APPENDIX L

CONSTRUCTION PLAN AND COST ESTIMATE
FOR
URGENT FLOOD CONTROL PROJECT

APPENDIX L

CONSTRUCTION PLAN AND COST ESTIMATE FOR URGENT FLOOD CONTROL PROJECT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. General

The construction works for urgent flood control project consist mainly of excavation/dredging, embankment and bank protections for channel improvement, constructions of structures such as diversion weir, drainage culvert, bridge and drop structures, and constructions of drainage pumping stations and improvement of major drainage channels in the urban area.

In the present study, two alternative construction plans are studied for executing the urgent flood control project. One is a seven-year plan that consists of 5 years for execution of main civil works and the another is a five-year plan that consists of 3 years for execution of main civil works. In conclusion, the seven-year construction plan is adopted.

Based on the construction plan, construction cost for the project is estimated under the price level of June 1983.

2. Construction Plan for Urgent Flood Control Project

2.1 Basic Line of Construction Plan

2.1.1 Workable Days and Working Hours

Generally, execution of earth work is suspended by rainfall. Workable days within a year are assumed based on the rainfall records during the period from 1973 to 1982 at Tabing rainfall station. For estimation of workable days, the days of rainfall of more than 10 mm per day are regarded as waiting days due to rainfall. Total workable days within a year is assumed to be 180 days as shown in Table L-1.

Daily working hours are assumed to be 8 hours for the construction works. While, daily operation hour of construction equipment is assumed to be 5 hours in net.

2.1.2 Existing Available Equipment

It is confirmed that the existing equipment owned by Pengairan DPU, West Sumatra are as listed in Table L-2. These equipment are

being used for the maintenance works of Pengairan, so that the equipment are not to be transferred to the project.

2.1.3 Execution System and Construction Method

The full-contracting system is adopted as the execution system for the project.

As for the period of construction, the following two alternatives are considered, taking into account work quantity of the works and workable days within a year. One is a seven-year plan consisting of 5 years for execution of the civil works and more than 2 years for preparation including detailed design prior to the execution of works, and the another is a five-year plan consisting of 3 years for execution of the civil works and more than one year for preparation.

2.2 Preparatory Works

2.2.1 Transportation Road and Access Road

The existing asphalt-paved road which starts from Teluk Bayur, runs through the city of Padang and cross the project area, and will serve for transportation. This is a trunk road for the project. Branching from the trunk road, access roads for each river are also available. It is required, however, that some existing roads are partly improved and some new access roads are partly constructed for the transportation.

2.2.2 Office and Quarters

The project office should be provided for designing and supervision of construction works. The temporary site offices are required to be constructed at several places for supervision of execution works. Also quarters for project personnel are required to be built in or near the yard of the project office.

Communication measure to be used exclusively for the project should be provided during the period of project implementation.

2.2.3 Topographic Survey

Topographic survey and soil survey are required for carrying out the detailed design and supervision.

2.2.4 Other Works

Clearing works must be executed at the sites of embankment and excavation and some other temporary works will be required.

2.3 Construction Plan

2.3.1 Required Construction Works

Required construction works for the urgent flood control project are described in APPENDIX K.

2.3.2 Land Acquisition and Compensation

Land acquisition and house compensation are required prior to the execution of the construction works, and are to be carried out by the city office of Padang. The total quantity is also shown in APPENDIX K.

2.3.3 Construction Plan

The construction method in combination with mechanical and man powers is applied to the construction work mentioned above. Construction method for major works is described below and the percentages of mechanical and man powers for major works are shown in Table L-3.

a. Excavation of River Channel

It is confirmed that excavated materials can be almost used for dike embankment except some portions according to the soil survey. Excavated materials which are suitable in quality are to be used for dike embankment. Unsuitable materials or excess materials to the required embankment are to be dumped in spoil bank and low-lying area near the river course.

Excavation works are planned to be carried out by using bull-dozer, backhoe and dragline.

b. Loading and Transportation of Excavated Materials

Loading and transportation of excavated materials are planned to be carried out by combination of backhoe and dump truck to embankment sites or low-lying area.

c. Dredging of River Channel

Dredging works are to be executed by using dredger. Dredged materials are to be used for embankment which will be carried out after building small dikes in spoil bank.

d. Embankment

The embankment works are planned to be carried out by a combination of man power (10 % to total) and equipment (90 %). The embankment works by equipment are planned to be carried out by a combination of bulldozer, backhoe, vibration roller and vibration compactor.

e. Back Protections

The two types of bank protections consisting of wetmasonry and gabion are taken as the protection measures for river channel. It is planned that the bank protections are to be executed mainly by man power. As for work in the low-water channel, coffering by using sand bags is planned to construct foundation with wooden piles for wetmasonry revetment. The wooden piles are to be driven by using drop hammar with winch.

f. Reconstruction of Diversion Weir at Lubuk Begalung

It is planned that reconstruction works of diversion weir at the head of flood relief channel are executed with 2 stages in order to discharge flood runoff in the rainy season. Firstly, the right half of the proposed weir is to be constructed, the river water is to be discharged through the remaining left half of the channel.

The construction of diversion dam is divided into three major work items, ie., earth works, concrete works and various protection works. The coffering works are to be executed by using sheet piles

and sand bags ahead of the earth works. Various protection works consist of wetmasonry, concrete block, riprap and gabion works. Concrete blocks are to be set by using crawler crane.

It is planned that the construction works of the weir including rehabilitation of the related structures, are completed within three years.

g. Reconstruction of Bridge

As explained in APPENDIX K, there are two bridge types of reinforcement and steel plate girders. The construction of bridge is divided into 2 items of sub and super structures.

The construction of sub structure consists of coffering, driving of foundation piles and concrete works. It was planned that reinforcement concrete piles are driven by using diesel pile driver. The reinforcement concrete girder is to be manufactured at the site. The steel plate girder is to be fabricated in the factory. This steel plate girder has to be ordered ahead of the commencement of the execution works.

h. Reconstruction of Drop Structure

It is planned that drop structure is reconstructed together with the works of excavation and embankment.

i. Construction of Drainage Culvert

Construction of drainage culvert is planned to be executed ahead of the construction of dikes.

j. Construction of Pumping Station

The construction of pumping station is divided into four major items, i.e., earth works, driving of foundation piles, concrete works and installation of pump plants. It is planned that reinforcement concrete piles are driven by using diesel pile driver and the pump plants are installed by using crawler crane. The construction of one pumping station is to be completed within 18 months.

k. Drainage Channel

Excavation of drainage channel is planned to be executed by man powers.

2.4 Construction Schedule

As mentioned in the previous paragraphs, two alternative plans of construction period are considered for the project. One is a seven-year plan consisting of 5 years for execution works and the another is a five-year plan consisting of 3 years for execution works.

2.4.1 Seven-year Construction Schedule

The proposed seven-year construction schedule for the project is given in Fig. L-1. This is planned based on the following assumptions.

a. Detailed design will be commenced in April 1985 and completed by June 1986 with a period of 15 months.

b. Immediately after completion of the detailed design, tendering will be started, and it will be completed by June 1987.

c. Land acquisition will be commenced in the first year of 1985/86 prior to the execution of civil works.

d. Main civil works will be started in July 1987 and completed by September 1991 with a construction period of 5 years.

The outline of the proposed sequence of execution works is described below.

a. Construction works of the Arau river and the flood relief channel are to be started in July 1987, and will be completed by March 1991, having a construction period of 45 months, respectively.

b. The Kuranji river improvement works are to be executed within 42 months from April 1988 to September 1991.

c. The Air Dingin river improvement works are to be started in April 1989 and completed by September 1991, with a construction period of 30 months.

d. Constructions of terminal drainage facilities such as pumping station and drainage channel are to be commenced in July 1987 and they are to be completed by September 1991, with a construction period of 51 months.

2.4.2 Five-year Construction Schedule

The proposed five-year construction schedule is given in Fig. L-2. This is planned based on the following assumptions.

a. Detailed design will be commenced at the beginning of April 1985 and completed by June 1986, having a total period of 15 months.

b. In parallel with detailed design, preparation of implementation proposal will be started and tendering will be completed by December 1986.

c. In parallel with detailed design, land acquisition will be commenced in October 1985.

d. Main civil works will be executed within 3 years from January 1987 to September 1989.

The outline of the proposed sequence of execution works is described below.

a. Channel improvement works of the Arau river, the flood relief channel and constructions of drainage facilities in the urban area are to be commenced in January 1987 immediately after completion of tendering. Those works will be completed by September 1989.

b. Channel improvement works of the Kuranji river is to be started in April 1987, and be completed by September 1989 with a construction period of 30 months.

c. The Air Dingin river improvement works are to be executed within 24 months from October 1987 to September 1989.

3. Cost Estimate

3.1 Composition of Construction Cost

The construction cost is estimated on the basis of unit construction cost supported by unit prices of labor, construction materials and cost for operation of equipment, in principle.

The costs are for the price level at the beginning of June 1983 and estimated on the following assumptions.

a. Execution of the works are carried out by full-contracting system as mentioned in the previous section 2.1.

b. All equipment and their spare parts required for the works are to be provided by the contractor.

c. The construction schedule and work quantity are as mentioned in the previous sections of 2.3 and 2.4.

d. The following conversion rates are applied to the estimate.

US$ 1 = Rp. 970 = ¥ 240

The construction cost consists of costs required for civil works, land acquisition and house compensation, engineering and administration cost, and contingency.

The cost required for civil works consists of costs for preparatory works, main civil works and miscellaneous. The cost for civil works is estimated by multiplying work quantity by unit cost. The cost for preparatory works is assumed to be 8 % of the total cost of the main civil works and miscellaneous is assumed to be 10 % of the total cost of preparatory and civil works. Cost for land acquisition and house compensation is estimated based on the unit prices required for similar project in Padang. Engineering cost is estimated based on the required expertise. Administration cost is assumed at 10 % of the total local component of civil works, and land acquisition and house compensation. The physical contingency is assumed at 10 % of the total cost of the above.

The construction cost is further broken down into two components

of foreign (US$) and local (Rp.) currencies as described below. The foreign currency component consists of :

a. Cost for construction equipment in depreciation basis including cost for spare parts and maintenance costs,
b. Cost for metal works and pumps,
c. Cost for procurement of special equipment such as observation and design instruments,
d. Cost for technician for execution of the works, and
e. Cost for engineering services by consultants.

The local currency component consists of :

a. Cost for land acquisition and compensation,
b. Cost for local labor and materials,
c. Cost for engineering and administration expenses of the execution agency, and
d. Cost for the consulting services at the site.

3.2 Unit Construction Cost

3.2.1 Unit Prices

For estimating the unit construction cost, the unit prices of labors, materials and equipment expenses are studied based on the data prepared by DPU West Sumatra and Padang city office, and taking into account the unit prices which is currently applied to the similar projects in Indonesia as shown in Table L-4.

The unit prices of the construction materials are divided into two components of foreign and local currencies based on the current data applied to the similar projects in Indonesia. The unit prices of labor and construction materials are shown in Table L-5.

The construction equipment including their spare parts are to be provided by the contractor. Operation cost of the construction equipment required for the works is estimated based on the costs for depreciation, repair and maintenance, fuel, and costs for labor and guidance. The estimated hourly operation costs of major construction equipment are shown in Table L-6.

The costs of land acquisition and house compensation are estimated based on the data obtained from Padang city office and taking into account the cost currently applied to the similar project in DPU West Sumatra. The unit costs of land acquisition and house compensation are shown in Table L-7.

3.2.2 Unit Construction Cost

The unit construction cost is estimated by applying the unit prices of labor, construction materials and equipment expenses, and based on the construction plan mentioned previously.

In estimating the unit construction cost, contract prices including site expenses, contractor's overhead and profit, and tax are assumed to be the following.

a.	Site expenses	20 % of direct cost
b.	Contractor's overhead and profit	15 % of the total cost of direct cost and site expenses
c.	Tax	2.5 % of total cost.

The estimated unit construction costs are shown in Table L-8. Table L-9 shows major unit construction costs of similar projects in Indonesia as reference data.

3.3 Construction Cost for the Project

The construction cost is estimated for 2 alternatives of seven-year and five-year plans.

The construction cost for seven-year plan is estimated at Rp.45,254 $\times 10^6$, consisting of Rp.14,886 $\times 10^6$ of local currency portion and US$ 31,307 $\times 10^3$ of foreign currency portion.

In the case of five-year plan, the construction cost is estimated at Rp.44,764 $\times 10^6$, consisting of Rp 14,816 $\times 10^6$ of local currency portion and US$ 30,874 $\times 10^3$ of foreign currency portion.

The breakdowns of the above construction costs are presented in Tables L-10 and L-11.

For the above, comparison of the two alternative construction plan is made from the economical aspect which is shown in Table L-12. According to the table, it shows that the both plans indicate no significant difference between them. In conclusion, the seven-year plan is selected taking into account the execution period of preparatory works, land acquisition and house compensation, and field conditions.

3.4 Operation, Maintenance and Replacement Cost

The operation and maintenance cost at full operation stage for the facilities after completion of the project is assumed to be annually 0.5 % of the total cost of civil works at the June 1983 price.

As for the replacement of the facilities, it was considered that the metal structures such as gates, plate girder, etc., are replaced only once during the entire period of the project life. The total replacement cost for the metal structures is estimated at Rp. 3,620 $\times 10^6$.

The total operation, maintenance and replacement cost is estimated at Rp.11,653 $\times 10^6$, as shown in Table L-13.

