THE REPUBLIC OF INDONESIA

THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTHEASTERN SLOPE OF MT. SEMERU

SUPPORTING REPORT (2)

FIRST PRIORITY PROJECT

FEBRUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

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1. INTRODUCTION

The principal objectives of the Feasibility Study of Mt. Semeru Volcanic Debis Control and Water Conservation Project (hereinafter referred to as "the Study") are: i) to identify and select a promising project which would contribute in protecting the study area from future volcanic debris disasters occuring on the southeastern slope of Semeru volcano located in Kab. Lumajang, East-Java, in the Republic of Indonesia and ii) to verify its feasibility.

In May, 1982 a full-scale on-site reconnaissance, investigations, surveys, etc. for this study was commenced. JICA Study Team conducted various technical studies as well as review of the existing Master Plans. As an interim result of such on-site surveys, JICA Study Team proposed the first and second priority areas as the regions with highest priority in September, 1982. The proposal was accepted and approved by the Directorate of Rivers, Directorate General of Water Resources Development, Ministry of Public Works of the Republic of Indonesia.

Since their approval, various on-site studies, review of the existing Master Plans and analyses were carried out. Then, proposed revisions of the existing Master Plans were made by JICA Study Team. The first priority project was identified and selected out of the proposed revision, and its feasibility was verified by JICA Study Team.

This report discusses: i) the procedure employed in the selection of the first priority project area, ii) the project feature of the first priority project, iii) verification of its feasibility and iv) finally its implementation program.

2. FIRST PRIORITY PROJECT AREA

In selecting priority projects which would be effective in their early stage from a number of projects described in the Existing Master Plans for K. Mujur and K. Rejali, the following considerations were taken into account.

(1) Disaster Potentials

- Magnitude of Disaster
- Frequency of Disaster

(2) Socio-economic Potential in Disaster Area

- Population
- Agricultural Productivities
- Immovable Properties
- Public Facilities/Infrastructures

(3) Disaster Prevention Effect of Existing Works

2.1 Disaster Potential

(1) Disaster Area

JICA Study Team has prepared a map of possible disaster area in the study area, on the basis of the field investigation results. (see to Fig.-2.1)

From the map, acreage of the possible disaster area in each of the two basins of K. Mujur and K. Rejali has been described in Table-2.1.

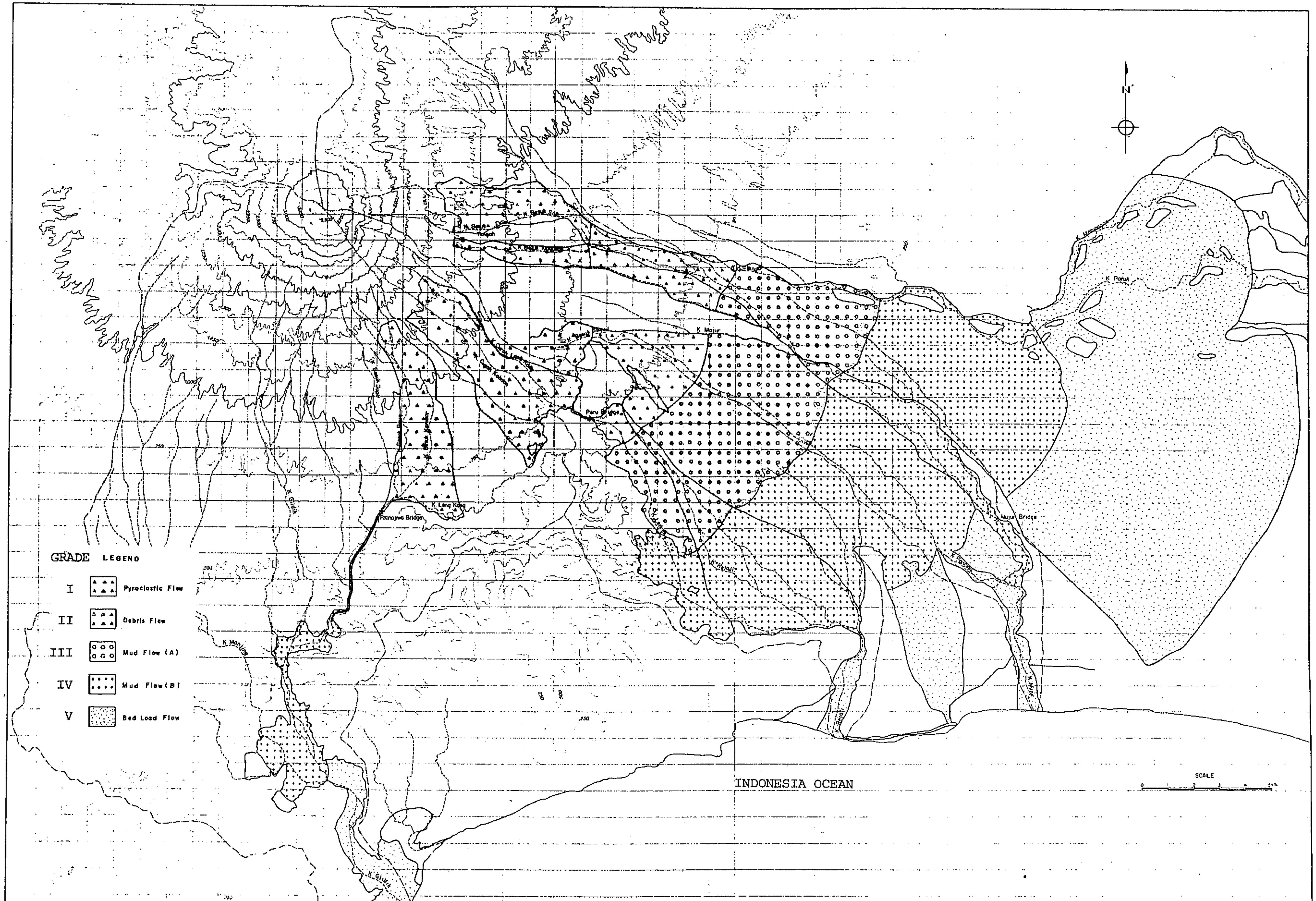


Fig.-2.1 Possible Disaster Area

Table-2.1 Possible Disaster Area

River System	Disaster Area		Percentage %
	Grade	Acreage (km^2)	
K. Mujur	I	4.60	2
	II	7.58	3
	III	34.68	14
	IV	71.00	30
	V	132.03	55
	Total	23.89	100
K. Rejali	I	9.40	18
	II	1.75	3
	III	12.04	23
	IV	26.27	50
	V	3.00	6
	Total	52.46	100

Note: Grade I : Pyroclastic flow disaster
" II : Debris flow disaster
" III: Mud flow (A) disaster
" IV : Mud flow (B) disaster
" V : Bed load flow disaster

(2) Disaster Magnitude

As an indication of a disaster magnitude, the following two sets of sediment volume are shown in Table-2.2.

① Sediment deposits of May 1981 flood estimated by JICA Study Team.

② Planned control sediment volume used in the Master Plans.

From the table, it can be ascertain that specific sediment volume of K. Rejali is about three times larger than that of K. Mujur.

Table-2.2 Sediment Volume

River System	Sediment Deposits in May '81		Master Plan	
	Total Sediment Volume	Specific Sediment Volume*	Design Control Sediment Volume	Specific Sediment Volume*
K. Mujur	1,650,000m^3	24,000m^3/km^2/flood	10,140,000m^3	2,100m^3/km^2/year
K. Rejali	1,900,000m^3	72,000m^3/km^2/flood	8,500,000m^3	6,500m^3/km^2/year

* Measured area:

K. Mujur (A=69.19 km^2) : Upper stream from confluence of K. Besuk Sat and K. Besuk Tunggeng

K. Rejali (A=26.35 km^2) : Upper stream from Curah Kobo'an No. 1 Check Dam

(3) Disaster Frequency

Fig.-2.2 is an example to compare the disaster frequency of K. Mujur and K. Rejali. This figure is prepared on the bais of past disaster records described in Master Plans.

The figure shows that the disaster frequency of K. Rejali has been increasing since 1942 after the river basin alternation of K. Rejali (because of the lava sedimentation caused by the flank eruption, B. Semut lost the upstream catchment area, meanwhile K. Rejali, by taking up the area, increased its catchment area).

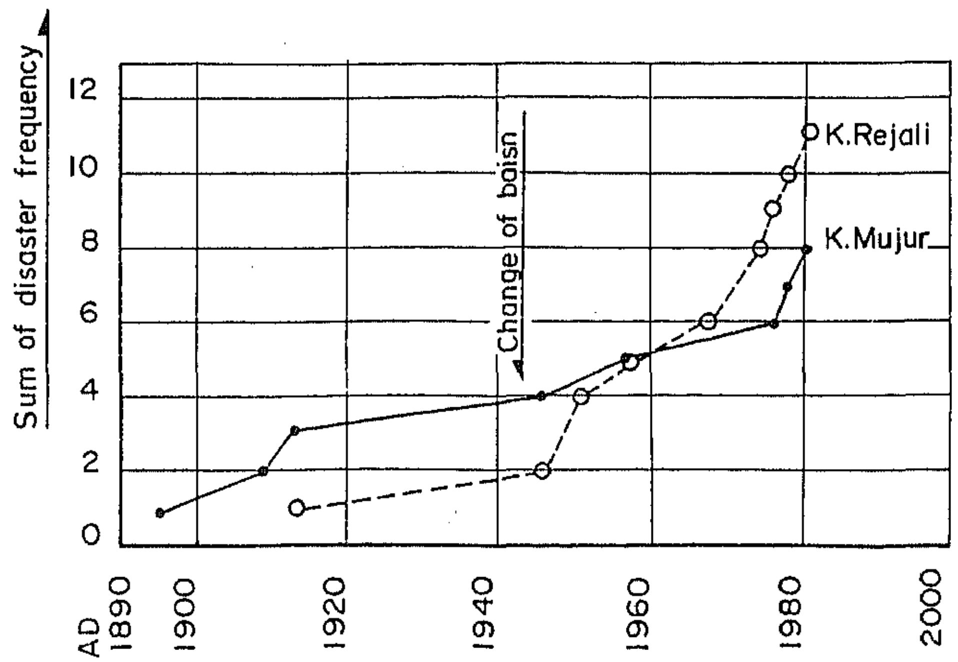


Fig. 2.2 Disaster Frequency

2.2 SOCIO-ECONOMIC POTENTIAL

① Population

On the basis of Administrative Division in Disaster Area and Table-2.5 (Disaster Area by Administrative Division), population in the disaster area is compiled in Table-2.3.

Table-2.3 Population in Disaster Area

River Systems	Population	Population Density
K. Mujur	160,000 persons	6.1 persons/ha
K. Rejali	23,000 persons	4.2 persons/ha

② Economic Potential

Agricultural productivities, immovable properties and public facilities in the disaster area must be considered as economic potential. As the basic representative data of above items, acreage of rice fields, acreage of villages and number of households are shown in Table-2.4. This table is prepared on the basis of Land Use in Disaster Area and Table-2.6 (Land Use Classification and Area).

Table-2.4 Economic Potential in Disaster Area

River System	Acreage of Rice Field (ha)	Acreage of Villages (ha)	Number of Households
K. Mujur	22,600	3,300	39,300
K. Rejali	4,400	400	5,300

Table-2.5 Disaster Area by Administrative Division

Acreage km^2
(rate)

No.	KECAMATAN	K. MUJUR							K. REJALI						
		I	II	III	IV	V	VI	Total	I	II	III	IV	V	VI	Total
1.	Lumajang				11.85 (0.16)	32.12 (0.24)	4.40 (0.20)	48.37 (0.81)							
2.	Sukodono					10.11 (0.08)	10.51 (0.49)	20.62 (0.08)							
3.	Senduro	1.67 (0.36)	2.95 (0.39)	7.15 (0.29)	4.15 (0.06)			15.92 (0.06)							
4.	Pasirian			0.40 (0.02)	5.60 (0.08)	2.05 (0.01)	2.30 (0.11)	10.35 (0.04)				21.67 (0.82)	3.00 (1.00)	1.73 (1.00)	26.40 (0.49)
5.	Tempeh			2.90 (0.12)	44.40 (0.63)	4.85 (0.04)	2.20 (0.10)	54.35 (0.21)							
6.	Candipuro	2.93 (0.64)	4.63 (0.61)	14.23 (0.57)				21.79 (0.08)		1.75 (1.00)	12.04 (1.00)	4.60 (0.13)			18.39 (0.34)
7.	Pronojiwo								9.40 (1.00)						9.40 (0.17)
8.	Yosowilungun					14.70 (0.11)		14.70 (0.06)							
9.	Kunir				5.00 (0.07)	44.95 (0.34)		49.95 (0.19)							
10.	Tekung					23.25 (0.18)	2.15 (0.10)	25.40 (0.10)							
	Total	4.60 (0.02)	7.58 (0.03)	24.68 (0.09)	71.00 (0.27)	132.03 (0.51)	21.56 (0.08)	261.45 (1.00)	9.40 (0.17)	1.75 (0.03)	12.04 (0.22)	26.27 (0.49)	3.00 (0.06)	1.73 (0.03)	54.19 (1.00)

Note:
I: Pyroclastic flow disaster
II: Debris flow disaster
III: Mud flow A disaster
IV: Mud flow B disaster
V: Bedload flow disaster
VI: Flood disaster

Table-2.6 Land Use Classification and Area

Acreage km^2
(rate)

River System	Disaster Classification	Classification of Land Use							
		Villages	Irrigated Rice Field	Unirrigated Rice Field	Estate	Unirrigated Area	Forecast	Bush	Total
K. Mujur	I	0.06	3.06	0.04	-	-	1.08	-	4.60 (0.02)
	II	0.60	4.68	0.60	0.54	-	1.16	-	7.58 (0.03)
	III	1.30	17.88	5.50	-	-	-	-	24.68 (0.09)
	IV	10.24	28.38	32.38	-	-	-	-	71.00 (0.27)
	V	19.82	75.50	36.71	-	-	-	-	132.03 (0.51)
	VI	0.72	14.78	6.06	-	-	-	-	21.56 (0.08)
	Total	32.74 (0.13)	144.28 (0.55)	81.65 (0.31)	0.54 -)	-	2.24 (0.01)	-	261.45 (1.00)
K. Rejali	I	0.20	3.28	5.00	-	-	0.92	-	9.40 (0.17)
	II	-	0.24	1.31	-	-	0.20	-	1.75 (0.03)
	III	1.08	9.14	0.84	0.24	0.50	0.24	-	12.04 (0.22)
	IV	2.44	19.18	3.33	-	0.44	0.88	-	26.27 (0.49)
	V	-	0.12	1.04	-	-	0.58	1.26	3.00 (0.06)
	VI	-	-	0.28	-	-	0.54	0.91	1.73 (0.03)
	Total	3.72 (0.07)	31.96 (0.59)	11.80 (0.22)	0.24 -)	0.94 (0.02)	3.36 (0.06)	2.17 (0.04)	54.19 (1.00)

Note:
I: Pyroclastic flow disaster
II: Debris flow disaster
III: Mud flow A disaster
IV: Mud flow B disaster
V: Bedload flow disaster
VI: Flood disaster

2.3 DISASTER PREVENTION EFFECT OF EXISTING WORKS

(1) Urgent Improvement Project

The Urgent Improvement Project financed by the O.E.C.F. loan is now being planned and scheduled to start construction in 1983. This project is designed to prevent disasters of the comparable magnitude of the one which occured in May, 1981.

- Estimated damage; approximately Rp. 8,200 million
- 365 person dead
- 1,002 houses damaged or destroyed

This project will bring about substantial effect to the K. Mujur basin when it is completed in 1985.

(2) Number of Sediment Control Works

As an indication of the disaster prevention effect of existing works, the number of existing sediment control works is shown in Table-2.7.

Table-2.7 Number of Existing Sediment Control Works

River System	Dam	Dike	Super Dike	Excavation	Total
K. Mujir	5	26	0	4	35
K. Rejali	4	9	3	0	16

2.4 PRIORITY PROJECTS

The Urgent Improvement Project of the highest priority is to start construction in 1983 and will bring about substantial effect to the K. Mujur basin in the near future. Therefore, the first priority should be given to K. Rejali Project and the second priority to K. Mujur due to the following considerations.

- K. Rejali would become more disaster prove than K. Mujur after the completion of Urgent Improvement Works.

- The percentage of high grade disaster zones of K. Rejali is larger than that of K. Mujur.

- In the Master Plans, specific sediment volume of K. Rejali is about 3 times as large as K. Mujur.

- The disaster frequency of K. Rejali after 1942 (alternation of river basin) is 1.6 times as often as K. Mujur.

- The total capacity of existing sediment control works of K. Rejali is considered to be lower than that of K. Mujur.

3. SELECTION OF ALTERNATIVES FOR FIRST PRIORITY PROJECT

3.1 POSSIBLE FACILITIES FOR FIRST PRIORITY PROJECT

Among the three basins situated in the south-east slope of Mt. Semeru, the K. Rejali basin was selected as the area for the first priority project for the following reasons: (i) the frequency of occurrence of disasters is high; (ii) the magnitude of disasters is quite extensive; and (iii) the number of existing sediment control facilities is few.

The Master Plan for K. Rejali is comprised of 1st, 2nd, 3rd and 4th steps, as shown in Table-3.1.

Table-3.1 Sediment Control Facilities in K. Rejali Master Plan

Work Step	Type of Work	Sediment Facilities: Name	Sediment Facilities: Specifications	
1st step	Sabo dam	BS. Kobo'an		
		Check Dam-3	H = 12 m	L = 58 m
		4	H = 11 m	L = 221 m
		5	H = 12 m	L = 235 m
		6	H = 23 m	L = 438 m
		7	H = 22 m	L = 170 m
		Curah Lengkong		
		Check Dam-1	H = 10 m	L = 53 m
		2	H = 18 m	L = 55 m
	Diversion work	Channel	L = 1350 m	
		K. Lengkong Check Dam-7	H = 10 m	L = 145 m
		6	H = 8 m	L = 305 m
		5	H = 8 m	L = 163 m
		4	H = 8 m	L = 170 m
		3	H = 10 m	L = 193 m
2nd step	Dike	K. Leprak Dike-12	H = 6 m	L = 280 m
		13	H = 6 m	L = 975 m
	Sand Pocket	K. Leprak Sand Pocket-1	Dike	H = 4 m L = 1050 m
			Spillway	H = 8 m L = 185 m
		K. Leprak Sand Pocket-1	Dike	H = 7 m L = 800 m
			Spillway	H = 8 m L = 820 m
		K. Leprak Sand Pocket-3	Dike	H = 3 m L = 1180 m
			Spillway	H = 8 m L = 125 m
3rd step	Dike	K. Leprak Dike-14	H = 5 m	L = 1000 m
		15	"	L = 740 m
		16	"	L = 200 m
		17	"	L = 200 m
		18	"	L = 300 m
		19	"	L = 220 m
		20	"	L = 1350 m
		21	"	L = 550 m
		22	"	L = 100 m
		23	"	L = 270 m
		24	"	L = 600 m
		25	"	L = 350 m
	River excavation		V = 367,500 m^3	
4th step	Consolidation dam	K. Leprak CD-2 - CD-22	Number of location = 21	
	Cross dike		H = 5 m	L = 2350 m

H: Height of dam or dike
L: Length of dike, dam or channel
V: Excavation volume

The sediment control facilities described in the 1st step and 2nd step in Table-3.1 are selected for the possibles of the first priority project because of the following considerations:

① Objectives of the 3rd and 4th steps are: i) defence of the regional area from disasters and ii) regional water conservation.

② Sediment control facilities in the 1st step and 2nd step would be able to control mostly the design sediment control volume under the 100 year return period plan.

Furthermore, to give concrete forms to the effects of land preservation and water conservation, the important aspects of sediment control work, additional facilities are required to the abovementioned facilities. Therefore, water conservation facility must be included in the possibles for the first priority facilities.

Consequently, the possible facilities for the first priority project are comprised of nine structures, as shown in Table-3.2 and Fig.-3.1.

3.2 ALTERNATIVES

The selection of alternatives for first priority project from among the probable facilities was made on the basis of the following considerations:

① The construction of the sediment control facilities embodied in the Master Plans should, in principle, be executed according to the implementation order given in the plans.

(2) The frequency of disasters in the K. Rejali basin has increased since 1942 when the upper stream of the BS. Semut altered the river basin to K. Rejali from K. Mujur. Because of this, it would be desirable to execute the diversion work designed to transform the present overfit situation back to the original state existing before 1942. The diversion work should take precedence of others.

(3) Acreage increase rate of the basin which inflows into K. Leprak fan in river basin alternation at 1942 was about 50% against before 1942. Therefore, sediment flood at the top of the fan will cease when 50% of the sediment discharged into the fan has been successfully controlled. After that, the construction of the planned sediment control facilities in the K. Leprak fan area can be started.

Following the above-mentioned basic policy, four alternatives should be chosen as shown in Table-3.2.

