FINAL

INCEPTION REPORT
FOR
THE FEASIBILITY STUDY
ON
THE VOLCANIC DEBRIS CONTROL
AND WATER CONSERVATION PROJECT
IN
THE SOUTH EASTERN SLOPE OF MT. SEMERU
IN
THE REPUBLIC OF INDONESIA

APRIL, 1982

JAPAN INTERNATIONAL COOPERATION AGENCY

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I. INTRODUCTION

According to existing record, the basin formed by the Mujur, Rejali, Gridik and Bondojudo Rivers on the south-eastern slope of Mt. Semeru was subject to major damage in 1909 along the Besuk Sat tributary at the upper reaches of the Mujur River. At that time, a "mudflow and debris-flow" (hereinafter called "mudflow") took place into the former Besuk Sat Lama river channel and hit the city of Lumajang, causing 208 deaths, destroying 1,449 homes and washing away 1,338 ha of paddy fields. The government at the time carried out a large-scale project to counteract against a possible reoccurrence of such damages through construction of the Leces sabo and Leces short-cut so as to transfer the Besuk Sat catchment area to the Tunggen and Mujur Rivers. In spite of these efforts, similar damage resulted repeatedly thereafter. In 1976, another occurrence of major damage took place around Curah Kobokan upstream on the Rejali River, resulting in 119 deaths and the loss of 880 ha of paddy fields and approximately 100 homes. In the wake of this disaster, in April 1977 a "Mt. Semeru Project" was established to devise countermeasures against such damage in the east and south sides of Mt. Semeru. Budget outlays for this project totaled Rp $2,554 \times 10^6$ for the first five years, including a budget of Rp 0.814×10^6 for the 1981-82 fiscal year.

Inspite of this ambitious program, four years after the inception of the Mt. Semeru Project, on May 14, 1981, a massive mudflow claimed another 365 lives, 1,002 dwellings and numerous fields and public facilities, thereby having a significant effect on the local populace and economy. If immediate, large-scale and thoroughly planned countermeasures are not taken now, the same type of disaster can be expected to occur with even greater frequency and causing even greater social and economic loss, thereby undermining the very stability for the infrastructure of the area.

The mudflow of 1981 brought a vast quantity of sediment to rest along the river channel, especially in the upper region of the river. Furthermore, these sediment deposits are located in unnaturally winding areas in the channel. This sediment may quite easily move once again, in which case a reoccurrence of flood or mudflow causing an overtop would be unavoidable. If a second mudflow were to occur on equal scale to that of May 14, 1981, the resulting damages and casualties can be expected to far exceed those of the previous disaster. Such a disaster could easily be triggered by the area's regular rainfall. For this reason, in order to avert the reoccurrence of damages such as those inflicted by the mudflow of May 14, 1981, it is necessary to re-devise the Sabo Master Plan and to come up with a radical sabo plan for immediate execution, in order to guarantee the continued development and social stability of the local area.

In its third Five-Year Plan (fiscal 1979-84), the Indonesian government has set its current national goals. In order to achieve these goals, the Water Resources Bureau of the Ministry of Public Works has established a three-point program:

(1) Maintaining the safety of agricultural regions

(2) Acquisition of popular equality through maintenance of safety in local regions

(3) Maintenance of safety in industrial activities through the protection of industrial regions against natural disasters.

With this background in mind, the Water Resources Bureau, taking cognizance of Indonesia's unusually large number of active volcanoes, recognizes the emergency nature of the necessity to carry out sabo work in the areas surrounding these volcanoes in order to avert damages from such volcanoes both directly and indirectly. The Bureau is taking great pains to carry out such measures.

In recognition of the technical cooperation offered by Japan in the sabo field, the Indonesian Government has asked for Japan's further technical assistance in The Volcanic Debris Control and Water Conservation Project in Mt. Semeru. The present study is to be conducted in response to this request.

A preliminary study team was dispatched by JICA in December 1981. Based on the results of their site investigation, a Scope of Work was prepared, and agreement on said Scope of Work was reached on December 18, 1981 between the JICA preliminary study team and the Water Resources Development Department, Ministry of Public Works, of the Indonesian Government.

This Inception Report contains information relating to study principles and methodologies, study contents, job allocation and the work execution system, as required to receive the authorization and agreement of the JICA Survey Team and the Indonesian Government prior to the commencement of the actual study.

II. OUTLINE OF THE STUDY

1. Study Objectives

The purpose is to conduct a feasibility study aimed at offering proposals from various points of view in order to prevent damages incurred by frequent mudflows on the southeastern slope of Mt. Semeru. In addition to assessing the potential water unilization volume which will result from implementation of the Sabo Plan, the Study is also to serve to transfer technical knowledge relating to the Sabo Plan and study methods to technicians of the Indonesian Government.

2. Study Area

The area to be studied comprises some 730 square kilometers lying in the basin of the Mujur, Rejali, Glidik and Asem Rivers, located on the southeast slope of Mt. Semeru in Java Province in eastern Indonesia (see map attached).

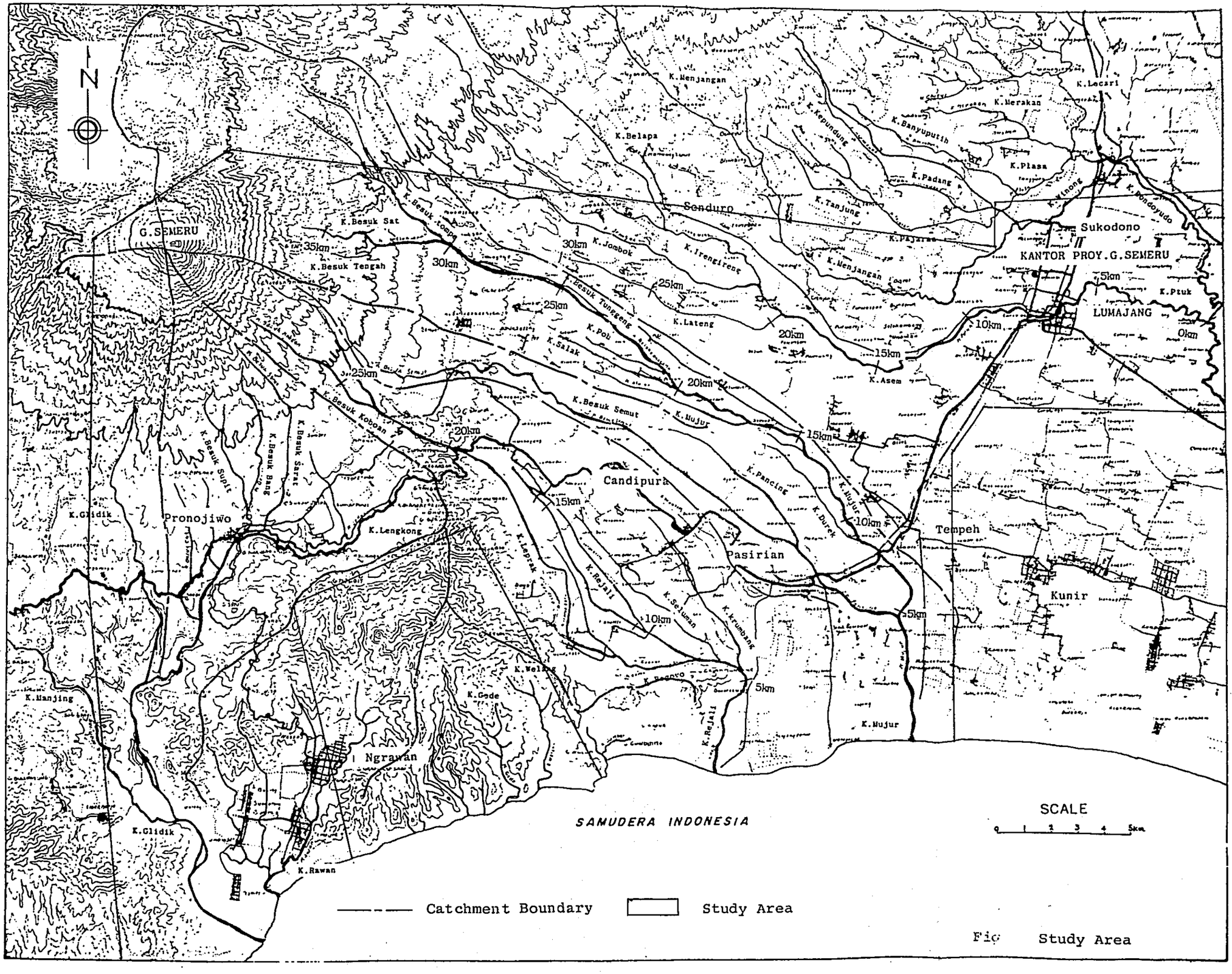


Fig Study Area

3. Investigation Method

(1) Work Flow

a) Work Flow for Preparation of 1:10,000 Scale Topographic Map (Phase 1)

This topographic map will be made using the aerial photographs (Scale: 1/13,000) which has already been provided by the Indonesian Government.

Position marks for aerial survey cannot be identified in these aerial photographs, and control point survey for aerial triangulation has not yet been conducted. Therefore, the control points in the area to be mapped will be selected in the site, and pricking for transferring these control points to the aerial photographs will be conducted. Subsequently, leveling and traversing between the selected control points will be done.

Furthermore, the main facilities (roads, railways, etc.) structures and buildings (bridges, public offices, hospitals, etc.), boundary lines and names of the prefectures, municipalities, towns, and villages, and other items to be indicated in the topographical map are studied in the site.

Such data and materials obtained as the results of the field survey and study will be brought back to Japan for the purpose of aerial triangulation survey and machine plotting compilation and drawing.

b) Work Flow for Main Study (Phase 2) Work to be conducted in Indonesia

The major purpose of this main study work is reviewing the Master Plan of Mt. Semeru Debris Control Works provided by the Indonesian Government, and thus selecting the project with the first priority based on the result of the review.

For this purpose, brief field survey in the entire Project Area with regard to hydrology, hydraulics, meteorology, topography, geology, soil engineering, social aspects, economy, damage assessment, sabo engineering, river engineering, etc. are done. Using results of such study, the master plan will be reviewed to select the first-priority project and the necessary detailed specifications for the study conducted by the Indonesian Government will be provided (Reference: V. WORK BREAKDOWN: 1. Work Allocation; 2. Outline of Specifications of Work to be Performed by the Indonesian Government). Regarding the first-priority project, an implementation program will be made.

Therefore, for selecting the project, the Indonesian Government's political, social, and budgetary decisions as well as technical aspects need to be considered. For this reason, sufficient discussion between the Indonesian Government and the study team on the concept of the first-priority project provided on the basis of the results of reviewing the master plan is required (Reference: IV. ITEMS OF CONSULTATION).

After the first-priority project is selected, a report will be made regarding the results of the master plan reviewing and the selection of the first-priority project. This report will become the Progress Report I, which is an imporant supporting report for the Implementation Program. Therefore, the contents of this report, too, must be fully discussed between the Indonesian Government and the study team.

After this, sabo plan, facility allocation plan, facilities design, construction cost estimation, construction schedule, economic effect estimation, social evaluation, and financial assessment will be provided for the first-priority project. Based on such work, the outline of the project name, project promoter, location, project purpose, necessity of the project, project features, project cost (foreign/local currencies), project features, project cost (foreign/local currencies), project benefits, mode of construction, stages of project preparation, and construction schedule will be determined.

Many of the contents of these items must be determined by the Indonesian Government. Therefore, the smooth proceeding of decisions and discussions on these items according to the schedule is indispensable for this study.

The items requiring discussion and the times for their decisions are referred to in IV. ITEMS OF CONSULTATION.

The technical items to be studied at the site are as follows:
Assets and property investigation, socio-economy investigation, actual land use investigation, water use investigation, promissing sabo facility location investigation, banking material investigation and material test, hydrogeological investigation, geological survey, water quality investigation, rainfall and run-off investigation, river channel investigation, actual disaster investigation, warning and evacuation system investigation, etc. Their contents will be specified in III. STUDY CONTENTS.

c) Work Flow for Works to be Executed in Japan for Main Study (Phase 2)

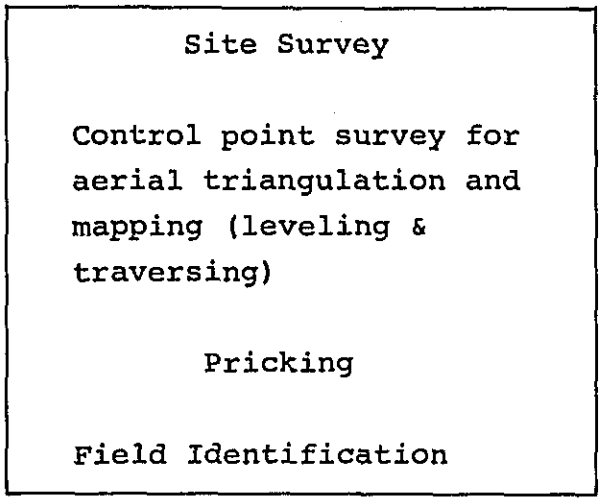
The results of the field survey will be brought back to Japan for the following purposes:

- Providing the implementation program for the first-priority project,
- Making a feasibility study report by providing the basic design, cost estimation, economical and social evaluation, and the study of potentiality of water development for the first- and second-priority projects.

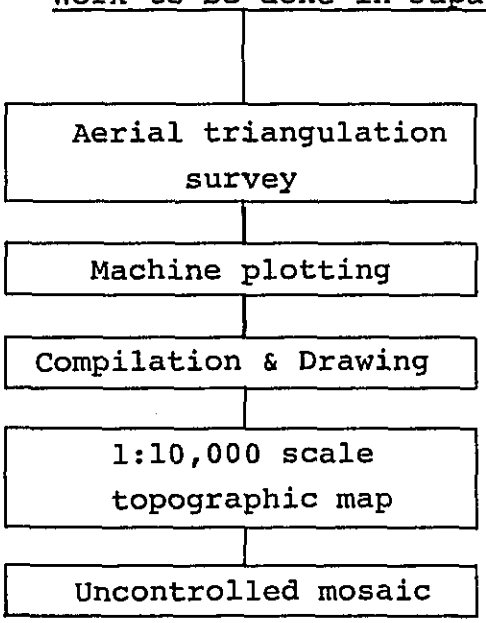
The relations between the "field investigation and analysis" and the "natural phenomena and the countermeasures" are indicated in the following chart, and the work flow of the review of the master plan is indicated in the following flow chart (Reference: d. General Arrangement of Investigation; 3. Flow Chart of the Study for the Master Plan).

a) Work Flow Chart for preparation of 1:10,000 scale topographic map (Phase 1).

