

社会開発調査部報告書

社会開発調査部報告書

社会開発調査部報告書

社会開発調査部報告書

社会開発調査部報告書

社会開発調査部報告書

FINAL REPORT

VOLUME II

EXECUTIVE SUMMARY

社会開発調査部

JICA LIBRARY



J 1130948 [1]

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE SOCIALIST REPUBLIC OF VIET NAM
MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

THE MASTER PLAN STUDY
ON
DONG NAI RIVER AND SURROUNDING BASINS
WATER RESOURCES DEVELOPMENT

FINAL REPORT

VOLUME I

EXECUTIVE SUMMARY

AUGUST 1996

NIPPON KOEI CO., LTD., TOKYO JAPAN

This Report consists of

Volume I	Executive Summary	
Volume II	Main Report	
Volume III	Appendix I	Socio-economy and Institution
Volume IV	Appendix II	Topography and Geology
	Appendix III	Meteorology and Hydrology
Volume V	Appendix IV	Natural Environment
Volume VI	Appendix V	Hydropower Generation
Volume VII	Appendix VI	Agricultural Development and Irrigation
Volume VIII	Appendix VII	Domestic and Industrial Water Supply
Volume IX	Appendix VIII	Flood Mitigation and Urban Drainage
	Appendix IX	Salinity Intrusion
Volume X	Appendix X	Formulation of Master Plan
Volume XI	Data Book	



The cost estimate was based on the December 1995 price level and expressed in US\$ according to the exchange rate of US\$ 1.00 = Vietnamese Dong 11,014 = Japanese Yen 101.53 as of December 15, 1995.

PREFACE

In response to a request from the Government of the Socialist Republic of Viet Nam, the Government of Japan decided to conduct a master plan study on Dong Nai River and Surrounding Basins Water Resources Development and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Viet Nam a study team headed by Mr. Masashi Yamaguchi Nippon Koei Co., Ltd., (four times between September 1994 and May 1996).

The team held discussions with the officials concerned of the Government of Viet Nam, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Socialist Republic of Viet Nam for their close cooperation extended to the team.

August, 1996



Kimio Fujita

President

Japan International Cooperation Agency

August 1996

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

Dear Sir,

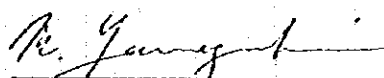
Letter of Transmittal

We are pleased to submit herewith the Final Report of the Master Plan Study on Dong Nai River and Surrounding Basins Water Resources Development. This Report deals with the formulation of master plan for water resources development in the Dong Nai River and its surrounding river basins. Studies were further extended to the master plan projects selected in this study taking into consideration not only economic viability but also contribution to the regional development and spatial distribution.

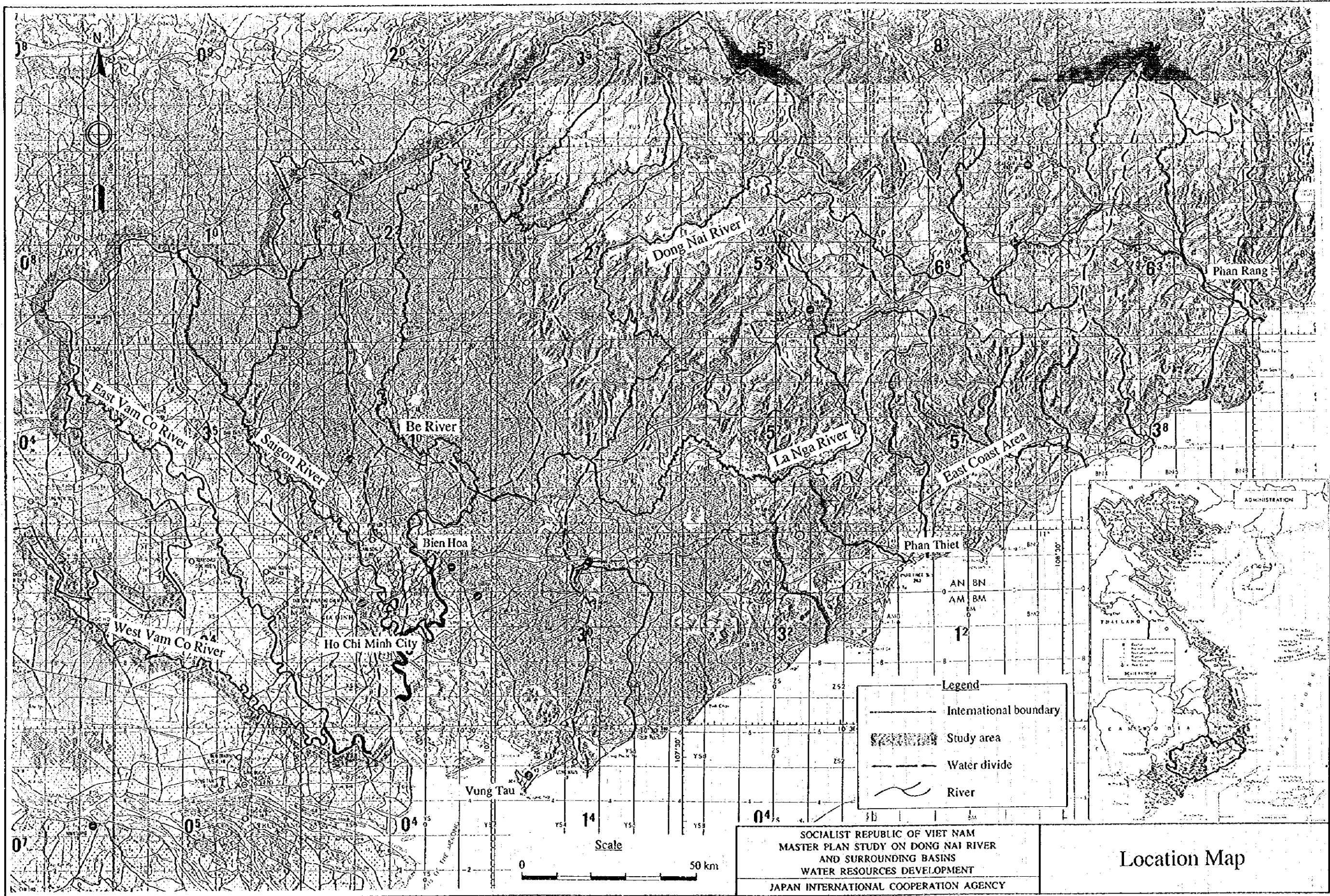
The Report consists of 11 volumes; Volume I for Executive Summary, Volume II for Main Report, Volumes III to X for Appendixes and Volume XI for Data Book. Main outputs of this study are presented in Executive Summary. The Main Report deals with the general study of the master plan including the preliminary discussions for the master plan projects selected in this study as well as the selection of priority projects to proceed to the further detailed study stage. Appendixes give in-depth discussions for respective study items. Data Book compiles the result of land use analysis by landsat image, hydrological records and the result of topographic survey.

We would like to express our grateful acknowledgment to the personnel of your Agency, Advisory Committee, Ministry of Foreign Affairs, Ministry of Construction, and Embassy of Japan in Viet Nam, and also to officials and individuals of the Government of Viet Nam for their assistance and advice extended to the Study Team. We sincerely hope that the results of this study would contribute to the regional development of the Study Area.

Your sincerely,

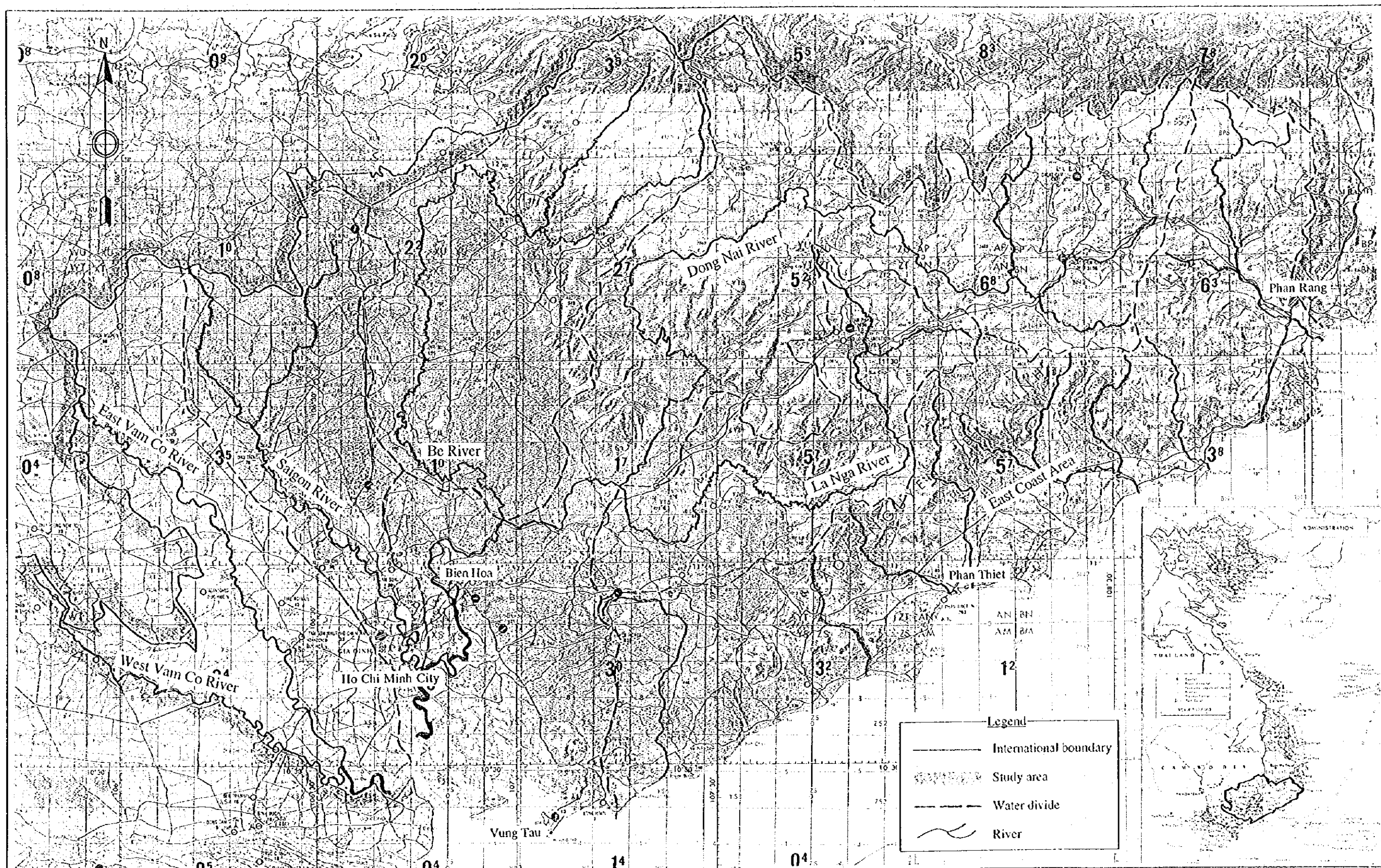


Masashi Yamaguchi
Team Leader
The Master Plan Study on
Dong Nai River and Surrounding Basins
Water Resources Development



