PLAN OF OPERATION OF THE MASTER PLAN STUDY FOR LAND EROSION AND VOLCANIC DEBRIS CONTROL IN THE AREA OF MT. MERAPI IN THE REPUBLIC OF INDONESIA

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Japan International Cooperation Agency

CONTENTS

1. GENERAL DESCRIPTION

The Directorate General of Water Resources Development of the Ministry of Public Works and Electric Power, operating through the Directorate of Rivers, had been undertaking preventive measures for immunient danger and disaster caused by land erosion and volcanic activities in whole of Indonesian islands.

In Japan, the Ministry of Construction operating through Sabo Division, has been carrying out many kind of measures against land erosion and volcanic activity from the technical and social points of view.

Java island, especially, has such similar conditions to Japan that the Government of Indonesia asked the Government of Japan to make a master plan on erosion and volcanic debris control in the area of Mt. Merapi as the model case in Indonesia.

2. PRINCIPLE OF THE STUDY

2-1 Introduction

The public works are most basic and important measures in order to develop a country, and the influence and effect of the public works have much complicated and extensive impact to the modern society.

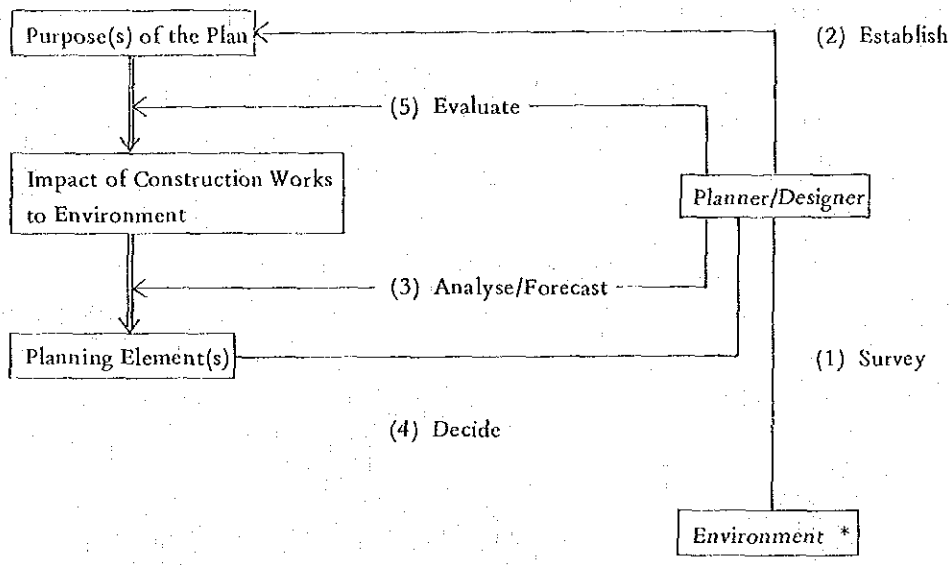
And, as the budget for public works occupy the greater part of the finances, the study and planning must be done sufficiently prior to the implementation of the public works. And also the aim of the public works must be made clear, reasonable and logical.

In addition, the public works aim at the establishment of welfare state or stabilization of the people's livelihood, therefore the study and planning based on the collection and analysis of the basic data should be done fairly and reasonably.

According to the reason mentioned above, it is quite important to establish the basic idea of data collection, analysis and planning of the master plan on the Mt. Merapi project based on the mutual consultation and cooperation.

2-2 Basic way of thinking concerning the study

Fig. 2-2-1 Framework of Planning



* Environment, herein, means all of the element or factor that influences our plan; everything natural and social