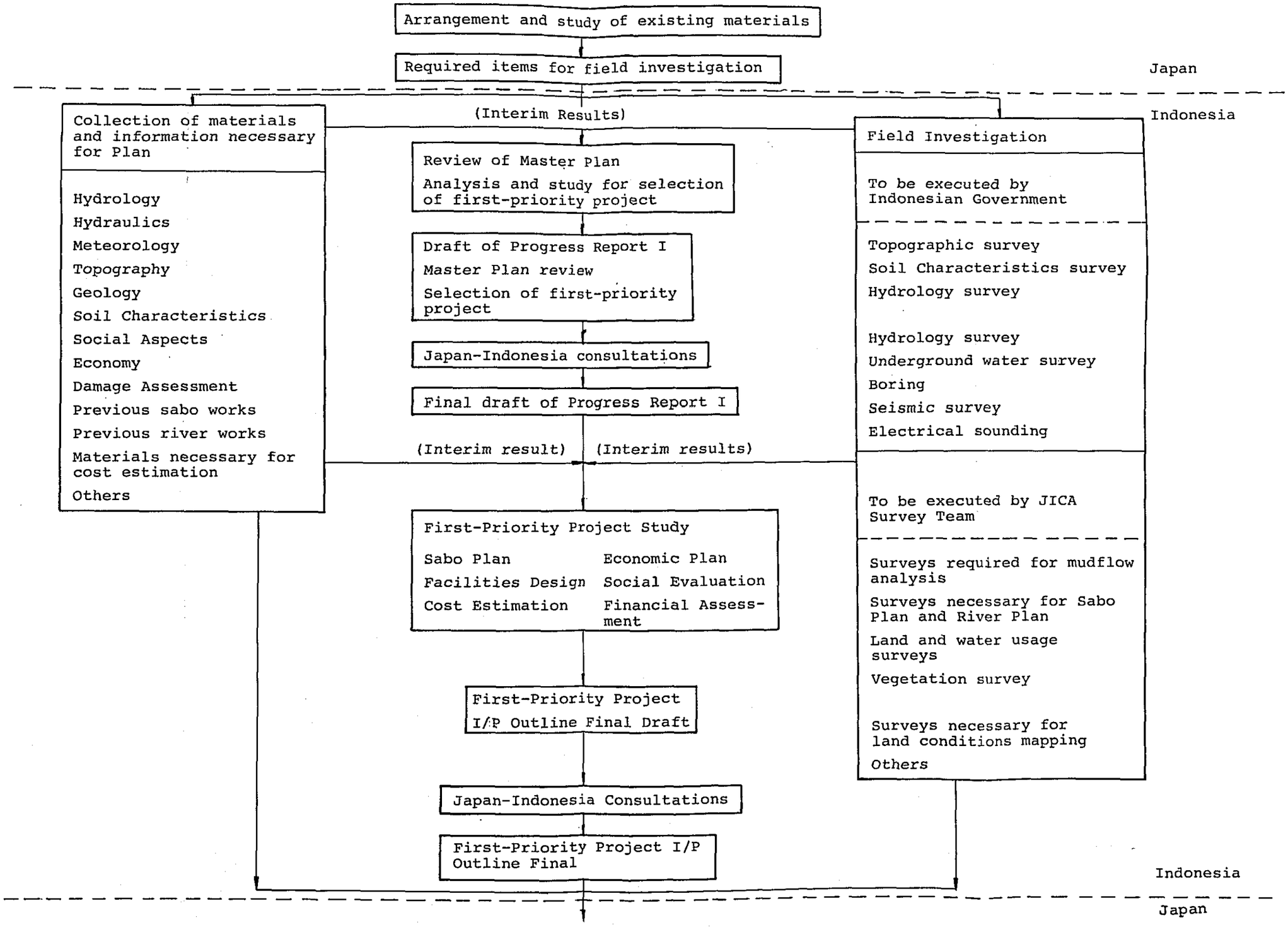
Work to be done in Indonesia:



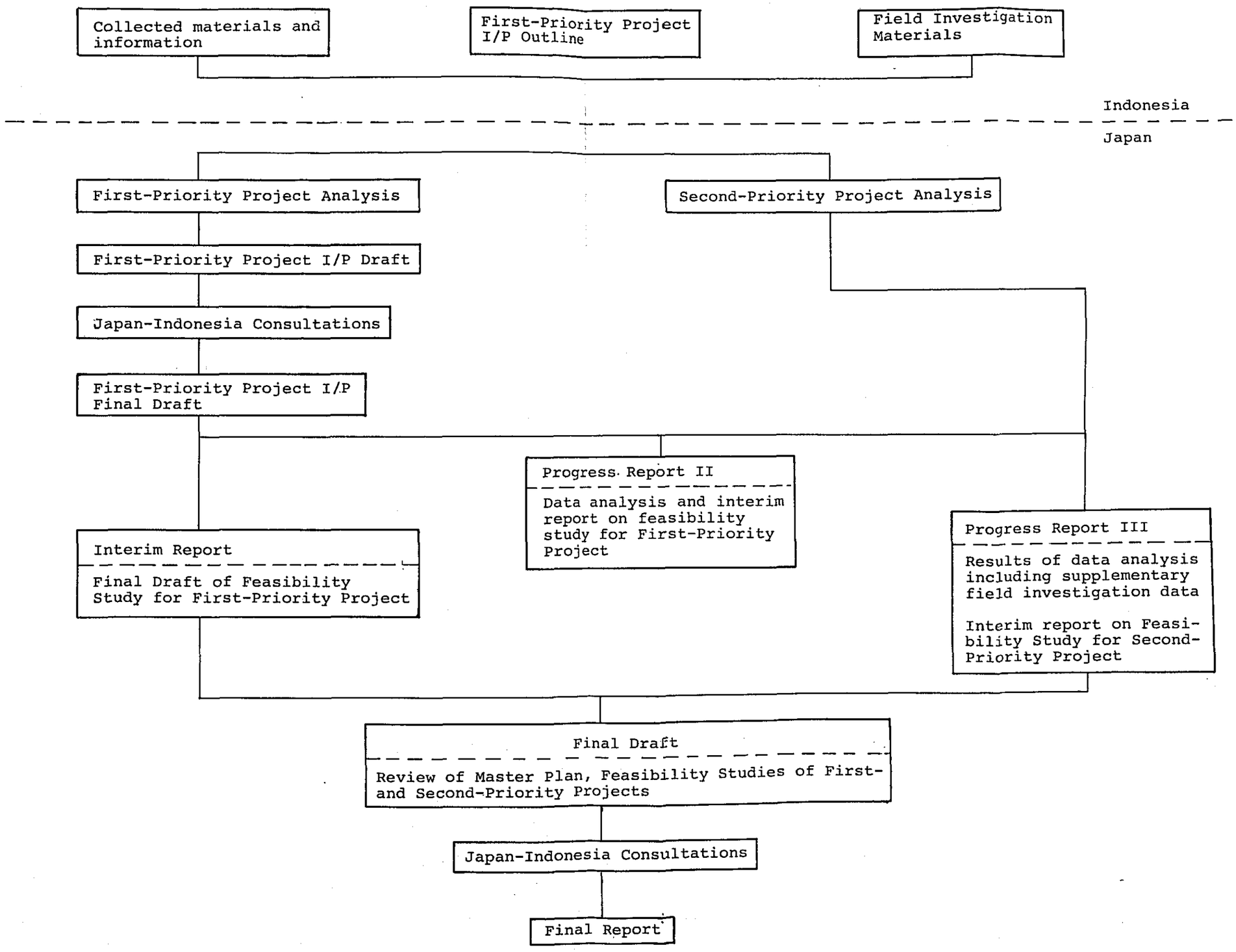
Work to be done in Japan:



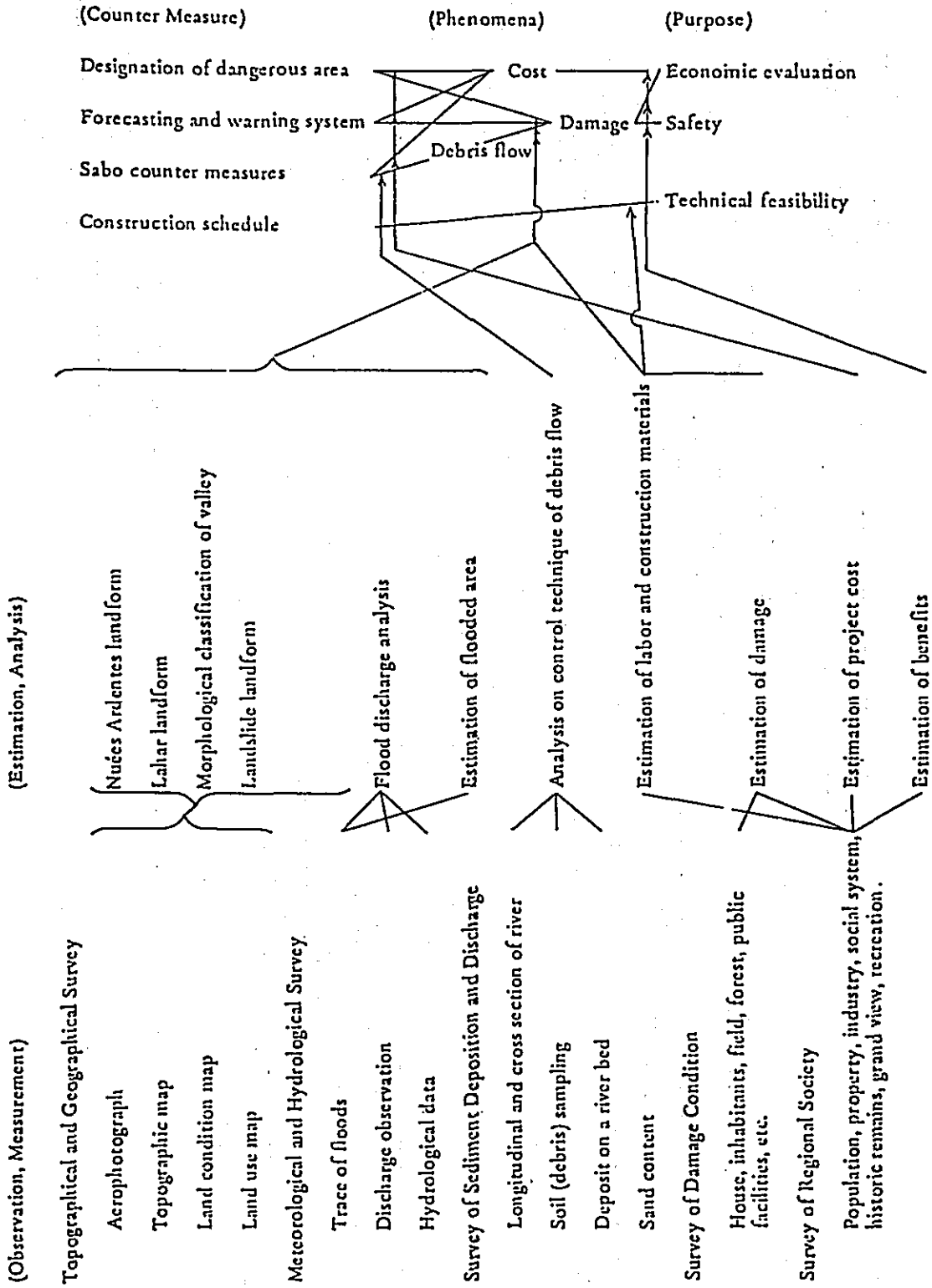
b. Work flowchart for Main Study (Phase 2) work to be conducted in Indonesia



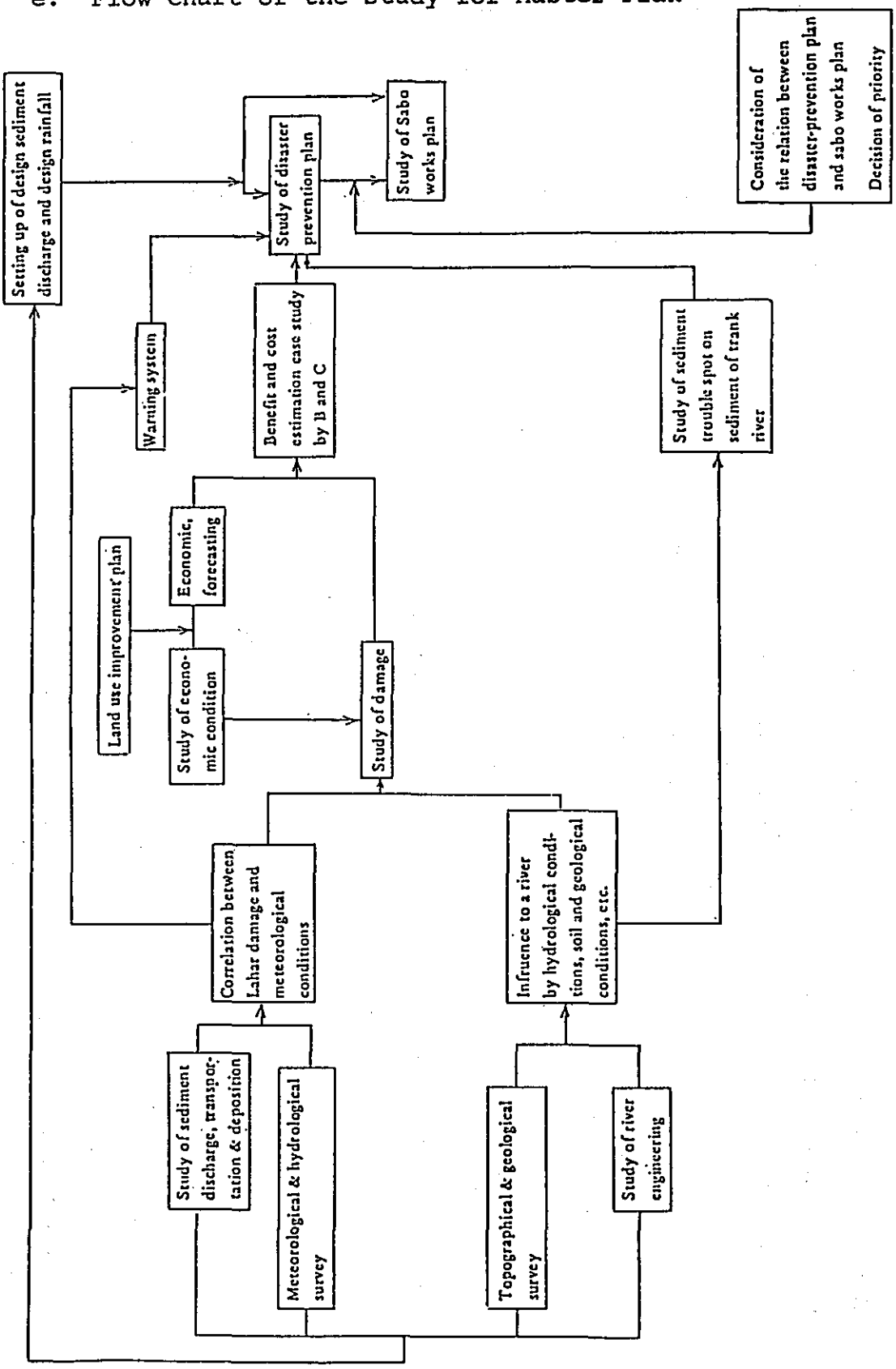
c. Work Flowchart for Work to be Executed in Japan for Main Study (Phase 2)



