

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
STATE OCEANIC ADMINISTRATION (SOA)
PEOPLE'S REPUBLIC OF CHINA

THE STUDY
ON
IMPROVEMENT OF MARINE
ENVIRONMENTAL MONITORING SYSTEM
FOR
THE PEARL RIVER ESTUARY
IN
THE PEOPLE'S REPUBLIC OF CHINA

FINAL REPORT
MAIN REPORT

September 2001

METOCEAN ENVIRONMENT INC.
UNICO INTERNATIONAL CORPORATION

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PREFACE

In response to a request from the Government of the People's Republic of China, the Government of Japan decided to conduct a study on Improvement of Marine Environmental Monitoring System for the Pearl River Estuary and entrusted the study to the Japan International Cooperation Agency (JICA).

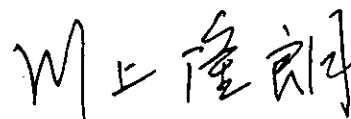
JICA selected and dispatched a study team headed by Mr. Noboru Sakuma of Metocean Environment Inc. (and consist of Metocean Environment Inc. and Unico International Corporation) to China, four times between March, 2000 and August, 2001. In addition, JICA set up an advisory committee headed by Mr. Masami Mizuguchi, Senior Advisor, Institute for International Cooperation, JICA between April, 2000 and August, 2001, which examined the study from technical point of view.

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

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

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

September, 2001



Takao Kawakami

President

Japan International Cooperation Agency

September 2001

Mr. Takao Kawakami
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Sir,

LETTER OF TRANSMITTAL

We are pleased to submit to you the Final Report entitled "The Study on Improvement of Marine Environmental Monitoring System for the Pearl River Estuary in the People's Republic of China." This report presents the results of all works conducted in both China and Japan during the period of April 2000 through August 2001.

The study: 1) consolidated baselines for the current state of the pollution load and marine water quality in the Pearl River Estuary, 2) developed a water quality simulation model for the estuary, 3) presented a blueprint for a comprehensive water quality monitoring program, and 4) implemented a technology transfer to the Chinese counterpart during the course of the joint study.

The study results, we believe, will contribute to the improvement of marine environmental monitoring system for the Pearl River Estuary that is indispensable for the sustainable development of the estuary.

We wish to express grateful acknowledgements to your Agency, Advisory Committee, Ministry of Foreign Affairs, and Ministry of Environment of Japan, Embassy of Japan in China, and JICA China Office for courtesies and cooperation extended to our team. We also wish to express our sincere appreciation to our counterpart, State Oceanic Administration (SOA) of People's Republic of China for close cooperation and assistance extended to us during our study in China.

