No.

Japan International Cooperation Agency

Ministry of Agriculture and Rural Development
The Socialist Republic of Vietnam

The Study on Nationwide Water Resources Development and Management in the Socialist Republic of Vietnam

Final Report

Volume II

Main Report

Phase 1: Master Plan for Nationwide Water Resources Development and Management in 14 Major River Basins

September 2003

Nippon Koei Co., Ltd.
Nikken Consultants, Inc.

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COMPOSITION OF FINAL REPORT

Volume I	**Executive Summary**
Volume II	**Phase 1, Main Report**
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Exchange Rates

US$ 1 = Vietnamese Dong 15,068
Yen 100 = Vietnamese Dong 12,212

As of December 3, 2001

PREFACE

In response to a request from the Government of Vietnam, the Government of Japan decided to conduct Study on Nationwide Water Resources Development and Management in the Socialist Republic of Vietnam and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched the study team headed by Mr. Norizou FUJITA of Nippon Koei Co.,Ltd. and consist of Nippon Koei Co., Ltd. and NIKKEN Consultants,Inc. to Vietnam, between September 2001 and September 2003. In addition, JICA set up the advisory committee headed by Dr.Eng. Tetsuo UESAKA, Vice President, Japan Dam Engineering Center between September 2001 and September 2003.

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

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

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

2003 September

川上隆朗

Takao KAWAKAMI
President
Japan International Cooperation Agency

September 2003

Mr. Takao Kawakami
President
Japan International Cooperation Agency

Letter of Transmittal

It is our great pleasure to submit to you the Final Report of the Study on Nationwide Water Resources Development and Management in the Socialist Republic of Vietnam.

This study report has been prepared by Nippon Koei Co.,Ltd. and Nikken Consultants. Inc., based on the contract with JICA. The study team conducted the works from September 2001 to September 2003.

The study has formulated a master plan for the water resources development and management up to the year 2020 for major 14 river basins in Vietnam as well as integrated river basin management plans both for the Huong River basin and the Kone River basin, and has conducted a feasibility study for the selected priority projects in the Kone River basin.

We wish to express our deep gratitude to the personnel from your Agency in Tokyo and Vietnam, Advisory Committee, and other authorities concerned of the Government of Japan. We wish to offer our sincere appreciation to the officials concerned of Ministry of Agriculture and Rural Development and other authorities concerned of the Government of Vietnam for their unlimited cooperation and assistance extended to the study team in connection with the execution of their duties.

Finally, we earnestly hope that this study report will contribute to future sustainable water resources development and management in Vietnam.

Very truly yours,

Norizo FUJITA
Team Leader
The Study on Nationwide Water Resources Development and Management in the Socialist Republic of Vietnam

Location Map of Study Area

OUTLINE OF THE STUDY

THE STUDY

1. Necessity of Study

Solution of the problems on water resources including severe water deficit in the dry season and, serious flood damages in the rainy season is of keen necessity of Vietnam. Several water resources development projects comprising mainly multipurpose dam based projects have been proposed by each province to cope with such problems. However, since the proposed projects are not integrated as a basin-wide and/or nationwide water resources development, the Ministry of Agriculture and Rural Development (MARD) required an integrated approach to water resources development and management.

In order to overcome such issues, the Government of Vietnam requested to the Government of Japan the technical assistance of the Study on Nationwide Water Resources Development and Management Master Plan (the Study). In response to request of the Government of Vietnam, the Government of Japan decided to conduct the Study within the general framework of the technical cooperation between the Government of Japan and the Government of Vietnam signed on October 20, 1998.

2. Study Area

The Study covers the 14 major river basins of i) Bang Giang and Ky Cung River basin, ii) Red and Thai Binh River basin, iii) Ma River basin, iv) Ca River basin, v) Thach Han River basin, vi) Huong River basin, vii) Vu Gia-Thu Bon River basin, vii) Tra Khuc River basin, ix) Kone River basin, x) Ba River basin, xi) Sesan River basin, xii) Srepok River basin, xiii) Dong Nai River basin and xiv) Cuu Long River delta.

