

Figure-4.20 Typical Section of Ayung Dam

4.3.2 Benel Dam Development Plan

Shortage of irrigation water with area of about 966 ha and local water supply in Mekarsari and Manistutu located at downstream of Aya Barat river in Jembrana Regency was very severe especially during dry seasons in recent years. Small reservoir at upstream of Aya Barat River was planned for the supply of water by Bali Water Resources Development and Management Project.

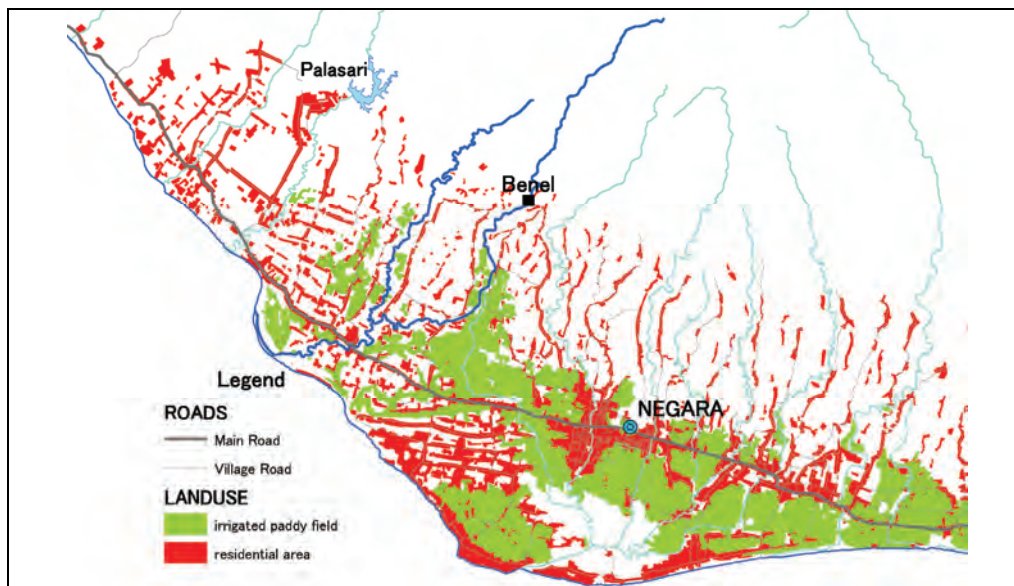


Figure-4.21 Location of Benel Dam

Main objectives of the Project are shown as follows;

- ◆ Irrigation water for irrigated area 966.0 ha with 1.59 m³/sec.
- ◆ Raw water supply for domestic use of about 64 l/sec for Melaya and Negara in Jembrana Regency.

Considering the above matters, a planning on Integrated Development Plan for Aya Barat River will be prepared. Specifications of Benel dam are shown in Table-4.22.

Table-4.22 Specifications for Benel Dam

Classifications	Items	Specifications
1. Reservoir	1) Location	Aya Barat River (Desa Manistutu)
	2) Catchments Area	18.3 km ²
	3) Full Supply Level(FSL)	EL 171.5 m
	4) Low Water Level(LWL) Minimum Operation Level(MOL)	EL 151.0 m
	5) Active Storage	1,618,000 m ³
	6) Sedimentation Storage	305,000 m ³
	7) Total Storage	1,923,000 m ³
2. Dam	1) Type of Dam	Rockfill Type (Central Core Type)
	2) Crest Elevation	EL 175.5 m
	3) Dam Basement	EL 138.0 m
	4) Dam Height	37.5 m
	5) Construction Cost	JP¥ 850.8 mill.

Plan and Typical Section are shown in Figure-4.22 and Figure-4.23.

