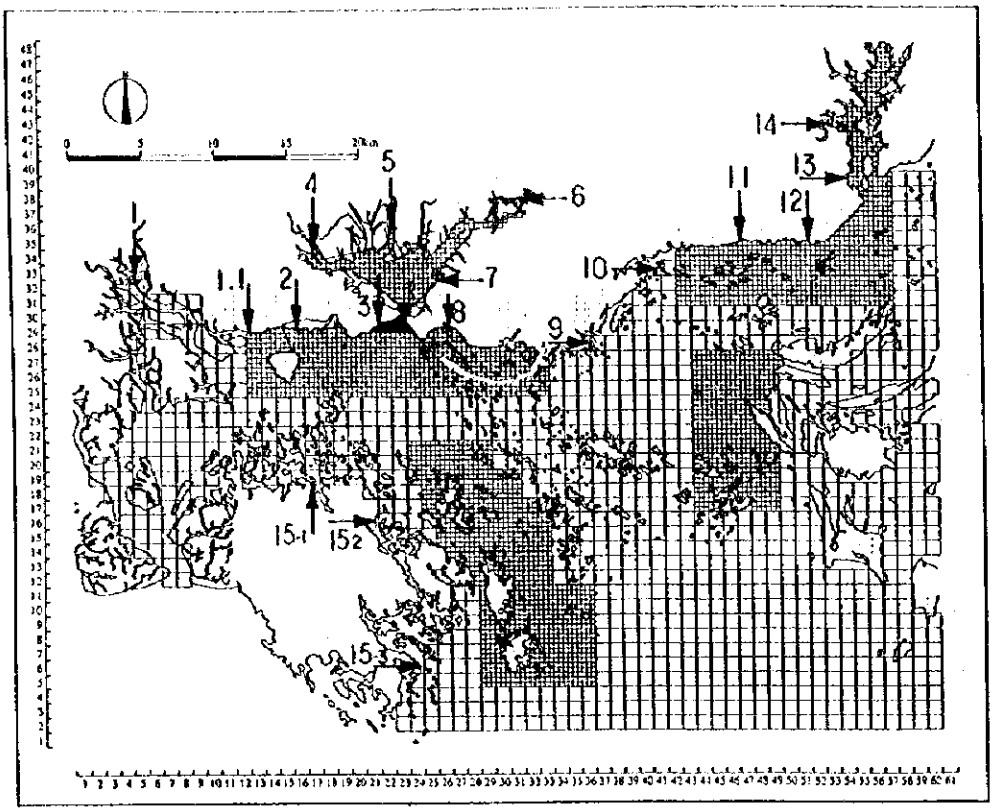


Figure 19.3.1 Locations of the River Discharges in Future

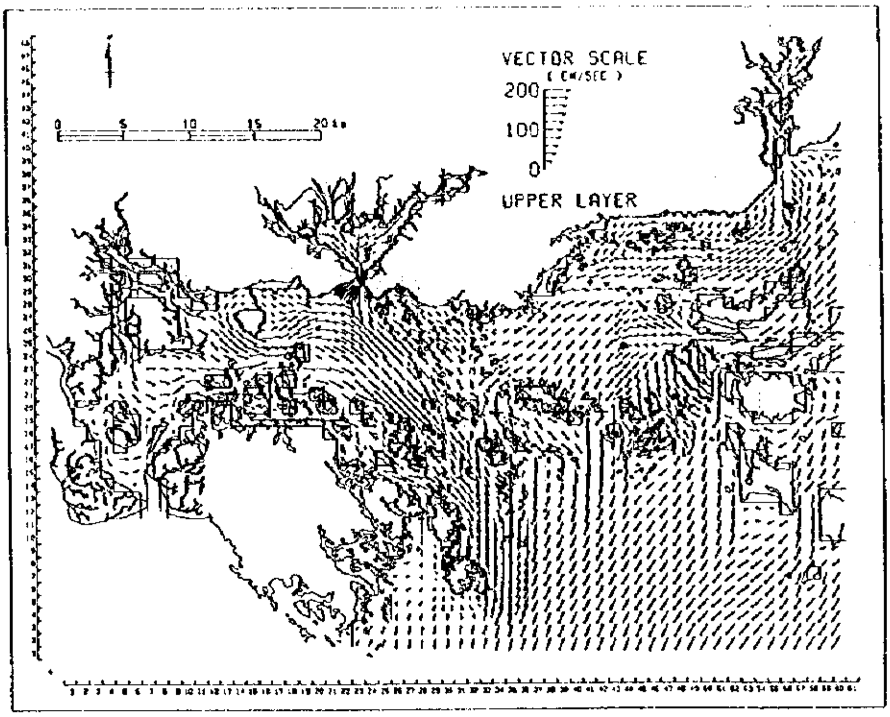


Figure 19.3.2(1) Predicted Ebb Tide of the Upper Layer by the Optimum Plan

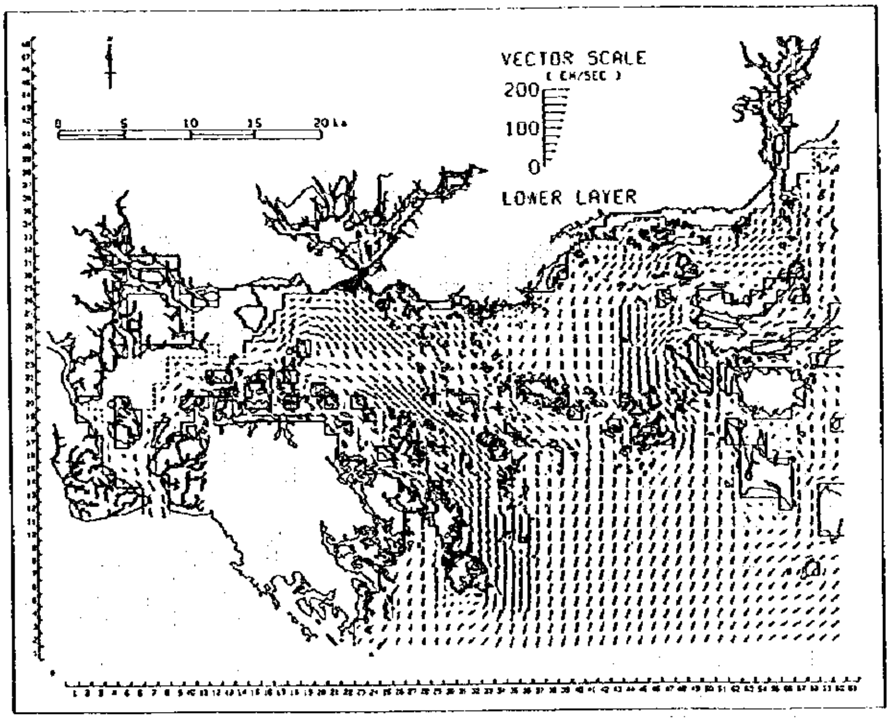


Figure 19.3.2(2) Predicted Ebb Tide of the Lower Layer by the Optimum Plan

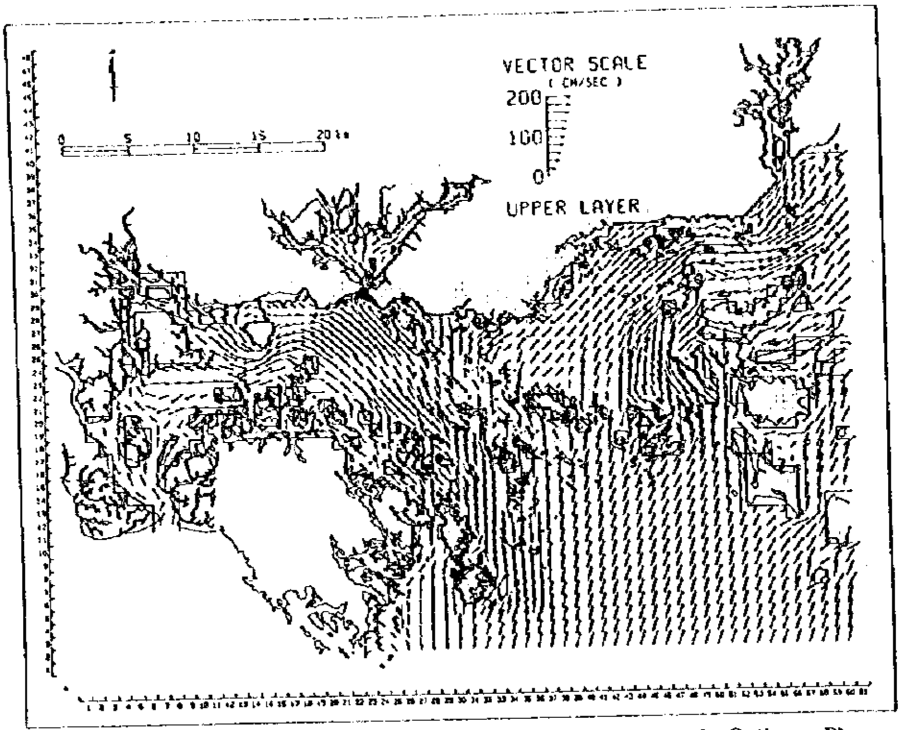


Figure 19.3.3(1) Predicted Rising Tide of the Upper Layer by the Optimum Plan

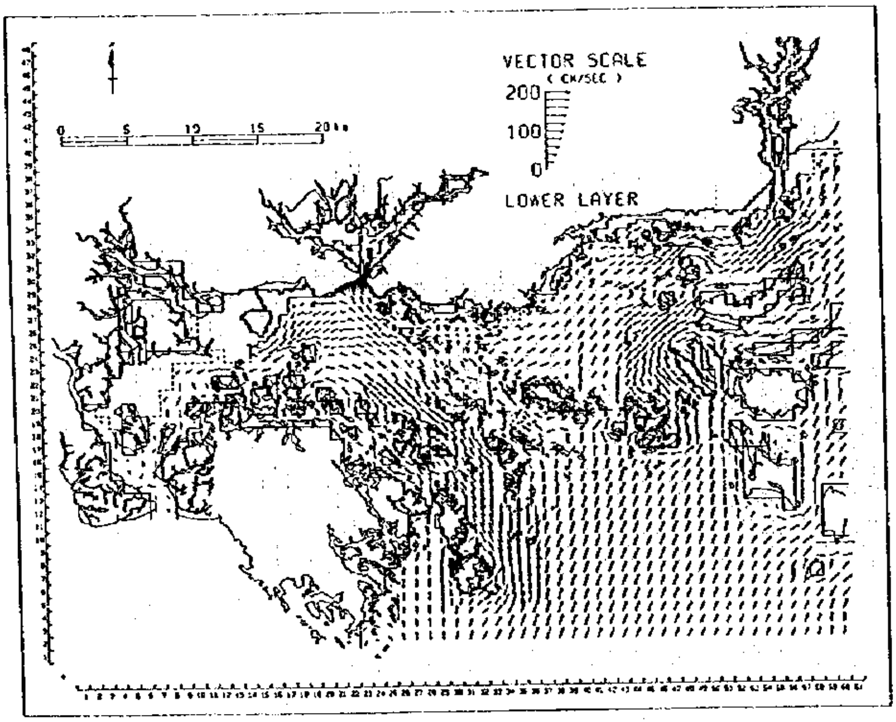


Figure 19.3.3(2) Predicted Rising Tide of the Lower Layer by the Optimum Plan

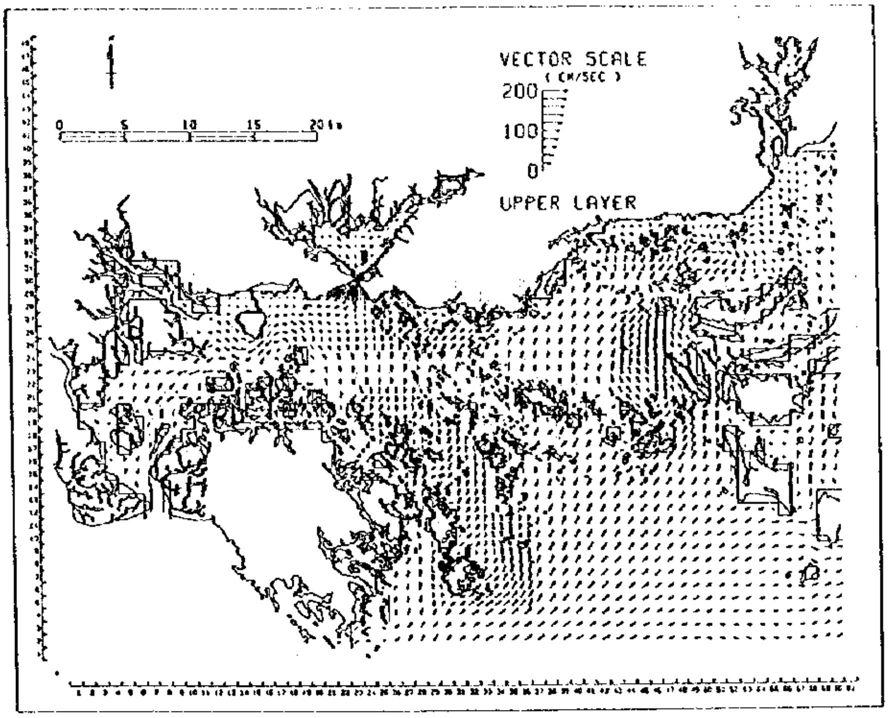


Figure 19.3.4(1) Average of the Predicted Currents of the Upper Layer by the Optimum Plan

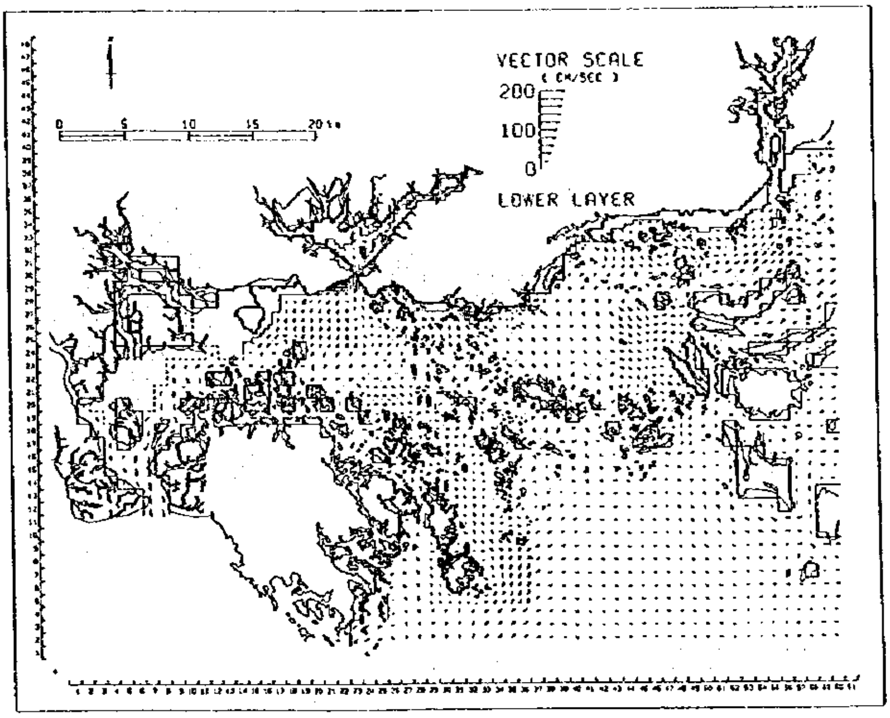


Figure 19.3.4(2) Average of the Predicted Currents of the Lower Layer by the Optimum Plan

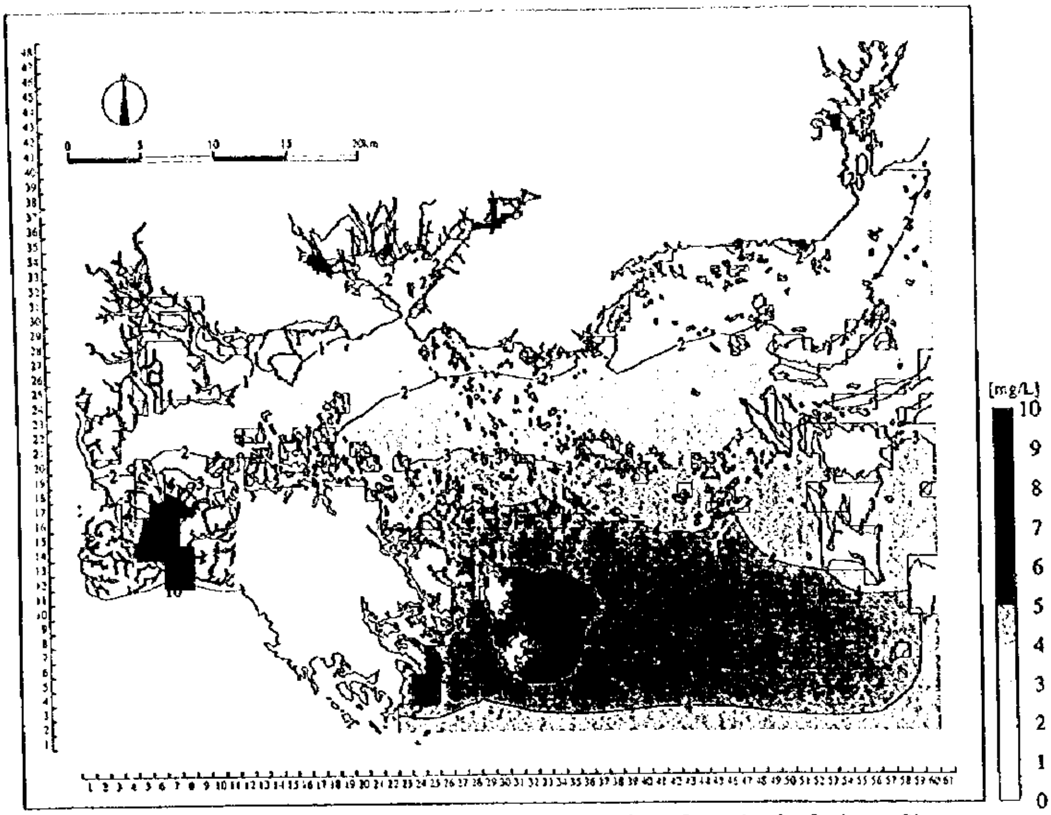


Figure 19.3.5(1) Predicted Concentrations of SS of the Upper Layer by the Optimum Plan

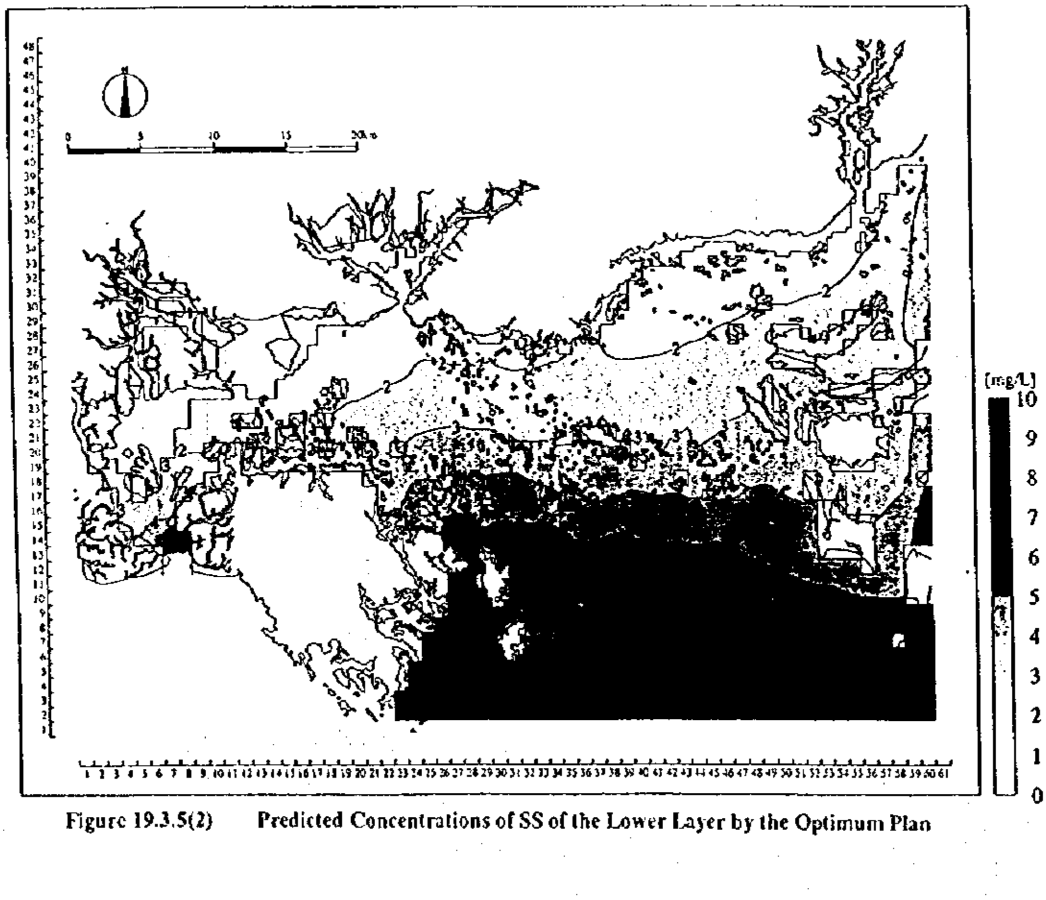


Figure 19.3.5(2) Predicted Concentrations of SS of the Lower Layer by the Optimum Plan

