CHAPTER II

II. PROJECT EFFECT

2.1 Technical Particularity

2.1.1 Risk Analysis and Identification of Zoning Area

Devastation due to mud/debris flows on the slope of Mayon Volcano was studied by field observation and comparative interpretation of aerophotos taken in 1980 and 1982. Based on these data, the risk analysis including the devastation area due to mud/debris flows were carried out. The devastation area by mud/debris flows at the foot of Mayon Volcano amounts to 1,329 ha in 1980 and 1,767 ha in 1982 as summarized below. The devastation area by mud/debris flows even before 1980 is also abstracted by the microrelief and vegetation of the area.

Devastation Area in 1980 and 1982

River Basin	Area in 1980 (ha)	Area in 1982 (ha)	Increase of Area (ha)
Quinali (A)	788	974	186
Quinali (B)	40	42	2
Yawa	271	430	159
East and Northeast	230	321	91
Total	1,329	1,767	438

Remarks: Quirangay, Tumpa, Maninila, Masarawag, Ogsong and Nasisi Rivers in the Quinali (A) River basin, Anuling, Budiao and Pawa-Burabod Rivers in the Yawa River basin, Buyuan, Matanag and Basud Rivers in the East & Northeast area.

General conditions of the devastation in the project area are described in the following paragraphs.

(a) Even before the 1981 disaster, the rivers running along the SE-SW side of the slopes of Mayon Volcano had suffered from devastation as a result of past mud/debris flows to a more marked degree than those running along the other sides.

(b) Similarly, large accumulations of mud and debris are observed in the beds of rivers running along the SE-SW side of the volcano's slopes even before the 1981 disaster. These seem to be caused by Mayon Volcano's eruptions in 1968 and 1978.

(c) There is no significant change in the lava flow and pyroclastic deposits located above EL. 1,500 m on the slopes of Mayon Volcano. It is not conceivable, therefore, that these phenomena are attributable to the mud/debris flows which occurred in 1981.

(d) The following rivers were seriously affected by the 1981 mud/debris flows: Anuling River; Budiao River; Pawa-Burabod River. The Ogsong River was affected to a moderately serious degree.

(e) Mud and debris flowed and spread along each of the above rivers in areas below EL. 150 m (downstream of the Provincial Road). However, areas upstream of the Provincial Road were devastated in the Anuling 2 and Ogsong Rivers. In addition, river channel erosion occurred along the Ogsong River below the Provincial Road.

(f) The following rivers were slightly affected by the 1981 mud/debris flows: Quirangay River; Maninila River; Masarawag River; Nasisi River.

(g) Large accumulations of mud and debris are observed in sections of these rivers between EL. 350 m and EL. 500 m. The gradient of the river bed in each case is approximately 10 degrees.

(h) Ground water emerges as surface water between EL. 100 m and EL. 200 m and gushes down the slopes across the Provincial Road. The gradient of the river beds is approximately 3 degrees.

(i) A feature of Mayon Volcano is its alternate accumulations of lava flows with a relatively high consolidation (average thickness: 2-3 m) and pyroclastics with a relatively low consolidation.

Specifically, where pyroclastic material is deposited under a lava flow, the pyroclastic material is first washed out allowing the lava flow to slide downwards under its own weight. This results in deeper and more widespread devastation of the gullies.

Risk analysis was carried out by the results of the study for danger zones and safety zones. Also shelter zones up to 20 places have been selected around the main villages. In addition to the shelter zones, the emergency evacuation areas were selected temporarily in the project area.

The identification of zoning area was made according to the following criteria, and Danger Zone Map for Mud/debris Flow (Scale: 1/50,000) was prepared in this section.

(a) Danger zones

These zones are defined to be the areas where the traces of mud/debris flows are clearly identified in and before 1979 and 1981. The areas extending from either the end point of gully or the top of fan down to the boundary with alluvial plain, even where the traces of mud/debris flows are not clearly recognized, are defined as danger zones. The railway, roads and river channels are also taken as boundaries.

(b) Safety zones

These zones are selected outside the above danger zones where gullies upstream are not developed. Furthermore, these zones are mainly selected based on the safety against mud/debris flows and mud flows. However, the disasters due to volcanic activities are not considered in selection, since the forecasting of disaster due to lavas, volcanic ejecta, growing clouds, heat mud flows, etc. is very difficult.

(c) Shelter zones

These zones are selected mainly against mud/debris flows excluding volcanic activities. However, the selection and delineation of the area is made based on the topographic conditions due to interpretation of aerophotos. The selection of shelter zones is made under the following conditions;

- The shelter zone shall not be selected within the danger zones in principle.
- If the shelter zone is selected on hills within the danger zones, the safety is carefully studied and confirmed against disasters due to mud/debris flows, flood inundation and landslides.
- The sheleter zones shall be selected at the places in and near the barangays and the municipalities to ensure the relief activities.

(d) Emergency evacuation areas

In addition to the shelter zones, emergency evacuation areas are selected temporarily by only interpretation of aerophotos. The selection of these areas are made under the following conditions in addition to these for shelter zones;

- Areas are selected as a temporary and emergent areas for the evacuation activity due to mud/debris flows.

- Areas are located in and near barangays, and are with road connection.

Significant mud/debris flows are observed along rivers on the south and southwest sides of Mayon Volcano. The rivers affected by mud/debris flows are the Anuling, Budiao, Pawa-Burabod, Ogsong and Nasisi Rivers.

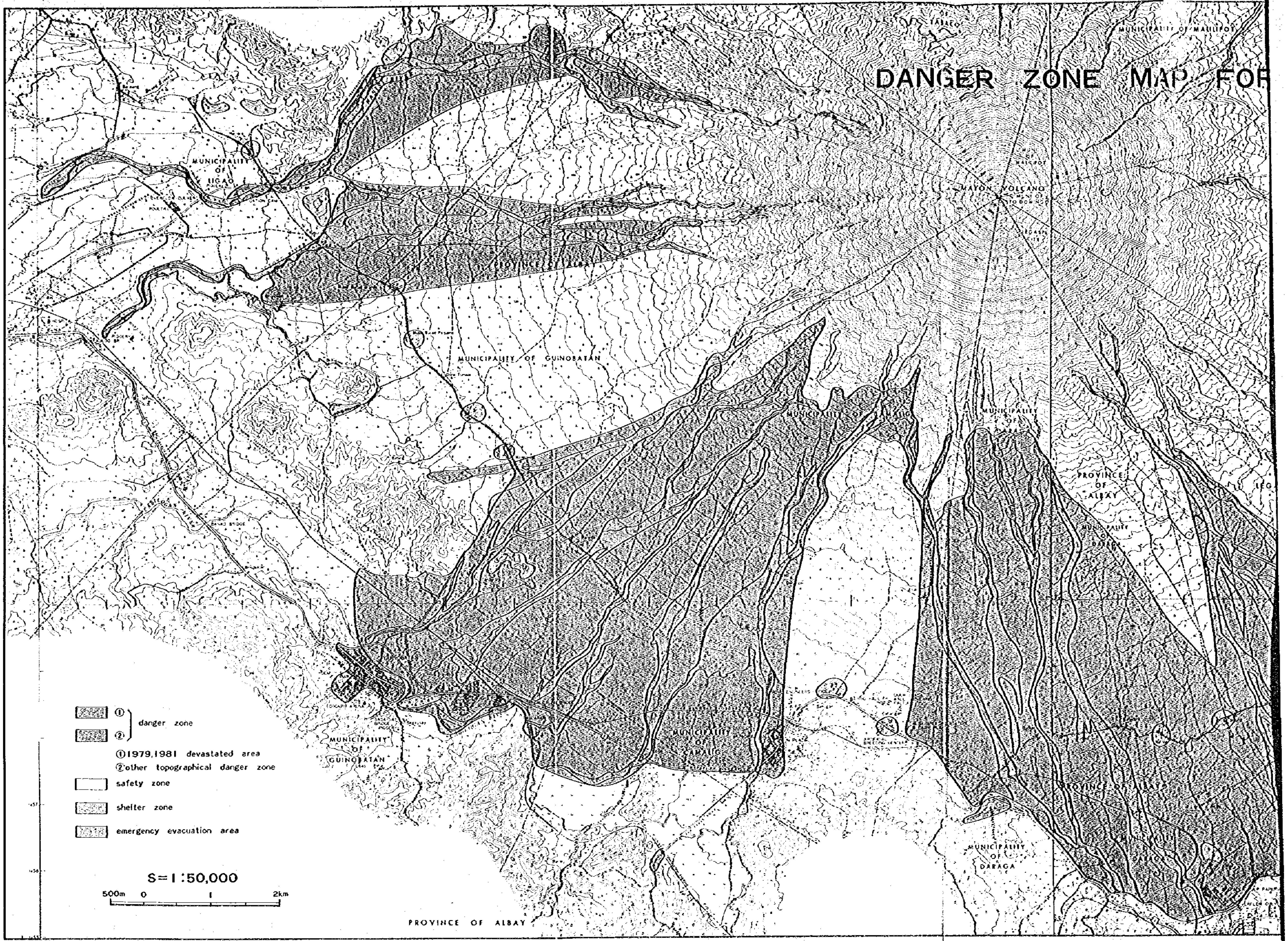
Aerophotos taken in 1980 and 1982 show that the areas affected by mud/debris flows extend down to the lower terrain and alluvial plains. However, the incidence of damage as a result of mud/debris flows is apparently limited to the end of the fan areas, where the gradient is 2-3 degrees. Also, some alteration is observed in river channels within the fan area before and after the disasters.

