1.4.3 Design and Cost Estimate

(1) Facility Design

(a) Design of River Improvement Works

The structure of river improvement works was designed and taking into account the following points: 1) sheet piles earth anchors are designed to protect existing flood walls against excavation of riverbed, 2) river stream was planned to be diverted constructing sheet piles in the center of river course, 3) Flood wall was designed as L-shape reinforced concrete revetment. Typical cross section of river improvement works is shown in Figure-1.26.

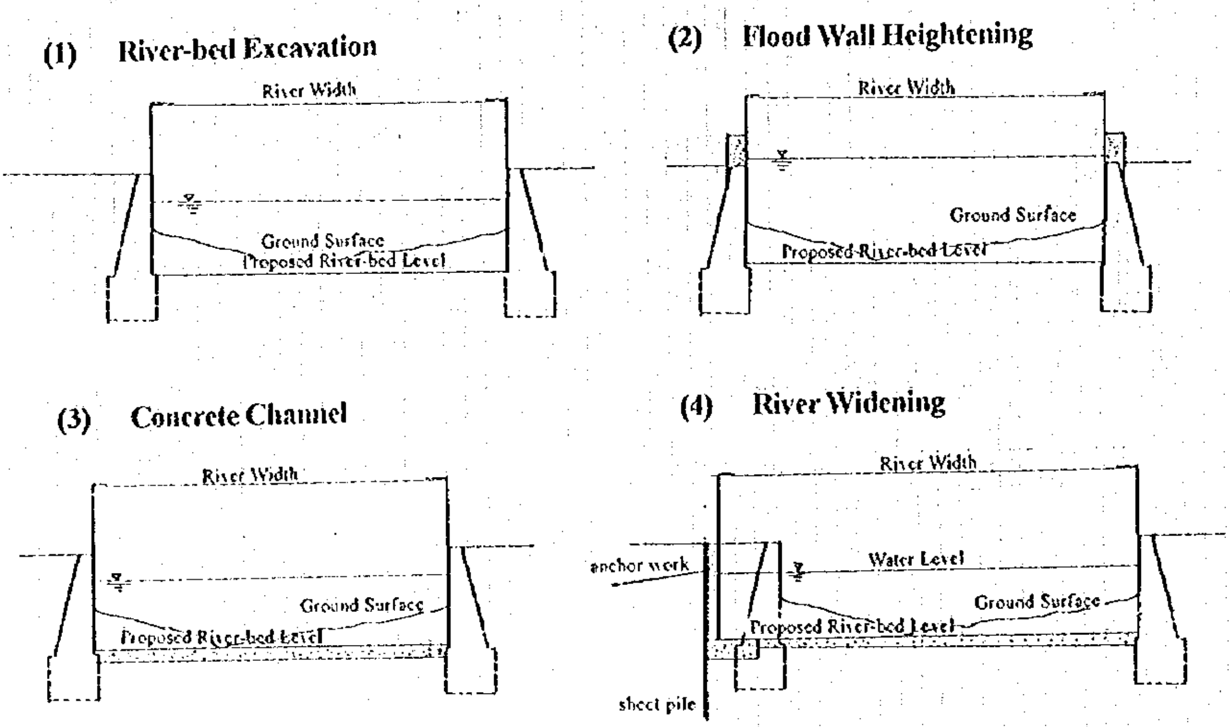


Figure-1.26 Typical Cross Sections of River Improvement

All the drainage to rivers should be improved installing the gates, which are classified into 3 types according to the sizes of drainage. Existing bridges are planned to be reconstructed or rehabilitated if necessary.

(b) Design of Diversion Works

The structure of diversion tunnel and fixed weir is shown in Table-1.30 and Table-1.31.

Table-1.30 Dimension of Diversion Tunnel

Item	Dimension	Remarks
Outlet Level	0.80m	High Tide Sea Level
Inlet Level	2.80	
Tunnel Length	900m	
Tunnel Gradient	1/450	
Diameter of Cross Section	6.00m	Horseshoe shape section

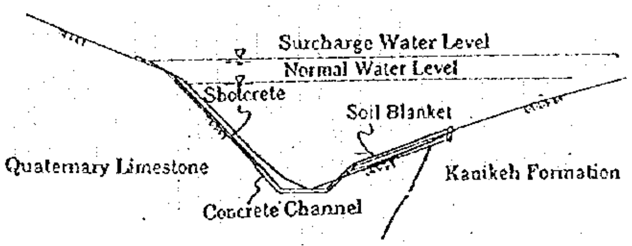
Table-1.31 Condition of Fixed Weir Design

Item	Main Stream	Diverted Stream
Weir	Fixed Weir	Fixed Weir
Top of Weir	4.39m	5.29m
Length of Weir	10.0m	18.0m
Height of Weir	1.0m	0.9m
Overflow Depth	2.6m	1.7m

(c) Design of Dams

The dam type of rock fill dam with inclined clay core was adopted because water leakage prevention measures are necessary and because dam foundation rock strength is not expected to be strong enough. The major structural features of the dams are shown in Table-1.32.

As quaternary limestone was found to be distributed in the both dam sites and reservoir areas, leakage prevention is designed in the reservoir area. The structure of water leakage prevention measures are shown in the following Figure-1.27.



Riverbed area : Concrete channel, Gentle slope area : Soil blanket, Steep slope area : Shotcrete

Figure-1.27 Reservoir Protection

Table-1.32 Major Structural Features of Dams

Structure	Item	Batu Gajah	Batu Gantung
Dam	Type	Rock Fill Dam with Inclined Clay Core	
	Height	50.00m	36.60m
	Crest Length x Crest Width	240 m x 10 m	100 m x 10 m
	Volume of Dam	597,000 m^3	159,000 m^3
	Dam Slope : Upstream/Downstream	1 : 3.0 / 1:2.5	1 : 3.0 / 1:2.5
Spillway	Type	Overflow	
	Width / Height	6.5m / 3.9m	4.2m / 4.2m
Emergency Spillway	Type	Non Gated Type	Non Gated Type
	Discharge Capacity	190m^3/s (2,000-year)	220m^3/s (2,000-year)
	Overflow Crest Elevation	EL. 66.60 m	EL. 96.80 m
	Overflow Depth / Length	1.5m / 13.5m	1.5m / 12.0m

(d) Design of Check Dam

The check dams were designed as a masonry gravity dam. Specifications of the check dams are shown in Table-1.33.

Table-1.33 Specification of Check Dams

River	Ruhu	Tomu	Batu Gajah	Batu Gantung
Dam Type	Masonry Gravity Dam			
Basement Elevation EL(m)	62.0	34.5	115.5	110.0
Dam Height (m)	3.8	4.9	6.1	3.5
Dam Length (m)	51.0	39.0	32.0	25.0
Overflow Depth (m)	4.17	1.89	2.44	2.96
Free Board (m)	0.80	0.60	0.60	0.60
Spillway Height (m)	4.97	2.69	3.04	3.56
Spillway Width (m)	17.0	15.0	10.0	8.0
Dam Volume (m^3)	1,000	800	750	300

Note: River Bed Excavation is set as 1.0m depth.

(e) Design of Land Reclamation Area

The maximum depth for the sea wall necessary to enclose the land reclamation area was assumed as - 2.0m below mean sea level. Reclamation area was assumed as + 2.0m above mean sea level. From the bathymetric map, which was surveyed and made by JICA Study Team, the available area for land reclamation and the potential volume for disposal of excavated material was calculated as shown in Table-1.34.

Table-1.34 Available Area for Land Reclamation

Name	Type	Area	Average Depth	Total Volume	Sea Wall Dimension	
					Average Height	Total Length
Wai Nitu	New Reclamation	6.56 ha	3.0 m	196,800 m^3	4.5 m	865 m

(2) Construction Schedule

The construction works of the project were divided into the four components such as 1) river improvement works, 2) diversion tunnel, 3) dam construction and 4) land reclamation. These works is planned to be constructed according to the construction schedule shown in Table-1.35. The total construction period is 5 years (60 months) from April, 2002 to March, 2006.

(3) Work Quantity and Cost Estimate

The construction cost and compensation cost of each work item is presented in Table-1.36.

Table-1.35 Construction Schedule

Item	Unit
1.River Improvement Works	
1.1 Preparatory Works	Ls
1.2 River Bed Excavation	105,600 m3
1.3 Concrete Work	42,650 m3
1.4 Drainage Gate Works	
1.5 Bridge Improvement	
1.6 Sheet Pile	
1.7 Anchor Work	
2.Diversion Tunnel	
2.1 Preparatory Works	Ls
2.2 Tunnel Excavation	40,900 m3
2.3 Concrete Lining	13,950 m3
2.4 Inlet Works	Ls
2.5 Outlet Works	Ls
3.Dam Construction	
3.1 Preparatory Works	Ls
3.2 Access Road	4,110 m
3.3 Resoriver Protection	
(1) Batu Gajah	Ls
(2) Batu Gantung	Ls
3.4 Diversion Tunnel	
(1) Batu Gajah	398 m3
(2) Batu Gantung	192 m3
3.5 Excavation	
(1) Batu Gajah	155,000 m3
(2) Batu Gantung	37,000 m3
3.6 Embankment	
(1) Batu Gajah	571,000 m3
(2) Batu Gantung	159,000 m3
3.7 Spillway	
(1) Batu Gajah	12,420 m3
(2) Batu Gantung	10,580 m3
3.8 Initial Filling	Ls
4. Land Reclamation	
4.1 Sea Wall	

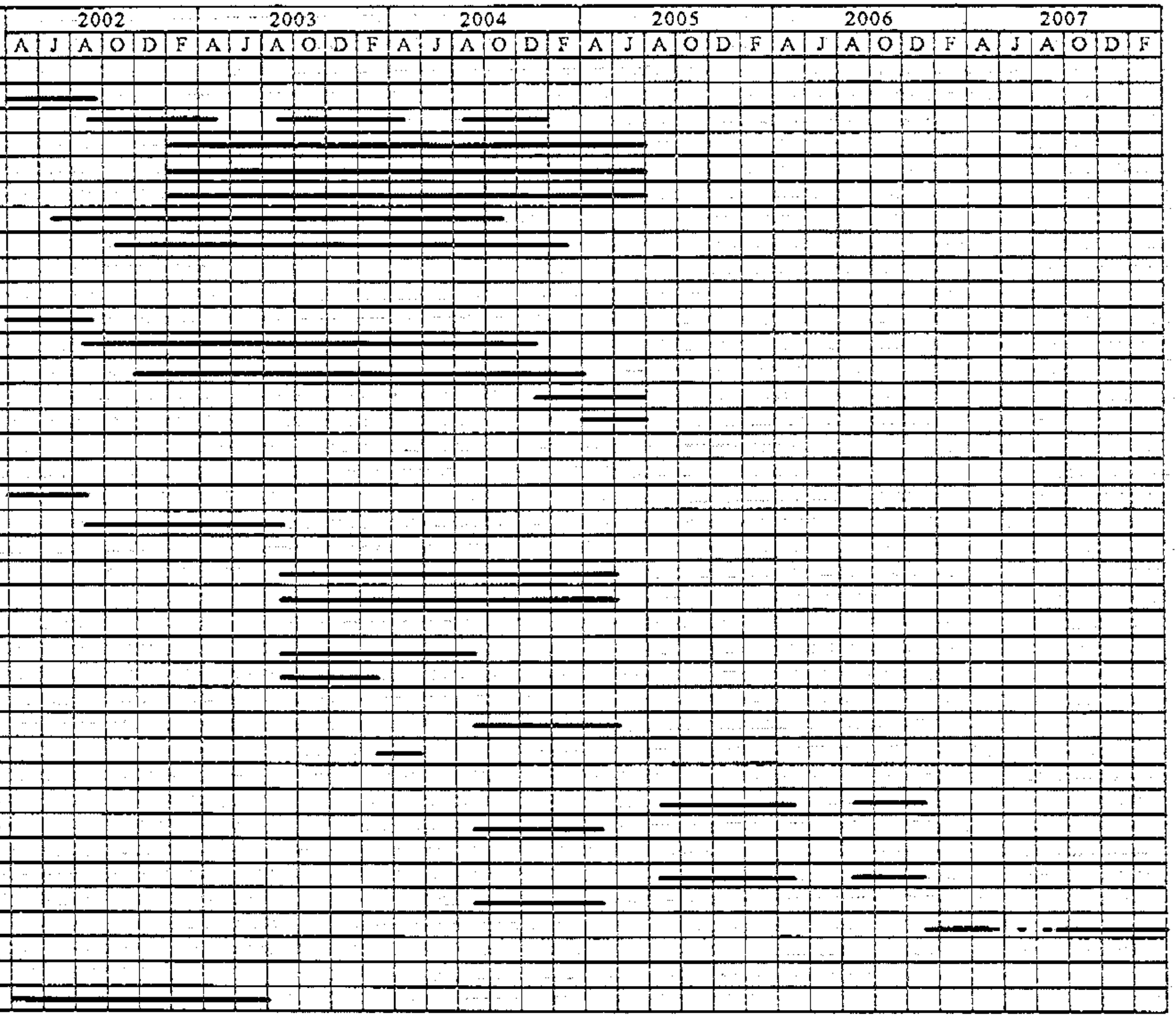


Table-1.36 Construction Cost and Land Acquisition & Compensation Cost of Work Items