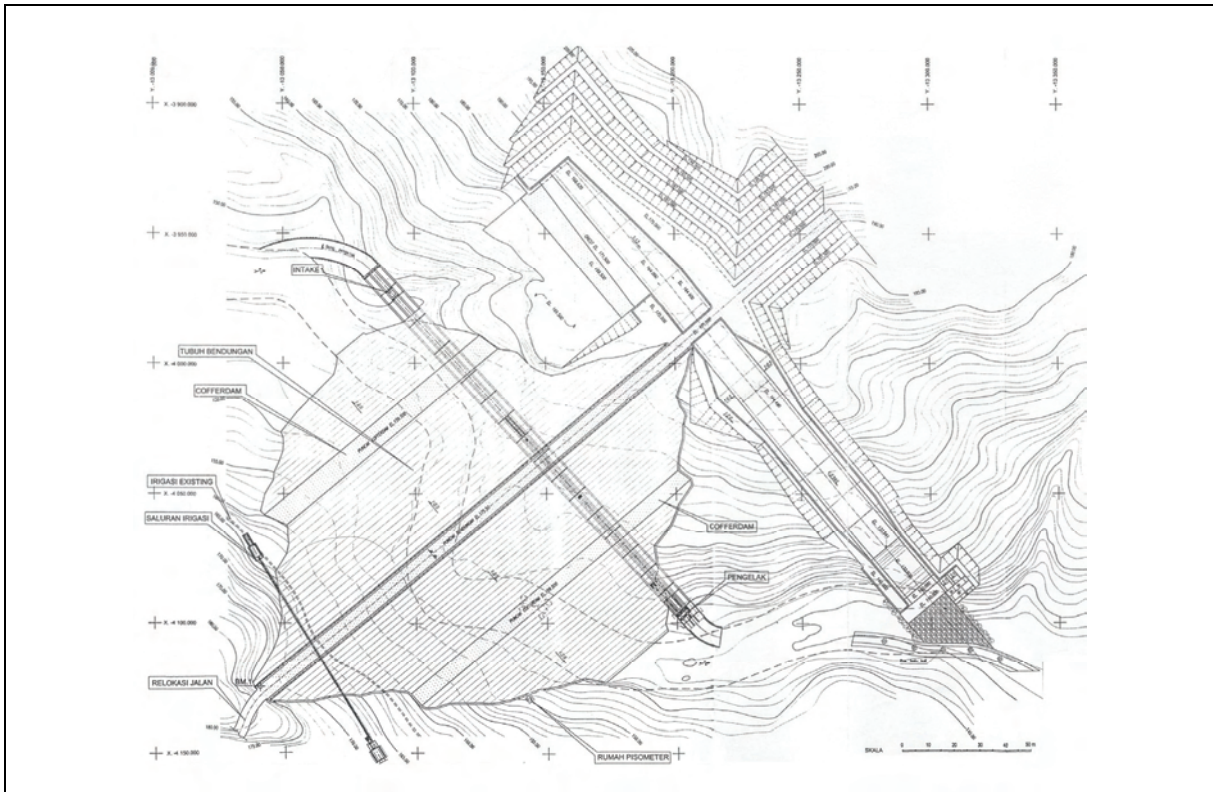


Figure-4.22 Plan of Benel Dam

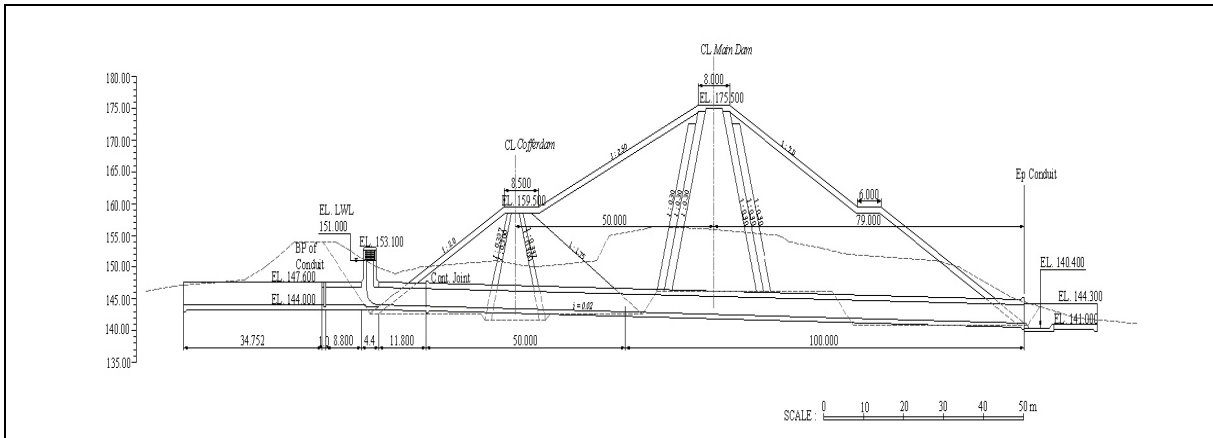


Figure-4.23 Typical Cross Section

4.4 Flood Control Plan

The flood control countermeasures which include not only structural measures but also non-structural measures are to be applied on the basis of the policy of “*STAY HARMONY WITH WATER*”.

Flood control plan for Badung River in the master plan, river improvement was adopted, whereas river improvement plan and construction of retarding area with land use restriction one of non-structural measures were adopted for Mati River. Flood defense activities by the reorganization of work unit SATGAS shall be found to be useful in the area of Badung River and Mati River.

4.4.1 Alternatives for Flood Control Plan

(1) Current Conditions and Problems on Flood Occurrences

There are 111 records of flood occurrence in Bali Province during 23 years starting from 1982. Of these records, the occurrences of flood concentrate in Denpasar City, Buleleng Regency, Jembrana Regency and Karangasem Regency. Locations of these disasters are shown in Figure-4.24.

