TABLES

Table 13.2.1 Estimation of Employment Change by Economic Sectors in Ha Long City

No.	Industry	1993		2000		2010		After 2010	
		Employment	%	Employment	%	Employment	%	Employment	%
I.	Sector I	12,020	18.3	12,800	13.9	17,400	6.8	37,000	10.6
1	Agriculture & Fishery	3,500	5.3	3,400	3.7	5,100	2.0	5,500	1.6
2	Forestry	220	0.3	400	0.4	700	0.3	1,500	0.4
3	Mining	8,300	12.6	9,000	9.7	11,600	4.5	30,000	8.6
II.	Sector II	27,550	41.9	35,650	38.6	143,300	55.9	163,000	46.6
4	Manufacturing	21,000	31.9	26,400	28.6	125,600	49.0	140,000	40.0
5	Construction	6,450	9.8	9,000	9.7	17,000	6.6	22,000	6.3
6	Other Products	100	0.2	250	0.3	700	0.3	1,000	0.3
III.	Sector III	26,162	39.8	43,890	47.5	95,600	37.3	150,000	42.9
7	Transport, post and communication services	6,100	9.3	14,100	15.3	32,100	12.5	40,200	11.5
8	Commerce, tourism	11,400	17.3	19,600	21.2	43,000	16.8	65,000	18.6
9	Housing & public service	1,460	2.2	1,500	1.6	4,200	1.6	5,500	1.6
10	Scientific research (R&D)	100	0.2	140	0.2	700	0.3	1,200	0.3
11	Education service	2,530	3.8	3,500	3.8	5,500	2.1	12,000	3.4
12	Culture, art, sports	480	0.7	900	1.0	900	0.4	13,000	3.7
13	Health & social services	1,400	2.1	1,500	1.6	5,000	2.0	6,500	1.9
14	Public administration	1,700	2.6	1,700	1.8	2,500	1.0	3,200	0.9
15	Financial service	650	1.0	650	0.7	1,200	0.5	2,700	0.8
16	Others	20	0.0	300	0.3	500	0.2	700	0.2
	Total	65,732	100.0	92,310	100.0	256,300	100.0	350,000	100.0

Source: Development Master Plan of Ha Long City for 1994-2010, 1994

Table 13.2.2 Estimation of Employment Change by Development Phase

No.	Industry	1993-2000	2001-2010	After 2010
I.	Sector I	780	4,600	19,600
1	Agriculture & Fishery	-100	1,700	400
2	Forestry	180	300	800
3	Mining	700	2,600	18,400
II.	Sector II	8,100	107,650	19,700
4	Manufacturing	5,400	99,200	14,400
5	Construction	2,550	8,000	5,000
6	Other Products	150	450	300
III.	Sector III	17,728	51,710	54,400
7	Transport, post and communication services	8,000	18,000	8,100
8	Commerce, tourism	8,200	23,400	22,000
9	Housing & public service	40	2,700	1,300
10	Scientific research (R&D)	40	560	500
11	Education service	970	2,000	6,500
12	Culture, art, sports	420	0	12,100
13	Health & social services	100	3,500	1,500
14	Public administration	0	800	700
15	Financial service	0	550	1,500
16	Others	280	200	200
	Total	26,608	163,960	93,700

Source: Development Master Plan of Ha Long City for 1994-2010, 1994

Table 13.2.3 Economic Potential and Future Production by Major Industry

Industry	Potential	1993	Phase I	Phase II	Phase III
Existing Ha Long City Area					
Coal mining (Hong Gai area)	-	1 mil. tons/yr	1.4 mil. tons/yr	1.8 mil. tons/yr	≦1 mil. tons/yr.
Brick	73 × 10^6 m^3 clay	60 mil. bricks/yr.	300 mil. bricks/yr.	400 mil. bricks/yr.	500 mil. bicks/yr.
Tile	-	6.3 mil. tiles/yr.	-	-	-
Cai Lan IP (industrial park)	100-15 ha	-	-	-	-
Ship building & Reporting	2 factories (Ba Lan, Ha Long)	1-35,000 dwt ships + lighters	3-50,000 dwt	4-60,000 dwt	≧60,000 dwt
Port Industry					
(B12 oil port)	-	0.8 mil. tons/yr.	≧0.8 mil. tons/yr.	≧0.8 mil. tons/yr.	removed
(Sa To port)	-	0.35 mil. tons/yr.	0.35 mil. tons/yr.	0.4 mil. tons/yr.	-
(Hong Gai port)	coal export port, transforming to a tourism port	1.5 mil. tons/yr.	1.5 mil. tons/yr.	1.5-3 mil. tons/yr.	≦3 mil. tons/yr.
(Cai Lan port)	deepwater port	-	4-5 mil. tons/yr.	7-15 mil. tons/yr.	15-20 mil. tons/yr.
Coal screening plant	-	500 tons/h	500 tons/h	removal	removal
Mechanical industry	-	38 vehicles/day	38 vehicles/day	50 vehicles/day	200 vehicles/day
Tourism	-	2,500 beds	5-7,000 beds	10-14,000 beds	23,600 beds
Expansion of City Area to Hoanh Bo District in the 2nd phase					
Cement factory	2.5 bil. tons of limestone	5,000 tons/yr	-	4-5 mil. tons/yr	10-12 mil. tons/yr
Hi-tech IP (Le Loi commune)	150 ha	-	-	-	-
Dong Dang IP	150 ha	-	-	-	-
Expansion of City Area to Cam Pha in the 3rd Phase (after 2010)					
Coal mining (Cam Pha area)	identified reserves: 2 bil. tons	2.5 mil. tons/yr	-	-	4.09 mil. tons/yr
Cement factory	-	-	-	-	82 thou. tons/yr
Cua Ong coal screening plant	coal screening for the whole area	500 tons/hour	-	-	700-900 tons/hour
Coal + other goods export port	deepwater port for over 10,000 dwt ships	2.5 mil. tons/yr	-	-	2.5-3.5 mil. tons/yr
Mining Equipments Mechanical Industry	2 units	2.7 tons/hour	-	-	3-5 tons/hour
Central mechanical factory	automobile for coal mining	44,000 tons/yr	-	-	50-80 thou. tons/yr
Automobile repair	2 units	700-1,000 cars/yr	-	-	1,000-1,500 cars/yr

Source: Development Master Plan of Ha Long City for 1994-2010, 1994

Table 13.2.4 Adjusted List of Major Development Projects in the Study Area

Sector	No.	project	Location	Area (ha)	From	To	Implementation Period
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 Trung		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	rehabilitation / upgrading
	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.

Table 13.2.5 Specifications of the Planned Industrial Parks

Cai Lan Concentrated Industrial Park	
The first phase	78 ha
Land use	(ha)
Production service area	5.22
Factories	50.56
Infrastructure construction	19.71
Existing construction	2.51
Ground leveling	2 mil. m^3
Connecting Road to No.18A	772 m
Water supply and drainage	600 m^3/day
1st phase (present – 2001)	78 ha
2nd phase (2002 – 2010)	222 ha
Located factories	
Grain milling (flour)	na
edible oil manufacturing	na
Expected factories	
Electromechanics, precision instrument	na
Apparel	na
Grain milling and processing	na
Packaging (all kinds)	na
Handicraft	na
Toy	na
Hoanh Bo Industrial Park	
Area	330 ha
Land use	(ha)
Factories	203
Storage ground	17.8
Communication	51.9
Production service area	7.3
Infrastructure construction	10.5
Open space, green, etc.	51.9
** sum of each land use is not equal to 330 ha*	
Ground leveling	4.3 mil. m^3
Water supply and drainage	14,000
1st phase (2005 - 2007)	140 ha
2nd phase (2008 – 2012)	190 ha

Source : Project Management Committee, QNPC, 1998
Notes : na : Not available

Table 13.3.1 Forecast of Population by Subdistrict in the Study Area

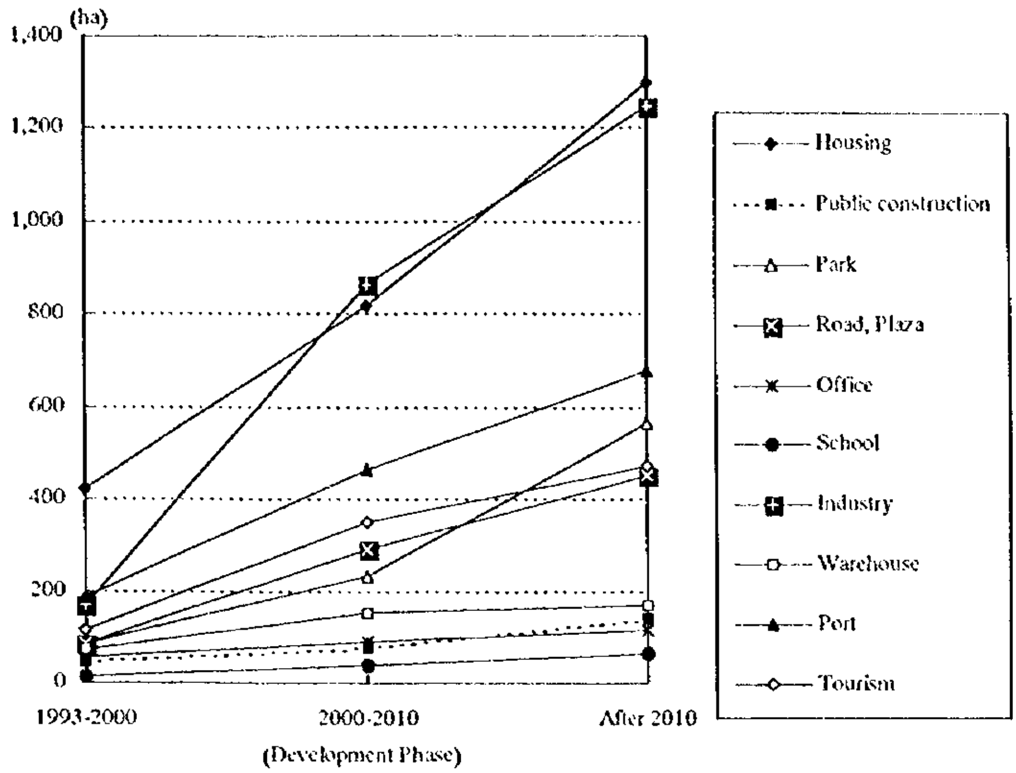
No.	Subdistrict	1996	1997	2000	2005	2010
Ha Long						
1	Hong Gai	7,611	na	10,398	13,831	17,246
2	Bach Dang	10,039	na	14,333	20,859	27,385
3	Yet Kieu	6,235	na	8,616	11,738	14,860
4	Tran Hung Dao	7,536	na	10,248	13,619	16,990
5	Cao Xanh	13,262	na	20,114	31,215	42,316
6	Cao Thang	14,126	na	20,821	30,819	40,817
7	Ha Lam	7,677	na	9,771	11,486	13,201
8	Ha Trung	5,939	na	7,833	9,863	11,893
9	Ha Tu	9,524	na	13,195	18,275	23,355
10	Ha Phong	8,690	na	11,913	16,006	20,100
11	Ha Khanh	5,093	na	6,801	8,820	10,839
12	Hong Ha	9,674	na	13,588	19,288	24,989
13	Hon Hai	9,554	na	14,092	20,794	27,496
14	Bai Chay	12,676	na	19,017	28,895	38,773
15	Gieng Day	9,151	na	12,883	18,070	23,256
16	Ha Khau	8,311	na	11,709	16,209	20,708
17	Hung Thang	3,517	na	4,668	6,626	8,583
18	Tuan Chau	1,461	na	1,681	1,743	1,806
	Subtotal	150,076	na	211,681	298,156	384,632
Hoanh Bo		(shaded subdistricts are consolidated to Ha Long city)				
1	Troi	na	7,344	7,627	12,401	17,174
2	Dai Yen	na	7,482	8,505	9,117	9,669
3	Son Duong	na	4,096	4,295	4,908	5,521
4	Viet Hung	na	8,506	9,754	10,415	11,076
5	Le Loi	na	4,385	4,544	5,081	5,618
6	Thong Nhat	na	7,142	7,572	8,839	10,106
7	Vu Oai	na	1,118	1,196	1,419	1,642
	Subtotal	na	40,073	43,553	52,179	60,806
Yen Hung						
1	Minh Thanh	na	9,840	10,630	12,596	14,502
	Total 1	na	na	255,234	350,336	460,000
Cam Pha						
1	Cam Thinh	7,854	na	8,290	8,772	9,254
2	Quang Hanh	15,281	na	17,244	21,427	25,611
3	Cam Dong	9,254	na	9,876	10,444	11,013
4	Cam Son	11,217	na	12,365	13,906	15,447
5	Cam Phu	14,687	na	15,910	17,701	19,492
6	Cua Ong	13,724	na	14,063	14,811	15,559
7	Cam Tay	7,949	na	8,021	7,797	7,574
8	Cam Thuy	8,142	na	8,594	9,022	9,451
9	Cam Thanh	8,077	na	9,039	9,909	10,779
10	Cam Thach	9,602	na	10,179	11,391	12,603
11	Cam Binh	6,234	na	6,865	7,711	8,557
12	Cam Trung	12,896	na	14,892	18,207	21,522
13	Mong Duong	10,478	na	11,217	11,974	12,732
14	Cong Hoa	2,428	na	2,661	2,924	3,187
15	Cam Hai	1,296	na	1,270	1,184	1,099
16	Duong Huy	2,694	na	2,816	3,091	3,365
	Subtotal	141,813	na	153,300	170,273	187,245
	Total 2 (14 & 15 excluded)	138,089	na	149,370	166,164	182,959
Study Area Total (1+2)			na	415,233	529,096	642,959

Notes: 1) The shaded subdistricts in Cam Pha are not included in the study area.
2) The population of Cat Hai commune (15,741 in 1994) in Cat Ba island is not included here because of data shortage at this stage of the study.

Estimation was based on the Development Master Plan of Ha Long City 1994-2010, May, 1994

na : Not available

FIGURE



Source: Development Master Plan of Ha Long City for 1994-2010, 1994

Figure 13.2.1 Future Demand for Urban Development Land in Ha Long City

CHAPTER 14

CHAPTER 14 PROJECTION OF FUTURE ENVIRONMENT IN THE STUDY AREA

14.1 Regional Development and its Environmental Impacts

14.1.1 Possible Environmental Impacts by Development Projects

Regional development projects may cause impacts on the environment in the study area through, for example, increase of wastewater and solid wastes, and change of land uses including land reclamation on tidal flats. It should be noted that the land reclamation on tidal flats and mangrove swamps would cause significant impacts as it would decrease their water purification function as well as aquatic ecosystem. Based on the nature of their impacts on the environment, planned projects can be classified into the following three categories and their combination.

- projects which discharge pollution loads and/or solid wastes into the environment,
- projects which reclaim mangrove area or tidal flat, and
- projects which bring about deforestation and subsequent sediment runoff.

Possible environmental impacts, which may be brought by the future development projects, are shown in Table 14.1.1. Expected necessary countermeasures for the future development projects are shown in Table 14.1.2. Detailed and concrete countermeasures of each development project should be established in the course of each Environmental Impact Assessment (EIA).

14.1.2 Mitigation Measures Proposed by Port Development Projects

(1) Mitigation Measures by Cai Lan Port Expansion Project

In the course of the EIA of the Cai Lan port expansion project, several environmental mitigation measures are proposed. The proposed mitigation measures are to prevent and reduce the anticipated physical, biological, and socioeconomic impacts that may occur during the port construction and operation. For example, wastewater treatment plants including septic tanks and oil separators are proposed against expected water quality impacts by wastewater discharge. The proposed mitigation measures are tabulated in Table 14.1.3, which can be implemented without an Environmental Management Plan (EMP).

(2) Cua Ong Coal Port

According to the study report for the Cua Ong coal port rehabilitation approved by the Ministry of Energy on December 20th 1990 (Decision No.96 NL/XDCB), the investment for rehabilitation and upgrading of the Cua Ong coal port was carried out as follows:

- 1st stage (1991 to 1992): repair of berth, installation of channel buoys, construction of reloading berth for 30,000 to 50,000 DWT ships, berth dredging to depth of 9.8 m, channel dredging to depth of 8.8m, and construction of the reloading port at the Coa Ong islet.
- 2nd stage (1996 to 1997): channel dredging for 50,000 DWT full cargo ships (Soi Den islet to sea mooring buoy), and development of channel from Soi Den islet to sea mooring buoy.

According to its EIA report 1998, environmental impacts by the above works were mainly oil pollution and increase in SS. The potential of oil pollution caused by discharged oil-containing wastewater and accidental oil leakage caused by ship collision would be increased due to the increased number of ships. SS would be also increased due to the increased shipping activities as well as regular dredging.

Therefore, it is necessary to carry out measures to manage and prevent such pollution. In order to minimize negative impacts on the surrounding environment, the mitigation measures were proposed as shown in Table 14.1.4. To evaluate the effectiveness of the measures taken, a monitoring plan has been also proposed as shown below.

Proposed Monitoring by Cua Ong Coal Port

Items	Air Quality and Noise	Water Quality
Parameters	SPM, dust, smoke (CO, SO_2, NO_2), noise	pH, DO, BOD, SS, Turbidity, T-P, Oil and grease, heavy metals (Pb, Mn, Zn)
Monitoring Points	Three (one in the port, two in the surrounding residential area)	Five (three in the berth area, two along the channel)
Frequency	Once a year	
Evaluation Standards	TCVN	

Source: EIA report of Cua Ong coal port, 1998

(3) B12 Oil Port

The environmental impacts caused by the B12 oil port operation are oil leakage or spill. The water in the bays could be polluted by leaked or spilled oil from storage tanks, broken pipe or by discharged bilge and ballast water. To cope with these impacts, several mitigation measures for B12 oil port have been proposed in its EIA report as shown below.

