

JAPAN INTERNATIONAL COOPERATION AGENCY

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JAPAN INTERNATIONAL COOPERATION AGENCY

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT  
MINISTRY OF PUBLIC WORKS  
THE REPUBLIC OF INDONESIA

**THE STUDY  
ON  
COMPREHENSIVE MANAGEMENT PLAN  
FOR  
THE WATER RESOURCES OF THE BRANTAS RIVER BASIN  
IN  
THE REPUBLIC OF INDONESIA**

**FINAL REPORT**

**VOLUME II**

**MAIN REPORT**

**OCTOBER 1998**

**NIPPON KOEI CO., LTD.  
NIKKEN CONSULTANTS, INC.**

**THE STUDY  
ON  
COMPREHENSIVE MANAGEMENT PLAN  
FOR  
THE WATER RESOURCES OF THE BRANTAS RIVER BASIN  
IN  
THE REPUBLIC OF INDONESIA**

**COMPOSITION OF REPORTS**

- Volume I** : **Executive Summary**
- Volume II** : **Main Report**
- Volume III** : **Supporting Report I**
- Annex
1. Meteorology and Hydrology
  2. Watershed Conservation, Sabo, and Flood Control
  3. Water Quality.
  4. Water Demand Forecast
  5. Water Balance Study
  6. Water Resources Development
  7. River Facility
  8. Effective Operation of Water Resources
  9. Monitoring and Information System
  10. River Environment
- Volume IV** : **Supporting Report II**
- Annex
11. Institutional Study
  12. Organization and Management
  13. Human Resources Development
  14. Financial Plan and Budget Resources
  15. Water Charge Mechanism
  16. Economic Evaluation
  17. Socio-economic Framework
- Volume V** : **Data Book**
- MH Meteorology and Hydrology
- WQ Water Quality
- IR Irrigation Water Demand
- RS River Survey
- CB Community and Beneficiaries' Participation Survey
- BI Biodiversity Inventory Survey
- AR PJT's Annual Report



**EXCHANGE RATE**

The exchange rates used in this Study are:
US Dollar(US\$) 1.00 = Indonesia Rupiah(Rp.) 2,446.6
Japanese Yen(¥) = Indonesia Rp.21.4
as of June, 1997

## PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct a development study on Comprehensive Management Plan for the Water Resources of the Brantas River Basin and entrusted the study to Japan International Cooperation Agency (JICA).

JICA sent to Indonesia a study team headed by Mr. Hideki Sato of Nippon Koei Co., Ltd. four times between February 1997 and August 1998.

The team held discussions with the officials concerned of the Government of Indonesia, 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 two countries.

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

October 1998



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Kimio Fujita

President

Japan International Cooperation Agency

October 1998

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

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the Final Report on Comprehensive Management Plan for the Water Resources of the Brantas River Basin in the Republic of Indonesia.

We carried out the study for a period of 21 months from February 1997 through October 1998. The Final Report presents a master plan for comprehensive water resources management in the Brantas river basin for the target year 2020 to achieve efficient water use and appropriate water resources management, reflecting the increase in water demand and the deterioration of water quality currently prevailing in the Brantas river basin.

The master plan which includes the construction of water supply dams and the implementation of water saving measures is proved to be technically viable and economically feasible. For implementation of the master plan, the Final Report makes recommendations on overall water resources management including organizational and institutional aspects. Further, the Final Report proposes (1) the establishment of a new water resources management organization in the year 2002 to strengthen the existing water resources management system and (2) the expeditious implementation of the pre-consolidation 3-year program which is indispensable for the aforesaid establishment of a new water resources management organization.

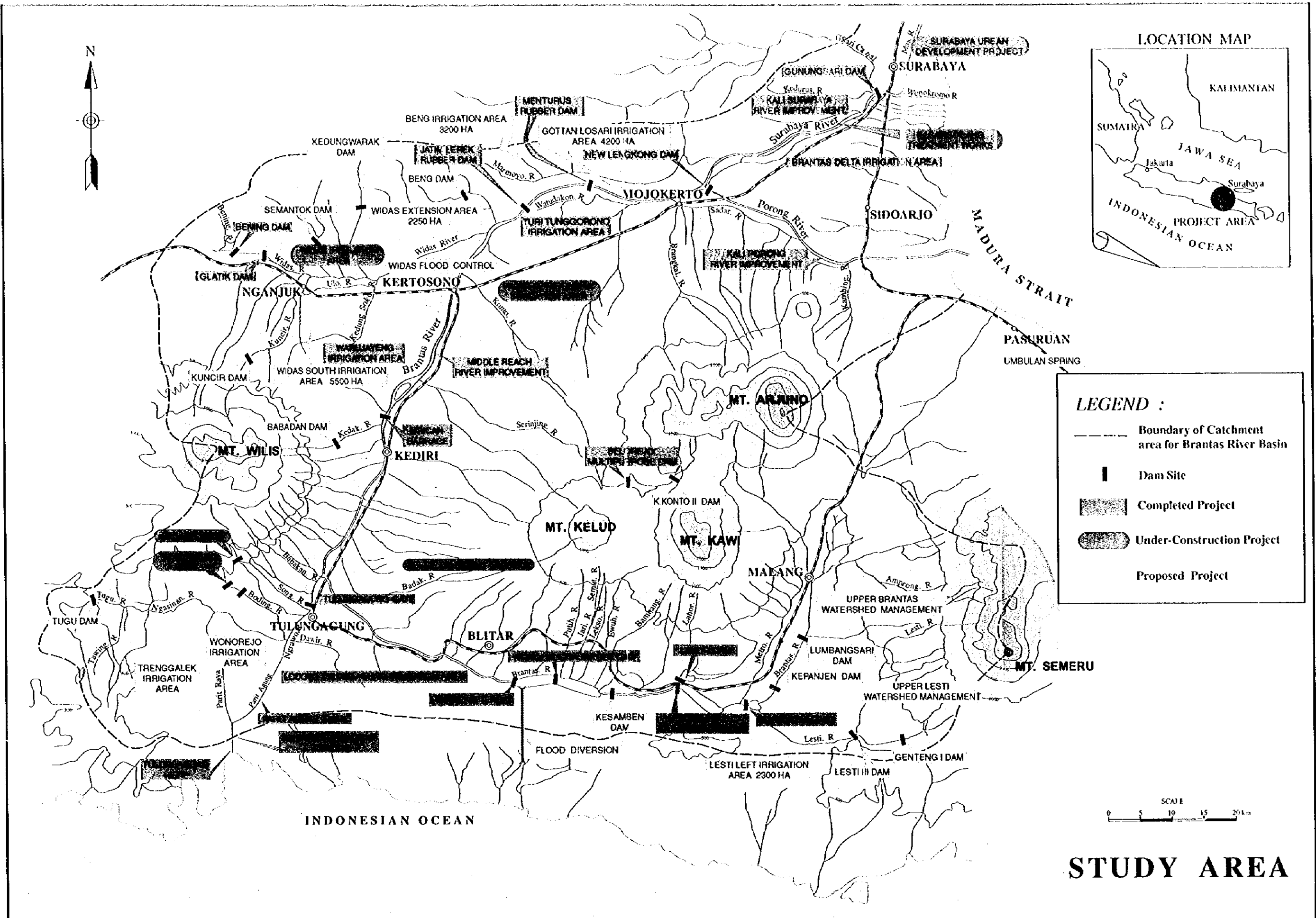
We wish to take this opportunity to express our sincere gratitude to your Agency and the Advisory Committee for the Study. We also wish to express our deep gratitude to the Government of the Republic of Indonesia, the Embassy of Japan in Indonesia, the JICA Indonesia Office and JICA experts for close cooperation and assistance extended to us during our investigation and study.

Very truly yours,



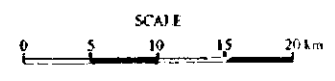
Hideki Sato  
Team Leader  
Comprehensive Management Plan for the Water  
Resources of the Brantas River Basin





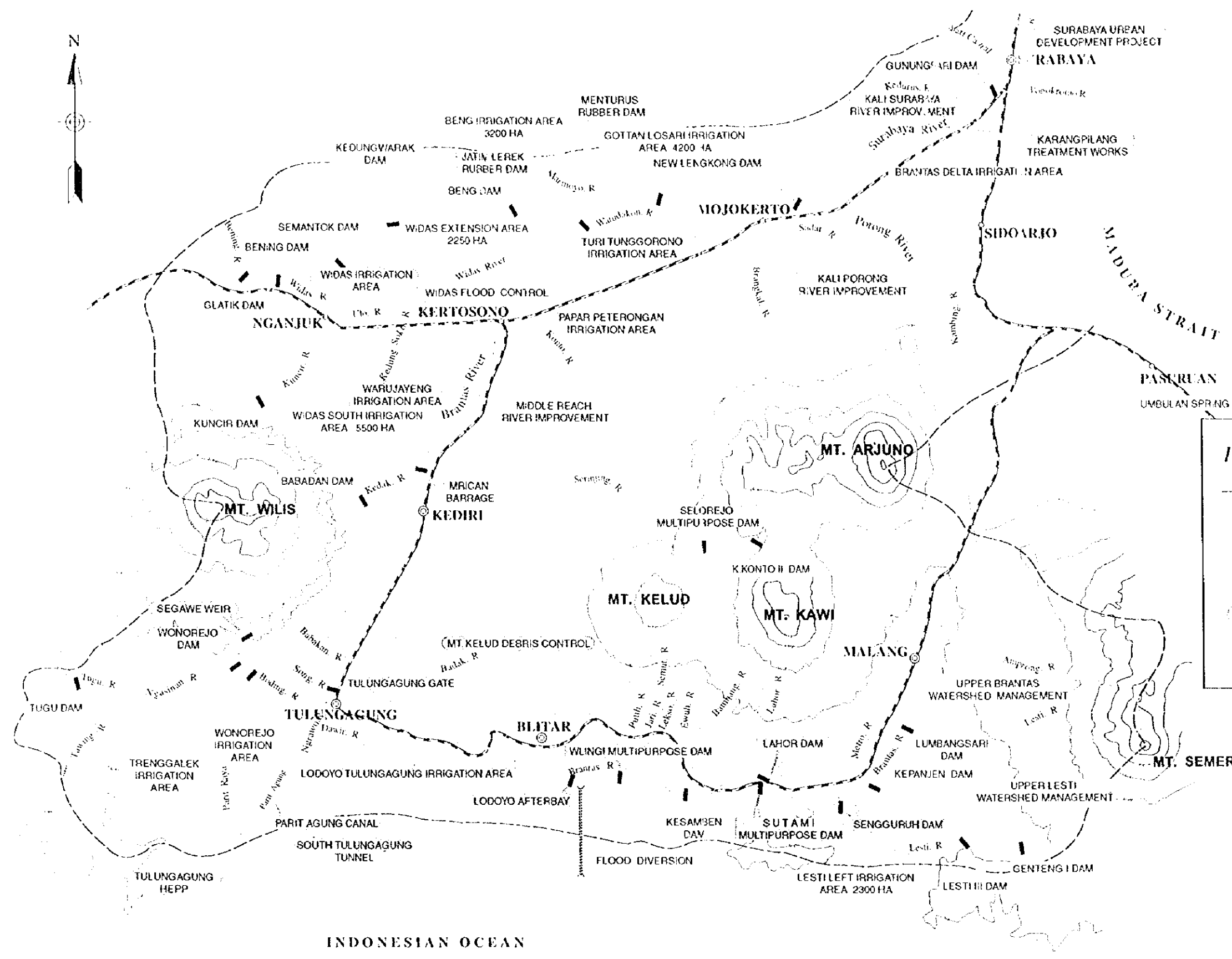
**LEGEND :**

- Boundary of Catchment area for Brantas River Basin
- | Dam Site
- ▨ Completed Project
- ▩ Under-Construction Project
- Proposed Project



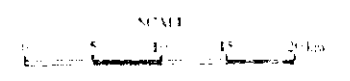
**STUDY AREA**





**LEGEND :**

- Boundary of Catchment area for Brantas River Basin
- Dam Site
- Completed Project
- Under-Construction Project
- Proposed Project



INDONESIAN OCEAN

# STUDY AREA



THE STUDY  
ON  
COMPREHENSIVE MANAGEMENT PLAN  
FOR  
THE WATER RESOURCES OF THE BRANTAS RIVER BASIN  
IN  
THE REPUBLIC OF INDONESIA

**FINAL REPORT**

**Volume II Main Report**

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## ABBREVIATIONS

### 1 UNIT

<u>Length</u>		<u>Weight</u>	
mm	millimeter	gr	gram
cm	centimeter	kg	kilogram
m	meter	t, ton	metric ton
km	kilometer		
<u>Area</u>		<u>Time</u>	
mm <sup>2</sup>	square millimeter	sec	second
cm <sup>2</sup>	square centimeter	min	minute
m <sup>2</sup>	square meter	hr	hour
km <sup>2</sup>	square kilometer	yr	year
ha	hectare		
<u>Volume</u>		<u>Others</u>	
cm <sup>3</sup>	cubic centimeter	%	percent
m <sup>3</sup>	cubic meter	°C	degree centigrade
Ltr	liter	10 <sup>3</sup>	thousand
		10 <sup>6</sup>	million
		10 <sup>9</sup>	billion

### 2 PLAN

ADIPURA	Kota Bersih ( <i>Clean City</i> )
PROKASIH	Program Kali Bersih ( <i>Clean River Program</i> )
REPELITA VI	Rencana Pembangunan Lima Tahun Tahap VI ( <i>Sixth Five Year Development Plan</i> )

### 3 ORGANIZATION

BAPEDAL	Badan Pengendalian Dampak Lingkungan ( <i>Environmental Impact Management Agency</i> )
BAPEDALDA	Badan Pengendalian Dampak Lingkungan Daerah ( <i>Provincial Office of Environmental Impact Management Agency</i> )
BAPPEDA	Badan Perencanaan Pembangunan Daerah ( <i>Regional Development Planning Agency</i> )
BAPPENAS	Badan Perencanaan Pembangunan Nasional ( <i>National Development Planning Agency</i> )
BBLH	Biro Bina Lingkungan Hidup ( <i>Bureau of Environmental Guidance, East Java</i> )
BKPMO	Badan Koordinasi Penanaman Modal Daerah ( <i>East Java Regional Investment Coordinating Board</i> )
BMG	Badan Meteorologi dan Geofisika ( <i>Meteorological and Geophysical Agency</i> )
BPPI	Balai Penelitian dan Pengembangan Industri, Surabaya ( <i>Agency of Industrial Research and Development, Surabaya</i> )