Table-3.2 Alternatives for First Priority Project

Alternative Plan No.	Scope of Work	Type of Work	Combination of Facilities	Design Scope (Probability Years)
No. 1	1st Step	Diversion	1,5,9,10	13
No.2	"	Check Dam & Diversion	1,2,3,4,5,6, 7,8,9,10	40
No.3	1st & 2nd Step	Diversion & Sand Pocket	1,5,8,9,10	50
No.4	"	Check Dam Diversion & Sand Pocket	1,2,3,4,5,6, 7,8,9,10	90

(Facility No.)	(Possible facilities)	
1	Curah Koboan Check Dam	No. 6
2	"	No. 5
3	"	No. 4
4	"	No. 3
5	Diversion Work	
	Channel	
	K. Lengkong Check Dam	No. 3
	"	No. 5
6	Curah Lengkong Check Dam	No. 1
7	"	No. 2
8	K. Leprak Sand Pocket	
9	Intake and Channel	

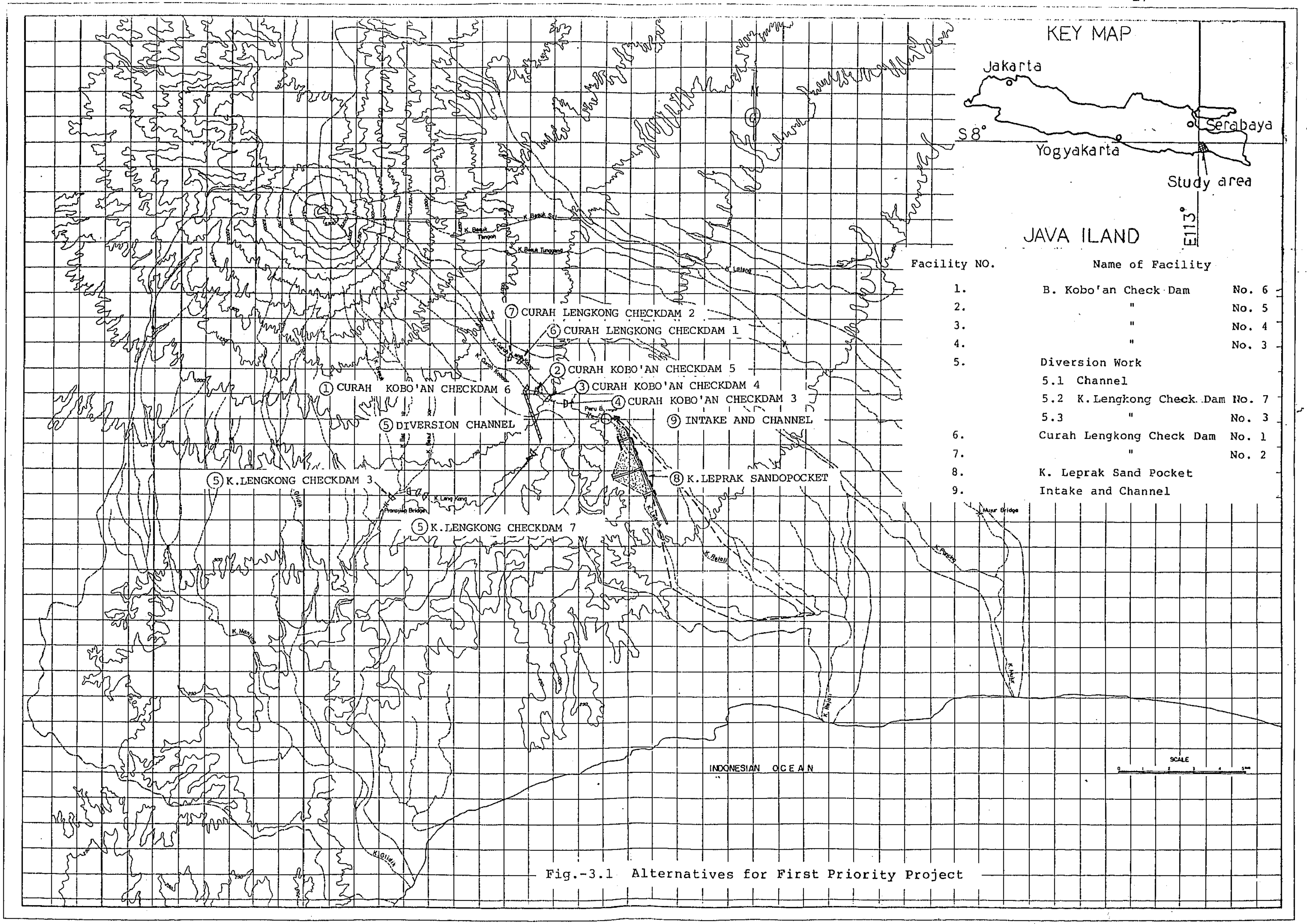


Fig.-3.1 Alternatives for First Priority Project

4. COST ESTIMATION

4.1 CONDITIONS FOR COST ESTIMATION

(1) Composition of Project Cost

The project cost consists of the following items.

① Construction Cost
- Direct Cost: Materials Cost, Machine Hiring Cost, Labour Cost
- Indirect Cost = Direct Cost x 15%
  - Preparation Works 5%
  - Overhead for contractor and tax 10%

② Land Acquisition Cost

③ Engineering Service Cost = ① x 20%

④ Government Administration Cost = ① x 4%

⑤ Contingency Reserve
- Price Escalation
  - Foreign Currency = 5%/year
  - Local Currency = 10%/year
- Physical Contingency = ① x 10%

The indirect cost is necessary expense incurred for preparation works such as a temporary construction plant, construction road, a stock yard for materials, residence, etc. The distribution ratio of indirect cost to direct cost is a ratio generally used in DPU of the Republic of Indonesia.

The land acquisition cost is necessary expense incurred to purchase land for construction of facilities as well as to pay compensation for stopping cultivation because of the said facilities.

The engineering service cost is necessary expense incurred for design works, preparation of tender documents, procurement works and construction supervision. The distribution ratio of this cost to construction cost was determined after carefully considering a concrete engineering services. (Refer to Appendix-10)

The government administration cost is necessary expense for project management by the government during the execution of the construction works. The distribution ratio of this cost to construction cost was determined after carefully considering the figures from past record of Mt. Semeru Project Office.

The physical contingency cost was set at 10% of the construction cost based on nature and scope of the project as well as on past exepriences. The contingency cost against price escalation, in foreign and local currency portions, was determined on the basis of records of past general price rises.

(2) Conditions of Cost Estimation

The unit price and computation method employed in the cost estimation is described below.

① After a rough design of each facility was made, the cost estimate was calculated on the basis of unit cost of materials, labour cost in Lumajang Prefecture of East-Java of Indonesia. The unit price is shown in Annex-2.

② The labour efficiency was determined on the basis of DAFTAR ANALISA UPAN DAN BAHAN (BOW) which Directorate River, DGWRD, DPU of the government of the Republic of Indonesia uses.

③ The hire cost for machinery was determined on the basis of "P-5 EDISI I" which Directorate River, DGWRD, DPU of the government of the Republic of Indonesia uses.

④ The cost of those materials and machinery, unavailable in Indonesia, was calculated by using the spot price estimate based on the C.I.F. price at Surabaya.

4.2 ROUGH DESIGN AND QUANTITY

4.2.1 Design Standard

For the purpose of computing a construction cost, a rough design of possible facilities was prepared on the basis of the following standard and examples.

(1) Check dam: Consolidation dam — Technical Standard for River and Sabo Works in Japan (Edited by River Bureau, Ministry of Construction in Japan, hereinafter referred to as "the Standard") The material for a dam body, however, shall be masonry concrete which is employed by Mt. Semeru Project Office at present. The method contributes in lowering the construction cost as well as decreasing the amount of heat generated from concrete, thereby minimizing the occurrence of cracks in concrete.

(2) Dike and Sand Pocket: Working examples in both Japan and the Republic of Indonesia were adopted as reference.

(3) The 1/2000 topographic maps, provided by the government of Indonesia, were used to design. For areas without any existing topographic maps, the newly obtained results of a simple survey, carried out by JICA Study Team, were used.

4.2.2 Outline of Design

(1) Curah Koboan Check Dam No. 6

It is designed to be as high as possible in so far as topography and foundation conditions would allow, because the dam is aiming at raising the elevation of the intake of the diversion channel. It is a gravity-type concrete dam. Since the foundation ground is gravels, it shall be used jointly as an apron and a water cushion. The thickness of apron is to be 2.5 m as the sediment flow is large.

(2) Curah Koboan Check Dam No. 5
Curah Lengkong Check Dam No. 1, No. 2

These are gravity-type concrete dams with gravel foundation. Regarding water cushion and apron, the design concept is the same as for No. 6 above.

(3) Curah Koboan Check Dam No. 4

It is to raise the height of the existing check dam (Curah Kobo'an Check Dam No.1), which fortunately sits on rock foundation, by 11 m as there are only a very few available excellent dam sites with rock foundation in Curah Koboan.

The spillway is to be a gravity-type concrete dam. The left wing is to be earth dam covered with an approximately 1 m thick concrete wall. The configuration of both the spillway and wing is such as to wrap around the existing Check Dam.

(4) Curah Koboan Check Dam No. 3

It is a gravity-type concrete dam with rock foundation. The design width of the spillway is narrow at 30 m in consideration of the downstream bottleneck of the river channel.

(5) Diversion Works

The diversion works are comprised of the following three facilities.

① Diversion channel:

It is a waterway to divert all run-off sediment from Curah Koboan to K. Lengkong. The design riverbed gradient is i = 1/40; the width of channel bottom is B = 30m. To prevent erosion, the slope length of 7 m from the riverbed on both banks shall be protected by Gabion work and consolidation dams constructed at the intervals of 200 m. The design depth of the channel is 5-15 m.

② K. Lengkong Check Dam No. 7:

It is designed to regulate sediment diverted by the waterway at its outlet. It is a gravity-type concrete dam on gravel and weathering tertiary laminar foundation. To enhance the sediment tractive capacity at normal years and to effect flush out of accumulated sediment, the spillway shall have compound cross-section of low water bed and flood bed.

K. Lengkong Check Dam No. 3 (Pronojiwo Dam):

It is a base key dam to prevent erosion of Lahar deposits in K. Lengkong Fan caused by diverted running water from a diversion channel and to regulate the run-off sediment from B. Bang. It is a gravity type concrete dam on andesite foundation.

Since volcanic products "Ladu" extends as far as the immediate upstream of this damsite, its configuration is designed to be well within established standard with large enough spillway section. There is a fall created as a result of advanced erosion of the riverbed at the sub dam downstream. To prevent such further vertical erosion, the fall shall be covered with concrete.

(6) K. Leprak sand pocket

At present, the K. Leprak runs through the highest point located at the center of the alluvial fan. Therefore, if the river floods at this point, the influence is very extensive. Flood-inundated area can be decreased by shifted the watercourse to either the right or left-bank side. While, on the other hand, there will be little influence on the lower reaches if the watercourse is shifted to the right-bank side because the topography of the right bank side is mountainous. Therefore, the sand pocket should be planned to be constructed near the right bank and the sand pocket's deposit area should also be located nearer to the right bank than the alluvial fan's center.

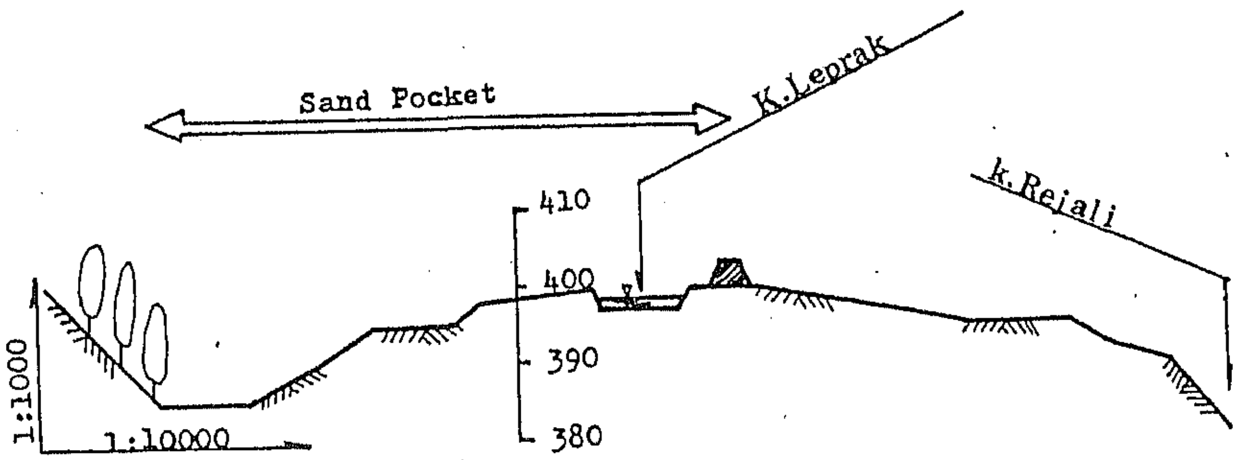


Fig.- 4.1 Cross Section of Leprak Fan

The sand pocket is comprised of three consolidation dams and dykes of 2,980 m in length. The consolidation dams are constructed to fix the direction of the water course to the present river course as well as to distribute run-off sediment in a uniform manner throughout the sand pocket. The elevation of the spillway shall be about 2 m lower than the elevation of both banks.

The consolidation dams planned at either the entrance or exist of the sand pocket shall be gravity-type concrete dams. Those consolidation dams planned in the middle of the sand pocket shall be made with rock baskets to allow for a change in the position of spillway. Thereby the efficient flush out of accumulated sediment will be promoted (Refer to Fig.-4.2).

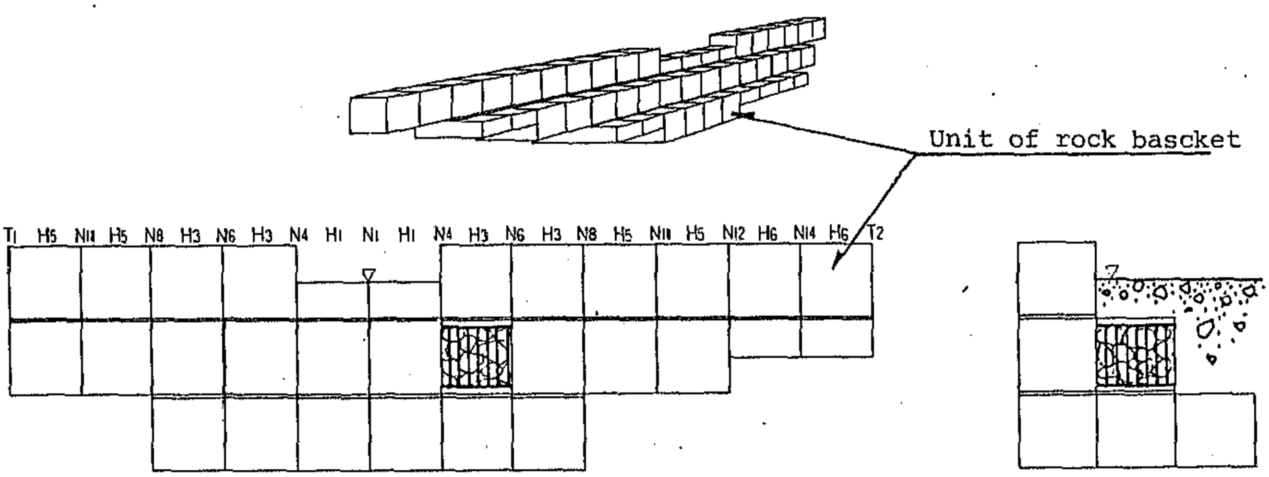


Fig.-4.2 Rock Basket

The height of a dyke at either side of the sand pocket shall be more than 3 m above the design riverbed and present surface of banks. The configuration which has been detrermined is graphically represented in Fig.-4.3 based on the structure of similar dykes found in both the Republic of Indonesia and Japan.

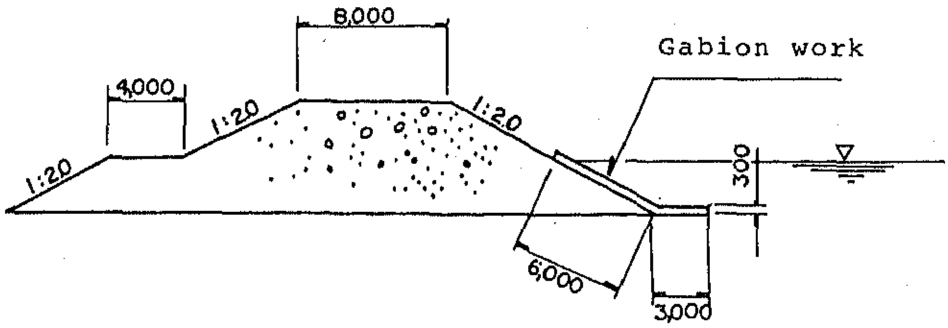


Fig.-4.3 Standard section of dike in K. Leprak sand pocket

4.3 Quantity of Construction Works

A rough estimate of the quantity of construction works for each of the facilities was computed on the basis of the following conditions.

① Quantity of concrete for main dams was computed by a mean-section method.

② Quantity of concrete for sub dams, side walls and aprons as well as the quantity of excavation for dam foundation were computed on the bases of the ratio of those quantity to concrete quantity for dam body at Curah Koboan Check Dam No.6.

③ Manpower and machine power excavation ratio at the dam foundation is 1:9. Rock cleaning should be carried out after the excavation of rock foundation.

④ Quantity of dam concrete less than 20,000 m^3 shall be supplied by the method presently being employed at Mt. Semeru Office, in other word, masonry concrete mainly produced by manpower.

⑤ All other works shall be executed by a method using chiefly mechanical power.

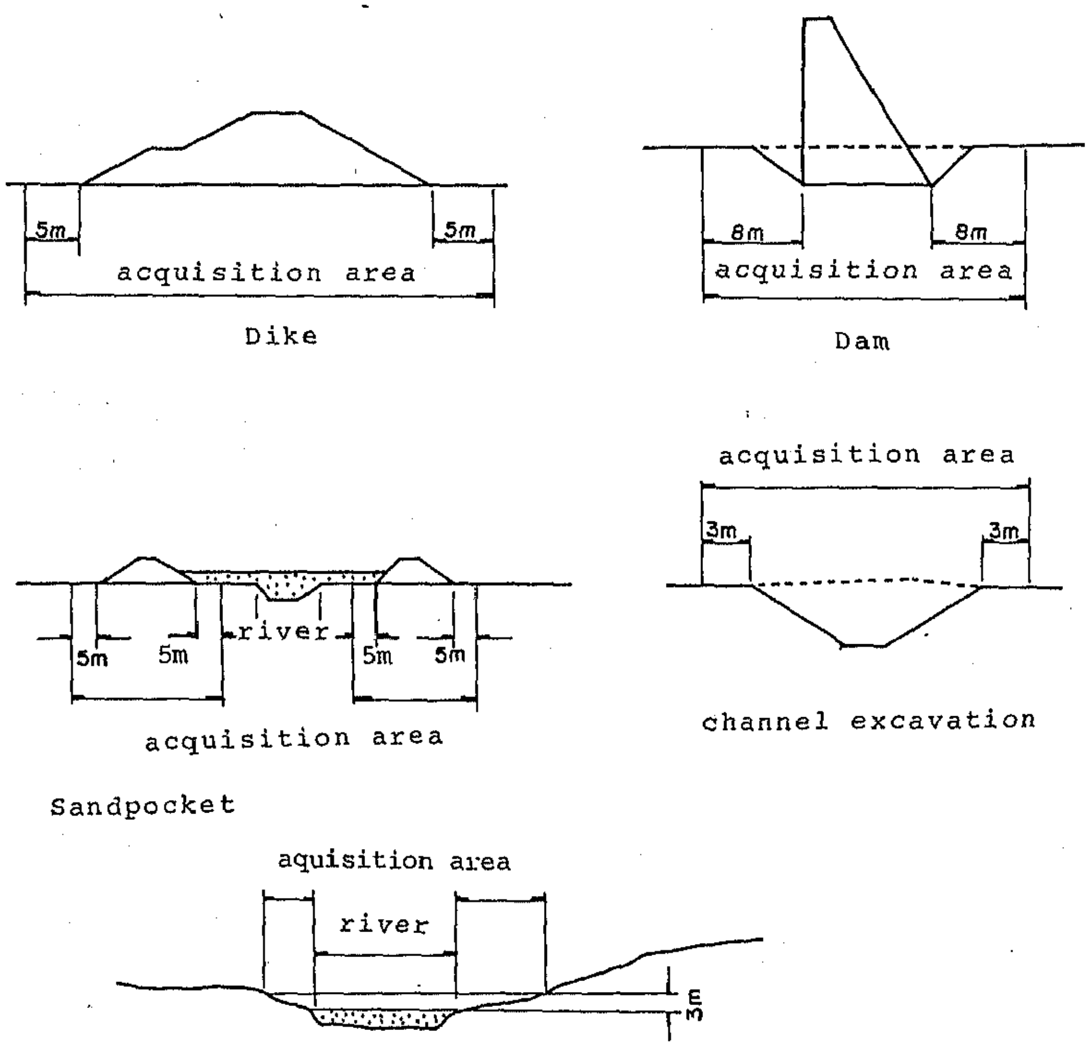
The quantity of construction works for each of the facilities is summarized in Table-4.1.

Table-4.1 Quantity of Construction Works

Kind of Work / Facility	Excavation (Hard soil)		Embankment		Rock Clean-ing	Masonry Concrete	Concrete	Gabion Work	Rock Basket
	By Man Power m^3	By Machine Power m^3	By Man Power m^3	By Machine Power m^3	m^2	m^3	m^3	m^3	m^3
Curah Koboan Check Dam - 6	6,900	61,800					120,800		
" - 5	1,000	8,700				17,000	0		
" - 4	1,400	12,300		51,000			34,400		
" - 3	300	3,000				5,800	0		
Diversion Channel	0	566,000				3,100	0	7,300	
K. Lengkong Check Dam - 5	300	2,400		19,600		4,700	0		
" - 3	2,400	21,900			5,600		42,700		
Curah Lengkong Check Dam - 1	100	1,400				2,600	0		
" - 2	500	4,300				8,400	0		
K. Leprak Sandpocket	0	145,100	145,100	14,700	0	14,100	43,200		

4.4 LAND ACQUISITION

The area of land purchased for the construction works has been determined as shown in Fig.-4.4.



Reservoir of K.Glidik checkdam No.5 and No.9

Fig.-4.4 Land acquisition area

The unit price for land acquisition was base on the 1982 prices in each Kecamatan (See Annex-8).

4.5 ECONOMIC COST

At first, economic unit price for each construction work was calculated in accordance with the conditions stated in section 4.1. Next, the direct construction cost for each facility was calculated based on the quantities stated in section 4.3 and the above-mentioned unit price. Then the economic cost was calculated considering the indirect cost, land acquisition cost, etc. However, since the excavation work of the diversion channel and concrete works of Curah Kobo'an Check Dam No.6, K. Lengkong Check Dam No.3 are executed with a large number of machinery and large scale construction facilities, the economic cost was calculated after rough implementation programs are drawn up (see Appendix-5 and 6.)

The following 2 points were revised in order to calculate the economic cost.

(1) Shadow wage of unskilled labour was estimated at the wage of unskilled labour x 0.5.

(2) In this revision of the machinery hire cost, tax was deducted from the machinery hire cost. However, the opportunity cost's interest rate, which was eliminated in the hire cost calculation, was added to the machinery hire cost.

Tax is imposed at the following rate:

$$0.2 \times \frac{a + 1}{2a} \times \frac{A}{b} \qquad \text{.......... (4.1)}$$

Where,

a = Service life

b = Operation time per hours

A = Purchase cost

The opportunity cost's interest is added to the machinery hire cost excluding tax. The real interest rate (19%) was applied in this estimation as the opportunity cost's interest rate.