Very truly yours,



Noboru Sakuma
Team Leader



Figure 1. The Pearl River Delta

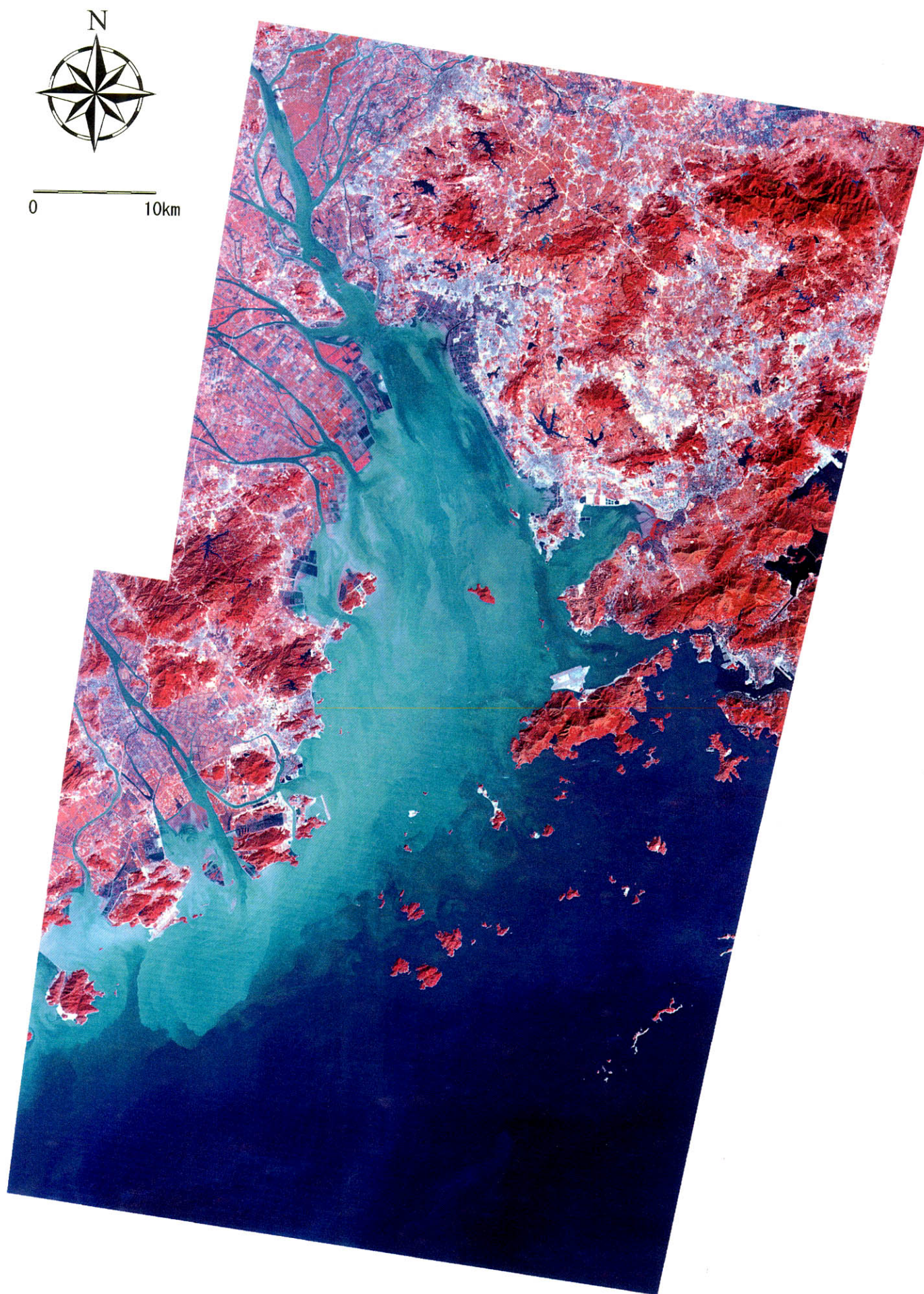


Figure 2. **Landsat TM Image (RGB:4,3,2)**
Date : 1999/12/25

Table of Contents

List of Abbreviations

List of Tables

List of Figures

Chapter I. Introduction.....	I-1
1. Background.....	I-1
1.1 Structure of this Report	I-1
2. Objectives of the Present Study	I-2
3. Study Area	I-2
4. Schedule.....	I-2
5. Organization.....	I-4
5.1 General Organization.....	I-4
5.2 Japanese Organization	I-4
5.3 Chinese Organization.....	I-5
6. Approaches to the Study.....	I-6
7. Technology Transfer	I-8
 Chapter II. Establishment of a Comprehensive Monitoring Plan.....	II-1
1. Overview of the Present Study Results	II-1
1.1 Description of the Environment	II-1
1.2 Water Pollution Mechanisms.....	II-4
1.3 Simulation Model Development	II-5
2. A Comprehensive Monitoring Plan	II-6
2.1 Objectives and Concepts of Monitoring.....	II-6
2.2 Monitoring Methodology	II-7
2.3 Data Analysis and Management	II-15
2.4 Facility Development Plan	II-18
2.5 Proposal for Organization, Regulations and Supporting System for Monitoring Operations	II-21
2.6. Cost Estimation.....	II-36

Chapter III. Description of the Environment	III-1
1. Environmental Profile.....	III-1
1.1 General Profile of the Pearl River Estuary	III-1
1.2 Topography and Geology.....	III-3
1.3 Meteorology.....	III-4
1.4 Oceanography	III-4
1.5 River Hydrology.....	III-9
1.6 Land Use	III-10
2. Satellite Imagery Analysis	III-11
2.1 Land Use	III-11
2.2 Water Quality Analysis	III-15
3. Socioeconomic Profile	III-28
3.1 Administrative Divisions	III-28
3.2 Population.....	III-31
3.3 GDP	III-34
3.4 Sewage and Industrial Discharge	III-38
3.5 Agricultural Activities.....	III-44
3.6 Industrial Activities	III-46
3.7 Transportation.....	III-46
3.8 Production Activities	III-47
3.9 Socioeconomic Development of Major Cities of the Pearl River Estuary	III-50
3.10 Current Development Plans	III-62
4. Existing Marine Environmental Monitoring System.....	III-66
4.1 Institutional Framework of Marine Environmental Monitoring.....	III-66
4.2 Laws and Regulations on Marine Environmental Monitoring.....	III-98
4.3 Technology on Marine Environmental Monitoring	III-106
 Chapter IV. Water Pollution Mechanisms	 IV-1
1. Physical Oceanography.....	IV-1
1.1 Overview of Existing Data and Information	IV-1
1.2 Tide.....	IV-1
1.3 Currents.....	IV-2
1.4 Temperature and Salinity.....	IV-3
1.5 Turbidity	IV-4
1.6 Light Quantum.....	IV-4