d. General Arrangement of Investigation



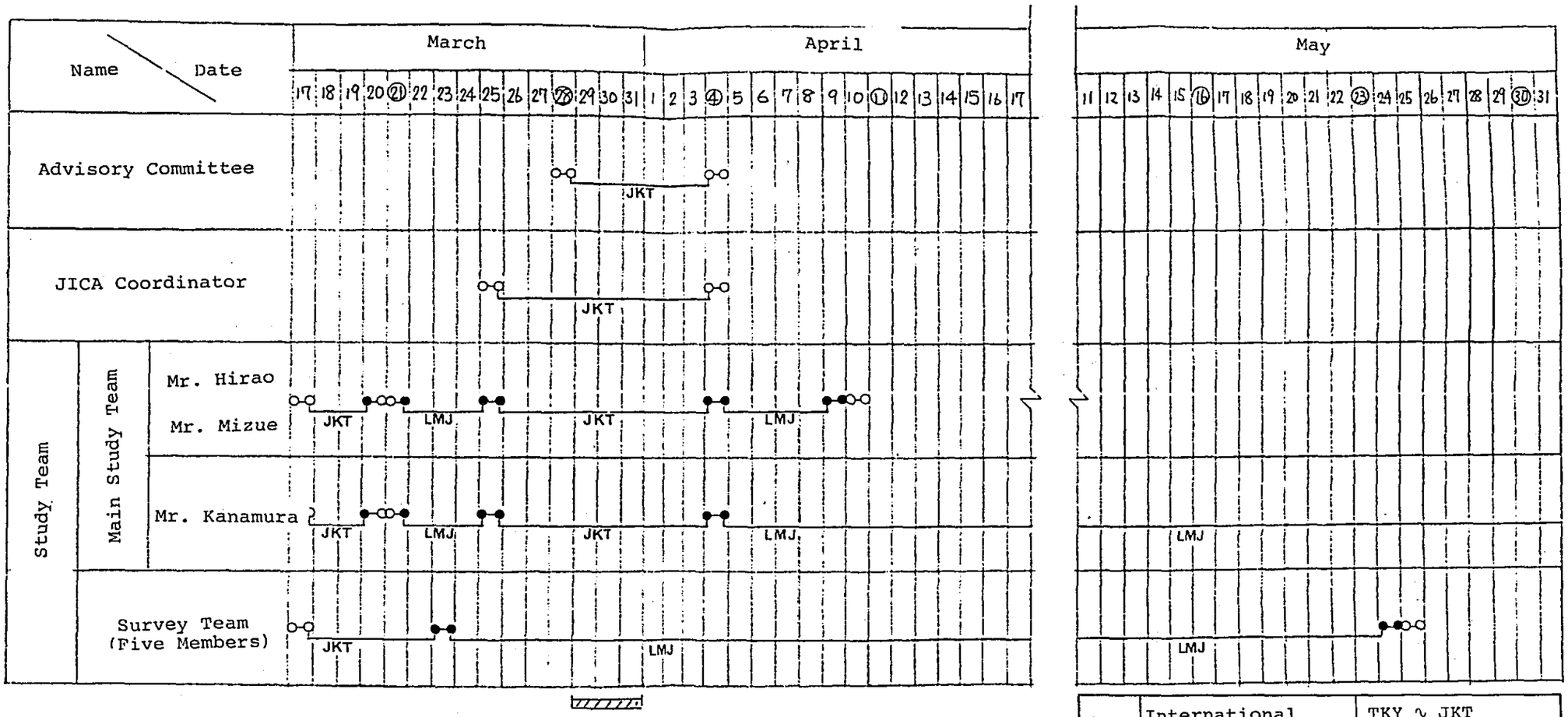
e. Flow Chart of the Study for Master Plan



(2) Work Schedule

a. Schedule for March 17 - April 10, 1982

Name / Date	Advisory Committee	JICA Coordinator	Study Team: Main Study Team: Leader Mr. Hirao & Sub-Leader Mr. Mizue	Study Team: Main Study Team: Mr. Kanamura	Survey Team (5 members)
March 17 Wed.			Tokyo - Jakarta		
18 Thu.			Courtesy visits to JICA, Japanese Embassy and		
19 Fri.			Ministry of Public Works		
20 Sat.			Meeting with Public Work Ministry,		Meeting with Public Works Ministry
21 Sun.			Jakarta - Surabaya Surabaya - Lumajang		Ditto
22 Mon.			Meeting with Mt Sumeru Sabo Project Office, Visist to the Site		Ditto
23 Tue.			Ditto		Jakarta-Surabaya-Lumajang
24 Wed.			Ditto		Meeting with Mt. Sumeru Sabo Project Office
25 Thu.		Tokyo - Jakarta	Lumajang - Surabaya - Jakarta		Field Work
26 Fri.		Courtesy Visits to Japanese Embassy and Ministry of Public Works			↓
27 Sat.		Meeting with Public Works Ministry			
28 Sun.	Tokyo - Jakarta	Arrangement of Materials			
29 Mon.	Meeting with Water Resources Bureau on the Inception Reports				
30 Tue.	Ditto				
31 Wed.	Ditto				
April 1 Thu.	Report on the Meeting Results with Public Works Ministry to Japanese Embassy and JICA				
2 Fri.	Ditto				
3 Sat.	Ditto				
4 Sun.	Jakarta - Tokyo		Jakarta - Surabaya - Lumajang		
5 Mon.			Meeting with Mt. Sumeru Sabo project Office, Field Work		
6 Tue.			Ditto		
7 Wed.			Ditto		
8 Thu.					
9 Fri.			Lumajang-Surabaya-Jakarta	Field Work	
10 Sat.			Jakarta - Tokyo	↓	
May 25 Tue.					Jakarta - Tokyo



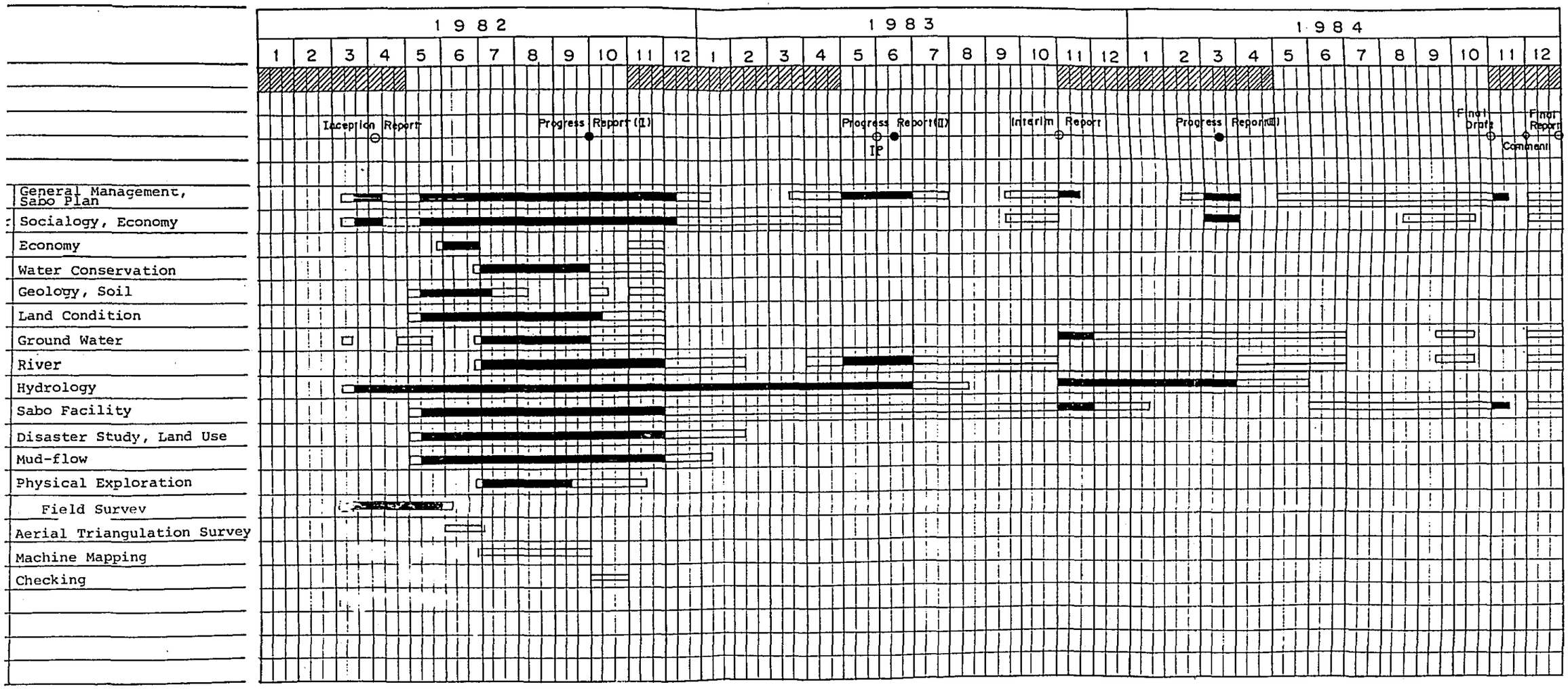
Consultation with Directorate

General of Water Resources

Development on the Inception Report

o—o	International Air Line	TKY ∿ JKT JKT ∿ TKY
●—o	Domestic Air Line	JKT ∿ SUB
o—●	Travel by Car	SUB ∿ LMJ
●—●	Travel by Domestic Air Line and Car	JKT ∿ SUB ∿ LMJ LMJ ∿ SUB ∿ JKT
JKT	Jakarta	
LMJ	Lumajang	

b. Work Schedule
(Tentative)



III. STUDY CONTENTS

1. Topographic Map Preparation (Phase 1)

(1) Outline

- Scale : 1/10,000
- Area to be covered : 730 km^2
- Counter interval : Intermediate contour line -- 10 m
  Half interval counter line - 5 m
  (flat area)
- Field survey will be conducted by Japanese surveyors and by Indonesian surveyors.
- Indoor Work (e.g. machine plotting, drawing, etc.) will be done in Japan.

(2) Detailed Plan

(a) Aerial Photo

- Existing aerial photos will be used for 1:10,000 scale topographic map production.
- Scale : 1:10,000
- Focal length of camera : 150 mm
- Date of aerial photo taken :

(b) Leveling

- Leveling will be conducted (along main roads) so as to keep the accuracy of elevation on the topographic map at a certain level.
- Original point of leveling will be selected from among existing Bench Mark and will be used as the original point of elevation for the survey work.
- Length of leveling route : approx. 70 km
- Accuracy of leveling route : closure error
  10 cm + 1 cm$\sqrt{S}$ (S=km)

Length of leveling will be measured on the existing 1:50,000 scale topographic map.

- Number of work party : 1 party
  Work party will consist of the one Japanese surveyor, one Indonesian counterpart from the Ministry of Public Works and local laborers.

(c) Traversing

- Traversing will be conducted (along main roads) so as to keep the accuracy of horizontal position on the topographic map at a certain level.
- Original point of traversing will be selected from among existing triangulation point and will be used as the original point of horizontal coordination for the survey work.
- Number of control points to be surveyed: about 26 points.
- Accuracy of traversing route: closure error less than 1:10,000
- Number of work party: 2 parties
  Each party will consist of two Japanese surveyors, one Indonesian counterpart from Ministry of Public Works and several local laborers.

(d) Pricking

- Pricking of existing Triangulation points, control points and leveling point will be done for aerial triangulation.
- Number of pricked point: about more than 26 points

(e) Field Identification

- Photo interpretation key will be determined for each classified area and major facilities in the area will be checked.
- Area to be identified: Area along main roads, Major villages, major topographic features.

(f) Aerial Triangulation

- Aerial Triangulations will be executed in area for which 1:10,000 scale topographic maps will be produced.
- PAT-M (or equivalent) computation program will be used for block adjustment of aerial triangulation.
- Number of models: approx. 700 models.

(g) Machine Plotting

- Counter interval: Intermediate counter line ---------- 10 m

  Half interval counter line ---------- 5 m (flat area)
- Instrument to be used: Second class plotting machine
- Number of models to be used: approx. 700 models.

(h) Compilation and Drawing

- Those symbols used in the topographic mapping will be discussed and determined between the Ministry of Public Works and survey team.
- The style of marginal information will also be discussed and determined between the Ministry of Public Works and the survey team.

- Size of sheet: 70 cm x 100 cm
- Grid and Grid tick will be U.T.M.
- Geographical names and administrative boundaries will be based on the information supplied by the Indonesian Government.

(3) Transfer of Knowledge

Indonesian surveyors of the Ministry of Public Works will be given on-the-job training.

(4) Works Schedule

Please refer to the attached figure.

(5) Final Products to be Delivered

a) Original topographic maps ---------- 1 set
b) Blue copy of topographic maps ---------- 5 sets
c) Duplicate topographic maps ---------- 1 set
d) Data and results of the field survey ---- 1 set
e) Uncontrolled mosaic ---------- 1 set

JAVA & MADURA
1:50.000

SEMERUF-GEBERGTE

SHEET 55/XLIII-A JAVA & MADURA 1:50.000

SENDOERA

SHEET NO. 55/XLIII-B

THE MAP OF THE MT. SEMERU VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT

PRICKING FOR AERIAL TRIANGULATION	△	16 POINTS
CONTROL POINT	○	26 POINTS
LEVELING ROUTE	———	70 KM
MAPPING AREA	= = =	ABOUT 730 KM^2
UNCONTROLLED MOSAIC AREA	———	ABOUT 175 KM^2

2. Main Study (Phase 2)

(1) Materials and Information Required for Planning

a. Hydrology and Hydraulics

Rainfall and Runoff Records

* Rainfall records through 1975 have been obtained, but hourly rainfall records are sorely inadequate.
In order to clarify the mutual relationships between short-time rainfall, hourly rainfall and daily rainfall according to rainfall analysis, supplementary material is to be gathered relating to short-time rainfall and hourly rainfall.