The transform formula, in which machinery hire cost is converted into economic cost, is as follows.

$$A' = (1.0 - 0.2 \times \frac{a + 1}{2a} \times \frac{A}{b}) \ (1 + r) \times A \ ..... \ (4.2)$$

Where,

r = Opportunity cost interest rate

A = Machinery hire cost

A'= Revised machinery hire cost

In economic evaluation, operation expenses were established so that the same amount of expenses may be allocated to each facility every year throughout the construction period.

The economic cost for each of the facilities is summarized in Table-4.2.

The maintenance cost of K. Leprak Sand Pocket listed in Table-4.2 is expense incurred for river channel excavation to effect flush out of accumulated deposits as well as to change the position of spillway of a consolidation dam made of rock baskets.

Table-4.2 Economic Cost

No.	Facility	Breakdown of Economic Cost 10^6Rp					Economic Cost 10^6Rp	Maintenance Cost 10^6Rp
		Construction Cost	Land Acquisition Cost	Government Administration Cost	Engineering Service Cost	Contingency		
1	Curah Koboan Check Dam No. 6	7,814	8.2	391	781	2,258	11,252	0
2	" No. 5	412	1.1	21	41	137	612	0
3	" No. 4	2,301	5.7	115	230	812	2,407	0
4	" No. 3	140	0.6	7	14	56	218	0
	Diversion Channel	3,256						
5	K. Lengkong Check dam No. 7	124	1,471.8	334	668	2,727	11,876	0
	" No. 3	3,295						
6	Curah Lengkong Check Dam No. 1	63	1.0	3	6	17	90	0
7	" No. 2	204	1.2	10	20	67	302	0
8	K. Leprak Sand Pocket	2,378	1,260.3	119	238	736	4,732	42
9	Intake and Channel	393	0	20	39	79	531	2
10	Cultivated Field	80	0	4	8	16	108	0

5. ECONOMIC BENEFIT

5.1 DISASTER MODEL

To compute the economic benefit derived from the construction of sediment control facilities, a disaster model was established. The disaster model consists of the following items.

(1) Disaster area
(2) Magnitude of disaster
(3) Damage ratio

To compute the effect of the diversion channel, it ought to be remembered that the influence extends not only to K. Rejali but also to K. Glidik.

(1) POSSIBLE DISASTER AREA

The extent of area where there is a possibility to suffer sediment disaster has been determined from its history and topographical features. This area was defined the possible disaster area. It is the area where a sediment run-off from the upper basin may flood and cause damages to the properties. The possible disaster area is divided into five zones in terms of type of disaster, thickness of sediment deposit and topographical factors (See Fig.-2.1).

These five zones are named according to disaster type; I-Pyroclastic Flow, II-Debris Flow, III-Mud Flow (A), IV-Mud Flow (B) and V-Bed Load Flow Zone.

The possible disaster area of each zone are shown on Table-5.1.

Table 5.1 Possible Disaster Area for Lahar Disaster

(Unit: km^2)

River System	Zone					
	I	II	III	IV	V	Total
K. Rejali	-	1.68	9.89	26.28	2.67	40.52
K. Glidik	4.99	0	0	9.23	8.35	17.58

(2) DESIGN EXCESS SEDIMENT VOLUME

Prior to deciding the magnitude of disasters, it is necessary to estimate the design excess sediment volume. The run-off sediment volume at each reference point is determined by calculating the riverbed fluctuation of each river based on each return period rainfall. The difference in run-off sediment volume between a supplementary reference point and a design reference point is the sediment volume which may cause disaster in the possible disaster area. This is defined design excess sediment volume. Design excess sediment volume for each return period is shown on Table-5.2 and Fig.-5.1. Details of the estimation of design excess sediment volume is described in Supporting Report (1) and (5).

(3) MAGNITUDE OF DISASTER

The magnitude of disaster indicates the severify of disaster.

It is a ratio of the actual disaster area to the possible disaster area.

The magnitude of disaster will be determined on the following suppositions.

Table-5.2 Design Excess Sediment Volume

Return Period (Year)	River System	
	K. Rejali	K. Glidik
3	1,610,000	1,510,000
5	1,940,000	1,830,000
10	2,390,000	2,310,000
20	3,020,000	3,200,000
40	3,680,000	3,700,000
70	4,510,000	4,200,000
100	5,220,000	4,500,000
Possible disaster area	16,240,000	9,050,000
Remarks	No.80-NO.62	NO.94-NO.4

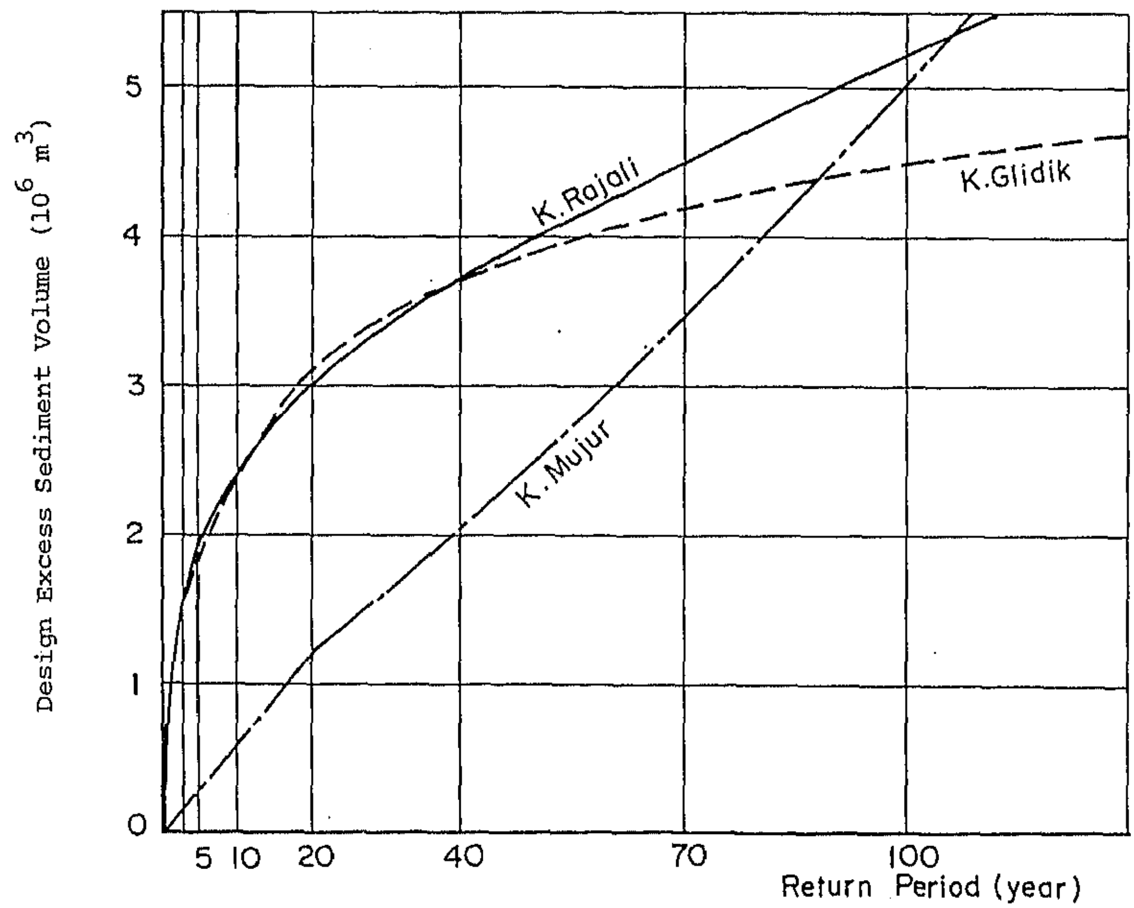


Fig.-5.1 Design Excess Sediment Volume

(i) The thickness of sediment deposit is constant in each of the five zones and has no relation to the deposit volume of the sediment. This is determined on the basis of study of deposit thickness caused by disasters in the past.

(ii) Accordingly, the acreage of flood is in proportion to sediment volume.

(iii) The likelyhood of occurrence of disaster at any given point in the possible disaster area is equal.

(iv) The flood area ratio of each zone to total flood area by any disaster is constant and is the same as that ratio of possible disaster area.

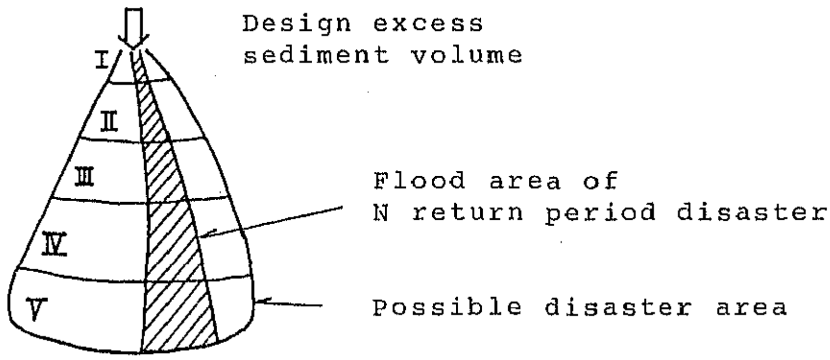


Fig.-5.2 Magnitude of Disaster

The magnitude of disaster in each river basin is shown in Table-5.3.

Table-5.3 Magnitude of Disaster

River Basin	Return Period (year) / Item	3	5	10	20	40	70	100	Possible Disaster Area
K. Rejali	Excess Sediment (10^6m^3)	1.613	1.944	2.389	3.015	3.675	4.510	5.218	16.238
	Magnitude of Disaster	0.099	0.120	0.147	0.186	0.226	0.278	0.321	1.000
K. Glidik	Excess Sediment (10^6m^3)	1.510	1.830	2.310	3.200	3.710	4.200	4.500	9.045
	Magnitude of Disaster	0.167	0.202	0.255	0.354	0.410	0.464	0.498	1.000

(4) DAMAGE RATIO

A damage ratio indicates a degree of damage suffered on assets by sediment flood in the possible disaster area.

As was mentioned before, classification of disasters in the possible disasteer area was established with reference to the deposit depth in 1981 flood. These six zones are supposed to have an average uniform deposit depth respectively, however, as yet there has been no occurrence of the secondary disaster in Zone I.

The average depth of deposit in each zone is as follows.

	K. Rejali	K. Glidik
Zone II	0.60 m	-
Zone III	0.47 m	-
Zone IV	0.36 m	0.60 m
Zone V	0.42 m	0.42 m

In zone VI, damage caused by sediment does not take place and flooding may occur. Water flood may occur in each zone II-V accompanying sediment disaster.

However, in zone II through V, only sediment damage shall be taken into consideration as it is more excessive than damage caused by floods.

A comparison between the height of dikes and discharge at the peak time of flood in Zone VI leads to the understanding that there is rarely danger of water flooding in both the basins of K. Rejali and K. Glidik. It can be safely said, therefore, that there is actually no danger of flood damage in Zone VI. The possible damage ratio was set up only for sediment disaster in these zones.

The damage ratio was established according to the following 12 classifications.

① Buildings (upper class)
② Buildings (middle class)
③ Buildings (lower class)
④ Household Effects
⑤ Facility
⑥ Merchandise
⑦ Paddy Rice
⑧ Dry Field Crops
⑨ Livestock
⑩ Poultry
⑪ Inhabitants
⑫ Public Facilities

Except for livestock, poultry and inhabitants, the damage ratio was set up not only by reference to "Standard for Economic Study of Flood Control" which published by River Bureau, Ministry of Construction in Japan, but also by finding the average deposit depth in each zone. The damage ratio of livestock, poultry and inhabitants was estimated on the basis of actual damage caused by flooding in November, 1976 and May, 1981.

The upper class category buildings as general assets, is sub-divided into six, i.e. large mosques, churches, large hospitals, schools, large factories and upper class houses. The middle class category is sub-divided into ten, i.e. small mosques, small hospitals, small factories, stores (five types), offices and middle class houses. The lower class category only applies to lower class houses.

Household effects cover assets within the house, belongings, assets within the store and goods. The damage ratio to facilities was applied to other in-house assets.

The damage ratio to dry field crops was applied to maize and coffee.

The livestock damage ratio was applied to livestock (buffaloes, cattle, horses, goats, sheep and pigs) and the poultry damage ratio was applied to poultry (ducks and fowls).

These damage ratios are shown in Table-5.4 and Table-5.5.

Table-5.4 Damage Ratio (K. Rejali)

Average Deposit Depth (m)	-	0.60	0.47	0.36	0.42	-
Zone	I	II	III	IV	V	VI
1. Buildings (upper class)	-	0.37	0.37	0.37	0.37	-
2. Buildings (middle class)	-	0.43	0.43	0.43	0.43	-
3. Buildings (lower class)	-	0.54	0.54	0.54	0.54	-
4. Household Effects	-	0.50	0.50	0.50	0.50	-
5. Facility, Office supplies	-	0.48	0.48	0.48	0.48	-
6. Merchandise	-	0.58	0.58	0.58	0.58	-
7. Paddy rice	-	0.31	0.68	0.68	0.68	-
8. Dry field crops	-	0.81	0.68	0.68	0.68	-
9. Livestock	-	0.45	0.45	0.05	0.05	-
10. Poultry	-	0.72	0.72	0.08	0.08	-
11. Inhabitants	-	0.15	0.15	0.03	0.03	-
12. Public Facilities	-	0.18	0.18	0.18	0.18	-

Table-5.5 Damage Ratio (K. Glidik)

Average Deposit Depth (m)	-	-	-	0.60	0.42	-
Zone	I	II	III	IV	V	VI
1. Buildings (upper class)	-	-	-	0.37	0.37	-
2. Buildings (middle class)	-	-	-	0.43	0.43	-
3. Buildings (lower class)	-	-	-	0.54	0.54	-
4. Household Effects	-	-	-	0.50	0.50	-
5. Facility, Office supplies	-	-	-	0.48	0.48	-
6. Merchandise	-	-	-	0.58	0.58	-
7. Paddy rice	-	-	-	0.81	0.68	-
8. Dry field crops	-	-	-	0.81	0.68	-
9. Livestock	-	-	-	0.45	0.05	-
10. Poultry	-	-	-	0.72	0.08	-
11. Inhabitants	-	-	-	0.15	0.03	-
12. Public Facilities	-	-	-	0.18	0.18	-

5.2 ECONOMIC BENEFIT

The economic benefit through the construction of sediment control facilities is classified into three categories: mitigation effect of direct damage, mitigation effect of indirect damage and water resource development effect.

The following damages by sediment flood are included in direct damage which is called "primary damage."

① Damage to houses and household effects buried or washed away

② Damage to roads and bridges broken or washed away

③ Damage to agricultural products including livestock washed away or destroyed

④ Expenses appropriate for removing sediment deposit and for restoring the divastated area

The followings are included in indirect damage which is called "secondary damage."

① Deterioration of services caused by the suspension of economic activities in disaster-striken area

② Substitutional action taken for restoring damaged transportation facilities and living functions

On the other hand, after stabilizing a divastated area by construction of sediment control plan, a new irrigation beneficiary area will be created. Benefit generated from this irrigation beneficiary area is called "water resource development benefit."

5.3 DIRECT DAMAGE

5.3.1 DIRECT DAMAGE ITEM

As the result of the investigation of statistics in the target area, the following six(6) items were picked up as exemplary direct damage categories.

(1) General property
(2) Agricultural products
(3) Livestock and poultry
(4) Inhabitants
(5) Public facilities
(6) Expenses for sediment removal

Regarding public facilities of the above 6 items, facilities existing in every zone were picked up from a map on a scale of 1 to 100,000 as well as a pontential disaster area map. Acreage classified by land category and by zone for the purpose of calculation of sediment removal expense was found from a land utilization map on a scale of 1 to 50,000.

Regarding items from (1) to (4), statistics of all Desas, included in Kecamatan covered by this project, were found. However, statistics of Kecamatan was applied to Kec. Ampel Goding in Kab. Malang because statistics classified by Desa were unavailable.

Next, the statistics of each Desa included in the possible disaster area were found by employing the following procedure: Firstly, the percentage of acreage included in the said zone as against the entire acreage of the Desa (making this acreage 100%) was surveyed from a map on a scale of 1 to 50,000. The sum of each Desa's acreage belonging to the said zone was calculated. Finally, statistics classified by zone were prepared through this procedure.

A serial number was put on all Desas, making Desa Pasirian in Kec. Pasirian No. 1. This serial number is called the "Identification (ID) Number" of each Desa. ID numbers included in study area are shown in Table-5.6.

Table-5.7 shows the Desa ID Number and acreage ratio included in possible disaster area classified by zone in K. Rejali. Table-5.8 shows the ID Number and acreage ratio in K. Glidik. Taking the case of Zone II in the Rejali basin, the number of houses included in this zone can be found by calculating the following formula.

$$\begin{pmatrix}\text{Number of houses included in}\\ \text{Zone II in K. Rejali basin}\end{pmatrix} = \begin{pmatrix}\text{Houses in Desa}\\ \text{ID No. 17}\end{pmatrix} \times 3.4\% + \begin{pmatrix}\text{Houses in Desa}\\ \text{ID No. 18}\end{pmatrix} \times 7.2\%$$

Table-5.6 ID Number of Desa

	PASIRIAN	CANDIPURO	PRONOJIWO	TEMPURSARI	AMPEL GADING
1	1 Pasirian	11 Candipuro	21 Pronojiwo	27 Tempursari	34 Ampel Gading
2	2 Ngutar	12 Jarit	22 Sidomulyo	28 Pundungsari	
3	3 Kali Bendo	13 Penanggal	23 Supiturang	29 Kaliulingsari	
4	4 Bades	14 Kloposawit	24 Oro-oro Ombo	30 Tempurejo	
5	5 Bago	15 Tumpeng	25 Sumber-Urip	31 Purorejo	
6	6 Condro	16 Jugosari	26 Tamanayu	32 Bulurejo	
7	7 Selok Awar-Awar		17 Sumberejo		33 Tagalrejo
8	8 Madu Rejo	18 Sumberwuluh			
9	9 Semeru	19 Sumber Mujur			
10	10 Gondoroso	20 Tambah Rejo			

Table-5.7 Desa Area Ratio (K. Rejali)

Zone	No. of Desa	Desa ID Number & Ratio (%)					
Zone-I	3	20(62.5)	23(17.3)	24(12.3)			
Zone-II	2	17(3.4)	18(7.2)				
Zone-III	3	12(12.0)	17(16.6)	18(36.8)			
Zone-IV	6	3(57.0)	4(19.7)	8(14.3)	12(16.9)	16(15.1)	17(3.4)
Zone-V	1	4(8.6)					
Zone-VI	1	4(4.2)					

Table-5.8 Desa Area Ratio (K. Gridik)

Zone	No. of Desa	Desa ID Number & Ratio (%)					
Zone-I	2	23(33.3)	26(1.8)				
Zone-II							
Zone-III							
Zone-IV	5	22(3.8)	26(3.7)	29(10.5)	31(12.8)	34(1.1)	
Zone-V	3	31(17.6)	33(63.7)	34(0.1)			
Zone-VI	4	30(5.4)	32(78.4)	33(25.5)	34(0.3)		

(1) General Property

(1)- 1	Mosque (large)	(1)-11	Grain & Rice Store
(1)- 2	Mosque (small)	(1)-12	Grocery Store
(1)- 3	Church	(1)-13	Other Stores
(1)- 4	Hospital (large)	(1)-14	Office
(1)- 5	Hospital (small)	(1)-15	House (upper class)
(1)- 6	School	(1)-16	House (middle class)
(1)- 7	Factory (large)	(1)-17	House (lower class)
(1)- 8	Factory (small)		
(1)- 9	Food/Beverage Store		
(1)-10	Clothing Store		

Since well-equipped, large mosques, hospitals and factories and those of a smaller size are found together, they were classified into 2 groups of large and small. The economic Trend Survey prepared by each village office classifies houses according to the purchase price of the house. The houses are then divided into 3 classes, upper class, middle class and lower class. Many upper class houses are made of brick, while many middle class houses are made of brick and wood. Lower class houses are generally made of bamboo.

The general property of the each Desa are shown in Table-5.9 - 5.12.

Table-5.13 shows the general property of the possible disaster area in the K. Rejali basin. Tables 5.14 and 5.15 show the general property of the possible disaster area in the K. Glidik area and both river basins respectively.