Summary of Mitigation Measures by B12 Oil Port

Items	Impacts	Mitigation Measures
Air Pollution	Exhaust gas	Improvement and modernization of port facilities
Water Pollution	Domestic wastewater from port facilities and ships	Septic tank treatment
	Wastewater from ship	Off-shore recycling of ballast water
Accidents	Oil leakage and spill	Buoy system for preventing spreading oil Oil fence Mobile pump for sucking leaked oil
	Fire/Explosion	Fire-prevention system Fire-extinguishing team

Source: EIA report of B12 oil port

There are a number of vessels including coal handling ships, car ferries, other transporting ships and fishermen boats sailing in and around the port. For an accident, the B12 oil port has installed a fire-prevention system as shown below:

- Fixed extinguishing system for the 3,500-DWT berth and the 300-ton exporting berth,
- Mobile extinguishing system consisting of 2 trucks and 131 fire extinguishers, and
- Communication system to contact every place in the port by telephone and wireless two-way radio.

The port also has a fire extinguishing team. The team has been trained under the guidance of experienced staff and under the supervision of the provincial police PC-23 division. The emergency response team for the B12 oil port is always ready for the environmental accidents on the 24-hour duty basis.

According to QNPC, the B12 oil port is planned to be relocated to the Con Ong island after 2005. The potential of environmental impacts as well as accidents can be reduces by this relocation.

14.2 Projection of Future Water Quality in the Study Area

Although there are many kinds of environmental factors in the study area, water quality could be a key integrated factor from the viewpoint of environmental management considering the mechanism of environmental degradation in the bays. Increase in organic substances in the water would lead to decrease in transparency as well as DO. Poor oxygen or anoxic water causes degradation of the bottom sediment and adverse impacts on ecosystem and fishery including aqua-culture. In addition, increase in nutrients such as nitrogen and phosphorous accelerate eutrophication in the bays. Eutrophication leads to decrease in transparency too. These phenomena, especially decrease in transparency, affects a landscape, water uses such as bathing and other recreational uses, and finally it might bring about negative impacts on the World Heritage area itself accompanied with declining the tourism industry. In case of increase in inflow of SS, this would also cause adverse impacts on water quality and on ecosystem as well as fishery including aqua-culture. Increased sediment runoff have impacts not only on water quality and but also on nursery grounds in the bays. Figure 14.2.1 shows the schematic process of environmental degradation caused by pollution loads inflow into the bays.

14.2.1 Basic Conditions for Projection of Future Pollution Load

In order to identify the magnitude of environmental impacts, especially water quality in the bays, pollution loads increment caused by the planned development projects and related socioeconomic changes such as an increase in population and changes of life style were identified. The projected future pollution loads could provide the basis with which the effectiveness of various countermeasures can be evaluated.

(1) Present Progress of Countermeasures

First of all, the present progress of countermeasures was identified. The sewage control and management project in the Bai Chay area aiming to reduce the direct inflow of pollution loads to the Bai Chay beach, is going on as of 1999. This project is not involved in the EMP. As for "Ha Long City Water Supply and Sanitation Project (HWSSP)" funded by DANIDA, the feasibility study for the sanitation and drainage component completed in April 1998. This project is now in the detailed design stage. The proposed sewer accompanied with a treatment plant in the Bai Chay area, namely first stage, is scheduled to be constructed before long, funded by WB. Therefore, at least this first stage of HWSSP will have been implemented without the EMP by 2010.

In case of environmental countermeasures being implemented by VINACOAL, their effects and future plan were not available. Thus, they are not involved in the present progress of the countermeasures.

The following environmental measures are set for the future water quality projection based on the current progress of environmental controls including planned measures project which will have been done by 2010, namely "without an Environmental Management Plan".

- Sewage construction and management project in the Bai Chay area,
- First stage of HWSSP,
    - Construction of Gien Day (sewered population 20,000) and Deo Sen (sewered population 45,000) wastewater treatment plants
    - Drainage improvement in Hang 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 industrial development projects including mining from now on,
- Present reforestation activities, and
- Present pollution control for coal mining activities by VINACOAL.

(2) Setting Future Pollution Load Unit

For the projection of future pollution loads, changes of pollution load unit were taken into consideration. In HWSSP, the increase rate of per capita water consumption was estimated at 30% from that of present level to 2010, i.e. from 100 ℓ/day/cap. to 130 ℓ/day/cap. This increase rate is assumed to be applicable to the increase in pollution load unit of household wastewater. For example, assuming the present BOD load from household water is 31 g/cap/day, the future (2010) BOD load from household water is predicted at 35 g/cap/day by applying increase rate of water consumption. BOD load of human waste is assumed to be the same as the present (19 g/cap/day). Therefore, total future BOD load is predicted at 54 g/day/cap. Same methods and assumption are used for other items. The following pollution load unit of resident is applied for the projection.

(Unit: g/day/cap.)

Items	BOD	COD_{Mn}	SS	T-N	T-P
Present	50	22	38	9.0	1.0
2010	54	24	40	9.1	1.0

In case of a pollution load unit for industry, it would be reduced based on an innovation of the production processes and/or facilities, especially for new industrial development. However, the present pollution load unit is applied for pollution load projection due to the limited information. As for pollution load units of livestock and non-specific pollution load, it is the same as the present.

(3) Future Land Use Pattern

Future land use of each sub-catchment is estimated on the basis of the Development Master Plan of Ha Long City for 1994-2010 (HLMP). The anticipated area to be changed by the planned development projects is shown in Table 14.2.1 and projected future land use pattern in 2010 is shown in Table14.2.2. It is assumed that denuded area by coal mining expands 20% by 2010 without countermeasures.

(4) Projection of Future Pollution Load Generation

1) Pollution load generation by resident

Projected population in 2010 in each sub-catchment is shown in Table 14.2.3. By using the projected population and the future pollution load unit, the pollution loads generated by residents in 2010 are projected as shown in Table 14.2.4. As for pollution load generated by tourists, pollution load is projected from the anticipated number of tourists in 2010 and the pollution load unit as shown in Table 14.2.5.

2) Pollution load generation by industries

For the projection of pollution load from planned industrial development, the following development of factories and industrial parks are taken into consideration.

a) Planned factories and industrial parks

- Cai Lan concentrated industrial park I & II,
- Hon Bo industrial park,
- High-tech industrial park,
- Coal burned thermal power stations (Hoanh Bo and Cua Ong),
- Steel refinery,
- Steel mill,
- Hoan Cau Taiwan cement,
- Hai Long South Korea cement, and
- Cement factories (Thong Nhat-Hoanh Bo).

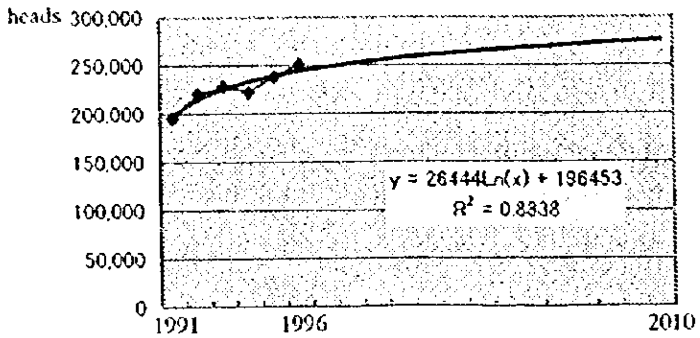
b) Expansion of existing factories

- Expansion of ship building factory, and
- Expansion of brick and tile factory.

Volume of water use, recycled water, and wastewater at each new developed factory and industry park are estimated respectively based on the historical data of the Japan Industrial Relocation Center (see Chapter 13). Water quality of wastewater is set by a typical industrial wastewater quality data taken from the Guideline for Comprehensive Basin-wide Sewerage System Planning in Japan. However, the water quality of industrial wastewater, which is expected to exceed the effluent standard in Vietnam, is set at the same value as the effluent standard in Vietnam. This is because wastewater treatment to meet effluent standards is prerequisite for new development of factories and industrial parks. In case of expansion of existing factories, volume of wastewater and it's water quality are set by the present data. With regards to coal burned thermal power stations, pollution load are set based on their EIA reports. Estimated pollution load generation by planned industrial development is tabulated in Table 14.2.6.

3) Pollution load generation by livestock

The population of livestock is projected by historical trend of livestock population in Quang Ninh province and the change of agricultural land area. As shown in the following figure, the population of pigs in Quang Ninh province was projected by the correlation formula obtained from the historical trend. It is assumed that the population of pigs in the study area would be increased with same increase ratio of Quang Ninh province.



Source: Statistical Year Book of Quang Ninh Province, 1996

Future Trend of Pig Population in Quang Ninh Province

On the other hand, although the population of buffalo and cattle has increased in Quang Ninh province in the past five years, in the study area it is considered to be decreased in the future in proportion to expected decrees in the agricultural land area. It is simply because they are mainly used by farming activities on the farmlands. Projected future population of livestock in the study area are as shown below:

(Unit: head)

Items	Buffalo	Cattle	Pig
Present	2,370	1,890	62,950
2010	2,270	1,810	69,250

Note: Present figures are from DARD.

Projected future population of livestock multiplied by pollution load unit is the pollution loads generation. The projected pollution load generation by livestock is shown in Table 14.2.7.

4) Pollution load generation by non-specific sources

Future pollution load generation by non-specific pollution sources is estimated based on the future land use pattern and the pollution load unit. The projected pollution load generation by non-specific pollution sources is shown in Table 14.2.8.

(5) Future Runoff Ratio

Basically, runoff ratio of pollution load is same as the present. However, it is assumed that a potential runoff ratio of the domestic pollution load in urban area will be increased due to the expansion of drainage system and paved areas as well as the spread of a flush toilet.

14.3 Projected Future Water Quality

14.3.1 Future Runoff Pollution Loads

Projected future runoff pollution loads are shown in Table 14.3.1 and summarized below:

(Units: tons/day)

Periods	BOD	CODMn	SS	T-N	T-P
Present (1996)	7.2	21.9	241	15.5	6.0
Future (2010)	12.9	30.2	272	20.0	6.8

Compared with the present pollution load, total runoff pollution load in 2010 will be 1.8 times in BOD, 1.4 times in COD, 1.1 times in SS, 1.2 times in T-N, and 1.1 times in T-P.

14.3.2 Application of the Simulation Model

(1) Prediction of the Future Hydrodynamic Conditions

The hydrodynamic model developed was run to provide hydrodynamic conditions of the future to be used in the water quality projection. Topographic conditions were modified for the future from the current conditions while other conditions were set the same. The modifications of the topography as shown in Figure 14.3.1 reflected the land reclamation in Bai Chay bay area and the causeway to Tuan Chau island based on the HLMP.

The results of the predicted currents of the future were shown in Figure 14.3.2 to 14.3.4. The circulation patterns around Tuan Chau island were separated by the causeway.

(2) Application of simulation model

As a tool for environmental management planning, the water quality simulation model is expected to estimate changes in key water quality parameters based on pollution loads calculated derived from the socioeconomic frame.

The diffusion model was run to predict the concentrations of SS of the future. The nutrient cycling model was run to predict the concentrations of COD, I-N, O-N, I-P, O-P, and DO of the future. The hydrodynamic conditions and each pollution loads were modified for the future from the current conditions while other conditions were set up as the same. BOD concentrations were estimated from COD by the conversion factor of BOD = COD/4.9 derived from the Field Survey by the JICA study team for reference.

14.3.3 Future Water Quality "Without an Environmental Management Plan"

The projected future water quality "without an Environmental Management Plan" by the simulation model is shown in Figure 14.3.5 ~ 14.3.14. The causeway toward Tuan Chau island clearly separated the distributions of all water quality parameters. These influences were not found in the results of the present condition as of 1998 because just less than half of the construction of the causeway was completed at that time. The distribution of such separated water quality parameters showed that the causeway prevented the water exchange through the northern channel of Tuan Chau island resulting in higher concentrations in eastern side of the separated sea where pollution loads were distributed more than the western side.

In case of COD_{Mn} in Bai Chay bay, it was estimated to increase from 4 mg/ℓ to 5 or 6 mg/ℓ in the upper layer. The increase in COD_{Mn} will 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 present progress of environmental control, namely without an Environmental Management Plan is not enough to prevent water quality deterioration in the Word Heritage core area. Thus, more stringent countermeasures are required.

TABLES

Table 14.1.1 Expected Environmental Impacts Caused by the Future Development Projects

Sector		Project	Location	Possible Environmental Impacts: Pollution Load Discharge	Reclamation of Mangrove Area or Tidal Flat	Deforestation and Sediment Runoff
Industry	1	Cai Lan Concentrated Industrial Park Phase I	Cai Lan	A	X	C
		Cai Lan Concentrated Industrial Park Phase II	Cai Lan	A	X	C
	2	Hoanh Bo Industrial Park (renamed from Dong Dang IP)	Dong Dang, Troi	A	B	C
	3	Expansion of brick and tile factory	Gieng Day, Hoanh Bo	B	X	C
	4	Expansion of ship building factory	Gieng Day	B	X	C
	5	Coal burned thermal power station (300MW)	Vu Oai - Hoanh Bo	A	B	C
	6	Coal burned thermal power station (300MW)	Bridge no. 20 - Cua Ong	A	B	C
	7	Steel refinery (1.5mil. t/year)	Bridge no. 20 - Cua Ong	A	X	C
	8	Steel mill (0.5mil. t/year)	Cai Lan	A	X	C
	9	Hoan Cau - Taiwan cement	Lang Bang - Hoanh Bo	B	B	C
	10	Hai Long - South Korea cement	Lang Bang - Hoanh Bo	B	B	C
	11	Cement factory	Thong Nhat - Hoanh Bo	B	X	C
Trans-port	12	Cai Lan port Phase I Stage1 (3 berths)	Cai Lan	C	C	C
		Cai Lan port Phase I Stage2 (4 berths)	Cai Lan	C	C	C
		Cai Lan port Phase II	Cai Lan	C	C	C
	13	Bai Chay Bay bridge	Cua Luc	X	X	C
	14	Relocation of Hong Gai port	Hong Gai	P	C	C
	15	Improvement of B12 oil port	Bai Chay	P	C	C
	16	Relocation of B12 oil port	(Not Available)	P	P	C
	17	Nam Cou Trang coal port	Nam Cou Trang	C	C	C
Road	18	Improvement of 18A (Hong Gai - Gua Ong)	(Not Available)	X	X	B
	19	Improvement of 18A (Chi Linh - Bai Chay: 35km-118km)	(Not Available)	X	X	B
	20	Improvement of 18A (Hong Gai - Mong Cai)	(Not Available)	X	X	B
	21	Improvement of 18B (Dong Dang - Lang Bang)	(Not Available)	X	X	B
	22	Improvement of Troi - Lang Bang (Hoanh Bo)	(Not Available)	X	C	C
	23	Improvement of Hong Gai - Ha Khanh (Dien Vong River)	(Not Available)	X	X	B
	24	Causeway and Bridge to Tuan Chau Island	Tuan Chau	X	A	C
Railway	25	Extension (Ha Long - Cai Lan, 4km)	Bai Chay	X	X	C
	26	Improvement (Kep - Ha Long)	(Not Available)	X	X	C
	27	Removal of Coal Transport Railway (Hong Gai - Ha Tu)	(Not Available)	X	X	C
Others	28	Land Reclamation Hung Tang I	Hung Tang	X	A	B
	29	Land Reclamation Hung Tang II	Hung Tang	X	A	B

Note: A: Relatively high magnitude of impact is expected. B: Relatively medium magnitude of impact is expected. C: Relatively low impact is expected. P: Positive effect is expected. X: There is no relation.