Table L-1 Estimated Workable Days in a Year

(Unit : day)

Month	Total days in month	Daily Rainfall (mm) 10 — 15 Rainfall days	10 — 15 Duration (day)	10 — 15 Waiting (day)	16 — 30 Rainfall days	16 — 30 Duration (day)	16 — 30 Waiting (day)	>30 Rainfall days	>30 Duration (day)	>30 Waiting (day)	Total Suspension days	Total Workable day
January	31	1.4	0.3	0.7	2.9	1.5	1.5	2.6	1.3	2.6	7.9	17.1
February	28	2.1	0.5	1.1	2.3	1.2	1.2	2.9	1.5	2.9	8.4	15.6
March	31	2.0	0.5	1.1	1.4	0.7	0.7	3.3	1.7	3.3	8.0	19.0
April	30	1.7	0.4	0.9	2.8	1.4	2.8	4.4	2.2	6.6	14.3	9.7
May	31	1.5	0.4	0.8	2.0	1.0	1.0	3.7	1.9	3.7	8.8	16.2
June	30	1.6	0.4	0.8	1.3	0.7	0.7	3.0	1.5	3.0	7.1	18.9
July	31	1.3	0.3	0.7	2 7	1.4	1.4	3.0	1.5	3.0	8.3	15.7
August	31	2.1	0.5	1.1	2.6	1.3	1.3	3.3	1.7	3.3	9.2	16.8
September	30	2.3	0.6	1.2	3.0	1.5	3.0	4.5	2.3	7.0	15.6	9.4
October	31	2.7	0.7	1.4	2.6	1.3	2.6	5.7	2.9	9.0	17.9	7.1
November	30	2.2	0.2	1.1	3.3	1.7	3.3	5.0	2.0	7.0	15.7	10.3
December	31	2.9	0.9	1.5	2.7	1.4	2.7	3.5	1.8	5.0	13.3	10.7
Total (for earth works)	365	23.8	6.1	12.4	29.6	15.1	22.2	44.9	22.3	56.4	134.5	180.5
Total (for dredging)	365	23.8	0	0	29.6	15.1	22.2	44.9	22.3	56.4	116.0	199.0

Note : 1. The following criteria is adopted to the above estimation

Description	Daily Rainfall (mm) 0 - 9	10 - 15	16 - 30	more than 30
- Duration of rainfall days	0	0.25	0.5	0.5
- Waiting of rainfall days Jan. August except April	0	0.5	0.5	1.0
- Waiting of rainfall days April, Sept. to Dec.	0	0.5	1.0	1.5

2. 50 days of holiday and Sunday in a year is considered.

Table L-2 Available Existing Construction Equipment Owned by Pengairan DPU. West Sumatra

(as of June '83)

Equipment	Capacity	Nos.	Year of Purchase	Age
Barge	500 m^3/h	1	1975	8
Backhoe	0.6 m^3	1	1980	3
Crowler Crane	30 t	1	1978	5
Bulldozer	0.50 m^3	2	1980	3
Dredger	750 HP	1	-	-
Dump Truck	5 t	6	1980	3
Loader Crowler	1.5 m^3	2	1976	7
Loader Tire	0.5 m^3	1	1980	3

Note : Collected from DPU. West Sumatra.

Table L-3 Percentage of Mechanical and Man Power for Major Works

	Works	Percentage (%) Man Power	Equipment	Composition of Equipment
1.	Excavation I (for high w. channel)	10	90	BD (15t,7t) BH ($0.7m^3$, $0.3m^3$)
2.	Excavation II (for major bed)	0	100	BD (15t,7t) BH ($0.7m^3$,$0.3m^3$) DL ($0.6m^3$)
3.	Loading and transportation	0	100	BH ($0.5m^3$) DT (9t,6t)
4.	Dredging	0	100	Dredger (class $40m^3$)
5.	Embankment	10	90	BD (15t,7t) BH ($0.3m^3$) VR (2t,1t) VPC (50kg)
6.	Sod-facing	100	0	-
7.	Excavation of drainage channel	100	0	-
8.	Backfilling	10	90	BH ($0.7m^3$) RR (60kg) VR (2t)
9.	Wet masonry and gabion	100	0	
10.	Gravel metaling (for inspection road)	0	100	MR (3m) TR (12t)
11.	Concrete work	0	100	Concrete mixer ($1.0m^3$,$0.3m^3$) Concrete vibrator (Ø30 mm)
12.	Unwatering	0	100	Submersible pump. (210 mm, 50 mm)
13.	Piling work (for R.C and sheet piles)	0	100	Diesel p. driver (2.5t,1.3t) Crawler crane (50t,30t) Truck crane (20t) Portable d. generator (100 KVA 45 KVA)
14.	Setting cross block, pump plants etc.	0	100	Crawler crane (30,50t)

Note BD : Bulldozer DT : Dump truck RR : Rammer
BH : Backhoe VR : Vibrating roller MR : Motor grador
DL : Dragline VPC: Vibrating plate Compactor TR : Tire roller

Table L-4 Comparison of Unit Price of Labor Wages and Construction Materials

(Unit : Rp)

Description	Unit	Cipta Karya /1	Ular River Improvement /2	West Jakarta Drainage /3
Labor :				
Foreman	(day)	3,000 - 3,500	3,400	3,300
Mason	"	3,000	3,000	2,750
Steel worker	"	3,000	3,000	2,400
Concrete worker	"	2,500	-	2,400
Carpenter	"	3,000	3,000	2,750
Skilled labor	"	3,000	2,600	2,750
Common labor	"	2,000	1,750	2,200
Operator	"	4,000	-	4,400
Driver	"	2,800	-	3,300
Material :				
Gasoline	(l)	320	-	320
Cement	(40 kg)	3,000	2,900	3,100
Stone (Cobble)	(m^3)	4,000 - 6,000	7,500	10,000
(cutted)	(m^3)	7,000	-	5,491
Gravel	(m^3)	4,000 - 5,000	6,500	10,000
Sand	(m^3)	3,250 - 7,500	4,000	7,590
Steel plate	(kg)	560	-	560
Wooden plate for form	(m^3)	70,000	74,100	70,000
Bamboo net	(m^2)	850	-	180
Steel bar	(kg)	600	310	600
Bolt and nut	(kg)	900	-	900

Note : /1. Collected from DPU West Sumatra (as of beginning of June, 1983)

/2. Collected from Ular River Flood Control and Improvement of Irrigation Project (as of beginning of June 1983, averaged cost of F.C 1 and F.C 3)

/3. Study Report on West Jakarta Flood Control Project (as of April, 1983).

Table L-5 Unit Prices of Labor and Construction Materials

(US$ 1 = Rp. 970)

Item	Unit	Unit Price L.C (Rp)	Unit Price F.C (US$)	Ratio of F.C (%)
I. Labor Wages				
Foreman	day (8hrs)	3,500	-	0
Skilled labor	"	3,000	-	0
Common labor	"	2,000	-	0
Concrete worker	"	2,500	-	0
Carpenter	"	3,000	-	0
Steel bar bender	"	3,000	-	0
Mason	"	3,000	-	0
Operator	"	4,400	-	0
Assistant operator	"	3,800	-	0
Mechanic	"	3,800	-	0
Assistant Mechanic	"	3,300	-	0
Driver	"	2,800	-	0
II. Fuel and Materials				
Gasoline	lit	160	0.17	50
Diesel oil	"	75	0.08	50
Lubricant	"	700	0.73	50
Hydraulic oil	"	600	0.62	50
Grease	kg	1,250	12.89	50
Gear oil	lit	1,250	12.89	50
Transmission oil	"	1,050	1.09	50
Light oil	"	55	0.06	50
Sand for concrete	cu. m	2,115	2.46	53
Sand for others	"	1,880	2.19	53
Gravel for concrete	"	2,350	2.73	53
Unscreened gravel	"	1,880	2.19	53
Stone for masonry	"	2,115	2.46	53
Cobble stone	"	1,880	2.19	53
Cement (portland)	kg	27	0.05	65
Reinforcement bar	"	120	0.50	80
Steel plate	"	-	0.58	100
Shape steel	"	-	0.47	100
Steel sheet pile	"	-	0.62	100
H section steel	"	-	0.52	100
Bolt and nut	"	-	0.94	100
Wire rope 18 mm	"	-	1.86	100
Zinc wire 0.4 mm	"	-	0.73	100
Nail	"	-	0.47	100
Wooden plate for form	cu. m	65,800	4.33	6
Wooden beam	"	47,000	3.09	6
Wooden pile Ø15x5m	nos	5,540	0.24	6
Ø15x3m	"	3,360	0.14	6
Paint	kg	800	0.83	50
Bamboo net	sq. m	850	-	0
Turf	"	135	0.02	10

Note : 1. Ratio of F.C in unit price is estimated based on the data prepared by West Jakarta Flood Control Project, April 1983.
2. Price level at the beginning of June 1983 is adopted.

Table L-6 Estimated Operation Cost of Equipment per Day

Equipment	Capacity	Local Currency (Rp.)			Foreign Currency (US$)				Eq. Total (Rp.)
		Fuel	Labor	Total	Owing and Repair	Fuel	Guidance	Total	
Bulldozer	15 t	18,910	6,400	25,310	108.80	19.50	8.50	136.80	158,006
	7 t	8,800	6,400	15,200	42.20	9.10	8.50	59.80	73,206
Backhoe	0.7 m^3	14,450	6,400	20,850	101.30	14.90	8.50	124.70	141,809
	0.5 m^3	11,730	6,400	18,130	73.30	12.10	8.50	93.90	109,213
	0.3 m^3	9,010	6,400	15,410	49.75	9.30	8.50	67.55	80,934
Dragline	0.6 m^3	13,910	6,400	20,310	164.00	14.35	8.50	186.85	201,555
Dredger	40 m^3	89,470	22,400	111,870	612.00	92.20	13.60	717.80	808,136
Dump truck	9 t	26,842	2,800	29,642	37.90	27.68	-	65.58	93,255
	6 t	17,895	2,800	20,695	26.90	18.45	-	45.35	64,685
Tire roller	12 t	11,610	6,400	18,010	62.05	12.00	-	74.05	89,839
Vibrating roller	2 t	2,025	4,800	6,825	46.60	2.10	-	48.70	54,064
	1 t	1,790	4,800	6,590	14.50	1.85	-	16.35	22,450
Vibrating compactor	50 kg	990	2,000	2,990	4.55	1.05	-	5.60	8,422
Rummer	60 kg	930	2,000	2,930	4.55	1.00	-	5.55	8,314
Portable C. mixer	1.0 m^3	775	2,000	2,775	50.40	0.80	-	51.20	52,439
	0.3 m^3	555	2,000	2,555	24.35	0.60	-	24.95	26,757
Concrete vibrator	Ø30 mm	1,725	2,000	3,725	3.25	1.80	-	5.05	8,624
Diesel pile driver	1.3 t	13,475	4,000	17,475	78.90	13.90	8.50	101.30	115,736
	2.5 t	20,575	4,000	24,575	117.65	21.20	8.50	147.35	167,505
Portable d. generator	100 KVA	15,875	2,000	17,875	32.85	16.35	-	49.20	65,599
	45 KVA	6,485	2,000	8,485	20.70	6.70	-	27.40	35,063
Motor grader		16,035	6,400	22,435	73.15	16.55	-	89.70	109,444
Portable air C.	50 PS	5,495	2,000	7,495	19.85	5.65	-	25.50	32,230
Crawler crane	40 t	14,560	6,400	20,960	160.15	15.00	8.50	183.65	199,101
	30 t	13,995	6,400	20,395	116.45	14.40	8.50	139.35	155,565
Hydraulic t. crane	20 t	20,575	6,400	26,975	97.5	21.20	8.50	127.20	150,359
	10 t	20,575	6,400	26,975	56.70	21.20	8.50	86.40	110,783
Submersible p.	200 mm	1,620	2,000	3,620	7.30	1.65	-	8.95	12,302
	50 mm	90	2,000	2,090	0.80	0.20	-	1.0	3,060
Dromphammer w/winch	400 kg	405	2,000	2,405	7.20	0.45	8.50	16.15	18,071
Engine breaker	60 CC	1,035	2,000	3,035	0.50	1.10	-	1.60	4,587
Grease car	6 t	16,600	9,600	26,200	66.20	17.10	-	83.30	121,406
Service car	1 t	18,370	9,600	27,970	14.40	18.95	-	33.35	63,230

Table L-7 Unit Costs of Land Acquisition and House Compensation

I. Land

Item	Residential Area : I (Rp./m^2)	Agricultural and Others : II (Rp./m^2)
Arau R.	5,000	1,500
Flood Relief C.	5,000	1,500
Lower Kuranji R. (downstream from Railway br.)	5,000	1,500
Lower Air Dingin (downstream from Railway br.)	5,000	1,500
Jirak R.	1,500	500
Middle and upper Kuranji R. (upstream from railway br.)	1,500	500
Balimbing R.	1,500	500
Laras R.	1,500	500
Middle and upper Air Dingin R.	1,500	500
Drainage Canal (Old urban area)	6,000	2,000
(New urban area)	6,000	2,000

II. House

Item	Average House Area (m^2)	Unit Price (Rp./m^2)	Compensation Cost (Rp./house)
Class I	80	90,000	3,600,000
II	60	60,000	1,800,000
III	40	25,000	500,000
IV	30	10,000	150,000

Note : 1. The above cost is estimated based on the cost applied to similar project in DPU. West Sumatra.

2. 50 % of the total evaluation cost (unit prices) is considered as house compensation cost.

