level

(1) Setting Scenarios for Environmental Management

The following three scenarios of environmental management in the future (2010) are set focusing on the water quality in the bays.

- Scenario I: Present progress of environmental control (without the EMP).
- Scenario II: Environmental control to keep pollution loads at the present level. This scenario also includes pollution control for specific areas such as the Bai Chay beach, Hong Gai and Cam Pha areas.
- Scenario III: Environmental control to reduce the present level of pollution loads (organic and inorganic pollutants, nutrients) in order to alleviate progress of eutrophication in the bays.

(2) Setting Environmental Conservation Level

The future water quality projected by the simulation model revealed effectiveness of each scenario to conserving the ambient water quality in the bays. In the case of Scenario I, the water quality, for example COD in Bai Chay bay was estimated to increase from 4 mg/ℓ to 5 or 6 mg/ℓ in the upper layer. The increase in COD could be most pronounced in the coastal area from Tuan Chau to Hong Gai areas, and it will extend out to the World Heritage core area. Thus, the projects in Scenario I are not enough to prevent water quality deterioration in the Word Heritage core area.

In Scenario II, almost the same water quality level as the present was projected.

In case of Scenario III with nearly the double cost of Scenario II, little changes of water quality were identified compared with Scenario II. These almost full-scale countermeasures can not improve the water quality in the bays drastically, especially in the World Heritage core area. This is because nutrients arise from non-specific pollution sources which can hardly be controlled.

It follows from this that the Scenario II level is a relatively efficient one to conserve water quality in the bays. Therefore, the Scenario II level should be applied to establish management level of the EMP.

5.7.2 Conservation Criteria

The conservation criteria by environmental zones are proposed for water quality, environmental resources including landscape.

(1) Water Quality Conservation Criteria

Considering the significance of each environmental zone, and the current water quality and beneficial uses of water in each zone, the water quality conservation criteria are set as shown below:

Water Quality Conservation Criteria (Sea Area 1)

Environ. zone	Applied area	Transparency (m)	BOD (mg/ℓ)	COD_{Mn} (mg/ℓ)	T-N (mg/ℓ)	T-P (mg/ℓ)	SS (mg/ℓ)
SCZ	Western Part	3.0	1.5	7.0	1.3	0.6	5
	Eastern Part	3.5	1.0	4.5	1.1	0.5	4
CZ	-	3.0	1.0	4.5	1.1	0.5	5
AMZ	Bai Chay coastal	0.5	1.3	7.5	1.6	0.7	15
	Hong Gai coastal	1.5	1.3	7.5	1.6	0.7	5
	Bai Chay bay	1.5	1.3	7.5	1.6	0.7	5
	Cam Pha and Cua Ong	1.5	1.1	5.0	1.6	0.7	7
	Binh Huong estuary	0.5	1.3	7.5	1.6	0.7	15

Water Quality Conservation Criteria (Sea Area 2)

Environ. zone	DO (mg/ℓ)	pH	Oil slick	Floating solid wastes	Fecal coliform (MPN/100 mℓ)
SCZ	5	7.0-8.3	nd	nd	nd
CZ	5	7.0-8.3	nd	nd	nd
AMZ	5	7.0-8.3	nd	nd	1,000

Note: 1) nd shows not detectable.
2) Fecal coliform is applied to sea bathing area.

The Inland Water Quality Standards of Vietnam (TCVN 5942, 1995) is to be applied to the surface water of all environmental zones.

(2) Environmental Resources

1) Natural Environment

No land reclamation is permitted in tidal flats in SCZ. For tidal flats with more than 16% coverage with mangrove, only existing planned land reclamation is permitted. For other tidal flats, 75% is to be conserved leavings some room for controlled development. As for mangrove swamps, at least the present acreage in each area should be protected to keep their functions. For some mangrove swamps with relatively low coverage ratio, conservation criteria were set at the present average coverage ratio of 16% to improve their function.

The conservation criteria for coral reef are set on the basis of the present distribution, species composition, and living coal cover.

Since fish and shellfish can be regarded as indexes of marine environment as well as economic value, their management need to be based on species composition and the amount of catches. Thus, it is recommended that management criteria should be carried out by controlling illegal fishing at the fishery grounds.