Table 14.1.2 Expected Necessary Countermeasures for the Future Development Projects

Sector		Project	Main Indicators to be concerned	Countermeasures
Industry	1	Cai Lan Concentrated Industrial Park Phase I Cai Lan Concentrated Industrial Park Phase II	Water quality (BOD, COD, T-N, T-P, SS) Industrial solid wastes	- Wastewater treatment - Solid wastes management
	2	Hoanh Bo Industrial Park (renamed from Dong Dang IP)	Water quality (BOD, COD, T-N, T-P, SS), Industrial solid wastes, Environmental resources (tidal flats, mangrove swamps, forest)	- Wastewater treatment - Solid wastes management - Site selection to minimize of land reclamation area - Revegetation of denuded areas
	3	Expansion of brick and tile factory	Water quality (SS), Industrial solid wastes	- Wastewater treatment - Solid wastes management
	4	Expansion of ship building factory		
	5	Coal burned thermal power station (300MW)	Water quality (SS), Air quality (Dust), Industrial solid wastes, Environmental resources (tidal flats, mangrove swamps)	- Wastewater treatment - Dust control - Solid wastes management - Site selection to minimize of land reclamation area
	6	Coal burned thermal power station (300MW)		
	7	Steel refinery (1.5mil. t/year)	Water quality (SS), Industrial solid wastes	- Wastewater treatment - Solid wastes management
	8	Steel mill (0.5mil. t/year)		
	9	Hoan Cau - Taiwan cement	Water quality (SS), Air quality (Dust), Industrial solid wastes, Environmental resources (tidal flats, mangrove swamps, forest)	- Wastewater treatment - Dust control - Solid wastes management - Site selection to minimize of land reclamation area - Revegetation of denuded areas
	10	Hai Long - South Korea cement		
	11	Cement factory	Water quality (SS), Air quality (Dust), Industrial solid wastes	- Wastewater treatment - Dust control - Solid wastes management
Trans-port	12	Cai Lan port Phase I Stage1 (3 berths) Cai Lan port Phase I Stage2 (4 berths) Cai Lan port Phase II	Water quality (SS, Oil)	- Wastewater treatment - Pollution prevention measures
	13	Bai Chay Bay bridge	Environmental resources (forest)	- Revegetation of denuded areas
	14	Relocation of Hong Gai port	Water quality (SS, Oil)	- Pollution prevention measures
	15	Improvement of B12 oil port		
	16	Relocation of B12 oil port		
	17	Nam Cou Trang coal port		
Road	18	Improvement of 18A (Hong Gai - Gua Ong)	- Environmental resources (tidal flats, mangrove swamps, forest) - Water quality (SS)	- Route selection to minimize deforestation, land reclamation areas on tidal flats and mangrove swamps - Revegetation of denuded areas
	19	Improvement of 18A (Chi Linh - Bai Chay: 35 -118km)		
	20	Improvement of 18A (Hong Gai - Mong Cai)		
	21	Improvement of 18B (Dong Dang - Lang Bang)		
	22	Improvement of Troi - Lang Bang (Hoanh Bo)		
	23	Improvement of Hong Gai - Ha Khanh (Dien Vong River)		
	24	Causeway and Bridge to Tuan Chau Island		
Railway	25	Extension (Ha Long - Cai Lan, 4km)	- Environmental resources (forest)	- Route selection to minimize deforestation - Revegetation of denuded areas
	26	Improvement (Kep - Ha Long)		
	27	Removal of Coal Transport Railway (Hong Gai - Ha Tu)		
Others	28	Land Reclamation Hung Tang I	- Environmental resources (tidal flats, mangrove swamps)	- Site selection to minimize decrease in mangrove swamps - Minimization of land reclamation area
	29	Land Reclamation Hung Tang II		

Table 14.1.3 Summary of Proposed Mitigation Measures by Cai Lan Port Expansion Project

Items	Impacts	Stages	Mitigation Measures
Physical Environment	1) Soil source sites	Const.	Minimize area of impact
	2) Solid and hazardous waste	Const. & Oper.	Waste minimization, landfill disposal of solid waste and burning of waste oil
Air Quality	1) Dust	Const.	Truck covers and watering of loose surfaces
	2) Vehicle emissions	Const. & Oper.	Maintenance and inspections
Water Quality	1) Dredging	Const. & Oper.	Use of curtains and best practice dredging and disposal methods
	2) Wastewater discharges	Oper.	
	- Domestic wastewater		Septic tanks (Stage I), wastewater treatment plant (State II)
	- Ship wastewater		Off-shore (Stage I), wastewater treatment plant (Stage II)
	- Bilge water		Next port-of-calls (Stage I), wastewater treatment plant (Stage II)
	- Storm water		Oil separators (Stage I), plus treatment (Stage II)
	3) Ballast water	Oper.	Off-shore recycling
	4) Accidental spills	Const. & Oper.	Oil separators for port deck surface, navigational aids, positioning of emergency response equipment
Biological Impacts	1) Terrestrial communities	Const.	Minimize area of impact
	2) Mangroves at port site	Const.	Minimize area of impact and restore degraded mangroves
	3) Mangroves near port	Oper.	Wastewater treatment
	4) Wetlands as port site	Const.	Minimize area of impact and restore degraded wetlands
	5) Wetlands near port	Oper.	Wastewater treatment
	6) Benthic communities	Const. & Oper.	Minimize area of impact, use curtains for dredging operations, off-shore disposal, and wastewater treatment
	7) Fish populations	Const. & Oper.	Minimize area of impact, use curtains for dredging operations, off-shore disposal, and wastewater treatment
	8) Coral reefs	Const.	Minimize area of impact, use curtains for dredging operations, and off-shore disposal
Social and Cultural Impacts	1) Affected buildings	Const.	Finance relocation
	2) Affected populations	Const.	Compensation
	3) Loss of agricultural lands	Const.	Compensation
	4) Loss of small business	Const.	Compensation
	5) Loss of access to water point	Const.	Other sources available
	6) Community impacts	Const. & Oper.	Jobs, transportation, minimize noise
	7) Aesthetics	Const.	Planning
	8) Tourism	Const. & Oper.	Minimal impacts
	9) Occupational health and safety	Const. & Oper.	Training and health station

Note: Const. means Construction, Oper. means Operation.
Source: Environmental Impact Assessment for the Cai Lan Port Expansion Project, 1998 September

Table 14.1.4 Summary of Proposed Mitigation Measures by Cua Ong Coal Port

Items	Impacts	Stages	Mitigation Measures
Air Quality	1) Dust pollution	Const. & Oper.	Shovel buckets must not exceed nominal/registered carrying capacity and tightly covered to prevent coal dropping. Daily sweeping of coal loading. Sprinkling. Regular maintenance of coal conveyors.
	2) Exhaust gas pollution	Oper.	Using low sulfur content fuel oil.
	3) Noise and vibration	Const.	Limitation of operation time. Maintenance of machinery and equipment.
Water Quality	1) Domestic wastewater from ships	Const. & Oper.	Prohibition of discharge to the surface water without treatment. Prohibition of dumping of all kinds of plastic waste into the rivers. Inland collection and disposing of wastewater from vessels.
	2) Domestic wastewater	Oper.	Using waste treatment station (septic tanks) for domestic wastewater from port area and ships.
	3) Storm water	Oper.	Using drainage system via sediment ponds. Application of discharge standards of wastewater (TCVN 5945-1995). International convention on pollution prevention from ship (MARPOL 73/78).
	4) Dredging	Const.	Using of silt curtains.
Solid Wastes	Solid wastes generation	Oper.	Using regional solid wastes disposal sites.
Safety and Accidents	1) Sanitation and labor safety	Const. & Oper.	Regular checking and monitoring of health of workers. Training and providing information on sanitation and labor safety for everyone.
	2) Accidents of ship collision	Const. & Oper.	Regular maintenance of buoys and navigation aids. Operation of ships in accordance with time-table. Regular maintenance of salvage vessels and fire-fighting facilities. Development of plan for prevention of accidents.

Source: EIA report of Cua Ong Coal Port, 1998

Table 14.2.1 Land Use Changes of Sub-catchment from 1996 to 2010

No.	Name of Sub-catchment	Changed Area of Sub-catchment (ha)						
		Reclaimed Land	Forest & Grass Area	Agri-cultural Area	Bare Area	(Coal)	Urban Area	Water Area in Land
1	Mip river basin	0	-8	0	8	(8)	0	0
2	Hung Thang basin	150	-65	-10	0	(0)	225	0
3	Bai Chay basin	0	-83	0	0	(0)	83	0
4	Troi river basin	400	-805	-228	135	(3)	1,298	0
5	Man river basin	400	-743	-332	654	(0)	821	0
6	Dien Vong river basin	0	-349	-32	339	(342)	42	0
7	Hong Gai north basin	150	-120	-80	39	(39)	311	0
8	Hong Gai south basin	0	-141	0	1	(1)	140	0
9	Ha Tu basin	0	-361	0	158	(158)	203	0
10	Cam Pha west basin	0	-227	-31	201	(13)	57	0
11	Cam Pha central basin	0	-75	-40	24	(75)	91	0
12	Cam Pha east basin	40	-97	0	43	(43)	94	0
13	Cua Ong basin	0	-28	0	28	(28)	0	0
14	Mong Duong basin	0	-375	0	375	(375)	0	0
15	Cat Ba islands	0	0	0	0	(0)	0	0
Total		1,140	-3,476	-753	2,004	(1,084)	3,365	0
		1%	-4%	-12%	32%	(20%)	88%	0%

Note: 1) Numbers in parenthesis (coal) are included in bare area.
2) Negative values in figures show decrease in area.
3) Water area in land means reservoir of dams, rivers, ponds, etc.

Table 14.2.2 Projected Future Land Use of Sub-catchment in 2010

No.	Name of Sub-catchment	Area of Sub-catchment (ha)						
		Total	Forest & Grass Area	Agri-cultural Area	Bare Area	(Coal)	Urban Area	Water Area in Land
1	Mip river basin	25,409	18,256	1,965	231	(49)	846	4,110
2	Hung Thang basin	957	652	14	4	(0)	239	48
3	Bai Chay basin	569	297	0	8	(0)	246	19
4	Troi river basin	20,075	15,408	1,561	434	(17)	1,678	994
5	Man river basin	12,367	9,073	655	669	(0)	1,037	933
6	Dien vong river basin	25,066	20,543	972	2,130	(2,051)	194	1,228
7	Hong Gai north basin	1,461	640	9	266	(234)	502	43
8	Hong Gai south basin	709	160	6	21	(3)	521	0
9	Ha Tu basin	2,901	1,415	169	969	(947)	297	51
10	Cam Pha west basin	3,137	2,410	49	317	(78)	332	30
11	Cam Pha central basin	1,523	365	9	440	(451)	674	36
12	Cam Pha east basin	1,143	341	31	293	(256)	471	7
13	Cua Ong basin	876	616	0	167	(165)	89	4
14	Mong Duong basin	8,179	5,755	0	2,292	(2,251)	33	99
15	Cat Ba islands	12,964	12,643	287	1	(0)	32	0
Total		117,335	88,575	5,728	8,241	(6,501)	7,190	7,601
		100%	75%	5%	7%	(6%)	6%	7%

Note: Numbers in parenthesis (coal) are included in bare area.

Table 14.2.3 Projected Future Population of Sub-catchment (2010)

No.	Name of Sub-catchment	Yen Hung District	Hoanh Bo District	Ha Long City	Cam Pha Town	Total	Population Density (pers./km²)
1	Mip river basin	14,600	9,700	0	0	24,300	96
2	Hung Thang basin	0	0	16,700	0	16,700	2,062
3	Bai Chay basin	0	0	20,700	0	20,700	3,632
4	Troi river basin	0	39,400	55,800	0	95,200	484
5	Man river basin	0	7,700	0	0	7,700	64
6	Dien vong river basin	0	4,100	37,800	42,700	84,600	337
7	Hong Gai north basin	0	0	148,700	0	148,700	11,351
8	Hong Gai south basin	0	0	81,700	0	81,700	11,192
9	Ha Tu basin	0	0	23,400	3,500	26,900	928
10	Cam Pha west basin	0	0	0	89,900	89,900	2,863
11	Cam Pha central basin	0	0	0	19,800	19,800	1,303
12	Cam Pha east basin	0	0	0	9,200	9,200	836
13	Cua Ong basin	0	0	0	8,900	8,900	1,011
14	Mong Duong basin	0	0	0	9,000	9,000	110
15	Cat Ba islands	0	0	0	0	0	0
	Total	14,600	60,900	384,800	183,000	643,300	620

Table 14.2.4 Domestic Pollution Loads Generation (2010)

Items	No.	Name of Sub-catchment	Population	Pollution Loads Generation (kg/day)				
				BOD	COD	SS	T-N	T-P
Residents in the Catchment	1	Mip river basin	24,300	1,310	570	980	220	20
	2	Hung Thang basin	16,700	900	390	670	150	20
	3	Bai Chay basin	20,700	1,120	490	830	190	20
	4	Troi river basin	95,200	5,130	2,240	3,820	870	100
	5	Man river basin	7,700	410	180	310	70	10
	6	Dien vong river basin	84,600	4,560	1,990	3,390	770	90
	7	Hong Gai north basin	148,700	8,010	3,490	5,970	1,360	150
	8	Hong Gai south basin	81,700	4,400	1,920	3,280	750	80
	9	Ha Tu basin	26,900	1,450	630	1,080	250	30
	10	Cam Pha west basin	89,900	4,840	2,110	3,610	820	90
	11	Cam Pha central basin	19,800	1,070	470	790	180	20
	12	Cam Pha east basin	9,200	500	220	370	80	10
	13	Cua Ong basin	8,900	480	210	360	80	10
	14	Mong Duong basin	9,000	480	210	360	80	10
	15	Cat Ba islands	0	0	0	0	0	0
Sub Total			643,300	34,660	15,120	25,820	5,870	660
Residents on the sea	8	Hong Gai south basin	2,000	110	50	80	20	0
	11	Cam Pha central basin	1,000	50	20	40	10	0
Sub Total			3,000	160	70	120	30	0
Total			646,300	34,820	15,190	25,940	5,900	660

Table 14.2.5 Pollution Loads Generation by Tourists (2010)

Items	Units (g/cap./day)					Number of Tourists (ave.)	Pollution Loads (kg/day)					Remarks
	BOD	COD_{Mn}	SS	T-N	T-P	per'n/day	BOD	COD	SS	T-N	T-P	
Tourists in hotels	43	19	32	7	1	15,000	647	282	482	110	12	Discharged near sub-catchment No.3
Tourist boats	16	7	12	3	0	9,500	154	67	114	26	3	Discharged tourist boats' routes
Total	-	-	-	-	-	-	800	349	600	140	15	

Notes: 1. Pollution load units of tourist in hotel are 80% of residence.
2. Pollution load units of tourist in boat are 30% of residence.

Table 14.2.6 (1) Projected Pollution Loads Generation by Planned Industrial Development (2010)

Catchment No.	No.	Name of company	Products	Land area (ha)	Water use (m^3/day)	Recycled Water (m^3/day)	Recycled Water (%)	Wastewater (m^3/day)	Water Quality (mg/ℓ) BOD	COD	SS	T-N	T-P	Pollution Loads Generation (kg/day) BOD	COD	SS	T-N	T-P
4	1	Expansion of Ship Building Factory	Ship building and repairing	31	592	215	36	377	5	11	43	2.7	0.7	2	4	16	1.0	0.3
	2	Cailan Concentrated Industrial Park I	Grain milling	7.2	2,658	1,385	52	1,273	50	2	100	60	6	64	3	127	76.4	7.6
			Edible oil	7.2	1,820	1,707	94	113	50	65	100	5	2	6	7	11	0.6	0.2
			Electromecanics	7.2	3,843	3,236	84	607	50	46	100	26	4	30	28	61	15.8	2.4
			Garment	7.2	2,831	1,580	56	1,251	50	65	100	13	1	63	81	125	16.3	1.3
			Precision instrume1t	7.2	3,539	2,725	77	814	50	46	31	3	0	41	37	25	2.4	0.0
			Packaging	7.2	1,430	718	50	712	50	65	100	10	6	36	46	71	7.1	4.3
			Toy	7.2	3,438	2,719	79	719	50	65	100	16	1	36	47	72	11.5	0.7
			Subtotal	51	19,559			5,489						274	250	493	130.1	16.5
	3	Cailan Concentrated Industrial Park II	Electromecanics	28.8	15,311	12,892	84	2,419	50	46	100	26	4	121	111	242	62.9	9.7
			Garment	28.8	11,282	6,295	56	4,987	50	65	100	13	1	249	324	499	64.8	5.0
			Precision instrument	28.8	14,102	10,858	77	3,244	50	46	31	3	0	162	149	101	9.7	0.0
			Packaging	28.8	5,699	2,861	50	2,838	50	65	100	10	6	142	184	284	28.4	17.0
			Toy	28.8	13,699	10,836	79	2,863	50	65	100	16	1	143	186	286	45.8	2.9
			Subtotal	144	60,093			16,351						818	955	1,411	211.6	34.6
			Zone I + Zone II	194	79,652			21,840						1,092	1,205	1,904	342	51
	4	Hon Bo Industrial Park	Grain milling	33.8	12,451	6,487	52	5,964	50	2	100	60	6	298	12	596	357.8	35.8
			Electromecanics	33.8	17,999	15,155	84	2,844	50	46	100	26	4	142	131	284	73.9	11.4
			Garment	33.8	13,263	7,401	56	5,862	50	65	100	13	1	293	381	586	76.2	5.9
			Precision instrument	33.8	16,578	12,765	77	3,813	50	46	31	3	0	191	175	118	11.4	0.0
			Packaging	33.8	6,699	3,363	50	3,336	50	65	100	10	6	167	217	334	33.4	20.0
			Toy	33.8	16,105	12,739	79	3,366	50	65	100	16	1	168	219	337	53.9	3.4
			Subtotal	203	83,095			25,185						1,259	1,135	2,255	606.6	76.4
	5	Expansion of Brick and Tile Factory (Gieng Day)	Bricks and Tiles	25	258	60	25	198	19	65	100	2	0	4	13	20	0.4	0.0
	6	Steel mil	Steel	25	7,500	3,300	44	4,200	50	65	100	42	4	210	273	420	176.4	16.8
		Total						51,300						2,567	2,629	4,615	1,126	145
5	7	Coal burned thermal power station (300MW)	Electricity	200	1,068,800	855,040	80	213,760	0	0	0	0	0	9	9	18	1.8	0.5
	8	Hoan Cau -Taiwn Cement	Cement	15	1,710	430	25	1,280	50	65	100	16	1	64	83	128	20.5	1.3
	9	Hai Long-South Korea Cement	Cement	15	1,710	430	25	1,280	50	65	100	16	1	64	83	128	20.5	1.3
		Total						216,320						137	175	274	43	3
10	10	Cement Factory	Cement	25	2,850	710	25	2,140	50	65	100	16	1	107	139	214	34.2	2.1
		Total						2,140						107	139	214	34.2	2.1
13	12	Coal burned thermal power station (300MW)	Electricity	200	1,068,800	855,040	80	213,760	0	0	0	0	0	9	9	18	1.8	0.5
	13	Steel refinery	Steel	25	7,500	3,300	44	4,200	50	65	100	42	4	210	273	420	176.4	16.8
		Total						217,960						219	282	438	178.2	17.3
		Grand Total						488,220						3,030	3,226	5,541	1,381	167

Source: Estimation of JICA Study Team

Note: Not available

Table 14.2.6 (2) Pollution Loads Generation by New Developed Industries (2010)

Catchment No.	Number of Industries		Pollution Loads Generation by Factories (kg/day)				
	Factories	Coal Mining	BOD	COD	SS	T-N	T-P
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	1	0
4	4+(2)	0	2,567	2,629	4,615	1,126	145
5	3	0	137	175	274	43	3
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	1	0	107	139	214	34	2
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	2	0	219	273	438	178	17
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
Total	11	0	3,030	3,216	5,541	1,382	167

Note: Numbers in parenthesis mean expanded factories.

