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-IV SUPPORTING REPORT: PART-B

FLOOD MITIGATION MASTER PLAN

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

LIST OF REPORTS

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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 Penyandang 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 Penyandang 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 Lingkingan	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 National	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

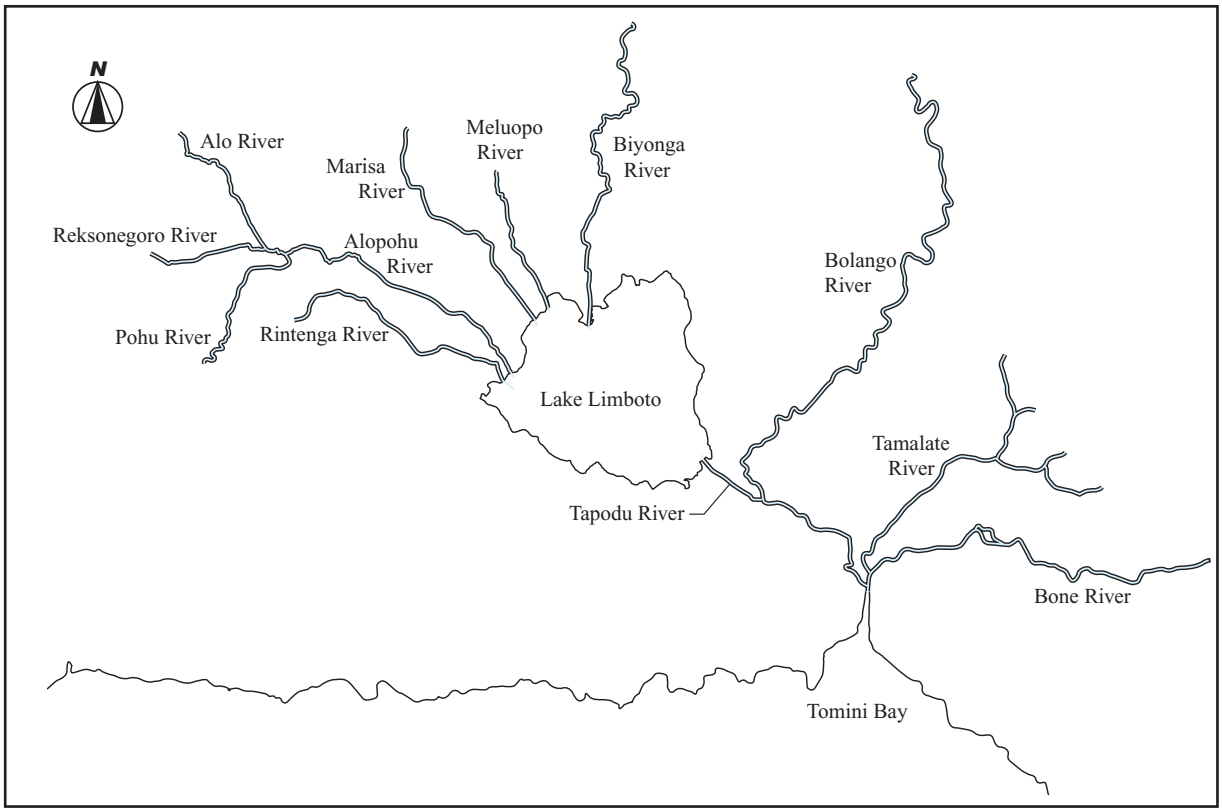
DPUP	Dinas Pekerjaan Umum Propinsi	Provincial Public Works Services
DTP	Dinas Tanaman Pangan	Office of Food Crops
Kanwil	Kantor Wilayah	Regional Office (of a Department)
Kaur	Kepala Urusan	Head of Sub Section
KDH	Kepala Daerah	Head of Regional Government
KDPP	Kepala Daerah Pengamatan Pengairan	Head of 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