2-3 Relation between plan and environment

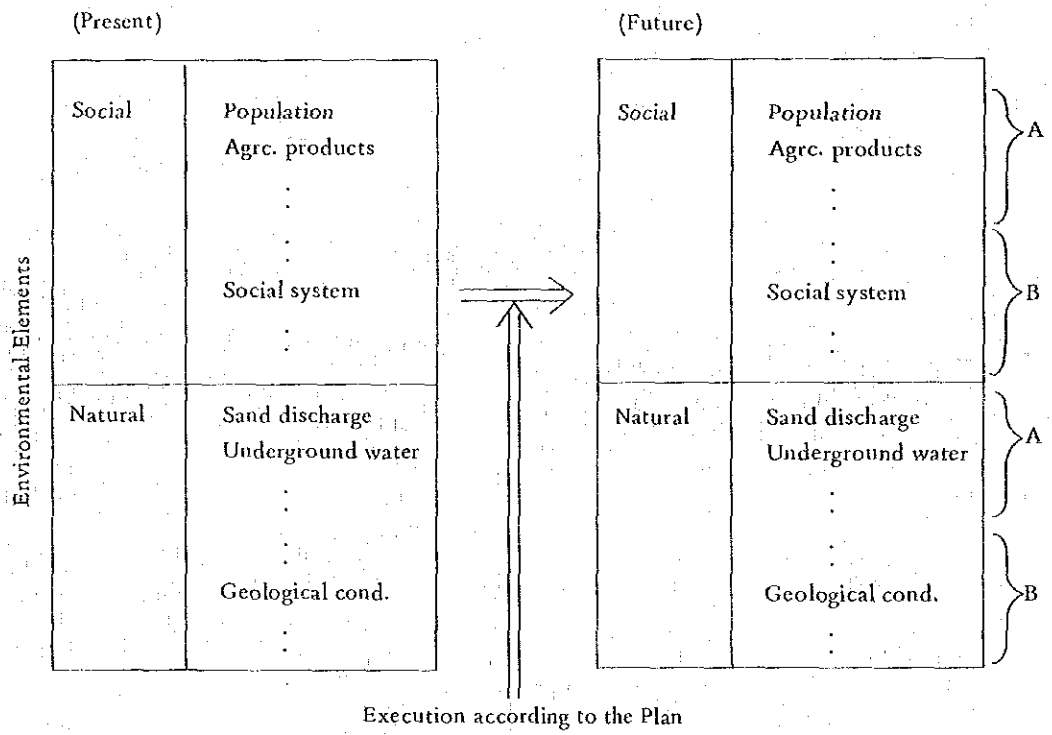
Our plan is always checked and influenced by quite many environmental elements.

We classify the environmental elements into two categories.

One of them is that we can recognize before execution of construction works.

And another one is that we can recognize or predict after execution; in the future.

Fig. 2-3-1



A: Elements which are influenced by plan

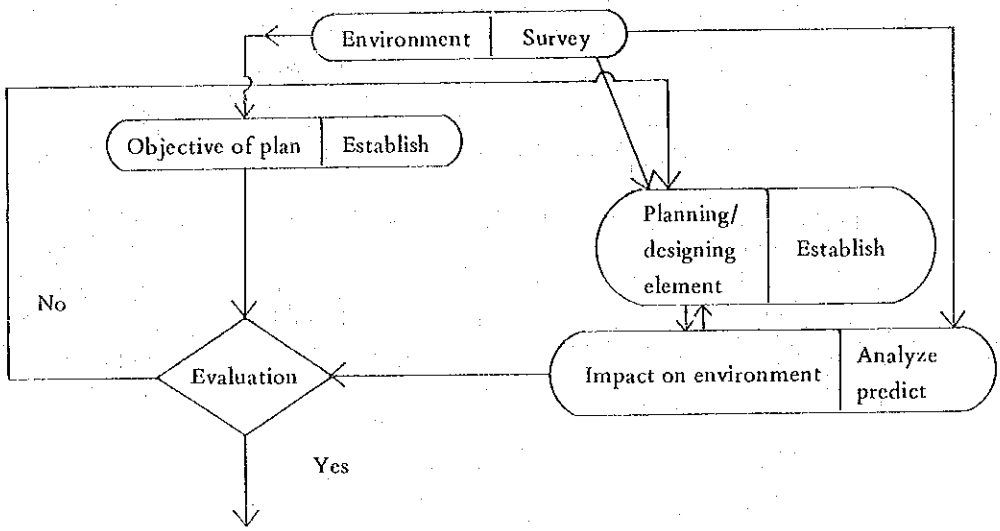
B: Elements which are not influenced by plan

As soon as / After we carried out our plan, especially construction works, some of environmental elements will change gradually or suddenly.