Unit : Rp. million

Work Item	River Improvement									
	Ruhu 1,600m		Batu Merah 1400m		Tomu 2,400m		Batu Gajah 2,200m		Batu Gantung 1,450m	
	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
1.1 Preparatory Work (LS)	1	407	1	706	1	1,210	1	825	1	587
1.2 River Bed Excavation (m^3)	25,900	389	20,600	309	28,000	420	18,800	282	12,300	185
1.3 Concrete (m^3)	3,050	2,248	7,200	5,306	15,900	11,719	9,950	7,333	6,550	4,828
1.4 Gate Work (piece)	18	163	14	145	19	186	25	247	9	105
1.5 Bridge Improvement (br.)	4	678	5	464	10	1,542	13	822	4	1,292
1.6 Sheet Pile (m)	600	1,197	1,140	2,274	1,010	2,015	920	1,836	630	1,237
1.7 Anchor Work (piece)	100	395	400	1,580	205	810	180	711	130	514
1.8 Check Dam (m^3)	1,000	737	-	-	800	590	750	553	300	221
Sub Total (1) (Construction Cost)	6,214		10,784		18,492		12,609		8,969	
2.1 Land Acquisition (m^2)	615	62	1250	250	1,781	802	859	387	791	356
2.2 Resettlement (household)	5	225	21	945	10	450	19	855	26	1,170
Sub Total (2)	287		1,195		1,252		1,242		1,526	
Construction Cost	6,214		10,784		18,492		12,609		8,969	
Indirect Cost (25%)	1,554		2,696		4,623		3,152		2,242	
Economic Cost	7,768		13,480		23,115		15,761		11,211	

Work Item	Dam Construction				Diversion		Disposal	
	Batu Gajah		Batu Gantung		Batu Merah		Wai Nitu	
	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
1.1 Preparatory Work (LS)					1	1,107		
1.2 Tunnel Excavation (m^3)					40,900	2,548		
1.3 Concrete Lining (m^3)					13,950	12,338		
1.4 Excavation (m^3)					5,500	83		
1.5 Concrete Work (m^3)					1,150	848		
2.1 Preparatory Work (LS)	1	3,825	1	2,500				
2.2 Access Road (m)	2,100	317	2,050	310				
2.3 Reservoir Sealing (m^2)	47,500	21,150	40,000	18,000				
2.4 Diversion Tunnel (m)	398	3,821	217	2,083				
2.5 Excavation (m^3)	155,000	2,279	37,000	544				
2.6 Embankment (m^3)	597,000	14,925	159,000	3,975				
2.7 Spillway Concrete (m^3)	12,420	9,154	10,580	7,798				
2.8 Intake (LS)	1	3,000	1	3,000				
3.1 Preparatory Work (LS)							1	432
3.2 Sea Wall (m)							865	6,176
Sub Total (1+2+3) (Construction Cost)	58,471		38,210		16,924		6,608	
5.1 Land Acquisition (m^2)	92,100	3,842	148,500	4,455	3,000	600		
5.2 Resettlement (household)	50	2,250	1	45	12	540		
Sub Total (5)	6,092		4,500		1,140			
Construction Cost	58,471		38,210		16,924		6,608	
Indirect Cost (25%)	14,618		9,553		4,231		1,652	
Economic Cost	73,089		47,763		21,155		8,260	

1.4.4 Project Evaluation

(1) Environmental Impact Assessment

Initial environmental examination was conducted for the Flood Control Master Plan and negative impacts were identified on 12 environmental elements of which resettlement, solid waste and groundwater were considered to be significant impacts during implemention of the proposed projects. On this basis, the environmental impact assessment (EIA) for the priority projects was conducted with the identified 12 environmental elements as main study items.

The Study Team carried out field surveys including an interview survey with the households which would be possibly involved in the resettlement program, a biological survey for the rivers and estuary areas, a water quality survey at the proposed dam sites and a hydrogeological survey in areas where groundwater may be influenced by the two dams at Batu Gajah and Batu Gantung and the diversion tunnel at Batu Merah.

Regarding all the environmental elements for which possible negative impacts were anticipated by the IEE, the extent of impacts were estimated and countermeasures were proposed to eliminate or reduce the impacts as far as possible. Regarding the three items for which significant impacts were identified, the impacts were carefully analyzed and conclusions were drawn as follows.

(a) Resettlement

Resettlement will unavoidably happen when the projects are implemented. However, efforts can be made to reduce the number of resettlement households to the minimum. This has already been considered during project planning. Resettlement may involve very sensitive social problems which need to be well solved under the responsibility of local government. Recommendations were given in the EIA report regarding impact reduction. In addition to reasonable compensation and provision of improved living conditions, continuous care of the resettled population was recommended.

(2) Solid Waste

Solid waste disposal is important with river improvement and dam construction. The quantity of solid waste was estimated and several sites were proposed for its disposal; namely, a land reclamation site at Wai Nitu, existing landfills and construction material reuse. Through these measures, solid waste disposal will not be a significant problem during project construction.

(3) Groundwater

Impacts on groundwater may be expected from the construction of the two multipurpose dams, the diversion tunnel at Batu Merah and river improvement with three-sided concrete channel.

Since the dam site geology has high permeability, water proof measures for reservoir and dam sites should be taken into account, in order to reduce the influence on the groundwater or springs at the downstream side.

During the diversion tunnel construction, loss of groundwater from the excavated tunnel is unavoidable. However, after tunnel construction, continuous loss of groundwater will not occur since the bottom and walls of the tunnel are concrete lined. Sealing of the diversion tunnel against groundwater flow may also affect groundwater levels. In order to reduce the impacts on people who are using groundwater from that aquifer, provision of new sources for supplying drinking water has to be considered.

Three-sided concrete channel reduces groundwater recharge and may cause a decrease in well water level. Thus countermeasures should be taken into account for the design of the three-sided channel structure during detail design.

(2) Economic Analysis

Table-1.37 shows the results of economic analysis on the construction of the flood control facilities for each of the five rivers and on the entire priority project, based on the assumption that all the facilities are constructed in five years for separate cases and in nine years for entire project.

Construction of river improvement facilities in each of the five rivers is highly feasible, showing IRR of between 19.9 % to 39.1 %. The projects for each river with 30-year return period, namely Batu Merah, Tomu, Batu Gajah is also access to be feasible showing IRR of between 10.5 to 25.8 %. Of these projects, IRR is very high on the project in Batu Merah and Tomu River, and is fair on that in Batu Gajah and Batu Gantung River.

The entire project is also assessed to be feasible, attaining IRR of 16.4 %

Table-1.37 Economic Cost, NPV, B/C and IRR of Each of the Five Rivers

Case		Economic Cost	NPV at 10%	B/C at 10%	IRR
Ruhu	River improvement (5 year return period)	Rp 7,768 million	Rp 26,154 million	5.3	28.1%
Batu Merah	River improvement (5 year return period)	Rp 13,480 million	Rp 88,955 million	9.6	39.1%
	River improvement and diversion channel	Rp 34,635 million	Rp 98,256 million	4.7	25.8%
Tomu	River improvement	Rp 23,115 million	Rp 36,474 million	3.0	19.9%
Batu Gajah	River improvement (10 year return period)	Rp 15,761 million	Rp 52,938 million	5.4	28.0%
	River improvement with multi-purpose dam	Rp 92,980 million	Rp 37,262 million	1.4	13.1%
Batu Gantung	River improvement (10 year return period)	Rp 11,211 million	Rp 29,932 million	4.4	25.1%
	River improvement with multi-purpose dam	Rp 63,104 million	Rp 3,619 million	1.1	10.5%
Five Rivers		Rp 221,602 million	Rp 168,756 million	2.2	16.4%

Note. Design scale of the priority projects are 5-year return period for Ruhu River and 30-year return period for the other rivers.

1.4.5 Implementation Program

(1) Implementation Schedule

The responsible agency for the project implementation is the Ambon Flood Control Project Office which will be newly established at the project site. The project is requested to be financed by the OECF (The Overseas Economic Cooperation Fund, Japan). The overall implementation schedule is shown in Table-1.38.

Table-1.38 Implementation Schedule

Items \ Fiscal Year (Month: Apr-Sep, Oct-Mar)	(1) 1998/99	(2) 1999/00	(3) 2000/01	(4) 2001/02	(5) 2002/03	(6) 2003/04	(7) 2004/05	(8) 2005/06	(9) 2006/07	(10) 2007/08
1 Loan Procedure										
a Pledge	x									
b Loan Agreement										
2 Procurement	x	x	x	x						
a Consulting Services	x	x								
b Construction Work			x	x						
- Pre-qualification			x							
- T/Doc. Preparation			x							
- Tender Period			x							
- Tender Evaluation				x						
- OECF Concurrence										
- Contract Negotiation				x						
- OECF Concurrence				x						
- L/C Open				x						
3 Consulting Services		x	x	x	x	x	x	x	x	x
a Survey & Design		x	x							
b Tendering			x	x						
c Const. Supervision					x	x	x	x	x	x
4 Construction					x	x	x	x	x	x
a Package-1					x	x	x	x	x	x
b Package-2					x	x	x	x	x	
c Package-3					x	x	x	x	x	
d Package-4					x	x	x	x	x	x
e Package-5					x	x	x	x	x	
5 Land Acquisition				x	x	x	x	x		

Note. Five construction packages are shown in the following table.

Packages for Civil Works

Packaging	Scope of Works
Package - 1	- Batu Gajah Multi-purpose Dam
Package - 2	- Batu Gantung Multi-purpose Dam - Wai Nitu Disposal Site
Package - 3	- Batu Merah River Improvement - Batu Merah Diversion Tunnel
Package - 4	- Ruhu River Improvement - Tomu River Improvement - Ruhu Check Dam - Tomu Check Dam
Package - 5	- Batu Gajah River Improvement - Batu Gantung River Improvement - Batu Gajah Check Dam - Batu Gantung Check Dam

(2) Finance and Disbursement Schedule

The total project cost is 302.049 billion Rupiah (12.379 billion Yen), estimated in September 1997 basis. Out of the total project cost, 242.838 billion Rupiah (9.952 billion Yen) will be financed by OECF loan. Other potion of the project cost: 59.211 billion Rupiah (2.427 billion Yen) will be financed by the national budget. The disbursement schedule of the project is summarized in Table-1.39.