BPPT	Badan Pengkajian dan Penerapan Teknologi (Agency for the Assessment and Application of Technology)
BPS	Biro Pusat Statistik (Central Bureau of Statistic)
BRLKT	Balai Rehabilitasi Lahan dan Konservasi Tanah (Land Rehabilitation and Soil Conservation Agency, Ministry of Forestry)
BTKL	Balai Teknik Kesehatan Lingkungan (Agency of Environment Health Techniques, Ministry of Health)
DBPP	Direktorat Bina Program Pengairan (Directorate of Planning and Programming, DGWRD)
Dep.HUT	Departemen Kehutanan (Ministry of Forestry)
Dep.KES/MOH	Departemen Kesehatan (Ministry of Health)
Dep.KEU	Departemen Keuangan (Ministry of Finance)
Dep.PE/MME	Departemen Pertambangan dan Energi (Ministry of Mining and Energy)
Dep.PRINDAG/MIT	Departemen Perindustrian dan Perdagangan (Ministry of Industry and Trade)
Dep.PU	Departemen Pekerjaan Umum (Ministry of Public Works)
Dep.TAN	Departemen Pertanian (Ministry of Agriculture)
DGWRD	Direktorat Jenderal Pengairan (Directorate General of Water Resources Development, Ministry of Public Works)
DIPENDA	Dinas Pendapatan Daerah Propinsi Daerah Tingkat I (Provincial Revenue Service)
DIPERTA	Dinas Pertanian Daerah Propinsi Daerah Tingkat I (Provincial Agricultural Service)
DJBM	Direktorat Jenderal Bina Marga (Directorate General of Highways, Ministry of Public Works)
DICK	Direktorat Jenderal Cipta Karya (Directorate General of Human Settlements, Ministry of Public Works)
DPERIKAN	Dinas Perikanan Daerah Propinsi Daerah Tingkat I (Provincial Fishery Service)
DPRIND	Dinas Perindustrian Daerah Propinsi Daerah Tingkat I (Provincial Industry Service)
DPU	Dinas Pekerjaan Umum (Public Works Service)
DPUK	Dinas Pekerjaan Umum Kabupaten (Municipal Public Works Service)
DPU Pengairan	Dinas Pekerjaan Umum Pengairan Daerah Propinsi Daerah Tingkat I (Provincial Water Resources Service)
GOI	(Government of Indonesia) Pemerintah Indonesia
GOJ	(Government of Japan) Pemerintah Jepang

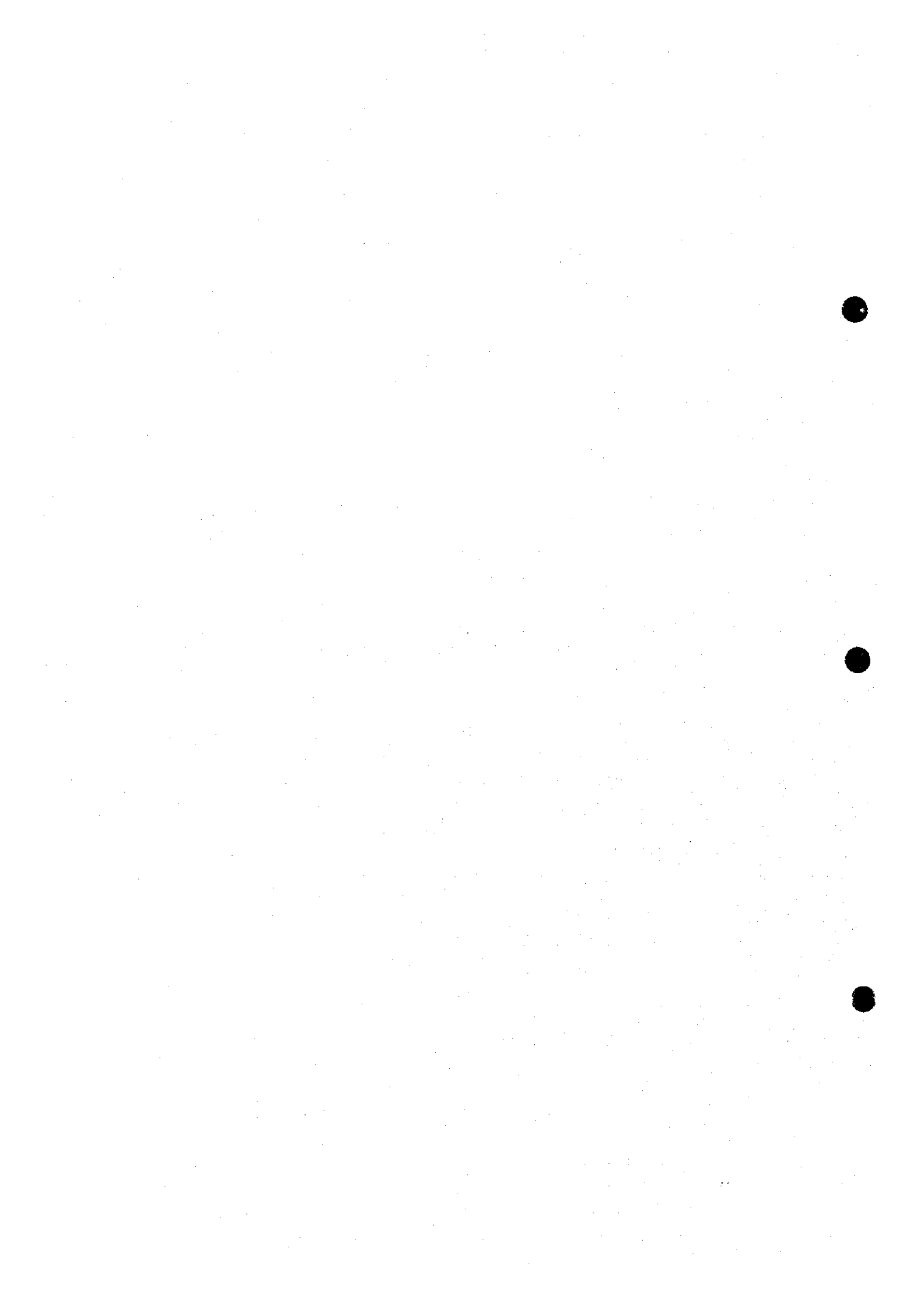
HIPPA	Himpunan Petani Pemakai Air ( <i>Water Users Association</i> )
IBRD	( <i>International Bank for Reconstruction and Development</i> )
IPAIR	Iuran Pelayanan Irigasi ( <i>Irrigation Service Fee</i> )
JICA	( <i>Japan International Cooperation Agency</i> )
Kem. Neg. LH	Kementerian Negara Lingkungan Hidup ( <i>State Ministry of Environment</i> )
KPH	Kesatuan Pemangku Hutan ( <i>Unit of Forestry Management</i> )
KPPPLH	Komisi Pengendalian dan Penanggulangan Pencemaran Lingkungan Hidup ( <i>Commission for Environmental Pollution Control and Abatement</i> )
LIPI	Lembaga Ilmu Pengetahuan Indonesia ( <i>Indonesian Institute of Science</i> )
MIT/Dep.PRIND	( <i>Ministry of Industry and Trade</i> ) Departemen Perindustrian dan Perdagangan
MME/Dep.PE	( <i>Ministry of Mining and Energy</i> ) Departemen Pertambangan dan Perdagangan
MOC	( <i>Ministry of Construction, Japan</i> )
MOF	( <i>Ministry of Finance</i> )
MOH/Dep.KES	( <i>Ministry of Health</i> ) Departemen Kesehatan
OECF	( <i>Overseas Economics Cooperation Fund, Japan</i> )
PBS	Proyek Induk Pengembangan Wilayah Sungai Bengawan Solo ( <i>Bengawan Solo River Basin Project</i> )
PDAB	Perusahaan Daerah Air Bersih ( <i>Regional Clean Water Supply Company</i> )
PDAM	Perusahaan Daerah Air Minum ( <i>Regional Drinking Water Supply Company</i> )
PGK	Proyek Gunung Kelud ( <i>Volcanic Disaster Prevention Project of Mt. Kelud, DOI</i> )
PGKS	Proyek Pengendalian Banjir Lahar G. Kelud Semeru ( <i>Volcanic Disaster Prevention Project of Mt. Kelud Semeru</i> )
PJT	Perum Jasa Tirta ( <i>Jasa Tirta Public Corporation</i> )
PKB	Proyek Pengembangan Wilayah Sungai Kali Brantas ( <i>Brantas River Basin Development Project</i> )
PLN	Perusahaan Umum Listrik Negara ( <i>State Electric Power Company</i> )
PLN PJB II	P.T. PLN Pembangkitan Tenaga Listrik Jawa - Bali II ( <i>PLN Electric Power Generator Corporation Java Bali II</i> )
POJ	Perum Otoritas Jatiluhur ( <i>Jatiluhur Authority Public Corporation</i> )
PPPLD	Pengendalian dan Penanggulangan, Pencemaran Limbah Domestik ( <i>Work Team for Controlling and Overcoming Domestic Waste Pollution</i> )

PPPLI	Pengendalian dan Penanggulangan, Pencemaran Limbah Industri ( <i>Work Team for Controlling and Overcoming Industrial Waste Pollution</i> )
UNDP	( <i>United Nations Development Program</i> )
USAID	( <i>United States of Agency for International Development</i> )
WARDEC	( <i>Water Resources Development Corporation</i> )

#### 4 OTHERS

APBD	Anggaran Pendapatan dan Belanja Daerah ( <i>Provincial Government Resources and Expenditure Budget</i> )
APBN	Anggaran Pendapatan dan Belanja Negara ( <i>Central Government Resources and Expenditure Budget</i> )
BOD	( <i>Biochemical Oxygen Demand</i> )
Bupati	( <i>Head of Regency</i> )
Camat	( <i>Head of sub District</i> )
COD	( <i>Chemical Oxygen Demand</i> )
CPI	( <i>Costumer Price Index</i> )
DIP	Daftar Isian Proyek ( <i>Development Budget Allocation</i> )
DO	( <i>Dissolved Oxygen</i> )
EOM	( <i>Effective Operation &amp; Maintenance (ISSD under IBRD)</i> )
FFWS	<i>Flood Forecasting and Warning System</i>
GDP	( <i>Gross Domestic Product</i> )
GERBANG KERTOSUSILA	Gresik, Bangkalan, Mojokerto, Surabaya, Sidoarjo, Lamongan
GRDP	( <i>Gross Regional Domestic Product</i> )
HWL	( <i>High Water Level</i> )
IPEDA	Iuran Pendapatan Daerah ( <i>Village Land Tax</i> )
ISF	( <i>Irrigation Service Fee</i> )
ISSP	( <i>Irrigation Subsector Project (IBRD Project)</i> )
Kabupaten	( <i>Regency</i> )
Kanwil	Kantor Wilayah ( <i>Provincial Office of a Ministry</i> )
Kecamatan	( <i>District</i> )
Kotamadya	( <i>Municipality</i> )
LWL	( <i>Low Water Level</i> )
O&M	( <i>Operation &amp; Maintenance</i> )
Polowijo	( <i>Second crop or collective term for all annual crops other than paddy and sugarcane</i> )
SS	( <i>Suspended Solid</i> )

***I SCOPE OF THE STUDY***



## **I.1 Background of the Study**

The Brantas river has a catchment area of 11,800 km<sup>2</sup>, which is the second largest in Java island. The Brantas river acts as a primary water resources for food production, water supply for domestic and industrial uses, fishery and hydropower generation in the basin.

The first comprehensive development plan of the Brantas river basin was formulated in 1961, emphasizing water resources development for hydroelectric power generation, flood control and water supply. The principal projects which were realized in line with the plan are; Selorejo Dam project, Karangates Multipurpose Dam and New Lengkong Dam projects, and Brantas Delta Irrigation project.

The master plan formulated in 1961 was reviewed and renewed in 1973 with technical assistance of the Government of Japan (OTCA) being focused on water resources development for irrigation and flood control. Following the recommendations of the study, several projects were constructed such as ; Wlingi Multipurpose Dam and Lodoyo Afterbay project, Lodoyo - Tulungagung Irrigation project, Surabaya river Improvement project, Bening Dam and Widas Irrigation project, and Tulungagung Drainage project.

The Japan International Cooperation Agency (JICA) reviewed of the basin master plan study in 1984 taking into consideration the change of socio-economic conditions in the basin thereafter and the severe water shortage experienced in 1982. The study proposed a basin development plan with a time horizon toward the year 2000, emphasizing urban water supply and well-balanced regional development of the basin.

In 1987, the Phase I Special Assistance for Project Sustainability(SAPS-I) in Brantas River Basin Development Projects by the Overseas Economic Cooperation Fund, Japan (OECF) was carried out to formulate a new organization for the Brantas river basin management. To efficiently operate and maintain completed facilities and integrated water management in the river basin, Perusahaan Umum Jasa Tirta (PJT) was established in February 1990 by the Government Regulation No.5.

In 1991, immediately after PJT's establishment, a follow-up study to sustain the project benefit was conducted under the OECF's SAPS II Program including improvement of the operation and maintenance system of the Brantas river basin as well as strengthening organization of PJT.

At present, the dry season water in the Brantas river is almost fully allocated to existing water users. No additional water is available for meeting new water demand. Further, since municipal and industrial raw water in Surabaya has been seriously contaminated due to urban and industrial effluents, the flushing water or minimum river maintenance flow is keenly required to improve the river water quality. To cope with these problems, the Wonorejo Multipurpose Dam is planned and now under construction to supply raw water to Surabaya and its vicinity for municipal and industrial uses.

Establishment of a comprehensive water resources management plan has been proposed to strengthen the river basin management system aiming at efficient use and adequate management of the water resources.

## **I.2 Objectives of the Study**

The objectives of the Study on Comprehensive Management Plan for the Water Resources of the Brantas River Basin in the Republic of Indonesia(the Study) are :

- 1) to formulate a comprehensive water resources management plan of the Brantas river basin including a structural development plan for appropriate development and management of the Brantas river basin, and
- 2) to transfer technology on planning methods and skills to the counterpart personnel.

## **I.3 Study Area**

The objective area of the Study is the Brantas river basin(catchment area:11,800 km<sup>2</sup>). The existing plan of water supply to the outside area from the Brantas river shall be incorporated as the giving conditions in formulating water allocation plan as well as the existing plan of water supply from the outside of the Brantas river basin to the Metro Surabaya area.

## **I.4 Scope of the Study**

The Study have been undertaken in the following manner in the two phases:

### **Phase I : [Basic Study and Review of the Existing Studies]**

The present status of water management of the Brantas river and the facilities in the Brantas river basin have been studied and examined through study and analysis of the collected data and documents as well as field investigations.