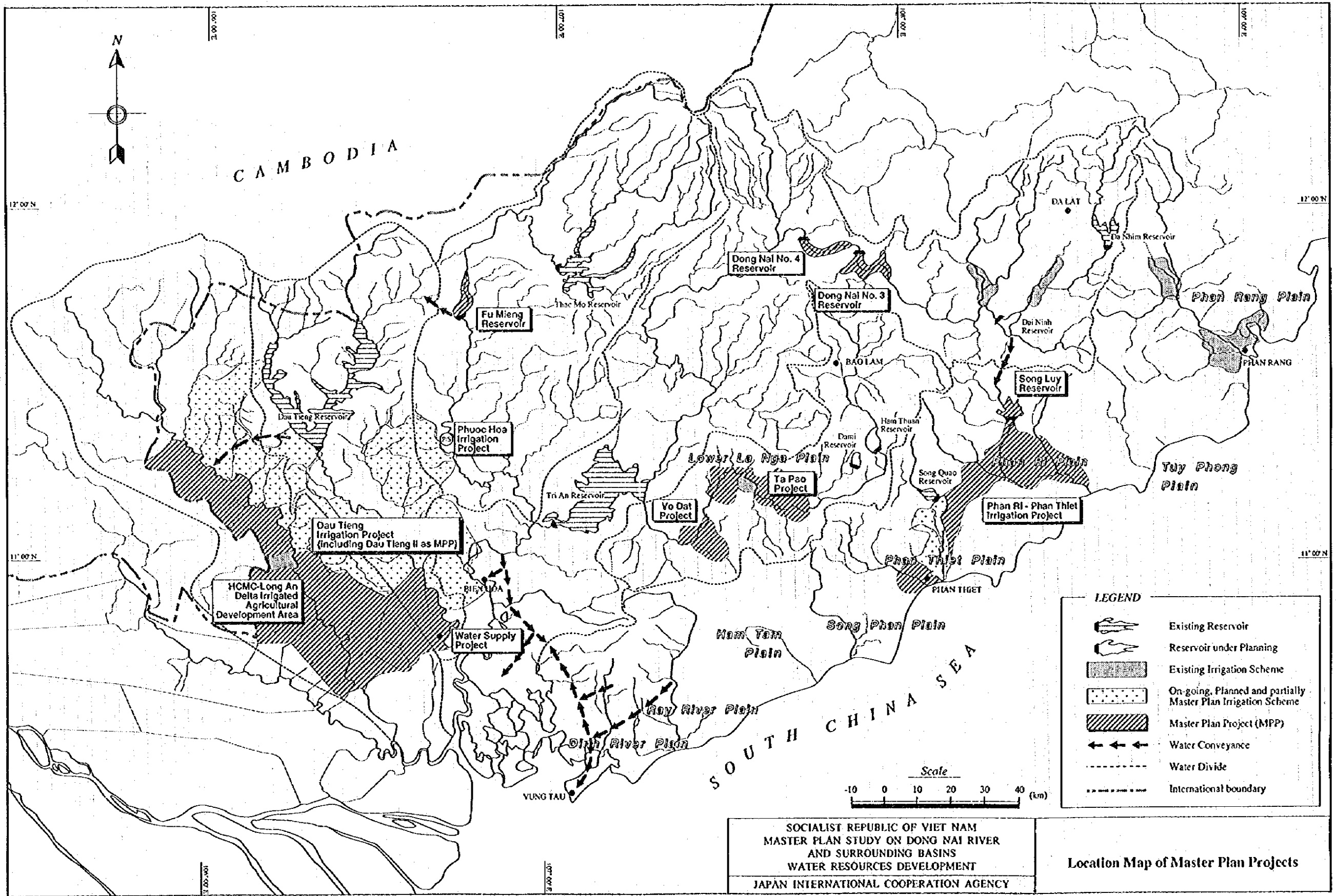
SOCIALIST REPUBLIC OF VIET NAM
 MASTER PLAN STUDY ON DONG NAI RIVER
 AND SURROUNDING BASINS
 WATER RESOURCES DEVELOPMENT
 JAPAN INTERNATIONAL COOPERATION AGENCY

Location Map



SOCIALIST REPUBLIC OF VIET NAM
 MASTER PLAN STUDY ON DONG NAI RIVER
 AND SURROUNDING BASINS
 WATER RESOURCES DEVELOPMENT
 JAPAN INTERNATIONAL COOPERATION AGENCY

Location Map



CAMBODIA

LEGEND

- Existing Reservoir
- Reservoir under Planning
- Existing Irrigation Scheme
- On-going, Planned and partially Master Plan Irrigation Scheme
- Master Plan Project (MPP)
- Water Conveyance
- Water Divide
- International boundary

**SOCIALIST REPUBLIC OF VIET NAM
MASTER PLAN STUDY ON DONG NAI RIVER
AND SURROUNDING BASINS
WATER RESOURCES DEVELOPMENT
JAPAN INTERNATIONAL COOPERATION AGENCY**

Location Map of Master Plan Projects

THE MASTER PLAN STUDY ON DONG NAI RIVER AND SURROUNDING BASINS WATER RESOURCES DEVELOPMENT OUTLINE OF STUDY

1. INTRODUCTION

This master plan study commenced its first field work in Viet Nam on September 22, 1994 with some preparatory work in Japan and was conducted over a time period of 23 months up to August 1996. The objective of this study is to formulate a water resources development master plan of the Dong Nai River and surrounding basins with development objectives of the effective use and optimal allocation of the water resources available in those river basins.

2. OVERVIEW OF VIET NAM

The Socialist Republic of Viet Nam extends along the east edge of the Indochinese peninsula, occupying a land area of 331,114 km². The population of Viet Nam was 71.5 million in the year 1994. Under the Doi Moi policy to pursue economic reform, Viet Nam recorded a high annual economic growth rate of more than 8.0 % in terms of Gross Domestic Product (GDP) since the year 1991. The main target of economic development to be reached is as follows:

- GDP per capita	:	Double that of 1990
- annual GDP growth rate	:	10 %
- annual industrial growth rate	:	13-14 %
- annual agricultural growth rate	:	4.5-5 %
- annual service growth rate	:	12-13 %

3. STUDY AREA

The Study Area covers an area of some 48,500 km² or shares 14.7 % of the total land area of the country, extending over one city and nine provinces of southern Viet Nam. The Study Area leads the national economic development with a production share of 14.3 % in agriculture, 53.6 % in industry and 32.1 % in services. Economic development in future is highly expected to continuously grow with a high rate of 7 to 10 % per annum in terms of GRDP.

4. NEEDS OF WATER RESOURCES DEVELOPMENT

In the Study Area, there are large demands for the supply of electricity and water for domestic and industrial uses as well as for the supply of food to sustain economic development. On the other hand, to avoid the economic disparity between the urban and rural areas, water resources are strongly urged to develop for enhancement of living standard as well as creation of job opportunities in the rural areas. Besides, watershed management as well as salinity intrusion is raised as the issues to be dealt with.

5. WATER RESOURCES DEVELOPMENT POTENTIAL

5.1 Principal Approaches

Taking into account the balanced development along with the high economic growth, macro targets for the Study Area are set for the years 1995, 2005, 2010 and 2015 as shown in the following Table:

Macro-Economic Targets of the Study Area

Year	1993	1995	2000	2005	2010	2015	
Population	Population (thousand)	11,406	12,026	13,726	15,484	17,290	19,089
	Annual Population Growth Rate (%)	(2.83%)	(2.68%)	(2.44%)	(2.23%)	(2.00%)	
	% Urban Population	40.3 %	42 %	44 %	46 %	48 %	50 %
GRDP	GRDP (Billion VND at 1989 price)	14,694	17,458	25,651	41,312	63,653	93,396
	Annual GRDP Growth Rate (%)	(9%)	(8%)	(10%)	(9%)	(8%)	
	% Changes by Sector						
	- Agriculture	10 %	10 %	8 %	7 %	6 %	5 %
	- Industry	50 %	50 %	45 %	43 %	42 %	40 %
- Service	40 %	40 %	47 %	50 %	52 %	55 %	
Per capita GRDP (VND)	1,274,194	1,435,876	1,848,444	2,638,894	3,636,324	4,839,277	

In view of the needs of water resources development and the uneven distribution of water resources potential, following three principal approaches are set in formulating the Master Plan of the water resources development in the Study Area:

- (1) Water development in the major potential area with creation of reservoirs-Dong Nai and Be River basins,
- (2) Agricultural development in the east coast area with water diverted from the Dong Nai River basin, and
- (3) Agricultural development in the HCMC-Long An delta area with water transfer from the Be River.

5.2 Hydropower Generation

A total of 17 hydropower potential projects including the committed Dai Nhin project are identified in the Study Area. Through first screening, second screening and generation expansion planning study, combined development of Dong Nai No. 3 and Dong Nai No. 4, and Fu Mieng multipurpose projects are finally selected as the candidate projects for the Mater Plan, following the development of Dai Nhin.

5.3 Irrigated Agricultural Development

All the large scale irrigation projects in the Study Area are broadly categorized into three groups, i.e. (1) six existing projects with an area of 30,300 ha, (2) five on-going and planned projects with an area of 159,270 ha and (3) 12 potential projects with an area of 243,180 ha. On the other hand, a total of 229 small scale irrigation projects are identified with a command area of 128,990 ha as the rural agricultural development project. Out of 12 potential projects, a total of eight projects are selected as the candidates of the Master Plan Projects along with the rural agricultural development projects.

5.4 Domestic and Industrial Water Supply

The demand of water supply for domestic and industrial use in the Southern Focal Economic Area (SFEA) will amount to about 3.8 million m³/day in the target year 2015 and, out of this, an amount of 1.7 million m³/day (10.9 m³/sec) will be needed for the industrial area along the National Highway No. 51, whilst 2.1 million m³/day for HCMC.

On the other hand, a total of 1,207 rural water supply projects are identified in the Study Area to enhance the living standard of 170 communes lying in the rural area. This rural

water supply project along with the water supply project along National Highway No. 51 and for HCMC is taken up as one of the candidate projects for the Master Plan.

6. WATER AND WATERSHED MANAGEMENT

6.1 Flood Mitigation and Urban Drainage

Large scale reservoirs which were constructed in the past decade in the main Dong Nai, Be and Saigon rivers have already enhanced the existing channel capacities of the lower Dong Nai and Saigon rivers to 15 to 20 year return period. The flood mitigation project as a social infrastructure was not, therefore, taken up as a component of the water resources master plan, but as an appurtenant work of regional development projects. On the other hand, the urban area of Ho Chi Minh City has been suffering from frequent inundation in rainy season and water pollution problems in dry season mainly due to the inadequate and deteriorated drainage facilities of the city. In order to cope with these problems an intensive study to prepare a master plan to improve drainage system in the urban area was proposed to be implemented separately from the present Study.

6.2 Salinity Intrusion

Characteristics of salinity intrusion in the deltaic lower Dong Nai River were studied by means of field observation and salinity intrusion simulation model. Results of the study revealed that the minimum flow required to maintain the salinity below allowable level for drinking and irrigation water source was 100 m³/sec at Hoa An of the Dong Nai River, 25 m³/sec at Thu Dau Mot of the Saigon River and 20 m³/sec at Xuan Khan of the East Vam Co River.

6.3 Protected Areas and Watershed Management

The middle and upper parts of the Dong Nai River and Be River catchment have residual forested areas including designated Protected Areas which are key components of the country's representative ecosystems and biodiversity. A comprehensive watershed management plan would require to reserve those protected areas.

7. FORMULATION OF THE MASTER PLAN

7.1 Optimal Water Allocation Study

A mathematical model is prepared to optimally allocate water resources available in the Dong Nai River among the candidate projects of the Master Plan and eventually to select the master plan projects. In this mathematical model, diversion amounts from the Dong Nai Main to the east coast area as well as from the Be River to the Saigon River are also assessed.