3. Objective of the Study

Objective of the Study consists of:

1) To formulate a master plan for nationwide water resources development and management in 14 River basins (Phase 1)
2) To formulate an Integrated River Basin Management Plan for the Huong River basin (Phase 2-1)
3) To formulate an Integrated River Basin Management Plan for the priority

river basin to be selected from 14 river basins (Phase 2-2)

4) To conduct a feasibility study for the priority projects to be selected from the priority river basin (Phase 2-3), and

5) To pursue technology transfer to counterpart personnel in the course of the Study.

WATER RESOURCES DEVELOPMENT AND MANAGEMENT PLAN FOR 14 MAJOR RIVER BASINS (Phase 1)

4. Formulation of Master Plan for 14 Major River Basins

Water resources development and management plans are formulated for 14 major River basins. The development and management plan in each river basin consists of components of the multipurpose dams, river improvement/dyking systems, agricultural development including irrigation/drainage systems and water supply for aquaculture and livestock, and domestic and industrial water supply, etc.

5. Priority River Basins and Projects

Aiming at selection of the priority basins for which the Integrated River Basin Management Plan will be formulated, the priority ranking study is conducted for 11 river basins excluding 3 river basins of the Red & Thai Binh, Dong Nai and Cuu Long River basins which already have the Master Plans approved and authorized by the Government.

The overall evaluation and scoring of projects and river basins indicates the following ranking and classification.

Ranking of 11 River Basins

Ranking	River Basin	Basin's Score	Classification
1	Huong	30.3	Group A
2	Kone	24.0	
3	Sesan	20.0	
4	Ma	14.0	
5	Tra Khuc	10.0	
6	Vu Gia-Thu Bon	0.0	Group B
7	Ba	0.0	
8	Srepok	-9.84	
9	Thach Han	-14.0	Group C
10	Bang Giang and Ky Cung	-16.0	
11	Ca	-26.0	

Ranking of Projects(11 River Basins)

Ranking	Name of Basin	Name of Project	Score	Classification
1	Huong	Ta Trach	32	Group A
2	Kone	Dinh Binh	24	
3	Sesan	Dak Bla	20	
4	Ma	Cua Dat	14	
5	Tra Khuc	Nuoc Trong	10	
6	Huong	Huu Trach	6	
7	Ba	Song Ba Ha	0	
8	Vu Gia-Thu Bon	Song Cai	-8	Group B
9	Srepok	Buon Kuop-Chupong Kron	-10	
10	Srepok	Krong Buong	-12	
11	Srepok	Upper Krong Pach	-12	
12	Srepok	Upper Krong Buk	-12	
13	Thach Han	Rao Quan	-14	Group C
14	Bang Giang and Ky Cung	Ban Lai	-16	
15	Ca	Ban La	-26	
16	Vu Gia-Thu Bon	Ho Son Thanh II	-26	

6. Recommendations

Major recommendations are summarized below.

(1) It is recommended, based on the study of the priority river basins, that the Huong River basin and the Kone River basin are selected as the most priority river basins to be taken up to the Phase 2-1 and Phase 2-2 studies, respectively to formulate the integrated river basin management plan.

(2) Implementation of the following Water Resources Management Plan is recommended:

(a) Flood damage mitigation

i) Establishment of the flood warning and communication system as an urgent measure for flood damage mitigation.

ii) Preparation of flood hazard map

iii) Land use management (control) and forestation.

(b) Water demand management

i) Proper intake control by appropriate intake water measurement

ii) Integration and coordination of water demand by an authority

(c) Improvement of river water quality

i) To establish / strengthen / maintain waste water management system

ii) Monitoring system of river water quality

iii) Management (control) system of required minimum river flow.

(d) Early establishment or strengthening of river basin organization with the following main tasks:

i) Formulation of a specific action plan to execute the tasks, and

ii) Capacity building of the organization and training of the personnel.