### **Phase II : [Formulation of Comprehensive Water Resources Management Plan]**

Based on the review and analysis of the relevant development plans undertaken in Phase I, appropriate water use and management plan has been formulated. Further, the comprehensive water resources management plan including improvement plans for the monitoring system, the institutional framework and the legal framework have been formulated to implement the aforesaid water use and management plan.

## **I.5 Implementation Organization**

Directorate General of Water Resources Development(DGWRD), Ministry of Public Works(MPW) act as the counterpart body to the JICA Study Team and also as the coordinating body in relation with other governmental and non-governmental organizations concerned in Indonesia for the smooth implementation of the Study. The organization is presented in Figure I.1.



The JICA Study Team is headed by the Team Leader who is responsible for maintaining a close liaison with the DGWRD staff, JICA and agencies concerned. He is also responsible for planning activities and monitoring the progress of the entire study for ensuring its timely and efficient completion. The members of the Study Team and the members of the Advisory Committee are presented in Table I.1

The Steering Committee was organized in June 1997, chaired by the Director of Water Resources Utilization and Conservation. The Committee consists of DGWRD, Ministry of Home Affairs, Perum Jasa Tirta(PJT) and other related organizations which have been invited by DGWRD based on the needs of the Study. The members of the Steering Committee are presented in Table I.2

The Technical Committee has been also organized in Surabaya to scrutinize the technical guidelines for the Study. The committee is chaired by the head of Water Resources Public Works Services, East Java Province and the members of the Technical Committee are presented in Table I.3

## **I.6 Study Schedule and Activities**

### **(1) General Schedule**

The study program and work schedule of the Study are respectively shown in Figures I.2 and I.3.

The Study comprises the following two phases:

**Phase I** : Basic study and review of the existing studies during a period from February to October 1997, including;

- 1) 1st Works in Indonesia
- 2) 2nd Works in Indonesia
- 3) 1st Works in Japan

**Phase II** : Formulation of Comprehensive Water Resources Management Plan during a period of October 1997 to October 1998, including

- 1) 3rd Works in Indonesia
- 2) 2nd Works in Japan
- 3) 4th Works in Indonesia
- 4) 3rd Works in Japan

### **(2) Activities in the Works in Indonesia**

In accordance with the objectives of the Study and schedule, the works in Indonesia were conducted in February and March 1997, and from June through September 1997 for the basic study and review of the existing studies. The third works in Indonesia were conducted from October through December 1997 for the formulation of comprehensive water resources management plan.

As a part of the works in Indonesia, the following field survey works have been carried out on sub-contract basis:

(i) **Biodiversity inventory survey of the Brantas river**

Period : August to January 1998 (dry and wet seasons)

Scope of Works : To undertake data collection including the previous survey in 1970 of the major aquatic ecosystems, fauna and flora of the watershed and habitat types, and be organized to inventory fauna and flora for the entire Brantas catchment.

Area : - Upper reaches of Brantas river basin  
- Middle reaches of Brantas river basin  
- Lower reaches of Brantas river basin

(ii) **River survey**

Period : August to September 1997

Scope of Works : Control point survey, leveling, cross section survey, plane survey, and longitudinal survey

(iii) **Community and beneficiaries' participation survey**

Period : August to September 1997

Scope of Works : To collect information on the beneficiaries' consciousness about water resources, efficient utilization of water and their socio-economic conditions with a focus on the concept of community and beneficiaries' participation in water resources management.

(3) **Transfer of Technology**

Transfer technology activities consists of on-the-job-training and lectures to the counterpart group. The lectures were conducted during the 2nd and 3rd works in Indonesia respectively as follows:

- (i) Water resources development scenario and concept of water balance calculation
- (ii) Hydrologic observation and analysis
- (iii) Irrigation water demand
- (iv) Water quality improvement plan
- (v) Demand forecast for domestic and industrial waters
- (vi) Financial Plan and Budget Resources/Future development scenario of PJT.

**Table I.1 Members of the Study Team and Advisory Committee**

Name	Work Assignment
<b>(1) Study Team</b>	
H. Sato	Team Leader/River Basin Management Plan
M. Ito	Water Resource Development Plan (Deputy Team Leader)
M. Matsumura	Watershed Conservation / Sabo/Flood Control Plan
Y. Usui	River Facilities (Operation and Maintenance)
N. Ohta	System Planning of Monitoring System
H.Narita /T.Ujii	Water Quality Improvement Plan
Y. Katsuhama	Hydraulics and Hydrology
M. Kodama	Water Demand Forecast (Irrigation/Fishery)
K. Yanagisawa	Organization / Management/ Private Sector Participation
T. Maruyama	Financial Plan and Budget Resources Study
A. Watanabe	Manpower Development Plan
T. Ishii	Institutional Study
M. Iqbal	River Environmental Study
Nasser U. Jamadar	Community and Beneficiaries Participation
H. Yamane	Economic Evaluation/Water Demand Forecast(Municipal and Industrial )
M.Yokokawa /T.Ichikawa	Coordinator
<b>(2) Advisory Committee</b>	
N. Oashi	Chairman,
F. Yonesaki	Member

**Table I.2 Members of the Steering Committee**

	Name	Position
Chairman / Member	Dr. Ir. A.Hafied A.Gany, MSc	Director of Utilization & Conservation of Water Resources, DGWRD
Deputy Chairman / Member	Dra. Hj. Djumilah Latief	Director of Regional Development Guidance, Ministry of Home Affairs
Secretary	Dr. Ir. M. Amron, Msc	Chief of Subdit. of Utilization & Conservation of Water Resources, DGWRD
Member	Ir. Hendratno Remiel Baswan, Msc	Director of Planning & Programming, DGWRD
Member	Ir. M. Napitupulu, Dip. HE	Director of Technical Guidance, DGWRD
Member	Ir. M. Subiyanto, Dip. HE	Director of Central Region Implementation, DGWRD
Member	Dr. Ir. Edward Simatupang	Director of Planning & Programming, Directorate General of Food Crops, MOA
Member	Ir. Abdul Manan Siregar	Director of Land Conservation, Directorate of Reforestation & Land Rehabilitation, Ministry of Forestry
Member	Ir. Aca Sugandhy Apandi, MSc	Assistant - I to the State Minister of Environment
Member	Ir. Rusfandi Usman, M. Eng.	President Director of Perum Jasa Tirta
Member	Ir. Liliek Dumairi, Dip. HE	Project Manager of Brantas River Basin Main Development Project

**Table I.3 Members of the Technical Committee**

	Name	Position
Chairman	Setiono	Head Water Resources Public Works Services, East Java Province
Secretary	Darsun Kartoredjo	Head of Programming Affairs Regional Office of Public Works, East Java Province
Member	Sulaiman	Head of River and Swamp Sub Services Water Resources Public Works Services, East Java Province
Member	Trie M. Sunaryo Mulat S.	Director Technical Affairs of Penum, Jasa Tirta
Member	Socheh	Project Manager Brantas River Basin Development Project
Member	Machmud	Head of Planning Staff Brantas River Basin Development Project
Member	Moch. Amron	Chief Sub Directorate of Management and Utilization of Water Resources, PPSDA, MPW
Member	Lex Laksamana	Head Sub-Directorate of Central Region
Member	Rustam Syarif	Head Sub Directorate of Water Resources Conservation, PPSDA, MPW
Member	M.Hasan	Head Sub-Directorate of General Planning
Member	Ketut Kaler	Head Sub-Directorate of River Technical Guidance
Member	Rapiali Zainuddin	Head Sub-Directorate of Irrigation Technical Guidance
Member	Tjoek Waluyo Subiyanto	Head Research and Planning Bureau, PJT
Member	Kusumarini	Head Counterparting Unit, PJT