Class I : Permanent house
II : Semi permanent house
III : Small house
IV : Temporary

Table L-8 Estimated Unit Construction Cost

Works	Unit	Unit Cost /1		
		Local C (Rp.)	Foreign C. (US$)	Eq. Total (Rp.)
Excavation				
I (high water channel)	m^3	499	1.50	1,954
II (major bed)	"	294	1.78	2,021
for rock	"	1,700	6.00	7,520
Dredging	"	801	3.54	4,235
Transportation	"	788	2.13	2,855
Embankment				
I (new levee)	m^3	425	1.51	1,889
II (strengthening)	"	456	1.07	1,494
Wet masonry revetment				
I (high water channel)	m^2	9,685	13.31	22,596
II (low water channel)	"	11,410	13.74	24,739
Dry masonry	"	7,453	9.32	16,494
Gabion	m^3	7,712	14.49	21,766
Riprap	m^3	13,709	10.83	24,215
Groin	"	7,712	14.49	21,766
Sod-facing	m^2	320	0.17	485
Drainage culvert				
I (1.5 x 1.5 x 1)	nos	15,200,100	22,726	37,244,320
II (2.0 x 2.5 x 1)	"	22,444,000	35,023	56,416,310
III (2.0 x 2.5 x 2)	"	32,120,000	49,665	80,295,050
Bridge (R.C)	m^2	173,730	274.82	440,306
(Metal)	m^2	201,352	543.82	728,858
Pier protection for existing bridge (riprap)	m^3	13,709	10.83	24,215
Drop structure	place	87,196,000	192,581	212,889,570
Groundsill works	m	474,462	424.91	886,620
Diversion weir				
Flood relief channel	l.s	317,914,110	508,496	811,155,230
Arau river (urgent)	"	246,874,420	229,963	469,938,530
Syphon	Place	31,263,100	45,067	79,978,090
Disposal of excess soil	m^3	176	0.81	963
Excavation of rock	"			
Pumping station				
I (3.5 m^3/s)	l.s	435,000,000	1,661,000	2,046,170,000
II (2.0 m^3/s)	"	359,000,000	1,401,000	1,717,970,000
Inspection road (gravel metaling)	m	2,422	3.03	5,362

Note /1 : US$ 1 = Rp. 970 = ¥ 240

Table L-9 Comparison of Major Unit Construction Cost in Similar Project

Work Item	Unit	PU Padang/1 Unit Cost (Rp.)	PU Padang/1 Construction Method	Ular River Improvement Project/2 Unit Cost (Rp.)	Ular River Improvement Project/2 Construction Method	West Jakarta Flood Control Project/3 Unit Cost (Rp.)	West Jakarta Flood Control Project/3 Construction Method
Excavation							
(1) High water C	m^3	1,563	100 % by man power	1,966	10 % by man power and 90 % by equipment(BD,BH,DL)	-	
(2) Major bed	m^3	1,880	"	-		2,052 1,793	100 % by man power 10 % by man power, 90 % by Equipment(BD,BH,DL)
(3) Drain	m^3	780	"	636	50 % by man power and 50 % by equipment (BH)	1,872	50 % by man power 50 % by equipment(BH)
(4) for structure	m^3	2,350	by man power	705	10 % by man power and 90 % by equipment(BD,BH,DL)	1,000	10 % by man power 90 % by equipment(BD,BH)
Transportation 1 = 2 km	m^3	1,400	Man power and Dump truck	1,123	100 % by equipment(DT,DS,BH)	7,061	100 % by equipment(BH,DT)
Dredging	m^3	-	-	3,158	100 % by equipment (amphibious dredger)	4,282	100 % by equipment (amphibious dredger)
Embankment							
(1) New levee	m^3	1,688	100 % by man power	1,176	10 % by man power 90 % by equipment(BD,VR,VC)	2,054	10 % by man power 90 % by equipment (BD,BH,VR)
(2) Heightening	m^3	-	-	2,684	"	-	
Sod facing	m^2	680	100 % by man power	348	100 % by man power	461	100 % by man power
Backfill for structure	m^3	525	100 % by man power	795	10 % by man power 90 % by equipment(BH,VR)	3,307	10 % by man power 90 % by equipment(BH,VR)
Disposal of soil	m^3	-	-	570	by bulldozer	747	by bulldozer
Concrete							
(1) Cement 120 kg/cm^2	m^3	48,450	by combination of man power and equipment	45,075	by combination of man power and concrete mixer, concrete vibration	56,723	by combination of man power and concrete mixer, concrete vibration
(2) Cement 180 kg/cm^2	m^3	51,550		54,873		67,783	
Wet stone masonry	m^3	32,295(dry)	100 % by man power	62,321	100 % by man power	73,312	100 % by man power
Gabion	m^3	24,750	"	-		81,047	"
Riprap	m^3	7,500	"	25,570	"	26,170	"

Note : /1 Collected from PU Padang (as of June 1983)

/2 Collected from Ular River Flood Control and Improvement of Irrigation Project (as of July 1983, average cost)

/3 Collected from Evaluation Report on West Jakarta Flood Control Project (as of April 1983)

Note : BD : Bulldozer DT : Dump truck VR : Vibrating roller
BH : Backhoe DS : Dozer shovel
DL : Dragline VR : Vibrating roller

Table L-10(1) Breakdown of Construction Cost (seven-year plan)

Item		Quantity Unit	Quantity (Amount)	Local Currency (Rp.) Unit Cost	Local Currency (Rp.) (Amount) (10^6)	Foreign Currency (US$) Unit Cost	Foreign Currency (US$) (Amount) ($10^3$)	Equivalent Total (Rp. 10^6)
1. Civil Works					(9,627.1)		(22,779.8)	(31,723.7)
1.1 Arau River					(1,311.8)		(2,581.6)	(3,816.0)
Preparatory /1					88.4		173.9	
(RIVER CHANNEL IMPROVEMENT)								
Excavation	I	10^3m^3	96	499	48.0	1.50	144.0	
	II	"	155	294	45.6	1.78	275.9	
Dredging		"	24	801	19.3	3.54	85.0	
Transportation		"	275	788	216.7	2.13	585.8	
Embankment	I	"	31	425	13.2	1.51	46.9	
Bank protection								
Wet masonry	I	m^2	504	9,685	4.9	13.31	6.8	
	II	"	10,362	11,410	118.3	13.74	142.4	
Gabion		m^3	3,093	7,712	23.9	14.49	44.9	
Sod-facing		10^3m^2	21.5	320	6.9	0.17	3.7	
Drainage culvert	I	nos	5	15,200,100	76.1	22,726	113.7	
	III	"	1	32,120,000	32.2	49,665	49.7	
Bridge (R.C)		m^2	204	173,730	35.5	274.82	56.1	
Pier protection (riprap)		10^3m^3	0.5	13,709	6.9	10.83	5.5	
Groundsill works		m	12	474,462	5.7	424.91	5.1	
Diversion weir		l.s	1	246,874,420	246.9	229,963	230.0	
Inspection road (gravel metaling)		m	8,500	2,422	20.6	3.03	25.8	
Disposal of excess soil		10^3m^3	241	176	42.5	0.81	195.3	
(DRAINAGE CHANNEL IMPROVEMENT)								
Excavation		10^3m^2	12	2,391	28.7	-	-	
Transportation		"	12	788	9.5	2.13	25.6	
Disposal of soil		"	12	176	2.2	0.81	9.8	
Revetment								
Wet masonry	II	m^2	8,800	11,410	100.5	13.74	121.0	
Miscellaneous /2					119.3		234.7	

Table L-10(2) Breakdown of Construction Cost (seven-year plan)

Item		Unit	(Amount)	Local Currency (Rp.) Unit Cost	Local Currency (Rp.) (Amount) (10^6)	Foreign Currency (US$) Unit Cost	Foreign Currency (US$) (Amount) ($10^3$)	Equivalent Total (R. 10^6)
1.2 Flood Relief Channel					(4,502.6)		(10,145.2)	(14,343.5)
Preparatory /1					303.2		683.2	
(RIVER CHANNEL IMPROVEMENT								
Excavation	I	10^3m^3	366	499	182.7	1.50	549.0	
	II	"	157	294	46.2	1.78	279.5	
Dredging		"	18	801	14.5	3.54	63.8	
Transportation		"	541	788	426.4	2.13	1,152.4	
Embankment	I	"	31	425	13.2	1.51	46.9	
	II	"	14	456	6.4	1.07	15.0	
Bank protection								
Wet masonry	I	m^2	1,992	9,685	19.3	13.31	26.5	
	II	"	57,600	11,410	657.3	13.74	791.5	
Dry masonry		"	22,026	7,453	164.2	9.32	205.3	
Sod-facing		10^3m^2	66	320	21.2	0.17	11.3	
Drainage culvert	I	nos	9	15,200,100	136.8	22,726	204.6	
	II	"	7	22,444,000	157.2	35,023	245.2	
Bridge (R.C)		m^2	812	173,730	141.1	274.82	223.2	
Pier protection (riprap)		10^3m^3	0.2	13,709	2.8	10.83	2.2	
Drop structure		place	3	87,196,000	261.6	129,581	388.8	
Diversion weir		l.s	1	317,914,110	318.0	508,496	508.5	
Syphone		place	2	31,263,100	62.6	45,067	90.2	
Inspection road (gravel metaling)		m	13,760	2,422	33.4	3.03	41.7	
Disposal of excess soil		10^3m^3	487	176	85.8	0.81	394.5	
(DRAINAGE CHANNEL IMPROVEMENT)								
Pumping station								
I (2.0 m^3/s)		l.s	1	359,000,000	359.0	1,401,000	1,401.0	
II (3.5 m^3/s)		l.s	1	435,300,000	435.3	1,661,000	1,661.0	
Excavation		10^3m^3	49	2,391	117.2	-	-	

Table L-10(3) Breakdown of Construction Cost (seven-year plan)

Item		Quantity Unit	Quantity (Amount)	Local Currency (Rp.) Unit Cost	Local Currency (Rp.) (Amount) (10^6)	Foreign Currency (US$) Unit Cost	Foreign Currency (US$) (Amount) ($10^3$)	Equivalent Total (Rp. 10^6)
Embankment		10^3m^3	3	425	1.3	1.51	4.6	
Transportation		"	45	788	35.5	2.13	95.9	
Disposal of soil		"	45	176	8.0	0.81	36.5	
Revetment								
Wet masonry	II	m^2	6,000	11,410	68.5	13.74	82.5	
Dry masonry		"	1,000	7,453	7.5	9.32	9.4	
Inspection road (gravel metaling)		m	2,870	2,422	7.0	3.03	8.7	
Miscellaneous /2					409.4		922.3	
1.3 Kuranji River					(2,982.7)		(7,937.9)	(10,682.5)
Preparatory /1					200.9		534.6	
(RIVER CHANNEL IMPROVEMENT)								
Excavation	I	10^3m^3	279	499	139.3	1.50	418.5	
	II	"	373	294	109.7	1.78	664.0	
for rock		"	3	1,700	5.1	6.00	18.0	
Dredging		"	39	801	31.3	3.54	138.1	
Transportation		"	682	788	537.5	2.13	1,452.7	
Embankment	I	"	168	425	71.4	1.51	253.7	
Bank protection								
Wet masonry	I	m^2	2,112	9,685	20.5	13.31	28.2	
	II	"	6,760	11,410	77.2	13.74	92.9	
Dry masonry		"	6,270	7,453	46.8	9.32	58.5	
Gabion		m^3	8,525	7,712	65.8	14.49	123.6	
Groin		m	10,500	7,712	81.0	14.49	152.2	
Sod-facing		10^3m^2	46.1	320	14.8	0.17	7.9	
Drainage culvert	I	nos	16	15,200,100	243.3	22,726	363.7	
	II	"	5	22,444,000	112.3	35,023	175.2	
	III	"	4	32,120,000	128.5	49,665	198.7	

Table L-10(4) Breakdown of Construction Cost (seven-year plan)

Item	Quantity Unit	Quantity (Amount)	Local Currency (Rp.) Unit Cost	Local Currency (Rp.) (Amount) (10^6)	Foreign Currency (US$) Unit Cost	Foreign Currency (US$) (Amount) ($10^3$)	Equivalent Total (Rp. 10^6)
Bridge (R.C)	m^2	336	173,730	58.4	274.82	92.4	
" (Metal)	"	360	201,352	72.5	543.82	195.8	
Pier protection (riprap)	10^3m^3	0.6	13,709	8.3	10.83	6.5	
Groundsill works	m	130	474,462	61.7	424.91	55.3	
Inspection road (gravel metaling)	m	21,090	2,422	51.1	3.03	64.0	
Disposal of Excess soil	10^3m^3	507	176	89.3	0.81	410.7	
(DRAINAGE CHANNEL IMPROVEMENT)							
Pumping station							
I (3.5 m^3/s)	l.s	1	435,300,000	435.3	1,661,000	1,661.0	
Excavation	10^3m^3	8	2,391	19.2	-	-	
Embankment	"	2	425	0.9	1.51	3.1	
Transportation	"	6	788	4.8	2.13	12.8	
Disposal of soil	"	6	176	1.1	0.81	4.9	
Revetment							
Wet masonry II	m^2	300	11,410	3.5	13.74	4.2	
Dry masonry	"	2,200	7,453	16.4	9.32	20.6	
Inspection road (gravel metaling)	m	1,450	2,422	3.6	3.03	4.4	
Miscellaneous /2				271.2		721.7	
1.4 Air Dingin River				(830.0)		(2,115.1)	(2,881.7)
Preparatory /1				55.9		142.5	
(RIVER CHANNEL IMPROVEMENT)							
Excavation I	10^3m^3	50	499	25.0	1.50	75.0	
II	"	199	294	58.6	1.78	354.3	
Dredging	"	30	801	24.1	3.54	106.2	
Transportation	"	279	788	219.9	2.13	594.3	
Embankment I	"	66	425	28.1	1.51	99.7	

Table L-10(5) Breakdown of Construction Cost (seven-year plan)