We recognize that these changes should be the impact on environment by our plan.

It is the objectives of the study to recognize these changes, and we call it 'study'.

2-4 Process of plan making



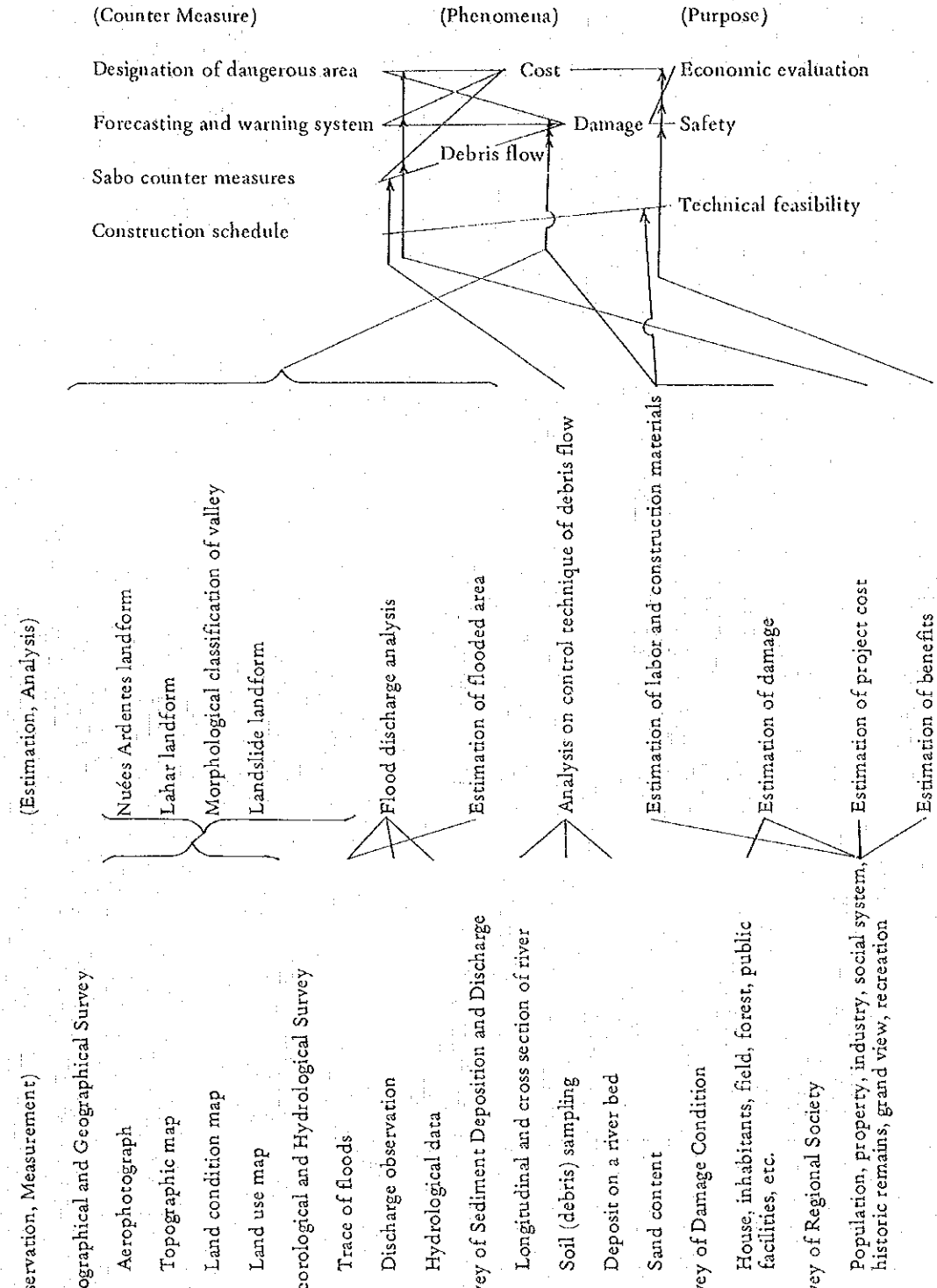
3. IMPLEMENTATION PLAN

The relations between each survey (environment survey) and analysis are explained in this chapter.