* In order to carry out runoff studies, both rainfall and runoff records are necessary for the same rainfall. Owing to the complete absence of existing runoff records, runoff analysis is therefore impossible. Accordingly, runoff studies of similar catchment areas will be collected to serve as reference material for the present runoff study.

* Intake rate records for intake points are still unobtained and shall be collected.

* Recent rainfall and runoff material will be collected.

b. Meteorology

* Records relating to temperature, sunshine and evapotranspiration are not presently on hand and must be obtained as required for the total water balance study.

c. Geology, Topography and Soil Characteristics

Because existing materials are primarily related to the volcano, general geological maps, soil characteristic reports, topography and soil characteristics materials, and boring materials relating to foundation structures are to be collected.

d. Land Use

Existing material consists of land use and irrigation main channel maps (both of scale 1:50,000) and statistical materials relating to agriculture, industry, cost of living and population. In addition, information will be collected in reference to the most recent agricultural, social and economic indices. Furthermore, material concerning this area's socio-agricultural development plan, including aspects currently under study, will be collected.

e. Damages from Mudflows and Floods

Because records of past damages are primarily of a qualitative rather than quantitative nature, material on recent damage, particularly that incurred in May 1981, will be collected.

f. Existing Sabo and River Works (Type, Scale, Cost, etc.)

Maps describing already completed sabo and river works including some design maps have been obtained. Additional drawings and materials relating to construction costs will be collected.

g. Material & Equipment and Labor Cost Materials as Required for Cost Estimate

Some materials have already been obtained, and additional materials will be collected systematically based on investigation of the range of necessity.

h. Others

(2) Field Survey

a. Field survey includes river profile and river cross-section required for analysing the river channel characteristics, cross-sectional and profile leveling and topographical survey required for structural design, survey of boring locations, determining survey line for seismic survey and electrical sounding, and cross levelling required for run-off observation and underground water level measurement.

b. Geological Survey

- Extended Geological Study

Geological reconnaissance for erosion control planning will be executed together with field work and aerial photograph interpretation to provide geological maps and to determine the area where detailed geological survey will be carried out.

- Detailed Geological Survey

Detailed geological survey will be carried out centered around underground water study, physical exploration, electrical exploration, planned locations for structures, boring locations, and so on. Boring, physical exploration, and electrical exploration will be conducted to clarify the subgrade stratum structures to provide basic data for structural design, run-off analysis, and water balance analysis.

c. Soil Investigation and Material Testing

Boring, physical exploration, and electrical exploration as well as sampling and testing will be done to obtain the subgrade strength under structures, constructional material characteristics, permeability and infiltration capacity required for underground water analysis and water balance analysis, and grain distribution of river-bed materials required for studying the river channel characteristics.

d. Hydrological Study

- Rainfall Observation

  Automatic rainfall observation method will be used to clarify the relations between the short-term, all hourly, and 24-hour rainfall intensities required for run-off analysis. Moreover, observation stations needed for run-off analysis will be improved and added based on the study of the existing allocation and data.

- Run-off Observation (Observation Period: 2 Hydrological years)

  i) High Water Observation

  High water observation will conducted selecting 1 point along the river i.e. at points where observation is easy and the flow condition is stable such as where bridges and sabo dams are located, and discharge rating curves will be provided. This, together with the rainfall data will serve as the basic data for fun-off analysis, designed flood, as well as the assumed disaster causing flow rate.

ii) Low Water Observation (Main Streams)

Low water observation will be carried out on the up-stream and down-stream sides of the planned points for the main sabo dams and the water intake points to provide the basis for long-term run-off analysis and economic effect estimation.

iii) Low Water Observation (Water Intake Channel)

The intake rates through the rainy and dry seasons will be measured to compare with the flow rate of the main streams as well as calculating the water intake effectiveness. Furthermore, during the rainy season, the transition in water intake effectiveness due to the river-bed height fluctuation which influences the degree of difficulty in taking water to provide the basis for calculating the economic effects.

- Underground Water Level Observation

The underground water levels at planned locations for major wells and erosion control facilities near the rivers will be measured to clarify the tendency of the underground water's height fluctuations. Furthermore, they will be compiled into a group of data required for water balance analysis together with the rainfall, flow rate, and hydrogeological data.

- Evapotranspiration Observation

Evapotranspiration amount together with temperature, sunshine, and rainfall will serve as the basic data water balance analysis.

- Water Quality Study

  The qualities of the river water, the spring water, and the underground water will be studied with the PH meter and water sample analysis to define the relations between the rever water, underflow water, and underground water and to provide the basic data for water balance analysis.

The above-mentioned study items a, b, c, and d will be done by the Indonesian Government according to the Scope of Works.

e. River Channel Investigation (Detailed Land Condition Study)

From the profile, cross-sections, birds-eye views, bank heights, dike heights, river widths, and river-bed gradients will be obtained from the survey results and the field study.
The strengths of dikes and river-bed materials, river-bed subgrade, and locations of the underground water and underflows near the river courses will be obtained from the boring, underground water level measuring, and field study. The grain-size distribution of the river-bed materials will be obtained by the sieve analysis on the material samples.
The above-mentioned data will be made into a set of basic data for analyzing the river channel characteristics to find out the run-off capacity, sediment transportations capacity, and points where destruction of dikes and over-flow are anticipated. The topography of the alluvial fan and sedimentation deposits as well as old river routes will be examined

through the field work and aerial photography interpretation to provide materials for river channel characteristics analysis which reveals the river routes' lateral movements and the river-beds' vertical fluctuation.

f. Mudflow Study & Sediment Volume Study

The topography of the points where the mudflow originated from, flew down, and deposited (Plan, Cross-section, Gradient), grain distribution, mudflow volume, the distance through which the mudflow rushed down, the state of the mudflow dispersion, the relations between the local plant lives and the soil collapse and sedimentation, the volume of soil and rocks which collapsed, and the amount of the sediment will be studied as data for the sediment balance study.

g. Damage Study

The relations between the total material value lossed because of the disaster, the area which suffered disaster, rehabilitation measures, and land conditions will be studied to provide basic data for disaster analysis.

h. Study of Warning & Evacuation Systems

Currently, 2 volcanic observation stations, 10 river observations stations, and 4 communication & administration organs have been provided. The radio and wire communications are used between these facilities. However, operation of these facilities have not been automatized. In order to inform the local residents of the occurrence floods and mudflows as well as public relations, telephones and word-of-mouth method are still used.

For this reason, there is a fear of information, communication, and public relation related to the occurrence of a disaster will not function well because of a communication line disturbances. Also, these dies not function sufficiently during the night time. In the case of the disaster that occurred on 14 August, 1981, communications for informing the residents of the disaster's occurrence and for requesting urgent counter-measures were obliged to depend on the word-of-mouth method because it happened during the night time and the communication lines were damaged. In this study, the functions and conditions of the warning and communication systems, which were used at the time of May, 1981 disaster, will be studied the problems of the existing systems will be reviewed, collecting ideas and suggestions related to the system improvement based on such experiences will be collected. These materials will be used as the data for warning and disaster prevention systems as well as determining the dangerous areas and criteria for such determination.

i. Vegetation Study

Plant lives in the area where the mudflow started and collapsed soil and rocks settled will be studied to examine the relations between the plant lives and landslide and mudflow occurrence and also to provide data to examine the relations between the plant lives and mudflow material dispersion.

j. Topographical Study

Local information required for providing the topographical classification chart, land condition map, stream order map, slope classification chart, and mudflow occurrence potential map will be collected.
The work for providing the land condition map will be limited to the scope where it is known from aerial photograph interpretation centered around the old river courses, mudflow deposits, and alluvial fan which are needed for assuming the scope of the disaster. The bank heights will be actually surveyed by means of river-bed study and river condition study.

K. Study of Actual Land Water Use

The field work of the land use and water use will be done through field study respectively considering the contents of the land use map and the actual use of take-in water as well as data obtained through low water observation. The relations between the land use and the water use will be studied through the field study to provide the basis for economic effect estimation. Especially, emphasis will be placed on the relations between the water use and the area where single cropping of rice is practiced and between the water use and the agricultural field area.

l. Others

Examination and confirmation of representative examples among the collected data, etc.

(3) Analysis

a. Hydrogeological Analysis

The geological structure, the distribution of the permeable and inpermeable layers, their permeabilities, underground water level, and the underflow locations will be made clear using the data obtained through the hydrogeological (geological structure) study, boring, physical exploration, electrical exploration, and material testing. In this way, hydrogeological information (on the subgrade as a water container) will be sorted out and organized. At the same time, data concerning the underground water level fluctuations through the dry and rainy seasons will be organized based on the study of the underground water levels and the water quality study in order to clarify the inflow and outflow of the underground water and finally to provide a model of the underground portion of the water balance analysis.

Furthermore, the amplitude of the underground water levels, transitions depending on the elevation, and the time lag among the underground water level, the rainfall, and the surface water volume have close relation with the water balance analysis model and the potential amount of water which can be developed.

b. Rainfall Analysis

i) The rainfall observation stations will be classified into the group where large amount of hourly rainfall has been recorded and the group where the rainfall amount has been recorded and the group where the rainfall amount has been small.

Also, Thiessen partition will be conducted on the river basins to provide the Thiessen poligons and rainfall correlation analysis will be done. In this way, the rainfall correlation diagram and correlation equation will be obtained.

Moreover, with regard to the observation stations where much hourly rainfall is observed, correlation analysis of the hourly and the daily rainfall will be performed to obtain the correlation equation of the short-term and daily rainfall.

Combining the above-mentioned tow, the correlation between the hourly and daily rainfalls in each observation station will be obtained.
Furthermore, combining these with the Thiessen diagram and the division diagram of catchment area, correlation equation of the catchment area mean rainfall will be obtained to find out equations to obtain the rainfall study input data.

ii) A probability analysis of each observation station's daily rainfall data will be conducted to make a probable rainfall list.
This will be come the basis for providing the designed rainfall.

iii) The above-mentioned i and ii will be combined to find out the probable hourly rainfall in the observation stations where hourly rainfall is small in amount.

iv) Because the flow run-off time in the study site is considered to be 1/2 - 1 hour near the state highway, it considered that the assuming the hourly rainfall is sufficient for considering the designed flow.

v) Sufficient short-term rainfall is required for the occurrence of a mudflow, the correlation between the daily and hourly rainfalls is doubtful. Therefore, special examination and consideration on the data is required.

iv) Rainfall with flow rate data are required for high water run-off analysis.

vii) For the long-term run-off analysis, also, rainfall with flow-rate data in an identical time period will be used.

viii) The purpose of rainfall analysis is to provide different kinds of hyetograph required for run-off analysis, river planning, and sabo planning.

c. River Channel Characteristics Analysis

The discharge capacity map, the sediment discharge capacity map will be drawn based on the shapes, widths, river-bed gradients, and river-bed materials of each river and the prediction of river-bed height fluctuation, the selection of points where distruction of dike and flooding may happen will be made as well as prospecting the flow-rate at the time of such flooding. Furthermore, the river system map, the catchment are division map, the geological diagram, and gradient classification diagram, the river basement shapes and quality related to the run-

off analysis, which are information as the container which receives rainfalls, will be classified and organized.

d. Disaster Analysis

The rainfall, flow rate, the river channel characteristics, collapsed soil and rocks, mudflow deposit amount, the area which suffered the disaster, the topography of the disaster-suffered area, the value of assets and properties lossed, and so on at the time of the disaster occurrence will be considered on overall basis, and the amount of the sediment run-off and deposits will be estimated at the time or flooding. The results of the topographical study, the river channel characteristics study, and the disaster study, dangerous areas will be pointed out. And their degree of danger will be assumed, and assumed disaster are map will be made to provide data for a sediment balance analysis, sabo planning, and economic effect prospect.

e. Run-off Study

i) High Water Run-off Analysis

There are the rational formula method, the unit hydrograph method, the storage function method, and the specific characteristics curve method as analysis methods. However, there are little existing flow-rate data which can be analyzed. Therefore, this depends on to what extent the future observation can be implemented and on whether or not an appropriate flood will occur.

Mainly, the rational formula method, the storage foundation method, and the specific characteristics curve method are planned to be used.

The required input data are as follows:

- Short-term rainfall curve
- Duration discharge curve
- Saturation rainfall
- Mean rainfall of catchment area
- Effective rainfall
- River system map
- Catchment area division map
- Area division slope classification map
- Area division slope map
- River-bed gradient
- Roughness of River-bed
- Equivalent roughness.