Item		Quantity Unit	Quantity (Amount)	Local Currency (Rp.) Unit Cost	Local Currency (Rp.) (Amount) (10^6)	Foreign Currency (US$) Unit Cost	Foreign Currency (US$) (Amount) ($10^3$)	Equivalent Total (Rp. 10^6)
Bank protection								
Wetmasonry	I	m^2	1,067	9,685	10.5	13.31	14.4	
	II	"	3,246	11,410	37.1	13.74	44.6	
Gabion		m^3	2,484	7,712	19.2	14.49	36.0	
Sod-facing		10^3m^2	29.6	320	9.5	0.17	5.1	
Drainage culvert	I	nos	2	15,200,100	30.4	22,726	45.5	
	II	"	1	22,444,000	22.5	35,023	35.1	
	III	"	2	32,120,000	64.3	49,665	99.4	
Pier protection (riprap)		10^3m^3	1.6	13,709	22.0	10.83	17.4	
Groundsill works		m	150	474,462	71.2	424.91	63.8	
Inspection road (gravel metaling)		m	8,500	2,422	20.6	3.03	25.8	
Disposal of excess soil		10^3m^3	202	176	35.6	0.81	163.7	
Miscellaneous /2					75.5		192.3	
2. Land Acquisition and House Compensation					(1,819.9)			(1,819.9)
2.1 Arau River					(489.4)			(489.4)
(RIVER CHANNEL IMPROVEMENT)								
Land		10^3m^2	131.6		434.2			
House		nos	90		29.2			
(DRAINAGE CHANNEL IMPROVEMENT)								
Land		10^3m^2	4.0		24.0			
House		nos	4		2.0			
2.2 Flood Relief Channel					(577.2)			(577.2)
(RIVER CHANNEL IMPROVEMENT)								
Land		10^3m^2	96.0		187.8			
House		nos	42		18.9			
(DRAINAGE CHANNEL IMPROVEMENT)								
Land		10^3m^2	78.0		340.0			
House		nos	52		30.5			

Table L-10(6) Breakdown of Construction Cost (seven-year plan)

Item	Quantity Unit	Quantity (Amount)	Local Currency (Rp.) Unit Cost	Local Currency (Rp.) (Amount) (10^6)	Foreign Currency (US$) Unit Cost	Foreign Currency (US$) (Amount) ($10^3$)	Equivalent Total (Rp. 10^6)
2.3 Kuranji River				(528.2)			(528.2)
(RIVER CHANNEL IMPROVEMENT)							
Land	10^3m^2	629.2		462.8			
House	nos	92		34.2			
(DRAINAGE CHANNEL IMPROVEMENT)							
Land	10^3m^2	8.0		24.0			
House	nos	2		7.2			
2.4 Air Dingin River				(225.1)			(225.1)
(RIVER CHANNEL IMPROVEMENT)							
Land	10^3m^2	200.0		217.5			
House	nos	20		7.6			
3. Total (1 + 2)				11,447.0		22,779.8	33,543.6
4. Administration /3				1,144.7		-	1,144.7
5. Engineering				940.6		5,680.8	6,451.0
6. Contingency /4				1,353.7		2,846.4	4,114.7
7. Grand Total				14,886.0		31,307.0	45,254.0

Note 1. Price level at the beginning of June '83 is applied
2. Conversion rate : US$ 1 = Rp. 970 = ¥ 240
3. The following lump sum costs are applied
for /1 8 % of the direct civil works cost
/2 10 % of the civil works cost, including cost for telemetering facilities
/3 10 % of the total local component of civil works, and land acquisition and House Compensation
/4 10 % of the total costs of civil works, land acquisition and house compensation, and engineering and administration

Table L-11 Breakdown of Construction Cost (five-year plan)

Item	Local Currency (Rp. 10^6)	Foreign Currency (US$ 10^3)	Equivalent Total (Rp. 10^6)
1. Civil Works /1	9,627.1	22,779.8	31,723.7
2. Land Acquisition and House Compensation /1	1,819.9	-	1,819.9
3. Total (1 + 2)	11,447.0	22,779.8	33,543.6
4. Administration /2	1,144.7	-	1,144.7
5. Engineering	877.0	5,287.4	6,005.8
6. Contingency /3	1,347.3	2,806.8	4,069.9
7. Grand Total	14,816.0	30,874.0	44,764.0

Note 1. Price level at the beginning of June '83 is applied

2. Conversion rate : US$ 1 = Rp. 970 = ¥ 240

3. The following lump sum costs are applied

for /1 : Same as the cost for seven-year plan

/2 : 10 % of the total local component of civil works, and land acquisition and House Compensation

/3 : 10 % of the total costs of civil works, land acquisition and house compensation, and engineering and administration

Table L-12 Economical Comparison of the Two Alternative Construction Schedules

Seven-year plan

Unit : Rp. 10^6

Year in order	Fiscal year	Economic cost				Benefit
		Construction cost	Replacement cost	O & M cost	Total	
1	1985/86	1,323	-	-	1,323	-
2	1986/87	1,234	-	-	1,234	-
3	1987/88	6,731	-	-	6,731	-
4	1988/89	9,672	-	-	9,672	-
5	1989/90	10,545	-	25	10,570	1,236
6	1990/91	10,545	-	75	10,620	3,707
7	1991/92	3,628	-	125	3,753	6,179
8	1992/93	-	-	150	150	7,415
.			-	.	.	.
31	2015/16	-	-	150	150	7,415
32	2016/17	-	1,191	150	1,341	7,415
33	2017/18	-	1,191	150	1,341	7,415
34	2018/19	-	1,195	150	1,345	7,415
35	2019/20	-	-	150	150	7,415
.			-	.	.	.
.				.	.	.
.				.	.	.
57	2041/42	-	-	150	150	7,415

IRR : 14.7 %

Five-year plan

1	1985/86	2,346	-	-	2,346	-
2	1986/87	4,541	-	-	4,541	-
3	1987/88	13,537	-	-	13,537	-
4	1988/89	14,618	-	-	14,618	-
5	1989/90	8,148	-	74	8,222	3,708
6	1990/91		-	148	148	7,415
.	.		-	"	"	"
.	.	-	-	"	"	"
.	.	-	-	.	.	.
.	.			.	.	.
.	.		.	.	.	.
29	2013/14	-	-	148	148	7,415
30	2014/15	-	1,173	"	1,321	7,415
31	2015/16	-	1,173	"	1,321	7,415
32	2016/17	-	1,178	"	1,326	7,415
33	2017/18	-	-	"	148	7,415
.	.	.	-	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
55	2039/40	-	-	148	148	7,415

IRR : 14.6 %

Table L-13 Estimated Operation, Maintenance and Replacement Cost After Completion of the Project

Year		Operation and Maintenance Cost(Rp.10^6)	Replacement Cost (Rp.10^6)
1	(0 %)	0	
|		|	
4	(0 %)	0	
5	(17 %)	26	
6	(50 %)	178	
7	(83 %)	129	
8	(100 %)	156	
|		|	
32		156	1,205
33		156	1,205
34		156	1,210
|		|	
57		156	
Total		8,033	3,620

Estimated Annual Operation and Maintenance Cost (Breakdown of Rp. 156 x 10^6)

Item		Amount (Rp.10^6)
Dredging work (once for 5 years = 30,000 m^3)		25
Pumping station (100 hrs operation)		15
Dike and bank protection		30
Machinery		
Dump truck	2 nos	
Tire roller	1 set	40
Backhoe	1 set	
Car	2 nos	
Office running cost including staffs for office		20
Miscellaneous		26
Total		156

Fig. L-1 Construction Time Schedule (7-year plan)

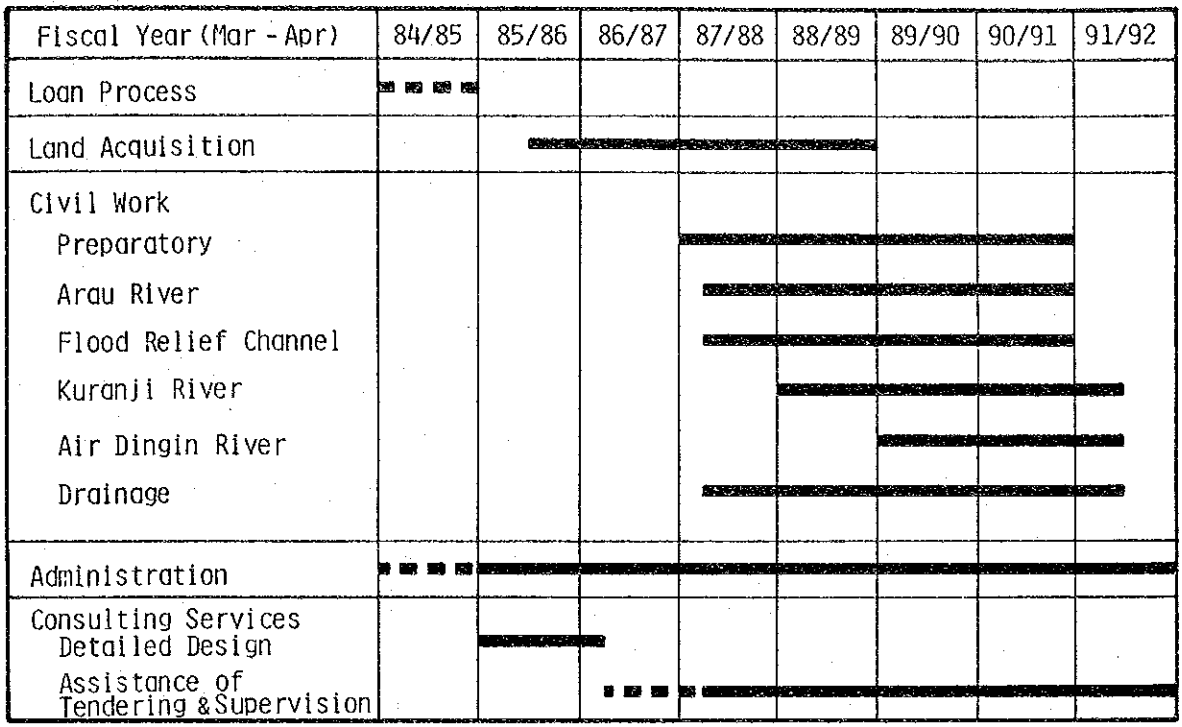
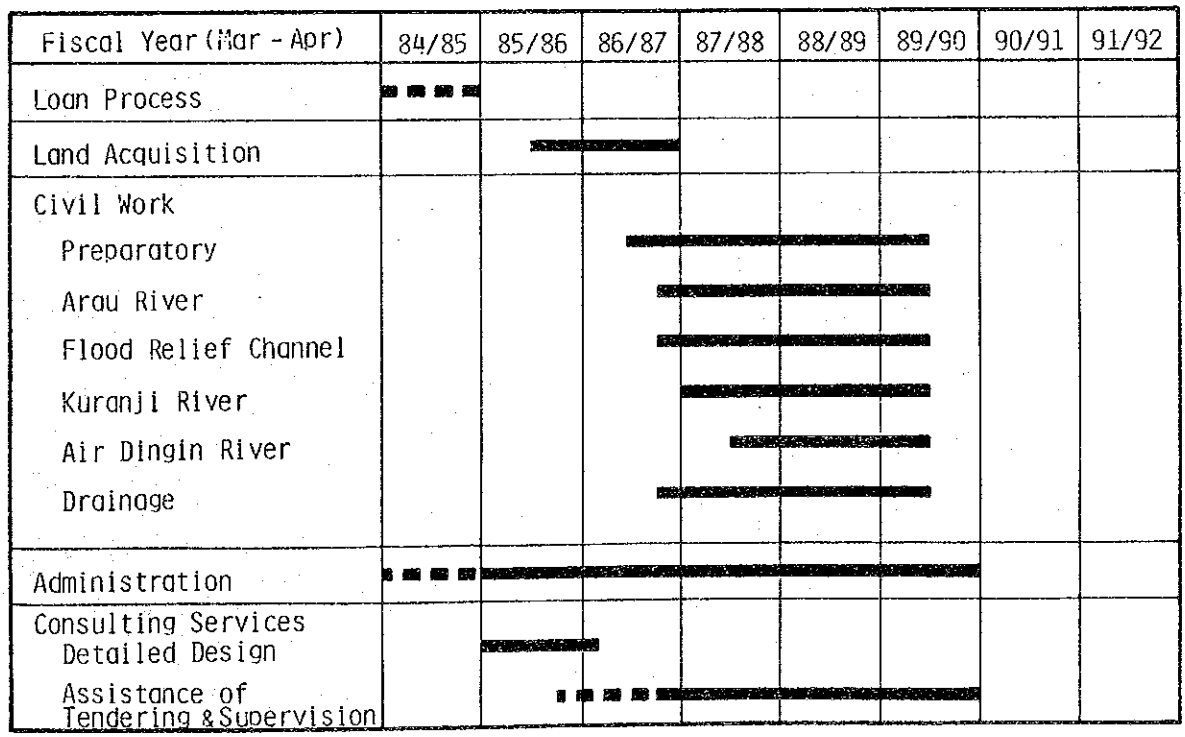


Fig. L-2 Construction Time Schedule (5-year plan)



APPENDIX M

ECONOMIC EVALUATION
FOR
URGENT FLOOD CONTROL PROJECT

APPENDIX M

ECONOMIC EVALUATION FOR URGENT FLOOD CONTROL PROJECT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. General

The economic evaluation is made using the economic benefit and cost. The urgent flood control project is planned to be commenced in 1985/86 fiscal year and to be completed in 1991/92. The economic benefit is therefore estimated under the condition in the year of 1991.

The economic construction cost is taken by deducting tax and contractor's profit from the local currency portion of the construction cost. For evaluation, the project life is assumed at 50 year after completion of the construction works.

This APPENDIX presents the results of economic evaluation for the urgent flood control project.

2. Economic Cost

2.1 Economic Construction Cost

For estimation of economic cost, the tax is applied at a rate of 4 % including income and sales taxes. The contractor's profit is applied at 10 % which is usually applied in the similar project.

The economic cost is estimated at Rp. $43,678 \times 10^6$ as shown in Table M-1, and yearly distribution of annual economic cost is shown in Table M-2.

2.2 Economic Cost for Operation, Maintenance and Replacement

The annual economic operation and maintenance cost is assumed at Rp. 150×10^6 which is 0.5 % of the total economic construction cost.

Facilities made of metal such as pump plant and gate are planned to be replaced once in the period of the project life. The replacement period is assumed at 3 years commencing from 25th year after completion of the construction works. The replacement cost is estimated at Rp. $3,577 \times 10^6$.