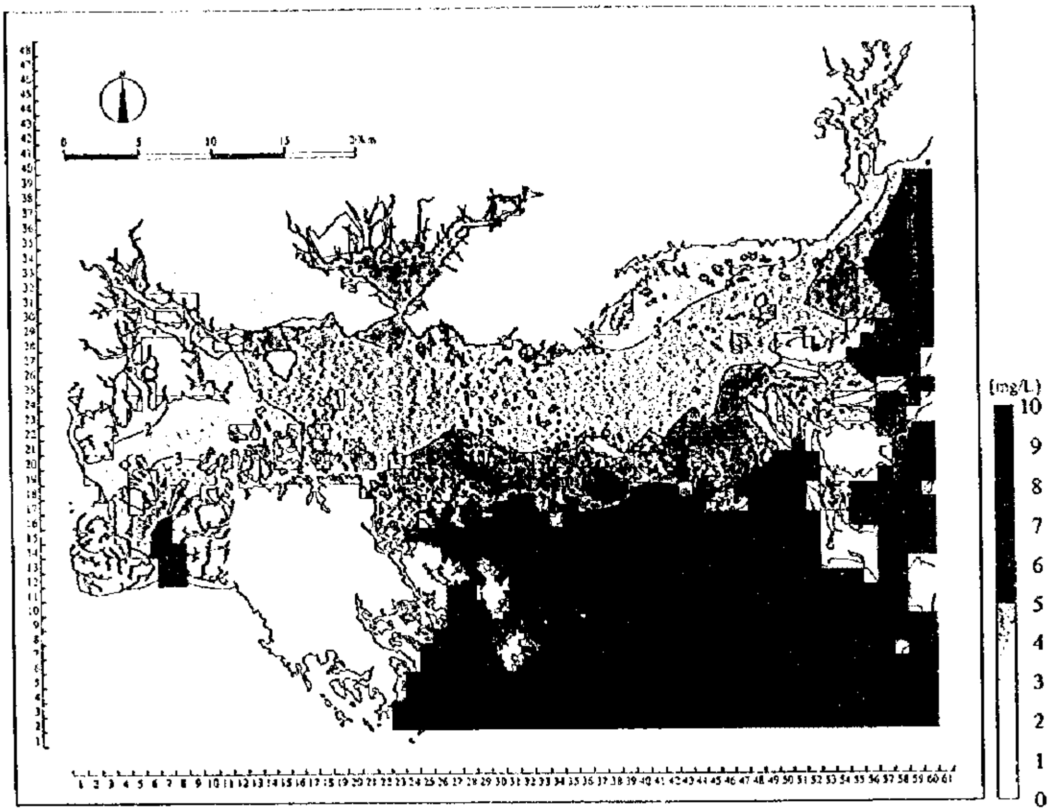


Figure 19.3.6(1) Predicted Concentrations of COD of the Upper Layer by the Optimum Plan

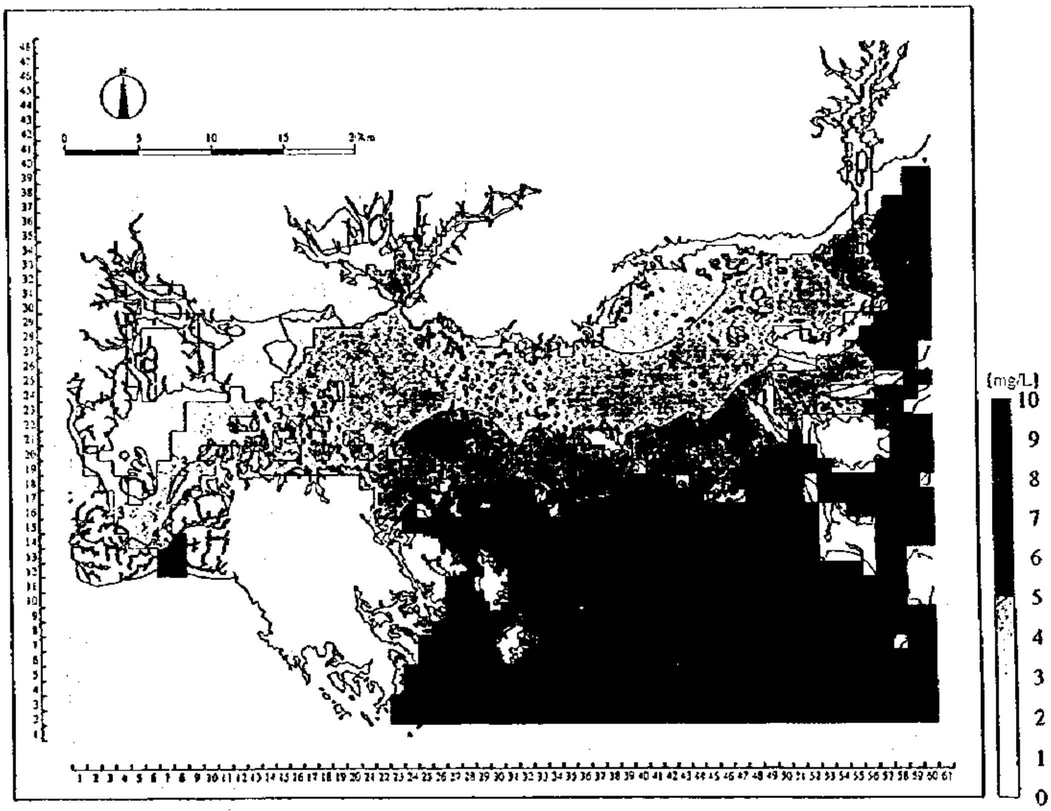


Figure 19.3.6(2) Predicted Concentrations of COD of the Lower Layer by the Optimum Plan

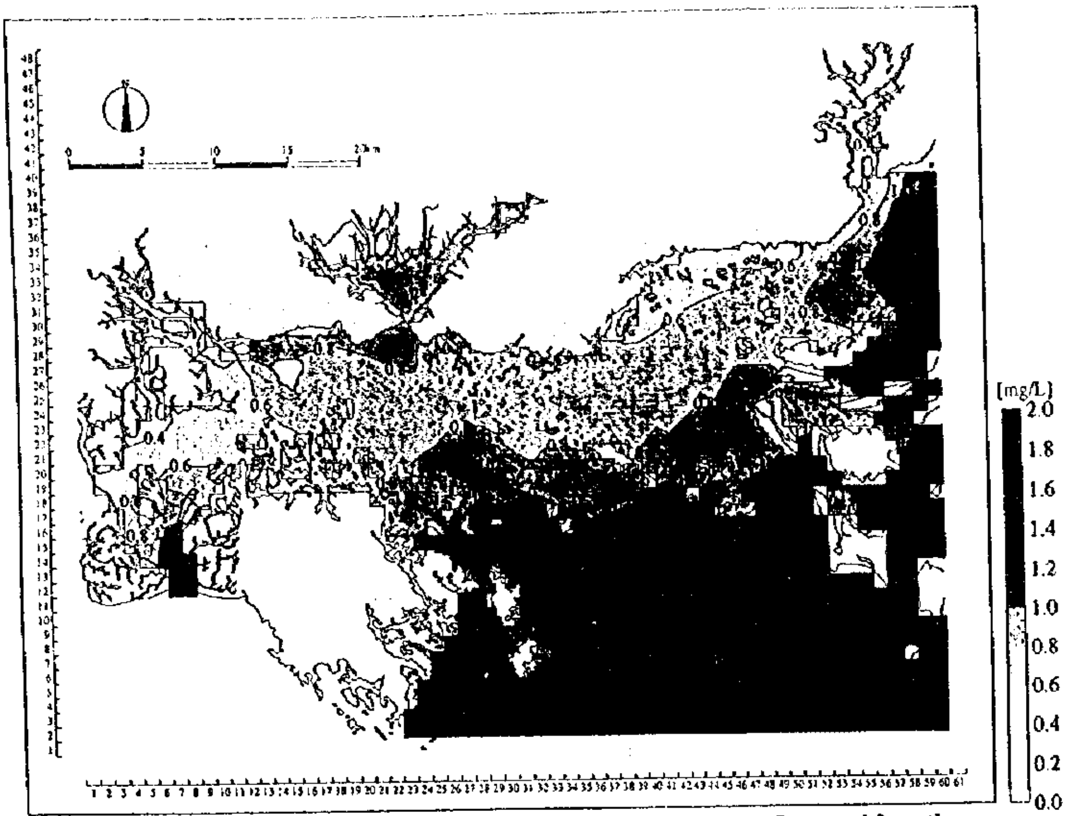


Figure 19.3.7(1) Estimated Concentrations of BOD of the Upper Layer Converted from the Predicted COD by the Optimum Plan

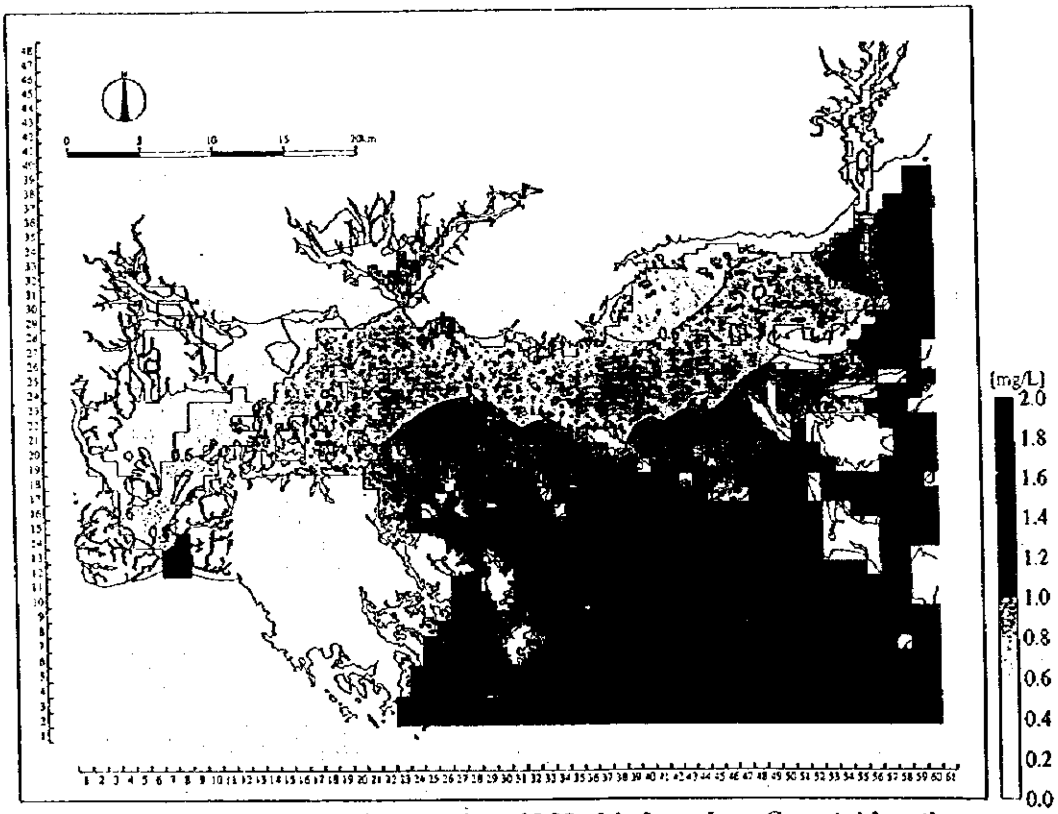


Figure 19.3.7(2) Estimated Concentrations of BOD of the Lower Layer Converted from the Predicted COD by the Optimum Plan

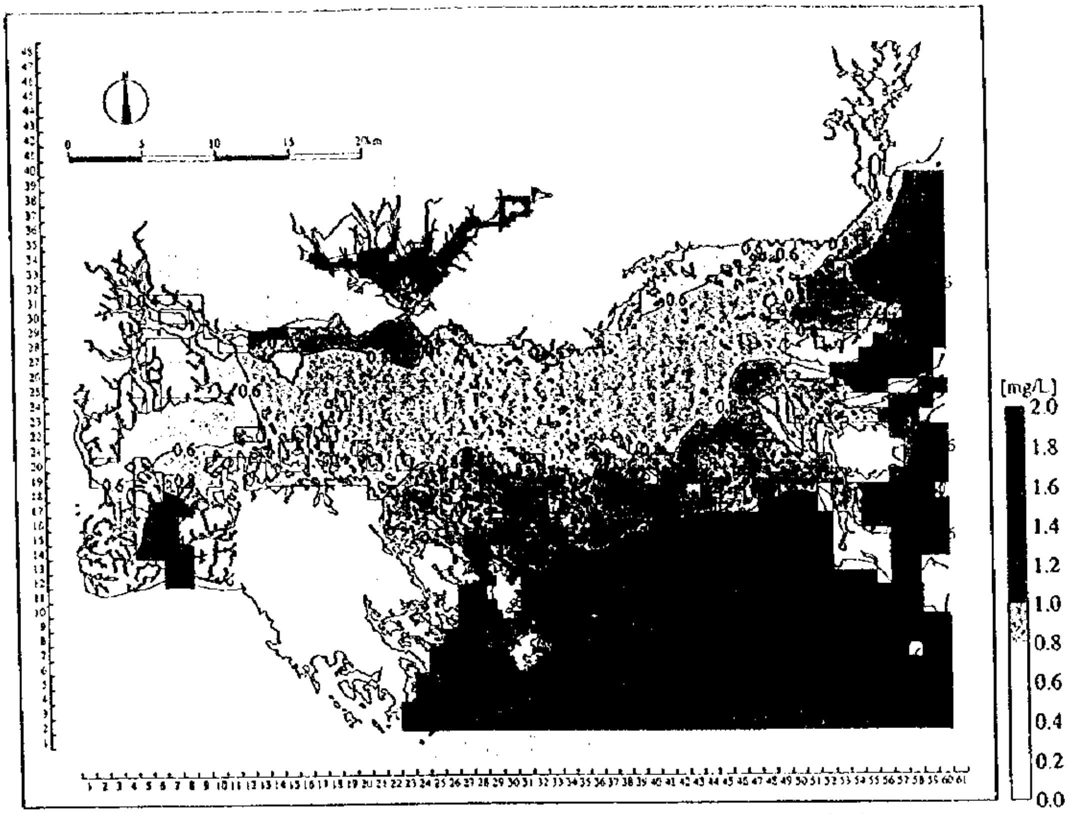
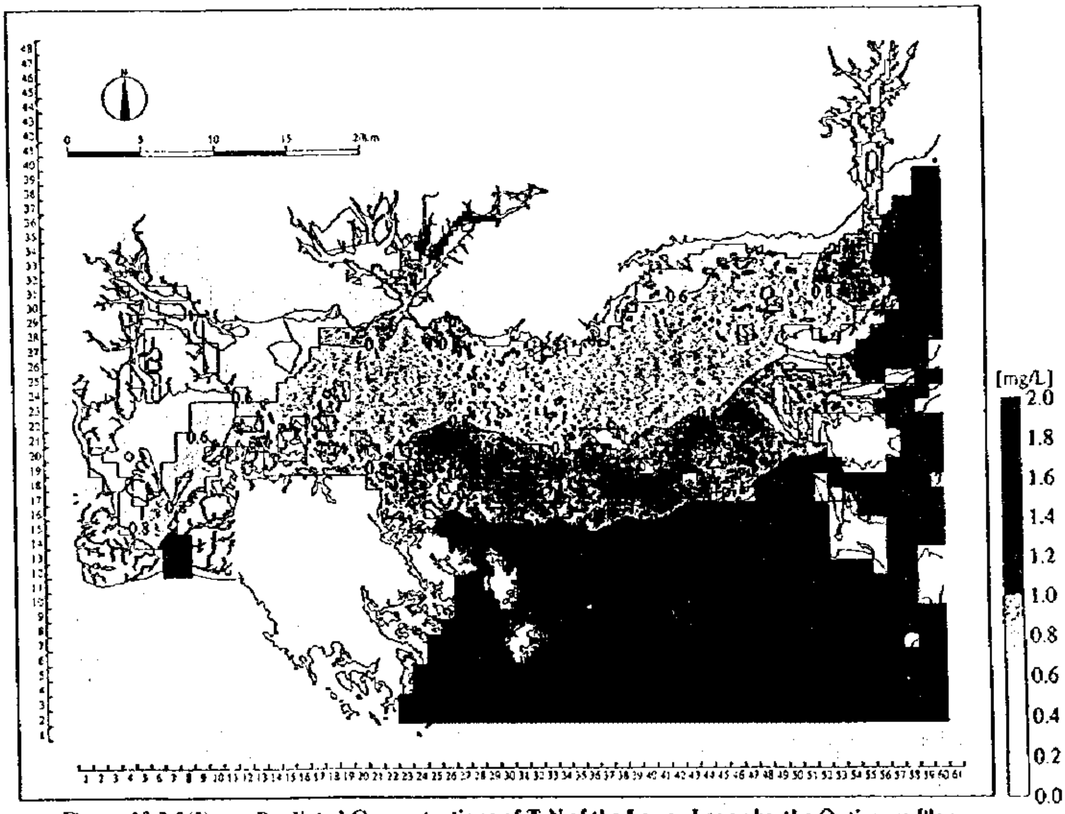


Figure 19.3.8(1) Predicted Concentrations of T-N of the Upper Layer by the Optimum Plan



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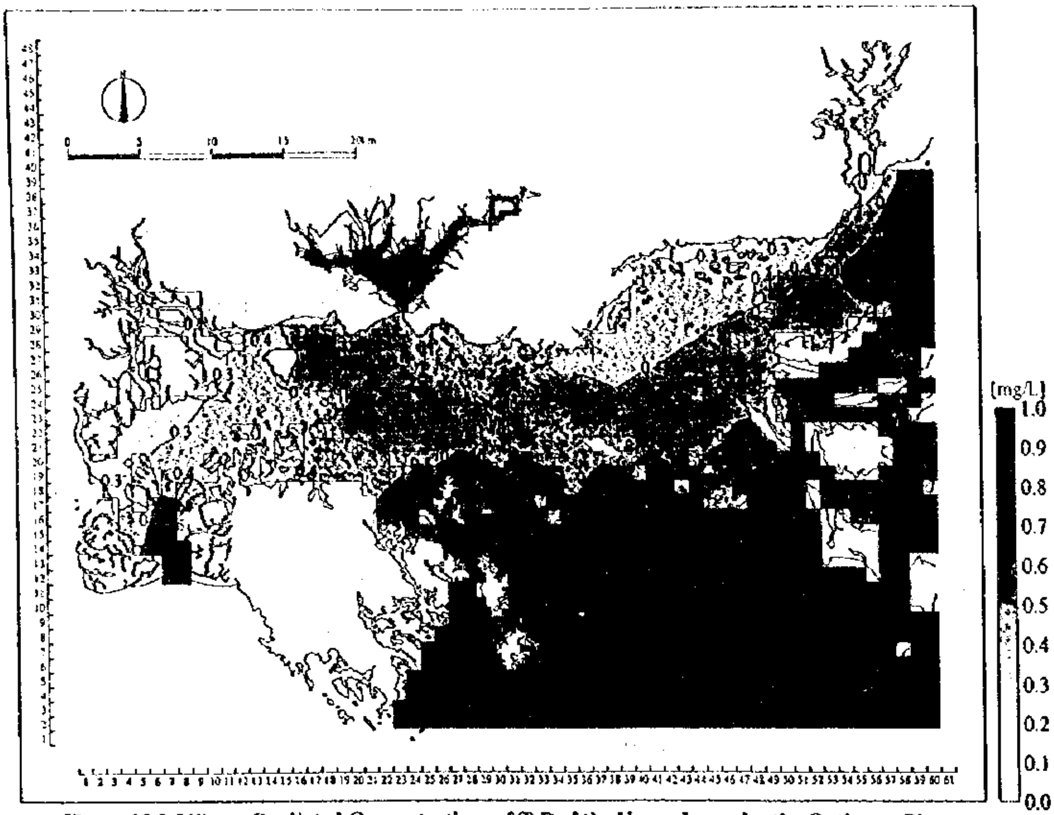


Figure 19.3.9(1) Predicted Concentrations of T-P of the Upper Layer by the Optimum Plan

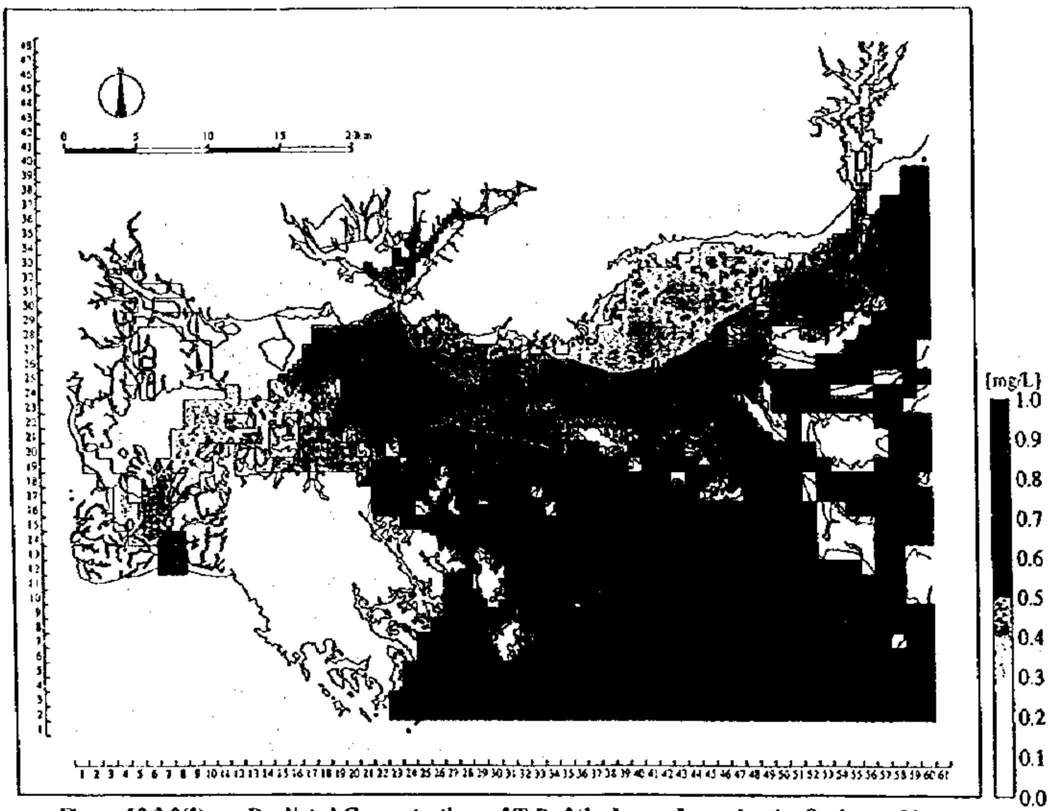


Figure 19.3.9(2) Predicted Concentrations of T-P of the Lower Layer by the Optimum Plan