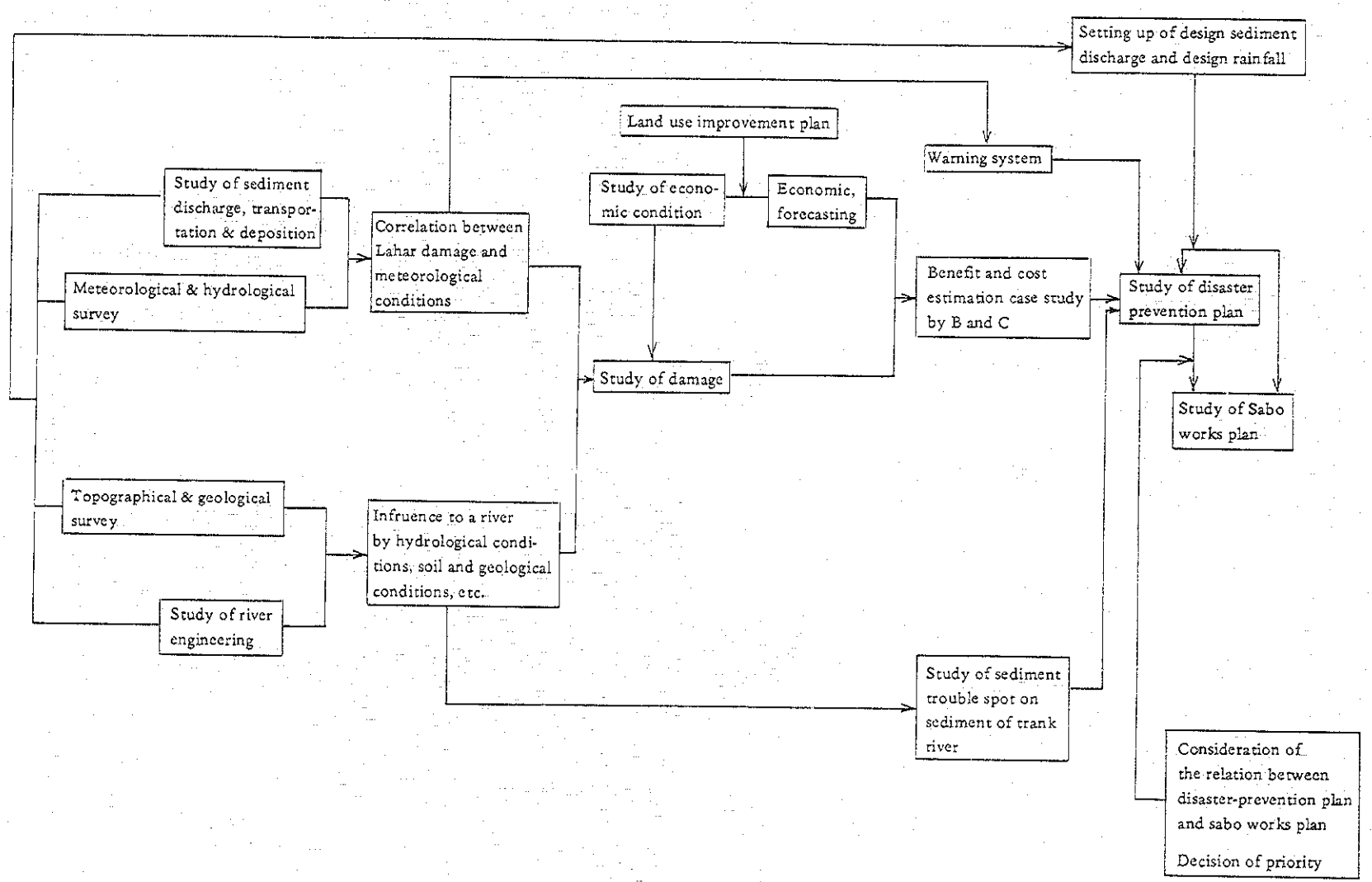
The results of each survey are combined with each other based on the principle of the study.