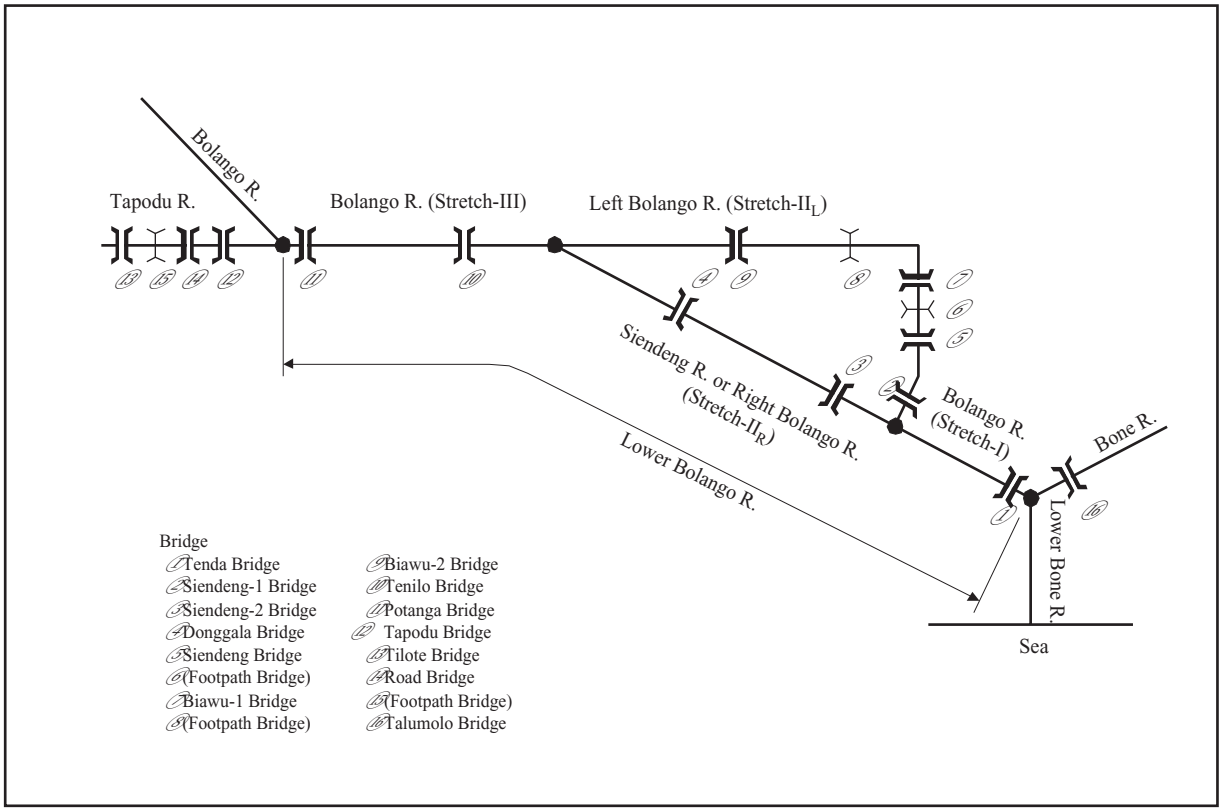
PSDA	Pengamanan Sumber Daya Air	Water Resources Conservation
PTPA	Panitia Tata Pengaturan Air	Provincial Water Resources Committee
PU	Pekerjaan Umum	Public Works
Puslitbang	Pusat Penelitian dan Pengembangan Pengairan PU	Institute of Hydraulic Engineering Center (Bandung)
PWS	Pengembangan Wilayah Sungai	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 Walikotamadya
Kotamadya	Municipality, Administrative District Headed by the Walikotamadya
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





B1. PLANNING BASIS

B1.1 Diagnosis of Flood and Sediment Problems

(1) Flood and Sediment Disasters

Suffering Areas: 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.

Flood Disasters: Types of flood disaster observed in the Study Area are flooding and inundation.

1) **Flooding:** The flooding is due to floodwater overtopping river and canal banks which is often seen along the river courses in the Study Area after heavy storm.
2) **Inundation:** The inundation is caused by stagnant floodwater in low-lying lands and the areas where gravity drainage is difficult because of natural and artificial obstacles. This type of flood disasters are seen near the confluence of the Bolango-Bone-Tamalate junction, left bank areas of the lower Bolango river, western lands of Lake Limboto, and Isimu-Pohu areas.

Sediment Disasters: Types of sediment disasters in the Study Area are Bank erosion, silting-up of river and canal beds, sedimentation of Lake Limboto, and slope failures and land slides.

1) **Bank erosion:** Bank erosion is found in most rivers of the Study Area, since the natural river is apt to meander eroding riverbanks, and the river stretches with bank protection works are very limited.
2) **Silting-up of river and canal beds:** Floodwater with high sediment concentration may silt up river and canal beds in the lower reaches where sediment transport capacity becomes low. The Alo-Pohu River is suffering from silting-up due to heavy sediment transport.
3) **Sedimentation of Lake Limboto:** Lake Limboto destines to silted up sooner or later, since it is functioning as a natural stilling basin for the sediment carried by the Biyonga, Alo-Pohu and other numerous rivers around the lake. The

sedimentation reduces lake's water storage capacity.

4) **Slope failure and land slides:** Menaces of slope failures and land slides lurk in the hillside slopes on the left bank of the Bone River, the right bank of the Bolango river, and the both side banks of the lower Bone River downstream from the Bolango junction.

(2) Causes of Disasters

Causes of Flood and Sediment Disasters: Flood and sediment disasters in the Study Area are induced basically by the following problems of the basin:

1) Concentration of properties on narrow plain
2) Insufficient flood mitigation facilities
3) Devastation of watershed
4) Inappropriate land use in flood plain

These problems may be associated with financial constraint, shortage of engineers and lack of comprehensive flood mitigation master plan to guide all the relevant activities.

Concentration of Properties on Flood Plain: Since the LBB basin is mountainous and the flat lands are only 20% or less, most of the arable lands and settlement are located in the flood plain formed by repeated river flooding for a long period. The flood prone areas of the LBB basin are located in such flood plains.

Insufficient Flood Mitigation Facilities: Flood mitigation facilities such as channel normalization, dikes and bank protection works are seen in the Bolango, Tamalate and Alo-Pohu rivers. However, the works are of small scale and for local measure. Other rivers and drainage channels are not improved yet and the drainage capacity remains low, which causes frequent flooding and elongates the period of flood inundation.

Devastation of Watershed Management: Deforestation and land development for agriculture and settlement take place in the watershed areas, especially in the Lake Limboto and the Bolango river basins. According to our study, 54 km^2 of bush lands and 21 km^2 of forest lands were converted to farm land during past 10 years. These activities reduce natural retention capacity of water and sediment and result in increase of floodwater and sediment runoffs.