Table 14.2.6 (3) Total Pollution Loads Generation by Industries (2010)

Catch-ment No.	Number of Industries		Pollution Loads Generation by Factories (kg/day)				
	Factories	Coal Mining	BOD	COD	SS	T-N	T-P
1	0	1	1	8	79	2	0
2	0	0	0	0	0	0	0
3	0	0	0	1	4	0	0
4	12	0	2,570	2,631	4,676	1,126	145
5	3	0	137	175	274	43	3
6	0	12	6	37	344	8	1
7	7	5	9	38	383	5	1
8	4	1	9	12	38	12	1
9	0	3	79	300	7,233	76	7
10	5	1	109	146	232	35	2
11	4	2	31	90	454	12	1
12	3	4	439	1,918	17,750	615	12
13	2	2	219	274	450	178	17
14	0	8	57	323	3,051	69	6
15	0	0	0	0	0	0	0
Total	40	39	3,666	5,956	34,968	2,181	196

Notes: 1. Catchment No.4 includes three industrial zones.
2. Pollution load from coal industries does not include soil erosion caused by coal mining activities.

Table 14.2.7 Livestock Pollution Loads Generation (2010)

No.	Heads		Pollution Loads Generation (kg/day)				
	Cattle &Buffalo	Pig	BOD	COD	SS	T-N	T-P
1	970	13,970	3,420	2,340	12,720	840	400
2	50	2,050	440	300	1,590	90	50
3	30	1,440	310	210	1,100	70	40
4	760	10,820	2,650	1,810	9,850	650	310
5	460	6,580	1,610	1,100	5,990	390	180
6	950	13,780	3,370	2,300	12,530	830	390
7	80	3,320	710	470	2,560	150	80
8	40	1,790	390	250	1,370	80	40
9	160	7,340	1,570	1,030	5,620	340	190
10	120	1,730	430	280	1,570	100	50
11	60	840	210	140	770	50	20
12	40	610	150	100	550	30	20
13	40	480	130	80	460	30	10
14	320	4,500	1,100	760	4,110	270	130
15	0	0	0	0	0	0	0
Total	4,100	69,250	16,490	11,170	60,790	3,920	1,910

Table 14.2.8 Pollution Loads Generation of Non-Specific Sources (2010)

Sub-catch. No.	Forest & Grass Land (kg/day)					Agricultural Land (kg/day)					Bare Land (kg/day)					Urban Area (kg/day)					Total (kg/day)				
	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P	BOD	COD	SS	T-N	T-P
1	2,556	3,651	36,513	1,826	730	354	550	49,120	707	157	37	60	4,552	74	14	322	356	1,693	169	102	3,268	4,617	93,336	2,776	1,003
2	91	130	1,304	65	26	2	4	344	5	1	1	1	111	1	0	91	100	478	48	29	185	236	2,237	119	56
3	42	59	594	30	12	0	0	0	0	0	1	2	192	2	0	93	103	491	49	29	136	165	1,277	81	42
4	2,157	3,082	30,817	1,541	616	281	437	39,017	562	125	69	113	10,425	139	26	638	705	3,357	336	201	3,145	4,336	84,111	2,577	969
5	1,270	1,815	18,146	907	363	118	183	16,372	236	52	107	174	16,719	214	40	394	435	2,073	207	124	1,889	2,607	53,310	1,564	580
6	2,876	4,109	41,086	2,054	822	175	272	24,305	350	78	341	554	1,972	681	128	74	81	387	39	23	3,465	5,016	129,271	3,124	1,050
7	90	128	1,281	64	26	2	3	230	3	1	43	69	798	85	16	191	211	1,004	100	60	325	411	10,345	253	103
8	22	32	321	16	6	1	2	158	2	1	3	5	450	7	1	198	219	1,042	104	63	225	258	2,063	129	71
9	198	283	2,830	142	57	30	47	4,225	61	14	155	252	542	310	58	113	125	594	59	36	496	707	36,613	572	164
10	337	482	4,820	241	96	9	14	1,233	18	4	51	82	5,963	101	19	126	139	664	66	40	523	717	15,021	426	159
11	51	73	729	36	15	2	3	225	3	1	70	114	.277	141	26	256	283	1,348	135	81	379	473	15,557	315	123
12	48	68	683	34	14	6	9	778	11	2	47	76	941	94	18	179	198	941	94	56	279	351	11,016	233	90
13	86	123	1,232	62	25	0	0	0	0	0	27	43	50	53	10	34	37	178	18	11	147	204	6,409	133	45
14	806	1,151	11,509	575	230	0	0	0	0	0	367	596	1,031	733	138	13	14	67	7	4	1,185	1,761	80,130	1,316	372
15	1,770	2,529	25,286	1,264	506	52	80	7,184	103	23	0	0	34	0	0	12	13	64	6	4	1,834	2,623	32,569	1,375	533
Total	12,400	17,715	177,150	8,857	3,543	1,031	1,604	143,191	2,062	458	1,319	2,143	43,503	2,637	494	2,732	3,020	14,380	1,438	863	17,482	24,481	573,263	14,995	5,358

Table 14.3.1 Runoff Pollution Loads into the Bays in 2010 (without an Environmental Management Plan)

Sub-catch No.	BOD (kg/day)					COD (kg/day)					SS (kg/day)					T-N (kg/day)					T-P (kg/day)				
	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total	Dom.	Ind.	Live.	Non-S.	Total
1	131	1	342	327	800	285	6	468	2,308	3,070	490	55	3,816	28,001	32,400	176	1	504	1,666	2,350	18	0	320	802	1,140
2	180	0	88	37	310	273	0	150	165	590	469	0	795	1,566	2,800	135	0	72	95	300	20	0	45	51	120
3	139	2	36	27	200	209	4	62	115	390	323	14	323	894	1,600	297	1	34	65	400	35	0	20	38	90
4	983	2,308	168	315	3,770	1,501	2,363	235	2,168	6,270	2,549	4,138	1,289	25,233	33,200	783	1,013	320	1,804	3,920	100	144	151	775	1,170
5	41	96	161	189	490	90	140	220	1,304	1,750	155	219	1,198	15,993	17,600	56	34	234	939	1,260	9	3	144	464	620
6	459	5	337	347	1,150	995	26	460	2,508	3,990	1,695	241	2,506	38,802	43,200	616	6	498	1,875	3,000	81	1	312	840	1,230
7	1,474	4	83	65	1,630	2,244	23	138	288	2,690	3,805	204	758	7,241	12,000	1,224	4	73	202	1,500	150	0	40	92	280
8	624	1	46	45	720	945	4	73	181	1,200	1,547	4	404	1,444	3,400	675	1	39	103	820	80	0	20	64	160
9	290	55	314	99	760	441	270	412	424	1,550	756	6,510	2,248	21,968	31,500	225	69	272	457	1,020	30	7	171	147	360
10	986	87	86	105	1,260	1,477	131	140	502	2,250	2,527	209	785	10,515	14,000	738	32	80	341	1,190	90	2	45	143	280
11	214	110	42	76	440	329	207	70	333	940	553	601	385	11,707	13,200	162	41	40	261	500	20	3	18	111	150
12	100	351	30	56	540	154	1,726	50	246	2,180	259	15,975	275	7,711	24,200	72	553	24	187	840	10	12	18	81	120
13	96	175	26	29	330	147	247	40	143	580	252	405	230	4,487	5,400	72	161	24	106	360	10	17	9	41	80
14	96	40	110	119	360	147	291	152	880	1,470	252	2,746	822	24,039	27,900	72	62	216	1,052	1,400	10	6	117	335	470
15	0	0	0	183	180	0	0	0	1,311	1,310	0	0	0	9,771	9,800	0	0	0	1,100	1,100	0	0	0	479	480
Total	5,810	3,230	1,870	2,020	12,940	9,240	5,440	2,670	12,880	30,230	15,600	31,300	15,800	209,400	272,200	5,300	1,980	2,430	10,250	19,960	660	200	1,430	4,460	6,750

FIGURES

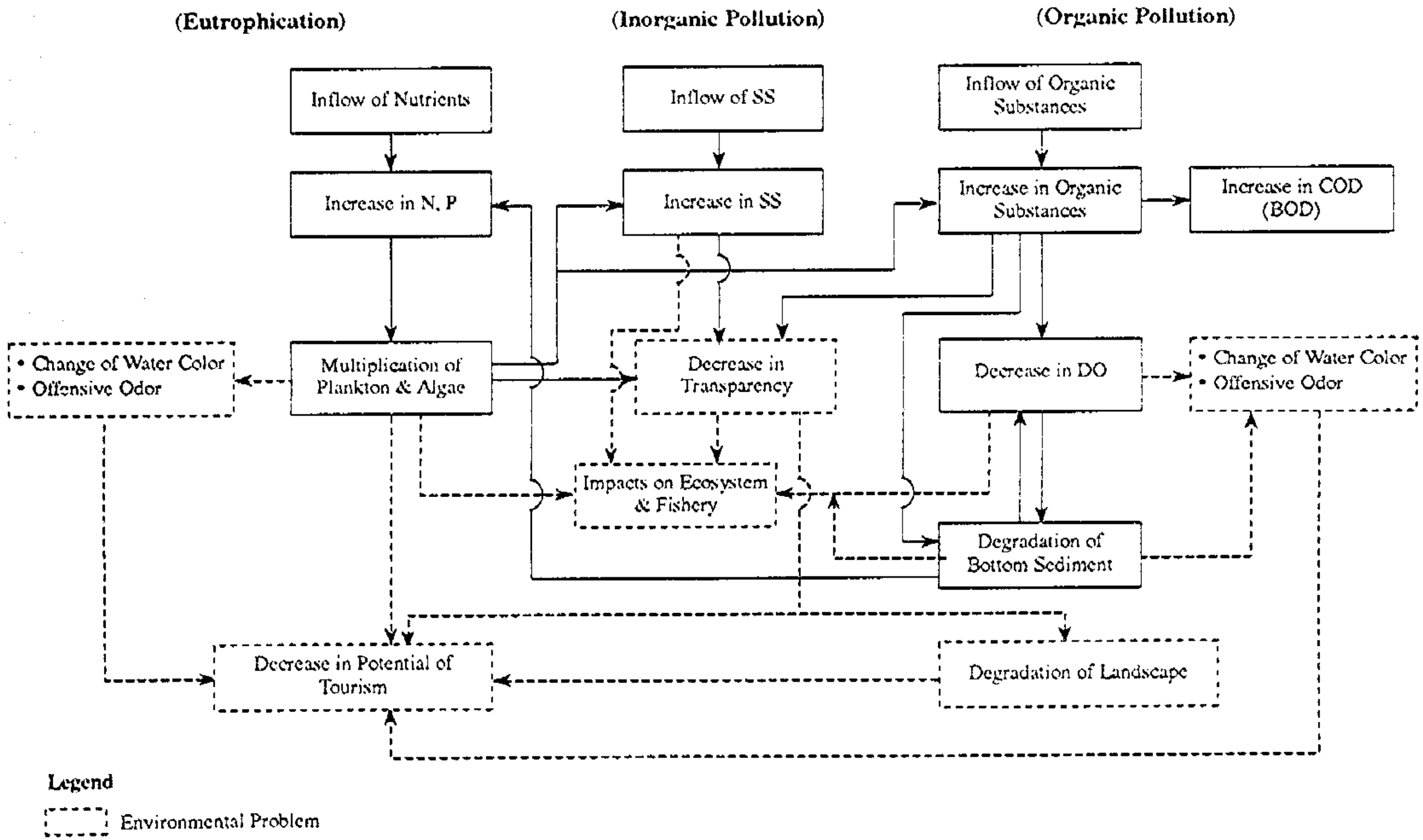


Figure 14.2.1 Schematic Relation of Pollution Loads Inflow and Environmental Problems