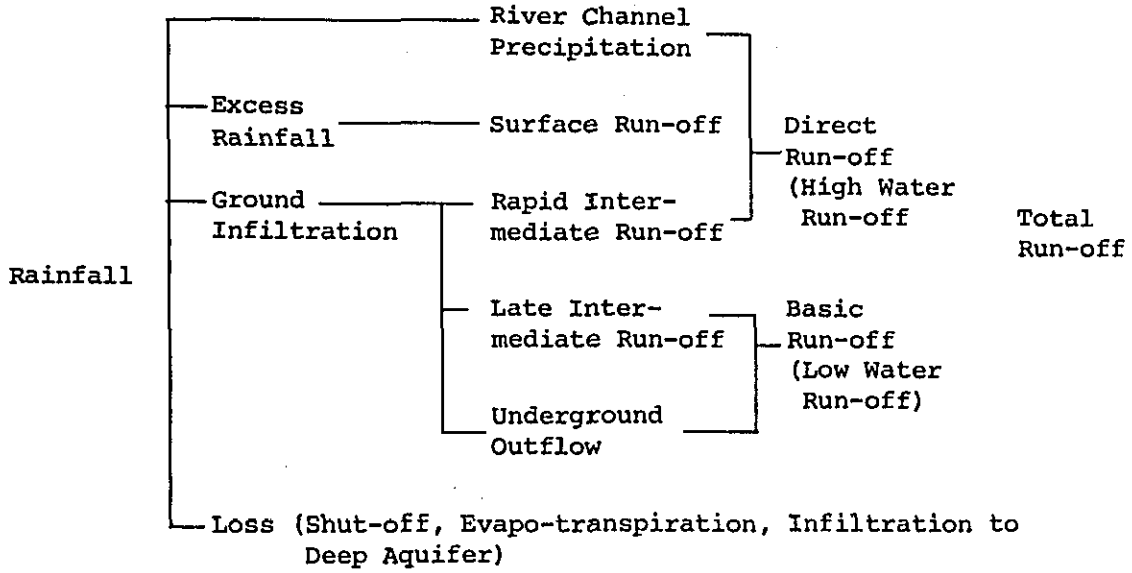
The obtainable output is the run-off function.

ii) Low Water Run-off Analysis

Using the daily low water flow rate and the daily rainfall and evapotranspiration records per one hydrological year (dry season and rainy season), a long-term run-off analysis by means of the multiple progression model and the low water run-off analysis by means of weighted statistical unit hydrograph method will be conducted. The response functions of the low water run-off will be obtained to serve as the data of water balance analysis and to serve as the basic data for the sabo plan's economic effects.

iii) Run-off Components

In order to understand the complex phenomenon of run-off, the run-off components can be classified in the following ways:



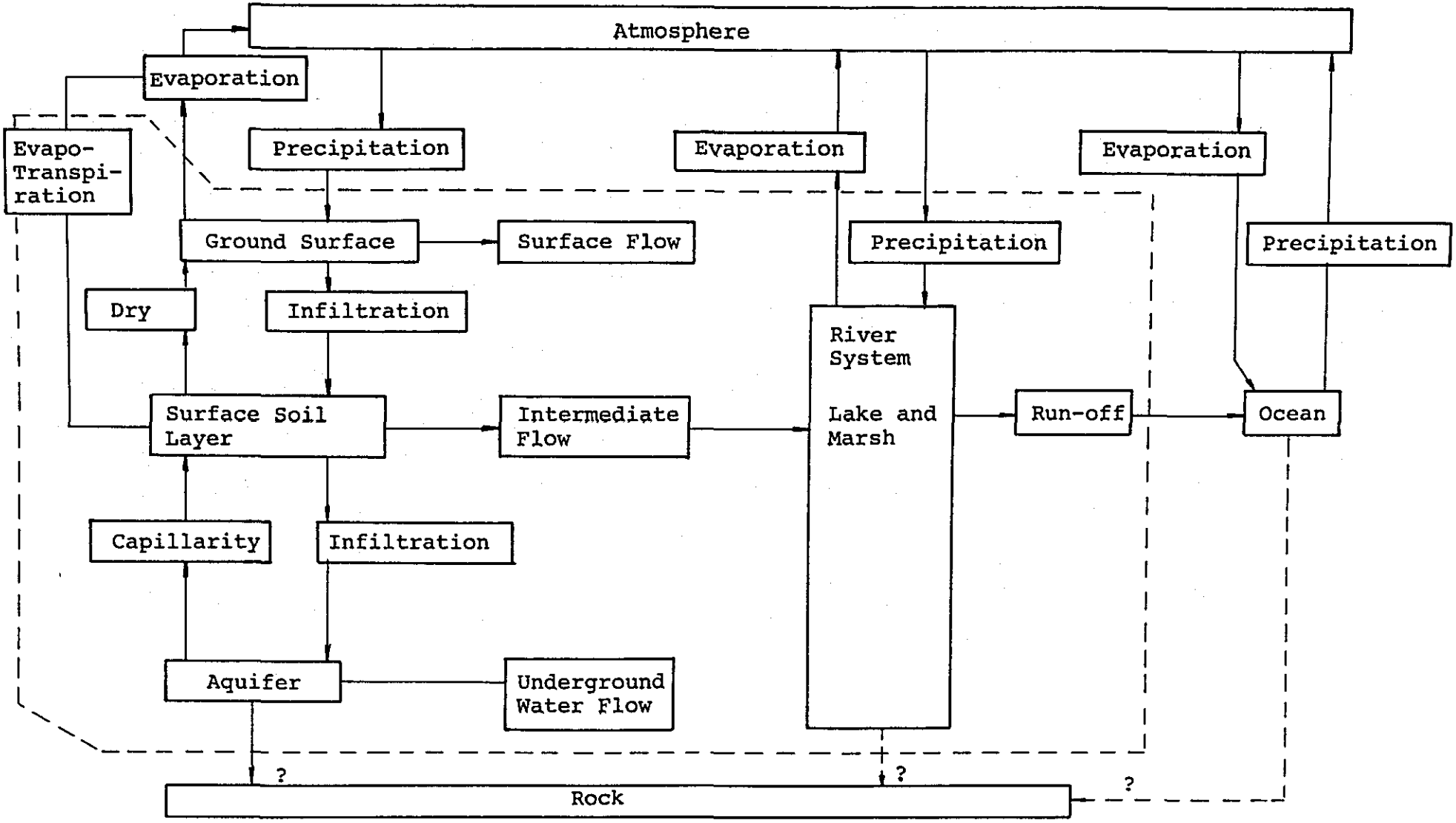
iv) Influence of Sabo Dam Sediment Deposit on Run-off

In the sediment deposit on the up-stream side of a sabo dam causes the river-bed gradient smaller than that of the original river-bed, and widens the river width. This consequently lessens the peak discharge of the flood. At this point also, the underground water will be stored and the underground water levels in the surrounding area will rise. Therefore, changes in the water depth and underground water level at sabo dam location causes fluctuations in

the underground water levels in the surrounding areas. The farther the distance from the sand deposit, the longer the time lag. This means changes in the basic outflow.

f. Water Balance Analysis

The hydrological calculation expressed macroscopically from the viewpoint of water balance appears in the following ways:


Atmosphere
Evaporation
Evapo-
Transpi-
ration
Precipitation
Evaporation
Evaporation
Ground Surface
Surface Flow
Precipitation
Precipitation
Dry
Infiltration
River
System
Lake and
Marsh
Surface Soil
Layer
Intermediate
Flow
Run-off
Ocean
Capillarity
Infiltration
Aquifer
Underground
Water Flow
?
?
?
Rock
Water balance area having
river basin as subject

The water balance analysis is purposed at examining the water balance in the river basin. In this study centered around the extended natural sediment deposit on the up-stream of the Leprak River, the possibility of increasing the low water amount during the dry season will be probed by controlling the underground aquifer and the underground streams through controlling the underground water level fluctuations by means of sabo dams and by utilizing the low velocity of the underground stream. Also, the effect of decreasing hazardous floods and conservating underground water on the up-stream of the Kobokan River, which is located on the up-stream of the Leprak River, by controlling the run-off soil by means of the sand pocket and by facilitating and increasing the penetration of surface water into the subgrade.

Furthermore, in the middle-stream of the Mujur River, by means of ground sill and channel work, the river route will be stabilized and water intake effectiveness will be increased by stabilizing the surface water intake and increasing water intake effectiveness.
At the same time, the possibility of increasing the usable amount of water by catching the underflow will be considered.

g. Sediment Balance Analysis

From the result of run-off analysis, the flood discharge at the time of the past disaster can be estimated. Also, from the river channel analysis and from the result of disaster analysis, the designed flood and the designed sediment discharge can be obtained.

And, also, from the river channel analysis, basic amount of soil for the sabo planning such as allowable sediment run-off and so on will be found out.

h. Function of Sabo and Flood Control Facilities

From sediment balance analysis, run-off analysis, disaster analysis, and river channel characteristics analysis, river channel routes, where flow discharge ability and sediment discharge ability are stable, are considered. The organic and effective combination of river improvement works and facility allocation will be considered for the sabo dam, ground sill, channel work, river improvement work will be considered, and the location where work is required and the facilities' effects in terms of sabo planning will be considered.

i. Design Conditions for Structures

The survey data of the project site, foundation conditions, materials, construction method, sizes of the facilities and limitations will be classified and organized, and the design conditions for each sabo facility will be classified and organized to provide the data for the design and calculations for sabo work.

j. Warning System Analysis

Based on the study results, consideration from both the hard and the soft sides including the observation, and the communication facilities' allocation, function, and administration will be considered.
The consistency between the local community and the replacement of the wire communication line with the radio communication, automotization of the observation and disaster finding,

and the systematization of the public relation facilities and equipment, will be considered. Furthermore, the communication equipment's distribution, specifications, and administration will be considered.

k. Constructional work estimation data such as labor costs, material unit prices, work efficiency per unit and so on from the collected data which are necessary for construction cost estimation will be organized.

(4) Planning, Design, Cost Estimation

Planning, design and cost estimation shall be carried out based on the materials described in items 1 through 3 above.

a. A review will be undertaken of the existing Master Plan of the Mt. Semeru Sabo Project, and a First-Priority Project will be selected on the basis of urgency of need and maximum degree of effectiveness.

b. A Facilities Plan for the Sabo Plan will be proposed on the basis of sabo dam(s), sand pockets, river channel work and river work.

c. Alternative proposals will be offered as follows for the Sabo Plan: alternative technical proposal, alternative financial proposal, alternative regional emphasis proposal.

d. A Non-Facilities Proposal will be offered relating to the following items: damage, advance warning, evacuation system, restrictions on land access and land use.

e. Basic designs shall be prepared for facilities required for executing the Plan, and a cost estimation shall be prepared.

f. Quantities of material and equipment required for execution of the Plan shall be determined.

g. The manpower requirements of the Plan will be determined.

h. A system for executing the plan, including subsequent maintenance and management, will be studied and a proposal offered.

(5) Sabo Plan Feasibility Study

a. Calculation of the costs involved in construction, maintenance and management will be carried out.

b. The benefits attending the execution of the plan will be clarified with unit price for each item.

c. Economic and financial analyses and evaluations will be conducted.

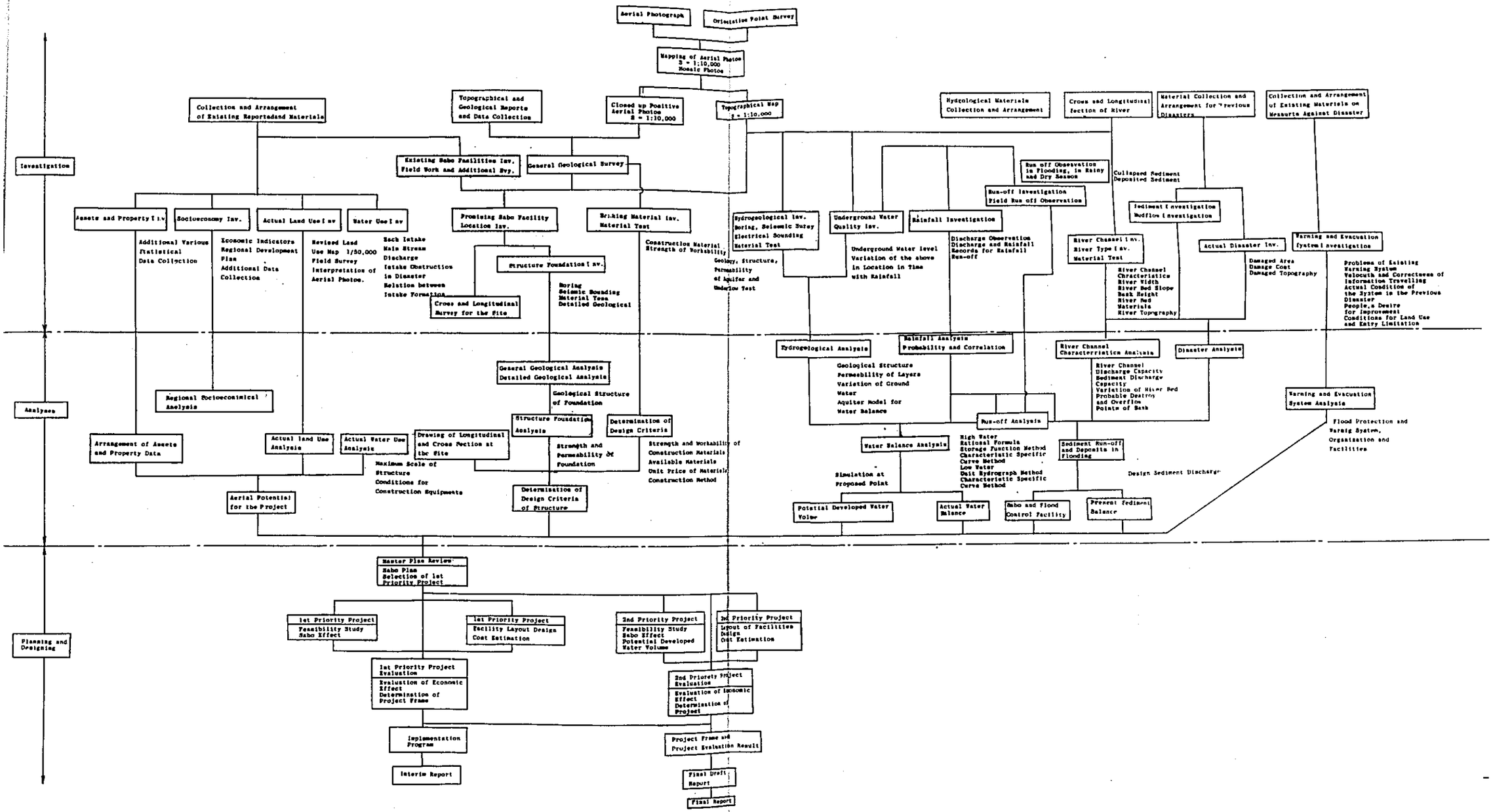
d. An evaluation of the Plan's effect on the social development plan for the area will be made.

e. The social and economic status of the study area will be determined considering the consistency with the basic policy the Indonesian Government.

f. A sociological evaluation of the non-facilities plan will be made, relating to disaster warning plans, restrictions on land access and land use rights, etc.

g. Uncertain factors and their evaluation.

h. The Implementation Program will be prepared for the First-Priority Project. Investigation will be made for two construction methods: direct management and subcontracting. A cost supply study will be made, divided into both foreign and local currencies.


