

**JAPAN INTERNATIONAL COOPERATION AGENCY
THE GOVERNMENT OF THE REPUBLIC OF INDONESIA**

**THE STUDY ON FLOOD CONTROL AND WATER MANAGEMENT
IN
LIMBOTO-BOLANGO-BONE BASIN
IN THE REPUBLIC OF INDONESIA**

**FINAL REPORT
VOLUME-I SUMMARY**

DECEMBER 2002

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

**THE STUDY ON FLOOD CONTROL AND WATER MANAGEMENT
IN
LIMBOTO-BOLANGO-BONE BASIN**

FINAL REPORT

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The costs are estimated based on the price and average exchange rate in November 2001. The average exchange rate is assumed as follows:

US\$ 1.00 = Rp.9,600

¥ 1 = Rp.77.4

PREFACE

In response to a request from the Government of the Republic of Indonesia, the Government of Japan decided to conduct the Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia and entrusted to study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Noboru JITSUHIRO of NIKKEN Consultants, Inc. (consisting of NIKKEN Consultants, Inc. and NIPPON KOEI Co, LTD.) to Indonesia, twice between June 2001 and December 2002.

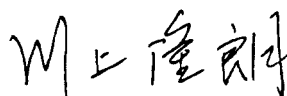
In addition, JICA set up an advisory committee headed by Mr. Katsuhiko INOUE, Senior Councilor of Japan Water Resources Association between June 2001 and December 2002, which examined the Study from technical points of view.

The team held discussions with the officials concerned of the Government of the Republic of Indonesia 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 the Republic of Indonesia for their close cooperation extended to the Study.

December 2002

A handwritten signature in black ink, appearing to read 'Takao Kawakami' in Japanese characters.

Takao Kawakami

President
Japan International Cooperation Agency

December 2002

Mr. Takao Kawakami
President
Japan International Cooperation Agency (JICA)
Tokyo, Japan

LETTER OF TRANSMITTAL

It is with great pleasure that we submit to you the Final Report of the Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia.

The Study has been made to formulate a flood mitigation master plan in Limboto-Bolango-Bone basin and to conduct a feasibility study on the priority projects. This Report includes all the study results and consists of Summary, Main Report, Supporting Report, Data Book and Drawings.

We hope that this Report will be helpful for the enhancement of people's livelihood in the flood prone areas and for the economic development of the new-born Gorontalo Province.

We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency, JICA Indonesia Office, the Embassy of Japan in Indonesia, Ministry of Settlement and Regional Infrastructure and other authorities concerned of the Government of Republic of Indonesia for the courtesies and cooperation extended to us during our Study.

Very truly yours,



Noboru JITSUHIRO

Team Leader
for the Study on Flood Control
and Water Management
in Limboto-Bolango-Bone Basin
in the Republic of Indonesia



DO YOU KNOW GORONTALO?

AND LIMBOTO–BOLANGO–BONE (LBB) BASIN?

- **Gorontalo Province is located** in the north of Sulawesi Island, and almost of the Limboto-Bolango-Bone basin (the LBB basin) is located administratively in Gorontalo Province.
- **Gorontalo** is a new province established in December 2000, separating from North Sulawesi Province, as the 32nd province of the Republic of Indonesia.



- **The LBB basin** has a total catchment area of 2,700 km², consisting of three basins of Lake Limboto (890 km²), Bolango River (490 km²) and Bone River (1,320 km²).
- **Estimated population** in the LBB basin is 442,000 consisting of 307,000 in Kabupaten Gorontalo and 135,000 in Kota Gorontalo. The urban population is about 205,000.
- **Economic activities** of Gorontalo Province are specialized in agriculture. The agriculture sector absorbed 64 % of labor force, followed by service sector (24 %) and industrial sector (12 %).
- **Per capita GRDP** is very low reported to be Rp.1.5 million which corresponds to only 23 % (or less than 1/4) of the national average.

FLOODS HIT GORONTALO REPEATEDLY. JUST LOOK AT REAL SITUATIONS !



**Inundated Gorontalo City
and evacuation tents
taken during floods
in February 2001 and May 2002**

LISTEN TO THE TALKS OF FLOOD SUFFERERS.

Mr. Ishak P. Thalib (70), Kelurahan Tenda, Kota Selatan, Gorontalo said:



In February 2001, Heavy rainfall in the evening caused midnight flooding in the village. Although the water level lowered in the morning, it rose again and again due to succeeding rainfalls. The flooding with rise and fall of water repeated for more than one month. This is the typical inundation pattern of this area.

The floodwater often stagnated in the house for 2 to 3 days. All the important movables were moved to higher places in the house before flood came. Man could not sleep well during the flood, watching the floodwater movement. The rising water stays at the same level for about 2 hours, it is the sign of flood peak. They started to prepared for house-cleaning works. The mud in the house must be removed by withdrawing floodwater.

While men and women were busy in coping with flood, children were playing in the inundated water and mud, and they suffered from skin disease. Many of the sufferers from flood have skin disease, cough and phlegm, and cold.

Mr. Anjuna Larafi (54), Farmer, Desa Tualango, Kecamatan Telaga said:



Since I was born here, I experienced more than 100 times of inundations. The inundation lasts long, for 3 months or more. When the lake water level is getting higher and black thick clouds appear on the mountain, village people start to prepare for evacuation.

In 2001, the inundation continued for 3 months. Inundation depth was kept high at about 1 m above floor level, though it lowered intermittently. During the flood, my family evacuated to friend's house with important movables. Some villagers evacuated to the mosque. Every evening during the evacuation, I came to see my house, riding on a raft made of banana stems.

During and after the inundation, peoples in the inundated area were suffered from skin disease and stomach troubles (vomiting and diarrhea). Most of the children experienced these diseases. Sufferers from flood were supported by various organizations including those of Japan. When lowering lake water was predicted, I went back to house to start cleaning. Even after resident got free from inundation, I had to wait long for farming, for my farmlands were still inundated covered with mud.