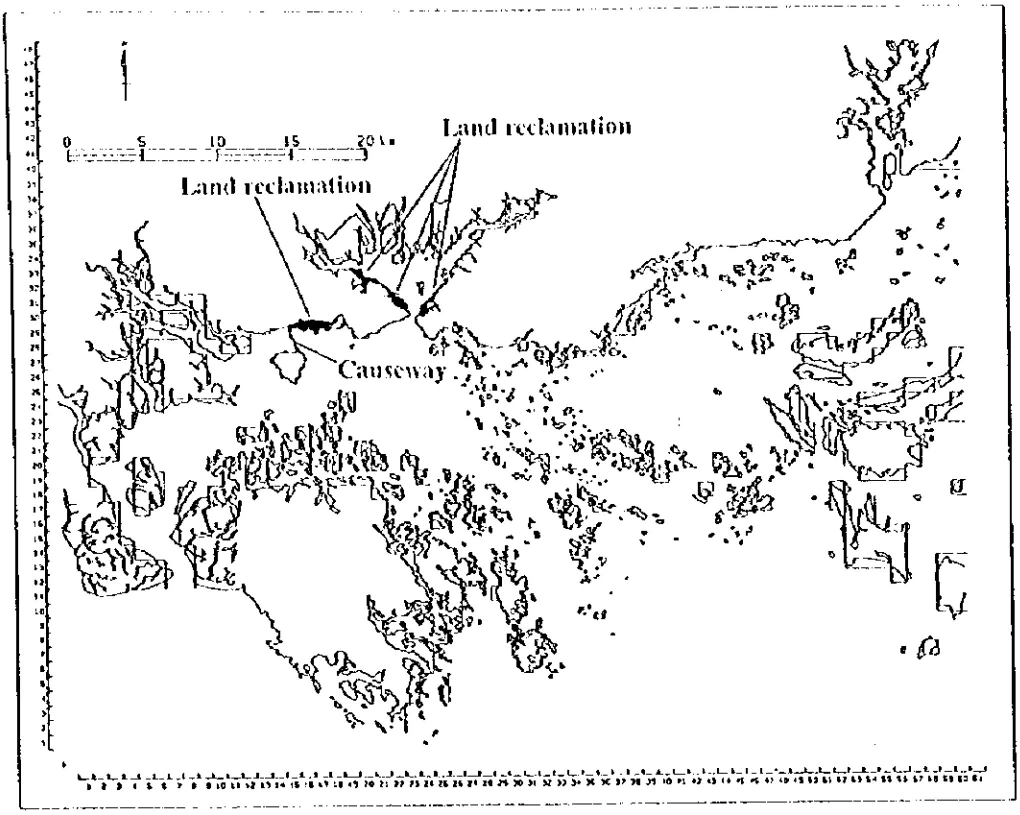


Figure 14.3.1 Topographic Conditions Modified for the Prediction

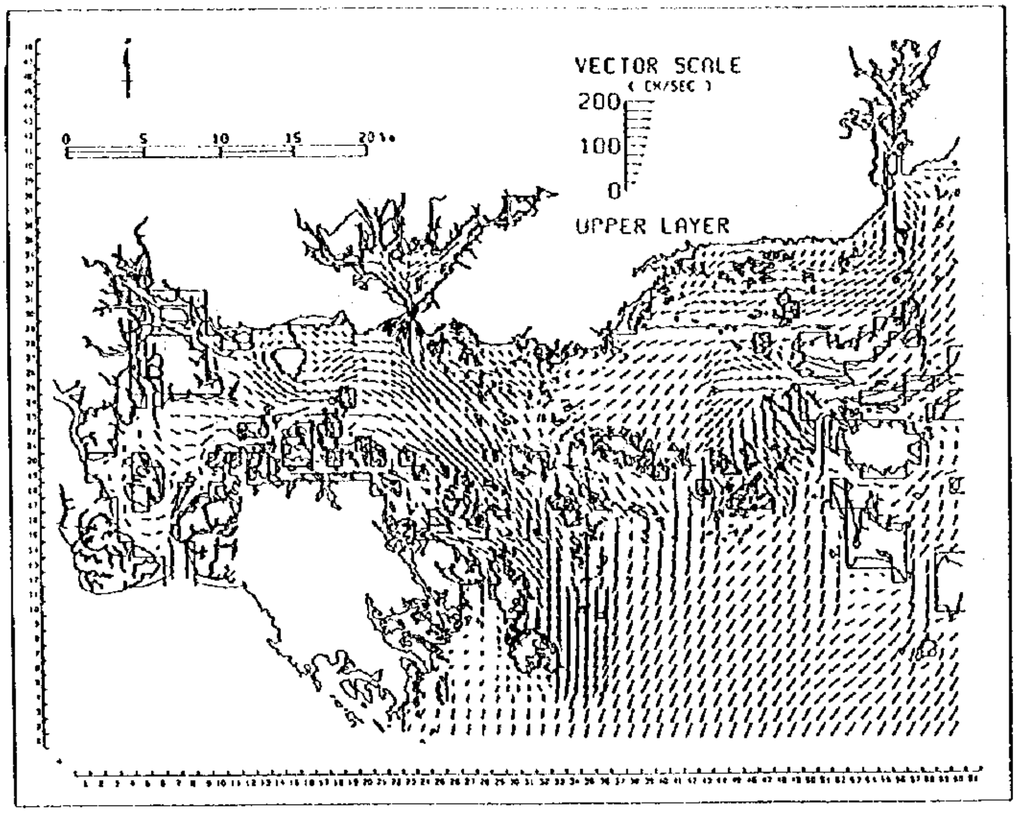


Figure 14.3.2 (1) Predicted Ebb Tide of the Upper Layer

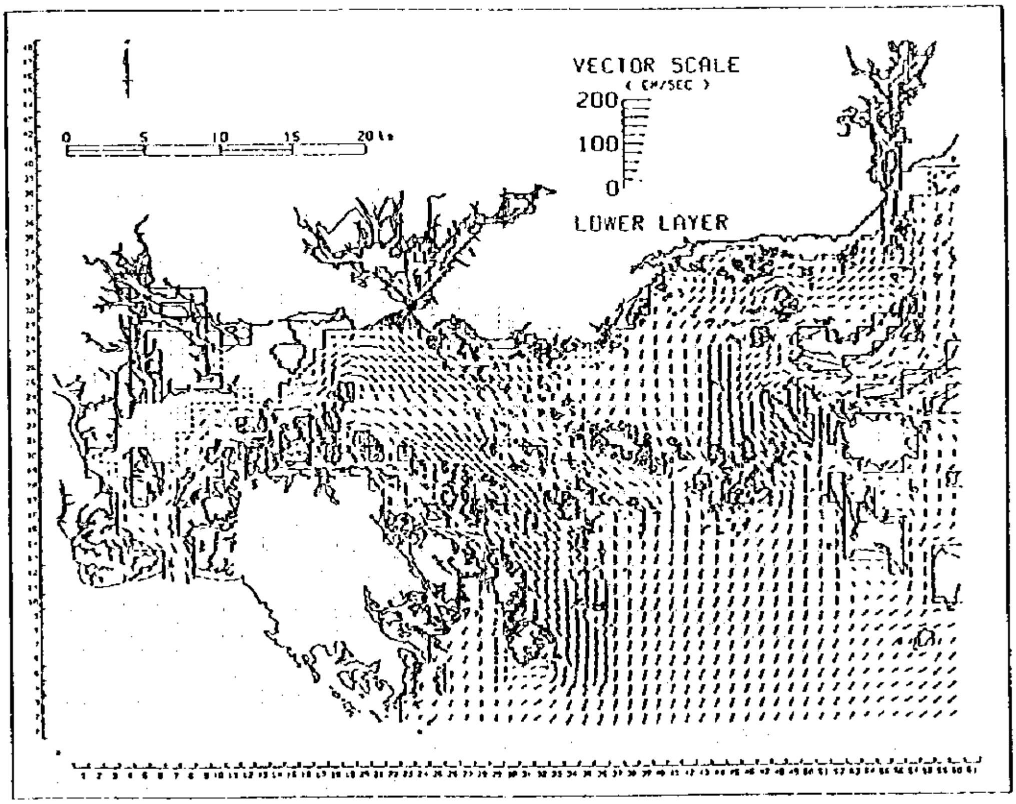


Figure 14.3.2 (2) Predicted Ebb Tide of the Lower Layer

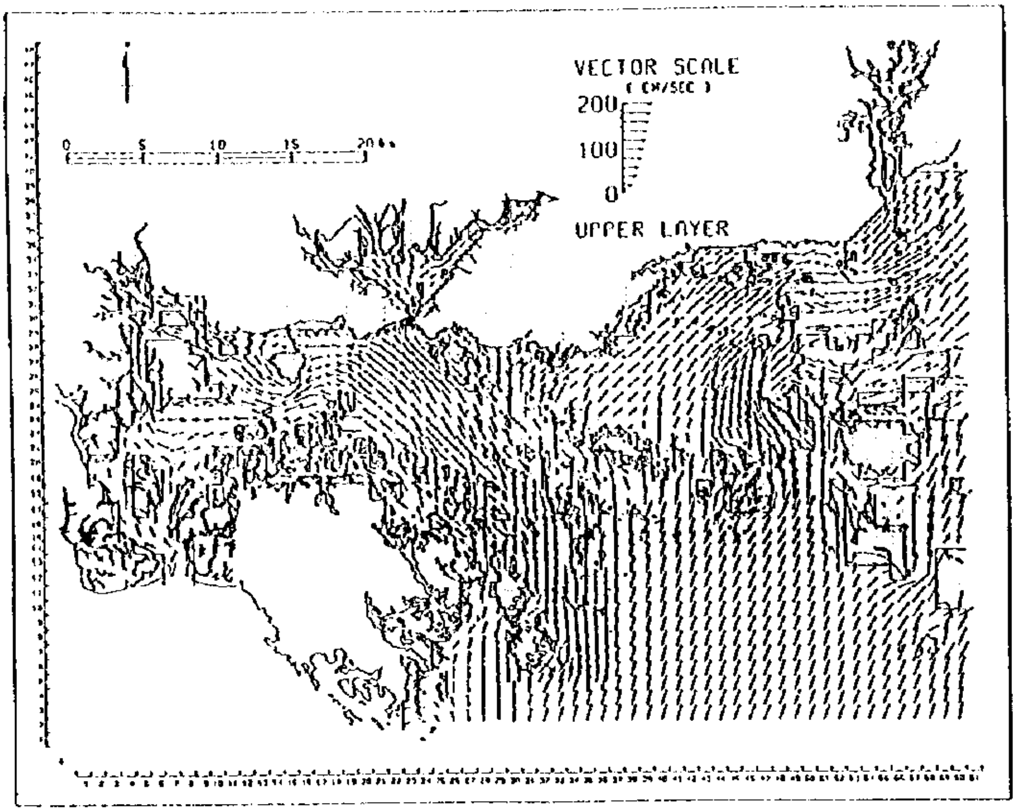


Figure 14.3.3 (1) Predicted Rising Tide of the Upper Layer

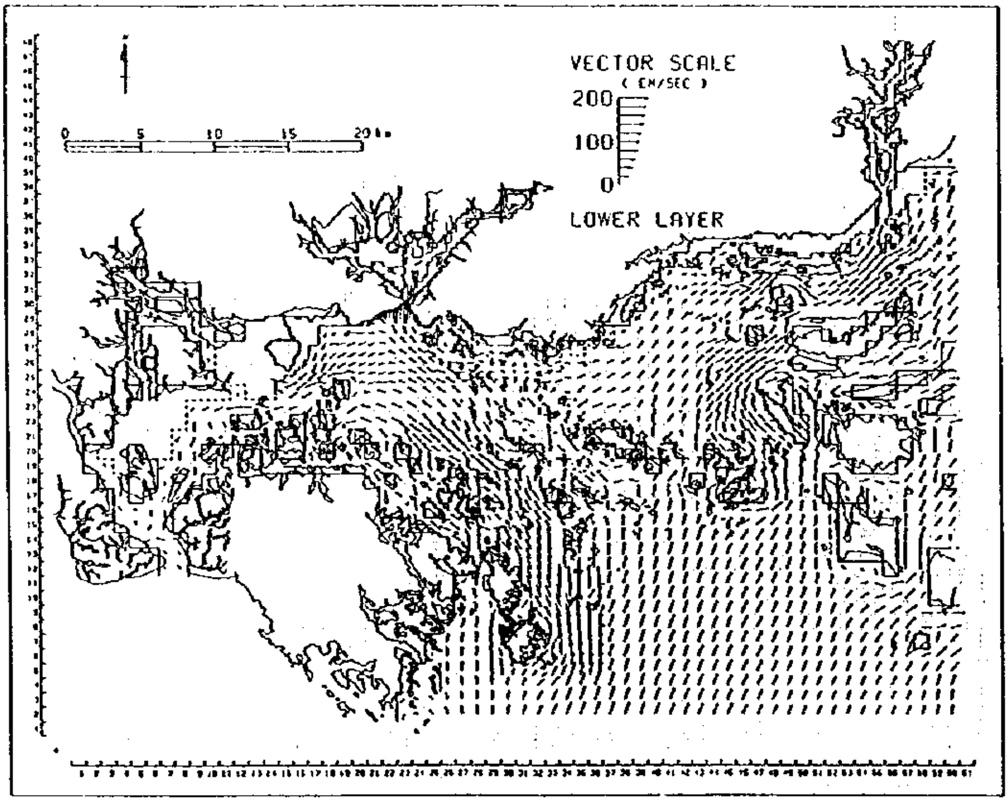


Figure 14.3.3 (2) Predicted Rising Tide of the Lower Layer

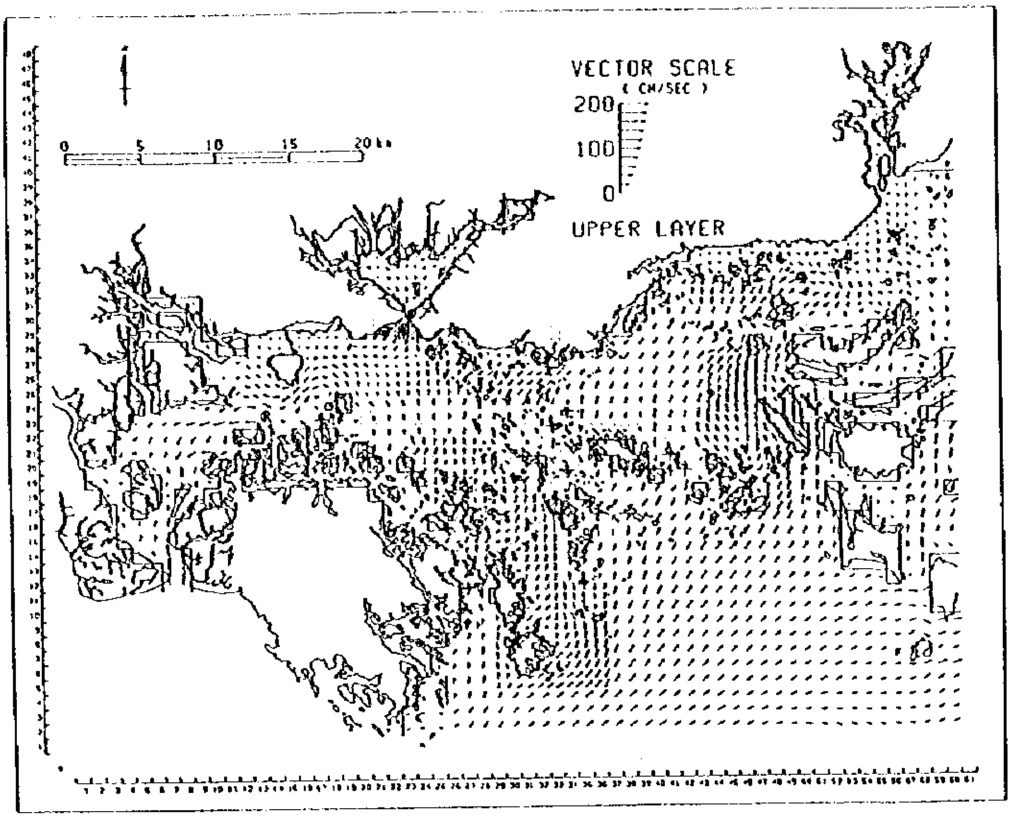


Figure 14.3.4 (1) Average of the Predicted Currents of the Upper Layer

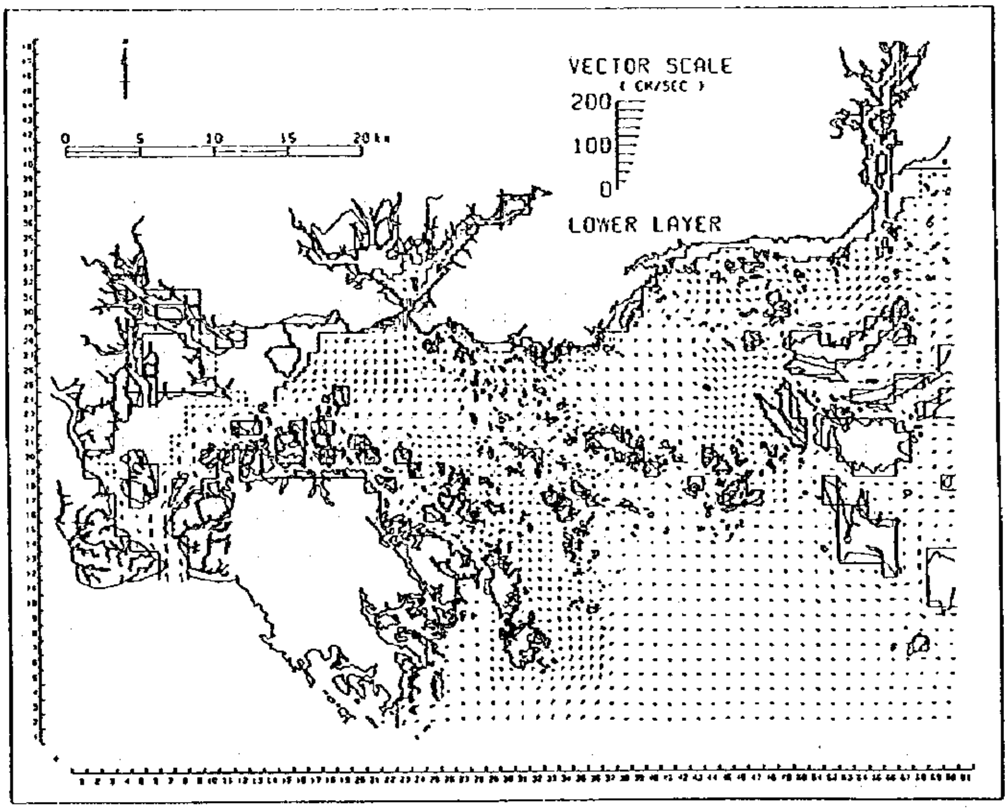


Figure 14.3.4 (2) Average of the Predicted Currents of the Lower Layer

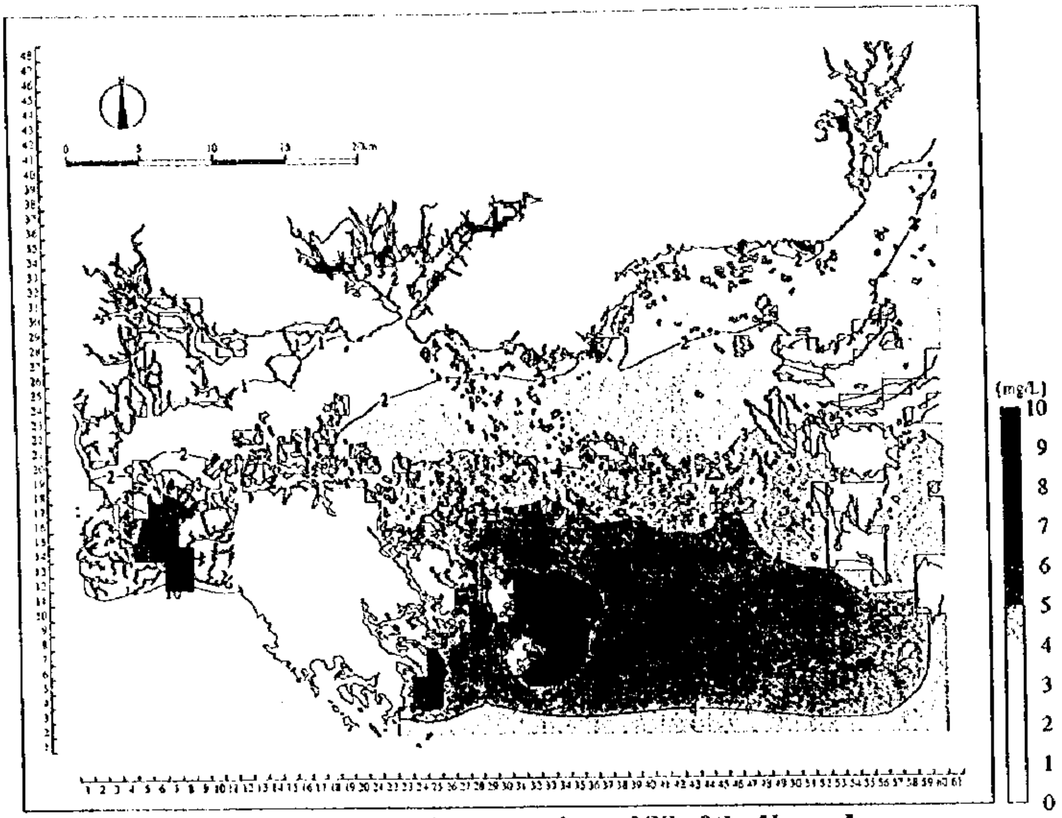


Figure 14.3.5 (1) Predicted Concentrations of SS of the Upper Layer "without an Environmental Management Plan"