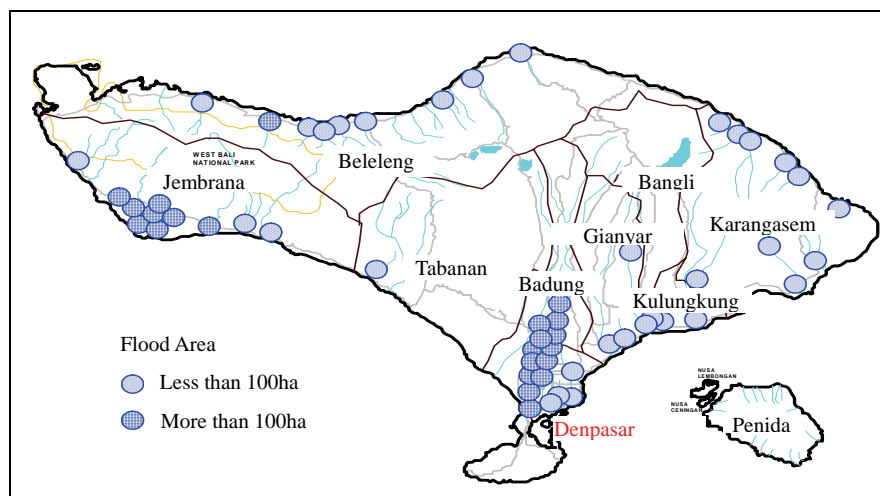


Figure-4.24 Flooding Area in Bali

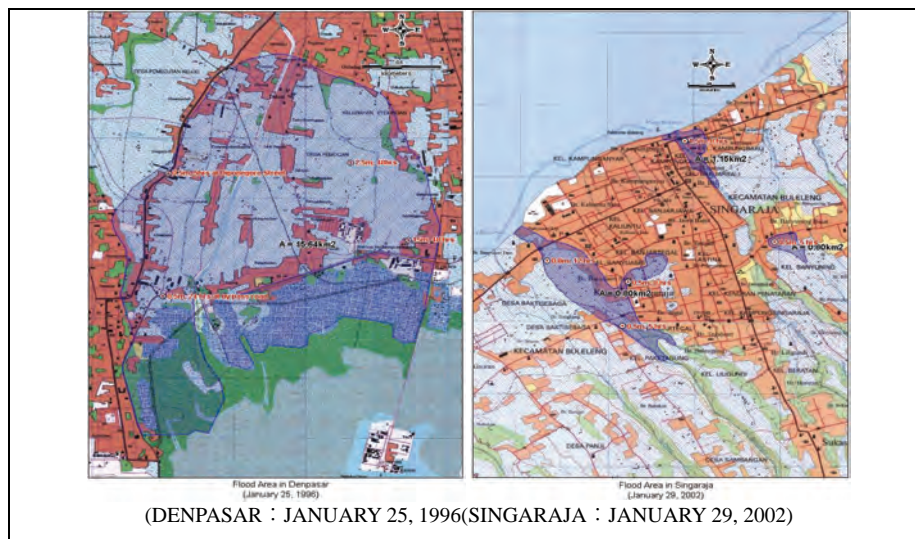


Figure-4.25 Flood Area in Denpasar and Singaraja

Current issues on disasters by flood based on the arrangement of past flood analysis is summarized as follows:

- ◆ Due to urbanization in urban area, run-off volume has been increasing in recent years in Denpasar City and its surrounding area. Increasing of runoff volume make disasters repeatedly in Badung River of Denpasar City and in Mati River of Badung Regency. There are many housing and buildings lined so close in both banks of rivers flowing in urban area. Taking into consideration of these current conditions, it is impossible to execute large-scale works of

widening and banking for river improvement plan. It would be appear that land acquisition is impossible due to rising land price.

- ◆ Many water channels which converted from irrigation channels of the paddy field in the past flows in Denpasar City. Almost of these channels show a shortage of flow capacity for large rainfall intensity.
- ◆ There was inundation disaster caused to mistake by gate operation of weirs in Denpasar City. For the disaster prevention, guidance for gate operation shall be required.
- ◆ The river improvement projects caused to inundation by 1998 flooding in progress are Sowan River and its tributaries near Negara in Jembrana Regency. In Sigaraja area, drainage countermeasures for inland low-lying area in Buleleng River and riverbed excavation as well as banking in Banumala River should be required.