Table-5.9 Original Data (1)

	PASIRIAN	NGUTAR	KALI BENDO	BADES	BAGO	CONDRO	SELOK AWAR	MADU REJO	SEMERU
MOSQUE (L)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
MOSQUE (S)	20.00	11.00	27.00	32.00	13.00	7.00	45.00	14.00	42.00
CHURCH	2.00	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SCHOOL	11.00	5.00	7.00	10.00	4.00	3.00	8.00	2.00	4.00
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	7.00	3.00	3.00	3.00	3.00	1.00	0.0	0.0	2.00
STR FD & BEV	13.00	11.00	12.00	17.00	3.00	6.00	20.00	3.00	4.00
STR CLOTHING	6.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STR GR &RICE	6.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STR GROCERY	3.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STR OTHERS	50.00	13.00	10.00	5.00	10.00	8.00	18.00	10.00	8.00
OFFICE	14.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.00
HOUSE (UPR)	327.00	301.00	338.00	618.00	135.00	28.00	110.00	75.00	188.00
HOUSE (MDL)	1348.00	859.00	616.00	835.00	637.00	165.00	665.00	235.00	568.00
HOUSE (LWR)	1269.00	485.00	448.00	438.00	680.00	406.00	1346.00	308.00	507.00
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	731.00	465.00	383.00	622.00	426.00	196.00	696.00	161.00	339.00
MAIZE AREA (ha)	353.00	225.00	185.00	300.00	206.00	95.00	336.00	78.00	164.00
COFFEE AREA (ha)	4.20	2.68	2.20	3.58	2.45	1.13	4.00	0.93	1.95
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	64.00	50.00	59.00	73.00	0.0	0.0	0.0	0.0	71.00
COW & OX	511.00	618.00	608.00	658.00	1526.00	727.00	1970.00	462.00	462.00
HORSE	24.00	55.00	25.00	39.00	16.00	16.00	21.00	0.0	12.00
GOAT	535.00	390.00	515.00	540.00	570.00	530.00	540.00	542.00	525.00
SHEEP	260.00	196.00	257.00	260.00	269.00	236.00	254.00	249.00	233.00
PIG	169.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DUCK	765.00	1872.00	375.00	500.00	2500.00	138.00	675.00	360.00	2748.00
CHICKEN	24908.00	6711.00	8265.00	4607.00	10350.00	2832.00	6135.00	1369.00	4384.00
PEOPLE	12425.00	7914.00	6508.00	10576.00	7248.00	3328.00	11834.00	2737.00	5769.00

Table-5.10 Original Data (2)

	GONDOROSO	CANDIPURO	JARIT	PENANGGAL	KLOPOSAWIT	TUMPENG	JUGOSARI	SUMBEREJO	SUMBERWULUH
MOSQUE (L)	1.00	3.00	2.00	3.00	1.00	1.00	0.0	1.00	2.00
MOSQUE (S)	26.00	0.0	1.00	1.00	1.00	2.00	2.00	1.00	4.00
CHURCH	1.00	0.0	0.0	1.00	0.0	0.0	0.0	1.00	0.0
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.0	1.00	0.0	1.00	0.0	0.0	0.0	0.0	0.0
SCHOOL	6.00	8.00	7.00	8.00	2.00	4.00	3.00	4.00	7.00
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.0	3.00	4.00	4.00	0.0	1.00	0.0	1.00	2.00
STR FD & BEV	2.00	8.00	10.00	6.00	3.00	1.00	4.00	6.00	4.00
STR CLOTHING	0.0	1.00	0.0	1.00	0.0	0.0	1.00	2.00	0.0
STR GR &RICE	0.0	7.00	6.00	8.00	2.00	2.00	1.00	16.00	3.00
STR GROCERY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.00	0.0
STR OTHERS	10.00	3.00	3.00	4.00	2.00	2.00	1.00	4.00	3.00
OFFICE	1.00	5.00	3.00	3.00	2.00	2.00	1.00	8.00	2.00
HOUSE (UPR)	175.00	592.00	1296.00	642.00	450.00	432.00	118.00	1038.00	355.00
HOUSE (MDL)	710.00	449.00	677.00	356.00	250.00	296.00	221.00	108.00	587.00
HOUSE (LWR)	276.00	216.00	80.00	38.00	51.00	487.00	214.00	51.00	768.00
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	326.00	369.00	626.00	452.00	235.00	326.00	206.00	315.00	384.00
MAIZE AREA (ha)	158.00	138.00	234.00	169.00	88.00	122.00	77.00	118.00	143.00
COFFEE AREA (ha)	1.88	11.53	19.55	14.13	7.35	10.17	6.44	9.83	11.98
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	74.00	83.00	101.00	178.00	118.00	61.00	46.00	137.00	35.00
COW & OX	670.00	346.00	578.00	667.00	307.00	583.00	334.00	205.00	607.00
HORSE	26.00	40.00	88.00	0.0	0.0	6.00	1.00	18.00	19.00
GOAT	542.00	215.00	244.00	231.00	108.00	779.00	139.00	94.00	318.00
SHEEP	269.00	50.00	132.00	60.00	38.00	162.00	124.00	101.00	352.00
PIG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DUCK	1370.00	326.00	124.00	79.00	113.00	251.00	145.00	96.00	216.00
CHICKEN	554.00	1366.00	2882.00	4696.00	2004.00	2992.00	965.00	1342.00	880.00
PEOPLE	5547.00	6255.00	10610.00	7666.00	3986.00	5520.00	3496.00	5336.00	6501.00

Table-5.11 Original Data (3)

	SUMBER MUJU	TAMBAH REJO	PRONOJIWO	SIDOMULYO	SUPITURANG	ORO-ORO OMB	SUMBER-URIP	TAMANAYU	TEMPURSARI
MOSQUE (L)	1.00	1.00	6.00	3.00	5.00	5.00	4.00	5.00	2.00
MOSQUE (S)	2.00	1.00	20.00	5.00	15.00	16.00	14.00	10.00	8.00
CHURCH	0.0	0.0	2.00	1.00	0.0	1.00	0.0	1.00	2.00
HOSPITAL (L)	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.0	0.0	0.0	0.0	1.00	0.0	1.00	1.00	1.00
SCHOOL	5.00	4.00	5.00	4.00	4.00	5.00	2.00	5.00	7.00
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	1.00	0.0	1.00	0.0	1.00	3.00	3.00	0.0	0.0
STR FD & BEV	2.00	2.00	15.00	2.00	2.00	3.00	4.00	4.00	5.00
STR CLOTHING	0.0	0.0	6.00	0.0	0.0	0.0	0.0	0.0	25.00
STR GR &RICE	4.00	2.00	0.0	0.0	0.0	0.0	0.0	0.0	10.00
STR GROCERY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.00
STR OTHERS	2.00	2.00	9.00	5.00	5.00	7.00	5.00	4.00	16.00
OFFICE	3.00	2.00	7.00	0.0	0.0	0.0	1.00	1.00	7.00
HOUSE (UPR)	406.00	539.00	0.0	0.0	0.0	0.0	0.0	0.0	3.00
HOUSE (MDL)	764.00	76.00	75.00	50.00	59.00	65.00	30.00	58.00	607.00
HOUSE (LWR)	172.00	127.00	1266.00	933.00	1050.00	1349.00	683.00	1211.00	3237.00
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	485.00	221.00	209.00	142.00	149.00	207.00	102.00	144.00	273.00
MAIZE AREA (ha)	181.00	82.00	70.00	48.00	50.00	69.00	34.00	48.00	92.00
COFFEE AREA (ha)	15.14	6.89	138.38	93.72	98.75	136.49	67.30	94.98	180.52
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	267.00	97.00	0.0	0.0	0.0	0.0	0.0	0.0	173.00
COW & OX	729.00	285.00	0.0	0.0	0.0	0.0	0.0	0.0	203.00
HORSE	6.00	1.00	0.0	0.0	0.0	0.0	0.0	0.0	4.00
GOAT	65.00	82.00	0.0	0.0	0.0	0.0	0.0	0.0	14.00
SHEEP	770.00	49.00	0.0	0.0	0.0	0.0	0.0	0.0	350.00
PIG	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	110.00
DUCK	362.00	159.00	0.0	0.0	0.0	0.0	0.0	0.0	337.00
CHICKEN	5072.00	1639.00	0.0	0.0	0.0	0.0	0.0	0.0	11245.00
PEOPLE	8218.00	3741.00	7769.00	5262.00	5544.00	7663.00	3779.00	5333.00	10135.00

Table-5.12 Original Data (4)

	PUNDUNGSARI	KALIULINGSA	TEMPUREJO	PUROREJO	BULUREJO	TEGALREJO	AMPEL GADING
MOSQUE (L)	1.00	4.00	2.00	1.00	2.00	1.00	46.00
MOSQUE (S)	6.00	13.00	3.00	12.00	8.00	5.00	282.00
CHURCH	1.00	1.00	1.00	0.0	0.0	2.00	11.00
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	1.00	1.00	0.0	0.0	1.00	1.00	1.00
SCHOOL	3.00	5.00	3.00	3.00	5.00	3.00	9.00
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.0	0.0	0.0	0.0	0.0	0.0	315.00
STR FD & BEV	0.0	0.0	0.0	0.0	13.00	0.0	191.00
STR CLOTHING	0.0	0.0	0.0	0.0	8.00	0.0	5.00
STR GR &RICE	0.0	0.0	0.0	2.00	8.00	0.0	73.00
STR GROCERY	5.00	13.00	8.00	8.00	34.00	11.00	2.00
STR OTHERS	10.00	6.00	0.0	6.00	36.00	15.00	133.00
OFFICE	1.00	1.00	1.00	1.00	1.00	1.00	44.00
HOUSE (UPR)	0.0	0.0	0.0	0.0	0.0	0.0	8242.00
HOUSE (MDL)	231.00	415.00	226.00	640.00	119.00	59.00	6655.00
HOUSE (LWR)	400.00	574.00	456.00	587.00	530.00	585.00	6850.00
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	96.00	155.00	97.00	164.00	83.00	89.00	1048.00
MAIZE AREA (ha)	32.00	52.00	31.00	55.00	28.00	30.00	2542.00
COFFEE AREA (ha)	63.53	102.53	61.01	108.19	54.72	59.13	6591.00
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	2.00	0.0	167.00	16.00	85.00	48.00	571.00
COW & OX	124.00	95.00	108.00	315.00	135.00	442.00	3785.00
HORSE	0.0	3.00	0.0	7.00	1.00	5.00	119.00
GOAT	17.00	10.00	20.00	2.00	10.00	10.00	234.00
SHEEP	150.00	475.00	85.00	393.00	85.00	253.00	7629.00
PIG	2.00	0.0	25.00	7.00	57.00	10.00	112.00
DUCK	100.00	50.00	217.00	166.00	960.00	1146.00	3999.00
CHICKEN	3000.00	2711.00	2609.00	2225.00	1384.00	2211.00	66251.00
PEOPLE	3567.00	5756.00	3425.00	6074.00	3072.00	3320.00	106179.00

Table-5.13 NUMBER OF EACH ITEM (REJAEI)

	ZONE - 1	ZONE - 2	ZONE - 3	ZONE - 4	ZONE - 5	ZONE - 6	TOTAL
MOSQUE (L)	2.10	0.18	1.14	1.28	0.09	0.04	4.83
MOSQUE (S)	5.19	0.32	1.76	24.20	2.75	1.34	35.56
CHURCH	0.12	0.03	0.17	0.23	0.09	0.04	0.68
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.17	0.0	0.0	0.0	0.0	0.0	0.17
SCHOOL	3.81	0.64	4.08	8.02	0.86	0.42	17.82
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.54	0.18	1.38	3.01	0.26	0.13	5.50
STR FD & BEV	1.96	0.49	3.67	13.12	1.46	0.71	21.42
STR CLOTHING	0.0	0.07	0.33	0.22	0.0	0.0	0.62
STR GR &RICE	1.25	0.76	4.48	1.71	0.0	0.0	8.20
STR GROCERY	0.0	0.03	0.17	0.03	0.0	0.0	0.23
STR OTHERS	2.98	0.35	2.13	8.91	0.43	0.21	15.00
OFFICE	1.25	0.42	2.42	1.98	0.09	0.04	6.20
HOUSE (UPR)	336.87	60.85	458.47	597.26	53.15	25.96	1532.56
HOUSE (MDL)	65.70	45.94	315.18	700.68	71.81	35.07	1234.38
HOUSE (LWR)	426.95	57.03	300.69	433.26	37.67	18.40	1273.99
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	189.36	38.36	268.72	511.48	53.49	26.12	1087.53
MAIZE AREA (ha)	68.39	14.31	100.29	230.89	25.80	12.60	452.28
COFFEE AREA (ha)	38.18	1.20	8.39	6.70	0.31	0.15	54.92
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	60.63	7.18	47.74	76.68	6.28	3.07	201.57
COW & OX	178.12	50.67	326.77	697.34	56.59	27.64	1337.13
HORSE	0.63	1.98	20.54	37.57	3.35	1.64	65.70
GOAT	51.25	26.09	161.91	542.86	46.44	22.68	851.23
SHEEP	30.63	28.78	162.14	277.78	22.36	10.92	532.61
PIG	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DUCK	99.38	18.82	110.30	409.84	43.00	21.00	702.34
CHICKEN	1024.37	108.99	892.45	6492.79	396.20	193.49	9108.29
PEOPLE	4239.79	649.50	4551.34	8686.82	909.54	444.19	19481.17

Table-5. 14 NUMBER OF EACH ITEM
(GRIDIK)

	ZONE - 1	ZONE - 2	ZONE - 3	ZONE - 4	ZONE - 5	ZONE - 6	TOTAL
MOSQUE (L)	1.75	0.0	0.0	1.35	0.86	2.07	6.04
MOSQUE (S)	5.17	0.0	0.0	6.56	5.58	8.55	25.87
CHURCH	0.02	0.0	0.0	0.30	1.28	0.60	2.20
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.35	0.0	0.0	0.15	0.64	1.04	2.18
SCHOOL	1.42	0.0	0.0	1.34	2.45	4.87	10.09
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.33	0.0	0.0	3.47	0.31	0.94	5.06
STR FD & BEV	0.74	0.0	0.0	2.32	0.19	10.76	14.02
STR CLOTHING	0.0	0.0	0.0	0.06	0.00	6.29	6.35
STR GR &RICE	0.0	0.0	0.0	1.06	0.43	6.49	7.97
STR GROCERY	0.0	0.0	0.0	2.41	8.42	29.90	40.73
STR OTHERS	1.74	0.0	0.0	3.20	10.74	32.45	48.13
OFFICE	0.02	0.0	0.0	0.75	0.86	1.22	2.85
HOUSE (UPR)	0.0	0.0	0.0	90.66	8.24	24.73	123.63
HOUSE (MDL)	20.69	0.0	0.0	202.75	156.88	140.51	520.82
HOUSE (LWR)	371.45	0.0	0.0	291.02	482.81	609.87	1755.14
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	52.21	0.0	0.0	59.52	86.60	95.88	294.21
MAIZE AREA (ha)	17.51	0.0	0.0	44.06	31.33	38.90	131.81
COFFEE AREA (ha)	34.59	0.0	0.0	104.19	63.30	81.05	283.13
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	0.0	0.0	0.0	8.33	33.96	89.61	131.90
COW & OX	0.0	0.0	0.0	91.93	340.78	235.74	668.45
HORSE	0.0	0.0	0.0	2.52	4.54	2.42	9.47
GOAT	0.0	0.0	0.0	3.88	6.96	12.17	23.01
SHEEP	0.0	0.0	0.0	184.10	237.96	158.63	580.69
PIG	0.0	0.0	0.0	2.13	7.71	48.92	58.77
DUCK	0.0	0.0	0.0	70.49	763.22	1068.58	1902.29
CHICKEN	0.0	0.0	0.0	1298.22	1866.26	1988.50	5152.97
PEOPLE	1942.15	0.0	0.0	2947.10	3290.04	3758.53	11937.82

Table-5.15 NUMBER OF EACH ITEM (TOTAL)

	ZONE - 1	ZONE - 2	ZONE - 3	ZONE - 4	ZONE - 5	ZONE - 6	TOTAL
MOSQUE (L)	3.86	0.18	1.14	2.63	0.94	2.11	10.87
MOSQUE (S)	10.36	0.32	1.76	30.76	8.33	9.90	61.44
CHURCH	0.14	0.03	0.17	0.53	1.37	0.64	2.88
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.52	0.0	0.0	0.15	0.64	1.04	2.36
SCHOOL	5.23	0.64	4.08	9.36	3.31	5.29	27.91
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.87	0.18	1.38	6.48	0.57	1.07	10.55
STR FD & BEV	2.70	0.49	3.67	15.44	1.65	11.48	35.44
STR CLOTHING	0.0	0.07	0.33	0.27	0.00	6.29	6.97
STR GR &RICE	1.25	0.76	4.48	2.77	0.43	6.49	16.17
STR GROCERY	0.0	0.03	0.17	2.44	8.42	29.90	40.96
STR OTHERS	4.71	0.35	2.13	12.11	11.17	32.66	63.13
OFFICE	1.27	0.42	2.42	2.74	0.94	1.27	9.05
HOUSE (UPR)	336.87	60.85	458.47	687.93	61.39	50.68	1656.19
HOUSE (MDL)	86.39	45.94	315.18	903.42	228.69	175.58	1755.20
HOUSE (LWR)	798.40	57.03	300.69	724.27	520.47	628.26	3029.13
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA (ha)	241.57	38.36	268.72	571.00	140.10	122.00	1381.75
MAIZE AREA (ha)	85.90	14.31	100.29	274.95	57.13	51.50	584.09
COFFEE AREA (ha)	72.77	1.20	8.39	110.89	63.61	81.20	338.05
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	60.63	7.18	47.74	85.01	40.24	92.68	333.48
COW & OX	178.12	50.67	326.77	789.27	397.37	263.37	2005.57
HORSE	0.63	1.98	20.54	40.09	7.89	4.05	75.18
GOAT	51.25	26.09	161.91	546.74	53.40	34.85	874.23
SHEEP	30.63	28.78	162.14	461.88	260.32	169.55	1113.30
PIG	0.0	0.0	0.0	2.13	7.71	48.92	58.77
DUCK	99.38	18.82	110.30	480.33	806.22	1089.58	2604.63
CHICKEN	1024.37	108.99	892.45	7791.00	2262.46	2181.99	14261.26
PEOPLE	6181.93	649.50	4551.34	11633.92	4199.58	4202.72	31418.98

There are 1,656 upper class houses, 1,755 middle class houses and 3,029 lower class houses built in these possible disaster areas (Zone I to Zone VI) in both river basins, characterized by a great many of the lower class houses being exposed to disaster. In the whole area there are 41 grocery stores, 35 Food and Beverage Stores and 16 Grain and Rice Stores.

(2) Agricultural Products

(2)-1 Paddy Rice

(2)-2 Maize

(2)-3 Coffee

99 percent of the rice paddy fields in Kab. Lumajang are irrigated and double-cropping of rice prevails in this irrigated area. In addition to rice, sugar cane is partially cultivated in the paddy fields. Maize, soy beans and casaba are cultivated in the dry fields. Coffee beans, coconuts, tobacco and rubber are grown as cash crops, although other than coffee beans, production is only nominal.

Paddy rice, dry field maize and coffee grown on an estate are the agricultural products to be included in the damage category. Tables 5.13, 5.14 and 5.15 describe the acreage under cultivation (unit: hectare). In the zones in possible disaster area of both river basins, the acreage of paddy rice and maize under cultivation is 571 ha and 275 ha respectively at Zone IV. Coffee is under cultivation in an estate on the southern slope of Mt. Semeru. The harvest acreage of coffee under cultivation is 111 ha.

(3) Livestock and Poultry

(3)-1	Buffalo	(3)-5	Sheep
(3)-2	Cow and Ox	(3)-6	Pig
(3)-3	Horse	(3)-7	Duck
(3)-4	Goat	(3)-8	Chicken

The farming of livestock in this area is not very active. Most of the livestock is used either for agricultural purposes, food for family use, or domestic dealing. All poultry are raised as food or for their eggs. So, poultry is an important source of additional income for farmers in this area.

Table-5.15 shows that some 2,000 cows and some 1,000 sheep and goats respectively are being raised in this area, but other kinds of animals are few. Domestic fowls number some 14,000.

(4) Inhabitants

The mortality rate of the inhabitants is higher in the case of sediment disaster than water flooding. Since the inhabitants are an important source of labour, their deaths are seriously felt.

The importance of the inhabitants as a source of labour will be discussed in the latter part of this report. Only the population in the possible disaster area is dealt with in this section. According to Table-5.15, the population of these areas totals 31,000. A little more than one third of them inhabit in Zone IV.

(5) Public Facilities

(5)-1	Rivers	Check dams
(5)- 2	Rivers	Consolidation dams
(5)- 3	Rivers	Dikes
(5)- 4	Rivers	Revetments
(5)- 5	Rivers	Spur dykes
(5)- 6	Rivers	Intake works
(5)- 7	Roads	National highways
(5)- 8	Roads	Prefectural roads
(5)- 9	Roads	Village roads
(5)-10	Roads	Others
(5)-11	Bridges	

Other than the above items, railroads, water supply and electric power and gas, etc. are also regarded as public facilities. The above 11 items were narrowed down as appropriate facilities to this area.

Table-5.16 Public Civil Work Facilities (K. Rejali)

Asset Classification \ Zone in Possible Disaster Area		I	II	III	IV	V	VI	Total
Rivers	Sand arrest dams (the number of units)	2	1					3
	Consolidation dams (")		1					1
	Dikes (")			10	3			13
	Revetments (")							
	Spur Dykes (")				2			2
	Intakes (")			1	2	1		4
Roads (Km)	National highways							
	Prefectural roads							
	Village roads				6.2			6.2
	Others	1.5	2.3	10.8	39.0	6.0	6.8	66.4
	Total	1.5	2.3	10.8	45.2	6.0	6.8	72.6
The number of bridges		1	1	1	6	1		10

Table-5.17 Public Facilities (K. Glidik)

Asset Classification \ Zone in Possible Disaster Area		I	II	III	IV	V	VI	Total
Rivers	Sand arrest dams (the number of units)							
	Consolidation dams (")							
	Dikes (")	6			1	1		8
	Revetments (")							
	Spur Dykes (")	1			2			3
	Intakes (")							
Roads (Km)	National highways							
	Prefectural roads							
	Village roads							
	Others				11.9	18.6		30.5
	Total				11.9	18.6		30.5
The number of bridges					1			1

(6) Sediment Removal Expense

The sediment flood buries housing sites, paddy fields, estates, farms and raise riverbeds rendering them useless. Money is now being spent, therefore, on the sediment removal operations to rehabilitate the affected areas so that they can recover their original functions. The expense incurred for sediment removal is defined as direct damage.

Since the method and expense for sediment removal, of course, are different depending on the land utilization classification, the sediment removal expense was computed considering the land utilization. The flood area was classified into housing sites, paddy fields, farms, estates, river channels, mountains and forest, etc. on a 1/50,000 land utilization map.

Assuming the ratio of land utilization classification at each disaster to be a constant, the same ratio was assigned to the potential disaster area. The land utilization classification of the potential disaster area is shown in Table-5.18.

Table-5.18 Ratio of Land Utilization Classification

(%)

Basin	Zone	Total	Housing Site	Paddy Field	Farm	Estate	River Channel	Forests, Others
K. Rejali	I	100	2.7	45.1	2.9	1.8	0.5	47.0
	II	100	7.7	75.0	0	4.8	3.0	9.5
	III	100	5.1	65.4	0	1.3	1.8	26.4
	IV	100	10.3	78.7	3.9	0	1.3	5.8
	V	100	0	36.7	0	0	6.7	56.6
K. Glidik	IV	100	3.0	45.4	6.6	3.7	36.1	5.2
	V	100	7.1	16.5	24.6	0	48.2	3.6

The method of sediment removal for each of the land utilization classification has been determined as below on the basis of operations carried out in past disasters.

① Housing sites

Excavation by hand, loading, transport by dump truck, (distance, 1,000 m) and dumping the sediment.

② Paddy fields

Sediment removal by bulldozer
Formation of approximately 5cm thick top soil

③ Farms

Sediment removal by bulldozer

④ Estates

Excavation and leap up together by hand

⑤ River channels

Sediment removal by bulldozer
(Distance 50 m)

5.3.2 Estimated Value

(1) Estimated Value of General Property

It was found, as a result of the field sampling survey on the estimation of general property, that a considerable variance in the estimation between the Desa with a large population and the Desa with a small population exists.

A different estimation was given, therefore, to those areas after dividing them into a large urban type community and a small rural community.

Field information gathered by going around each Kecamatan in addition to population was used for reference in classifying into urban typed communities and rural communitieis. Desa decided to be urban type communities are Pasirian, Candipuro, Pronojiwo and Tempursari.