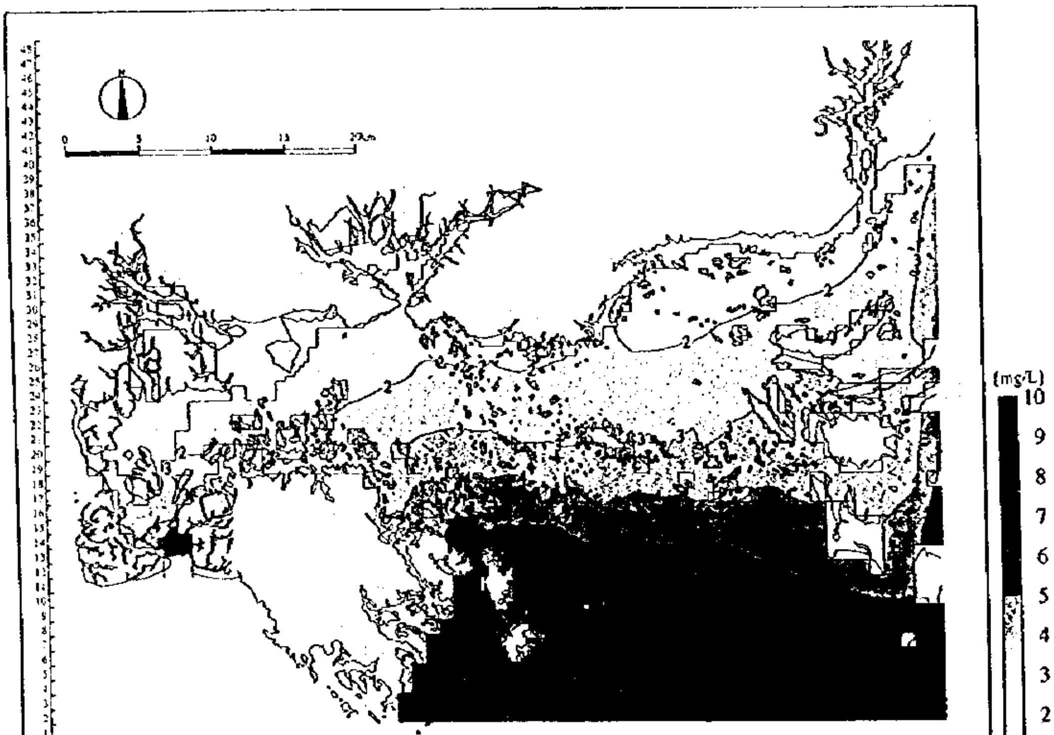


Figure 14.3.5 (2) Predicted Concentrations of SS of the Lower Layer "without an Environmental Management Plan"

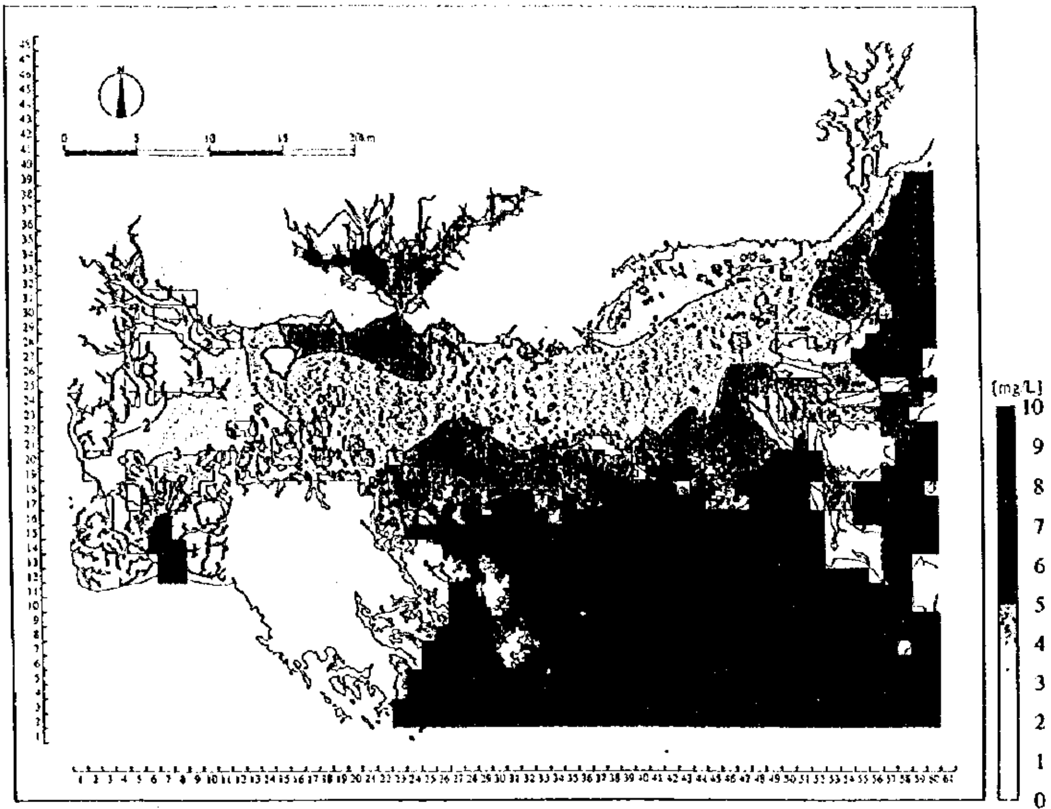


Figure 14.3.6 (1) Predicted Concentrations of COD of the Upper Layer "without an Environmental Management Plan"

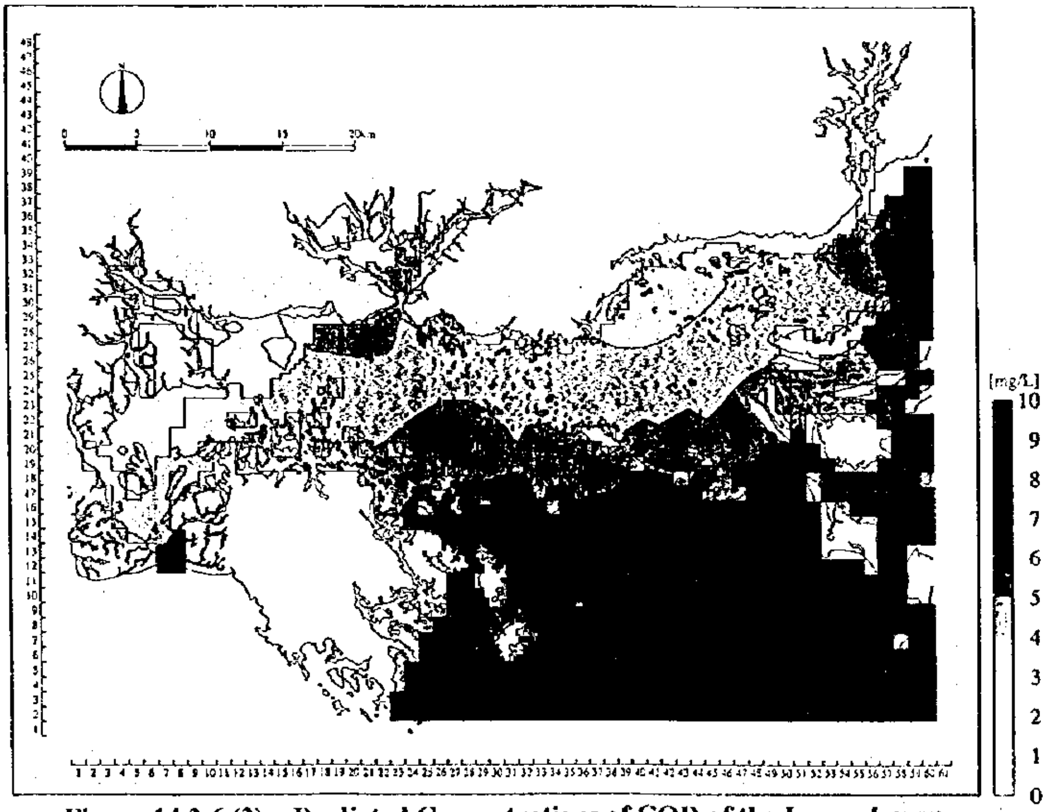


Figure 14.3.6 (2) Predicted Concentrations of COD of the Lower Layer "without an Environmental Management Plan"

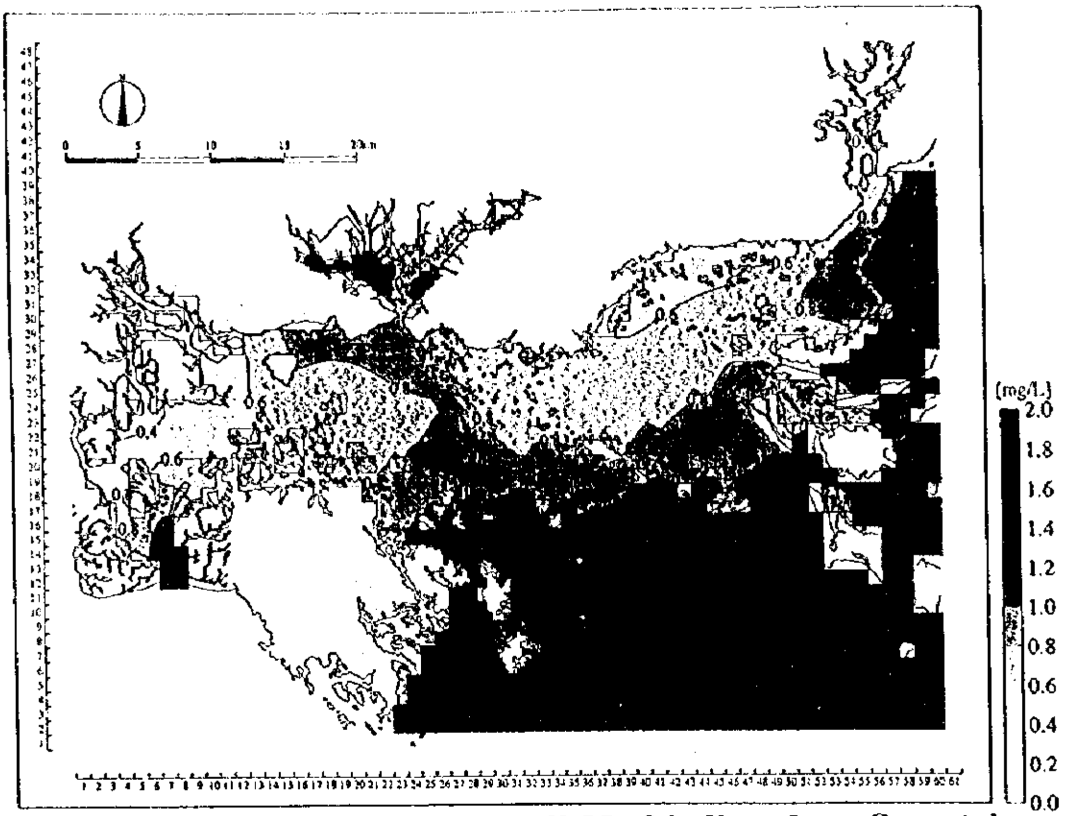


Figure 14.3.7 (1) Estimated Concentrations of BOD of the Upper Layer Converted from the Predicted COD "without an Environmental Management Plan"

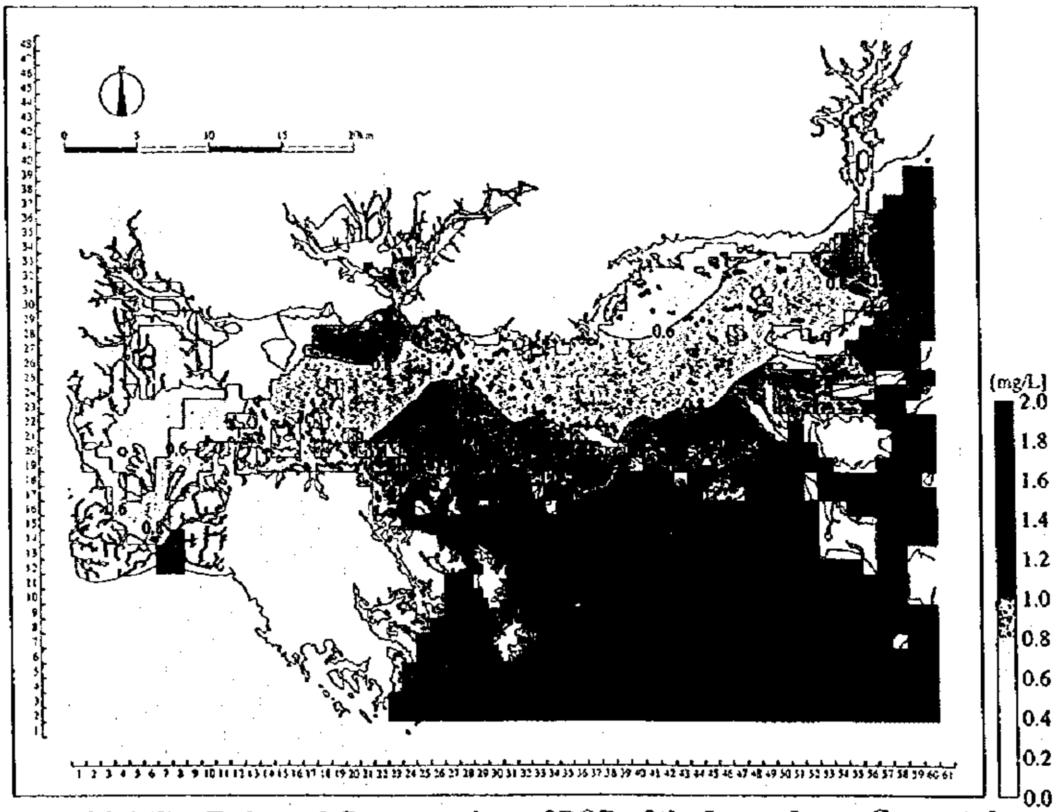


Figure 14.3.7 (2) Estimated Concentrations of BOD of the Lower Layer Converted from the Predicted COD "without an Environmental Management Plan"

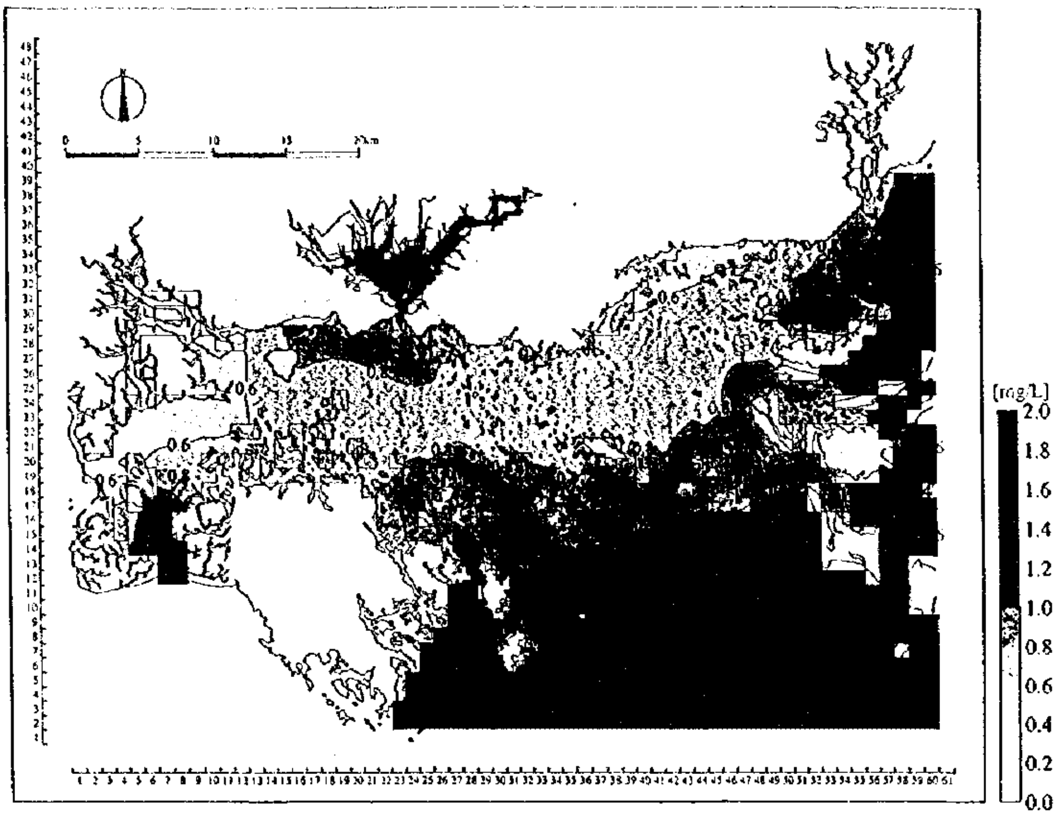


Figure 14.3.8 (1) Predicted Concentrations of T-N of the Upper Layer "without an Environmental Management Plan"

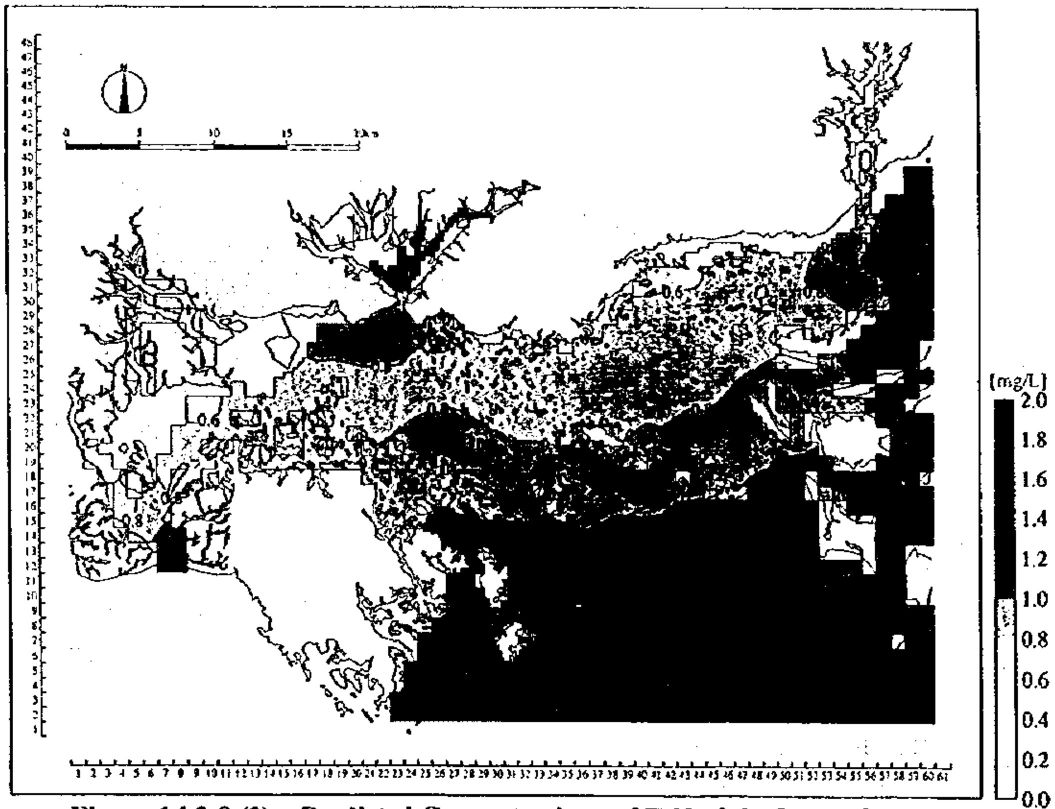


Figure 14.3.8 (2) Predicted Concentrations of T-N of the Lower Layer "without an Environmental Management Plan"