Table-1.39 Annual Disbursement Schedule of the Project

Unit: Million Rupiah

Items		Total	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Consulting Engineering S.											
Construction											
Land Acquisition & Comp.											
1 Construction Cost		246,302				49,708	50,699	51,716	52,748	27,055	14,375
a Direct Cost		203,555				41,081	41,900	42,741	43,593	22,359	11,880
Package - 1	- Base Cost	58,471				9,745	9,745	9,745	9,745	9,745	9,746
	- Price Esc.	9,402				1014	1230	1449	1673	1901	2134
	<Total>	67,873				10,759	10,975	11,194	11,418	11,646	11,880
Package - 2	- Base Cost	44,818				8,964	8,963	8,964	8,963	8,964	
	- Price Esc.	6,685				933	1131	1333	1539	1749	
	<Total>	51,503				9,897	10,094	10,297	10,502	10,713	
Package - 3	- Base Cost	27,708				6,927	6,927	6,927	6,927		
	- Price Esc.	3,815				721	874	1030	1189		
	<Total>	31,523				7,648	7,801	7,957	8,116		
Package - 4	- Base Cost	24,706				6,177	6,176	6,177	6,176		
	- Price Esc.	3,401				643	779	919	1060		
	<Total>	28,107				6,820	6,955	7,096	7,236		
Package - 5	- Base Cost	21,578				5,395	5,394	5,395	5,394		
	- Price Esc.	2,971				562	681	802	926		
	<Total>	24,549				5,957	6,075	6,197	6,320		
b Contingency	5% of a	10,178				2,054	2,095	2,137	2,180	1,118	594
c Administration	5% of a	10,178				2,054	2,095	2,137	2,180	1,118	594
d Tax : 10% of (a + b + c)		22,391				4,519	4,609	4,701	4,795	2,460	1,307
2 Land Acquisition & Comp.		23,732			3,761	3,837	3,914	3,992	4,072	4,156	
a Direct Cost		19,613			3,109	3,171	3,234	3,299	3,365	3,435	
	- Base Cost	17,234			2,872	2,872	2,872	2,872	2,872	2,874	
	- Price Esc.	2,379			237	299	362	427	493	561	
b Contingency	5% of a	981			155	159	162	165	168	172	
c Administration	5% of a	981			155	159	162	165	168	172	
d Tax : 10% of (a + b + c)		2,157			342	349	356	363	370	378	
3 Consulting Engineering S.		32,015	4,456	4,545	1,236	3,784	3,859	3,936	4,015	4,095	2,088
a Direct Cost		27,719	3,858	3,935	1,070	3,276	3,341	3,408	3,476	3,546	1,808
	- Base Cost	24,723	3,708	3,708	989	2,967	2,967	2,967	2,967	2,967	1,483
	- Price Esc.	2,996	150	227	81	309	374	441	509	579	325
b Contingency	5% of a	1,386	193	197	54	164	167	170	174	177	90
c Tax : 10% of (a + b + c)		2,910	405	413	112	344	351	358	365	372	190
Grand Total		302,049	4,456	4,545	4,998	57,329	58,472	59,615	60,835	35,306	16,463
OEC Loan Portion		242,838	4,051	4,132	1,124	46,575	47,504	48,456	49,423	27,200	14,373

[Note] Base for cost estimation : September 1997
Conversion rates : 1 US$ = Rp 2,928 = Y 120 Rp/Y = 24.4 Y/Rp = 0.041

1.5 Recommendations

(1) Implementation of Priority Project

The Priority Project proposes flood control measures and water resources development for the center of Ambon city as follows:

- Ruhu River : River Improvement, Check Dam
- Batu Merah River : River Improvement, Diversion Tunnel
- Tomu River : River Improvement, Check Dam
- Batu Gajah River : River Improvement, Multi-purpose Dam, Check Dam
- Batu Gantung River : River Improvement, Multi-purpose Dam, Check Dam

The Government of Indonesia has raised the policy to support and promote development of the eastern regions, which are relatively undeveloped within Indonesia. Ambon City has long been the social and economic center of eastern Indonesia including Maluku Province. One of the projects being most urgently implemented in the effort to develop the infrastructure of Ambon is to put flood prevention measures and city water supply in place in the urban districts of the city. Therefore, implementation of the priority project proposed in this study should commence as soon as possible.

Although Ruhu Multi-purpose dam is not included in the priority project, water development is needed considering long term city water demand. The implementation of this dam should start following the priority project.

(2) Implementation of Non-structural Measures

Non-structural flood control measures were proposed in this study and aimed at 1) suppression of flood runoff, 2) improvement of flood proof function, and 3) facilitation of flood disaster prevention activities. As non-structural measures are as important as the structural measures, the non-structural measures should be implemented in line with the structural measures by establishing the special committee proposed as a coordination body.

(3) Financing the Project Cost

The total priority project cost is estimated to be 302.049 billion Rupiah (12.379 billion Yen). In order to implement the project, 59.211 billion Rupiah (2.427 billion Yen) should be financed by the national budget. The other portion of the project cost 242.838 billion Rupiah (9.952 billion Yen) could be financed by OECF loan. Thus necessary preparation and arrangement should be taken by the central government as soon as possible.

(4) Countermeasures to Land Acquisition and Resettlement

Totally 144 households will be involved in the resettlement program. Land acquisition of 8,300 m^2 in the city area and 241,000 m^2 in the upstream area is needed to implement the priority project. As these land acquisition and resettlement shall be settled by the local government, careful and appropriate measures are necessary.

(5) River Environment Management

As one of the non-structural measures, river environment management has been proposed in the flood control master plan. This includes restriction on garbage dumping in the rivers, installation of sanitary facilities such as septic tanks and public sewers. In order to improve the biological condition and protect reservoir water quality for water supply by dams, it is recommended that in Batu Gajah and Batu Gantung, the dams and reservoirs and their surrounding areas shall be taken as natural protection areas. Reforestation around the reservoir is an important measure for this purpose.

(6) Water Distribution Plan

The priority project includes water resources development with Batu Gajah and Batu Gantung Multi-purpose Dams, but does not include water distribution plan such as purification plants and distribution pipe network from the dams. Therefore, this plan should be studied and formulated as soon as possible by the local government.

(7) Continuous Effort of Collecting Hydrometric Data

For the further study of the plan on flood control and water resources development, hydrometric data, such as rainfall data and river discharge data must be collected. As hydrometric stations were installed in this Study, these data should be continuously measured, stored and processed.

CHAPTER 2 FLOOD CONTROL FOR PASAHARI AREA

2.1 General Condition of Pasahari Area

2.1.1 Socio-economy

(1) Current Socio-economic Conditions

Transmigration to Seram Island is concentrated in the Pasahari Area. It is located in the Seram Utara Sub-District of the Central Maluku District. The study area is composed of seven villages (Wailoping, Kobi, Waitonipa, Marasahua, Morokai and Samal) and other new transmigration units outside the villages. Most of the families in the Pasahari Area migrated under the Government's transmigration policy. There were 27 resettlement units as of August 1996. Table-2.1 shows the number of households and population in the Study Area, including both transmigrated and local people.

Table-2.1 No. of Households and Population in the Study Area (December 1996)

Transmigration Area	Potential Irrigation Area	No. of Households	Population
Samal I	2,217 ha	1,488	5,764
Samal II	2,500 ha	815	3,500
Kobi	2,898 ha	1,779	6,522
TOTAL	7,515 ha	4082	15,786

Source : JICA Study Team

Social facilities such as schools, clinics and religious facilities are provided by the Government under the transmigration scheme. No public transport is available yet; bicycles and motorcycles are the major means of transport within the villages, while private trucks/vehicles are available for transport between or outside the villages.

(2) Irrigation Scheme

The construction of the Ministry of Public Works' irrigation scheme, which has mainly been financed by the Asian Development Bank, started in the fiscal year 1993/94. It is expected that construction on 1,884 ha in Samal I and 1,411 ha in Kobi (and 281 ha in Lofin) will be completed by the end of the fiscal year 1996/97. The total construction costs are expected to be Rp 3,250 million for Samal I and Rp 10,550 million for Kobi.

(3) Current Agricultural Production

The population is highly dependent on the agricultural sector for employment. Trading activities are expected to increase in accordance with the increase in agricultural production; food crops are already shipped to Ambon City through Kobisadar Port, which is located close to the mouth of the Samal River. This port is equipped with a relatively large pier that enables loading of agricultural products onto several medium-sized boats at one time. It takes about four days to go by boat from Kobisadar to Ambon. Rice production is expected to significantly increase, in line with the development of irrigation facilities. Agricultural income is still small, estimated at Rp 2.5 to 3 million per household.

(4) Future Population

According to the Transmigration Agency, 4,120 people are scheduled to be transmigrated by the end of fiscal year 1998/99. Since no more transmigration is currently planned by the Transmigration Agency in the Pasahari Area, this study used 1.9% as the figure for future population growth rate in this area, which is the same as the national population growth rate. The future population in the Study Area is shown in Table-2.2.

Table-2.2 Future Population in the Study Area

Year	1996	1998	2000	2005	2010	2015	2020	2025	2030
New Transmigration	-	4,120	4,278	4,700	5,164	5,674	6,233	6,849	7,524
Existing Population	15,786	16,392	17,020	18,700	20,545	22,573	24,800	27,247	29,936
Total	15,786	20,512	21,298	23,400	25,709	28,246	31,034	34,096	37,460

Source : JICA Study Team

(5) Expected Increase in Agricultural Production

It is expected that agricultural production in the Pasahari Area will increase in line with development of irrigation canals. The Seram Irrigation Project of DGWRD anticipates that the future cropping intensity in paddy will be 170% for Samal I (limited water availability will prevent the second cropping in some areas) and 200% for Kobi. Each area is expected to attain a yield of 4.5 ton/ha/harvest by the year 2001. As a result, the anticipated rice production in Samal I and Kobi from 2001 is 16,960 tons/year and 26,082 tons/year, respectively. Although there are no data available regarding water availability in Samal II, cropping intensity in paddy is expected to increase significantly also in this area when the irrigation project is realized.

2.1.2 Physical Geography

(1) Topography and Geology

Vast alluvial lowlands are formed to the north of the center of Seram Island near the estuary. The Samal River and the Kobi River flow generally north from hilly areas to alluvial plains, where the river is very gentle in slope and meanders significantly. Flood water sometime overflows from the river course to alluvial plains. Meandered rivers are eroded on the outer section of the curve and cause sedimentation on the inner section of the curve and thus form flood plains.

The free intake of Samal River is situated at the extreme position where the hilly area, formed from sedimentary rock of the neogene tertiary period, changes to alluvial lowlands. Non-consolidated conglomerates containing pebbles with diameters of 30 to 50 centimeters are distributed in the river bed. Further downstream, the pebbles become smaller and sand and silt are found to be superior. The free intake of the Kobi River is located in the alluvial lowlands formed non-consolidated conglomerates containing pebbles with diameters of 5 to 10 centimeters.

(2) Current and Future Land Use

The overall land use situation in Pasahari Area in 1988 is shown in Figure-2.1. This land use map was compiled by the Study Team based on the aero-photographs which were taken in 1988. The Pasahari area was once covered mainly with forests and grasslands, with mangrove forests along the coast. However, since cultivation is expanding rapidly in line with the transmigration and irrigation schemes, some forest and grasslands have already been turned into farmland.

The resettlement to the Samal and Kobi areas is scheduled to be finished in the fiscal year 1998/99, while irrigation facilities for Samal I and Kobi will be completed by the end of the fiscal year 1996/97. Except for the Samal II project, no further irrigation projects are yet scheduled. Paddy field has been developed on the alluvial plains of Samal and Kobi by avoiding habitually flooded areas. These areas will be turned into paddy field if flood control facilities are constructed. The area located between the mainstream of Kobi River and Tinupa River (a branch of Kobi River) has potential to be developed into farmland in the near future.

2.1.3 Hydrology and Flood Damage

(1) Climate

The weather conditions in the Pasahari Study Area are outlined in Figure-2.2. The average temperature and humidity are as high as 24.7 °C and 89% respectively, indicating a hot and humid climate.