(e) Dispatch of specialists with the following categories and tasks:

i) Water resources management and coordination for effective water utilization

ii) Capacity building in the engineering and the institutional aspects for smooth establishment of an organization or strengthening of the existing RBOs

INTEGRATED RIVER BASIN MANAGEMENT PLAN FOR HUONG RIVER BASIN (Phase 2-1)

7. Background

The flood in November 1999 caused very severe casualties in which 89 people reportedly died and huge assets were damaged. In view of high urgency for countermeasure, both the Government of Vietnam and Japan agreed that an Integrated River Basin Management Plan should be formulated for the Huong River basin at the earliest.

8. Study Area

The study area is the Huong River basin located in the south central coast region of Vietnam. The Huong River basin has a catchment area of 3,300 km^2, belonging to the Thua Thien Hue Province.

9. Formulation of Integrated River Basin Management Plan

The development targets of the basin are the mitigation of severe flood damages, and water supply for targeted agricultural development and domestic & industrial water demand towards 2020, etc.

Various alternative basin development plans including the multipurpose dam schemes and non-dam schemes are examined to find the optimum basin development plan from the technical, economic and environmental aspects in due consideration of the basin's development targets, and the examination revealed through an overall evaluation that the basin development plan consisting of the maximum Ta Trach Dam and the maximum Huu Trach Dam will be the most

favorable measure to meet the basin's targets most efficiently. Recommended and proposed basin development plan is as follows:

Recommended Basin Development Plan

Ta Trach Dam with

Crest level	: EL. 55.0m
Effective storage volume	: 460 million m^3
Flood control volume	: 392.6 million m^3

Huu Trach Dam with

Crest level	: EL. 61.0m
Effective storage volume	: 182 million m^3
Flood control volume	: 105 million m^3

10. Project Cost Estimate

The project costs for the proposed major facilities are estimated at 415.4 million US$ as follows:

Description	Project Cost (VND)	(unit : million) (US$ Equiv.)
Ta Trach Reservoir Project (Earthfill type Dam with Hydropower)	2,512,381	166.7
Huu Trach Reservoir Project (Earthfill type Dam)	738,061	49.0
Irrigation and Drainage Facilities	1,600,868	106.2
Domestic and Industrial Water Supply	1,147,030	76.0
Total	5,998,340	398.1
Value Added Tax (VAT)	260,341	17.3
Grand Total	6,258,681	415.4

11. Economic Evaluation

The basin development plan is sufficiently justifiable economically according to the economic validity as shown below:

Alternative	EIRR (%)	B/C Ratio	NPV (Million US$)
I-B.2 (Max. Ta Trach + Max. Huu Trach)	16.5	1.56	47.5

12. Environmental Evaluation

It is anticipated that the Ta Trach Dam project would cause the negative impacts of land acquisition and resettlement as well as split of the communities. The mitigation measures/monitoring system to cope with/identify these impacts should be developed and provided.

13. Recommendation

(1) Both the Ta Trach Dam and the Huu Trach Dam will be required to meet the target of the basin. However, implementation of both the dams may face the financial difficulty. In this case, the Ta Trach Dam which will have much higher effectiveness for the flood control and water supply should be implemented earlier.

(2) The non-structural measures for flood damage mitigation or water saving as discussed in Section 8.3 of the Main Report which will be efficient both before and after the completion of upstream dam(s) should be implemented at the earliest.

(3) As a provisional flood control measure until the completion of the Huu Trach Dam, the present condition of the left side river branch located just upstream of the Hue City which will mitigate the flood damage of the urban areas should be maintained.

INTEGRATED RIVER BASIN MANAGEMENT PLAN FOR KONE RIVER BASIN (Phase 2-2)

14. Kone River Basin

The Kone River basin has been selected as a priority River basin for which the Integrated River Basin Management Plan would be formulated in Phase 2-2. The priority projects for the feasibility study is to be selected through the Phase 2-2 study.