7.2 Selection of Master Plan Projects

Taking into consideration the result of the optimal allocation study, the development of the rural area and the necessity to strengthen the organization of water-related institutions, the master plan projects to be implemented within coming 20 years, i.e. by the year 2015, in the Study Area are proposed as follows:

- (1) Improvement and rehabilitation of 164 small scale irrigation projects as well as implementation of 65 new ones as rural agricultural development projects (RADP),
- (2) A total of 1,207 rural water supply projects
- (3) Two (2) hydropower projects with reservoirs (420 MW in total);
Dong Nai No. 3 : 180 MW
Dong Nai No. 4 : 240 MW

- (4) The Be-Saigon diversion project (a diversion amount of 60 m³/sec to the existing Dau Tieng in the Saigon River basin),
- (5) Eight (8) irrigation projects (242,560 ha in total) including Song Luy irrigation reservoir project (110 million m³ in active storage capacity);
Phuoc Hoa (45,680 ha), Ta Poa (19,000 ha), Vo Dat (12,620 ha),
Phan Ri (29,700 ha), Phan Thiet (10,000 ha),
Dau Tieng Extension (48,390 ha), HCMC (46,000 ha), Long An (31,170 ha)
- (6) Water supply project along National Highway No. 51 (1.7 million m³/day in demand) and
- (7) Strengthening of the organization on water-related institutions.

HCMC water supply project and Dai Ninh project, which are among the most important water resources development project, are not included in the list of master plan projects due to the fact that a master plan was completed for the former project, whilst the committed projects for the latter.

8. PRELIMINARY EVALUATION FOR THE SELECTED MASTER PLAN PROJECTS

The selected master plan projects are classified into three groups; one is the social development project to aim at narrowing down the economic disparity between urban and rural areas, another is the economic development project and the other is the institutional plan. Construction costs are estimated for the social development project, whilst cost estimate and economic evaluation for the economic development project and recommendations for the institutional plan as given below:

Master plan project	Construction cost, million US\$	
Social Development Project		
(1) Rural agricultural development	231	
(2) Rural water supply projects	72	
Economic Development Project		
(3) Dong Nai No. 3 and No. 4	888	(11.4)
(4) Be-Saigon diversion project (in case of Fu Mieng multipurpose project)	285	(11.3)
(5) Eight irrigation projects	803	(8.0 to 13.4)
(6) Water supply project along National Highway No. 51	464	(12.9)
Total	2,743	
Institutional Plan		
(7) Strengthening of the organization on water-related Institutions		

Note : EIRR (%) in parentheses

A comparison of Fu Mieng and Phuoc Hoa, which are two alternatives of the Be-Saigon diversion project, is made based on the newly available topographic information, showing the former more attractive. However, the final selection from among the two alternatives will rely on further detailed studies in future.

Initial environmental examination (IEE) is carried out for the master plan projects which would cause negative impacts to natural and social environment. As for Dong Nai No. 3 and No. 4, the environmental adverse effects would relate to further losses in riverine habitat of the Dong Nai River system, whilst the Fu Mieng, if taken up as a diversion measure of the Be-Saigon diversion project, would need to displace 500 to 550 families, settled in the past 10 to 15 years, from the reservoir area. As for irrigation projects, change of water quality and so on are considered as a major environmental issue.

9. IMPLEMENTATION PLAN OF THE SELECTED MASTER PLAN PROJECTS

9.1 Implementation Schedule and Fund Management

An implementation schedule of the selected master plan projects is prepared so that all the proposed projects can be developed within coming 20 years by the target year 2015 with a balanced disbursement of public funds required for the construction of those projects.

As a result, total investment requirements necessary for the implementation of those master plan projects are nearly VND 1,870 billion (US\$ 170 million) during Phase I (1996 to 2000), VND 12,010 billion (US\$ 1,090 million) during Phase II (2001 to 2005), VND 13,330 billion (US\$ 1,210 million) during Phase III (2006 to 2010) and VND 3,080 billion (US\$ 280 million) during Phase IV (2011 to 2015), corresponding to 24.9, 103.8, 77.1 and 12.5 % of the public funds available to the hydropower, irrigation and water supply sectors in the Study Area.

9.2 Management System for the Master Plan Projects

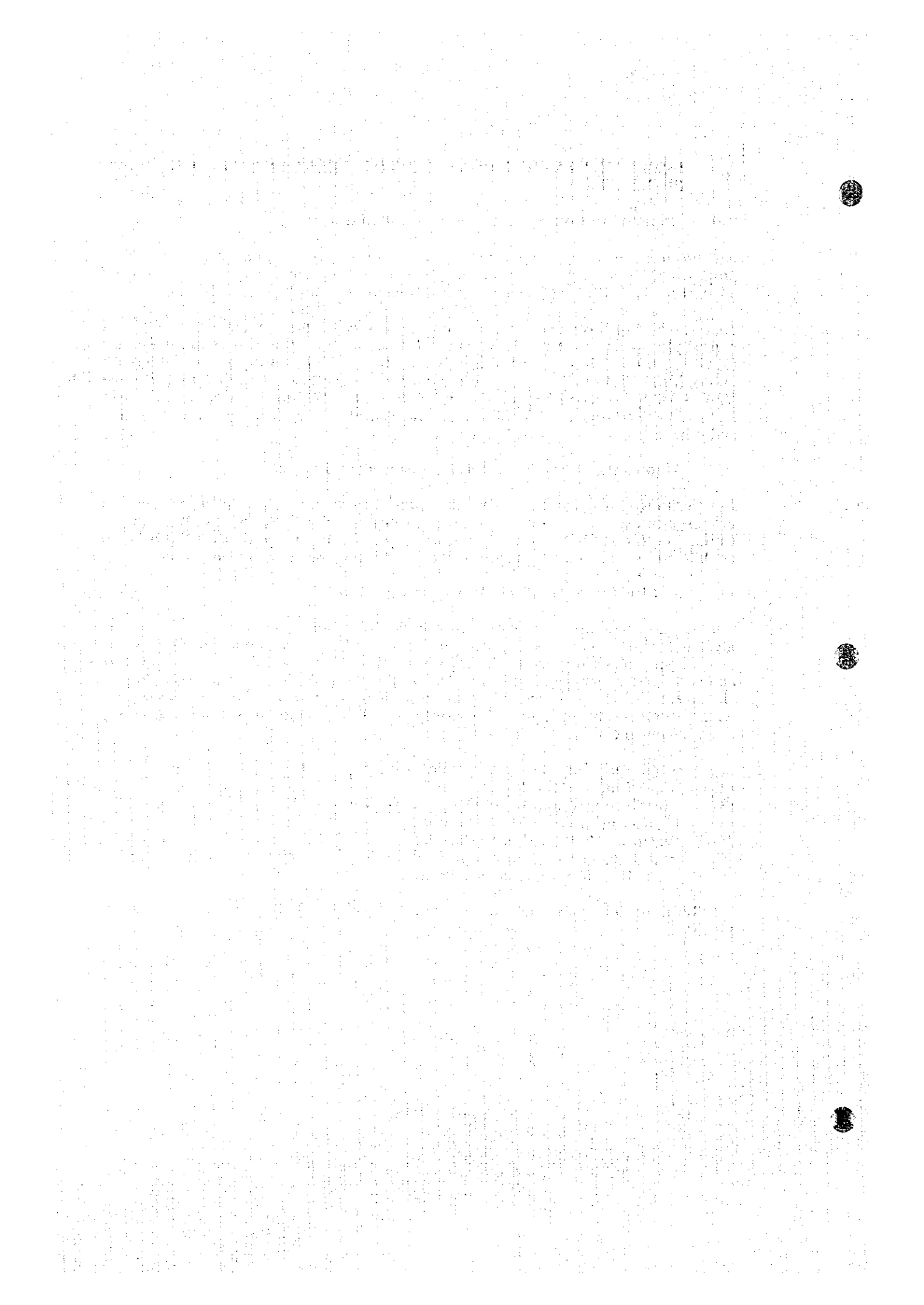
In order to well manage the implementation of the proposed master plan projects, it is proposed to establish a committee called "Dong Nai Water Resources Development Committee (DWRDC)", under which a "Project Management Office (PMO)" is to established for facilitating the implementation of the proposed master plan projects.

10. SELECTION OF PRIORITY PROJECTS

Taking into account the urgency of project implementation, the maturity of the study level, the effect and quickness of expected benefit, and contribution to the improvement of economic disparity among the regions as well as the fact that master plans are composed of five independent sectors with different development objectives, following six projects including institutional management are selected from each sector related to the water resources development as the priority projects subject to further study (feasibility study) among the master plan projects:

- (1) Rural Agricultural Development Projects,
- (2) Rural Water Supply Projects,
- (3) Combined Development of Dong Nai No. 3 and No. 4,
- (4) Phan Ri-Phan Thiet Irrigation Project,
- (5) Water Supply Project along National Highway No. 51, and
- (6) Action Plan on Institutional Strengthening for Implementation of the Dong Nai Water Resources Development Project.

The Terms of Reference (TOR) to carry out the feasibility study of the above projects is prepared.



**MASTER PLAN STUDY
ON
DONG NAI RIVER AND SURROUNDING BASINS
WATER RESOURCES DEVELOPMENT**

**FINAL REPORT
Volume I Executive Summary**

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION.....	1
2. OVERVIEW OF VIET NAM	1
3. STUDY AREA.....	2
3.1 Socio-economy	2
3.2 Natural Condition	3
4. NEED OF WATER RESOURCES DEVELOPMENT.....	4
4.1 General Background	4
4.2 Hydroelectric Power Development	5
4.3 Agricultural Development	5
4.4 Development of Domestic and Industrial Water Supply	6
4.5 Development of Rural Area	7
4.6 Deforestation, Flooding and Salinity Intrusion	7
5. WATER RESOURCES DEVELOPMENT POTENTIAL	8
5.1 Principal Approaches	8
5.2 Hydropower Generation	9
5.3 Irrigated Agricultural Development	10
5.4. Domestic and Industrial Water Supply	12
6. WATER AND WATERSHED MANAGEMENT	13
6.1 Flood Mitigation and Urban Drainage	13

6.2	Salinity Intrusion	14
6.3	Protected Areas and Watershed Management	15
7.	FORMULATION OF THE MASTER PLAN	15
7.1	Optimal Water Allocation Study	15
7.2	Development of Rural Area	16
7.3	Selection of Master Plan Projects	17
8.	PRELIMINARY BASIC DESIGN AND EVALUATION FOR THE SELECTED MASTER PLAN PROJECTS	18
8.1	Rural Agricultural Development Projects (RADP).....	18
8.2	Rural Water Supply Projects	18
8.3	Combined Development of Dong Nai No. 3 and Dong Nai No. 4	18
8.4	Fu Mieng Multipurpose Project	19
8.5	Irrigation Master Plan Projects	20
8.6	Water Supply Project along National Highway No. 51	22
8.7	Initial Environmental Examination	23
9.	IMPLEMENTATION PLAN OF THE SELECTED MASTER PLANS	24
9.1	Implementation Schedule	24
9.2	Fund Management	25
9.3	Management System for the Master Plan Projects	27
10.	SELECTION OF PRIORITY PROJECTS	27

LIST OF TABLES

Table 1	Summary of Rural Development Project
Table 2	Principal Feature of Hydropower Master Plan Projects
Table 3	Principal Feature of Irrigation Master Plan Projects
Table 4	Principal Feature of Water Supply Project