The estimated value of buildings was made by estimating the residual value based on the sampling survey. A residual value was also estimated for movables such as household effects, office supplies and equipment. Furthermore, an inventory of products and stores in factories and shops was included in the movables.

Table-5.22 shows a building estimate which is classified into urban type communities, rural communities and movables.

(2) Estimated Value of Agricultural Products

Estimation of agricultural products varies slightly among products. Since the growing period of paddy rice and maize is less than one year, the damage is not carried forward to the next year. In the case of coffee, however, if a fully matured tree has been damaged by flooding or sediment runoff, future profits for several years will be lost as a coffee tree requires several years to grow. However, not all coffee trees in the estate are fully matured, so we can basically suppose that the trees are distributed evenly in the area from the stage of saplings. The damaged unit price of coffee can then be determined in the following manner:

The profit for the next three years is estimated and then this estimated profit is added to the present value. This is then the damage unit price of coffee.

In regards to the price of rice, a lowest guaranteed price and a highest guaranteed price was set by the Government in order to stabilize rice prices. In addition to this, the Food Agency set up a controlled distribution of rice in all districts. The agency buys the rice at the central market when the price is lower than the lowest guaranteed price and then releases it which the price is raised above the highest guaranteed price.

In 1982, the market price of polished rice in Kab. Lumajang was 240-250 Rupiah per kg, however, the FOB price at Surabaya Port was 250 Rupiah. When transportation is considered, the domestic price is a little higher. But, it is unlikely that the domestic market price is much distorted owing to the Government control of rice. At present, the supply and demand of rice is almost balanced, though a slight unbalance is seen on the year-to-year basis. Such a tendency is likely to continue in the future, and the domestic market price can be used as the price for economic analysis.

The price of dry, unhulled rice (gobah hering) is 135 Rupiah per Kg as of 1982. The average crop of Padi Kering for one year throughout both the dry season and the rainy season will be approximately 4.7 tons per hectare. When Padi Kering is converted to Gabar Kering on a 80:65 basis according to the Weight Conversion Table prepared by the Food Agency (BULOG), the average crop per hectare becomes 3.8 tons. From this figure, the estimated earnings of rice per hectare is 513×10^3 Rupiah.

Maize is cultivated for the farmer's own use and part of the crop is traded at the village market. Therefore, the price ex farmhouse is used as the price for economic analysis. The price of dry corn grains (pipilan kering) is 120 Rupiah per Kg as of 1982. The average crop of corn on the cob (Jajung Glondhong) is estimated to be some 1.6 ton per hectare in one year. Though an exact value on the weight conversion rate of maize is unknown, it is conceivable that the net weight will become almost half if it is taken off the cob and dried out. The crop of dry corn grains per hectare will then become 0.8 tons. Then, income of maize per hectare will amount to 96×10^3 Rupiah.

Since the greater part of the coffee crop is exported, the border price is used for economic analysis. In 1982, the FOB price at Surabaya port was $1,120 \times 10^3$ Rp/ton. On the other hand, the unit price of freight between Surabaya and Kab. Lumajang (280 km) was 150 Rp/ton.km so actual freight is 42×10^3 Rp/ton. The unit price of freight reduced from the FOB price is $1,078 \times 10^3$ Rp/ton.

As mentioned before, the estimated profit for the next three years is added to the present price. Given that the unit price of coffee is q and the discount ratio is r, the present value Q excluding the estimated 3 years profit can be found by applying the following formula

$$Q = q + \frac{q}{1+r} + \frac{q}{(1+r)^2}$$

Then, given that $q = 1.078 \times 10^3$ Rp/ton and r is 19%, Q will be $2,745 \times 10^3$ Rp/ton. (The discount ratio will be discussed in the paragraph "Estimation"). Since the average coffee crop is 0.41 ton/ha, earnings per hectare will be $1,125 \times 10^3$ Rp/ha. These estimated values are shown in Table-5.19.

Table-5.19 ESTIMATED UNIT PRICE
(10**6 RP)

ASSET	BUILDING URBAN AREA	BUILDING RURAL AREA	MOVABLE GOODS URBAN AREA	MOVABLE GOODS RURAL AREA
MOSQUE (L)	100.000	0.800	12.000	0.600
MOSQUE (S)	6.000	0.600	2.000	0.400
CHURCH	4.000	0.400	2.000	0.200
HOSPITAL (L)	8.000	3.600	7.000	2.400
HOSPITAL (S)	7.000	2.400	2.000	0.800
SCHOOL	10.000	6.000	4.000	1.600
FACTORY (L)	6.000	10.000	6.000	2.000
FACTORY (S)	1.600	1.400	1.600	0.300
STR FD & BEV	1.800	3.000	1.400	2.000
STR CLOTHING	6.000	12.000	2.000	4.000
STR GR &RICE	3.000	5.100	1.800	1.600
STR GROCERY	4.000	4.000	1.800	0.800
STR OTHERS	6.000	6.000	2.000	2.000
OFFICE	4.000	2.000	0.800	0.140
HOUSE (UPR)	18.000	3.000	8.000	2.000
HOUSE (MDL)	7.000	2.000	3.600	1.800
HOUSE (LWR)	1.800	0.200	1.200	0.160

CROP	YIELD	UNIT PRICE
PD RICE AREA	3.800	0.135
MAIZE AREA	0.800	0.120
COFFEE AREA	0.410	2.745

	EXPECTED RETURN
BUFFALO	0.600
COW & OX	0.722
HORSE	0.314
GOAT	0.040
SHEEP	0.031
PIG	0.074
DUCK	0.005
CHICKEN	0.005
PEOPLE	1.100

(3) Estimated Value of Livestock and Poultry

The estimated value of livestock and poultry is found as the sum of the expected benefits which livestock and poultry will produce every year. This estimated value can be found by discounting the expected future profits and by converting them into the current value.

Given that the expected benefits which poultry (i) will produce every year is Vi, that the discount ratio is r, and also that the average service life of i is n years, then, the estimated value Vi of i can be found by the following equation:

$$Vi = \sum_{t=1}^{n} \frac{Vi}{(1+r)^{t-1}}$$

(The discount ratio Y will be discussed in the paragraph of "Estimated value of inhabitant").

The yearly benefit livestock produces is determined according to use. Labour, reproduction or raising the animals for slaughter are conceivable main uses. In the case of buffaloes and cattle, they are used for farming and the transportation of agricultural products.

The owner of the animal is not always the person who uses it as the leasing of animals is common. In this case, the yearly lease charge is regarded as part of the profit accrued from the labour of the animal (buffaloes and cattle). Horses are used for pulling carriages and from the findings of the survey on file, a horse is estimated to earn 70 Rupiah a year.

Cattle are sold for slaughter at the end of their working life, while goats, sheep and pigs are mainly raised for slaughter. The profit obtained from slaughter can be converted into the annual profit accrued from the animal based on its average economic life. The profit from domestic ducks and fowls, however, comes from eggs before they are finally slaughtered for meat.

As young livestock are sold in the market, the yearly profit from breeding can be found through the number of animals born in a year and the market price.

Table-5.20 shows a summary of the estimated annual profit of livestock classified by use.

The estimated value of livestock and poultry was found by estimating that the remaining work life as half of the average work life (N), by using the discount rate of 19% (R) and finally substituting these values of N and R into the formula shown on the above. The estimated values are shown on Table-5.19.

Table-5.20 Evaluation of Livestock and Poultry

	Market Price (10^3 Rp)	Use	Yearly Profit Per Head (10^3 Rp)			Remaining Work Life	Estimated Value (10^3 Rp)
Buffalo	250	Labour	Profit from labour (lease charge for labour) Profit from reproduction (Production of calves)	Rp 90 Rp 75	165	5	600
Cow & Ox		Labour Meat	Profit from labour (lease charge of labour) Profit from reproduction (production of calves) Profit from slaughter	Rp 90 Rp 75 Rp 65	230	4	722
Horse	125	Labour	Profit from labour (carriage) Profit from reproduction	Rp 70 Rp 30	100	4	314
Goat	30	Meat	Profit from slaughter Profit from reproduction	Rp 7 Rp 15	22	2	40
Sheep	30	Meat	Profit from slaughter Profit from reproduction Profit from wool	Rp 5 Rp 9 Rp 3	17	2	74
Pig	60	Meat	Profit from slaughter Profit from reproduction	Rp 25 Rp 15	40	2	74
Duck	2	Eggs	Profit from egg-laying	Rp 3		2	5.5
Fowl	2.5	Eggs	Profit from egg-laying	Rp 3		2	5.5

(4) Estimated Value of Inhabitants

The most common method in estimating inhabitant's economic value is as follows: 1) at first, to estimate, over a long period, the remaining economic life of that person and the net income (after deducting necessary expenses from the gross income). 2) secondly, to find the current value of the latter.

However, since it is very difficult to obtain income statistics classified by the age of inhabitants living in the possible disaster area, GRDP (Gross Regional Domestic Product) per capita should be used in place of the gross income. In addition, the estimated remaining average life should be used in place of the estimated remaining economic life when using GRDP per capita. The necessary expenses are to be considered the average consumption expenses per capita.

In 1979, GRDP per capita in the East Java was 149,175 Rp. GRDP in 1982 was estimated to be 276 x 10^3 Rp by using the average annual growth rate of GRDP per capita (22.78%, actual performance between 1975 and 1979). On the other hand, the average consumption expenses per capita in 1982 was estimated to be 139 x 10^3 Rp by using the above growth rate due to the average consumption expenses per capita being 61,356 Rp in 1978. Therefore, the average net income was estimated to be 137 x 10^3 Rp per capita.

In Kab. Lumajang, according to population composition statistics classified by age and the field survey, the average age in this area was estimated to be 23 years old with an average life span of 53 years.

On the other hand, the growth rate of real GRDP per capita in East Java from 1975 to 1979 was 4.52% in the yearly mean. This figure should be used in estimating the average net income per capita for the next 30 years. In other words, calculations are to be made on the basis that the average net income per capita for the next 30 years will increase at the rate of 4.52% every year.

The effective interest after deducting inflationary factors from the nominal interest shall be used for the discount rate in order to find the current value. In the case of interest, the local bank rate of 30% a year shall be used. From 1976 to 1980, the rate of inflation in regard to the farmer's economy was 11% in the yearly mean, thus making the real interest 19%. This 19% interest shall be applied as the discount rate in the calculation for coffee, livestock and poultry, too.

In view of the above, the general equation to find an estimated human value is as follows:

$$V = \sum_{t=1}^{n} \frac{u(1+g)^{t-1}}{(1+(k-h))^{t-1}}$$

Given V = Estimated human value
u = Average net income per capita in one year
g = Growth of the average net income per capita
k = Nominal interest
h = Rate of inflation
n = Average remaining life
t = Year

Accordingly, the estimated human value is $1,100 \times 10^3$ Rp.

(5) Estimated Value of Public Facilities

The estimated value of public facilities shall be given as the residual value in the same way as for general assets. However, since the cost of construction in the year of completion is unknown, it is found by estimating firstly the construction cost in 1982 and by putting back it to completion year considering the number of years elapsed.

The residual value is then computed by using the estimated construction cost, the service life and the number of years elapsed.

Estimated total value of the public facilities in the possible disaster area is shown on Table-5.21 and Table-5.22.

Table-5.21 Estimated Value of Public Facilities in the possible disaster area (K. Rejali)

Unit: Rp1,000,000

Assets	Possible Disaster Area	I	II	III	IV	V	VI
Rivers	Sand arrest dams	253.4	106.2				
	Consolidation dam		96.2				
	Dikes			135.7	40.0		
	Embankment						
	Spur dikes				3.6		
	Intakes			1.4	9.2	4.1	
Roads	National highways						
	Prefectural roads						
	Village roads					11.1	
	Others	1.8	2.8	12.8	46.3	7.1	8.1
Bridges		2.0	0.1	0.1	1.1	0.1	
Total		257.2	205.3	150.0	100.2	22.4	8.1

Table-5.22 Estimated Value of Public Facilities in the possible disaster area (K. Glidik)

Unit: Rp1,000,000

Assets	Possible Disaster Area	I	II	III	IV	V	VI
Rivers	Sand arrest dams						
	Consolidation dams						
	Dikes	67.2			3.6	1.6	
	Embankments						
	Spur dikes	14.8			19.2		
	Intakes						
Raods	National highways						
	Prefectural roads						
	Village roads						
	Others				3.6	5.5	
Bridges					1.8		
Total		82.0			28.2	7.1	

(6) Sediment Removal Expense

The unit price for sediment removal expense was computed on the basis of the same labour cost and machine hire cost that were used in the calculation of construction cost estimation. The removal of sediment is not carried out in the mountains and forests.

The calculated sediment removal expense for the entire possible disaster area is indicated in Table-5.23.

Sediment removal expense for possible disaster area was estimated based on the above-mentioned unit cost as well as the harmful sediment volume of the possible disaster area and land utilization classification, as shown in Table-5.24.

Table-5.23 Unit Price of Sediment Removal

(1982 price)

Land use classification / River basin	Housing Site	Paddy Field	Farm	Estate	River Channel
Unit price (Rp/m^3)	1,116	461	430	535	430

Table-5.24 Sediment Removal Expense for Possible Disaster Area

(10^6Rp)

Zone in possible disaster area / River basin	I	II	III	IV	V
K. Rejali	0	474	1,734	4,732	222
K. Glidik				2,471	1,642

5.3.3 INCREMENT OF DAMAGE POTENTIAL

The properties in the possible disaster area are considered to fluctuate due to such factors as the increase in population and the improvement of agricultural productivity or enhanced local production activities. In order to establish a reliable assessment of sediment damage in the distant future, it is necessary to estimate the increase of the damage potential.

The rate of population increase from 1971 to 1980 in Kab. Lumajang was 1.17%. After supposing that the increment rate of general property and public facilities is the same, then the increase rate of damage potential of general property, public facilities and inhabitants will be 1.17%.

Damage to paddy rice causes the greatest concern among agricultural products. However, since the output of paddy rice goes up and down every year, a general trend of paddy rice products cannot be seen. Therefore the average rate of increase was calculated by finding the moving average of every three years between 1969 and 1979. The average of increase rate of paddy rice production for the last 10 years was 7.58%. As the increase rate of maize and coffee production is considered to be lower than that of paddy rice, the future increase rate of production was estimated to be 7%. The average products of the crops of these agricultural products has been increasing for several years. Though, it is anticipated to level off within the next 10 years. The increase in the rate of damage potential is, therefore, set at 7% for the next 10 years and at 3.5% thereafter.

Cattle comprise the major part of livestock in this area using the cattle as an example of livestock, the increment rate in the past 3 years was some 3%. As cattle are used for farming, the increase rate of damage potential is established at 3% for the next 10 years and 1.5% thereafter, as in the case of agricultural products.

<u>Rate of Increase of Damage Potential</u>

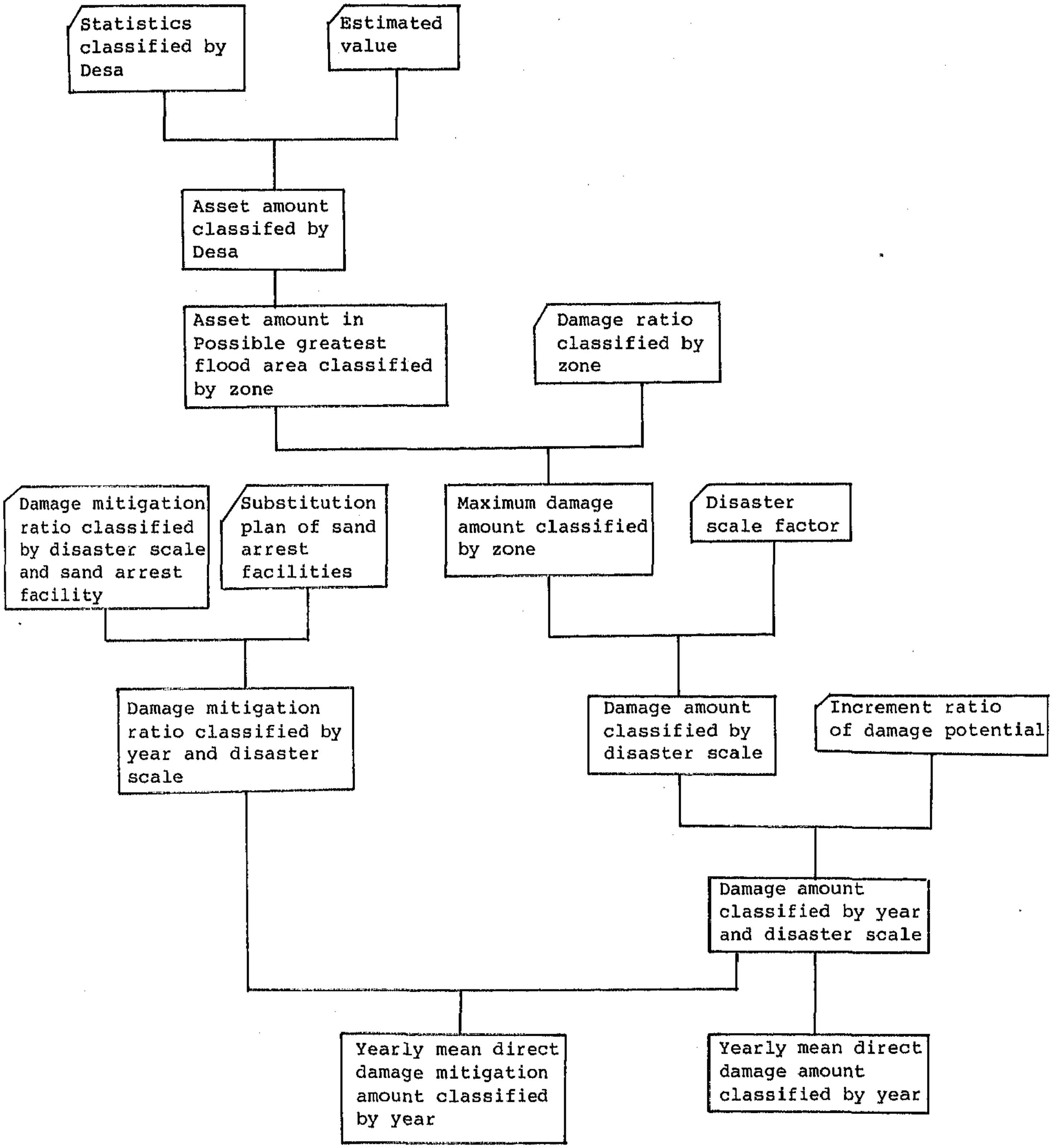
	Next 10 years	Thereafter
General property	1.17%	
Agricultural products	7%	3.5%
Livestock and poultry	3%	1.5%
Inhabitants	1.17%	
Public facilities	1.17%	

Furthermore, it should be noted in the economic evaluation that, although the numerical values in 1982 are used, the estimated damage amount in 1986 as a starting year of this project, will already include the damage potential for 4 years and that all these figures are estimated on the supposition. There is no increment of potential in sediment removal expense.

5.3.4 Estimated Value of Direct Damage

The calculation procedure for finding direct damage is as shown on Fig.-5.3. Expenses for public facilities and sediment removal are directly apportioned to each zone by consulting the map. However, as mentioned above, the statistics on general property, agricultural products, livestock, poultry and population are prepared for every zone on the ratio of acreage and classified by Desa. Because the estimated value of general properties are classified into urban and rural types; they were converted into a monetary value at the time of preparing the statistics classified by Desa.

Figure-5.3 Flow Chart of Measurement of Direct Damage Amount



$$Qi = qi \times Pi \qquad \ldots\ldots 1$$

Given i = Item of detail properties
Qi = Monetary value of i
qi = Quantity of i
Pi = Estimated value of i

(The relevant estimated value is applied according to the type of Desa)

The estimated value of each item in each possible disaster area zone was found by comparing the ratio of Desa acreage with the acreage of the each zone of the possible disaster area. The estimated value of each detail item in each possible disaster area is shown in Table-5.25, 26, 27.

$$DMAXij = QMAXij \times dij \qquad \ldots\ldots 2$$

Given i = Item of detail properties
j = Classification of Zone (I - VI)
$DMAXij$ = Damage amount of detail i in possible disaster area in Zone j
$QMAXij$ = Monetary value of detail i in possible disaster area in Zone j
dij = Damage ratio of i in Zone j

DMAXij, is therefore the damage amount of all items at the possible disaster area, classified by zone.

Next, the damage amount of all items at all possible disaster zones was found by employing the following equation. The direct damage of possible disaster area is shown in Table-5.28, 30, 32.

$$DMAXk = \sum_{j=1}^{6} \sum_{i=i1}^{i2} DMAXij \qquad \ldots\ldots \quad 3$$

Given k = Item of properties
i1 = The first of the item number included in k
i2 = The last of the item number included in k
j = Zone of the possible disaster area
DMAXk = Damage amount of k at the all possible disaster area

The damage amount classified by item in each return period can be found by multiplying the damage amount classified by item at all the possible disaster area by the return period of 100 years. The damage amount in each return period is shown in Table-5.29, 31, 33.

$$DFKl = Dk \times fl \qquad \ldots\ldots \quad 4$$

Given k = Item of properties
l = Return period (year)
DFkl = Damage amount of k at l
fl = Disaster magnitude of l years return period

The damage amount increases every year by an increase in damage potential. Therefore, adjustment by the increased rate of damage potential is necessary throughout the project life.

$$DFklr = DFkl \times (1+rk)^{t+3} \qquad \ldots\ldots \quad 5$$

Given t = Year
rk = Increased rate of damage potential of k

However, as the basic year is 1982, the damage potential increase factor already becomes $(1+rk)^{1+3} = (1+rk)^{4}$ in

1986, as the initial year of the project. Therefore the time series numerical value of the direct damage amount in every return period should be found by finding the total damage amount for each item.

$$SDFet = \sum_{k=1}^{6} DFket \qquad \ldots\ldots \quad 6$$

Given SDFet = Time series value of the direct damage amount in every return period

The direct damage amount of every return period is translated into the form of the annual mean direct damage amount by applying the following equation.

$$D = \frac{1}{2} \sum_{i=1}^{S} (P_{i-1} - Pi)(G_{i-1} + Gi) \qquad \ldots\ldots \quad 7$$

Given P = Probability density function

$P_{i-1} - Pi$ = Occurrence probability of flood taking place between i-1 and i

G = The damage amount in a certain year

S = The number of return period used for the damage amount calculation

In this research, the return period were established at 3, 5, 10, 20, 40, 70 and 100 years. Supposing that 1 and 2 years (less than 3 years) are zero year, the calculation could be made on the basis that the probability density function was Po = 1.00 and the damage amount was Go = 0.