THE STUDY ON FLOOD CONTROL AND WATER MANAGEMENT IN LIMBOTO-BOLANGO-BONE BASIN

OUTLINE OF THE STUDY

1. THE STUDY																							
11. Objectives of Study	1) To formulate a master plan of sustainable flood control and water management plan in Limboto-Bolango-Bone (LBB) basin 2) To conduct the feasibility study on the priority project(s) 3) To transfer technology to counterpart personnel in the course of the Study																						
12. Period of Study	For 19 months from June 2001 to December 2002																						
2. DIAGNOSIS ON FLOOD DISASTERS																							
21. Major Flood Suffering Areas	1) Southern part of Gorontalo City (most serious) 2) Middle reaches of the Bolango River 3) Limboto and Isimu-Pohu areas 4) Western area of Lake Limboto																						
22. Causes of Disasters	1) Devastation of watershed 2) Concentration of properties on narrow plain 3) Insufficient flood mitigation facilities 4) Inappropriate land use in flood plain Besides, financial constraint, shortage of engineers, and lack of flood mitigation master plan aggravate the situation.																						
3. PRINCIPLES FOR PLANNING																							
31. Objective of Master Plan	To direct or guide the flood mitigation activities to be carried out toward the target year by various agencies concerned.																						
32. Scope of Planning	Structural and non-structural measures should be incorporated in the plan. The structural measures are limited to primary facilities to mitigate flood and sediment damages of the area.																						
33. Target Year	At the end of Tenth Five-Year Plan in 2019.																						
34. Design Scale	The flood mitigation plan shall cope with the 20-year flood.																						
4. PROPOSED FLOOD MITIGATION MASTER PLAN (FM-MP)																							
41. Structural Measures	After studying various alternative schemes, the following projects were proposed for the FM-MP: <table border="1" style="margin-left: 40px; width: 100%;"> <thead> <tr> <th>Sub-projects</th><th>Rp. Billion</th></tr> </thead> <tbody> <tr><td>1) Bone River Improvement</td><td>75.0</td></tr> <tr><td>2) Tamalate River Improvement with Floodway:</td><td>189.5</td></tr> <tr><td>3) Bolango River Improvement</td><td>44.5</td></tr> <tr><td>4) Biyonga River Improvement</td><td>30.2</td></tr> <tr><td>5) Meluopo River Improvement</td><td>15.3</td></tr> <tr><td>6) Marisa River Improvement</td><td>23.7</td></tr> <tr><td>7) Alo-Pohu River Improvement</td><td>109.0</td></tr> <tr><td>8) Rintenga River Improvement</td><td>23.9</td></tr> <tr><td>9) Lake Limboto Management</td><td>43.9</td></tr> <tr> <td>TOTAL</td><td>555.0</td></tr> </tbody> </table>	Sub-projects	Rp. Billion	1) Bone River Improvement	75.0	2) Tamalate River Improvement with Floodway:	189.5	3) Bolango River Improvement	44.5	4) Biyonga River Improvement	30.2	5) Meluopo River Improvement	15.3	6) Marisa River Improvement	23.7	7) Alo-Pohu River Improvement	109.0	8) Rintenga River Improvement	23.9	9) Lake Limboto Management	43.9	TOTAL	555.0
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42. Non-structural Measures	<p>Non-structural measure generally takes time to realize the effects, but it steadily strengthens the basin against floods. Following measures were incorporated in the FM-MP:</p> <ol style="list-style-type: none"> 1) Watershed management: To promote activities undertaken by the relevant agencies and community people for floodwater and sediment retention in the watershed areas. 2) Flood-plain management: To guide and support self-help activities of the community people in the flood-prone areas and reduce substantial damages due to floods.
43. Implementation Plan	<ol style="list-style-type: none"> 1) Preparatory Stage: 2003 to 2004 2) Intensive Implementation Stage: 2005 to 2009 3) Sustainable Implementation Stage: 2010 to 2019
44. Project Evaluation	The FM-MP was evaluated economically viable (EIRR: 14.7%). The plan was also evaluated to be valid from the natural and social environmental aspects.
45. Selection of Priority Projects	<p>Following projects were selected for intensive implementation as the Priority Projects:</p> <ol style="list-style-type: none"> 1) River Improvement of the Lower Bone-Lower Bolango rivers 2) Tapodu River Improvement with Tapodu Gate 3) Construction of Tamalate Floodway 4) Sediment Trap Works in Lake Limboto <p>Non-structural measures (watershed and flood plain management) are also proposed as a part of the Priority Project.</p>
46. Effects of Priority Projects	<ol style="list-style-type: none"> 1) Flood mitigation in urban area of Gorontalo City 2) Water level control of Lake Limboto and the quick drainage of retained water 3) Alleviation of sedimentation problems of Lake Limboto
5. FEASIBILITY STUDY FOR PRIORITY PROJECTS	
51. Review of FM-MP	Considering existing channel capacity and minimizing resettlement houses, design discharge of the lower Bolango River was revised to be 200 m ³ /s based on 20-year flood, and the remaining discharge from the upper Bolango (550 m ³ /s) shall be controlled by Lake Limboto.
52. Bone-Bolango-Tapodu River Imp. Project	<p>The Bone-Bolango River from the Tapodu River confluence to the sea is to be improved for 200 m³/s. The right Bolango River shall be improved as main flood channel. Cut-off channel, excavation and normalization of river channel, construction and strengthening of dikes, and bank protection works were also proposed.</p> <p>Main function of the Tapodu River is to lead floodwater from the Bolango River (550 m³/s), and to drain it quickly after the flood. A control gate to be constructed near the Bolango confluence has main function to maintain the lake water level during dry season.</p>
53. Tamalate Floodway Project	The Tamalate floodway aims to divert flood runoff (120 m ³ /s) from the upper Tamalate River to the Bone River before flowing into Gorontalo City. At the divergence, a diversion weir is installed. Although the existing Tamalate River is closed for floods at the divergence, a sluice gate is installed for water supply during ordinary time for domestic use and river maintenance.
54. Sediment Trap Works in Lake Limboto	The sediment trap works aims to guide and trap the sediment in the northern part of the lake. The work is proposed as research works to measure lake sedimentation and as test works to develop usage of lake sediment. Major project works are the construction of bamboo-net fence to trap sediment and realignment of the Biyonga and Alo-Pohu rivers toward the sedimentation area.

55. Project Cost and Fund Required	<p>The project cost for the implementation of the Priority Projects was estimated at the fixed price as of November 2001 as follows:</p> <table border="1" data-bbox="478 288 1347 454"> <thead> <tr> <th>Sub-projects</th><th>Rp. Billion</th></tr> </thead> <tbody> <tr> <td>1) Bone-Bolango-Tapodu River Improvement</td><td>120.2</td></tr> <tr> <td>2) Tamalate Floodway:</td><td>20.8</td></tr> <tr> <td>3) Sediment Trap Works in Lake Limboto</td><td>2.7</td></tr> <tr> <td>TOTAL</td><td>143.7</td></tr> </tbody> </table> <p>The fund required for the implementation of works was estimated at Rp.179.4 billion in total, considering price contingency until and during the construction period.</p>	Sub-projects	Rp. Billion	1) Bone-Bolango-Tapodu River Improvement	120.2	2) Tamalate Floodway:	20.8	3) Sediment Trap Works in Lake Limboto	2.7	TOTAL	143.7
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56. Watershed and Flood-Plain Management	<p>Besides the structural measures above, watershed and flood-plain management shall be implemented so as to realize the basin and communities invulnerable to floods. These activities should be implemented continuously as a routine work, not as a project. It is also advisable to conduct these activities in collaboration with NGOs acting among communities and government agencies.</p>										
57. Project Implementation	<p>1) Preparatory period: 2003-2004 2) Land and Compensation: 2004-2008 3) Construction: - Bone-Bolango River Improvement Project: 2005-2007 - Tapodu River Improvement Project with Gate: 2005-2007 - Tamalate Floodway Project: 2007-2009 - Sediment Trap Works in Lake Limboto: 2005-2006 4) Non-structural Measures: Continuously from 2003</p>										
58. Economic Evaluation of Priority Project	<p>The EIRR of the Priority Projects were worked out under the future socio-economic conditions as follows: 1) Bone-Bolango-Tapodu River Improvement Project: 17.0% 2) Tamalate Floodway Project: 16.2% 3) Whole Priority Projects: 16.9% Sensitivity analysis also confirmed their viability even for 10% of cost over-run and 10% of benefit-shortage. The Priority Projects were evaluated to be economically viable.</p>										
59. EIA of Priority Project	<p>Study for environmental impact assessment (EIA study) was carried out. Since the considerations have been given in the facility plan, the negative impact of the Priority Project is slight. In conclusion, the Priority Project was evaluated to be valid for natural and social environment. The EIA Evaluation Committee of Gorontalo Province has already issued a written approval on the EIA.</p>										
6. CONCLUSION AND RECOMMENDATION											
<p>The Priority Project (the Project) was evaluated to be technically feasible and economically viable. The negative impacts to the environment can be mitigated giving consideration in planning project facilities and environmental management and monitoring plans.</p> <p>The Project aims to mitigate flood damages in the most important areas of the new-born Gorontalo Province including its capital city. The Project contributes to enhance peoples' livelihood in the flood-prone areas. The Project is a core infrastructure to support economic development of the Province. In addition, the implementation of the Project is significant to the capacity building of the relevant staff and to the arrangement of the administrative setup as well. Implementation of the Priority Project at an early stage is recommended.</p>											

