4.6.2 Analysis of Rainfall Characteristics by Observation System

The following steps are involved in the basic process that leads up to a prediction of the occurrence of debris flow.

Step 1

The rainfall characteristics - particularly the occurrence of rain zones and the status of their movements - for the specified region (especially for Ciponyo I from the sandpocket to the top flow area) must be understood.

The analysis is as follows. First, monitor the image recorded in the hard drum of radar rain gauge, and while each of the rainfall unit measures on the television monitor, the movement of the rain zones and variations in the intensity of the rainfall is taken into account. At the ideal rate of 5-10 minutes, one image is selected, and the chosen image is recorded on the floppy disc or printed out. These selected images are then interpreted as a time series.

Step 2

The rainfall patterns of the study area (Hyetograph) which are drawn from the radar image will be compared and studied, as will the times of the predicted reference points downstream, the curve of the water level (hydrograph), and the runoff sediment conditions (mud flow, sediment flow, bed load flow, suspended flow, non-flowing mud flow).

Step 3

Based on the accumulation of data up to Step 2, a "Warning and Evacuation Standard" for debris flow as a standard based on rainfall intensity will be established.

Amount the above steps, for the matter at hand, the analysis of rainfall characteristics that occurs in step one is thought to be of great significance. From December 1987 to March 1988, these observations were carried out.

The subject observation area and the locations of the monitoring stations for the observation are indicated in Fig. 4.7. Observed items include 1) size of the rain zone 2) the rate of movement of the rain zone 3) the direction of the movement of the rain zone and 4) a schedule of the occurrence of rainfall.

A summary of 20 minute rainfall for main rainfall (where overall rainfall was over 80mm), the size of the rain zone (at its largest), and the direction of movement of the rain zone are indicated in Table - 4.12.

In addition, the results of the observations of the above steps 1-3 are notated in the supporting report (I).

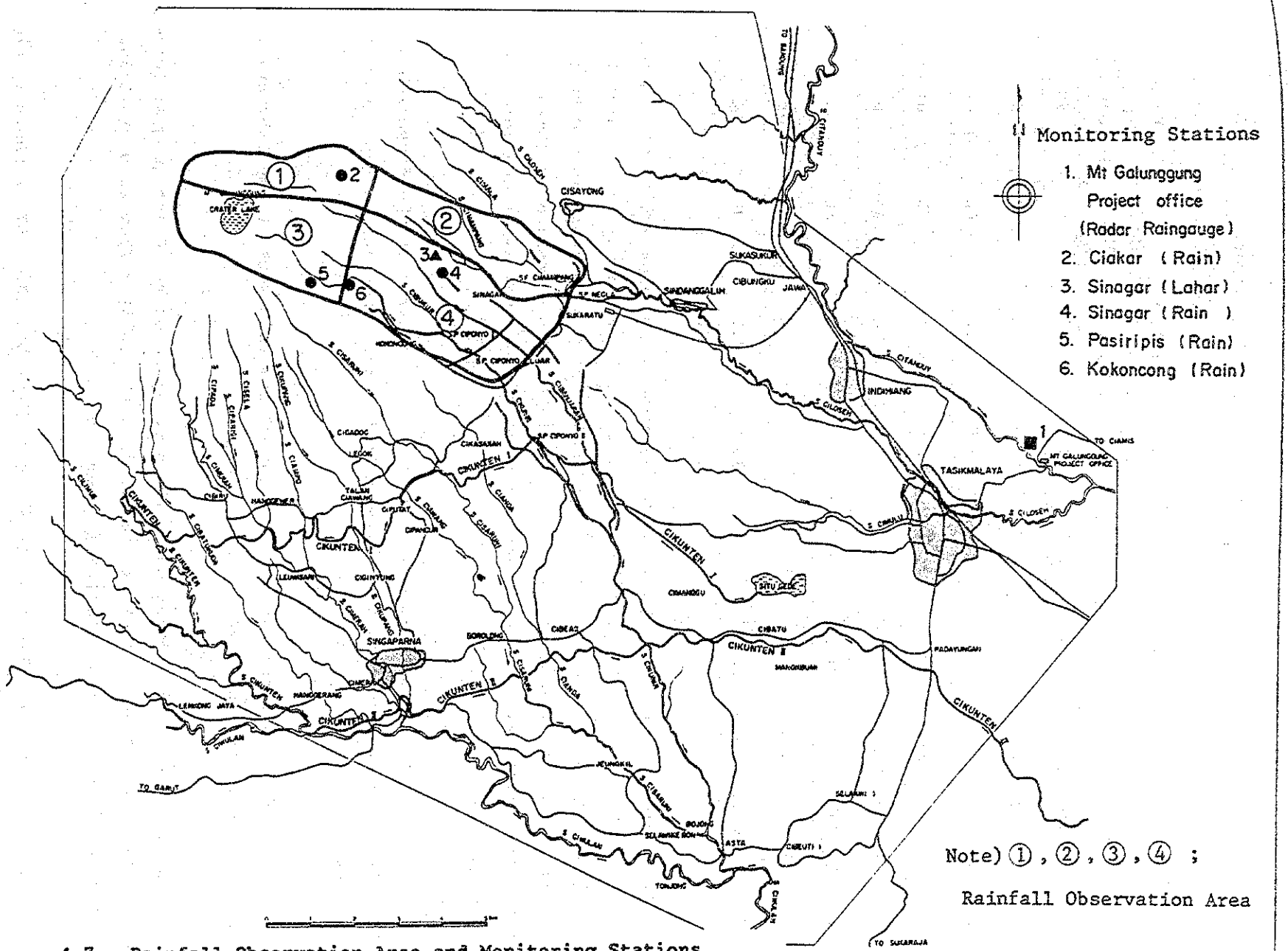


Fig. - 4.7 Rainfall Observation Area and Monitoring Stations

Table - 4.12 Rainfall Zone and its Movement

Zone No	Date	Maximum Rainfall in 20 minute(mm)				Rainfall Area (km^2)	Rainfall Movement Direction
		Area 1	Area 2	area 3	Area 4		
1	7 Dec, 1987	14.0	0.8	20.6	1.4	50	NE
2	13 Dec, 1987	15.3	3.8	16.5	1.1	110	NE or E
3	5 Jan, 1988	8.6	29.5	6.5	11.2	80	SE or E
4	6 Jan, 1988	4.2	15.5	5.0	12.8	90	NE or N
5	11 Jan, 1988	0.8	4.2	4.0	17.0	40	N
6	15 Feb, 1988	0.3	4.5	0.2	18.8	60	E
7	17 Feb, 1988	19.5	14.8	0.0	3.8	60	SE or E
8	19 Feb, 1988	11.5	24.8	35.8	22.5	90	E

From Table - 4.12, it can be seen that within the observation period the maximum 20 minute rainfall was 35.8 mm. Looking into the rainfall depths in area 1 through area 4, the only one that shows uniform rainfall is number 8 rainfall. It can be understood from the fact that other rainfalls showed substantial variation in depth that the rain regions were small and large rain volume differences existed.

The largest rain zone size was 40-110 km^2. In terms of the direction of the rainfall zone movement, the movement to the northeast and to the east were most frequent.

Fig. - 4.8 shows the typical movement of the rain zone at the February 19, 1988 flood that is indicated in Table - 4.12.

The rain zone which occurred on the west slope of Mt. Galunggung at 18:00 moved toward the east. After it reached into the subject flow area at 19:30, it continued to move in an eastward direction.

The same trend is also brought forth on December 12, 1987 as shown in Fig. - 4.9. The rainfall of October 30, 1987 (Fig. - 4.10) indicates a slightly different trend.

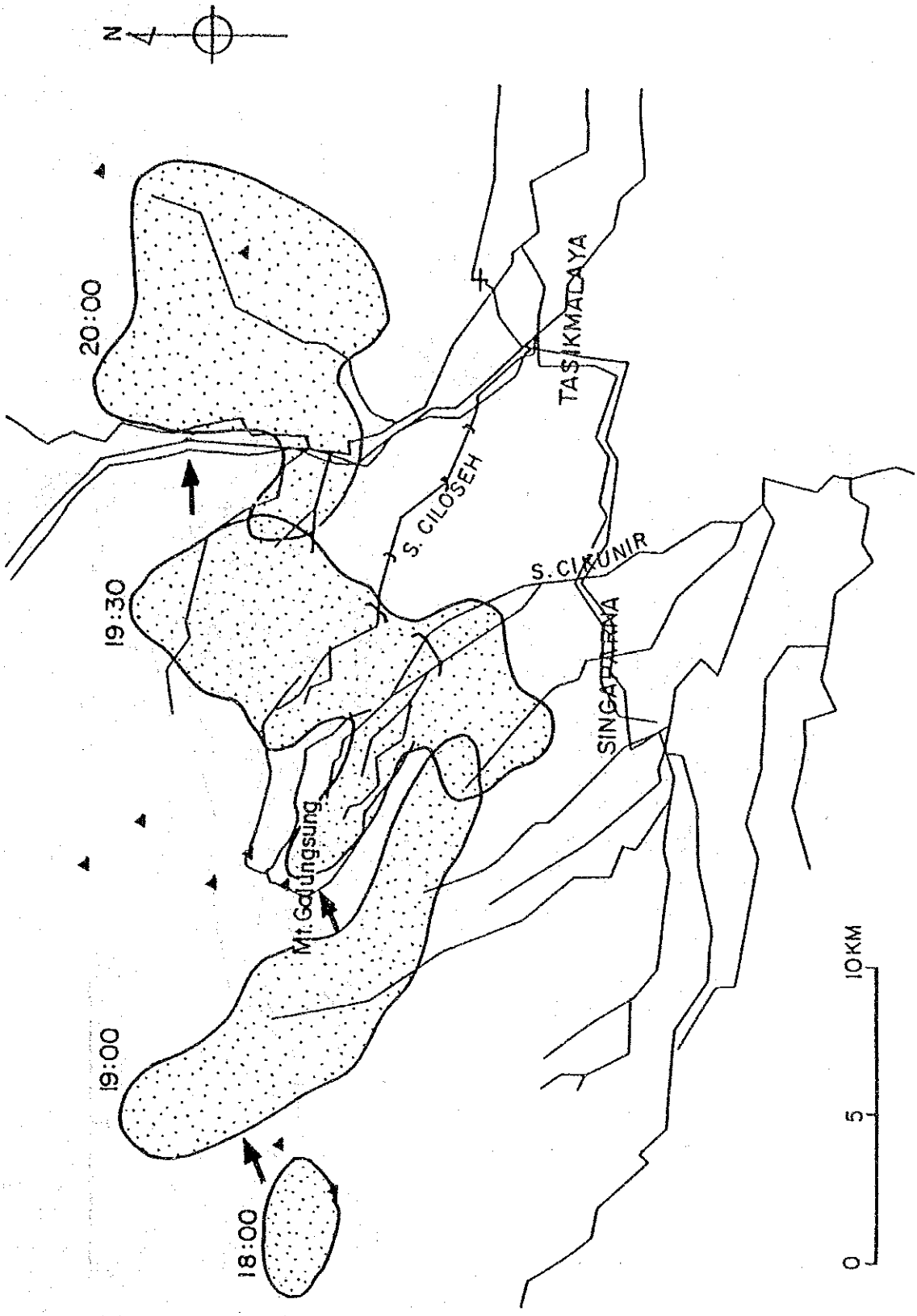


Fig. - 4.8 Rain Zone Movement
(February 19, 1988)

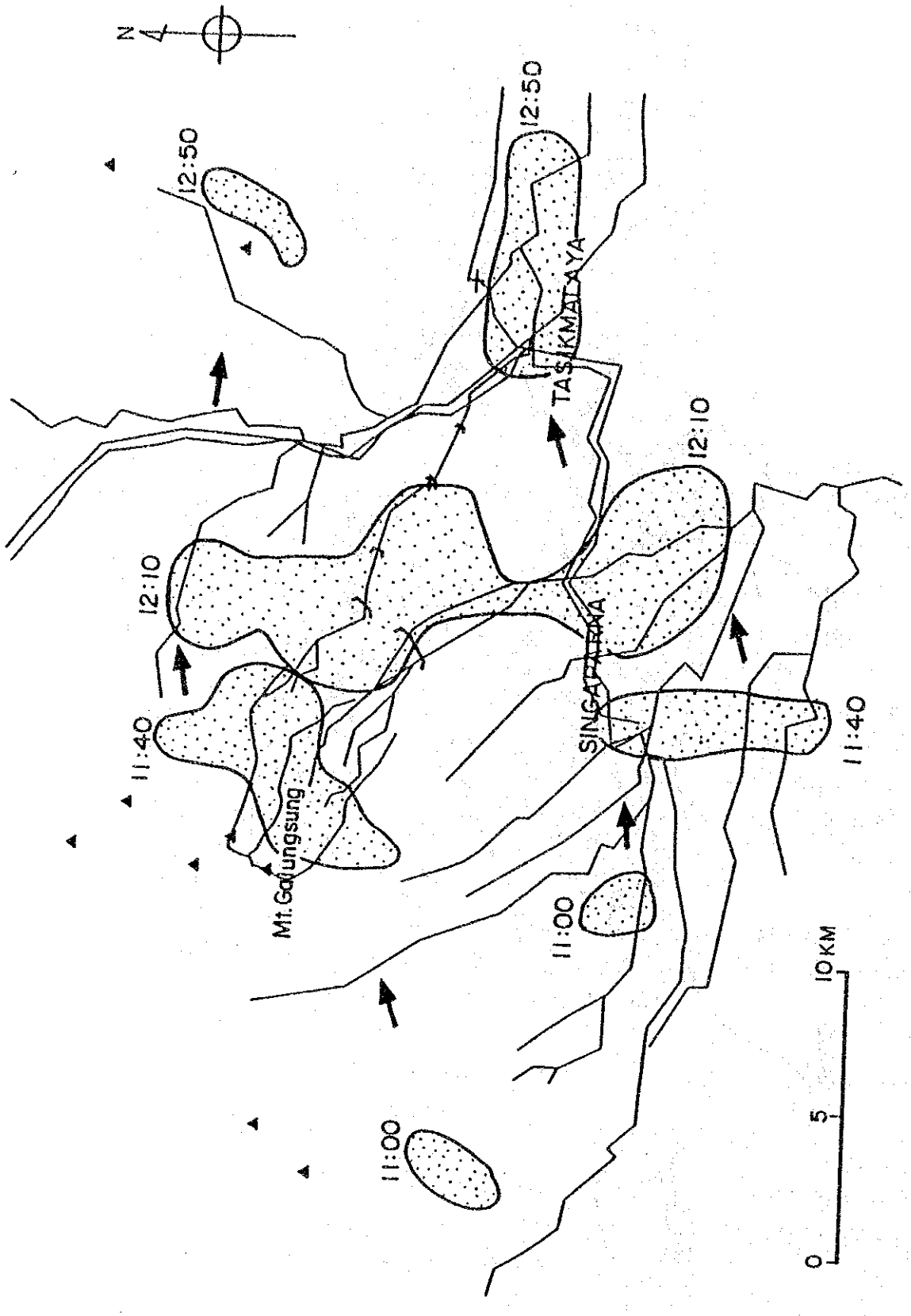


Fig. - 4.9 Rain Zone Movement
(December 12, 1988)