The Kone River basin is situated in the south central Vietnam and almost entirely situated within the Binh Dinh Province. The river basin is defined as the basin that discharges into the East Sea through the Quy Nhon Estuary. The total basin area amounts to 3,640 km^2.

15. Formulation of the Integrated River Basin Management Plan

Formulation of the Integrated River Basin Management Plan for Kone River basin is conducted under the precondition that the water transfer from the adjacent Ba

River basin(the An Khe-Kanak hydropower project contemplated in the power sector) is not taken into account since the investigation and study on the project are considered still premature and its realization is not definite.

The integrated management plan of the Kone River basin has been formulated through the studies on various alternative plans. The formulated Integrated River Basin Management Plan is composed of the water resources development plan and the water resources management plan. Components of the formulated Integrated River Basin Management Plan are shown in Figure 1 and outlined as follows:

1) Dinh Binh Multipurpose Reservoir
2) Agricultural Development Plan consisting the Van Phong Weir and Irrigation/Drainage Plan
3) Domestic and Industrial Water Supply Plan
4) Flood Control and Bank Erosion Protection Plan
5) Rural Development Plan, and
6) Water Resources Management Plan

The optimum development scale of the Dinh Binh Dam/Reservoir is found as follows:

Recommended Dinh Binh Dam Development Plan

- Dam Type : Concrete Gravity Dam with a Gated Spillway
- Dam Crest Level : EL.100.3 m
- Dam Height About 55 m
- Dam Flood Control Volume : 292.8 MCM
- Dam Effective Storage : 279.5 MCM

16. Project Cost

The cost for the proposed facilities is estimated in due consideration of the construction schedule, resulting in US$ 720.5 million.

Description	Project Cost (million VND)	(million US$ equivalent)
Ta Trach Reservoir Project (Earth-fill type dam with Hydropower)	2,512,381	166.7
Huu Trach Reservoir Project (Earth-fill type dam)	738,061	49.0
Irrigation and Drainage Facilities	1,600,868	106.2
Domestic and Industrial Water Supply	1,147,030	76.0
Total	5,998,340	398.1
Value Added Tax (VAT)	260,341	17.3
Grand Total	6,258,681	415.4

17. Economic Viability

The economic validity of the Integrated River Basin Management Plan is shown as follows:

Economic Analysis for the Integrated River Basin Management Plan

Alternative	EIRR (%)	B/C Ratio	NPV (US$ million)
I-1.3B	15.1	1.52	92.4

The result indicates that the Integrated River Basin Management Plan has sufficient economic efficiency with EIRR of 15.1% and Net Present Value (NPV) of US$92.4 million.

Sensitivity analysis also indicates that the Integrated River Basin Management Plan maintains EIRR of more than 10% even under the conditions that 20% increase in costs and 20% decrease in benefits occur simultaneously. Therefore, the project is evaluated viable from the economic point of view.

18. Selection of Priority Projects

The following three (3) projects are recommended as the priority projects for which the Feasibility Study is to be conducted in Phase 2-3:

a) Dinh Binh Multipurpose Reservoir Project,
b) Van Phong Weir as well as Irrigation and Drainage System, and
c) Flood Control Project in the Downstream Reaches of the Kone River Basin.

FEASIBILITY STUDY FOR PRIORITY PROJECTS IN KONE RIVER BASIN (Phase 2-3)

19. Feasibility Study

The following three(3) priority projects have been selected for the Feasibility Study :

a) Dinh Binh Multipurpose Reservoir Project,

b) Van Phong Weir and Irrigation & Drainage System, and

c) Flood Control Project in the Downstream Reaches of the Kone River Basin.

Since a feasibility study was already conducted for the Dinh Binh Multipurpose Reservoir Project by HEC1 (existing Feasibility Study (F/S)) as well as the Technical Design (T/D) following the existing Feasibility Study, the JICA Feasibility Study made a review study on the existing Feasibility Study, duly referring to the Technical Design. Further, it is noted that the JICA Feasibility Study aimed at reviewing the existing Feasibility Study and/or the Technical Design in the light of the internationally widely accepted standard.