Figure-4.26 Badung River in Denpasar

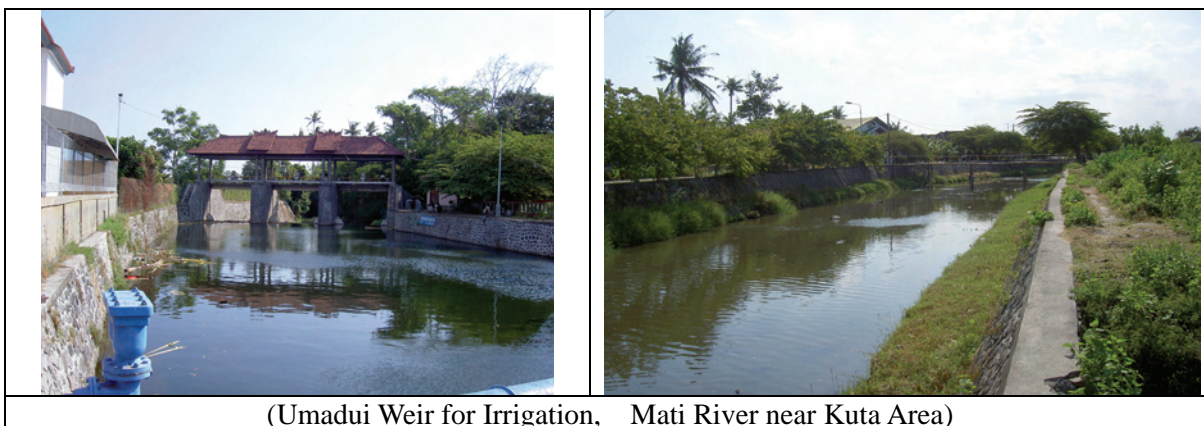


Figure-4.27 Mati River in Badung Regency

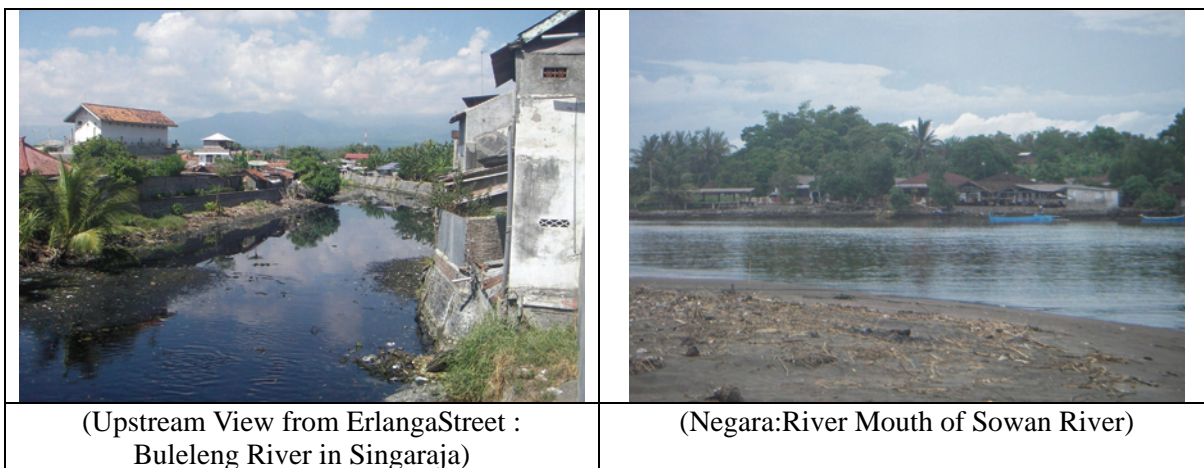


Figure-4.28 River Condition in Singaraja and Negara Area

(2) Basic Policies for Flood Control Plan

Basic policies for flood control plan shall be summarized as shown in bellow:

<Basic Policy>

To achieve the purposes mentioned above, the following structural and non-structural countermeasures are to be applied on the basis of the policy of “*STAY HARMONY WITH WATER*”:

- ◆ **Structural Measures:**
 - ✓ River course improvement by dikes, revetment, excavation, consolidation etc.
 - ✓ Flood peak discharge regulation by reservoir, retarding basin, diversion channel etc.
- ◆ **Non-structural Measures:**
 - ✓ Flood forecast and evacuation system
 - ✓ To minimize the increased discharge by urban development based on the policy “Zero Delta Q Policy”
 - ✓ To enhance (or maintain) the flood control function of current basin through conservation of forest and/or reforestation, and conservation of firm lands such as rice fields.

A system of comprehensive flood control countermeasures including non-structural measures is shown in Table-4.23.

Table-4.23 System of Comprehensive Flood Control Countermeasures

Classifications	Contents of Countermeasures		Non-structural