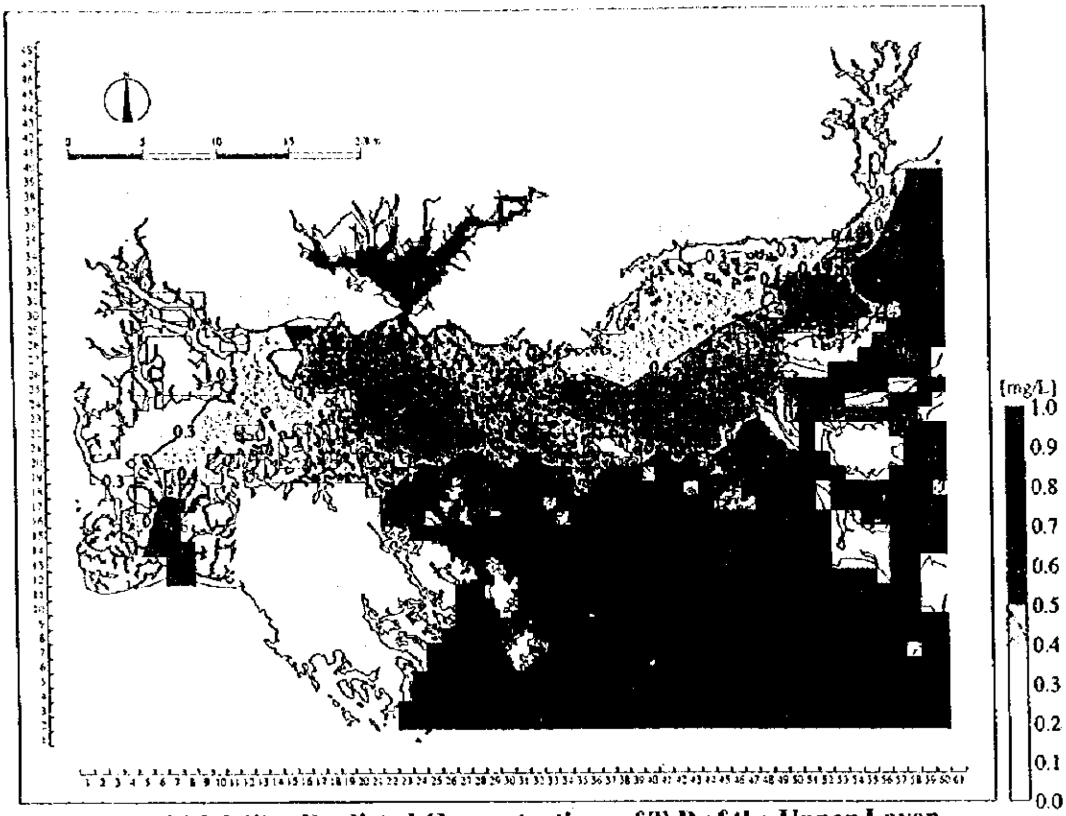


Figure 14.3.9 (1) Predicted Concentrations of T-P of the Upper Layer "without an Environmental Management Plan"

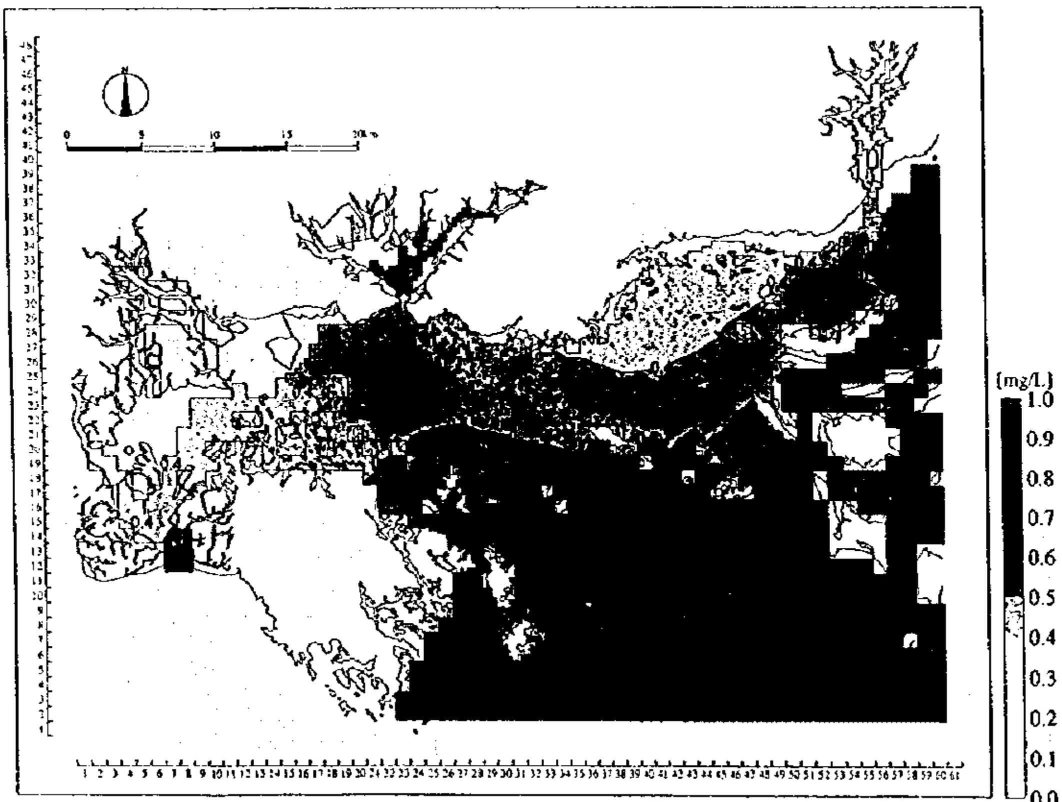


Figure 14.3.9 (2) Predicted Concentrations of T-P of the Lower Layer "without an Environmental Management Plan"

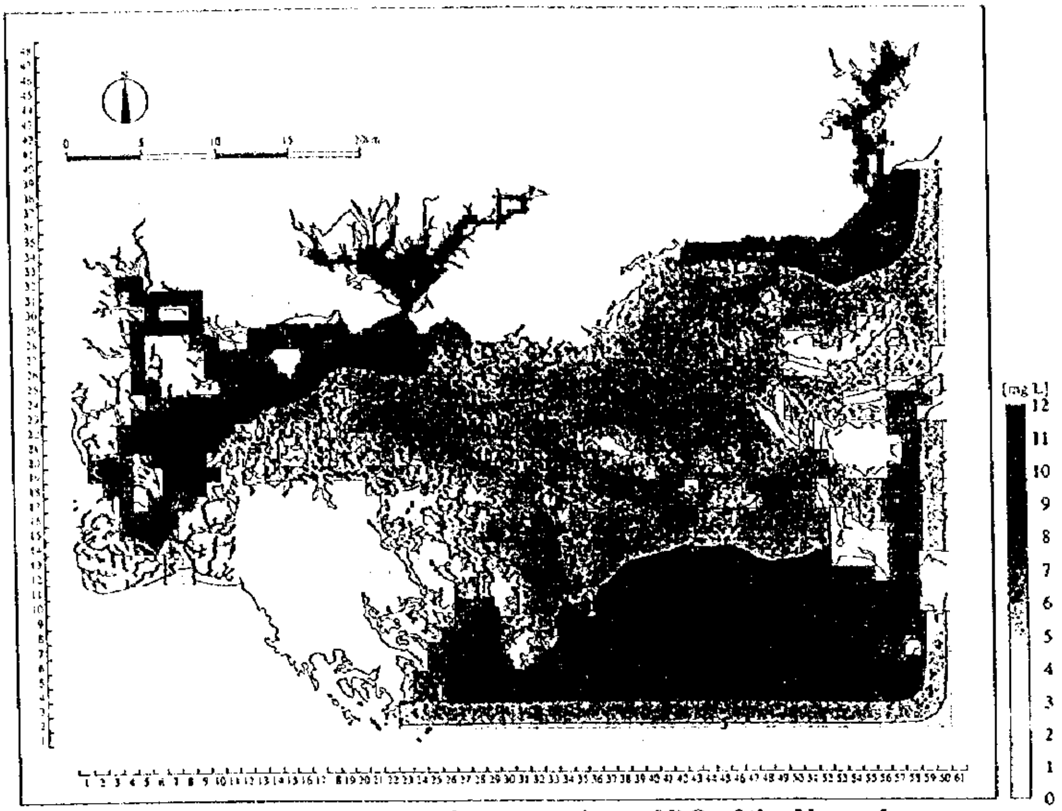


Figure 14.3.10 (1) Predicted Concentrations of DO of the Upper Layer "without an Environmental Management Plan"

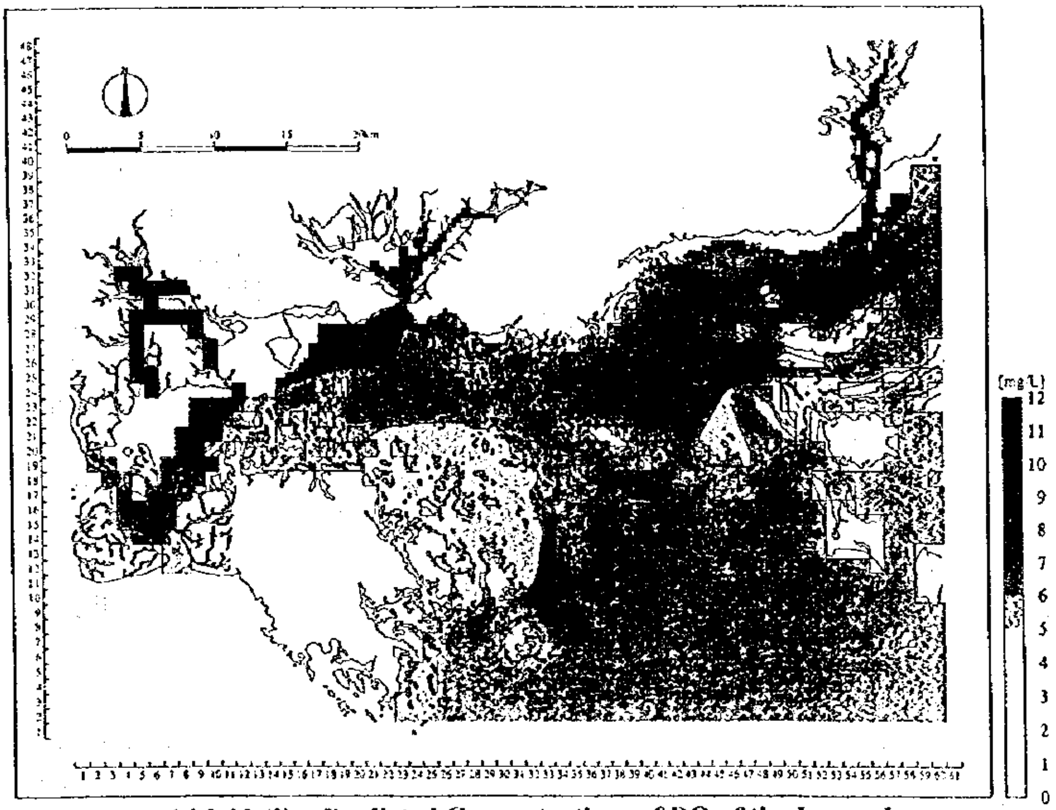


Figure 14.3.10 (2) Predicted Concentrations of DO of the Lower Layer "without an Environmental Management Plan"

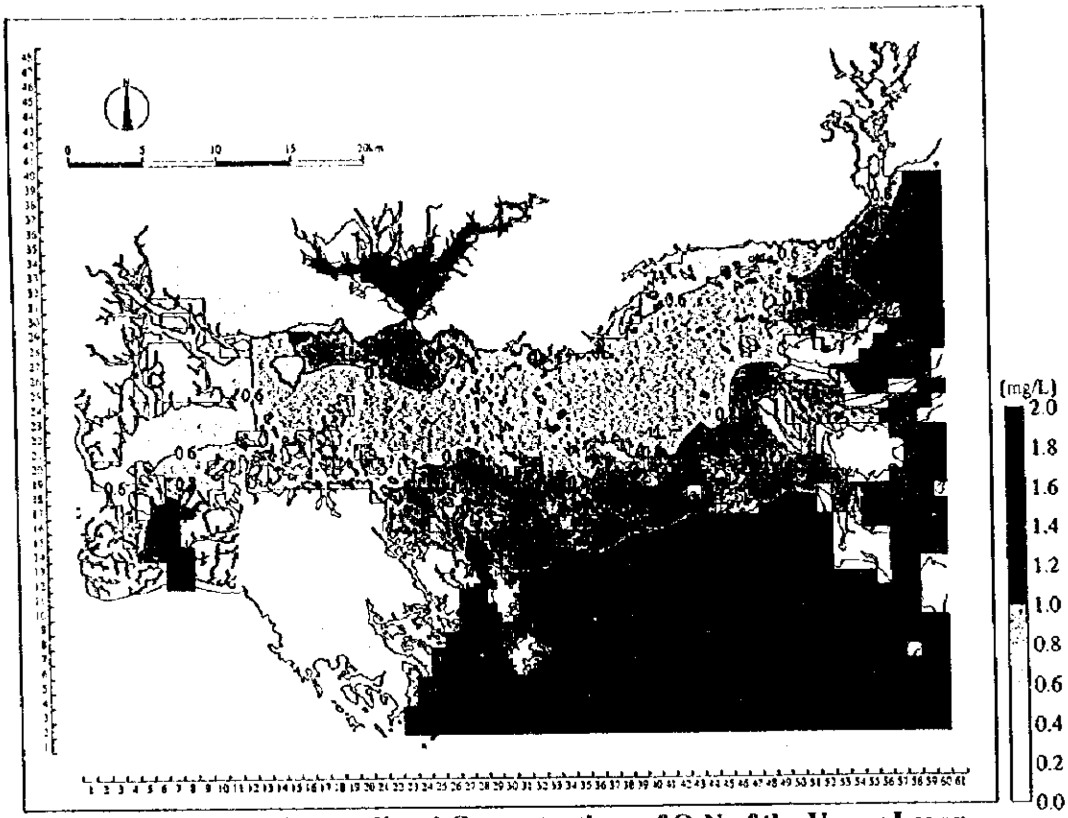


Figure 14.3.11 (1) Predicted Concentrations of O-N of the Upper Layer "without an Environmental Management Plan"

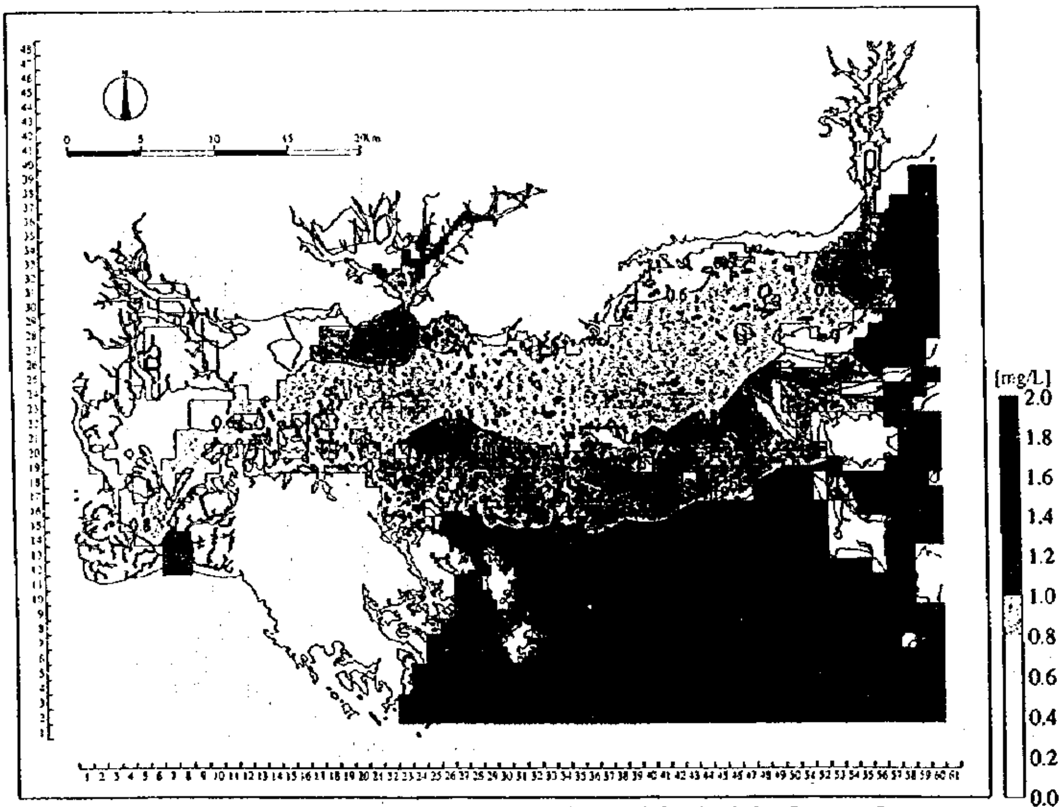


Figure 14.3.11 (2) Predicted Concentrations of O-N of the Lower Layer "without an Environmental Management Plan"