20. Major Conclusion

(1) The JICA Feasibility Study revealed that the projects will be technically feasible with some rearrangements of the design conducted for the Dinh Binh Dam and Van Phong Weir by HEC-1.

(2) The total project cost for all sectors is estimated at 4,790,831 million VND or 317.9 million US$ as follows:

		Project Cost (million VND,US$)		
		Foreign Currency	Local Currency	Total
1.Dinh Binh Multipurpose Reservoir	(VND)	520,910	928,504	1,449,414
	(US$)	34.6	61.6	96.2
2.Van Phong Weir & Irrigation / Drainage System	(VND)	740,893	1,174,439	1,915,332
	(US$)	49.2	77.9	127.1
3.Downstream Flood Control Plan	(VND)	518,395	907,690	1,426,085
	(US$)	34.4	60.2	94.6
Total	(VND)	1,780,198	3,010,633	4,790,831
	(US$)	118.1	199.8	317.9

Note : The above project costs indicate the case that the water supply to the La Tinh River basin is included.

(3) The results of the economic analysis indicated that the priority project has sufficient economic efficiency with EIRR of 12% and Net Present Value (NPV) of US$22.6 million.

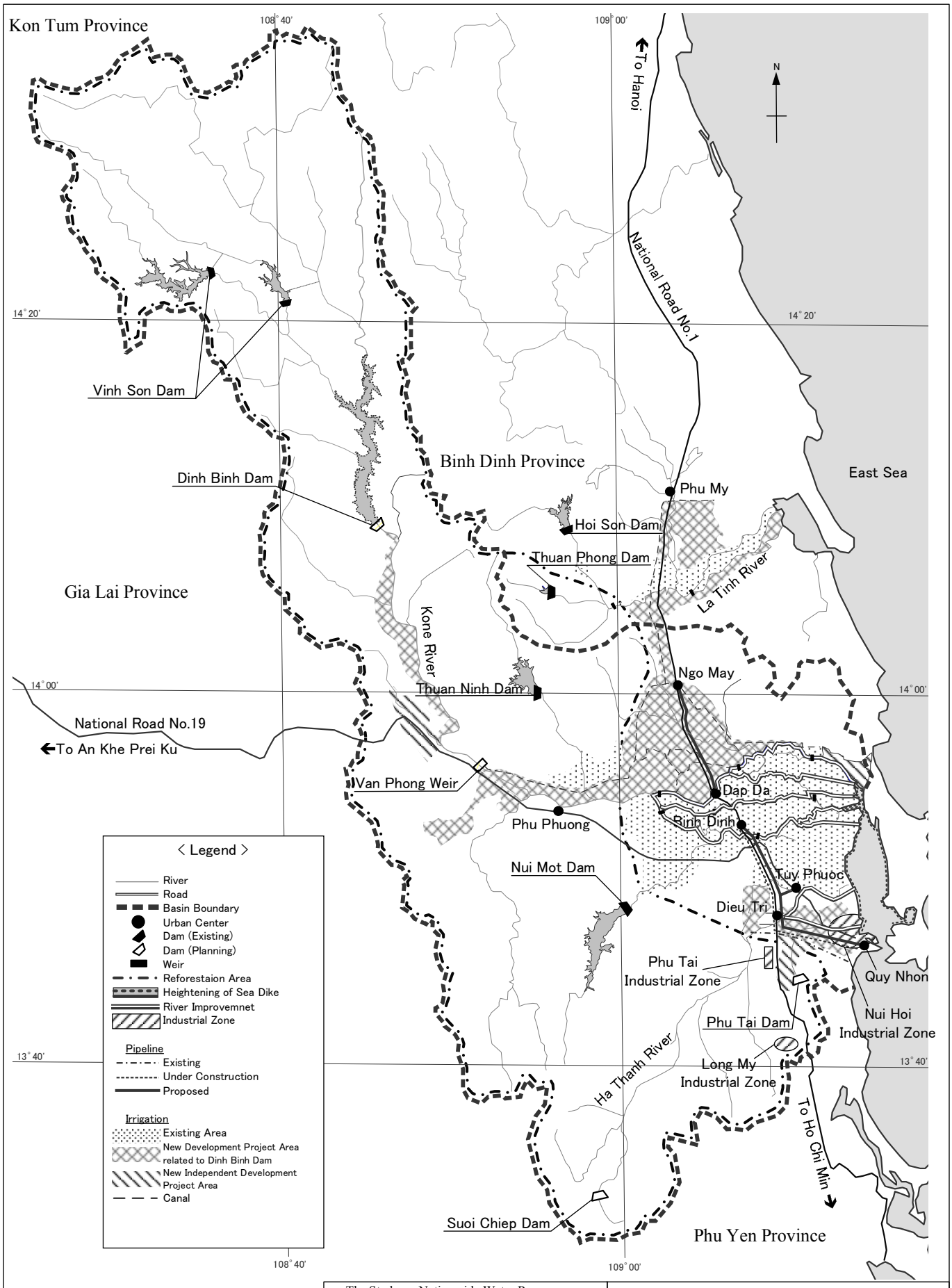
The financial analysis also shows that if a soft loan is applicable, implementation of the project will be financially feasible.