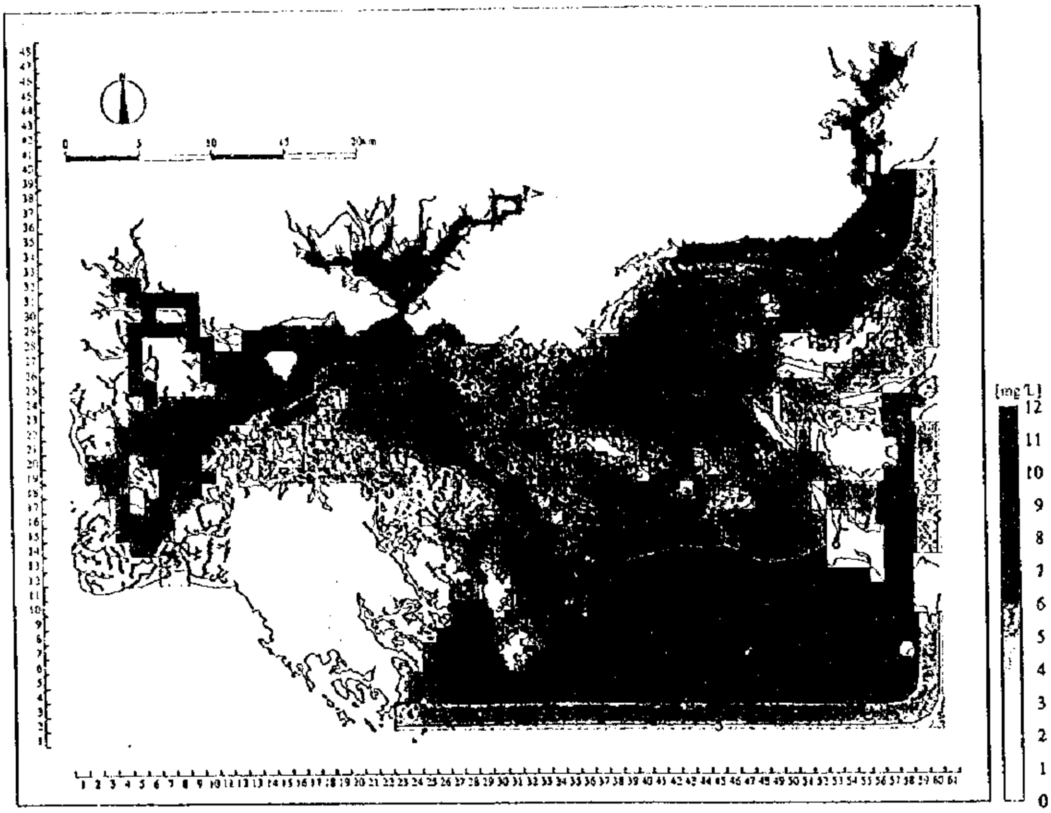


Figure 19.3.10(1) Predicted Concentrations of DO of the Upper Layer by the Optimum Plan

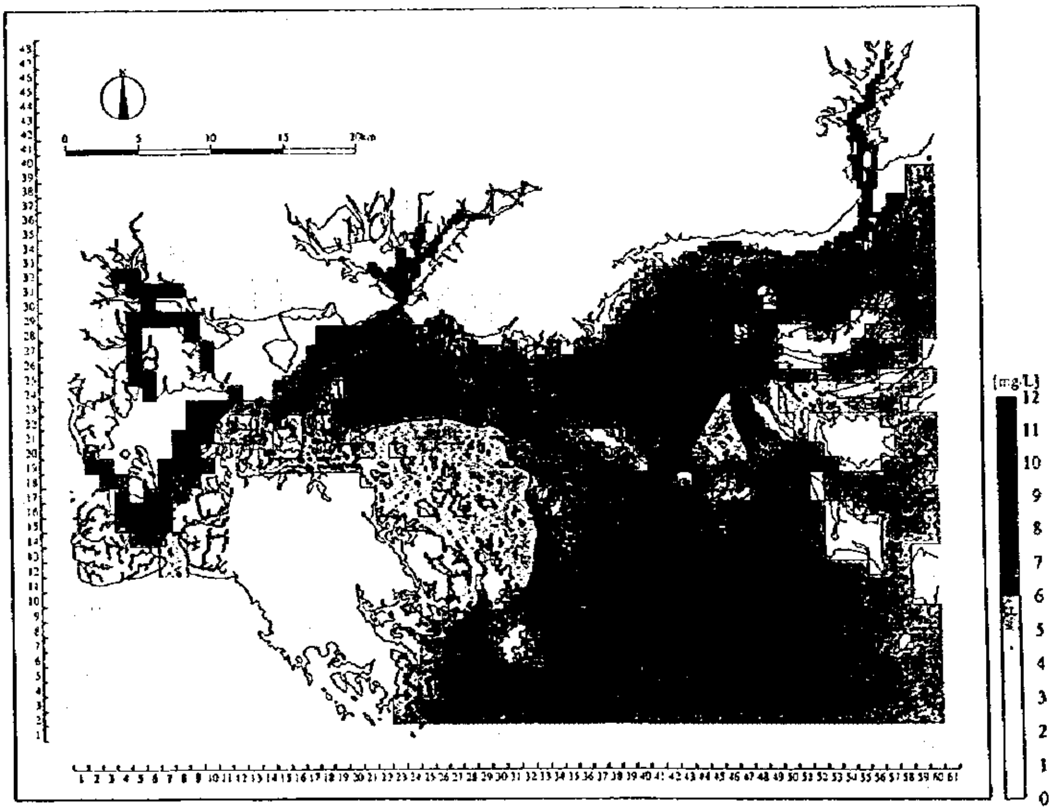


Figure 19.3.10(2) Predicted Concentrations of DO of the Lower Layer by the Optimum Plan

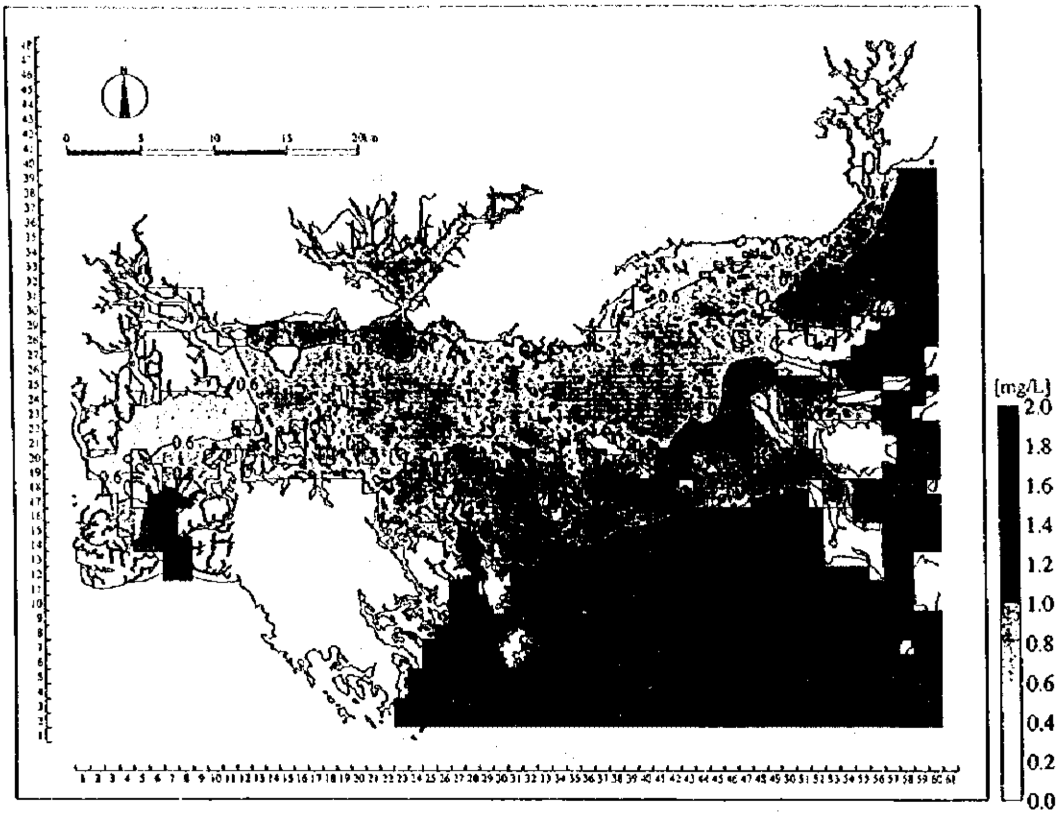


Figure 19.3.11(1) Predicted Concentrations of O-N of the Upper Layer by the Optimum Plan

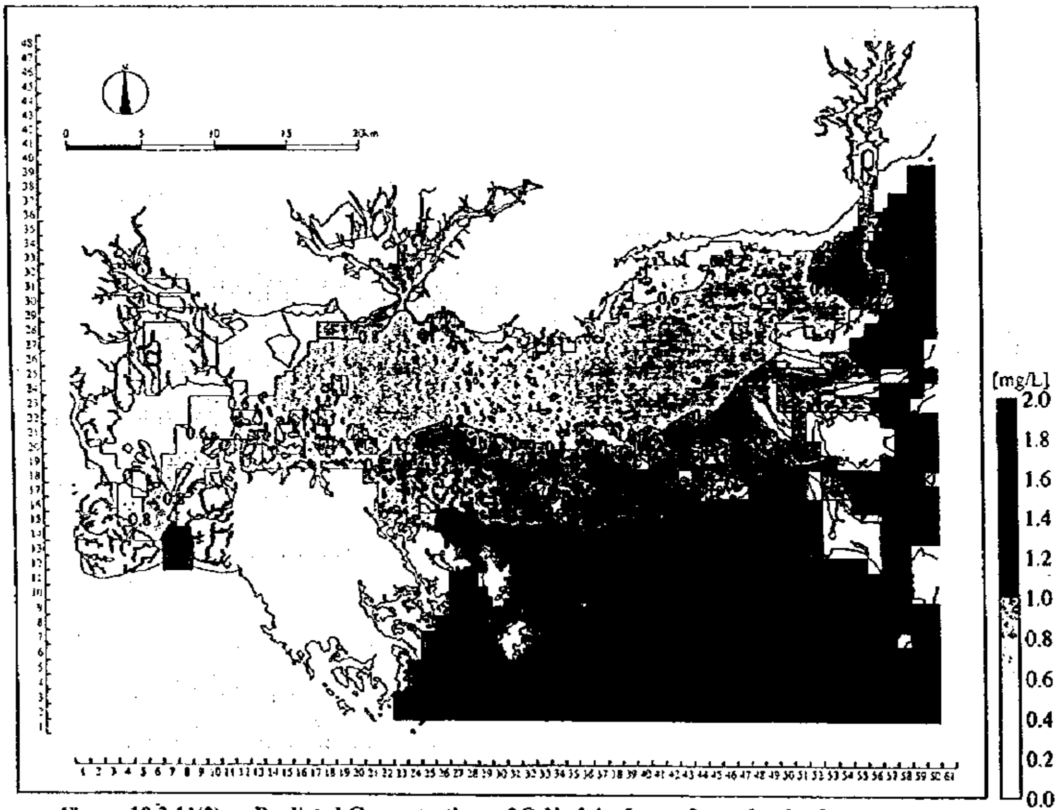


Figure 19.3.11(2) Predicted Concentrations of O-N of the Lower Layer by the Optimum Plan

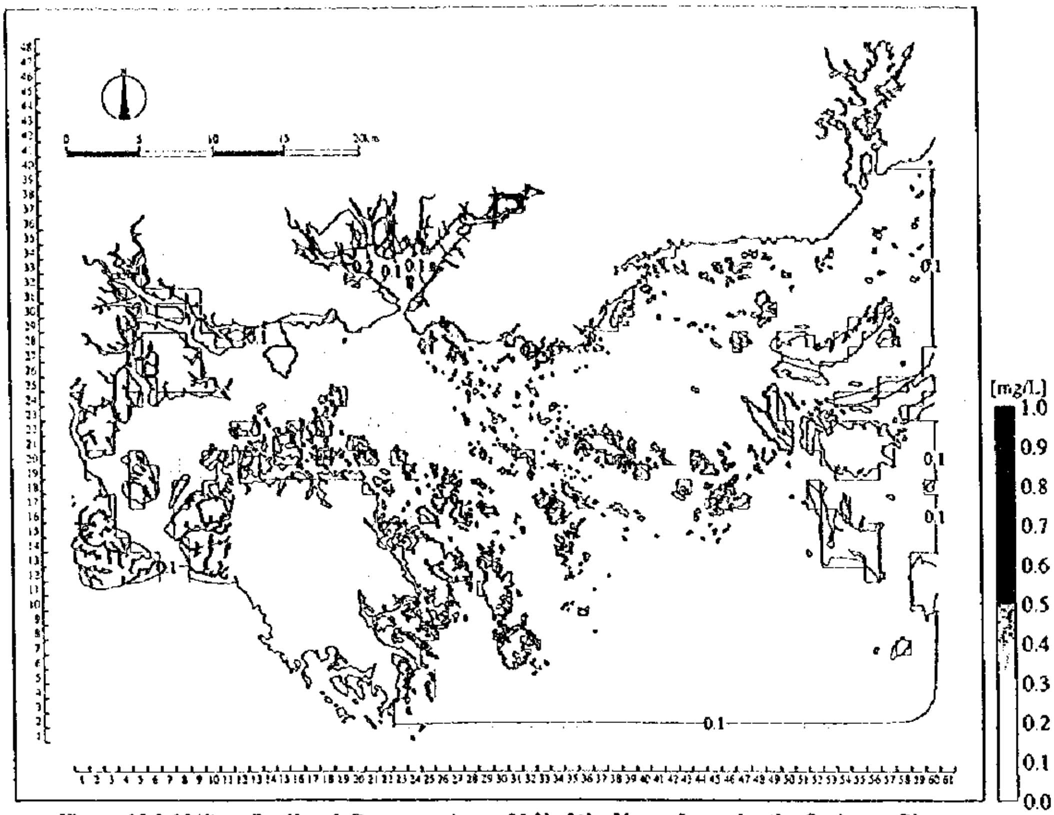


Figure 19.3.12(1) Predicted Concentrations of I-N of the Upper Layer by the Optimum Plan

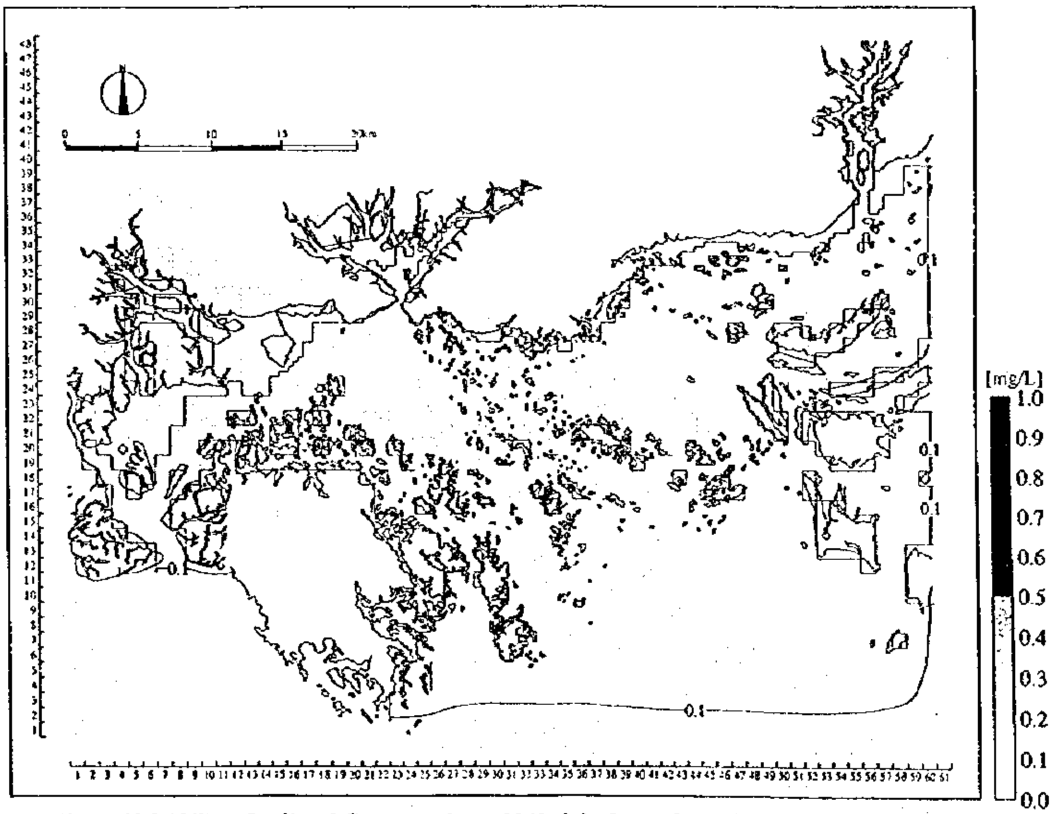
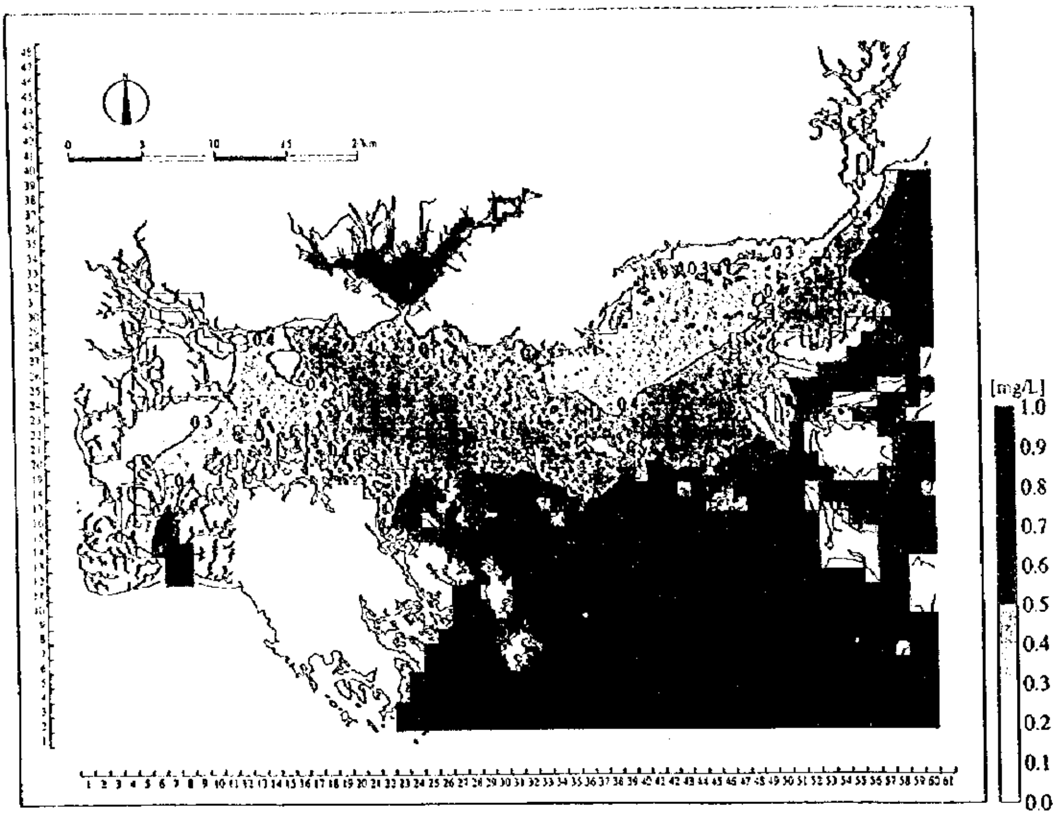


Figure 19.3.12(2) Predicted Concentrations of I-N of the Lower Layer by the Optimum Plan



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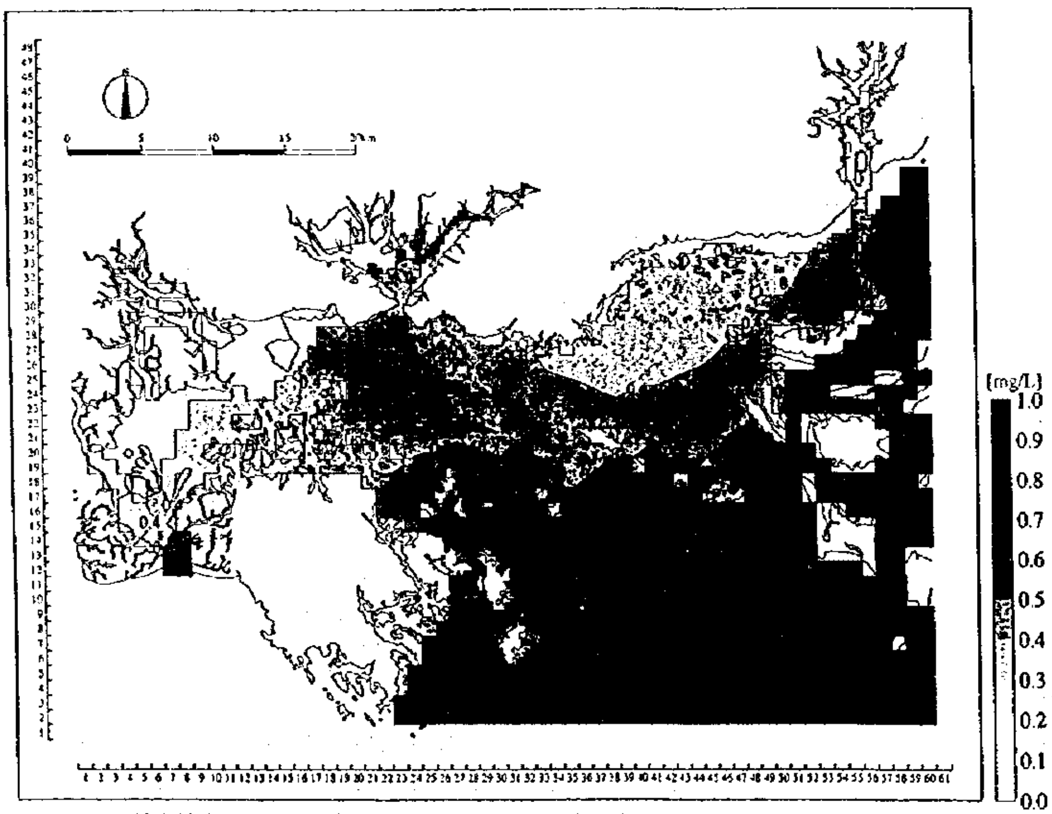