We can realize the importance of each study, survey from General arrangement of investigation and their flows.

3-1 General arrangement of investigations



3-2 Flow chart of the study for master plan in the Area of Mt. Merapi



3-3 Item and contents of survey and study

The activities undertaken in the survey and study are as follows:

Phase I (Survey)

(1) Topography
(2) Present land use

(Phase I is scheduled to be finished in 1976 fiscal year)

Phase II (Study)

(3) Geology
(4) Hydrology, meteorology and river engineering
(5) Sediment discharge, transportation and deposition
(6) Damage
(7) Economic condition
(8) Synthetic disaster prevention plan
(9) Sabo works plan

3-3-1 Topographical survey (1976)

i) Aerophotograph taking

Scale:	1 : 40,000
Covered area:	2,300 km^2
Scale:	1 : 10,000
Covered area:	800 km^2

ii) Topographic map

Scale:	1 : 25,000
Mapping area:	1,500 km^2

3-3-2 Survey of present land use (1976)

This will be prepared for regional planning and intake planning, etc. The scale of map is 1 : 25,000 and the covered area is 1,500 km^2 which is produced by photo-interpretation and field survey.

3-3-3 Study of geology

1. Land condition map preparation

This will be basic data for analysis of Lahar behaviour. The above mentioned map shall be produced by the discipline of geomorphology with help of geology and by means of photo-interpretation and field survey.

Land condition map will be made in applying correspondingly to Japanese standard, and additional contents will be as follows:

(1) Distribution of Nuées Ardentes landform.
(2) Distribution of Lahar landform.
(3) Morphological classification of valley.
(4) Distribution of landslide landform.

3-3-4 Study of hydrology, meteorology and river engineering

1. Hydrological and meteorological study

(1) Data collection and analysis

Meteorological and hydrological data mentioned below are able to be collected at G. Merapi project office, K. Progo project office and Indonesian meteorological agency.

1) Rainfall data and compilation at rainfall gauging stations in the area of Mt. Merapi

a) Daily, monthly and annual rainfall data are able to be collected at:

G. Merapi project office	7 points, from 1973
K. Progo project office	35 points, from 1953

Rainfall gauging station belong to the meteorological agency

b) Hourly rainfall data are able to be collected at:

G. Merapi project office	7 points
Other places (in the period of flood)	

2) Data of water level and discharge

K. Progo project office	8 points
B. Sala project office	1 point

(2) Field trace survey and information collecting survey

In this field survey, certain information about flood or inundation will be collected. In the tributaries, running water always contains much sand and stone materials at the time of a flood. The trace of the flood can be used to determine the inundation area. A great part of this survey depends on cooperation by inhabitants living along the river.

(3) Study of sand content

It needs to measure the sand content in order to investigate the transport capacity.

2. River engineering study

Study of trouble spot due to erosion and sedimentation at trank river.

3-3-5 Study of sediment discharge, transportation and deposition

Rivers will be divided into three types in this area, and study will be carried out in detail by Japanese team according to the following method in type I rivers, where, at present, the movement of Lahar flow is considered to be most active in Mt. Merapi area.

TYPE	I:	K. Krasak, K. Bebeng, K. Putih, K. Blongkeng
	II:	K. Woro, K. Gendol
	III:	Others

And survey of rivers (type II, III) is expected to be done in Indonesian side in accordance with the same method mentioned as follows:

1) Survey of longitudinal and cross section

a) Purpose of the survey

This survey aims at analyzing following items by getting the correct and precise longitudinal and cross section of each river.

(1) Presumption of boundary (condition) of origination and stop of DOSEKIRYU (Extraordinary debris flow) among Lahar flows.
(2) Estimation of amount of deposited debris in each river.
(3) Confirmation of the movement condition of deposited debris on each river at the time of a flood.
(4) Evaluation of the effectiveness of Sabo structures.
(5) Fundamental data for study of construction sites of New Sabo structures and design of these structures.

b) Specification

(1) Area of survey

In upper and middle part of each rivers concerned, survey of cross section is required, at intervals of 500 m with scale of 1/500 and also, longitudinal section (Profile) of each river connecting the deepest point of each cross section is necessary.