The conditions described above are a further indication that similar danger exists throughout the area around Mayon Volcano. The lower reaches of rivers which have been subject to mud/debris flows and to devastation of gullies in their upper reaches, are particularly risky.

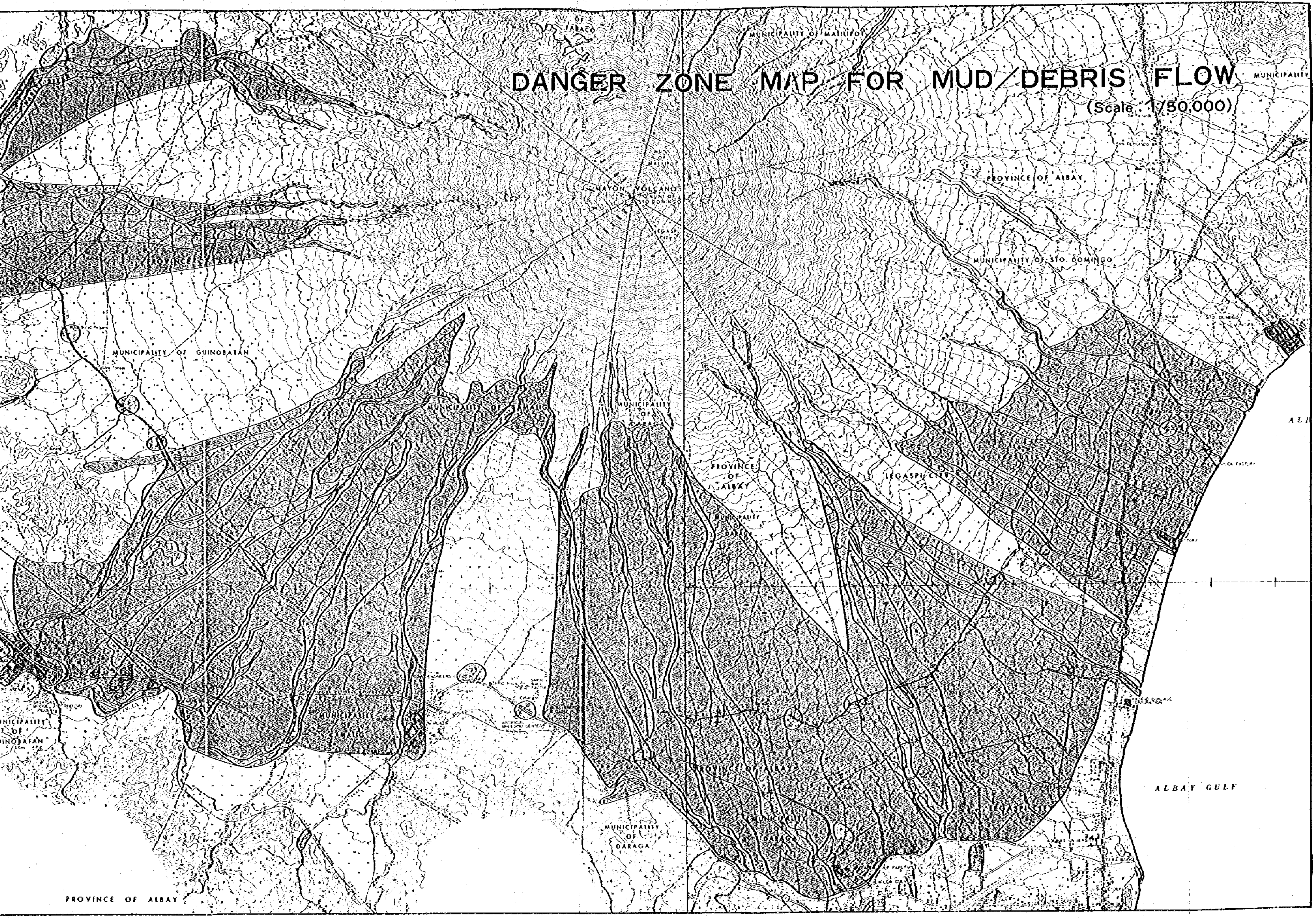
On the basis of the risk analysis described above, areas unaffected by mud/debris flows and where there is no devastation of gullies in the upper reaches of rivers are designated safety zones. In addition to the areas around Mayon Volcano, other safety zones exist at the end of the north and east fans, around the Yawa River and Maharlika National Highway in the south, and in the mountainous area adjoining the SW-NW side of the volcano and within the reaches below approximately EL. 100 m of the Nasisi and the Ogsong Rivers.

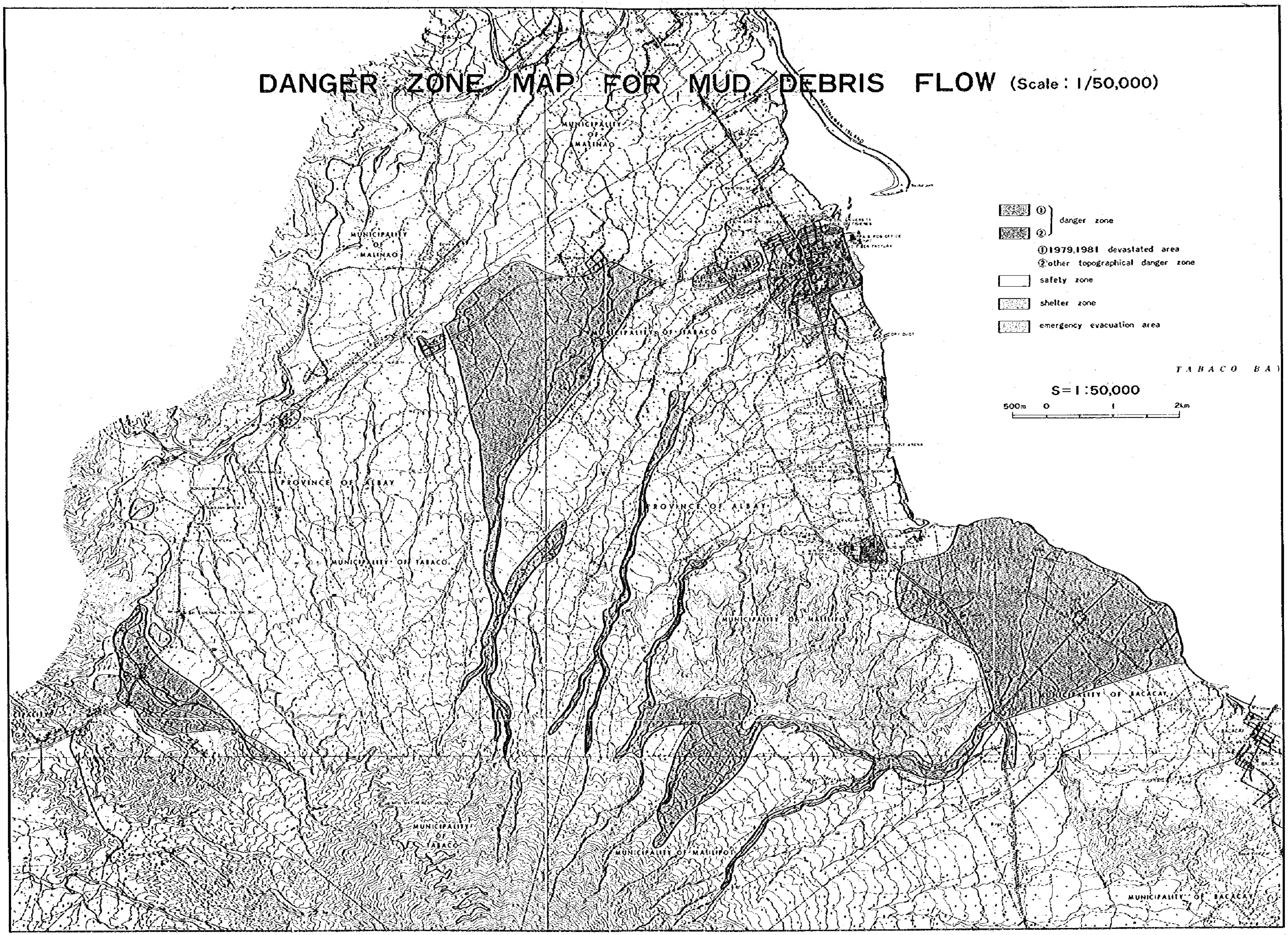
In villages where devastation by mud/debris flows is likely, shelter zones and emergency evacuation areas are selected. As a rule, these must have suitable houses and facilities for refuges. Where such areas are too distant, however, tablelands free from the risk of mud/debris flows, flooding and devastation are selected instead even within the danger zones. The shelter zones and emergency evacuation areas should be finally established in due consultation with the relevant authorities and by further study for the above criteria.