3. Benefit

Benefits are the expected reduction of flood damages for private

properties, farm crops, public facilities etc., and the expected development effect for the land which has not been utilized during the wet season is defined as enhancement benefit.

3.1 Flood Damages Reduction

Flood damages reduction is expressed as difference between with and without project. The average annual flood damages without project is Rp. 7,160 × 10^6 as described in APPENDIX G. On the other hand, reduction of the flood damages with project is estimated at Rp. 5,895 × 10^6 in the value of average annual. Reduction of the damages for each block are shown below.

(Unit: Rp. 10^6)

Block/river	Damages without project	Damages reduction with project
Block 1 / Arau main stream	2,630	2,175
Block 2 / Jirak river	80	48
Block 3 / interia water area	2,570	2,270
Block 4 / Kuranji main stream	680	578
Block 5 / Balimbing and Laras river	390	243
Block 6 / interia water area	380	208
Block 7 / Air Dingin river	460	373
Block 8 / interia water area	30	0
Total	7,160	5,895

3.2 Enhancement Benefits

At the present time, Padang has a need for taking residential area owing to high population growth as mentioned in APPENDIX C. The urgent flood control project will give an effect for land development in the area to be protected from floods, so that the area may be used as residential quarter in the future with the project.

Usually, these kind of enhancement of land use by a project such as flood control is to be taken as one of enhancement benefits. For converting the enhancement effects, into the monetary term, a rental

value of land is usually used so that the effects can be counted in monetary term as a benefit.

The enhancement benefit as development of land use is estimated by the following equations.

$$P_{Ra-Rb} = (P_a - P_b) \times N \times R \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$B = P_{Ra-Rb} \times A \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where, P_{Ra-Rb} : difference of rental value yielded by improvement of environment for living

P_a : land value after project is implemented

P_b : land value before project is implemented

N : rate of rental value to land value. (the rate of 1/12 is applied on the basis of Feasibility Study of Kampung Improvement Program of Padang)

R : increasing ratio (25 %) of rental value after improvement of environment for living

B : enhancement benefit

A : housing area (ha)

Using the above equation (1), unit difference amount of rental value with and without projects is given. Then multiplying the housing area with unit difference amount by equation (2), total difference amount is given as the enhancement benefit in case of with project.

Land value

Site investigation is made for collection of land price data. The data is used for modifying the standard land price guided by the Agrarian Office of Padang city. The result is shown in Table M-3 and Fig. M-1.

Housing area

The area which would be developed to be use for housing is assumed based on the information from Padang city office and based on the data on actual housing program obtained from the office of National Housing

Program (PERUMANAS) of the Ministry of Domestic Affairs and several private developers as mentioned in APPENDIX C.

As a result of estimation mentioned above, the enhancement benefits for respective return periods are estimated as shown in Table M-4 and the annual average enhancement benefits are shown in Table M-5 respectively.

The estimated average annual enhancement benefit with project is Rp. 1,167 × 10^6 for the whole mainstream and Rp. 277 × 10^6 for the tributaries respectively.

3.3 Average Annual Benefit

The average annual benefit with urgent flood control project is estimated at Rp. 7,339 × 10^6 as a total of reduction of flood damages and enhancement benefit mentioned above.

4. Comparison of Cost and Benefit

Flow of the economic costs and benefits is shown in Table M-6. Based on this flow, cost-benefit analysis is made. The internal rate of return (IRR) is calculated at 14.7 %. The benefit-cost ratio (B/C) is calculated at 1.24 at discount rate of 12 %.

5. Sensitivity Test

Sensitivity of IRR of the project has been examined adopting increase in cost and decrease in benefit. The results of sensitivity test are summarized in Table M-7 which shows the value of IRR of the project exceeds 12 % even if the cost goes up by 20 % or the benefit comes down by 20 %. The results of comparison of cost and benefit are graphycally shown in Fig. M-2.

Table M-1 Economic Cost for Urgent Flood Control Project

Item	Construction cost						Economic cost
	L.C				F.C		
	Const. cost	Deduction factor Tax/1 (%)	Deduction factor Profit/2 (%)	Economic cost	Const. cost	Equiv./3 in Rp.	
	($Rp.10^6$)	($Rp.10^6$)	($Rp.10^6$)	($Rp.10^6$)	($US\$10^3$)	($Rp.10^6$)	($Rp.10^6$)
1. Land acquisition	1,820	-	-	1,820	-	-	1,820
2. Civil works							
(1) Earth works	5,391	216	518	4,657	13,212	12,816	17,473
(2) Structure works	4,236	169	407	3,660	9,568	9,281	12,941
Sub-total	9,627	385	925	8,317	22,780	22,097	30,414
3. Cost for engineering and administration	2,085	83		2,002	5,681	5,511	7,513
4. Contingency	1,354	54	130	1,170	2,846	2,761	3,931
5. Total	14,886	522	1,055	13,309	31,307	30,369	43,678

/1 : rate of tax : 4 %

/2 : rate of contractor's profit : 10 %

/3 : US$ 1 = Rp. 970

Table M-2 Yearly Distribution of Economic Construction Cost for Urgent Flood Control Project

Unit : Rp. 10^6

Item	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	Total
Loan Process									
Land acquisition			607	607	606	-	-	-	1820
Civil works				4544	6992	8390	8390	2098	30414
Administration		286	286	286	286	286	286	286	2002
Engineering		919	230	689	919	918	918	918	5511
Sub-total		1205	1123	6126	8803	9594	9594	3302	39747
Investment rate (%)			2.7	15.3	22.0	24.1	24.1	8.5	100.0
Contingency		118	111	605	869	951	951	326	3931
Total economic cost		1323	1234	6731	9672	10545	10545	3628	43678

Replacement cost : 3,577

O.M cost : 150

Table M-3 Land Value of the Objective Area

Unit: Rp/m^2

Zone/Class	Commercial area	Industrial area	Residential area	Agricultural land
- Zone : A				
Class I	200,000	-	60,000	-
Class II	100,000	-	40,000	-
Class III	60,000	-	20,000	-
- Zone : B				
Class I	60,000	30,000	40,000	6,000
Class II	40,000	20,000	30,000	3,000
Class III	20,000	10,000	15,000	1,500
- Zone : C				
Class I	25,000	20,000	20,000	3,000
Class II	20,000	10,000	10,000	1,500
Class III	10,000	5,000	5,000	1,000
- Zone : D				
Class I	10,000	5,000	4,000	1,000
Class II	5,000	3,000	2,000	750
Class III	2,500	1,500	1,000	500
- Zone : E				
Class I	-	-	1,500	500
Class II	-	-	1,000	250
Class III	-	-	500	100

Source : Agrarian office of Kotamadya Padang.

Remarks: This table corresponds to the Map of Land Value attached later "Fig. M-1".

Table M-4 Enhancement Benefit for Respective Return Periods

Unit : Rp. 10^6

Block	Return period					
	2 - yr	5 - yr	10 - yr	25 - yr	50 - yr	100 - yr
A. Arau river system						
Block 1 : Arau mainstream (incl F.R.C.)	0	947	1,418	1,418	1,418	1,418
Block 2 : Jirak river	0	650	650	650	650	650
Block 3 : Interior drainage area	0	0	0	0	0	0
Sub-total	0	1,597	2,068	2,068	2,068	2,068
B. Kuranji river system						
Block 4 : Kuranji mainstream	0	1,770	2,150	2,150	2,150	2,150
Block 5 : Balimbing and Laras river	0	384	763	763	763	763
Block 6 : Interior drainage area	0	0	0	0	0	0
Sub-total	0	2,154	2,913	2,913	2,913	2,913
C. Air Dingin river system						
Block 7 : Air Dingin river	0	915	976	976	976	976
Block 8 : Interior drainage area	0	0	0	0	0	0
Sub-total	0	915	976	976	976	976
Grand total	0	4,666	5,957	5,957	5,957	5,957

Table M-5 Annual Average Enhancement Benefit in Case of with Project for Urgent Plan

River	Return period (year)	Exceedance	Difference of exceedance	Damage (Rp.10^6)		Annual damage (Rp.10^6)	
				Amount	Mean	Segment	Cumulative
Arau river system	1	1.000	-	0	-	-	0
	2	0.500	0.500	0	0	0	0
	5	0.200	0.300	1,597	799	240	240
	10	0.100	0.100	2,068	1,833	183	423
	25	0.040	0.060	2,068	2,068	124	547
	50	0.020	0.020	2,068	2,068	41	588
	100	0.010	0.010	2,068	2,068	21	609
Kuranji river system	1	1.000	-	0	-	-	0
	2	0.500	0.500	0	-	0	0
	5	0.200	0.300	2,154	1,077	323	323
	10	0.100	0.100	2,913	2,534	253	576
	25	0.040	0.060	2,913	2,913	174	750
	50	0.020	0.020	2,913	2,913	58	808
	100	0.010	0.010	2,913	2,913	29	837
Air Dingin river system	1	1.000	-	0	-	-	0
	2	0.500	0.500	0	0	0	0
	5	0.200	0.300	915	458	137	137
	10	0.100	0.100	976	946	95	232
	25	0.040	0.060	976	976	59	291
	50	0.020	0.020	976	976	20	311
	100	0.010	0.010	976	976	10	321

Table M-6 Economic Cost and Benefit Flow for Urgent Flood Control Project

Unit: Rp. 10^6

Year in order	Year	Economic cost				Benefit
		Construction cost	Replacement cost	O & M cost	Total	
1	1985/86	1,323	-	-	1,323	-
2	1986/87	1,234	-	-	1,234	-
3	1987/88	6,731	-	-	6,731	-
4	1988/89	9,672	-	-	9,672	-
5	1989/90	10,545	-	25	10,570	1,223
6	1990/91	10,545	-	75	10,620	3,669
7	1991/92	3,628	-	125	3,753	6,116
8	1992/93	-	-	150	150	7,339
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
31	2015/16	-	-	150	150	7,339
32	2016/17	-	1,191	150	1,341	7,339
33	2017/18	-	1,191	150	1,341	7,339
34	2018/19	-	1,195	150	1,345	7,339
35	2019/20	-	-	150	150	7,339
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
57	2041/42	-	-	150	150	7,339

Table M-7 Sesitivity of IRR

Assumption	IRR
1. Base estimate	14.7
2. Cost : + 10 %	13.4
3. Cost : + 20 %	12.4
4. Benefit : - 10 %	13.3
5. Benefit : - 20 %	12.0
6. Cost +20 % & Benefit - 20 %	10.2