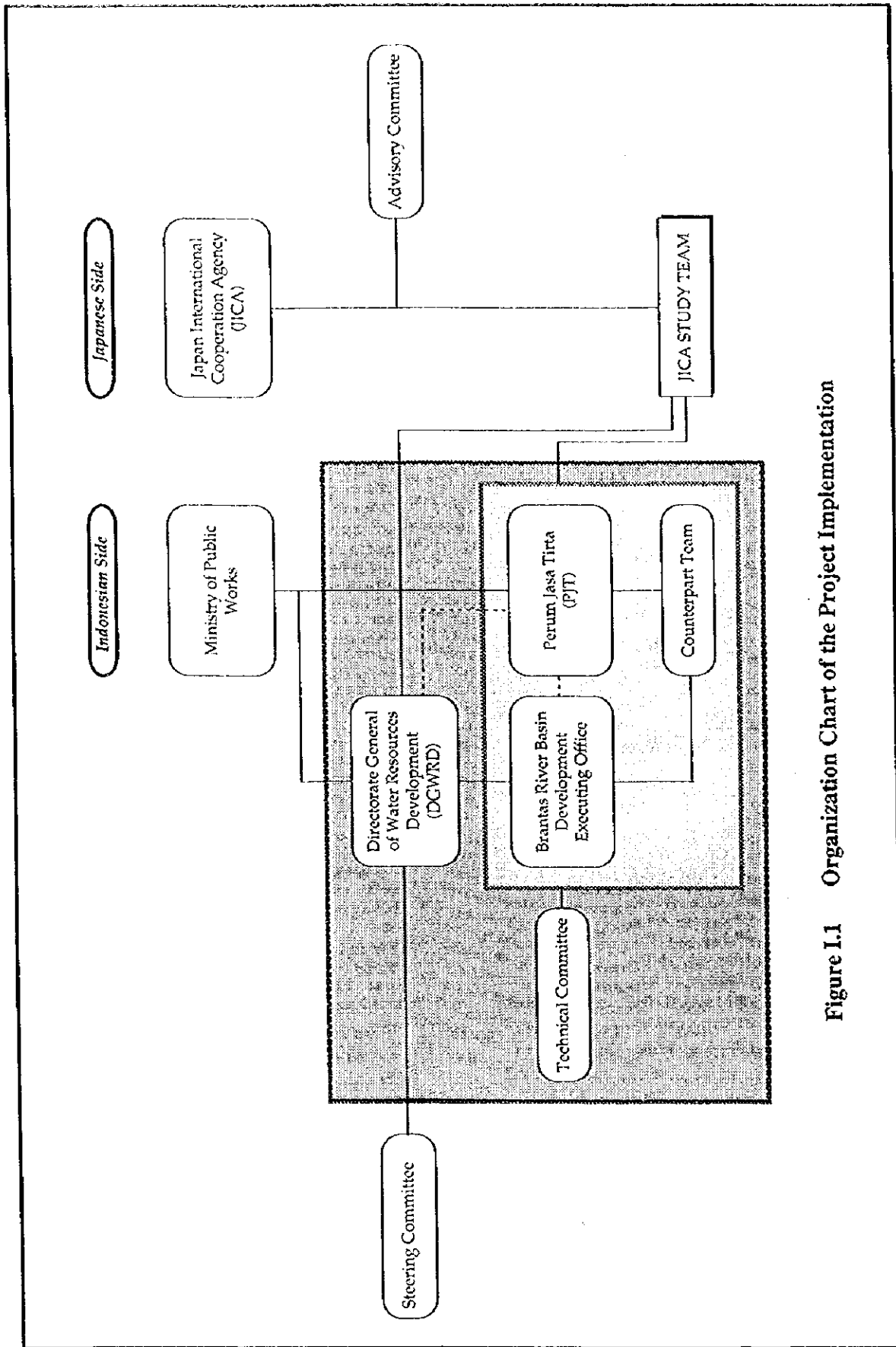


Figure I.1 Organization Chart of the Project Implementation

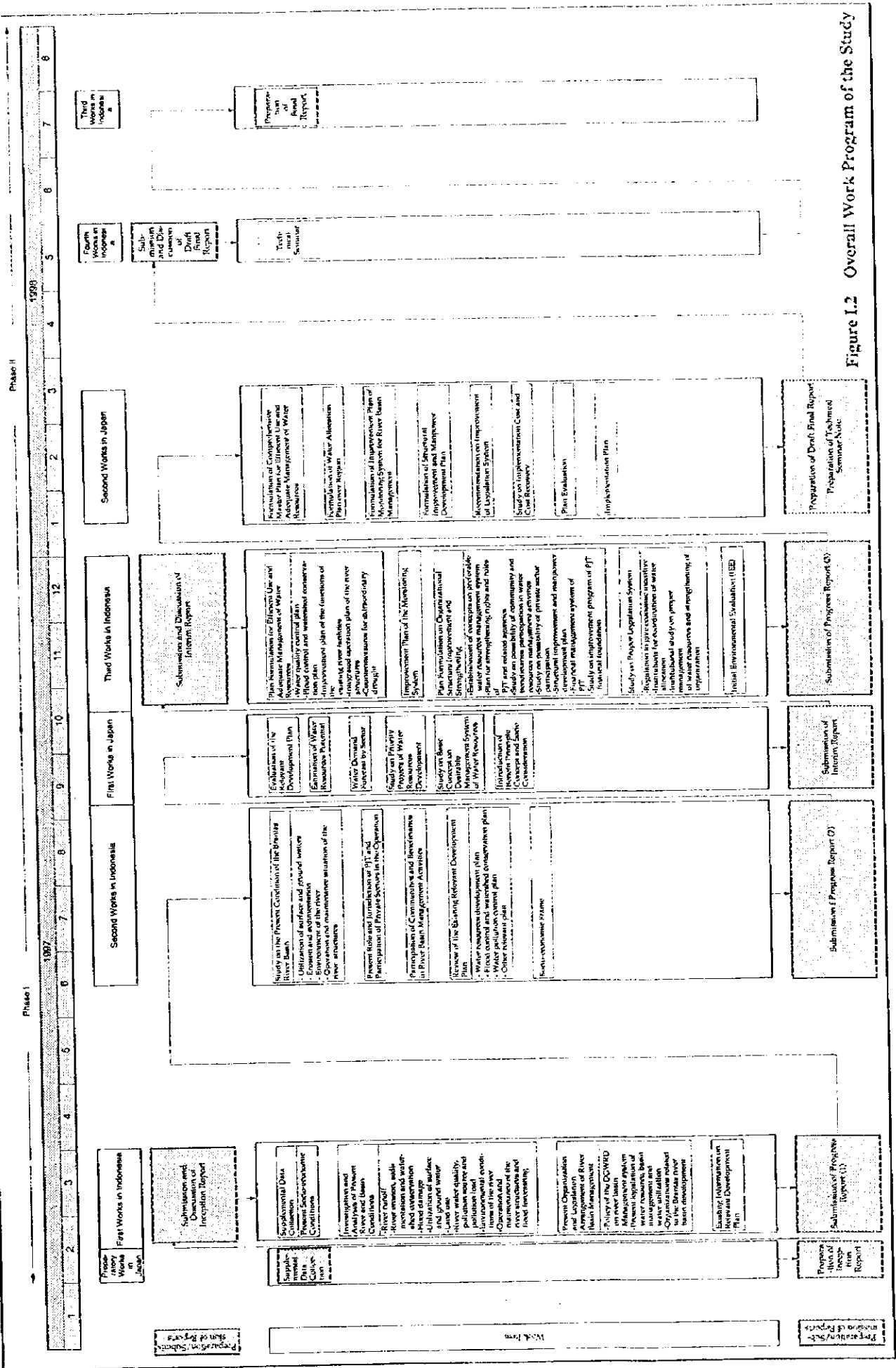
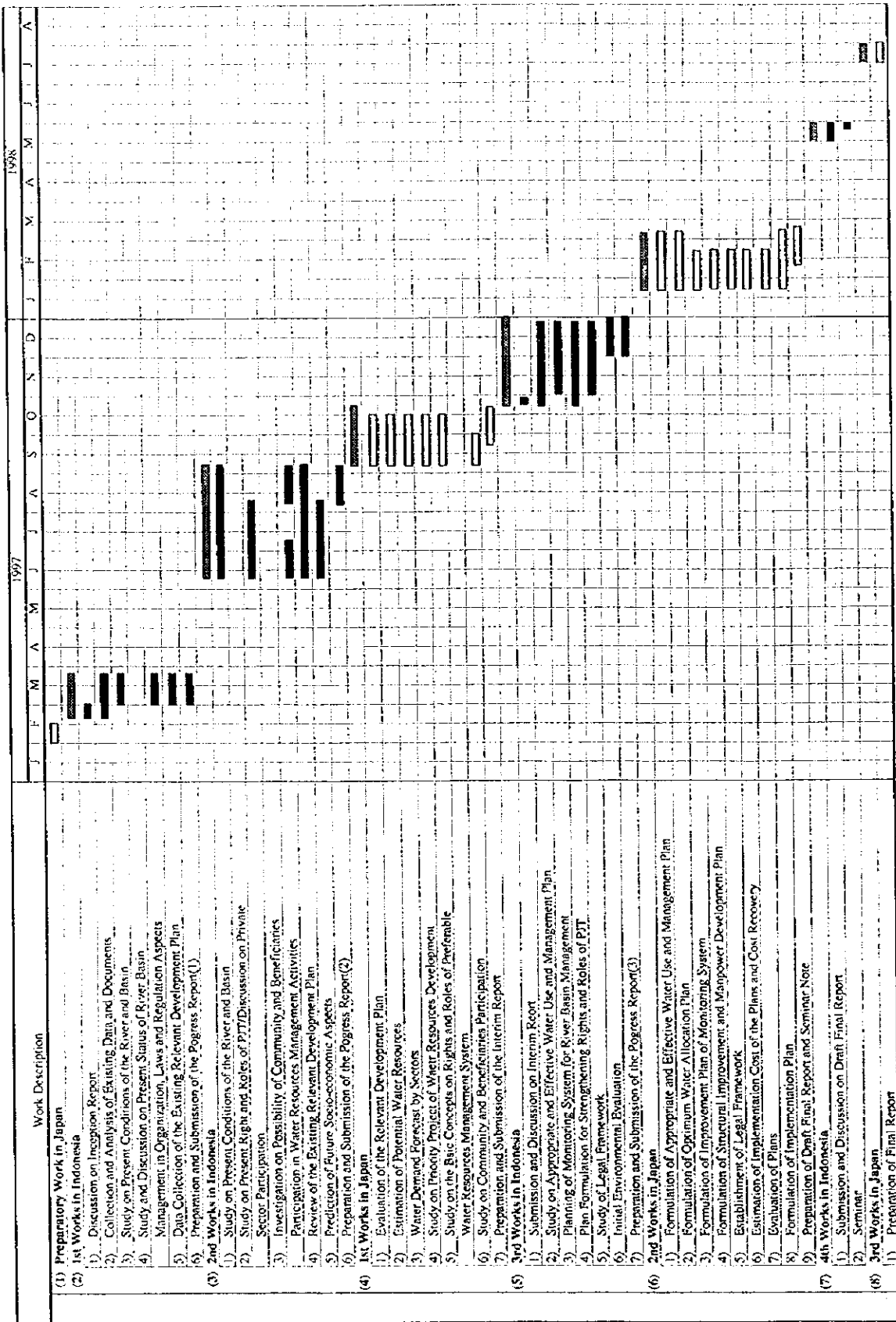


Figure 1.2 Overall Work Program of the Study

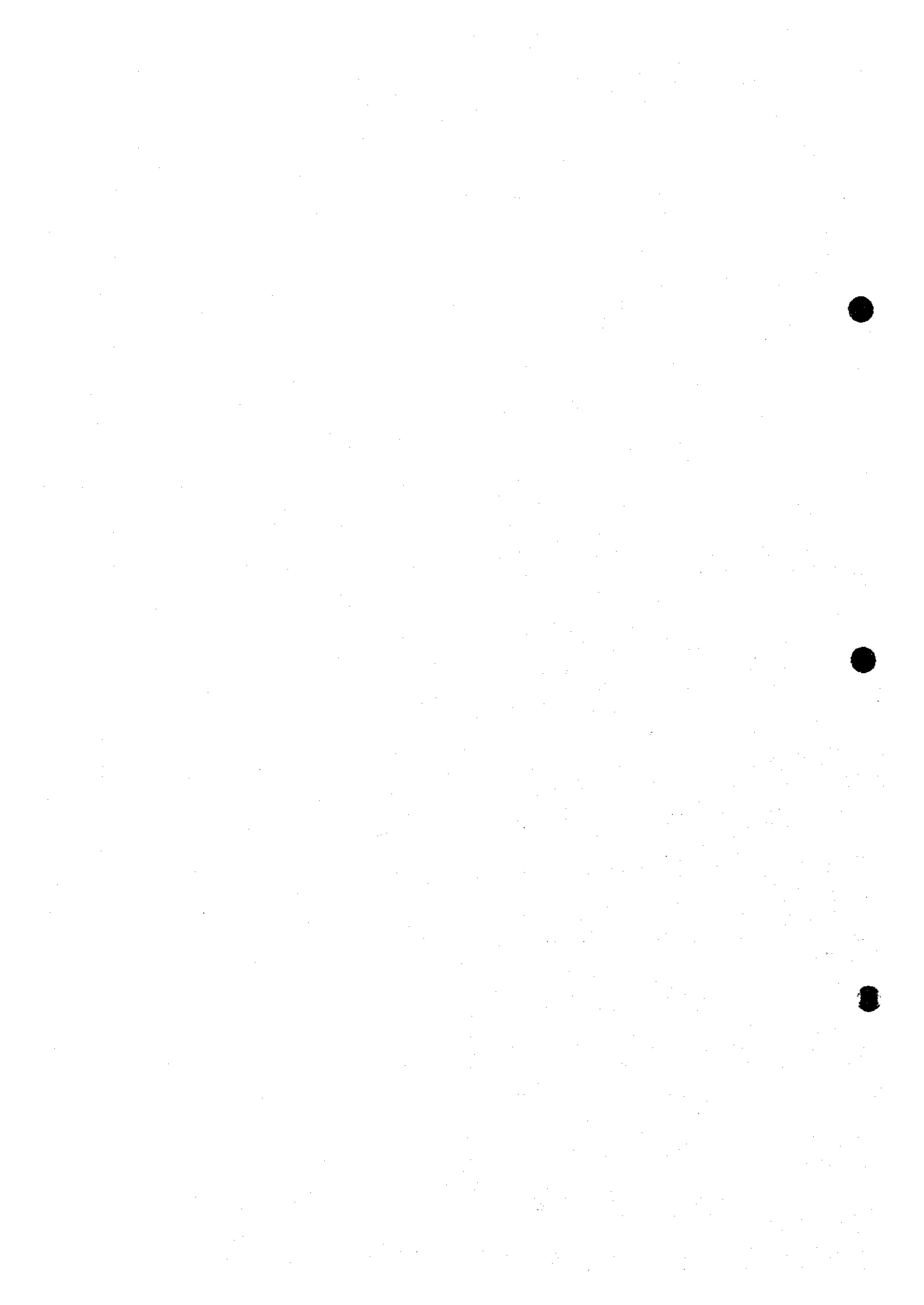
Figure I.3 Work Schedule



Note : ■ Work Period in Indonesia □ Work Period in Japan



**II    *GENERAL FEATURE  
OF THE STUDY AREA***



## **II.1 Natural Condition**

### **II.1.1 Basin Boundary**

The Brantas river in the East Java lies between 110°30' and 112°55' east longitude and between 7°01' and 8°15' south latitude. The area of the basin is approximately 12,000 km<sup>2</sup>. The boundary and major river system within the basin is shown in the figure on the opening page of this report.

The Brantas river basin is bounded by Mt. Bromo (EL. 2,392 m) - Mt. Semeru (EL. 3,676) in the east, a series of low Kidul ridges (EL. 300 - 500 m) in the south, Mt. Wilis (EL. 2,169 m) and its families in the west and Kedung ridges and the Madura strait in the north. The Arjuno Mountain Complex consisting of Mt. Arjuno (EL. 3,339 m), Mt. Butak (EL. 2,868 m) and Mt. Kelud (EL. 1,731 m) locates in the center of the basin.

### **II.1.2 Geology and Soils**

Geology of the East Java is mostly made of the Neogene Tertiary formation with many volcanic members such as basalts and andesite, and sometimes containing coral limestone. The Brantas basin is generally of agglomerate, tuff breccia, tuff, and coral limestone, accompanying volcanic ashes with different degree of consolidation.

Active volcanoes in the basin are Mt. Semeru on the eastern boundary and Mt. Kelud in the center. Mt. Semeru erupts continuously, but majority of ashes from it fall in the outside of the basin. Mt. Kelud erupted in 1901, 1919, 1951, 1966 and 1990 in this century with huge amount of volcanic products which caused damages to human life and properties at times of eruption and aggradation of the riverbed after eruption. The average cycle of eruption is estimated at 15 years and the average amount of erupted materials is estimated at 200 million m<sup>3</sup> at one eruption.

The flat plains are composed of alluvial soils of loam, silt and clay, which are mostly suitable for paddy cultivation. The hilly and mountainous areas are covered by weathered materials of volcanic products.

### **II.1.3 Climate and Hydrology**

The climate in the basin is dominated by tropical monsoons. In the normal years, the rainy season is about 6 months long from November to April, and the dry season prevails from May to October. The yearly mean temperature in the basin ranges from 24.2°C in Malang to 26.6°C in Porong. The average annual rainfall over the basin is around 2,000 mm, of which more than 80% occurs in the rainy season.

Variation of annual rainfall is large; 2,960 mm in a water rich year and 1,370 mm in a drought year. The average annual rainfall in the high elevation areas is generally high, 3,000 through 4,000 mm especially in southern and western slopes of Mt. Kelud. The yearly mean relative humidity in the basin ranges from 75 % to 82% depending on the location.

## II.2 Social and Economic Conditions

### II.2.1 Brantas River Basin

For the purpose of socio-economic analysis, the Brantas river basin is defined as composing of the following regencies and municipalities.

Regencies : Sidoarjo, Mojokerto, Malang, Blitar, Kediri, Nganjuk, Jombang, Tulungagung, Trenggalek

Municipalities : Surabaya, Mojokerto, Malang, Kediri, Blitar

The Brantas river basin in the geographic sense is delineated according to watershed boundaries, which in some parts do not coincide with administrative boundaries. For the socio-economic analysis purpose, the present study avoided additions and deletions of areas to make the study area boundaries strictly consistent with watershed boundaries considering that the difference in the area by the two types of boundaries is negligibly small.

### II.2.2 Population

Population in the Brantas river basin was 13,534 thousand in 1994, accounting for 42% and 7% of East Java Province and Indonesia, respectively. The population growth rates was 1.65% per year in Indonesia between 1990 and 1994, while those in East Java and Brantas were respectively 1.00 % per year during the same period. A rise in population growth rates is observed in East Java and Brantas. The level of growth rates, however, is lower than those in Indonesai.

Year/period	Indonesia	East Java	Brantas
(Population in thousand)			
1980	147,490	29,169	11,996
1985	164,047	29,857	12,372
1990	179,381	31,113	13,004
1994	191,523	32,370	13,534
(Growth rate, %/year)			
1980-85	2.15	0.47	0.62
1985-90	1.80	0.83	1.00
1990-94	1.65	1.00	1.00

The population of municipalities accounted for 25 % of the total population in the Brantas river basin, while that for the East Java Province was 12%. This large difference comes from the existence of two major cities, Surabaya and Malang in the Brantas river basin area, with a population of 2.3 million and 700 thousand respectively. Within the Brantas river basin

area, the proportion of the municipality population increased gradually between 1988 and 1994 as shown below:

Area	(unit :thousand)		
	1988	1994	Growth rate (%/year)
Regencies	9,573 (74.8%)	10,086 (74.5%)	0.87
Municipalities	3,224 (25.2%)	3,447 (25.5%)	1.12
Total	12,797 (100.0%)	13,534 (100.0%)	0.94

Note : Time series data can be traced back only to 1988, since change in administrative boundaries of municipalities took place before 1988.

Among all the regencies and municipalities, those showing fast growth in population included Malang (2.02%/year) and Mojokerto (1.21%/year) for municipalities and Sidoarjo (1.93%/year), Mojokerto (1.18%/year) and Jombang (0.96%/year) for regencies as shown in Table II.1.

### II.2.3 GDP and GRDP

Gross Regional Domestic Product (GRDP) of the Brantas river basin area amounted to 39,018 billion Rupiah in 1995 at current prices (about 17.3 million US\$), accounting for 58.9% of GRDP in East Java (66,212 billion Rupiah) and 9.4 % of Indonesia's Gross Domestic Product (416,342 billion Rupiah).