Inappropriate Land Use in Flood Plain: Inappropriate land use in flood plain is another cause to aggravate the flood and sediment disasters. The flood plain is the land originally formed by floods and flooding is apt to take place often there. The inappropriate land use and development regardless this matter may cause the increase of damages in vain.

(3) Mechanism of Flood and Sediment Disasters

Damages due to the disaster generally depend on the basin's physical conditions, peoples' economic activities, and progress of disaster prevention activities in the Study Area. These are illustrated in Figure B1.1.1. In order to secure the stability of peoples' livelihood and development of the region, appropriate watershed and flood plain management are substantial as well as structural flood mitigation measures. Major causes and mechanism of flood and sediment disasters for respective suffering areas are briefed below:

Southern Part of Gorontalo City:

1) Southern part of Gorontalo City is located in the low land near the confluence of the Bolango and Bone rivers.
2) Channel capacity of the lower Bolango River downstream of Tapodu junction is low with only 88% of 2-year flood.
3) Water level of the lower Bolango is raised high for long period due to:
   (1) Long lasting outflow from Lake Limboto which retains huge amount of water,
   (2) Back-water effects of the Bone River of which flood duration is longer because of long shaped basin and better vegetation cover, and
4) Flush flood runoff from the upper Bolango River easily overtops the bank and causes frequent flooding of the city.
5) The Tamalate River carries flood water from the north eastern mountainous basin into the City and aggravates the conditions.

Lake Limboto and Western Area of Lake:

1) Lake Limboto receives flood runoff from drainage basins of a total area of 890 km^2 including the Alo-Pohu and Biyonga rivers, etc.
2) During the flood of the Bolango River, flood water from the lake cannot be drained due to high Bolango water level.
3) Even after the flood of the Bolango, it takes time to drain the stored water

because of low channel capacities of the Tapodu and the lower Bolango rivers.

4) This situation brings about the long period inundation in the western part of the lake and other lake side lands.
5) Sedimentation of the lake mainly due to sediments from the Biyonga, Alo-Pohu and Meluopo rivers aggravate the situation reducing lake's storage volume.

Limboto Area: The town of Limboto locating on the alluvial fan is subject to direct attack of flush flood and sediment runoff. Flooding in the low-lying lands upstream of the town area alleviate the flood and sediment disasters in the town area.

Middle Bolango River and Isimu-Pohu Areas: These are the low-lying lands sandwiched by alluvial fans and local relief located at the head of plain basins. In addition to the natural topography, artificial barriers like road embankment make the gravity drainage difficult.

B1.2 Administrative and Socio-Economic Frame

(1) Administrative Innovation

Establishment of Gorontalo Province: The establishment of Gorontalo Province was agreed by Central Government with the Law No.38/2000 and the organization and working order of the Dinas in Gorontalo Province have been established, among which Dinas of Public Works/Settlement and Regional Infrastructure was included. Though the organizational and institutional setup of new Gorontalo Province is progressing, it would take much more time to attain full function.

Decentralization Policy: Government administration changed to decentralization system, mainly by the Law No.22/1999 pertaining regional governance and the Law No. 25/1999 pertaining fiscal balance between central and regional governments. Under the decentralization system, all the authorities regarding the water resources matters are to be transferred to local government (Kabupaten/Kota). In order to administrate issues in the water resources sector, the local governments have established Dinas, i.e., Dinas Pekerjaan Umum Kota Gorontalo and Dinas Pekerjaan Umum dan Prasarana Wilayah Kabupaten Gorontalo. These two Dinas will have very big job. Formerly the jobs in these regions were only operation and maintenance of irrigation facilities carried out by branch offices of provincial Dinas.

(2) Socio-Economic Situation

Relevant Kabupaten/Kota: The area of 94% of the LBB basin is located in Kabupaten Gorontalo, 2% in Kota Gorontalo and 4% in Kabupaten Bolaang-Mongondow. Most of the developed area of Kabupaten Grontalo and whole of Kota Gorantalo is located in the plain area to be protected from flood and sediment disasters.

Population: According to the census 2000, the population was estimated 445,000 in the LBB basin, among which urban population was 205,000 comprising 120,000 in Kota Gorontalo and 85,000 in Kabupaten Gorontalo.

Regional Account: Per capita gross regional domestic products (GRDP) was estimated at Rp.1,160,000 (US$122 equivalent) for Kabupaten Gorontalo and Rp.2,388,000 (US$251 equivalent) for Kota Gorontalo, which respectively correspond to only 18% and 38% of the national average. The economic activity in Kabupaten Gorontalo is specialized for agriculture, while that in Kota Gorontalo for services in particular.

(3) Roles of Flood Mitigation

Per capita GRDP of the Study Area is far low comparing with the national average. The basin's economic activities have been constrained by the flood and sediment disasters. Flood mitigation is one of the basic infrastructures of the basin and is duly necessary to support sound economic development of the basin and to stabilize people's livelihood, accordingly to alleviate poverty of the region.

B1.3 Approach to Planning

In order to cope with the problems mentioned above, the Flood Mitigation Master Plan (FM-MP) is to be planned placing importance on the following.

1) Basin-wide approach
2) Comprehensive flood mitigation plan
3) Sustainable implementation of flood mitigation activities

(1) Basin-wide Approach

River is a continuous channel system to transport water and sediment from any point of

the basin to the river mouth. Figure B1.3.1 schematically shows the locations of the flood and sediment disasters in the LBB river system. As seen in the Figure, the flood mitigation activities in the upper reaches may adversely influence the areas in the lower reaches of the river system, and the work site and beneficiary area are not always the same. Flood mitigation measures of the LBB basin must be discussed from basin-wide view point.