The annual mean direct damage amount in the both river basins of K. Rejali and K. Glidik will be put at 2,108 million Rupiah in the starting year of the project (1986).

The amount found herewith is the damage sum which might occur if sediment control facilities were not constructed.

Furthermore, the public facilities and the sediment removal expenses were computed by adding the equations (2) and (4) respectively.

The annual direct damage by each return period is shown in Table-5.34, 35, 36.

Table-5.25 ESTIMATED TOTAL VALUE OF EACH ITEM ***
(REJALI)

	ZONE - 1	ZONE - 2	ZONE - 3	ZONE - 4	ZONE - 5	ZONE - 6	TOTAL
MOSQUE (L)	1.68	0.14	0.91	1.03	0.07	0.03	3.87
MOSQUE (S)	3.11	0.19	1.05	14.52	1.65	0.81	21.34
CHURCH	0.05	0.01	0.07	0.09	0.03	0.02	0.27
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.42	0.0	0.0	0.0	0.0	0.0	0.42
SCHOOL	22.84	3.84	24.48	48.11	5.16	2.52	106.95
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.76	0.25	1.93	4.22	0.36	0.18	7.70
STR FD & BEV	5.89	1.48	11.00	39.35	4.39	2.14	64.25
STR CLOTHING	0.0	0.82	3.98	2.63	0.0	0.0	7.43
STR GR &RICE	6.38	3.88	22.85	8.72	0.0	0.0	41.81
STR GROCERY	0.0	0.14	0.66	0.14	0.0	0.0	0.94
STR OTHERS	17.86	2.11	12.77	53.45	2.58	1.26	90.03
OFFICE	2.50	0.83	4.85	3.97	0.17	0.08	12.40
HOUSE (UPR)	1010.62	182.56	1375.40	1791.79	159.44	77.87	4597.68
HOUSE (MDL)	131.40	91.87	630.37	1401.35	143.62	70.14	2468.75
HOUSE (LWR)	85.39	11.41	60.14	86.65	7.53	3.68	254.80
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSQUE (L)	1.26	0.11	0.69	0.77	0.05	0.03	2.90
MOSQUE (S)	2.08	0.13	0.70	9.68	1.10	0.54	14.23
CHURCH	0.02	0.01	0.03	0.05	0.02	0.01	0.14
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.14	0.0	0.0	0.0	0.0	0.0	0.14
SCHOOL	6.09	1.02	6.53	12.83	1.38	0.67	28.52
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.16	0.05	0.41	0.90	0.08	0.04	1.65
STR FD & BEV	3.93	0.98	7.34	26.23	2.92	1.43	42.83
STR CLOTHING	0.0	0.27	1.33	0.88	0.0	0.0	2.48
STR GR &RICE	2.00	1.22	7.17	2.73	0.0	0.0	13.12
STR GROCERY	0.0	0.03	0.13	0.03	0.0	0.0	0.19
STR OTHERS	5.95	0.70	4.26	17.82	0.86	0.42	30.01
OFFICE	0.17	0.06	0.34	0.28	0.01	0.01	0.87
HOUSE (UPR)	673.75	121.70	916.94	1194.53	106.30	51.91	3065.13
HOUSE (MDL)	118.26	82.68	567.33	1261.22	129.26	63.13	2221.88
HOUSE (LWR)	68.31	9.12	48.11	69.32	6.03	2.94	203.84
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA	97.14	19.68	137.85	262.39	27.44	13.40	557.91
MAIZE AREA	6.57	1.37	9.63	22.17	2.48	1.21	43.42
COFFEE AREA	42.97	1.35	9.44	7.54	0.35	0.17	61.81
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	36.37	4.31	28.65	46.01	3.77	1.84	120.94
COW & OX	128.61	36.59	235.92	503.48	40.86	19.95	965.40
HORSE	0.20	0.62	6.45	11.80	1.05	0.51	20.63
GOAT	2.05	1.04	6.48	21.71	1.86	0.91	34.05
SHEEP	0.95	0.89	5.03	8.61	0.69	0.34	16.51
PIG	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DUCK	0.55	0.10	0.61	2.25	0.24	0.12	3.86
CHICKEN	5.63	0.60	4.91	35.71	2.18	1.06	50.10
PEOPLE	4663.76	714.45	5006.48	9555.51	1000.49	488.61	21429.29
TOTAL	7155.84	1298.61	9163.20	16530.42	1654.40	807.97	36610.43

Table-5.26 ESTIMATED TOTAL VALUE OF EACH ITEM ***
(GRIDIK)

	ZONE - 1	ZONE - 2	ZONE - 3	ZONE - 4	ZONE - 5	ZONE - 6	TOTAL
MOSQUE (L)	1.40	0.0	0.0	1.08	0.69	1.66	4.83
MOSQUE (S)	3.10	0.0	0.0	3.94	3.35	5.13	15.52
CHURCH	0.01	0.0	0.0	0.12	0.51	0.24	0.88
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.84	0.0	0.0	0.37	1.53	2.50	5.24
SCHOOL	8.53	0.0	0.0	8.07	14.69	29.24	60.53
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.47	0.0	0.0	4.85	0.44	1.32	7.08
STR FD & BEV	2.21	0.0	0.0	6.98	0.57	32.29	42.06
STR CLOTHING	0.0	0.0	0.0	0.66	0.06	75.44	76.16
STR GR &RICE	0.0	0.0	0.0	5.40	2.17	33.10	40.67
STR GROCERY	0.0	0.0	0.0	9.64	33.67	119.60	162.91
STR OTHERS	10.42	0.0	0.0	19.19	64.46	194.69	288.77
OFFICE	0.04	0.0	0.0	1.51	1.71	2.45	5.71
HOUSE (UPR)	0.0	0.0	0.0	271.99	24.73	74.18	370.89
HOUSE (MDL)	41.38	0.0	0.0	405.49	313.76	281.02	1041.65
HOUSE (LWR)	74.29	0.0	0.0	58.20	96.56	121.97	351.03
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSQUE (L)	1.05	0.0	0.0	0.81	0.52	1.24	3.62
MOSQUE (S)	2.07	0.0	0.0	2.63	2.23	3.42	10.35
CHURCH	0.00	0.0	0.0	0.06	0.26	0.12	0.44
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.28	0.0	0.0	0.12	0.51	0.83	1.75
SCHOOL	2.28	0.0	0.0	2.15	3.92	7.80	16.14
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.10	0.0	0.0	1.04	0.09	0.28	1.52
STR FD & BEV	1.48	0.0	0.0	4.65	0.38	21.53	28.04
STR CLOTHING	0.0	0.0	0.0	0.22	0.02	25.15	25.39
STR GR &RICE	0.0	0.0	0.0	1.69	0.68	10.39	12.76
STR GROCERY	0.0	0.0	0.0	1.93	6.73	23.92	32.58
STR OTHERS	3.47	0.0	0.0	6.40	21.49	64.90	96.26
OFFICE	0.00	0.0	0.0	0.11	0.12	0.17	0.40
HOUSE (UPR)	0.0	0.0	0.0	181.32	16.48	49.45	247.26
HOUSE (MDL)	37.24	0.0	0.0	364.94	282.38	252.92	937.48
HOUSE (LWR)	59.43	0.0	0.0	46.56	77.25	97.58	280.82
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA	26.78	0.0	0.0	30.53	44.43	49.19	150.93
MAIZE AREA	1.68	0.0	0.0	4.23	3.01	3.73	12.65
COFFEE AREA	38.93	0.0	0.0	117.26	71.24	91.21	318.65
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	0.0	0.0	0.0	5.00	20.38	53.77	79.14
COW & OX	0.0	0.0	0.0	66.37	246.04	170.20	482.62
HORSE	0.0	0.0	0.0	0.79	1.42	0.76	2.97
GOAT	0.0	0.0	0.0	0.16	0.28	0.49	0.92
SHEEP	0.0	0.0	0.0	5.71	7.38	4.92	18.00
PIG	0.0	0.0	0.0	0.16	0.57	3.62	4.35
DUCK	0.0	0.0	0.0	0.39	4.20	5.88	10.46
CHICKEN	0.0	0.0	0.0	7.14	10.26	10.94	28.34
PEOPLE	2136.36	0.0	0.0	3241.81	3619.05	4134.39	13131.60
TOTAL	2453.87	0.0	0.0	4891.67	5000.21	6063.62	18409.37

Table-5.27 ESTIMATED TOTAL VALUE OF EACH ITEM ***
(TOTAL)

	ZONE - 1	ZONE - 2	ZONE - 3	ZONE - 4	ZONE - 5	ZONE - 6	TOTAL
MOSQUE (L)	3.09	0.14	0.91	2.11	0.76	1.69	8.70
MOSQUE (S)	6.22	0.19	1.05	18.46	5.00	5.94	36.86
CHURCH	0.06	0.01	0.07	0.21	0.55	0.26	1.15
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	1.26	0.0	0.0	0.37	1.53	2.50	5.66
SCHOOL	31.37	3.84	24.48	56.18	19.85	31.76	167.48
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	1.22	0.25	1.93	9.07	0.80	1.50	14.78
STR FD & BEV	8.11	1.48	11.00	46.32	4.96	34.44	106.31
STR CLOTHING	0.0	0.82	3.98	3.29	0.06	75.44	83.59
STR GR &RICE	6.38	3.88	22.85	14.12	2.17	33.10	82.49
STR GROCERY	0.0	0.14	0.66	9.78	33.67	119.60	163.84
STR OTHERS	28.28	2.11	12.77	72.65	67.04	195.95	378.80
OFFICE	2.54	0.83	4.85	5.47	1.89	2.53	18.11
HOUSE (UPR)	1010.62	182.56	1375.40	2063.78	184.17	152.05	4968.57
HOUSE (MDL)	172.79	91.87	630.37	1806.84	457.38	351.16	3510.40
HOUSE (LWR)	159.68	11.41	60.14	144.85	104.09	125.65	605.83
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOSQUE (L)	2.32	0.11	0.69	1.58	0.57	1.27	6.52
MOSQUE (S)	4.15	0.13	0.70	12.31	3.33	3.96	24.57
CHURCH	0.03	0.01	0.03	0.11	0.27	0.13	0.58
HOSPITAL (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HOSPITAL (S)	0.42	0.0	0.0	0.12	0.51	0.83	1.89
SCHOOL	8.37	1.02	6.53	14.98	5.29	8.47	44.66
FACTORY (L)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FACTORY (S)	0.26	0.05	0.41	1.94	0.17	0.32	3.17
STR FD & BEV	5.41	0.98	7.34	30.88	3.31	22.96	70.87
STR CLOTHING	0.0	0.27	1.33	1.10	0.02	25.15	27.86
STR GR &RICE	2.00	1.22	7.17	4.43	0.68	10.39	25.88
STR GROCERY	0.0	0.03	0.13	1.96	6.73	23.92	32.77
STR OTHERS	9.43	0.70	4.26	24.22	22.35	65.32	126.27
OFFICE	0.18	0.06	0.34	0.38	0.13	0.18	1.27
HOUSE (UPR)	673.75	121.70	916.94	1375.85	122.78	101.36	3312.39
HOUSE (MDL)	155.51	82.68	567.33	1676.16	411.64	316.04	3159.36
HOUSE (LWR)	127.74	9.12	48.11	115.88	83.28	100.52	484.66
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD RICE AREA	123.93	19.68	137.85	292.92	71.87	62.59	708.84
MAIZE AREA	8.25	1.37	9.63	26.40	5.48	4.94	56.07
COFFEE AREA	81.90	1.35	9.44	124.80	71.59	91.38	380.46
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUFFALO	36.37	4.31	28.65	51.01	24.14	55.61	200.09
COW & OX	128.61	36.59	235.92	569.85	286.90	190.16	1448.02
HORSE	0.20	0.62	6.45	12.59	2.48	1.27	23.61
GOAT	2.05	1.04	6.48	21.87	2.14	1.39	34.97
SHEEP	0.95	0.89	5.03	14.32	8.07	5.26	34.51
PIG	0.0	0.0	0.0	0.16	0.57	3.62	4.35
DUCK	0.55	0.10	0.61	2.64	4.43	5.99	14.33
CHICKEN	5.63	0.60	4.91	42.85	12.44	12.00	78.44
PEOPLE	6800.12	714.45	5006.48	12797.31	4619.54	4623.00	34560.89
TOTAL	9609.70	1298.61	9163.20	21422.09	6654.61	6871.59	55019.79

Table-5.28 MAXIMUM DIRECT DAMAGE TO EACH CATEGORY
(REJALI)

TYPE OF FLOOD	ASSET	CROP	CATTLE	PEOPLE	FACILITY	REH.LAND
MUD FLOW	4799.55	344.05	186.39	1174.82	84.74	7162.00
FLOOD	.00	.00	.00	.00	.00	.00

Table-5.29 DIRECT DAMAGE TO EACH CATEGORY BY RETURN PERIOD
(REJALI)

RETURN PERIOD	ASSET	CROP	CATTLE	PEOPLE	FACILITY	REH.LAND
3	475.16	34.06	18.45	116.31	8.39	709.04
5	575.95	41.29	22.37	140.98	10.17	859.44
10	705.53	50.58	27.40	172.70	12.46	1052.81
20	892.72	63.99	34.67	218.52	15.76	1332.13
40	1084.70	77.76	42.12	265.51	19.15	1618.61
70	1334.28	95.65	51.82	326.60	23.56	1991.04
100	1540.66	110.44	59.83	377.12	27.20	2299.00

Table-5.30 MAXIMUM DIRECT DAMAGE TO EACH CATEGORY (GRIDIK)

TYPE OF FLOOD	ASSET	CROP	CATTLE	PEOPLE	FACILITY	REH.LAND
MUD FLOW	1098.05	203.92	55.56	594.84	6.35	4113.00
FLOOD	.00	.00	.00	.00	.00	.00

Table-5.31 DIRECT DAMAGE TO EACH CATEGORY BY RETURN PERIOD (GRIDIK)

RETURN PERIOD	ASSET	CROP	CATTLE	PEOPLE	FACILITY	REH.LAND
3	183.38	34.05	9.28	99.34	1.06	686.87
5	221.81	41.19	11.22	120.16	1.28	830.83
10	280.00	52.00	14.17	151.68	1.62	1048.81
20	388.71	72.19	19.67	210.57	2.25	1456.00
40	450.20	83.61	22.78	243.89	2.61	1686.33
70	509.50	94.62	25.78	276.01	2.95	1908.43
100	546.83	101.55	27.67	296.23	3.16	2048.27

Table-5.32 MAXIMUM DIRECT DAMAGE TO EACH CATEGORY
(TOTAL)

TYPE OF FLOOD	ASSET	CROP	CATTLE	PEOPLE	FACILITY	REH.LAND
MUD FLOW	5897.61	547.98	241.95	1769.66	91.10	11275.00
FLOOD	.00	.00	.00	.00	.00	.00

Table-5.33 DIRECT DAMAGE TO EACH CATEGORY BY RETURN PERIOD
(TOTAL)

RETURN PERIOD	ASSET	CROP	CATTLE	PEOPLE	FACILITY	REH.LAND
3	658.53	68.12	27.73	215.65	9.45	1395.91
5	797.75	82.48	33.59	261.14	11.45	1690.27
10	985.54	102.58	41.57	324.38	14.08	2101.63
20	1281.43	136.18	54.34	429.09	18.01	2788.13
40	1534.90	161.36	64.90	509.39	21.76	3304.94
70	1843.77	190.27	77.60	602.61	26.51	3899.47
100	2087.49	211.99	87.50	673.35	30.37	4347.28

Table-5.34 ANNUAL DIRECT DAMAGE BY RETURN PERIOD
(REJALI)

YEAR	RETURN PERIOD (YEARS) 3	5	10	20	40	70	100	AVE.
1	1413.98	1713.91	2099.54	2656.56	3227.87	3970.56	4584.71	1119.88
2	1425.40	1727.76	2116.51	2678.03	3253.95	4002.64	4621.76	1128.93
3	1437.17	1742.02	2133.97	2700.13	3280.80	4035.68	4659.90	1138.24
4	1449.29	1756.71	2151.98	2722.91	3308.48	4069.72	4699.21	1147.85
5	1461.79	1771.87	2170.54	2746.39	3337.02	4104.82	4739.74	1157.75
6	1474.69	1787.50	2189.69	2770.63	3366.46	4141.05	4781.57	1167.96
7	1462.23	1772.41	2171.20	2747.23	3338.03	4106.07	4741.19	1158.10
8	1472.28	1784.56	2186.11	2766.10	3360.96	4134.27	4773.75	1166.05
9	1482.48	1796.95	2201.26	2785.27	3384.25	4162.92	4806.83	1174.13
10	1492.84	1809.51	2216.65	2804.74	3407.91	4192.03	4840.43	1182.34
11	1503.37	1822.27	2232.28	2824.52	3431.95	4221.60	4874.58	1190.68
12	1514.07	1835.24	2248.17	2844.62	3456.37	4251.64	4909.27	1199.16
13	1524.95	1848.42	2264.31	2865.05	3481.19	4282.17	4944.52	1207.77
14	1536.00	1861.81	2280.72	2885.81	3506.41	4313.20	4980.35	1216.52
15	1547.22	1875.42	2297.39	2906.91	3532.05	4344.73	5016.76	1225.41
16	1558.64	1889.26	2314.34	2928.35	3558.10	4376.78	5053.76	1234.45
17	1570.24	1903.32	2331.57	2950.15	3584.59	4409.36	5091.38	1243.64
18	1582.03	1917.62	2349.08	2972.30	3611.51	4442.48	5129.62	1252.98
19	1594.02	1932.15	2366.88	2994.83	3638.88	4476.15	5168.50	1262.48
20	1606.21	1946.93	2384.98	3017.74	3666.71	4510.38	5208.03	1272.13
21	1618.61	1961.95	2403.39	3041.03	3695.01	4545.19	5248.22	1281.95
22	1631.22	1977.23	2422.11	3064.71	3723.79	4580.59	5289.09	1291.93
23	1644.04	1992.77	2441.15	3088.80	3753.05	4616.59	5330.66	1302.09
24	1657.08	2008.58	2460.51	3113.29	3782.82	4653.20	5372.94	1312.41
25	1670.34	2024.65	2480.20	3138.21	3813.10	4690.45	5415.95	1322.92
26	1683.83	2041.01	2500.24	3163.57	3843.90	4728.34	5459.70	1333.61
27	1697.56	2057.65	2520.62	3189.36	3875.24	4766.89	5504.21	1344.48
28	1711.53	2074.58	2541.36	3215.60	3907.13	4806.11	5549.50	1355.54
29	1725.74	2091.81	2562.47	3242.30	3939.57	4846.02	5595.59	1366.80
30	1740.21	2109.34	2583.94	3269.48	3972.59	4886.64	5642.49	1378.25
31	1754.93	2127.19	2605.80	3297.14	4006.20	4927.98	5690.22	1389.91
32	1769.91	2145.35	2628.05	3325.29	4040.41	4970.06	5738.81	1401.78
33	1785.17	2163.84	2650.71	3353.95	4075.23	5012.90	5788.27	1413.86
34	1800.70	2182.67	2673.77	3383.13	4110.69	5056.51	5838.63	1426.16
35	1816.51	2201.83	2697.25	3412.84	4146.79	5100.91	5889.90	1438.69
36	1832.61	2221.35	2721.15	3443.09	4183.54	5146.13	5942.11	1451.44
37	1849.01	2241.23	2745.50	3473.90	4220.98	5192.18	5995.28	1464.43
38	1865.71	2261.47	2770.30	3505.28	4259.11	5239.08	6049.44	1477.66
39	1882.73	2282.09	2795.57	3537.25	4297.94	5286.85	6104.60	1491.13
40	1900.06	2303.10	2821.30	3569.81	4337.51	5335.52	6160.80	1504.86

Table-5.35 ANNUAL DIRECT DAMAGE BY RETURN PERIOD
(GRIDIK)

	RETURN PERIOD (YEARS)							
YEAR	3	5	10	20	40	70	100	AVE.
1	1046.16	1265.42	1597.43	2217.61	2568.42	2906.70	3119.69	843.41
2	1053.35	1274.11	1608.40	2232.84	2586.06	2926.66	3141.11	849.21
3	1060.82	1283.14	1619.81	2248.67	2604.40	2947.42	3163.39	855.23
4	1068.59	1292.54	1631.68	2265.15	2623.48	2969.01	3186.57	861.49
5	1076.68	1302.33	1644.03	2282.30	2643.35	2991.49	3210.70	868.02
6	1085.11	1312.53	1656.91	2300.18	2664.05	3014.92	3235.84	874.82
7	1070.03	1294.29	1633.88	2268.21	2627.02	2973.02	3190.87	862.66
8	1075.71	1301.16	1642.55	2280.24	2640.96	2988.79	3207.80	867.23
9	1081.49	1308.15	1651.38	2292.51	2655.16	3004.87	3225.05	871.90
10	1087.39	1315.28	1660.38	2305.00	2669.63	3021.25	3242.63	876.65
11	1093.40	1322.55	1669.56	2317.74	2684.39	3037.94	3260.55	881.49
12	1099.52	1329.96	1678.91	2330.72	2699.42	3054.95	3278.81	886.43
13	1105.76	1337.51	1688.44	2343.95	2714.75	3072.30	3297.42	891.46
14	1112.13	1345.21	1698.16	2357.44	2730.37	3089.98	3316.40	896.60
15	1118.62	1353.06	1708.07	2371.20	2746.30	3108.01	3335.75	901.83
16	1125.23	1361.06	1718.17	2385.23	2762.55	3126.40	3355.49	907.16
17	1131.98	1369.23	1728.48	2399.53	2779.12	3145.15	3375.61	912.60
18	1138.87	1377.55	1738.99	2414.13	2796.02	3164.28	3396.14	918.15
19	1145.89	1386.05	1749.71	2429.01	2813.26	3183.79	3417.08	923.81
20	1153.05	1394.71	1760.65	2444.20	2830.85	3203.69	3438.45	929.59
21	1160.36	1403.55	1771.81	2459.69	2848.80	3224.00	3460.24	935.48
22	1167.82	1412.58	1783.20	2475.50	2867.11	3244.73	3482.49	941.50
23	1175.44	1421.78	1794.83	2491.64	2885.80	3265.88	3505.19	947.64
24	1183.21	1431.18	1806.69	2508.11	2904.88	3287.47	3528.36	953.90
25	1191.14	1440.78	1818.80	2524.93	2924.35	3309.51	3552.02	960.30
26	1199.24	1450.58	1831.17	2542.10	2944.24	3332.01	3576.17	966.82
27	1207.51	1460.58	1843.80	2559.63	2964.54	3354.99	3600.83	973.49
28	1215.95	1470.79	1856.69	2577.53	2985.27	3378.46	3626.01	980.30
29	1224.58	1481.23	1869.86	2595.81	3006.45	3402.42	3651.74	987.25
30	1233.39	1491.88	1883.32	2614.49	3028.08	3426.90	3678.01	994.36
31	1242.39	1502.77	1897.06	2633.57	3050.18	3451.91	3704.85	1001.61
32	1251.59	1513.89	1911.10	2653.06	3072.75	3477.46	3732.27	1009.03
33	1260.98	1525.26	1925.45	2672.98	3095.83	3503.57	3760.30	1016.60
34	1270.59	1536.86	1940.12	2693.34	3119.40	3530.25	3788.93	1024.35
35	1280.40	1548.75	1955.11	2714.15	3143.50	3557.53	3818.21	1032.26
36	1290.44	1560.89	1970.43	2735.42	3168.14	3585.41	3848.13	1040.35
37	1300.70	1573.30	1986.09	2757.16	3193.32	3613.91	3878.72	1048.62
38	1311.19	1585.98	2002.11	2779.40	3219.08	3643.05	3910.00	1057.08
39	1321.91	1598.96	2018.49	2802.14	3245.41	3672.86	3941.99	1065.72
40	1332.88	1612.23	2035.24	2825.39	3272.35	3703.34	3974.71	1074.57