1.River Improvement	1.1River improvement (Dykes, Revetment, Excavation)		
	1.2Construction of Retarding area, Diversion water way, and so on		
2.Countermeasures for Catchments Areas	2.1 Retention Areas	2.1.1 Land use restriction	○
		2.1.2 Vegetation control & Greenery conservation	○
		2.1.3 Detention pond	
		2.1.4 Rain water storage (off-site, on-site)	
		2.1.5 Permeable pavement, Infiltration pit	
	2.2 Retarding Areas	2.2.1 Land use restriction	○
		2.2.2 Land banking restriction	○
		2.2.3 Farm environment improvement	○
	2.3 Low land Areas	2.3.1 Landside drainage system	○
		2.3.2 Storing Pond	
2.3.3 Water proof houses, buildings, facilities			
3.Damage Mitigation	3.1 Evacuation and warning system		○
	3.2 Flood defense activities		○
	3.3 Hazard map (Flood, Sediment)		○
	3.4 General river management (sedimentation, facilities, deposits, etc)		○
	3.5 Public relations, awareness		○
	3.6 Flood insurance		○

<Target Areas>

The target area to be protected against flood should cover the whole Bali Province. In the Master Plan, however, priority is put on urban areas such as Denpasar and Kuta areas, Singaraja and Negara.

- ◆ Singaraja (Beleleng River, Banumala River in Buleleng)
- ◆ Denpasar City (Badung River, Mati River)
- ◆ Negara (Sowan River, Bilikpoh River in Jembrana)