**THE STUDY ON FLOOD CONTROL AND WATER MANAGEMENT
IN
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GLOSSARY

(ENGLISH ABBREVIATION)

ADB	Badan Pembangunan Asia	Asian Development Bank
ASTM		American Standards for Testing Materials
BCR, B/C	Rasio Harga dan Keuntungan	Benefit Cost Ratio
BOD		Biochemical Oxygen Demand
CEA	Badan Pelaksana Kanada	Canadian Executing Agency
CIDA	Badan Penyandang Dana Kanada	Canadian International Development Agency
COD		Chemical Oxygen Demand
DD, D/D	Disain Teknis/Rencana Teknis	Detailed Design
DGWR	Direktorat Jenderal Sumber Daya Air	Directorate General of Water Resources
DGWRD	Direktorat Jenderal Pengairan	Dir. General of Water Resources Development
DO		Dissolved Oxygen
EIA	Analisa/Penelitian Lingkungan	Environmental Impact Assessment
EIRR	Tingkat Pengembalian Modal Internal Ekonomi	Economic Internal Rate of Return
FAO	Organisasi Pangan Dunia	Food and Agriculture Organization of the United Nations.
FS, F/S	Studi Kelayakan	Feasibility Study
FY	Tahun Anggaran	Fiscal Year
GDP	Produk Domestik Bruto	Gross Domestic Product
GIS	Sistem Informasi Geografi	Geographical Information System
GOI	Pemerintah Indonesia	Government of Indonesia
GPS	Penentuan Posisi Global	Global Positioning System
GRDP	Produk Domestik regional Bruto	Gross Regional Domestic Product
IBRD	Bank Dunia	International Bank for Reconstruction and Development (World Bank)
IEE		Initial Environmental Examination

JBIC		Japan Bank for International Cooperation (Former OECF)
JICA		Japan International Cooperation Agency
LAN	Jaringan Komputer Lokal	Local Area Network (Computer)
MCM	Juta Meter Kubik	Million Cubic Meters
MP, M/P	Rencana Induk	Master Plan
MSL	Tinggi Muka Air Laut Rata-rata	Mean Sea Level
NGO	Lembaga Swadaya Masyarakat	Non-Governmental Organization
NPV	Nilai Sekarang Neto	Net Present Value
O&M	Operasi dan Pemeliharaan	Operations and Maintenance
OECF	Badan Penyanggah Dana Jepang	Overseas Economic Cooperation Fund (Japan), Now reorganized JBIC
OJT	Latihan di Lapangan	On-the-Job Training
PCM	Pertemuan Konsultasi Masyarakat	Public Consultation Meeting
R	Sungai	River
S/W		Scope of Works
TIU	Unit Pelaksana Teknis Dinas	Technical Implementation Unit
UNESCO	Badan Pendidikan, Ilmu Pengetahuan dan Kebudayaan, P.B.B	United Nations Educational, Scientific, and Cultural Organization
USAID	Badan Penyanggah Dana Amerika Serikat	United States Agency for International Development
VAT		Value Added Tax
WATSAL	Wanita dalam Pembangunan	Water Sector Adjustment Loan
WID	Pengembangan Sumber Daya Air	Women in Development
WUA	Federasi Petani Pemakai Air	Water Users Association

(INDONESIAN ABBREVIATION)

AMDAL	Analisis mengenai Dampak Lingkungan	Environmental Impact Analysis
ANDAL	Analisis Dampak Lingkungan	Environment Impact Statement
APBD	Anggaran Pendapatan dan Belanja Daerah	Regional Income and Expenditure
APBN	Anggaran Pendapatan dan Belanja Nasional	National Income and Expenditure
Ass.	Asisten	Assistant
BAKORNAS PBP	Badan Koordinasi Nasional Penanggulangan Bencana dan Penanganan Pengungsian	National Coordination Board of Disaster and Evacuation
BAPEDAL	Badan Pengendali Dampak Lingkungan	Environmental Impact Management Board
BAPEDALDA	Badan Pengendali Dampak Lingkungan Daerah	Regional Environmental Impact Management Agency
Bappeda	Badan Perencanaan Pembangunan Daerah	Provincial Development Planning Board
Bappenas	Badan Perencanaan Pembangunan Nasional	National Development Planning Board
Binlak	Pembinaan & Pelaksanaan	Construction Management
BMG	Badan Meteorologi dan Geofisika	Meteorological and Geophysical Institute
BPS	Badan Pusat Statistik	National Statistics Office
Bupati	Kepala Daerah Tingkat II/Kabupaten	Head of District (Regency)
CD, Cabdin	Cabang Dinas	Branch of Dinas
DATI I	Daerah Tingkat I	Regional Level I (Province)
DATI II	Daerah Tingkat II	Regional Level II (District)
DI	Daerah Irigasi	Irrigation Schemes
DinasPU, DPU	Dinas Pekerjaan Umum	Public Works Services
DIP	Daftar Isian Proyek	List of Project Budget
DPR	Dewan Perwakilan Rakyat	National Parliament
DPRD	Dewan Perwakilan Rakyat Daerah	Regional Parliament
DPU	Departemen Pekerjaan Umum	Ministry of Public Works