(4) The following possibilities are recognized as environmental issues to which a special consideration is to be given:

- Water quality degradation in the Kone river system including Dinh Binh dam reservoir,
- Environmental change of Thi Nai swamp resulting in the impacts on ecology and fishery, and
- Considerable magnitude of impact of land acquisition and resettlement.

21. Recommendation

It is found through the study that the project would be feasible from the technical, economic, and social aspects. Thus, realization of the project is important. However, since the realization of the project is forced to take some long time, it is recommended that the non-structural measures for mitigating the flood damages and for water saving, which were presented in Sub-section 8.2.2 of Main Report and are considered effective with less cost, should be implemented at the earliest.



The Study on Nationwide Water Resources Development and Management in the Socialist Republic of Vietnam

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure 1

Location Map of Integrated River Basin Management Plan

THE STUDY
ON
NATIONWIDE WATER RESOURCES DEVELOPMENT AND MANAGEMENT
IN
THE SOCIALIST REPUBLIC OF VIETNAM

FINAL REPORT

Phase 1: Main Report

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Abbreviations

1. Organization

ADB	:	Asian Development Bank
AFD	:	Agence Française de Développement
AusAID	:	Australian Agency for International Development
BARD	:	Bank of Agriculture and Rural Development
CWRET	:	Center of Water Resources and Environment Technology
DANIDA	:	Danish International Development Assistance
DARD	:	Department of Agriculture and Rural Development
DOSTE	:	Department of Science, Technology and Environment
DSI	:	Development Strategy Institute
EPRI	:	Electric Power Research Institute
EVN	:	Electricity of Vietnam
ESCAP	:	United Nations Economic and Social Commission for Asia and the Pacific
FAO	:	Food and Agriculture Organization
FPD	:	Forest Protection Department
GSO	:	General Statistical Office
HEC 1	:	Hydraulic Engineering Consultants Corp. No.1
HMS	:	Hydro Meteorological Service
IBRD	:	International Bank for Reconstruction and Development
ICD	:	International Cooperation Department
IUCN	:	International Union for Conservation of Nature and National Resources/ World Conservation Union
ISG	:	International Support Group
IFEP	:	Institute of Fishery Economics and Planning
IWRP	:	Institute of Water Resources Planning
IWRR	:	Institute of Water Resources Research
JBIC	:	Japan Bank for International Cooperation
JICA	:	Japan International Cooperation Agency
MABR	:	Man and the Biosphere Reserve
MARD	:	Ministry of Agriculture and Rural Development
MOF	:	Ministry of Fishery
MOH	:	Ministry of Health
MONRE	:	Ministry of Natural Resources and Environment
MOSTE	:	Ministry of Science, Technology and Environment
MOTC	:	Ministry of Transport and Communication
MPI	:	Ministry of Planning and Investment
NEA	:	National Environmental Agency
NGO	:	Non-governmental Organization
NIAPP	:	National Institute of Agricultural Planning and Projection
NWRC	:	National Water Resources Council
PC	:	People's Committee