(2) Comprehensive Flood Mitigation Plan

In order to cope with the natural and social issues related to the flood and sediment disasters, the FM-MP of the LBB basin should be formulated in comprehensive manner, employing every possible measures. The flood mitigation measures are divided, in general, into structural and nonstructural approaches as shown in Figure B1.3.2.

(3) Sustainable Implementation of Flood Mitigation Activities

The flood mitigation activities should be conducted and sustained keeping up with the changes of the physical and social features of the basin. It is desirable that the local government conducts and sustains the flood mitigation activities with participation of local communities. It is much more so under the recent decentralization policy. In order to make the activities sustainable, the FM-MP should take the following into account:

1) **Real needs of Community:** The plan must meet for real needs of the community. It is important to involve the intentions of community people from the initial stage, in order to make the project sustainable. Public consultation (PC) contributes much to know actual flood conditions and people's real needs.
2) **Adoption of technology locally available:** The local government and communities shall implement the FM-MP. Local materials should be adopted as much as possible. Capacity building is another important aspect for this purpose. In order to secure the sustainability of the project, it is also useful to learn from the current practice and experience in the region and other similar basins, not only from successful projects but also from projects in difficulties.
3) **Cost payable locally:** Cost for the activities should be payable by the local government and communities. The project scale and development level should be determined considering the solvency of the implementing agency and the immediate realization of the project effects as well as economic viability

4) **Participatory manner of implement:** It is a general principle that the beneficiaries should implement the work on their own cost. In view of this, implementation of flood mitigation activities in participatory manner would be a basic approach. In participatory manner, the community people would learn the objectives of activities and functions of facilities for the flood mitigation, and would contribute to make the activities and facilities more practical and sustainable.

B1.4 Principles for Planning Flood Mitigation Master Plan

(1) Flood Mitigation Master Plan

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 FM-MP shall cover structural and non-structural measures. 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. The proposed project will be implemented to support basin's socio-economic conditions at the target year.

(2) Design Scale of Facility

Return period of 20 years was decided to be applied to the Flood Mitigation Master Plan of the LBB basin, judging from the physical conditions of the basin and channels, design scale of other similar rivers and socio-economic situation of the basin. Flood control facilities are designed based on the 20-year flood, then, the economic and financial soundness shall be examined.

Design Scale: Design scale of the flood control facilities shall be determined in general, considering characteristics of runoff and topography, capacity of existing facilities, design scale of other rivers in similar conditions, importance of properties to be protected at present and in future, fund available for the construction and maintenance works, and economic viability.

Design Scale of Rivers in Indonesia: Design discharges of rivers in Indonesia are summarized in Table B1.4.1 together with their design scales. As seen in the Table, various return periods ranging from 10 years to 50 years are adopted for the design of channels. The 50- and 40-year floods are applied to the long-term plans and the 10 year floods are to the short-term or urgent plan. The 20- and 25-year floods are applied to the design of many rivers in Indonesia.

Recommended Design Scale: According to "Recommended Minimum Return Period of Design Flood" in Flood Control Manual (DGWRD, 1993) shown in Table B1.4.2, the design scale of river is stated as follows:

Project type	Initial phase	Final phase
Emergency project	5-yr.	10-yr.
New project	10-yr.	25-yr.
Updating project		
- For rural or urban with population <2,000,000	25-yr.	50-yr.
- For urban with population >2,000,000	25-yr.	100-yr.

Return Period of Recent Storms: Only for reference to the design scale, return period of recent floods was examined. Rainfall record is the only data available for the examination. According to the data available at Jalaluddin Airport and Boidu Tapa, the annual maximum daily rainfalls and their return periods are listed in Table B1.4.3. The return period was worked out based on the probable point rainfall estimated based on the data at each station. For the year 2002, rainfall records are available at four stations installed by the Study Team. These data are also shown in the Table. Looking over the return periods corresponding to respective annual maximum rainfalls, return periods of the recent major storms are less than 20-year, except for those in 1989 and 2000 at Jalaluddin Airport and in 1997 at Boidu Tapa. These three records give extremely high return period as point rainfall. However, considering the records available at other stations in the same year, areal rainfall values, which have close

correspondence with the magnitude of flood, are 67mm in 1989, 91mm in 1997 and 104mm in 2000 by using the arithmetic-mean method.