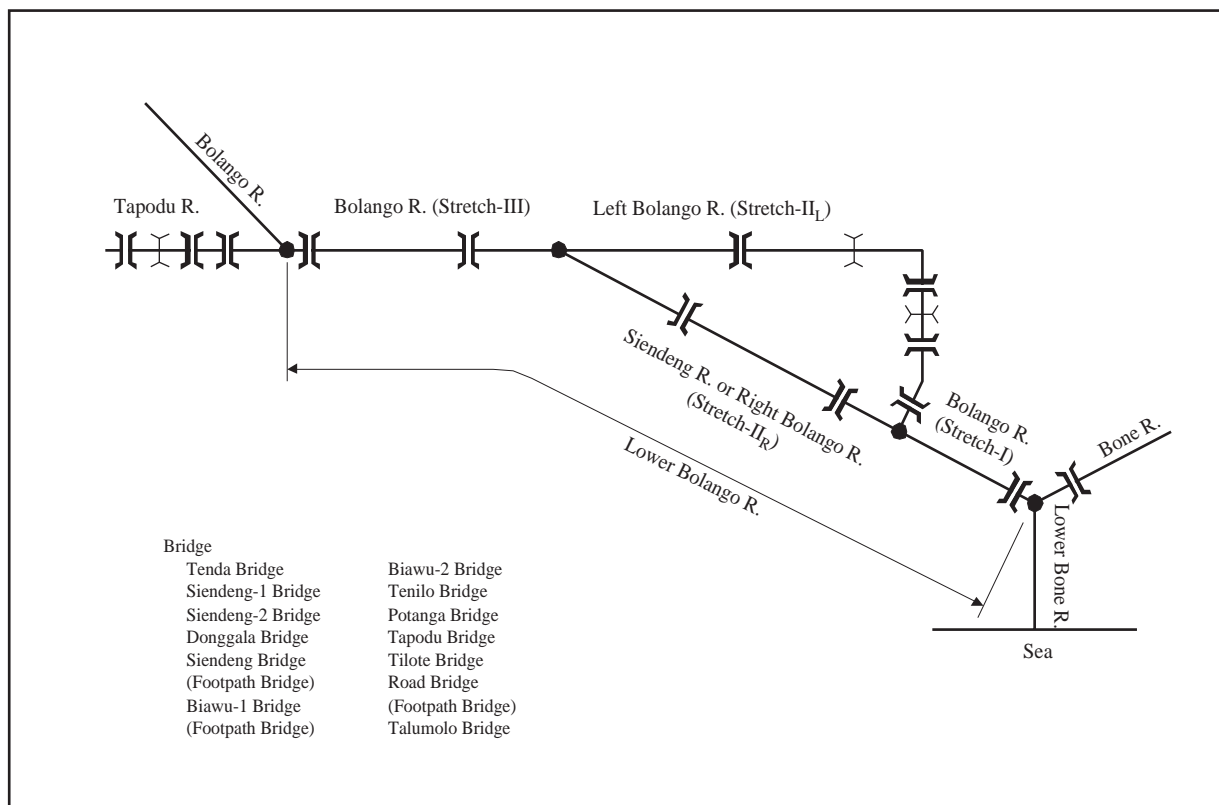
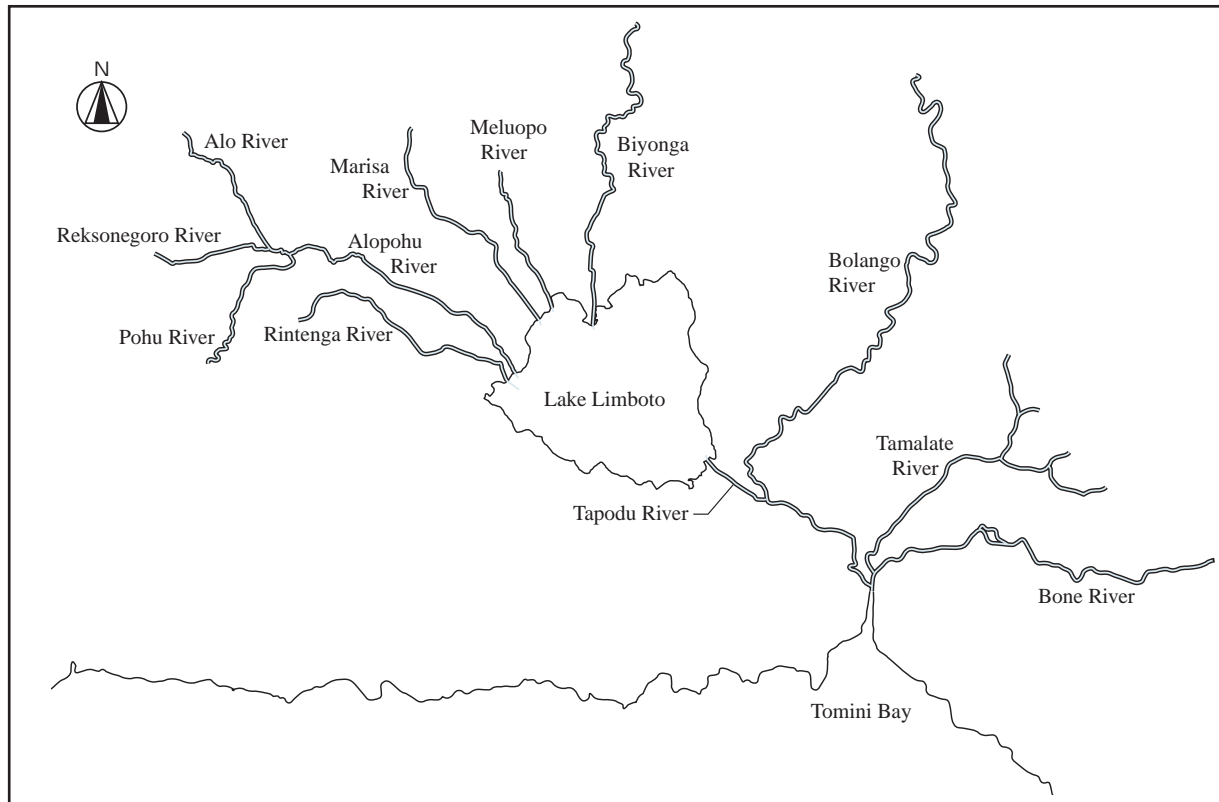
DPUP	Dinas Pekerjaan Umum Propinsi	Provincial Public Works Services
DTP	Dinas Tanaman Pangan	Office of Food Crops
Kanwil	Kantor Wilayah	Regional Office (of a Department)
Kaur	Kepala Urusan	Head of Sub Section
KDH	Kepala Daerah	Head of Regional Government
KDPP	Kepala Daerah Pengamatan Pengairan	Head of Water Resources Sub District
Kepmen	Keputusan Menteri	Minister's Decree
Keppres	Keputusan Presiden	Presidential Decree
KIMPRASWIL	Departemen Permukiman dan Prasarana Wilayah	Ministry of Settlement and Regional Infrastructure (MSRI)
KSDP	Kepala Sub Dinas Pengairan	Head of Provincial Water Resources Service
KTL	Kegiatan Tindak Lanjut	Follow-up Activity
KUD	Koperasi Unit Desa	Village Cooperative Unit
LBB	Limboto-Bolango-Bone	Limboto-Bolango-Bone
LSM	Lembaga Swadaya Masyarakat	Non-Governmental Organization
MONEV	Monitoring & Evaluasi	Monitoring & Evaluation
O&P	Operasi dan Pemeliharaan	Operations and Maintenance
P3A	Perkumpulan Petani Pemakai Air	Water Users' Association (WUA)
P3SU	Proyek Pembinaan Pengairan Sulawesi Utara	North Sulawesi Water Resources Institutional Development Project
PDAM	Perusahaan Daerah Air Minum	Regional Water Company
PDSA	Pengumpulan Data Sumber Air	Water Resources Data Collection
PEMDA	Pemerintah Daerah	Regional Government
PERDA	Peraturan Daerah	Regional Regulation
Pimpro	Pemimpin Proyek	Project Manager
Pinbagpro	Pemimpin Bagian Proyek	Sub Project Manager
PJP	Program Jangka Panjang	Long Term National Dev. Program
PLN	Perusahaan Listrik Negara	State Electricity Company
PPTPA	Panitia Pelaksanaan Tata Pengaturan Air	Basin Water Management Committee

PSDA	Pengamanan Sumber Daya Air	Water Resources Conservation
PTPA	Panitia Tata Pengaturan Air	Provincial Water Resources Committee
PU	Pekerjaan Umum	Public Works
Puslitbang	Pusat Penelitian dan Pengembangan Pengairan PU	Institute of Hydraulic Engineering Center (Bandung)
PWS	Pengembangan Wilayah Sungai	River Basin Development
RKL	Rencana Pengelolaan Lingkungan	Environmental Management Plan
RPL	Rencana Pemantauan Lingkungan	Environmental Monitoring Plan
SATKORLAK PBP	Satuan Koordinasi Pelaksanaan Penanggulangan Bencana dan Penanganan Pengungsian	Implementation Coordination Unit of Disaster Mitigation and Evacuation
SATLAK PBP	Satuan Pelaksanaan Penanggulangan Bencana dan Penanganan Pengungsian	Implementation Unit of Disaster Mitigation and Evacuation
SDA	Sumber Daya Air	Water Resources
Sulut	Sulawesi Utara	North Sulawesi
Tkt. I	Tingkat I	Level I Administration (Province)
Tkt. II	Tingkat II	Level II Administration (Region)
UNSRAT	Universitas Sam Ratulangi	Sam Ratulangi University
UPTD	Unit Pelaksana Teknis Dinas	Technical Implementation Unit

(SOME INDONESIAN WORDS)

Desa	Village (rural area), The Lowest Administrative Unit, Headed by Kepala Desa or Kades who is elected by the residents
Kabupaten, Kab.	Administrative District Headed by Bupati (regency)
Kecamatan, Kec.	Administrative Sub District within the Kabupaten
Kelurahan	Village (urban area), The Lowest Administrative Unit, Headed by Lurah who is Appointed
Kota	Municipality, Administrative District Headed by the Walikota
Kotamadya	Municipality, Administrative District Headed by the Walikota
Propinsi	Province
Ribu	thousand = 1,000
Juta	million = 1,000,000
Milyar	billion = 1,000,000,000
Trilyun	trillion = 1,000,000,000,000

NAME OF RIVER



**THE STUDY ON FLOOD CONTROL AND WATER MANAGEMENT
IN
LIMBOTO-BOLANGO-BONE BASIN**

SUMMARY

CHAPTER 1. INTRODUCTION

1.1 Background of Study

Upon request of the Government of Indonesia, the Government of Japan had decided to conduct the Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin (the Study). Japan International Cooperation Agency (JICA), who is responsible for implementation of the technical cooperation of the Government of Japan, entrusted the Study work to the joint venture of NIKKEN Consultants, Inc. and Nippon Koei Co., Ltd. (the Study Team).