PECC2	:	Power Engineering and Consulting Company No.2
SBV	:	State Bank of Vietnam
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNESCO	:	United Nation Educational, Scientific and Cultural Organization
USDA	:	United States Department of Agriculture
VNMC	:	Vietnam National Mekong Committee
WB	:	World Bank (International Bank for Reconstruction and Development)
WHO	:	World Health Organization
WWF	:	World Wide Fund for Nature

2. Unit

MW	:	mega-watt	km	:	kilometer
kW	:	kilo-watt	km^2	:	square kilometer
MWh	:	mega-watt hour	ha	:	hectare
kWh	:	kilo-watt hour	$mile^2$	:	square mile
GWh	:	giga-watt hour	m^3	:	cubic meter
GWh/yr	:	giga-watt hour per year	m^3/year	:	cubic meter per year
kV	:	kilo volt	m^3/sec, m^3/s	:	cubic meter per second
MVA	:	mega-volt ampere	m^3/sec/km^2	:	cubic meter per second per square kikometer
mm	:	millimeter	$feet^3$/sec/$miles^2$	:	cubic feet per second per square mile
mm/day	:	millimeter per day	g	:	gram
mm/year	:	millimeter per year	mg/l	:	milligram per liter
m	:	meter	Mm^3	:	million cubic meter
m/s or m/sec	:	meter per second	MCM	:	million cubic meters
m/sec^2	:	meter per square second			

3. Currency

VND	:	Vietnamese Dong
US$	:	US Dollar
JPY	:	Japanese Yen

4. Others

AC	:	Alternating Current
BOD	:	Biochemical Oxygen Demand
C.A.	:	Catchment Area
C-Cycle	:	Combined Cycle
CHES	:	Cultural and Historical Environmental Site
COD	:	Chemical Oxygen Demand
CPI	:	Consumer Price Index
DO	:	Dissolved Oxygen
DP	:	Dynamic Programming
EGEAS	:	Electric Generation Expansion Analysis System
EIA	:	Environmental Impact Assessment

EIRR	:	Economic Internal Rate of Return
FC	:	Foreign Currency
FDI	:	Foreign Direct Investment
F.M.	:	Finess Modulus
FIRR	:	Financial Internal Rate of Return
FSL	:	Full Supply Level
FWL	:	Flood Water Level
GDP	:	Gross Domestic Products
GNP	:	Gross National Products
GRDP	:	Gross Regional Domestic Products
HCM	:	Ho Chi Minh
HCMC	:	Ho Chi Minh City
HPP	:	Hydropower Project
ICB	:	International Competitive Bid
IEE	:	Initial Environmental Examination
IPP	:	Independent Power Producer
LC	:	Local Currency
LCB	:	Local Competitive Bid
LEP	:	Law on Environmental Protection
LOLP	:	Loss of Load Probability
LRMC	:	Long Run Marginal Cost
MDD	:	Maximum Dry Density
MIT	:	Massachusetts Institute of Technology
MOL	:	Minimum Operation Level
NGO	:	Non-Governmental Organization
ODA	:	Official Development Aid
OMC	:	Optimum Moisture Content
PMP	:	Probable Maximum Precipitation
RAC	:	Resettlement Action Committee
RAP	:	Resettlement Action Plan
RBO	:	River Basin Organization
ROE	:	Return on Equity
SCF	:	Standard Conversion Factor
SGS	:	Streamflow Gauging Station
SME	:	Small and Medium Enterprises
SRMC	:	Short-Run Marginal Cost
SS	:	Suspended Solids
UFW	:	Unaccounted For Water
VAT	:	Value Added Tax
WASP	:	Wien Automatic System Planning Package