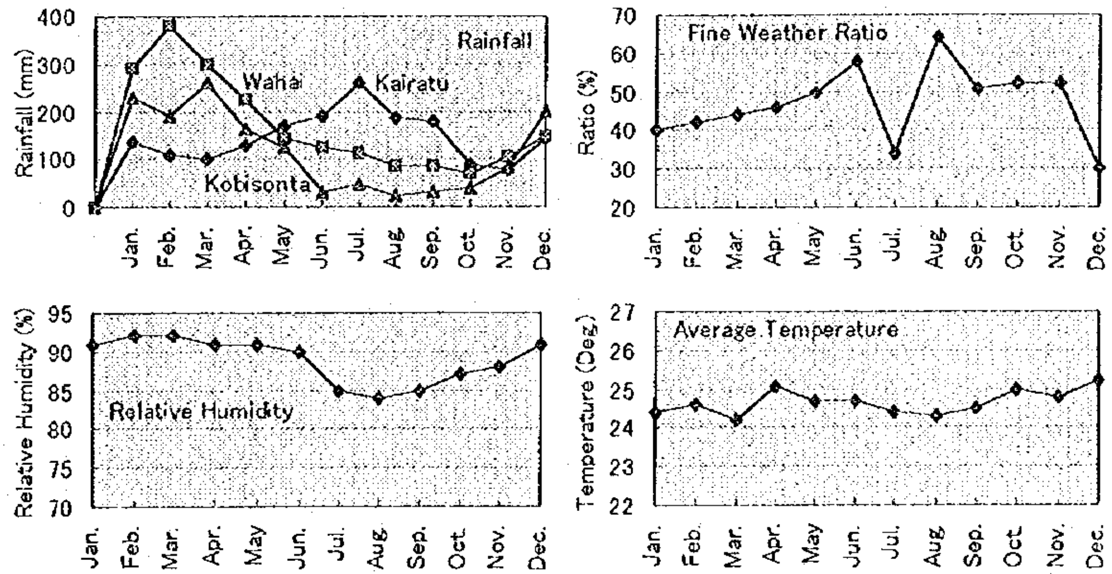


Figure-2.2 Seasonal Fluctuation of Weather in Kobisonta Station

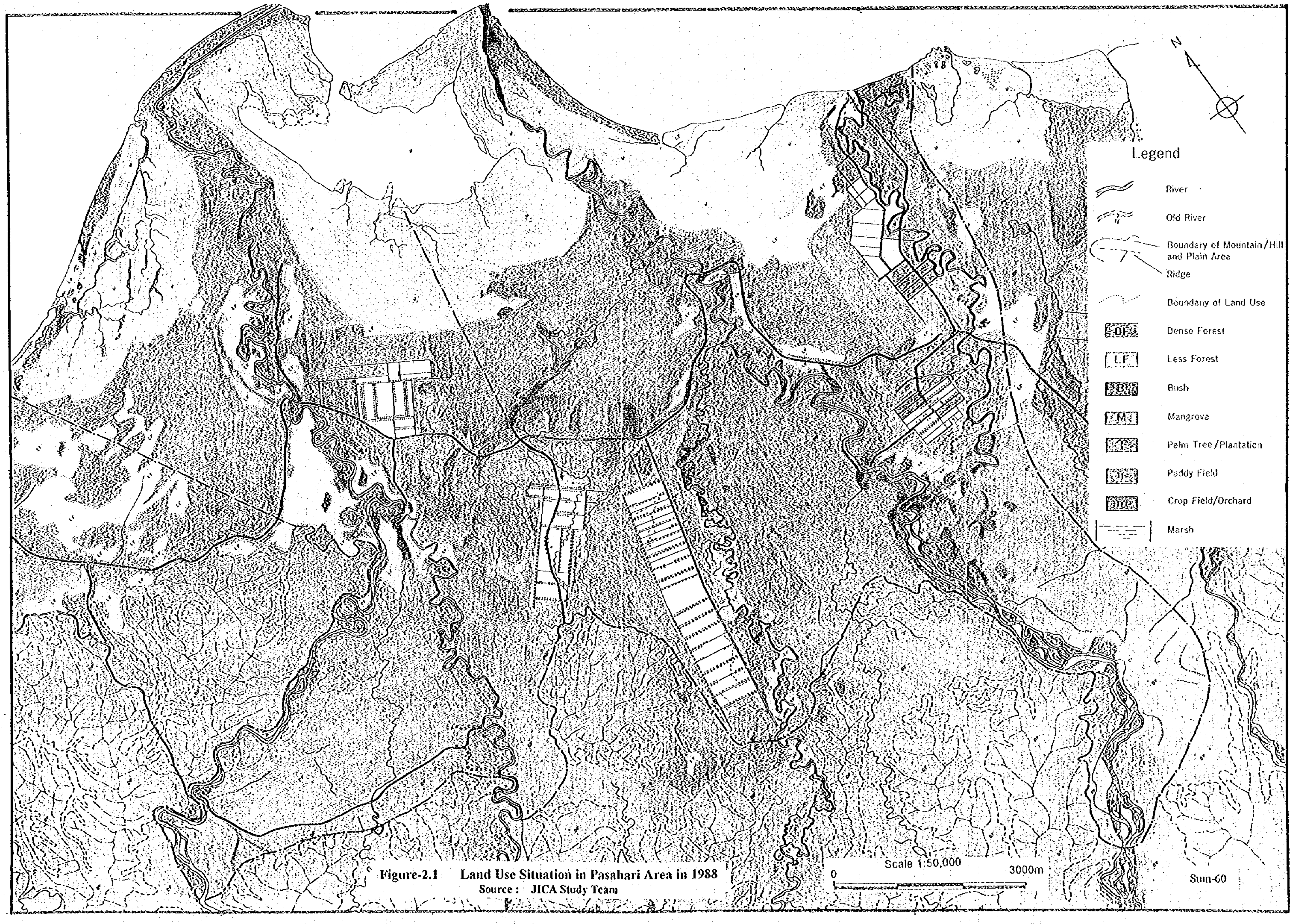


Figure-2.1 Land Use Situation in Pasahari Area in 1988
Source : JICA Study Team

(2) River Systems

The Study area in the Pasahari area of Seram includes the two river basins, namely Samal and Kobi rivers, and their tributaries Musi and Tinupa rivers. The catchment areas and main river lengths have been measured by the Study Team using the revised 1:100,000 scale topographical map. The results are given in Table-2.3 and the longitudinal profiles of the two rivers are shown in Figure-2.3 below. The river systems are shown in Figure-2.4.

Table-2.3 Study River Basins - Pasahari Area

River Name	Catchment Area (km^2)	Length of Main River (km)
Samal River	268.9	56.8
Kobi River	271.8	50.6

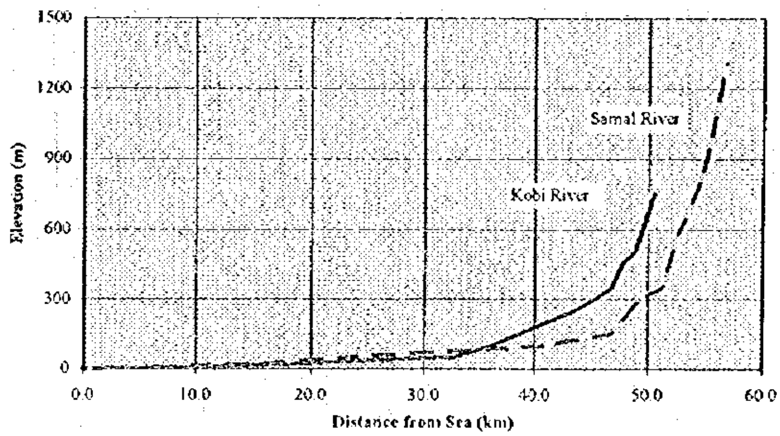


Figure-2.3 Longitudinal Profiles of Samal and Kobi Rivers

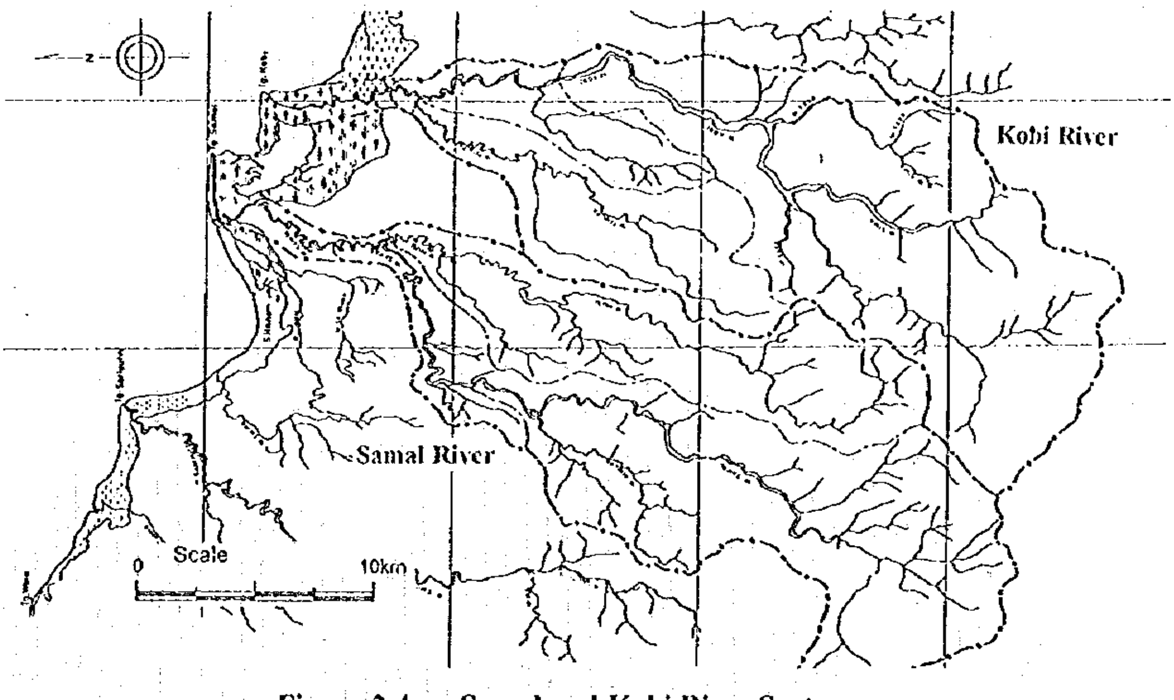


Figure-2.4 Samal and Kobi River Systems

(3) Hydrometric Stations

In Seram Island, there are eight meteorological (rainfall) stations, two of which are located in the vicinity of the Study Area (Wahai and Kobisonta in Pasahari). Of the seven hydrological stations, two stations are located in Samal River and Kobi River, but no data are available.

In order to verify meteorological and hydrological data in the target river basins, an automatic rainfall recorder (ARR), an automatic water level recorders (AWLR) and two water level staff gauges have been installed as part of this Study as shown in Table-2.4. The location of these observation stations are shown in Figure-2.5.

Table-2.4 List of Installed Observation Stations

Item	Station Code	River or Basin	Catchment Area (km^2)	
			Station	Total
Staff Gauge	S-SM-1	Samal River	260.4	269
	S-KB-1	Kobi River	264.0	272
AWLR	AW-SM-1	Samal River	260.4	269
ARR	AR-PH-1	Samal River	-	-

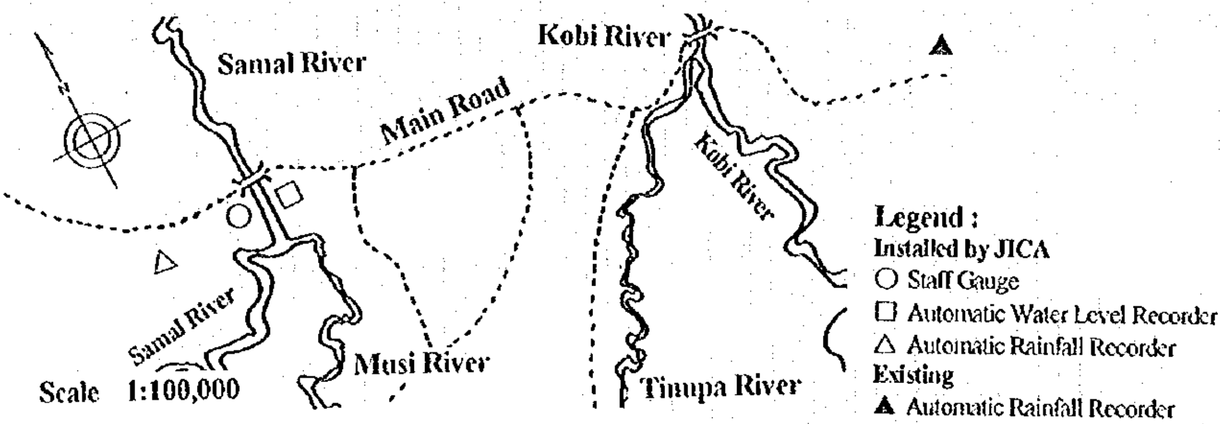


Figure-2.5 Location of Observation Stations

(4) Experienced Flood Damage

Based on the flood damage survey for 1988/01/27, 1989/04/03, 1996/02/19 and annual floods, the inundation area was drawn for each flood and the inundation area and depth of the biggest flood, 1988/01/27 flood, is shown in Figure-2.6.