LIST OF FIGURES

Figure 1	Administrative Boundaries and Infrastructures in the Study Area
Figure 2	Isohyetal Map of the Study Area
Figure 3	Development Potential of Groundwater
Figure 4	Hydropower Potential Scheme Sites
Figure 5	Location Map of Major Existing, On-going, Planned and Potential Irrigation Schemes
Figure 6	Industrial Development Zones in the Study Area
Figure 7	Protected Areas in the Study Area
Figure 8	Schematic Diagram of Basic Model
Figure 9	Location Map of Existing and Proposed Small Irrigation Schemes
Figure 10	Location Map of Master Plan Projects
Figure 11	Implementation Sequence of Master Plan Projects
Figure 12	Proposed Structure for Implementing the Dong Nai Water Resources Development Projects



LIST OF ABBREVIATIONS

AFS	Agriculture and Forestry Service (PC)
CEMMA	Committee for Ethnic Minorities and Mountainous Areas
DCWSSS	Design Company for Water Supply and Sanitation System (HCMC-PC)
EA	Environment Assessment (Multi-lateral Lending Agencies)
ECSP	Evaluation Commission for State Projects
EIA	Environmental Impact Assessment
ENCO	Ho Chi Minh City Environmental Committee
EVN	<i>General Company of Electricity of Viet Nam (Abolished and renamed in November 1995 as Vietnamese Power Corporation)</i>
FIPI	Forest Inventory and Planning Institute (MOARD)
GCOP	Governmental Committee on Organization and Personnel
GDLA	General Department of Land Administration
GDMH	General Department of Meteorology & Hydrology
GOV	Government of Viet Nam
GSO	General Statistical Office
HCMC	Ho Chi Minh City
HEC	Ho Chi Minh Environment Committee (HCMC)
HIDC	Hydraulic Investigation and Design Company (MOARD)
HPC	Ho Chi Minh People's Committee (HCMC)
HSDC (or SDC)	Ho Chi Minh Sewerage and Drainage Company (HCMC)
HWSC (or WSC)	Ho Chi Minh Water Supply Company (HCMC)
IDD	Irrigation and Drainage Department (MOARD)
IEE	Initial Environmental Examination
IER	Institute for Economic Research (HCMC-PC)
IHPH	Institute of Hygiene and Public Health (MOPH)
IM	Institute of Mines (MOID)
INVESCO	Investment Company for the Development of Water Sector (HCMC-PC/TUPWS)
IOE	Institute of Energy (MOID)
IURP	Institute of Urban and Rural Planning (HCMC-PC/Construction Service)
IWRE	Institute of Water Resources Economics (MOARD)
IWRP	Institute of Water Resources Planning (MOARD)
IWRR	Institute of Water Resources Research (MOARD)
JICA	Japan International Cooperation Agency (Japan)

MOAFI	<i>Ministry of Agriculture and Food Industry (Abolished and integrated into the new MOARD)</i>
MOAP	Ministry of Aquatic Products
MOARD (New)	Ministry of Agriculture and Rural Development (Created in October 1995 by the merger of the former Ministry of Water Resources, Ministry of Agriculture and Food Industry and Ministry of Forestry)
MOC	Ministry of Construction
MOCI	Ministry of Culture and Information
MOD	Ministry of Defence
MOE	<i>Ministry of Energy (Abolished and integrated into the new MOID)</i>
MOET	Ministry of Education and Training
MOFI	Ministry of Finance
MOFO	<i>Ministry of Forestry (Abolished and integrated into the new MOARD)</i>
MOFA	Ministry of Foreign Affairs
MOHI	<i>Ministry of Heavy Industry (Abolished and integrated into the new MOID)</i>
MOID(New)	Ministry of Industry (Created in November 1995 by the merger of the former Ministries of Heavy Industry, Light Industry and Energy)
MOJ	Ministry of Justice
MOIT	Ministry of Interior
MOLI	<i>Ministry of Light Industry (Abolished and integrated into the new MOID)</i>
MOLWISA	Ministry of Labour, War Invalids and Social Affairs
MOPH	Ministry of Public Health
MOPI (New)	Ministry of Planning and Investment (Formed from a merger of the former SPC and SCCI)
MOSTE	Ministry of Science, Technology and Environment
MOTC	Ministry of Transport and Communications
MOT	Ministry of Trade
MOWR	<i>Ministry of Water Resources (Abolished and integrated into the new MOARD)</i>
MPAC	Ministrial Project Appraisal Committee
NEA	National Environment Agency
NGO	Non-Governmental Organization
NIAPP	National Institute for Agricultural Planning and Projection
NPAC	National Project Appraisal Committee
OECC	Overseas Environmental Cooperation Centre
OECP	Overseas Economic Cooperation Fund (Japan)
PC	People's Committee (executive arm of the People's Council)

PCC	Power Construction Company (VPC)
PIDC	Power Investigation and Design Company (VPC)
PPC	Provincial People's Committee (City People's Committee = CPC)
SBV	State Bank of Viet Nam
SCCI	<i>State Committee for Cooperation and Investment (Abolished and integrated into the new MOPI)</i>
SFEZ (or SFEA)	Southern Focal Economic Zone (or Southern Focal Economic Area)
SIWRP	Sub-Institute of Water Resources Planning (MOARD-IWRP)
SIWRR	Southern Institute of Water Resources Research (MOARD)
SPC	<i>State Planning Committee (Abolished and integrated into the new MOPI)</i>
SRV	Socialist Republic of Viet Nam
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Education Fund
UNIDO	United Nations Industrial Development Agency
VPC (New)	Vietnam Power Corporation (the former General Company of Electricity of Viet Nam = EVN)
WASECO	Water and Sewerage Construction Company (MOC)
WB	World Bank
WHO	World Health Organization
WPMI (IWRPM)	Water Planning and Management Institute (MOARD)
WRD(or WRS)	Water Resources Department or Water Resource Service (PC)
WSC	Water Supply Company (under Construction Services of the PC)

Note : Abbreviations in *Italics* are no more existent (already abolished and integrated in November 1995).

Measurements

Length

mm	=	millimeter
cm	=	centimeter
m	=	meter
km	=	kilometer
ft	=	foot
yd	=	yard

Area

cm ²	=	square centimeter
m ²	=	square meter
ha	=	hectare
km ²	=	square kilometer

Volume

cm ³	=	cubic centimeter
l	=	litre
kl	=	kilolitre
m ³	=	cubic meter

Weight

g	=	gram
kg	=	kilogram
ton	=	metric ton

Time

s	=	second
min	=	minute
h	=	hour
d	=	day
y	=	year

Electric Measurements

V	=	Volt
A	=	Ampere
Hz	=	Hertz (cycle)
W	=	Watt
kW	=	kilowatt
MW	=	Megawatt
GW	=	Gigawatt

Other Measures

%	=	percent
PS	=	horsepower
°	=	degree
10 ³	=	thousand
10 ⁶	=	million
10 ⁹	=	billion

Derived Measures

m ³ /s	=	cubic meter per second
kWh	=	Kilowatt hour
MWh	=	Megawatt hour
GWh	=	Gigawatt hour
kVA	=	kilovolt ampere

Currencies

US\$	=	US Dollar
VND	=	Vietnamese Dong

EXECUTIVE SUMMARY

1. INTRODUCTION

The Master Plan Study on the Dong Nai River and Surrounding Basins Water Resources Development commenced its first field work in Viet Nam on September 22, 1994 with some preparatory work in Japan and was carried out based on the Scope of Work agreed upon between the Ministry of Agriculture and Rural Development (former Ministry of Water Resources), the Vietnamese Government, and Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of technical cooperation programmes of Japanese Government, in March 1994. The Study conducted over a time period of 23 months was completed by submitting the Final Report in August 1996.

This Master Plan is formulated to achieve the effective use and optimal allocation of the water resources available in the Dong Nai River and surrounding basins for the relevant sectors up to the target year of 2015. It has incorporated all of the findings, survey results and study results gained through the field and home work during the Phase I (September 1994 to March 1995), Phase II (May 1995 to November 1995) and Phase III (December 1995 to August 1996) study periods.

2. OVERVIEW OF VIET NAM

The Socialist Republic of Viet Nam extends along the east edge of the Indochinese peninsula, occupying a land area of 331,114 km². The population of Viet Nam was 71.5 million in the year 1994.

Under the Doi Moi policy to pursue economic reform, Viet Nam recorded a high annual economic growth rate of more than 8.0 % in terms of Gross Domestic Product (GDP) since the year 1991.

There is a mid-term socio-economic development plan called "Socio-economic Stabilization and Development Strategy to the Year 2000" and "Five-year Economic Development Plan", which set out the basic framework for development of Viet Nam. The main target to be reached is the following:

- GDP per capita : Double that of 1990
- annual GDP growth rate : 10%
- annual industrial growth rate : 13-14%

- annual agricultural growth rate : 4.5-5 %
- annual service growth rate : 12-13%.

3. STUDY AREA

3.1 Socio-economy

The Study Area covers the Dong Nai and its surrounding river basins with an area of some 48,500 km² or sharing 14.7 % of the total land area of the country. It extends over one city and nine provinces of southern Viet Nam; Tay Ninh, Song Be, Dac Lac, Lam Dong, Ninh Thuan, Binh Thuan, Ba Ria-Vung Tau, Dong Nai, Ho Chi Minh City and Long An provinces (refer to Figure 1).

The population of the Study Area accounts for 11.7 million or 16.3 % of total population in the nation in the year 1994. In the year 1992, the gross production of the Study Area shares 40% of the gross national production. The sectoral share of production of the Area to the national total is 14.3% in agriculture, 53.6% in industry and 32.1% in services. For the value of exports in foreign trade, the Study Area accounts for 21.7% to the national total in the year 1992. Except for the figure in the agricultural sector, these are substantially larger than the territorial share of the Study Area of 14.7% .

Given the rich natural and human resources, the Study Area as a whole has recorded higher economic growth rates compared to the whole economy. Besides, in view of its large potential, the area is expected to continue to develop keeping more or less the presently enjoyed growth rates up to the target year of 2015. However, it is apprehended, on the other hand, that such rapid growth led by the Ho Chi Minh City area might generate more large economic disparities between the urban and rural area and might skew the balanced and sustainable development.

To maintain the high economic growth with the well balanced development, a macro target for the Study Area is set for the years 1995, 2000, 2005, 2010 and 2015 as shown in the following Table:

Macro-Economic Targets of the Study Area

Year	1993	1995	2000	2005	2010	2015	
Population	Population (thousand)	11,406	12,026	13,726	15,484	17,290	19,089
	Annual Population Growth Rate (%)	(2.83%)	(2.68%)	(2.44%)	(2.23%)	(2.00%)	
	% Urban Population	40.3 %	42 %	44 %	46 %	48 %	50 %
GRDP	GRDP (Billion VND at 1989 price)	14,694	17,458	25,651	41,312	63,653	93,396
	Annual GRDP Growth Rate (%)	(9%)	(8%)	(10%)	(9%)	(8%)	
	% Changes by Sector						
	- Agriculture	10 %	10 %	8 %	7 %	6 %	5 %
	- Industry	50 %	50 %	45 %	43 %	42 %	40 %
	- Service	40 %	40 %	47 %	50 %	52 %	55 %
	Per capita GRDP (VND)	1,274,194	1,435,876	1,848,444	2,638,894	3,636,324	4,839,277

Source : JICA Team's estimates

3.2 Natural Condition

The Study Area is divided into seven basins; river basins of the Dong Nai, La Nga, Be, Saigon, West Vam Co, East Vam Co, and the east coast area covering Binh Thuan, Ninh Thuan and Ba Ria-Vung Tau provinces as summarized below:

River	Definition of Catchment Area	Catchment Area (km ²)	Study Area (km ²)
Dong Nai	confluence at the Be River	14,979	14,979
	including the La Nga River basin	(4,093)	(4,093)
Dong Nai	from the confluence at the Be River to the estuary	4,093	4,093
Be	confluence at the Dong Nai	7,427	7,201
Saigon	confluence at the Dong Nai	4,717	4,316
West Vam Co	confluence at the East Vam Co excluding the west bank area	921	921
East Vam Co	including the estuary	8,546	5,005
East Coast	estuaries with north-eastern bound of Khanh Hoa/Ninh Thuan province	11,956	11,956
Total		52,639	48,471

It is noted that the remaining catchment area of 4,168 km² between the catchment area and the Study Area lies in the Cambodia border.