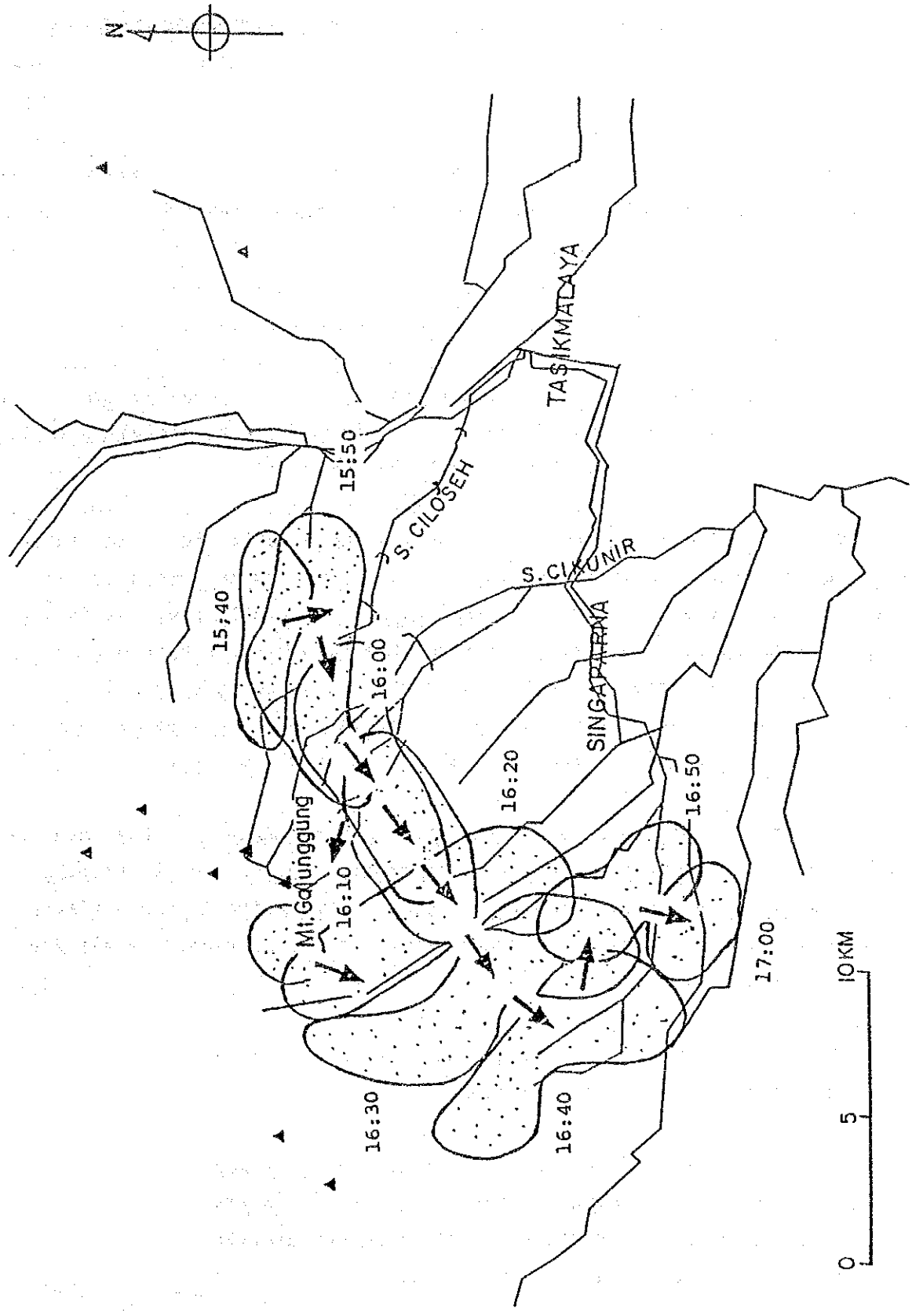


Fig. - 4.10 Rain Zone Movement
(October 31, 1987)

4.6.3 Recommendations Concerning the Future Operation of the Warning and Evacuation System

Taking into account the status of the warning and evacuation system mentioned in section 4.6.1 and based on the results of rainfall observations of section 4.6.2, the following are recommendations for the future operation of the system.

(1) The Observation System

The radar rain gauge can be considered the optimal observation equipment in areas such as the Galuunggung basin where the rainfall area is small and rainfall is distributed unevenly in the basin.

This metering equipment should continue to be utilized in the future for the main rainfall observation in the basin. The radar rain gauge is capable of real-time measurement of the range of rainfall zone, rainfall zone movement, and rainfall intensity. Through the recording of this data on floppy discs, this becomes an effective method in grasping rainfall characteristics and predicting rainfall. For such observations, a rain gauge installed on the ground is used to calibrate the radar gauge.

Rainfall predictions become possible when the data from the radar gauge is prepared and interpreted. However, in order to grasp the relationship between rainfall and the occurrence of debris flow, which is the ultimate objective of this project, it is necessary to watch and record debris flow by human observation.

Future observation and management of data will be conducted in accordance with the following policies.

1) Hard copy from the data rain gauge shall be kept and accumulated so as to serve as the basic data for the management of rainfall zone range, rainfall zone movement, and direction of movement information and also for flood occurrence prediction.

2) The relation of rainfall depth and the amount of runoff (hydrograph) will be determined. At that time, the analysis of cumulative rainfall data including previous rainfall before the main rainfall shall be considered.

3) Data on the occurrence of debris flow shall be collected. Through an understanding of the relationship between this and rainfall intensity, a "Warning and Evacuation Standard" shall be established as a rainfall depth standard to allow the prediction of debris flow occurrence 30 minutes to one hour beforehand. From among the above, the accumulation of data in 1) and 2) is considered highly significant, and it is hoped that this observation shall be continued in the future.

(2) Warning Transmission System

Because the organization of the Warning Transmission system which existed at the time of the disaster in 1982 has basically been maintained, there are no particular problems with it. For the residents who live within the sandpocket in sediment or flood regions, the security of an evacuation plateau is considered necessary in addition to the Warning and Transmission System in the future.

The role that the amateur (Ham) radio network plays in the transmission system is quite important. As a result, the strengthening of an emergency energy system by such means as battery back-up is considered necessary for the future.

4.7 Quantity of Construction Works

Each project unit from project unit 1 to project unit 4 was classified into the following facilities and quality of construction work was calculated for each facility.

1) Dike improvements
2) Maintenance of sandpocket (excavation, hauling and aggregate production)
3) Check dams
4) Consolidation dams
5) Revetment works
6) Crater lake drainage tunnel

Quantity of construction work for each alternative is shown in Table - 4.13 and Table - 4.14.

Tabel - 4.13 Quantity of Construction Works for each Project Area

	Description	Unit	S.Ciloseh Area	S.Cikunir Area *1	Southern Slope Area	Crater Lake	Total
(1)	Dike Improvement & Raising Lenth	m	3,801	11,631	-	-	15,432
	Embankment Volume	m^3	19,956	256,110	-	-	276,066
(2)	Riverbed Leveling						
	Leveling Volume	m^3	-	1,370,000	-	-	1,370,000
(3)	Riverbed Aggragation						
	Aggradation Volume	m^3	-	3,932,000	-	-	3,932,000
(4)	Excavation & Hauling						
	Hauling Volume	m^3	394,000	630,000	-	-	1,024,000
(5)	Aggregate Plant						
	Number	site	-	1	-	-	1
	(Manufacture Capacity)	ton/h	-	(140)	-	-	(140)
(6)	Diversion Channel						
	Length	m	-	1,500	-	-	1,500
	Embankment Volume	m^3	-	147,705	-	-	147,705
	Masonry Volume	m^3	-	19,125	-	-	19,125
(7)	Check Dam						
	Number	site	2	4	20	-	26
	Excavation Volume	m^3	2,640	5,370	43,530	-	51,540
	Masonry Volume	m^3	8,800	17,900	135,100	-	161,800
(8)	Consolidation Dam						
	Number	site	-	6	-	-	6
	Dike Length	m	-	1,400	-	-	1,400
	Embankment Volume	m^3	-	34,320	-	-	34,320
	Excavation Volume	m^3	-	4,620	-	-	4,620
	Masonry Volume	m^3	-	15,400	-	-	15,400
(9)	Revetment						
	Length	m	-	1,700	-	-	1,700
	Excavation Volume	m^3	-	10,817	-	-	10,817
	Masonry Volume	m^3	-	9,615	-	-	9,615
(10)	Drainage Tunnel						
	Length	m	-	-	-	655	655

Note)

*1 Alternative D for the sediment management works in Ciponyo I Dalam

Table - 4.14 Quantity of Construction Works for each Alternatives

	Description	Unit	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
(1)	Dike Improvement & Raising Lenth	m	11,631	11,631	11,631	11,631	11,631
	Embankment Volume	m^3	165,544	189,100	209,580	256,110	470,630
(2)	Riverbed Leveling						
	Leveling Volume	m^3	1,370,000	1,370,000	1,370,000	1,370,000	1,370,000
(3)	Riverbed Aggragation Aggradation						
	Volume	m^3	0	1,356,000	2,355,000	3,932,000	4,956,000
(4)	Excavation & Hauling						
	Hauling Volume	m^3	4,513,000	3,206,000	2,158,000	630,000	0
(5)	Aggregate Plant Number (Manufacture Capacity)	site ton/h	1 (640)	1 (470)	1 (330)	1 (140)	1
(6)	Diversion Channel						
	Length	m	0	1,500	1,500	1,500	1,500
	Embankment Volume	m^3	0	85,500	103,020	147,705	288,720
	Masonry Volume	m^3	0	14,895	16,196	19,125	25,947
(7)	Check Dam						
	Number	site	4	4	4	4	4
	Excavation Volume	m^3	5,370	5,370	5,370	5,370	5,370
	Masonry Volume	m^3	17,900	17,900	17,900	17,900	17,900
(8)	Consolidation Dam						
	Number	site	6	6	6	6	6
	Dike Length	m	1,400	1,400	1,400	1,400	1,400
	Embankment Volume	m^3	34,430	34,320	34,320	34,320	34,320
	Excavation Volume	m^3	4,620	4,620	4,620	4,620	4,620
	Masonry Volume	m^3	15,400	15,400	15,400	15,400	15,400
(9)	Revetment						
	Length	m	1,700	1,700	1,700	1,700	1,700
	Excavation Volume	m^3	1,0817	10,817	10,817	10,817	10,817
	Masonry Volume	m^3	9,615	9,615	9,615	9,615	9,615

4.8 Construction Schedule

4.8.1 Outline of Construction Schedule

As for disaster prevention facilities, there are facilities which must be operated immediately judging from the past disasters and those which may more expediently be operated extending over a long period of time, or, gradually, paying attention to the changing situation of runoff sediment and that of riverbeds. The period of implementation of this project was set for ten years hence, during which inflow sediment will be high in volume. The first five years were planned for the first stage of the work and the remaining five years for the second.

In the first stage, facilities urgently needed for disaster prevention and essentially important in terms of sediment disposal are to be adopted. In the second stage, the remaining facilities are to worked on. The contents of each period of work are shown below:

1) The first stage (5 years)

a) Raising and repair work for the dike at the sand pocket for the length of 15.5 km.
b) Sediment management works at the sand pocket.
c) Repair works for aggregate plant indispensable to sediment management.
d) Drainage works at crater lake (655 m).
e) Check dam work (15 sites).
(S. Cimampang .... 2, S. Cikunir .... 2, S. Cibanjaran .... 2, South Slope ... 9)
f) Ciponyo II consolidation dam works (4 sites), revetment works (1.7 km).

2) The second stage (5 years)

a) Sediment management works at sand pocket.
b) Construction of check dam on southern slope (11 sites).

4.8.2 Construction Plans

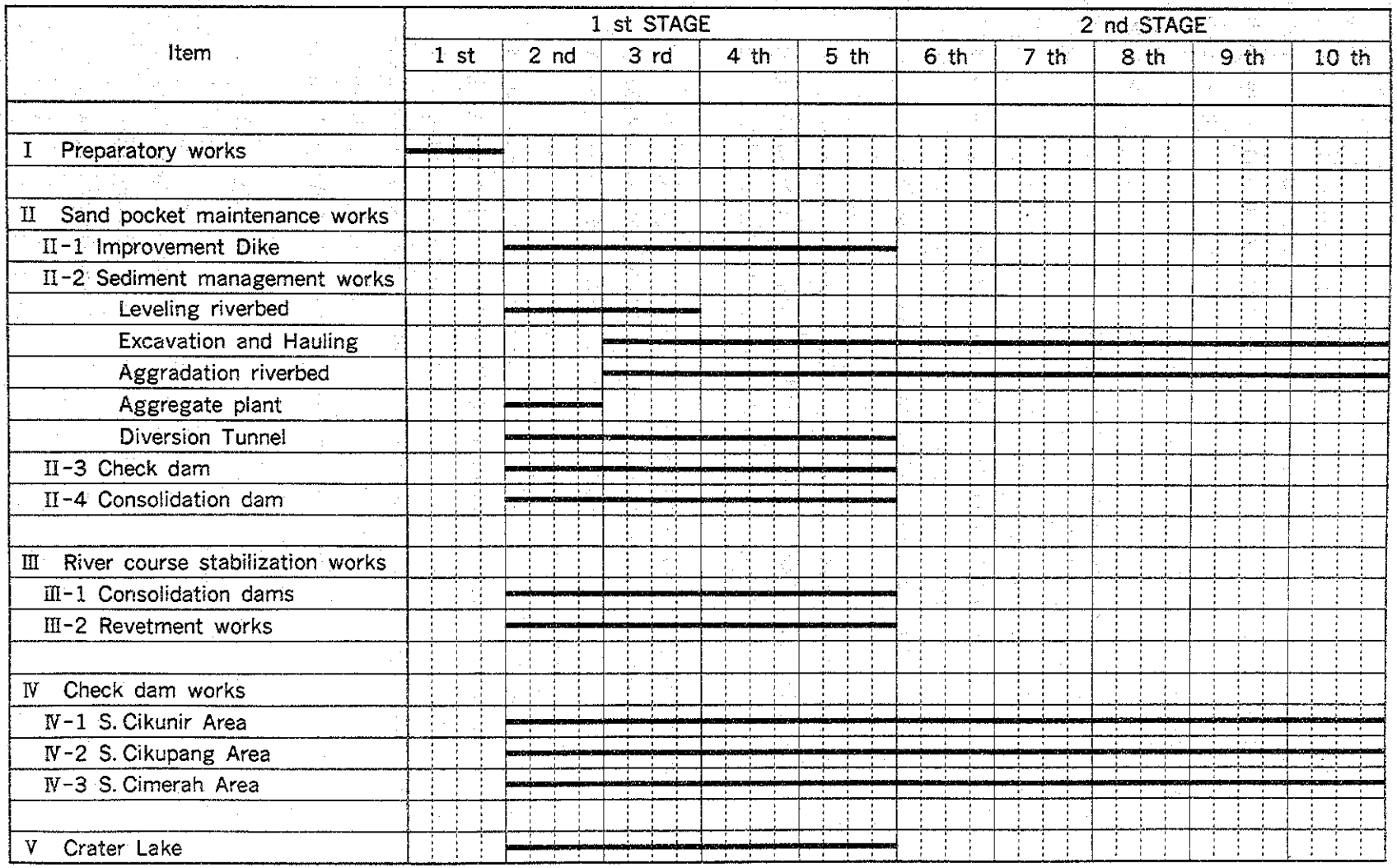
In laying out the construction plan, the availability of machinery and materials for construction at the site, their prices, builders' operational abilities, insurance for machinery, transport of materials into the jobsite, and other matters related to construction work were taken into account.

General construction materials, such as cement, timber, brick, stone, fuel, oil, are all available at the sight. Aggregate plant materials, tunnel lining and the like, however, have to be imported.

Workable days were decided to be 207 for earth work, 221 for aggregate plants, 300 for aggregate transportation. As regards construction methods for structures, in view of economical and employment conditions, the full use of stone, sediment, water and manpower were conclusively adopted.

With all of the above considered, the construction schedule was designed as shown in Fig. - 4.11.

Fig. - 4.11 Construction Schedule



4.9 Cost Estimate

4.9.1 Condition for Cost Estimate

The project costs consists of the following items shown below;

(1) Construction Costs

1) Main Construction Works Costs
   (A) Direct Costs
      a. Depreciation Costs
      b. Labor Costs
      c. Material Costs
      d. Fuel and Lubricant Costs

   (B) Indirect Costs
      a. Site Expense = 10% of (A)
      b. Profit = 15% of (A)

2) Preparatory Work Costs = 7% of (1)
3) Tax (Value Added Tax: PPN) = 10% of ((1) + (2))

(2) Land Acquisition Costs

(3) Government Administration Costs = 5% of ((1) + (2))

(4) Contingency Reserve for Construction Cost Excluding Tax

1) Physical Contingency (for change in amount)
2) Price Escalation

(5) Engineering Service

(6) Contingency Reserve for Engineering Service

1) Physical Contingency (for change in amount)
2) Price Escalation.