(5) Flood Forecasting and Warning System

For inhabitants in Pasahari, flood forecasting is only based upon experienced rainy season in December, January and February. Simple methods of flood forecasting by the indigenous people include the observation of very dark rain clouds in the mountainous upstream regions and the fact that large floods tend to occur every four years, usually after the long period of the dry season. Although there are government offices in Masohi and Wahai, there is no government office in Pasahari and actually no formal methods of flood forecasting. For the people living in the study area, generally they do not have any flood warning system and the only warning method is by shouting on the river banks.

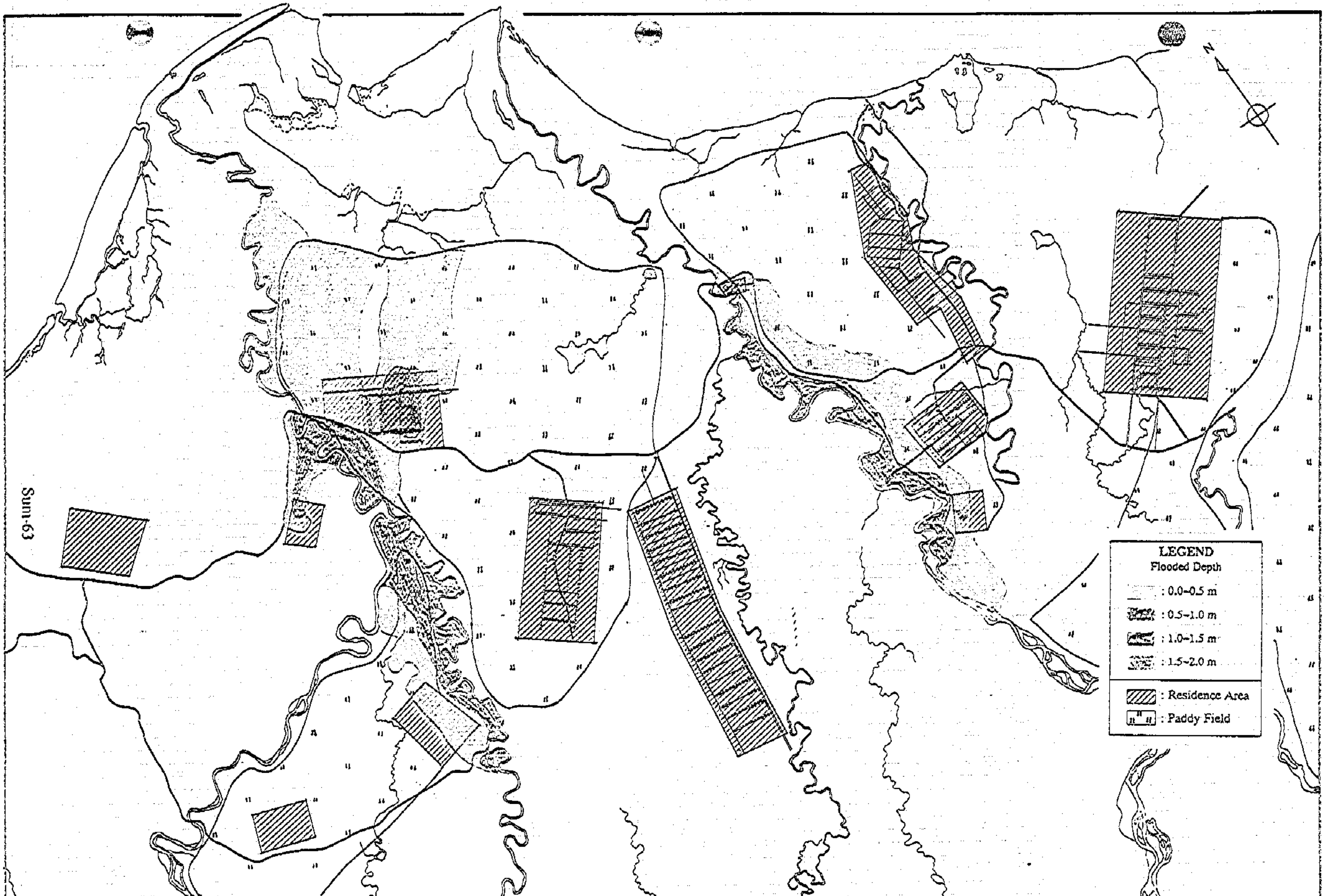


Figure-2.6 Inundation Area and Depth caused by 1988/01/27 Flood

2.1.4 Environment

(1) Resettlement and Land Acquisition

Pasahari is a newly developed agricultural area where most of the population are transmigrated from Java under the Government's Transmigration Program. Therefore, resettlement is a common practice in this area although there has been no experience of resettlement due to industrial or any infrastructure development activity. Since Pasahari is still an underdeveloped area and lands are allocated by the Government to the resettled people for housing and farming, and to other developments such as the construction of the irrigation systems etc., land acquisition has not become a problem so far.

(2) Transportation and Public Facilities

Infrastructure has not yet been well constructed in Pasahari area - most of the roads are unpaved, electricity is not available in most of the villages and there is almost no public telecommunication service. No public transport is yet available. The public facilities in Pasahari area are limited to schools (one junior high school and one senior high school at Kobisonta and primary schools at most of the villages), health centers, one post office (at Kobisonta) and mosques (at each village).

(3) Public Health

As for public health service, there is one community health center in Samal area with 2 doctors and one in Kobi area with 1 doctor. There are sub-health centers in most of the villages each with one person for simple medical care. The medical services are provided by the Government under the transmigration scheme. Malaria, skin infection, diarrhea and influenza are the main diseases in this area, and death from diarrhea happens occasionally.

(4) Environmental Sanitation

In Pasahari area, domestic water supply mainly depends on groundwater from dug-wells. In the rainy season well water is sufficient, but in the dry season people in some villages have to get water from the Samal and Kobi Rivers at their upstream side. There are no water quality data available but villagers have complained salinity, high iron concentration and turbidity problems. To improve water supply, the Transmigration Agency planned to construct water pipes to transfer clean river water to the transmigration villages and piping work has already started at some villages in Samal area.

(5) Flora and Fauna

Although there are no data available on the vegetation in Pasahari area, it is said that the main flora species, especially those in the forests, are about the same as those in Ambon area. As for wildlife, wild boar, deer and some species of birds are dominant in the forest area.

(6) River and Coastal Environment

In the estuaries of the Samal and Kobi Rivers, there are large areas of mangrove forests which extend 2 or 3 km to the upstream direction and protect the river bank well. Bank erosion is found to be serious from the end of mangrove forest to the middle stream part of the river. The upstream part of the river flows through the forest and grassland area where river course is broad and shallow and bank erosion is less serious.

In rainy season, sediment runoff is the main problem for the rivers and estuaries. Sea water turns yellowish in a broad coastal area. Through a survey from the estuary to the upstream part of Kobi River, it was found that most of the sediment was from the middle stream part of the river. The influence of sediment runoff on the coastal environment is significant.

(7) Environmental Pollution

No environmental monitoring has ever been conducted in Pasahari area. However, considering its low population density and limited development activity, it can be said environmental pollution is not significant presently from man-made pollution sources. Some environmental problems mentioned above are mainly caused by natural reasons. For example, sea water intrusion may be the main reason for the salinity problem with the groundwater and river water quality.

2.2 Flood Analysis

2.2.1 Rainfall Analysis

(1) Representative Rainfall Stations and Basin Rainfall

In Pasahari area, since the station at Kobisonta is within the Study Area and possesses eight years of daily rainfall data, it can be taken as a representative station for both of the target river basins. However, the station at Kairatu is the only station to provide hourly rainfall data in Seram, but is 160 km from Kobisonta and located on the opposite side of the island where the rainy season and dry season are reversed. However, a comparison of the data from Kairatu and Kobisonta shows the similarity of the two stations in terms of probable daily rainfall. As for the hourly rainfall, therefore, the data in Kairatu can be taken as a representative station For the above mentioned reasons, the representative rainfall observation stations in the Pasahari Area are chosen as follows:

- Daily Rainfall : Kobisonta - Hourly Rainfall : Kairatu

In Pasahari area, the representative rainfall stations of Kobisonta and Kairatu are at low altitude (El. 2m and 20m, respectively). However, because the basins of the two target rivers cover a wide area of approximately 250 km^2 and reach an altitude about 1,000 m in the upstream mountainous area, it is necessary to take into account the altitude difference for basin rainfall. Manusela rainfall station is located in the mountainous area, and mean annual rainfall data is about two times as that of Kobisonta. From rough Tiesen division based on the location of Kobisonta and Manusela in the river basin, it is decided that the basin mean rainfall can be taken as the arithmetic average of the data from the two stations, i.e. 1.5 times the mean annual rainfall recorded at Kobisonta.

(2) Rainfall Probability Analysis

Table-2.5 shows the probable daily and hourly rainfall calculated based on the representative rainfall station data. The Non Annual Probability Method is applied since daily and hourly rainfall data are only available for 7 years at Kobisonta station and 8 years at Kairatu station.

Table-2.5 Probable Daily Rainfall [Pasahari Area - Kobisonta]

Return Period	year	2	3	5	10	20	30	50	100	200
Probable Daily Rainfall	mm	99.3	109.8	122.9	140.7	158.5	169.0	182.1	199.9	217.7
Probable Hourly Rainfall	mm	41.8	43.9	46.6	50.3	54.0	56.1	58.8	62.5	66.2

Note : - Calculated by Non Annual Probability Method
- Non Annual Daily Rainfall Data more than 50mm/day for 7 years
- Non Annual Hourly Rainfall Data for 8 years

2.2.2 Flood Runoff Analysis

(1) Division of Catchment Areas

The division of the Samal and Kobi catchment areas is shown in Figure-2.7. The main discharge reference points were chosen as the existing road bridges near the downstream of both rivers. In addition, the confluence of the tributaries of Musi and Tinupa rivers were taken as discharge reference points. The catchment area, river length and average slope associated with each of the reference points are given in Table-2.6.

Table-2.6 Division of Samal and Kobi Catchment Areas

River	Catchment Area (km^2)	River Length (km)	Max. Elev (m)	Min. Elev (m)	Slope
Samal - Total to Bridge	260.4	45.1	1300	16	1/35
Samal Free Intake	152.7	30.4	1300	40	1/24
Intake - Bridge	20.4	14.7	40	16	1/612
Wai Musi	87.3	35.5	500	20	1/74
Kobi - Total to Bridge	264.0	42.5	800	3	1/53
Kobi Free Intake	177.8	32.1	800	20	1/41
Intake - Bridge	28.1	10.4	20	3	1/612
Wai Tinupa	58.1	24.2	350	5	1/70

(2) Runoff Coefficient

The runoff coefficient used in the Rational Formula is determined based on the topography, ground cover, vegetation and land use in the catchment area. A value of runoff coefficient f = 0.7 is adopted for the rivers in the Pasahari study area.