The Study Area is blessed with fairly rich rainfall. The mean annual rainfall is 1,945 mm with a range of 2,800 mm around the Dac Te River area to 1,400 mm at the estuary of the Dong Nai River, whilst it sharply declines to 800 mm around the Phan Ri- Mui Dinh area in the east coast plain (refer to Figure 2).

According to the data collected from 15 discharge gauging stations, the mean annual runoff falls in a range of 4.64 cms to 1.23 cms in terms of specific discharge per 100 km². The higher average values are observed to be 3.35 cms in the Dong Nai River basin, 4.18 cms in the Be River basin and 4.22 cms in the La Nga River basin, while the lower to be 2.24 cms in the Saigon River basin and 2.07 cms in the east coast area. This fact suggests that the major potential of water resources lie in the area of the Dong Nai, La Nga and Be River basins. Runoff coefficients at the above 15 stations are estimated to fall in a range of 0.4 to 0.6.

In terms of hydrogeology, the Study Area can be divided into five areas; lower plain area, central plateau area, granite-diorite area, coastal area and mountainous area. The development potential of groundwater is prepared, and the results indicate that lower plain and central plateau areas, where basalt extends, are promising for development of groundwater. As of the year 1993, groundwater of an amount of some 640,000 m³/day is lifted in the Study Area, which is assumed to be only 2.2 % of the estimated total possible yield of about 30 million m³/day (refer to Figure 3).

4. NEEDS OF WATER RESOURCES DEVELOPMENT

4.1 General Background

Water resources development is the public investment indispensable to secure sustainable economic growth in the developing countries. In particular, the Study Area is one of the areas leading the economic growth in Viet Nam and it includes, as its main part, the Southern Focal Economic Area (SFEA) which covers the whole of Ho Chi Minh City, Dong Nai province and Ba Ria-Vung Tau province and a part of Song Be and Binh Thuan provinces with a land area of 12,400 km² and a population of 7.8 million. The SFEA is expected to be the locomotive of economic development in the nation along with the Hanoi-Hai Phong area and the Da Nang area.

In the Area, there are large potential demands for the supply of electricity and water for domestic and industrial uses as well as for the supply of food. According to the study made by

the government agencies, the expected GDP growth rate in the area is 12 to 13% per annum up to the year 2010.

On the other hand, it is recognized that to avoid the economic disparity between the urban and rural areas, the water resources development for enhancement of living standard in the rural areas should be considered in addition to the large-scale integrated development.

4.2 Hydroelectric Power Development

In the Southern Region where the Study Area occupies its main part, after the completion of the Thac Mo Hydropower Project in the year 1994, total available generation capacity of electricity is 1,271 MW in which the hydropower plant is 713 MW, approximately 56% of the total capacity, against the peak load of approximately 1,000 MW with the annual energy generation of 5,500 GWh. The region has been suffering from the shortage of electricity especially in the dry season primarily due to reduction of energy generation by the existing hydropower plants. In June 1994, the 500 kV transmission line began its first operation sending surplus energy of the Northern Region to the Southern Region with the maximum capacity of 500 MW to reduce the power shortage in the Study Area.

Based on the historical trends and the estimated GDP growth rate, the power and energy demands in the year 2015 are estimated to be 7,900 MW and 42,000 GWh in the low case scenario, and 12,800 MW and 67,000 GWh in the high case scenario, which will be almost ten times larger than the present demands.

To secure the economic high growth which will be supported by the industry and service sectors in future, the development of hydropower generation, as far as economically viable, is virtually needed to meet the future demands by taking share of the system supply capacity, although the major share will be taken by the thermal power in the year 2015. It is to be noted that the hydropower development is given preference recently not only from economic viability, but also from advantage for environmental protection and natural resources conservation.

4.3 Agricultural Development

The food production in Viet Nam reached about 26 million tons or 350 kg/capita in the year 1994 with an export of paddy of about 2 million tons. The national policy in the Five-year Economic Development Plan emphasizes in particular two issues, i.e. continuing to increase

food production for ensuring national food security and diversifying the farming structure for promoting market-oriented economy, setting out the target of national food production as 30 million tons or 366 kg/capita in the year 2000.

With such a national policy and increasing population, Viet Nam has to increase the paddy production by about ten million tons for the next two decades from the present 23 million tons to the estimated 33.5 million tons with maintaining about 10 % export in the year 2015. This requirement calls for more investment on developing new irrigation and drainage systems in the potential agricultural lands as well as improving the existing 5.39 million ha of cultivated area for annual crops, of which 2.1 million ha is facilitated with irrigation systems.

In the Study Area, the prime crop is paddy and the present production of 1.8 million tons satisfies around 60 % of its regional demand with the population of 11.4 million in the year 1993. Self-sufficiency of paddy in the Study Area should drop further to 30 % for the estimated 19.3 million in the year 2015 if the present production level is maintained.

The east coast area, covering Ninh Thuan and Binh Thuan provinces, is fairly dry with less rainfall and therefore cannot develop its large land potential for a wide range agriculture due to shortage of local water resources available in the small basins. A possible water diversion from the Dong Nai River basin to the east coast area is expected to significantly improve such situation. In HCMC-Long An delta area, the water resources presently available would not permit the expansion of dry season paddies, and the further development in the remaining potential lands, which is suffering from water shortage, acid soils and salinity intrusion, will not be possible unless additional fresh water is conveyed from the other basins to this area.

In view of above situation in the Study Area, the development of water resources for the possible irrigation schemes, as far as it is economically justifiable, should be pursued to the maximum extent.

4.4 Development of Domestic and Industrial Water Supply

In the Study Area as a whole, the demand of domestic and industrial water supply in the year 2015 is estimated to be 4.3 million m³/day, of which the demand in HCMC will be 2.1 million m³/day. The demand in the SFEA will reach 3.79 million m³/day, and, to meet this demand, the required capacity to be developed will be 4.12 million m³/day including the existing and planned projects. Out of the required development, an amount of 3.18 million m³/day (36.8 m³/sec) will be sought mainly to the Dong Nai River, whilst 0.94 million m³/day (10.9 m³/sec) will be sought to the Saigon River.

In the industrial area along the National Highway No. 51 including the planned industrial estates and nearby towns, the water demand in the year 2015 is estimated to be 1.7 million m³/day (19.7 m³/sec).

4.5 Development of Rural Area

Excessive migration of people to urban areas is mainly due to lower income level and living standard of rural area and results in deteriorating urban amenity by increasing squatters. Taking into account the poor living condition in the rural area, matters to be carried out for the socio-economic development in the Study Area most urgently are to improve social amenity and to create job opportunities in the rural area.

In terms of water resources development, enhancement of social amenity can be made by improving water supply systems in the rural area in the respective regions. On the other hand, creation of job opportunities will be made by improving and rehabilitating small irrigation projects scattered through the Study Area.

It is true that it takes much time to complete the rural development programmes due to their numerous number. However, implementation of one rural water supply project or small scale irrigation scheme generates quick effect to the beneficial area. Thus, it is considered urgent to make an implementation programme of rural water supply and small irrigation projects to carry out step by step.

4.6 Deforestation, Flooding and Salinity Intrusion

Deforestation

Deforestation in Viet Nam between the year 1943 and 1991 resulted in a reduction of forested area from 67 % to 29 %. A similar loss from 69 % to 29 % is indicated to have occurred in the Study Area. More significantly from the biodiversity viewpoint are the losses in most (evergreen) forests with the remaining area indicated to be 20 % or less. Similarly losses in lowland riverine habitats in the Study Area have been serious and detrimental to the regional ecology and wildlife.

Deforestation is also directly linked to erosion problem and indirectly to sedimentation transport in the local rivers which are of direct concern to the reservoir projects. Controls of deforestation and remedial measures for reducing erosion and sedimentation will need to be planned and implemented when water resources development projects are taken up.

Flood and Urban Drainage

The type of flooding can be classified into three groups, i.e. flooding due to flush runoff at east coast areas, flooding due to passage of flood flow through topographically insufficient sections at Cat Tieng, Tanh Linh and Tan Uyen areas, and stagnancy of flood water due to high water level of trunk channel and sea tide at lower Dong Nai areas.

Since the coastal rivers are short in length and have steep slope, the peak time is rather short but once it occurs, the flood usually causes damages in the lower plains such as Phan Rang plain, Luy River plain and Phan Thiet plain.

The lower Dong Nai areas experienced large flooding in the year 1932, 1952, 1964 and 1978 with serious damage, however since the completion of Tri An reservoir in the year 1988, such damage has been significantly reduced. In this respect, the major problem at the cities located in a low-lying land with many canals, especially Ho Chi Minh City, is not the flood damage but the poor conditions and limited capacity of the existing drainage and sewerage system.

Salinity Intrusion

The Dong Nai River multi-furcates into several branch channels in the deltaic estuary, forming a complicated channel network. Major inlets of sea water into the Study Area are the Dong Nai main, the Long Tau River and the Dong Tranh River. Sea water further intrudes into the tributaries of the Dong Nai River such as the Vam Co and Saigon rivers. Due to the gentle slope of these rivers with the strong influence of the seas water level, the salinity intrusion problems have brought about adverse effects to the agricultural productivity and people's daily life in the areas.

This issue needs to be considered as the environmental constraints when the water resources development projects are taken up.

5. WATER RESOURCES DEVELOPMENT POTENTIAL

5.1 Principal Approaches

The Study Area is blessed with fairly rich rainfall of about 2,000 mm on an annual average. However, as described in Section 3, the rainfall is not evenly distributed over the area, and the major potential of the water resources lies in the mainstream basins-the Dong Nai River and Be River basins, while less in the Saigon and Vam Co River basins and least in the east coast area.

In view of the before-mentioned needs in each sector and the uneven distribution of water resources potential, following principal approaches are set in formulating the Master Plan of the water resources development in the Study Area :

- (1) Water development in the major potential area with creation of reservoirs-Dong Nai and Be River basins,
- (2) Agricultural development in the east coast area with water diverted from the Dong Nai River basin,
- (3) Agricultural development in the HCMC-Long An delta area with water transfer from the Be River.

Screening process to select candidate projects in each sector is described below, and the formulation of the Master Plan Projects based on the optimal water allocation study is discussed in Chapter 7.

5.2 Hydropower Generation

As for the hydropower development in the major potential area, potential projects identified in the Study Area are classified into two groups; one consists of projects located in the main streams of the Dong Nai and Be Rivers, which generally have large storage capacity with large catchment areas but have rather limited head; Dong Nai No. 1, No. 2, No. 3, No. 4, No. 5, No. 6 and No. 8 in the Dong Nai River; Can Don and Fu Mieng in the Be River and Bao Loc and La Nga No. 3 in La Nga River. The other group consists of projects located on the tributaries of the main streams with limited catchment areas but with high head for power generation (refer to Figure 4).

It is to be noted that the second group will be attractive as those to generate peak power for the limited demand time, however, their annual energy output is limited due to its small catchment area. In this respect these projects are proposed to be developed as pumped storage projects in future, however they are not subject to further study in this Master Plan.