1.2 Objective of Study

The objectives of the Study are (1) to formulate a master plan of sustainable flood control and water management plan in Limboto-Bolango-Bone basin, (2) to conduct the feasibility study on the priority project(s), and (3) to transfer technology to counterpart personnel in the course of the Study.

In the Study, flood control aspects are mainly discussed, and water management plan is studied only in relation with the flood control planning, since the water management master plan has already been established.

1.3 Study Area

The Study covers the areas in Limboto-Bolango-Bone (LBB) basin in Sulawesi Island. The LBB basin has a total catchment area of about 2700 km², consisting of the Lake Limboto basin (890 km²), the Bolango river basin (490 km²) and the Bone river basin (1,320 km²).

Administratively the LBB basin extends mostly in the south-eastern part of Gorontalo

Province (2,400 km²) covering 11 Kecamatan and small portion in the south-western part of North Sulawesi Province (300 km²).

1.4 The Study

The Study was carried out for about 19 months from June 2001 to December 2002. The Study was carried out in two phases, i.e., Phase-1 to formulate Flood Mitigation Master Plan (FM-MP) and select priority project(s), and Phase-2 to conduct Feasibility Study for the selected priority project(s). 《Figure 1.1》

CHAPTER 2. EXISTING CONDITIONS

2.1 Topography and Geology

Topography: The Bone River draining eastern half of the Study Area joins the Bolango River at the southern most of Gorontalo City and finally empties into the Tomini Bay. Basins of the Bolango River and tributaries of Lake Limboto share the western half of the Study Area and transport much sediment to the lower plain areas and finally to Lake Limboto. 《Figure 2.1》

Geology: Sulawesi appears to be formed by the collisions of two main crustal plates. Geology of the Study Area consists mainly of igneous, volcanic and sedimentary rocks of middle Tertiary to early Quaternary periods. Latest volcanic activities of early Quaternary formed the frame of the present topography in the Study Area. Unconsolidated deposits of gravels and sands are widely distributed in the lowland of the basin. 《Figure 2.2》

2.2 Hydro-Meteorology

Climate: The climate of the LBB Basin is generally classified as humid tropical, having a tropical rainy climate with no definite dry period, with a temperature exceeding 18 in the coolest month. Rainfall in the Study Area is typical of bimodal peaks. 《Figure 2.3》

Monthly Rainfall: The mean annual rainfall is 1,286 mm/yr at Boidu/ Lomaya weir of the Bolango River ranging from 2,249 mm in 1997 to 471 mm in 1972. Maximum monthly rainfall at Jalaludin appears in May (165 mm) with a secondary peak in November (138 mm). The dry month with monthly rainfall less than 100 mm extends from July to October. February is also a dry month. 《Figure 2.3》

Monthly Runoff: The monthly runoff distribution is almost similar to the rainfall distribution with peaks occurring in May/June with a secondary peak in January. 《Figure 2.4》

2.3 River Basin and River Channel

Lake Limboto Basin: The Lake Limboto basin has a total basin area of 890 km²

located in the western half of the LBB basin. Its major tributaries are the Biyonga River (66 km²), the Meluopo River (27 km²), the Marisa River (64 km²), and the Alo-Pohu River (466 km²) consisting of the Alo River (342 km²) and Pohu River (124 km²). 《Figure 2.5》

Bone River Basin The Bone River originates at the eastern mountain of the LBB basin. The Bone River, passing the Alale weir (1,060 km²) at the outlet of the mountainous basin, runs further toward west in the south of Gorontalo City and joins the Tamalate and Bolango rivers. At its confluence with the Bolango River, the Bone River changes direction southwards and finally discharges into the Tomini Bay. Basin area of the Bone River is 1,320 km² at river mouth. Total basin area including the Bolango River basin amounts to 2,700 km². 《Figure 2.5》

Bolango River Basin The Bolango River, passing through Lomaya weir (388 km²) at the outlet of the mountainous areas, flows down in the west of Gorontalo City. After joining the Tapodu River, outlet channel of Lake Limboto, it changes the direction toward east and empties into the Bone River at about 1 km upstream from the sea. Basin area is 490 km² at Bone confluence. If Lake Limboto basin is included the area amount to 1,380 km² in total. 《Figure 2.5》

Land Use: Land use study by SPOT satellite images, the LBB basin consists of forest land (60%), bush land (10%), farmland (23%), and others (7% in total for grass, settlement and other lands). During the past 10 years, 54 km² of bush lands and 21 km² of forest lands were converted to farmland.

2.4 Natural Environment

The geological history of Sulawesi makes the flora and fauna unique with one of the highest levels of species endemism in the world. The plain basin subject to flood mitigation project, however, has already been developed and no precious species are found any more. Organic contamination is progressing in Lake Limboto and lower reaches of the Bolango, Tamalate and Bone rivers.

2.5 Present Social Conditions

The peoples of the Study Area are originally from the ethnic group of Gorontalo, There are also small villages implanted by government sponsored migrations from Bali and

Jawa islands. Indonesian language is widely spoken in Gorontalo Province, but the Gorontalo people speak also their distinct language. Islam is the dominant religion in the area. Muslim is the majority (98.1% of the population) and among the minorities there are Christian (1.6%) and Hindu & Buddhist (0.4%).

2.6 Socio-Economy

Administrative Subordinate: The LBB Basin has an area of about 2,700 km² in total, in which located are Kabupaten Gorontalo and Kota Gorontalo of Gorontalo Province, and Kabupaten Bolaang-Mongondow of North Sulawesi Province. Most of the developed area of the LBB basin is in the Kabupaten and Kota Gorontalo. 《Figure 2.6》

Population: According to census data in 2000, population in the LBB Basin was estimated at 445,000. The average growth rate during the 1990's was 1.29% per annum. Kota Gorontalo is the largest town in the basin, and functions as the center of the basin and Gorontalo Province as well. Its census population was 135,000. Urban population in the LBB Basin was estimated at 205,000, comprising 120,000 in Kota Gorontalo and 85,000 in Kabupaten Gorontalo. It accounted for 46% of the basin population.

Regional Accounts: Representing regional account of the LBB Basin, per capita gross regional domestic products (GRDP) of Kabupaten Gorontalo and Kota Gorontalo were estimated at Rp.1,160,000 and Rp.2,388,000 (equivalent to US\$122 and US\$251) respectively in 2000, which are only 18% and 38% of the national average (Rp.6,344,000). The economy of the Kabupaten is said to specialize in agricultural production. On the other hand, the Kota specializes in services in particular.

Public Finance According to the budget base data of the national government, the total amount for the water resources and irrigation sub-sector including flood control rose from Rp.2.0 trillion in 1995/96 to Rp.3.5 trillion in 1999/2000. In North Sulawesi Province, the national government invested Rp.666 billion for development projects in the fiscal year 1999/2000. Of this total, Rp.121 billion (18%) was allotted to public work projects including Rp.46 billion (7%) for water resources development projects. For the recent 4 years, the development expenditure for flood control varied from Rp.3.9 billion to Rp.7.8 billion. As to the LBB basin, it is estimated at around Rp.1.15 to 2.73 billion.