Investigation
Analyses
Planning and Designing
Aerial Photograph
Orientation Point Survey
Mapping of Aerial Photos
S = 1:10,000
Mosaic Photos
Collection and Arrangement of Existing Reportsand Materials
Topographical and Geological Reports and Data Collection
Closed up Positive Aerial Photos
S = 1:10,000
Topographical Map
S = 1:10,000
Hydrological Materials Collection and Arrangement
Cross and Longitudinal fection of River
Material Collection and Arrangement for Previous Disasters
Collection and Arrangement of Existing Materials on Measures Against Disaster
Existing Sabo Facilities Inv. Field Work and Additional Svy.
General Geological Survey
Run off Observation in Flooding, in Rainy and Dry Season
Collapsed Sediment Deposited Sediment
Run-off Investigation Field Run off Observation
Assets and Property I nv.
Socioeconomy Inv.
Actual Land Use I nv
Water Use I nv
Promising Sabo Facility Location Inv.
Boring Material Inv. Material Test
Hydrogeological Inv. Boring, Seismic Surey Electrical Sounding Material Test
Underground Water Quality Inv.
Rainfall Investigation
Sediment Investigation Mudflow Investigation
River Channel Inv. River Type I nv. Material Test
Actual Disaster Inv.
Warning and Evacuation System Investigation
Additional Various Statistical Data Collection
Economic Indicators Regional Development Plan
Additional Data Collection
Revised Land Use Map 1/50,000 Field Survey Interpretation of Aerial Photos.
Each Intake Main Stream Discharge Intake Obstruction in Disaster Relation between Intake Formation
Structure Foundation I nv.
Cross and Longitudinal Survey for the Site
Boring Seismic Sounding Material Tests Detailed Geological
Construction Material Strength of Workability
Geology, Structure, Permeability of Aquifer and Underflow Test
Underground Water Level Variation of the above in Location in Time with Rainfall
Discharge Observation Discharge and Rainfall Records for Rainfall Run-off
River Channel Characteristics River Width River Bed Slope Bank Height River Bed Materials River Topography
Damaged Area Damage Cost Damaged Topography
Problems of Existing Warning System Velocity and Correctness of Information Travelling Actual Condition of the System in the Previous Disaster People,s Desire for Improvement Conditions for Land Use and Entry Limitation
Regional Socioeconomical Analysis
General Geological Analysis Detailed Geological Analysis
Geological Structure of Foundation
Hydrogeological Analysis
Rainfall Analysis Probability and Correlation
River Channel Characterristics Analysis
Disaster Analysis
Geological Structure Permeability of Layers Variation of Ground Water Aquifer Model for Water Balance
River Channel Discharge Capacity Sediment Discharge Capacity Variation of River Bed Probable Destroy and Overflow Points of Bank
Warning and Evacuation System Analysis
Flood Protection and Warnig System, Organization and Facilities
Arrangement of Assets and Property Data
Actual Land Use Analysis
Actual Water Use Analysis
Drawing of Longitudinal and Cross Section at the Site
Structure Foundation Analysis
Determination of Design Criteria
Maximum Scale of Structure Conditions for Construction Equipments
Strength and Permeability of Foundation
Strength and Workability of Construction Materials Available Materials Unit Price of Materials Construction Method
Run-off Analysis
Water Balance Analysis
High Water Rational Formula Storage Function Method Characteristic Specific Curve Method Low Water Unit Hydrograph Method Characteristic Specific Curve Method
Simulation at Proposed Point
Sediment Run-off and Deposits in Flooding
Design Sediment Discharge
Aerial Potential for the Project
Determination of Design Criteria of Structure
Potetial Developed Water Volme
Actual Water Balance
Sabo and Flood Control Facility
Present Sediment Balance
Master Plan Review
Sabo Plan
Selection of 1st Priority Project
1st Priority Project
Feasibility Study Sabo Effect
1st Priority Project
Facility Layout Design Cost Estimation
2nd Priority Project
Feasibility Study Sabo Effect Potential Developed Water Volume
2nd Priority Project
Layout of Facilities Design Cost Estimation
1st Priority Project Evaluation
Evaluation of Economic Effect
Determination of Project Frame
2nd Priority Project Evaluation
Evaluation of Economic Effect
Determination of Project
Implementation Program
Project Frame and Project Evaluation Result
Interim Report
Final Draft Report
Final Report

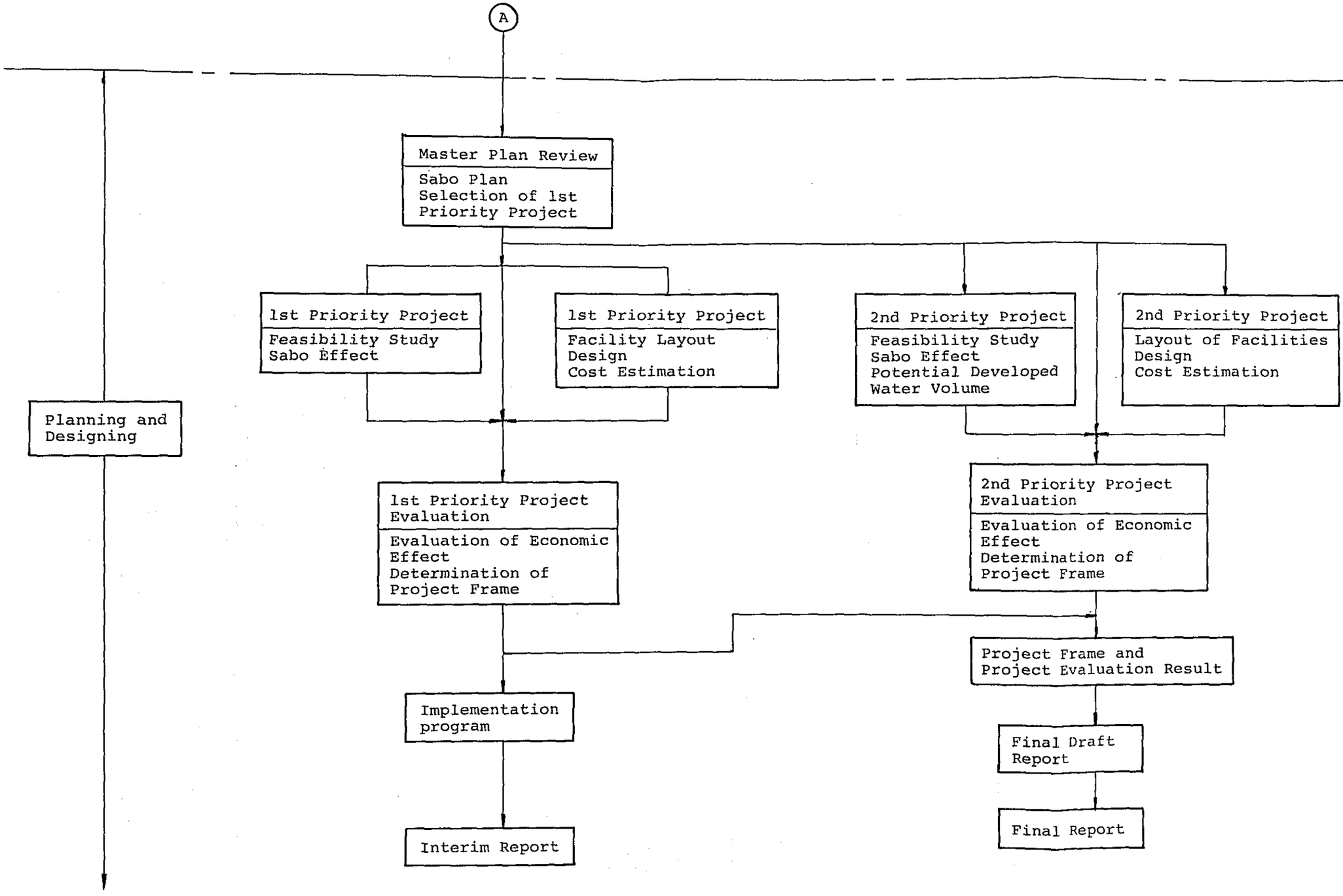


Fig. Flow of the Study (No.2)

IV. ITEMS OF CONSULTATION

The items which require consultation between the Indonesian Government and the JICA Study Team are as follows:

1. Results of the Master Plan Review and Selection of First-Priority Project (tentatively scheduled for July 1982)

   As the First-Priority Project requires preparation of an Implementation Program, the consultation with the Indonesian Government shall be centered upon selection and scope of project area, contents of construction, economic and social effectiveness, and mutual relationship between these factors and other development programs, already planned or now under study, public utility programs and other conditions.

2. Progress Report I Draft (scheduled for September 1982)

   The Progress Report I contains a general outline determining the scope and construction contents of the First-Priority Project. It is designed to serve as supporting report to the Implementation Program. Based on discussed and agreed upon based on a comprehensive analysis including such factors as the Project's social significance, etc.

3. First-Priority Project Implementation Program Outline Draft (tentatively scheduled for November 1982)

   This Outline is to serve as the basis of the Project Aid Proposal. Items to be discussed include the following:

1. Project name
2. Project promoter
3. Location
4. Project purpose
5. Necessity of the project
6. Project features
7. Project cost: foreign/local currency
8. Project benefits
9. Mode of construction (procurement method)
10. Stages of project preparation
11. Construction schedule

4. First-Priority Project Implementation Program Draft (tentatively scheduled for May 1983)

   The following items shall be included in the discussions: Project site, Background, Purpose of necessity, Project description, Technical particulars, Socio-economic effects, Mode of construction, Construction plan and schedule, Project operation, Disbursement schedule of the required fund loan application.

5. Final Draft (tentatively scheduled for November 1984)

   Results of the Master Plan Review

   Final results of the Feasibility Study on the First-Priority Project

   Final results of the Feasibility Study on the Second-Priority Project

   Overall and thorough discussion shall be had since this Draft is the final result and serves as the supporting report for the Implementation Program of the First-Priority Project.

V. WORK BREAKDOWN

1. Work Allocation

The allocation of work items, work periods and main work contents for the Indonesian Government and the JICA Study Team shall be as follows.

INDONESIAN GOVERNMENT	JICA STUDY TEAM
1. Topographical Survey June to November, 1982 River cross-section and longitudinal section survey, Location survey and mapping for boring, seismic survey and electrical sounding, Hydrological observation point, Topographical survey for proposed facility	• Survey point and area • Survey accuracy, survey method • Selection of drawing specifications and technical guidance relating to surveying

INDONESIAN GOVERNMENT	JICA STUDY TEAM
2. Geological Survey, Survey Boring June to September 1982 Total boring length: approx. 130 m	• Field reconnaissance: Selection of boring points, Selection of boring depth, Boring specification • An outline of anticipated specifications is presented separately.
3. Geological Survey, Seismic Survey July 1982 Total length of seismic investigation: approx. 5 km	• Selection of survey lines and specifications based on field reconnaissance • Interpretation of survey results • Technical guidance for survey execution An outline of anticipated specifications is presented separately.

INDONESIAN GOVERNMENT	JICA STUDY TEAM
4. Geological Survey, Electrical Sounding July to September 1982 Electrical sounding to be carried out at approximately 80 points.	• Selection of survey specifications and survey lines based on field reconnaissance • Determination and analysis of survey results • Technical guidance for survey execution • An outline of the anticipated specifications is presented separately
5. Geological Survey, Site Permeability Testing July 1982	• Selection of test points and survey specifications based on field reconnaissance • Interpretation of survey results • Technical guidance for survey execution

INDONESIAN GOVERNMENT	JICA STUDY TEAM
6. Materials and Soil Characteristics Testing July to August 1982 Sampling and testing	• Determination of sampling points • Test methods • Preparation of samples • Arrangement of test results • Technical guidance in testing
7. River Bed Materials Testing July to September 1982 Sampling and sieve analysis	Same as #6 above.
8. Economic Status Survey May to November 1982 Investigation of economic and social status, collection and arrangement of materials	• Selection of necessary material categories • Technical guidance in materials arrangement

INDONESIAN GOVERNMENT	JICA SURVEY TEAM
9. Hydrology Survey, Water Quality Survey August to September 1982 March to April, 1983 Sampling of water quality survey materials Partial water quality investigation	• Selection of sampling points • Determination of time and method of sample collection • PH meter measurement • Technical guidance in data arrangement
10. Hydrology Observation March 1982 to June 1984 Water level and discharge observation, Underground water level observation, Rainfall observation	• Selection of observation points • Technical guidance relating to observation method and data analysis methods

2. Outline of Specifications of Work to be Performed by Indonesian Government

In accordance with VI. 2 of the Scope of Work, the following concerns the boring survey, electrical sounding and seismic investigation from among those parts of the field investigation which are to be performed by the Indonesian Government.

(1) Boring Survey

a. Objectives

- Confirmation of Lithology
- Verification of Electrical Sounding and Seismic Survey
- Confirmation of Underground Water Level

b. Location

i) Pronojiwo (Sabo Dam Planning Site)

ii) Kobokau (Sabo Dam Planning Site)

iii) Middle Reach of K. Lengkong

iv) Two points of proposed ground sill points in K. Mujur.

c. Quantity

Dam Sites	30m/hole x 2 holes =	60m (Lengkong. Kobokan)
River Sites	20m/hole x 2 holes =	40m (K. Mujur)
Underground water graben	30m/hole x 1 hole =	30m (K. Lengkong)
	Total	130m

d. Method

Because boring test points are located at the foot of a volcano, a gravel layer with boulders is anticipated.

With casing, boring shall be performed using the telescopic method shown in the accompanying figure.