2. Water Quality	IV-16
2.1 Overview of Existing Information	IV-16
2.2 The Water Quality Monitoring Program	IV-19
2.3 Result of Principal Component Analysis for the Water Quality.....	IV-44
2.4 Similarity between Survey Points in Water Quality Characteristics	IV-55
3. Bottom Sediment Quality	IV-58
3.1 Overview of Existing Information	IV-58
3.2 Bottom Sediment Quality by the Monitoring Program	IV-58
4. Aquatic Biota	IV-62
4.1 Overview of Existing Information	IV-62
4.2 The Aquatic Biota Monitoring Program	IV-63
5. Rates of Settlement, Decomposition, Primary Production, and Elution	IV-73
5.1 Settlement Rate.....	IV-73
5.2 Decomposition Rate.....	IV-73
5.3 Primary Production (AGP: Algae Growth Potential Test)	IV-74
5.4 Elution Rate.....	IV-75
6. Water Pollution Mechanisms	IV-76
 Chapter V. Simulation Model Development	V-1
1. Pollutant Load.....	V-1
1.1 Concept of Pollutant Load Analysis	V-1
1.2 Pollutant Loads from Four Outlets of the Pearl River	V-5
1.3 Estimation of Pollutant Load from the Coastal Area	V-12
1.4 Atmospheric Deposition	V-22
1.5 Pollutant Load to the Pearl River Estuary.....	V-22
2. Development of a Hydrodynamics-Water Quality Simulation Model	V-25
2.1 Objectives.....	V-25
2.2 Practicality of the Simulation Model	V-25
2.3 Basic Functions Required for the Simulation Model	V-26
2.4 Hydrodynamics Model	V-27
2.5 Biochemical Cycle Model	V-35
2.6 Summary and Subjects of Future Study.....	V-44

List of References

List of Tables

Chapter I

- Table 1. Major Activities of the Study
- Table 2. Members of the JICA Study Team
- Table 3. Members of the Advisory Committee
- Table 4. Chinese Organization
- Table 5. Members of the Steering Committee
- Table 6. Major Subjects of Technology Transfer

Chapter II

- Table 2.2.1 Proposal of Monitoring Points
- Table 2.2.2 Proposal of Monitoring Items
- Table 2.4.1 Equipment of the Central Data Control Station
- Table 2.5.1 Improvement Plan for a Marine Environmental Monitoring System (Draft) (1/3)
- Table 2.5.1 Improvement Plan for a Marine Environmental Monitoring System (Draft) (2/3)
- Table 2.5.1 Improvement Plan for a Marine Environmental Monitoring System (Draft) (3/3)
- Table 2.5.2 Master Plan for Human Resources Development (1/2)
- Table 2.5.2 Master Plan for Human Resources Development (2/2)
- Table 2.6.1 Cost Estimation of Facility Improvement of SCSB and its Subordinate Units

Chapter III

- Table 2.1.1 Land Use of the Direct Runoff Basin
- Table 3.2.1 Population by City (Year-end, 10,000 persons)
- Table 3.3.1 Macroeconomic Indicators of China
- Table 3.3.2 Macroeconomic Indicators of Guangdong
- Table 3.3.3 Economic and Social Status of the Cities of the Pearl River Estuary (1999)
- Table 3.4..1 Economic and Social Development of Guangdong (1/3)
- Table 3.4..1 Economic and Social Development of Guangdong (2/3)
- Table 3.4..1 Economic and Social Development of Guangdong (3/3)
- Table 3.8.1 Production Activities in Coastal Areas of the Pearl River Estuary (1/2)
- Table 3.8.1 Production Activities in Coastal Areas of the Pearl River Estuary (2/2)
- Table 3.9.1 Economic and Social Development of Guangzhou
- Table 3.9.2 Economic and Social Development of Shenzhen
- Table 3.9.3 Economic and Social Development of Zhuhai
- Table 3.9.4 Economic and Social Development of Dongguan
- Table 3.10.1 Socioeconomic Development in the '9th 5 Year Plan' and '10th 5 Year Plan'
- Table 4.1.1 Details of the Organizations Relating Marine Environmental Monitoring in Guangdong (1/6)
- Table 4.1.1 Details of the Organizations Relating Marine Environmental Monitoring in Guangdong (2/6)
- Table 4.1.1 Details of the Organizations Relating Marine Environmental Monitoring in Guangdong (3/6)
- Table 4.1.1 Details of the Organizations Relating Marine Environmental Monitoring in Guangdong (4/6)
- Table 4.1.1 Details of the Organizations Relating Marine Environmental

Monitoring in Guangdong (5/6)

Table 4.1.1 Details of the Organizations Relating Marine Environmental Monitoring in Guangdong (6/6)

Table 4.1.2 Existing Equipment of SCSEMC

Table 4.1.3 Present Investment Plan for New Equipment of SCSEMC

Table 4.1.4 Equipment to be Introduced in the Future in SCSEMC

Table 4.1.5 Existing Equipment of GMO

Table 4.1.6 Present Investment Plan for New Equipment of GMO

Table 4.1.7 Equipment to be Introduced in the Future in GMO

Table 4.1.8 Existing Equipment of SCSEEC

Table 4.1.9 Present Investment Plan for New Equipment of SCSEEC

Table 4.1.10 Equipment to be Introduced in the Future in SCSEEC

Table 4.1.11 Existing Equipment of SCSIC

Table 4.1.12 Present Investment Plan for New Equipment of SCSIC

Table 4.1.13 Equipment to be Introduced in the Future in SCSIC

Table 4.1.14 Equipment to be Introduced in the Future in SOAO

Table 4.1.15 Existing Equipment of ZCMS

Table 4.1.16 Present Investment Plan for New Equipment of ZCMS

Table 4.1.17 Equipment to be Introduced in the Future in ZCMS

Table 4.1.18 Existing Equipment of SCSIO

Table 4.2.1 The Law and Regulation of Marine Environmental Administration (1/6)

Table 4.2.1 The Law and Regulation of Marine Environmental Administration (2/6)

Table 4.2.1 The Law and Regulation of Marine Environmental Administration (3/6)

Table 4.2.1 The Law and Regulation of Marine Environmental Administration (4/6)

Table 4.2.1 The Law and Regulation of Marine Environmental Administration (5/6)

Table 4.2.1 The Law and Regulation of Marine Environmental Administration (6/6)

Chapter IV

Table 2.2.1 Environmental Standard for Seawater in People's Republic of China (GB 3097-1997)

Table 2.2.2 Corresponding Percentage of Water Quality to the Environmental Standard for Seawater in People's Republic of China

Table 2.2.3 Water Quality (Salinity)

Table 2.2.4 Water Quality (DO)

Table 2.2.5 Water Quality (COD)

Table 2.2.6 Water Quality (SS)

Table 2.2.7 Water Quality (I-N)

Table 2.2.8 Water Quality ($\text{PO}_4\text{-P}$)

Table 2.2.9 Water Quality (Oil Contents)

Table 2.2.10 Water Quality (Pb)

Table 2.2.11 Water Quality (Zn)

Table 2.3.1 Variables and Number of Data for Principal Component Analysis

Table 2.3.2 Correlation Matrix for the Results of Water Quality Surveys ($n = 291$)

Table 2.3.3 Eigenvalue, Proportion and Accumulated Proportion of 3 Principal Components

Table 2.3.4 High Correlation Items for Factor Loadings to Each Principal Component

Table 2.4.1 Similarity of Water Quality among Monitoring Points by Cluster Analysis

Table 3.1.1 The Heavy Metal Ion Enrichment Coefficients in the Sediment of Lingdingyang, the Pearl River Mouth

Table 3.2.1 Bottom Sediment Quality (Organic Matter and Oil Contents)

Table 3.2.2 Bottom Sediment Quality (Sulfide and Eh)

Table 3.2.3 Bottom Sediment Quality (Hg, Cu, and As)

Table 3.2.4 Bottom Sediment Quality (Zn, Pb, and Cd)

Table 4.2.1 Average Chlorophyll-a Concentration

Table 4.2.2 Average number of Coliform Bacteria (inds./1000cm³) in different seasons

Table 4.2.3 Principal Zooplankton Species

Table 4.2.5 Average numbers of cells excluding P10 (Unit: cell/L)

Table 4.2.6 Principal Species of Phytoplankton

Table 4.2.7. Average Number and Wet Weight of Benthos

Table 5.1.1 Settlement Rate

Table 5.2.1 Decomposition Rate

Table 5.3.1 Primary Production

Table 5.4.1 Elution Rate

Chapter V

Table 2.4.1 Current Components in Tidal Estuary Bay

List of Figures

Chapter I

Figure 1. The Pearl River Delta

Figure 2. Landsat TM Image of [Please state what it is of] (RGB 4.3.2) (Date: 1999/12/25)

Figure 3. Organizational Chart of the Study Implementation Bodies

Chapter II

Figure 2.2.1. Monitoring Points Operated by Chinese Organizations

Figure 2.2.2. Survey Stations in Two Seasons

Figure 2.4.1. Plan of the Central Data Control Station for Marine Environmental Monitoring

Figure 2.5.1. Environmental Protection System of Setonaikai in Japan

Figure 2.5.2. Network for Supporting Government Decision Making of Environmental Protection Policy and Measure of Setonaikai in Japan

Chapter III

Figure 1.1.1 Study Area

Figure 1.4.1 Time Series of Estimated Tide Levels

Figure 1.4.2 A Diagrammatic Representation of Upwelling in The Pearl River Estuary

Figure 2.1.1 Landsat TM Image of [Please state what it is of] (RGB:4.3.2) (Date 1999/12/25)

Figure 2.1.2 The Land Cover Image (Date 1999/12/25)

Figure 2.1.3 Image of ISODATA method

Figure 2.2.1 Correlation between Estimated values and *In situ* Values for Chlorophyll-a, Suspended Solids and Surface Water

Figure 2.2.2 Sea Surface Water Temperature Image (Date 2000/08/13)

Figure 2.2.3 Sea Surface Water Temperature Image (Date 2000/11/01)

Figure 2.2.4 SS Image (Date 2000/08/13)

Figure 2.2.5 SS Image (Date 2000/11/01)

Figure 2.2.6 Chlloophyll-a Image (Date 2000/08/13)

Figure 2.2.7 Chlloophyll-a Image (Date 2000/11/01)

Figure 2.2.8 Water Temperature in Surface Layer

Figure 2.2.9 Suspended Solid (SS) in Surface Layer

Figure 2.2.10 Chlloophyll-a in Surface Layer

Figure 3.1.1 Administrative Divisions of Guangdong

Figure 3.2.1 Socioeconomic Development of Guangdong (1985-1999)

Figure 3.4.1 Industrial Development of Guangdong (1985-1999)

Figure 3.4.2 Sewage Treatment Plant in Guangzhou

Figure 3.5.1 Agricultural Development of Guangdong (1985-1999)

Figure 3.9.1 Economic Development of Guangzhou (1985-1999)

Figure 3.9.2 Economic Development of Shenzhen (1985-1999)

Figure 3.9.3 Economic Development of Zhuhai (1985-1999)

Figure 3.9.4 Economic Development of Dongguan (1985-1999)

Figure 4.1.1 Institutional Framework of State Oceanic Administration

Figure 4.1.2 Institutional Framework of South China Sea Branch of SOA

Chapter IV

Figure 1.3.1 Residential Currents during Spring Tide

Figure 1.3.2 Residential Currents during Neap Tide

Figure 1.4.1 Vertical Distribution of Temperature at Central Traverse Line
 Figure 1.4.1 Vertical Distribution of Temperature at the Central Traverse Line
 Figure 1.4.2 Vertical Distribution of Salinity at the Central Traverse Line
 Figure 1.4.3 Time Series of Salinity, Temperature, Current Vector and Water Level (P11 Jul.31- Aug.1, 2000)
 Figure 1.4.4 Time Series of Salinity, Temperature, Current Vector and Water Level (P20 Aug.1 to 2, 2000)
 Figure 1.5.1 Vertical Distribution of Turbidity at the Central Traverse Line
 Figure 1.5.2 Time Series of Turbidity, Light Quantum Attenuation Rate, Current Vector and Water Level (P11 Jul.31-Aug.1,2000)
 Figure 1.5.3 Time Series of Turbidity, Light Quantum Attenuation Rate, Current Vector and Water Level (P11 Dec.13-14,2000)
 Figure 1.6.1 Vertical Distribution of Light Quantum Attenuation Rate at the Central Traverse Line

Figure 2.2.1 Horizontal Distribution of COD (Layer Averaged) in Two Seasons
 Figure 2.2.2 Horizontal Distribution of NO₃-N (Layer Averaged) in Two Seasons
 Figure 2.2.3 Relationship between T-N and T-P
 Figure 2.2.4 Horizontal Distribution of PO₄-P (Layer Averaged) in Two Seasons
 Figure 2.3.1 Factor Loadings to Major 3 Components of PCA
 Figure 2.3.2 Water Quality Multiple Component Analysis (Component 1, Rainy Season)
 Figure 2.3.3 Water Quality Multiple Component Analysis (Component 1, Dry Season)
 Figure 2.3.4 Water Quality Multiple Component Analysis (Component 2, Rainy Season)
 Figure 2.3.5 Water Quality Multiple Component Analysis (Component 2, Dry Season)
 Figure 2.3.6 Water Quality Multiple Component Analysis (Component 3, Rainy Season)
 Figure 2.3.7 Water Quality Multiple Component Analysis (Component 3, Dry Season)
 Figure 2.4.1 Results of Cluster Analysis (Case: Dry Season, Spring Tide)

Figure 3.2.1 Horizontal Distribution of Sediment Quality in Rainy Season

Chapter V

Figure 2.3.1 A Conceptual Model of Three-Dimensional Biochemical Cycle Process
 Figure 2.4.1 Extended Computational Domain and its Bathymetry
 Figure 2.4.2 Comparison of Current Vectors between Observations and Simulation at the Center of the Pearl River Estuary (Spring Tide)
 Figure 2.4.3 Comparison of Current Vectors between Observations and Simulation at the Center of the Pearl River Estuary (Neap Tide)
 Figure 2.5.1 Result of the SS Simulation in Spring Tide
 Figure 2.5.2 Results of the SS Simulation in Neap Tide
 Figure 2.5.3 Results of the Biochemical Cycle Model (Spring Tide, Upper Layer)
 Figure 2.5.4 Results of the Biochemical Cycle Model (Spring Tide, Middle Layer)
 Figure 2.5.5 Results of the Biochemical Cycle Model (Spring Tide, Lower Layer)
 Figure 2.5.6 Results of the Biochemical Cycle Model (Neap Tide, Upper Layer)
 Figure 2.5.7 Results of the Biochemical Cycle Model (Neap Tide, Middle Layer)
 Figure 2.5.8 Results of the Biochemical Cycle Model (Neap Tide, Lower Layer)

List of Abbreviations

GOJ	the Government of Japan
JICA	the Japan International Cooperation Agency
GOC	the Government of People's Republic of China
SOA	State Oceanic Administration
SCSB	South China Sea Branch of SOA
SCSEMC	South China Sea Environmental Monitoring Center
GMO	Guangzhou Marine Observatory
SCSEEC	South China Sea Exploitation Engineering Center
SCSIO	South China Sea Institute of Oceanology, Chinese Academy of Science
CORC	Coastal Ocean Research Center, Zhongshan University
SCSFI	South China Sea Fisheries Research Institute, Chinese Academy of Fishery Science
PRWRC	Pearl River Water Resources Commission
PRWRPB	Pearl River Basin Water Resources Protection Bureau of PRWRC
GEPB	Guangdong Environment Protection Bureau
GEPMC	Guangdong Environment Protection Monitoring Center
GIG	Guangzhou Institute of Geography
GDRGC	Guangdong Remote Sensing and GIS Center
SCM	South China National Center of Metrology
GIM	Guangdong Institute of Metrology

Chapter I.

INTRODUCTION

Chapter I. Introduction

1. Background

The inner bay of the Pearl River Estuary covers approximately 4,000 km². Its drainage basin, the so-called 'Pearl River Delta Economic Development Zone', encompasses many highly industrialized and densely populated cities, including Guangzhou, Shenzhen, Zhuhai, and Dongguang.

Since the 1970s, accelerating population and industrial growths in the Pearl River Delta have brought large-scale exploitation without adequate environmental consideration, which have caused various environmental pollution problems. In particular, water quality in the estuary has degraded considerably as a result of the increased quantity of under-treated wastewater drainage from cities, industries and agricultural land.

As a result, marine pollution and eutrophication in the Pearl River Estuary are thought to have advanced to such an extent that frequent occurrences of 'red tides', the depression of fisheries and aquaculture industries, and a decrease in biodiversity have become evident.

The Government of China (hereafter referred to as GOC) recognized an urgent need to control the advancing marine pollution. As a first step, to improve the existing marine water quality monitoring system in the estuary to establish a scientific basis for the causal relationship between the pollution load and the water quality. Consequently, GOC extended a request to the Government of Japan (hereafter referred to as GOJ) for assistance in conducting a joint study to establish a comprehensive water quality monitoring program in the estuary.

GOJ responded to the request by offering technical assistance through the Japan International Cooperation Agency (hereafter referred to as JICA), the official agency responsible for undertaking technical cooperation programs, to conduct such a joint study, in close cooperation with a relevant counterpart organization of China.

1.1 Structure of this Report

This report presents the methods and results of an intensive monitoring study and water quality computer simulation of the Pearl River Estuary. It also presents a detailed monitoring proposal arising from the monitoring and simulation work of the present study as well as other related studies.

The report is structured in the following way. The present chapter introduces an overview of the objectives, organization, schedule and approach to the study, including the preparation of the proposal.

Chapter II summarizes the results of this study and then presents a comprehensive monitoring plan for promoting an environmentally sustainable

estuary that is compatible with the needs of the community. The study team opted to present the proposal before the detailed results of the study, as the target audience of this report is likely to be mostly concerned with future management issues.

Chapters III to IV detail the results of this study and summarizes data from previous studies. Chapter III describes various components of the Pearl River environment, including the geology, meteorology, oceanography and economic sociology, and how the interactions of these components result in very complex and vulnerable marine ecology.

Chapter IV details the physical, chemical and biological structure of the estuarine water, and reports the major types, sources and the mechanisms of pollutants in the estuary.

Chapter V presents a complex computer simulation of water quality in the estuary, based on results from this survey and other monitoring programs.