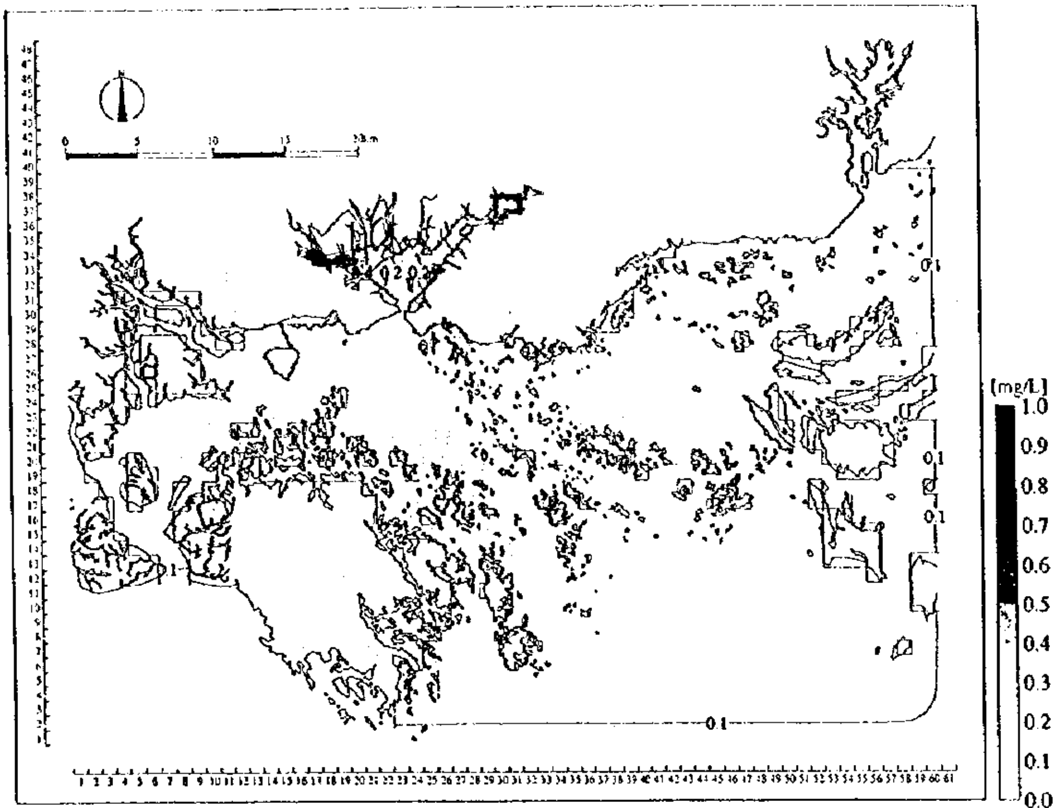


Figure 14.3.12 (1) Predicted Concentrations of I-N of the Upper Layer "without an Environmental Management Plan"

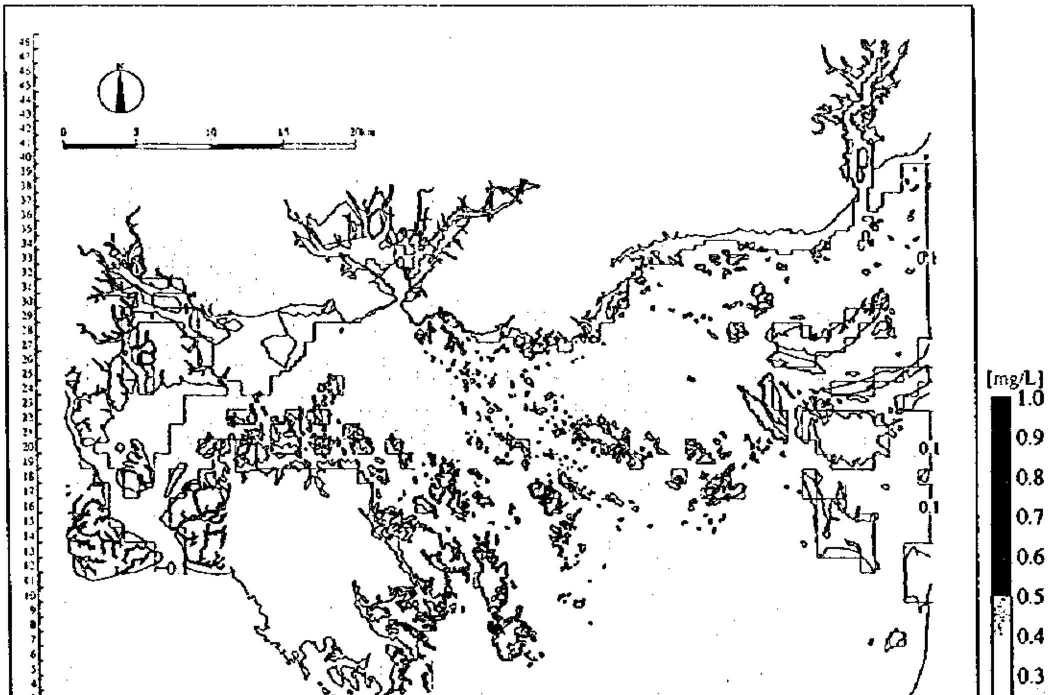


Figure 14.3.12 (2) Predicted Concentrations of I-N of the Lower Layer "without an Environmental Management Plan"

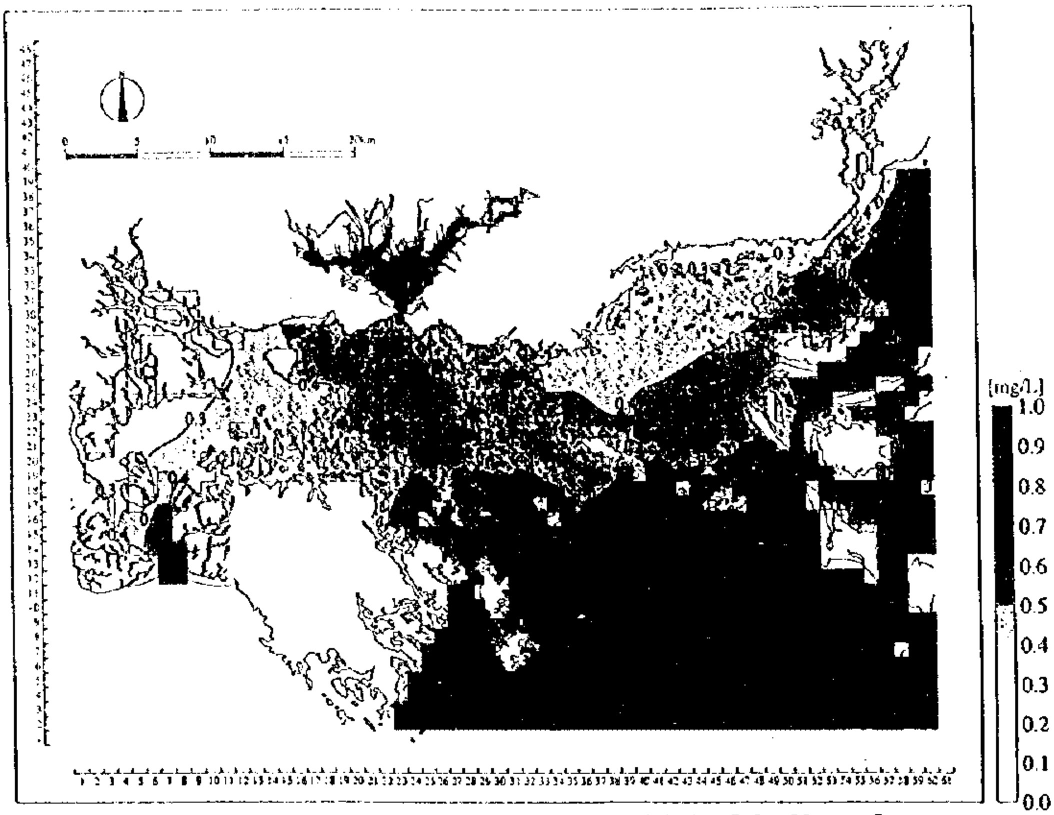


Figure 14.3.13 (1) Predicted Concentrations of O-P of the Upper Layer "without an Environmental Management Plan"

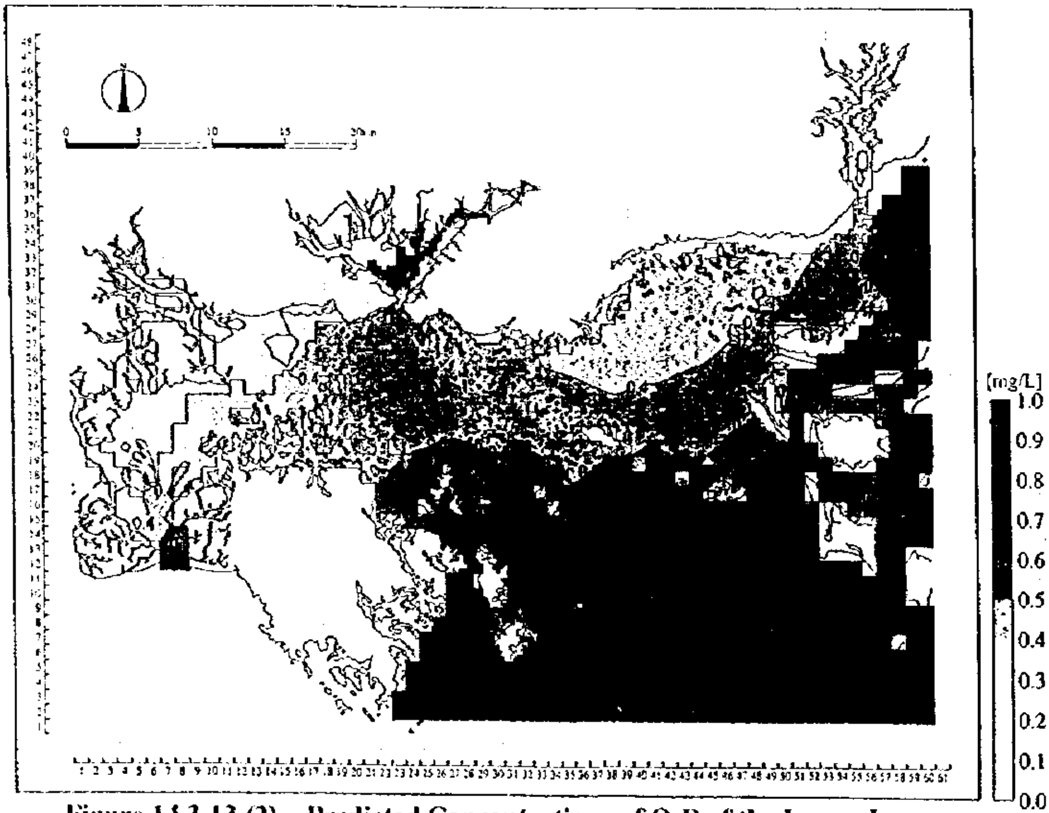


Figure 14.3.13 (2) Predicted Concentrations of O-P of the Lower Layer "without an Environmental Management Plan"

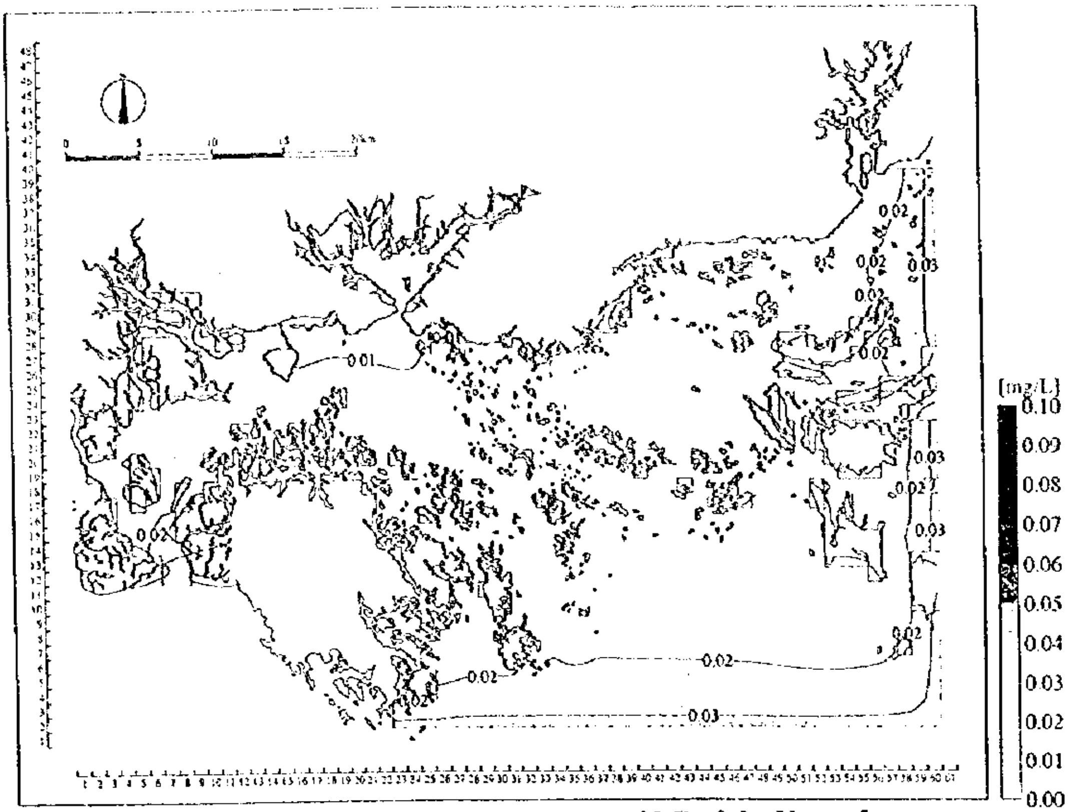


Figure 14.3.14 (1) Predicted Concentrations of I-P of the Upper Layer "without an Environmental Management Plan"

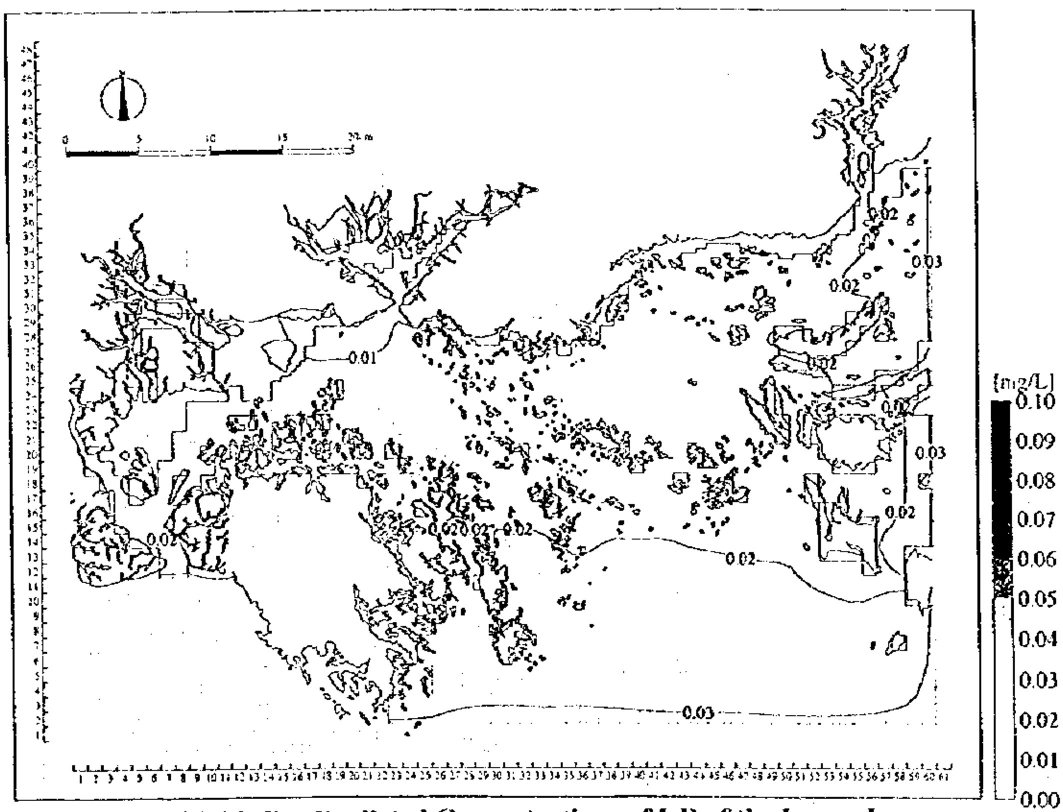


Figure 14.3.14 (2) Predicted Concentrations of I-P of the Lower Layer "without an Environmental Management Plan"