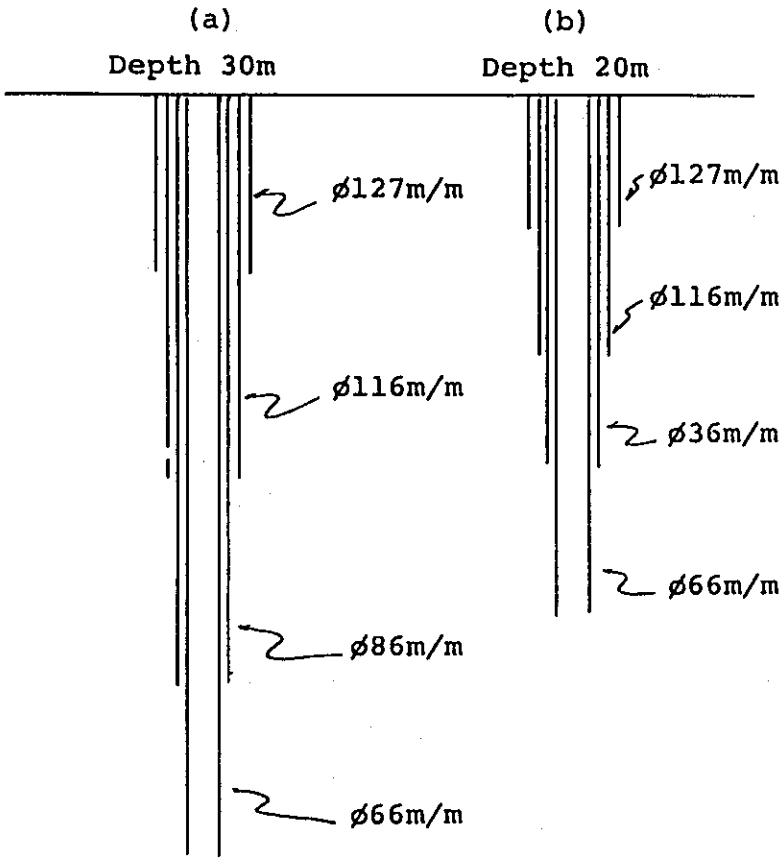


Fig. Installation of Protective Casing

Bore hole diameters and casing lengths are as follows:

a. Depth : 30 m

Bore Hole Diameter	Boring Length (m)	Casing Length (m)
ϕ 127 mm	6.0	6.0
ϕ 116 mm	9.0	15.0
ϕ 86 mm	12.0	27.0
ϕ 66 mm	3.0	-

b. Depth : 20 m

Bore Hole Diameter	Boring Length (m)	Boring Length (m)
ϕ 127 mm	4.0	4.0
ϕ 116 mm	6.0	10.0
ϕ 86 mm	8.0	18.0
ϕ 66 mm	2.0	-

The casing shall be extracted after finishing boring. After the casing is extracted, PVC pipes (ϕ 65 mm; VP-65) shall be inserted at full length.

(2) Electric Sounding

a. Purpose of Study

Rough estimation of hydrogeological structure

b. Location

i) Natural sand pocket (underground water graben) in K. Lengkong

ii) Vicinity of elevation of 750 m between K. Mujur and K. Rejali

iii) 2 of the proposed ground sill points in K. Mujur

c. Quantity

Section i)	:	39 points
Section ii)	:	22 points
Section iii)	:	16 points
Total	:	77 points

d. Method

Arrangement of Electrode	:	Wenner's Four Electrode Method
Sounding Depth	:	100 m
Sounding Equipment	:	E5-G2-type Specific Resistibility Meter

(3) Seismic Exploration

a. Study Objectives

Rough estimation of foundation of structure

b. Location

i) Pronojiwo : Planned site of sabo dam

ii) Kobokau : Planned site of sabo dam

c. Quantity

Along Dam Axis	:	Survey line of 1 km x 2 x 2 Sites = 4 km
Vertical with Dam Axis	:	Survey line of 0.5 km x 1 x 2 Sites = 1 km
Total	:	5 km

d. Method

Survey Point Spacing	:	10 m
Explosion Point Spacing	:	50 m
Survey Depth	:	40 - 50 m
Measuring Equipment	:	TR-4, 24 Components

e. Application Procedures for Permission to Use Explosives

Application for permission to carry out seismic surveys and to use explosives as well as all related procedures shall be carried out by the Indonesian Government.

3. Outline of Existing Studies

(1) Main Reports

a. Report on Mt. Semeru Activities & Disaster

Ir. Praktek, 1952, (Written in the Indonesian language)

This book includes an introduction to a book regarding erosion control engineering, general description of volcanic activities, and collection of disaster records which was published in Germany in 1903. A large number of related materials are collected in this book as a general reference for disaster prevention. This book is valuable because of disaster records in earlier times.

b. Preliminary Survey Report on the Volcanic Debris Flow T. Matsushita, 1975

The study report of the mudflow disaster which occurred in the Rejali and the Lengkong Rivers in September, 1975. The report was made on the viewpoints related to the measures against the transition of river channel conditions caused by the mudflow.

c. Laporan Kegiatan dan Masalah Gn. Semeru

Direktorat Sungai, DG..W.D., P.U., 1978 (Written in the Indonesian language)
(Report on Mt. Semeru's Activities & Problems)

This report outlines the rivers in the area which is the subject of the study of this time, Mt. Semeru's geological activities, disasters, and erosion control work plans to be executed in the future. This is the report on erosion control program at time when the Mt. Semeru project started.

d. Survey Keadaan Umum Sosial Ekonomi di Daerah Sekitar

Gunung Semeru di Kabupaten Lumajang

Universitas Brawijaya, Malang, 1978

(Survey on General Social & Economic Situations in the Vicinity of Mt. Semeru in Lumajang Prefecture; Brawijaya Univ., Malang, 1978)

This is the report on the study implemented based on the Mt. Semeru Sabo Project Office's request to Brawijaya University at the time when the Mt. Semeru Project by the Ministry of Public Works started. This is a well-written report with wide-spread study in the fields of sociology and economy in general.

e. Preliminary Study Report on Disaster Prevention Works in Mt. semeru and Its Vicinity in East Java, Republic of Indonesia, Ministry of Construction and International Construction Engineering Association, 1981.

With regard to the mudflow disaster on the south-eastern slope of Mt. Semeru, the study was done concerning the socio-economic conditions, the present time disaster prevention measures and their problems, and basic policies for disaster prevention measures required in the future. Consideration on the optimum investment amount is made in this report.

f. Report of the Advisory Team on the Guidance for Mt. Semeru Project, JICA, 1981

On 14 May, 1981 when the JICA mission was conducting a site survey for the purpose of providing a guidance to be the basis of the Mt. Semeru Project Master Plan and for an advisory service, and enormous mudflow happened causing a serious disaster. The study mission could witness the mudflow directly.
The report mainly consists of the valuable reports on the occurrence, flowing down, and depositing of the mudflow through the observation at that time, and measures against such a disaster is described.

g. Preliminary Study Report for Volcanic Debris Control & Water Resource Conservation Project in Mt. Semeru JICA, 1982

This is a preliminary study report for the study of this time, and proposals for the selection of study items, major viewpoints, and contents and methods of the study are given in the report.

Well written major reports related to the study in this site are as mentioned above.

(2) Position of Existing Main Reports

Report "a", which contains years of disasters in early times, is helpful together with the rainfall study, the disaster study, and the disaster records mentioned in 5), for the frequency of disaster occurrence and estimation of economic effects.

Report "b" serves as the basis for considering the sabo and flood control functions in relation to the river form study and measures concerning river channel study.

Report "c", actually, is a master plan. Currently, a new master plan is being made by a consulting firm in Surabaya as part of Mt. Semeru Project. According to the presently obtained information, nothing has been completed except Basuk Sat. Therefore, this is indispensable for reviewing the master plan.

Regarding Report "d", detailed socio-economic study has been done, and, therefore, the basis for this field can be said to have been completed with this. It is possible to say that the outline has been mostly completed if the recent price statistics, the relations between the agricultural water intake amount and agricultural production, and this region's development programs are additionally studied.

Report "e" provides necessary data for selecting the project site for the first-priority project, selecting the project feature, and briefly estimating the project costs.

Report "f" is useful for setting the viewpoint of mudflow study and selecting the damaged area.

Report "g" is important as a basic material for setting the specifications for the study of this time. The method is very authodox.
In this study, the master plan will be reviewed by means of a three-month field study, and the implementation program of the first-priority project must be completed by proceeding the sabo planning, designing for construction, construction cost estimation, and economic effect estimation through the 6 months of study in Indonesia and about 3 months of domestic work (9 months in total). If so, it is considered that the method using the aerial photograph does not meet the time requirement.
Therefore, necessary study related to the topography in the project site and its vicinity might as well to be proceeded by limiting the scope of the study and by simultaneously proceeding with field study and photograph interpretation.

(3) Materials to be Needed

- Data and materials of identical rainfall's amount and flow rate
- Run-off analysis report of the rivers in the project area and similar rivers
- Geological map and geological survey report
- Explanation and reports on the land use map
- Topographical survey report
- Data, statistics, and reports related to amount of water for irrigation
- Statistics and reports concerning the recent agriculture
- Statistics and reports regarding the recent socio-economic indices
- Socio-economic development plan

- Regional development plan
- Data and statistics regarding the public work investment in different regions
- Up-to-date labor costs and material-and-equipment prices for calculating the construction costs
- Construction cost calculation criteria
- Feasibility study reports in near-by areas
- Mt. Semeru Project master plan

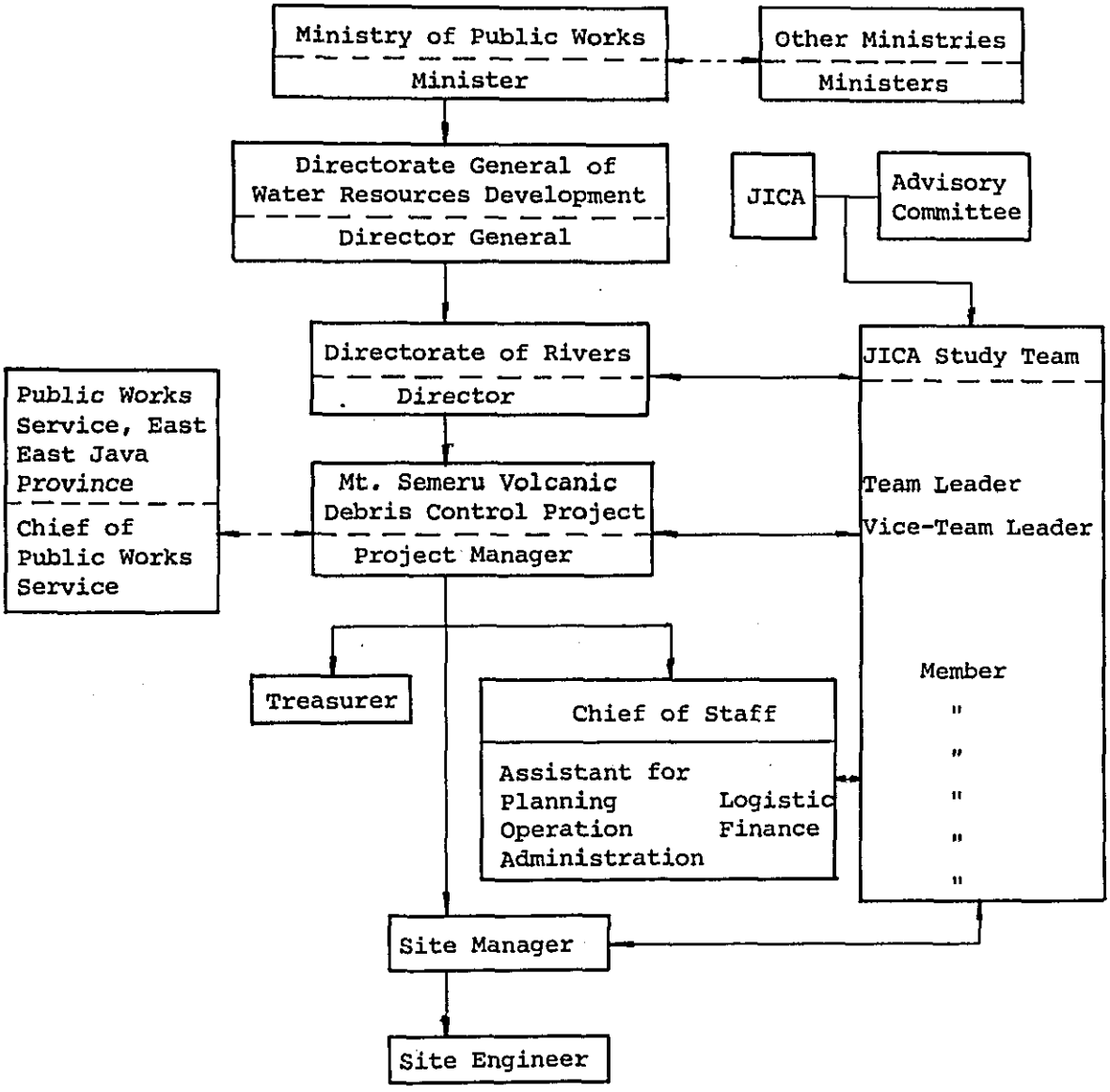
VI. WORK EXECUTION SYSTEM

1. Work to be Performed by the Indonesian Government and JICA.

Refer to the Minutes of Meeting on the Scope of Work on this Feasibility Study as described in Appendix (1) and Appendix (2.)