(3) Peak Discharge by Rational Formula

The peak flood discharge was calculated for various return periods using the Rational Formula. The results of the peak discharge calculation, and the corresponding specific discharge for each return period, are given in Table-2.7.

Table-2.7 Peak Flood and Specific Discharge by Rational Formula

Discharge Ref. Point	C.A. (km2)	Tp (min)	Peak Discharge (m3/sec)										
			2	5	10	15	20	25	30	50	70	100	200
Talbot Formula Coeff (a)			170.7	210.4	240.4	258	270.7	280.5	288.6	311	325.6	341.5	372.3
Talbot Formula Coeff (b)			1.723	2.009	2.187	2.276	2.341	2.388	2.429	2.526	2.582	2.643	2.749
SAMAL RVER													
Free Intake	152.7	215	955	1117	1237	1307	1356	1395	1425	1511	1568	1629	1746
Before Confl.	171.0		1070	1251	1385	1464	1519	1562	1596	1693	1756	1824	1955
Wai Musi	87.3	169	638	740	816	860	891	915	934	988	1024	1062	1135
After Conf.	258.3		1708	1990	2201	2324	2410	2477	2530	2681	2780	2886	3090
Road Bridge	260.4		1721	2006	2218	2342	2428	2496	2549	2702	2801	2908	3114
Specific Discharge (m3/sec/km2)			6.61	7.70	8.52	8.99	9.33	9.59	9.79	10.37	10.76	11.17	11.96
KOBI RIVER													
Free Intake	177.8	202	1160	1353	1497	1581	1639	1685	1721	1825	1892	1965	2105
Before Confl.	204.5		1334	1556	1722	1818	1885	1938	1980	2099	2177	2260	2421
Wai Tinupa	58.1	115	530	605	662	695	718	736	750	791	818	846	901
After Conf.	262.6		1864	2161	2384	2513	2604	2675	2730	2890	2994	3106	3322
Road Bridge	264.0		1873	2172	2395	2526	2616	2688	2744	2904	3009	3121	3339
Specific Discharge (m3/sec/km2)			7.09	8.23	9.07	9.57	9.91	10.18	10.39	11.00	11.40	11.82	12.65

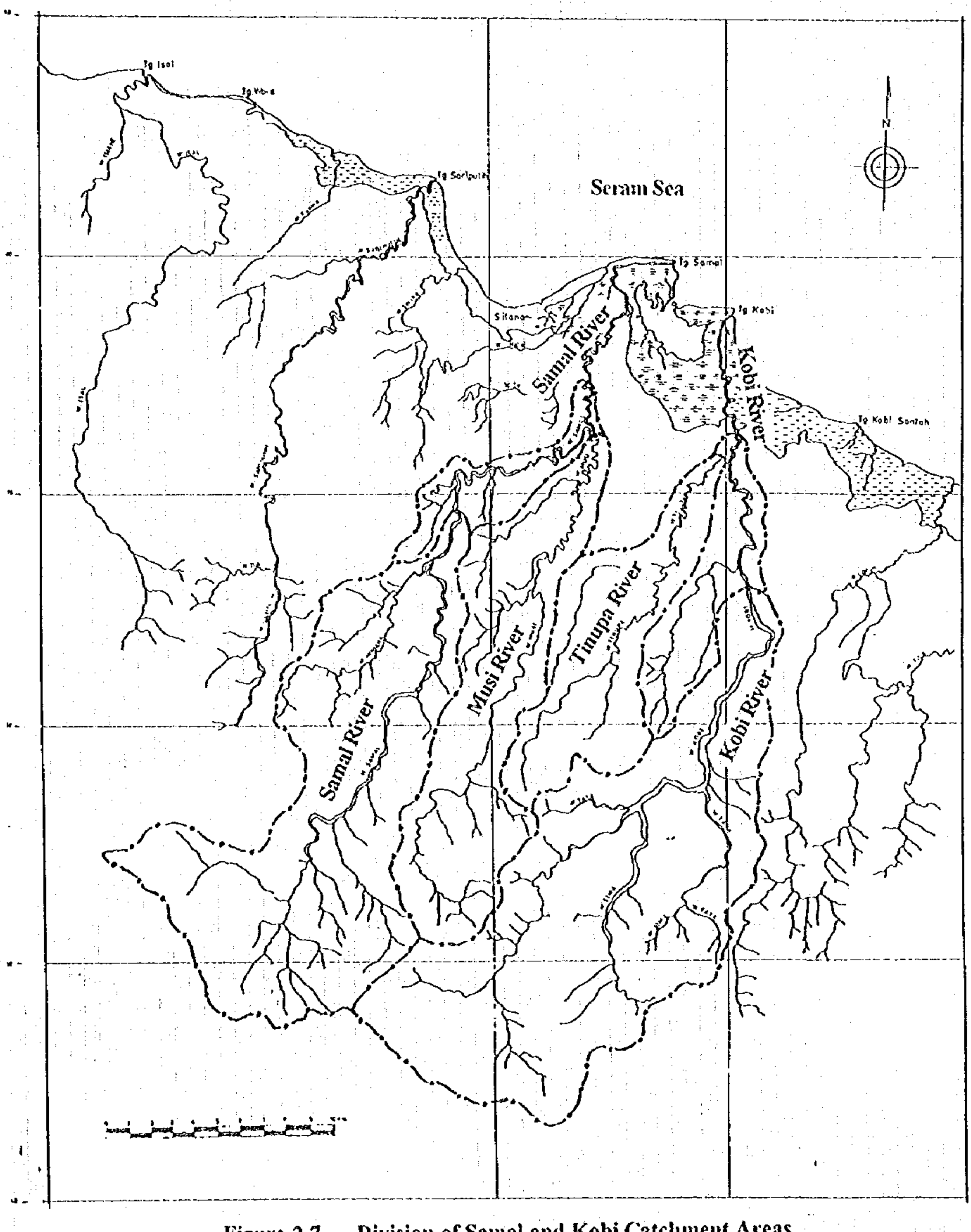


Figure-2.7 Division of Samal and Kobi Catchment Areas

2.2.3 Flood Damage Analysis

(1) Discharge Capacity of River Channels

Longitudinal and cross sectional river surveys for Samal and Kobi rivers, and their tributaries Musi and Tinupa, were carried out during this Study. The results of these surveys were used to assess the current discharge capacity of the rivers. This cross section data was compiled and the uniform flow calculation method was used to obtain stage discharge (H / Q) curves for every cross section over a range of flows up to a maximum of 800 m^3/sec (400 m^3/sec for Musi & Tinupa). The discharge capacity at each section was then estimated by comparing the left and right bank heights to the calculated stage discharge curves. Based on this analysis, the discharge capacity of each river is summarized in Table-2.8. The summary table gives the average and extreme values of minimum discharge capacity.

Table-2.8 Summary Result of Discharge Capacity

River Name	Discharge Capacity (m^3/sec) - Uniform Flow	
	Average Minimum	Extreme Minimum
Samal River	100 - 150	81
Musi River	100 - 150	66
Kobi River	100 - 150	84
Tinupa River	100 - 150	72

(2) Estimation of Flood Damage

It is necessary to estimate the damage to be caused by future floods in the "without Project" case, in order to quantify the benefits in the "with Project" case. In this Study, the flood damage analysis was carried out in the following way:

1) Specify the height of water and the area flooded of the past three major floods and annual flood through interviews and contour analysis
2) Estimate the damage of the above floods
3) Draw a "flood discharge - damage value" curve based on the results of above 2)
4) Calculate yearly benefits of the project, in other words, yearly average of damage alleviation derived from probabilities of several water amount cases.

(3) Damage to General Assets (houses/buildings, household articles and farmland)

The damage to the houses and buildings and farm had to be estimated through interviews with residents and owners of business activities. The exact damage to houses and buildings was, however, difficult to estimate, since people's memory on the floods was already lost, while damage to the structure of the houses does not show immediately. After comparing the damage situation acquired from interviews with the standard damage rate used in Japan, the Study Team judged that it would be reasonable to apply the Japanese damage rate which was acquired by the past experience in Japan.

The Study Team estimated the value of each type of general assets in all the flooded area through the field investigation (refer to Table-2.9), and made a zoning map based on this information. In addition, the data on the height of water were obtained by the flood damage survey, through interviews with around 50 residents in the Study Area.

Table-2.9 Value of General Assets

Item	Houses	Household Articles	Farm Depreciable Assets	Farm Stock Assets	Rice Crop
Unit	per Building	per Building	per Building	per Building	per ton
Unit Value (Rp million)	8	1.5	2	0.4	0.4

(4) Damage to Infrastructure

Damage data to the infrastructure in Pasahari were not obtained. Then the Study Team used the Japanese standard damage rate on the infrastructure: when damage to general assets is 100, the damage to roads and bridges can be estimated at 28, to fields 6 and to irrigation facility 43, to the electricity system 2.4, totaling 79.4.

(5) Crop Damage

The main farm crop in Pasahari is paddy rice. Since the flood damage cost and rates to crops are not known, the damage rates shown in the following table for the cost of crop damage caused by past floods in Japan shall be applied to calculate crop damage in the Project area.

Table-2.10 Paddy Rice Damage Rates

Inundation Depth	Less than 0.5m				0.5-0.99m				1.0m or more			
Inundation Days	1-2	3-4	5-6	6<	1-2	3-4	5-6	6<	1-2	3-4	5-6	6<
Damage Rate (%)	21	30	36	50	24	44	50	71	37	54	64	74

Source : Manual for River Works in Japan, Survey, Ministry of Construction

Note: The farm crop damage rate is the ratio of damage assuming the crop production value to be 100.

(6) Estimation of Past Flood Damage

The past flood damages are estimated and shown in Table-2.11.

Table-2.11 Estimation of Past Flood Damage Unit : Rp. million

Flood	Item	Samal	Kobi	Total
1988/01/27	No. of Houses	577	201	778
	General Assets Damage	1103	328	1431
	Crop Damage	568	372	940
	Infrastructure Damage	1327	556	1883
	Total Damage	2997	1255	4252
1992/04/03	No. of Houses	505	115	620
	General Assets Damage	882	192	1074
	Crop Damage	476	294	770
	Infrastructure Damage	1078	386	1464
	Total Damage	2436	872	3308
1996/02/19	No. of Houses	60	13	73
	General Assets Damage	91	29	120
	Crop Damage	62	116	178
	Infrastructure Damage	121	114	235
	Total Damage	274	259	533
Annual	No. of Houses	28	8	36
	General Assets Damage	43	17	60
	Crop Damage	42	3	45
	Infrastructure Damage	67	16	83
	Total Damage	152	36	188

Source : JICA Study Team

(7) Estimation of Assumed Flood Damage

Flood damage at probable discharge with 100-year return period was estimated. In this case, assuming that all of flood discharge flows inside of the river course, river water level, namely flood water level is calculated by using uniform flow calculation. Referring to the estimated flood water level, micro-topography of flooded area, the past flooded area and water depth, flooded area and water depth with 100-year return period was studied. The flooded area with 100-return period is presented in Figure-2.8.

Applying the same method of the past flood damage estimation, the flood damage with 100-year return period was estimated and is shown in Table-2.12. The peak discharges are shown in Table-2.12.

Table-2.12 Estimation of Flood Damage with 100-year return period

Flood	Item	Samal	Kobi	Total
Flood with 100-year Return Period	No. of Houses	1147	906	2053
	General Assets Damage (Rp. Million)	2937	2243	5180
	Crop Damage (Rp. Million)	1581	1883	3464
	Infrastructure Damage (Rp. Million)	3587	3276	6863
	Total Damage (Rp. Million)	8105	7402	15507

Source : JICA Study Team

Table-2.13 Peak Discharge (m^3/sec)

Probability	Location	Samal	Kobi
1/20	Road Bridge	2,428	2,616
1/100	Road Bridge	2,908	3,121

(8) Estimation of Past Flood Discharge

The past flood discharges and probability were estimated from daily rainfall, because hourly rainfall data were not obtained. These are presented in Table-2.14.