The following table summarizes GRDPs at current prices, average annual growth rates between 1993 and 1995 and GRDP per capita for all the regencies and municipalities in the Brantas river basin area(Source : Tables II.2 and II.3):

Kabupaten/ Kotamadya	GRDP in 1995 (billion Rp.)	Share in 1995 (%)	Annual growth (1993-95, %/year)	GRDP/GD per capita in 1995 (US\$)	Kabupaten/ Kotamadya	GRDP in 1995 (billion Rp.)	Share in 1995 (%)	Annual growth (1993-95, %/year)	GRDP/GD per capita in 1995 (US\$)
(Regency)					(Municipality)				
Sidoarjo	4,203	10.8	8.0	1,400	Surabaya	15,554	39.9	10.7	2,581
Mojokerto	1,319	3.4	6.8	710	Mojokerto	206	0.5	11.1	864
Malang	2,888	7.4	5.8	553	Malang	2,569	6.6	4.9	1,509
Blitar	1,037	2.7	6.2	439	Kediri	5,768	14.8	12.8	9,855
Kediri	1,407	3.6	6.6	454	Blitar	167	0.4	6.3	607
Nganjuk	1,151	3.0	6.3	532					
Jombang	1,269	3.3	6.0	521	Total (Brantas)	39,019	100.0	9.0	1,269
Tulungagung	976	2.5	7.5	479	East Java	66,191	-	7.7	872
Trenggalek	505	1.3	4.8	348	Indonesia	416,342	-	7.9	880

Surabaya is the center of services and industries in East Java, accounting for 40% of the total GRDP of the Brantas river basin area. Kediri follows Surabaya with Gudang Garam, one of the largest tobacco manufacturers in Indonesia, accounting for 15% of the total GRDP. Sidoarjo is the area where industrial location accelerated since 1980s leading to a GRDP share of 11%, significantly higher than the population share of 8%. Malang plays a role of industrial and service center in the southern part of the basin with a share of 7%.

GRDP growth in the Brantas river basin area exceeded those of Indonesia and East Java : 9.0% per year between 1993 and 1995 in Brantas in comparison with 7.7% per year in East Java and 7.9% per year in Indonesia. As shown in Table II.4, GRDP growth of the Brantas area started to accelerate in late 1980s, led by Surabaya, Mojokerto, Malang and Sidoarjo. Once showing a slight slowing down in 1992, growth began to accelerate again since 1993. The areas with especially high growth in recent years (1993 to 1995) are Kediri (12.8%/year), Mojokerto (11.1%/year), and Surabaya (10.7%/year). Most of other areas showed growth of around 6% per year, which is lower than the Brantas average, but is a high level of growth in an international context. Much of growth in these areas could be attributed to ripple effect of the fast growing areas.

High economic growth in the Brantas river basin area is attributed to the industrial sector. In the absence of sector-wise GRDP data at regency and municipality level, those for the East Java Province as representing major trends of the Brantas river basin area are referred to. Growth rates of the industrial sector including manufacturing and mining sub-sectors, of which the latter is minor in East Java, jumped up from 4.7% per year in the 1984-85 period to 10.7 % per year in the 1985 -92 period, further rising to 12.2 % per year in the 1993-1995 period. As a result, the share of the industrial sector in GRDP rose from 17% in 1984 to 30% in 1995. The table below summarizes this trend:

Sector	(Unit: %/year)		
	1984-85	1985-92	1993-95
Agriculture	3.1	3.2	0.5
Industry	4.7	10.7	12.2
Services	7.3	7.3	7.9
GRDP	5.5	6.7	7.7

Source : Table II.5

Note : Due to the change in base year from 1983 to 1993 taking place in 1993, a comparison of the data between 1992 and 1993 is impossible.

On average, GRDP per capita of Brantas was 1,269 US\$ per capita in 1995, 46% and 44% respectively higher than those of East Java (872 US\$) and Indonesia (880 US\$). Regencies and municipalities in the Brantas river basin area, however, were polarized into high income group and low income group. The high income group include municipalities and regencies where industries and services have developed rapidly. This group includes Kediri (9,855 US\$), exceptionally high due to the production by Gudang Garam, followed by Surabaya (2,581 US\$), Malang (1,509 US\$) and Sidoarjo (1,400 US\$). The low income group, on the other hand, includes areas where low value added activities such as agriculture production and agro-related and consumption related industries and services are dominant. GRDP per capita

of this group ranged from 348 US\$ (Trenggalek) to 864 US\$ (Mojokerto Municipality). The high income areas were, at the same time, fast growing areas. As a result, gap between high income group and low income group expanded between 1993 and 1995. For example, the ratio of GRDP per capita of Kediri to that of Trenggalek rose from 22 times in 1993 to 28 times in 1995. An essential challenge for the Brantas area for the coming years would be the reduction in income gap between urban and rural areas and agriculture and industry/service sectors.

#### II.2.4 Labor Force by Sector

The following table summarizes Table II.6, showing the number of labor force by sector in East Java.

Sector	1989 (thousand persons)	1992 (thousand persons)	Rate of change (%/year)
Agriculture	7,967	8,563	2.4
Industry	1,569	1,772	4.1
Services	5,389	5,871	2.9
Total	14,925	16,206	2.8
	(Composition in %)	(Composition in %)	
Agriculture	53.4	52.8	-
Industry	10.5	10.9	-
Services	36.1	36.2	-
Total	100.0	100.0	-

Note : Agriculture : agriculture, livestock, forestry, fishery  
 Industry ; mining, manufacturing  
 Services : all the others

The following characteristics are observed.

- (a) Half of the total job opportunities are created by the agriculture sector, indicating the importance of the agriculture sector.
- (b) The rate of growth of the total job opportunities was 2.8% per year between 1989 and 1992, higher than the rate of population increase at 1.1% per year during the same period, indicating that the population was provided with more job opportunities.
- (c) The increase in job opportunities was led by the industrial sector growing at 4.1% per year, especially the manufacturing subsector showing an expansion of 4.2% per year.

## **II.3 Economic Development Plans**

### **II.3.1 National Plans**

#### **(1) Second 25-Year Development Plan**

The First 25-Year Development Plan was initiated in the fiscal year 1969/1970 with the Development Trilogy, maintenance of harmony between equity, economic growth and stability, as the basic philosophy. During this period, the Indonesian economy grew steadily, increasing per capita GDP at US\$ 70 in 1969 to US\$ 700 at the end of the period in 1993. The Second 25-Year Development Plan starting in 1994/1995 is the continuation, enhancement and renovation of the First Plan that would support the Indonesian society and economy entering into a take-off stage, relying on its own ability and resources.

The major challenges during the second 25-Year Development Plan are summarized as follows.

- a. Sustaining high economic growth and control of population growth
- b. Promotion of equitable growth and reduction of gaps between regions, social groups, sectors and urban and rural areas as well as eradication of poverty population
- c. Resolving unemployment and underemployment through job creation and productivity improvement and reduction in unbalanced population distribution
- d. Improvement in the quality of the Indonesian people as human beings and development resources
- e. Development of science and technology for Indonesia to transfer into a developed and self-reliant nation
- f. Maintaining a balance between high economic growth and conservation of natural resources
- g. Development of an appropriate legal system to meet rapid economic growth and strengthening social institutions that would minimize adverse impacts of economic growth on social values and culture

Tackling these major challenges, the Second 25-Year Development Plan aims to achieve the following major socio-economic targets. Details are shown in Table II.7.

- population growth : 1.2 % per year
- economic growth : 7.3 % per year
- industrial growth : 9.2 % per year
- Agricultural growth : 3.5 % per year



## (2) REPELITA VI

The Sixth Five-Year Development Plan (" REPELITA VI ") is the first five-year plan of the Second 25-Year Development Plan. Within a general framework of the second 25-Year Plan, REPELITA VI sets forth policies and targets for social and economic development of Indonesia for the 1994/95 to 1998/99 period. REPELITA VI is an indicative plan to guide economic activities of the public and private sectors. The following are the policies and targets regarding industrial sector, agriculture sector, water resources sector and population growth.

### Industrial development

The industrial sector is expected to become the main vehicle for leading the economic growth of Indonesia. Its target growth rate is set at 9.4% per year for the industrial sector and 10.3% per year for the manufacturing subsector. As a result of leading role of the industrial sector, the shares in GDP are planned to rise from 20.8% to 24.1% for the industrial sector and from 17.6% to 21.3% for the manufacturing subsector. Export of manufactured goods is planned to grow by 17.8% per year, with its export amount reaching 54.8 billion US\$ by the end of REPELITA VI.

Priorities in industrial development are placed on agroindustry, mineral processing industry, machinery, capital goods and electronics industry and export-oriented industry. Growth targets of the major manufacturing subsector are set as follows.

- Agroindustries : 8.2% per year
- Basic metals and capital goods : 12.6% per year
- Chemical industries : 9.7 % per year
- Other industries ; 13.0 % per year

Out of these, growth targets set for paper and pulp industries, which are one of the two largest water consumers in the Brantas river basin are set as follows. The figure for the other large water consumer, sugar industry, is not available.

- pulp : 5.6% per year
- paper : 7.9% per year

### Agriculture development

The major objectives of agriculture development are the improvement of the standard of living for farmers and meeting food and nutritional needs of the population. These are to be achieved through the following policies.

- to raise the quantity, quality and diversity of agriculture products
- to improve efficiency in agriculture production
- to enhance and expand linkages with agro-industries

The following growth targets are set.

- agriculture sector : 3.4 % per year
- food crops/horticulture : 2.5 % per year
- animal husbandry : 6.4 % per year
- plantations : 4.2 % per year

#### Water resources

The following policies are presented.

- improvement in efficiency and productivity in water utilization
- increase in the supply of water for human settlements, agriculture, industry, tourism and power generation
- extension of irrigation networks
- improvement in water utilization through development of fair and efficient allocation system
- control of damage to environment
- strengthening of water resources institutions
- supporting regional water resources development

#### Population growth

Reduction in the population growth rate is the major objective. Population growth at 1.66 % per year in 1993 is planned to be decreased down to 1.51 % per year by 1998 through reduction in crude birth rate to 22.6 births per 1,000 population from 24.5 in 1993. The population of Indonesia is projected to reach 204.4 million in 1998, once this target is achieved.

#### **II.3.2 Provincial Plan**

Development policies and targets for the East Java Province are stipulated in a draft version of " Rencana Tata Ruang Wilayah Propinsi Daerah Tingkat I Jawa Timur 2008 " ( " Regional Development Plan of East Java Province for Year 2008 " hereafter " the Provincial Plan ") prepared by the East Java Provincial office. The major policies for provincial development are prepared based on the following principles.

- promotion of regional economic growth
- equitable development throughout the province
- enhancement of unity based on the archipelago concept
- efficient utilization of natural resources
- a good ecological balance
- protection of development assets

The following issues presented in the Provincial Plan are relevant to the present study.

(a) Economic growth

The Provincial Plan stipulates that the proportion of the East Java's economy to the national economy will rise from 15.3% in 1993 to 16.4% in 2018 in the high growth scenario and to 15.9% in the slower growth scenario. These targets can be converted to annual average growth rates by applying the national growth targets given in the aforementioned national 25-Year Development Plan. The following economic growth rates are derived for the East Java Province.

High growth scenario : 7.7% per year until 2020  
 Low growth scenario : 7.5% per year until 2020

(b) Population

The following table shows that the population of East Java is projected to grow to 39.2 million under the high case and to 37.7 million under the low case, while that of the Brantas river basin area is projected to reach 17.4 million in 2008 in the high growth case and 16.6 million in low growth case.

Population of East Java Province Projected by Provincial Plan (Unit : thousand)			
Item	Population in 1990	Population in 2008	Growth rate (%/year)
(High case)			
Municipality	4,136	5,633	1.7
Regency	28,352	33,586	0.9
Total	32,488	39,219	1.1
(Low case)			
Municipality	4,136	5,295	1.4
Regency	28,352	32,446	0.8
Total	32,488	37,741	0.8
Population of Brantas River Basin Area Projected by Provincial Plan (Unit : thousand)			
Item	Population in 1990	Population in 2008	Growth rate (%/year)
(High case)			
Municipality	3,637	5,028	1.8
Regency	10,083	12,341	1.1
Total	13,720	17,369	1.3
(Low case)			
Municipality	3,637	4,714	1.5
Regency	10,083	11,838	0.9
Total	13,720	16,552	1.0

(c) Land use plan

The land use plan projects an increase of industrial land at 3% per year, while irrigation area is set to grow at 0.3% per year as follows.

(Unit : ha)

Land use	Area in 1993	Area in 2008	Growth rate (%/year)
Irrigation area	896,292	933,097	0.3
Industrial area	34,288	53,182	3.0
Residential area	569,794	644,497	0.8
Other areas	3,291,874	3,161,472	-0.3
Total	4,792,248	4,792,248	0.0

Land use data were available only for the East Java Province and not for the Brantas river basin.

(d) Industrial development

Industrial development is to be promoted generally in the northern part of the province with the aim of preserving fertile agriculture area in the middle and southern areas, while promoting industries in northern areas with improved transportation access through such means as Surabaya - Madura Bridge Project. Such areas as Gresik and Tuban in the Bengawan river basin and Bangkalan in the Madura Island are high priority areas for industrial development.

### II.3.3 Surabaya - Madura Bridge Project

The study makes an analysis of the Surabaya - Madura Bridge project as part of industrial and domestic water demand forecast. It is planned that the water required for industrial and domestic purposes in the Madura Island, once the Surabaya - Madura Bridge project be implemented, will be supplied from the Surabaya river through the existing Kayoon water treatment plant. This plan, thus, necessitates the inclusion of the Madura project in the water demand projection in the Brantas river basin area.

The Surabaya - Madura Bridge Project was formerly initiated as a national project following the presidential decree number 55 in 1990. The decree designated the Agency for the Assessment and Application of Technology (BPPT) as the central body to promote the project. A number of studies and designs have been carried out until now under the guidance of BPPT.

The project aims to construct a bridge over the Madura Strait with a length of 5,438 meters, as well as developing an urban and industrial complex in the Bangkalan Regency, the westernmost regency on the Madura Island. The main objective of the project is to upgrade the economic standard of the population in the Madura Island and create a new industrial complex to absorb rapidly growing industrial activities away from the fertile Brantas river

basin area, thus enhancing growth momentum of the Surabaya metropolitan area. The project cost is estimated to be about 600 billion Rupiahs (about US\$ 250 million) with an estimated IRR of 23.4%. Funding of the project is planned as follows:

- equity by Indonesian consortium (including Jasa Marga): 5 %
- equity by Japanese consortium : 5 %
- loan from the Overseas Economic Cooperation Fund of Japan (OECF) : 80 %
- local loan : 10 %

Since 1996, negotiation between the Indonesian side and OECF has been focusing on the provision of guaranteeing the repayment of the OECF loan by the Indonesian government. The conclusion is yet to be seen as of October 1997.

By the year 2030 development of a 4,728 ha area is planned. The first stage development by the year 2010 will create an area of 1,570 ha containing industrial estate, residential area and business and commercial area.

#### **II.4 General Feature of the Brantas River Basin**

The Brantas river originates from the southern slope of the Arjuno Mountain Complex and debauches to the Madura Strait. The total length of the main course is as long as 320 km. The Brantas river flows southward on the Malang Plateau at about 400 m above SHVP, and turns to the westward near Kepanjen. After joining the Lesti river on the left bank and the Metro river on the right bank, the river reaches the Sutami dam site where the river bed elevation is about 200 m SHVP. The total catchment area at the dams site is about 2,050 km<sup>2</sup>, including 625 km<sup>2</sup> of the Lesti river basin. The average riverbed slope in the Upper Brantas is steeper than 1/200.