Table B1.4.1 DESIGN SCALE AND DISCHARGE OF RIVERS IN INDONESIA

No.	Name of River	Province	Chatchment Area (km^2)	Design Flood (m^3/s)	Specific Discharge ($m^3/s/km^2$)	Return Period (year)	Remarks
1	Brantas	East Java	10,000	1,500	0.15	50	*2
2	Ciujung	North Banten	1,850	1,600	0.86	50	*2
3	Jenebarang	South Sulawesi	729	3,700	5.08	50	
4	Surabaya	East Java	631	370	0.59	50	
5	Kuranji	West Sumatra	213	1,000	4.69	50	*2
6	Air Dingin	West Sumatra	131	700	5.34	50	*2
7	Solo	Central/East Java	3,400	2,000	0.59	40	*2
8	Madium	East Java	2,400	2,300	0.96	40	*2
9	Citanduy	West Java	3,680	1,900	0.52	25	
10	Cimanuk	West Java	3,006	1,440	0.48	25	
11	Pemali	Central Java	1,228	1,300	1.06	25	
12	Ular	North Sumatra	1,080	800	0.74	25	
13	Serang	Central Java	937	900	0.96	25	
14	Cipanas	West Java	220	385	1.75	25	
15	Kuranji	West Sumatra	213	870	4.08	25	*1
16	Air Dingin	West Sumatra	131	600	4.58	25	*1
17	Arakundo	Ache	5,495	1,800	0.33	20	
18	Wampu	North Sumatra	3,840	1,320	0.34	20	
19	Walarue	South Sulawesi	3,190	2,900	0.91	20	
20	Bah Bolon	North Sumatra	2,776	1,220	0.44	20	
21	Kring Ache	Ache	1,775	1,300	0.73	20	
22	Biba	South Sulawesi	1,368	1,900	1.39	20	
23	Marmoyo	East Java	290	230	0.79	20	
24	Brantas	East Java	10,000	1,350	0.14	10	*1
25	Solo	Central/East Java	3,400	1,500	0.44	10	*1
26	Madium	East Java	2,400	1,100	0.46	10	*1
27	Ciujung	North Banten	1,850	1,100	0.59	10	*1

Note * 1 : For short-term or urgent plan
* 2 : For long-term plan

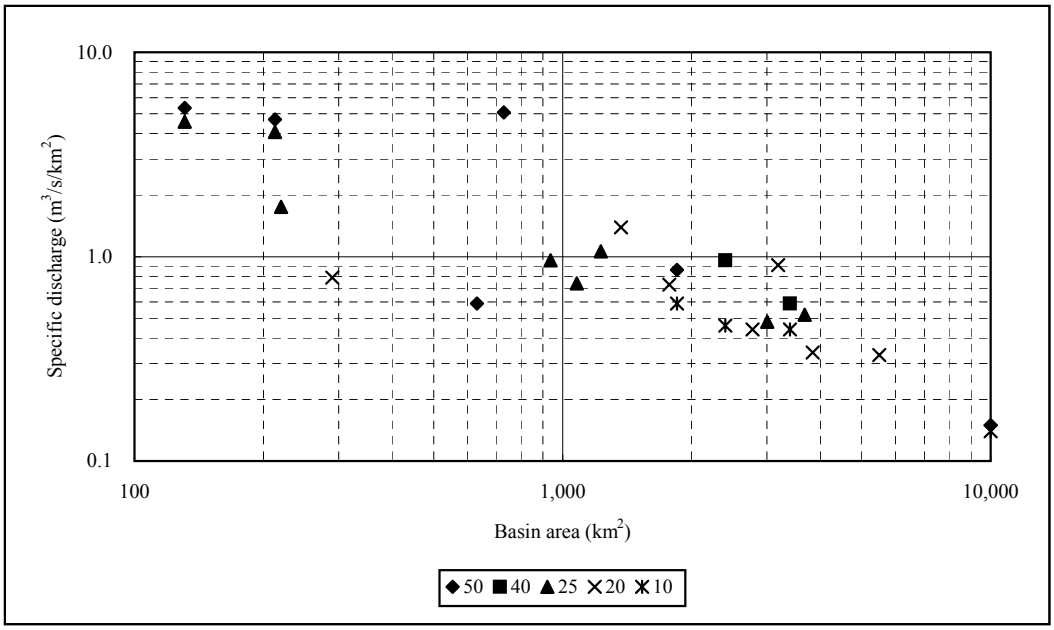


Table B1.4.2 RECOMMENDED DESIGN SCALE IN INDONESIA

Conveyance System	Project type (for river flood control project) and total population (for drainage system)	Initial phase	Final phase
River	Emergency project	5	10
	New project	10	25
	Updating project		
	- for rural and/or urban with P < 2,000,000	25	50
	- for urban with P > 2,000,000	25	100
Primary drainage system (catchment area > 500 ha)	Rural	2	5
	Urban P < 500,000	5	10
	Urban 500,000 < P < 2,000,000	5	15
	Urban P > 2,000,000	10	25
Secondary drainage system (catchment area > 500 ha)	Rural	1	2
	Urban P < 500,000	2	5
	Urban 500,000 < P < 2,000,000	2	5
	Urban P > 2,000,000	5	10
Secondary drainage system (catchment area < 500 ha)	Rural and urban	1	2

Notes:

1. Higher design flood standard should be applied if an economic analysis indicates that it is desirable, or if flooding is a significant risk to human life.
2. P = Total urban population
3. Emergency Project: Emergency projects are developed without preliminary engineering and economic feasibility studies at sites where flooding is excessive and flooding problems present a significant risk to human life.
4. New Project: New project include flood control projects where no previous flood control projects have been developed or where Emergency Projects have been developed.
5. Updating Project: Updating projects include rehabilitation projects and improvements to existing projects. Most river basin development projects are considered to be updating projects

Source: "Recommended Minimum Return Period of Design Flood" in Flood Control Manual, Volume II, Guidelines for Planning and Survey (DGWRD, June 1993)