Table-2.14 Estimation of Past Flood Discharge

Item		1988/01/27 Flood	1992/04/03 Flood	1996/02/19 Flood
Daily Rainfall (mm/day)		145.8	108.9	63.1
Return Period		10-year	5-year	1-year
Discharge (m^3/sec)	Samal at Road Bridge	2218	2006	1520
	Kobi at Road Bridge	2395	2172	1670

Source : JICA Study Team

(9) Flood Discharge - Damage Value Curve

Based on the above flood damage study, relationship between flood discharge and flood damage is estimated, taking into account of follows: Refer to Table-2.15.

- The flood discharge with no damages is assumed as the discharge capacity of each river.
- Damaged flood occurs 1 times a year in both rivers.
- The flood on 1996/02/19 was estimated to be 1-year return period.
- The flood on 1992/04/03 was estimated to be 5-year return period.
- The flood on 1988/01/27 was estimated to be 10-year return period.
- Flood damage with 20-year and 100-year return period were estimated by the Study Team.

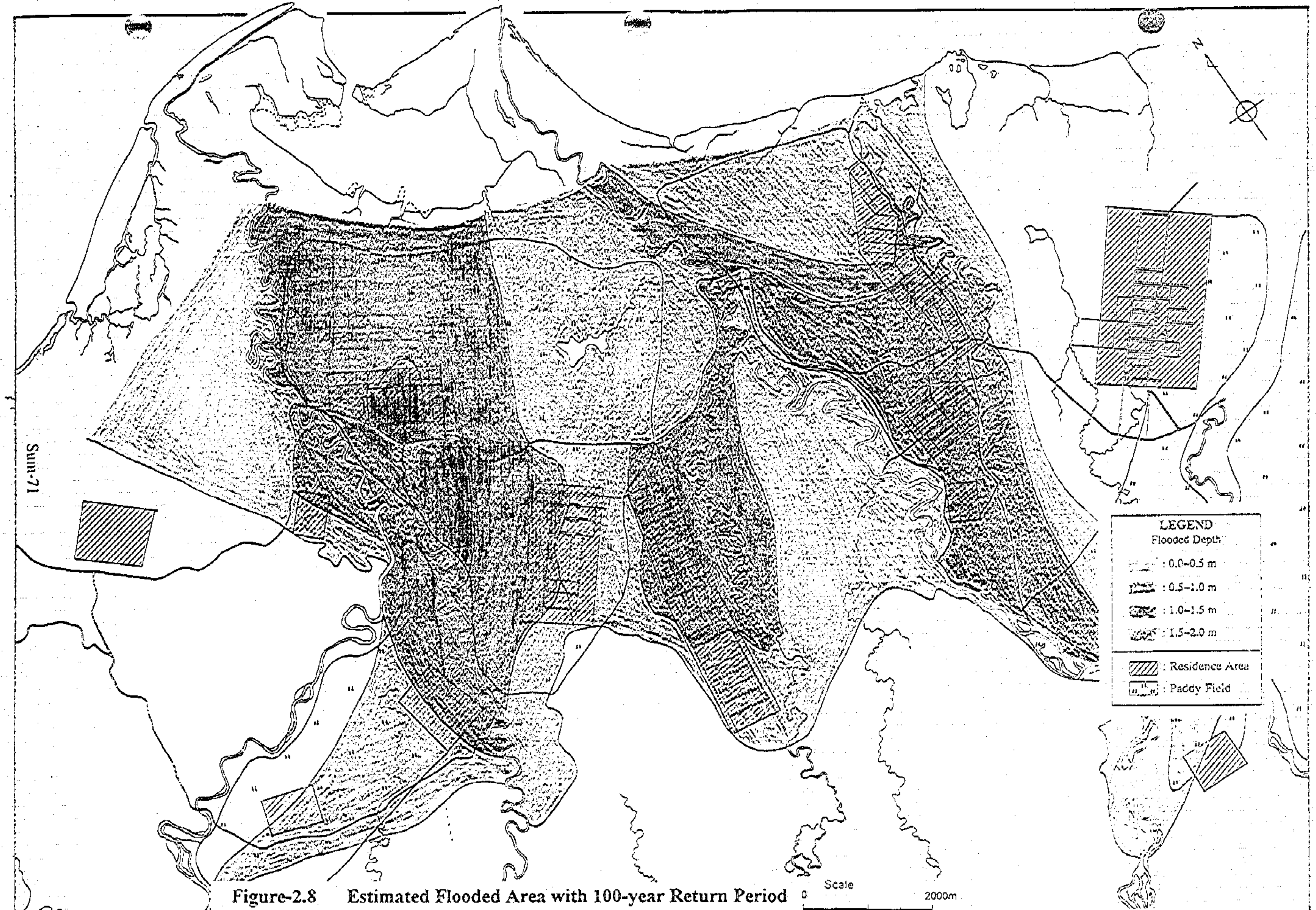


Figure-2.8 Estimated Flooded Area with 100-year Return Period

The relationship between flood discharge / flood probability and damage value was shown in Table-2.16, Figure-2.9 and Figure-2.10.

Table-2.15 Estimation Method

Return Period	Discharge	Damage
0.5-year	Discharge capacity	No damage
1-year *	Annual flood discharge	Actual annual flood damage(1996/02/19)
5-year	Discharge with 5-year return period	Actual flood damage on 1992/04/03
10-year	Discharge with 10-year return period	Actual flood damage on 1988/01/27
20-year	Discharge with 20-year return period	Flood damage with 20-year return period read from graph
100-year	Discharge with 100-year return period	Estimated flood damage with 100-year return period

Table-2.16 Relationship between Flood Discharge and Damage Value

Samal River			Kobi River		
Return Period	Discharge (m3/sec)	Damage (Rp Mil.)	Return Period	Discharge (m3/sec)	Damage (Rp Mil.)
0.5-year	1310	0	0.5-year	1450	0
1-year	1520	274	1-year	1670	259
5-year	2006	2436	5-year	2172	872
10-year	2218	2998	10-year	2395	1256
20-year	2428	3565	20-year	2616	1939
100-year	2908	8105	30-year	3121	7402

Source : JICA Study Team

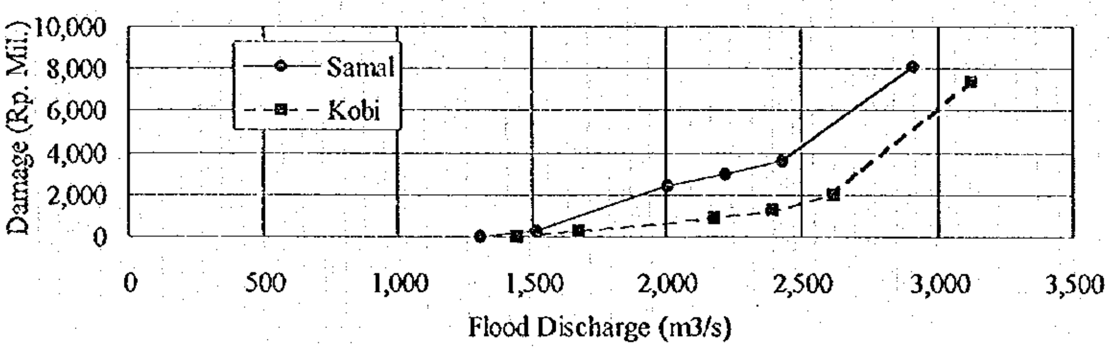


Figure-2.9 Flood Discharge - Damage Value Curve

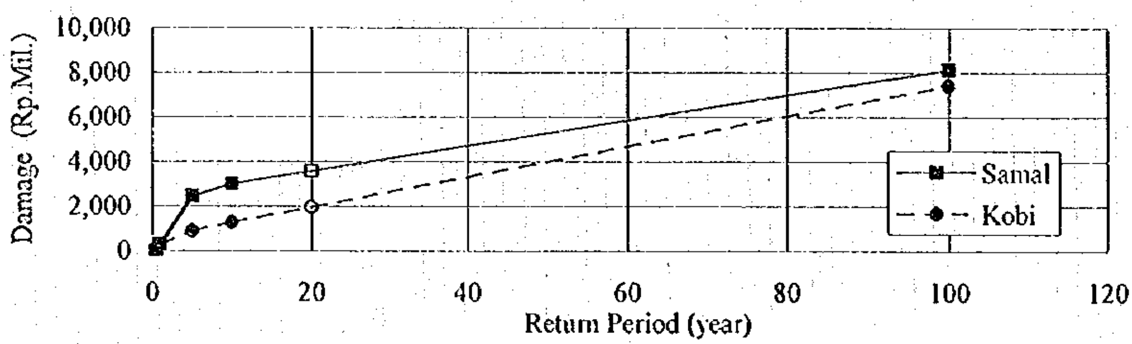


Figure-2.10 Flood Return Period - Damage Value Curve

2.3 Flood Control Conceptual Plan

2.3.1 Basic Planning Conditions and Policies

In preparation of the flood control conceptual plan for Pasahari Area, various planning conditions and policies are set as shown in Table-2.17.

Table-2.17 Basic Policy of Flood Control Plan for Pasahari Area

Items	Description
Plan Conditions	
- Target Year	Year of 2015
- Protected Area	Downstream areas from the proposed irrigation weirs including three irrigation areas: Samal I, Samal II and Kobi.
- Design Scale	20 - year return period
Flood Control Measures	
- Low Cost Works	As the Pasahari area is still undeveloped, low cost river improvement works for flood control should be recommended rather than high cost flood control measures such as dams and reservoirs. The height of the river dikes should be kept low, using areas with slightly higher elevation as natural dikes and increasing the river width as much as possible. Thus, dike construction cost could be reduced, and rain water drainage facilitated because flood water level will be lower.
- Wider River Channel	As both the rivers are meandering on the alluvial plain, river dikes should be planned to widely surround the current river course. The current river course will act as the low water channel and flood plains with a wide compound cross section should be formed by the river dikes.
- Multi-purpose Dike	Dikes should be planned as multi-purpose dikes, such as for roads, irrigation canal yard etc., in order to maximize the benefit of the initial investment.
- Staged Construction	Currently flooded areas to be protected should be prioritized according to importance. Further, staged construction should be proposed based on the development plans of the irrigation area, residential area and upstream area.

2.3.2 Proposed Flood Control Plan

(1) Alternative Flood Control Plans

Assuming several dike heights (H = 1.5m - 3.0m), the necessary river width for 20-year return period design scale was calculated using the uniform flow calculation method.

For Samal river and its tributary, Musi river, dikes are planned on both left and right banks, since irrigation areas have been planned and developed on both sides of the river. However, the left side of Samal River from 10k000 to 16k000 is located close to the hill side so that it is not necessary to construct dikes. In addition, the left side of Samal River from 0k000 to 7k000 is mostly marsh and dikes are not necessary. Refer to Table-2.18.

For Kobi river and its tributary, Tinupa river, dikes are planned on the right bank of Kobi river and on the left bank of Tinupa river, because there is no planned irrigation in the area between Kobi River and Tinupa River. However, for Kobi River from 4k000 to 6k000 (confluence), construction of dikes is necessary on both sides. In addition, the area downstream from 3k000 is mostly marsh so that dikes are not necessary. Refer to Table-2.18.

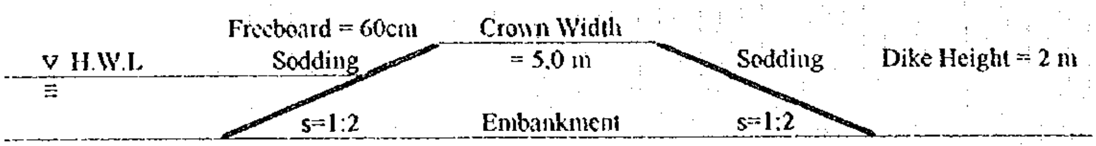
(2) Optimum Flood Control Plan

Based on the cost estimation results, the most economical alternative plan for each river was selected as optimum plan. For both river, typical dike of 2 meter height is selected as shown in Table-2.18. The standard dike cross section is designed as shown in Figure-2.11. Refer to Figure-2.12 for details of the Conceptual Flood Control Plan.