2. Objectives of the Present Study

The objectives of the present study were to:

- consolidate baselines for the current state of the pollution load and marine water quality in the Pearl River Estuary by (1) the collection and analyses of existing data; (2) a land-based field survey and (3) an offshore pilot water quality monitoring program;
- develop a water quality simulation model for the estuary, based on the results of the baseline study;
- present a blueprint for a comprehensive water quality monitoring program that can be realistically implemented by the GOC;
- implement a technology transfer to the Chinese counterpart during the course of the joint study.

3. Study Area

The study area is shown in Figures 1 and 2. The main area of this study was the inner bay area that is the northern part of the line connecting Macau to Lantau Island, Hong Kong.

4. Schedule

The study commenced in March 2000 and was completed in July 2001 (about 17 months in total). The study period was divided into two phases: the first phase was from March 2000 to December 2000 and the second phase was from January 2001 to July 2001. The major activities of this study are shown in Table 1.

Table 1. Major Activities of the Study

Phase	Activity
1st phase	<ul style="list-style-type: none"> • collection of existing data and information • field reconnaissance • satellite image analysis • evaluation of monitoring capability • identification of pollution sources and pollutant loads • first water quality monitoring: rainy season (summer) • second water quality monitoring: dry season (winter) • development and evaluation of a hydrodynamics simulation model • development of a water quality simulation model
2nd phase	<ul style="list-style-type: none"> • third, supplementary, water quality monitoring: transient season (spring) • evaluation of the water quality simulation model • formulation of a comprehensive monitoring plan • proposal for organization and regulation • cost estimation for development of monitoring • confirmation of the 'technology transfer' plan • 'technology transfer' seminar • submission of final report

5. Organization

5.1 General Organization

The study was carried out by the study team, dispatched by JICA, in close collaboration with the counterpart agency i.e., State Oceanic Administration (hereafter referred to as SOA). On commencement of the study, JICA organized an advisory committee composed of experts and Japanese Government officials to advise and supervise the progress of the study. The general organization for the study is shown in Figure 3.

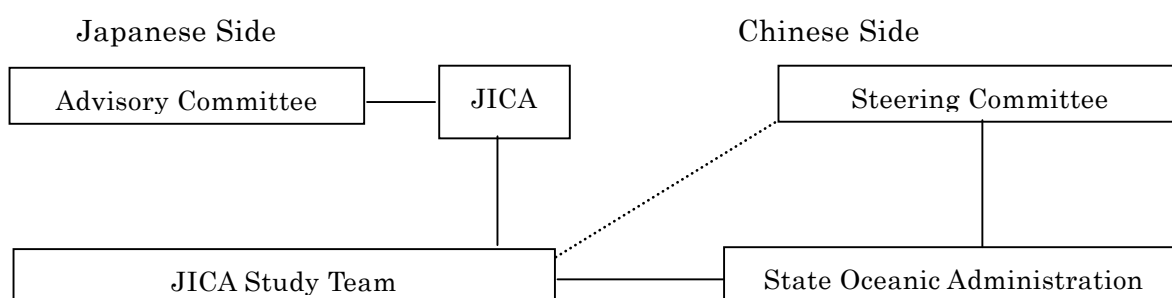


Figure 3. Organizational Chart of the Study Implementation Bodies

5.2 Japanese Organization

The study was carried out by the JICA study team. The team was composed of the following nine specialists.

Table 2. Members of The JICA Study Team

Team Leader	Mr. Noboru SAKUMA
Vice Team Leader / Marine Environment / Water Quality Monitoring	Mr. Mitsuaki ITO
Water Quality Analysis	Mr. Takeharu KAWAMURA
Ecosystem	Mr. Motoi GONDA
Pollution Mechanisms	Mr. Masao ITOI
Hydro-oceanography	Mr. Youichi HARADA
Pollution Analysis / Simulation	Dr. Akio WAKE
Satellite Imagery Analysis	Mr. Yuji HATAKEYAMA
Socioeconomics / Organization / Institution	Mr. Taiichi KONDO

An advisory committee for the study, organized by JICA, was composed of the following three members.

Table 3. Members of the Advisory Committee

Chairman of the Committee	Mr. Masami MIZUGUCHI
Committee member	Mr. Kazuhiro URAYA

5.3 Chinese Organization

The counterpart team was composed of the following ten specialists.

Table 4. Members of the Counterpart Team

Team Leader	Mr. WANG MINGWEN
Vice Team Leader / Marine Environment	Mr. Yu Bin
Marine Environment / Water Quality Monitoring	Mr. JIANG YUEJIN
Water Quality Analysis	Mr. ZHONG SISHENG
Ecosystem	Ms. DONG YANHONG
Pollution Analysis / Simulation / Pollution mechanisms	Mr. LIN SHAOYI Ms. JIA YANSHUANG
Hydro-oceanography	Mr. LIOU MENGLAN
Satellite Imagery Analysis	Mr. LIOU HANZHI
Socioeconomics / Organization / Institution	Ms. HE GUIFANG

The Chinese side also organized a steering committee composed of the following scientific experts, familiar with the transitional state of the Pearl River Estuary and the delta region.