Figure 19.3.13(2) Predicted Concentrations of O-P of the Lower Layer by the Optimum Plan

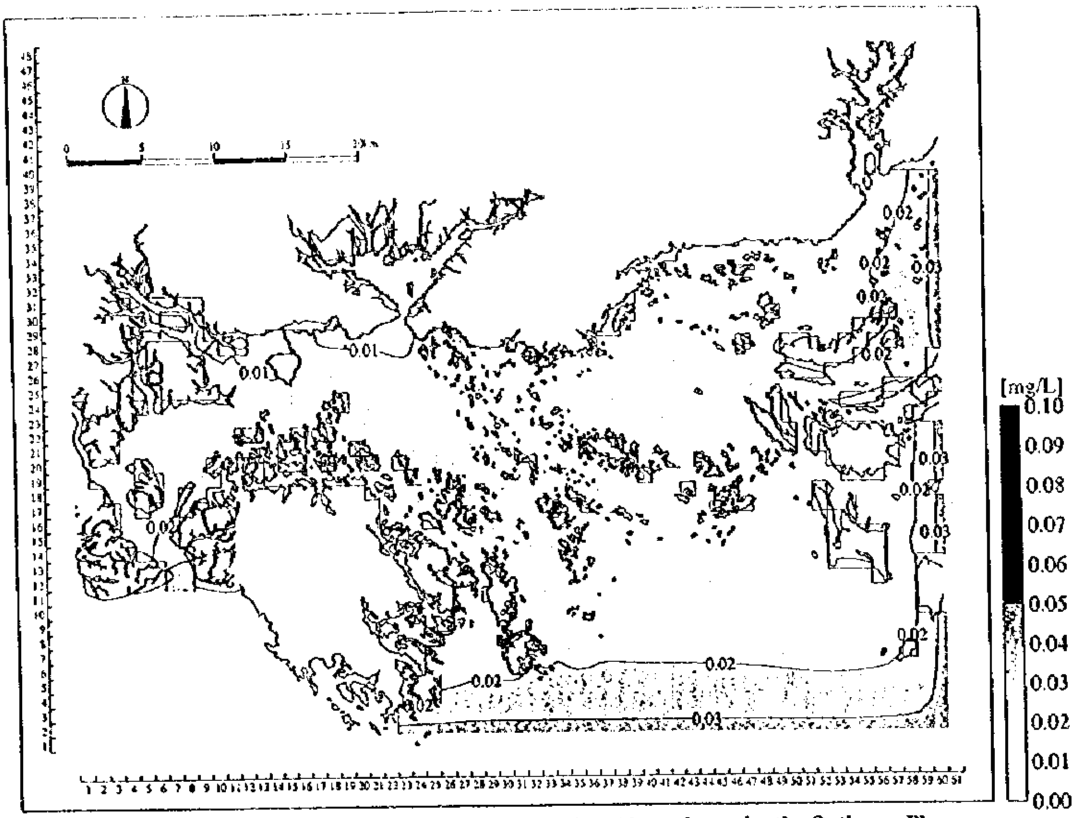


Figure 19.3.14(1) Predicted Concentrations of I-P of the Upper Layer by the Optimum Plan

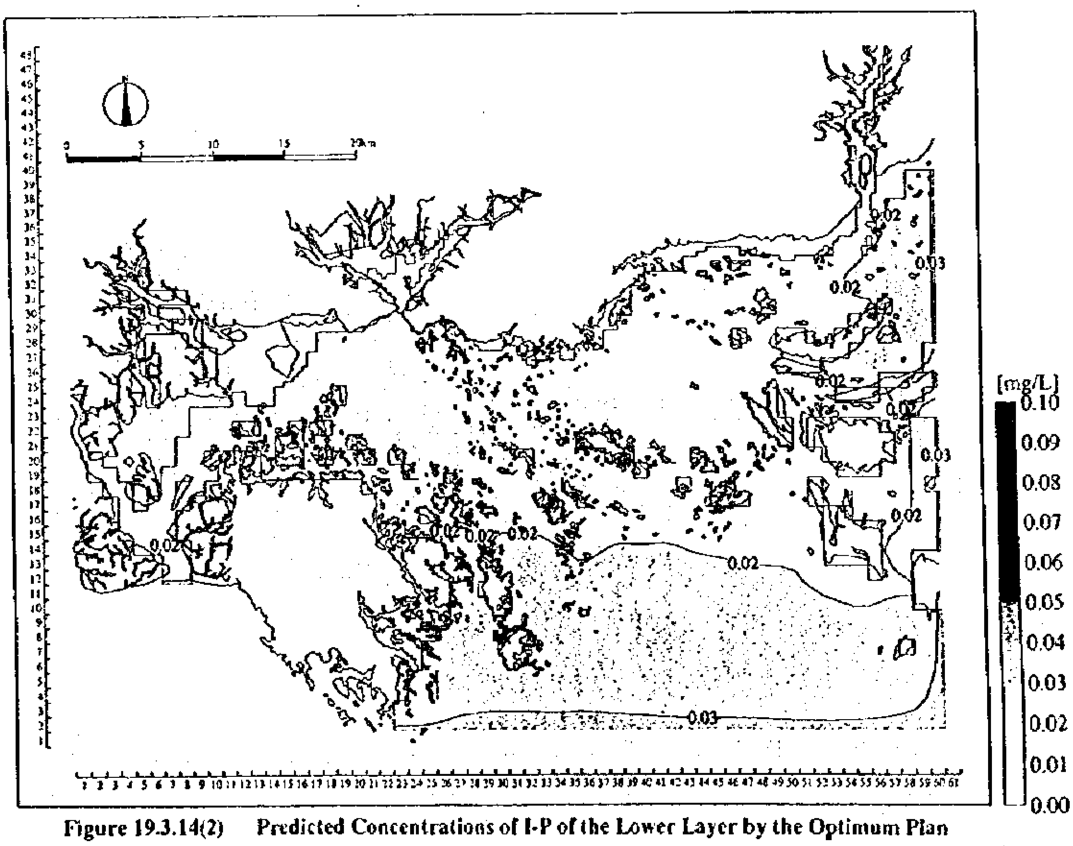


Figure 19.3.14(2) Predicted Concentrations of I-P of the Lower Layer by the Optimum Plan

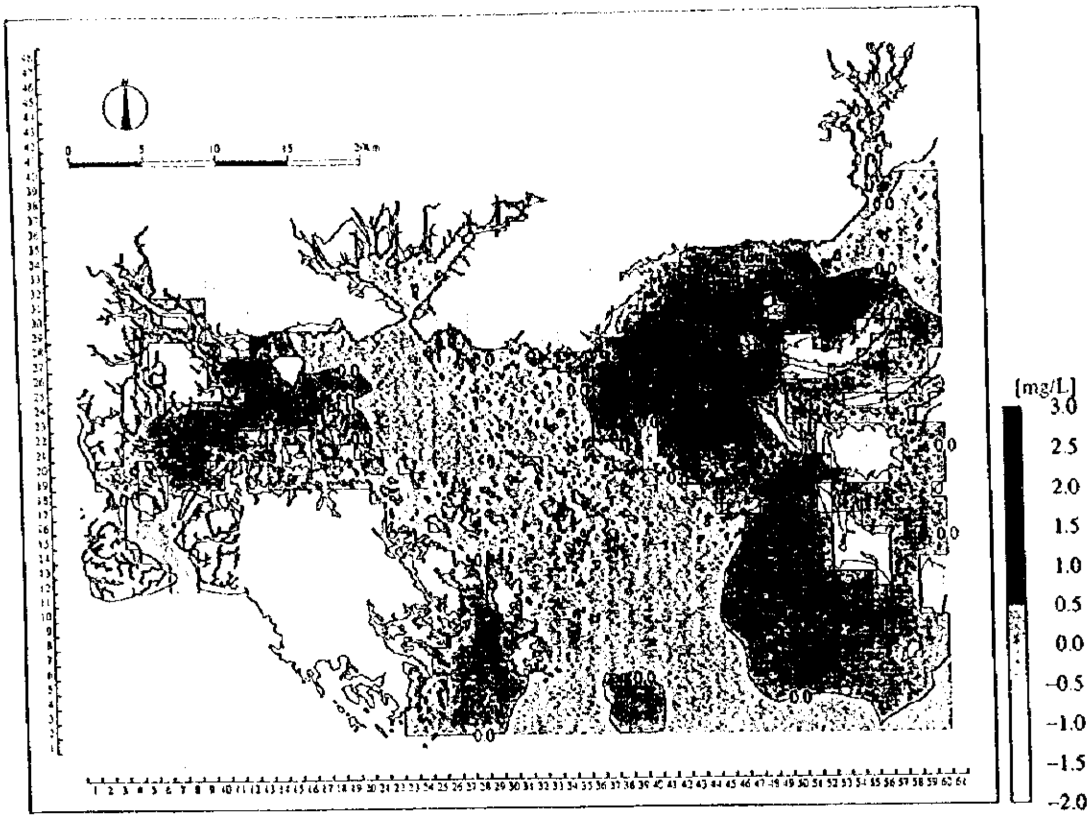
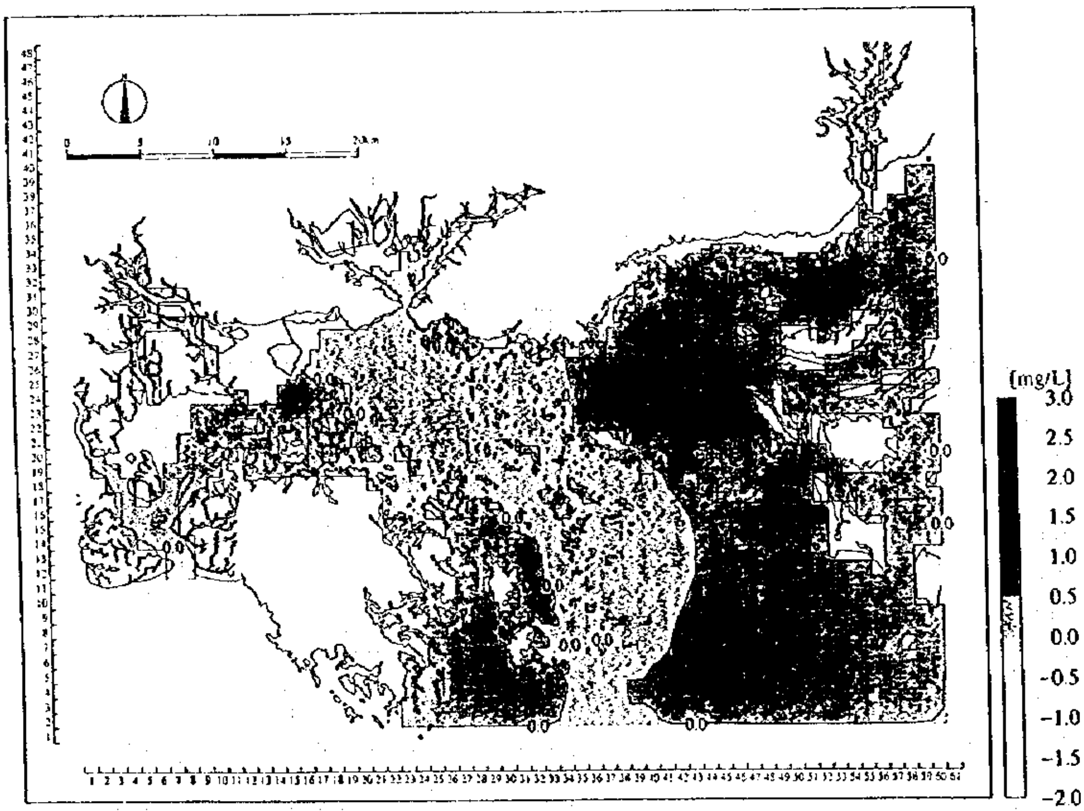


Figure 19.3.15(1) Difference between the Predicted Concentrations of SS of the Upper Layer by the Optimum Plan and Scenario II



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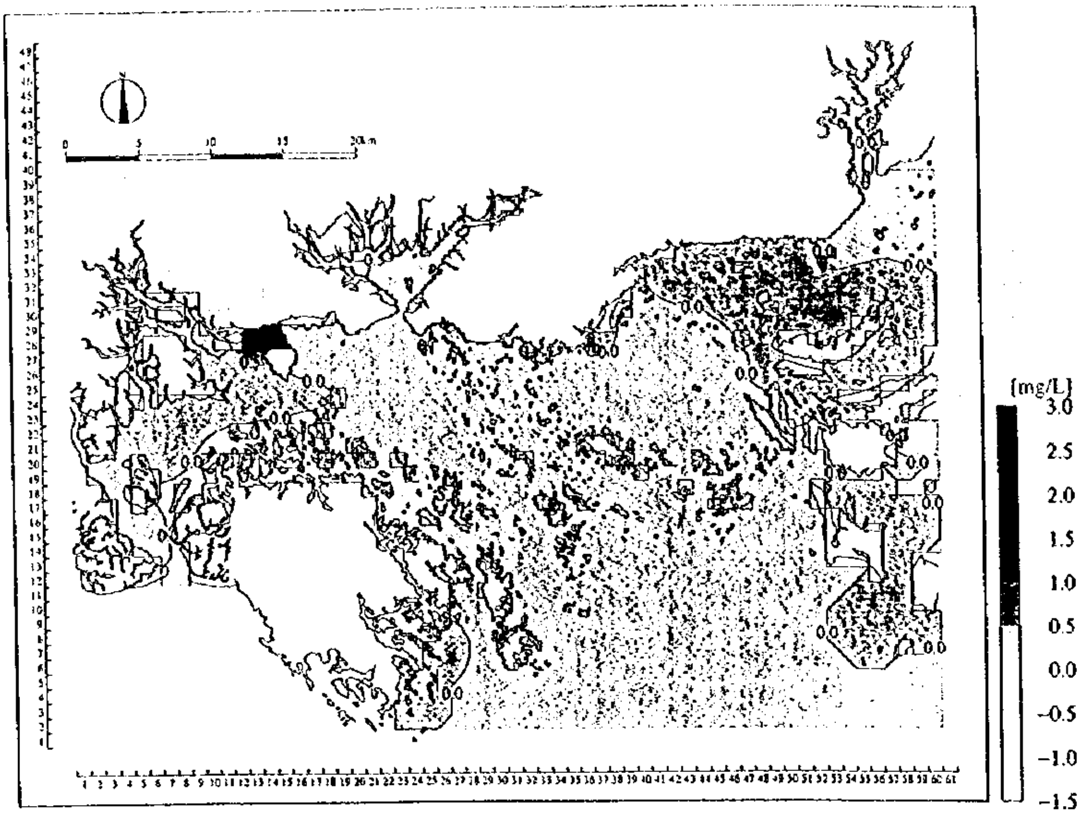


Figure 19.3.16(1) Difference between the Predicted Concentrations of COD of the Upper Layer by the Optimum Plan and Scenario II

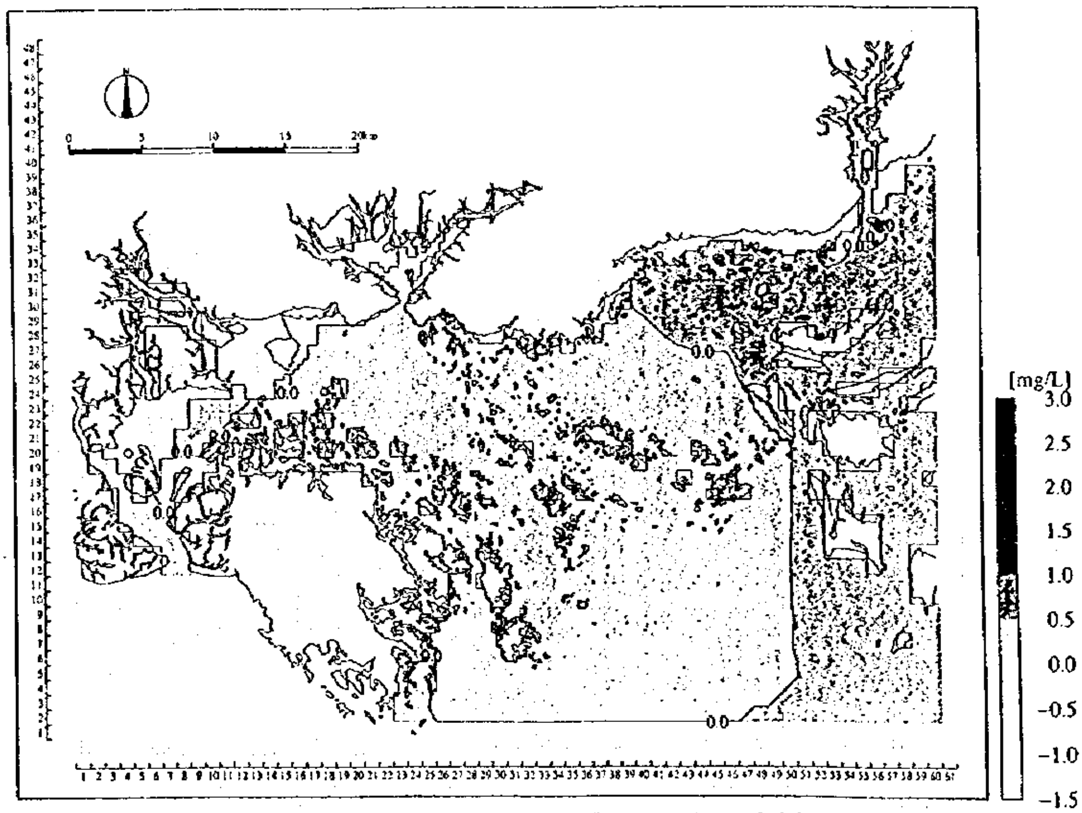


Figure 19.3.16(2) Difference between the Predicted Concentrations of COD of the Lower Layer by the Optimum Plan and Scenario II

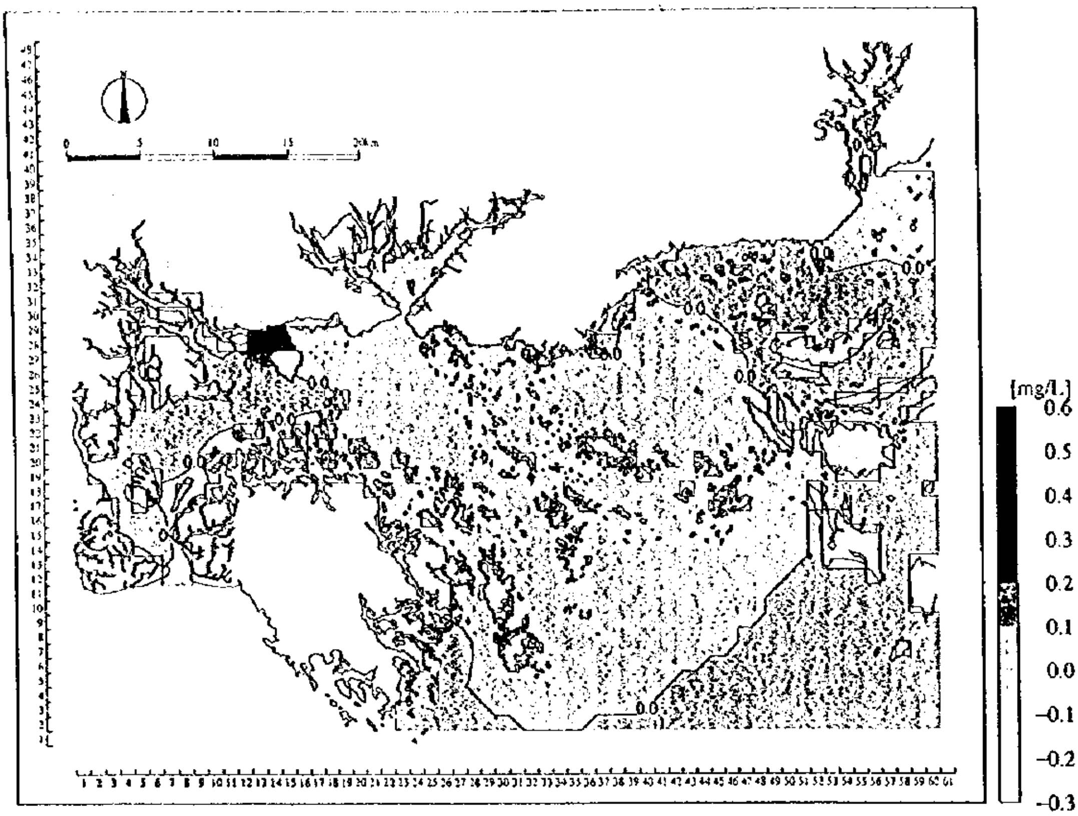


Figure 19.3.17(1) Difference between the Estimated Concentrations of BOD of the Upper Layer Converted from COD by the Optimum Plan and Scenario II