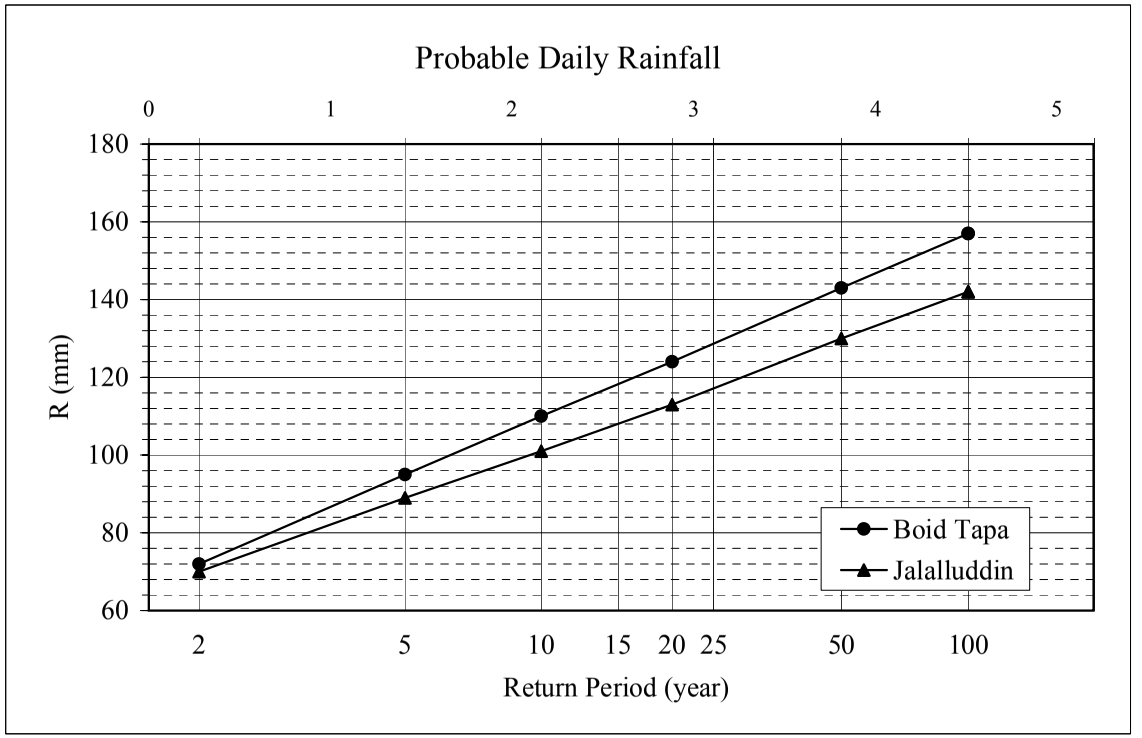
Table B1.4.3 RETURN PERIOD OF RECENT STORMS