The river continues to flow westward up to the confluence with the Ngrowo river through Wlingi and Lodoyo dams on it. The total catchment area at the confluence is about 3,600 km<sup>2</sup> including 177 km<sup>2</sup> of the residual basin area of the Ngrowo river. As the results of the past drainage works, water from about 1,300 km<sup>2</sup> in the Ngrowo basin is drained to the Indonesian Ocean. The riverbed slope becomes gentle and is about 1/1,000 near the confluence. Tributaries in this stretch come from the southern slope of Mt. Kelud, and they carry large amount of sediment load erupted from Mt. Kelud.

After joining the Ngrowo river, the Brantas river flows north-northeastward up to Ploso through Kediri and Kertosono, and then turns to eastward up to Mojokerto, where it branches into the Porong river debauching to the Madura Strait and the Surabaya river debauching to the sea at the north of Surabaya city. Tributaries in this stretch are the Widas river on the left bank and the Konto river and others originating from Arjuno Mountain Complex. The total catchment area at the Lengkong dams site is about 8,650 km<sup>2</sup> including 687 km<sup>2</sup> of the Konto

river basin and 1,539 km<sup>2</sup> of the Widas river basin. The average riverbed slope in this stretch is 1/1,500 to 1/2,000.

The Porong and Surabaya rivers flow through a very flat plain lower than the elevation of 25 m SHVP. The Porong river works as flood diversion canal in the rainy season. The Surabaya river works as water supply canal to the Surabaya city as well as drain of the city. Tributaries are the Sadar and Kambing rivers to the Porong river and the Marmoyo river to the Surabaya river.

## II.5 History of the Brantas River Basin Development

Water resources in the Brantas river basin have been developed for irrigation, domestic and industrial water supply and power generation. Principal projects in the basin are given below:

No.	Project	Project Cost (million Yen)	Completed Year	Feature
1	South Tulungagung Drainage	-	1961	I/R(28,000ha), Tunnel L: 950 m Drain. Capacity: 500m <sup>3</sup> /s
2	Kali Konto Multipurpose Dam Project	1,604	1971	Dam H: 49 m, E.Storage: 54.6 mil. m <sup>3</sup> , H/P(4.5 MW), I/R(5,700 ha), F/C(460 m <sup>3</sup> /s)
3	Karangkates Multipurpose Dam Project (I)	7,713	1972	Dam H: 100.0 m, E.Storage: 253 mil. m <sup>3</sup> , H/P(70 MW), I/R(34,000 ha), F/C(1,490 m <sup>3</sup> /s)
4	Brantas Delta Irrigation Rehabilitation Project	468	1973	I/R( 29,250 ha)
5	Kali Porong River Improvement Project(I)	1,459	1977	F/C(1,500, 50 km)
6	Karangkates Multipurpose Dam Project (II) (Lahor Dam)	3,268	1977	Dam H: 74 m, E.Storage: 29.4 mil. m <sup>3</sup> , H/P(35 MW), I/R(1,100 ha)
7	Wlingi Multipurpose Dam Project (I)	6,150	1978	Dam H: 28 m, E.Storage: 5.2 mil. m <sup>3</sup> , H/P(27MW), I/R
8	Wlingi Multipurpose Dam Project (II)	7,008	1980	H/P(27MW)
9	Kali Surabaya River Improvement Project (I)	4,080	1981	Surabaya Riv.(370 m <sup>3</sup> /s), Mas Riv. (25-70 m <sup>3</sup> /s), Maryomo Riv. (230 m <sup>3</sup> /s)
10	Bening Dam and Widas Irrigation Project	1,833	1984	Dam H: 35.6 m, E.Storage: 33 mil. m <sup>3</sup> , I/R(8,600 ha)
11	Brantas Middle Reach River Improvement Project (I)	6,222	1985	F/C, FFWS Embank. Vol.: 14,000 m <sup>3</sup>
12	Brantas Middle Reach River Improvement Project (II)	6,000	1994	Excav. Vol.: 1,500,000 m <sup>3</sup> Barrage(Jatimlelek, Menturus) Watudakon Syphon
13	Kali Porong River Improvement Project (II)	5,905	1996	Cannel Improv.: 8.3 km, Drainage Pump
14	Kali Porong River Improvement Project	1,767	1993	Rehabilitation project, Embank. Vol.: 53,000 m <sup>3</sup>

No.	Project	Project Cost (million Yen)	Completed Year	Feature
15	Lodoyo Tulungagung Irrigation Development Project	20.50	1984	I/R(14,200 ha)
16	Tulungagung Drainage Project(II)	39.50	1985	Tunnel L: 1,156m Drain. Capacity: 570m <sup>3</sup> /s
17	Sengguruh Dam And Hydropower Project	18.20	1989	Dam H: 33 m, E.Storage: 2.7 mil. m <sup>3</sup> , H/P(29 MW)
18	Mt. Kelud Debris Control Project	2,880	On-going	Sandpocket(9), Check dam (27), Consoli. dam(29), Cross-dike(3)
19	East Java Ground Water Development Project	-	1992	I/R(30,000 ha)
20	Tulungagung Hydropower Project	-	1993	I/P(32 MW)
21	Wonorejo Multipurpose Dam Project (E/S)	241	On-going	Dam H: 100 m, E.Storage: 106 mil. m <sup>3</sup> , H/P(6.5 MW), E/C(280 m <sup>3</sup> /s)
22	Mt. Kelud Urgent Sabo Project	3,246	1996 On-going (Putih diversion tunnel)	Tunnel Rehabili (1), Sandpocket(1), Checkdam(6), Consoli. dam(1), Cross dike(3)

Table II.1 Population of the Brantas River Basin and Madura Island (Mid-year)

Area	Population										Annual average population growth rates (%/year)				
	1988	1989	1990	1991	1992	1993	1994	88-89	89-90	90-91	91-92	92-93	93-94	88-94	
(Regency)															
Sidoarjo	962,654	982,292	1,003,425	1,024,264	1,043,916	1,062,550	1,079,446	2.0	2.2	2.1	1.9	1.8	1.6	1.93	
Mojokerto	762,805	770,655	784,499	791,471	800,111	809,471	818,383	1.0	1.8	0.9	1.1	1.2	1.1	1.18	
Malang	2,109,233	2,121,026	2,134,865	2,208,864	2,212,914	2,232,831	2,231,564	0.6	0.7	3.5	0.2	0.9	-0.1	0.94	
Blitar	1,037,271	1,041,305	1,045,661	1,048,423	1,053,004	1,055,919	1,059,883	0.4	0.4	0.3	0.4	0.3	0.4	0.36	
Kediri	1,265,846	1,273,293	1,283,202	1,295,293	1,301,805	1,307,304	1,315,630	0.6	0.8	0.9	0.5	0.4	0.6	0.64	
Nganjuk	932,794	936,150	939,648	948,417	950,835	955,354	957,949	0.4	0.4	0.9	0.3	0.5	0.3	0.44	
Jombang	1,006,062	1,014,758	1,022,428	1,039,796	1,049,407	1,057,375	1,065,106	0.9	0.8	1.7	0.9	0.8	0.7	0.96	
Tulungagung	883,785	889,092	895,346	900,631	905,102	911,706	917,356	0.6	0.7	0.6	0.5	0.7	0.6	0.62	
Trenggalek	612,595	617,608	622,496	629,101	633,236	636,662	641,318	0.8	0.8	1.1	0.7	0.5	0.7	0.77	
Sub-total	9,573,045	9,646,179	9,731,570	9,886,260	9,950,330	10,029,172	10,086,635	0.8	0.9	1.6	0.6	0.8	0.6	0.87	
(Municipality)															
Surabaya	2,161,314	2,181,223	2,184,702	2,214,087	2,246,880	2,270,082	2,294,148	0.9	0.2	1.3	1.5	1.0	1.1	1.00	
Mojokerto	94,998	96,247	97,515	98,429	99,413	100,881	102,116	1.3	1.3	0.9	1.0	1.5	1.2	1.21	
Malang	620,880	634,171	644,801	654,798	669,754	681,684	699,853	2.1	1.7	1.6	2.3	1.8	2.7	2.02	
Kediri	232,638	228,604	230,018	231,018	230,497	231,371	232,685	-1.7	0.6	0.4	-0.2	0.4	0.6	0.00	
Blitar	114,571	115,532	116,333	116,940	117,471	117,877	118,753	0.8	0.7	0.5	0.5	0.3	0.7	0.60	
Sub-total	3,224,401	3,255,777	3,273,369	3,315,272	3,364,015	3,401,895	3,447,555	1.0	0.5	1.3	1.5	1.1	1.3	1.12	
Total (Brantas)	12,797,446	12,901,956	13,004,939	13,201,532	13,314,345	13,431,067	13,534,190	0.8	0.8	1.5	0.9	0.9	0.8	0.94	
Bangkalan	712,840	713,437	714,014	713,654	716,109	717,924	719,086	0.1	0.1	-0.1	0.3	0.3	0.2	0.15	
Sampang	617,215	620,018	620,316	703,142	704,975	704,055	704,281	0.5	0.0	13.4	0.3	-0.1	0.0	2.22	
Pamekasan	647,495	599,476	599,617	621,863	625,783	632,152	633,403	-7.4	0.0	3.7	0.6	1.0	0.2	-0.37	
Sumenep	901,918	905,675	905,716	915,014	914,233	917,432	920,173	0.4	0.0	1.0	-0.1	0.3	0.3	0.33	
Total (Madura)	2,879,468	2,838,606	2,839,663	2,953,673	2,961,100	2,971,563	2,976,943	-1.4	0.0	4.0	0.3	0.4	0.2	0.56	
East Java	30,816,391	30,944,202	31,112,878	31,856,287	32,022,032	32,206,021	32,370,441	0.4	0.5	2.4	0.5	0.6	0.5	0.82	

Source : Jawa Timur Dalam Angka 1990 and 1995, East Java Statistics Office



**Table II.2 Gross Regional Domestic Product of Regencies and Municipalities in Brantas River Basin**

Regency/ municipality	GRDP in current price						GRDP in 1993 price			Growth rates (%/year)			GRDP per capita in 1995	
	1994		1995		1995 (%)		1993	1994	1995	93-94	94-95	93-95	(Rupiah)	*(US\$)
	1993	1994	1995	1995 (%)	1993	1994	1995	93-94	94-95	93-95	(Rupiah)	*(US\$)		
(Regency)	3,280,313	3,716,160	4,203,324	10.8	3,280,313	3,513,903	3,828,677	7.1	9.0	8.0	3,149,265	1,400		
Sidoarjo	1,033,318	1,161,564	1,319,233	3.4	1,033,318	1,100,174	1,178,758	6.5	7.1	6.8	1,596,555	710		
Mojokerto	2,311,463	2,572,699	2,888,414	7.4	2,311,463	2,427,759	2,587,001	5.0	6.6	5.8	1,243,131	553		
Malang	830,963	926,966	1,036,905	2.7	830,963	881,992	936,754	6.1	6.2	6.2	987,341	439		
Blitar	1,111,220	1,243,290	1,406,573	3.6	1,111,220	1,180,623	1,263,827	6.2	7.0	6.6	1,020,736	454		
Kediri	928,431	1,032,427	1,151,218	3.0	928,431	986,180	1,049,138	6.2	6.4	6.3	1,196,009	532		
Nganjuk	972,624	1,105,095	1,268,791	3.3	972,624	1,029,441	1,093,148	5.8	6.2	6.0	1,171,986	521		
Jombang	786,267	896,382	975,750	2.5	786,267	843,259	909,061	7.2	7.8	7.5	1,077,701	479		
Tulungagung	430,472	473,664	504,516	1.3	430,472	447,760	473,140	4.0	5.7	4.8	781,833	348		
Trenggalek	10,804,460	12,939,502	15,554,250	39.9	10,804,460	11,904,188	13,231,986	10.2	11.2	10.7	5,804,583	2,581		
(Municipality)	179,539	190,676	205,871	0.5	179,539	202,147	221,739	12.6	9.7	11.1	1,942,181	864		
Surabaya	1,898,698	2,214,060	2,568,831	6.6	1,898,698	1,923,351	2,088,753	1.3	8.6	4.9	3,392,988	1,509		
Mojokerto	3,719,118	4,711,559	5,768,176	14.8	3,719,118	4,181,037	4,735,223	12.4	13.3	12.8	22,163,983	9,855		
Malang	131,592	149,304	166,905	0.4	131,592	142,067	148,566	8.0	4.6	6.3	1,364,719	607		
Kediri	28,418,478	33,333,348	39,018,757	100.0	28,418,478	30,763,881	33,745,771	8.3	9.7	9.0	2,854,707	1,269		
Blitar	618,356	692,498	792,993	-	618,356	637,140	670,180	3.0	5.2	4.1	1,028,060	457		
Total (Brantas)	49,141,792	57,132,626	66,191,133	-	49,141,792	52,713,233	57,028,429	7.3	8.2	7.7	1,960,519	872		
Bangkalan	57.8	58.3	58.9	-	57.8	58.4	59.2	113.6	118.4	116.1	145.6	145.6		
East Java (% Brantas/East Java)														

Source : Gross Regional Domestic Product of Regencies/Municipalities in Indonesia 1993-1995, Biro Pusat Statistik

Note : \* Exchange rate : 2.249 Rupiah per US\$ as average of 1995

Table II.3 Gross Regional Domestic Product Per Capita of Regencies and Municipalities in Brantas River Basin

Regency/ Municipality	GRDP per capita (in Rupiah)		GRDP per capita (in US\$)		Growth rates (%/year)		
	1993	1994	1993	1994	93-94	94-95	93-95
(Regency)							
Sidoarjo	2,599,607	2,862,438	1,250	1,325	6.0	5.7	5.8
Mojokerto	1,275,387	1,419,311	613	657	7.1	8.0	7.6
Malang	1,010,653	1,115,800	486	517	6.3	7.0	6.6
Blitar	792,025	883,120	381	409	7.3	7.4	7.3
Kediri	814,379	906,519	392	420	7.1	8.1	7.6
Nganjuk	971,011	1,076,006	467	498	6.7	6.8	6.7
Jombang	909,249	1,026,658	437	475	8.7	9.6	9.2
Tulungagung	873,824	992,892	420	460	9.4	4.2	6.8
Trenggalek	675,940	738,716	325	342	5.2	1.6	3.4
(Municipality)							
Surabaya	4,166,941	4,908,020	2,004	2,272	13.4	13.6	13.5
Mojokerto	1,736,356	1,820,296	835	843	0.9	2.5	1.7
Malang	2,597,577	2,975,088	1,249	1,377	10.2	9.5	9.9
Kediri	14,530,646	18,251,247	6,989	8,450	20.9	16.6	18.7
Blitar	1,087,992	1,227,326	523	568	8.6	6.8	7.7
Total (Brantas)	2,115,876	2,462,899	1,018	1,140	12.0	11.3	11.7
Bangkalan	810,056	902,278	390	418	7.2	9.4	8.3
East Java (Brantas/EJ.%)	1,478,111 143.1	1,704,978 144.5	711 143.1	789 144.5	11.0 109.2	10.4 108.5	10.7 108.8

Source : Gross Regional Domestic Product of Regencies/Municipalities in Indonesia 1993-1995.