2.7 Organizations and Institutions

Agencies for Water Resources Sector: Ministry of Settlement and Regional Infrastructure is the authority in public work sector. The water resources are administrated in the Directorate General of Water Resources (DGWR) of the Ministry. Dinas PU/Kimpraswil, Dinas PU-Praswil and Dinas PU were established in Province, Kabupaten and Kota Gorontalo, respectively, as their public work agencies. Dinas carries out the water resources administration through its Sub-Dinas. Agencies mentioned above are still in transition stages adjusting toward the decentralization administration and the establishment of new province.

PTPA and PPTPA: Water and water resources management at the provincial level are coordinated by Governor, establishing Panitia Tata Pengaturan Air (PTPA: Province Water Resources Management Committee). Coordination at the river-basin level is implemented by Panitia Pelaksana Tata Pengaturan Air (PPTPA: River Basin Water Resources Management Committee). The PPTPA can be established by the Governor. Since Gorontalo is a new province the PTPA is not established yet. The members of the PTPA consist of Vice Governor as chairman, representatives of water related government agencies, university, NGO and other organizations.

Progress of Establishment of Gorontalo Province: The establishment of Gorontalo Province was agreed by Central Government with the Law No. 38/2000. The Provincial Governor was appointed by the Central Government. The organization and working order of Gorontalo Province including Dinas were established and the member of the Provincial Parliament was formed. New Governor was elected by the Parliament. New setup of the province is progressing and the region seems to be activated rapidly.

WATSAL: Coping with financial deficit, the Government of Indonesia prepared a structural adjustment program in the water resources and irrigation sector in 1999. the program was supported by the World Bank with Water Resources Sector Adjustment Loan (WATSAL) financed by Asian Development Bank (ADB) and Japan Bank for International Cooperation (JBIC). The present Study has strong concern with the outcomes of the WATSAL program, because all the activities related to the water resources should follow them. Among others, major concerns of the Study are decentralizing water resources management and establishing integrated water resources organization (Balai PSDA) in the provincial level.

Progress of Decentralization System in Water Resources Sector: Administration system is changing from the centralization to the decentralization system. Legislative arrangements for the new administration system is now carrying out in central government and then in local governments. Under the decentralization system, all the authorities regarding the water resources are transferred to local government (Kabupaten/Kota). In order to cope with new jobs, Kabupaten and Kota Gorontalo established Dinas and Sub-Dinas related to the water resources sector. However, the procurement of qualified staff and capacity building still need time.

CHAPTER 3. BASIC STUDIES

3.1 Field Surveys and Investigations

For the study on flood mitigation master plan, field surveys and investigations were carried out, for such as topography (including aerial photo), geology, water quality and bottom sediment, riverbed materials, and land use.

3.2 Runoff and Flood Flow Analyses

In order to simulate flooding and inundation in the Study Area, runoff and flood flow analyses were carried out. Channel model and flood plain model are incorporated in the flood flow model. Flood flows were analyzed for various probable floods.

3.3 Studies on River Channels and Sediment

River Channel Study: Based on the latest survey results, channel capacities of the rivers in the western plain area of Lake Limboto are low as a whole, while the Bone and Biyonga rivers have relatively high capacities. According to harmonic analysis of tides, tidal variation in the river mouth of the Bone River is from +0.767 to -0.620 m,MSL. Influence of the tidal variation is limited only up to 2 km from the river mouth, chiefly due to the relatively steep channel slopes of the Bone and Bolango rivers.

Sediment Transport Capacity: According to the sediment transport analysis of the existing river, the Biyonga, Meluopo and Alo-Pohu rivers are the main sources of sediment in the Lake Limboto basin, though the share of the Biyonga River is by far much. In the Bone-Bolango river basin, the Bolango River shares 62% of total sediment and the Bone River 38%. The Lake Limboto basin (890 km²) transports 1.3 times more sediment than that of the Bone-Bolango river basin (1,810 km²).

3.4 Studies on Lake Limboto

Sedimentation of Lake Limboto According to the estimates based on historical data of the lake areas and corresponding maximum water depths from 1952 to 1983 and the sounding survey data in 1996 and 2001, the annual sedimentation rate of Lake Limboto was estimated to be around 1 to 2 MCM/year.

Design Water Levels of Lake Limboto: Design water levels of Lake Limboto was studied based on the past water level records, lake water use, topography and land use, and flood water retention, and proposed as follows:

- 1) Lowest lake water level at +4.00 m,MSL for better and stable fish production
- 2) Highest lake water level at +5.50 m,MSL for flood mitigation in lake side areas especially in the western area of the lake.

CHAPTER 4. STUDY ON FLOOD MITIGATION MASTER PLAN (FM-MP)

4.1 Planning Basis

Flood and Sediment Disasters: Major areas suffering from flood and sediment disasters in the Study Area are southern part of Gorontalo City, middle reaches of the Bolango River, Limboto and Isimu-Pohu areas, and western area of Lake Limboto. Among these, problems are more serious in the southern part of Gorontalo City near the confluence of the Bolango and Bone rivers. 《Figure 4.1》

Causes of Flood and Sediment Disasters: Flood and sediment disasters are induced basically by (1) devastation of watershed, (2) concentration of properties on narrow plain, (3) insufficient flood mitigation facilities, and (4) inappropriate land use in flood plain. These problems are associated with financial constraint, shortage of engineers, and lack of comprehensive flood mitigation master plan to direct all the relevant activities.

Principles for Planning FM-MP: Flood mitigation master plan (FM-MP) for the LBB basin was studied along the following principles:

- 1) Objective of Master Plan: The FM-MP aims to direct or guide the flood mitigation activities that will be conducted toward the target year by various agencies and organizations concerned.
- 2) Scope of Planning: Flood mitigation, in the present study, includes the mitigation of flood damages and sediment induced disasters. The structural measures discussed in the master plan are limited to the primary facilities to mitigate flood and sediment damages of the area.
- 3) Target Year: In line with the phasing of National Five-Year Plan, target year of the FM-MP was set at the end of Tenth Five-Year Plan in 2019.
- 4) Design Scale: Facilities for the FM-MP are planned and designed based on 20-year flood.

4.2 Studies on Flood Mitigation Master Plan (FM-MP)

Structural Measures Adopted: Adopting river improvement as a fundamental scheme, other alternative schemes such as floodways, flood control dams, and lake management were studied in comparison. By these measures, effects of flood mitigation will be

realized soon, but continuous maintenance activities are required. The following measures were adopted for the FM-MP 《Figure 4.2》 :

- 1) **River improvement schemes:** Existing channels of the Bone, Tamalate and Bolango rivers of the Bolango-Bone river system; and the Biyonga, Meluopo, Marisa, Alo-Pohu and Rintenga rivers of the Lake Limboto system are improved so as to have enough capacity to carry flood water of 20 year return period. The river improvement includes the works for channel excavation, dike embankment, bank protection, and drainage sluice across the dike.
- 2) **Floodway schemes:** Tamalate floodway was proposed to divert all the flood runoff of the upper basin to the Bone River. The lower Tamalate shall serve as a trunk drainage channel of Gorontalo City.
- 3) **Lake Limboto management scheme:** In order to conserve the flood mitigation function of the lake for the sound development of lake side area and other existing functions of the lake, Lake Limboto management scheme was proposed with (1) construction of lake dikes, (2) Tapodu River improvement with gate, and (3) construction sediment traps.

Non-Structural Measures Adopted: Besides the structural measures, (1) watershed management and (2) flood-plain management were also proposed for the FM-MP. The watershed management aims to promote activities undertaken by the relevant agencies and community people for floodwater and sediment retention in the watershed areas. These activities may takes time, but steadily strengthen the basin against flood. The flood-plain management aims to guide and support self-help activities of the community people in the flood-prone areas and reduce substantial damages due to floods.