In lower part, survey of cross section is required at intervals of 500 m or 1,000 m. Especially, survey of cross section at intervals of 50 m and / or 100 m is necessary in the upper and lower part of Sabo structures (Check dam, Sand pocket, Consolidation dam and so on).

c) Frequency of survey

Once in a year (dry season) at the active rivers (for examples K. Krasak, K. Bebeng, K. Putih, K. Blongkeng).

2) Soil (debris) sampling by means of test pit

a) Purpose

It is necessary to make clear the thickness (depth) of deposit of Nuée Ardentes and Lahar and, especially in case of Lahar, it is possible to judge whether Lahar flow is DOSEKIRYU (Extraordinary debris flow) or not by analyzing the change of distribution of debris grain size along a tributary from upper part to middle part. And also it is possible to get unit weight and specific gravity.

b) Specification

It is necessary to dig pits in depth of 4 - 6 m in a river bed, in order to make clear the thickness (depth) of Lahar deposit, situation of deposit, distribution of grain-size, specific gravity and unit weight of materials.
This survey will be carried out at some places in necessary rivers.
It is necessary to provide excavator and operator in Indonesian side for the implementation of the study.

3) Survey of condition of debris deposit on a river bed

It is necessary to make the distribution map of debris deposit as possible as practicable in the river course from upper part to middle part where the movement of debris flow is considerably active, by observing and examining the conditions and thickness of Lahar deposit and grain size.

4) Study of cross section by means of aerophotogrametric survey

The study in the vicinity of the sources of the basin will be done in order to obtain

the basic data for the sediment discharge by means of aerophotograph reading at intervals of 500 m about 3 or 5 km length using the photographs taken in 1973 (1969) and 1976 in the overlapped area.

3-3-6 Study of damage

1) The damage in and around Mt. Merapi is to be divided into two types, namely direct damage by Lava-watenche and Nuées Ardentes flow caused by the eruption of Mt. Merapi and, damage by Lahar flow scouring and eroding old debris deposit by a heavy rainfall.

Nuées Ardentes flow reaches up to considerable lower part of a river and, according to the information of Mt. Merapi office, Nuées Ardentes flow reached 13 km from the top of the volcano in 1969 eruption and 7 km in 1973 eruption, and occurred much damage along rivers.

On the other hand, damage by Lahar spreads wider farther lower part of a river and the amount of damage on October 3, 1975 reached about 208 million Rp. and, bridge was broken, and economic and social activities were considerably suffered and affected by this casuality.

We can not neglect this influence to economic and social activities. Further more, the frequency of damage by Lahar is considerably high and damage occurred twelve times in case of Kali Putih in 1969.

2) Therefore, the damage condition of following items will be examined chronologically as possible as practicable as for Nuées Ardentes flow and Lahar flow after 1930 eruption:

(1) Dwelling house and facilities
(2) Paddy field and other field
(3) Forest
(4) Estate
(5) Stock farming
(6) Transportation and communication
(7) Commerce
(8) Inhabitants
(9) Public facilities (school, hospital, road, bridge, railway and etc.)
(10) Agriculture and irrigation facilities
(11) Water supply system

It is necessary to mention about the cause and economical loss caused by the suspension of economical activities.

The damages other than direct damages mentioned above can be observed in lower part of each tributary and trunk river (for example Kali Progo).

Supply of debris from upper part has caused upgradation of a river bed and increase of inundation damage caused by decrease of river course capacity, and has caused the damage of irrigation intake by filling up with sand materials.

Economical loss by debris deposit of lower part of each tributary and trunk river (for example Kali Progo) is supposed to reach considerable amount because its affected area spreads widely and broadly.

As the method of this survey, the study of statistic data of provincial Government, information collection from inhabitants and project offices concerned, other published report in this area concerning irrigation system are recommended.