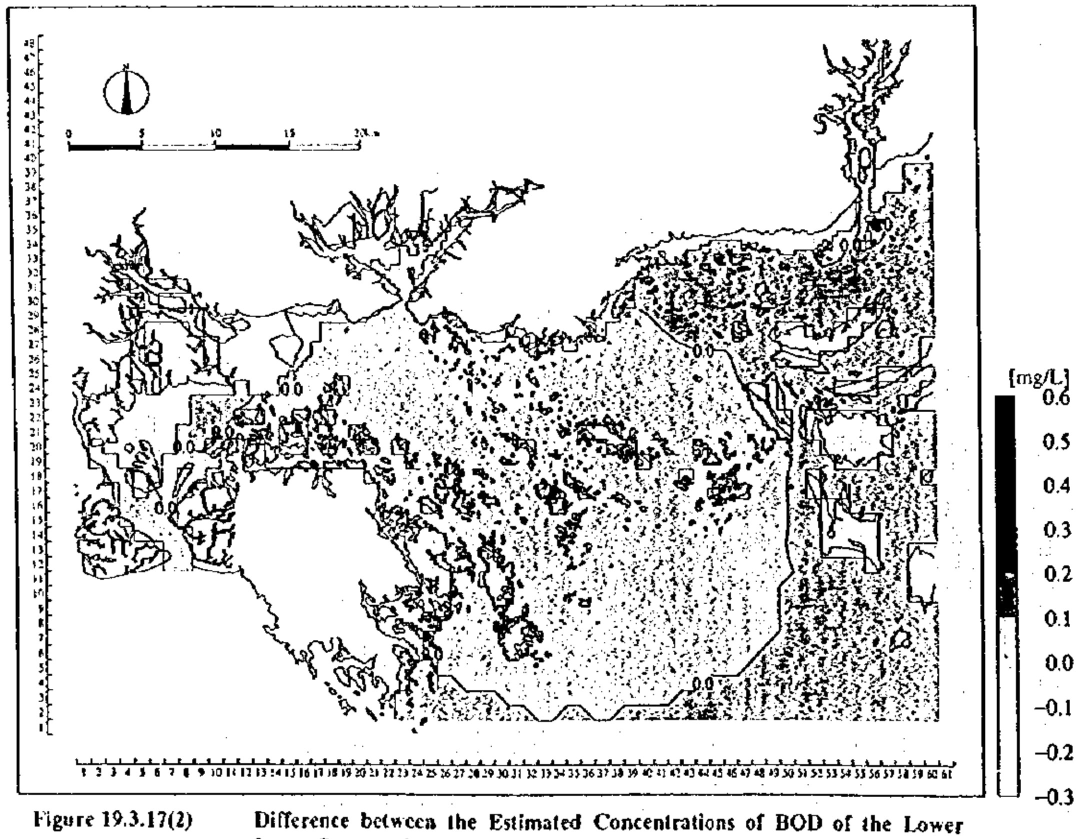


Figure 19.3.17(2) Difference between the Estimated Concentrations of BOD of the Lower Layer Converted from COD by the Optimum Plan and Scenario II

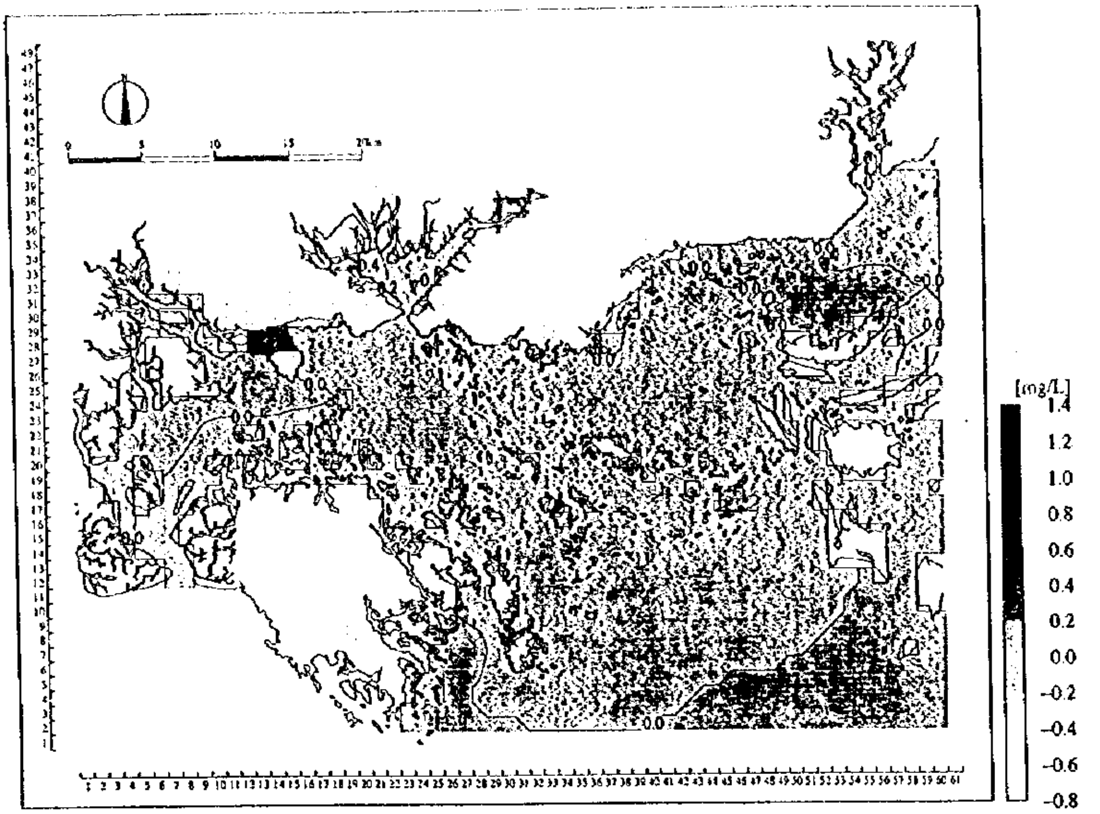


Figure 19.3.18(1) Difference between the Predicted Concentrations of T-N of the Upper Layer by the Optimum Plan and Scenario II

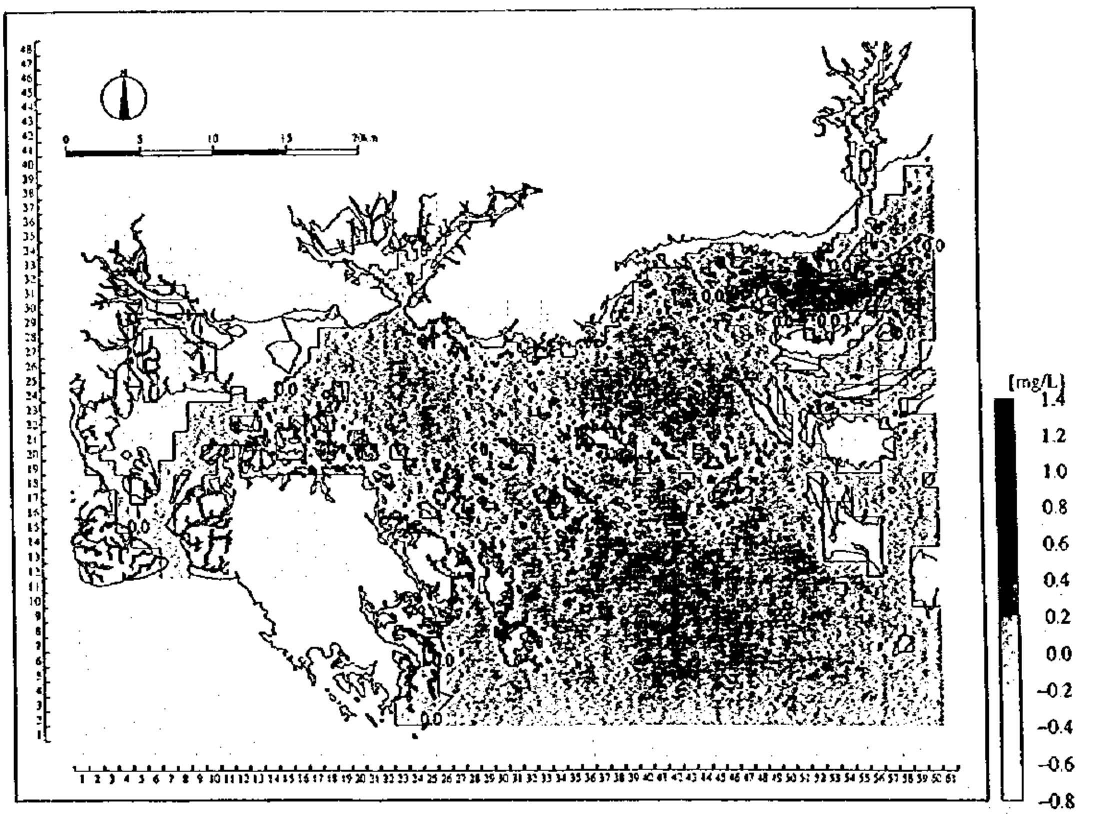


Figure 19.3.18(2) Difference between the Predicted Concentrations of T-N of the Lower Layer by the Optimum Plan and Scenario II

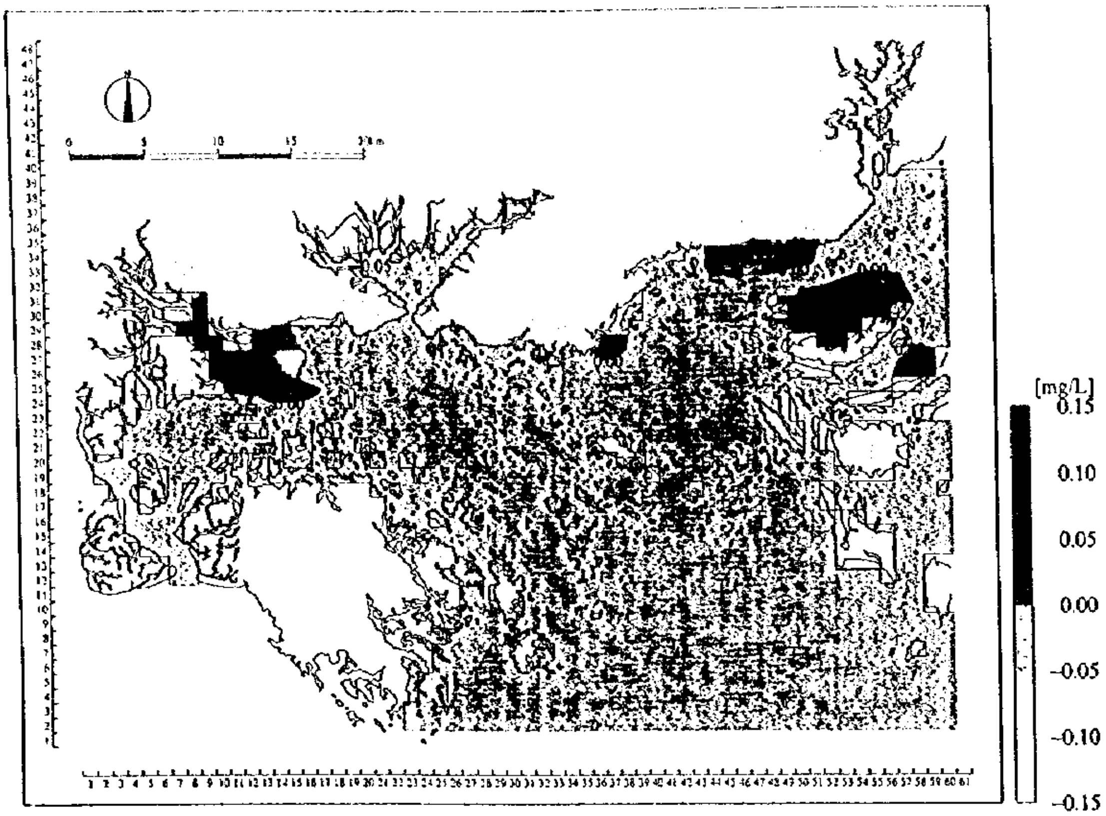
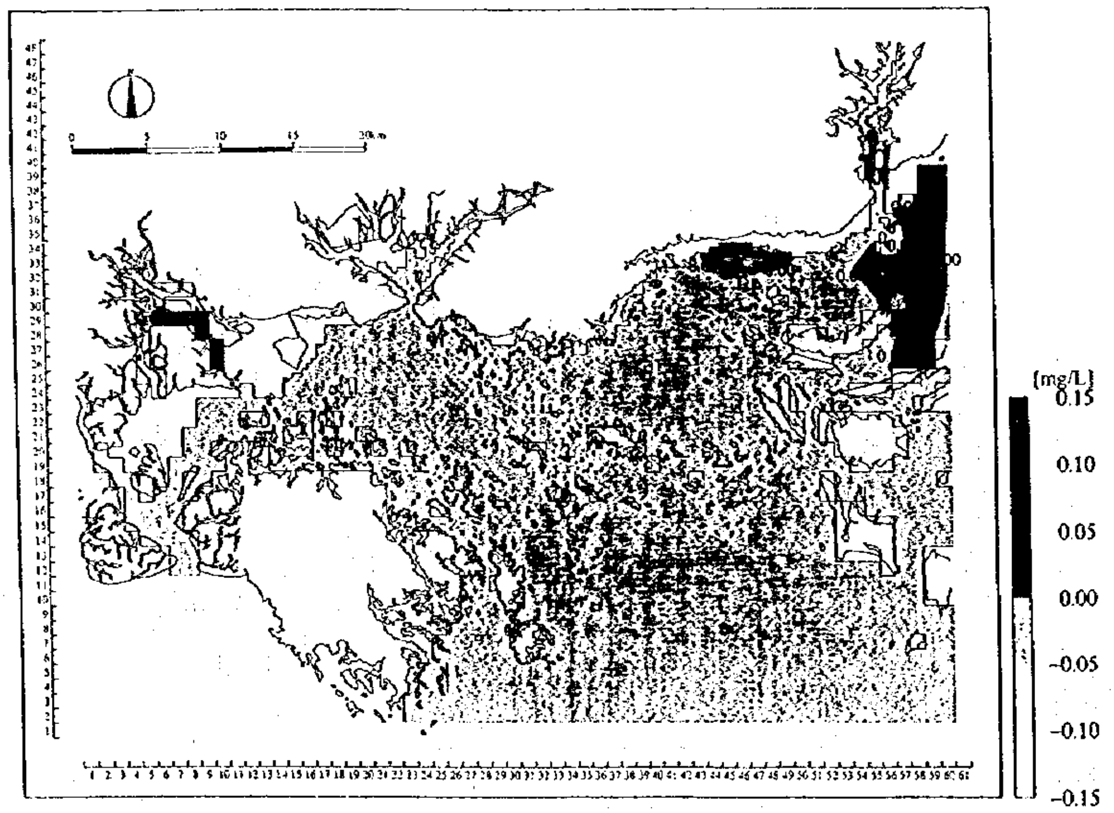


Figure 19.3.19(1) Difference between the Predicted Concentrations of T-P of the Upper Layer by the Optimum Plan and Scenario II



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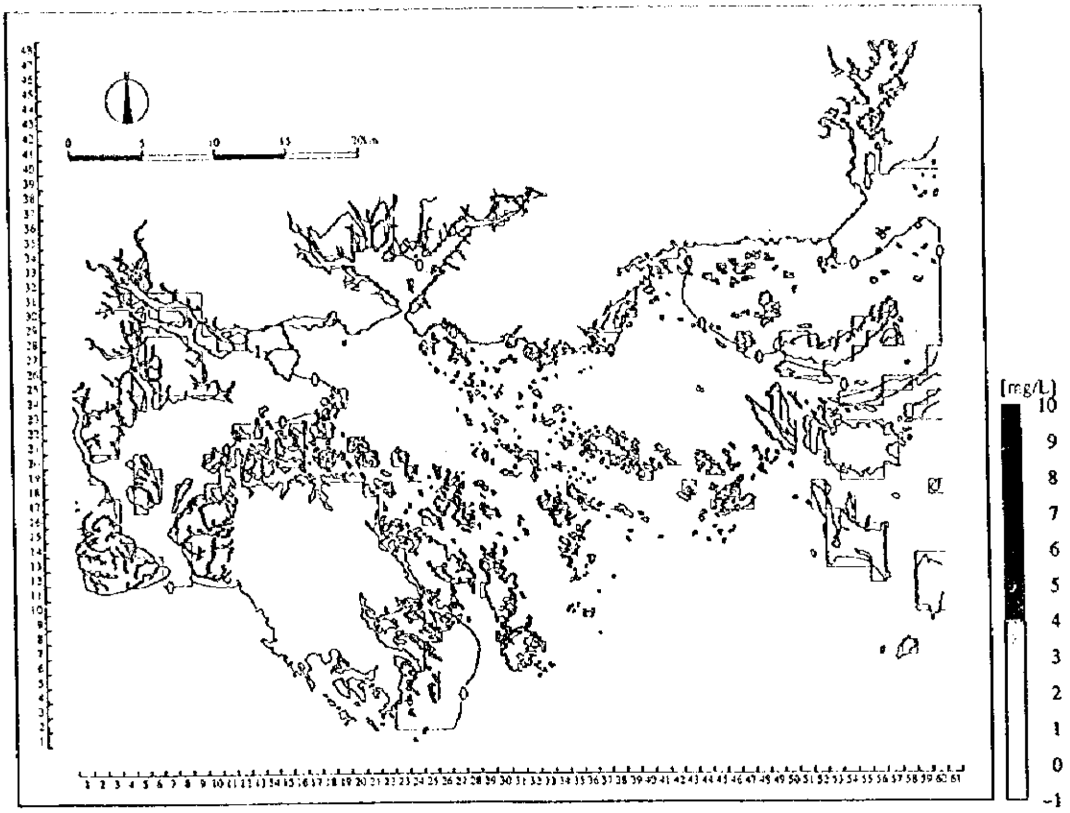

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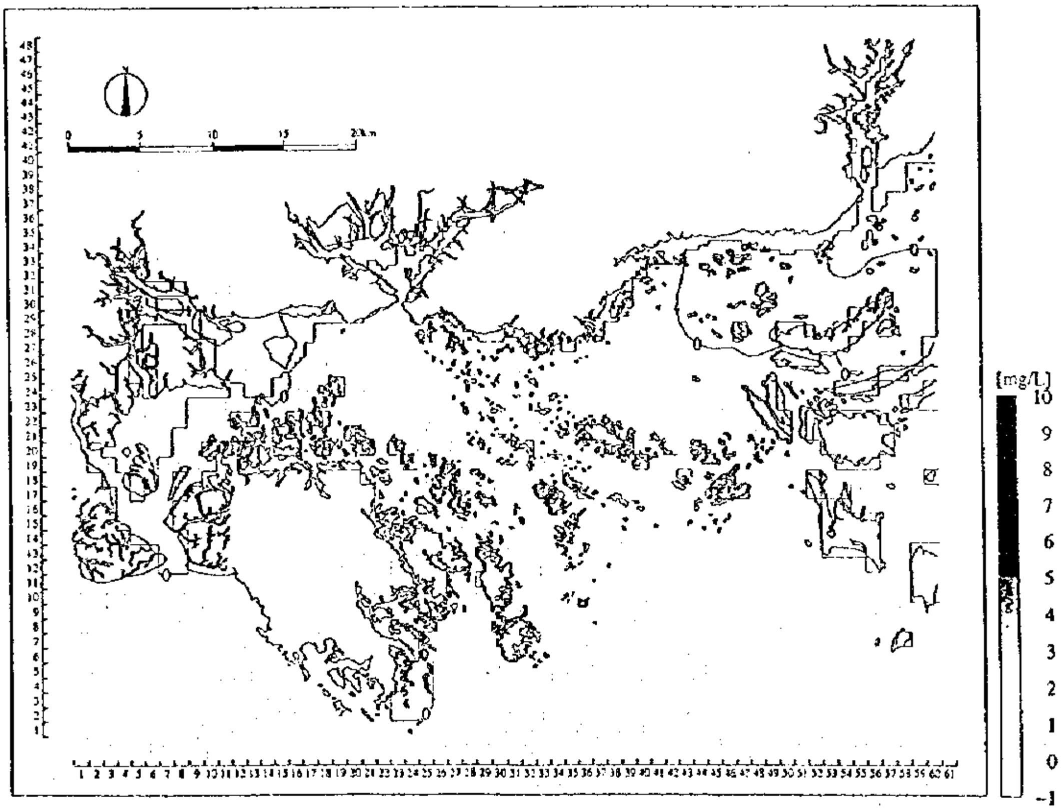


Figure 19.3.20(2) Difference between the Predicted Concentrations of DO of the Lower Layer by the Optimum Plan and Scenario II

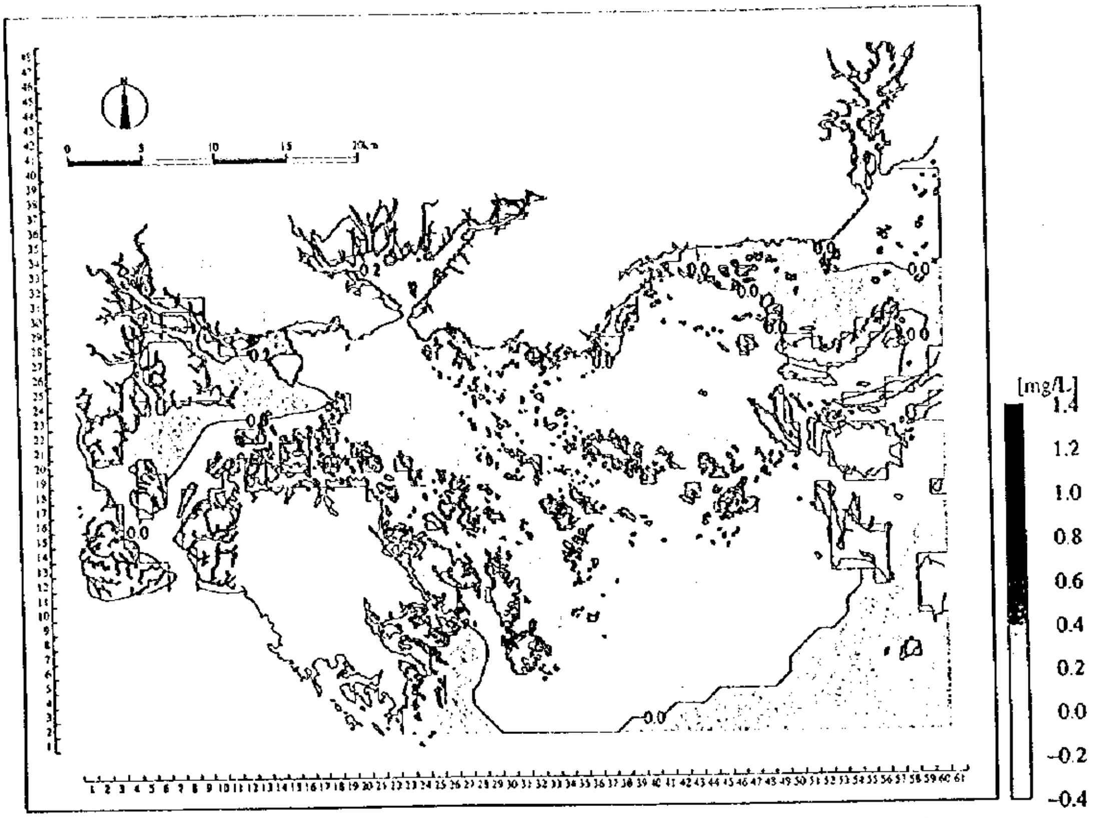


Figure 19.3.21(1) Difference between the Predicted Concentrations of O-N of the Upper Layer by the Optimum Plan and Scenario II