(7) Project Costs (the sum of ((1) ~ (6))

Furthermore, the condition of the project costs consists of the following items:

a. Project costs were estimated in accordance with prices in Kab. Tasikmalaya of the present province of West Java, as of October, 1987. At that time, the exchange rate was 1 U.S. dollar = 1,630 rupiah = 145 yen.

b. The cost of those materials and machinery not available in Indonesia, was calculated by using the CIF (Cost Insurance and Freight) price in Jakarta as the border price.

c. The engineering service costs are used for design, drawing up of personnel expenses and construction administration costs. The rate of this expense against work was judged 7%.

d. The Government's administration costs are paid by the Indonesian Government directly to the work office at the jobsite. The ratio of this expense against the construction costs was 5% based on the past achievements of the Mt. Galunggung work office, or similar check dam projects of the Mt. Sumeru work office and the Merapi work office.

e. Costs for the contingency reserve fund were appraised as below.

1. Price Escalation
   Foreign currency was appraised at 5%, and
   domestic currency at 12%.

2. Physical Contingency

For a change in the amount of work it was decided to add 10% to the construction cost.

4.9.2 Project Cost

The project costs for each alternative plans are shown in Table - 4.15.

Table - 4.15 Project Cost for Each Alternative Plans

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
1. Construction Equipment					
1-1 Aggregate Plant	3,056.2	2,412.4	1,975.7	1,475.0	0
2. Spare Parts Consumable Materials for construction equipment					
2-1 Aggregate Plant	611.3	482.5	395.1	295.0	0
2-2 Spare parts	1,473.9	1,473.9	1,473.9	1,473.9	1,473.9
2-3 Spare tire	1,180.5	1,180.5	1,180.5	1,180.5	1,180.5
Sub total	6,321.9	5,549.3	5,025.2	4,424.4	2,654.4
3. Civil Works					
3-1 Crater lake drainage works	3,791.0	3,791.0	3,791.0	3,791.0	3,791.0
3-2 Dike improvement works					
3-2.1 Embankment	1,820.0	1,820.0	1,820.0	1,820.0	1,820.0
3-3 Sand pocket maintenance work					
3-3.1 Excavation (1)	5,406.0	5,406.0	5,406.0	5,406.0	5,406.0
3-3.2 Excavation (2)	14,256.6	10,127.8	6,817.1	1,990.1	0
3-3.3 Excavation (3)	-	3,309.4	6,256.2	10,607.4	12,603.7
3-3.4 Raising dike	1,744.6	1,951.2	2,223.6	2,830.1	4,872.1
3-3.5 Diversion Cannel	-	1,321.7	1,505.3	1,954.6	3,250.5
3-5.6 Check dam	1,870.9	1,870.9	1,870.9	1,870.9	1,870.9
3-4 River course stabilization works					
3-4.1 Consolidation dam	792.7	792.7	792.7	792.7	792.7
3-4.2 Revetment works	981.0	981.0	981.0	981.0	981.0
3-5 Check dams works	6,859.6	6,859.6	6,859.6	6,859.6	6,859.6
3-6 Aggregate plant	2,139.0	1,711.1	1,254.0	941.4	0
3-7 Plant operation cost	1,010.9	718.1	483.4	141,1	0
3-8 Preparatory works	2,847.1	2,846.2	2,804.3	2,799.0	2,957.3
Sub total	43,519.4	43,506.7	42,865.1	42,784.9	45,204.8
Construction Cost	49,841.3	49,056.0	47,890.3	47,209.3	47,859.2
Project Cost	102,315.3	99,750.9	98,310.2	97,828.7	98,246.4

Note: Project cost is estimated (Co: Construction Cost) as follows;
Project cost = Co x 2.0528

5. Economic Evaluation

5.1 General

The purpose of the economic evaluation is to analyze the economic effects and influences that could conceivably be brought about by he implementation of the Mt. Galunggung Disaster Prevention Project. In this way,the suitability of the project can be considered.

Economic evaluation has been made for each river basin based on the expenses and benefits the project holds for each basin. The economic feasibility of the unit projects on each river has been evaluated by calculating the economic internal rate of return (EIRR, abbreviated as IRR below) and net present value (NPV) of the project.

With regard to the project for the S. Cikunir area, since then are 5 alternative plans for 4.2 "Sandpocket Maintenance" each has been individually evaluated.

5.2 Calculation of Benefit

5.2.1 Outline

The following are considered to be the project effects (benefits) accruing from the execution of the project.

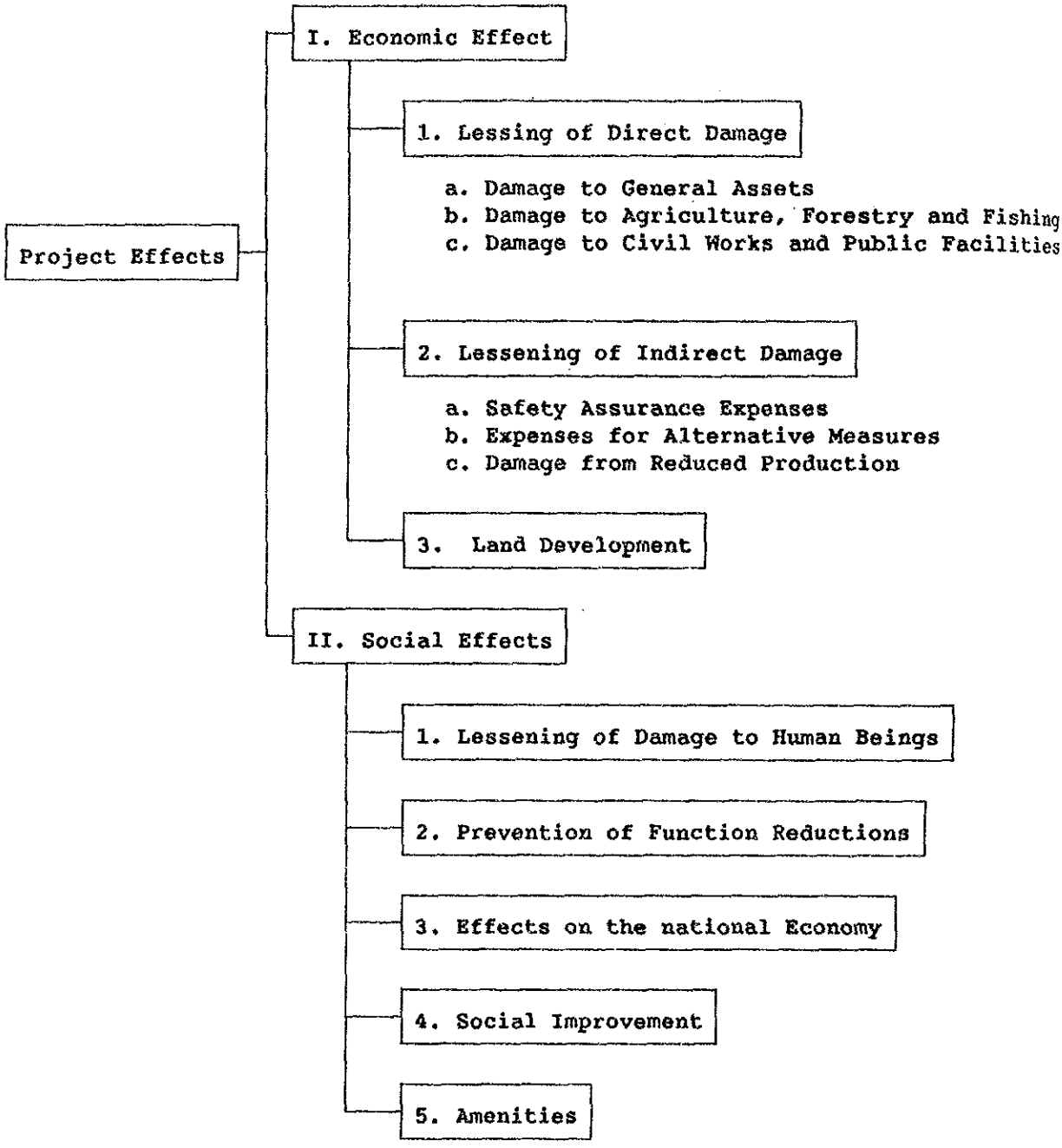


Fig. - 5.1 Project Effects Accuring from the Execution of the Project

Most of the economic effects listed above can be converted into monetary terms. The social effects are in the form of social changes which the project will bring, and are not readily expressible in terms of money. Nevertheless, they should be given mention as aspects of the project.

For this project consideration was weighted towards effects a, b and c of the direct effects, and all of the indirect effects.

Most of the indirect damage to be lessened consists of expenses to the people for rescue activities, public sanitation activities, emergency housing construction, material support and reduced productivity of the irrigation areas.

The benefits were evaluated as the differences between the effects without the project and the effects with the project.

5.2.2 The Possible Disaster Areas and its Assets

(1) The Possible Disaster Areas

The following 6 districts were selected as the areas in which to study the mud flows and floods that occurred after the 1982 eruption of Mt. Galunggung, and based on their topographical, sediment yield and flooding characteristics they are considered to be the areas in which disasters occurred (the Possible Disaster Areas). (Refer to Fig. - 5.2)

The areas were divided up into 9 flood zones in consideration of their possible disaster areas and topographically characterized political divisions. The classification of possible disaster areas and the flood zones are shown in Table - 5.1.

Table - 5.1 Classification of Flooding Zones in Disaster Area

Name of Possible Disaster Area	Area of Flooding Zone (km^2)									
	Total	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9
Area I (S. Ciloseh Area)	10.68	5.08	5.60	-	-	-	-	-	-	-
Area II (S. Cikunir Area)	50.29	5.08	5.60	13.09	11.06	8.98	6.48	-	-	-
Area III (S. Cisaruni Area)	5.95	-	-	-	-	-	-	5.95	-	-
Area IV (S. Cikupang Area)	2.05	-	-	-	-	-	-	-	2.05	-
Area V (S. Cimerah Area)	3.30	-	-	-	-	-	-	-	-	3.30
Area VI (Crater Lake Area)	57.40	5.08	5.60	13.09	11.06	8.98	6.48	-	-	-

(2) The Assets of the Possible Disaster Areas

The possible disaster areas include the 6 Kecamatans (counties) and 34 Desas (towns and villages) shown in Table - 5.2. The assets and population of each desa in the flooding zones was multiplied by the ratio (to the whole) of the desa's area to calculate the amount of assets and population in the zone. The assets and population of each flooding zone and possible disaster area are shown in Table - 5.3 and 5.4.

The area supplied with water from the Cikunten I irrigation canal includes the entire irrigation area depending on intake from within areas to be conserved.

Refer to Supporting Report V for details concerning the assets of each desa.

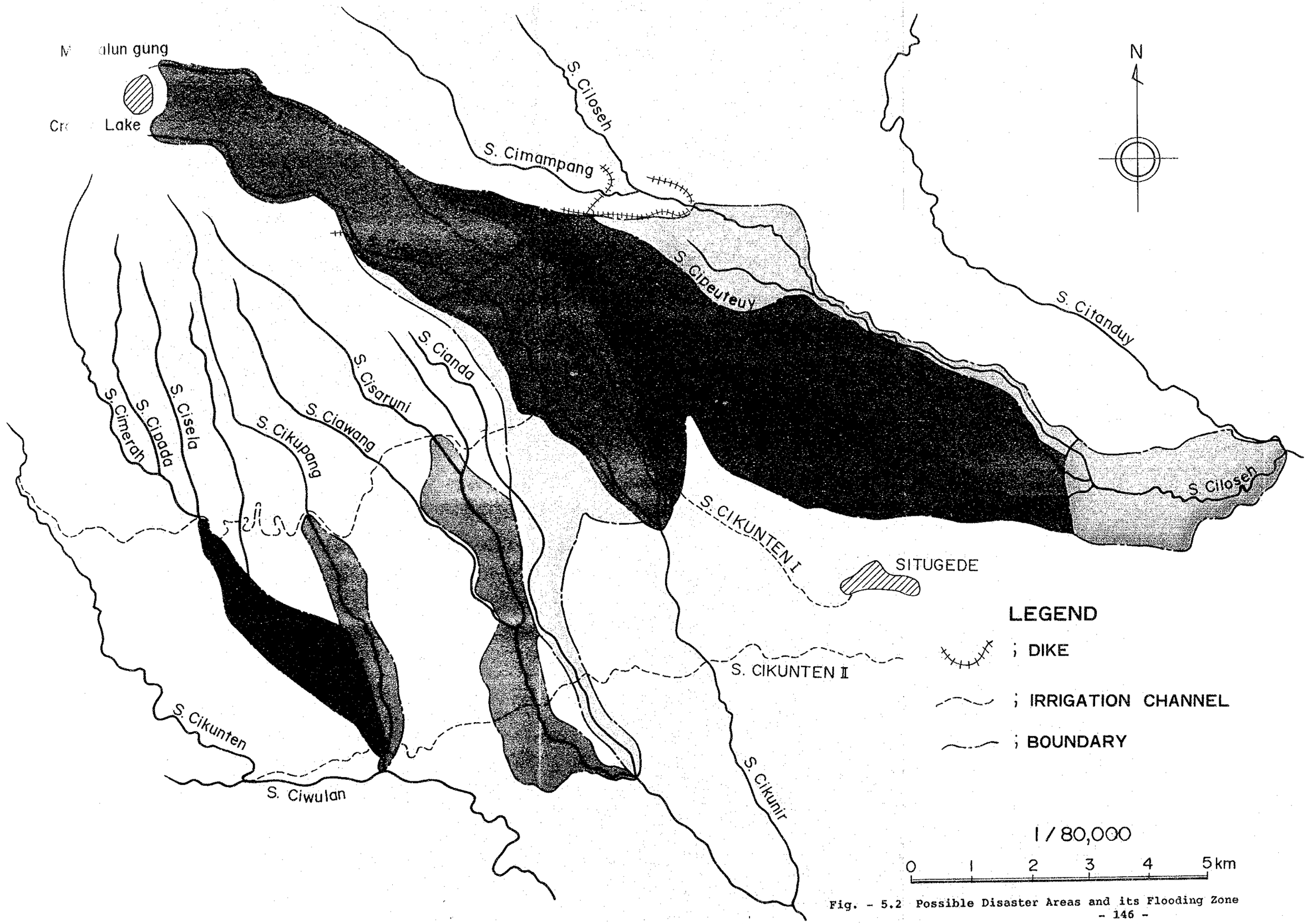


Fig. - 5.2 Possible Disaster Areas and its Flooding Zone

Table - 5.2 Kecamatan and Desa in the Possible Disaster Area

Name of Kecamatan	Name of Desa
Indihiang	Sukagarih, Sukamahi, Sukaratu, Sinagar, Linggajati Tawangbanteng, Gunungsari, Sukalaksana, Bungusari, Cibunigeulis, Sukarindik, Panyingkiran, Sukamulya, Sukajaya, Bantersari
Leuwisari	Rancapaku, Mekarjaya, Cisaruni, Ciawang, Arjessari, Sariwaygi, Linggawangi, Linggasari
Singaparna	Cilampunghilir, Cipakat, Singaparna, Cikunten
Cipades *	D. Sukamanah, D. Nagarasari, D. Cipedes, D. Panglangungan
Cihideung *	D. Argasari
Tawang *	D. Tawang + Lengk

Note: * these Kecamatans compose Kota Tasikmalaya

Table - 5.3 General Assets and Population in the Possible Disaster Areas

Name of Area / Item	Area I	Area II	Area III	Area IV	Area V	Area VI
Area (km^3)	10.68	50.29	5.95	2.06	3.30	57.40
General Assets ($Ep*10^6$)	77,336	136,862	4,729	8,308	5,123	138,029
Agricultural Products ($Rp*10^6$)	2,379	10,607	907	353	351	11,098
Total ($Rp*10^6$)	79,715	147,469	5,636	8,661	5,474	149,127
Irrigation Area * of Cikunten I (ha)	-	1,043	979	1,956	2,370	1,043
Population (person)	46,041	109,781	5,615	5,190	4,051	112,497
Note: Density ($person/km^2$)	4,310	2,180	940	1,520	1,220	1,960

* Irrigation Area = Proposed Area on Irrigation Plan

Source; "Draft System Planning Pengukuran Perencanaan Dan Rehabilitasi Daerah Irigasi Cikunten I 4,100 ha Daerah Irigasi Cikunten I 5400 ha ...Departmen Pekerjaan Umum, Direktorat Jenderal Pengairan, Proyek Irigasi Jawa Barat"

Table - 5.4 General Assets and Populations in the Flooding Zone

Name of Zone	Area (km^2)	Population (persons)	Properties($Rp*10^6$)			Irrigation Area of Cikunten I (ha)
			General Assets	Agricul. Products	Total	
Zone 1	5.08	10,406	8,422	1,294	9,716	-
Zone 2	5.60	35,635	68,914	1,085	69,999	-
Zone 3	13.09	31,568	32,037	3,260	35,297	-
Zone 4	11.06	16,663	17,821	2,495	20,316	-
Zone 5 Area II	8.98	7,956	4,377	1,358	5,735	1,043
Zone 5 Area VI	16.09	10,672	5,544	1,849	7,393	1,043
Zone 6	6.48	7,553	5,291	1,115	6,406	-
Zone 7	5.95	5,615	4,729	907	5,636	979
Zone 8	2.05	5,130	8,308	353	8,661	1,956
Zone 9	3.30	4,051	5,123	351	5,474	2,370
Total	68.70	127,293	156,189	12,709	168,898	4,413

5.2.3 Flooding Analysis

Flooding analysis of sediment and water run-off was performed for each possible disaster area. Damage coefficients were sought in order to calculate the amount of damage by probability of exceedance.