Fig. M-1 Land Value of the Objective Area

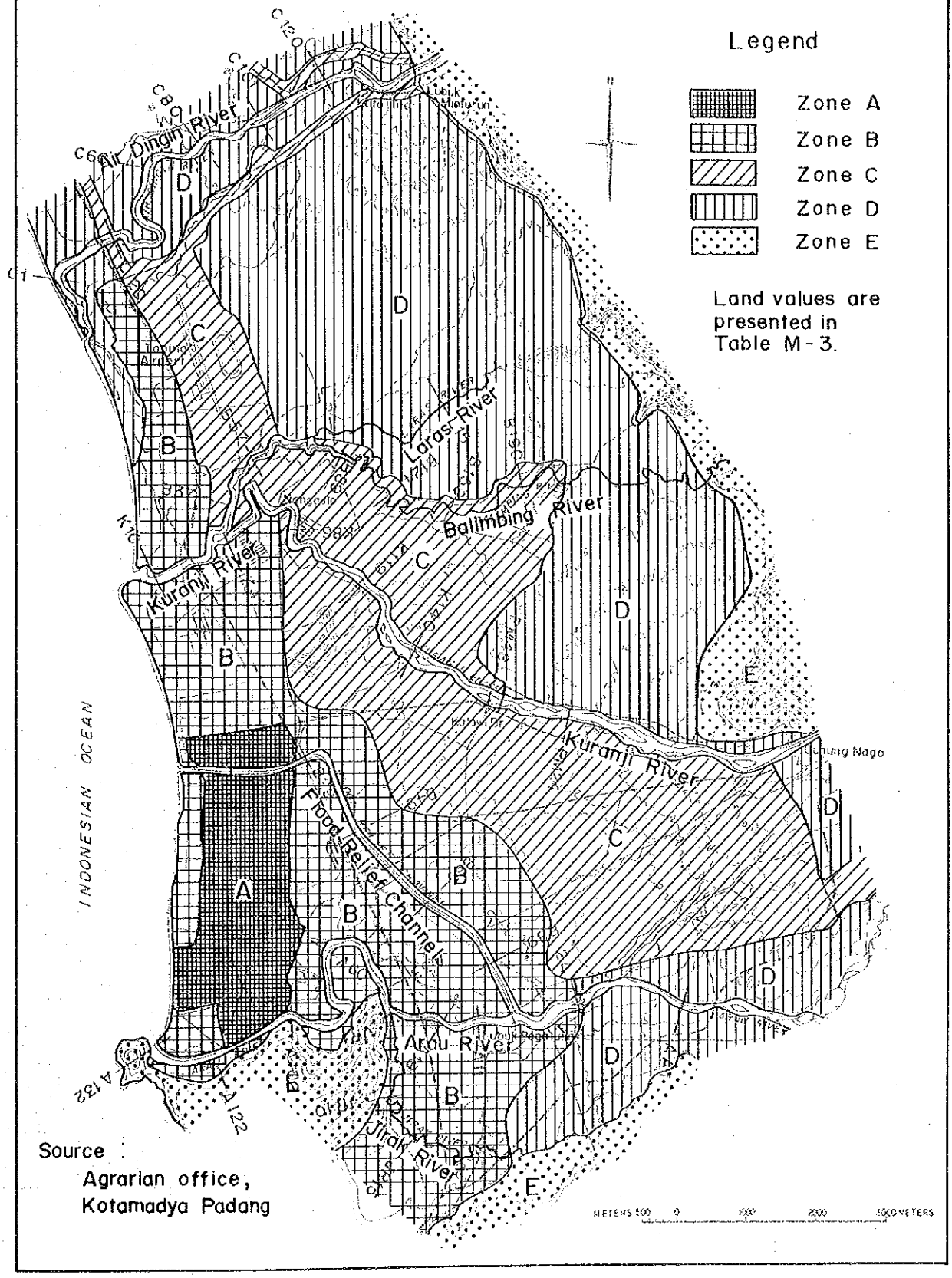
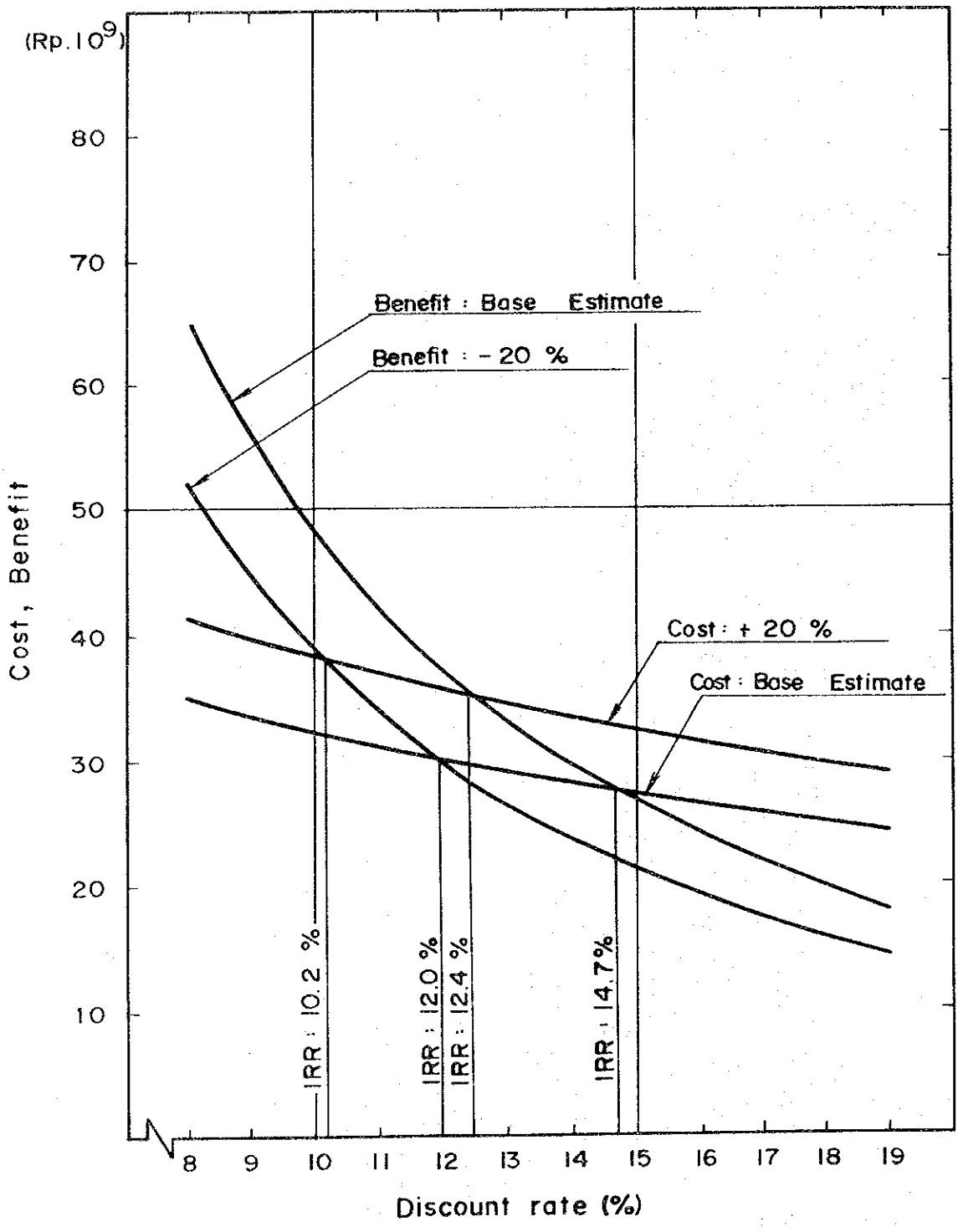


Fig. M-2 Sensitivity of IRR of Urgent Flood Control Project



APPENDIX N

LAND CONSERVATION

APPENDIX N

LAND CONSERVATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF ANNEX

1. General

This is a reconnaissance report on the land conservation problems of the Arau, Kuranji and Air Dingin river basins. The present study aims at grasping the existing land conservation problems and giving some considerations on them.

For the convenience of description, the study area is divided into three, i.e., upper basin, plain area, and Padang coast. The upper basin is the non-cultivated mountainous area in the upper reaches of the object rivers. The plain area is the cultivated or urbanized lands on the volcanic fan, alluvial fan and coastal plain. The Padang coast is the coastline stretching between the river mouths of the Arau and Air Dingin.

2. Upper Basin

2.1 Present Condition

Geology

According to a geological map published by Directorat Geology, the upper basin is mainly covered with the Tertiary volcanic rocks consisting of conglomerate, tuff, andesite and basalt. The Pretertiary metamorphic rocks consisting of phyllite, quartzite and limestone are found in and around Indarung.

Soil covers on these rocks seem to be thin. Exposed rocks are seen in places from the road at the foot of the mountainous area connecting Indarung to G. Nago and Lb. Minturun.

Vegetation

Since the area is mountainous, the accessible areas are limited. The conditions of vegetation and land erosion are inspected by topographic maps, aerial photos and visual observations from airplane as well as site inspections on land.

The vegetation of the upper basin seems to be fairly good. No collapse is found on the mountain slopes.

Most of these mountainous areas are specified as conserved forest (hutan cadangan) by the governmental office of the Forestry Services (Dinas Kehutanan), West Sumatra as shown in Fig. N-1. The western mountainous area between the conserved forest and plain area is privately owned lands. Some portions of the private forest are being replaced by the clove plantations such as in Gunung Padang near the Arau river mouth and upstream areas from Lb. Minturun.

River Channel

Channel conditions of the object three rivers and their tributaries are inspected at their outlets from the mountanous area. The channels are observed to be stable covered with large boulders transported, possibly, by the eruptions of volcanos. Sediment from the mountainous area transported into the plain area by these channels seems not much.

2.2 Recommendation

Since no collapse is found in the mountainous areas and sediment yield seems not much, land erosion control in the upper basin is not deemed to be necessary.

From the viewpoint of flood control in the plain area, the existing forest has contributed to the reduction in peak runoff by storing rainfall and retarding the runoff. If the forest were devastated, the flooding in the plain would be more destructive than ever.

In some parts of the private forest, the clove plantations are developing. The clove tree needs the clearing of the ground surface because of its growing nature, which might reduce the existing water storage function and the land would be unfortified against erosion. The development of clove plantation should be implemented in due consideration of these adverse effects.

In order to maintain the land and water conservation funcitons of the existing upper basin, it is recommendable to conserve the forest by the properly arranged land use regulation. The regulation is duly necessary in the private forests adjacent to the developed plain area to prevent the land erosion and the destructive mud flow.

Andalas University has an idea to construct a model forest for the conservation of forest environment and education of natural science, using Kebun Raya Setia Melia (KRSM) of which administration and maintenance has been transferred from the Government. The KRSM-scheme is expected to contribute to promote the forest conservation, although the scheme is still on the conceptional level.

3. Plain Area

3.1 Present Condition

Channels in Volcanic Fan

The plain area covers the volcanic fan, alluvial fan and coastal plain. According to the topographic maps, aerial photos and surveying results, the river channels in the volcanic fan are braided in their course or flat and wide river beds. In addition, the main stream course is changeable.

The major land conservation problem in the volcanic fan stretches is bank erosion.

Channels in Alluvial Fan and Coastal Plain

On the other hand, the river channels in the alluvial fan and coastal plain meander in places eroding the river banks. Because of milder channel slope, the flood runoff from the upper basin often overflows in the plain. In the coastal plain, sand spits formed by tide and wave actions may interfere in gravity drainage and forms back swamp areas which inevitably have difficulty of local drainage.

The major problems in the alluvial fan and coastal plain are bank erosion, flooding of river water and inundation due to local storm.

River Bed Lowering

In the alluvial fan, the lowering of river bed is remarkable especially in the Arau river near Kp. Baru and the Air Dingin river near Kp. Koto Tuo. The exploitation of river bed materials is also active in these stretches.

Judging from the channel conditions and verbal information from the neighboring people, the river bed lowering may be caused by both the stream flow and the exploitation of boulders. It is quite possible that the sediment transported by stream flow is accelerated by removal and disturbance of boulders which armor the finer materials beneath them.

In the rivers of primitive condition, the lowering of river bed may not cause the substantial damage, on the contrary it may increase the channel flow capacity. However, in such rivers in urban area as the Arau, Kuranji and Air Dingin the river bed should be stabilized so as to prevent the damage of river structures such as revetments, drop structures, bridges, siphons, etc, and to ensure the stable water supply for irrigation, municipal and industrial uses.

3.2 Countermeasures

The major problems in the plain area are the erosion of lands and flooding. In order to mitigate damages due to the erosion and flooding, flood control works are to be conducted. The details of the flood control measures are discussed in other appendices. So as to maintain the flood control facilities, stabilization of river bed is also taken into account.

The existing river channels are not provided with the diking systems to confine the flood water within the designed river area. With regard to the erosion control, revetment and groyne works have been executed

by the DPU, West Sumatra to prevent stream flow from eroding the public roads and village areas. The works are mostly by the stone baskets (beronjong) and they are successfully functioning.

4. Padang Coast

4.1 Present Condition

The present conditions of the Padang Coast are shown briefly in Fig. N-2. Further descriptions are given below for respective stretches.

Coast between Arau River and Flood Relief Channel

According to a series of reports, Masalah Pantai Padang, prepared by DPU, West Sumatra, erosion of coastline of this portion is reported to have occurred after the completion of the flood relief channel. Coast erosion at Wisma Panca Sila is shown in Fig. N-3. The wisma was located around No. 5 Jetty. According to the figure, the coastline regressed 67 m during 31 years from the year 1938 to 1969. The annual regression rate is, thus, about 2.2 m/year. The erosion become active, in general, twice a year in July/August and November/December.

The substantial erosion control works were started in 1968 and are still ongoing now. The progress of the works is shown in Fig. N-4. As seen in the figure, the erosion control works mainly consist of jetty works and supplying sand except for sea wall works which were executed in earlier stages.

Lately, Final Report on Inspection and Investigation Works of Deposition Effects of Jetties in Padang Coast (Final Report Pekerjaan Pengamatan dan Penelitian Krib Terhadap (Pengaruh) Endapan Pantai Padang) was prepared in 1983. According to the report, the coastline surveyed in 1983 advanced in the southern and northern stretches and regressed in the central stretches in comparison with the survey results in 1977.

The coast erosion in this stretch seems to be neutralized, as a

whole due to the effects of the jetties. However, an incessant effort to maintain the present coastline may be required, since the coastline in this stretch seems to have inherent nature of regression.

Coast between Flood Relief Channel and Kuranji River

The coastline is regressive for the whole stretch except the left bank of the Kuranji river mouth where the coral reef is exposed and maintains the coast stable. According to the verbal information on site, the coast regressed by around 20 m during these 20 to 35 years.

At Kp. Purus Atas near the river mouth of the flood relief channel, people said that the coastline had regressed by around 25 m during the past 20 years. The sea water encroaches close to the village houses. Trees and other plants in the garden are hurted by salt water.

At Kp. Kelaping Ulak Karang, people told that the erosion of coastline had become active since 1957. The lands were eroded around 20 m by now and the erosion was still ongoing. On the lands eroded, there had been a row of village houses and three rows of coconut trees. Some vestiges of former village houses and trees are found there.

At Kp. Pasir Ulak Karang, the coastline is said to have regressed by around 20 m during these 30 to 35 years. The old coconut trees which already died or are about to die exist on the seashore showing the encroachment of sea water.

At the river mouth of the Kuranji, the left bank pushes out about 300 m to open sea compared with the right bank. Since the left bank is formed by a coral reef, the bank has not suffered from erosion.

Coast between Kuranji and Air Dingin Rivers

Based on the site reconnaissance and verbal information given on site, the coastline in this stretch is considered advancing as a whole. In the southern half of this stretch, new housing areas are developing on the newly created lands.

At Kp. Air Tawar and Kp. Air Tawar Barat, new housing areas are developing. All of the residents moved into during these 5 years. There is no people who know the former conditions of the coastline. However, we can see wide bare lands between the old vegetated land and seashore, which may indicate the advance of coastline.

At Kp. Perupuk Tabing, people there said that the coastline had advanced continuously and the land of around 40 m width was created along the coast during past 45 years. They could indicate the coastline 45 years ago referring to the location of old trees.

At Kel. Pasir Sabalah on the right side bank of the Air Dingin river, according to the verbal information from the people, the location of the coastline about 30 years ago was about 20 m landside from the existing coast. The coast, then, advanced by about 35 m around 15 years ago. Since then the coastline has changed to regression. By now, the coast regressed by about 15 m and is still regressive.