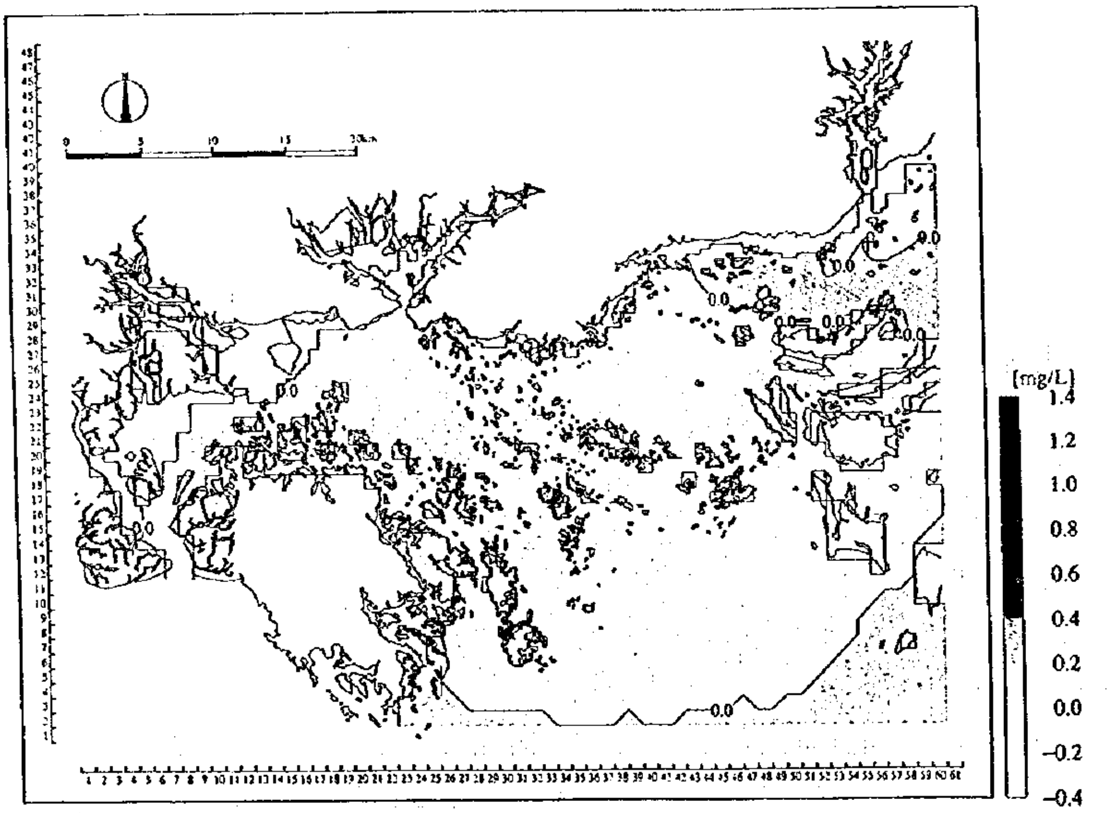


Figure 19.3.21(2) Difference between the Predicted Concentrations of O-N of the Lower Layer by the Optimum Plan and Scenario II

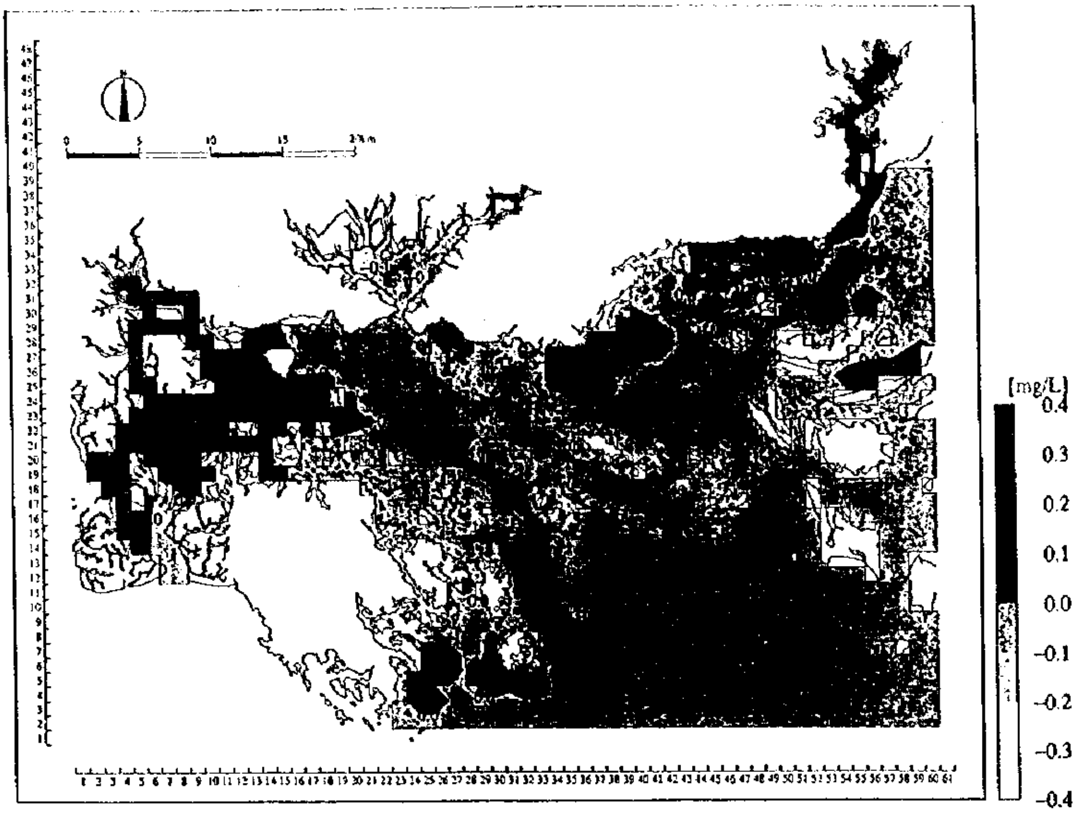


Figure 19.3.22(1) Difference between the Predicted Concentrations of I-N of the Upper Layer by the Optimum Plan and Scenario II

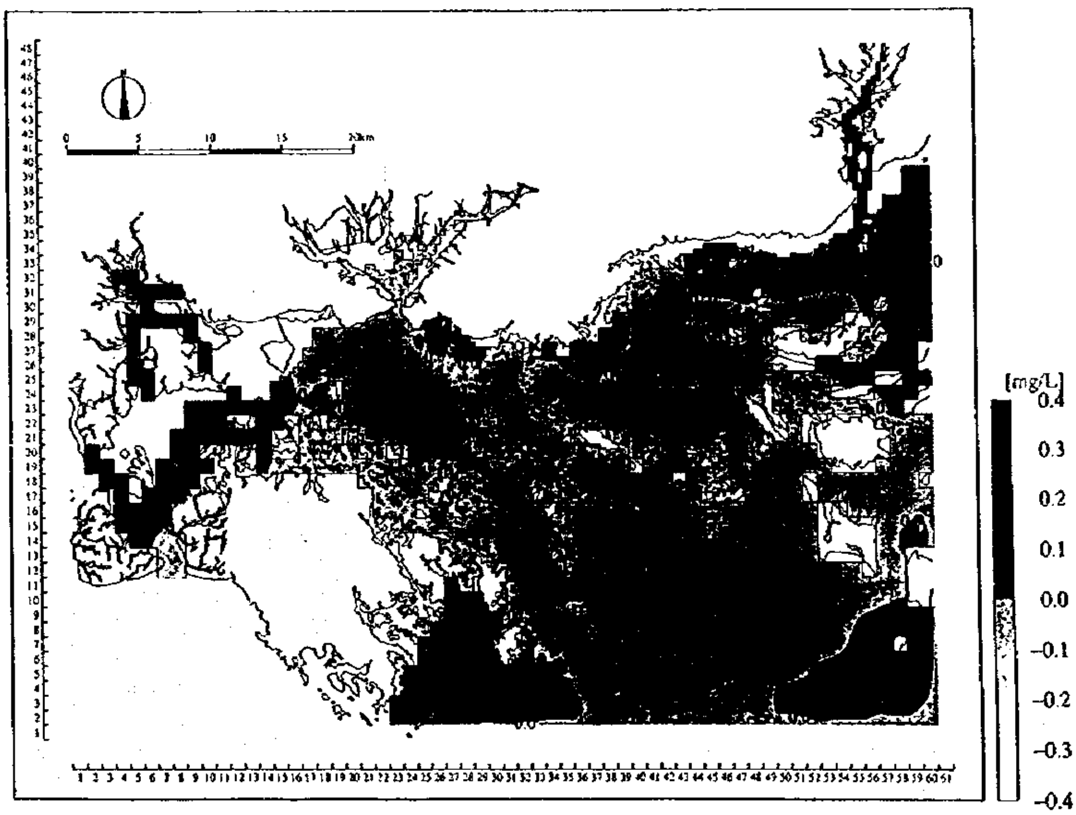


Figure 19.3.22(2) Difference between the Predicted Concentrations of I-N of the Lower Layer by the Optimum Plan and Scenario II

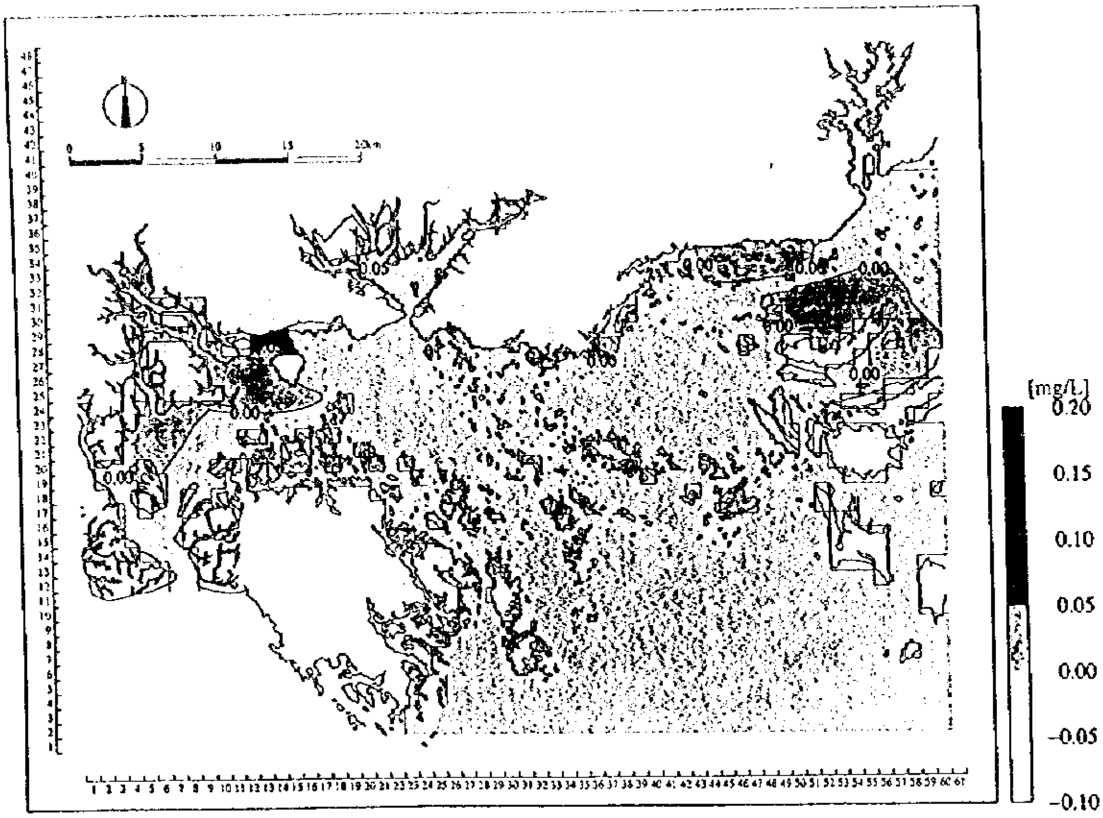


Figure 19.3.23(1) **Difference between the Predicted Concentrations of O-P of the Upper Layer by the Optimum Plan and Scenario II**

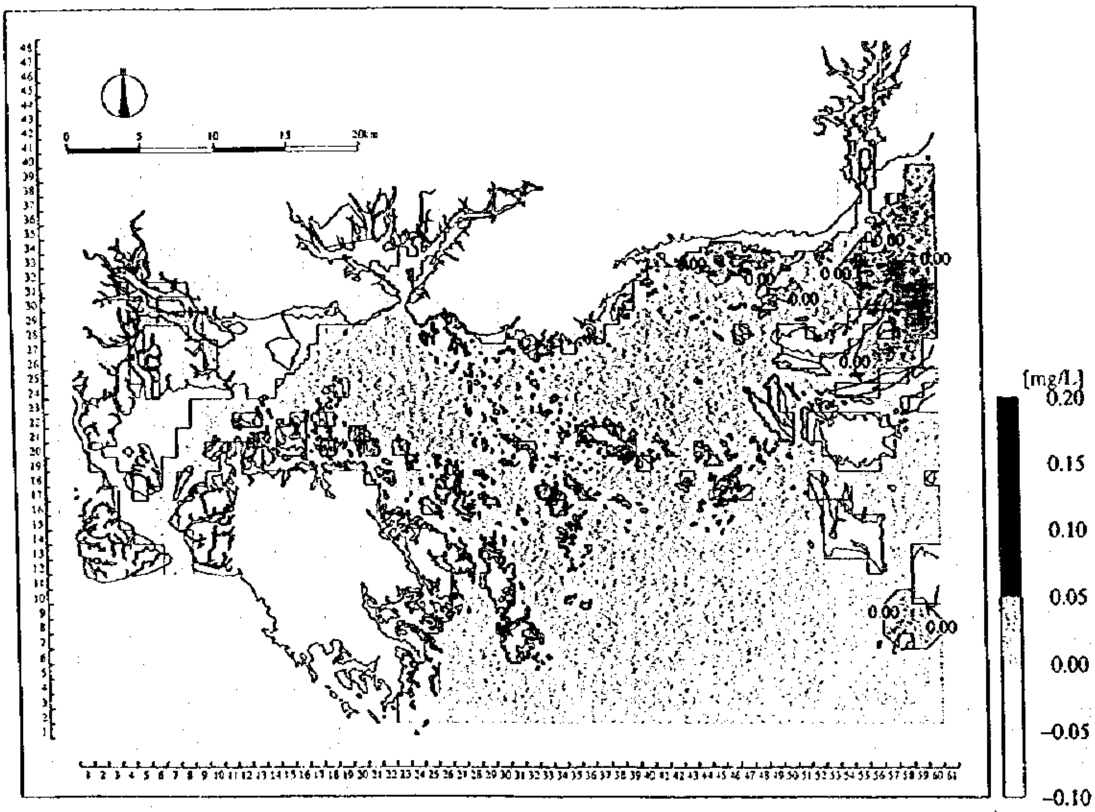


Figure 19.3.23(2) **Difference between the Predicted Concentrations of O-P of the Lower Layer by the Optimum Plan and Scenario II**

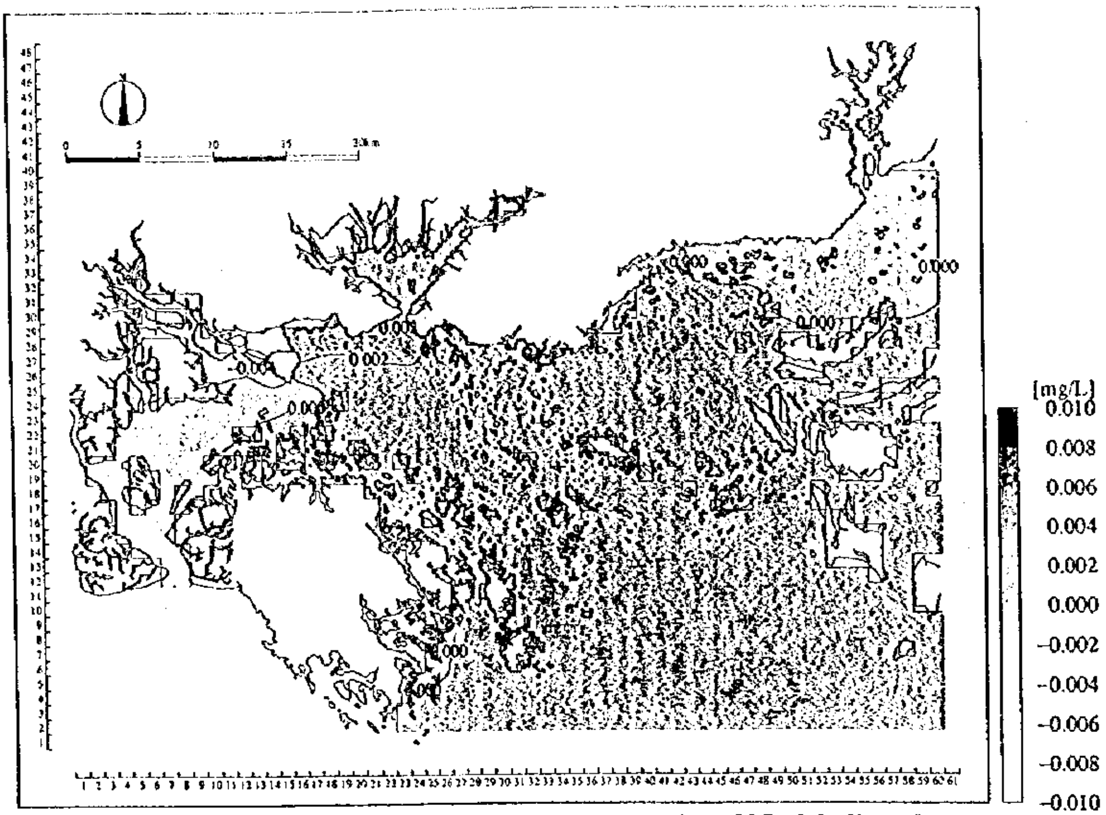


Figure 19.3.24(1) Difference between the Predicted Concentrations of I-P of the Upper Layer by the Optimum Plan and Scenario II

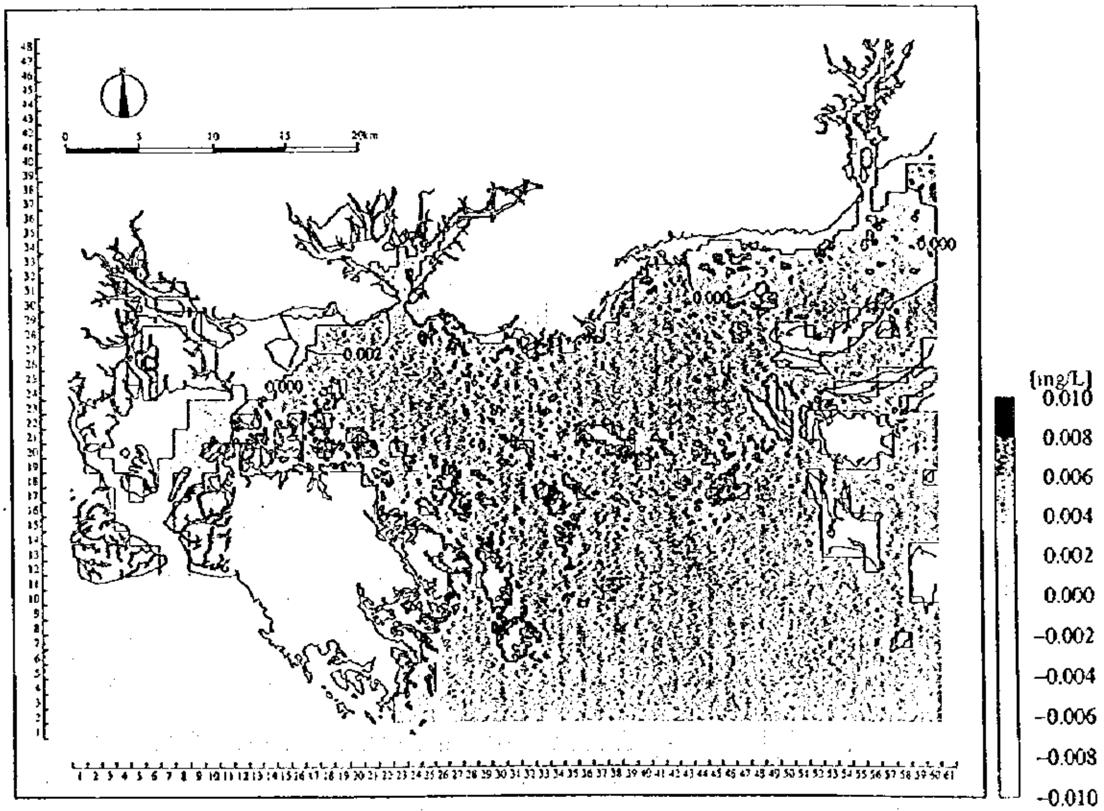


Figure 19.3.24(2) Difference between the Predicted Concentrations of I-P of the Lower Layer by the Optimum Plan and Scenario II

CHAPTER 20

CHAPTER 20 ENVIRONMENTAL MONITORING PLAN

20.1 General Concept

20.1.1 Objectives of Environmental Monitoring

In order to protect and conserve the environment in the EMP area, it is essential to continuously monitor the environmental quality. The existing system of monitoring and environmental management is not sufficient to achieve these functions, in spite of the fact that there are indications of the negative impacts of urbanization and industrialization such as coal mining, tourism, ocean transportation and other planned development. Considering possible environmental impacts on the EMP area, there is a need for establishment of an environmental monitoring plan to ensure sustainable development of the area. The following general objectives are set for environmental monitoring as an essential component of the EMP:

a) collection of environmental data and information contributing to database management,
b) periodical assessment on achievement levels to environmental goals set in the EMP,
c) clarification of necessity of further revision on the measures proposed in the EMP,
d) reliable recommendations on environmental considerations to the existing and future development activities, and
e) provision of detail data for inspection activities and environmental education to local residents, industrial sectors, and tourists.