3-3-7 Study of economic condition

1) Circumstance survey of regional society

Above mentioned survey will be carried out in order to estimate the cost-benefit in case of setting Sabo works around Mt. Merapi, as well as to estimate the damage in case of no countermeasure as Sabo works. In another way of description, the purpose of this survey is forecasting future circumstances influenced by Sabo works.

Contents of the circumstance survey are shown in the following table. Some of them has been already carried out by census and these data are put in order to each local administrative units. As far as Yogyakarta special city is concerned, most of data required for this survey has been also prepared in the Regional Planning Project carried out by UNDP.

It is necessary to take into consideration of the influence to the regional and social stabilization of the inhabitants by the plan when we make Sabo works plan in addition to benefit and cost estimation.

This survey will be done by Indonesian side and analysis and evaluation will be done by Japanese team.

2) The contents of survey

Item		Index	
1.	Population	(1)	Population male, female, village
2.	Property	(1)	Personal property, house, household furnishings farm, implements farm products
		(2)	Public property, road, railway, water supply, electricity, communication, irrigation facilities, school public house, temple
3.	Industry	(1)	Agriculture area, farm product – classification, amount of each farm products
		(2)	Forestry area, farm product - classification, amount of each farm products
		(3)	Live stock raising live stock classification and each number
		(4)	Commerce number of shop, amount of commodity
4.	Social system	(1)	Irrigation ownership
		(2)	Associated working system in village
		(3)	Thinking way of people
		(4)	Religion
5.	Historic remains	Distribution of historic remains	
6.	Grand view	(1)	Grand view check by usual map and bird's eye map
	Recreation	(2)	Recreation

Notes: Item 3 (Industry) is being concerned, mining industry and service industry is excluded because it is pure agricultural area. Rehabilitation is excluded from this survey because it is beyond the scope of this project.

3-3-8 Study of synthetic disaster prevention plan

1) Sabo works plan

2) Arrangement of Lahar and flood forecasting and warning system in cooperation with the volcanological survey

The relation between rainfall and origination (occurrence) of Lahar flow is expected to be cleared and analysed by the team.

Therefore, we hope, it is expected to be possible to forecast the origination (occurrence) of Lahar flow if raingauges are fully installed in the area concerned and communication net-works are fully operated in the area. These arrangements would be better to be implemented by Indonesian side.

3) Recommendation for improvement on land use in the area

After due consideration of above mentioned study-items, it is expected to set up the suitable scale of Sabo Plan.

3-3-9 Study of Sabo works plan

1) Sabo countermeasures for controlling volcanic debris flow during rainfall

Debris-flow at the time of heavy rainfall, is caused by erosion of deposit of Nuées Ardentes (Ladu) and old Lahar deposit in the upper part and also, it is caused by erosion of old Lahar deposit in the middle part of mountain slope or in the upper part of river bed.

Therefore, as for making of Sabo works plan, it is necessary to carry out direct check method by means of Sabo step dams based on the erosion phenomena of the deposit of Nuées Ardentes (Ladu) and the deposit of old Lahar.

And then, in the transportation area of the debris, it is necessary to shorten (decrease) the running-distance of Lahar-flow and control debris transportation at the time of a flood by means of a series of Sabo dams and sand pocket. And channel work is required at the lower part in such a river. In this part, we will study based on Sabo engineering as well as river engineering.

As for the fundamental dimension of Sabo master plan for necessary tributaries of Mt. Merapi, it is necessary to set up average annual sediment discharge and the maximum run-off Sediment discharge at the time of a designed flood which will be determined during the course of study; and the making of countermeasures which diminish the above mentioned debris amount as much as practicable is required.

The following studies will be done by the team:

(1) Field survey of the expected area for making Sabo works plan
(2) Evaluation of effectiveness of the existing Sabo structures
(3) Survey of the gradient and width of each river
(4) Hearing and discussion of future idea and opinion of Mt. Merapi Project Office and Japanese Sabo Colombo Plan Experts
(5) Making of Sabo Works Plan and estimation of the approximate construction cost of Sabo Works
(6) Study of the possibility of utilization of Sabo Structures to another purposes

In the river course of trunk river where occurs many sedimentation problems, some countermeasures will be adopted. This will be done in cooperation with river engineer.