The screening of the candidate projects in the first group was made in two steps. In the first screening, the projects of Dong Nai No. 1, Dong Nai No. 2, Dong Nai No. 5 and Bao Loc were considered to be economically less attractive because of its low economic indices in terms of Specific Generation Cost of more than US Cent 11/kWh or Specific Capacity Cost of more than US\$ 4,000/kW.

In the second screening, with the topographic maps then available and the hydrological data updated, further assessment of the remaining potential projects was carried out in view of the

economic and the environmental impact. The result indicates that Dong Nai No. 6, Dong Nai No. 8 and La Nga No. 3 projects were judged to be economically less attractive and that the former two projects are likely to involve controversial adverse environmental impacts on the Cat Tien National Park and the resettlement problem due to large inundation area.

The projects of Dong Nai No. 3, Dong Nai No. 4, Can Don and Fu Mieng are judged technically and economically viable. Dong Nai No. 3 project has a large storage reservoir of nearly one billion m³, creation of which make it possible to increase not only the installed capacity of Dong Nai No. 4 (almost double), but also its firm energy generation. It also contributes to increasing the firm energy generation of Tri An project. Simultaneous combined development of Dong Nai No. 3 and Dong Nai No. 4 projects will generate the highest annual net benefit of more than 5 times of the single development of Dong Nai No. 4 only. Thus, the combined development of Dong Nai No. 3 (180 MW) and Dong Nai No. 4 (240 MW) should be given first priority.

Fu Mieng project (55 MW) with a reservoir to be created in the Be River is the multipurpose project, not only contributing to electricity generation but also enabling to divert water to the HCMC-Long An delta through the existing Dau Tieng reservoir which can expand the irrigation schemes of approximately 88,000 ha therein.

The generation expansion planning study was carried out to deal with the optimal input timing of these promising projects to be added to the power supply system. The study indicated that Dong Nai No. 3 & No. 4 and Fu Mieng are required to be implemented in the year between 2005 to 2009, however, Can Don project is not required within the time horizon up to the year 2015 unless the cost of alternative thermal energy source is increased enough to allow its implementation.

Finally, the combined development of Dong Nai No. 3 and Dong Nai No. 4, and Fu Mieng multipurpose projects were selected as the candidate projects for the Master Plan.

5.3 Irrigated Agricultural Development

Figure 5 shows the existing, under-planning and potential irrigation schemes. Their brief descriptions are as follows:

Agricultural Development in the Major Potential Area

The Phuoc Hoa irrigation scheme, which is now under planning for implementation, intends to irrigate an area of 45,680 ha in the southern part of Song Be province by taking the water from the Be River. Construction of the Phuoc Hoa dam with a storage of about 67 million m³ and

the main secondary canals with a length of about 210 km is proposed by MOARD. However it is to be noted that there is a considerable gap in the estimated project cost between one done in the prefeasibility study made by the MOARD in the year 1995 and one by the Study Team. Hence the Study Team recommends to construct a small weir with pumping station as a more economical alternative.

The potential irrigation area in the Lower La Nga Plain is estimated at 38,000 ha in total, consisting of the Ta Pao scheme of 23,000 ha and the Vo Dat scheme of 15,000 ha, both of which are to be developed with the water from the Lower La Nga River. The Ta Pao irrigation scheme will involve the existing Vo Xu pump irrigation scheme with a designed area of 5,000 ha, also low-lying flood-prone areas along the Lower La Nga River.

In the major potential areas, the above three potential irrigation schemes are taken up as the candidate projects for the Master Plan.

Agricultural Development in the East Coast Area

The Dai Ninh reservoir to be created in the upper Dong Nai River will be the core component to divert water from the Dong Nai River to the east coast area. Water diversion will make it possible to generate an electric power of 300 MW and then to expand the irrigation schemes in the Phan Ri and Phan Thiet plains.

The selected candidate projects of the Master Plan is the scheme for irrigating a cultivated land of about 39,700 ha with the water diverted from the Dai Ninh reservoir in conjunction with the local water resources available in the east coast area. The scheme covers an area of 29,700 ha in the Phan Ri plain and an area of 10,000 ha in the eastern part of the Phan Thiet plain. The maximum possible area in the Phan Thiet plain irrigable with the water diverted from the Dai Ninh reservoir through the Phan Ri plain is limited to be 10,000 ha because of topographical reason. The scheme to divert the water from the La Nga River for irrigating an additional potential irrigation area in the Phan Thiet plain was initially considered, however, since economic viability of the scheme is found low, this diversion concept was canceled.

To regulate the local flow and re-regulate the outflow from Dai Ninh power plant, the Luy reservoir is proposed to be created in the Luy River. Since the reservoir is indispensable to implement the whole scheme in the Phan Ri and Phan Thiet plains, this project is also selected as one of the candidate projects of the Master Plan.

Agricultural Development in HCMC-Long An Delta

The possible measure to improve the present situation in the HCMC-Long An delta is to introduce fresh water by water transfer from the Be River through the existing Dau Tieng reservoir to this area.

Selected as one of the candidate project for the Master Plan is the scheme to supply the water to the potential irrigation area in HCMC-Long An delta based on the same concept. The beneficiary area is estimated at about 100,000 ha, which consists of 54,000 ha for Long An delta to be fed by the East Vam Co River and 46,000 ha for Hoc Mon area to be fed by the Saigon River.

Besides the HCMC-Long An delta, there is another beneficiary area in the Dau Tieng irrigation scheme with the water transfer from the Be River. Out of the Dau Tieng irrigation scheme of 93,390 ha, only the gravity area of 45,000 ha has been so far facilitated with the irrigation system. The remaining area of 48,390 ha will not be fully irrigated from the water from the Dau Tieng reservoir unless supplemental water is supplied by transfer from the Be River to the Dau Tieng reservoir. This scheme is also added to the candidate project for the Master Plan as the Dau Tieng Extension.

Rural Agricultural Development Project

The Rural Agricultural Development Project (RADP) aims at increasing the farmers' income, enhancing the living standard in the rural area, creating job opportunities and ultimately narrowing down the economic disparity between urban and rural areas by rehabilitating and improving the small existing irrigation schemes as well as constructing new small scale irrigation schemes, which are not covered by the large scale irrigation projects. A total of 229 small scale irrigation projects with a total command area of 128,987 ha are identified in the Study Area, consisting of 164 projects (67,745 ha) for the former and 65 projects (61,242 ha) for the latter. This rural agricultural development project is taken up as one of candidate projects for the Mater Plan.

5.4 Domestic and Industrial Water Supply

The demand of water supply for domestic and industrial use in the SFEA will amount to about 3.8 million m³/day in the target year 2015 and, out of this, an amount of 1.7 million m³/day (10.9 m³/sec) will be needed for the industrial area along the National Highway No. 51 (refer to Figure 6), and 2.1 million m³/day will be needed for HCMC.

Although the present river flow of the Dong Nai River is enough to meet the demand to this extent even in the dry season, the water supply project for the industrial area along the National Highway No. 51 and for HCMC are taken up as one of the candidate projects for the Master Plan.

On the other hand, a total of 1,207 rural water supply projects are identified in the Study Area to enhance the living standard of 170 communities lying in the rural area. This rural water supply project is also taken up as one of the candidate projects for the Master Plan.

6. WATER AND WATERSHED MANAGEMENT

6.1 Flood Mitigation and Urban Drainage

Cat Tien-Ta Lai area

Although it is expected that approximately 30 % of flood discharge will be retained by the proposed Dong Nai No. 3 and No. 4 reservoirs, intensive flood mitigation measures may adversely affect the natural environment of the area since Cat Tien-Ta Lai area has been designated as the national reserve park. In addition, it is noted that the existing flooding areas have contributed to reducing the flood peak flow with its natural flood retention.

In view of this, the first priority should be given to the clarification of the boundary between the area to be reserved for the national park and the areas for settlers and their farming. The mitigation measure is rather local and to be limited for protecting the properties of these people.

La Nga River Area

The main cause of flooding in this area is markedly limited channel capacity, i.e. 150 m³/sec in the lower and 350 m³/sec in the upper flood-prone areas.

Owing to the runoff retention effect of Ham Thuan reservoir which is now under construction stage, the flood damage is expected to be reduced significantly.

Flood mitigation measures will be limited to protect properties of the farmers and the agricultural lands, and the channel improvement and dike system will be the main components. Therefore the detailed mitigation plans should be established and incorporated as part of agricultural development schemes in the area.

HCMC Area

The existing drainage system has seriously been degraded mainly due to rapid urbanization and budgetary constraints, and the inundation has been hampering the economic activities as well as people's daily life in the area.

Water quality of the city including the economic triangle zone is also serious environmental problem in this area, where almost all the domestic sewage and industrial waste water is still being released to the canals and rivers without proper treatment. According to the appraisal

study conducted in the year 1990/91, Tan Hoa-Lo Gom canal, Nhieu Loc-Thi Nghe canal and upper half of Tham Luong canal were the most polluted areas.

Taking into account the situation mentioned above and the recent rapid urbanization, it is recommended to conduct a master plan study for improving the urban drainage system of HCMC at an early stage. The study should cover not only the improvement of drainage and sewerage system accompanied with the existing canal network which is affected by the sea water level, but also the pollution control measures to be adopted to maintain the sustainable development of this area.

Coastal Area

The area is subject to sharp flood peak with a short duration. Runoff retention by creating reservoir at the upstream would be the most effective measure for this type of flood. Channel improvement by diking system and river training will also augment the mitigation effect.

6.2 Salinity Intrusion

The salinity intrusion simulation model was prepared based on intensive river cross section survey as well as taking into account the complicated network of the existing canals with the effect of the sea water level.

The standard criteria on salinity concentration of the river water as a water source of domestic water and irrigation water are as follows:

- a) $CL < 4 \text{ g/l}$: For an irrigation water source according to the practice in the Study Area and the Mekong delta, and
- b) $CL < 0.25 \text{ g/l}$: For a municipal water source according to Provincial Environmental Criteria, 1993 ; Ministry for Science, Technology and Environment.

On the above basis, the simulation study was carried out for the various combination of river flows at the strategic points such as at the Hoa An intake in the Dong Nai River, at Thu Dau Mot in the Saigon River and at Xuan Khan in the Vam Co River, and the minimum flow requirements were eventually determined to be $100 \text{ m}^3/\text{sec}$ at Hoa An, $25 \text{ m}^3/\text{sec}$ at Thu Dau Mot and $20 \text{ m}^3/\text{sec}$ at Xuan Khan.

6.3 Protected Areas and Watershed Management

As of the year 1992, there are 87 Protected Areas or Special Use Forests covering about 3 % of the whole country or about 993,000 ha, and the preliminary list of the Protected Areas located within the Study Area is presented in Figure 7 together with the potential reservoir sites identified. From the Figure, it is seen that some of identified projects such as Dong Nai No. 5, No. 6 and No. 8 seem to have potential conflicts with the boundary of the national park.

The middle and upper parts of the Dong Nai River and Be River catchment have residual forested areas including designated Protected Areas which are key components of the country's representative ecosystems and biodiversity, and specific designated Protected Areas such as the Cat Tien National Park are considered internationally significant and could be critical habitat for preservation of some water-related endangered fauna in Viet Nam.

A comprehensive watershed management plan would require the cooperation of three or four Provincial Forestry Departments and ten to twelve District People's committees at present. In this respect, close coordination and communication among authorities concerned are the key factor to successfully implement the most appropriate watershed management plan.