(1) Flooding Analysis Model

As the basin characteristics and form of sediment run-off differs for each possible disaster area, flooding analysis has been adopted to each possible disaster area. In Table - 5.5 are shown the flooding analysis for each possible disaster area, and the calculation conditions. The following points were also assumed for purpose of analysis.

a) The excess sediment volume accumulates entirely in the rivers in the possible disaster area, or within the flooding zone.

b) Excess sediment accumulates first along the river course. When the thickness of the sediment deposit becomes higher than the bank height, the sediment accumulates in the flooding zone inside the embankment.

c) The maximum flood water level is calculated in principle to be the water level during peak flow periods when 1/2 the excess sediment volume has been deposited. However, the maximum flood water level when the wall of the crater lake breaks is the water level during peak flow periods before the excess sediment has been deposited.

d) River water levels and flood water levels are calculated from equivalent flows.

Table - 5.5 Fundamental Conditions for Flooding Analysis

Items	Name of Area		Area I (S. Ciloseh Area)	Area II (S. Cikunir Area)	Area III, VI, V (Southern Slope Area)	Area VI (Crater Lake Area)
Cause of Damage	Without Project		Water and Sediment Flooding	Water Flooding	Water Flooding	Nothing
	With Project		Water and Sediment Flooding	Water and Sediment Flooding	Water and Sediment Flooding	Water and Sediment Flooding
Discharge for Analysis	Without and With Project	Target River	Probable Peak Discharge by Flood Return Period =1/50, 1/25, 1/10 1/5, 1/3, 1/2	Probable Peak Discharge by Flood Return Period =1/50, 1/25, 1/10 1/5, 1/3, 1/2	Probable Peak Discharge by Flood Return Period =1/50, 1/25, 1/10 1/5, 1/3, 1/2	Peak Overflow Discharge from Crater Lake
		Other Rivers	Same Magnitude as Target River	Same Magnitude as Target River	Same Magnitude as Target River	Neglegible Small
Excess Sediment Volume	Without Project	Sediment Yield Area in Target River	Probable Excess Sediment Volume by Flood	(Probable Excess Sediment Volume by Flood + (Summention Volume of Design Annual Deposited Sediment Deposited Period = 10 years)	Probable Excess Sediment Volume by Flood	Sediment Volume of Present Unstable Materials on the Slope
		Other River	Neglegible Little	Neglegible Little	Neglegible Little	Neglegible Little
	With Project	Sediment Yield Area in Target River	Probable Excess Sediemtn Volume by Flood	Neglegible Little		
		Other River	Neglegible Little	Neglegible Little	Neglegible Little	Neglegible Little
Condition at Max. Flooding Depth	Without and With Project	Discharge	Peak Discharge	Peak Discharge	Peak Discharge	Peak Discharge
		Deposited Sediment	0.5*(Max. Probable Excess Sediment Volume; MPESV)	0.5*(MPESV) + (Excess Volume of Annual Deposited Sediment Deposited Period = 10 years)	0.5*(Max. Probable Excess Sediment Volume; MPESV	Nothing

e) The width of the flow course during floods is calculated with the following regime theory.

$$B = 5 \times Q^{0.5} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5.1)$$

Where,

B: width of the flood flow course (m).

Q: peak flood discharge (m^3/s).

f) Sediment run-off forms are classified as follows according to riverbed gradients.

Riverbed Surface Gradient	Sediment Run-off Form
Over 1/50	Debris Flow
1/50 - 1/100	Sediment Flow
Under 1/100	Bed Load (Flood)

g) Should the project not be implemented, the following percentage of the excess sediment and flood volume will inundate either the left or the right bank of the rivers.

Cibanjaran River (S. Cibanjaran): 50%

Cikunir River (S. Cikunir) : 10%

(2) Excess Sediment Volume by Return Period

Excess sediment for each of the possible disaster areas has been determined as shown below in accordance with the sediment runoff characteristics of the basins as noted in Chapter 3.

Area I : Excess sediment volume by flood
Area II : Design annual sediment volume and excess sediment volume by flood
Area III-IV : Excess sediment volume by flood
Area IV : When the crater wall is cracked by a rise in water level or eruption

The excess sediment volume with the project is the sediment volume obtained by subtracting the design control sediment volume from the excess sediment volume without the project.

Excess sediment volume with and without the project is shown in Table - 5.6 for return periods of 50 and 25 years.

Refer to Supporting Report V for the excess sediment volume for other return periods.

Table - 5.6 Excess Sediment Volume with and without the Project

Name of Area	Name of River	Excess Annual Sediment Volume at 10th Years (10^3 m^3)	Excess Sediment Volume by Flood (10^3 m^3)			
			Without Project		With Project	
			1/50 R=250mm	1/25 R=220mm	1/50 R=185mm	1/25 R=165mm
Area I	S. Ciloseh	-	1,969	1,341	1,575	947
Area II	S. Cibanjaran	2,465	718	489	0	0
	S. Cikunir	2,276	662	451	0	0
	Total	4,741	1,380	940	0	0
Area III	S. Cisaruni	-	134	91	0	0
Area IV	S. Cikupang	-	46	31	0	0
Area V	S. Cimerah		534	364	0	0
Area VI Case 1	S. Cibanjaran		2,570		0	
	S. Cikunir	-	1,722		0	
	Total	-	4,292		0	
Area VI Case 2	S. Cibanjaran	-	5,160		0	
	S. Cikunir	-	4,312		0	
	Total	-	9,472		0	

Note) R; Probable Daily Rainfall

1) Maximum excess sediment volume of Area I - Area V is design excess sediment volume by flood

2) Excess sediment volume of Area VI is present unstable materials in riverbed and slope.

3) Case 1; Case of overtopping of storage water.

4) Case 2; Case of collapse of crater wall eruption.

(3) Peak Flood Discharge

a) Probable Peak Discharge

Probable peak discharges were calculated from probable daily rainfall for Tasikmalaya using a rational formula. They were considered to be the probable peak discharges without the project, taking into account the rate of inclusion of excess sediment volumes shown in Table - 5.6.

The peak discharges for return periods of 50 and 25 years with the project and without the project are shown in Table - 5.7.

Refer to Supporting Report I for the probable daily rainfall for Tasikmalaya, and probable peak discharges calculated from that value.

b) Peak flood discharge when the crater walls are destroyed, and peak discharges at the water way of sandpocket Ciponyo I are shown in Table - 5.8. The discharge at the waterway of the sandpocket Ciponyo I were considered as the discharge without the project at the inundation point for the possible disaster area IV.

Refer to Supporting Report V for the calculation conditions and processes for these discharges.

Table - 5.7 Probable Peak Discharge with the Project and without the Project

Name of Flooding Zone	Name of River	Name of Reference (Sub-Reference) Point	Catch-ment Area (km^2)	Probable Peak Discharge (m^3/S)			
				Without * Project		With Project	
				1/50	1/25	1/50	1/25
Zone 1	S. Ciloseh	Negla	32.33	716	592	(679) 558	(556) 490
Zone 2	S. Ciloseh	Tasikmalaya	63.64	875	733	(838) 717	(697) 631
Zone 3	S. Cibeureum	Middle Reach	6.63	111	97	111	97
Zone 4	S. Cimulu	Middle Reach	4.89	93	82	93	82
Zone 5	S. Cibanjaran	Sinagar	6.77	259	207	169	148
	S. Cikunir	Kokoncong	7.11	255	208	175	155
Zone 6	S. Cianda	Taranggel	3.12	88	77	88	77
Zone 7	S. Cisaruni	Nagrag	6.26	188	160	176	154
Zone 8	S. Cikupang	Kondang	3.40	87	76	85	75
Zone 9	S. Cimerah	Bonjongpel	10.95	274	228	225	197

Note) *; Include sediment runoff with excess sediment volume

( ); Probable peak discharge of Area I

Table - 5.8 Peak Discharge When the Crater Wall Destroyed

Items \ Case	Case 1		Case 2	
Cause of Overflow of Storage Water in Crater Lake	Overtopping of Storage Water by Rising of Water Level		Collapse of Crater Wall by Eruption	
Highest Water Level (H.W.L.) of Crater Lake at Overflow	EL. 1,140 m (Supposed HWL)		EL. 1,108 m (Past HWL)	
Overflow Point	S. Cikunir	S. Cibanjaran	S. Cikunir	S. Cibanjaran
Width of Overflow	34 m	44 m	520 m	
Max. Overflow Depth	17 m	17 m	32 m	
Peak Discharge at Crater Wall Site	3,690 m^3/S	4,780 m^3/S	137,000 m^3/S	
Peak Discharge at S.P Ciponyo I	2,040 m^3/S	2,060 m^3/S	2,080 m^3/S	2,810 m^3/S

(4) Damage Ratio

Damage ratio shows the amount of asset damage that will be inflicted in the possible disaster area by inundation from flood waters and sediment. The damage ratio for each asset is calculated from the depth of submersion, depth of sediment deposits and area of the afflicted district.

Damage ratio to general assets and agricultural products are based on the criteria established in Japan's "River and Sabo Engineering Standards" (Ministry of Construction) and "The Standard of Economic Studies for Flood Control." Refer to Table - 5.9 shown below.

Table - 5.9 Damage Ratio

Type of Damage	General Assets					Agricultural Properties		
	Depth or Thickness					Depth or Thickness		
	Under 0.5 m	0.5 -0.99	1.0 -1.99	2.0 -2.99	Over 3.0-	Under 0.5 m	0.5 -0.99	Over 1.00
by Flood Water	0.145	0.266	0.371	0.715	0.780	0.24	0.30	0.44
by Sedimentation	0.485	0.803	0.803	0.803	0.803	0.68	0.81	1.00

Source: "River and Sabo Engineering Standards" .... Ministry of Construction, JAPAN

(5) Damage Coefficients

The scale of damage to each of the flood zones inside possible disaster areas from water and sediment inundation is evaluated with damage coefficients as shown below.

a) The scale of direct damage is shown by a damage coefficient calculated with the following formula.

Damage Coefficient for Direct Damage

= Damage Ratio x Damage Area ..... (5.2)

Where,

Damage Area Ratio = (Damage Area)/(Flooding Zone Area)

b) The scale of indirect damage is shown by the damage area rate above. They are considered to be the damage coefficient for indirect damage.

c) The scale of damage to irrigation areas is shown by the percentage of excess sediment included in probable flooding. This shall be considered the damage coefficient by probability for the irrigation area. With a probability of 1/50, the damage coefficient is 1.00.

Refer to Supporting Report V for the damage coefficients with and without the project calculated from the damage area rate and damage ratio obtained from flooding analysis. Also found will be the process by which damage rations were calculated from the flooding analysis.

5.2.4 Amount of Annual Average Damages Mitigation

(1) Amount of Damage

The amount of damage is calculated by multiplying the amount of assets by the damage coefficient for various possible disaster areas and probabilities.

Refer to Supporting Report VI for amounts of damage with or without the project by possible disaster area and probability.

The amount of damage to public facilities was calculated from the actual damage from the 1982 eruption using the following formula.

Probable Damage to Public Facilities =
(Amount of General Assets Damage + Amount of
Agricultural Damage) x 20% ..... (5.3)

Indirect damage is calculated at 19,750 Rp per person living in an afflicted area. This comes from the actual damage done during the 1982 eruption.

Based on data from the 1982 eruption, rice production in the irrigation area is considered to drop by 55%.

(2) Amount of Annual Average Damage Mitigation

The amount of annual average damage mitigation for each possible disaster area with and without the project was calculated by multiplying the difference between damage for different probabilities by different excess probabilities. Refer to Supporting Report VI for the calculation process.

The amount of annual average damage mitigation is shown in Table - 5.10.

Table - 5.10 Amount of Annual Average Damage Mitigation

Area		Annual Average Damage ($Rp*10^6$)		Annual Average Damage Mitigation ($Rp*10^6$)	Project Unit
		without Project (1)	with Project (2)		
Area I (S. Ciloseh Area)		770.3	394.5	375.8	1 & 2
Area II (S. Cikunir Area)		5,084.4	168.3	4,916.1	2
Area III (S. Cisaruni Area)		102.8	17.7	85.1	3
Area IV (S. Cikupang Area)		160.6	6.8	153.8	3
Area V (S. Cimerah Area)		212.4	6.3	206.1	3
Area IV (Crater Lake area	Case 1	337.2	0	337.2	4
	Case 2	452.3	0	452.3	4

Note) Case 1 ; In case of Overtopping of Storage Water.
Case 2 ; In case of Collapse of Crater Wall by Eruption.

5.3 Economic Costs

Economic costs based on the design of the disaster prevention facilities in each project area were estimated. Items taken into consideration so as to estimate the economic costs for projects are as follows;

1) Labor costs were calculated as being one a half the cost for each item, taking into account the cost of unskilled labor and labor from the city of Tasikmalaya.

2) As taxes are a transferable cost they were not included in calculations.

3) Price escalations were not included in reserve funds in consideration of changes in the amount of construction.

The economic cost for each basin is shown in Table - 5.11.

Table - 5.11 Economic Costs by Project Area for the Mt. Galunggung Disaster Prevention Project

Project Area	Economic Cost (Rp $x10^6$)	Remarks
S. Ciloseh	3,620.9	Project Unit 1
S. Cikunir	36,020.6	Project Unit 2
S. Cisaruni	2,992.8	Project Unit 3
S. Cikupang	774.2	Project Unit 3
S. Cimerah	5,526.4	Project Unit 3
Crater Lake	5,378.9	Project Unit 4

The economic cost for the S. Cikunir area was based on the alternative D of the five alternatives plans for the sediment works in the sandpocket. Refer to Chapter 5.4.2 for the economic evaluation results of the other alternatives.

5.4 Economic Evaluation

5.4.1 Basic Condition for Economic Evaluation for the Project Unit

A cash flow chart was prepared showing the economic cost and the benefit of the project. IRR and NPV were calculated from the chart and economic evaluation was made. The following conditions were adhered to in the preparation of the cash flow chart.

(a) The construction period shall be divided up into two phases and shall be a total of 10 years.

(b) As it will be necessary to repair and manage check dam facilities, maintenance fees will be considered to be 5% of the yearly construction fees for each possible disaster area.

(c) The prices for October 1987 shall be taken standard prices.

(d) The economic life of the project is to be 50 years.

(e) The amount of annual average damage mitigation shall be calculated from the value of current assets in the area. It is, however, thought that population in the area will increase, thus increasing the area's assets. Therefore, the annual average damage mitigation in the economic benefits category will be increased at the following population growth rate:

The rice production increase rate by prevention of the irrigation facilities from debris flow was set as follows;

Table - 5.12 Population Growth and Rice Productivity Growth

Year	Population Growth	Rice Productivity Growth
1-10	1.56%	2.0%
11-50	1.42%	1.0%

(f) Economic benefits are assumed to come into effect the year following the completion of disaster prevention facilities.

5.4.2 Economic Evaluation for the Project Units

Economic evaluation were carried out for project units and for possible disaster areas where projects are to be carried out (called project areas). The results of the economic evaluation are as shown in Table - 5.13.

Table - 5.13 Results of Economic Evaluation

Area	Economic Cost (Rp $x10^6$)	Benefit (Rp $x10^6$)	IRR (%)	NPV (6%)* (Rp $x10^6$)
Project Unit 1 (Project Unit 2)	39,641.5	5,292.0	11.3	41,519.5
S. Ciloseh	3,620.9	375.8	9.7	2,205.2
S. Cikunir	36,020.6	4,916.2	11.4	39,314.3
Project Unit 3	9,293.4	445.0	5.6	-416.0
S. Cisaruni	2,992.8	85.1	2.4	-937.6
S. Cikupang	774.2	153.8	24.0	1,766.1
S. Cimerah	5,526.4	206.1	3.8	-1,244.5
Project Unit 4				
Crater Lake	5,378.9	452.3	8.3	2,039.9

Note) NPV: at a discount rate 6%

The results of the economic evaluations from Table - 5.13 are summarized as follows;

(1) Project areas with IRR value over 6%* are the three project units 1, 2 and 4. The order of priority for the execution of the project is shown as follows;

---

* Because most of the disaster prevention projects are implemented in mountainous areas, assets are few, and with the main objective of the projects as the stability of the people, protecting lives and other such sociological factors, it is normal for the IRR value to decrease when compared to other sectors, such as electrical power and roads. Here, evaluation has been undertaken with the IRR value at 6% as standard, based on selected standards of OECF and other agencies.

1) Project Unit 1: maintenance of sandpocket
2) Project Unit 2: stabilization works of river course in sandpocket
3) Project Unit 4: drainage works of the crater lake

(2) S. Cikunir area (with an IRR value of 11.4%) is the best area for sandpocket maintenance using Project Unit 1.

(3) There is no preference for project unit 3 because the IRR value is low. However, in the southern slope area, the S. Cikupang area has a great (high) IRR value of 24%. The economical effect by the execution of the project in this area would be very high.

The results of the economic evaluation indicate that the first priority works on the disaster prevention project is made up of the maintenance works of the sandpocket and the stabilization works of river course in sandpocket Ciponyo II. These works are the most economically feasible.

The second works on the disaster prevention project is made up of the drainage works in the crater lake and check dam works on the southern slope in the S. Cikupang area.

The specifications for disaster prevention projects are shown in Table - 5.14; that for project costs in Table - 5.15 and the construction schedule is shown in Fig. - 5.3.

Table - 5.14 Specifications for Disaster Prevention Plan

(1) Sandpockets Maintenance Works	1) Check dams	6 sites
	2) Consolidation dams	2 sites
	3) Dike improvement	15.5 km
	4) Excavation (1)	1,370,000 m^3
	5) Excavation (2)	3,932,000 m^3
	6) Excavation (3)	1,024,000 m^3
	7) Aggregate plant (140t/h)	
(2) River Course Stabilization	1) Consolidation dams	4 sites
	2) Dike	1.4 km
	3) Revetment work	1.7 km
(3) Crater Lake Drainage Works	1) Tunnel 2.0 m	L = 665.0 m
	2) Shaft 4.0 m	L = 90.0 m

Note: Excavation (1): Riverbed leveling works
Excavation (2): Riverbed aggradation works
Excavation (3): Sediment excavation and hauling

Table - 5.15 Project Cost

Item	Project Cost ($Rpx10^6$)	Local Currency ($Rpx10^6$)	Foreign Currency ($x10^6$)
1. Construction Equipment	1,475.0	-	1,475.0
1-1 Aggregate Plant	1,475.0	-	1,475.0
2. Spare Parts Consumable Materials for Construction Equipment	2,949.4	-	2,949.4
2-1 Aggregate plant	295.0	-	295.0
2-2 Spare parts	1,473.9	-	1,473.9
2-3 Spare tire	1,180.5	-	1,180.5
3. Civil Works	39,772.4	22,022.7	17,749.7
3-1 Crater lake drainage works	3,791.0	777.6	3,013.4
3-2 Dike improvement works			
3-2.1 Embankment	1,820.0	938.9	881.1
3-3 Sandpocket maintenance work	24,659.1	11,911.6	12,747.5
3-3.1 Excavation (1)	5,406.0	2,446.0	2,960.0
3-3.2 Excavation (2)	10,607.4	4,384.9	6,222.5
3-3.3 Excavation (3)	1,990.1	904.6	1,085.5
3-3.4 Raising dike	2,830.1	1,722.2	1,107.9
3-3.5 Diversion works	1,954.6	1,126.4	828.2
3-3.6 Check dam	1,870.9	1,327.5	543.4
3-4 River course stabilization work	1,773.7	1,226.7	547.0
3-4.1 Consolidation dam	792.7	511.4	281.3
3-4.2 Revetment works	981.0	715.3	265.7
3-5 Aggregate plant	941.1	380.4	560.7
3-6 Plant operation cost	141.1	141.1	0
3-7 Preparatory works	2,628.5	2,628.5	0
3-8 Government tax	4,017.9	4,017.9	0
4. Land Acquisition Cost	3,763.0	3,763.0	0
5. Government Administration Cost	2,398.0	2,398.0	0
Sub Total	50,357.8	28,183.7	22,174.1
6. Contingency of Item 1 to 6	32,410.9	14,336.1	18,074.8
6-1 Price escalation	26,391.7	12,358.7	14,033.0
6-2 Physical contingency	6,019.2	1,977.4	4,041.8
7. Engineering Service	9,723.3	1,153.5	8,569.8
8. Contingency of Item 8	4,167.0	988.7	3,178.3
8-1 Price escalation	3,241.0	823.9	2,417.1
8-2 Physical contingency	926.0	164.8	761.2
Total	96,659.0	44,662.0	51,997.0

Notes: (1) Price level is as of Oct. 1987.
(2) Exchange rate is as follows: US=145=Rp.1,630 (10 Oct. 1987).
(3) Annual Price Escalation: Foreign Currency=5%, Local Currency=12%.
(4) Physical Contingency of Foreign and Local Currency=10%.
(5) (1.0/0.7-1.0)% Ceiling of Local Currency.

Fig. - 5.3 Construction Schedule

Item		1 st STAGE					2 nd STAGE				
		1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th	9 th	10 th
I Preparatory works											
II Sandpocket maintenance works											
II-1 Improvement Dike	L=15.5km V=209,000m³										
II-2 Sediment management works											
Riverbed leveling	V=1,370,000m³										
Excavation and Hauling	V=1,024,000m³										
Storing	V=3,932,000m³										
Aggregate plant	140t/h										
Diversion Tunnel	L=1.5km										
II-3 Check dam	6 site										
II-4 Consolidation dam	2 site										
III River course stabilization works											
III-1 Consolidation dams	4 site										
III-2 Revetment works	L=1.7km										
IV Crater Lake	L=665.0m										

5.4.3 Economic Evaluation for the Alternatives on the Sediment Management Works

The results of economic evaluation for the alternatives on the sediment management works for the S. Cikunir area as noted in 4.2.3 are shown in Table - 5.16.

Table - 5.16 Results of Economic Evaluation for the Alternatives on the Sediment Management Works

Alternatives	Economic Cost ($Rp \times 10^6$)	Benefit ($Rp \times 10^6$)	IRR (%)	NPV Discount Rate (6%) ($Rp \times 10^6$)
Alternative A	42,083.5	4,916.2	11.28	37,366.2
Alternative B	39,806.5	4,916.2	11.49	38,666.2
Alternative C	37,697.0	4,916.2	11.41	38,983.4
Alternative D	36,020.6	4,916.2	11.39	38,314.3
Alternative E	38,152.4	4,916.2	10.80	38,921.1

According to Table - 5.16 the benefit for each alternative is the same: $4,916 \times 10^6$ Rp.

In the case of same benefit, the alternative which shows the minimum economic cost should be selected as feasible alternative.

The alternative with the lowest economic cost is Alternative D, and D has been chosen as the alternative for the sediment management works for sandpocket Ciponyo I Dalam.

The cash flow of the alternative D is shown in Table - 5.17.

Table - 5.17 Cash Flow of Alternative D

CASH-FLOW OF AREA-2 (ALTERNATIVE D)

(Rp. 1,000,000.)

YEAR	COST TOTAL	CONSTRUCTION	MAINTE.	BENEFIT TOTAL	DIRECT	INDIRECT	IRRIG.	SOCIAL BASE
1	2304.60	2304.60		0.00	0.00	0.00	0.00	
2	9766.90	9766.90		0.00	0.00	0.00	0.00	
3	9117.60	9117.60		0.00	0.00	0.00	0.00	
4	4692.50	4692.50		0.00	0.00	0.00	0.00	
5	3697.00	3697.00		0.00	0.00	0.00	0.00	
6	1670.40	1670.40		908.05	830.34	56.05	13.67	
7	1197.80	1197.80		1822.42	1681.53	113.18	27.70	
8	1197.80	1197.80		2778.62	2564.20	171.85	42.57	
9	1197.80	1197.80		3763.93	3474.01	232.80	57.92	
10	1198.80	1198.80		4773.28	4406.20	293.22	73.78	
11	133.40		133.40	5810.46	5364.77	356.23	89.46	
12	133.40		133.40	5906.46	5448.95	375.16	98.35	
13	133.40		133.40	5989.95	5518.21	380.48	91.26	
14	133.40		133.40	6074.63	5596.57	385.89	92.17	
15	133.40		133.40	6160.50	5676.04	391.37	93.09	
16	133.40		133.40	6247.59	5756.64	396.92	94.02	
17	133.40		133.40	6335.91	5838.39	402.56	94.96	
18	133.40		133.40	6425.48	5921.29	408.28	95.91	
19	133.40		133.40	6516.32	6005.38	414.07	96.87	
20	133.40		133.40	6608.45	6090.65	419.95	97.84	
21	133.40		133.40	6701.87	6177.14	425.92	98.82	
22	133.40		133.40	6796.63	6264.86	431.97	99.81	
23	133.40		133.40	6892.72	6353.82	438.10	100.80	
24	133.40		133.40	6990.17	6444.04	444.32	101.81	
25	133.40		133.40	7089.00	6535.55	450.63	102.83	
26	133.40		133.40	7189.24	6628.35	457.03	103.86	
27	133.40		133.40	7290.89	6722.47	463.52	104.90	
28	133.40		133.40	7393.98	6817.93	470.10	105.95	
29	133.40		133.40	7498.53	6914.75	476.78	107.00	
30	133.40		133.40	7604.56	7012.94	483.55	108.07	
31	133.40		133.40	7712.09	7112.52	490.41	109.16	
32	133.40		133.40	7821.14	7213.52	497.38	110.25	
33	133.40		133.40	7931.74	7315.95	504.44	111.35	
34	133.40		133.40	8043.90	7419.84	511.60	112.46	
35	133.40		133.40	8157.65	7525.20	518.87	113.59	
36	133.40		133.40	8273.01	7632.05	526.23	114.72	
37	133.40		133.40	8390.01	7740.43	533.71	115.87	
38	133.40		133.40	8508.66	7850.34	541.29	117.03	
39	133.40		133.40	8629.99	7961.82	548.97	119.20	
40	133.40		133.40	8751.03	8074.88	556.77	119.38	
41	133.40		133.40	8874.79	8189.54	564.67	120.58	
42	133.40		133.40	9000.31	8305.83	572.69	121.78	
43	133.40		133.40	9127.60	8423.78	580.82	123.00	
44	133.40		133.40	9256.69	8543.39	589.07	124.23	
45	133.40		133.40	9387.62	8664.71	597.44	125.47	
46	133.40		133.40	9520.39	8787.75	605.92	126.73	
47	133.40		133.40	9655.05	8912.53	614.52	127.99	
48	133.40		133.40	9791.62	9039.09	623.25	129.27	
49	133.40		133.40	9930.11	9167.45	632.10	130.57	
50	133.40		133.40	10070.57	9297.62	641.08	131.87	
TOTAL	41356.60	36020.60	5336.00	324394.68	299215.35	20590.26	4588.99	0.00

IRR= 0.1139

DISCOUNT RATE (%)	ACCUM. DISCOUNTED COST	ACCUM. DISCOUNTED BENEFIT	B/C RATIO	NET PRESENT VALUE
0	41356.60	324394.68	7.84	283038.08
1	39042.26	241654.51	6.19	202612.25
2	37159.94	183224.52	4.93	146064.58
3	35587.38	141329.17	3.97	105741.79
4	34241.99	110824.41	3.24	76582.43
5	33067.12	88269.63	2.67	55202.51
6	32023.34	71337.66	2.23	39314.32
7	31082.69	58436.34	1.88	27353.65
8	30225.04	48463.61	1.60	18238.57
9	29435.62	40647.54	1.38	11211.92
10	28703.38	34440.96	1.20	5737.58
11	28019.90	29451.29	1.05	1431.39
12	27378.66	25393.49	0.93	-1985.17
13	26774.47	22058.06	0.82	-4716.42
14	26203.28	19289.22	0.74	-6913.98
15	25661.44	16969.88	0.66	-8691.64
16	25146.36	15010.62	0.60	-10135.74
17	24655.58	13343.09	0.54	-11312.50
18	24187.07	11913.87	0.49	-12273.20
19	23739.07	10681.10	0.45	-13057.97
20	23310.05	9611.55	0.41	-13698.50

INTERNAL RATE OF RETURN 0.1139

6. Conclusion and Recommendations

Based on the study of the existing basic plan and the results of fullscale study, the design for the Mt. Galunggung disaster prevention project and project studies were carried out.

In this chapter, the conclusions are given and urgent projects are indicated, as well as recommendations concerning alternatives of sediment management works.

(1) Urgent Project

With regard to the proposed plans for the Mt. Galunggung disaster prevention projects, the following project units were selected as urgent project by taking into account the results of the economic evaluation. These were given an order of priority.

The project will be executed in the S. Cikunir area, S. Ciloseh area and the crater lake of Mt. Galunggung.

The description of the urgent project are shown as follows;

1-1) Specifications

a) Maintenance Works of the Sandpocket, Stabilization Works of River Course in the Sandpocket

	Total length
Dike Improvement (S. Cikunir, S. Ciloseh)	15.5 Km
Sediment Management Works in the Sandpocket	Total volume
(S. Cikunir, S. Ciloseh)	6,536,000 m^3
Aggregate Plant (S. Cikunir)	1 unit
Check Dam (S. Cikunir, S. Cimampang)	6 sites
Consolidation Dam (S. Cikunir)	6 sites
	Total length
Revetment (S. Cikunir)	1.7 Km

b) Drainage Works in the crater lakes of Mt. Galunggung

	Total length
Drainage Tunnel (Diameter = 2.0 m)	665 m
Vertical Shaft (Diameter = 4.0 m)	90 m
Cooling Plant	2 sites

1-2) Project Cost

The implementation period is 10 years, divided into the first and second stages.

The project cost (financial cost) of the urgent project is, US$59,300,000. The currency portion is shown as follows;

Foreign Currency;	US$ 31,900 $x10^3$	(53.8%)
Local Currency;	US$ 27,400 $x10^3$	(46.2%)
	(Rp.44,662 $x10^6$)	
Total ;	US$ 59,300 $x10^3$	(100%)

1-3) Social-economic Impact through the execution of the project

In addition to the reduction of damage which is caused by sediment runoff and flood runoff, the following social-economic impact can be expected through the execution of the urgent project.

i) The development of the regional economy through the expansion of employment - This would come about through the execution of the project

ii) The improvement of land utilization and population, and improving the living environment through the construction of disaster prevention facilities.

The disaster prevention will also have extremely important and fundamental effects in addition to the direct and indirect effects described above. Human life will be protected, and people will be relieved from anxiety over possible loss or damage to their property. The project will thus add stability to the life of the citizens and help maintain the social fabric of the nation.

The disaster prevention project consists of the sediment control project and the drainage project in the crater lake is technically feasible. With an IRR of 10.9%, the execution of the project is also confirmed as being economically feasible. The project will also increase the safety from the point of view of disaster prevention in the executed regions, engender the economic development of the local economy, and create greater stability in day-to-day life.

In consideration of the sediment outflow conditions of the basin as well as the construction schedule of the project, it is recommended that the above mentioned project be executed as the disaster prevention project for the southeastern area of Mt. Galunggung.

(2) Alternatives for the Sandpocket Management Works

As a result of the economic evaluation, Alternative D (aggregate production; 120,000 m^3) which shows the least cost among the five alternatives was selected for the sandpocket management works.

Table - 6.1 Economic Cost for each Alternative on the Sediment Management Works in the Sandpocket

Alternatives	Economic Cost (Rp x10^6)
Alternative A	42,083.5
Alternative B	39,806.5
Alternative C	37,698.0
Alternative D	36,020.8
Alternative E	38,152.4

Alternative D was selected for the sandpocket management works from the economic point of view. However, apart from this, the actual condition of the sandpocket area of Mt. Galunggung, the aggregate market condition in Jakarta where the final consumption place of aggregate from the Mt. Galunggung area takes place and the social circumstance surrounding this area are summarized as follows;

i) It is impossible to acquire the land for the sediment management in the Mt. Galunggung area. Technically, also, it is not desirable to raise the check dams to their limit.

ii) The cumulative transport volume of aggregate from the Mt. Galunggung area from Pirusa Station to Jakarta over a one year period (July, 1987 - June, 1988) was 428,000 m^3.

iii) In Tangerang area which has been serviced as the main supply base of aggregate to Jakarta and surrounding area, the lowering of ground water level by over excavation, environmental destruction, traffic conjection and road damage have all become problems, causing the Indonesian government to issue an edict in 1988, banning further excavation. Due to increased demands for aggregate in the Jakarta area, it is urgently necessary to maintain a source of aggregate.

It is an effective plan for both areas (Mt. Galunggung area, Jakarta area) to produce the aggregate at an aggregate plant and transport it to Jakarta by PJKA to be sold.

Taking into account the background mentioned above, the financial evaluation was made for the effective use of the sediment accumulated in the sandpocket area. (Refer to Supplement in detail)

The results of financial evaluation are shown in Table - 6.2.

Table - 6.2 Results of Financial Evaluation for the Effective Use of the Sediment in the Sandpocket Area

Alternatives	FIRR (%)	Aggregate Production
Alternative A	29.6	610,000 m^3
Alternative B	26.9	420,000
Alternative C	22.2	300,000
Alternative D	5.8	120,000

According to the financial evaluation, alternative A shows the highest value of FIRR at 29.6%.

According to the above mentioned aspects, alternative D is desirable for the management alternatives of the accumulated sediment in the sandpocket from the point of view of the least cost. However, alternative A is the best one from the point of view of the effective use of accumulated sediment, the importance of the shift to Tangerang as the supply base, and the social factors. Therefore, Considering all the various points, alternative A should be the best alternative. However, because 428,000 m^3 is the highest possible capacity of aggregate that the PJKA can guarantee to transport at present, it would be difficult to implement it at this time. For this reason, alternative B, with the actual transportation volume, is selected for the management of the accumulated sediment in the sandpocket area.

While taking into account the economic and financial feasibility of the project it is necessary to analyze the demand of the aggregate market.

(3) Increasing the Capacity of PJKA to Transport Aggregate to Jakarta

Aggregate is currently being transported from Tasikmalaya to Jakarta by truck and rail (PJKA). Truck transportation, however, may bring about traffic conjection and road damage, making it desirable to use railroad transportations for large-volume transportation.

The aggregate production capacity for alternative B (aggregate producing 450,000 m^3) was set by transportation capacity of PJKA during the period from July 1987 to June 1988 with loss ratio by aggregate plant. That is, the aggregate production capacity in the Galunggung area is restricted by the transportation capacity of PJKA.

The transportation capacity of PJKA is the most important condition for the aggregate production on the effective use of the accumulated sediment in the sandpocket area. According to the traffic diagram of PJKA, it is possible to increase the number of train departures by a few trains a day. The maximum excavation volume on disaster prevention is 614,000 m^3. This volume means the excavation volume in sandpocket Ciponyo I Dalam only. The actual excavation volume of 428,000 m^3 is the volume from the sandpocket areas except for sandpocket Ciponyo I Dalam. It means that the total excavation volume in Mt. Galunggung area is 1,042,000 m^3.

It is necessary to increase the transportation capacity of PJKA so as to correspond with the increase of aggregate demand in Jakarta.

(4) Operation of Warning and Evacuation System

The warning and evacuation system was introduced with the purpose of preventing human losses and establishing a system of warning notification to promote the evacuation of people should mud slides occur. This is done through the processing of data on rainfall water levels, etc.

Concerning the warning transmission system, the system established in the 1982 disaster has been sufficiently maintained and there are no particular problems. However, at the time of disaster, the number of instances where the amateur radio network that went into effect, and was depend upon commercially available electricity was high. As a result, emergency electric power sources - such as batteries - should be maintain in the future.

The following steps are involved in the basic process that lead up to a prediction of the occurrence of debris flow.

Step 1) Grasping of rainfall characteristics - amount of rainfall and movement patterns - by using radar rain-gauge

Step 2) Relation analysis between rainfall (or hydrograph) and the occurrence of flood as well as debris flow

Step 3) Establishment of a "Mud flow Warning and Evacuation Standard" based on rainfall intensity.

From among the above, the accumulation of data in steps 1 and 2 are considered highly significant, and it is necessary that these observations be continued in future.

APPENDIX

APPENDIX-1

Scope of Works

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY ON THE DISASTER PREVENTION PROJECT

IN THE SOUTHEASTERN SLOPE OF MT. GALUNGGUNG

IN

THE REPUBLIC OF INDONESIA

AGREED UPON BETWEEN

JAPAN INTERNATIONAL COOPERATION AGENCY

AND

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MINISTRY OF PUBLIC WORKS

JAKARTA, MARCH 25 1987

Ir. Putra Duwarsa
Assistant Director General
for River Development,
Ministry of Public Works,
Government of Indonesia

渡邊義正

Mr. WATANABE Yoshimasa
Leader of
Preliminary Survey Team,
Japan International
Cooperation Agency

I. INTRODUCTION

In response to the request of the Government of the Republic of Indonesia (hereinafter referred to as " the Government of Indonesia") the Government of Japan decided to conduct the Feasibility Study on the Disaster Prevention Project in the southeastern slope of Mt. Galunggung (hereinafter referred to as " the Study "), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan Interntional Cooperation Agency (herinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study, in close cooperation with the authorities concerned of the Government of Indonesia.

The Directorate General of Water Resources Development, the Ministry of Public Works (hereinafter referred to as "DGWRD") shall act as counterpart agency to the Japanese Study Team (hereinafter referred to as " the Team ") and also as coordinating body to the other relevant organizations for the smooth implementation of the Study.

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are :

1. to conduct the feasibility study on the disaster prevention project in the southeastern slope of Mt. Galunggung.
2. to perform technology transfer to the Indonesian counterpart personnel.

III. STUDY AREA

The Study area shall cover the southeastern slope of Mt. Galunggung including Ciwulan river with approximately 550 km^2 as shown in the attached map.

IV. OUTLINE OF THE STUDY

In order to achieve the objectives mentioned above, the Study shall cover the following items :

1. Data collection and analysis

   (1) topographic and geological maps
   (2) meteorology and hydrology
   (3) land use and water use
   (4) past damage by flood, erosion and other disasters
   (5) existing facilities related to flood and erosion control
   (6) existing plans and study reports on disaster prevention
   (7) construction cost and construction materials
   (8) administrative and socio-economic conditions
   (9) existing facilities related to warning and evacuation system
   (10) others

2. Reconnaisance survey

   (1) topographic survey for updating of existing maps
   (2) geological survey and geotechnical survey
   (3) longitudinal and cross-sectional survey
   (4) hydrological observation
   (5) survey on sedimentation and flood area
   (6) survey on present land use and water use
   (7) others

3. Review of existing basic plan.

4. Formulation of urgent disaster prevention project plan.

   (1) setting up a basic plan for disaster prevention
   (2) basic layout of disaster prevention facilities
   (3) preliminary design of disaster prevention facilities
   (4) construction plan
   (5) estimation of cost for construction and operation & maintenance
   (6) estimation of benefit
   (7) economic and financial analysis
   (8) programme and organization for operation and maintenance
   (9) social and environmental aspect.

5. Recommendation for warning and evacuation system

6. Recommendation for utilization of materials deposited on the southeastern slope.

V. SCHEDULE OF THE STUDY

The Study will be performed in accordance with the tentative study schedule drawn in the appendix.

VI. REPORTS

JICA will prepare and submit the following reports in English to the Government of Indonesia.

1. Inception Report ;

   Twenty (20) copies within one (1) month from the date of commencement of the field survey in Indonesia.

2. Progress Report ;

   Twenty (20) copies within five (5) months after commencement of the Study.

3. Interim Report ;

   Twenty (20) copies within nine (9) months after commencement of the Study.

4. Draft Final Report;

   Twenty (20) copies within fourteen (14) months after commencement of the Report.

   The Government of Indonesia will provide JICA with its comments within two (2) months after its reception of the Draft Final Report.

5. Final Report ;

   Fifty (50) copies each within two (2) months after JICA's reception of the said comments on the Draft Final Report.

VII. UNDERTAKINGS OF THE GOVERNMENT OF INDONESIA

1. To facilitate smooth conduct of the Study, the Government of Indonesia shall take necessary measures:

(1) to secure the safety of the Team,

(2) to permit the members of the Team to enter, leave and stay in Indonesia for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,

(3) to exempt the memebrs of the Team from taxes, duties and other charges on equipment, machinery and other materials brought into Indonesia for the conduct of the Study,

(4) to exempt the members of the Team from income tax and other charges of any kind imposed on or in connection with any emoluments or allowances paid to the member of the Team for their services in connection with the implementation of the Study,

(5) to provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Indonesia from Japan in connection with the implementation of the Study,

(6) to secure permission for the Team to take all data and documents and necessary materials related to the Study out of Indonesia to Japan, and

(7) to provide medical services as needed. Its expenses will be chargeable on members of the Team.

2. The Government of Indonesia shall bear claims, if any arises against the members of the Team resulting from, occuring in the course of, or otherwise connected with the discharge of their duties in the implementation of the study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

3. DGWRD shall, at its own expenses, provide the Team with the followings, in cooperation with other relevant organizations :

   (1) available data and information related to the Study

   (2) counterpart personnel and support staff necessary for the Study

   (3) suitable office space with necessary equipment in Tasikmalaya and Jakarta

   (4) credentials or identification cards.

4. The Government of Indonesia shall provide a vehicle necessary for the implementation of the Study.

VIII. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA shall take the following measures :

1. to dispatch, at its own expense, the Team to Indonesia, and

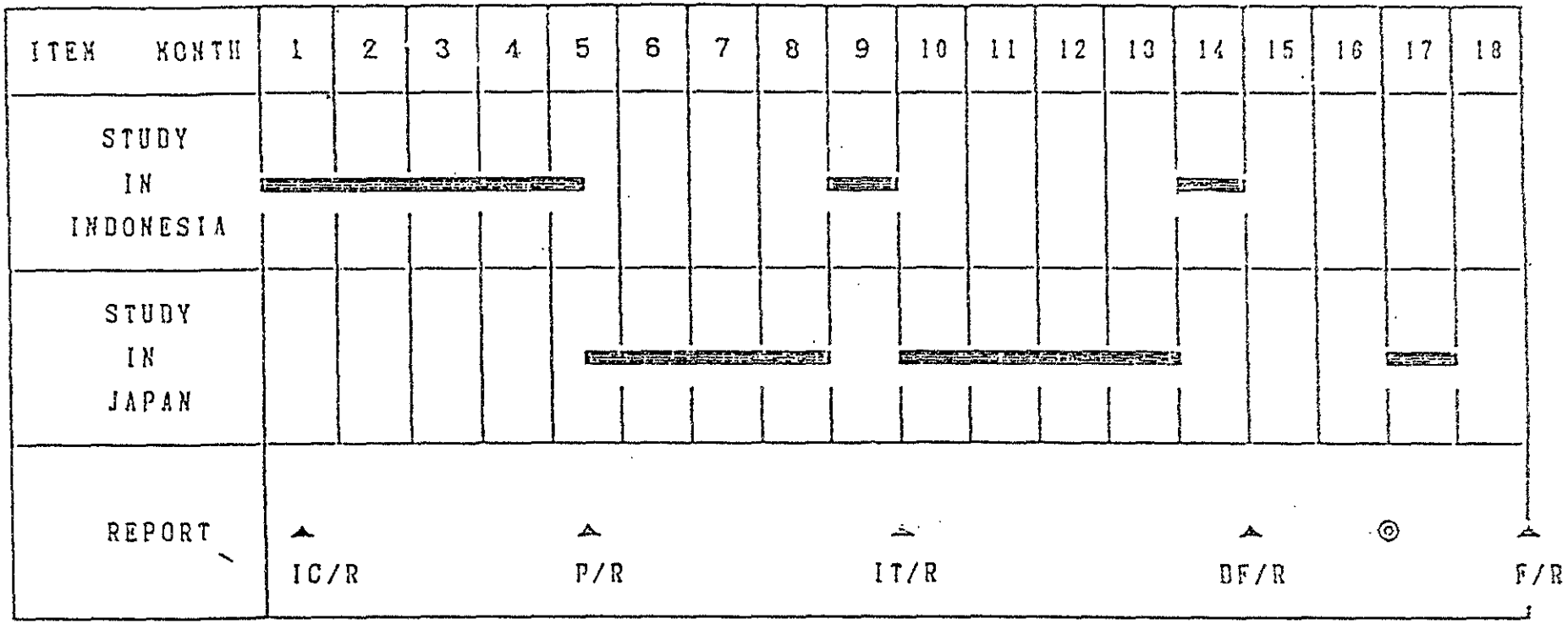
2. to perform technology transfer to the Indonesian counterpart personnel in the course of the Study.

IX. CONSULTATION

JICA and DGWRD will consult each other in respect of any matter that may arise from or in connection with the Study.

APPENDIX

TENTATIVE SCHEDULE



(REMARKS)
IC/R : Inception Report
P/R : Progress Report
IT/R : Interim Report
DF/R : Draft Final Report
F/R : Final Report
◎ : Comment

APPENDIX-2

Member List

I. JICA Advisory Committee

1)	Chairman	Mr. Keiji Masuko
2)	Member	Mr. Koichi Kondo
3)	Member	Mr. Michio Hirano
4)	Coordinator	Mr. Kazuo Nakagawa Mr. Mitsuru Suemori Mr. Tomiaki Ito

II. Study Team and Counterparts

1)	Team Leader	Dr. Koichi Hirano	Ir. Mugiono
2)	Sub Team Leader (Disaster Prevention Plan)	Mr. Shotoku Yamada	Ir. Adhy D. Soemono
3)	Hydrologist	Mr. Hidetoshi Kanamura	Mr. Dasiran
4)	Sediment Hydraulic Engineer	Mr. Toru Takahashi	Mr. Roni Komarudin
5)	Goelogist	Mr. Nobuhiko Uchiseto	Mr. Sihono
6)	Geomorphologist	Mr. Ryota Nagasawa	Mr. Itang
7)	Facility Plan and Sabo Engineer	Mr. Junichi Kojima	Mr. Sihono
8)	Cost Estimate Engineer	Mr. Koichi Nagayoshi	Mr. Roni Komarudin
9)	Socio-Economist	Mr. Shigeru Okutsu	Mr. Wasito
10)	Economist for Aggregate Use	Mr. Tsuneji Sasaki	Mr. Maman
11)	Engineer for Warning and Evacuation System	Mr. Tetsuo Haga	Mr. Dasiran
12)	Survey Engineer	Mr. Yukio Koike	Mr. Haposan Lumban

APPENDIX-3

Assignment Schedule

Assignment Schedule of the Study Team is shown in Table - 3.1.

Table – 3.1. ASSIGNMENT SCHEDULE

FIELD	MEMBER	1987 6	7	8	9	10	11	12	1988 1	2	3	4	5	6	7	8	9	10	11
TEAM LEADER	HIRAO / K																		
DISASTER PREV. PLAN (SUB TEAM LEADER)	YAMADA/S																		
HYDROLOGY	KANAMURA/H																		
SEDIMENT HYDRAULICS	TAKAHASHI/T																		
GEOLOGY & SOIL MECHANICS	UCHISETO/N																		
TOPOGRAPHIC SURVEY	KOIKE/Y																		
GEOMORPHOLOGY	NAGASAWA/R																		
DESIGN & FACILITY PLAN	KOJIMA/J																		
CONSTRUCTION PLAN & COST ESTIMATION	NAGAYOSHI/K																		
SOCIO ECONOMIC ANALYSIS	OKUTSU/S																		
WARNING& EVACUATION	HAGA/T																		
SEDIMENT UTILIZATION	SASAKI/T																		
REPORT				▲ Inception Report			▲ Progress Report				▲ Interim Report						▲ Draft Final Report		▲ Final Report

NOTES) ▬▬ WORK IN INDONESIA
▭▭ WORK IN JAPAN

APPENDIX-4

Technology Transfer

The Study Team transferred technology to the assigned counterpart personnel of the Government of Republic of Indonesia through the study period, as shown in Appendix - 2.

The method of technology transfer is as follows:

(1) On the job training with a series of studies including data collection, arragement and analysis, planning and design.

(2) Opening a lecture for the counterpart personnel on the subjects, as shown in Table - 4.1.

Table - 4.1 List of Lecture for Indonesian Counterparts

	Name of Member	Field	Date of Lecture	Sujects
1.	N. Uchiseto	Geology & Soil Mech.	25 Aug.'87	General Geology in the Southeastern Slope of Mt. Galunggung
2.	R. Nagasawa	Geomorphology	9 Sep.'87	Geomorphological and Sediment Balance Study in the Southeastern Slope
3.	Y. Koike	Topography	ditto	On the Bench Mark settled up by DPU
4.	H. Kanamura	Hydrology & Hydraulics	26 Sep.'87	Meteorological and Hydrological Study
5.	N. Uchiseto	Geology & Soil Mech.	7 Nov.'87	Geological Survey in the Crater Lake of Mt. Galunggung
6.	Y. Koike	Topography	ditto	Topographic Survey
7.	J. Kojima	Facility P/D	ditto	Sabo Facilities
8.	T. Takahashi	Sediment Hydr.	ditto	Hydrological Study & Sediment Hydraulic Study
9.	T. Sasaki	Aggregate Use	9 Nov.'87	Market situation in Jakarta and Transportation Problem, LKMD's Sales System.
10.	K. Nagayoshi	Construction Plan & Cost Estimation	ditto	Cost Estimation Survey
11.	T. Haga	Warning & Evacuation System	ditto	Data Collection Method
12.	S. Okutsu	Economic & Financial Anal.	ditto	Economic Evaluation (1)
13.	S. Yamada	Disaster Prevention Plan	ditto	Review of Basic Plan
14.	K. Hirano	Team Leader	ditto	Target of Our Study

The counterparts training in Japan for technical cooperation by Colombo plan was carried out by JICA.

The trainees are shown as follows:

1) Ir. Mugiono ; 23 Nov., '87 - 26 Dec., '87
2) Ir. Adhy ; 24 Feb., '88 - 24 Mar., '88
3) Mr. Dasiran ; 22 Sep., '88 - 24 Oct., '88
4) Mr. Roni ; 22 Sep., '88 - 24 Oct., '88

APPENDIX-5

Minutes of Meeting

1) Minutes of Meeting on the Scope of Work
   (March 25, 1987)

2) Minutes of Meeting on Inception Report
   (July 22, 1987)

3) Minutes of Meeting on Progress Report
   (November 13, 1987)

4) Minutes of Meeting on Interim Report
   (March 17, 1988)

5) Minutes of Meeting on Draft Final Report
   (September 13, 1988)

1) Minutes of Meeting on
the Scope of Work

(March 25, 1987)

MINUTES OF MEETING

ON

THE FEASIBILITY STUDY ON THE DISASTER PREVENTION PROJECT

IN

THE SOUTHEASTERN SLOPE OF MT. GALUNGGUNG

March 25,1987
Jakarta
the Republic of Indonesia

Ir. Putra Duwarsa
Assistant Director General
for River Development,
Ministry of Public Works,
Government of Indonesia

渡邊義正

Mr. WATANABE Yoshimasa
Leader of the Japanese
Preliminary Survey Team
The Japan International
Cooperation Agency

In response to the request of the Government of the Republic of Indonesia, the preliminary survey team (hereinafter referred to as " the Team") of Japan International Cooperation Agency (hereinafter referred to as "JICA"), visisted Indonesia from March 15th to March 27th, 1987, to discuss the Scope of Work for the feasibility study on the disaster prevention project in the southeastern slope of Mt. Galunggung (hereinafter referred to as " the Study ").

The Team carried out field surveys of the study area and held series of discussions with officials of Directorate General of Water Resources Development (hereinafter referred to as "DGWRD") and other agencies concerned.

A final meeting was held on March 25th,1987, at DGWRD, Jakarta . A list of those who attended the meeting is shown in the attached sheet.

The draft Scope of Work proposed by the Team was discussed in details between the Team and DGWRD and both sides agreed to adopt the Scope of Work with the following understandings:

1. The Team presented the list of necessary data for the study and Indonesian side promised that Mt. Galunggung office will try to collect the available data as much as possible in cooperation with authorities concerned before the arrival of the study team at Tasikmalaya.

2. Both side confirmed the necessity to carry out the additional survey mentioned below whose contents will be discussed and confirmed in detail in the course of the Study by both side ;

   (i) topographic survey
   (ii) geological and geotechnical survey
   (iii) longitudinal and cross-sectional survey
   (iv) hydrological observation at the crater lake

ATTENDANTS LIST

1. Japanese side

(1) Preliminary Survey Team

Mr. Y. WATANABE	Team Leader
Mr. K. KONDO	member
Mr. N. HIRANO	member
Mr. K. NAKAGAWA	member

(2) Short Term Expert for Radar System

Mr. T. FUJIHARA	Ministry of Construction

2. Indonesian Side

1. Ministry of Public Works

Ir. Putra Duwarsa	Assistant Director General for River Development

2. Directorate of Rivers

1. Ir. Hartono Pramudo	Director of Rivers
2. Ir. Amir Muryadi	Chief of Sub Directorate of Planning & Design
3. Ir. Sutrisno D	Chief of Sub Directorate of Erosion Control and Natural Disaster Rehabilitation
4. Ir. Sumarso M	Chief of Volcanic Debris Control Section
5. Ir. Sarwono Sukardi	Chief of Erosion Control Planning & Design Section
6. Sukiyoto, B.E.	Staff of Erosion Control Planning and Design Section.
7. Mr. M. Nakahiro	Leader of JICA Expert on Rivers
8. Mr. O. Itagaki	JICA Expert on Sabo

3. Institute of Hydraulic Engineering

1. Ir. L. Taulu	Head of Geotechnic Experimental Station
2. Ir. Supardiyono	Chief of Geotechnic Section

4. Volcanology

Ir. A.C. Effendi	Chief of Sub Directorate of Vulcanological Survey

5. Directorate of Planning & Programming

   Mr. Aziz Booking, Msc

6. Mt. Galunggung Project

1. Ir. Adhy D. Sumono	Assistance Planning
2. Mr. Dasiran	Staff Planning Section

2) Minutes of Meeting on
Inception Report

(July 22, 1987)

MINUTES OF MEETING

ON

THE FEASIBILITY STUDY ON THE DISASTER PREVENTION PROJECT

IN

THE SOUTHEASTERN SLOPE OF MT. GALUNGGUNG

The Study Team of Japan International Cooperation Agency (hereinafter referred to as " JICA ") submitted the attached Inception Report of the Feasibility Study on the Disaster Prevention Project in the Southeastern Slope of Mt. Galunggung to Government of Republic of Indonesia.

JICA Study Team carried out Intitial Findings of the study area and held discussions on this Inception Report with Mt. Galunggung Office.

The meeting concerning Inception Report was held on July 22 at Directorate General of Water Resources Development (hereinafter referred to as " DGWRD ") at Jakarta.

A list of those who attended the meeting is shown in the attached sheet.

As a result of the meeting, the Government of Indonesia accepted the Inception Report with the following understandings ;

1. Selection of Urgent Disaster Prevention Project

Urgent Disaster Prevention Project composed of various project units and/or sub project units will be selected from the Disaster Prevention Plan in consideration of several kinds of aspect, such as not only occurrence frequency and damage potencial of disaster but social and financial importance of the project, urgency of the project etc.

2. Estimation of Sediment Volume in the Sand Pocket

Sediment Volume in the Sand Pocket will be estimated by JICA Study Team by using existing data.

3. Sediment Transportation Capability Analysis in the downstream

The critical points will be selected through the field reconnaissance in the downstream of Ciwulan River from the confluence of Ciwulan River and Cikunir River to the rivermouth.

Hydraulic Analysis concerning sediment transportation capability on these critical points will be executed additionally by using the results of longitudinal and cross-section survey, river bed materials survey, etc.
This item will be added in Inception Report as a new item as shown follows :

8.10. Analysis of Sediment Transportation Capability

Sediment Transportation Capability in Ciwulan River from BOJONGPARANG to the rivermouth will be calculated and analyzed.

4. Repair of Radar Rain Gauge System

Japanese Side requests for the repair of Radar Rain Gauge System in order to analyze the rainfall characteristics of Mt. Galunggung South-eastern Slope Basin in the coming rainy season.

Dr. Koichi HIRAO
Leader of JICA Study Team
for
The Feasibility Study on the
Disaster Prevention Project
in the southeastern slope of
Mt. Galunggung

Ir. K. Putra Duarsa
Assistant Director General
for River Development,
Ministry of Public Works,
Government of Indonesia

ATTENDANTS LIST

1. Japanese Side

(1) JICA Advisory Committee

Mr. K. Masuko	Chairman of Committee
Mr. K. Kondo	Member
Mr. K. Nakagawa	Planning Coordinator

(2) JICA Jakarta Office

Mr. N. Matsuda	Assistant Resident Representative

(3) JICA Study Team

Dr. K. Hirao	Team Leader
Mr. S. Yamada	Member
Mr. T. Takahashi	Member
Mr. H. Kanamura	Member
Mr. N. Uchiseto	Member

2. Indonesia Side

(1) Directorate of River

Ir. Hartono Pramudo, DIP. HE.	Director of River
Ir. Amir Muryadi	Chief of Sub Directorate of Planning and Design
Ir. Sutrisno D.	Chief of Sub Directorate of Erosion Control and Natural Disaster Rehabilitation and Prevention
Ir. Sumarso M.	Chief of Volcanic Debris Control Section
Ir. Sarwono Sukardi	Chief of Erosion Control Planning & Design Section
Mr. M. Nakahiro	Leader of JICA Expert on Rivers
Mr. O. Itagaki	JICA Expert on Sabo

(2) Mt. Galunggung Project

Ir. Mugiono, DIP. HE.	Project Manager

3) Minutes of Meeting
on Progress Report

(November 13, 1987)

MINUTES OF MEETING
FOR
THE PROGRESS REPORT
ON
THE FEASIBILITY STUDY ON THE DISASTER
PREVENTION PROJECT
IN
THE SOUTHEASTERN SLOPE OF MT. GALUNGGUNG

The meeting concerning the Progress Report for the Feasibility Study on the Disaster Prevention Project in the Southeastern Slope of Mt. Galunggung Between the Study Team of Japan International Cooperation Agency (hereinafter referred to as "Study Team") and Directorate General of Water Resources Development (hereinafter referred to as "DGWRD") was held on November 13 1987 at DGWRD, JAKARTA.

Study Team submitted the Progress Report and explained their findings based on the data collection and field survey in Indonesia.

A list those who attended the meeting is shown in the attached sheet.

As a result of the meeting, Study Team and DGWRD agreed the followings :

1. Sediment Balance Analysis

Sediment Balance Analysis will be excuted based on the requirement for Disaster Prevention in the existing sand pocket area, considering also the existing site condition.

2. Analysis of Sediment Transportation Capability

Analysis of sediment transportation capability concerning S. Cikunir and lower part of S. Ciwulan will be calculated by using data obtained from field survey in Indonesia. Application of roughness factor (n) in Manning Formula

will be done based on the actual condition of river.

3. Selection of Construction Method

Selection of construction method for the drainage of crater lake will be considering hydrological and geological viewpoint including volcanic activities.

4. Arrangement of Coordination Work for the Sediment Utilization Study

Arrangement of coordination work for the sediment utilization study with the Department of Communication was requested by Study Team.
Furthermore, necessity of sediment utilization study, especially demand survey of aggregate and study of railway transportation capacity, was pointed out by DGWRD.

Dr. Koichi HIRAO
Leader of JICA Study Team
for
The Feasibility Study on the
Disaster Prevention Project
in the Southeastern Slope of
Mt. Galunggung

Ir. Hartono Pramudo
on behalf of
Assistant Director General
for River Development
Ministry of Public Works,
Government of Indonesia

ATTENDANTS LIST

(1) JICA Jakarta Office

Mr. N. Matsuda	Assistance Resident Representative

(2) JICA Study Team

Dr. K. Hirao	Team Leader
Mr. S. Yamada	Member
Mr. T. Takahashi	Member
Mr. J. Kojima	Member
Mr. N. Uchiseto	Member
Mr. K. Nagayoshi	Member
Mr. T. Haga	Member
Mr. S. Okutsu	Member
Mr. T. Sasaki	Member
Mr. Y. Koike	Member

(3) Directorate of River

Ir. Amir Muryadi	Chief of Sub Directorate of Planning and Design, DOR
Ir. Soetrisno D.	Chief of Sub Directorate of Erosion Control and Natural Disaster Rehabilitation and Prevention,DOR
Ir. Sumarso M.	Chief of Volcanic Debris Control Section
Ir. Sarwono Sukardi	Chief of Erosion Control Planning and Design Section
Mr. M. Nakahiro	Leader of JICA Expert, DOR
Mr. Itagaki	JICA Expert on Sabo.

(4) Mt. Galunggung Project

Ir. Mugiono, Dip.HE.	Project Manager

4) Minutes of Meeting on Interim Report

(March 17, 1988)

MINUTES OF MEETING
FOR
THE INTERIM REPORT
ON
THE FEASIBILITY STUDY ON THE DISASTER PREVENTION PROJECT
IN
THE SOUTHEASTERN SLOPE OF MT. GALUNGGUNG

The meeting concerning the Interim Report of the Feasibility Study on the Disaster Prevention Project in the Southeastern Slope of Mt. Galunggung between the Study Team of Japan International Cooperation Agency (hereinafter referred to as "The Study Team") and The Directorate General of Water Resources Development (hereinafter referred to as "DGWRD") was held on March 17th, 1988 at DGWRD, Jakarta.

After discussions, the Interim Report prepared by the Study Team has been mutually confirmed and agreed by both parties.