4.2 Recommendation

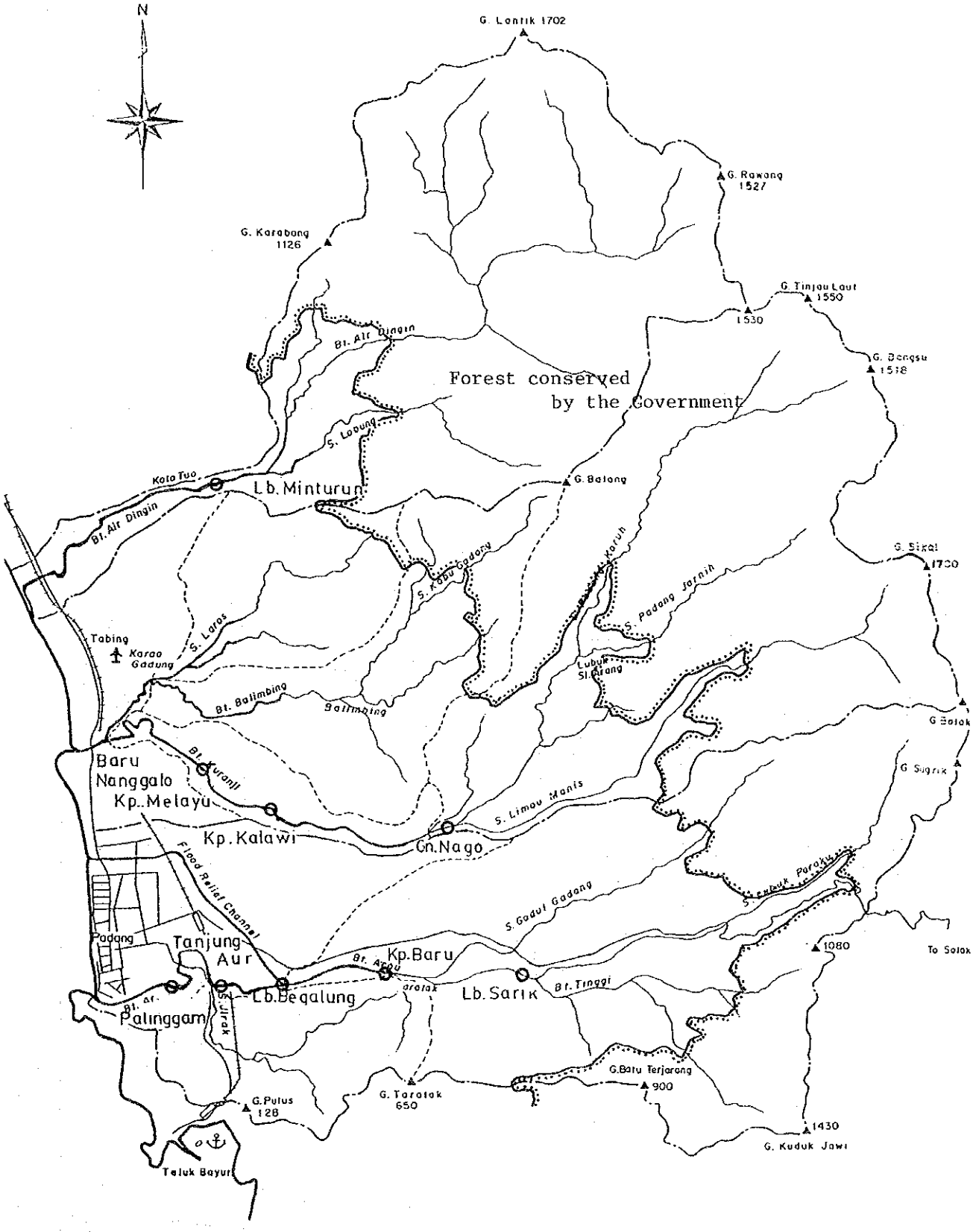
The existing Padang coast protection works are deemed to be well considered and functioning well. However an incessant maintenance effort may be necessary, as far as the coast has inherent regressive nature.

The coast protection works should be planned and designed in due consideration of results of investigation and studies on the mechanism of the erosion. Since the coastal movement is affected by many factors, the mechanism is rather complicated, which may require a variety of investigation and studies. Survey items required for coast erosion control is shown in ANNEX N-1 for reference.

DPU, West Sumatra already conducted some investigation on coast erosion and compiled them in reports. Among these, observation of waves are not included yet although the characteristics of waves are most important and fundamental data for the study on coastal problems.

It is recommendable to collect wave data in Padang coast such as wave height, wave length, wave period, wave direction, and seasonal variation of these wave characteristics. The wave height, length and period could be observed by wave height recorder installed in the offing of the Padang coast. Further descriptions on installation of the wave height recorder are given in ANNEX N-2. With regard to the observation of the wave direction, competent method and gauge do not seen to be developed yet. Gunung Padang at the river mouth of the Arau river may be convenient for visual observation of wave directions. It is also recommendable to install a station on the top of Gunung Padang to observe the meteorological conditions as well as wave direction. The meteorological observation may include the rainfall, atmospheric pressure, wind speed and direction, etc.

Fig. N-1 Conserved Forest by Government



LEGEND

: Boundary of forest conserved by the Government (Hutan cadangan)

: Basin boundary

: River channel

: Road

O : Stream gauging sta.

0 1 2 3 4 5 km

Fig. N-2 Condition of Padang Coast

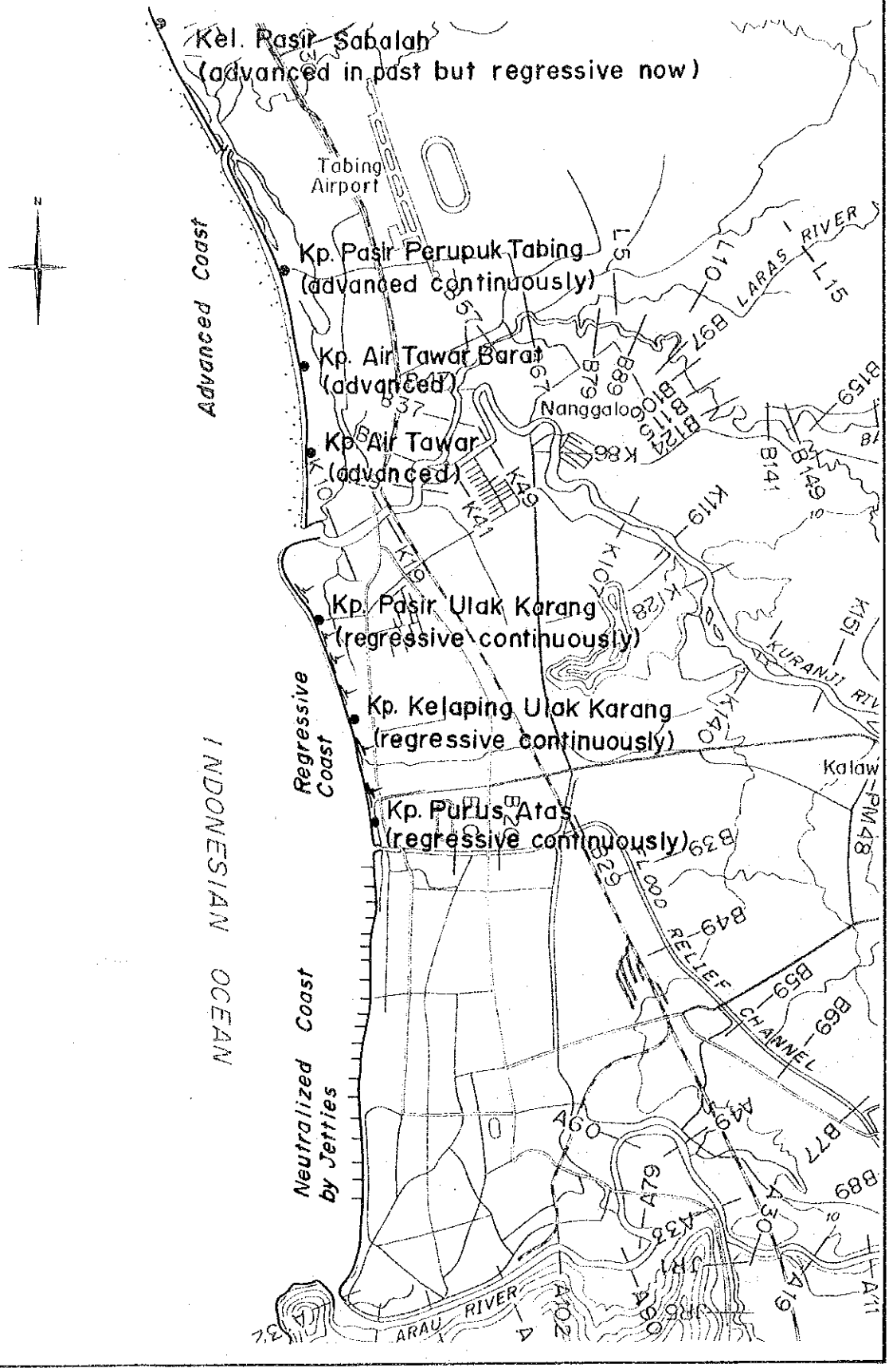
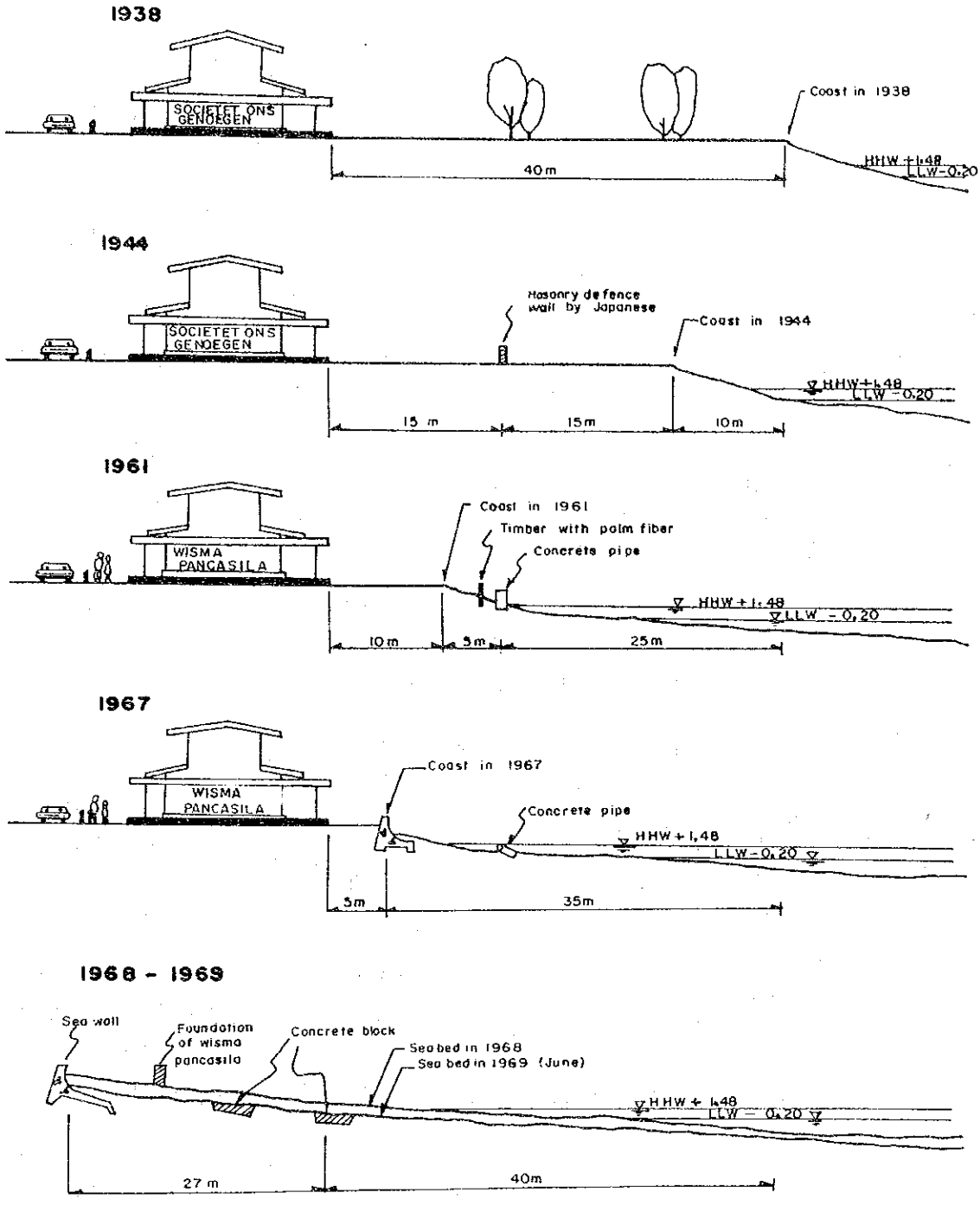


Fig. N-3 Coast Erosion at Wisma Panca Sila

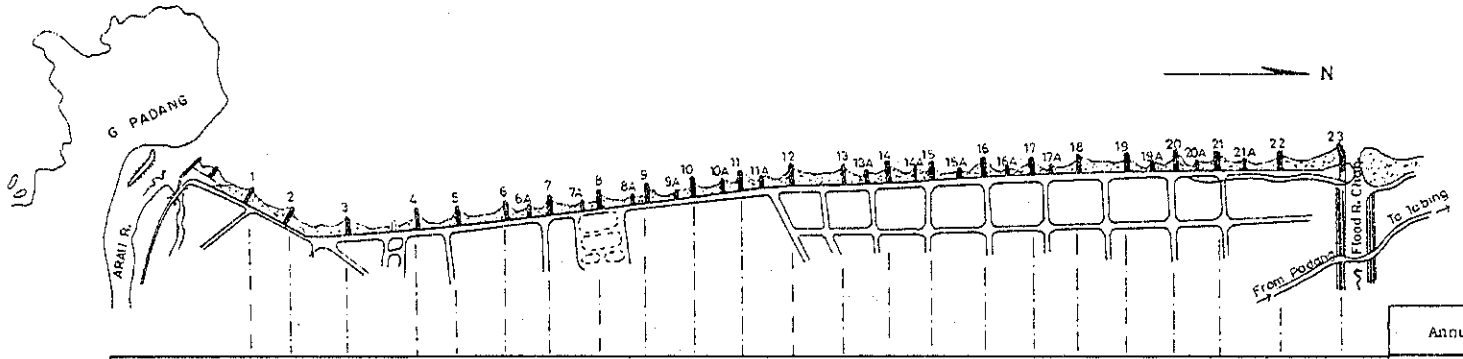


Notes

1 Erosion rate : 67 m / 31 yrs = 2.2 m/yr

2 Source : Masalah Pantai Padang ,1973 , D P U. West Sumatra

Fig. N-4 Padang Coast Protection Works



DISTANCE (M)	150	300	500	715	860	1000	1150	1300	1450	1600	1750	1960	2050	2170	2330	2500	2650	2800	2950	3100	3279	3475	3675
Jetty No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

		Annual work quantity		
		Seawall (m)	Jetty (m)	Supply sand (m^3)
1942	(Block : Dutch)	400	-	-
1944	(Block : Japan)	3,000	-	-
1964	(Temporary seawall)	485	-	-
1968/69	(Temporary seawall)	1,865	B. 160	-
1971/72		Re. 280	S. 200	-
1972/73			S. 275	-
1973/74		G. 480 Re. 150	S. 120	2,000
1974/75		Site:? Re. 120	S. 150	3,500
1975/76		Site:? G. 140	S. 105	3,000
1976/77			S. 100	3,000
1977/78			S. 95	2,000
1978/79			S. 100	Site:? 3,000
1979/80			S. 100	
1980/81			S. 100	
1981/82			S. 75	
1982/83			S. 75	

LEGEND: Jetty works, Supplying sand, Seawall works

NOTES:
G.:gabion P.V.C. Re.:rehabilitation work B.:concrete block S:stone

SURVEY ITEMS FOR COAST EROSION CONTROL

1. General

In order to select appropriate erosion control measures and protection sites, the investigation to clarify the following matters should be performed and provided for the planning and designing :

a. Historical variation of the coastline

b. Principal factors affecting the historical variation of the coastline

c. Present situation of coastline variation and its mechanism.