Conservation Criteria for Natural Environment

Environ. zone	Forest (green) coverage	Tidal flats	Mangrove swamps	Coral reefs	Fish and shellfish
SCZ	464 km² (94%)	1,120 ha	200 ha	Present conditions	No illegal fishing at fishing grounds
CZ	208 km² (85%)	-	-	-	ditto
AMZ	-	17,300 ha	3,800 ha	-	ditto
DZ	228 km² (52%)	-	-	-	-

Note: Present conditions of coral reefs are distribution, species composition, and living coral reefs.

2) Landscape

The present condition of landscape of the World Heritage area (SCZ) should be absolutely protected. This requires that the elements producing high value of landscape, such as shape and the surface conditions of islands as well as color and clearness of seawater should be conserved as they are. As for natural scenery, artificial obstacles should be controlled strongly in SCZ. Therefore, the following conservation criteria are proposed on the sea area in SCZ.

Conservation Criteria for Landscape

Environ. zone	Shape and surface of islands	Color and clearness of seawater	View of natural resources	Natural scenery
SCZ	No islands changed artificially	To be controlled as water quality	- No islands having bald spots - To be controlled as tidal flats and mangrove swamps	No cargo ships anchored in the World Heritage core area and deviated from the courses

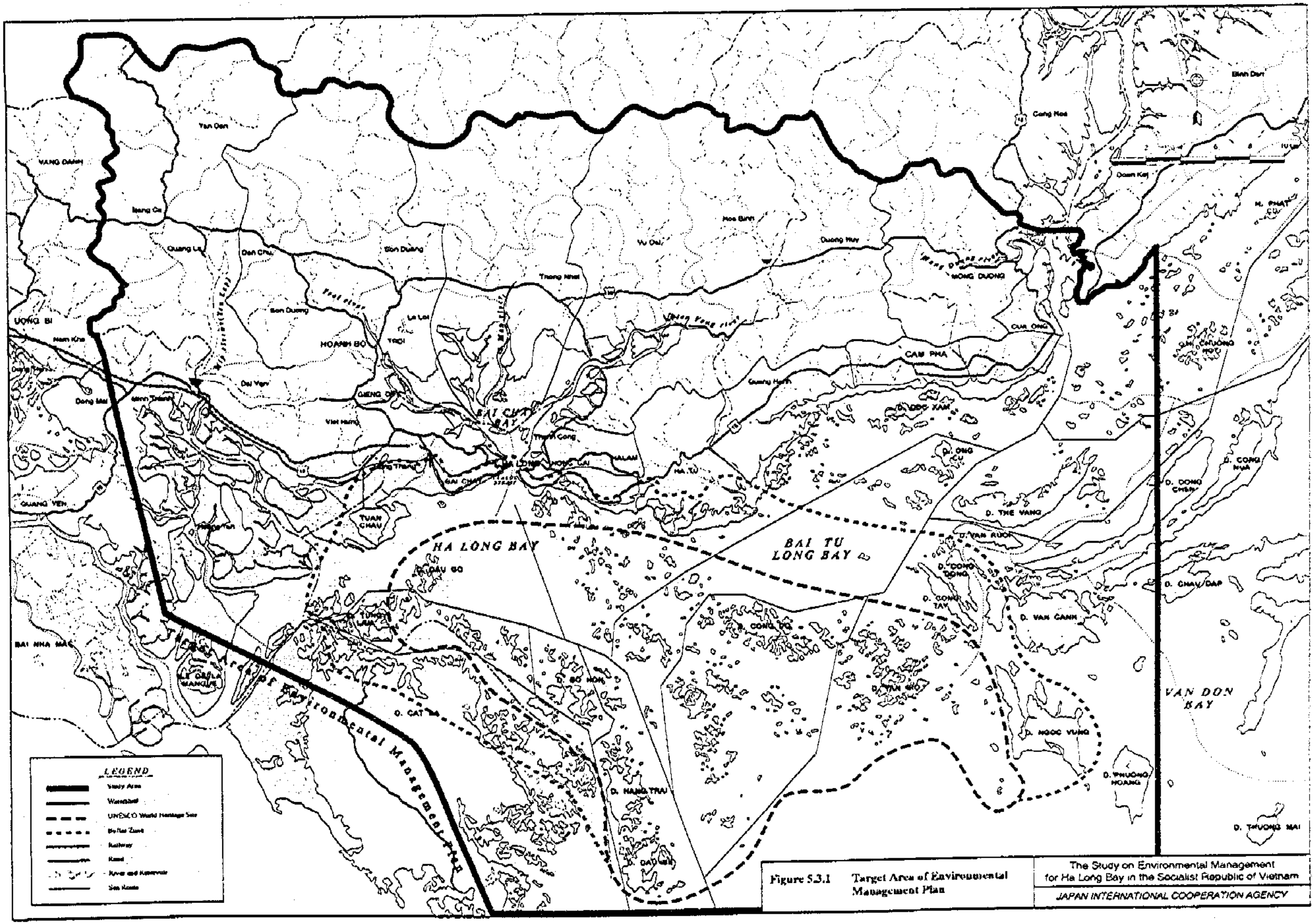


Figure 5.3.1 Target Area of Environmental Management Plan

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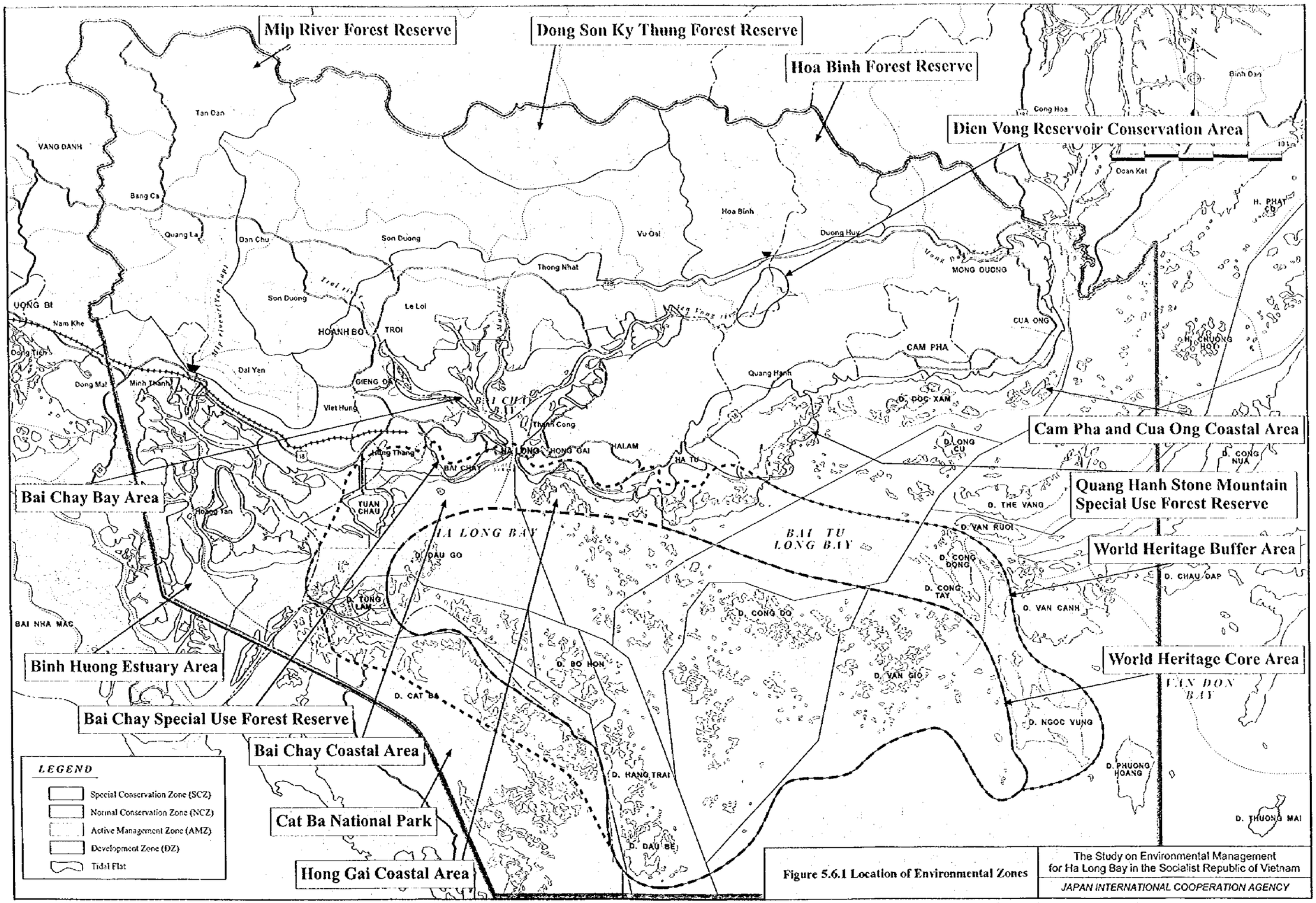

Figure 5.6.1 Location of Environmental Zones

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