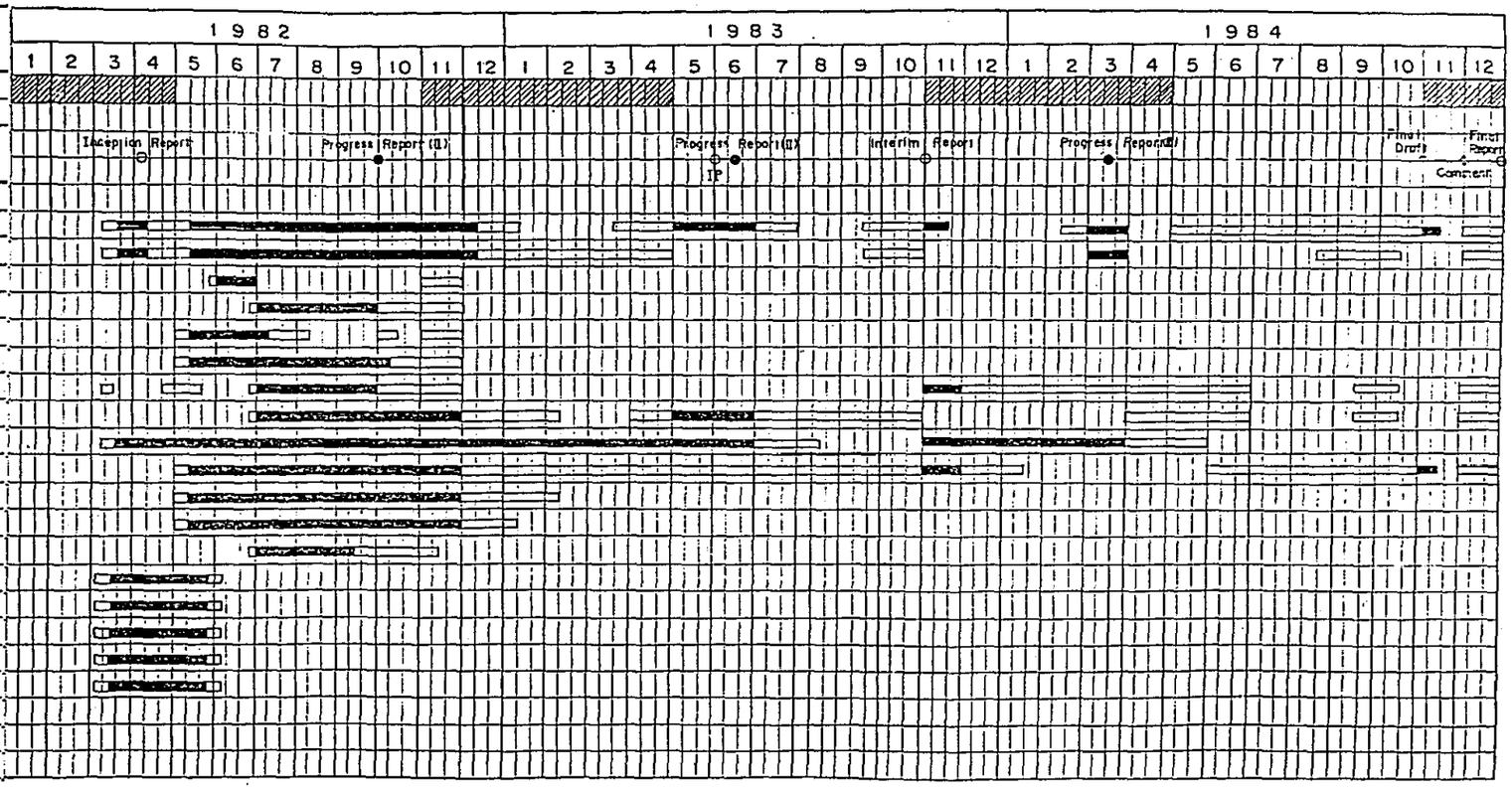
2. Organization

Organization of Mt. Semeru Debris Control & Water Conservation Study



3. Assignment Schedule (Tentative)

Site Study Team & Japan-side Personnel List			
		Rainy Season / Dry Season	
		Months after Contract	
		Report to be Submitted	
Speciality		Name	Grade
Team Leader	General Management, Sabo Plan	Koichi Hirao	I
Sub-team Leader	Socialogy, Economy	Kazuo Mizue	I
Member	Economy	Masaki Kobayashi	V
"	Water Conservation	Toru Takahashi	V
"	Geology, Soil	Nobuhiko Uchiseto	II
"	Land Condition	Yosuke Sasaki	V
"	Ground-Water	Yoshiyuki Uemura	IV
"	River	Masatomo Watanabe	IV
"	Hydrology	Hidetoshi Kanamura	V
"	Sabo Facility	Yoshifumi Shimoda	IV
"	Disaster Study, Land Use	Kazuo Ikeda	IV
"	Mud-flow	Shuji Hamana	VI
"	Physical Exploration	Minoru Nakazawa	IV
"	Survey	Hitoshi Koami	III
"	"	Hiroyuki Koshikawa	IV
"	"	Akito Yasuda	IV
"	"	Masumi Ikuno	V
"	"	Mitsuaki Matsuzaki	V



VII. REPORTS

JICA Survey Team will submit the following reports to the Indonesian Governments.

List of Reports to be submitted

Kind of Report	Time of Submission	Contents	Number of Report
Inception Report (this report)	Mar. 1982	Plan for the feasibility study	50
Progress Report (I)	Sep. 1982	1. Interim report on the review of Sabo Master Plan 2. Interim report on the selection of the First-Priority Project from among the Sabo Plans	50
Implementation Program	May 1983	Implementation Program for the First-Priority Project	50
Progress Report (II)	June 1983	1. Interim report on the results of data analysis 2. Interim report on the feasibility study of the First-Priority Project	50
Interim Report	Oct. 1983	Final report on the feasibility study of the First-Priority Project	50

Kind of Report	Time of Submission	Contents	Number of Report
Progress Report (III)	Mar. 1984	1. Interim report on the results of data analysis 2. Interim report on the Second-Priority Project	50
Draft Final Report	July 1984	1. Review of Sabo Master Plan 2. Feasibility report on the First-Priority Project 3. Feasibility report on the Second-Priority Project	50
Final Report	Sep. 1984	Ditto	70

Appendix

Appendix (1)

MINUTES OF MEETING
ON
THE SCOPE OF WORK FOR THE FEASIBILITY STUDY
OF
THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH - EASTERN SLOPE OF MT. SEMERU IN THE REPUBLIC OF INDONESIA.

The preliminary Study Team of Japan International Cooperation Agency (JICA) for the Volcanic Debris Control and Water Conservation Project in the South - Eastern Slope of Mt. Semeru and the Directorate of Rivers of the Directorate General of Water Resources Development, Ministry of Public Works, the Government of the Republic of Indonesia exchanged their views on the draft of Scope of Work for the said Feasibility Study prepared by the JICA Team.

Both parties agreed with some modifications to the draft and finalized the Scope of Work (refer to the attachment) with the following understandings:

1. The Government of Indonesia will undertake additional aerial photo - taking of 1:10,000 scale covering surrounding area of Kota Lumajang totalling about 85 km^2 and retaking of a part of the existing aerial photo prepared by the Government of Indonesia which is not sufficient for mapping required for the feasibility study.
2. The Government of Indonesia requests JICA to present all reports concerning the study two weeks before the date of discussion.
3. JICA shall provide necessary vehicles for the implementation of the study. In case JICA is not able to provide the vehicles sufficiently, the Government of Indonesia will make its best efforts to fulfill the remaining requirement.

4. With regard to the training of Indonesian counterpart in Japan, the Government of Indonesia expressed its request that JICA shall provide opportunities for training in Japan especially during the period of study work in Japan.

5. Based on the request of the Government of Indonesia, JICA shall provide the following hydrologic and hydraulic equipment:
   - 3 automatic recording rain gauges,
   - 11 automatic recording water level gauges,
   - 2 portable water level gauges, and
   - water level gauging staffs totalling 15 m length.

6. The Government of Indonesia shall install the above equipment at the places as recommended by the Team as soon as possible.

7. The Government of Indonesia will carry out appropriate operation and maintenance including data collection of the above equipment in accordance with the manuals concerned.

8. The Government of Indonesia will collect the data of rainfall and discharge of Kali Bondoyudo, which will be further analysed by the Study Team for the purpose of formulation of the rainfall and discharge relationship needed for the water resources potential study.

9. The Government of Indonesia shall conduct underground water level survey once a week by using portable water level gauges at the key wells, neighbouring wells, and the surrounding areas, to obtain underground water level contour line for the study of potential underground water development.

10. The Government of Indonesia will send the negative and positive areal photo film of the study area to the JICA Team through the Japanese Embassy at the latest on the middle of January, 1982, provided that it is in accordance with the Indonesian security regulation.

11. The JICA Team will prepare the recommendation for the Implementation Programme by the end of May, 1983.

12. The JICA Team will carry out the study of the forecasting and warning system in the study area.

13. The Government of Indonesia strongly requests to the JICA Team to make its best effort to accelerate the study in such a way that the implementation of the disaster prevention works proposed by the study will become the continuation of the urgent rehabilitation works.

Jakarta, December 18, 1981.

Mr, Masayuki Watanabe,
Leader of JICA Preliminary
Survey Team for the
Feasibility Study of the
Volcanic Debris Control
and Water Conservation
Project in the South -
Eastern Slope of Mt. Semeru,
Government of Japan.

Ir. Putra Duarsa,
Director of Rivers,
Directorate General of
Water
Resources Development,
Ministry of Public Works,
Government of Indonesia.

SCOPE OF WORK
FOR
THE FEASIBILITY STUDY
ON
VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTH EASTERN SLOPE OF MT. SEMERU
IN
THE REPUBLIC OF INDONESIA

BETWEEN

JAPAN INTERNATIONAL COOPERATION AGENCY

AND

DIRECTORATE OF RIVERS

DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MINISTRY OF PUBLIC WORKS

December, 1981

Appendix (2)

SCOPE OF WORK
FOR
THE FEASIBILITY STUDY
ON
VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT
IN THE SOUTH EASTERN SLOPE OF MT. SEMERU
IN
THE REPUBLIC OF INDONESIA

I. INTRODUCTION

In response to the request made by the Government of the Republic of Indonesia, the Government of Japan has decided to assist the Government of Indonesia, in accordance with laws and regulations in force in Japan, to conduct a Feasibility Study on the Volcanic Debris Control and Water Conservation Project in the South Eastern Slope of Mt. Semeru (hereinafter referred to as "the Study").

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for Implementation of technical cooperation programs of the Government of Japan, will carry out the Study in close cooperation with the authorities concerned of the Government of Republic of Indonesia.

The following scope of works was set forth, based on the Terms of Reference prepared in November 1980 and the result of the JICA's preliminary survey carried out in December 1981.

II. OBJECTIVES OF THE STUDY.

The objectives of the study are:

1. To verify the feasibility of the disaster prevention plan as selected sites.

2. To formulate a land and water conservation plan, and

3. To improve the capability of the Indonesian counterpart personnel.

III. STUDY AREA

The study area covers the south eastern slope of Mt. Semeru extending the area of 730 km^2, and their surrounding area, namely Kali Mujur, Kali Rejali, Kali Glidik, Kota Lumajang, part of Kabupaten Lumajang, Pasirian, Candipuro and Tempeh in East Java Province. (See attached map).

IV. SCOPE OF THE STUDY

The activities to be undertaken in the Study are as follows:

1. Map Preparation (Phase I)

   Terrestrial survey and mapping with a scale of 1/10,000 covering the Study area.

2. Main Study (Phase II)

   1). Collection of existing data and information.
   - a. Hydrology and hydraulics.
   - b. Meteorology.
   - c. Geology and geomorphology.
   - d. Regional economy.
   - e. Damage and behavior of sediment and flood.
   - f. Construction cost and construction materials.
   - g. Others.

   2). Field Survey.
   - a. Terrestrial survey.
   - b. Geological survey.
   - c. Soil survey.
   - d. Hydrological and hydraulic survey.
   - e. Survey on river condition.

f. Survey on sediment and flood area.
g. Survey on present land use.
h. Survey on present water use.
i. Others.

3). Study and Analysis.
a. Review of the Master Plan prepared by the Government of Indonesia, other materials relevant to the Study and on-going projects.
b. Regional economy.
c. Hydrology, hydraulics, sedimentation and erosion.
d. Potential of land and water resources development.
e. Land and water conservation plan.
* Land classification with respect to vulnerability and productivity.
f. Disaster prevention plan.
* Structural and non-structural measures.
g. Preliminary design of disaster prevention facilities.
h. Construction materials, labour force, construction method, and equipment.
i. Organization for the implementation.

4). Verification of feasibility for disaster prevention plan.
a. Estimation of costs for construction, operation and maintenance.
b. Estimation of benefits.
c. Economic and financial evaluation.
d. Social and evnvironmental aspect.
e. Implementation schedule.

V. REPORTS

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

1. Inception Report.

   * Thirty (30) copies at the beginning of the Study.

2. Progress Report I.

   * Thirty (30) copies at the end of September 1982.

   Progress Report II.

   * Thirty (30) copies at the end of the first works in Indonesia.

3. Interim Report.

   * Thirty (30) copies at the end of the first works in Japan.

   * Discussion on the Interim Report will be held after the submission.

4. Progress Report III.

   * Thirty (30) copies at the end of second works in Indonesia.

5. Draft Final Report.

   * Thirty (30) copies within four (4) months after the commencement of the second works in Japan.

   * The Government of the Republic of Indonesia will provide JICA with its comments within one (1) month after the discussion on the Draft Final Report.

6. Final Report.

   * Fifty (50) copies within two (2) months after the receipt of the comments on the Draft Final Report from the Government of the Republic of Indonesia.

VI. UNDERTAKING BY THE GOVERNMENT OF THE REPUBLIC OF INDONESIA.

For the purpose of the Study, the Government of the Republic of Indonesia will undertake.

1. To provide the Japanese Study Team with available data, information and materials concerned for its use in connection with the Study and to arrange the Team access to such sources of information as are considered necessary for the execution of the Study.
2. To carry out such works as terrestrial survey, geological survey, material and soil test, hydrological observation and economic situation survey.
3. To secure permission for entry into private properties and restricted area in connection with the field survey, according to prevailing Government of Indonesia regulations.
4. To exempt the Team from any taxes and duties for materials, equipment and personal effects necessary for the study performance which are to be brought into Indonesia by the Team.
5. To assign counterpart personnels and clerical staffs to the Team during the Study period.
6. To provide the Team with suitable office space with necessary equipment and services for the Study (in Jakarta and the project site).
7. To make arrangements for accommodations for the team should be paid by the team.
8. To provide drivers, fuel and maintenance cost for vehicles to be provided by JICA, and other survey equipment necessary for the Study.
9. To provide fund for local counterpart slaries assigned to the Study and operational cost.

10. To provide any other available facilities that may be required for the execution of the Study.

11. To allow the team to use necessary frequency band for transceiver, in accordance with the permission of the Government of Indonesia.

12. To assist the team a quick access to medical services during its stay in Indonesia, if requested.

13. To make arrangements for the team to take all data, maps and materials concerned including aerophoto out of the Republic of Indonesia to Japan according to the regulation in Indonesia, and they will be used only for the purpose of the Study, and

14. To bear claims if any, against the Study occurring in course of, or otherwise connected with the discharge of their official functions in the Republic of Indonesia, except for those claims arising from the wilfull misconduct or gross negligence of the team members.

VII. UNDERTAKING BY JICA

For the purpose of the Study, JICA will undertake.

1. To send the Japanese Study Team to conduct the Study.
2. To make maps necessary for the Study (scale:1/10,000).
3. To carry out on-the-job training and transfer of knowledge to the Indonesian counterpart personnel in Indonesia and Japan during the Study period, and
4. To provide vehicles and equipment necessary for the efficient implementation of the Study.

VIII. STUDY SCHEDULE

The whole work will be conducted in accordance with the attached schedule.

TENTAT STUDY SCHEDULE

ACTIVITY \ Year / Month	1982												1983												1984											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
*Phase I (Mapping)																																				
Work in Indonesia	⊢	—	—	—	—	⊣																														
Work in Japan				⊢	-	-	-	-	-	⊣																												
*Phase II (Main Study)																																				
Work in Indonesia	⊢	—	—	—	—	—	—	—	—	⊣			⊢	—	—	—	—	—	—	—	—	—	⊣		⊢	—	—	—	—	⊣						
Work in Japan																		⊢	-	-	-	-	-	⊣						⊢	-	-	-	-	-	-	-	⊣
Inception Report	o																																			
Progress Report									o (I)							o I/P					o (II)									o (III)						
Interim Report																							o													
Draft Final Report																																	o			
Comments on Draft Final Report																																		o		
Final Report																																			o