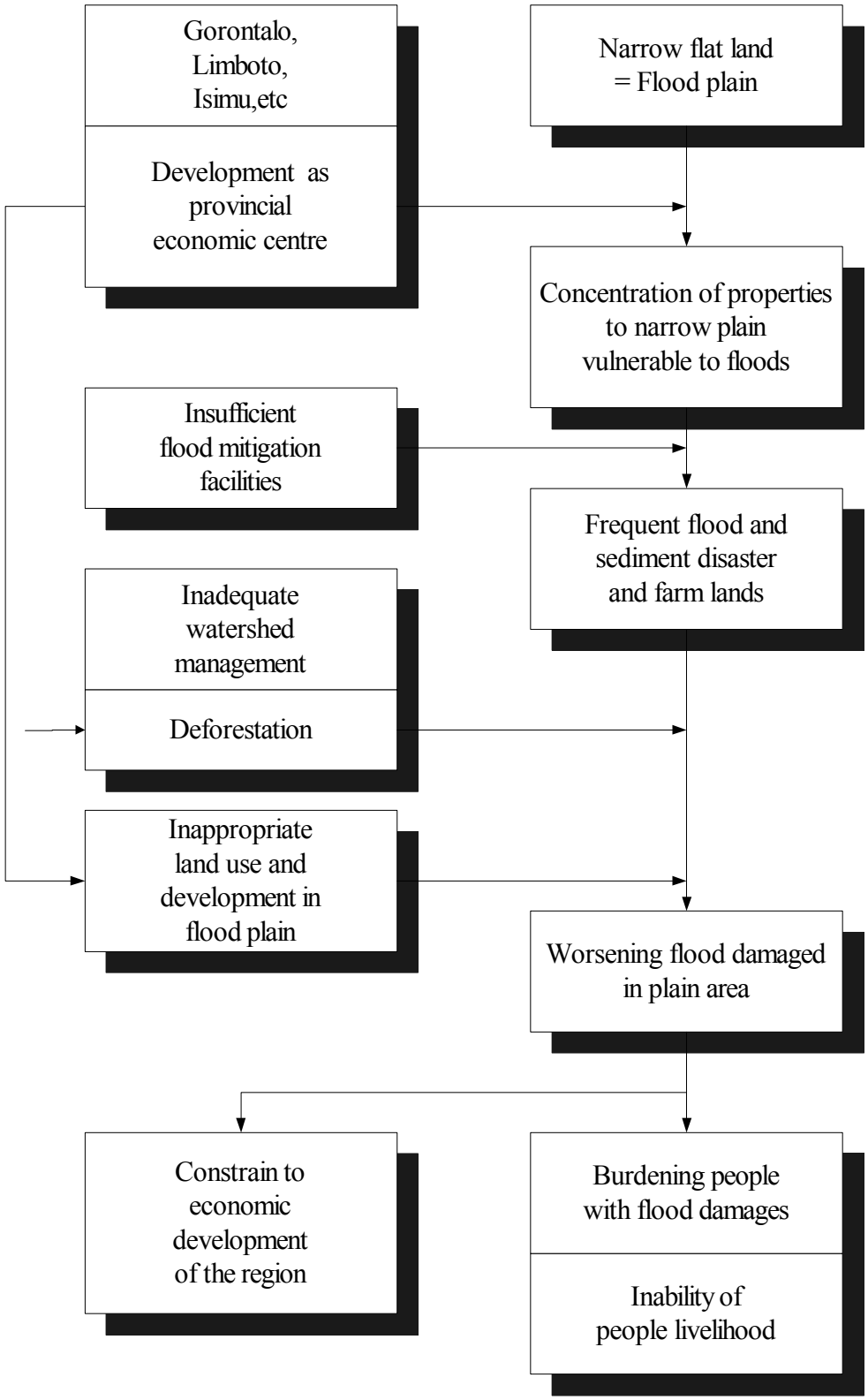
Annual Maximum Daily Rainfall

Year	Jalalluddin Airport		Boid Tapa	
	Daily Rainfall (mm)	Estimation	Daily Rainfall (mm)	Estimation
1972			34	<2-yr
1973			66	<2-yr
1974			99	6-yr
1975	82	4-yr	86	4-yr
1976	58	<2-yr	52	<2-yr
1977	73	2-yr	90	4-yr
1978	57	<2-yr	71	<2-yr
1979	55	<2-yr	112	11-yr
1980	60	<2-yr	50	<2-yr
1981	70	2-yr	84	4-yr
1982	64	<2-yr	68	<2-yr
1983	86	5-yr	72	2-yr
1984	73	2-yr	71	<2-yr
1985	58	<2-yr	58	<2-yr
1986	48	<2-yr	63	<2-yr
1987	79	3-yr	64	<2-yr
1988	74	3-yr	75	2-yr
1989	120	32-yr	72	2-yr
1990	86	5-yr	59	<2-yr
1991	61	<2-yr	60	<2-yr
1992	69	<2-yr	62	<2-yr
1993	73	2-yr	96	5-yr
1994	56	<2-yr		
1995	82	4-yr	107	9-yr
1996	53	<2-yr	83	3-yr
1997	99	9-yr	161	120-yr
1998	97	8-yr		
1999	73	2-yr		
2000	138	80-yr		
2001	65	<2-yr		