The investigation may consist of, mainly, the following work items, of which further descriptions are given in the succeeding sections :

a. Collection of data and information

b. Topographic survey

c. Observation of waves

d. Observation of current

e. Investigation of littoral drift

2. Collection of Data and Information

a. Topographic data : Old and new maps, survey results, aerial photos

b. Geological data

c. Meteohydrological data

d. Data showing the former conditions of the coast such as historical booklets, photos and drawings

e. Verbal information from the old residents

3. Topographic Survey

a. Installation of bench marks along the coast which will be the definite points for any surveys of the coast

b. Cross-sectional survey of the coast by direct leveling on land and sounding in the sea : The survey results are compared with the former survey results so as to know the variation of sections and to confirm the limit of sounding area.

c. Plan survey : On the plan, the location of bench mark, latest sounding results in MSL datum, shoreline at 0 m, MSL should be shown clearly.

d. Photos and aerial photos : Photos of coast taken from time to time should be compiled in a photo book with date and descriptions. Aerial photos are the valuable data showing the topographic conditions not only for those on land also for those in the sea. The aerial photos taken from a helicopter, balloon or a remote controled model aeroplane could also provide variety of information.

e. Shoreline survey : This is a plan survey of shoreline by measuring the horizontal distance from bench mark (or line connecting two bench marks) to shoreline at 0 m, MSL. The shoreline survey is adopted when the frequent and quick surveys of shoreline are needed.

4. Observation of Waves

Wave is one of the major direct causes of coast erosion. The wave is characterized by its wave height, wave length, wave period and wave direction. The characteristics of wave should be observed all the year round.

a. Wave height, length and period : Wave height recorder is used for the observation. Further description on the wave height recorder will be given in ANNEX D-2.

b. Wave direction : Competent method and gauge do not seen to be developed yet. Gunung Padang at the river mouth of the Arau river may be convenient for visual observation of wave directions.

5. Observation of Current

Coastal current due to wave actions and tidal current due to tidal movement are the major current affecting the littoral drift.

a. Coastal current : Observation by floats

b. Tidal current : Observation by current meter

c. Aerial photos also provide data on coastal and tidal current

6. Investigation of Littoral Drift

The investigation of littoral drift includes following survey and study items :

a. Bed material survey to find out the source of littoral drift and direction of its transport.

b. Tracing the movement of littoral drift by use of tracer such as glass balls, sands with fluorescent color, radioactive sands, etc.

c. Measurement of amount of littoral drift by suspended load sampler.

d. Estimation of amount of littoral drift by calculation based on wave data.

e. Estimation of sediment transported from river by sediment records and analytical method.

INSTALLATION OF WAVE HEIGHT RECORDER

1. Location of Wave Gauge

Figure D.2.1 shows the typical section of Padang coast at NO. 10 jetty section which is located at almost the center of coast between the Arau river and flood relief channel. The sea bed is relatively flat with water depth of 6 m on the stretch about 200 m to 1400 m distance from the shoreline. The point on the stretch about 200 m to 400 m distance from the shoreline on the NO. 10 jetty section seems suitable for installation of the wave gauge.

2. Wave Height Recorder

There are mainly two types of wave height recorder, i.e., stepped type and pressure type recorders.

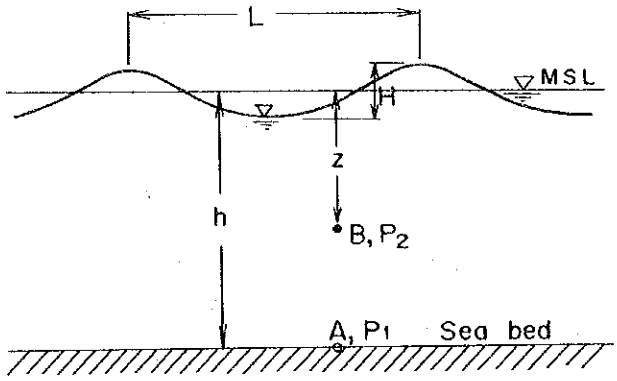
a. Stepped type : The wave gauge is installed on the water surface mounted on a tower built in the sea. Wave height is recorded directly. However, in general, building of the tower is difficult and costly.

b. Pressure type : Wave gauge is installed on the sea bed. Wave height is measured indirectly by the variation of water pressure at the sea bed. Installation of the gauge is not so difficult. However, the water pressures recorded are not always proportional to the wave heights, since the water pressure is influenced by the wave length or wave period as well as wave height as shown in the following equations :

$$H = P_2 \frac{\cosh \frac{2\pi h}{L}}{\cosh \frac{2\pi (h-z)}{L}} \qquad \text{at point B}$$

$$H = P_1 \cosh \frac{2\pi h}{L} \qquad \text{at point A}$$

$$L = \frac{gT^2}{2\pi} \tanh \frac{2\pi h}{L}$$



The pressure type wave height recorder has two types for its installation method, cable type and direct type, as shown in Fig. D.2.2. The cable type is used for a permanent wave gauge station to take continuous wave records for long period, while the direct type is for temporary use. The direct-type recorder, however, is easy to be installed and operated and not costly compared with other types of recorders. The direct-type wave height recorder is recommendable in Padang coast for the first step observation of waves.

The cost of direct-type wave height recorder is estimated around Rp. 6,900,000 (or ¥ 1,700,000) including spare parts, recording paper and other consumables for one year as shown in Table D.2.1.

The wave height recorder should be operated incorporated with tide records by automatic water level gauge installed in Teluk Bayur port under the management of Administrator Pelabuhan Teluk Bayur.

Table N-2-1 Estimated Price of Wave Height Recorder

Quantity	Description of goods	Unit price (¥)	Amount Yen (¥)	Amount Equiv. Rupiah (Rp.)
1 set.	DIRECT WAVE HEIGHT RECORDER, Pressure Type KYOWA Model: DW-III		1,071,400	4,330,200
	- Optional Accessories -			
1 pce.	Light Buoy, S-1		64,300	259,900
3 pcs.	Manila Rope, 18mm(dia.) x 20m(L.) With Shackles on both ends.	3,860	11,580	46,800
1 pce.	Manila Rope, 8mm(dia.) x 20m(L.)		3,430	13,900
3 pcs.	Anchor, Danhose Type, A-10D	37,500	112,500	454,700
2 pcs.	Spare Tube Sensor, DW-P	39,650	79,300	320,500
15 rolls.	Recording Paper, DW-3-C	7,290	109,350	441,900
2 pcs.	Recording Pen, DW-3-P	2,570	5,140	20,800
2 pcs.	Timer Pen, DW-3-T-P	1,120	2,240	9,000
30 pcs.	Dry Battery, FM-5	1,220	36,600	147,900
15 pcs.	Dry Battery, UM-2	90	1,350	5,500
120 pcs.	Dry Battery, UM-1	90	10,800	43,700
1 pce.	Spare Timer, DW-W		134,000	541,600
1 pce.	Spare Pressure Gage, 0.5 Kg/cm^2		10,700	43,200
	Total: F.O.B. JAPAN		1,652,690	6,679,600
	Ocean freight and Insurance		55,000	222,300
	GRAND TOTAL: C.I.F. JAKARTA by Seafreight		1,707,690	6,901,900

Fig. N.2.1 Typical Section of Padang Coast
(No.10 Jetty Section)

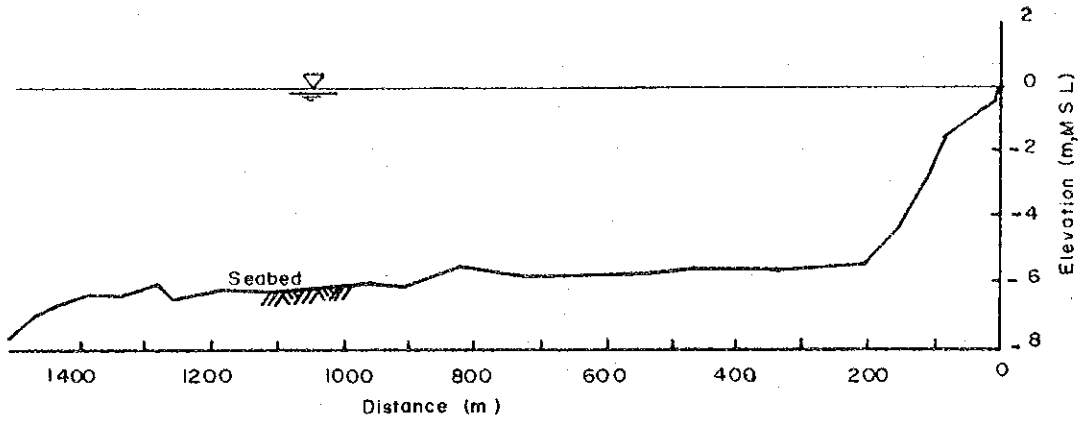
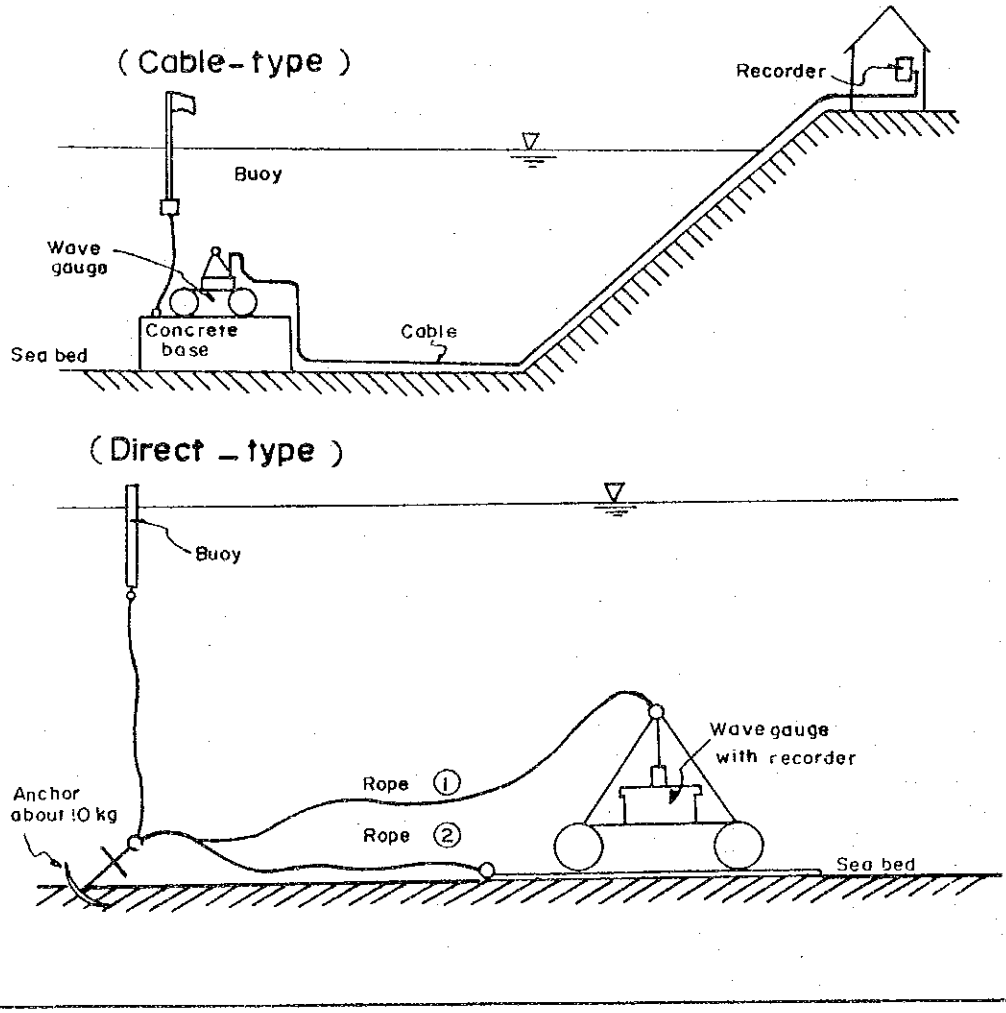


Fig. N.2.2 Installation of Pressure Wave Gauge



APPENDIX O

POTENTIALITY OF WATER RESOURCES DEVELOPMENT

APPENDIX O

POTENTIALITY OF WATER RESOURCES DEVELOPMENT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES