Table 12 Basic Proposed Sediment Amount

(1) Scale of sediment amounts for the master plan

Unit: x $10^3 m^3$

	Amount of sediment / River	(1) Amount of produced sediment (A)	(2) Amount of controlled sediment amount on river course (C)	(3) Amount of discharged sediment (G)=(A)-(C)	(4) Allowable amount of discharged sediment (F)	(5) Amount of excess sediment (H)=(G)-(F)	(6) Amount of excess sediment during the project life (50 years)
Type-I	K. Blongkeng	6,060	3,630	2,430	310	2,120	4,240
	(K. Lamat)	459	225	234	170	64	64
	K. Putih	6,060	3,630	2,430	260	2,170	4,340
	K. Batang	11,760	2,449	9,311	280	9,031	18,062
	K. Krasak	11,804	2,449	9,355	900	8,455	16,910
	Sub-Total	36,143	12,383	23,760	1,920	21,840	43,616
Type-II	K. Gendol	3,158	468	2,690	210	2,480	2,480
	K. Woro*	4,219	488	3,731	6	3,725	3,725
	Sub-Total	7,377	956	6,421	216	6,205	6,205
Type-III	K. Pabelan	4,210	1,443	2,767	340	2,427	2,427
	K. Boyong	1,437	523	914	90	824	824
	K. Kuning	1,844	730	1,114	40	1,074	1,074
	Sub-Total	7,491	2,696	4,795	470	4,325	4,325
	Total	51,011	16,035	34,976	2,606	32,370	54,146
*K. Woro normal years:		-		24	6	18	

Note: "(6) Amount of excess sediment during the project life (50 years)" is based on the assumption of twice eruptions in Type-1 Area tributaries except K. Lamat.

(2) Sediment Disposal Plan by Type of Sabo Works for each tributary and area type

(Unit = 10^3 m^3)

Area Type	Type of Sediments Production / Sabo Work / Tributaries	Reduction of Production			Reduction of Discharge	Control of Discharge		Total
		Consolidation Dam	Check Dam	Valley Mouth Fixation Works	Sand Pocket	Consolidation Dam	Check Dam	
Type-I	K. Blongkeng	-	55x2	814x2	2,920	-	-	4,658
	(K. Lamat)	-	24	-	-	-	41	65
	K. Putih	-	512x2	814x2	5,640	-	-	8,296
	K. Batang	62x2	2,777x2	3,123x2	8,360	-	-	20,284
	K. Krasak	69x2	1,889x2	3,123x2	7,120	-	-	17,282
	Sub-Total	262	10,494	15,748	24,040	-	41	50,585
Type-II	K. Gendol	427	752	-	1,580	-	-	2,759
	K. Woro	47	1,690	-	2,650	-	-	4,387
	Sub-Total	474	2,442	-	4,230	-	-	7,146
Type-III	K. Pabelan	-	660	-	-	-	1,776	2,436
	K. Boyong	-	515	-	-	-	310	825
	K. Kuning	-	622	-	-	-	456	1,078
	Sub-Total	-	1,797	-	-	-	2,542	4,339
	TOTAL	736	14,733	15,748	28,270	0	2,583	62,070

*Note: x2 means twice eruptions during the project life (50 yeears).

Table 13 Review of Sediment Disposal Plan

Unit: $10^3 m^3$

Name of River	Proposed Excess Amount of Sediment (H)	Volume of Sediment Reduction by Type				Excess Sediment Capacity After Reduction of Sediment Discharge Q'=H-(B+E)	Evaluation		
		Reduction of Production (B)	Reduction of Discharge (D)	Control of Discharge (E)	Total (T)		T≧H	D/Q'	Type-I D/Q>2 Type-II D/Q>1
K. Blongkeng	2,120	869	2,920	-	3,789	1,251	O.K	2.33	O.K
(K. Lamat)	64	24	-	41	65	-	O.K	-	-
K. Putih	2,170	1,328	5,640	-	6,968	842	O.K	6.70	O.K
K. Batang	9,031	5,962	8,360	-	14,322	3,069	O.K	2.72	O.K
K. Krasak *	8,455	5,081	7,120	-	12,201	3,374	O.K	2.11	O.K
Sub-total	21,840	13,264	24,040	41	37,345	8,536			
K. Gendol	2,480	1,179	1,580	-	2,759	1,301	O.K	1.21	O.K
K. Woro	3,725	1,737	2,650	-	4,387	1,988	O.K	1.33	O.K
Sub-total	6,205	2,916	4,230	-	7,146	3,289			
K. Pabelan	2,427	660	-	1,776	2,436	-	O.K	-	-
K. Boyong	824	515	-	310	825	-	O.K	-	-
K. Kuning	1,074	622	-	456	1,078	-	O.K	-	-
Sub-total	4,325	1,797	-	2,542	4,339	-	O.K	-	-
Total	32,370	17,977	28,270	2,583	48,830	11,825			

*Alternative to pass through upper K. Krasak, not K. Bebeng.

8,455	5,196	7,120	-	12,316	3,259	O.K	2,18	O.K

Table 14 Amount of Sediment discharge to the Main Rivers

unit: $10^3 m^3$

Name of Rivers		Sediment Discharge from Tributaries Estimated			
		Before Implementation	After Implementation	Reducted Amount	Ratio of Reduction
K. Progo	K.Pabelang	340	340	0	- (%)
	K.Blongkeng	310	310	0	-
	K.Putih	2,430 1/	260	2,170	89
	K.Batang	280	280	0	-
	K.Krasak	9,355 1/	900	8,455	90
	Total	12,715	2,090	10,625	84
K. Opak	K.Boyong	914	90	824	90
	K.Kuning	1,114	40	1,074	96
	K.Gendol	2,690	210	2,480	92
	Total	4,718	340	4,378	93

Note:

1/ Proposed amount of Sediment discharged assumed from K.Krasak and K.Putih since flooding will follow either the K.Putih - K.Krasak system or K.Pabelan - K.Blongkeng - K.Batang system.

Table 15 Probable Hazard Areas without Sabo Facilities

	Name of Rivers	Degree of Danger-5 ($\times 10^3 m^2$)	Degree of Danger-4 ($\times 10^3 m^2$)	Total ($\times 10^3 m^2$)
Type-I	K.Krasak	13,836	4,402	18,238
	K.Batang	11,439	6,661	18,100
	K.Putih	8,329	6,688	15,017
	K.Blongkeng	2,283	8,261	10,544
	Sub-Total	35,887	26,012	61,899
Type-II	K.Woro	45,702	-	45,702
	K.Gendol	6,936	-	6,936
	Sub-Total	52,638	-	52,638
Type-III	K.Poyong	11,481	-	11,481
	K.Kuning	4,475	-	4,475
	K.Pabelan	4,153	-	4,153
	Sub-Total	20,109	-	20,109
Total		108,634	26,012	134,646

Table 16 Alternative Implementation Plan

Alternative No.	Sabo Facilities Stage Plan		Associated Works Stage Plan	
1	A	All main facilities	a	Total main canal-1 from K. Pabelan to K. Woro
2	A	– ditto –		Intakes only
3	B	Type-I and K. Pabelan facilities only	b	Part of main canal-1 from K. Pabelan to K. Krasak only
4	B	– ditto –		Intakes only

Table of Facilities Stage Plans

Unit: million Rp.

		Facility	Stage – 1 No.	Stage – 1 Construction Cost	Stage – 2 No.	Stage – 2 Construction Cost	Total No.	Total Construction Cost
Sabo Facilities Stage Plan	A	Check Dam	28	20,458	30	18,921	58	39,379
		Consolidation Dam	43		36		79	
		Embankment and Revetment	48,200m		67,870m		116,070	
		Training Levee	16,490m		–		16,490	
	B	Check Dam	24	15,524	34	23,855	58	39,379
		Consolidation Dam	29		50		79	
		Embankment and Revetment	23,060		93,010		116,070	
		Training Levee	16,490		–		16,490	
Associated Works Stage Plan	a	Intake	12	2,471	–	–	12	2,471
		Canal	26,700m		–		26,700m	
		Aqueduct	66		–		66	
		Bridge	12		–		12	
	b	Intake	8	1,336	4	1,135	12	2,471
		Canal	11,700m		1,500m		26,700m	
		Aqueduct	27		39		66	
		Bridge	8		4		12	

Fig. 24 Map of Design Basic Points for Sabo Plan and Types of River Areas

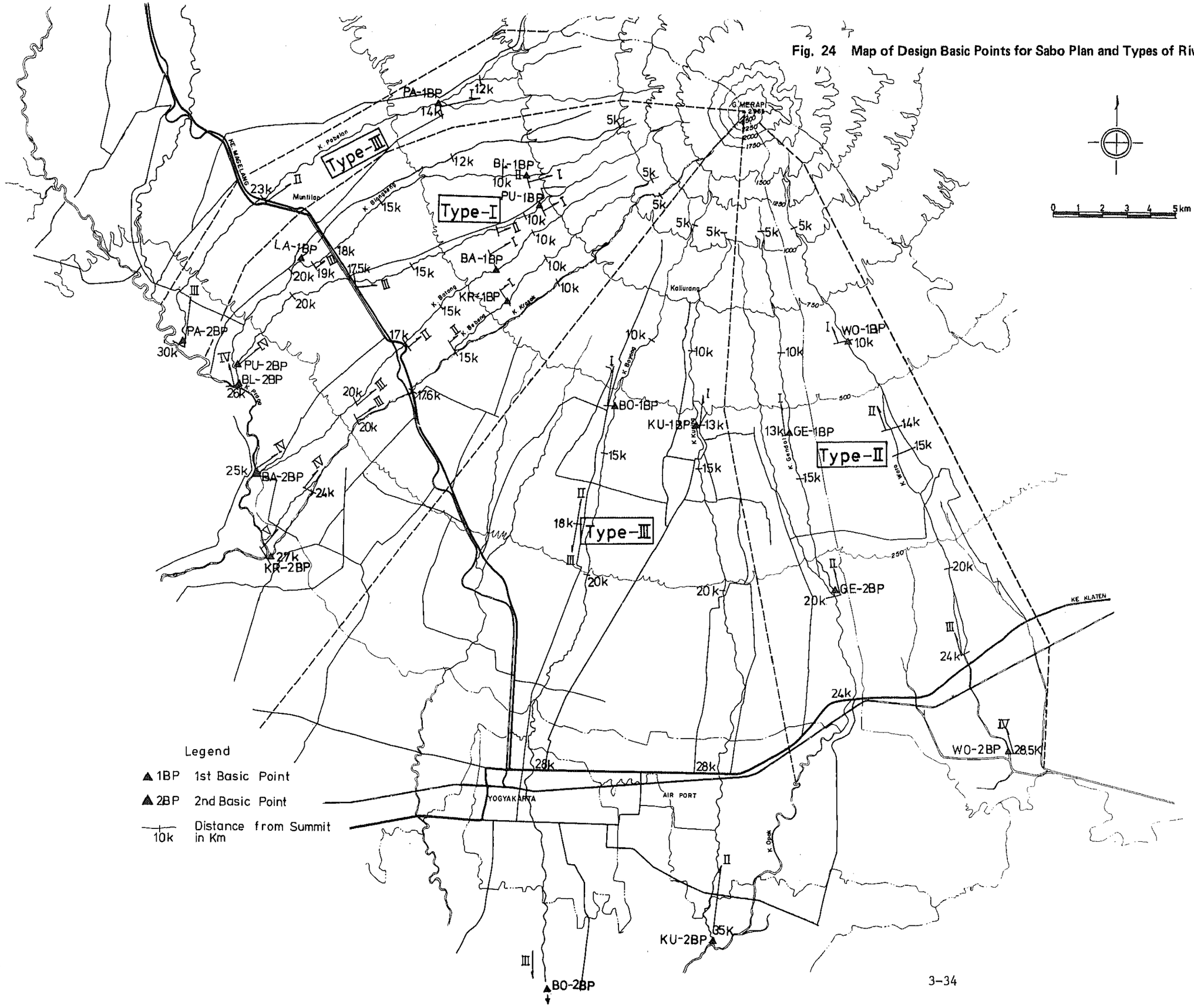
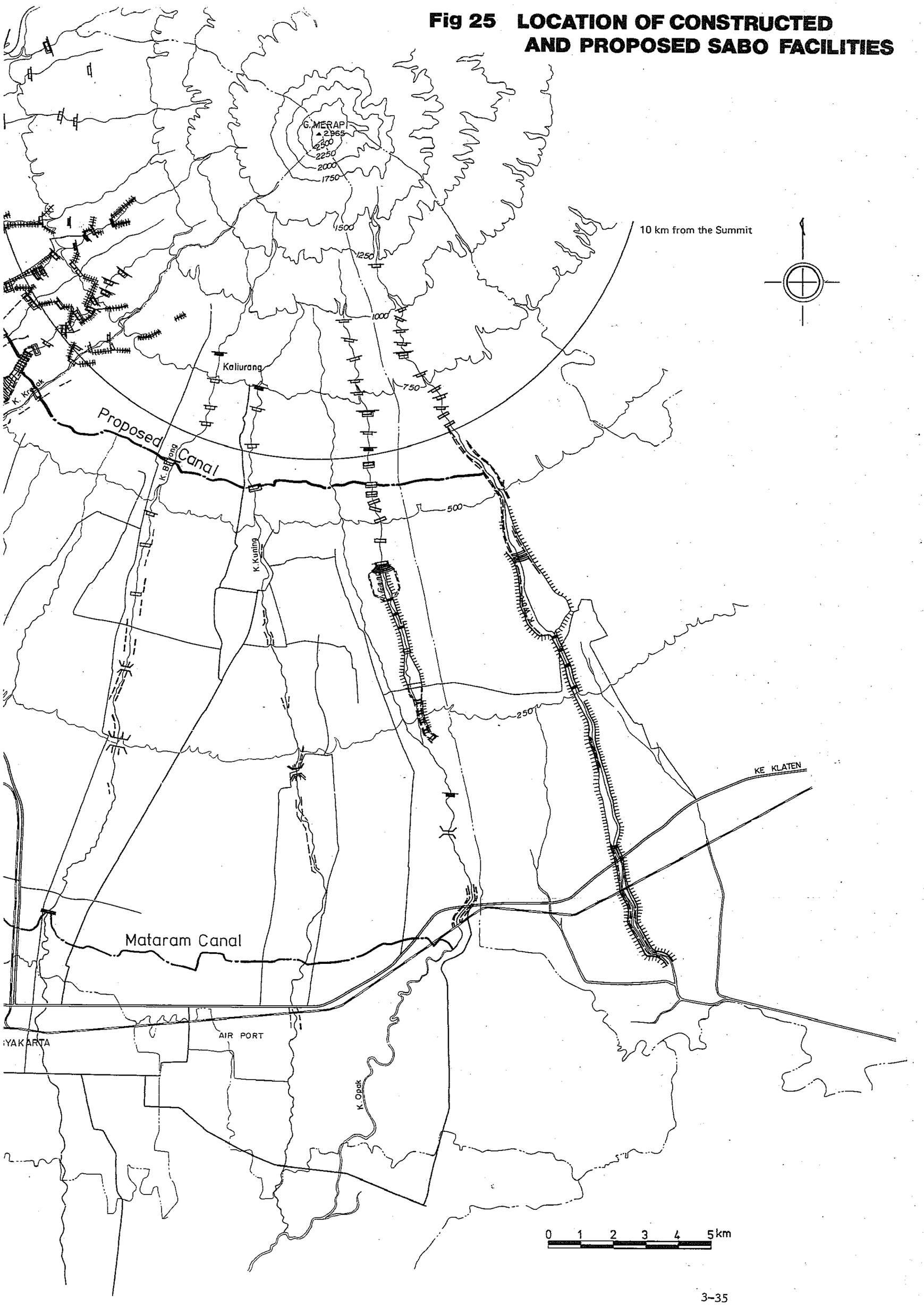
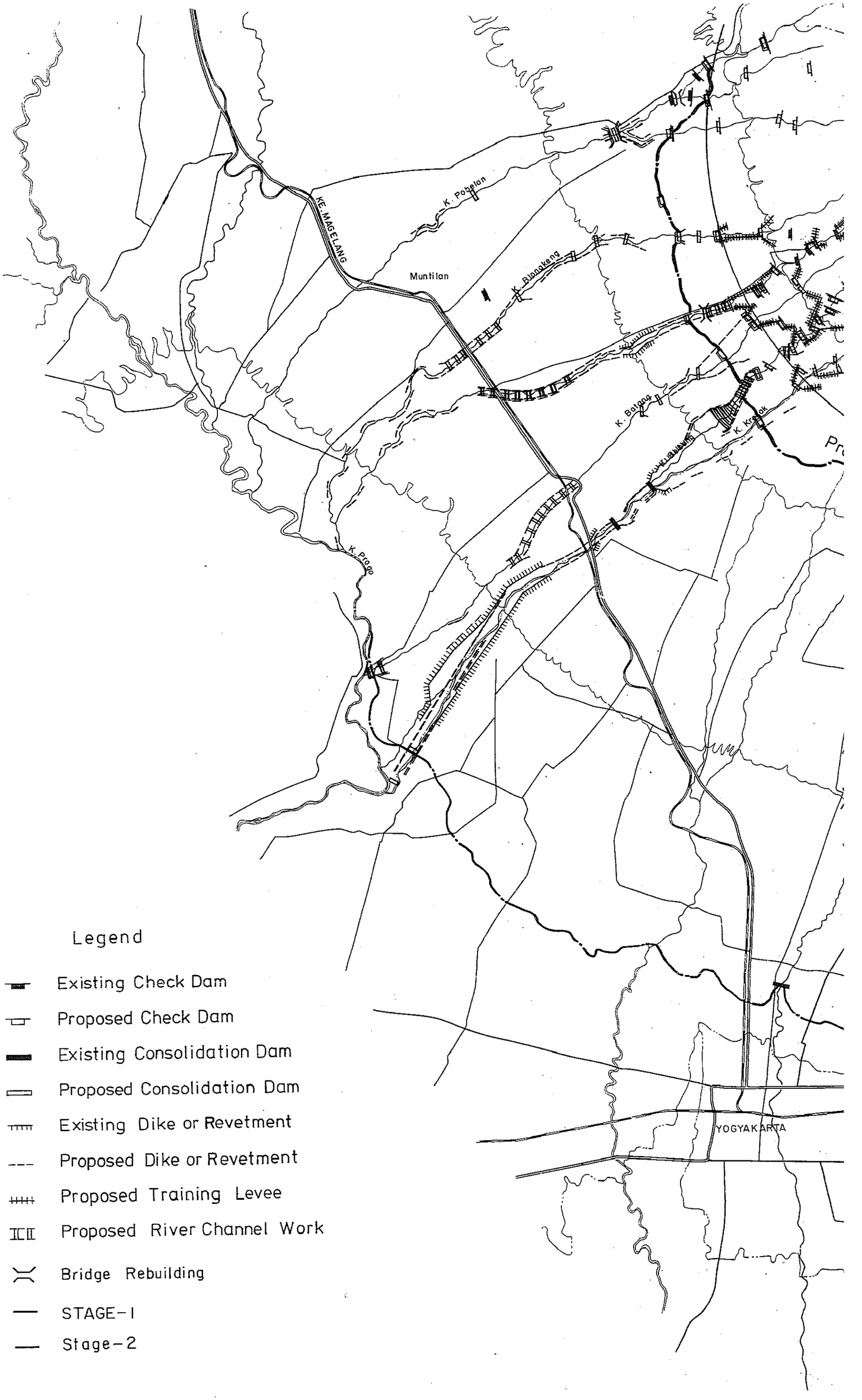


Fig 25 LOCATION OF CONSTRUCTED AND PROPOSED SABO FACILITIES





Legend

- Existing Check Dam
- Proposed Check Dam
- Existing Consolidation Dam
- Proposed Consolidation Dam
- Existing Dike or Revetment
- Proposed Dike or Revetment
- Proposed Training Levee
- Proposed River Channel Work
- Bridge Rebuilding
- STAGE-1
- Stage-2

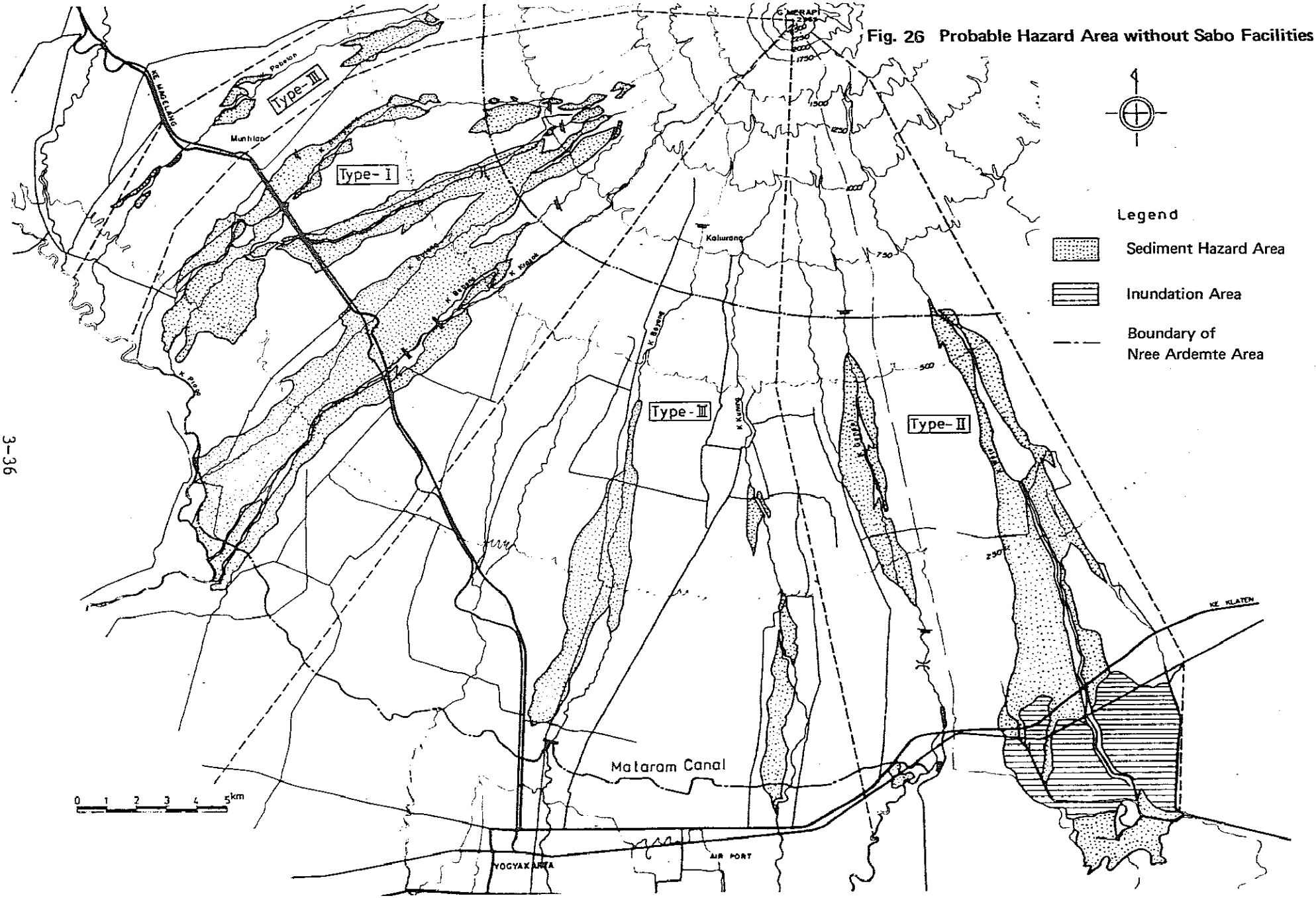


Fig. 26 Probable Hazard Area without Sabo Facilities

3.2.4 Associated Works Plan

1) General Purpose of Associated Facilities

The purpose of the associated facility plans is to make maximum effective use of the disaster prevention facilities so as to assist the areas on the slopes of G. Merapi to improve the poor conditions stemming from disaster damage, unstable supply of irrigation water, lack of adequate provision of living infrastructure, and so on. The following associated facility plans have been formulated for this purpose:

a) Irrigation Plan

b) Road Plan

c) Micro Hydroelectric Power Plan

d) Other Related Plans

The disaster prevention facilities can be used as irrigation intake facilities from the standpoint of the irrigation plan and as bridges from the standpoint of the road plan. Furthermore, these intake facilities and bridges can each be linked along contour lines to form main irrigation canals and main roads, and the main irrigation canal head can be used for micro hydroelectric power generation. It is such direct and indirect applications of the disaster prevention facilities for other purposes that the associated facility plans calls for.

2) Irrigation Plan

(1) Background on Irrigation for Agriculture

Rice Intensity and Yield

Farmland is being used for the priority land use of paddy fields wherever there is an adequate supply of water. At upstream area, however, the supply of irrigation water is unstable, and therefore the rice intensity is only 1.4 times/year opposed to 2.0 times/year in downstream areas. There is also a difference in the average yield between the two: 3.4 t/ha upstream versus 4.0 t/ha downstream. With a stable supply of irrigation water, the yield of upstream areas can be improved.

Amount of Irrigation Water Available During Dry Season

From data available with respect to neighboring areas the amount of irrigation water available during the dry season is estimated at 1 ∿ 3 $m^3/s/100km^2$ (0,1 ∿ 0,3 ℓ/s/ha) ever, the amount of irrigation water needed is estimated 0.3 ℓ/s/ha at present and is expected to be 10 ℓ/s/ha in the future.

This being the case, there cannot be expected to be enough irrigation water to cultivate wet paddy on all paddy field

acreage during the dry season, but with stabilization of irrigation intake and establishment of the cropping pattern, it should be possible to plant an average of at least two paddy crops annually.

Technical Feasibility

Since the terrain at the planned locations of the intake facilities is very rugged, such facilities will be limited by the amount of intake that can be expected. In view of the fact that such facilities are technically feasible and only entail minor structural changes in the disaster prevention facilities that are to be provided anyway, the intake facilities will be very economical.

(2) Description of the Plan

The following is a general description of the irrigation plan.

a) Delivery of the Water

In view of the imbalance between different areas in terms of intake capacity, that of K. Pabelan on the west side being large and that of K. Woro on the east side being inadequate, the intake facilities on the different rivers are to be linked along continuous lines for delivery of water in the direction of deficiency, with repeated intake and use along the way. In this manner will be possible to make up for the deficiency in intake capacity on some of the rivers.

b) Routing

The proposed route of the main irrigation canal, which is to pass through safe downstream parts of the zone off-limits to housing and to make use of the sabo facilities. The velocity of flow is not to be high in view of the fact that the water of this main irrigation canal is also to be used for household purposes and fishery nurseries.

c) Irrigation Acreage

In the dry season an intake capacity of 1.44 ∿ 4.32 m^3/s can be expected in the case of the main tributaries. Assuming a supplementary supply of 0.6 ℓ/s/ha from the main irrigation canal and dependence on excess and supply from smaller rivers for the remaining 0.4 ℓ/s/ha, the acreage of stable wet paddy cultivation that will be possible in the dry season will be in the range 2,400 ∿ 7,200 ha. Furthermore, it will be possible to use 760 ha of dry crop fields in the K. Woro catchment area as paddy fields in the rainy season, although not in the dry season.

d) Structural Design

i) Intake Facilities

Concrete pipes are to be inlaid into the bodies of the check dams for the main irrigation canal to cross the main tributaries. Moreover, for a larger intake capacity, culverts are to be provided on the upstream side of the bodies of the check dams so as to be able to take in the water stored by the dams.

ii) Irrigation Canal

The irrigation canal is to have a masonry lining in order to narrow the required width of the canal, reduce loss, and maintain stability of the canal.

iii) Aqueducts

Aqueducts, which can also be used for roads, are to be provided for crossing small rivers.

iv) Total Quantities of Structures

Intakes:	12
Main irrigation canal:	26,700 m
River crossings:	10
Aqueducts:	66

3) Road Plan

The road networks are fairly adequate in areas between rivers since even the remote hamlets can be reached by motor vehicle, although the condition of the roads is not always very good. However, there is difficulty in terms of transportation from and area on one side of a river to an area on the other side in upstream areas owing to the lack of bridges.

Accordingly, the width of the main canal has been broadened so that a road can be built along it all the way from K. Pabelan across to K. Woro.

There should be no problems in technical or economic terms with respect to the crossings of the main tributaries since the design of the crossings and that of the check dams are to be integrated.

4) Micro Hydroelectric Power Station Plan

Of the area covered by the plan, only urban areas of Yogyakarta, the main resort town Kaliurang along the national road, and a few other places have a supply of electricity. Even in the future, rural areas cannot expect to be supplied by the Yogyakarta power system.

For this reason, micro hydroelectric power stations are to be provided as related facilities of this plan to make use of the main irrigation canal.

These power stations are to be located in the vicinity of intake facilities, where there is necessarily a head of 5 ∿ 10 m. The plan calls for eleven of them, but the number can be increased since there is sufficient head all along the canal.

The total capacity of these eleven stations can be expected to be 400 ∿ 500 KW, which is enough to supply 4,000 ∿ 5,000 house

5) Other Associated Work Plans

(1) Fishery Nurseries

At the present time, many farm households in the area use yard ponds and paddy fields as fishery nurseries that provide cash income and serve as a valuable source of animal protein. By using the main canal itself for fishery nurseries, this activity can be greatly expanded.

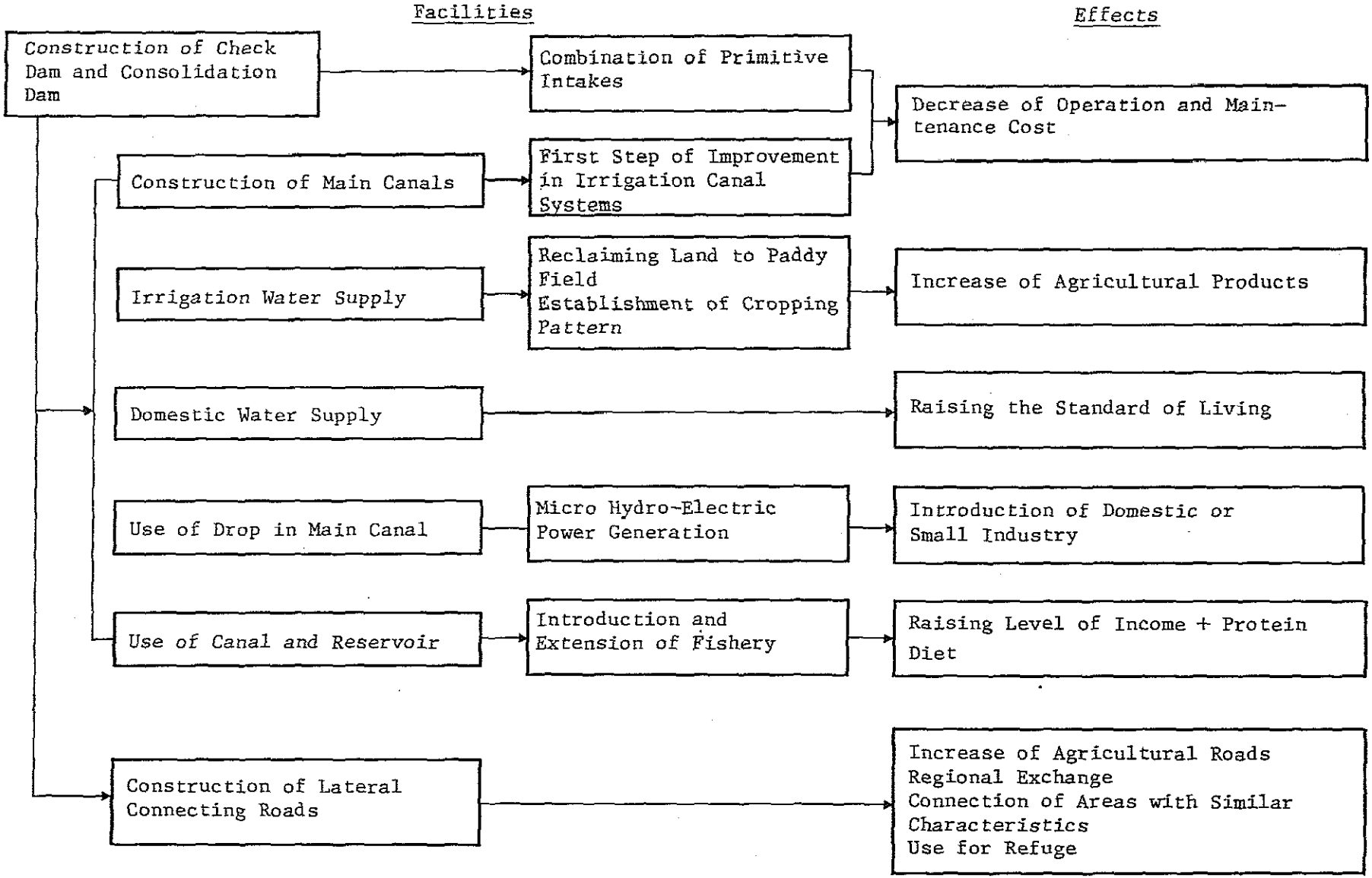
(2) Supply of Water for Household Uses

In areas above elevation 400 m in the upstream section of K. Woro, the groundwater level is low, and the residents have a hard time getting enough water for household use in the dry season. By providing them with a new source of water, it should be possible to improve their living conditions immensely.

(3) Comprehensive Village Improvement Plan

This plan calls for the establishment of model zones with maximum efficient use of all related facilities so that other parts of the area covered by the plan can observe and follow their example, thereby raising the standard of living of all of the residents of the area.

Fig. 27 Outline of Effects of Multi-Purpose Facilities



3.3 Secondary Planning Area Countermeasures

Since flood inundation and blockage due to damage of irrigation intakes are considered as major damage caused by the rivers, the following basic policies are proposed to prevent such damage from occuring in the future.

3.3.1 General

1) Control of Sediment Load

K. Progo suffers from sediment loads transported down by repeated floods and a considerable volume of silt deposit can be observed over the channel of the river. The eruption of G. Merapi in 1969 and floods during the succeeding wet season brought a silt deposit of about 7,000,000 cu.m. to the river channel between the confluence of the K. Krasak and the estuary.

The basic concept of flood control is to secure the steadiness of the riverbed as much as is practically possible.

Accordingly, it is essential to check and control the sediment discharge below the rated flow capacity of the river channel by effective sabo facilities to be constructed in the upstream area.

On the other hand, it is also essential to increase the flow capacity of the river channel to the possible maximum. The flow capacity of the river channel, estimated that the sediment load of K. Progo is 3,240,000 cu.m/year at the site downstream of the Srandakan Bridge, and 33,400,000 cu.m/year at the Duet Gauging Station in the upstream area. The sediment load capacity of the latter is about five times higher than that of the former. It is reported that the stream gradient of the section of the river between Duet and the estuary is an almost steady 1:600. To regulate the flood discharge below the proposed HWL and taking an anticipative increase of flow capacity of the above mentioned section into consideration, it is recommended that the river width in the lower reach, presently 500 ∿ 700 m, should be narrowed to a width reasonably corresponding to the existing river width of the upstream area and that the riverbed should also be excavated as required.

3.3.2 Countermeasures Against Specific Problems

1) Stabilization of Meander

A steep stream gradient and alluvial fans are observed along the river channels of both the K. Progo and K. Opak. In the lower reach of the K. Progo where the river has a great width, it is observed that sand dunes are distributed extensively in the riverbed.

Under these circumstances, the major stream line at the time of flood is extremely unstable; hence, the impact zone is also unstable. This situation enhances the risk of lateral erosion of the river bank, and as a result, loss of valuable land along

the full length of the river channel. Countermeasures should include a narrowing down of the existing river width in the way mentioned above, a change of the scale meander with alternating sand bars to eliminate the unstable meandering as much as possible, and protection of banks along the impact zones.

2) Construction of Training Dikes at Estuaries

The estuaries of the K. Progo and K. Opak are almost completely blocked during dry seasons without development of a delta to the sea at the river mouth from east to west.

This is caused by the tremendous volume of sediment transported to and deposited over the estuary during rainy seasons, and further by the low stream flow during dry seasons, the change of wind from east to west, and the strong tidal flow of the sea in front of the estuaries. On the island of Java, the above-mentioned estuary block-ups are generally observed in rivers flowing into the Indian Ocean; however, since the Java sea is shallow enough to allow the growth of deltas, practically no estuary block-up is observed th there.

Construction of training dikes is recommended as an effective measure of prevention of estuary block-ups and elimination of damage cause by inland water inundation along the rivers.

3) Proposed River Bed Improvements

The chief aim of the proposed river improvement is to increase the tractive force by limiting the width of flow by the construction of new dikes in the downstream course where the width is extensive. In addition, the aim is to reduce damage caused by inundation by means of new dikes. Since the inundation damage is rather small at present, it is recommended that the schedule to construct the proposed dikes should start from the lowest dike required and follow a step-by-step increase in height to the final dike.

Based on the observation data previously outlined, a channel improvement plan for the K. Progo was proposed as described below. The plan is a rough one as it is prepared from extremely limited data available for longitudinal and cross levelling, and plane map surveying. One of the most urgent and important matters yet to be performed is to make river channel survey data as complete as is practically possible. The proposed river improvements are limited to the section between the estuary to the point about 20 km upstreams.

K. Progo Channel Improvement Plan

a) Design the downstream channel cross sections big enougb to take care of sediment transport from the upstream area taking stabilization of the riverbed into consideration.

b) Improve the present longitudinal riverbed gradient of 1:600 to a steeper 1:550. (Refer to Fig. 28)

c) Make standard designs of the cross sections of the channel taking the desired gradient into consideration is shown in Fig. 29. As shown, the low water channel along the section between the Srandakan Bridge and the estuary, is currently about 500 m in width; as shown, the new low water channel of about 200 m in width and 2 to 3 m in depth will be excavated in the existing low water channel in all sections.

d) The remaining portion of the existing channel, 500 m in width, will be regarded as a reclaimed land for utilization in agriculture, etc.; however, for the sake of safety, the utilization may have to be limited only during dry seasons.

e) For the proposed flood stage, it is recommended that a stage be high enough to allow the discharge of 5,000 cu.m/sec. (the biggest flood in the past) through the present cross section of the channel.

f) Since it is estimated that the volume of excavation of the riverbed from the estuary to the point about 20 km up-stream will be about 15,000,000 cu.m, it is advisable to utilize excavated soil for construction of embankments and reclamation of hinterland.

g) With the progress of the proposed improvement plan, some modifications and repairs of the existing irrigation intakes and bridges may become advisable.

4) Countermeasures against Blockage of Irrigation Intakes

For a steady intake for the whole year round operation, the following measures should be taken.

a) Construction of full lateral weirs instead of lateral intakes

b) To cope with unexpected riverbed evolution, and also convert the intakes to overflow and underflow types for the whole year round operation, addition of a gate in cases of intakes without a gate, and conversion to double gate for intakes with gate.

c) Through administration and maintenance programs.

5) Countermeasures against General Problems

Execution of the basic measures sections 1) ∿ 3) will serve as countermeasures against inundation caused by inland water, blocking-up of the estuary, and lateral erosion of the river banks; through administration and maintenance will serve the purpose as well.

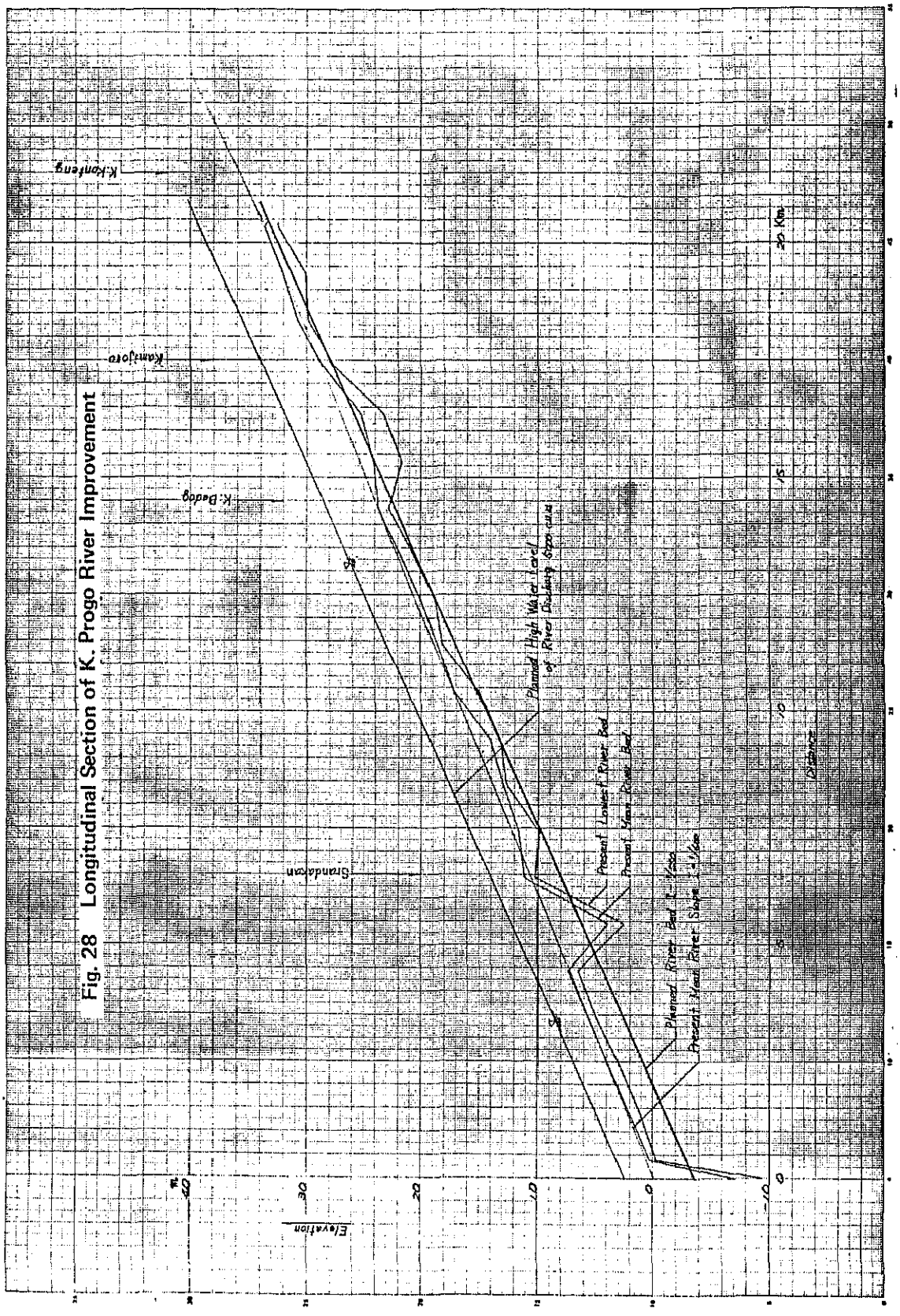
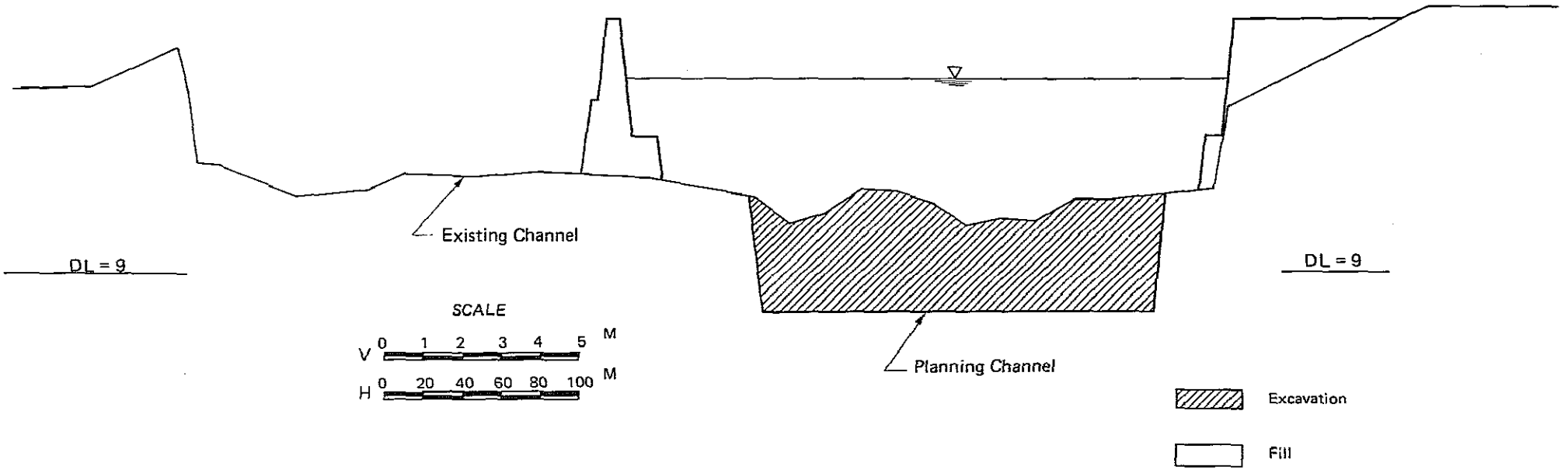


Fig. 28 Longitudinal Section of K. Progo River Improvement

Fig. 29 Cross Section of K. Progo River Improvement at Surandakan Bridge



CHAPTER 4

IMPLEMENTATION PLANNING

CHAPTER 4 IMPLEMENTATION PLANNING

4.1 General

The master plan consists of a warning and evacuation plan, land-use improvement plans (resettlement and afforestation), a disaster prevention facilities plan, and a associated facilities plan. The implementation for these plans has taken into account present conditions in the area covered by the plan, the characteristics of the individual plans, the present state of implementation as well as the interrelationships between the plans and ways of enhancing their socioeconomic effects. Four alternatives (see Table 16) have been considered with respect to the disaster prevention facilities plan and the related facilities plan, and the best one has been selected. The construction work is to be implemented over a period of fifteen years, with a 5-year fitst stage and a 10-year second stage. Table 17 shows what works are to be carried out in which phase.

4.2 *Disaster Prevention Works*

4.2.1 Land-use Improvement

There are two land-use improvement plans: a plan for resettlement of people living in certain hazard areas and a plan for afforestation of the vacated land. Resettlement of people living in Zone-1 areas is to take place in the first phase, and the vacated Zone-1 areas are to be afforested. People living in Zone-2 area are to be resettled in the 2nd stage and the vacated Zone-2 areas afforested in the 2nd stage.

4.2.2 Warning and Evacuation Systems

Considering the present disaster hazards involved, it is urgently necessary to establish the warning and evacuation system set forth in the master plan.

A truly effective evacuation plan can only be formulated on the basis of accumulation of technical data regarding advance lahar warnings. This being the case, it has been decided to implement the warning and evacuation plan in two stages. The first stage is to be a period of two years, with formulative of a tentative plan on the basis of existing knowledge and the data collected over two years on rainfall and lahar occurrence and implementation on a trial basis. The second stage is to begin in the third year and last for a period of three years, during which further data will be collected and the state of implementation of the trial system evaluated for revision thereof. The monitoring and other studies should continue even after these five years, however, since on-going revision will be necessary on the basis of the latest eruption, rainfall, topographical, social, and other conditions.

4.2.3 Sabo Facilities

Of the facilities proposed by this plan, some need to be urgently provided in view of present disaster hazards and others should be provided over a longer period on the basis of observation of sediment discharge conditions and riverbed fluctuation conditions. Consequently, this plan should be implemented in two stages, with provision of urgent facilities, facilities of basic importance in dealing with sediment discharge, and facilities important in connection with the associated facilities in the first stage and the rest in the second stage. An alternative plan involving postponement of provision of the facilities for all Type-II and -III area rivers except K. Pebelan to the second stage was considered, but not adopted since it was found less attractive economically and technically.

Since the purpose of a sharp reduction of sediment production in an early stage is to reduce sediment discharge effectively and to decrease the total amount of sediment discharge during the project life, all of the necessary sabo facilities to check sediment production from river piracy and Lahar should be provided systematically in an early stage.

Early provision of all of the necessary facilities in the case of rivers with frequent occurrence of Lahar and considerable riverbed fluctuation and sediment discharge will made them all more effective and prevent back-sliding. And internsive investment in the first stage is very important.

Small-scale irrigation facilities for direct intake from check dams and other disaster prevention facilities are incorporated in this disaster prevention facilities plan.

The implementation policy for each of the two stages is outlined below:

1) First Stage (5 years)

   (1) Completion of facilities for reducing and controlling sediment production and discharge (referred to hereunder as basic facilities) in Type-I areas.

   (2) Completion of river course improvement facilities in Type-I areas at places of particularly large danger or importance.

   (3) Completion of those basic facilities in Type-II and -III areas that are particularly important or that are connected with the related facilities.

   (4) Completion of those river course improvmeent facilities in Type-II and -III areas that are particulary important in terms of the danger involved and the places where they are to be located.

2) Second Stage (10 years)

   Over this period the remaining sabo facilities are to be provided.

3) Construction Order

The construction order for sabo facilities takes the sediment reduction effects to the downstream and the hazard and socio-economic importance degrees of the area to be protected and associated works into account.

Since the area is highly affected by volcanic activities and since sabo works have a great influence on riverbed variation and sediment load, there are many prenomena that cannot be foreseen at the planning stage. It is necessary to carry out the construction work in a flexible manner through constant observation of the varying situation.

a) Construction Order on the Rivers

The construction order planned on the rivers is mainly based on the hazard degree as shown in the following table.

Construction Order on the Rivers

Priority	River	Type
1	K. Krasak	I
2	K. Putih	I
3	K. Batang	I
4	K. Blongkeng	I
5	K. Pabelan	III
6	K. Gendol	II
7	K. Woro	II
8	K. Boyong	III
9	K. Kuning	III

(1) The reasons why K. Batang has higher priority than K. Blongkeng area as follows:

- Although K. Blongkeng seems less stable than K. Batang The result of geomorphological analysis shows that in the next major eruption, the possibility of volcanic debris flowing to K. Batang is higher than to K. Blongkeng.

- After provision of sabo works including valley mouth fixation works in the upper stream of K. Putih, Lahar flow to K. Blongkeng will be checked and the possibility of disaster damage to K. Blongkeng will decrease.

(2) The reasons why K. Gendol has higher priority than K. Woro is as follows:

- Although K. Gendol has less sediment discharge than K. Woro, K. Gendol has not been arranged as much as K. Woro with sabo facilities and is more dangerous than K. Woro.

(3) The reason why K. Pabelan has higher priority than the tributaries of Type-II is as follows:

- K. Pabelan is the most hazardous among the tributaries of Type-III. Furthermore, the irrigation canal (an associated work) will start from K. Pabelan and an early provision of intakes on K. Pabelan is very important.

(4) K. Boyong is more important than K. Kuning, because K. Boyong flows through the center of Kota, Yogyakarta and has more socio-economic importance than K. Kuning.

b) Construction Order of Facilities

The construction order of sabo facilities planned is summarized in the following table:

Construction Order of Sabo Works

Category	Priority	Item
Sabo Works	1	- Valley mouth fixation works for fixation of flow courses
	2	- River course improvement facilities at places of urgency and importance
	3	- Check dams (in the direction from downstream to upstream)
	4	- Consolidation dams
	5	- Embankments and revements

A more detailed construction order is shown in Table 17 (4) and (5).

However, the speed of implementation could not follow the implementation schedule and the construction order (shown in Table 17) should be changed, because scouring problems downstream from the check dams will occur due to a slow construction speed. Additional countermeasures such as consolidation dams should be planned.

4) Implementation of the sabo facilities that are located in the nuée ardent hazard area.

The planned sabo facilities are divided into two groups by the distance (10 km) from the summit as follows:

(1) The first group located within 10 km from the summit.

(2) The second group located further than 10 km from the summit.

Although first-group facilities are fundamental for reduction of sediment production and debris control, they have adverse effects on nuée ardent flow in terms of Indonesian guidelines. Therefore the implementation of first-group facilities should be investigated in more detail in the subsequent project stage.

5) Intensive Use of Manpower and Local Materials

In consideration of economy and providing employment opportunities in the project area, maximum use of manpower and localy available materials such as rocks, bamboo, and wood should be made as well as using methods that are labor-intensive. Moreover, the structures and construction methods used should be flexible in order to be adjusted to such circumstances as riverbed fluctuation, etc. In addition, every effort should be made to plant trees and grass for protection against erosion wherever possible. As for construction machinery, use should be made of hand winches and other machinery to improve the efficiecy of labor, vibrators and other machinery for improvement of quality, and some heavy machinery only when needed for urgent or emergency excavation.

6) Construction Methods and Administration for Maintenance

The riverbed variation is so large that the implementation of the project will require constant observation of the situation to determine the optimum method of construction and administration.

7) Associated Works

a) Sabo Facilities and Associated Works

Since the associated facility plans depend on the sabo facility plan, the construction work for the intakes and the siphons and bridges for crossing the main tributaries will be carried out at the same time as that of the sabo facilities themselves, but the construction work for the main irrigation canal and some other associated facilities will take place later. This is because it is better for such facilities to be provided after area stability has been enhanced by the disaster prevention facilities.

b) Problems for the Future Study

Before the implementation of irrigation canal, more detailed technical feasibility study on security considerations, topographical conditions, soil mechanic conditions and maintenance should be carried out in the subsequent project stage.

For the further promotion of regional development through associated works, the use of ground water and application of new types of agricultural methods should be investigated in the subsequent project stage.

Table 17 Implementation Schedule of Disaster Prevention Works

(1) Sabo Facilities (Alternative-3 and Alternative-4)

		Stage-1								Stage-2								Total	
		Check dam (No.)	Consolidation (No.)	Embankment and revetment (m)	Training levee (m)	Groin (m)	Bridge (No.)	Reduction of probable endangered area to flooding (No.)	Construction cost (Rp.1,000)	Check dam (No.)	Consolidation (No.)	Embankment and revetment (m)	Training levee (m)	Groin (m)	Bridge (No.)	Reduction of probable endangered area to flooding (ha)	Construction cost (Rp.1,000)	Reduction of probable endangered area to flooding (ha)	Construction cost (Rp.1,000)
Type I	K. Krasak	11	10	15,410	7,140	2,250	1	1,390.6	7,164,710	4	-	4,790	-	2,250	-	433.2	2,498,650	1,863.8	9,663,360
	K. Batang	2	4	1,650	2,520	-	-	959.3	1,814,970	-	13	11,680	-	900	-	557.4	2,235,380	1,576.7	4,050,350
	K. Patih	4	14	6,000	4,600	-	-	1,033.5	3,446,680	-	-	10,380	-	1,980	-	337.4	1,038,190	1,370.9	4,484,870
	K. Blongkeng	3	1	-	2,230	-	-	833.3	1,254,980	-	11	14,430	-	1,560	-	221.1	2,380,960	1,054.4	3,635,940
	Sub Total	20	29	23,060	16,490	2,250	1	4,216.7	13,681,340	4	24	43,280	-	6,690	-	1,549.1	8,153,180	5,765.8	21,834,520
Type II	K. Woro							-	-	10	5	20,920	-	3,000	-	2,894.6	5,667,460	2,894.6	5,667,460
	K. Gendol							-	-	7	17	8,750	-	780	-	693.6	4,611,270	693.6	4,611,270
	Sub Total									17	22	29,670	-	3,780	-	3,588.2	10,278,730	3,588.2	10,278,730
Type III	K. Boyong							-	-	5	2	6,960	-	-	2	1,148.1	1,745,200	1,148.1	1,745,200
	K. Kuning							-	-	3	-	7,700	-	-	1	447.5	1,669,590	447.5	1,669,590
	K. Pabelan	4	-	-	-	-	-	392.5	1,842,850	5	2	5,400	-	90	1	16.5	2,008,750	409.0	3,851,600
	Sub Total	4	-	-	-	-	-	392.5	1,842,850	13	4	20,060	-	90	4	1,612.1	5,429,540	2,004.6	7,266,390
	Total	24	29	23,060	16,490	2,250	1	4,609.2	15,524,190	34	50	93,010	-	10,560	4	6,749.4	23,855,450	11,358.6	39,379,640

Table 17 Implementation Schedule of Disaster Prevention Works

(2) Sabo Facilities (Alternative-1 and Alternative-2)

		Stage-1								Stage-2								Total	
		Check dam	Consolidation dam	Embankment and revetment	Training levee	Groin	Bridge	Reduction of Probable endangered area to flooding	Construction cost	Check dam	Consolidation dam	Embankment and revetment	Training levee	Groin	Bridge	Reduction of Probable endangered area to flooding	Construction cost	Reduction of Probable endangered area to flooding	Construction cost
		(No.)	(No.)	(m)	(m)	(m)	(No.)	(No.)	(Rp.1,000)	No.)	(No.)	(m)	(m)	(m)	(No.)	(ha)	(Rp.1,000)	(ha)	(Rp.1,000)
Type I	K. Krasak	11	10	15,410	7,140	2,250	1	1,370.6	7,164,710	4	-	6,790	-	2,250	-	433.2	2,498,650	1,823.8	3,663,360
	K. Batang	2	4	1,650	2,520	-	-	959.3	1,814,970	-		11,680	-	900	-	557.4	2,235,380	1,516.7	4,050,350
	K. Patih	4	14	6,000	4,600	-	-	1,033.5	3,446,680	-	-	18,380	-	1,980	-	337.4	1,038,190	1,370.9	4,484,870
	K. Bongkeng	3	1	-	2,230	-	-	833.3	1,254,980	-	11	14,438	-	1,560	-	221.1	2,380,960	1,054.4	3,635,940
	Sub Total	27	29	23,060	16,490	2,250	1	4,816.7	13,681,340	4	24	43,280	-	6,690	-	1,549.1	8,153,180	5,765.8	21,834,520
Type II	K. Woro	1	-	12,490	-	1,500	-	668.8	1,710,570	9	5	8,430	-	1,500	-	2,225.8	3,956,890	2,894.6	5,667,460
	K. Gendol	1	13	8,750	-	780	-	505.6	2,231,050	6	4	-	-	-	-	188.0	2,080,220	693.6	4,611,270
	Sub Total	2	13	21,240	-	2,280	-	1,174.4	1,904,620	15	9	8,430	-	1,500	-	2,413.8	6,337,110	3,588.2	18,278,730
Type III	K. Boyong	1	-	1,300	-	-	-	31.0	228,520	4	2	5,660	-	-	2	1,117.1	1,516,680	1,148.1	1,745,200
	K. Kuning	1	-	1,400	-	-	1	61.3	450,150	2	-	6,300	-	-	-	386.2	1,219,440	447.5	1,669,590
	K. Pabelan	4	1	1,200	-	-	1	392.5	2,156,390	5	1	4,200	-	90	-	16.5	1,695,210	409.0	3,851,600
	Sub Total	6	1	3,900	-	-	2	484.8	2,805,060	11	3	16,160	-	90	2	1,519.8	4,431,330	2,004.6	7,266,390
	Total	28	43	48,200	16,490	4,530	3	5,875.9	20,458,020	30	36	67,870	-	8,280	2	5,482.7	18,921,620	11,358.6	39,379,640

(3) Time schedule

Item			Stage / Year	Preparatory Stage		Stage - 1					Stage - 2									
				-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Sabo Facilities and Associated Facilities	Type-I	Main Sabo Facilities	(A)																	
		Mainor Sabo Facilities	(B)																	
	Type-II	Main Sabo Facilities	(A)																	
		Mainor Sabo Facilities	(B)																	
	Type-III	Main Sabo Facilities	(A)																	
		Mainor Sabo Facilities	(B)																	
	Associated Facilities																			
Land use Improvement	Zone-I	Relocation	(C)																	
		Afforest	(D)																	
	Zone-II	"	(C)																	
		"	(D)																	
Warning System	Type - I																			
	Type - II																			
	Type - III																			
Sabo Technical Center																				

Preparatory Activity

-------: Survey and Investigation

[ ]: Design and Implementation

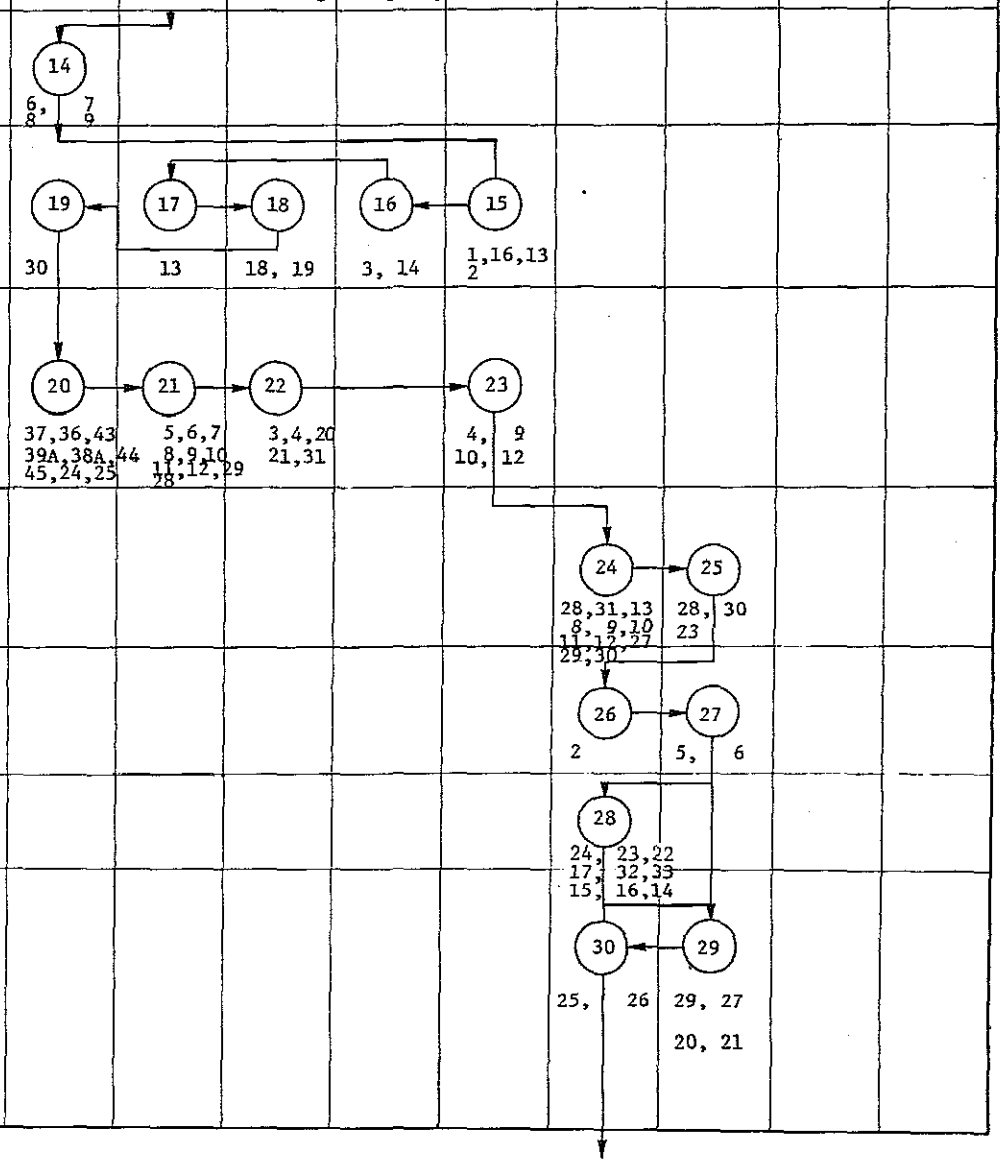
(4) Detail Construction Order of Sabo Facilities

Priority Order			Facilities	Location	Construction Order								
					K.Krasak	K.Putih	K.Batang	K. Blongkong	K. Pabelan	K.Gendol	K.Woro	K.Boyong	K.Kuning
Stage - 1	Tributaries of Type-I areas and K. Pabelan (Type - III)	1	Valley mouth fixation works No. 1 . check dams, and . training levees	In the vicinity of 10 km from the summit, not including K. Krasak	① 1/ 2,3,4,5 29,27,26	② 1,37,36 2,38,3,39	③ 1,32,33 34	④ 1, 41 40					
		2	River course improvement works No. 1 . cosolidation dams . embankment and revetment etc.	At places of urgency and importance	⑤ 57,59,40 39F,38F	⑥ 35, 16 15, 14 34							
		3	Valley mouth fixation works No. 2 . check dams and . training levees	In the vicinity of 10 km from the summit on K. Krasak, and in the upper stream of valley fixation works (No. 1)	⑦ 28,31,53 52	⑧ 4,40,41 17,18	⑨ 2,36,35	⑩ 2, 43 42					
		4	Sand pockets and consolidation dams Second dam and consolidation dam should be implemented through observation of the valying situation at the down stream of BE - D.1 check dam.	In the middle stream area of K. Krasak, and second dam and consolidation dams	⑪ 1,18,17 16,15,14 23,22,21 13,19,20 10,11								
		5	Valley mouth fixation works No. 3	In the upper most reaches of the rivers	⑫ 54,55,56	⑬ 42, 43							

Note: 1/ (1st) (4th) 2, 3, 4, 5 (5th) (7th) 29, 27, 26 Numbers show the structure numbers of each tributaries. They are listed in Table-17 (5).

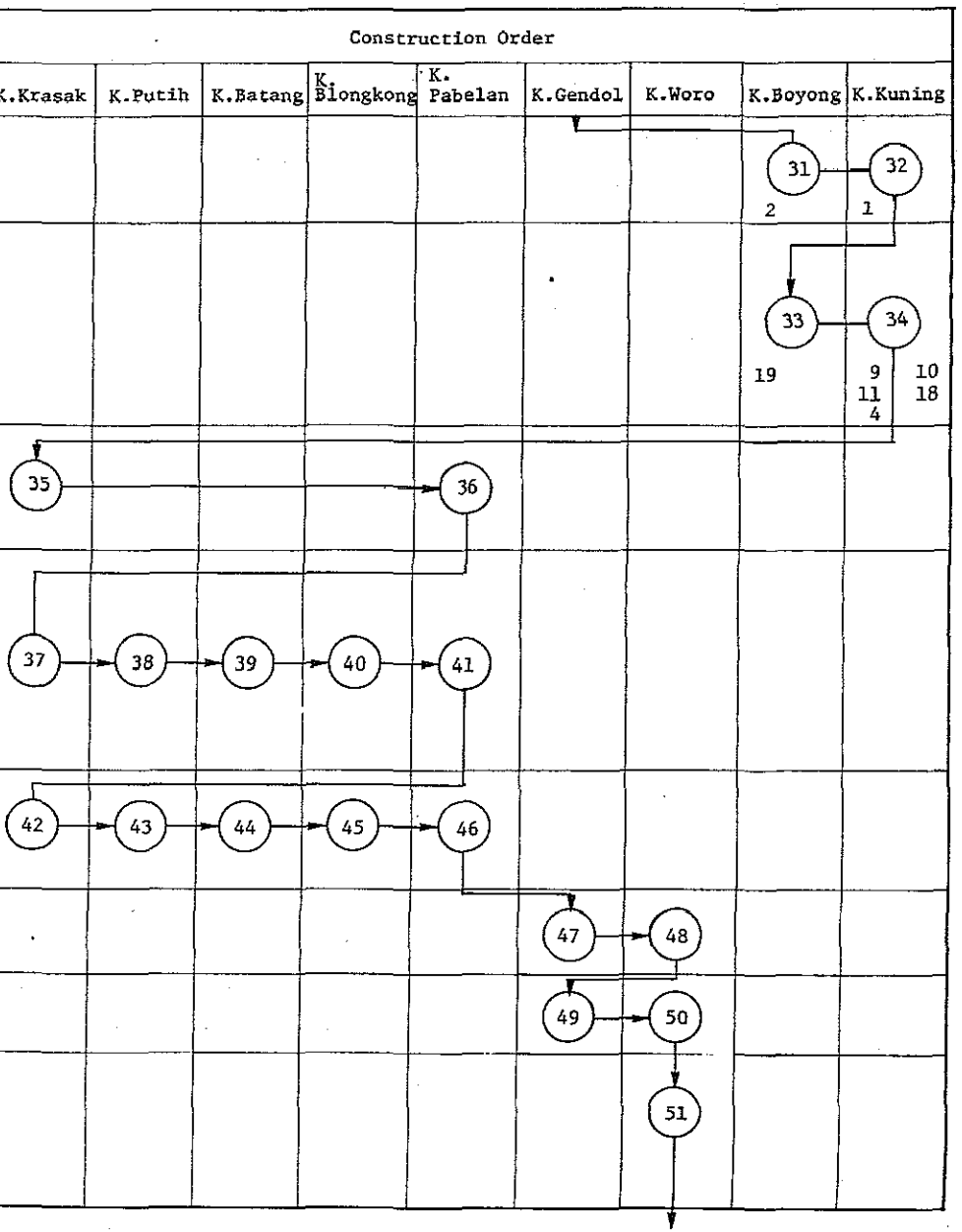
Continued

Priority Order		Facilities	Location	Construction Order
				K.Krasak / K.Putih / K.Batang / K. Blongkong / K. Pabelan / K.Gendol / K.Woro / K.Boyong / K.Kuning
Stage - 1	Tributaries of Type - I and K. Pabelan	6	Check dams	In the upper stream area of K. Bebeng (K. Krasak)
		7	Check dams and consolidation dams	In the middle stream area where the main irrigation canal is crossed or connected
		8	River course improvement works No. 2 . consolidation dams . embankment and revetment	In the downstream areas
	K. Gendol and K. Woro (Type - II)	9	River course improvement works No. 3	In the downstream area of K. Gendol, and the middle and downstream areas of K. Woro
		10	Check dams	In the upper stream area of K. Gendol and K. Woro
		11	Sand pockets and consolidation dams	In the middle stream area of K. Gendol
		12	River course improvement works No. 4	In the downstream area of K. Gendol, and the middle and downstream areas of K. Woro



Continued

Priority Order			Facilities	Location	Construction Order
Stage - 1	K. Boyong and K. Juning	13	Check dams	In the upper stream areas of K. Boyong and K. Kuning	
		14	River course improvement works No. 5 . embankment and revetment . Bridges	In the middle stream area of K. Boyong and the middle and downstream areas of K. Kuning	
Stage - 2	Tributaries of type-I and K. Pabelan	15	Check dams	In the upper stream areas of K. Krasak (main) and K. Pabelan	
		16	River course improvement works No. 6	In the vicinities of the National road for K. Krasak, K. Putih, K. Batang and K. Brong upper stream of K. Pabelan	
		17	River course improvement works No. 7	Where are not included in the River improvement works No. 1 ∿ 6	
	K. Gendol and K. Woro	18	Check dams	In the upper stream area of K. Gendol and K. Woro	
		19	Consolidation dams works No. 8	In the middle stream of K. Gendol and K. Woro	
		20	River course improvememt	At the sand pockets and the downstream area of K. Woro	



Continued

Priority Order			Facilities	Location	Construction Order								
					K.Krasak	K.Putih	K.Batang	K. Blongkong	K. Pabelan	K.Gendol	K.Woro	K.Boyong	K.Kuning
Stage - 2	K.Boyong and K.Kuning	21	Check dams	In the upper stream area of K. Boyong and K. Kuning								52 →	53
		22	River course improvement works No. 9	In the middle and down-stream areas of K. Boyong and K. Kuning								54 →	55

(5) Sabo Facility Numbers and Construction Costs

(1) K. Krasak

No.	Facility	Element				Construction Cost (Rp x 1,000)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)		
1	BE- D.1	Check Dam			1,100	15,400	Sub Dam
2	D.2	"	6.5	85	6,000	84,000	
3	D.3	"	11.0	134	13,400	187,600	
4	D.4	"	11.5	140	18,600	260,400	
5	D.5	"	10.9	80	10,500	147,000	
6	D.6	"	7.5	88	7,800	109,200	
7	D.7	"	10.0	104	12,800	179,200	
8	D.8	"	11.0	100	12,500	175,000	
9	D.9	"	12.5	140	13,300	186,200	
10	EE- C.1 *	Consolidation Dam	4.0	630	10,500	115,500	
11	C.2 *	"	"	550	9,200	101,200	
12	C.3 *	"	"	425	7,100	78,100	
13	C.4	"	"	108.	4,100	57,400	
14	C.5	"	3.0	111	3,100	43,400	
15	C.6	"	4.0	"	3,200	44,800	
16	C.7	"	3.5	"	3,700	51,800	
17	C.8	"	4.5	118	4,100	57,400	
18	C.9	"	4.0	61	2,400	33,600	
19	BE- R.1	Revetment, Dike (B-4)	5.0	1,230		118,080	
20	R.2	(")	"	950		91,200	
21	R.3	(B-3)	3.0	600		55,800	
22	R.4	(")	"	570		53,010	
23	R.5	(D-4)	5.0	420		20,160	
24	R.6	(B-5)	3.0	750		36,000	
25	R.7	(D-3)	5.0	220		12,540	
26	BE- T.1	Training Levee	6.0	630		92,610	
27	T.2	"	"	1,000		147,000	
28	T.3	"	"	950		139,650	
29	T.4	"	"	1,070		157,290	
30	KR- D.1 **	Check Dam	14.0	190	35,400	672,600	
31	D.2	"	"	190	35,400	495,600	
32	D.3	"	14.5	178	34,600	484,400	
33	D.4	"	8.0	143	11,900	166,600	
34	D.5	"	"	155	17,200	240,800	
35	D.6	"	10.0	128	12,500	175,000	
36	KR- R.1	Revetment, Dike (D-1)	3.0	1,950		89,700	
37	R.2	(")	"	2,050		94,300	
38	R.3	(A, F)	3.0	1,100		97,900	
39	R.4	(")	"	2,050		182,450	
40	R.5	(B-1)	"	1,600		102,400	
41	R.6	(")	"	2,400		153,600	
42	R.7	(")	"	"		153,600	
43	R.8	(D-2)	"	450		17,100	
44	R.9	(")	"	330		12,540	
45	R.10	(")	"	1,140		43,320	
46	R.11	(B-5)	"	350		16,800	
47	R.12	(")	"	230		11,040	
48	R.13	(")	"	580		27,840	
49	R.14	(")	"	430		20,640	
50	R.15	(")	"	200		9,600	
51	R.16	(")	"	"		9,600	
52	KR- T.1	Training Levee	6.0	400		58,800	
53	T.2	"	"	550		80,850	
54	T.3	"	"	540		123.480	
55	T.4	"	"	840		183,750	
56	T.5	"	"	1,250		66,150	
57	KR- C.1	Consulidation Dam	4.1	69	2,100	37,560	Protection Work for Sypnone.
58	KR- G	Groin	–	4,500		310,500	
59	–	(Chipping the crest of head work)			13,380	13,380	
						7,002,440	

* unit cost : Rp.11,000/m^3

** " : Rp.19,000/m^3

NO The location of facility within the 10 km from the summit.

(2) K. Batang

No.	Facility	Element				Construction Cost (Rp x 1,000)	Remarks
		Type	Height (m)	Length (m)	Volume (m^3)		
1	BA- D.1	Check Dam	13.0	300	22,600	316,400	
[2]	D.2	"	11.0	400	21,900	306,600	
3	BA- C.1	Consolidation Dam	3.0	80	4,400	61,600	
4	C.2	"	3.0	100	3,800	53,200	
5	C.3	"	3.0	80	4,400	61,600	
6	C.4	"	3.0	100	3,800	53,200	
7	C.5	"	3.0	80	3,500	49,000	
8	C.6	"	3.0	80	3,500	49,000	
9	C.7	"	3.0	100	3,800	53,200	
10	C.8	"	3.0	80	3,500	49,000	
11	C.9	"	3.0	80	3,500	49,000	
12	C.10	"	3.0	80	3,500	49,000	
13	C.11	"	3.0	100	3,800	72,200	
14	C.12	"	3.0	100	3,800	72,200	
15	C.13	"	4.0	130	4,900	68,600	
16	C.14	"	5.0	70	4,300	60,200	
17	C.15	"	4.0	70	3,500	49,000	
18	C.16	"	4.0	80	3,700	51,800	
19	C.17	"	4.0	80	3,700	51,800	
20	BA- R.1	Revetment, Dike (D-2)	3.0	450	–	24,750	
21	R.2	(D-2)	3.0	600	–	22,800	
22	R.3	(D-1)	3.0	400	–	18,400	
23	R.4	(B-2)	3.0	3,000	–	165,000	
24	R.5	(B-2)	3.0	3,100	–	170,000	
25	R.7	(D-3)	3.0	350	–	19,950	
26	R.8	(B-3)	5.0	100	–	9,300	
27	R.8	(B-3)	5.0	880	–	81,840	
28	R.9	(B-3)	5.0	850	–	79,050	
29	R.10	(B-3)	5.0	1,500	–	139,500	
30	R.11	(B-3)	5.0	1,500	–	139,500	
31	R.12	(B-3)	5.0	600	–	55,800	
32	BA- T.1	Tranining Levee	7.0	280	–	41,160	
33	T.2	"	7.0	700	–	102,900	
[34]	T.3	"	7.0	480	–	67,620	
[35]	T.4	"	7.0	520	–	76,440	
[36]	T.5	"	7.0	560	–	82,320	
37	BA- G	Groin	–	900	–	62,100	
Total						2,935,030	

[N] *The location of facility within the 10 km from the summit.*

(3) K. Putih

No.	Facility	Element				Construction Cost (Rp. x 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	PU - D.1	Check Dam	10.0	250	16,300	228,200
2	D.2	"	11.0	80	10,700	149,800
3	D.3	"	9.0	150	13,300	186,200
4	D.4	"	8.0	90	7,600	106,400
5	PU - C.1	Consolidation Dam	3.0	80	4,400	61,600
6	C.2	"	3.0	80	3,500	49,000
7	C.3	"	3.0	100	3,800	53,200
8	C.4	"	3.0	80	3,500	49,000
9	C.5	"	3.0	80	3,500	49,000
10	C.6	"	3.0	80	3,500	49,000
11	C.7	"	3,0	80	3,500	49,000
12	C.8	"	5.0	100	6,200	86,800
13	C.9	"	3.0	100	3,800	53,200
14	C.10	"	4.0	110	4,500	63,000
15	C.11	"	4.0	110	4,500	63,000
16	C.12	"	5.0	110	5,300	74,200
17	C.13*	"	6.0	270	3,600	39,600
18	C.14*	"	6.0	300	4,000	44,000
19	PU - R.1	Revetment (D-1)	3.0	130	-	5,980
20	R.2	(D-1)	3.0	180	-	8,280
21	R.3	(D-1)	3.0	430	-	19,780
22	R.4	(D-3)	5.0	250	-	14,250
23	R.5	(D-3)	5.0	450	-	25,650
24	R.6	(D-1)	3.0	350	-	16,100
25	R.7	(D-1)	3.0	190	-	8,740
26	R.8	(D-1)	3.0	800	-	36,800
27	R.9	(D-1)	3.0	350	-	16,100
28	R.10	(B-1)	3.0	2,400	-	110,400
29	R.11	(B-1)	3.0	2,400	-	153,600
30	R.12	(B-1)	3.0	2,050	-	131,200
31	R.13	(B-1)	3.0	2,050	-	131,200
32	R.14	(B-1)	3.0	1,400	-	89,600
33	R.15	(B-1)	3.0	1,750	-	112,000
34	R.16	(B-4)	5.0	600	-	51,600
35	R.17	(B-4)	5.0	600	-	51,600
36	PU - T.1	Training Levee	7.0	1,100	-	161,700
37	T.2	"	7.0	700	-	102,900
38	T.3	"	7.0	630	-	92,610
39	T.4	"	7.0	220	-	32,340
40	T.5	"	7.0	500	-	73,500
41	T.6	"	7.0	100	-	14,700
42	T.7	"	7.0	1,050	-	154,350
43	T.6	"	7.0	300	-	44,100
44	PU - G	Groin	-	1,980	-	136,620
						3,249,900

* unit cost: Rp.11,000/m^3

(4) K. Blongkeng

No.	Facility	Element				Construction Cost (Rp. x 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	BL - D.1	Check Dam	7.0	85	6,500	91,000
2	D.2	"	10.0	110	11,700	163,800
3	LA - D.1**	"	12.0	70	11,800	224,200
4	BL - C.1	Cons. Dam	3.0	90	4,900	68,600
5	C.2	"	3.0	90	3,900	54,600
6	C.3	"	3.0	110	4,300	60,200
7	C.4	"	3.0	90	3,900	54,600
8	C.5	"	3.0	90	3,900	54,600
9	C.6	"	5.0	150	7,900	110,600
10	C.7	"	4.0	120	6,000	84,000
11	C.8	"	4.0	110	5,600	78,400
12	C.9	"	4.0	140	5,200	72,800
13	C.10	"	4.0	120	4,700	65,800
14	C.11	"	5.0	120	5,800	81,200
15	C.12**	"	4.0	150	5,400	102,600
16	BL - R.1	A	2.0	250	-	147,750
17	R.2	(D - 1)	3.0	260	-	11,960
18	R.3	(D - 1)	3.0	160	-	7,360
19	R.4	(D - 1)	3.0	250	-	11,500
20	R.5	(D - 1)	3.0	400	-	18,400
21	R.6	(D - 1)	3.0	950	-	43,700
22	R.7	(D - 3)	5.0	1,150	-	65,550
23	BL - R.8	(D - 1)	3.0	2,000	-	92,000
24	R.9	(D - 2)	3.0	2,050	-	77,900
25	R.10	(D - 2)	3.0	950	-	36,100
26	R.11	(B - 1)	3.0	1,200	-	76,800
27	R.12	(B - 3)	5.0	250	-	23,250
28	R.13	(B - 1)	3.0	1,450	-	92,800
29	R.14	(B - 1)	3.0	400	-	25,600
30	R.15	(B - 1)	3.0	600	-	38,400
31	R.16	(B - 3)	5.0	250	-	23,250
32	R.17	(B - 3)	5.0	200	-	18,600
33	R.18	(B - 3)	5.0	300	-	27,900
34	R.19	(B - 3)	5.0	100	-	9,300
35	R.20	(B - 3)	5.0	500	-	46,500
36	R.21	(B - 3)	5.0	300	-	27,900
37	R.22	(B - 3)	5.0	80	-	7,440
38	R.23	(B - 3)	5.0	100	-	9,300
39	R.24	(B - 3)	5.0	280	-	26,040
40	BL - T.1	Training Levee	7.0	300	-	44,100
41	T.2	"	7.0	1,450	-	213,150
42	T.3	"	7.0	180	-	26,460
43	T.4	"	7.0	300	-	44,100
44	BL - G	Groin	-	1,560	-	107,640
						2,634,750

** unit cost: Rp.19,000/m^3

(5) K. Woro

No.	Facility	Element				Construction Cost (Rp. x 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	WO - C.1*	Consolidation Dam	5.0	360	6,000	66,000
2	C.2*	"	"	320	5,400	59,400
3	C.3*	"	"	318	5,300	58,300
4	C.4	"	"	130	5,000	70,000
5	C.5	"	7.0	125	8,100	113,400
6	WO - D.1	Check Dam	10.0	135	13,200	184,800
7	D.2	"	"	120	12,300	172,200
8	D.3	"	13.5	125	17,500	245,000
9	D.4	"	12.0	"	17,700	247,800
10	D.5	"	13.0	97	15,300	214,200
11	D.5'	"	7.0	162	19,700	275,800
12	D.6	"	13.0	55	11,300	158,200
13	D.7	"	12.0	158	18,200	254,800
14	D.8	"	8.0	70	7,500	105,000
15	D.9.A	"	14.5	141	16,300	228,200
16	D.9.B	"	10.0	148	19,100	267,400
17	D.10	"	"	72	9,500	133,000
18	WO - R.1	Revetment, Dike (D - 1)	3.0	2,500		115,000
19	R.2	(")	"	"		115,000
20	R.3	(")	"	"		115,000
21	R.4	(")	"			115,000
22	R.5	(B - 2)	"	230		12,650
23	R.6	(")	"	600		33,000
24	R.7	(")	"	580		31,900
25	R.8	(B - 5)	"	1,050		50,400
26	R.9	(")	"	1,570		75,360
27	R.10	(")	"	650		31,200
28	R.11	(")	"	1,070		51,360
29	R.12	(")	"	1,900		91,200
30	R.13	(B - 1)	"	3,270		209,280
31	WO - G	Groin	"	3,000		207,000
						4,106,850

* unit cost: Rp.11,000/m^3

(6) K. Gendol

No.	Facility	Element				Construction Cost (Rp. x 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	GE - D.1	Check Dam	14.5	80	20,900	292,600
2	D.2	"	14.0	90	20,800	291,200
3	D.3	"	10.0	75	10,000	140,000
4	D.4	"	14.5	100	23,000	322,000
5	D.5	"	14.0	70	19,000	266,000
6	D.6	"	14.5	"	19,900	278,600
7	D.7	"	"	40	16,800	235,200
8	GE - C.1	Consolidation Dam	3.0	70	2,100	29,400
9	C.2	"	"	"	"	29,400
10	C.3	"	"	"	"	29,400
11	C.4	"	"	"	"	29,400
12	C.5	"	"	"	"	29,400
13	C.6	"	"	250.	7,400	103,600
14	C.7	"	"	110	3,200	44,800
15	C.8*	"	4.0	200	"	35,200
16	C.9*	"	"	280	4,480	49,280
17	C.10	"	"	60	4,700	65,800
18	C.11	"	5.0	70	3,600	50,400
19	C.12	"	6.0	75	3,200	44,800
20	C.13	"	5.0	70	3,600	50,400
21	C.14	"	4.0	80	3,200	44,800
22	C.15	"	6.0	70	4,600	64,400
23	C.16	"	7.0	60	5,500	77,000
24	C.17	"	"	50	5,200	72,800
25	GE - R.1	Rivetment, Dike (D-5)	3.0	1,150		65,550
26	R.2	(")	"	"		65,550
27	R.3	(B-1)	"	1,300		83,200
28	R.4	(")	"	700		44,800
29	R.5	(")	"	350		22,400
30	R.6	(D-1)	"	850		39,100
31	R.7	(B-1)	"	650		41,600
32	R.8	(B-4)	5.0	1,300		124,800
33	R.9	(")	"	"		124,800
34	GE - G.1	Groin	-	390		26,910
35	G.2	"	-	390		26,910
						3,341,500

* unit cost: Rp.1,000/m^3

(7) K. Boyong

No.	Facility	Element				Construction Cost (Rp. 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	BO - D.1	Check Dam	8.0	61	7,900	110,600
2	D.2	"	7.0	130	8,300	116,200
3	D.3	"	11.0	120	14,300	200,200
4	D.4	"	"	75	11,300	158,200
5	D.5	"	"	80	10,300	144,200
6	BO - C.1	Consolidation Dam	5.0	74	6,100	85,400
7	C.2	"	"	"	"	85,400
8	BO - R.1	Revetment, Dike (D - 2)	3.0	160		6,080
9	R.2	(")	"	350		13,300
10	R.3	(")	"	"		13,300
11	R.4	(")	"	300		11,400
12	R.5	(")	"	450		17,100
13	R.6	(")	"	980		37,240
14	R.7	(")	"	190		7,200
15	R.8	(")	"	"		7,200
16	R.9	(")	"	200		7,600
17	R.10	(")		1,340		50,920
18	R.11	(")	"	1,150		43,700
19	R.12	(")	"	1,300		49,400
20	BO - B.1	Bridge				50,000
21	B.2	"				50,000
						1,264,640

(8) K. Kuning

No.	Facility	Element				Construction Cost (Rp. 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	KU - D.1	Check Dam	12.0	100	14,100	197,400
2	D.2	"	13.0	145	18,400	257,600
3	D.3	"	10.0	70	9,400	131,600
4	KU - R.1	Rivetment, Dike (D-1)	3.0	600		27,600
5	R.2	(")	"	700		32,200
6	R.3	(B-3)	5.0	2,400		223,200
7	R.4	(B-1)	3.0	400		23,600
8	R.5	(B-3)	5.0	800		74,400
9	R.6	(B-1)	3.0	100		6,400
10	R.7	(")	"	50		3,200
11	R.8	(")	"	650		41,600
12	R.9	(")	"	300		19,200
13	R.10	(")	"	300		19,200
14	R.11	(B-3)	5.0	450		41,850
15	R.12	(B-1)	3.0	300		19,200
16	R.13	(")	"	450		28,800
17	R.14	(")	"	200		12,800
18	KU - B	Bridge				50,000
						1,209,850

(9) K. Pabelan

No.	Facility	Element				Construction Cost (Rp. x 1,000)
		Type	Height (m)	Length (m)	Volume (m^3)	
1	PA - D.1**	Check Dam	14.5	110	22,600	429,400
2	D.2	"	8.0	130	10,400	145,600
3	PA - C.1	Consolidation Dam	5.0	70	3,600	50,400
4	C.2	"	5.0	67	3,600	50,400
5	PA - R.1	Rivetment, Dike (B-1)	3.0	700		44,800
6	R.2	(")	"	1,300		83,200
7	R.3	(")	"	900		57,600
8	R.4	(A)	"	1,300		83,200
9	R.5	(B-1)	"	800		51,200
10	R.6	(")	"	400		25,600
11	PA - G	Groin		90		6,210
12	PA - B	Bridge				100,000
13	SE - D.1**	Check Dams	14.5	65	19,300	336,700
14	D.2	"	13.0	80	12,700	177,800
15	D.3	"	13.5	130	17,400	243,600
16	TR - D.1**	Check Dams	14.5	94	22,300	423,700
17	D.2	"	10.0	60	8,800	123,200
18	D.3	"	12.0	96	13,800	193,200
19	D.4	"	12.0	70	11,800	165,200
						2,791,010

** unit cost: Rp.19,000

CHAPTER 5

CONSTRUCTION COST

CHAPTER 5 CONSTRUCTION COST

5.1 General

The construction costs of the present plan have been estimated as follows for the purpose of economic assessment of the plan:

1) The construction costs are based on the quantities of materials to be used, and the prices of labor and materials those cited by the Merapi Project Office for fiscal 1979.

2) The only contingency costs that have been considered are those for construction quantities, at a rate of 15% of direct construction costs. In other words, no contingency costs have been considered for rise in the prices of materials purchased due to inflation.

3) Expenses for Administrative/Overhead, and Consulting Services have each been taken as 10% of the sum of the direct construction costs and the contingency costs referred to in 2) above.

4) The total construction cost has been taken as the sum of 1), 2), and 3) above.

5) Maintenance and management costs have been taken as the annual average (one-fifteenth) of the total construction costs, starting from the sixteenth year and for a duration of 35 years.

5.2 Construction Costs of Works

The total construction cost for the disaster prevention facilities and the associated works has been estimated at Rp 41,851 million (see Table 18 for details), and the annual maintenance and management cost has been estimated at Rp 418 million.

The costs of the land-use improvement plan, the warning and evacuation plan, and the micro hydroelectric power stations, model rural village improvement and other parts of the associated works plan are not included in these figures.

Table 18 Construction Costs

unit: 1,000Rp.

Type	Name of River	Construction Cost	Contingency	Administration and Overhead	Consulting Survice	Total
Type – I	K. Krasak	7,002,440	1,050,360	805,280	805,280	9,663,360
	K. Batang	2,935,030	440,260	337,530	337,530	4,050,350
	K. Putih	3,249,900	487,490	373,740	373,740	4,484,870
	K. Blongkeng	2,634,750	395,210	302,990	302,990	3,635,940
	Sub Total	15,822,120	2,373,320	1,819,540	1,819,540	21,834,520
Type – II	K. Woro	4,106,850	616,030	472,290	472,290	5,667,460
	K. Gendol	3,341,500	501,230	384,270	384,270	4,611,270
	Sub Total	7,448,350	1,117,260	856,560	856,560	10,278,730
Type – III	K. Boyong	1,264,640	189,700	145,430	145,430	1,745,200
	K. Kuning	1,209,850	181,480	139,130	139,130	1,669,590
	K. Pabelan	2,791,010	418,650	320,970	320,970	3,851,600
	Sub Total	5,265,500	789,830	605,530	605,530	7,266,390
Total		28,535,970	4,280,410	3,281,630	3,281,630	39,379,640
Associated Work Main canal-1 and Bridge		1,790,880	268,630	205,950	205,950	2,471,410
G. Total		30,326,850	4,549,040	3,487,580	3,487,580	41,851,050

CHAPTER 6

PLAN IMPLEMENTATION ENTITY AND ORGANIZATION

CHAPTER 6 PLAN IMPLEMENTATION ENTITY AND ORGANIZATION

6.1 General

The entity in charge of implementation of the plans to be the Directorate General of Water Resources Development of the Ministry of Public Works, which, besides being entirely responsible for implementation of the master plan, will also have the role of coordinator of the work of other government agencies and local administrative offices in connection with implementation of the plan.

The G. Merapi Project Office, which participated in formulation of the master plan, is to perform the actual implementation of the plan, with staff requirements increasing in the course of implementation. It is advisable that the implementation plan should be formulated on the basis of technical guidance and cooperation as in the case of the master plan.

It is also advisable to establish auxiliary entities for the purposes of technical guidance, and training of technical personnel in the field of volcanic disaster prevention so as to make the master plan more effective.

6.2 Plan Implementation Entity

The reason for making the Directorate General of Water Rosources Development of the Ministry of Public Works the entity responsible for implementation of this disaster prevention master plan is that the plan deals primarily with provision of disaster prevention facilities and promotion of disaster prevention works. Besides being fully responsible for implementation of the basic plan, it must also coordinate the work of other government agencies and local administrative offices in connection with implementation of the plan.

Since the master plan covers a number of fields, it is necessary that a single entity provide centralized project control and management in order that the work may progress smoothly. The local offices in charge of project implementation is to be the G. Merapi Project Office, which has carried out disaster prevention works and participated in the formulation of the master plan. Its technical staff will have to be increased, however, for this purpose.

In order to make the master plan as effective as it is hoped that it will be, the implementation planning should be undertaken on the basis of technical guidance from experts and technical cooperation, as was the case in the master planning.

The requirements for technical personnel and experts for the implementation stage will be studied in the following Implementation Planning Stage of the project.

6.3 Establishment of a Sabo Technical Center

6.3.1 Background and Objections

The sediment discharge produced by volcanic eruption causes serious damage to irrigation facilities and farmland, while in the volcanic areas, violent floods of volcanic materials destroy fertile land year after year. It is unmeasurable how much the national wealth is thus lost by sediment discharge and land erosion, but in order to develop the nation, it is essential to promote sabo projects aiming at sediment control and soil conservation in the volcanic region and to secure the safety and stability of the region.

In order to carry out sabo projects in a volcanic region in an effective manner, it is recommended to introduce the ready-made sabo technology of Japan into Indonesia in an organized way so that it can be digested, developed and standardize to meet local conditions in Indonesia. This goal can best be accomplished by conducting long-term and organized observation and analysis of local volcanic phenomena and researching sabo technology.

The consequently, it is recommended to establish a Sabo Technical Center which will be intensively engaged in providing continuous guidance, developing technoloty concerning the conservation and development of volcanic areas, and cultivating sabo engineers and technicians.

6.3.2 Function and Organization

1) Location and Organization

It is recommended that the Technical Center should be established and located in the neighborhood of G. Merapi Project Office of Yogyakarta in Central Java in order to enable the Technical Center to be engaged in guidance activities, using the Merapi area (whose masterplan has been studied). The Center will be tentatively called the Sabo Technical Center (herein after referred to only as "the Center").

2) Function of the Center

The Center will aim to provide guidance in sabo engineering (planning, design and construction supervision) which will contribute to the conservation and development of volcanic areas of Indonesia, to develop new technology, and to give technical training to engineers and technicians.

The Center will transfer of technical knowledge and development of new sabo technology by using the Merapi area as a model for technical guidance and conducting its practical activities through implementation of the Merapi master plan. Hence, the Center will play a pivotal role in guidance activities concerning the volcanic area conservation and development technology for the whole area of Indonesia.

The goals of the Center will be as follows:

(1) Technical guidance in regard to sabo planning, design for sabo facilities and construction supervision;

(2) Establishment of observation and technical guidance concerning collection and analysis of data;

(3) Development of new sabo technology and its standardization through actual construction works.

(4) Establishment of a technical guidance for lahar warning systems;

(5) Guidance for Socio-economic development of mountain slope areas including planning and implementation; and

(6) Training of engineers and technicians in actual construction works.

3) Technical Guidance

(1) Commencement of Technical Guidance Activity

It is suggested that the Center should start its activities at the earliest possible time for the implementation of the Merapi master plan.

(2) Contents of Technical Guidance Activities

It is suggested that the Center establish the following two functions:

(a) Transfer of Sabo Technology

Sabo technology should be transferred through practice of budgeting the Merape masterplan and planning its facilities including the following:

-Preparation and guidance of implementation program;

-Model study of engineering and designing of sabo facilities, construction supervision and technical guidance;

-Practical training of warning and evacuation system;

-Planning and technical guidance of mountain slope area development in regard to multi-purpose use of sabo facilities;

-Establishment of a volcanic phenomenon observation system, analysis of data and technical guidance;

-Development of sabo technology fitting regional requirements and preparation of design criteria;

-Preparation of warning system plan criteria.

(b) Training of Sabo Engineers and Technicians

It is recommended that the Center offer courses of training

for sabo engineers and technicians. The courses should provide theoretical lectures and practice with regard to volcanic area conservation and development. The training should be offered for both short and long-term periods depending upon attendants' needs.

The following Table lists equipment and laboratory test apparatus that probably will be needed to accomplish the two functions listed above.

List of Equipment and Laboratory Test Apparetuses

1. Test Apparatuses

   - Concrete field testing equipment
   - Soil testing equipment
   - Survey instruments
   - Office equipment

2. Observation Equipment

   - Telemetric rainfall observation stations
   - Runoff observation stations
   - Water samplers
   - Mud flow indicators

3. Pilot Works

   - Equipment for concrete
   - Heavy machines for civil works
   - Equipment for transportation
   - Machines and equipment for temporary works
   - Quality control equipment

4. Vehicles for Transportation

(3) Fields of Technical Guidance Activities

The following is a list of fields in which the Center will be engaged:

1) Geomorphology
2) Civil engineering geology
3) Hydrology
4) River engineering
5) Volcanic mud flows
6) Sabo survey
7) Sabo Planning
8) Sabo facilities design
9) Protection Forest planning
10) Socio-economic planning
11) Construction supervision
12) Regional development

4) Organization and Operation

(1) Period of Technical Cooperation

It is suggested that technical cooperation to be provided by the cooperating country should cover at least five years.

(2) Organization of the Center

The Center will be composed of a chairman board of directors and experts from the cooperating country; the project manager, Head of the Center and counterparts will be Indonesian. The Organization of the Center is outlined in charts 1 and 2.

(3) Operation

The Indonesian side will take responsibility and bear the expenses for construction of the Cnter and administration and operation of the Center; the cooperating country will take responsibility for technical matters.

6.3.3 Schedule for Establishment of the Center

As the first step in the establishment of the Center, it will be necessary that the Government of Indonesia make a request for despatch of a survey mission immediately to the Government of the cooperating country. In regard to operation program of the Center and items for the cooperating country, it is recommended that be exchanged between the Directorate General of Water Resources Development of the Ministry of Public Works of Indonesia and the survey mission representing the Government of the cooperating country in order to clarify responsibilities.

Practical schedules for establishment and operation of the Center will be worked out as a result of implementation surveying and negotiation. In view, however, of urgency of execution of the Merapi debris control master plan and also of the project effects to be brought about by the implementation of the first program stage, the earliest possible establishment of the Center is recommended.

Chart-I Sabo Technical Center

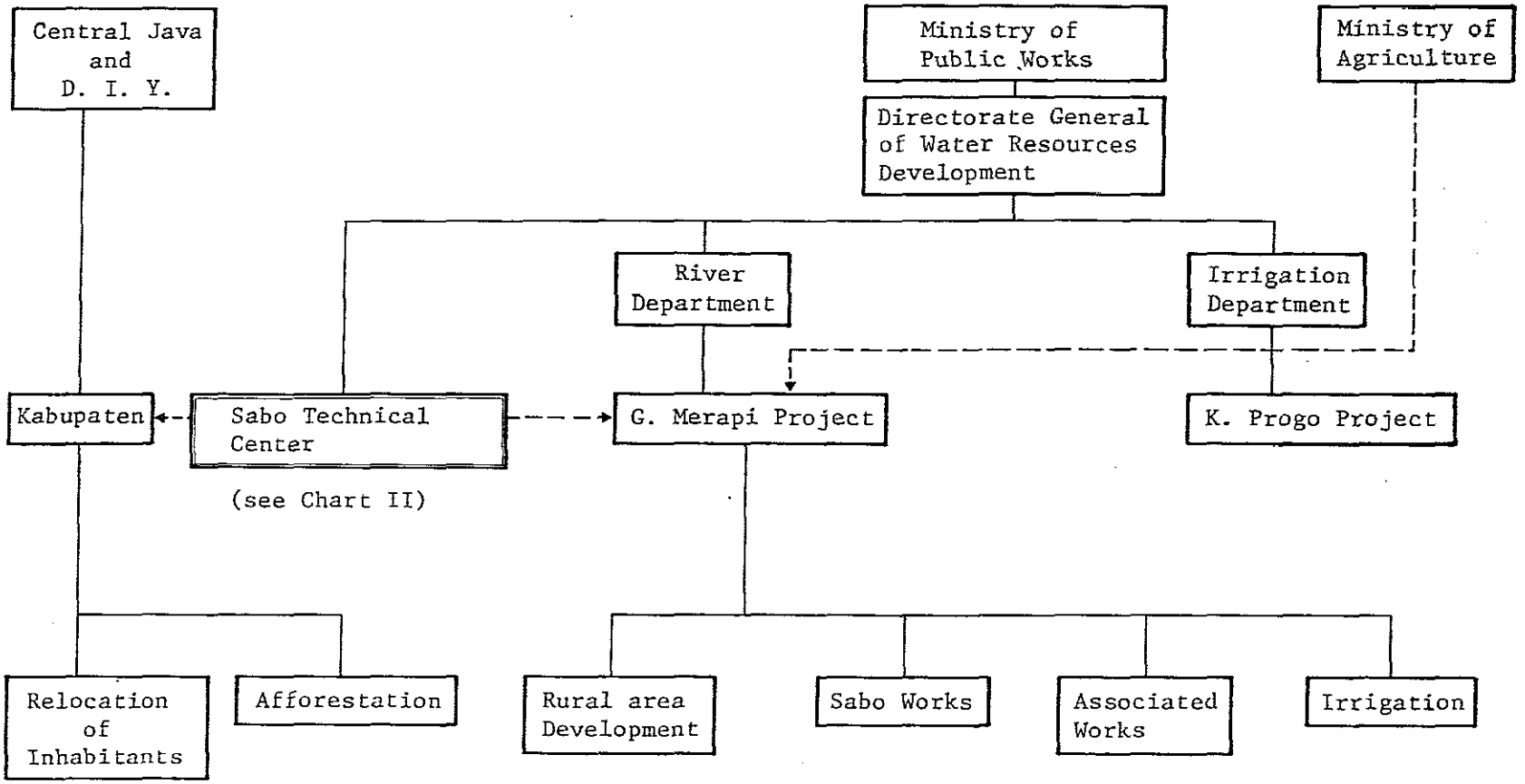
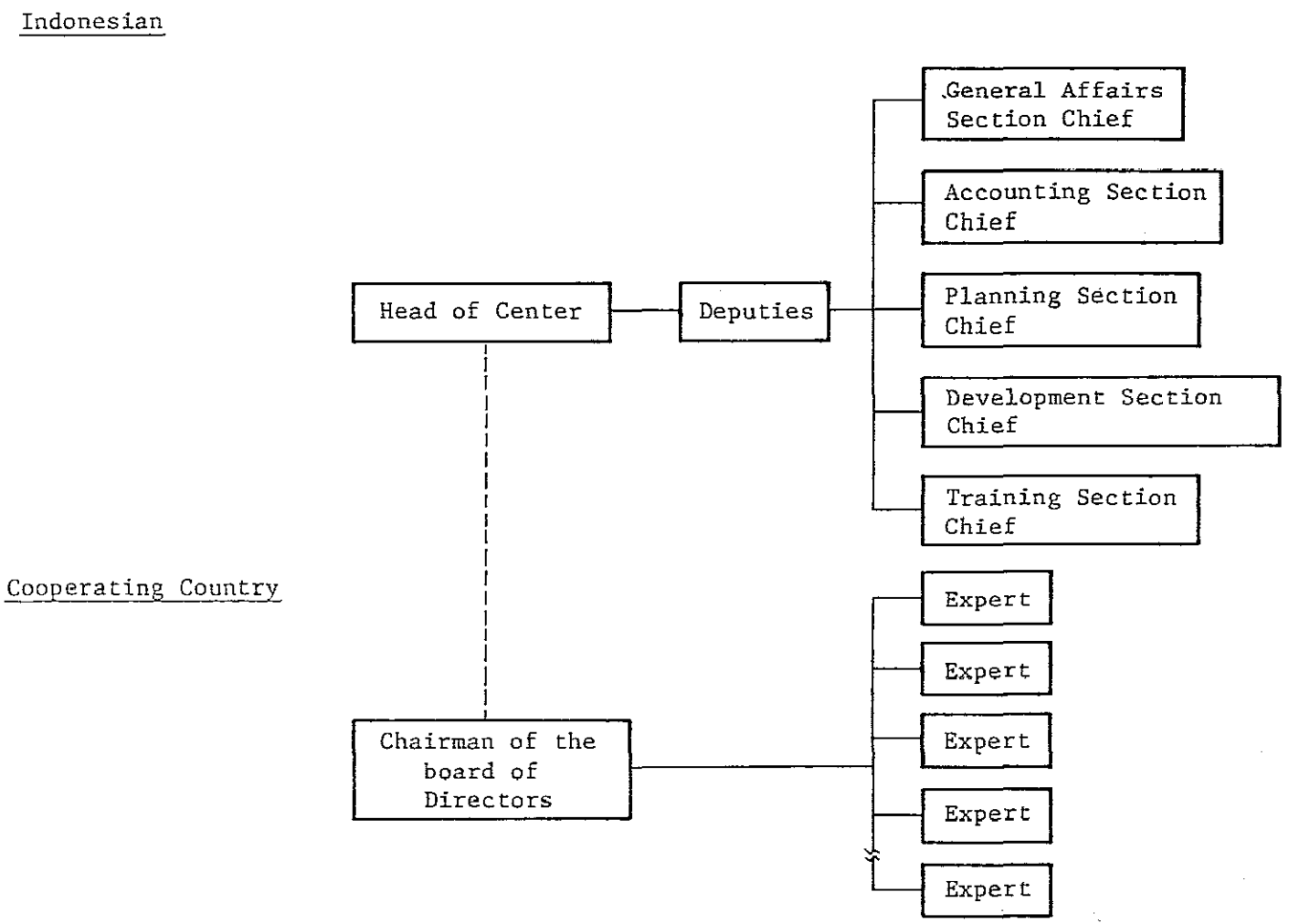


Chart-2 Organization Chart of Sabo Technical Center



CHAPTER 7

SOCIO-ECONOMIC EVALUATION

CHAPTER 7 SOCIO-ECONOMIC EVALUATION

7.1 General

The purpose of this chapter is to analyse the economic, social and financial impacts by the present disaster prevention plan to determine the feasibility of the plan.

Generally, land erosion and volcanic debris control works have a number of different effects. In this chapter, a cost-benefit analysis is to be made of the anticipated effects that relate to economic efficiency. A qualitative and quantitative analysis is also to be made of the main social effects expected. In addition, the financial significance of implementation of the plan is to be considered from the standpoint of procurement of funds. Finally, an overall analysis is to be made of the results of these economic, social and financial analysis, taking into account congruency with the goals of Repelita-III on the national level and the level of Central Java Province and D.I. Yogyakarta, so as to assign priorities to the alternatives.

Due to the nature of G. Merapi, the evaluation method in this report is a little different from ordinal one in the following two points:

(1) It is impossible to forecast disasters on probability basis from the relationship between eraption of G. Merapi and rainfall. Annual area of damage, therefore, estimated by river type from the data of past experience of disaster in the area and the amount of sediment.

(2) Lahar damage to farmland is different in nature from inundation damage that causes the decrease of agricultural crops at one harvest, because farmland damaged by lahar will not yield nothing for a rather long time without large-scale restoration work. The estimated amount of damage can be considered as net income from agriculture lost during the time when no agricultural production in damaged farmland can be made. In this report, amount of damage is net income from agriculture lost during project life on the assumption that no restoration word for damaged farmland will be carried out.

7.2 Economic Evaluation

7.2.1 Benefits

The economic benefits taken into account in this report comprise of the followings:

(1) Effects of reducing damages

(2) Increase in agricultural production through stabilization of the project area

(3) Increase in paddy production by the associated facilities

Table 19 gives the estimated annual amount of damage that could be expected if the plan were not to be implemented, while Table 20 gives the estimated figures for increase in agricultural production due to implementation of the project in the third year after completion of the construction work and in the fifth year.

The expected increase in paddy production due to the associated works is shown in Table 20-2. It has been assumed that such increase in production will arise in the third year after completion of the construction work.

7.2.2 Cost

The total investment cost involved in the implementation of the present disaster prevention plan is estimated at Rp. 39,379,640,000 at 1979 prices. As for the investment cost of the associated facilities, the total construction cost of the main irrigation canal is estimated at Rp. 1,693,092,000.

Annual maintenance and operation cost after the completion of the work is estimated at Rp. 411 million for Alternative 1 and 3, and Rp. 394 million for Alternative 2 and 4. These amounts are about one percent of total construction costs.

The annual disbursement schedule for the plan is shown in Table 21.

7.2.3 Evaluation

The calculated internal rates of return for the four alternatives are as follows:

	With Sabo Facilities	Sabo Facilities and Associated Works
Alternative-1	7.7%	11.4%
Alternative-2	7.7	-
Alternative-3	7.3	10.6
Alternative-4	7.3	-

In terms of economic efficiency, therefore, the order of priority of the alternatives is: Alternative-1, Alternative-2, Alternative-3 and Alternative-4.

Sensitivity analysis was performed on the internal rates of return for the following cases: a project life of 40 years, 10% higher construction costs, and 10% lower construction costs. The results have been calculated as follows:

	Alternative-1	Alternative-2	Alternative-3	Alternative-4
Project life of 40 years	11.2%	7.2%	10.4%	6.7%
10% higher construction costs	10.1	6.7	9.4	6.6
10% lower construction costs	12.7	8.9	11.7	8.3

7.3 Social Evaluation

7.3.1 Increase in Food Production

The increased paddy production due to the implementation of the plan will heighten self-sufficiency in the area. Table 22 gives estimated figures for the amount of increased paddy production that will result from the project.

7.3.2 Employment Opportunities

Implementation of the disaster prevention plan will mean creation and availability of employment opportunities. Temporary employment will be increased by the jobs available in the construction of the disaster prevention facilities and the related facilities and in the supply of materials for use in such construction works; permanent employment will be increased by the jobs available in maintenance and management of the facilities after that are completed, in afforestation and other planting activities for conservation and land use improvement purposes, and in agriculture as a result of further intensification of agricultural production. Furthermore, protection of farmland from lahar will be of great significance in terms of stabilizing employment opportunities in agriculture. Table 23 and Table 24 give the expected increase of employment opportunities with sabo works and associated works and expected increase of employment opportunities in agriculture, respectively.

7.3.3 Income Distribution

In the area covered by the plan the overwhelming majority of the farmers have less than 0.3 ha of farmland, and the average income per household, therefore, is quite low. Furthermore, there is a considerable surplus of labor in this area. Through implementation of the plan, money will be pumped into the local economy in the form of wages of the

workers employed at the construction sites of the facilities and after completion of such facilities farm income can be expected to increase through higher yields of agricultural products. Fig. 30 gives figures on the amount of increase in farm household income that can be expected per person with respect to the 164,000 persons living in the areas that will be protected by the disaster prevention facilities after they are completed.

7.3.4 Resettlement

With the implementation of the resettlement program, the annual rate of population increase will be lowered from 1% to 0.75%.

7.3.5 Other Social Effects

(1) Construction and Maintenance Roads

Construction roads, facility management roads after completion of the works, and maintenance roads improve local communications and raise development potential in addition to their basic functions. Access to markets will stipulate economic activity, and better communication between local areas will have many positive social and cultural effects.

(2) Transfer of Technology

A long-term 15-year disaster prevention project of this kind provides an excellent opportunity for transfer of technology to unskilled workers in the area.

(3) Social Effects of the Related Facilities

Micro hydroelectric plants could very well stimulate domestic industry. Fishery nurseries and domestic water supply will greatly improve local nutrition and sanitation conditions.

7.4 Financial Evaluation

7.4.1 Procurement of Funds

As already stated, the cost estimates of Rp. 39,379,640,000 for construction of the sabo facilities and Rp. 1,693,092,000 for construction of the associated irrigation canal facilities are based on 1979 prices. Possible future inflation has not been taken into account in these figures, but it will have to be taken into account in the procurement of funds.

Table 25 shows the amount of funds that each alternative would require in the first 5-year construction stage if the works were to commence in 1981, and Table 26 gives the annual budgets of the Merapi Office for fiscal 1969 through fiscal 1978. For the five years from 1973 to 1978, there was a tremendous average annual increase of 35% in that budget. Furthermore, this budget accounted for 1.7% of the total budget for River Bureau works in fiscal 1978. Accordingly, in the first year of implementation of the plan, funds equivalent to three times the Merapi Office budget of fiscal 1978 will be needed.

The budget of the Merapi Office continues to increase at the rate of 5 ∿ 15% a year. Therefore much preparation will be necessary in order to ensure that the funds needed can in fact be procured.

7.4.2 Present Value of the Amount of Investment

The total investment entailed by Alternative-1 or Alternative-3 over the 15-year period at 1979 prices will be Rp. 41,072,732,000, and that of Alternative-2 or Alternative-4 will be Rp. 39,379,640,000. However, the necessary flow of funds for the different stages will be different between the two alternatives of each pair. Accordingly, it is necessary to determine the extent of the fiscal burden that such investment will entail by considering the present value thereof for each alternative Table 27 gives the figures for the present value of such investment in the case of each alternative on the basis of discount rates of 8% and 10%.

Table 19 Estimated Annual Damage Amount

(1) Type-I

Items \ Rivers	K. Krasak	K. Batang	K. Putih	K. Blongkeng
1. Estimated damage area (ha)	1,823.8	1,516.7	1,370.9	1,054.4
2. Land use				
farmland (%)	64.4	64.4	64.4	64.4
yard (%)	28.0	28.0	28.0	28.0
road (m/ha)	118.4	118.4	118.4	118.4
3. House	5,289	4,398	3,976	3,058
4. Income and Assets				
farm income (Rp./ha)	523,900	260,600	260,600	260,600
yard income (Rp./ha)	188,500	188,500	188,500	188,500
house and assets	1,000,000	1,000,000	1,000,000	1,000,000
road construction cost (Rp./m)	13,500	13,500	13,500	13,500
5. Estimated annual damage area (ha)	73.0	60.7	54.8	42.2
farmland (ha)	47.0	39.1	35.3	27.2
yard (ha)	20.4	17.0	15.3	11.8
house	53	44	40	
road (m)	8,643	7,187	6,488	4,996
6. Estimated annual damage area				
farmland (million Rp)	25	10	9	7
yard (")	4	3	3	2
house and assets (")	53	44	40	31
road (")	117	97	88	67

(2) Type-II

Items \ Rivers	K. Woro	K. Gendol	
1. Estimated damage area (ha)	2,894.6 (1,675.6)	693.5	
2. Land use			
famland (%)	63.4	63.4	
yard (%)	31.8	31.8	
road (m/ha)	57.5	57.5	
3. House	8,105 (4,692)	1,942	
4. Income and Assets		739,300	
farm income (Rp./ha)	550,300	739,300	
yard income (")	81,600	81,600	
house and assets	1,000,000	1,000,000	
road construction cost (Rp./m)	13,500		
5. Estimated annual damage area (ha)	57.9(33.5)	13.9	
farmland (ha)	36.7(21.2)	8.8	
yard (ha)	18.4(10.7)	4.4	
house	41 (23)	10	
road (m)	3,341(1,933)	799	
6. Estimated annual damage area			
farmland (million Rp)	20 (3)	7	
yard (")	2 (-)	-	
house and assets (")	41 (6)	10	
road (")	45 (-)	11	

(3) Type-III

Items \ Rivers	K. Boyong	K. Kuning	K. Pabelan
1. Estimated damage area (ha)	1,148.1	447.5	409.0
2. Land use			
farmland (%)	70.6	70.6	70.6
yard (%)	21.0	21.0	21.0
road (m/ha)	55.7	55.7	55.7
3. House	1,952	761	695
4. Income and Assets			
farm income (Rp./ha)	739,300	739,300	260,600
yard income (Rp./ha)	71,700	71,700	188,500
house and assets	1,000,000	1,000,000	1,000,000
road construction cost (Rp./m)	13,500	13,500	13,500
Estimated annual damage area (ha)	11.5	4.5	4.1
farmland (ha)	8.1	3.2	2.9
yard (ha)	2.4	0.9	0.9
house	5	2	2
road (m)	641	251	228
6. Estimated annual damage area			
farmland (million Rp)	6	2	1
yard (")	-	-	-
house and assets (")	5	2	2
road (")	9	3	3

Table 20 Estimated figures for Increase in Agricultural Production

(unit: million Rp)

Type		3rd Year After the Project	5th Year After the Project
Type-I	K. Krasak	106	142
	K. Batang	50	67
	K. Putih	46	60
	K. Blongkeng	35	46
Type-II	K. Woro	257	343
	K. Gendol	52	69
Type-III	K. Boyong	93	123
	K. Kuning	36	48
	K. Pabelan	13	18

Table 21 Annual Construction Costs of four Altanative Plans

(unit: million Rp)

Altanative \ Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Altanative - 1	Sabo Facilities	4,092	4,092	4,092	4,092	4,092	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
	Associated Works	339	339	339	339	339	-	-	-	-	-	-	-	-	-	-
	Total	4,431	4,431	4,431	4,431	4,431	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
Altanative - 2	Sabo Facilities	4,092	4,092	4,092	4,092	4,092	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892	1,892
Altanative - 3	Sabo Facilites	3,105	3,105	3,105	3,105	3,105	2,386	2,386	2,386	2,386	2,386	2,386	2,386	2,386	2,386	2,386
	Associated Works	163	163	163	163	163	88	88	88	88	88	88	88	88	88	88
	Total	3,268	3,268	3,268	3,268	3,268	2,474	2,474	2,474	2,474	2,474	2,474	2,474	2,474	2,474	2,474
Altanative - 4	Sabo Facilities	3,105	3,105	3,105	3,105	3,105	2,386	2,386	2,386	2,386	2,386	2,386	2,386	2,386	2,386	2,386

Table 22 Expected Growth in Farm Incomes in the Hazard Area Without and With Project

Unit: 0.1 ton or 1 quintal

	Without Project	With Project			
		Alter-native-1	Alter-native-2	Alter-native-3	Alter-native-4
0	44,853	44,853	44,853	44,853	44,853
5	35,396	54,354	45,970	50,318	45,665
10	30,573	70,323	49,363	60,526	48,502
15	25,749	72,946	51,986	68,879	50,717
20	20,927	74,783	53,823	74,783	53,823

Unit: 0.1 ton or 1 quintal

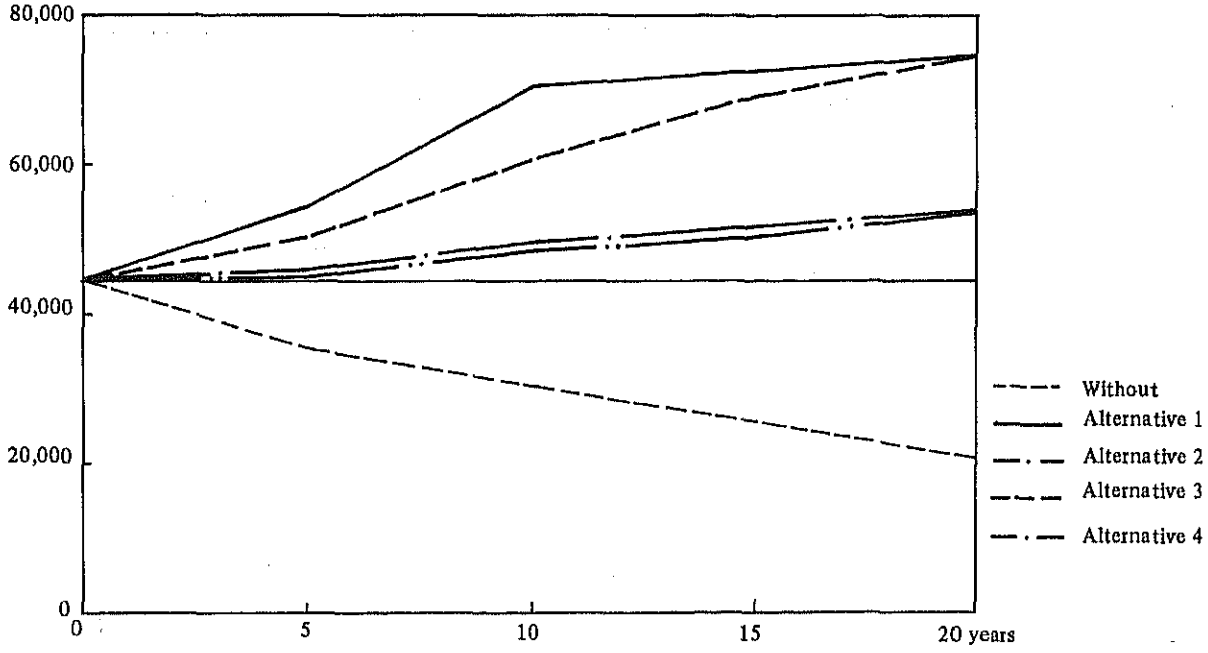


Table 23 Expected Increase of Employment Opportunities with Sabo Works and Associated Works

(1) Construction

Unit: man-year

Year	Alter-native-1	Alter-native-2	Alter-native-3	Alter-native-4
1 ~ 5	88,620	81,840	65,360	62,100
6 ~ 10	37,840	37,840	49,470	47,710
11 ~ 15	37,840	37,840	49,470	47,710
1 ~ 15	164,300	157,520	164,300	157,520
Average	10,953	10,501	10,953	10,501

(2) Maintenance

unit: man-year

Year	Alternative-1 and -3	Alternative-2 and -4
16 ~ 50	1,640	1,575

Table 24 Expected Increase of Employment Opportunities in Agriculture

1) Expected Decrease in Paddy field Hazarded by Lahar

(unit: person)

Type-I	Type-II	Type-III	Total
231	65	23	319

2) Expected Increase in Paddy Field Improved by Associated Works

(Unit: person)

By Improvement of Irrigation System	By Improving Dry Field to Paddy Field	Total
4,800	1,520	6,320

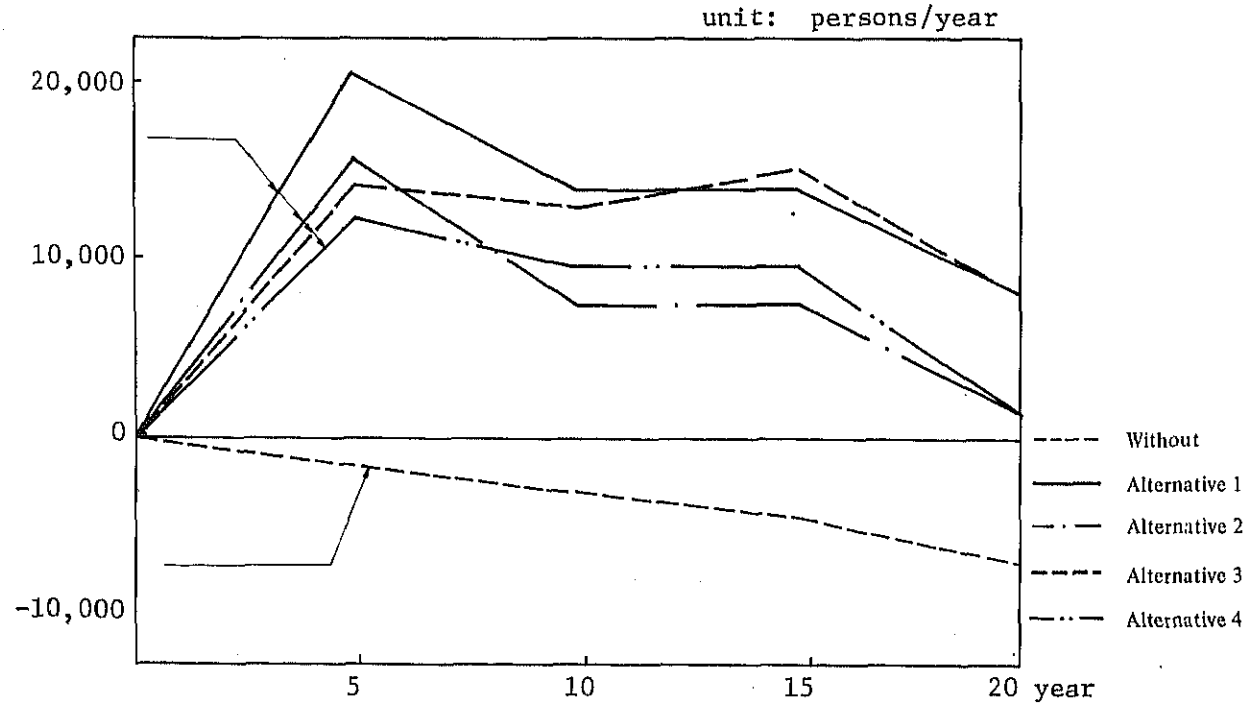


Fig. 30 Expected Increase in Personal Income

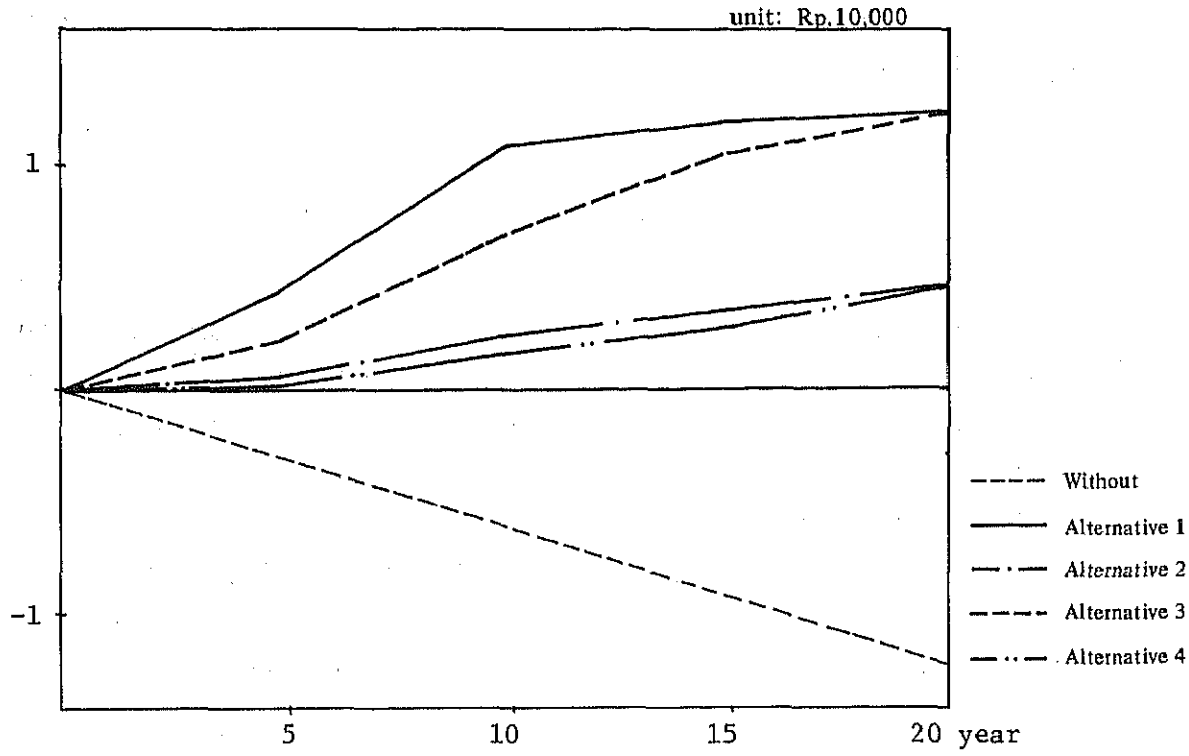


Table 25 Procurement of Funds

(Unit: Rp. 1,000,000)

Item \ Year	1981	1982	1983	1984	1985
Alternative-1	5,361	5,897	6,486	7,135	7,848
Alternative-2	4,951	5,446	5,991	6,590	7,249
Alternative-3	3,954	4,350	4,785	5,263	5,789
Alternative-4	3,757	4,133	4,546	5,001	5,501

(Note:) Expected rate of inflation is assumed to be 10% yearly.

Table 26 Yearly Budget of Merapi Project Office

Year	Construction		Operation/ Maintenance		Total (Rp)	%
	Cost (Rp)1/	%	Cost (Rp)	%		
1969-'70	(98,000,000) 134,900,999	58.4	96,100,000	41.6	231,000,000	100
'70-'71	131,773,000	73.2	48,227,000	26.8	180,000,000	100
'71-'72	110,550,000	71.3	44,450,000	28.7	155,000,000	100
'72-'73	122,800,000	79.2	32,200,000	20.3	155,000,000	100
'73-'74	129,100,000	83.3	25,900,000	16.7	155,000,000	100
'74-'75	224,600,000	86.4	35,400,000	13.6	260,000,000	100
'75-'76	325,500,000	87.8	45,300,000	12.2	370,800,000	100
'76-'77	290,400,000	78.8	78,200,000	21.2	368,600,000	100
'77-'78	234,500,000	79.1	88,500,000	20.9	423,000,000	100
'78-'79	528,000,000	88.0	72,000,000	12.0	600,000,000	100
Total	2,332,123,000 (80.5%)		566,277,000 (19.5%)		2,898,400,000 (100%)	

Note: 1/ An Amount for Pre-Project expenses was added in brackets in the First Year; however precentages were calculated without it.

Table 27 Present Value of Project Investment

(Unit: Rp. 100,000)

	Alter-native-1	Alter-native-2	Alter-native-3	Alter-native-4
8%	30,759	29,066	27,610	26,394
10%	28,447	26,823	25,095	23,979

CHAPTER 8

PROJECT EVALUATION

CHAPTER 8 PROJECT EVALUATION

Table 28 integrates the results of the economic, social, and financial assessments in score card form. As can be seen, Alternative-1 ranks best in every respect except the fiscal burden, with respect to which it ranks last.

The project was evaluated in terms of internal rate of return (IRR) calculated on the basis of the following direct effects expected from the planned sabo facilities and the associated irrigation canal-1 works, excluding those effects from K. Progo and K. Opak and Mataram Canal;

(1) Sediment damage reduction effects by way of sabo facilities,

(2) Effects from stabilization of the rivers and agricultural in the area, and

(3) Development effects resulting from the multi-purpose use of sabo facilities; use of the associated irrigation canal-1 facilities.

Four alternative implementation proposals were considered in determining the effects for the project. The results of the comparison are shown in Table 28 and indicate that alternative-1 would bring the greatest amount of benefits to the project area in terms of economic and social effects.

In addition to direct economic benefit, the project implementation can be expected to contribute greatly to the balanced development of the area through such social effects as protection of life and property, increase of development potential through enhancement of safety and quantifiable benefits such as the following;

(1) An increase in rive production in the foothills of G. Merapi by 9 ∿ 21%,

(2) A creation of employment opportunities on sabo construction works and agricultural stability and development for 10,500 ∿ 11,000 persons/year

(3) An increase in the income level in the sabo-protected area to Rp. 12,550/person/year

In summary the project is highly recommendable not only to solve regional problems, but to establish a firm foundation for regional frowth and achievement of regional development targets.

Table 28 Summary of Socio-economic Analysis

Item	Alter-native-1	Alter-native-2	Alter-nati:e-3	Alter-native-4
1. Economic Evaluation (IRR)	1 (11.4%)	3 (7.7%)	2 (10.6%)	4 (7.3%)
2. Social Evaluation				
Protected and Stabilized Area in 5 years	1 (5875.9)	1 (5875.9)	3 (4609.2)	3 (4609.2)
Increase in Paddy Production in 15 years (Unit: ton)	1 (72,946)	3 (51,986)	2 (68,879)	4 (50,717)
Increase in Employment Opportunity (Unit: person)	1 (14,001)	4 (7,568)	2 (12,843)	3 (9,542)
Increase in Personal Income in 10 years (Unit: Rp.)	1 (12,147)	3 (3,858)	2 (10,768)	4 (3,674)
Improvement of Social Environment and Increase of Potentiality for Regional Development	1	3	2	4
3. Present Value of Investment (Discount Rate: 10%) (Unit: million Rp.)	4 (28,447)	3 (26,823)	2 (25,095)	1 (23,979)
4. Total Project Evaluation	1	3	2	4

Legend: Rank

(Value) (Unit: Rp million unless otherwise indicated)

where 1 = Highest
4 = Lowest

Note: 1. IRR: Internal Rate of Return

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

9.1 General

The present study has led to the conclusion that this master plan is technically feasible, and will be very effective in economic and social terms as well. It is therefore recommended that this master plan be used as a basis for expeditionsly proceeding to the implementation planning, detailed design, and early implementation of the project.

9.2 Conclusions

9.2.1 Master Plan - General

The purpose of formulation of this master plan has been to raise the development potential of the area by reducing and preventing damage due to flooding and sediment discharge and increasing the safety of the area and promote the balanced development of the area by means of the associated facilities plan making multipurpose use of the sabo facilities.

The resettlement plan, afforestation plan, warning and evacuation plan, sabo facilities plan, and associated facilities plan are designed to be implemented as a comprehensive whole.

9.2.2 Land Use Improvement - Resettlement and Afforestation

Since it would be technically difficult to prevent direct damage from nuée ardente and other direct influences of volcanic eruptions, nuée ardente harzard areas (136 km^2) are to be put off-limits. This will involve relocation of 11,000 homes and resettlement of 50,400 persons for their own safety. As for the land vacated by such resettlement (6,010 ha) it is to be afforested for disaster prevention and water source preservation purposes.

9.2.3 Warning System

The warning and evacuation plan, which covers all areas other than the nuée ardente areas, calls for the establishment of a better warning and evacuation system in terms of accurately forecasting of lahar and banjir, timely issuing the communication of warnings, prompt evacuation when necessary and provision of an additional evacuation road.

9.2.4 Sabo Works

The large amounts of sediment discharged to downstream areas that give rise to considerable damage do not result directly from eruptions, but rather are for the most part produced by erosion resulting from rainfall after major eruptions. Moreover, reduction and prevention of such sedi-

ment production and discharge is technically feasible. Accordingly it has been decided to cope with disaster hazards in lahar and banjir flooding areas by means of the sabo facilities plan and a warning and evacuation system.

The sabo facilities plan is designed to reduce and prevent disaster damage in areas on the slopes of G. Merapi with a high degree of danger of lahar/banjir flooding and to stabilize the river courses of K. Progo, K. Opak, K. Dengkeng, etc. by reducing sediment discharged.

(1) The anticipated amounts of sediment discharge to be coped with are as follows: for Type-I areas, the amount that would occur with an eruption of the same scale as that of 1969, and for Type-II areas, the maximum amount that can be expected to occur from present unstable sediment deposits. As for the amounts of sediment discharged into K. Progo and the other main rivers that could be expected to occur in excess of the amounts that are safe and necessary, they are to be eliminated or controlled by sabo facilities totalling 58 check dams, 79 consolidation dams, 14 sand pocket areas, 16,490 m of training levees, and other facilities in upstream area.

(2) Furthermore, in order to prevent river channel piracy and change in course of flow in Type-I areas, valley outlets are to be fixed by means of check dams and training levees.

(3) In addition, 116 km of embankments and revetment are to be constructed. Even with a reduced amount of sediment discharge, however, the river course structure at certain areas makes for such problems as excessive deposits, stoppage of river mouth, and poor drainage; the structure of intake weirs, too, causes various kinds of problems. Accordingly, low water course fixation, river mouth training levees, and other measures for structural improvement of the rivers at such points as well as improvement of intake weirs will be necessary.

9.2.5 Construction Period

The construction period for the project has been set at 15 years, taking into consideration conditions in the area covered by the plan and the nature of the works themselves, with a 5-year first stage and a 10-year second stage. In view of the urgent need to reduce and prevent present disaster hazards, the disaster prevention facilities, which constitute the core of the master plan, are to be completed for the most part within the 5-year first phase, as is the main irrigation canal-1 considering its pivotal role among the associated facilities for enhancement of the socio-economic benefits of the project.

9.2.6 Construction Cost

The estimated construction costs of the disaster prevention facilities

and the main irrigation canal-1 are Rp. 41,851,000,000 and the annual maintenance and management costs after their completion are estimated at Rp. 419,000,000.

9.2.7 Economic Evaluation

The economic effects of the project which can be directly expected from the planned sabo facilities and the associated works, excluding those effects from K. Progo, K. Opak and Mataram canal, include the following:

1) Damage reduction effects by way of sabo facilities

2) Effects from Stabilization of the rivers and agriculture in the area, and

3) Development effects resulting from the multi-purpose use of sabo facilities; i.e., use of the associated facilities.

The internal rate of return (IRR) has been calculated on four alternative combinations of sabo facilties and associated works. The damage reduction and stability effect and the developmental effect are shown below.

Internal Rates of Return on Construction Alternatives

Alternative No.	Damage Reduction/ Stability Effect with Sabo Facilities	Total (sabo facilities with associated works)
1	7.7	11.4
2	7.7	7.7
3	7.3	10.6
4	7.3	7.3

The internal rate of return for the project has been taken as 11.4% on the basis of alternative-1 (construction of all main facilities and the total main irrigation canal-1) being the most beneficial.

9.2.8 Socio-Economic Effects

This project has a very high feasibility in that besides its direct economic benefits, it can be expected to contribute greatly to the balanced development of the area through such social effects as protection of life and property, increase of development potential through enhancement of safety, increase of flood production, creation of more employment opportunities, narrowing of the regional income gap, improvement of social infrastructure and living standards, and mitigation of population pressure by resettlement.

The quantifiable effects are:

1) An increase in rice production in the foothills of G. Merapi (an increase by 9 - 21%);

2) A creation of employment opportunities on sabo construction works and agricultural stability and development (10,500 - 11,000 persons/year);

3) An increase in the income level in the sabo-protected area to Rp. 12,550/person/year; and

4) A decline of the population growth rate by 0.26% as a result of removal of houses in the danger area.

In addition to these, there are a number of other socio-economic elements will benefit the region: improvement of the standard of living as a by-product of the road construction, electrification from installation of micro-hydraulic generators, supply of water for daily domestic use diversification of agriculture through introduction of improved technology, and introduction of domestic industry.

9.3 Recommendations

9.3.1 High Priority for Implementation

Considering the socio-economic benefits that will accure to the area through implementation of this project, it is strongly recommended that the project be implemented at the earliest date on the basis of the implementation planning in the present master plan. In view of the diversity of the projects to be implemented over a long period, if should be implemented in a well-planned fashion, taking into full account the inter-relationships between its parts.

9.3.2 Organization for Project Execution

It is recommended that the project-executing organization be the Directorate General of Water Resources Development of Ministry of Public Works and that the project office site be at the G. Merapi Project Office, with technical experts in various fields strengthened gradually as the project implementation proceeds.

9.3.3 Establishment of a Sabo Technical Center

The master plan covers many technical fields. In order to produce satisfactory effects, it is necessary to establish a well-organized Technical Center which is engaged in technical guidance in regard to sabo planning, design for sabo facilities and construction supervision as well as able to train of engineers and technicians through the execution of the master plan and through practical training.

For this purpose, it is advisable a Technical Center, tentatively called the "Sabo Technical Center" (hereinafter called "the Center") be established.

The function of the Center will be as follows:

1) To give technical support and guidance for the implementation of G. Merapi master plan

2) To conduct development and study concerning technology for conservation and development of the volcano area

3) To provide training to engineers and technicians.

In the light of implementation of the master plan it is recommended that the Center be established at as early a date as possible in order to start the process of technical transfer through the execution of master plan and through practical training.

The technical foundation should be established in cooperation with and guidance from experts. The Center will have the role in future to give technical guidance concerning the conservation and development of volcanic areas throughout Indonesia. The period for such cooperation and guidance by experts will be necessary for at least five years.

9.3.4 Construction

1) Intensive Investment in the First Stage

Because of the frequent occurrence of lahar, the great volume of sediment discharge, and the considerable amount of river course fluctuation that take place in the area as a result of eruptions, the disaster prevention facilities should be built in the first phase on the basis of thorough preparation with respect to procurement of funds and construction arrangements. Early provision of all of the necessary facilities in the case of rivers with frequent occurrence of lahar and considerable riverbed fluctuation and sediment discharge will made them all more effective and prevent back-sliding. Consequently, there will be a need for multiplying the current budget of the Merapi Project by at least three times to cater for the initial years of master plan implementation.

2) Choice of Construction Method and Administration for Maintenance

The riverbed variation is so large that the implementation of the project will require constant observation of the varying situation to determine the optimum method of construction and administration for maintenance of facilities after construction.

3) Order of Construction

The project is to be implemented in two stages, with provision of urgent facilities, facilities of basic importance in dealing with sediment discharge, and facilities important in connection with the associated facilities in the first stage and the rest in the second stage. It is suggested that the order of construction should be as follows:

Category	Priority	Item	
Sabo Works	1	- Valley mouth fixation works for fixation of flow courses	
	2	- River course improvement facilities at places of urgency and importance	
	3	- Check dams (in the direction from downstream to upstream)	
	4	- Consolidation dams	
	5	- Embankments and revetments	
Location	1	K. Krasak	Type-I
	2	K. Putih	
	3	K. Batang	
	4	K. Blongkeng	
	5	K. Pabelan	Type-III
	6	K. Gendol	Type-II
	7	K. Woro	
	8	K. Boyong	
	9	K. Kuning	

Although the planned sabo facilities within 10 km from the summit have adverse effects on nuée ardente flow in terms of Indonesian guidelines, all of the facilities are quite fundamental for reduction of sediment production and for control of volcanic debris. Therefore the implementation of these facilities should be investigated in more detail in the subsequent project stage.

It is suggested that the asociated facilities be constructed in parallel with sabo facilities since the associated facility plans depend on the sabo facility plan: the construction work for the intakes and siphons and bridges for crossing the main tributaries will be carried out at the same time as that of the sabo facilities themselves, but the construction work for the main irrigation canal and some other associated facilities will take place later. This is because it is better for such facilities to be provided after area stability has been enhanced by the sabo facilities.

Before the implementation of associated works, a more detailed feasibility study for the planned irrigation canal and other associated facilities should be carried out. In addition, the new development of ground water and the application of new types of agricultural methods in the foothill zone should be investigated in the subsequent project stage.

4) Construction Methods, Construction Materials and Labor

For considerations of economy and employment opportunities, maximum use should be made of locally available materials such as rocks, bamboo, and wood and of construction methods that are

labor-intensive. Moreover, structure and construction methods should be flexible in view of such circumstances as riverbed fluctuation. In addition, every effort should be made to use trees and ground covering for protection against erosion wherever possible. As for the kinds of construction machinery, use should be made of hand winches and other machinery to improve the efficiency of labor, vibrators and other machinery for improvement of quality, and some heavy machinery such as that needed for urgent or emergency excavation.

9.3.5 Hydrological Observation and River Flow Measurement

In order to collect rainfall data, new additional observation stations (equipped with a telemeric system) are proposed to be established in the Lahar occurrence area at an elevation of more than 1,500 m.

As to the water level and runoff of the river, it is suggested that the existing measuring equipment should be improved and new ones should be installed (along K. Pabelan) to make observation possible throughout the year for analysis of the river's discharge capacity and available amount for irrigation and other usages.

1) Observation of Sediment Discharge

Besides continuing observation of suspended load and bedload, sediment is to be measured in terms of the sediment storage of new check dams and other facilities. Furthermore, it will be necessary to measure the particle size of sediment load at times of major flood waters.

2) Observation of Riverbed Variation

In the rivers where there is a pronounced change of riverbed, a regular observation and survey will have to be conducted:

River	Observation
K. Krasak	Once a year
K. Putih	Once every two years
K. Woro and K. Gendor	Once every three years

3) Monitoring of Lahar

Observation of the conditions of occurrence and the characteristics of lahar will be necessary for the purpose of formulating criteria for the warning and evacuation system.

9.3.6 Preparation of Topographical Maps

It is recommended that topographical maps (10 a scale of 1/3000 - 1/5000) for the foot of G. Merapi should be prepared for implementation of the project.

APPENDIX

APPENDIX A

PARTICIPATING PERSONAL

1. Japanese Government Supervisory Committee

1.	Chairman	Prof. Dr. Aritsune TAKEI	Kyoto University
2.	Disaster Prevention Sabo Works Plan	Ushio DAIKUBARA	Director of Sabo Division, Sabo Department
3.	"	Takayuki KOYABU	"
4.	"	Tadahiro MATSUSHITA	Sub Director of Sabo Division
5.	Volcanic Debris	Dr. Masayoshi MATSUBAYASHI	Director of The Japan Sabo Association
6.	Geology	Masasuke WATARI	Public Works Research Institute
7.	Socio-economic and Disaster Analysis	Koichi HIRAO	Director of Water Resources Development Public Corporation
8.	Hydrology and River Engineering	Fujio CHIKAMORI	Director of Slope Protection Division, Sabo Department
9.	Land Condition	Keiji NISHIMURA	Director of Geographic Department

2. Indonesian Government Steering Committee

1.	Management	Ir. Sarbini Ronodibroto	Directorate of Rivers
2.	Regional Planning	Ir. K.P.H. Probokusumo	BAPPEDA D.I.Y.
3.	"	Ir. A. Kristanto	BAPPEDA Central Java
4.	Socio-economic Survey	Dr. Sulistyo MBA	Gaja Mada University
5.	Rural Sociology	Prof. Dr. Sartono Kartodirdjo	Gaja Mada University
6.	Volcanology	I. Suryo	Dit. Geologi Bandung
7.	Sabo Engineering	Ir. Dyoko Legowo	Directorate of Rivers

3. Study Team

		1977/1978	1978/1979	1979/1980
Team Leader	Isao TANI	+	+	
	Hiroshi SUZUKI			+
General Planning for Disaster Prevention Planning	*Hiroshi SUZUKI	+	+	+
Disaster Prevention Planning	Hajime TANAKA		+	+
Sabo Facilities Planning	Shohei TSUCHIYA	+	+	
	Nobuo ASAKAWA			+
	Okichika KUROKAWA		+	+
River Engineering	Kazumi NOBE	+	+	
Hydraulics and Hydrology	Masahiro ASADA	+		
	Yoshiharu MATSUMOTO		+	
Geomorphology	Yuichi MARUYAMA	+	+	
	Kazuo IKEDA	+		
	Masahiro HIGURASHI		+	
Geology and Lahar Deposit Analysis	Masaichi NAKAYAMA	+	+	
	Akito NAKASUJI	+	+	
Ground Survey	Takashi WATANABE	+		
Aerial Survey	Tohru WATANABE	+	+	
Damage	*Hajime TANAKA	+		
Agro-economy	Prof. Dr. Kazuo MUTO		+	
	Kenji ISHIMITSU		+	
Socio-economy	Kazuhiko DENDA		+	+
	Yoshitake KOMURO		+	+
Associated Works	Takashi FUJITA			+

4. Indonesian Counterparts

	1977/1978	1978/1979	1979/1980
Team Leader	Ir. Bambang	Ir. Bambang	Ir. Darmadi
General Planning and Disaster Prevention Planning	Wardhono Sucilo	Ir. Agus Sumaryono Wardhono Mujoko	Wardhono Subarkah Sumitro BRE Drs. Sutikno Mujoko Suwartoyo
Sabo Facilities Planning	Adaningkung	Adaningkung Subarkah Yaskur	Adaningkung *Wardhono Ngroho Hariyanto Suparman Mukhman Jaad Sidig
River Engineering	Sumitro BRE Diro Supangkat	Sumitro BRE Diro Supangkat Sucilo Djarot Suharyadi	-
Hydraulics and Hydrology	Jarot Suharyadi Wartoyo	*Djarot Suharyadi Drs. Sutikno	
Geomorphology	*Wardhono Haryanto Nugroho	*Wardhono Haryant Nugroho	-
Geology and Lahar Deposit Analysis	Ir. Sumartono Agus Sumaryono	Ir. Sumartono Suwartoyo BE Jimmy Sinaga	-
Ground Survey	*Wardhono Jimmy Sinaga	-	-
Damage	Mujoko Agus Sumaryono Bambang Sumitro	-	-
Socio-economy	-	Djatiyo Djatmiko BSC *Ir.Agus Sumaryono Bambang Sumitro	Djatiyo Djatmiko BSC Bambang Sumitro Bambang Sutejo BA

APPENDIX B

OBJECTIVES OF NATIONAL AND REGIONAL DEVELOPMENT POLICIES

Objectives of National and Regional Development Policies

The National Five Year Development Plan and the Regional Five Year Development Plans in D.I. Yogyakarta and in Central Java Province provide the national and regional developmental objectives for evaluating G. Merapi masterplanning and for this purpose, are reviewed below.

The Third National Five Year Development Plan (REPELITA-III) was drawn up for the fiscal years 1979/80 - 1983/84 and supercedes REPELITA-I (1969/70 - 1973/74) and -II (1974/74 - 1978/79). The fundamental principles (Pancasila) of the National Development Plan and the 1945 Constitution:

- Improvement of low income groups;
- Guidance of public projects;
- Improvement of food production and supplies of other fundamental needs; and
- Planning transmigration, housing, and extention of education, health and other social welfare.

REPELITA III has the two major objectives of:

- Improving the standard of living, the intellectual development and equity of the people's welfare; and
- Establishing a strong foundation for the next development stage with an emphasis on the following three principles of development:

  1) Equity of development (and its results) to achieve social justice for all people;
  2) High economic growth; and
  3) Healthy and stable national development.

Regarding principle of 'equity of development', REPELITA-III puts particular stress on the following eight items (delapan jalur):

1) Equity-1: provision of primary needs (inter alia, food, clothing and housing);
2) Equity-2: opportunity of receiving education and medical care;
3) Equity-3: income distribution;
4) Equity-4: employment opportunity;
5) Equity-5: opportunity of enterpreneurship;
6) Equity-6: opportunity of participating in development;

7) Equity-7: development opportunity; and

8) Equity-8: opportunity of receiving social justice.

The economic growth aimed at during the period of REPELITA-III is an annual average rate of GDP of 6.5 per cent as shown in the following table.

Sector	1978/79 Share (Percent of GDP)	Average annual growth rate	1983/84 Target (Percent of GDP)
1. Agriculture	31.4%	(3.5%)	27.2%
2. Mining	17.9%	(4.0%)	15.9%
3. Manufacturing	10.2%	(11.0%)	12.6%
4. Construction	4.9%	(9.0%)	5.5%
5. Transportation and Communication	4.6%	(10.0%)	5.4%
6. Others	31.0%	(8.1%)	33.4%
G.D.P.	100.0%	(6.5%)	(100.0%)

The population growth during REPELITA-III is estimated as follows:

	1979/80 (Estimated)	1983/84 (Estimated)
Population	137,000,000	151,000,000
Birth Rate	2.3%	2.0%

It is also estimated that 68% of total population will be under the age of 30 at the end of PELITA-III. Additional manpower of 6.4 million during REPELITA-III will be absorbed by the creation of new employment opportunities under the fisical and monetary policy as well as the regional and sectoral development policy. The population density will become as follows during REPELITA-III.

	Area	Population (Million)		Population Density (Km^2)	
	(1,000 Km^2)	1978	1983	1978	1983
Java	135	87	95	644	704
Other Areas	1,892	50	56	26	30
Indonesia	2,027	137	151	68	75

The tables that follow will give an accounting of how the government plans financial and monetary policies to develop the national resources in the period of REPELITA-III.

GDP and Investment Planning

(At nominal market prices)

(Unit: Billion Ruphiah)

	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	Total in Five Years
1. GDP	23,165	26,920	30,675	34,955	39,835	45,390	–
2. Investment	4,915	6,195	7,345	8,450	9,700	11,145	42,835
a. Government Development Investment	(2,455)	(3,488)	(3,892)	(4,350)	(4,778)	(5,341)	(21,845)
b. Others	(2,460)	(2,707)	(3,453)	(4,100)	(4,922)	(5,804)	(20,986)
3. Ratio of Investment to GDP	21.2%	23.0%	23.9%	24.2%	24.4%	24.6%	–

Financial Sources of Development Investment

(At nominal market prices)

(Unit: Billion Ruphiah)

	1978/79	1979/80	1980/81	1981/82	1982/83	1983/84	Total in Five Years
I. Domestic Savings	4,085	4,911	5,764	6,641	7,657	8,886	33,859
1. Government Savings	(1,598)	(1,995)	(2,245)	2,510)	2,759)	(3,104)	(12,613)
2. Private Savings	(2,487)	(2,916)	(3,519)	(4,131)	(4,898)	(5,782)	(21,146)
II. Foreign Aid	830	1,284	1,581	1,809	2,043	2,259	8,976
III. TOTAL	4,915	6,195	7,345	8,450	9,700	11,145	42,835

Balance of Payment

(Unit: Million US Dollars)

	1979/80	1980/81	1981/82	1982/83	1983/84
A. Goods and Services					
1. Export	8,984	9,832	11,065	12,350	14,010
°Excluding Oil (f. o. b.)	(4,046)	(4,712)	(5,759)	(6,649)	(7,680)
°Oil LNG (net)	(4,938)	(5,120)	(5,306)	(5,701)	(6,330)
2. Import (c. & f.)	-8,711	-9,765	-10,990	-12,335	-13,870
3. Services (net 1)	-1,697	-1,873	-2,079	-2,292	-2,499
4. Ordinary accounts	-1,424	-1,806	-2,004	-2,277	-2,359
B. External loans	2,551	2,763	3,074	3,308	3,650
1. Program Aid	220	258	288	200	185
2. Project Aid	2,331	2,505	2,786	3,108	3,465
C. Reimbursement	-630	-724	-890	-992	-1,255
D. Private Capital (net)	-147	67	200	411	414
E. Capital Movement	-350	-300	-380	-450	-450

1) Exclusive of freight costs
2) Inclusive of export credits
3) Capital funds alone

The draft REPELITA-III relating to D.I. Yogyakarta and Central Java Province are summarized below. Those objectives which either have a clos close connection with or are directly served by the Merapi project are marked (+).

Regional Program	Merapi Project Contribution	Regional Objective
For D.I. Yogyakarta		
1) General Programs		
- Employment:	(+)	·Promotion of modern "Padat Karya" in poor area
		·Vocational training
	(+)	·Absorption by afforestation after transmigration
		·Promotion of industry sector
- Transmigration:	(+)	·Transmigration of a rather large number of families from hazard areas; G. Kidul, hilly area of K. Progo and Bantul, slope of G. Merapi
- Re-organization of regional function:		·Center of settlement, trade, industry, recreation and culture
		·Construction of loop road around Yogyakarta
- Environment and ecology:	(+)	·Critical area and densely populated area in city
		·Anti-population
2) Sectoral Programs		
- Agriculture:	(+)	·Intensification (land ownership; efficient use of irrigation system and ground water)
	(+)	·Betterment of land use and production methods
	(+)	·Development of hillside area and critical area
	(+)	·Promotion of plantation (sugar cane, clove, fruit, coconut)

Regional Program	Merapi Project Contribution	Regional Objective
- Fishery:	(+)	·Promotion of inland fishery to get addition income in rural area
- Breeding:	(+)	·Intensification and improvement of feedstuff production
		·Improvement of marketing system
	(+)	·Improvement of nutrition of the people
- Industry:		·Achievement of high growth rate
		·Improvement of investment
	(+)	·Provision of facilities and official guidance to small scale industry, home industry and handicrafts
- Electricity:		·Extension of electrification in rural area
		·Exploitation of hydro-electric power
- Tourism:	(+)	·Prambanan as National Park
		·Improvement of airport
		·Construction of new monuments
For Central Java Province		
1) General Programs		
- Lessen the pressure of population	(+)	·Implementation of resettlement program in better cooperation with other Provincial areas
		·Family planning
		·Educating the community in a systematic and continuous way
- Accelerating the development of the four developmental areas:		·Developmental center: improvement of communition infrastructure, especially the harbours of Semarang and Cilacap
		·Increase of electrical facilities to stimulate capital investment
	(+)	·Construction and improvement of road networks and bridges

Regional Program	Merapi Project Contribution	Regional Objective
- Employment:	(+)	·Creation of new field of employment
	(+)	·Absorption by development projects
		·Vocational training
		·Research on building materials which is directed towards the development of building material and construction industry
		·Improvement in "Kampangs"
2) Sectoral Programs		
- Agriculture:	(+)	·Diversification of crops
	(+)	·Intensification in land use and irrigation
		·Improvement of the systems of production and facility distribution as well as marketing organization
		·Establishment of a policy of price standardization
	(+)	·Construction, rehabilitation and maintenance of irrigation system
		·Promotion of plantation by supplying intensified guidance and investment credit with soft terms
- Cattle breeding:	(+)	·Increase of cattle population and production by means of "Panca Usaha Ternak"
		·Provision of soft-term credit and improvement of marketing system
	(+)	·Improvement of nutrition of the people
- Fishery:	(+)	·Intensified educational activities, guidance and regional researches
		·Improvement of fishing techniques, facilities and marketing system
		·Provision of soft-term credit

Regional Program	Merapi Project Contribution	Regional Objective
- Forestry:	(+)	·Rehabilitation and reforestation in line with appropriate land use
		·Improvement of the function of teak forestry business
- Industry:	(+)	·Development of industries which process agricultural forestry, cattle and fishery products and basic mining materials
		·Development of consumer goods production industries
	(+)	·Development of handicraft industries
		·Improvement of physical facilities to develop industry
- Transportation & Telecommunication:		·Improvement of maintenance, guidance, control and coordination of railway and highway transport
		·Improvement of harbor facilities
		·Improvement of ground facilities for air transport
- Electricity:		·Construction of electric power station using various kinds of energy and transmission and distribution networks
	(+)	·Extension of rural electricity with micro-hydro and diesel-powered plant
- Tourism:		·Improvement in the management and development of tourism attractions

APPENDIX C

CASH FLOW

(1) Alternative-1

Year	Cost	Farm-land	Yard	House	Road	Production increase by stabili-zation	Production increase by im-provement	Production increase from new Paddy field
0	4,431							
1	4,431	90	14	228	440			
2	4,431	177	28	228	440			
3	4,431	264	42	228	440	55	250	65
4	4,431	351	56	228	440	109	500	130
5	1,909	438	70	228	440	176	750	195
6	1,909	525	84	228	440	243	1,000	260
7	1,909	612	98	228	440	310	1,248	327
8	1,909	699	112	228	440	366	1,248	327
9	1,909	786	126	228	440	446	1,248	327
10	1,909	873	140	228	440	504	1,248	327
11	1,909	960	154	228	440	560	1,248	327
12	1,909	1,047	168	228	440	618	1,248	327
13	1,909	1,134	182	228	440	674	1,248	327
14	1,909	1,221	196	228	440	733	1,248	327
15	411	1,308	210	228	440	790	1,248	327
16	411	1,395	224	228	440	849	1,248	327
17	411	1,482	238	228	440	903	1,248	327
18	411	1,569	252	228	440	918	1,248	327
19	411	1,656	266	228	440	935	1,248	327
20	411	1,743	280	228	440	935	1,248	327
21	411	1,830	294	228	440	935	1,248	327
22	411	1,917	308	228	440	935	1,248	327
23	411	2,004	322	228	440	935	1,248	327
24	411	2,091	336	228	440	935	1,248	327
25	411	2,178	350	228	440	935	1,248	327
26	411	2,214	352	60	71	935	1,248	327
27	411	2,250	354	60	71	935	1,248	327
28	411	2,286	356	60	71	935	1,248	327
29	411	2,322	358	60	71	935	1,248	327
30	411	2,358	360	60	71	935	1,248	327
31	411	2,394	362	60	71	935	1,248	327
32	411	2,430	364	60	71	935	1,248	327
33	411	2,466	366	60	71	935	1,248	327
34	411	2,502	368	60	71	935	1,248	327
35	411	2,538	370	60	71	935	1,248	327
36	411	2,574	372	60	71	935	1,248	327
37	411	2,610	374	60	71	935	1,248	327
38	411	2,646	376	60	71	935	1,248	327
39	411	2,682	378	60	71	935	1,248	327
40	411	2,718	380	60	71	935	1,248	327
41	411	2,754	382	60	71	935	1,248	327
42	411	2,790	384	60	71	935	1,248	327
43	411	2,826	386	60	71	935	1,248	327
44	411	2,862	388	60	71	935	1,248	327
45	411	2,898	390	60	71	935	1,248	327
46	411	2,934	392	60	71	935	1,248	327
47	411	2,970	394	60	71	935	1,247	327
48	411	3,006	396	60	71	935	1,248	327
49	411	3,042	398	60	71	935	1,248	327

(2) Alternative-2

Year	Cost	Farm-land	Yard	House	Road	Production increase by stabili-zation	Production increase by im-provement	Production increase from new Paddy field
0	4,092							
1	4,092	90	14	228	440			
2	4,092	177	28	228	440			
3	4,092	264	42	228	440	55		
4	4,092	351	56	228	440	109		
5	1,892	438	70	228	440	176		
6	1,892	525	84	228	440	243		
7	1,892	612	98	228	440	310		
8	1,892	699	112	228	440	366		
9	1,892	786	126	228	440	446		
10	1,892	873	140	228	440	504		
11	1,892	960	154	228	440	560		
12	1,892	1,047	168	228	440	618		
13	1,892	1,134	182	228	440	674		
14	1,892	1,221	196	228	440	733		
15	394	1,308	210	228	440	790		
16	394	1,395	224	228	440	849		
17	394	1,482	238	228	440	903		
18	394	1,569	252	228	440	918		
19	394	1,656	266	228	440	935		
20	394	1,743	280	228	440	935		
21	394	1,830	294	228	440	935		
22	394	1,917	308	228	440	935		
23	394	2,004	322	228	440	935		
24	394	2,091	336	228	440	935		
25	394	2,178	350	228	440	935		
26	394	2,214	352	60	71	935		
27	394	2,250	354	60	71	935		
28	394	2,286	356	60	71	935		
29	394	2,322	358	60	71	935		
30	394	2,358	360	60	71	935		
31	394	2,394	362	60	71	935		
32	394	2,430	364	60	71	935		
33	394	2,466	366	60	71	935		
34	394	2,502	368	60	71	935		
35	394	2,538	370	60	71	935		
36	394	2,574	372	60	71	935		
37	394	2,610	374	60	71	935		
38	394	2,646	376	60	71	935		
39	394	2,682	378	60	71	935		
40	394	2,718	380	60	71	935		
41	394	2,754	382	60	71	935		
42	394	2,790	384	60	71	935		
43	394	2,826	386	60	71	935		
44	394	2,862	388	60	71	935		
45	394	2,898	390	60	71	935		
46	394	2,934	392	60	71	935		
47	394	2,970	394	60	71	935		
48	394	3,006	396	60	71	935		
49	394	3,042	398	60	71	935		

(3) Altanative-3

Year	Cost	Farm-land	Yard	House	Road	Production increase by stabili-zation	Production increase by im-provement	Production increase from new Paddy field
0	3,268							
1	3,268	52	12	170	372			
2	3,268	104	24	170	372			
3	3,268	156	36	170	372	37	138	22
4	3,268	208	48	170	372	75	276	44
5	2,474	260	60	170	372	119	414	66
6	2,474	350	74	234	440	165	552	88
7	2,474	437	88	234	440	211	692	110
8	2,474	524	102	234	440	270	748	132
9	2,474	611	116	234	440	354	804	154
10	2,474	698	130	234	440	423	860	176
11	2,474	785	144	234	440	491	916	198
12	2,474	872	158	234	440	560	972	220
13	2,474	959	172	234	440	628	1,028	242
14	2,474	1,046	186	234	440	698	1,084	264
15	411	1,133	200	234	440	765	1,140	286
16	411	1,220	214	234	440	835	1,196	308
17	411	1,307	228	234	440	903	1,248	327
18	411	1,394	242	234	440	920	1,248	327
19	411	1,481	256	234	440	934	1,248	327
20	411	1,568	270	234	440	934	1,248	327
21	411	1,655	284	234	440	934	1,248	327
22	411	1,742	298	234	440	934	1,248	327
23	411	1,829	312	234	440	934	1,248	327
24	411	1,916	326	234	440	934	1,248	327
25	411	2,003	340	234	440	934	1,248	327
26	411	2,039	342	66	71	934	1,248	327
27	411	2,075	344	66	71	934	1,248	327
28	411	2,111	346	66	71	934	1,248	327
29	411	2,147	348	66	71	934	1,248	327
30	411	2,183	350	66	71	934	1,248	327
31	411	2,219	352	66	71	934	1,248	327
32	411	2,255	354	66	71	934	1,248	327
33	411	2,291	356	66	71	934	1,248	327
34	411	2,327	358	66	71	934	1,248	327
35	411	2,363	360	66	71	934	1,248	327
36	411	2,399	362	66	71	934	1,248	327
37	411	2,435	364	66	71	934	1,248	327
38	411	2,471	366	66	71	934	1,248	327
39	411	2,507	368	66	71	934	1,248	327
40	411	2,543	370	66	71	934	1,248	327
41	411	2,579	372	66	71	934	1,248	327
42	411	2,615	374	66	71	934	1,248	327
43	411	2,651	376	66	71	934	1,248	327
44	411	2,687	378	66	71	934	1,248	327
45	411	2,723	380	66	71	934	1,248	327
46	411	2,759	382	66	71	934	1,248	327
47	411	2,795	384	66	71	934	1,248	327
48	411	2,831	386	66	71	934	1,248	327
49	411	2,867	388	66	71	934	1,248	327

(4) Alternative-4

Year	Cost	Farm-land	Yard	House	Road	Production increase by stabili-zation	Production increase by im-provement	Production increase from new Paddy field
0	3,105							
1	3,105	52	12	170	372			
2	3,105	104	24	170	372			
3	3,105	156	36	170	372	37		
4	3,105	208	48	170	372	75		
5	2,386	260	60	170	372	119		
6	2,386	350	74	234	440	165		
7	2,386	437	88	234	440	211		
8	2,386	524	102	234	440	270		
9	2,386	611	116	234	440	354		
10	2,386	698	130	234	440	423		
11	2,386	785	144	234	440	491		
12	2,386	872	158	234	440	560		
13	2,386	959	172	234	440	628		
14	2,386	1,046	186	234	440	698		
15	394	1,133	200	234	440	765		
16	394	1,220	214	234	440	835		
17	394	1,307	228	234	440	903		
18	394	1,394	242	234	440	920		
19	394	1,481	256	234	440	934		
20	394	1,568	270	234	440	934		
21	394	1,655	284	234	440	934		
22	394	1,742	298	234	440	934		
23	394	1,829	312	234	440	934		
24	394	1,916	326	234	440	934		
25	394	2,003	340	234	440	934		
26	394	2,039	342	666	71	934		
27	394	2,075	344	66	71	934		
28	394	2,111	346	66	71	934		
29	394	2,147	348	66	71	934		
30	394	2,183	350	66	71	934		
31	394	2,219	352	66	71	934		
32	394	2,255	354	66	71	934		
33	394	2,291	356	66	71	934		
34	394	2,327	358	66	71	934		
35	394	2,363	360	66	71	934		
36	394	2,399	362	66	71	934		
37	394	2,435	364	66	71	934		
38	394	2,471	366	66	71	934		
39	394	2,507	368	66	71	934		
40	394	2,543	370	66	71	934		
41	394	2,579	372	66	71	934		
42	394	2,615	374	66	71	934		
43	394	2,651	376	66	71	934		
44	394	2,687	378	66	71	934		
45	394	2,723	380	66	71	934		
46	394	2,759	382	66	71	934		
47	394	2,795	384	66	71	934		
48	394	2,831	386	66	71	934		
49	394	2,867	388	66	71	934		

APPENDIX D

STUDY OUTPUTS AND JOINT MEETINGS

1. Output of the Study

In keeping with the progress made in the study, the following reports have been submitted to the Government of Indonesia.

(1) Progress Report March '78

Preliminary results of initial survey from July '77 to February '78.

(2) Progress Report Sept. '78

Outline of activies and preliminary field analysis of the main survey June - Sept. '78.

(3) Progress Report March '79

In-depth analysis and summary of two years of study including presentation of a preliminary Disaster Prevention Plan.

(4) Progress Report July '79

Outline of activities and additional field analysis of the main survey June - July '79.

(5) Draft Final Report Dec. '79

In-depth analysis, summary at three years of study and presentation of the draft final of the Master Plan.

(6) Final Report March '80

Master Plan and Appendies.

2. Joint Meetings

During the course of the studies and in keeping with the project progress, six joint meetings were held between the Indonesian Steering Committee, the Japanese Supervisory Committee and the Study Team as follows:

1st Meeting	Feb. 1978
2nd Meeting	June, 1978
3rd Meeting	Sept. 1978
4th Meeting	March, 1979
5th Meeting	June, 1979
6th Meeting	Feb. 1980