Table-5.36 ANNUAL DIRECT DAMAGE BY RETURN PERIOD
(TOTAL)

YEAR	RETURN PERIOD (YEARS) 3	5	10	20	40	70	100	AVE.
1	2460.14	2979.33	3696.97	4874.17	5796.28	6877.26	7704.40	1963.29
2	2478.75	3001.87	3724.91	4910.87	5840.00	6929.30	7762.87	1978.13
3	2497.98	3025.16	3753.78	4948.81	5885.20	6983.09	7823.29	1993.47
4	2517.88	3049.26	3783.65	4988.06	5931.96	7038.73	7885.78	2009.34
5	2538.47	3074.20	3814.57	5028.70	5980.36	7096.32	7950.44	2025.76
6	2559.80	3100.03	3846.60	5070.81	6030.51	7155.97	8017.41	2042.78
7	2532.26	3066.69	3805.08	5015.44	5965.05	7079.09	7932.05	2020.76
8	2547.99	3085.73	3828.66	5046.34	6001.92	7123.07	7981.55	2033.29
9	2563.97	3105.10	3852.64	5077.77	6039.41	7167.79	8031.88	2046.03
10	2580.23	3124.79	3877.03	5109.74	6077.54	7213.27	8083.06	2058.99
11	2596.77	3144.82	3901.84	5142.26	6116.33	7259.53	8135.12	2072.18
12	2613.59	3165.20	3927.08	5175.34	6155.79	7306.59	8188.08	2085.59
13	2630.71	3185.93	3952.75	5209.00	6195.94	7354.47	8241.95	2099.23
14	2648.12	3207.02	3978.88	5243.25	6236.79	7403.18	8296.75	2113.11
15	2665.84	3228.48	4005.46	5278.11	6278.35	7452.74	8352.51	2127.24
16	2683.87	3250.32	4032.51	5313.58	6320.65	7503.18	8409.25	2141.61
17	2702.22	3272.55	4060.04	5349.68	6363.71	7554.51	8467.00	2156.24
18	2720.90	3295.17	4088.07	5386.43	6407.53	7606.75	8525.76	2171.13
19	2739.91	3318.19	4116.59	5423.84	6452.14	7659.93	8585.58	2186.29
20	2759.27	3341.64	4145.63	5461.93	6497.56	7714.07	8646.47	2201.72
21	2778.97	3365.50	4175.20	5500.72	6543.80	7769.19	8708.47	2217.43
22	2799.04	3389.81	4205.31	5540.21	6590.90	7825.31	8771.58	2233.43
23	2819.47	3414.56	4235.97	5580.44	6638.85	7882.47	8835.86	2249.72
24	2840.28	3439.76	4267.20	5621.41	6687.70	7940.67	8901.31	2266.31
25	2861.48	3465.43	4299.01	5663.14	6737.45	7999.96	8967.97	2283.21
26	2883.07	3491.59	4331.41	5705.66	6788.14	8060.35	9035.87	2300.43
27	2905.07	3518.23	4364.42	5748.98	6839.78	8121.88	9105.04	2317.97
28	2927.48	3545.37	4398.06	5793.13	6892.40	8184.57	9175.52	2335.84
29	2950.32	3573.03	4432.33	5838.12	6946.02	8248.44	9247.32	2354.05
30	2973.60	3601.22	4467.26	5883.97	7000.67	8313.54	9320.50	2372.61
31	2997.32	3629.96	4502.87	5930.71	7056.38	8379.89	9395.07	2391.53
32	3021.50	3659.24	4539.16	5978.35	7113.16	8447.52	9471.08	2410.81
33	3046.15	3689.10	4576.16	6026.93	7171.06	8516.47	9548.57	2430.47
34	3071.29	3719.54	4613.88	6076.47	7230.09	8586.76	9627.56	2450.51
35	3096.91	3750.58	4652.35	6126.99	7290.29	8658.44	9708.11	2470.95
36	3123.05	3782.24	4691.58	6178.51	7351.68	8731.54	9790.24	2491.79
37	3149.71	3814.52	4731.60	6231.07	7414.30	8806.09	9874.01	2513.05
38	3176.90	3847.46	4772.41	6284.68	7478.18	8882.13	9959.44	2534.73
39	3204.64	3881.05	4814.05	6339.38	7543.36	8959.71	10046.59	2556.86
40	3232.94	3915.33	4856.54	6395.20	7609.86	9038.86	10135.51	2579.43

5.3.5 ECONOMIC BENEFIT BY MITIGATION OF DIRECT DAMAGE AMOUNT

An economic benefit is created when the amount of direct damage, found by the above paragraph 5.3.4, is reduced through the construction of sediment control facilities. In other words, the economic benefit is mitigated by the amount of direct damage.

A sediment damage reduction ratio is set for return period and every sediment control facilities, (details on the establishment of the damage reduction ratio are stated in 5.5, Damage reduction effect by sediment control facilities).

Several combinations of the facilities can be regarded as alternative plans for economic evaluation. In any event the damage reduction ratio of a combination of the facilities is identical to the sum of the reduction ratio in each facility (because the damage reduction ratio is set for the every facility). The maximum reduction ratio is 1.00 as a matter of course.

While the construction cost, construction period, depreciation period and maintenance expenses are established for the every facility, the time of construction completion varies depending on the combination of the facilities. In this case, the economic benefits are generated after the completion of each construction in proportion to the damage reduction ratio. Therefore the damage reduction ratio of all the facilities can only be applied when all construction work is completed.

As the damage reduction ratio is established every return period (from 3 years to 100 years). The direct damage amount in every return period, multiplied by the damage reduction ratio, stands at the direct damage reduction amount in every return period. In addition, the annual mean direct damage reduction amount can be found by substituting the direct damage reduction amount in equation G (direct damage amount) shown on equation (7) in paragraph 5.3.4.

The annual mean direct damage reduction amount in every year becomes an economic benefit through the effects of direct damage reduction in any given year.

5.4 INDIRECT DAMAGE

The "Lumajang Local Government Report on the Occurrence of the 14 May, 1981 Disaster on Behalf of the Plenary Session of D.P.R.D. Kabupaten Lumajang in June 6, 1981" which is summarized in relation to the disaster in May, 1981 was referred to for an estimate of indirect damage.

As a result of distinguishing carefully with the direct damage, the following amount of damage was estimated to be the indirect damage amount:

(1)	Food supply from Food Supply Center Rp. 200 x 10^3/day x 23 days =	Rp. 4,400 x 10^3
(2)	Purchase of sugar	Rp. 750 x 10^3
(3)	Construction of refuge huts	Rp. 1,750 x 10^3
(4)	Purchase of blanket	
(5)	Purchase of fish (2,000 kg)	Rp. 800 x 10^3
(6)	Purchase of kerosene for refuge huts	Rp. 675 x 10^3
(7)	Voluntary help activities	Rp. 500 x 10^3
(8)	Safety guarantee activities	Rp. 600 x 10^3
(9)	Liaison facilities set up	Rp. 1,250 x 10^3
(10)	Care of injured and funeral expenses	Rp. 1,900 x 10^3
(11)	Rice (supply in kind) 44,000 kg estimated unit price: 250 Rp/kg	Rp. 11,000 x 10^3
	Total	Rp. 24,525 x 10^3

On the other hand, on the basis of a flood disaster map, prepared with reference to the 1981 May disaster, population within the flood area was estimated at 12,242. The approximate indirect damage amount, therefore, was estimated at Rp. 2,000 per capita.

Rp. 24,525 x 10^3 $\div$ 12,243 person = Rp. 2,000/person

The possible indirect damage amount was then established by multiplying the population with the possible disaster area by the indirect damage amount per capita.

Further, such calculations as the damage amount in return period, the annual mean indirect damage amount and the indirect damage reduction amount by the sediment control facilities were conducted with the same procedure as that for the direct damage amount. An increase ratio of population of 1.17% was used as an increment of damage potential.

The measurement process of the indirect damage amount is shown in Fig.-5.4. The annual indirect damage by each return period is shown in Table-5.37, 5.38, 5.39.

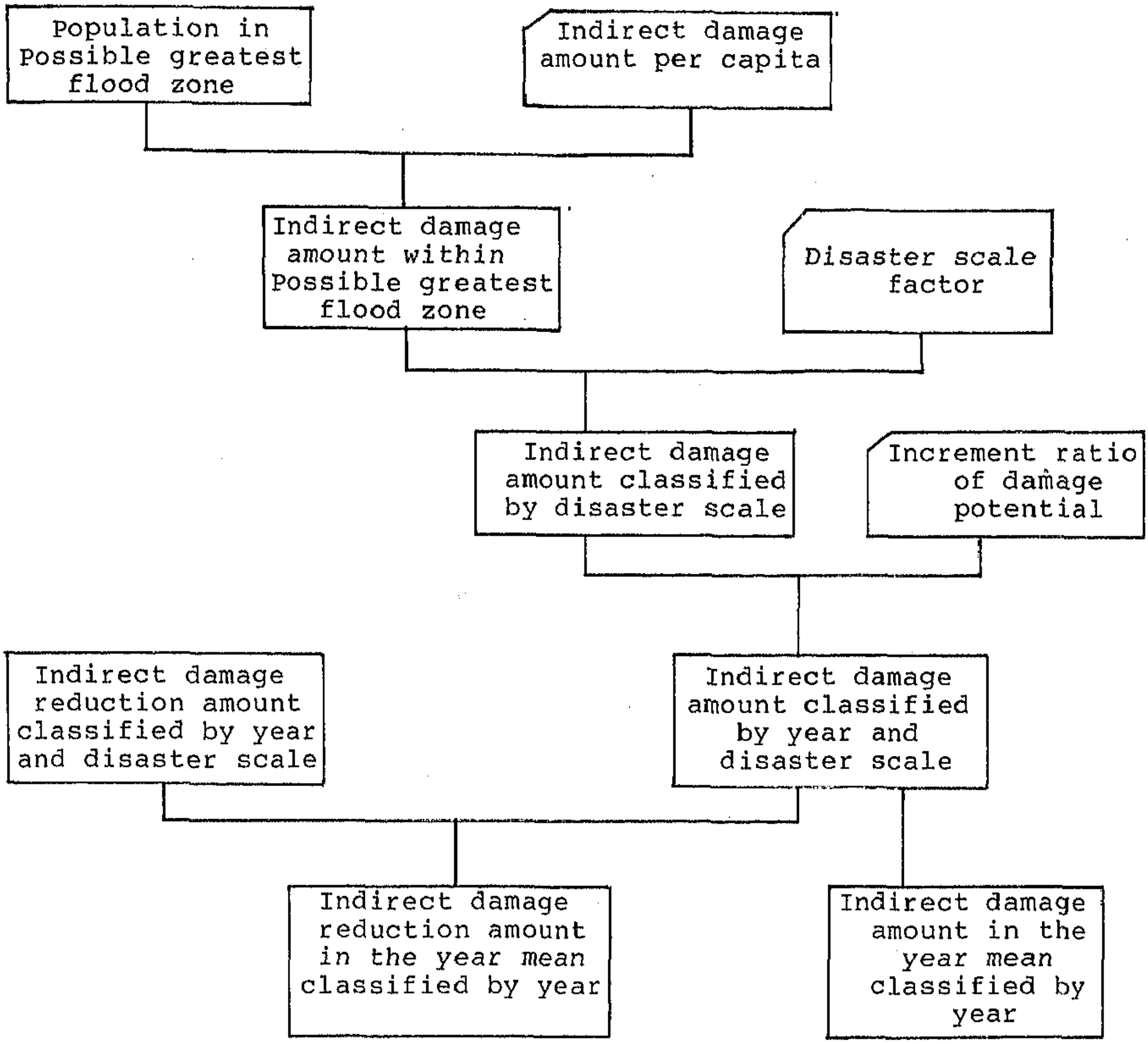


Fig.-5.4 Flow Chart of Measurement of Inirect Damage Amount

Table 5.37 ANNUAL INDIRECT DAMAGE BY RETURN PERIOD
(REJALI)

YEAR	RETURN PERIOD (YEARS) 3	5	10	20	40	70	100	AVE.
BASE YEAR	2.93	3.55	4.35	5.50	6.69	8.23	9.50	2.32
1	3.11	3.76	4.61	5.83	7.09	8.72	10.07	2.46
2	3.14	3.81	4.66	5.90	7.17	8.82	10.19	2.49
3	3.18	3.85	4.72	5.97	7.26	8.93	10.31	2.52
4	3.22	3.90	4.77	6.04	7.34	9.03	10.43	2.55
5	3.25	3.94	4.83	6.11	7.43	9.14	10.55	2.58
6	3.29	3.99	4.89	6.18	7.51	9.24	10.67	2.61
7	3.33	4.04	4.94	6.26	7.60	9.35	10.80	2.64
8	3.37	4.08	5.00	6.33	7.69	9.46	10.92	2.67
9	3.41	4.13	5.06	6.40	7.78	9.57	11.05	2.70
10	3.45	4.18	5.12	6.48	7.87	9.68	11.18	2.73
11	3.49	4.23	5.18	6.55	7.96	9.80	11.31	2.76
12	3.53	4.28	5.24	6.63	8.06	9.91	11.44	2.80
13	3.57	4.33	5.30	6.71	8.15	10.03	11.58	2.83
14	3.61	4.38	5.36	6.79	8.25	10.14	11.71	2.86
15	3.65	4.43	5.43	6.87	8.34	10.26	11.85	2.89
16	3.70	4.48	5.49	6.95	8.44	10.38	11.99	2.93
17	3.74	4.53	5.55	7.03	8.54	10.50	12.13	2.96
18	3.78	4.59	5.62	7.11	8.64	10.63	12.27	3.00
19	3.83	4.64	5.68	7.19	8.74	10.75	12.41	3.03
20	3.87	4.69	5.75	7.28	8.84	10.88	12.56	3.07
21	3.92	4.75	5.82	7.36	8.95	11.00	12.71	3.10
22	3.96	4.81	5.89	7.45	9.05	11.13	12.85	3.14
23	4.01	4.86	5.96	7.54	9.16	11.26	13.01	3.18
24	4.06	4.92	6.03	7.62	9.26	11.39	13.16	3.21
25	4.11	4.98	6.10	7.71	9.37	11.53	13.31	3.25
26	4.15	5.03	6.17	7.80	9.48	11.66	13.47	3.29
27	4.20	5.09	6.24	7.89	9.59	11.80	13.62	3.33
28	4.25	5.15	6.31	7.99	9.70	11.94	13.78	3.37
29	4.30	5.21	6.39	8.08	9.82	12.08	13.95	3.41
30	4.35	5.27	6.46	8.17	9.93	12.22	14.11	3.45
31	4.40	5.34	6.54	8.27	10.05	12.36	14.27	3.49
32	4.45	5.40	6.61	8.37	10.17	12.51	14.44	3.53
33	4.51	5.46	6.69	8.47	10.29	12.65	14.61	3.57
34	4.56	5.53	6.77	8.56	10.41	12.80	14.78	3.61
35	4.61	5.59	6.85	8.66	10.53	12.95	14.95	3.65
36	4.67	5.66	6.93	8.77	10.65	13.10	15.13	3.70
37	4.72	5.72	7.01	8.87	10.78	13.25	15.31	3.74
38	4.78	5.79	7.09	8.97	10.90	13.41	15.48	3.78
39	4.83	5.86	7.17	9.08	11.03	13.57	15.67	3.83
40	4.89	5.92	7.26	9.18	11.16	13.73	15.85	3.87

Table-5.38 ANNUAL INDIRECT DAMAGE BY RETURN PERIOD
(GRIDIK)

YEAR	RETURN PERIOD (YEARS) 3	5	10	20	40	70	100	AVE.
BASE YEAR	2.08	2.52	3.18	4.42	5.11	5.79	6.21	1.68
1	2.21	2.67	3.37	4.68	5.42	6.13	6.58	1.78
2	2.23	2.70	3.41	4.74	5.48	6.21	6.66	1.80
3	2.26	2.73	3.45	4.79	5.55	6.28	6.74	1.82
4	2.29	2.77	3.49	4.85	5.61	6.35	6.82	1.84
5	2.31	2.80	3.53	4.90	5.68	6.43	6.90	1.86
6	2.34	2.83	3.57	4.96	5.75	6.50	6.98	1.89
7	2.37	2.86	3.62	5.02	5.81	6.58	7.06	1.91
8	2.40	2.90	3.66	5.08	5.88	6.66	7.14	1.93
9	2.42	2.93	3.70	5.14	5.95	6.73	7.23	1.95
10	2.45	2.97	3.74	5.20	6.02	6.81	7.31	1.98
11	2.48	3.00	3.79	5.26	6.09	6.89	7.40	2.00
12	2.51	3.04	3.83	5.32	6.16	6.97	7.48	2.02
13	2.54	3.07	3.88	5.38	6.23	7.05	7.57	2.05
14	2.57	3.11	3.92	5.44	6.31	7.14	7.66	2.07
15	2.60	3.14	3.97	5.51	6.38	7.22	7.75	2.09
16	2.63	3.18	4.01	5.57	6.45	7.30	7.84	2.12
17	2.66	3.22	4.06	5.64	6.53	7.39	7.93	2.14
18	2.69	3.25	4.11	5.70	6.61	7.48	8.02	2.17
19	2.72	3.29	4.16	5.77	6.68	7.56	8.12	2.19
20	2.75	3.33	4.21	5.84	6.76	7.65	8.21	2.22
21	2.79	3.37	4.25	5.91	6.84	7.74	8.31	2.25
22	2.82	3.41	4.30	5.98	6.92	7.83	8.41	2.27
23	2.85	3.45	4.35	6.05	7.00	7.92	8.50	2.30
24	2.89	3.49	4.41	6.12	7.08	8.02	8.60	2.33
25	2.92	3.53	4.46	6.19	7.17	8.11	8.70	2.35
26	2.95	3.57	4.51	6.26	7.25	8.21	8.81	2.38
27	2.99	3.61	4.56	6.33	7.34	8.30	8.91	2.41
28	3.02	3.66	4.62	6.41	7.42	8.40	9.01	2.44
29	3.06	3.70	4.67	6.48	7.51	8.50	9.12	2.47
30	3.09	3.74	4.72	6.56	7.60	8.60	9.23	2.49
31	3.13	3.79	4.78	6.63	7.68	8.70	9.33	2.52
32	3.17	3.83	4.84	6.71	7.77	8.80	9.44	2.55
33	3.20	3.88	4.89	6.79	7.87	8.90	9.55	2.58
34	3.24	3.92	4.95	6.87	7.96	9.01	9.67	2.61
35	3.28	3.97	5.01	6.95	8.05	9.11	9.78	2.64
36	3.32	4.01	5.07	7.03	8.14	9.22	9.89	2.67
37	3.36	4.06	5.12	7.11	8.24	9.33	10.01	2.71
38	3.40	4.11	5.18	7.20	8.34	9.43	10.13	2.74
39	3.44	4.16	5.25	7.28	8.43	9.54	10.24	2.77
40	3.48	4.20	5.31	7.37	8.53	9.66	10.36	2.80

Table-5.39 ANNUAL INDIRECT DAMAGE BY RETURN PERIOD
(TOTAL)

YEAR	RETURN PERIOD (YEARS) 3	5	10	20	40	70	100	AVE.
BASE YEAR	5.01	6.07	7.53	9.92	11.80	14.02	15.71	4.00
1	5.31	6.43	7.98	10.51	12.51	14.85	16.65	4.24
2	5.38	6.51	8.08	10.64	12.66	15.03	16.85	4.29
3	5.44	6.59	8.17	10.76	12.80	15.20	17.04	4.34
4	5.50	6.66	8.27	10.89	12.95	15.38	17.24	4.39
5	5.57	6.74	8.36	11.02	13.11	15.56	17.45	4.44
6	5.63	6.82	8.46	11.14	13.26	15.74	17.65	4.49
7	5.70	6.90	8.56	11.27	13.41	15.93	17.86	4.55
8	5.76	6.98	8.66	11.41	13.57	16.11	18.07	4.60
9	5.83	7.06	8.76	11.54	13.73	16.30	18.28	4.65
10	5.90	7.14	8.86	11.67	13.89	16.49	18.49	4.71
11	5.97	7.23	8.97	11.81	14.05	16.69	18.71	4.76
12	6.04	7.31	9.07	11.95	14.22	16.88	18.93	4.82
13	6.11	7.40	9.18	12.09	14.38	17.08	19.15	4.87
14	6.18	7.49	9.29	12.23	14.55	17.28	19.37	4.93
15	6.25	7.57	9.39	12.37	14.72	17.48	19.60	4.99
16	6.33	7.66	9.50	12.52	14.89	17.69	19.83	5.05
17	6.40	7.75	9.62	12.67	15.07	17.89	20.06	5.11
18	6.48	7.84	9.73	12.81	15.24	18.10	20.29	5.17
19	6.55	7.93	9.84	12.96	15.42	18.31	20.53	5.23
20	6.63	8.03	9.96	13.12	15.60	18.53	20.77	5.29
21	6.70	8.12	10.07	13.27	15.79	18.75	21.01	5.35
22	6.78	8.22	10.19	13.42	15.97	18.96	21.26	5.41
23	6.86	8.31	10.31	13.58	16.16	19.19	21.51	5.48
24	6.94	8.41	10.43	13.74	16.35	19.41	21.76	5.54
25	7.02	8.51	10.55	13.90	16.54	19.64	22.02	5.60
26	7.11	8.61	10.68	14.06	16.73	19.87	22.27	5.67
27	7.19	8.71	10.80	14.23	16.93	20.10	22.53	5.74
28	7.27	8.81	10.93	14.39	17.13	20.34	22.80	5.80
29	7.36	8.91	11.06	14.56	17.33	20.57	23.06	5.87
30	7.44	9.02	11.18	14.73	17.53	20.81	23.33	5.94
31	7.53	9.12	11.32	14.91	17.73	21.06	23.61	6.01
32	7.62	9.23	11.45	15.08	17.94	21.30	23.88	6.08
33	7.71	9.34	11.58	15.26	18.15	21.55	24.16	6.15
34	7.80	9.45	11.72	15.43	18.36	21.81	24.45	6.22
35	7.89	9.56	11.85	15.62	18.58	22.06	24.73	6.30
36	7.98	9.67	11.99	15.80	18.80	22.32	25.02	6.37
37	8.08	9.78	12.13	15.98	19.02	22.58	25.31	6.44
38	8.17	9.90	12.28	16.17	19.24	22.84	25.61	6.52
39	8.27	10.01	12.42	16.36	19.46	23.11	25.91	6.60
40	8.36	10.13	12.56	16.55	19.69	23.38	26.21	6.67

5.5 WATER CONSERVATION BENEFIT

(1) Conservation Water

The water to be conserved by the First Priority Project is the base flow of K. Rejali.