Table 5. Members of The Steering Committee

Mr. WANG MINGWEN (Chairman)	Deputy Director South China Sea Branch (SCSB) of State Oceanic Administration (SOA)
Ms. LIN YANTANG	Professor South China Sea Institute of Fishery of China
Dr. HAN WUYING	Professor South China Sea Institute of Oceanography, Academia Sinica
Dr. WU CHAOYU	Professor Oceanography Center, University of Zhongshan
Mr. HUANG ZHIMIN	Senior Engineer Guangdong Province Environmental Protection Bureau
Mr. XIA ZHONGWAN	Professor South China Sea Branch (SCSB) of State Oceanic Administration (SOA)
Mr. ZHOU MAO deceased	Chief Engineer Guangdong Province Environmental Protection Monitoring Center

6. Approach to the Study

(1) Proposal of Implementation System

Prior to the present study, at least six organizations were known to be independently engaged in a monitoring and/or a survey of the aquatic environment of the study area. The present study team classified these organizations according to their responsibilities. An outcome of this was to formulate an alternative, more efficient, implementation scheme for ongoing monitoring program.

(2) Arrangements for Supporting Scheme

Necessary measures for supporting the monitoring system were identified in the areas of legislation, administration, finance, and technical competence, as well as elements required for sustainability.

(3) Utilization of a Monitoring System for Environmental Impact Assessment and Fishing Environment Management

The proposed monitoring system was designed to assess not only the current conditions but also to predict future conditions on the basis of projected changes in pollutant variety and loads.

The proposed monitoring system, including a water quality simulation model, was designed to be useful in performing Environmental Impact Assessment (EIA) and Fishery Environment Management (FEM), and provide possible financial resources to the counterpart agency.

(4) Monitoring Program as a Tool for Environmental Decision Making

The proposed monitoring program was designed to assist administrative decision makers as a tool for effective management, by providing bases for the environmental management and planning in the study area, including coastal and upstream development projects.

(5) Securing Reliability of Marine Water Quality Analyses

Samples were analyzed in multiple local laboratories. The results were cross-checked to ensure accuracy and reliability.

(6) Management and Utilization of Monitoring Database

The problems of the present database control were identified and an appropriate cost-effective improvement plan is proposed.

(7) Development and Utilization of Water Quality Simulation Model

To simulate the complex nature of the Pearl River Estuary, the model included:

- 1) a three-dimensional hydrodynamics model that can simulate stratification and density currents generated by the salinity and temperature gradients common in the bay;
- 2) a nutrient cycle model that can simulate pollution mechanisms, such as convection, dispersion, algal production, decomposition, settling and release of nutrients from the bottom sediments, incorporating the hydrodynamics obtained by 1); and
- 3) post-processing software to visualize the results of 1) and 2).

On-site experiments to determine the biochemical parameters required for 2) were designed specifically for the present study because the parameters are highly site-specific.

The model is targeted for the summer conditions, since the water quality is likely the worst in the summer.

(8) Utilization of Satellite Imagery Analysis

Satellite imageries were purchased and processed, and distributions of water surface temperature and concentrations of SS and chlorophyll-a were visualized and utilized as supplementary information for the pilot monitoring and simulation model development.

(9) Estimate of Project Cost

The current figures of personnel expenses, operation costs and facility investments were estimated and utilized as the basis of assessing the running costs of the proposed monitoring program.

(10) Technology Transfer

During the course of the collaborative study, technology transfer of water quality analysis, data quality control and assurance, data management and utilization of the simulation model were implemented. In addition, institutional and legislative methodologies for administration, operation and facility maintenance needed for effective marine environment management were disseminated.

Occasional meetings between the study-team members and the counterpart team members were convened in order to mutually assure the progress of technology transfer.

7. Technology Transfer

There were numerous transfers of technology that will influence the ongoing monitoring and management of the study site. The major subjects are shown in Table 6.

Table 6. Major Subjects of Technology Transfer

Subjects	Methods
Marine survey technology	OJT, seminars and DVD
Experimental analysis for water pollution mechanisms	OJT, manual for experiments, seminars and DVD
Visual presentation technology for results of marine survey and water quality analysis	OJT with text and seminar
Multivariate analysis method for the water environment, such as principal component analysis	OJT with text and seminar
Data and its precision management	OJT with text and seminar
Satellite imagery analysis	Seminar and DVD
Simulation model	OJT, user's manual, seminar and DVD
Utilization of monitoring and simulation model for the decision making	Seminar and presentation of draft final report of this study
Comprehensive monitoring plan	Seminar and presentation of draft final report of this study