20.1.2 Types of Environmental Monitoring

Environmental monitoring can be broadly divided into the following two types:

a) ambient environmental monitoring to monitor the status of the regional environment including the water quality and natural resources, and
b) monitoring of pollution sources to control release of pollutants from each source.

These two types of monitoring differ significantly in their objectives, methodology, and legal framework.

20.1.3 Key Considerations for Establishment of Environmental Monitoring Plan

The ultimate goal of the environmental monitoring plan is to protect and conserve water quality, natural resources, and human uses of the bays and rivers defined in the EMP. The environmental monitoring plan has been developed with the following key considerations:

(1) Information Needs of the EMP

First point is to generate information on ambient conditions and changes in water quality and natural resources that are required by the EMP. Regular information on ambient environment is required in order to assess the effectiveness of the EMP, and to provide the rationale for required future changes to pollution management actions as they arise.

(2) Improvement of Understandings of Environment in the EMP Area

The second is to test existing and future hypotheses of factors and mechanisms that govern water quality and ecosystem in the bays and rivers. Research monitoring, which is generally site specific and short-term, is needed to continue improving scientific understanding of pollution mechanisms and ecosystem in the bays and rivers. In addition to protecting and conserving environment the monitoring program will also provide information for public awareness and education programs on the importance of environmental protection of the bays.

20.1.4 Research Monitoring Needs

The Study, with guidance from earlier studies, has significantly increased understanding of the factors and mechanisms of water and sediment quality in the bays and rivers. The examination of pollution loads, pollution mechanisms and ambient water quality, and effects on sensitive aquatic resources and human uses has created a comprehensive knowledge base. The Study has formulated a number of hypotheses of factors and mechanisms that govern water quality of the bays and rivers that require continued study.

As an example, a major outcome of the Study has been development of conservation criteria for water quality in the bays that represent current conditions in nearshore and offshore waters. Implicit with these criteria is that land-based pollution loads are not creating widespread water pollution, that in general water quality is not harmful to valued aquatic resources and human uses of the bays. While the water quality data clearly support the existence of mesotrophic or slightly eutrophic conditions in the bays that are normal of marine coastal areas, with only localized pollution problems, further data collection and monitoring is required to support the chosen conservation criteria.

In addition to documenting ambient conditions and changes in water quality through time, the monitoring plan needs to generate information to further examine the following results and hypotheses emanating from the Study that are listed below.

a) The effects of land based pollution are tend to be stagnant nearshore of Ha Long City and Cam Pha - Cua Ong.
b) The water quality of the World Heritage area is not deteriorated on the whole so far.
c) However, there is a possibility that a relatively contaminated water body exists in offshore area, which may influence the water in the bays, mainly during the rainy season.

20.2 Proposed Environmental Monitoring Plan

20.2.1 Water Quality Monitoring

(1) Water and Sediment Quality

1) Location of monitoring sites

Monitoring locations was selected by taking the environmental zones into account. Considering the value of the World Heritage area, the monitoring area should first involve the bays designated for the World Heritage area that are defined as Special Conservation Zone (SCZ). Then, the bays which have relatively large land-based impacts which are to be Active Management Zone (AMZ), should be focused on such as Bai Chay bay and coastal areas of Bai Chay, Hong Gai, Cam Pha and Cua Ong. The bays' hinterland areas defined as SCZ, Conservation Zone (CZ), and Development Zone (DZ) are also involved.

Location of monitoring sites was selected based on the hydrological and oceanographic conditions, such as the watershed of the rivers, and depth of the bays. The results of the pollution mechanism studies were utilized to set the monitoring sites. In addition, the monitoring concept recommended by Chu Hoi (1997), namely Triangular Grid, was incorporated into the design of monitoring sites around the Cua Luc strait.

For the land area, the Major rivers such as the Mip, Troi, Man, Dien Vong, and Mong Duong rivers are selected to be monitored. This is because the surface runoff from the Major rivers accounts for more than 80%. For the marine area, the monitoring sites were further classified to representative sites and supplemental sites based on the their priority. At representative sites, more frequent monitoring should be carried out than at the supplemental sites.

Locations of the strategically designed water quality monitoring sites are shown in Figure 20.2.1. Correspondence between individual monitoring sites and environmental zones is summarized in Table 20.2.1. The sites of both the short-term and the long-term plans should be the same to ensure the smooth transition from the short-term plan to the long-term plan in the future.

In case of the sites in the bays, field measurement and sampling should be implemented at two layers, because the bays' water is considered to be stratified especially during the rainy season. While in the rivers, field measurement and sampling should be implemented at the main river course.

2) Monitoring system and frequency

To conduct the environmental monitoring, it is essential to prepare the equipment and skilled personnel. Considering current monitoring capability of DOSTE, the development schedule of the monitoring system should be divided into three terms such as "the short-term" mainly by using existing equipment, "the transition-term" for preparing new equipment in parallel, and "the long-term" by conducting complete monitoring as the goal of the EMP. The short-term will be 2000 to 2002, the transition-term be 2003 to 2006, and the long-term be after 2007.

In the bays, monitoring frequency is four times a year to grasp seasonal changes. For the representative sites, however, the monitoring should be carried out on a monthly basis to grasp detailed seasonal change. Monitoring frequency for the rivers' sites is four times a year in principle.

a) Short-term monitoring program

The short-term monitoring program (2000 to 2002) will cover the items as shown below. Considering monitoring capacity of DOSTE, it is recommended that BOD and COD should be analyzed by entrusting to a well trained laboratory such as HIO and CMERSC, while other items should be covered by DOSTE.

Monitoring Items for Short-term Program

Items		Sampling Layer	
		Marine Sites	River Sites
Field measurement	Depth, Weather, Air temperature, Wind direction and velocity, Color of water	(at site)	(at site)
Discharge	Current direction and velocity	0.5 m, B - 1m	Main river course
Water quality	Transparency	all layer	-
	Water temperature, Salinity	every 0.5 m to 1 m above the bottom (B - 1 m)	Main river course
	pH, DO, Turbidity	0.5 m, B - 1m	- ditto -
	COD, BOD	0.5 m, B - 1m	- ditto -

Note: B - 1 m means 1 m above the bottom.

b) Transition-term and long-term monitoring programs

During the transition-term monitoring programs (2003 to 2006), DOSTE is expected to complete its laboratory facilities and equipment. The technical training for the long-term monitoring program (2007 to 2010) should be carried out corresponding to the installation of additional monitoring equipment. DOSTE itself shall commence the monitoring of COD and BOD from 2003, nitrogen and phosphorus from 2004, sediment quality and coliform bacteria from 2005, heavy metal from 2006. The monitoring phase will shift to the long-term from the transition-term after 2006.

Monitoring Items for the Transition-term and the Long-term Program

Items		Sampling Layer	
		Marine Sites	River Sites
Field measurement	Depth, Weather, Air temperature, Wind direction and velocity, Color of water	(at site)	(at site)
Discharge	Current direction and velocity	0.5 m, B - 1 m	Main river course
Water quality	Transparency	all layer	-
	Water temperature, Salinity	every 0.5 m to 1m above the bottom (B - 1 m)	Main river course
	pH, DO, Turbidity, SS	0.5 m, B - 1 m	- ditto -
	COD, BOD, NH_4-N, NO_2-N, NO_3-N, T-N, PO_4-P,T-P, Chlorophy-a	- ditto -	- ditto -
	Coliform bacteria	- ditto -	- ditto -
	Heavy metals (Pb, Zn, Cu, Cd, As, Fe), Oil	- ditto -	- ditto -
Sediment quality	Grain size composition	bottom	-
	Water content, ORP, COD, I.L., TOC, T-S, T-N, T-P	- ditto -	-
	Heavy metals (Pb, Zn, Cu, Cd, As, Fe)	- ditto -	-

Note: B - 1 m means 1 m above the bottom.

(2) Dust

A settled dust on the ground is considered to be a part of origin of land run-off of SS. In order to grasp effects of measures for dust, a monitoring of amount of settled dust is proposed. Location of monitoring sites is selected considering open-pit coal mining areas which are main source of dust in the EMP area. Five monitoring sites consisting of ones located in seaside of Bai Chay, Hong Gai, Cam Pha and Cua Ong (two sites) areas are selected as shown in Figure 20.2.2. Monitoring frequency is four times a year to gasp seasonal changes, while a series of dust surveys are implemented for thirty days continuously.

According to the Vietnamese Standards (TCVN 5498, 1995), settled dust is sampled by a petri dish. Sampled settled dust in a petri dish, however, is easy to be blown off by a gust wind. Thus, it is recommended that a dust jar or a deposit gage be used for dust sampling. Also, sampling height should be more than 3m above the ground to avoid impacts of blown up or stirred up dust from the ground. The weight of sampled settled dust should be measured by an analytical balance in a laboratory. The wind direction and speed should be also recorded during the sampling periods to grasp impacts of considered pollution sources.

(3) Equipment and Facilities

1) Field measurement equipment

The monitoring equipment possessed by DOSTE can be used for the field measurement in the short-term monitoring program. The list of monitoring equipment in possession by DOSTE is shown below.

List of Monitoring Equipment in Possession by DOSTE (Field Measurement)

1. Lazer dust monitor	16. Van Dorn water bottles*
2. Sound meter	17. Ekman sediment samplers*
3. Hach Kit	18. Horiba Multi-parameter meter*
4. ELE Flow meter	19. UK 2030 pH meters*
5. Palintest soil analyzer	20. TOA oxygen meter*
6. YSI multi-parameter meter	21. NT-3P Turbidity meter*
7. TOA multi-parameter meter	22. Plankton nets*
8. YSI oxygen meter	23. Secchi disks*
9. Soil auger	24. YSI multi-parameter meter*
10. Wildco water bottle	25. GPS*
11. Ekman grab	26. TDS meter*
12. Radioactivity meter	27. Boats*
13. Vibration meter	28. Sediment sieves*
14. Gas (CO, H_2S, HN) meters	29. Wind meter*
15. Freshwater secchi disks	

Note: * Procured by JICA

2) Laboratory analysis equipment

Toward the long-term monitoring program, it is necessary to procure additional equipment for the laboratory analysis of water quality, sediment quality, heavy metals, and coliform bacteria. The necessary equipment was categorized into five groups as shown in Table 20.2.2. Group 1 is the equipment for BOD and COD analysis, Group 2 for phosphorus and nitrogen, Group 3 for sediment quality, Group 4 for heavy metals, and Group 5 for coliform bacteria. It is recommended that Group 1 should be procured by 2002, Group 2 by 2003, Group 3 by 2004, and Group 4 by 2005. Group 5 has been already in the possession of DOSTE.

Existing equipment for laboratory analysis, which is in the possession of DOSTE is shown below:

List of Monitoring Equipment in Possession by DOSTE (Laboratory Analysis)

1. UV-VIS Spectrophotometer	8. BOD incubator
2. Muffle furnace	9. Coliform lab
3. Drying oven	10. COD lab (Palintest Soil)
4. Digital balance*	11. Hi volume air pumps
5. Refrigerator*	12. COD Meter*
6. Fume hood	13. Water Distiller*
7. BOD lab	14. Oil Analyzer*

Note: * Procured by JICA

For the long-term monitoring program, it is also necessary to prepare a laboratory, which has enough space for analyzing activities and the installation of equipment considered in the program. Since the number of the planned personnel will be 5 in 2000 as shown in Table 20.2.3, the necessary space for the laboratory will be 50 m^2. After 2000, the number of the personnel will increase up to 25 by the end of the long-term program. Therefore, the necessary space for the laboratory together with 100 m^2 of the storage space will be 300 m^2.

3) Operation of the equipment

a) Storage of the operation manuals

All of the original manuals for the monitoring equipment should be kept in the library. Photocopies of the manuals should be made and kept always with the equipment for the daily needs.

b) Special attention for the voltage

The special attention should be paid to the voltage required for the imported equipment. The voltage requirement is not always written in the manual. It is necessary to identify the required voltage and to use the proper transformer to the voltage in Vietnam.

c) Calibration

The monitoring equipment has to be calibrated in such a way as written in the manual, otherwise the data quality would be poor. The calibration has to be conducted at the first use of the sensors, at the replacement of the solutions or cartridges, at the replacement of the batteries, and at the time when suspicious data were obtained. In addition, it is expected to conduct the calibration regularly such as once in a week.

To conduct the calibration consistently, a calibration plan should be established. The quality manager, who is responsible for the data quality measured, should be appointed to implement such a calibration plan.

d) Overhaul

Salinity of the seawater gradually damages the equipment. Therefore, an overhaul is necessary including the replacement of the sensors to keep the equipment in good condition about every six months.

4) Boats

a) Objectives

Boats are required for the marine area monitoring as a means of transportation to the sampling stations. It is assumed that a speed boat procured by JICA will be granted to DOSTE.

b) Mooring

The mooring location of the boats should be safe and close to DOSTE to keep the boats ready for departure whenever necessary for the monitoring. To fulfil the two conditions, it is expected to use the wharf where is now exclusively used for the official boats.

c) Maintenance

Maintenance is essential to operate the boats safely. It is proposed to make a subcontract with a local company which has enough skill to maintain the boats.

d) Operation

The positioning of the sampling stations has to be done exactly by using a Global Positioning System (GPS). At the sampling stations, the screw of the boats has to be always set in the downstream position otherwise the screw disturbs the water and sediments resulting in poor data quality.

The operating skill of the boats should be recognized as an important factor to influence the data quality. The captain of the boat is expected to be a professional subcontractor rather than the staff of DOSTE because the special skills such as stopping at the stations without anchoring are necessary to minimize the total sampling time for many locations by one boat.

c) Sampling

The sampling will be conducted at 10 stations in the land area for rivers and 20 stations in the sea as shown in Table 20.2.4. The total number of the samples will be 376 for water quality and 6 for sediment quality per year.

The sampling order should be chosen considering the tidal conditions and the locations of the stations. For example, the recommended order during the rising tide would be from Nos. 12, 13, 14, 15, 16, 17, 19, 20, 11, 10, 9, 8, 18, 7, 5, 3, 4, 2, to 6.

(4) Data processing and Reporting

1) Field notes

Field notes during sampling are required to clarify the source of the data. The items to be recorded in field notes should include the date, the name of the personnel, the weather, and the number (name) of the stations. The example of the format of the field notes is shown in Table 20.2.5.

2) Records of the receipt

Records of the receipt of the samples should be made and kept in the laboratory. The items to be recorded in the receipt should include the date, the name of person who handed over the samples to the laboratory, the name of the person who received the samples, the name of the samples, and the number of the samples.

3) Records of the analysis

The results of the analysis should be recorded in the form of tables for each item as soon as analyzed. Comments on the relation between two or more items should be recorded such as the relation between the concentration and the absorption. The information in the field notes should be referred in the record of the analysis to clarify the condition of the sampling.

4) Linkage to the EMP

Data processing should be conducted after recording as following manner:

- obtaining maximum, minimum, and average of the data,
- mapping of the data,
- plotting time series including previous data, and
- comparing the data with the criterion defined in the EMP as well as the Vietnamese standard.

If extreme values are found from the results of the processing, further efforts should be made to identify the causes. The cause could be natural conditions such as heavy rain. However, if discharges from specific factories were identified as the possible cause, the data should be used to authorize the emergency inspections.

20.2.2 Environmental Resources Monitoring

(1) Natural Environment

The environmental monitoring for natural environment consists of three surveys as follows:

- Vegetation survey: Forests
- Wetland survey: Tidal flats and mangrove swamps
- Marine biological survey: Coral reefs, fish and shellfish, plankton (phytoplankton and zooplankton), benthos

1) Monitoring area and location

Monitoring area and location were set as follows based on the distribution of selected items. As for plankton and benthos, the same sites used for water quality monitoring in the marine area are proposed to ensure the comprehensive understanding on the aquatic ecosystem of the bays.

a) Forests

The survey area of forests covers all land area and surface of islands of the EMP area.

b) Tidal flats and mangrove swamps

A total of eight survey sites of tidal flats and mangrove swamps are set as the representative areas (see Figure 20.2.3). Quang Hanh and Cat Ba island are located in SCZ, while the others are in AMZ.

- Binh Huong estuary	- Bai Chay coast	- Bai Chay bay	- Hong Gai coast
- Quang Hanh coast	- Cam Pha coast	- Cua Ong coast	- Cat Ba Island

c) Coral reefs

The survey sites of coral reefs are set on the sites that have been identified as existing coral reefs. With reference to existing literature and the results of the Field Survey, the following 17 survey sites are proposed (see Figure 20.2.3). These are all located in the SCZ.

- Dam Nam	- Cong Go	- Ba Trai Dao	- Hang Trai	- Cong La
- Hang Cao	- Cong Do	- Cong Tra San	- Hang Tra San	- Gian Muop
- Cong Dong Nam	- Cat Da To	- Cong Dam	- Van Gio	- Hang Gieng
- Hang Mat Men	- Cong Tay			

d) Fish and shellfish

The survey sites of fish and shellfish are set on main fishing grounds in the EMP area. The following 7 survey sites are proposed (see figure 20.2.4). Tuan Chau is in AMZ. Hon Net is located in CZ, while the others are situated in SCZ.

- Dau Be	- Dau Go	- Soi Den islet	- Ngoc Vung
- Cua Dua -Cong Do	- Tuan Chau	- Cong Dong	- Cong Tay
- Hon Net-Hon Ong Cu			

e) Plankton and benthos

The survey is conducted at the same sites as water quality monitoring sites at sea. Correspondence of each sites with environmental zones is shown in Table 20.2.1.

2) Monitoring system and frequency

As it is difficult to commence this monitoring only with existing equipment and manpower, this monitoring should involve a local research institute which have enough skill, experience and the capacity. Thus, phased development plan as discussed in water quality monitoring is not applicable. The monitoring should be carried out with the following frequency.

a) Forests: every two years
b) Tidal flats and mangrove swamps: every five years
c) Coral reefs: every five years
d) Fish and Shellfish: every five years
e) Plankton and Benthos: every five years

3) Monitoring items and methodology

Monitoring items and methodology of each survey are as follows. The proposed ERMU in DOSTE will be in charge of natural environmental monitoring. While it is recommended that the tasks related to field survey, analysis, and identification of samples will be contracted to the local research institutions.

Items and Methodology of the Natural Environment Monitoring

Survey	Targets	Monitoring Items	Methodology
Vegetation	Forests	Forest coverage	Analysis of satellite images - Ground truth
Wetland	Tidal Flats and Mangrove Swamps	Distribution of tidal flats and mangrove swamps, Species composition and biomass of mangrove swamps and zoobenthos	Field Survey - Aerial observation - Belt transect - Sampling & analysis
Marine Biology	Coral Reefs	Distribution, Species composition of corals, living coral coverage	Field Survey - Belt transect - Sampling & analysis
	Fish and Shellfish	Species composition and biomass of fish and shellfish	Field Survey - Catch test with gill net and trawl net
	Plankton (Phytoplankton and Zooplankton)	Species composition and biomass of plankton	Field Survey - Water sampling - Sampling with net
	Benthos	Species composition and biomass of zoobenthos	Field Survey - Sampling with grab

(2) Landscape

The landscape in the EMP area is strongly characterized by the World Heritage area, which has an unique landscape of aesthetic value. In order to manage landscape in the EMP area, it is proposed to carry out a landscape monitoring program. This monitoring program consists of two surveys: the landscape element survey and the landscape value survey.

1) Monitoring area and location

a) Landscape element survey

The landscape element survey covers all of the World Heritage area and its vicinities.

b) Landscape value

The landscape value survey employs questionnaire research for 150 samples of tourists, 50 samples of tourism agents, and 250 samples of resident in the coastal areas scoping the World Heritage area and its vicinity.

2) Monitoring system and frequency

HLMB has conducted periodical patrols to maintain of the World Heritage area. It is expected that HLMB be an implementation body of landscape monitoring because of the similarity of the program activity required. ERMU should collect the obtained data to manage the landscape conservation linking with other monitoring outputs. The frequency of surveys is as follows.

- Landscape element: once a month
- Landscape value: every five years

3) Monitoring items and methodology

Monitoring items and methodology of each survey are as follows. The landscape element survey and landscape value survey will be conducted by HLMB.

Items and Methodology of the Landscape Monitoring

Survey	Monitoring Items	Methodology
Landscape Element	Shape and surface of islands, Color and clearness of seawater, View of natural resources, Natural scenery	Field reconnaissance
Landscape Value	Change of value of the World Heritage area	Questionnaire Survey

Example of questionnaire sheet for landscape value monitoring is shown in Appendix 7.

20.3 Proposed Environmental Inspection Plan

20.3.1 Purpose of the Environmental Inspection

The proposed environmental inspection aims at guiding every pollution source toward environmentally friendly performance to achieve successful implementation of the EMP. It is necessary to prepare a framework for inspection system which defines the responsible and implementing bodies and methodology.

Though inspection activities have been operated by some authorities severally, their individual results have not worked to lead the province to an environmental conservation target due to a lack of a comprehensive system. Thus, the EMP requires the linkage or integration of the environmental monitoring and inspection.

20.3.2 Content of the Inspection

The main targets of the inspection include specific pollution sources consisting of pollution sources on land such as factories, coal mining, markets, floating gas stations and pollution sources on the sea such as ships.

(1) Inspection of the Factories and Enterprises

1) Targets

Based on the results of the proposed monitoring, the inspection should be conducted of possible sources such as factories and business enterprises without an advance notice. Factories to be inspected are selected based on the criteria for screening which will be prepared considering the magnitude of impacts on the environment. After finishing the short-term monitoring program, relatively large enterprises should be registered for inspection.

2) Items

The items of the inspection should be chosen from those of the Industrial Effluent Standards (TCVN5945-1995) as well as applicable sectoral standards such as Technical Regulation on the Exploitation of Open Cast Mines (TCVN5326-1991). Discharge, water temperature, pH, DO, COD, BOD, SS, T-N, T-P, oil content, and total coliform bacteria should be checked at all targeted factories and enterprises. While heavy metals and other harmful substances should be selected based on the type of the factory.

The inspection aimed at solid wastes is also very important. The manner of treatment and disposal of solid wastes should be checked strictly, especially for harmful substances.

3) Methods

Basically, the methods of the inspection should follow the Guidance on Sampling of Wastewater (TCVN5999-1995). The on-the-spot inspection should be carried out.

Frequency of the inspection should not be routinely decided such as every three months because predictable regular inspections spoil the effect of warning without notice. The inspectors should be able to inspect any factories and enterprises at any time to maximize the warning effect. If it is necessary to prioritize the frequency of the inspection depending on the targets, the criteria should be carefully prepared considering the magnitude of impacts on the environment.

4) Evaluation

The evaluation of the results should be based on the conservation criteria set in the EMP and Industrial Effluent Standard (TCVN5945-1995). Assessment of the results of the inspection should be made not only the concentration of the wastewater but also total pollution loads discharged and solid wastes produced.

5) Guidance and penalty

Proper guidance and the countermeasures should be conducted, when the wastewater does not meet the conservation criteria and/or other relevant standard. Fine or suspension of business would be imposed on if it were not improved.

(2) Inspection of Ships

1) Time and targets

The on-the-spot inspection should be conducted of every kind of ships such as cargo ships, ferryboats, tourist boats and fishing boats without an advance notice. It is recommended that the inspection should be combined with the existing ship's safety standard inspection conducted by the Department of Transportation (DOT).

2) Items

Collection, treatment, and disposal manner of wastewater, solid wastes, and waste oil are the major items to be inspected. In particular, oil contents in the discharge such as a bilge water, a ballast water, and the facility conditions so as not to leak oil should be inspected.

3) Methods

On-the-spot inspection should be implemented. For checking oil contents, the methods should follow the Guidance on Sampling of Wastewater (TCVN5999-1995).

Inspection of the cargo ships and tankers should be conducted every touch at ports. In case of tourist boats, fishermen boat, and floating gas stations, the inspection should be conducted by random sampling to maximize the warning effect of the inspection without notice.

4) Evaluation

The results should be evaluated based on the strategies and countermeasures that will be defined in the EMP. In particular, evaluation based on the MARPOL Protocol of 1978 (MARPOL 73/78) should be conducted on the cargo ships and tankers.

5) Guidance and penalty

Fines should be imposed on and the proper guidance for the countermeasures should be conducted.

20.4 Institutional Frame

20.4.1 Organization for Environmental Monitoring

(1) Organization for Environmental Monitoring

There are two ways to initiate the implementing organization of the EMP. One is the reinforcement of the existing organization of DOSTE and another is the establishment of a new organization. The reinforcement of DOSTE is proposed rather than the establishment of new organization because of the following reasons.

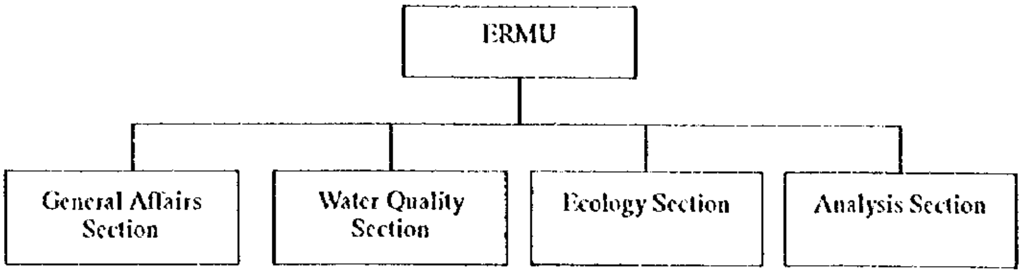
The advantage of the reinforcement of DOSTE is that starting from the existing organization is easier than initiating new organization while the disadvantage is that DOSTE can not concentrate on the EMP because of the existing role required in the whole Quay Ninh province.

The advantage of the establishment of a new organization is that the new organization can concentrate on the EMP while the disadvantage is that it will require lots of adjustment with the existing organizations and will take time.

The proposed Environmental Research and Monitoring Unit (ERMU) is expected to perform environmental research and monitoring activities in the EMP area. Environmental Management Division (EMD) in DOSTE will ultimately be responsible for the environmental administration including execution of environmental monitoring plan. Research activities are to be joint activities between proposed ERMU and local research institutes, such as HIO or CMESRC. DOSTE should coordinate its efforts with the other management agencies and institutes that contribute to ERMU. Agencies, institutes, and groups that may contribute to the activities of ERMU include HLMB, HIO, CMESRC, DOC, DARD, and NGOs such as the Women's Union and the Homeland Front.

(2) Organization of ERMU

ERMU consists of four sections, such as general affairs, water quality, ecology, and analysis sections as shown below.



Organization of ERMU

The proposed number of staff of each section are discussed in the following. The personnel for the boat operation will be employed from outside the organization at the each monitoring time.

1) General affairs section

General affairs section will be initiated from the existing section in DOSTE.

- Short-term (2000~2002): One manager only.
- Transition-term (2003~2006): One additional section chief and section member. Three staff members are required as a total.
- Long-term (2007~): One additional member. Four staff members are required as a total.

2) Water quality section

Water quality section will be in charge of the water quality monitoring including dust monitoring in the EMP area.

- Short-term: Three staff, namely, one engineer for supervising and measuring, one assistant engineer for preparation and measuring, and one assistant for preparation and water and dust sampling are required to start the field measurement and sampling by one party from 2000. These three staff will be the minimum to commence the monitoring practically.
- Transition-term: Six staff are required to compose the same type of two parties as described for the short-term in 2006.

- Long-term: Additional two staff, namely, one for an assistant engineer and one for just an assistant are required in 2008. Eight staff are required as a total.

3) Ecology section

Ecology section will be in charge of monitoring of environmental resources such as vegetation, wetland, marine biology and landscape. The monitoring items require the special skills and knowledge on the ecology and landscape.

- Short-term: Three staff, namely, one engineer, one assistant engineer, and two assistants are required.
- Transition-term: No additional staff is required during this term while the improvement of the skills of existing staff is required.
- Long-term: Two additional staff, namely, an assistant engineer and one assistant are required in 2009. Six staff are required as a total.

4) Analysis section

Analysis section will analyze the sampled water after the completion of the laboratory. It is expected to have two parties, one for general items like COD, BOD, T-N, T-P, and one for heavy metals and coliform bacteria.

- Short-term: No staff is required at the beginning, however, one engineer will be necessary in 2002 for the completion of the laboratory facility and equipment.
- Transition-term: Three staff, namely, one engineer, one assistant engineer, and one assistant are required in 2003. Six staff, namely, two engineers, two assistant engineers, and two assistants are required in 2006.
- Long-term: No additional staff is required. Six staff are required just as at the end of the transition-term.

(3) Human Resource

Human resource is a key factor to obtain the reliable data for the environmental monitoring. It is expected that the staff for the monitoring have at least graduated from universities in the course of engineering or science because the laboratory operation requires the discipline of analyzing and validating methods, and managing system of the laboratory. At the beginning of the implementation, it is recommended that the staff of EMD should become the core members of ERMU for smooth technology transfer.

EMD currently consists of 5 persons. The size of EMD will need to be increased with ERMU is mandate for environmental monitoring.

The necessary staff number of ERMU which is expected to have a responsibility of the environmental monitoring is shown in Table 20.2.3.

20.4.2 Organization for Environmental Inspection

It is necessary to gather data obtained through inspection and distribute it to a certain responsible agency to organize an effective environmental conservation scheme. The responsible agency for the inspection of pollution sources on land area is expected to be the Inspection Division (ID) in DOSTE, in close collaboration with IPCU and ERMU. It is rational to carry out inspection on pollution sources on the sea utilizing the existing organizations as implementation agencies, such as HLMB, Port Authority (PA), and Board of Tourist Ferry Dock (BTFD), which have conducted inspection for their respective responsibilities, because working within the existing government framework can avoid difficulties likely encountered if some new organization had the direct operation of inspection.

Environmental data obtained through regular monitoring can be used for pointing out any pollution sources to be inspected. DOSTE urges competent authorities to conduct further inspection and to let polluters to take necessary countermeasures.

Proposed demarcation of responsibilities of inspection is as follows.

Inspection Targets	Responsible Agencies	Cooperation Agencies
Factories and enterprises	ID, IPCU, ERMU	DOI
Coal mining	ID, IPCU, ERMU	DOI
Cargo ships, ferry boats	PA, ERMU	DOT, BTFD
Fisherman boat	DOF, ERMU	DOT, PA
Tourist boat	HLMB, ERMU	DOT, PA
Floating gas station	HLMB, ERMU	DOT, PA

Note: * ERMU will be in charge of water quality analysis.

20.5 Capacity Development

20.5.1 Development of Laboratory

The proposed ERMU's capacity for environmental monitoring is developed by the completion of the laboratory facilities followed by practical training on environmental monitoring.

An updated pollution sources inventory and basic laboratory equipment for environmental sampling and analysis in possession by DOSTE has been created. DOSTE has allocated space for a simple laboratory and field equipment storage area. Development of DOSTE's laboratory and field equipment storage area needs to be completed in order for their laboratory and field equipment to become fully functional.

1) Field equipment room and laboratory

Figure 20.5.1 shows a floor plan for the completed field equipment storage area. The equipment storage area will be used to prepare and calibrate equipment for use in the field. Equipment is also washed ard serviced in this area. Completion of the field equipment room is relatively simple requiring some benches and shelving, electrical outlets as well as a sink. It is noted that due to space limitations in DOSTE laboratory, the refrigerators and water distiller have been placed in this room.

Consumables and spare parts for the field equipment, and the location of closest suppliers that are required to maintain the field equipment need to be identified. Of particular importance are spare probes for water quality meters, standard buffer calibration solution, buckets, graduated line, sampling trays. Other required accessory equipment includes glassware, pipettes, and rubber bulbs. In the course of the Study, extra sampling trays and buckets, rubber bands for Van Dorn Bottles, and supplementary supplies of buffer solutions and pipettes has been provided to DOSTE. However, these items are consumables, and will need to be replaced.

Consumables and Spare Parts List for Some Equipment

Equipment	Consumables and Parts
1) UV-VIS spectrophotometer	light bulbs
2) Coliform lab	culture media, petri plates
3) COD lab	sample reagent kits
4) Hi volume air pumps	filters and filter holders
5) COD meter	calibration reagents
6) Fume hood	filters
7) Water distiller	deionized water
8) Van Dorn water bottles	rubber bands, graduated line
9) Hach Kit	reagent pillows, bulb for spectrophotometer
10) Single and multi-parameter meters	calibration solutions and probes
11) Plankton nets	bridles and mesh
12) Boats	normal maintenance and parts
13) Miscellaneous	glassware, chemicals, sample bottles

2) Laboratory

Figure 20.5.2 outlines a floor plan for the room that DOSTE has allocated for their laboratory. The proposed plan outlines placement of equipment received from WB and UNDP. Placement of laboratory grade benches, shelves, sinks and electrical outlets is included in that floor plan. The benches should be standard acid resistant and include some underneath storage shelves. The floor plan has been designed to permit both stand up and sit down works. Not shown are standard laboratory chairs and a fire extinguisher.

The laboratory requires support equipment in the form of chemicals, glassware, pipettes, rubber stoppers and bulbs, and plastic squeeze bottles. The sources of all consumable chemicals and parts need to be identified and a procedure for acquiring parts should be developed.

20.5.2 Training

The capacity for successful environmental monitoring is developed with practice. DOSTE has received introductory classroom and field training on monitoring design and implementation as part of the Study. This field training combined with training on use of the laboratory equipment provided by UNDP and WB has provided DOSTE with a firm base from which developing their skills in environmental monitoring is continued.

More classroom and practical training on monitoring design, field sampling, and laboratory analysis with their equipment is required. The capacity development model currently being applied to four other DOSTEs in the VCEP is very relevant to DOSTE. Of particular importance is immediate development of a practical field and laboratory that will generate required information on the conditions of the bays and rivers. The following courses and practical projects are required:

a) Expanded course(s) on monitoring design and sampling in the EMP area
b) Laboratory operation, maintenance, and budgeting
c) Environmental indicators development in the EMP area
d) Data analysis and state of the environment reporting
e) Practical project that integrates subject matter of all courses

The initial practical training should be simple, such as water quality meter measurements at a series of stations to determine trends in one or more variables in the bays. The practical training forms the initiation of the short-term monitoring program. Parameters such as BOD and fecal coliform can be added as DOSTE or ERMU becomes more proficient with these analyses. The training should be designed to begin to address the research and monitoring needs that have been identified for the environmental monitoring plan.

Training in other countries should also be considered. It is expected that relating institutes staff or newly dispatched experts from international donors will conduct the training.

20.6 Cost Estimation

20.6.1 Required Cost for Environmental Monitoring

(1) Personnel Expenses

Estimated personnel expenses of staff of ERMU for the proposed monitoring are shown in Table 20.6.1. The cost will be US$ 5,288 for seven staff members at the beginning of the short-term development schedule in 2000 and will be US$ 17,040 for 25 staff members at the end of the long-term development schedule in 2010.

(2) Water Quality

1) Equipment and laboratory

The costs of the equipment which should be procured for the proposed monitoring plan as shown in Table 20.6.2 will be US$ 7,300 for Group 1 (BOD, COD) in 2003, US$ 24,400 for Group 2 (nitrogen, phosphorus) in 2004, US$ 99,700 for Group 3 (sediment quality) and US$ 8,000 for Group 5 (coliform bacteria) in 2005, and US$ 90,200 for Group 4 (heavy metal) in 2006.

The laboratory space will be allocated in the existing buildings of QNPC. The additional cost for the facility is estimated at US$ 71,500 (see Table 20.6.2).

The cost for electricity is estimated by the unit price of US$ 0.1/kW and the necessary unit power for the laboratory of 8 kw/m^2/month. Thus, the estimated cost for the initial laboratory space of 50 m^2 until 2002 will be:

50 m^2 × 8 kw/m^2/month × US$ 0.1/kW = US$ 40/month or US$ 480/year

The cost for the complete space of 300 m^2 from 2003 will be:

300 m^2 × 8 kw/m^2/month × US$ 0.1/kW = US$ 240/month or US$ 2,880/year

2) Entrusting

Enrusting analysis will be necessary from 2000 to 2002 because of the urgent need for COD and BOD analysis for 10 river points and 6 sea points as shown in Table 20.6.3. The total estimated cost for the outsourcing analysis of COD and BOD will be about US$ 1,300/year (see Table 20.6.4).

3) Training

The training cost will be included in the outsourcing cost from 2003 for the on the job training by the contractor.

The training cost for water quality analysis will be US$ 5,672 in 2003. In addition, the cost for the transportation and accommodation will be US$ 1,380 for two trainees per week (see Table 20.6.5).

The training cost including analysis of sediment quality will be US$ 498 in 2005. In addition, the cost for the transportation and accommodation will be US$ 1,080 for two trainees per week (see Table 20.6.6).

4) Boat and vehicle costs

The total cruising distance for a series of sampling is estimated at 140 km. It takes 7 hours running and 2 hours sampling (6 minutes/station × 20 stations) by a boat with an engine of 200 horsepower resulting in 9 hours total.

The engine consumes about 60 liters gasoline per hour while running and 15 liters per hour while idling. Therefore, 420 liters for 7 hour run and 30 liters for 2 hour idling consume 450 liters as a total for one monitoring. The estimated cost for one monitoring will be:

$450\,\ell \times$ US\$ $0.2/\ell$ = US\$ 90

Therefore, the cost for the monitoring per year will be:

US\$ 90/time × 12 times/year = US\$ 1,080/year

Additional mooring and maintenance costs of US\$ 50/year, the estimated cost required for a boat operation is about US\$ 1,100/year.

As for vehicle for monitoring of rivers, one vehicle is required for sampling and field measurement. Table 20.6.8 shows the total estimated cost for boat and vehicle operation from 2000 to 2010, it is about US\$ 53,100.

5) Estimated cost

The estimated cost for water quality from 2000 to 2010 is about US\$ 413,400 as shown in Table 20.6.10. The largest component is US\$ 333,500 for the completion of the laboratory and equipment including O&M costs.

(3) Environmental Resources

1) Natural environment

All the tasks related to monitoring for natural environment will be entrusted to the local research institutions. The estimated cost of each monitoring item are shown in Table 20.6.9. Total estimated cost from 2000 to 2010 will be about US\$ 242,000 as shown below.

Estimation Costs for Natural Environmental Monitoring (2000-2010)

(Unit: US$/year)

Survey Name	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
Vegetation	18,800		18,800		18,800		18,800		18,800		18,800	112,800
Wetland	22,100					22,100					22,100	66,300
Marine Biology	20,900					20,900					20,900	62,700
Total	61,800	0	18,800	0	18,800	43,000	18,800	0	18,800	0	61,800	241,800

2) Landscape monitoring

The monitoring the landscape element and the landscape value will need two staff. Staff of HLMB is expected to conduct this survey, supported by staff of ERMU. It is assumed that current staff can do that by providing intensive training to them. Thus, personnel cost is not considered and only operation cost of boat is estimated. It is assumed that existing boat of HLMB can be shared for the landscape monitoring.

The total cruising distance for the monitoring of landscape element is estimated at 100 km. It takes 5 hours by the boat with the engine of 200 horsepower. The engine consumes 60 liters gasoline per hour while running. Therefore, 300 liters of gasoline is expected to be consumed for a series of monitoring. The cost for a series of monitoring will be:

300 liter x US$ 0.2/ℓ = US$ 60

Therefore, the cost for the monitoring per year will be:

US$ 60 x 12 times/year = US$ 720/year ≒ US$ 700/year

This cost is required every year. Therefore, total cost of landscape monitoring from 2000 to 2010 is estimated at US$ 7,700.

3) Estimated cost for environmental resources monitoring

The total estimated cost for environmental resources monitoring from 2000 to 2010 is US$ 249,500.

(4) Total Estimated Cost

Total estimated cost for environmental monitoring from 2000 to 2010 is about US$ 787,000 as shown in Table 2.6.10.

20.6.2 Required Cost for Environmental Inspection

The proposed environmental inspections of pollution sources on land area will be in charge of ID in collaboration with IPU and ERMU. Considering required responsibilities of each division and unit, it is expected that their working volume will be increased inevitably, especially in ID. Additional staff will be also required with increase in working volume. Such a number of staff is counted six in 2010 in the required number of staff in ID. It is assumed that a team of 3 will be in charge of inspection of coal mining actives and another team of 3 will inspect other factories and enterprises. With regards to the proposed new units of IPU, required staff who will support ID on coordination and technical issues in counted in the institutional development (see Chapter 21). Required staff in ERMU who will support ID on wastewater sampling and analysis is also counted in the staff for the ambient environmental monitoring.

In case of HLMB and DOF which will be in charge of the inspection of marine area, their inspection works are considered to be covered by proposed reinforcement of patrolling capabilities (see Chapter 18.4 and 18.5). As for PA, however, the expected future works can be covered by the current staff number by providing intensive skill training to them.

Necessary equipment and facilities for the proposed environmental inspection are mainly vehicles, boats, and computers for daily works. Required computers are counted as the institutional devilment. As for required boats, it is assumed that existing boats of DOF and PA can be fully utilized and boats to be procured for the reinforcement of patrolling capability of HLMB can be utilized too.

With regards to check on the wastewater from factories, enterprises, and ships, sampling and analysis are expected to be conducted by the proposed ERMU. Required costs for sampling and analysis of wastewater are involved in the costs for ambient environmental monitoring.

Thus, incremental costs for the proposed environmental inspection are mainly those of additional staff and vehicles for ID. The estimated costs are shown in Table 20.6.11 and summarized as follows:

Estimated Incremental Costs for Environmental Inspection

Estimation Items	Costs (US$ × 10^3)
Staff of ID	25
Vehicle	60
Vehicle (O&M)	30
Total	115

20.7 Recommendations

20.7.1 Necessity of Wide-range Monitoring

The intrusion of relatively contaminated water body just outside of the EMP area was identified by the Study. Although monitoring outside of the EMP area is beyond the EMP, the monitoring area will be extended to cover the southern outskirts of the EMP area. Meanwhile, it is strongly recommended that MOSTE be urged to develop environmental monitoring programs to deal with this cross-provincial issue in the Northern Tonkin Gulf area.

20.7.2 Public and Stakeholder Awareness

An obstacle to sustainable environmental development in Vietnam is the lack of public awareness and understanding of the importance of environmental protection and conservation. The monitoring program can provide information which conveyed to the residents and tourists of the area can act to educate the community on the value of environmental protection.

Monitoring results should be summarized in simple brief information bulletins that are made available to residents and tourists at public places and as part of tourist activities such as boat cruises out to the Heritage area. Agencies like MOSTE, MOI, DOSTE, HLMB, coal enterprises, factories, and hotels should also receive them to draw attention to the environment in the EMP area. Groups like the Women Union and the Homeland Front can assist in developing awareness on environment. The proposed Visitor Center (see Chapter 21.4.5) can be fully utilized for promotion of public awareness.