4.3 Estimation of Project Cost

The project cost for structural measures of the FM-MP was estimated at Rp.555.0 billion (US\$57.81 million or ¥7,169 million equivalent) in total, consisting of Rp.362.0 billion as direct cost, Rp.66.9 billion as land acquisition and compensation cost, and Rp.126.2 billion as indirect cost including administration, engineering and physical contingency, at the fixed price as of November 2001 assuming exchange rate of currencies US\$1.00 = Rp.9,600 = ¥124.4. Estimated costs by sub-projects are as follows:

Sub-projects	Cost (Rp. billion)
1) Bone River Improvement	75.0
2) Tamalate River Improvement with Floodway	189.5
3) Bolango River Improvement	44.5
4) Biyonga River Improvement	30.2
5) Meluopo River Improvement	15.3
6) Marisa River Improvement	23.7
7) Alo-Pohu River Improvement	109.0
8) Rintenga River Improvement	23.9
9) Lake Limboto Management	43.9
Total	555.0

4.4 Implementation of FM-MP

The FM-MP is proposed to support the socio-economic conditions at the target year 2019. In order to carry out the works effectively in orderly manner toward the target year, stage-wise implementation was proposed as follows:

- 1) **Preparatory stage** (until end of 2004): Various preparatory works and activities shall be performed for forthcoming full-scale implementation. The works may include feasibility study, fund arrangement, definite plan/detail design, preservation of lands, research and investigation, and coordination with relevant agencies and communities. The non-structural activities such as dissemination activities and community mobilization for watershed and flood plain management shall also be started from this stage.
- 2) **Intensive implementation stage** (from beginning of 2005 to end of 2009): Actual construction works will start at site. The projects in this stage must be the priority projects which are expected to yield higher outcome. With the intensive implementation, it is expected the flood mitigation activities in the basin will be stimulated and relevant personnel and administration will be trained and adjusted toward effective implementation of the FM-MP.
- 3) **Sustainable implementation stage** (from beginning of 2010 to end of 2019): The remaining sub-projects will be carried out in sustainable manner in parallel with the watershed management and flood plain management. With completion of these sub-projects, basic flood mitigation facilities in the LBB basin will be enhanced high enough to the 20-year flood.

4.5 Project Evaluation

Economic Viability: Flood damage reduction benefit accruing from the implementation of the structural measures was compared with the economic cost to be invested. The analysis endorsed the economic viability of the project under future socio-economic conditions as follows:

Item	EIRR (%)	B/C*	NPV* (Rp.billion)
Under present socio-economic conditions	6.0	0.51	-99
Under future socio-economic conditions	14.7	1.28	57

Note: *: Discounted at 12%

Financial Aspects A study on financial sources based on the past trend of public expenditure of the national government resulted in disclosing financial deficit of the project fund. It is substantial to implement the plan mobilizing communities in participatory manners from self-support standpoint to cope with flood and sediment disasters. In addition, external inputs are also deemed necessary to activate flood mitigation activities in the basin and to lead economic circle toward upward trend.

IEE for Natural and Social Environment: Although the component projects of the FM-MP may bring negative impacts on natural and social environment in a short run, most of such impacts are able to be mitigated by carefully designing and implementation. On the contrary, the plan is considered to extend favorable impact to natural environment stabilizing the water regime. In terms of social environment, the FM-MP is valid as a whole provided that non-structural and structural measures are implemented in a harmonic and strategic manner

Overall Evaluation: The FM-MP is evaluated economically viable. The FM-MP is evaluated to be valid from the view points of natural and social environment too. The basin is suffering from frequent flood disasters constraining sound economic activities and people's livelihood. Implementation of the FM-MP in early stage is recommended.

4.6 Selection of Priority Projects

The following structural measures were proposed for the intensive implementation as

priority projects. Implementation of these projects are expected to play vital roles for (1) flood mitigation in urban area of Gorontalo City, (2) water level control of Lake Limboto and the quick drainage of retained water, and (3) alleviation of sedimentation problems of Lake Limboto:

- 1) River Improvement of the Lower Bone and Lower Bolango rivers
- 2) Tapodu River Improvement with Tapodu Gate
- 3) Construction of Tamalate Floodway
- 4) Sediment Trap Works in Lake Limboto

Besides, activities for the non-structural measures such as watershed management and flood-plain management should be started even before the intensive implementation stage as a priority activity. 《Figure 4.3》

CHAPTER 5. FEASIBILITY STUDY FOR PRIORITY PROJECTS

5.1 Field Survey

Focusing on the priority projects sites, field survey were conducted for (1) detailed river survey and topographic mapping, and (2) geological investigation. Besides, a study on environmental impact assessment (EIA) for the priority project was carried out in succession to the initial environmental examination (IEE) carried out in the Master Plan study stage.

5.2 Supplementary Studies

Existing River Facilities: Detailed field survey on the existing river facilities was conducted for the Bolango River from the confluence of the Bone River to the confluence of the Tapodu River. The dike is provided with the Bolango River in the upper suburban area, while in the lower reaches located in Gorontalo City, dikes were not provided. The dike system in the upper reaches may concentrate floodwater to the lower urban area. Implementation of measures in the lower reaches is required soon. 《Figures 5.1》

Existing Channel Capacity: According to the result of study based on the latest river survey, the Bolango River has capacity of about $100 \text{ m}^3/\text{s}$ in the lower reaches of the confluence of left and right Bolango rivers. In this stretch, the riverine areas are suffering from floods both from the Bolango and the Bone rivers. The left and right Bolango rivers have capacities of about $75 \text{ m}^3/\text{s}$ each or $150 \text{ m}^3/\text{s}$ in total. In the upstream from the divergence of the left and right Bolango, existing channel has about $200 \text{ m}^3/\text{s}$ of capacity confined by dikes. 《Figure 5.2》

Control of Bolango Flood by Lake Limboto: In the FM-MP, flood control by Lake Limboto was not incorporated considering the existing sedimentation issues of the lake. The plan, however, was revised considering the difficulty in land acquisition in the lower urban areas and effective usage of the existing facilities. Considering existing channel capacity and minimizing houses to be relocated, design discharge of the Lower Bolango River was decided to be $200 \text{ m}^3/\text{s}$ based on 20-year flood, and the remaining $550 \text{ m}^3/\text{s}$ shall be controlled by Lake Limboto. The flood storage calculation confirmed that the lake water level can be kept below +5.50 m,MSL receiving the flood discharge from the Bolango River. 《Figure 5.3》

5.3 Structural Measures

Bone-Bolango River Improvement Project: Excavation in the Bone estuary was not planned, since the bed would be buried again soon because of thick sediment cover. Tenda cutoff channel is constructed at the sharp bend near the confluence of the left and right Bolango rivers, to prevent flooding and ensure smooth floodwater passage around the meandering reaches. The right Bolango River is improved as main flood channel by channel excavation and normalization for $125 \text{ m}^3/\text{s}$, while the left Bolango River which passes through city center is subject to minor improvement for $75 \text{ m}^3/\text{s}$. The Bolango River upstream from the divergence of the left and right Bolango is subject to channel excavation. In the downstream reaches of the divergence dikes are constructed, and in the upstream reaches the existing dikes are strengthened. Bank protection works were planned at the critical banks for the whole reaches. 《Figures 5.4 and 5.5》