Table-2.18 Flood Control Plan for Pasahari Area

River	Samal River				Musi River		Total
	- 7.0k	- 10.0k	- 16.0k	- 16.6k	- 4.5k	- 5.5k	
Planned Gradient	1/5600	1/550	1/330	1/200	1/270	1/220	-
Planned River Length (m)	7,000	3,000	6,000	600	4,500	1,000	-
Design Discharge (m³/sec)	2,450	2,450	1,550	1,550	900	900	-
Dike Height (m)	2.00	2.00	2.00	2.00	2.00	2.00	-
Planned River Width (m)	2,850	1400	540	350	340	260	-
Water Height (m)	7.40	6.40	3.90	3.90	3.90	3.40	-
Velocity (m/sec)	0.58	1.13	1.62	2.23	1.66	1.96	-
Land Acquisition Area (ha)	2.21	13.09	10.37	0.85	14.11	1.87	42.50
Project Cost (million Rp)	-	-	-	-	-	-	20,077
River	Kobi River				Tinupa River		Total
	- 6.0k	- 9.5k	- 15.0k	- 16.6k	- 4.0k	- 6.5k	
Planned Gradient	1/4900	1/430	1/250	1/180	1/520	1/230	-
Planned River Length (m)	6,000	3,500	6,000	1,600	4,000	2,500	-
Design Discharge (m³/sec)	2,650	1,900	1,900	1,900	750	750	-
Dike Height (m)	2.50	2.00	2.00	2.00	2.00	2.00	-
Planned River Width (m)	1500	920	540	540	410	220	-
Water Height (m)	6.90	6.40	3.90	2.90	4.90	4.40	-
Velocity (m/sec)	0.90	1.30	1.90	2.10	1.17	1.92	-
Land Acquisition (ha)	10.26	6.80	10.88	2.04	5.95	5.44	41.37
Project Cost (million Rp)	-	-	-	-	-	-	22,190

<< Dike Typical Section for Velocity < 2.0 m/sec >>



<< Dike Typical Section for Velocity ≧ 2.0 m/sec >>

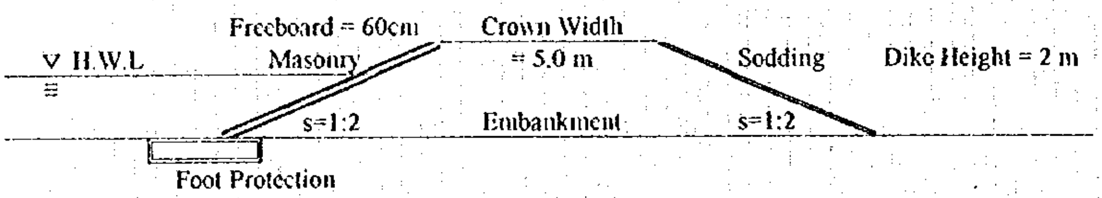


Figure-2.11 Standard Cross Section of Dike

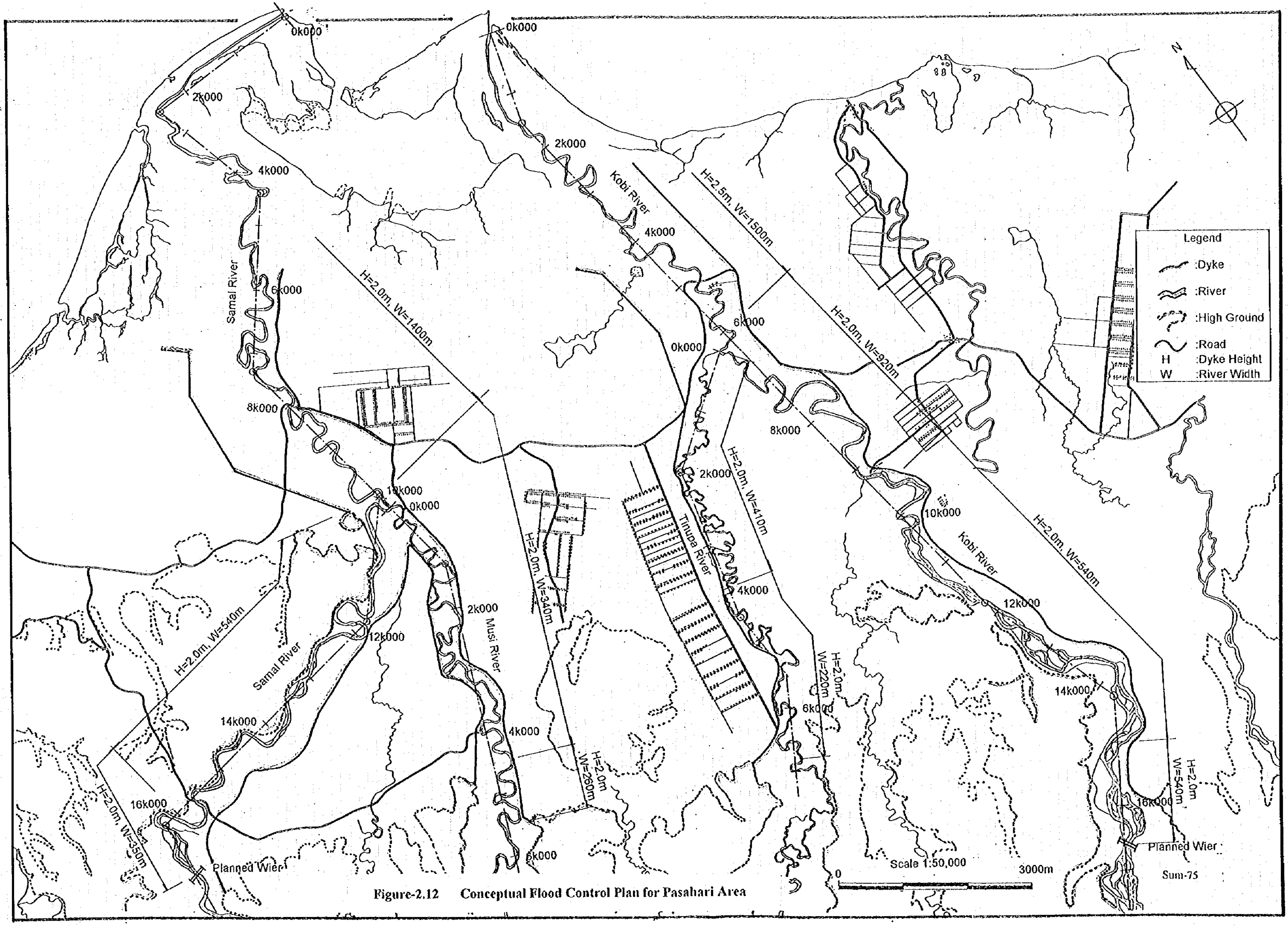


Figure-2.12 Conceptual Flood Control Plan for Pasahari Area

2.3.3 Implementation Schedule

Implementation schedule of the conceptual flood control plan for Samal River and Kobi River was prepared as shown in Table-2.19. Dikes for all the river section are divided into stages and each section is implemented as staged construction. In principal, dikes are constructed from the downstream of each river.

Table-2.19 Implementation Schedule of Conceptual Flood Control Plan

Work Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
(1) Preparation	■	■	■															
(2) Construction																		
- Samal (0.0k-10.0k)				■	■	■	■	■										
- Samal (10.0k-16.6k)														■	■	■	■	■
- Musi (0.0k-5.5k)									■	■	■	■	■					
- Kobi (0k.0-9.5k)				■	■	■	■	■										
- Kobi (9.5k-16.6k)									■	■	■	■	■					
- Tinupa (0.0k-6.5k)														■	■	■	■	■

2.3.4 Evaluation of Plan

(1) Initial Environmental Examination

Table-2.20 shows an environmental examination matrix summarizing the IEE (Initial Environmental Examination) results. Certain negative impacts may occur on some environmental elements during project construction, but no negative impact is anticipated when the project is put into operation.

Table-2.20 Environmental Examination Matrix

Environmental Element		Project Activity			
		Construction Phase		Operation Phase	
		Samal R.	Kobi R.	Samal R.	Kobi R.
Social Environment	Resettlement	-	Δ	-	-
	Economic Activity	Δ	Δ	-	-
	Traffic and Living Facilities	-	Δ	-	-
	Archaeological and Cultural Properties	-	-	-	-
	Water Right and Right of Common	-	-	-	-
	Public Health and Sanitation	-	-	-	-
	Solid Waste	Δ	Δ	-	-
	Risk of Disaster	-	-	-	-
Natural Environment	Topography and Geology	-	-	-	-
	Soil Erosion	-	-	-	-
	Groundwater	-	-	-	-
	Lake and River	-	-	-	-
	Coastal Area	Δ	Δ	-	-
	Flora and Fauna	-	-	-	-
	Landscape	-	-	-	-
Environmental Pollution	Air Pollution	-	-	-	-
	Water Pollution	Δ	Δ	-	-
	Soil Pollution	-	-	-	-
	Noise and Vibration	-	-	-	-
	Ground Subsidence	-	-	-	-
	Offensive Odor	-	-	-	-

×: Significant Negative Impact, Δ: Possible Negative Impact, -: No Negative Impact

(2) Economic Evaluation

Economic analysis was conducted under the following assumptions :

- Price level : End of December 1996
- Design scale : 20-year Return Period
- Project life : 50 years
- Maintenance costs : 0.5% of the total construction costs per year
- Standard conversion rate : 85%
- Growth rate of property value : 6.0% per annum (Until 2010)
  1.6% per annum (From 2011)

Table-2.21 shows the results of economic analysis on the construction of the flood control facilities in Samal and Kobi river, on the assumption that the facilities are constructed in three stages in line with the implementation schedule.

Since a 16.0% IRR will be achieved for the Samal Flood Control Project, the construction of flood control facilities for Samal river is judged to be economically feasible. On the other hand, economic feasibility of the construction of Kobi River flood control facilities is marginal as its IRR is 8.2%. However, it should be noted that flood control facilities in Kobi River can be used as roads which would have additional impact on the local economy, although benefits are difficult to quantify due to lack of traffic data.

The future development plan of the Pasahari Area is currently not yet defined by the Government. The feasibility of the construction of Kobi River's flood control facilities cannot be judged at this moment since it is contingent on future development prospects of the area.

Table-2.21 Economic Evaluation of Flood Control Plan for Pasahari Area

River System	Project Cost (Economic Cost) Million Rp	Net Present Value at 10% Million Rp	Benefit/Cost at 10%	Internal Rate of Return
Samal River	17,065	7,885	1.88	16.0 %
Kobi River	18,862	-2,122	0.79	8.2 %

2.4 Recommendations

(1) Further Stages of the Conceptual Plan

The flood control measures on Samal and Kobi Rivers in Pasahari were proposed as a conceptual plan, based on the following concept: 1) low cost river improvement works, 2) river dikes planned widely surrounding the current river course, 3) economical flood control measures and 4) multi-purpose dikes. As Pasahari area has high potential for agricultural production, further stages of flood control plan and implementation, such as Master Plan, Feasibility Study, Detail Design and Construction should proceed in line with irrigation projects.

(2) Continuous Effort of Collecting Hydrometric Data

There are daily rainfall data in Pasahari but no hourly rainfall data. As for water level and discharge data in Samal and Kobi Rivers, there are practically no available data. For the further study of not only flood control plan but also irrigation projects, hydrometric data, such as rainfall data and river discharge data is needed. As hydrometric stations were installed in this Study, these data should be continuously measured, stored and processed.

(3) Land Use Regulation

The river dikes were planned widely surrounding the current river course. The planned river width is set at 1,400-1,500 m in the downstream of Samal and Kobi Rivers, with the dike height of 2.0-2.5 m. The area between dikes (inside area of the rivers) has very wide space and people may want to utilize the area as a residential area or agricultural land. However it should be reminded that this area is the area inside of the rivers and is prone to flooding. Thus land use regulation for the area between dikes is needed. These area should be utilized as a farm land for inundation-proof crops, not as a residential area.