From the long-term simulation of 30 years, the annual mean discharge at K. Leprak No. 1 Check Dam is sought to be 1.0 m^3/sec.

(2) Irrigated Area

The area along the K. Rejali will be protected from the sediment disaster and conserved by the sediment control facilities. The area of 1,000 ha will be irrigated as paddy field with the water mentioned above.

With the project, the sugar cane field of 100 ha, the dry field of 500 ha and the forest or devastated field of 400 ha will be cultivated, irrigated and produce paddy rice twice and half a year.

5.6 DAMAGE MITIGATION EFFECT BY SEDIMENT FACILITIES

The sediment control effect of the facilities would reduce the excess sediment volume which would otherwise harmful sediment volume in the disaster prevention area, thus mitigating a disaster.

The damage mitigation effect of the sediment control facilities is given as a difference in the extent of damage area with and without the facilities.

Sediment control volume of each facility is given as a difference in the volume of run-off sediment volume with and without the facilities. These run-off sediment volume are calculated by riverbed fluctuation simulation. The details of riverbed fluctuation simulation are explained in Supporting Report (1) and in Part-G of Supporting Report (5).

Sediment volume to be controlled by each facility is shown in Table-5.40 and 5.41.

Table-5.40 Sediment Control Effect of Sediment Control Facilities

(Unit: 10^3 m^3)

Facility \ Return period (year)	3	5	10	20	40	70	100
1) Curah Kobo'an Check Dam No. 6	430						
2) " No. 5	90						
3) " No. 4	660						
4) " No. 3	90						
5) Diversion Work Channel K. Lengkong CHD No. 7 No. 3	700	(80	1,320	1,680	2,000	2,100	2,200
6) Curah Lengkong Check Dam No. 2	160						
7) " No. 1	80						
8) K. Leprak Sand Pocket	1,340						

Table-5.41 Sediment Control Effect of K. Lengkong Check Dam No. 3 in K. Lengkong

(Unit: 10^3 m^3)

Facility \ Return period (year)	3	5	10	20	40	70	100
K. Glidik Check Dam No. 5	800	520	180	0	0	0	0

6. EVALUATION

6.1 ECONOMIC EVALUATION

Benefits from a sediment control plan is defined as the mitigation effects which reduce direct and indirect damages as described in 5.4.4. Benefits in agricultural products increase which can be obtained with some additional construction work will be considered in water conservation effect.

Economic cost, maintenance cost, I.R.R. and total benefit for the alternatives of first priority project are shown in Table-6.1.

As shown in Fig.-6.1, a design magnitude of sediment control plan of 50 years return period, yields the maximum economic benefit. It is desirable, therefore, that the design magnitude shall be at 50 years return period from economic point of review.

Among the alternative plans, Plan No. 3 has the highest I.R.R. of 8.31%.

6.2 SOCIAL EVALUATION

The possible disaster area of K. Rejali has 19,500 inhabitants. Records of recent disasters show 119 people dead and 100 houses washed away in 1976, and 365 people dead and 1,002 houses washed away in May, 1981.

Those who had lost their houses were transmigrated to other places and, as such, social insecurity in the face of possible disaster is high in the area.

It is impossible to prevent these damages by mere construction of local dike; and therefore, a comprehensive sediment control work in the area is needed.

Table- 6.1 Results of Economic Evaluation

Plan	Combination of Facilities	Design Scope (Probabiity Year)	Economic Cost 10^6 Rp	Maintenance Cost 10^6 Rp/Year	I.R.R.	Total Benefit 10^9 Rp
No. 1	1,5,9	13	19,210	2	7.89	76.7
No. 2	1,2,3,4,5,6,7,9	40	24,048	2	7.84	95.1
No. 3	1,5,8,9	50	22,394	38	8.31	94.5
No. 4	1,2,3,4,5,6,7,8,9	90	27,232	38	6.97	97.7

Facility No.	Name of Facility	
1.	Curah Kobo'an Check Dam	No. 6
2.	"	No. 5
3.	"	No. 4
4.	"	No. 3
5.	Diversion Work Channel.	
	K. Lengkong Check Dam	No. 7
	"	No. 3
6.	Curah Lengkong Check Dam	No. 1
7.	"	No. 2
8.	K. Leprak Sand Pocket	
9.	Intake and Channel	

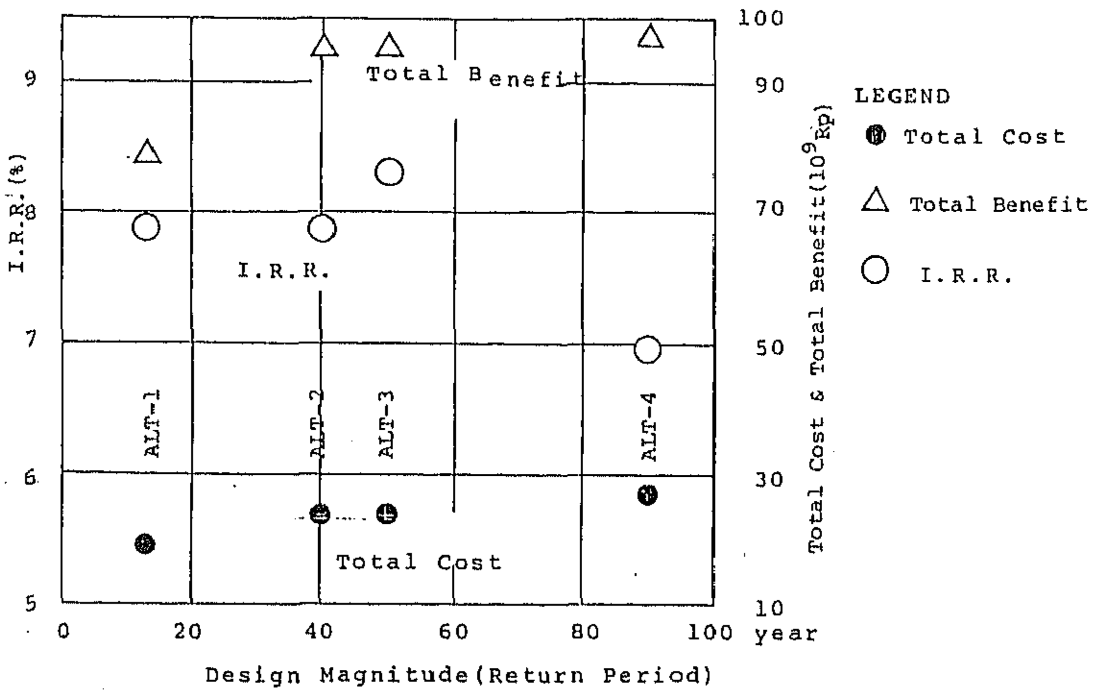


Fig- 6.1 I.R.R.,Total Benefit and Total Cost of Alternatives

Although economic value of intangible benefits which contribute greatly to the maintenance of social stability in the area would be difficult to assess, a sediment control project is extremely important.

Such intangible benefits are listed below.

① Protection of Human Life

② Stabilization

Safety, security and stability of inhabitants will be strengthened by freeing them from the fear of debris disaster.

6.3 TOTAL EVALUATION

As stated previously, I.R.R. of all alternative plans described here is between 6.97% and 8.31%. Execution of a plan will certainly strengthen the basis of the total development plan for the area. Therefore this porject of this nature is indispensable.

Design magnitude of a plan should be 50 years return period, for I.R.R. begins to decline beyond this period as shown by the result of economic evaluation. Accordingly, the alternative plan No. 3 which enjoys the highest I.R.R. is recommended.

The disaster in this area tends to cause a great loss of live as is seen in the past records in October 1976 (the number of victims amounted to 119) and in May 1981 (Victims rose to 365). Such a tragedy has an unfathomable impact on the local society. However, it would take a long period of time to prevent perfectly such an occurrence by implementing "Sediment Control Facility" shown above. Therefore, it would be imperative to carry out the execution of Warning system project along with the above first priority project. These warning system project which is composed of Information collection system, Information processing system and Public information system is recommended. Its project cost is estimated at 960 x 10^6 Yen.

7. IMPLEMENTATION PLAN OF FIRST PRIORITY PROJECT

This section describes the implementation plan of the first priority project, which is recommended in section 6, Project Evaluation.

The financial cost of the project is 10,210 x 10^6 yen (27,600 x 10^6Rp; exchange rate at 1 US$ = 905 Rp = 240 yen). The mean annual financial cost of the implementation plan, described in this section, is 1,700 x 10^6 yen (6,800 x 10^6 Rp).

7.1 OUTLINE OF PROJECT

Facilities to be constructed by the first priority project are shown in Table-7.1 and drawings of SMF-101,102,103,104.

Table-7.1 Description of First Priority Project

Name of River	Name of Facility	Specifications
K. Rejali	Curah Kobo'an CHD-6	H=23m L=438m Vc=120,800m Vs=2,112,000m
	Diversion channel	L=1,350m B=30m Ve=566,000m Vg=7,300m
	K. Leprak Sand Pocket	Consolidation dam 3 Vc=14,300m Vs=4,300m Vem=155,000m Vg=15,000m
	Intake and Channel	L=430m
K. Glidik	K. Lengkong CHD-3 (Pronojiwo Dam)	H=10m L=2,330m Vc=42,700m Ve=24,000m
	K. Lengkong CHD-7	H=10m L=145m Vc=4,670m Ve=4,000m

H: Dam height
B: Width of channel
Vc: Concrete volume
Vem: Embankment volume
L: Length of dam or channel
Vs: Steel basket volume
Vg: Gabion work volume

7.2 CONSTRUCTION SCHEDULE

The construction period of the first priority project is six years including surveying, detail designing and preparatory works.

Schedule for the entire construction works is shown in Table-7.2.

Annual construction quantity is shown in Table-7.3.

Table-7.2 Project Work Schedule

Description / Fiscal year	1st 1987 (4 9 3)	2nd 1988 (4 9 3)	3rd 1989 (4 9 3)	4th 1990 (4 9 3)	5th 1991 (4 9 3)	6th 1992 (4 9 3)
1. Engineering Service						
(Design, Tender and Procurement Process)						
(1) B. Kobo'an check dam No.6						
(2) Diversion channel						
(3) K. Lengkong check dam No.3						
(4) " No.7						
(5) Leprak sand pocket						
(6) Intake and channel						
(7) Construction equipment and spare parts						
(8) Construction supervision						
2. Civil Works						
(1) B. Kobo'an check dam No.6						
(2) Diversion channel						
(3) K. Lengkong check dam No.3						
(4) " No.7						
(5) Leprak sand pocket						
(6) Intake and channel						
(7) Preparation work						

Table-7.3 Annual construction quantity

Year / Fiscal Year / Work Item	1st	2nd	3rd	4th	5th	6th
	1987	1988	1989	1990	1991	1992
1. Concrete Work (m^3)						
B.Kobo'an check dam No.6		15,000	43,000	43,000	20,000	
Leprak Sandpocket					14,300	
K.Lengkong check dam No.3					8,000	34,700
K.Lengkong check dam No.7						6,500
2. Excavation (m^3)						
Diversion channel			280,000	286,000		
B.Kobo'an check dám No.6			69,000			
K.Lengkong check dam No.3					24,000	
K.Lengkong check dam No.7						4,000
3. Embankment (m^3)						
Leprak sandpocket			60,000	50,000	45,000	
4. Gabion work (m^3)						
Diversion channel			1,300	4,000	2,000	
Leprak sandpocket				6,000	9,000	
5. Steel basket (m^3)						
Leprak sandpocket			15,000	15,000	13,000	
6. Tunnel (m)						
Intake and tunnel						430m

The content of work for each year is described below.

First year:
- (i) To complete the all detail designs.
- (ii) To purchase the all construction equipments and spare parts.

Second year:
- (i) To set up a concrete plant, an aggregate plant, concrete placing facility and other preparation works.
- (ii) To complete the excavation of the foundation of the B. Kobo'an check dam No.6.
- (iii) To start the excavation of the diversion channel.
- (iv) To start the concrete placing of B. Kobo'an check dam No.6.

Third year:
- (i) To complete the excavation of the diversion channel.
- (ii) To start construction of gabion work of diversion channel.
- (iii) To start excavation and steel basket construction of K. Leprak sand pocket.

Fourth year:
- (i) To start the gabion work of K. Leprak sand pocket.

Fifth year:
- (i) To complete the all construction works of K. Leprak sand pocket, B. Kobo'an check dam No.6, and diversion channel.
- (ii) To start the excavation and concrete placing of the K. Lengkong check dam No.3.

Sixth year:
- (i) To complete the concrete placing of K. Lengkong check dam No.3.
- (ii) To complete the K. Lengkong check dam No.7 and tunnel.

7.3 CONSTRUCTION METHOD AND EQUIPMENT

The main work of the project is the placement of large quantities of concrete for the B. Kobo'an check dam No.6 and the K. Lengkong check dam No.5, and the extensive excavation work for the diversion channel.

In addition, there is a special work, i.e. the steel basket work at the K. Leprak sand pocket.

Works other than that mentioned above will be dealt with by the ordinary construction method, employed in the Mt. Semeru Project, using construction equipment owned by the Mt. Semeru Project Office.

(1) Method of Concrete Work

With the manpower method of dam concrete placing which has been used up until now, the annual maximum concrete placing volume is estimated to be around 5,000 m^3. This method will not, therefore, the capable of meeting the concrete placing requirement for either the B. Kobo'an check dam No.6 or the K. Lengkong check dam No.3. The production of concrete aggregate, the production of concrete and the concrete placing is accordingly planned to be carried out using machines.

The central plant system is employed for the production of concrete, and the aggregate plant and concrete plant will be set up at the same place as where the K. Leprak sand pocket is planned. The concrete produced there will be transported to the dam site by truck mixers and will be placed using the cable crane and the crawler crane. These construction machines are selected adequate on the basis of the given construction volume and period (cf. Fig.-7.1).

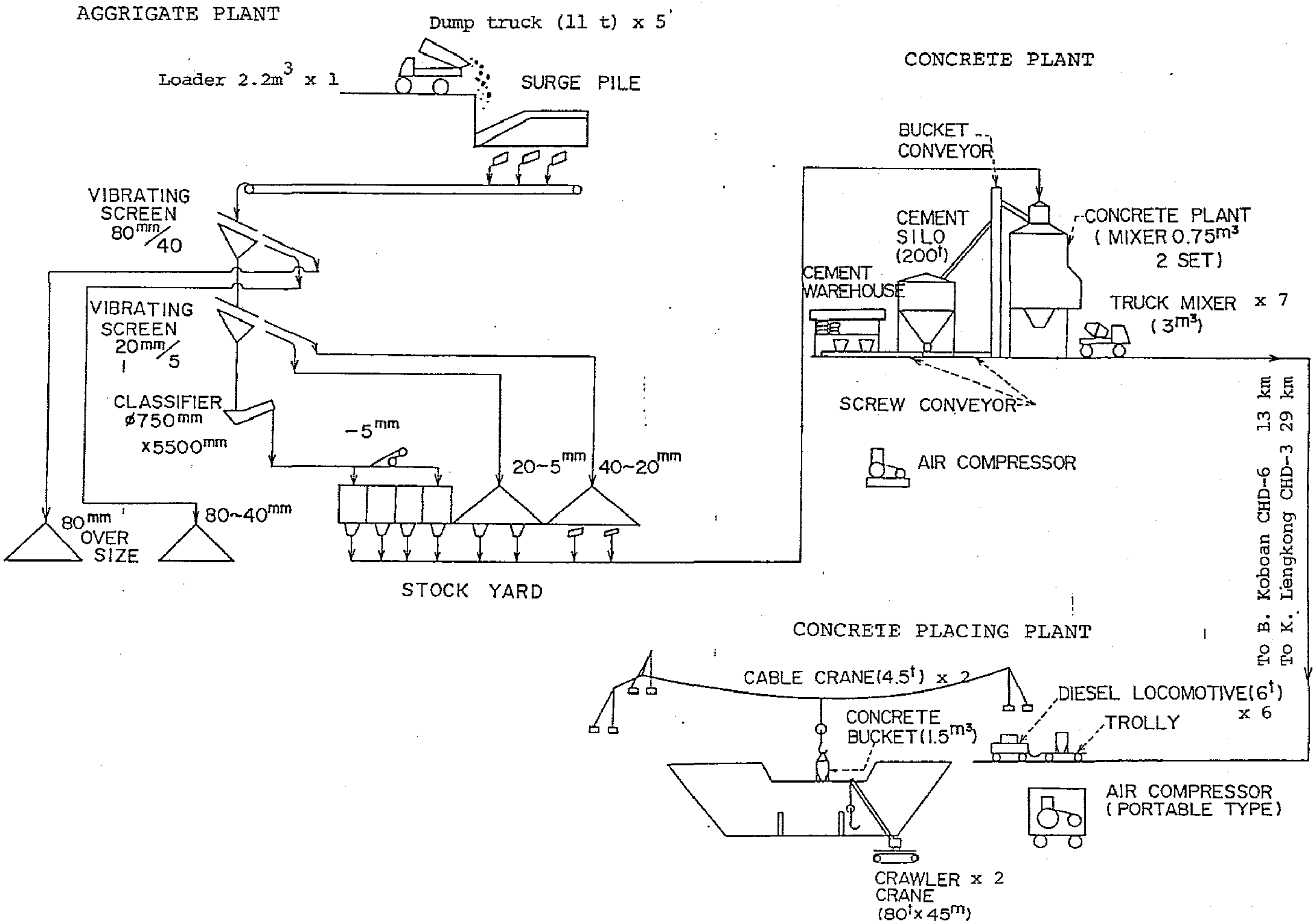


Fig-7.1 Method of Cocrete Work

Places where the aggregate can be collected are the K. Mujur fan, the K. Leprak fan and the K. Lengkong fan. Since 42% of the sand at the K. Lengkong fan, however, consists of minutes grains, i.e. silt with a diameter less than 0.074 mm, it is inadequate to be used as concrete aggregate. As a result, the aggregate and concrete plants are planned at the K. Leprak fan which is near the dam sites and where a large volume of aggregate can be possibly obtained.

Masonry concrete will be used as material for the dam body owing to final reasons and because of the need to reeduce the hardening calorific value. Stones, a diameter of more than 80 mm, will be emptied by the crawler crane and then the spaces surrounding them will be filled with plain concrete.

(2) Excavation Method of Diversion Channel

Since a lot of water exists in the area around Sumber Sary where the diversion channel is planned, spring water is expected at the time of excavation. Excavation work, therefore, will be mainly done by the back hoe (1.4 m^3) with the supplementary use of a ripper dozer (25 t). Excavated sediment will be loaded directly with the back hoe to a dump truck, transported to the spoil bank and then banked by a bulldozer and a vibration roller. The excavation of the diversion channel will commence at the lower stream area, moving up to the upper stream area.

(3) Construction Method of Steel Basket

The steel basket is similar to the gabion mattress although its durability is higher as it uses formed steel instead of gabion wire. This steel basket will be used as construction material for the consolidated dam, planned at the middle point of the K. Leprak sand pocket.

The measurements of a steel basket unit are 2.2m x lm x lm and both its assembly and stone stuffing will be done by hand.

(4) Method of Other Construction Work

The excavation of the dam foundation will be mainly done by back hoe with supplementary assistance by hand.

Sediment within the channel will be excavated by back hoe (1.4 m^3) and bulldozer (25 t) and will be used for the construction of the dike. The banking and tamping will be done by bulldozer (16 t).

Masonry concrete will be used for the purpose of dam concrete, where the required volume is under 5,000-6,000 m^3/year, and construction will be done by hand, as has been the case until now.

(5) Construction Equipment

Construction equipment and spare parts to be newly purchased for the main work are as shown in Table-7.4.

Table-7.4 Price List of Construction Equipment

Item	Description Power (KW)	Weight (Ton)	Amount (10^3 Yen)	Remarks
1. Equipment				
(1) Aggregate Plant	2,107 PS 207.65 KW	354.1	274,622	
(2) Concrete Plant	1,417 PS 33.65 KW	530.9	149,278	
(3) Concrete Setting Plant	2,360 PS 930.2 KW	864	971,846	
(4) Paving Equipment	315 PS 109 KW	64.1	94,500	
(5) Earth Work Equipment		248	329,047	
(6) Laboratory Equipment			5,000	
Sub Total	6,199 PS 1,459.5 KW	2,061.1	1,824,293	
2. Spare Parts				
(1) Aggregate Plant			47,223	
(2) Concrete Plant			43,943	
(3) Concrete Setting Plant			202,734	
(4) Paving Equipment Plant			32,790	
(5) Earth Work Equipment			59,600	
(6) Laboratory Equipment			2,000	
Sub Total			388,290	
Total			2,212,583	