Main points discussed at the meeting were summarized as follows:

1) The following sub units are selected with high priority among Sub Units proposed in Interim Report for the further study by the Japanese side.

Sub. Unit 1-1 Improvement of existing facility in S. Ciloseh Area and S. Cikunir Area.

Sub. Unit 1-2 Excavation of deposited sediment in sand pockets and its utilization.

Sub. Unit 1-3 Construction of check dams in S. Cibanjaran and S. Cikunir (excluded S. Ciloseh area).

Sub. Unit 2-1 Construction of consolidation dams in sand pocket (Ciponyo II).

Sub. Unit 4-1 Construction of diversion channel for crater lake.

Indonesian side requested to add the following units from the point of view of social and other aspects.

The Japanese side agreed on it.

Sub. Unit 1-3 Sub-sub Unit 1-3-2 S. Cimampang

Sub. Unit 2-2 Sub-sub Unit 2-2-1 Confluence of S. Cikunir and S. Cibanjaran.

Sub. Unit 3-1 Sub-sub Unit 3-1-1 S. Cisaruni
Sub-sub Unit 3-1-2 S. Cikupang
Sub-sub Unit 3-1-3 S. Cimerah

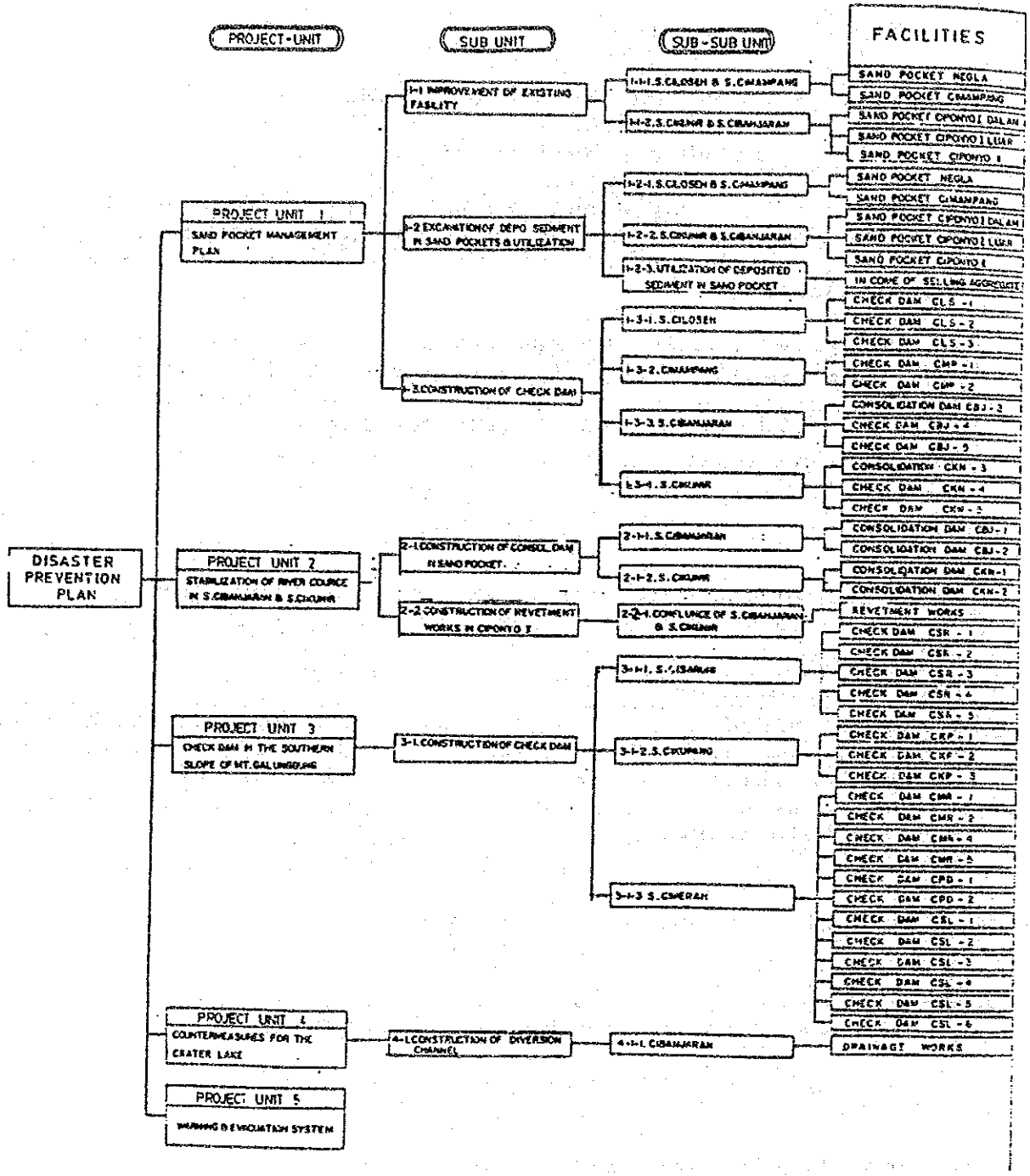
2). The Study Team explained that it is effective to excavate deposited material in the sand pockets based on a certain schedule in the point of view of disaster prevention and economic aspects.

The design excavation volume is estimated approximately 6500 x 1000 m3 (for 10 years) at this Stage of the study.

Indonesian side agreed on its explanation.

Dr. Koichi HIRAO
Leader of JICA Study Team
for The Feasibility Study
on the Southeastern slope
of Mount Galunggung.

Ir. Hartono Pramudo Dip.HE
Director of Rivers, DGWRD
Ministry of Public Works,
Government of Indonesia.


PROJECT-UNIT
SUB UNIT
SUB-SUB UNIT
FACILITIES
DISASTER PREVENTION PLAN
PROJECT UNIT 1
SAND POCKET MANAGEMENT PLAN
1-1 IMPROVEMENT OF EXISTING FASILITY
1-2 EXCAVATIONOF DEPO SEDIMENT IN SAND POCKETS & UTILIZATION
1-3 CONSTRUCTION OF CHECK DAM
1-1-1. S.CILOSEN & S.CIMANPANG
1-1-2. S.CIKUNIR & S.CIBANJARAN
SAND POCKET NEGLA
SAND POCKET CIMANPANG
SAND POCKET CIPONTO I DALAM
SAND POCKET CIPONTO I LUAR
SAND POCKET CIPONTO II
1-2-1. S.CILOSEN & S.CIMANPANG
1-2-2. S.CIKUNIR & S.CIBANJARAN
1-2-3. UTILIZATION OF DEPOSITED SEDIMENT IN SAND POCKET
IN CASE OF SELLING AGGREGATE
1-3-1. S.CILOSEN
1-3-2. CIMANPANG
1-3-3. S.CIBANJARAN
1-3-4. S.CIKUNIR
CHECK DAM CLS - 1
CHECK DAM CLS - 2
CHECK DAM CLS - 3
CHECK DAM CMP - 1
CHECK DAM CMP - 2
CONSOLIDATION DAM CBJ - 3
CHECK DAM CBJ - 4
CHECK DAM CBJ - 5
CONSOLIDATION CKN - 3
CHECK DAM CKN - 4
CHECK DAM CKN - 5
PROJECT UNIT 2
STABILIZATION OF RIVER COURCE IN S.CIBANJARAN & S.CIKUNIR
2-1 CONSTRUCTION OF CONSOL. DAM IN SAND POCKET.
2-2 CONSTRUCTION OF REVETMENT WORKS IN CIPONTO I
2-1-1. S.CIBANJARAN
2-1-2. S.CIKUNIR
2-2-1. CONFLUNCE OF S.CIBANJARAN & S.CIKUNIR
CONSOLIDATION DAM CBJ - 1
CONSOLIDATION DAM CBJ - 2
CONSOLIDATION DAM CKN-1
CONSOLIDATION DAM CKN-2
REVETMENT WORKS
CHECK DAM CSR - 1
CHECK DAM CSR - 2
CHECK DAM CSR - 3
CHECK DAM CSR - 4
CHECK DAM CSR - 5
PROJECT UNIT 3
CHECK DAM IN THE SOUTHERN SLOPE OF MT.GALUNGGUNG
3-1 CONSTRUCTION OF CHECK DAM
3-1-2. S.CIKUNING
3-1-3 S.CIWERAH
CHECK DAM CKP - 1
CHECK DAM CKP - 2
CHECK DAM CKP - 3
CHECK DAM CWR - 1
CHECK DAM CWR - 2
CHECK DAM CWR - 4
CHECK DAM CWR - 5
CHECK DAM CPD - 1
CHECK DAM CPD - 2
CHECK DAM CSL - 1
CHECK DAM CSL - 2
CHECK DAM CSL - 3
CHECK DAM CSL - 4
CHECK DAM CSL - 5
CHECK DAM CSL - 6
PROJECT UNIT 4
COUNTERMEASURES FOR THE CRATER LAKE
4-1 CONSTRUCTION OF DIVERSION CHANNEL
4-1-1 CIBANJARAN
DRAINAGE WORKS
PROJECT UNIT 5
WARNING & EVACUATION SYSTEM

ATTENDENTS LIST

1. Japanese Side

(1) JICA Advisory Committee

Mr. K. Masuko	Chairman of Committee
Mr. K. Kondo	Member
Mr. M. Hirano	Member
Mr. K. Nakagawa	Planning Coordinator

(2) JICA Jakarta Office

Mr. N. Matsuda	Assistant President Representative

(3) JICA Study Team

Dr. K. Hirao	Team Leader
Mr. S. Yamada	Member
Mr. J. Kojima	Member
Mr. T. Takahashi	Member
Mr. T. Haga	Member

2. Indonesia Side

(1) Directorate of Rivers

Ir. Hartono Pramudo, Dip. HE	Director of River
Ir. Amir Muryadi	Chief of Sub. Directorate of Planning and Design
Ir. Sutrisno Darmosoerono	Chief of Sub. Directorate of Erosion Control and Natural Disaster Rehabilitation and Prevention
Ir. Rubiyanto	Chief of Volcanic Debris Control Section
Ir. Sarwono Sukardi	Chief of Erosion Control Planning and Design Section
Ir. Imam Anshori	Chief of Preparation of Exploitation and Maintenance for River Section
Mr. I. Suryo	Expert on Volcanology - assigned to Directorate of Rivers
Mr. M. Nakahiro	Leader of JICA Expert on Rivers

Mr. O. Itagaki	JICA Expert on Sabo
Mr. M. Matsui	JICA Expert on Sabo

(2) Bureau of Planning

Ir. Romulus	Staff, Bureau of Planning, Ministry of Public Works

(3) Directorate of Planning and Programming

Mr. Y. Hidayat	Staff, Sub. Directorate of Foreign Aid Administration

(4) Mt. Galunggung Project

Ir. Mugiono, Dip.HE	Project Manager

DAFTAR HADIR RAPAT.

ACARA RAPAT : F/R. M.t. Galunggung
HARI/ TANGGAL : Kamis ... 17. Maret. 1988
T E M P A T : R. S. Dit. Sungai ...
PEMIMPIN RAPAT : Direktur. Sungai ...

	Nama Name	Instansi Office.	Jabatan Occupation.	Tanda tangan. Signature.
1.	IR. HARTONO PRAWIRO	- DG. SDA	Direktur	
2.	AMIR HAKIM	- " -	P.T.	
3.	IR. SARWONO S.	- " -	Kasi Pp Gol	
4.	RUBIYANTO.	- " -	Sie G. Api.	
5.	Y. Hidayat	ARLN Dit. BPP	Sie Bilateral	
6.	M NAKAHIRO	Dit Sungai	JICA Expert	
7.	M. MATSUI	Dit Sungai	JICA Expert	
8.	Dr K. HIRAO	JICA Study Team	Team Leader	
9.	J. Kojima.	"	Team. member	
10	T. HAGA	"	"	
11	N. Matsuda	JICA Indonesia	Ass. Representative	
12	Romulus	B. Penic.		
13	O. ITAGAKI	~~JICA~~ DOR	JICA expert	
14.	Imam A.	DOR	Si PSEP	
15	I SALYU	Dit. Sda		
16	MUGIONO	Dit. SUNGAI PRO. GAL.	PIM. PRO.	
17.	SUTRISNO. D	DIT SUNGAI	SUBDITDEBA	
18	M. HIRANO	Advisary Committee	JICA.	
19	K. NAKAGAWA	JICA TOKYO	JICA	
20.	K. KONDO	Advisary Committe	"	
21	K. MASUKO	"	"	
22	S. YAMADA	JICA Study Team	JICA Study Team member	
23.	T. ~~TAKAHASHI~~	"	"	

5) Minutes of Meeting on Final Report

(September 13, 1988)

Minutes of Meeting
on
Draft Final Report
of
The Feasibility Study on the Disaster Prevention Project
in
The Southeastern Slope of Mt. Galunggung

On September 12, 1988, the meeting for the Feasibility Study on the Disaster Prevention Project in The Southeastern Slope of Mt. Galunggung was held between the Study Team of Japan International Cooperation Agency (hereinafter refer to "the Study Team") and the Directorate General of Water Resources Development (hereinafter refer to "DGWRD") at the Meeting Room of Directorate of Rivers.

The meeting which was also attended by the Advisory Committee headed by Mr. Keiji MASUKO was started with the opening address by Mr. Hartono Pramudo. The introductory speech for the background of the Project was followed by Dr. Koichi HIRAO, the Study Team Leader. The broad explanation on the content of the Draft Final Report was explained and continued to the discussion between both parties.

Concerning the Conclusion and Recommendation, the Study Team emphasized that within the framework of a disaster prevention project like this, the criteria to choose the conclusion among various alternatives should be the least economic cost method, and therefore the alternative D was selected.

The Study Team continued as follows:

1. The Alternative B is also attractive that excavated aggregate can be sold in the market where the demand for it may be high.

2. However, there are some hypothesis because the actual demand is unknown, moreover the transportation capacity by train and/or by other way is not fixed either.

3. This project is simply an urgent disaster prevention project excluding marketing factors.

4. If the above mentioned hypothesis can be left, the alternative B will be taken according to the recommendation in the report.

The DGWRD responded as follows:

1. The demand has been higher and higher these days.

2. The very recent record of transportation by train almost meets the amount showed in the alternative B.

3. There are some environmental problems occurred around Jakarta due to over-excavation of aggregate materials

4. Therefore, the alternative B would be most recommendable.

Jakarta, September 12, 1988.

Dr. Koichi HIRAO
Leader of JICA Study Team for
The Feasibility Study on
the Disaster Prevention Project
in the Southeastern Slope of
Mt. Galunggung.

Ir. Hartono Pramudo
Director of Rivers
Directorate General of
Water Resources Development
Ministry of Public Works

ATTENDANT LIST

1. Japanese Side

(1) JICA Advisory Committee

Mr. K. Masuko	Chairman of Committee
Mr. M. Hirano	Member
Mr. H. Takama	Planning Coordinator

(2) JICA Jakarta Office

Mr. S. Hagiwara	Assistant President Representative

(3) JICA Study Team

Dr. K. Hirao	Team Leader
Mr. S. Yamada	Member
Mr. J. Kojima	Member
Mr. T. Takahashi	Member
Mr. S. Okutsu	Member

2. Indonesian Side

(1) Directorate of Rivers

Ir. Hartono Pramudo Dip.HE.	Director of River
Ir. Amir Muryadi	Chief of Sub. Directorate of Planning and Design
Ir. Sutrisno Darmosoerono	Chief of Sub. Directorate of Erosion Control and Natural Disaster Rehabilitation and Prevention
Ir. Rubiyanto	Chief of Volcanic Debris Control Section
Ir. Sarwono Sukardi	Chief of Erosion Control Planning and Design Section
Mr. Sutrisno	Staff ABLN, DOR
Mr. T. Khon	Leader of JICA Expert of River
Mr. M. Matsui	JICA Expert on Sabo

(2). Directorate of Planning

Mr. Dhono Bantolo	Staff Directorate of Planning

(3). Mt. Galunggung Office

Ir. Suharyono M. Eng.	Project Manager
Ir. Adhy D. Soemono	Assistance of Planning Section