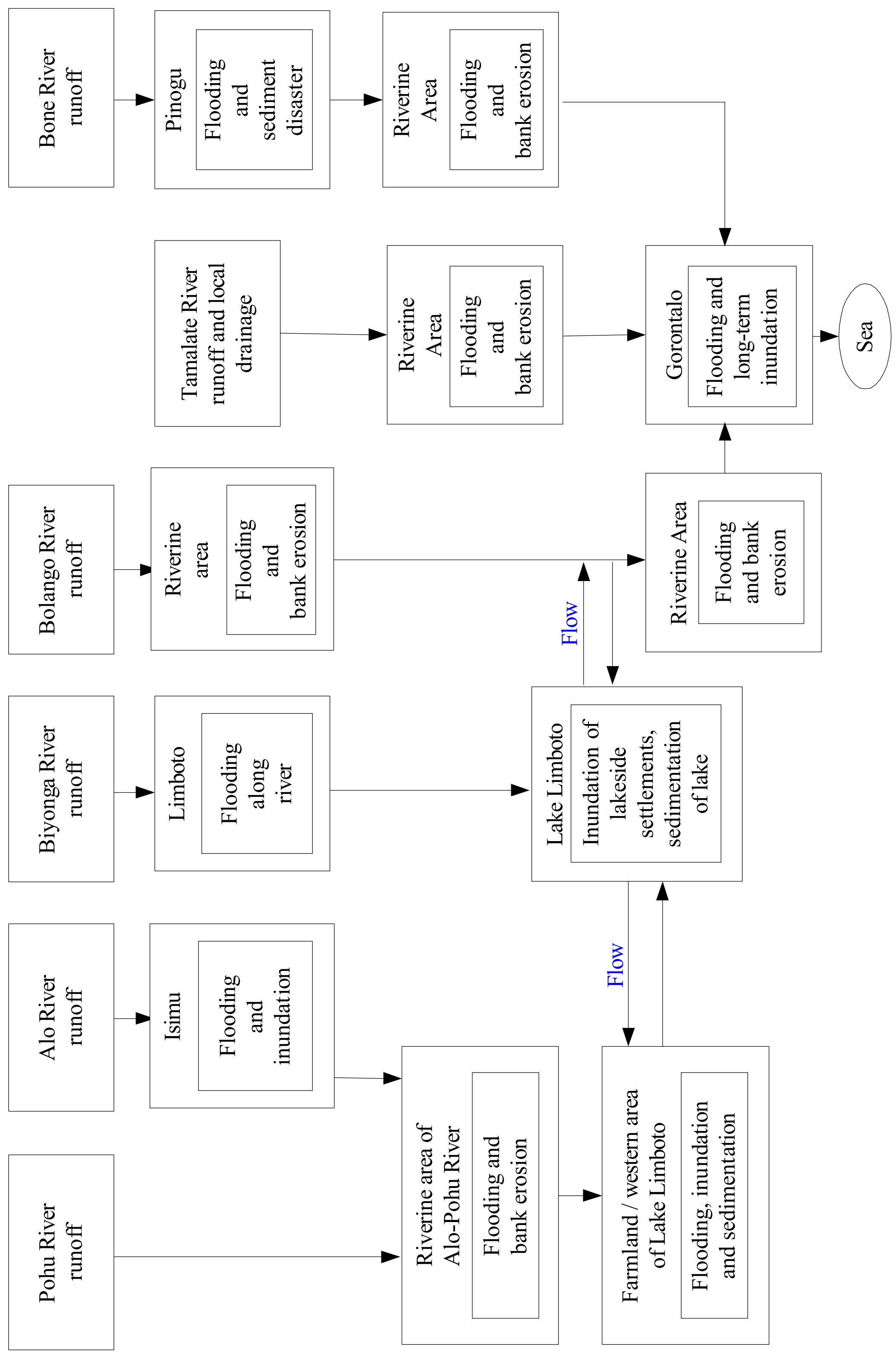
Flood on May 2002

Station	Daily rainfall		
	(mm)	Date	Estimation
Biyonga	30.0	8 May	< 2-yr
Dulamayo	88.0	7 May	5-yr
Bongomeme	79.5	7 May	3-yr
Alale	108.5	11 May	15-yr

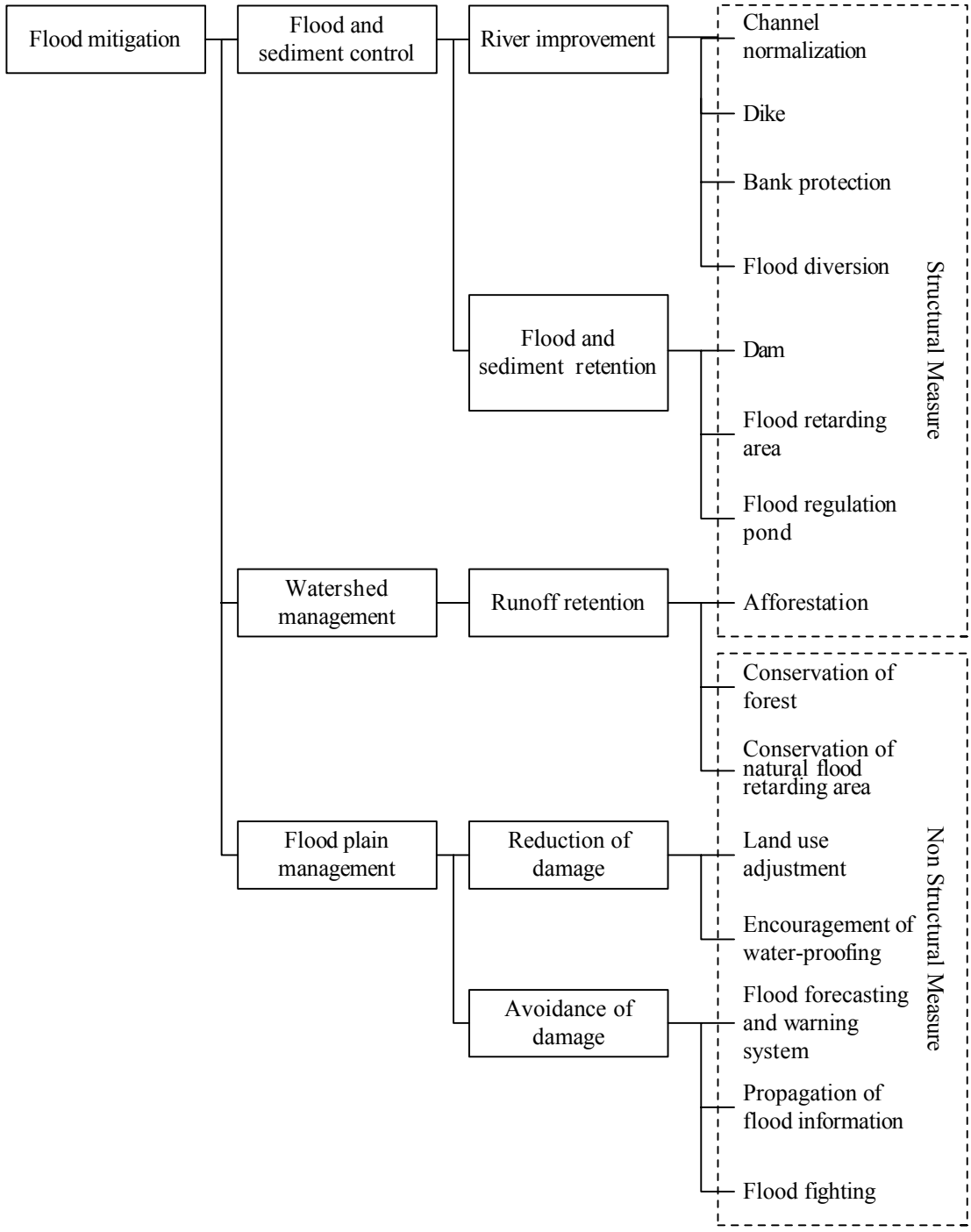




The Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia *Japan International Cooperation Agency*	**Figure B1.1.1** **MECHANISM OF FLOOD AND SEDIMENT DISASTER**



The Study on Flood Control and Water Management in Limboto-Bolango-Bone Basin in the Republic of Indonesia	**Figure B1.3.1**
Japan International Cooperation Agency	**INTERRELATEDNESS OF FLOOD AND SEDIMENT DISASTER**



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

Japan International Cooperation Agency

Figure B1.3.2
COMPREHENSIVE FLOOD MITIGATION MEASURES