7. FORMULATION OF THE MASTER PLAN

7.1 Optimal Water Allocation Study

A mathematical model to seek the solutions for the optimal allocation of water resources in the Study Area, one of the operations research method, Mixed Integer Programming Method, has been applied. Given the structured problem and the constraints as described in the preceding Chapters, the model is solved using the General Algebraic Model (GAMS) incorporating Optimization Subroutine Library (OSL) solver. The candidate projects for hydropower generation, irrigation and water supply, which constitute the model, have been already selected among the potential projects in the relevant sectors as described in the preceding Section 6. The schematic diagram of basin model is shown in Figure 8.

It is to be noted that the natural flow in the year 1974, which is defined as 4-year drought flow based on the hydrological analysis for the whole basin of the Dong Nai and Be Rivers (at Hoa An), is utilized in the model as the representative flow for the optimization study in conformity with the design standard (guaranteed level) for the irrigation development. The mathematical output, therefore, appropriately reflects the irrigable area and the required storage capacity under the 4-year drought condition, however the energy output of single purpose hydropower

projects tends to be underestimated, resulting in objection of the candidate projects. To supplement such disadvantage of the model, the generation expansion planning study is separately carried out for the hydropower projects under the normal hydrological condition (29-year simulation).

Through the above-mentioned analysis, the whole of the candidate schemes are proved feasible as the Master Plan Projects although it was found that available water resources do not allow the development to the full extent in the Ta Pao, Vo Dat and Long An Delta irrigation schemes.

The model also indicated that a further development of some 100 m³/s be possible beyond the target year 2015 at the downstream reaches of the Dong Nai River, provided that the minimum flow of 100 m³/s is kept at the Hoa An intake for salinity intrusion and that the minimum monthly firm discharge at Tri An is kept at 230 m³/s. Direct diversion of this surplus water from Bien Hoa of the Dong Nai River to the Saigon River and further through the Rach Tra canal to the East Vam Co River would be considered as one of development alternatives beyond the year 2015 for further development of low-lying areas extended in HCMC and Long An province.

As to the size of the Master Plan Projects, it is to be noted that in the Be River basin only, 4-year drought flow is the natural flow in the year 1969 and that the irrigable area of the Long An delta in that year is found to decrease to about 23,800 ha. This means that the irrigable area of the Long An delta varies depending on the regional hydrological conditions of the Be River basin.

It is also to be noted that two alternative diversion schemes from the Be River to the Saigon River, i.e. Fu Mieng diversion and Phuoc Hoa diversion, were compared in the model, and it confirmed that the Fu Mieng diversion has higher net benefit against the Phuoc Hoa diversion, nevertheless the difference is rather marginal.

7.2 Development of Rural Area

For improving the living condition and creating the job opportunities in the rural areas, a total of 229 small scale irrigation schemes are identified in the Study Area, consisting of 164 existing irrigation schemes for rehabilitation as well as 65 small irrigation schemes for newly development (refer to Figure 9).

For water supply for the rural development, a total of 1207 projects are required to be implemented by the year 2015. The projects are scattered over the Study Area as 119 in the Tai Ninh province, 79 in the Song Be province, 43 in the Dac Lac province, 96 in the Lam Dong province, 47 the Ninh Thuan province, 193 in the Binh Thuan province, 239 in the Ba Ria-

Vung Tau province, 193 in the Dong Nai province and 200 in the Long An province. The major possible sources of these rural water supply projects will be groundwater.

7.3 Selection of Master Plan Projects

Based on the result of the optimization study in Section 7.1 as well as the discussion on the development of the rural area, the master plan projects to be implemented within coming 20 years, i.e. by the year 2015, in the Study Area are proposed as follows:

- (1) Improvement and rehabilitation of 164 small scale irrigation projects as well as implementation of 65 new ones (refer to Table 1) as rural agricultural development projects (RADP),
- (2) A total of 1,207 rural water supply projects (refer to Table 1),
- (3) Two (2) hydropower projects with reservoirs (420 MW in total);
Dong Nai No. 3 : 180 MW
Dong Nai No. 4 : 240 MW,
- (4) The Be-Saigon diversion project (a diversion amount of 60m³/sec to the existing Dau Tieng in the Saigon River basin),
- (5) Eight (8) irrigation projects (242,560 ha in total) including Song Luy irrigation reservoir project (110 million m³ in active storage capacity);
Phuoc Hoa (45,680 ha), Ta Poa (19,000 ha), Vo Dat (12,620 ha),
Phan Ri (29,700 ha), Phan Thiet (10,000 ha),
Dau Tieng Extension (48,390 ha), HCMC (46,000 ha), Long An (31,170 ha),
- (6) Water supply project along National Highway No. 51 (1.7 million m³/day in demand), and
- (7) Strengthening of the organization on water-related institutions.

To implement all of the above projects except for Item 7, the total investment cost required at the price level of the year 1995 is estimated at approximately US\$ 2,750 million. The location map of the projects is shown in Figure 10.

8. PRELIMINARY BASIC DESIGN AND EVALUATION FOR THE SELECTED MASTER PLAN PROJECTS

8.1 Rural Agricultural Development Projects (RADP)

A preliminary screening is made for all the identified 229 RADPs to exclude those covered by eight large scale irrigation master plan projects, and results in selecting 118 existing small irrigation schemes with a total area of 50,082 ha and 58 new schemes with 52,294 ha in total. The construction cost of RADP is preliminarily estimated to be US\$ 231 million in total, consisting of US\$ 58 million for the existing schemes and US\$ 173 million for the new schemes.

8.2 Rural Water Supply Projects

As a preliminary estimate, it will require to invest an amount of US\$ 72 million for the implementation of all the identified 1,207 rural water supply projects.

8.3 Combined Development of Dong Nai No. 3 and Dong Nai No. 4

Taking into consideration a rather steep profile lying downstream of the Dong Nai No. 3, extension of the headrace tunnel is envisaged as an alternative to efficiently utilize available head, and accordingly FSL (Full Supply Level) of Dong Nai No. 4 reservoir is reduced from El. 480 m to El. 440 m. In case of setting FSL at El. 440 m, the layout for the dam and spillway of Dong Nai No. 4 becomes more compact and is improved for construction (refer to Table 2).

As a result of power optimization study with various different FSL of the Dong Nai No. 3 and No. 4 reservoirs, it is concluded that the combination of Dong Nai No. 3 (180 MW) with FSL of El. 570 m and Dong Nai No. 4 (240 MW) with FSL of El. 440 m is found to be the best combination.

The project construction costs of Dong Nai No. 3 and Dong Nai No. 4 are estimated to be US\$ 490 million and US\$ 398 million respectively, making a total of US\$ 888 million. The economic evaluation shows that the combined development of these projects gains a net present value of US\$ 81.1 million and an EIRR of 11.4 %, being economically viable.

8.4 Fu Mieng Multipurpose Project

The project layout and design of Fu Mieng multipurpose project, which is tentatively selected as the diversion measure of the Be-Saigon diversion project, are modified based on the field survey made during Phase III field work. The tail water level is raised by 5 m to El. 45 m according to the survey results and the power output is also revised to 55 MW. Earthfill type dam is recommended from the viewpoint of site geology and availability of construction material (refer to Table 2).

The diversion channel from the Fu Mieng to the Ton Le Tru River which flows into the Dau Tieng reservoir has the maximum flow capacity of 60 m³/sec, and its diversion will make it possible to irrigate an area of 88,300 ha including the HCMC-Long An delta. The channel has a length of 7 km and some improvement works may be required for the 10 km long river section immediately downstream reaches of the channel to receive the diverted flow without causing artificial flooding.

To compare the water diversion route from the Be River to the Saigon River, i.e. Fu Mieng diversion and the Phuoc Hoa diversion, economic evaluation for following three cases was carried out:

Scheme A : Fu Mieng multipurpose with the diversion canal and Phuoc Hoa low weir with pumping station,

Scheme B : Fu Mieng hydropower (single purpose) and Phuoc Hoa high weir with the diversion canal, and

Scheme C : Phuoc Hoa high dam with the diversion canal without Fu Mieng project.

In respect of the net present value and the EIRR, it is confirmed that scheme A is the most economical among the three alternatives, and consequently Fu Mieng diversion is proved to be the best option. However, the final selection between Fu Mieng and Phuoc Hoa as the diversion alternatives will be made in further study in future due to marginal difference in terms of economic viability.

The economic evaluation of the Fu Mieng multipurpose project itself without Phuoc Hoa irrigation scheme indicates that the net present value at 10 % discount rate is US\$ 67.8 million, whilst the EIRR is 11.3 %, and therefore that the project is economically viable.

In respect of the environmental aspect of the project, it is to be noted that the inundation area of the project is relatively large and may involve possible compensation and resettlement

problems, and therefore that the implementation of the project should carefully be judged in view of the large scale socio-economic benefits as well as the possible environmental issues.

8.5 Irrigation Master Plan Projects

Phan Ri-Phan Thiet Irrigation Project

The Phan Ri-Phan Thiet irrigation project should be developed with an area of 39,700 ha, consisting of 29,700 ha in Phan Ri plain and 10,000 ha in Phan Thiet plain. The proposed Luy reservoir has a function of regulating water released from the Dai Ninh power station as well as the natural flow of the Luy River with a reservoir (active storage capacity 110 million m³), and it is recommended to be of a rockfill type, judging from the topographic and geological conditions at the damsite. Meanwhile, the Ca Giay reservoir (active storage capacity 30 million m³) having an irrigation capacity of 2,000 ha will be constructed from the year 1996 (refer to Table 3).

The irrigation system has two main canals from the Luy reservoir; one is the west main canal of 26 km long, commanding west half of the Phan Ri plain and also conveying water to the Phan Thiet plain of 10,000 ha area, and the other east main canal of 8 km long commanding the remaining area. The proposed routes of main canals have a relatively flat topography, however it may encounter rock layers at relatively shallower depth in several places.

The construction cost of Phan Ri-Phan Thiet irrigation project is updated to be US\$ 209.1 million in total including both the Luy and the Ca Giay dams. The project will be implemented on a stage-wise development basis over a ten-year period with development of irrigation area of about 4,000 ha annually.

The EIRR is estimated for two alternative cases either the development combined with the Ca Giay reservoir and its irrigation system or independent from them. The EIRR in the former case is calculated at 12.6%, while the latter is 14.8%. This proves that the project is economically feasible even constructing both the dams, and also that construction of the Ca Giay reservoir irrigation system ahead of the Luy reservoir and its irrigation system is justified, even considering a possible delay of commissioning of the Dai Ninh power project.

Lower La Nga Plain Irrigation Project

The Ta Pao irrigation scheme is to be formulated with an irrigation area of 19,000 ha out of the potential 23,000 ha area, and the reduced 4,000 ha is allocated to the flood-prone area of about 4,700 ha estimated by the flood mitigation study. While, the Vo Dat irrigation scheme is to be

formulated with 12,620 ha for the potential 15,000 ha area, and the potentially reclaimable forest land in the right bank of the La Nga River is excluded from the scheme area.

Two diversion weirs will be constructed on the main stream of the La Nga River; one is the Ta Pao weir and the other is the Vo Dat weir. The construction cost for the 19,000 ha area of the Ta Pao irrigation scheme including the diversion weir is updated at US\$ 77.3 million in total. While, the cost of the Vo Dat irrigation scheme with 12,620 ha is updated at US\$ 83.2 million in total. The EIRR of both the schemes are assessed at 12.2% and 9.9%, respectively.