Tapodu River Improvement with Gate: Main function of the Tapodu River is to lead floodwater from the Bolango River, and to drain it quickly after the flood. The Tapodu River is partly improved with new alignment keeping away from the settlement areas. A control gate is constructed across the Tapodu River near the confluence with the Bolango River. The gate has a function mainly to maintain lake water level. Dikes are constructed on both banks of the Tapodu River to protect surrounding lakeside areas from the Bolango floodwater using excavated earth from the channel. As to the lake water level, the influence of the Bolango flood is slight. Lake water level varies mainly due to the runoffs from its own tributary. On the other hand, the Tapodu River improvement contributes much to the lakeside farmlands, lowering the peak water level and shortening the duration of inundation. The existing north and south Tapodu channels will serve for water supply, fish way and drainage in the areas protected by dikes, providing sluice gates at the heads and tails of the channels. 《Figure 5.6》

Tamalate Floodway: The Tamalate River, which comes from the mountainous basin in the north-east of Gorontalo City, is one of the major causes of inundation of Gorontalo City. The Tamalate floodway aims to divert whole runoff ($120 \text{ m}^3/\text{s}$) of the upper basin to the Bone River before flowing down to the urban area. The proposed floodway takes route away from settlements and connect two rivers in short distance. The bed slope is 1/1000 which is almost same slope as the upper Tamalate. At the divergence, diversion weir with no operation device is installed. Although the existing Tamalate

River is closed for floods at the divergence, a sluice gate is installed for water supply during ordinary time for domestic use and river maintenance. 《Figures 5.7 and 5.8》

Sediment Trap Works in Lake Limboto: The sediment trap works aims to guide and trap the sediment in the northern part of the lake. The work is proposed as research works to measure lake sedimentation and as test works to develop usage of lake sediment. Realignment of the lowest portions of the Biyonga and Alo-Pohu rivers and construction of bamboo-net fence with crest elevation of +4.00 m,MSL are the major project works. As to the usage of lake sediment, reclamation of near-by low-lying lands and exploitation of construction materials could be considered. Implementation of sediment usage as the third sector program should also be considered. 《Figure 5.9》

5.4 Non-Structural Approaches

Non-Structural Approaches: Besides the structural measures mentioned above, watershed management and flood-plain management shall be implemented in order to materialize invulnerable basin and communities against floods. Activity for the watershed and flood-plain management should be executed constantly and continuously as a routine activity for flood mitigation, not as a project. It is also advisable to conduct the activities in collaboration with the community-based NGOs acting among the community people and the government agencies.

Watershed Management: Sedimentation problem of Lake Limboto is serious and watershed management is indispensable. The agencies in charge of flood mitigation should encourage (1) construction of sediment control facilities, and (2) afforestation and land use regulation, in collaboration with the relevant agencies and communities. For this purpose, (3) dissemination activities should be conducted as well.

Flood-Plain Management: This program aims to complement vulnerability of the local communities in the flood-prone area. For this purpose, local community organization should be first established as a basis of flood mitigation activities in the community. Then, the local coping measures such as (1) flood proofing; (2) flood forecasting, warning and evacuation, (3) flood fighting, and (4) community-based flood mitigation measures should be carried out. The agencies in charge of flood mitigation should guide and promote these self-help activities by the community people, so that they can participate in the activities with incentive.

5.5 Project Implementation

The priority project shall be implemented during the intensive implementation stage (2005-2009) as follows 《Figure 5.10》 :

- | | |
|----------------------------------------------|--------------------------|
| 1) Preparatory Period | : 2003-2004 |
| 2) Land and Compensation | : 2004-2008 |
| 3) Construction | |
| - Bone-Bolango River Improvement Project | : 2005-2007 |
| - Tapodu River Improvement Project with Gate | : 2005-2007 |
| - Tamalate Floodway Project | : 2007-2009 |
| - Sediment Trap Works in Lake Limboto | : 2005-2006 |
| 4) Non-structural Measures | : Continuously from 2003 |

5.6 Estimation of Project Cost

Project Cost: The project cost required for the implementation of the structural components of the priority projects was estimated at Rp.143.7 billion (US\$14.96 million or ¥1,856 million) in total, consisting of Rp.110.0 billion as direct cost, Rp.3.9 billion as land acquisition and compensation cost and Rp.29.8 billion as indirect cost including administration, engineering and physical contingency, at the fixed price as of November 2001 assuming exchange rate of currencies US\$1,00=RP.9,600=¥124.4.

The estimated costs by sub-projects are as follows:

Sub-projects	Cost (Rp. billion)
1) Bone-Bolango-Tapodu River Improvement	120.2
2) Tamalate Floodway	20.8
3) Sediment Trap Works in Lake Limboto	2.7
Total	143.7

Fund Required: The fund required for implementation of works was estimated at Rp.179.4 billion (US\$18.69 million or ¥2,318 million), considering price contingency until and during the construction period.

5.7 Project Evaluation

Economic Evaluation of Priority Project: Two projects, Bone-Bolango-Tapodu

(BBT) River Improvement Project and Tamalate Floodway Project, were subject to economic evaluation. Flood reduction benefit accruing from project implementation was compared with economic values invested. Under the future socio-economic conditions the project was evaluated to be viable economically. Results of analysis are summarized below. Sediment trap works in Lake Limboto are the test works and were not subject to the economic evaluation. Economic evaluation on the non-structural measures was not made, since they are a part of river management to be performed as routine works of the agencies in charge of flood mitigation.

Indices	BBT R. Imp		Tamalate FW		Whole projects	
	Present	Future	Present	Future	Present	Future
EIRR(%)	8.3	17.0	6.3	16.2	8.1	16.9
B/C*	0.71	1.54	0.55	1.44	0.69	1.53
NPV*	-21.5	39.4	-5.8	5.7	26	44

(Note) *: Social discount rate 12% was applied; NPV: in Rp. billion

The sensitivity analysis confirmed that even for 10% of cost over-run and 10% of benefit shortage the EIRR was above the social discount rate of 12%.

EIA of Priority Project: Study for environmental impact assessment (EIA study) was conducted. Based on the EIA study, environmental management plan and environmental monitoring plan were prepared. The negative impact of the Priority Projects is slight, since the considerations have been given on the identified impacts in the facility plan, and in the environmental management and the monitoring plans. The major impacts identified are public nuisance due to construction and land acquisition. In conclusion, the priority project was evaluated to be valid for natural and social environment. The EIA Evaluation Committee of Gorontalo Province has already issued a written approval on the EIA.

CHAPTER 6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The Priority Project (the Project) was evaluated to be technically feasible and economically viable. The negative impacts to the environment can be mitigated giving consideration in planning project facilities and environmental management and monitoring plans. The EIA Evaluation Committee of Gorontalo Province has already issued a written approval on the EIA.

6.2 Recommendations

- 1) The Project aims to mitigate flood damages in the most important areas of the new-born Gorontalo Province including its capital city. The Project contributes directly to enhance peoples' livelihood in the flood-prone areas. The Project is a core infrastructure to support economic development of the province. In addition, the implementation of the Project is significant to the capacity building of the relevant staff and to the arrangement of the administrative setup as well. Implementation of the Project at an early stage is recommended.
- 2) Considering the required fund and the budget available currently, assistance and support in and out of the province would be inevitable for the implementation of the Project. It is desirable that Gorontalo Province makes haste the administrative decision toward the implementation the Project in association with Kabupaten Gorontalo and Kota Gorontalo, so as to initiate preparatory actions for funding and coordination among the agencies concerned.
- 3) The Bolango River Improvement heavily depends on the storage function of the Lake Limboto, while the lake is now troubled with serious sedimentation primarily caused by deforestation in the watershed area. It is recommended to take actions as early as possible for the watershed management to conduct afforestation and regulation of deforestation, giving considerations on the enhancement of livelihood of resident peoples in watershed area.
- 4) The Project was evaluated to be valid from natural and social environment aspects. The evaluation is yes, provided that (1) the watershed management would be carried out strictly, and (2) management and monitoring regarding the water environment of Lake Limboto would be conducted appropriately in sustainable manner.