Biro Pusat Statistik

Note : \* Exchange rates :

1993	2,079 Rupiah/US\$
1994	2,160 Rupiah/US\$
1995	2,249 Rupiah/US\$

Table II.4 (1/2) Gross Regional Domestic Product of Regencies and Municipalities in Brantas River Basin in 1983 Constant Price

(Unit : million Rupiah)

Kabupaten/ (Regency)	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Kotamadya											
Sidoarjo	464,517	481,670	505,333	537,253	571,075	617,581	692,236	788,846	899,656	955,137	1,050,259
Mojokerto	228,906	231,628	241,091	254,510	267,176	288,098	297,175	318,587	334,875	352,282	372,208
Malang	687,297	726,526	783,009	834,392	884,388	923,685	999,973	1,083,498	1,132,379	1,227,136	1,297,942
Blitar	225,802	237,318	253,572	265,774	274,792	287,447	298,856	310,513	327,726	346,057	357,987
Kediri	356,369	376,559	403,926	415,268	429,388	458,469	483,204	507,696	543,166	578,308	599,568
Nganjuk	211,248	224,471	236,419	249,040	259,522	274,615	291,986	307,230	330,768	350,475	365,845
Jombang	243,758	256,280	269,685	284,640	303,388	327,226	344,121	359,282	376,965	407,312	426,270
Tulungagung	250,260	264,027	276,798	286,885	305,545	323,629	348,605	366,573	392,116	420,326	445,143
Trenggalek	111,074	122,743	131,443	138,313	146,160	153,074	159,089	164,597	173,938	182,543	189,645
(Municipality)											
Sumbawa	1,399,920	1,503,003	1,595,922	1,719,881	1,831,517	1,985,753	2,190,741	2,399,280	2,626,337	2,851,148	3,131,633
Mojokerto	52,459	53,420	56,938	62,526	66,540	72,069	77,119	85,244	91,694	97,829	104,197
Malang	386,326	413,403	430,680	462,423	499,613	547,931	612,195	700,593	749,801	805,897	894,417
Kediri	502,820	536,643	562,356	605,977	676,725	729,526	800,823	871,289	932,579	998,203	1,119,643
Blitar	37,147	39,820	42,133	44,357	47,182	49,779	54,016	56,917	61,343	66,581	71,256
Total (Brantas)	5,157,903	5,467,411	5,786,325	6,160,239	6,563,411	7,037,792	7,650,139	8,320,245	8,973,043	9,639,204	10,426,013
Bangkaan	210,800	207,971	214,919	223,829	226,350	239,027	244,871	260,706	274,872	284,090	298,312
East Java	10,848,294	11,513,187	12,147,393	12,895,552	13,523,845	14,420,048	15,493,182	16,736,981	17,924,002	19,183,887	20,311,498
(% Brantas/Est. Jn)	48	47	48	48	49	49	49	50	50	50	51

Source : Gross Regional Domestic Product of Regencies/Municipalities in Indonesia 1983-1993, Biro Pusat Statistik

Table II.4 (2/2) Gross Regional Domestic Product of Regencies and Municipalities in Brantas River Basin in 1983 Constant Price : (Annual Growth Rate)

(Unit : %/year)

Kabupaten/ (Regency)	1983 Price				1993 Price				by period						
	83-84	84-85	85-86	86-87	87-88	88-89	89-90	90-91	91-92	92-93	93-94	94-95	83-87	87-93	93-95
Koamadya															
Sidoarjo	3.7	4.9	6.3	6.3	8.1	12.1	14.0	14.0	6.2	10.0	7.1	9.0	5.3	10.7	8.0
Mojokerto	1.2	4.1	5.6	5.0	7.8	3.2	7.2	7.2	5.2	5.7	6.5	7.1	3.9	5.7	6.8
Malang	5.7	7.8	6.6	6.0	4.6	8.3	8.4	4.5	8.4	5.8	5.0	6.6	6.5	6.6	5.8
Blitar	5.1	6.8	4.0	4.2	4.6	4.0	3.9	6.1	5.6	3.4	6.2	6.2	5.0	4.5	6.2
Kediri	5.7	7.3	2.8	3.4	6.7	5.4	5.1	7.0	6.5	3.7	6.2	7.0	4.8	5.7	6.6
Nganjuk	6.3	5.3	5.7	3.8	5.8	6.3	5.2	7.7	6.0	4.4	6.2	6.4	5.3	5.9	6.3
Jombang	5.1	5.2	5.5	6.7	7.8	5.2	4.4	4.8	8.1	4.7	5.8	6.2	5.6	5.8	6.0
Tulungagung	5.5	3.6	6.5	6.5	6.6	7.1	5.2	7.0	7.2	7.8	5.8	7.8	5.1	6.5	7.8
Trenggalek	10.5	7.1	5.2	5.7	4.7	3.9	3.5	5.7	4.9	3.9	4.0	5.7	7.1	4.4	4.8
(Municipality)															
Sumbawa	7.4	6.0	8.0	6.5	8.3	10.5	9.5	9.5	8.6	9.8	10.2	11.2	6.9	9.4	10.7
Mojokerto	1.8	6.6	9.8	6.4	8.3	7.0	10.5	7.6	6.7	6.1	12.9	9.7	6.1	7.8	11.1
Malang	7.0	4.2	8.0	7.4	9.7	11.7	14.4	7.0	7.5	11.0	13.3	8.6	6.6	10.2	4.9
Kediri	6.7	4.8	7.8	11.7	7.8	8.8	7.0	7.0	7.0	12.2	12.4	13.3	7.2	8.8	12.8
Blitar	7.2	5.8	5.3	6.4	5.5	8.5	5.4	7.0	7.8	8.2	4.6	4.6	6.2	7.1	6.3
Total (Brantas)	6.0	5.8	6.5	6.5	7.2	8.7	8.8	7.8	7.4	8.2	8.3	8.5	9.7	6.2	9.0
East Java	6.1	5.5	6.2	4.9	6.6	7.5	8.0	7.1	7.0	6.9	7.3	8.2	5.7	7.2	7.7

**Table II.5 Sectorwise Gross Regional Domestic Product  
in East Java in 1983 and 1993 Constant Prices**

(unit : billion Rupiah)

Year	Agriculture	Industry	Service	GRDP
		(1983 price)		
1984	3,723	1,991	5,799	11,513
1985	3,839	2,085	6,223	12,147
1986	4,001	2,274	6,621	12,896
1987	4,070	2,526	6,928	13,524
1988	4,145	2,777	7,498	14,420
1989	4,278	3,120	8,097	15,495
1990	4,475	3,499	8,762	16,736
1991	4,607	3,839	9,478	17,924
1992	4,775	4,239	10,166	19,180
		(1993 price)		
1993	9,669	13,342	26,161	49,172
1994	9,666	14,946	28,115	52,727
1995	9,773	16,802	30,473	57,048
		(Annual growth rates, %/year)		
1984-85	3.12	4.72	7.31	5.51
1985-86	4.22	9.06	6.40	6.17
1986-87	1.72	11.08	4.64	4.87
1987-88	1.84	9.94	8.23	6.63
1988-89	3.21	12.35	7.99	7.45
1989-90	4.60	12.15	8.21	8.01
1990-91	2.95	9.72	8.17	7.10
1991-92	3.65	10.42	7.26	7.01
1993-94	-0.03	12.02	7.47	7.23
1994-95	1.11	12.42	8.39	8.20
(1984-1985)	3.12	4.72	7.31	5.51
(1985-1992)	3.17	10.67	7.26	6.74
(1993-1995)	0.54	12.22	7.93	7.71
		(Share of sectors in %)		
1984	32.34	17.29	50.37	100.00
1985	31.60	17.16	51.23	100.00
1986	31.03	17.63	51.34	100.00
1987	30.09	18.68	51.23	100.00
1988	28.74	19.26	52.00	100.00
1989	27.61	20.14	52.26	100.00
1990	26.74	20.91	52.35	100.00
1991	25.70	21.42	52.88	100.00
1992	24.90	22.10	53.00	100.00
1993	19.66	27.13	53.20	100.00
1994	18.33	28.35	53.32	100.00
1995	17.13	29.45	53.42	100.00

Source : East Java in Figures, 1990, 1992 and 1995 (East Java Statistics Office)

Note : (1) Data for 1993 in 1983 price are not available.

(2) Components of each sector are as follows.

- Agriculture includes livestock, forestry and fishery sub sectors.
- Industry includes manufacturing and mining sub sectors.
- Services are all the remaining sub sectors.

**Table II.6 Number of Job Opportunities in East Java by Sector**

Sector	1989	1992	Rate of change (%/year)
		(Number)	
Agriculture	7,966,807	8,562,717	2.4
Mining	99,677	109,508	3.2
Manufacturing	1,468,961	1,662,335	4.2
Electricity	14,710	14,469	-0.5
Construction	673,505	729,940	2.7
Trade	2,552,002	2,865,616	3.9
Transportation	423,573	456,687	2.5
Finance	75,305	80,353	2.2
Services and others	1,650,346	1,724,140	1.5
<b>Total</b>	<b>14,924,886</b>	<b>16,205,765</b>	<b>2.8</b>
		(Composition in %)	
Agriculture	53.4	52.8	-
Mining	0.7	0.7	-
Manufacturing	9.8	10.3	-
Electricity	0.1	0.1	-
Construction	4.5	4.5	-
Trade	17.1	17.7	-
Transportation	2.8	2.8	-
Finance	0.5	0.5	-
Services and others	11.1	10.6	-
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>-</b>

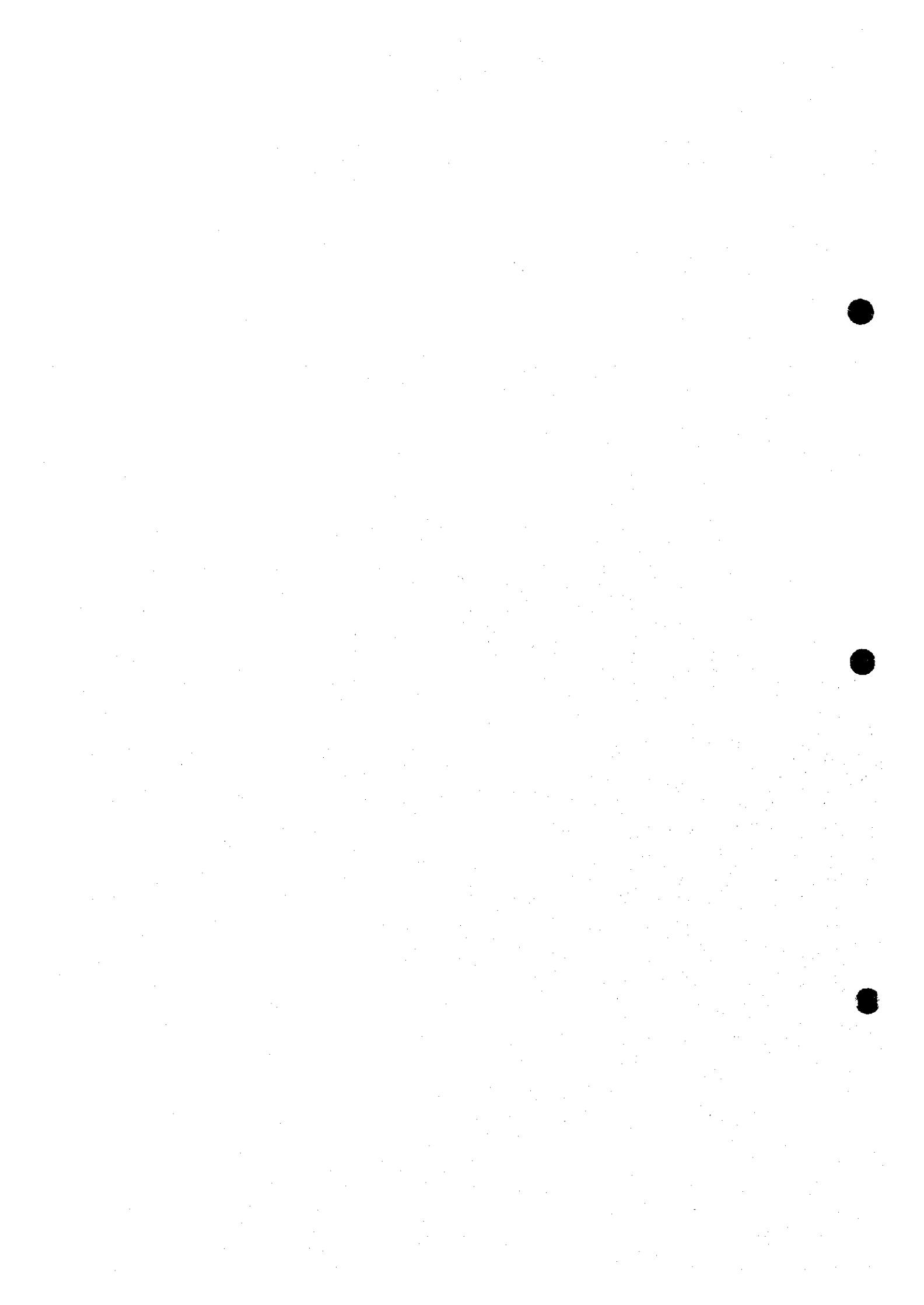
Source : Repelita VI report for East Java Province

Table II.7 Major Socio-Economic Targets of the Second 25-Year Plan  
and Sixth Five-Year Plan

Indicators	Unit	Ongoing Plan V	Five-Year Plans					Average
			VI	VII	VIII	IX	X	
1. Population	million	189.1	204.4	219.4	233.6	246.5	258.2	-
2. Life expectancy	%/year	1.66	1.51	1.37	1.20	1.01	0.88	1.19
3. GDP growth rates	years of age	62.7	64.6	66.3	67.8	69.3	70.6	-
Agriculture	%/year	2.4	3.4	3.5	3.5	3.5	3.5	3.5
Industry	%/year	10.0	9.4	9.4	9.4	9.1	8.7	9.2
(Manufacturing)	%/year	11.0	10.3	10.2	10.0	9.5	9.0	9.8
Other	%/year	7.2	6.0	6.3	6.8	8.0	9.5	7.3
Total	%/year	6.6	6.2	6.6	7.1	7.8	8.7	7.3
4. GDP per capita (end of each period)	US\$	676	775	995	1,317	1,816	2,631	-
5. GDP composition								
Agriculture	%	20.2	17.6	15.2	12.8	10.5	8.2	-
Industry	%	20.8	24.1	27.4	30.5	32.4	32.5	-
(Manufacturing)	%	17.6	21.3	25.1	28.7	31.0	31.5	-
Other	%	59.0	58.3	57.4	56.7	57.1	59.4	-
Total	%	100.0	100.0	100.0	100.0	100.0	100.0	-
6. East Java's GRDP growth								
Agriculture	%/year	n.a	2.5	-	-	-	-	n.a
Industry	%/year	n.a	6.2	-	-	-	-	n.a
Manufacturing	%/year	n.a	9.6	-	-	-	-	n.a
Construction	%/year	n.a	7.4	-	-	-	-	n.a
Trade and transportation	%/year	n.a	6.0	-	-	-	-	n.a
Services	%/year	n.a	5.8	-	-	-	-	n.a
Other	%/year	n.a	5.5	-	-	-	-	n.a
Total	%/year	n.a	6.1	6.4	6.7	7.4	8.3	7.0

Source : REPELITA VI Indonesia's Sixth Five-Year Development Plan (BAPPENAS)

**III PRESENT CONDITIONS OF  
THE WATER RESOURCES MANAGEMENT  
OF THE BRANTAS RIVER BASIN**





### **III.1 Meteorology and Hydrology**

#### **III.1.1 Meteorological and Hydrological Observations**

##### **(1) Meteorological and Hydrological Observatories in the Brantas River Basin**

The meteorological and hydrological observation are conducted in the Brantas river basin by various agencies including PJT (Jasa Tirta Public Corporation), Dinas PU Pengairan (Provincial Water Resources Service) and BRIKT (Land Rehabilitation and Soil Conservation Bureau, Ministry of Forestry), etc. as shown in Table III.1.

##### **(2) Meteorological and Hydrological Observation by PJT**

###### **(a) Observation Organization in PJT**

The Planning and Controlling Unit is responsible for the meteorological and hydrological observation in PJT. The site observation is carried out by ASA I (Division of upstream water service) located close to the Lahor dam and ASA II (Division of downstream water service) located in Kediri. ASA I and ASA II consist of three(3) sub divisions each which operate all the observatories located in the catchment area of the Brantas river.

###### **(b) Meteorological Observation**

The PJT operates 109 meteorological stations as shown in Figure III.1. ASA I manages 68 stations including 18 telemetering stations of the FFWS (Flood Forecasting and Warning System) stations while ASA II manages 41 stations including eight(8) telemetering stations. The rainfall data of 26 telemetering stations are sent to PJT, Malang by the telecommunication system after the installation of FFWS in 1991.

###### **(c) Hydrological Observations**

The PJT operates 52 hydrological stations of which 28 stations are operated by ASA I and 24 by ASA II (ref. Figure III.2). The hydrological stations including 21 telemetering stations are conducting water level and outflow observations.

#### **III.1.2 Sedimentation of the Existing Reservoirs**

##### **(1) Reservoir Storage Volume of the Existing Dams**

Gross and effective storage volume of the existing dams at the completion of the construction are shown below to compare with the respective volumes based on the latest survey of each dam. The previous surveys conducted in the respective dams are presented in Table A1-8 in Annex 1.

Name of Reservoir	H.W.L. (m)	L.W.L. (m)	Original			Latest Survey			(Latest)/(Original)	
			Gross Storage (Mil.m <sup>3</sup> )	Effective Storage (Mill.m <sup>3</sup> )	Completion Year	Gross Storage (Mil.m <sup>3</sup> )	Effective Storage (Mill.m <sup>3</sup> )	Survey Year	Gross Storage (%)	Effective Storage (%)
Sengguruh	292.5	291.4	21.50	2.50	1988	3.37	1.17	Jul.1996	15.7	46.8
Sutami	272.5	246.0	343.00	253.00	1972	183.42	146.63	Aug.1997	53.5	58.0
Lahor	272.7	253.0	36.10	29.40	1977	32.88	26.54	Jul.1995	91.1	90.3
Wlingi	163.5	162.0	24.00	5.20	1977	4.97	1.41	Nov.1996	20.7	27.1
Lodoyo	136.0	125.5	5.80	4.20	1980	2.35	2.35	Nov.1996	40.5	56.0
Serolejo	622.0	598.0	62.30	50.10	1970	48.76	44.51	Nov.1993	78.3	88.8
Benibg	108.6	96.4	32.90	28.40	1981	31.70	28.05	Nov.1993	96.4	98.8

Source : PJT, Itaric is estimated by the Study Team

The above table shows a large reduction in the effective storage of the Sengguruh, Sutami, Wlingi and Lodoyo reservoirs with a range from 27% of the original in Wlingi reservoir to 58% in the Sutami reservoir.

## (2) Evaluation of Sedimentation in Sengguruh and Sutami-Lahor Reservoirs

Figure III.3 show the change of longitudinal profile of the Sutami reservoir(the lowest elevation) along the Brantas river while those of the Sengguruh and Lahor reservoirs are presented in Figure A1-8 through A1-10 of Annex 1.

The reservoir storage capacity in the Sutami reservoir is computed as follows:

Survey Year	Gross Storage		Effective Storage		Storage between El.260m and H.W.L		Remarks
	(Mil.m <sup>3</sup> )	(1977) = 100	(Mil.m <sup>3</sup> )	(1977) = 100	(Mil.m <sup>3</sup> )	(1977) = 100	
1977	261.68	100.0	194.48	100.0	108.19	100.0	Surveyed by HRS
1982	221.29	84.6	167.20	86.0	97.88	90.5	Surveyed by PKB
1987	192.41	73.5	152.87	78.6	95.34	88.1	Surveyed by PKB
1988	193.82	74.1	151.35	77.8	92.77	85.7	Surveyed by PKB
1989	192.39	73.5	152.63	78.5	94.37	87.2	Surveyed by PKB
1992	194.65	74.4	154.81	79.6	96.86	89.5	Surveyed by PJT
1994	185.27	70.8	148.41	76.3	96.31	89.0	Surveyed by PJT
1995	184.59	70.5	148.62	76.4	95.38	88.2	Surveyed by PJT
1997	183.42	70.1	146.63	75.4	94.45	87.3	Surveyed by PJT

Source : Computed by the Study Team.

The change of accumulated sediment volume calculated from the storage shown above is illustrated in Figure III.4. The figure shows clearly that the completion of the Sengguruh dam in 1988 has contributed to reduce the additional sedimentation in the Sutami reservoir though the possible effect of compaction of the sediment should be taken into consideration. Even though after the Sengguruh reservoir is almost full by accumulated sediment after 1993, the increase of sediment in the Sutami reservoir has been insignificant.

### III.2 Watershed Conservation, Sabo and Flood Control

This section presents main results of the study on present condition of the watershed conservation, sabo and flood control in the Brantas river basin. Detailed discussions and data not incorporated in this section are presented in the ANNEX-2 "WATERSHED CONSERVATION, SABO AND FLOOD CONTROL" of the Supporting Report.

#### III.2.1 Present Condition of Watershed Conservation

##### (1) Land Use

The present land-use in the Brantas river basin is surveyed by authorities concerned for their own purposes. Those authorities are Agrarian office, BRLKT including its sub-sections, Perum Perhutani and East Java Province.

Based on the surveys and plans by East Java Province and Perum Perhutani, land use in 1990 and land use plan in 2008 in the Brantas river basin are presented in Figures III.5 and III.6, respectively. Although there are some difference of the land classification between the surveys and the plans, those land use areas are summarized below:

Land Categories	Present (1990)			Plan (2008)		
	Whole Basin (km <sup>2</sup> )	Mountainous		Whole Basin (km <sup>2</sup> )	Mountainous	
		(km <sup>2</sup> )	%		(km <sup>2</sup> )	%
Paddy field	4,315	1,010	18	4,371	1,144	20
Upland field	2,143	1,852	32	1,107	823	14
Forest	3,094	2,288	40	3,411	2,360	41
Homestead	1,701*	319*	6	2,072	834	15
Others	547	259	4	839	567	10
<b>Total</b>	<b>11,800</b>	<b>5,728</b>	<b>100</b>	<b>11,800</b>	<b>5,728</b>	<b>100</b>

%: Land use ratio in the mountainous area.

\*: Village area

Land use in the whole basin in 1990 was estimated at farm land: 55%, forest: 26%, homestead area: 14% and others: 5%, respectively. On the other hand, in 2008, farm land will be decreased and forest and homestead areas will be increased comparing with those in 1990.

##### (2) Watershed Conservation

According to the study in 1988 by the Ministry of Forestry, critical land is widely distributed in the basin as shown in Figure III.7 and is classified as shown in Table III.2. Based on this study, the critical land of erosion in the Brantas river basin is estimated at around 3,300 km<sup>2</sup> in total. Watershed conservation works are necessary for such lands.

### (3) Present Operation and Maintenance

At present, three (3) authorities, consisting of Sub-BRLKT, DPKT and Perum Perhutani, mainly conduct the watershed conservation in the Brantas river basin. Tasks of those authorities are as follows.

Authority	Tasks
Sub-BRLKT	<ul style="list-style-type: none"><li>- Establishment of 25-year long-term plan and 5-year short term plan for land rehabilitation and soil conservation in the Brantas river basin except Perum Perhutani area.</li><li>- Engineering consultant activities for farmers.</li><li>- Experimental study on relation among vegetation, runoff and erosion. (Pilot plot: Dampit and Blitar)</li></ul>
DPKT	<ul style="list-style-type: none"><li>- Guidance of forestation and land conservation in the Brantas river basin except Perum Perhutani area based on the 5-year plan by Sub-BRLKT.</li><li>- Preparation of material for forestation and land conservation.</li><li>- Training and education of farmer.</li><li>- Production of natural silk.</li><li>- Production of honey.</li></ul>
Perum Perhutani	<ul style="list-style-type: none"><li>- Planning and implementation of reforestation.</li><li>- Production of woods</li><li>- Watershed conservation</li></ul>

#### III.2.2 Present Condition of Sabo

Sediment yield in the Mt. Kelud basin mainly result from eruption of Mt. Kelud. As a result, Wlingi and Lodoyo reservoirs located at the lower reaches of the basin were damaged by sediment deposition coming from southern slopes of Mt. Kelud. In order to settle this problem, the sabo works have been being constructed by PGKS. Figure III.8 shows the location of the Mt. Kelud sabo project by PGKS. The progress of the project up to 1996 is only about 50 % of the target of the master plan in 1970.

The sabo works in the Konto, Upper Brantas and Lesti river basins have been also being constructed or rehabilitated by PKB and PJT, however, these are insufficient to trap sediment discharge thoroughly.

#### III.2.3 Present Condition of Flood Control

Flood control works in the Brantas river basin have been being implemented by PKB, based on the master plan formulated in 1985 (refer to as the 1985 Master Plan). The design discharge distribution in the Brantas river basin are shown in Figure III.9.

The main stream of the Brantas river is almost improved with a safety level of 50 years return period based on the 1985 Master Plan and the discharge capacity is shown in Figure III.10. At present, the Widas flood control project has been being implemented with a safety level of 10 years return period which responds to the first stage plan formulated in the 1985 Master Plan. The progress of the project is around 65% as of 1997.

According to the river survey results of the Brantas river, the riverbed degradation is a serious problem in the lower and middle stretches of the Brantas river. Sand-mining activities seems to be main cause of the degradation. The sand mining volume surveyed by PJT is estimated at 2,000,000 m<sup>3</sup> per annum and that corresponds to 13 cm of the riverbed degradation in the stretches of the sand mining. On the other hand, existing river bed in the same stretches is lowered at 9.5 cm/year in average as shown in Figure III.11.

#### **III.2.4 Problems and Recommendation**

Based on the studies on the present condition of the watershed conservation, saabo and flood control, the following problems are identified and recommendations are made.

##### **(1) Problem**

- At present, land use related to the Brantas River basin are surveyed by four authorities, namely Agrarian office, BRLKT and East Java Province, for their own purpose. As for future land use, BRLKT and East Java Province have respective plans. As a result, there is no responsible authority in an aspect of the watershed management.
- Sub-BRLKT is implementing the experimental research for the watershed management. However, areas of the experimental research are rather small and the results of research are limited to use for planning.
- The progress of the saabo works in Mt. Kelud is only about 50 % by the target storage capacity of the master plan in 1970. On the other hand, it is forecasted that Mt. Kelud erupt in 2005.
- Three authorities, consisting of PKB, PGKS and PJT are carrying out the present saabo works in the basin based on the their own plans. Therefore, the present saabo works seems not to be coordinate each other, considering the whole Brantas River basin. For example, there are many critical areas located in the Lesti iiver basin and the Ngrowo river Basin. For these area, even though the saabo works are urgently needed.
- The riverbed degradation becomes a serious problem in the lower and middle stretches of the Brantas River. Sand-mining activities seems to be main cause of the degradation.
- At present, most of flood damage happens in the tributaries. However, the flood control works in tributaries except major tributaries are scarcely implemented.

##### **(2) Recommendation**

- Considering the PJT's Tasks, PJT shall be responsible to the watershed management and

coordinate the watershed conservation activities among the authorities concerned.

- The experimental research should be implemented by PJT in cooperation with Sub-BRLKT.
- It is necessary to grasp urgently the present conditions of deposited sediment amount in the basin, to prepare a detailed sediment control plan for the next eruption and to execute the continuous sabo works.
- Three authorities should cooperate in establishing the basin-wide master plan of the sabo works and should adjust the implementation of their works. To carry out the sabo works efficiently and certainly, however, it is recommendable that three authorities be integrated into one authority.
- Considering the influence of the riverbed degradation on the river facilities, it is required to stop the sand mining activities immediately. However, it is difficult to stop the activities completely. Therefore, it is recommendable to carry out the following activities.
  - a. To carry out inventory surveys of the sand mining activities separately in the rainy season and dry season.
  - b. To study the sediment controls taking into consideration of the sabo works, sediment transport, sand mining and so on.
- It is recommendable to review the 1985 Master Plan considering needs of inhabitants and flood damage in tributaries.