Phuoc Hoa Irrigation Project

The study of optimum water allocation selects the Phuoc Hoa irrigation project as one of the master plan projects with an area of 45,680 ha by pump irrigation method with a small diversion weir. The investment cost of the Phuoc Hoa irrigation project is estimated at US\$ 220.2 million as described in Section 6.3. The EIRR is estimated at 10.9% in case of irrigation scheme only, while it would be increased to 17.3% when the benefit of domestic and industrial water supply is added.

Dau Tieng Extension and HCMC-Long An Delta Irrigation Project

The Fu Mieng multipurpose project is tentatively selected as the most viable water diversion scheme from the Be River to HCMC-Long An delta area through the Dau Tieng reservoir as compared with an alternative diversion from Phuoc Hoa reservoir. This results in optimizing the scale of Dau Tieng Extension and HCMC-Long An delta irrigation project with areas of 125,560 ha in total. The economic viability of the Fu Mieng multipurpose project by both the hydropower and agricultural benefits is verified by the updated construction costs of all the related project facilities.

The construction cost of Dau Tieng Extension and HCMC-Long An delta irrigation project is updated at US\$ 242.5 million in total. The EIRR of the overall Dau Tieng Extension and HCMC-Long An delta irrigation project is estimated at 10.5 % subject to sharing a part of the cost of Fu Mieng dam and diversion canal amounting to US\$ 127 million in economic cost. This proves that the Dau Tieng Extension and HCMC-Long An delta irrigation project is economically viable as a whole, although the EIRR is in the marginal level.

Impact of Master Plan Projects

The incremental paddy production is estimated at 1.16 million tons including the rural agricultural development project. While, the increased cultivating area of cash crops in the eight master plan projects would be about 165,000 ha including sugarcane of 19,800 ha and cotton of 13,200 ha.

By implementing all the master plan projects, the paddy production in the Study Area is expected to increase to about 3 million tons in the year 2015 from the present 1.8 million tons level. This will meet about 50% of the total demand in the Study Area in the year 2015, assuming the population increase by 7.3 million and anticipated per capita consumption of 285 kg/year. While, the cultivating area of cash crops is expected to increase remarkably. In particular, cultivation area of sugarcane in the eight master plan project areas will share one-third of target increasing area of about 60,000 ha in the Study Area, and those of cotton share the half of the target 25,000 ha as well.

The irrigation development to the full extent under the optimum utilization of water resources in the Dong Nai and surrounding river basins would contribute to the enhancement of socio-economic conditions and living standard in the rural areas as well as the stable food supply in the Study Area.

8.6 Water Supply Project along National Highway No. 51

In the industrial area along the National Highway No. 51, there are five demand centres; Bien Hoa, Tam Phuoc, Nhon Trach, Phu My and Vung Tau, which will need the water amounting to a range from 250,000 to 420,000 m³/day respectively by the target year 2015. Potential water sources for these demand centres are the Dong Nai River, groundwater and the local rivers of La Buong, Song Ca Phuoc Thai, Da Den and Song Ray.

To meet the demands in each centre, three alternative development schemes are conceivable by combination of three water sources of the Dong Nai River water, groundwater and reservoir projects of the local rivers.

Owing to the highest benefit in the scheme as a whole as well as economic soundness in each demand centre, selected is the project with the basic idea to seek the water source to the Dong Nai River for the demand centre (Bien Hoa, Tam Phuoc and Nhon Trac) in Dong Nai province , whilst Da Den and Song Ray reservoirs for the demand centres (Phu My and Vung Tau) in Ba Ria-Vung Tau province. The main components of the project are the Thien Tan new intake in the Dong Nai River, pipe lines to Nhon Trach and the reservoirs in the local rivers of Da Den and Song Ray (refer to Table 4).

The total project cost is estimated at US\$ 464 million. The economic evaluation of the project presents a net benefit of US\$ 64 million and an EIRR of 12.9 %. The project is economically viable.

8.7 Initial Environmental Examination

(1) Dong Nai No. 3 and No. 4 Projects

The combined development of the Dong Nai No. 3 and No. 4 projects, although located in relatively remote areas, could be constructed and operated in an environmentally acceptable way. The main environmental adverse effects would relate to further losses in riverined habitat of the Dong Nai River system. This could be acceptable, provided the extent of losses of the habitat type does not extend completely along the Dong Nai River through cascade type dam and reservoir development. It is considered that socioeconomic benefits would accrue in the long term relating to local, district and regional development, and provided in-migration for land development in the catchment is controlled.

The exact elevation of the Dak Plao community and its associated hamlets as well as traditional lands used by the minority groups (Mnong) and the project effect on this community require special attention (including anthropological survey) at an early stage so that a comprehensive Resettlement or Indigenous People Action Plan can be prepared to comply with any multilateral lending agency's requirement.

(2) Fu Mieng Multipurpose Project

Fu Mieng multipurpose project requires a comprehensive EIA, including detail assessment of diverting water to Dau Tieng reservoir. The proposed reservoir and surrounding areas warrant particular attention in terms of watershed management and erosion control due to the past history of destruction of vegetation in this area during the 2nd Indochina War.

The families living in the reservoir area are limited to road side hamlets, and thus scattered houses together with those along the diversion channel route have a total population of 500 to 550 families. The compensation and resettlement issues, although not extensive, could be complicated because land has been under re-occupation and redevelopment for agriculture in the past 10 to 15 years. Land status and holding entitlements of resettlers may be uncertain at this moment.

(3) Irrigated Agricultural Development

The irrigated agricultural developments proposed in the master plan have such several common environmental and social effects requiring mitigation measures as change of water quality affecting other production activities and human life, crop loss during the project construction, need for guiding benefited farmers to accustomed with changed conditions under the project, need of soil erosion and watershed management and effect on medico-ecological and public health. These general effects will be applied to EIA for all the master plan projects including

the RADP. In general, the farming communities involved agree with implementation of irrigation schemes, provided adequate compensation and relocation of lands are satisfactory.

Besides such social and environmental effects as commonly identified above, specific issues involved in the respective master plan projects will be:

Phan Ri-Phan Thiet irrigation project

- changes in hydrological situation by water released from the Dai Ninh power station;
- effect on ethnic communities; and
- forest control in the upper Luy River basin,

Lower La Nga irrigation project

- preserve wetland ecology; and
- effect on ethnic communities,

Phuoc Hoa irrigation project

- effect of HCMC/Bien Hoa industrial development on the irrigated agricultural lands, and

Dau Tieng and HCMC-Long An Delta irrigation project

- long term effects of acid sulfate on water and soil quality; and
- ecological effects in the estuary zones.

(4) Water Supply Project along the National Highway No. 51

Although the environmental impact of water supply project is usually considered to be small and limited, the study level of the project has not been matured yet in respect of the pipeline route, the layout of facilities, etc. at this moment, therefore the IEE should be completed at the feasibility study stage even with some comments on environmental issues.

9. IMPLEMENTATION PLAN OF THE SELECTED MASTER PLANS

9.1 Implementation Schedule

A total of six master plan projects, which are to be implemented within coming 20 years by the target year 2015, are selected from five sectors, i.e. (1) Rural agricultural development projects, (2) Rural water supply projects, (3) Two hydropower projects, (4) Be-Saigon diversion project, (5) Eight large scale irrigation projects and (6) Water supply project along

National Highway No. 51. An implementation schedule for those projects is prepared by incorporating necessary lead time such as feasibility study and detailed design as given Figure 11, which includes the implementation schedule for the Dai Ninh project and the HCMC water supply project as well for reference.

The implementation schedule of three hydropower projects including Fu Mieng basically follows the study results of generation expansion planning, which suggests to commission Dong Nai No. 3 and No. 4 in the beginning of year 2008 and Fu Mieng in the year 2010 taking into consideration the development scenario of irrigation schemes in HCMC-Long An delta.

As for eight irrigation projects, the plan to build the reservoir as well as project viability and needs in the region is given the high priority in preparing the implementation schedule, i.e. commissioning of Dai Ninh project in the year 2003 and construction of the Phan Ri and Phan Thiet irrigation projects over the year 2001 to 2010, whilst the irrigation projects of Dau Tieng Extension and HCMC-Long An delta will be implemented in the year 2004 to 2015.

The water supply project along the National Highway No. 51 which seeks main water source to the Dong Nai and Ray rivers is scheduled to implement respective water supply projects added to the demand centres step by step so as to meet their water demand. And, all the facilities proposed in this project will be completed by the year 2010.

The rural agricultural development projects need a study to determine the implementation order of numerous projects prior to actual construction works. Implementation of the new projects will be undertaken with a slight time delay of two years for that of improvement of small irrigation projects. The implementation schedule will span over the entire period until the target year 2015.

Rural water supply projects also need a study and investigation to select the priority communes and their drilling sites of wells prior to the actual construction works. Taking into account that the lowest category among three provinces in the nation in terms of income, less availability of aquifer and small rainfall as well, Ninh Thuan and Binh Thuan provinces would be the first provinces to implement rural water supply projects. The implementation schedule will also extend over the time period until the target year 2015.

9.2 Fund Management

Regarding the public fund required for implementation of the master plan projects, it is necessary to see whether or not the scale of the required public fund is in a reasonable range in view of GDP of the nation or the annual expenditure in the Vietnamese government budget.

The availability of public fund to be allocated to the projects in the master plan has been estimated by the ratio of all public investment (capital expenditure) to GDP, investment shares by the Study Area, and expected GDP growth. The average ratio of all public investment to GDP during a time period of 1988 to 1993 was calculated as 6.5 %. Public investment shared by the Study Area was 27.3 % in the year 1992. GDP is expected to grow on an average at 9.0 % per annum in real terms during the time period of the year 1993 to 2005, 8.0 % per annum during 2006 to 2010 and 7.0 % per annum during 2011 to 2015.

The master plan projects selected in this study belong to hydropower, irrigation and water supply sectors, the share of which is estimated at 20 %, 10 % and 5 % respectively in the public investment of the Study Area based on the past performance. Applying a rate of 35 %, which is the sum of shares for the three public sectors, funds available for hydropower, irrigation and water supply are estimated by dividing a time period of 20 years into four phases as follows:

Fund Availability for the Master Plan Projects

(Unit: Billion VND)

	Projected GDP in Nation	Public Investment in Nation	Public Fund Allocated in Study Area	Fund Available for Three Sectors* in Study Area (1)	Funds Required for Implementing MPP (2)	% share of MPP (2)/(1) %
Phase I (1996 to 2000)	1,210,609	78,690	21,484	7,519	1,870	24.9
Phase II (2001 to 2005)	1,862,671	121,073	33,053	11,569	12,010	103.8
Phase III (2006 to 2010)	2,783,616	180,936	49,395	17,288	13,330	77.1
Phase IV (2011 to 2015)	3,972,146	258,189	70,486	24,670	3,080	12.5
TOTAL	9,829,042	638,888	174,418	61,046	30,290	49.6

Note * : Hydropower, Irrigation and Water Supply sectors

Total investment requirements necessary for the implementation of the master plan projects are nearly VND 1,870 billion (US\$ 170 million) during Phase I, VND 12,010 billion (US\$ 1,090 million) during Phase II, VND 13,330 billion (US\$ 1,210 million) during Phase III and VND 3,080 billion (US\$ 280 million) during Phase IV, corresponding to 24.9, 103.8, 77.1 and 12.5 % of the public funds available to the hydropower, irrigation and water supply sectors in the Study Area. The study on fund management tells that the total investment costs for the master plan projects during Phase II will require a marginally larger share of the projected public fund availability.

However, taking into consideration the future promised development in the region as well as the importance of three sectors to boost its economic development, a total investment of some VND 30,300 billion (US\$ 2,750 million) for the master plan projects is judged to be within a reasonable range of the public investment to be allocated to the Study Area.