Prior to establishment of the shelter zones, emergency evacuation areas and the proposed disaster prediction and warning system, the possibility and information of the disaster due to mud/debris flows shall be first disseminated to inhabitants in the project area through circular notice, congregation, poster column, etc.



DANGER ZONE MAP FOR
MUNICIPALITY OF MALILIPOT
MUNICIPALITY OF LIGAO
MAYON VOLCANO
PROVINCE OF ALBAY
MUNICIPALITY OF GUINOBATAN
MUNICIPALITY OF CAMALIG
MUNICIPALITY OF DARAGA
PROVINCE OF ALBAY
MUNICIPALITY OF CAMALIG
MUNICIPALITY OF GUINOBATAN
MUNICIPALITY OF DARAGA
PROVINCE OF ALBAY
① } danger zone
②
①1979,1981 devastated area
②other topographical danger zone
safety zone
shelter zone
emergency evacuation area
S=1:50,000
500m 0 1 2km


DANGER ZONE MAP FOR MUD/DEBRIS FLOW
(Scale 1/50,000)
MUNICIPALITY OF MALILIPOT
MAYON VOLCANO
PROVINCE OF ALBAY
MUNICIPALITY OF STO. DOMINGO
MUNICIPALITY OF GUINOBATAN
MUNICIPALITY OF DARAGA
LEGASPI CITY
PROVINCE OF ALBAY
ALBAY GULF
PROVINCE OF ALBAY



DANGER ZONE MAP FOR MUD DEBRIS FLOW (Scale: 1/50,000)
① ② danger zone
①1979,1981 devastated area
②other topographical danger zone
safety zone
shelter zone
emergency evacuation area
TABACO BAY
S=1:50,000
500m 0 1 2km
MUNICIPALITY OF MALINAO
MUNICIPALITY OF TABACO
PROVINCE OF ALBAY
MUNICIPALITY OF MALILIPOT
MUNICIPALITY OF BACACAY

2.1.2 Sabo Project

(1) General

The objective of Sabo plan is to ensure safety control on sediment discharge in the whole river basin. They are generally classified into two (2) categories, namely one (1) "River Basin Management of Sediment" and two (2) "Sabo Works for Preventing Direct Disaster due to Sediment". The classification is based only on the location and effect of the facilities. The Stage-I construction works are identified as an urgent Sabo project based on the re-study of the Master Plan.

The Sabo project should be implemented in a long term. The proposed Sabo plan has been made based on the present river conditions and the recent disaster due to typhoon "Daling". Therefore, the detailed design of Sabo facilities should be modified timely and properly prior to and during implementation period, taking into account the changes of topographic conditions due to heavy rain and unforeseen mud/debris flows in future.

(2) Subject Rivers

Subject rivers of the Stage-I construction works for the Sabo project are streams of the Quinali (A) River and the Yawa River basins around the southern slope of Mayon Volcano.

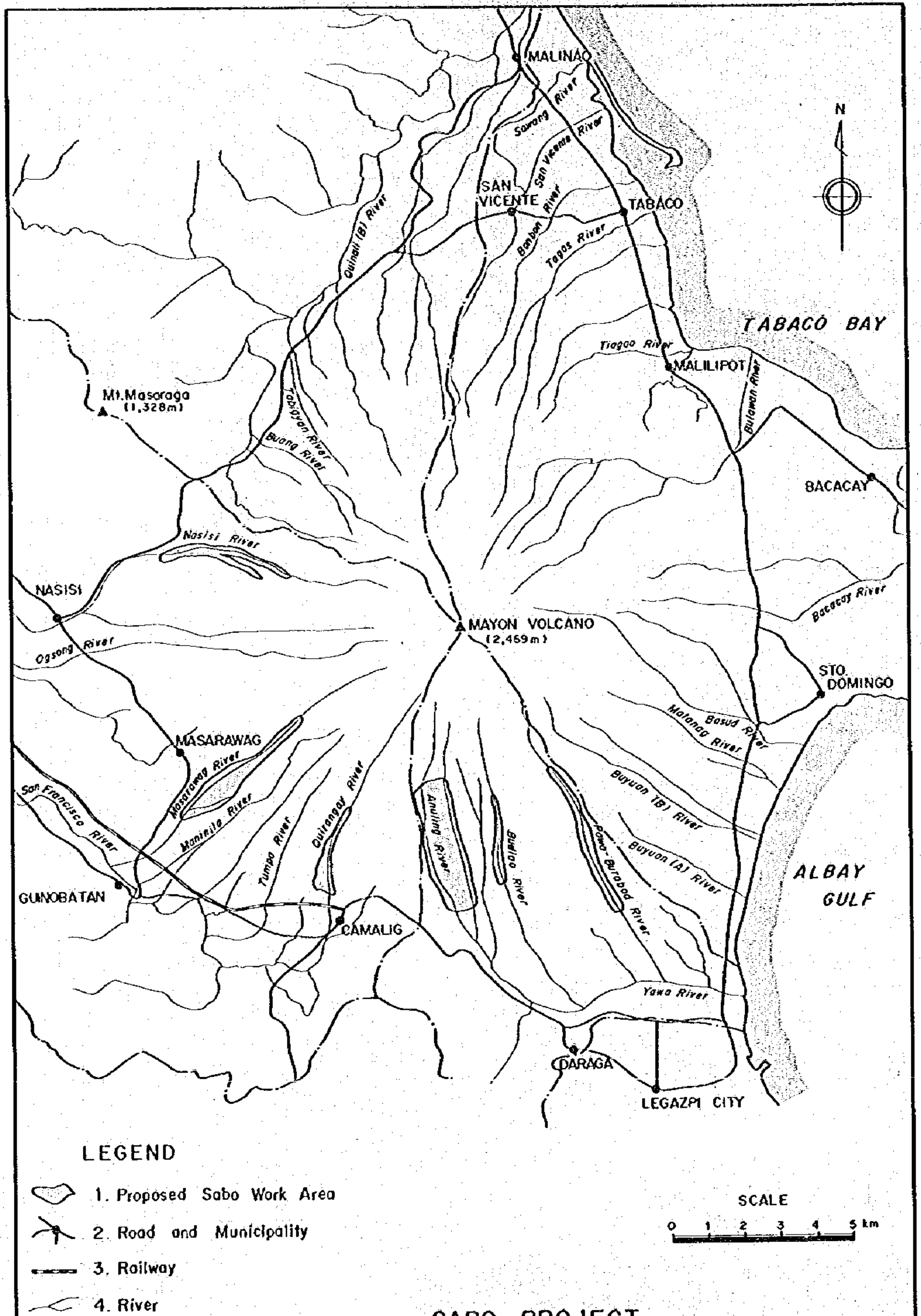
There are three (3) tributaries to be treated as the rivers for Stage-I construction works in the Quinali (A) River basin. They are the Quirangay River which passes across Camalig, the Masarawag River which passes across Maharlika National Highway between Camalig and Guinobatan, and the Nasisi River which passes across the Ligao-Tabaco National Highway.

The Yawa River gathers three (3) main streams on the southern to southeastern slope of Mayon Volcano and other small streames from the southern hills which are outside the scope of this study. The three (3) streams are the Anuling River which has two (2) torrents of the Anuling 1 River and the Anuling 2 River, the Budiao River and Pawa-Burabod River.

(3) Priority and Necessity of the Sabo Works

During typhoon "Daling" in 1981, the mud/debris flows occurred and caused great disasters on the southeastern to southwestern slope of Mayon Volcano. Aerophotos covering the project area were taken two (2) times before and after the typhoon in 1980 and 1982 respectively. The rough amount of sediment runoff and the conditions of devastation in respective rivers were studied by the aerophoto interpretation. These data and informations obtained are very important because there were no data for sediment runoff and yield in the area to date.

The priority of implementation of the Sabo works in subject rivers including those for the Stage-II construction works are classified into 3 categories (First Priority, Second Priority and Third Priority) depending on such factors as degree of devastation, main objects to be protected and necessity of Sabo works. It is summarized in the following table.



SABO PROJECT
STAGE - I CONSTRUCTION AREA

PRIORITY OF IMPLEMENTATION OF THE SABO WORKS

Subject Rivers	Present River Condition (Degree of Devastation)	Main Objects to be protected	Necessity of Sabo Works		Priority of Implementation
			River Basin Management of Sediment	Sabo Works for Preventing Direct Disaster due to Sediment	
Quinali (A) River Basin					
1. Quirangay River	**	Camalig, PNR	B	A	I
2. Tumpa River	*		C	C	III
3. Maninila River	*		C	C	III
4. Masarawag River	***		B	B	II
5. Ogsong River	**		B	B	III
6. Nasisi River	**	Downstream reaches	A	B	II
Yawa River Basin					
7. Anuling River	***	Legazpi, Salvacion	A	A	I
8. Budiao River	***	Legazpi	A	B	II
9. Pawa-Burabod River	***	Legazpi, Mabinit. Bonga, Buyuan and Burabod	A	A	I

Remarks:
*** - Extremely devastated
** - Devastated
* - Not much devastated

A - Very urgently necessary
B - Urgently necessary
C - Not urgently necessary

I - First priority
II - Second priority
III - Third priority

(4) Sediment Control Plan and Sabo Facilities Arrangement Plan

In the Sabo plan, it is important to estimate the sediment amount transported as mud/debris flows or dense sediment flows caused by major floods. In the Master Plan, the empirical formula proposed by Ashida and Okumura was employed to estimate the sediment runoff volume. The coefficient of the formula is re-studied because the sediment runoff volume during typhoon "Daling" is estimated by interpretation of the two (2) series of aerophotos. The sediment runoff volume at the base points is estimated for the design flood with a return period of 50 years. The base points and sub-base points for the Sabo plan are presented in the Supporting Report I.

Sediment control plan is made to reduce sediment yield and to check or retard sediment runoff by the proper arrangement of Sabo facilities. And it finally aims at reducing the amount of sediment runoff to the allowable sediment volume at base points as much as possible. The sediment control plan and Sabo facilities arrangement plan for the respective rivers are described as follows.

The proposed Sabo facilities are designed as a massive types. These facilities are able to withstand or resist the forces induced by heavy mud/debris flows. Consequently the maintenance cost will not be high even if mud/debris flows attacks. While, the flexible type structures such as gabions and mattresses will be applicable only to selected sites where the mud/debris flows will not affect directly.

The typical engineering designs of each kind of Sabo facility are shown in FIG.-2.1.1 to FIG.-2.1.9. Dimensions of typical design of these facilities are given in this study. However, the actual dimensions should be so determined to follow the changes of river bed conditions before the constructions.

Excess and allowable sediment volume estimated are listed as follows.

Name of River	Sediment Runoff Volume (m3)	Allowable Sediment Volume (m3)	Excess Sediment Volume (m3)
Quirangay	260,100	82,600	177,500
Masarawag	276,800	77,600	199,200
Nasisi	992,100	270,900	721,200
Anuling	415,600	85,800	329,800
Budiao	234,600	58,100	176,500
Pawa-Burabod	252,000	69,500	182,500

i) Quirangay River

The unstable sediment deposit in the upstream reaches became notable due to typhoon "Daling". And left bank erosion at the top of fan was developed. Thus, it seems that a new river channel on inland side of the left bank might be formed and cause mud/debris flows, which attack the town of Camalig passing across PNR.

A training levee is planned to be constructed to protect Camalig from mud/debris flows and sediment flows. The capacity of natural sand retarding basin will be increased with four (4) spur dikes (Type A). These Sabo facilities are arranged as shown in FIG.-2.1.10. After the completion of the Stage-I construction works, one (1) slit type Sabo dam is proposed to fix the unstable sediment and to check sediment runoff in the upper reaches. The sediment runoff at the base point is planned to reduce finally from 260,100 m^3 to 39,900 m^3. The sediment runoff volume at the base point with the facilities will be less than the allowable sediment volume of 82,600 m^3. The river profile is presented in the Supporting Report I.

ii) Masarawag River

The large amount of sediment runoff was accumulated in the upper part of fan above EL. 325 m due to typhoon "Daling". And in the left distributary from the top of fan, the river channel erosion was notable.

Three (3) spur dikes (Type A) are planned to increase the sand retarding capacity and to form the main river course to the east to protect Maninila as shown in FIG.-2.1.11. The river profile is presented in the Supporting Report I. After the completion of the Stage-I construction works, one (1) slit type Sabo dam and one (1) spur dike are to be planned in addition to the above Sabo facilities. The sediment runoff will be consequently changed into bed load from mud/debris flow and the amount of the sediment runoff will be reduced finally from 276,800 m^3 to 59,500 m^3, which will be less than the allowable sediment volume of 77,600 m^3.

iii) Nasisi River

The sediment runoff from the upstream reaches due to the flood during typhoon "Daling" was not notable. Thus, the Bridge of Ligao-Tabaco National Highway was washed out due to erosion. It seems that the river bed in the downstream reaches are under lowering and stabilization. However, the sediment runoff from the upstream reaches are dispersed and deposited in the reaches above EL. 200 m. It is anticipated that further deposition leads to gushing out of the sediment and to disasters due to mud/debris flows.

Considering the conditions of before and after typhoon "Daling", it was found to be important for the Nasisi River to reduce and retard the sediment runoff and yield in the upper reaches. Therefore, one (1) consolidation dam and two (2) ground sills are planned in the upper reaches in order that sediment runoff as mud/debris flow may be transformed to bed load condition. In the downstream reaches, the intake weir of NIA functions as a consolidation dam. After completion of the Stage-I construction works, one (1) consolidation dam and one (1) ground sill are to be planned in addition to the above Sabo facilities. Consequently, the sediment runoff volume at the base point will be finally reduced from 992,100 m^3 to 278,400 m^3, which slightly exceeds the allowable sediment volume of 270,900 m^3. However, the excess will be regulated by the natural retarding function just downstream of the base point. These Sabo facilities arrangement is shown in FIG.-2.1.12. The river profile is presented in the Supporting Report I.

iv) Anuling River

Even though there had not been mud/debris flows nor floods on a large scale before typhoon "Daling", there occurred a mud/debris flow at that time to count loss of lives of 13 at Salvacion, and it reached down to the National Highway. It seems that the mud/debris flow was due to the unexpectedly large amount of sediment runoff from the upstream reaches yielded at that time. Furthermore, there still remains large amount of unstable sediment deposit.

One (1) Sabo dam and two (2) ground sills and training levee are planned to protect Anuling from mud/debris flow coming from the upper reaches of the Anuling 1 River. In the upper reaches of the Anuling 2 River, one (1) Sabo dam and two (2) spur dikes (Type A) are planned. Four (4) spur dikes (Type A) and one (1) spur dike (Type B) are planned downstream of the confluence of these two rivers. Finally, the sediment runoff volume at the base point is planned to reduce from 415,600 m^3 to 17,200 m^3 by the above Sabo facilities as shown in FIG.-2.1.13. It will become less than the allowable sediment volume of 85,800 m^3. The river profile is presented in the Supporting Report I.

v) Budiao River

The sediment runoff due to typhoon "Daling" was deposited in the reaches between EL. 300 m and EL. 250 m. And it seems that the river channel might shift left-ward at the top of fan to attack Banadero, if no appropriate measure is taken.

As shown in FIG.-2.1.13, one (1) Sabo dam, training levee, three (3) spur dikes (Type A) and one spur dike (Type B) are planned to reduce the sediment runoff and to control the direction of mud/debris flows, from the upper reaches to the down reaches. The river profile is presented in the Supporting Report I. Consequently, the sediment runoff volume at the base point will be reduced from 234,600 m^3 to 54,400 m^3 which is less than the allowable sediment volume of 58,100 m^3. As Stage-I construction works, two (2) spur dikes are selected to protect Budiao and Banadero.

vi) Pawa-Burabod River

During typhoon "Daling", sand retarding effect did not function adequately, as the sediment content in the mud/debris flow was lower than previously assumed. And it is recognized that the canalization downstream does not function properly as a right river channel was newly formed below EL. 150 m at that time. The mud/debris flow caused the largest number of loss of lives of 18. It is found that the direction of mud/debris flow suddenly changed right-ward around EL. 130 m, and that it hit Mabinit after destroying coconut trees for about 100 m in length. Due to typhoon "Daling" the river reaches around the outlet of the gorge was eroded and the dam site in the Master Plan became improper with big boulders.

One (1) Sabo dam and one (1) consolidation dam are planned in the upper reaches. Four (4) spur dikes (Type A) and three (3) spur dikes (Type B) are planned in series from the middle to the down reaches to protect Mabinit, to retard the sediment and to control the direction of mud/debris flows. These facilities arranged are shown in FIG.-2.1.14. The river profile is presented in the Supporting Report I. Consequently, the sediment runoff of 252,000 m^3 at the base point will become the only bed load of 69,500 m^3 in volume.

2.1.3 Disaster Prediction and Warning System Project

(1) Method of Prediction

Mud/debris flow, flood inundation and storm surge are the principal direct causes of disaster to be studied in the project area. They claim casualties of dead, missing and injured not only economic damages. Accordingly it is concluded that the planned system should serve to predict the occurrence of these causes well in advance to avoid casualties. The causes mentioned above are brought by a torrent and heavy rainfall and strong wind. Only tropical storm causes a strong wind which leads to storm surge in the project area.

The gathering data and information on the following items are assigned to the planned prediction system;

(a) Rainfall in the project area, especially in the slope of Mayon Volcano.

(b) Nation-wide rainfall information for approaching tropical storm.

(c) River water stages at relevant sites.

(d) Velocity and direction of stormy wind for approaching tropical storm.

(e) Volcanic activities during eruptive period.

i) Mud/debris Flow

The heavy rainfall attributable to the typhoon "Daling" was received from late evening to night on June 30, 1981. The mud/debris flow occurred at 8 simultaneously, and continued for 2 to 3 hours with certain interruptions. The cumulative rainfall depths are 145 mm and 135 mm at this time at the Ligao and Legazpi observatories, respectively. The hourly rainfall intensities at the antecedent two hours of 6 and 7 o'clock are 65 mm and 55 mm at the Ligao gaging station, whereas 33 mm and 63 mm at the Legazpi gaging station. It should be specially noted that the figures mentioned above coincide with the critical rainfall commonly acknowledged in Japan. In Japan, rainfall with intensities of 20 mm per 10 minutes or 50 mm per hour and a rainfall depth of 150 mm are understood to be critical for mud/debris flows. With this regard mud/debris flows are planned to be forecasted through rainfall observation, and the installation of telemeterized rainfall gaging stations are proposed at the following sites;

COMVOL Mayon Rest House, Quirangay, Mabinit, Tabaco (EL. 300 m), San Roque, Legazpi Golf, Micericordia, Legazpi Weather Station Nasisi, Balaigang and Masarawag

ii) Flood Inundation

The runoff caused by a rainfall with 2-year return period spilled out from some sides of river channel. If the relations between the rainfall and runoff are studied and runoff models are established, the magnitude of flood and inundation can be estimated applying the rainfall data to the runoff model. It should be noted that the sites subject to inundation damages are located in the downstream reaches of the Quinali (A), the Yawa and the Quinali (B) Rivers. The total lag time can be divided into the time of concentration and the travelling time of flood wave. The available data are limited and tentative lag time is arbitrarily estimated for each major rivers as follows;

River	Time of Concentration		Travelling Time			Total Lag Time
	at	Hour	From	To	Hour	(Hour)
Quinali (A)	Nasisi	1.0	Nasisi	Libon	1.5	2.5
Yawa	Culiat	1.0	Culiat	Yawa Bridge	0.5	1.5
Quinali (B)	Bantayan	1.0	Bantayan	Balza Bridge	1.0	2.0

The inundation at the downstream reaches can be predicted advancing at least this lag time applying the observed rainfall data at the proposed stations to the established runoff model. In other words, if a heavy rainfall, say one exceeding the 2-year probable rainfall, is observed at the proposed Mabinit or Legazpi Golf gaging station, it can be said that an inundation will occur with respective magnitude at Legazpi City 1.5 hours later. Further, the magnitude of flood depends also on the initial water stage at the relevant site and local inflow or runoff from the remnant catchment area. Accordingly the data on water stages at relevant sites and rainfall data at remnant catchment areas are indispensable to provide an accurate prediction of flood inundation.

In this respect, the following telemeterized gaging stations are proposed besides ones proposed in the previous paragraph for the disaster prediction and warning system;

Rainfall gaging station;	(Ligao) and Libon
Water level gauging station;	Yawa River; Culiat dam and Yawa bridge
	Quinali (A); Guinobatan, Polangui, Oas and (Lake Bato)
	Quinali (B); Bantayan and Balza bridge

Combined rainfall and water level gaging station; Nasisi

The parenthesized stations mean the modification of the existing stations for the Bicol River Basin Flood Forecasting and Warning System.

iii) Storm Surge

Almost all storm surge are brought by the tropical storm accompanied by strong wind. The location and the forecasted track of movement are obtained by the PAGASA Central Office as well as the wind velocity for each storm in the Philippines area of responsibility. The weather station of Legazpi can predict the future change of wind direction availing the information described above. For this purpose, the communication system between the PAGASA Manila Central Office and the PAGASA Legazpi (Weather Station) Office should be improved and upgraded from the existing simple SSB system.

According to the hydrologic analysis, the location and track of eye movement and the month of occurrence of tropical storm are the dominating factors for the magnitude and intensities of stormy rainfall. Typhoons which passed the project area from south-east to north-west have brought heaviest rainfall to the project area. And the highest rainfall intensity has been experienced in the project area when the eye of typhoon was located at 500 to 700 kilometers south-east of the Legazpi City. Whereas, typhoons which took courses from south-east to north-east or south-east to south-west have brought little rainfall in and around the project area. The facts imply that the additional rainfall in the future can predict at respective time with certain reliability, if the course of approaching typhoon is predicted. In other words, 2-year probable rainfall or cumulative rainfall of 100 mm is to be predicted some hours before they are actually received.

In this connection, data communication system between the PAGASA Central Office and the Legazpi City is proposed in addition to the voice communication system mentioned above. To obtain higher accuracy, it is considered to be most effective to exchange data with the Bicol River Basin Flood Forecasting System to refer the information to predict the rainfall in the project area.

(2) Method of Warning

Warning for impending disaster is to be disseminated from Regional OCD to the relevant offices and inhabitants. DCC of respective level is to be organized to integrate and to make effective the disaster prevention works of various offices upon the first warning from OCD. Offices, member of DCC, act in line with the disaster preparedness plan basing on the warning. Inhabitants prepare for evacuation and flood protection. The detailed warning method for each disaster is proposed as follows;

i) Mud/Debris Flow

With due regard to the records of rainfall and mud/debris flows, the tentative critical rainfall is designated as proposed hereunder. In this designation, the experiences in Japan were also referred.

(a) Cumulative rainfall depth of 60 mm
(b) Cumulative rainfall depth of 80 mm
(c) Hourly rainfall intensity of 50 mm
(d) Rainfall intensity of 20 mm per 10 minutes

Warning of respective level will be disseminated mainly based on these critical rainfall as follows;

(Level 1) A warning signal should be automatically transmitted from the supervisory control unit of the proposed system to the PAGASA Weather Station and Regional OCD Office in case critical rainfall (a) is observed in and around Mayon Volcano. The PAGASA and OCD should observe rainfall in the adjacent period with care. Similar activities should be taken in case the Regional OCD or the PAGASA Weather Station received typhoon information that a tropical storm has entered the Philippines area of responsibility.

(Level 2) In case a critical rainfall (b) is observed, the PAGASA and OCD should disseminate the warning (level 2) to offices and inhabitants in the relevant area. In this case, actions should be taken by the Offices which is assigned the evacuation aspects. People can stay home but should prepare to evacuate. And everybody should be ready to listen to the next warning with careful attention.

(Level 3) In case a critical rainfall (c) or (d) is observed after critical rainfall (b), the OCD should disseminate the warning (level 3) to offices and inhabitants in the relevant area. In this case, all the Offices concerned should take actions in line with the command from DCC. People should start to evacuate the area to proceed to the relevant evacuation center and should wait for the next instruction from the DCC.

ii) Flood Inundation

With due regard to the records of rainfall, flood and inundation, the following are designated as the critical conditions for inundations.

(a) 2-year hourly rainfall
(b) 5-year hourly rainfall
(c) Water level corresponds to 1.5-year flood discharge

(Level 1) In case the critical condition (c) is observed, the MPWH, the NWRC and other Offices concerned should observe the fluctuation of the water level with care. The installed data processing unit carries out simulation through the runoff models for relevant sites. And if the flood magnitude is estimated to exceed one with 2-year return period, warning (level 2) should be disseminated. And if not, actions should be taken by only the Offices which are assigned the evacuation aspects. People can stay home but should prepare to evacuate. And everybody should be ready to listen to the next warning with careful attention.

(Level 2) In case critical conditions (a) and (c) is observed, the OCD should disseminate the warning (level 2) to offices and inhabitants in the relevant area. All the Offices concerned should take actions in line with the command from DCC. People should start to evacuate to the relevant evacuation center and should wait for the next instruction from the DCC.

(Level 3) In case critical conditions (b) and (c) is observed, the actions of the Offices concerned should be in full swing. People should evacuate the area without delay giving the first priority to protect ones life.

iii) Storm Surge

Storm surge is attributable to tropical storm which is to be observed by international organization. The OCD should be facilitated to be able to obtain the information on the approaching typhoon. The OCD should disseminate appropriate warning to the Offices and public in collaboration with the PAGASA.

The critical conditions mentioned above are tentative and should be examined in the adjacent stage of study. Especially the information on tropical storm should be amalgamated to make the warning more effectively. The warning station sites are proposed as follows;

Legazpi Area; Legazpi OCD, Governmental offices in Legazpi City, Sto. Domingo, Camalig, Daraga, Matanag, Bonga, Mi-Isi, Budiao, Quirangay and Malabog.

Mayon North East Area; Micericordia (COMVOL), Tabaco, Malinao and Oson.

Ligao Area; Ligao, Guinobatan, Oas, Libon, San Agustin, Polangui, Nasisi and Masarawag.

Aside from above stations, mobile warning system should be installed to reinforce the transmission of warning to the areas wherein no warning station is to be provided.

(3) Design of Communication System

Communication systems to be constructed by this Project are threefold as described hereunder. Route maps of these systems appear in FIG.-2.1.15 and FIG.-2.1.16. Meanwhile, this study is mainly made by the map study. At the time of project implementation, necessary field tests including the propagation test must be carried out, in order to examine the degree of radio interference from the existing radio stations.

i) 150 MHz Band Radio System (for telemetering system)

The 150 MHz band radio system is to be constructed for telemeter signal transmission between the rainfall/water level observatory and the base station to be established in each area.

Hop by hop profile maps are given in the Supporting Report II. As is evident in those maps, all hops command good visibility and allow radio propagation in favorable condition. At all stations, the antenna height of less than 20 m is considered to be sufficient. As for Legazpi radio station, the antenna height must be less than 10 m because the station is located close to the airport.

ii) 400 MHz Band Radio System (for warning system)

The 400 MHz band radio system is to be constructed for voice signal transmission between the warning station and the base station to be established in each area. All base stations are designed to permit them to be co-used as base stations of the 150 MHz band radio system.

Hop by hop profile maps appear in the Supporting Report II. All hops are free from propagational problems. The hop between Legazpi radio station and Camalig station requires mountain diffraction propagation which, however, does not affect the system performance adversely.

iii) 800 MHz Band Radio System (for multiplex radio system)

The 800 MHz band radio system is to be constructed for voice signal and telemeter signal transmission between the base station in each area and the warning center at Legazpi.

Capacity of this radio system is for 24 telephone channels. This system, designed as a backbone system, is to be capable of high quality telephone service.

The distance between Legazpi radio station as a base station in Legazpi area and Legazpi Weather Station where the meteorological observation center is to be established, is short. Therefore, in this section, a transmission route is planned to be cable system.

For 800 MHz band radio system between Naga (Camarigan) radio station established in the Bicol River Basin Flood Forecasting and Warning System and the proposed Ligao radio station, the study for the system design is omitted since the maps is not available. However, by establishing a radio repeater station newly between Naga radio station and Ligao radio station, foreseeable propagational problems can be prevented.

(4) System Configuration and Function (Equipment)

Equipment required in the implementation of the project is classified into four major categories. They are telemetry system equipment, warning system equipment, multiplex communication system equipment and HF radio communication system equipment. Station by station equipment installation configurations are shown in FIG.-2.1.15 to FIG.-2.1.19. Detailed equipment list is presented in the Supporting Report I and II. A summary of required equipment is as follows:

i) Telemetry System Equipment

The network of telemetry system and the system diagram are presented in FIG.-2.1.15 and FIG.-2.1.17, respectively.

(a) Equipment to be installed at Meteorological Observation Center

Telemetering Supervisory Equipment

This equipment is to be installed for the purpose of supervising and controlling equipment of each observatory station. The supervisory and control function of this equipment can cover 20 stations. By means of installing additional units, the equipment function can be increased to cover a maximum of 30 stations.

Operating Console

This operating console makes each observatory station supply required data periodically or as occasion dictates.

Display Equipment

This display equipment is made of wall type and digitally indicates rainfall and water level data supplied from each observatory station. Indicated data covering 20 stations includes the time of observation (year, month, day and hour) and the name of station concerned.

CVCF Power Supply Equipment

This equipment supplies AC power to the loads without momentary interruption in the event of commercial power failure. The equipment input is AC 220 V and the output is AC 100 V. The equipment capacity is planned to be 5 kVA.

(b) Equipment to be installed at Weather Station

Rain Gauge

The rain gauge is planned to be the tipping bucket type. Measured data are sent through telemetering equipment to the meteorological observation center.

Water Gauge

The well type water gauge is planned to be installed as a reason of easy maintenance. The water gauge with float makes variation data processing by means of analog/digital converter, and sends processed data through telemetering equipment to the meteorological observation center.

Telemetering Equipment

This equipment converts the data of rainfall and water level into F/S signal and sends out such signal to the transmitter. The equipment also detects control signal supplied from the meteorological observation center, and supplies necessary data to the meteorological observation center at the same time.

Radio Equipment and Antenna

The radio equipment frequency is of 150 MHz band. For transmitter output, either 10 W, 3 W or 1 W is to be selected. The transmitter output should be determined based on the propagation test. In this study, the output is planned to be 10 W. Antenna is planned to be sleeve type.

Shelter

The rainfall observation stations is planned to be a shelter type.

Solar Cell Power Supply System

The power supply system for rainfall and water level observation stations is planned to be solar cell power supply system.

ii) Warning System Equipment

The network of municipal multi-disaster communication system and the system diagram are presented in FIG.-2.1.16 and FIG.-2.1.18 respectively.

(a) Equipment to be installed at Legazpi Warning Center

MCA Control Equipment

The communication traffic between Legazpi warning center and proposed warning stations is considered to be extremely small except during disaster prevention/relief activities during the typhoon season. The multi channel access (MCA) system is planned for the communication system.

Mobile Control Equipment

The communication between warning station and mobile station and between one mobile station and another is conducted via base station to be established in the area. The mobile control equipment is to control radio equipment of the base station.

Telephone Exchange Equipment

With telephone exchange equipment installed, dial system communication between warning stations themselves and between the warning center and warning stations becomes possible. For trunk lines, 3 channels are to be accommodated at Legazpi R/S, 3 channels at Ligao R/S and 2 channels at Mayon Rest House. Extension lines total 30.

Remote Supervisory and Control Equipment

Legazpi R/S and Ligao R/S except Mayon Rest House are planned to be unattended stations.

(b) Equipment to be installed at Legazpi R/S, Ligao R/S and Mayon Rest House

Radio Equipment for MCA System

This equipment frequency is of 400 MHz band. The transmitter output is set at 5 W. However, in case radio frequency is 150 MHz band, the study of radio interference with the existing 400 MHz band system, as well as the field propagation test, should first be carried out before final decision of frequency band, transmitter output, antenna type and so forth.

Radio Equipment for Mobile System

This equipment frequency is of 150 MHz band. The communication system is planned to be the simplex system. The transmitter output is set at 10 W.

(c) Equipment to be installed at Warning Station

Radio/Control Equipment

This equipment is composed of radio equipment and control units. Control units are used for radio channel selection. Yagi antenna is planned for this station.

Power Supply Equipment

The most part of municipalities and barangays where warning stations are proposed hold access to commercial power supply. Floating system power supply equipment is planned to be adopted in order to cope with traffic growth successfully. Portable motor generator instead of standby motor generator is planned to be transported from Legazpi, Ligao or Tabaco in case the commercial power failure continues for a long time.

iii) Multiplex Radio Communication System

This communication system is planned to be established on the warning center - Legazpi R/S - Ligao R/S - Mayon Rest House route and Ligao R/S - Naga (Camarigan) R/S route. These systems are planned to transmit a maximum of 24 telephone channels. Channel accommodation plan for each of the abovementioned route appears in FIG.-2.1.19. Radio equipment frequency of 800 MHz band and transmitter output of 5 W are planned for this system. Power supply is of floating system.

iv) HF Radio Communication System

The HF radio equipment is planned to be installed at Manila PAGASA, Manila OCD, Legazpi Meteorological Observation Center, Legazpi OCD and Virac Rader Station. The frequency range of radio equipment is to be set at 2.0 MHz - 18.0 MHz. Transmitter output is to be 150 W (PEP) for A3J, A3A and A1 models and 40 W (carrier) for A3H model. Input power is DC 24 V. The log periodic type antenna for Manila - Legazpi section and 3-band dipole type antenna for Legazpi - Virac section are planned at each station.

2.2 Socio-economic Effect

2.2.1 Sabo Project

(1) Cost Estimate

i) Basic Condition

Construction cost of the Sabo project including nine streams, under the Mayon Volcano Sabo and Flood Control Project, is estimated on the basis of the preliminary design and the proposed construction plan and schedule. For the cost estimate, local conditions of the Philippines, available equipment and materials, suitability of construction method, working rules, the Government estimate procedure, etc. are taken into account. The basic conditions applied for the cost estimates are presented below:

(a) Prices are based on current prices for labor, materials and equipment as of Mid-1982.

(b) Ruling exchange rate used in this estimate is 1.0 US Dollar = 8.0 Pesos = 240 Japanese Yen.

(c) Work quantities are calculated from the preliminary design and presented in the Detailed Cost Estimates Report.

(d) Unit prices are estimated on the basis of the current prices in the Philippines adding tax and duties for imported materials and equipment.

(e) All construction materials are to be supplied by contractors mainly from local markets. The costs of steel product and reinforcing bar, cement, fuel and lubricant are divided into foreign currency portion and local currency portion.

(f) Direct daily wages of local labor applied to the construction cost are estimated based on the wages in Albay Province in Mid-1982.

(g) Equipment cost is estimated on the basis of depreciation cost, repair cost and administration cost against CIF price.

(h) Construction cost (Financial) comprises contract cost, right of way/site acquisition, resettlement, engineering cost, project management cost and contingencies.

(i) Contract cost components are direct cost, general, supervision & miscellaneous, profit and contractor's tax.

(j) Direct cost is estimated as the unit price including materials, labor and equipment expenses.

(k) General cost including mobilization and demobilization, vehicles, field offices and other temporary works, is taken as 10 per cent of direct cost.

(l) Supervision & miscellaneous is taken as 6 per cent of the sum of direct cost and general cost.

(m) Contractor's profit is the cost of 10 per cent of the sum of direct cost plus general and supervision & miscellaneous.

(n) Contractor's tax is estimated at 3 per cent of the sum of direct cost, general, supervision & miscellaneous and profit.

(o) Engineering cost which is 10 per cent of contract cost includes topographic survey, design, soil testing prior to and during construction, construction surveys and construction management.

(p) Project management cost is the cost of 5 per cent of contract cost.

(q) Physical contingency of the Sabo project is taken as 15 per cent of contract cost. Price escalation contingency is estimated based on disbursement schedule and price escalation rate. The price escalation rate is taken as 7 per cent per annum for foreign currency portion and 13 per cent per annum for local currency portion.

ii) Construction Cost

The construction cost of the Stage-I construction works for the Sabo project is estimated at P161.5 million, of which P44.0 million is the foreign currency portion and P117.5 is the local currency portion as shown in TABLE-2.2.1 and as summarized below. The cost of price escalation over the 5-year construction period (1983 to 1987) is taken into account in the cost estimate and is calculated based on the construction cost disbursement schedule.

(unit: 1,000 Pesos)

Description	Construction Cost	
	Foreign Currency Portion	Local Currency Portion
Contract Cost	31,209	58,028
Right of Way/Site Acquisition	-	25
Engineering Cost	-	8,923
Project Management Cost	-	4,462
Contingency		
Physical	4,681	8,704
Escalation	8,074	37,390
Total	43,964	117,532

The construction cost disbursement schedule is estimated in consideration of the Philippine's budget (Investment Requirement, CY 1983-1987, Flood Control and Drainage). The disbursement schedule is shown in TABLE-2.2.2.

The detailed data including breakdown of the construction cost estimate are presented in the Detailed Cost Estimates Report.

iii) Economic Cost

For the economic evaluation of the Stage-I construction works of the Sabo Project, the economic cost is estimated by adjusting the construction cost. The economic cost excludes taxes of materials and equipment, contractor's profit and tax, land acquisition, and price escalation. The economic cost is estimated at P92.9 million, of which P31.7 million is the foreign currency portion and P61.2 million is the local currency portion. The economic cost and the economic cost disbursement schedule are listed in TABLE-2.2.3 and TABLE-2.2.4, and as summarized below.

(unit: 1,000 Pesos)

Description	Economic Cost	
	Foreign Currency Portion	Local Currency Portion
Contract Cost	27,542	43,966
Right of Way/Site Acquisition	-	-
Engineering Cost	-	7,152
Project Management Cost	-	3,575
Contingency		
Physical	4,132	6,595
Escalation	-	-
Total	31,674	61,288

iv) Operation and Maintenance Cost

The annual operation and maintenance cost of the Sabo project is estimated at P580 thousand on the basis of mid-1982 prices which is taken as 0.5 per cent of the construction cost excluding the price escalation.

(2) Socio-economic Effect

Economic evaluation is made on the basis of "with and without project principle". The direct and indirect benefits attributable to the project is defined as the change of the economic and socio-economic conditions with and without the project. "Without project" condition in this study is assumed as the condition that no improvement works are undertaken. All the benefits and costs are valued as of 1982 and exchange rate of US$1 = P8.0 is used in this study.

In addition, project evaluation is made taking into consideration the intangible benefit and social impact induced through the implementation of the project.

Project benefits in the project area are the expected reduction of damage to houses, rehabilitation cost of paddy field covered by mud/debris, re-transplanting cost and production loss of coconut damaged by mud/debris flow and cost of relief goods and medical assistance. These benefits are presented in TABLE-1.3.3, TABLE-2.2.5 and TABLE-2.2.6 and are summarized in TABLE-2.2.8. In addition, the reduction of sediment runoff volume can be evaluated for project benefit. Owing to the sediment runoff from the foot of Mayon Volcano, unexpected river improvement works for flood control such as river dredging and levee raising will be required in future without flood control and Sabo projects. The sediment runoff reduction benefit is presented in TABLE-2.2.7.

The annual project benefit under full development stage is estimated at P5.06 million and most of this project benefit will accrue from the Stage-I construction works.

The total economic construction cost for the Stage-I construction works is estimated at P93 million and annual O&M cost is P580 thousand as shown in TABLE-2.2.8.

In order to estimate the economic internal rate of return, the benefit and cost stream is prepared as shown in TABLE-2.2.9, and a result of estimation are given in FIG.-2.2.1. As shown in this figure, economic internal rate of return for the Stage-I construction works of the Sabo project is estimated at 3.5%. As a result of economic evaluation based on the tangible benefit, it is very difficult to justify such Sabo project only from the viewpoints of economy.

In fact, due to typhoon "Daling", there was the casualties of a total of 261, of which 154 were dead and missing, and 107 injured. Out of them, a total of 159 which is about 60 percent were due to mud/debris flow. Legazpi City and 4 municipalities, such as Daraga, Camalig, Guinobatan and Ligao are situated adjacent to the Sabo project area, and 36 barangays where about 50 thousand people make their living are located in the Sabo project area on the foot of Mayon Volcano. These inhabitants are exposed to a menace of damages due to mud/debris flow, unless proper facilities are provided to prevent the disaster.

In this sence, such Sabo project should be considered as a social project that can provide a social stabilization in this region. The evaluation of intangible and social benefits is rather important for this Sabo project than the evaluation by economic benefits only. The following are the intangible and social benefits to be derived from the project.

(a) Protection of Human Life
The mud/debris flow in 1981 also caused serious damage to invaluable human lives which are estimated at 52 persons as shown in TABLE-1.3.18. The injured by this flow reached more than 100 persons. These casualties will be largely reduced by the implementation of the project.

(b) Social and Mental Stabilization: People at the foot of Mayon Volcano has been suffering from large damage due to mud/debris flows and has been exposed to a menace of such mud/debris flows. This situation produces an unfavorable effect on their social and mental stabilization. The implementation of the Sabo project will contribute to the stabilization of these people's livelihood.

With the above benefits, the Sabo project is justified not only to solve the regional problems, but to establish a firm foundation for future regional development as well as to ensure a happier life of the people in this region.

2.2.2 Disaster Prediction and Warning System Project

(1) Cost Estimate

i) Basic Condition

(a) Construction cost is estimated at the price level as of Mid-1982. The foreign currency portion is estimated based on the Japanese Yen, since the system equipment installed in the Bicol River Basin Flood Forecasting System was the one made in Japan and the proposed system equipment is required to be connected to those Bicol System equipment. The exchange rate is 1.0 US Dollar = 8.0 Pesos = 240 Japanese Yen. All equipment and materials are to be exempted from domestic tax and duty of the Philippines.

(b) Construction cost breakdown for foreign currency portion and local currency portion is as follows:

Foreign currency portion:

- Radio equipment, carrier terminal equipment, power supply equipment, tower, antenna, telemetering equipment, rain gauge, water-level gauge, publicity car, other equipment
- Shelter type building
- Construction materials cost and work cost
- Sea transportation and insurance cost
- Training and operation/maintenance guidance
- Consultant fee

Local currency portion:

- Cost of inland transportation to station site
- Work cost

(c) The undermentioned work items are to be taken care of by the Authorities concerned in charge of this Project. The system plan was formulated based on the study by limited information and data. It is necessary to conduct more detailed studies for setting the actual work site by a detailed reconnaissance and topographic map.

- Station site, land acquisition, ground levelling and fencing
- Access road, land acquisition and road construction
- Station building extension and construction, except shelter type station buildings
- Legazpi R/S, communication cable installation
- Commercial power drop-in to station site

ii) Construction Cost

The construction cost of the Stage-I disaster prediction and warning system project is estimated at ¥1,394 million in foreign currency portion and P2,253 thousand in local currency portion as shown in TABLE-2.2.10 and as summarized below. The disbursement schedule is presented in TABLE-2.2.11.

Description	Foreign Currency Portion /1 (1,000 Yen)	Local Currency Portion (1,000 Pesos)
Telemetry System by 150 MHz Radio System	156,802	-
Warning System by Multi-Access Radio System	300,083	-
Multiplex Radio Communication System	249,348	-
HF Communication System	9,800	-
Installation Materials	93,560	-
Installation Work	211,803	2,048
Training	27,000	-
Maintenance	73,000	-
Consultancy Service	145,676	-
Contingency	126,707	205
Total	1,393,779	2,253

/1: The exchange rate is 240 Japanese Yen = 8.0 Pesos.

(2) Socio-economic Effect

The disaster prediction and warning system project should also be formulated as a social project. The project area planned for this system covers Legazpi City, 12 municipalities and 307 barangays, and total population is about 420 thousand. Mud/debris flow, flood inundation and storm surge are the principal direct disaster to be studied in the project area. They claim casualties of dead, missing and injured not only economic damages.

Although project benefits accuruing from the implementation of warning system include a few direct and indirect benefits, the major part consists of intangible benefits such as protection against loss of life, social stabilization, etc. which are difficult to be quantified. The project benefit produced by the warning system will be considered as follows.

(a) The wind damage to houses will be reduced by the warning to people.

(b) If large floods come, the safe and smooth evacuation of people will be carried out by the warning system.

(c) The warning of typhoons before coming to the area will produce a favorable result to social and mental stabilization of the people in the project area.

(d) The effective relief activities by the Authorities Concerned will be expected by the communication line of warning system.

(e) The damages due to floods and mud/debris flows will occur during the construction period of flood control and Sabo facilities. However, these damages will be minimized by the effective warning activities.

CHAPTER III

III. PROJECT IMPLEMENTATION PROGRAM

3.1 General

The Sabo project and the disaster prediction and warning system project are integral parts of the overall disaster prevention scheme. However, they can be implemented separately.

The Sabo project comprises Stage-I (5 years) and Stage-II (3 years) construction works in the re-study. The Stage-I construction works are recommended for immediate implementation to prevent direct disaster, especially casualties due to mud/debris flows and with a view to securing the social stabilization in the project area. The Sabo facilities to be constructed in the Stage-I construction works are as follows: a training levee and four (4) spur dikes in the Quirangay River, three (3) spur dikes in the Masarawag River, a consolidation dam and two (2) ground sills in the Nasisi River, a Sabo dam, two (2) ground sills, a training levee and five (5) spur dikes in the Anuling 1 River, a Sabo dam and two (2) spur dikes in the Anuling 2 River, two (2) spur dikes in the Budiao River, and a Sabo dam, a consolidation dam and seven (7) spur dikes in the Pawa-Burabod River.

The disaster prediction and warning system project will be implemented to disseminate the information of the possibility of unforeseen natural disaster such as mud/debris flows, floods and storm surges in whole project area including flat area and coastal area, even under with- and without- project condition.

The disaster prediction and warning system project comprises Stage-I (3 years), Stage-II (2 years) and Stage-III (2.5 years) construction works. The Stage-I disaster prediction and warning system is recommended to be established urgently in the project area. The facilities included in the Stage-I disaster prediction and warning system are as follows: necessary minimum number of rainfall observatories; meteorological observation center; warning stations and warning center; improvement of HF communication system between Manila PAGASA and Legazpi PAGASA.

3.2 Sabo Project

3.2.1 Implementation Method and Schedule

The Stage-I construction works are proposed to be carried out by Philippine constractors on competitive bidding basis, taking into account the Philippine's prevailing procedures for civil construction works.

The Stage-I construction works will take 5 years, including detailed survey and design, tendering and contract awarding, and the necessary preparatory works.

The Stage-I construction works is scheduled to be commenced in middle-1983 and will be completed by the end of 1987. The construction schedule and annual Sabo facilities to be constructed are shown in FIG.-3.2.1.

(a) First Year (1983)

The detailed design conducted by the JICA Study Team and the preparation of tender documents prepared by the Philippine Government is to be completed by the end of March 1983.

The compensation and land acquisition for the first year construction works will be executed by the MPWH in advance of the commencement of the contract.

Upon completion of contract awarding, the construction works will be commenced immediately.

Anuling River: No.3 and No.4 spur dikes are scheduled to be constructed to protect Salvacion and houses along Maharlika National Highway. No.1 Sabo dam and No.1 ground sill which are urgently necessary to control unstable river bed sediment in the upper reaches will be constructed.

Pawa-Burabod River: No.5 and No.6 spur dikes are scheduled to be constructed first, as it is urgently necessary to fix the river channel by returning it back to the old channel and to protect Mabinit.

The detailed survey and design and preparation of tender document for the second year program will be made by the end of 1983 in parallel with the construction of the first year.

(b) Second Year (1984)

Upon completion of contract awarding for the second year construction works at the beginning of 1984, the construction of second year program will be started.

Anuling River: The construction of No.1 Sabo dam and No.3 spur dike will be continued and completed to protect Budiao. The completion of these spur dikes ensure the increase of sand retarding capacity of the river channel.

Pawa-Burabod River: The construction of No.5 spur dike will be continued and completed. No.3, No.4 and No.7 spur dikes are scheduled to be constructed to supplement the function of No.5 and No.6 spur dikes. The series of these dikes ensure the sand retarding capacity.

Quirangay River: No.2 spur dike is scheduled to be constructed to avoid left-ward shift of the river channel around EL. 200 m. It prevents the town of Camalig from being attacked by mud/debris flows.

The detailed design, preparation of tender documents and contract awarding for the third year program will be finished by the end of 1984.

(C) Third Year (1985)

After the completion of the construction of the first and second year program and contract awarding for the third year construction works, the third year program will be started.

Anuling River: No.1 training levee is scheduled to be constructed to protect Anuling and Cabangan. No.1, No.2 and No.5 spur dikes will be constructed to supplement the function of the ones previously constructed.

Pawa-Burabod River: No.1 consolidation dam is scheduled to be constructed to control long-term sediment runoff including unstable river bed sediment in the upper reaches.

Quiranga y River: No.3 and No.4 spur dikes are scheduled to be constructed to supplement the function of No.2 spur dike. These three spur dikes should be considered as one set, which should be implemented at an early stage.

Nasisi River: No.2 consolidation dam is scheduled to be constructed to control the unstable river bed sediment in the reaches between EL. 280 m to EL. 200 m. It prevents the occurring of mud/debris flows and to force the mud and debris to be transformed into the bed load conditions.

The engineering services and contract awarding for the fourth year program will be completed by the end of 1985.

(d) Fourth Year (1986)

Anuling River: The construction of No.1 training levee will be continued and completed. No.2 ground sill is scheduled to be constructed to control unstable sediment on river bed in the upper reaches. It also avoid left-ward shift of the river channel.

Pawa-Burabod River: The construction of No.1 consolidation dam will be continued and completed. No.1 Sabo dam is scheduled to be constructed for the same purpose as No.1 consolidation dam.

Quirangay River: No.1 spur dike is scheduled to be constructed based on the changes in the river channel. These four spur dikes ensure the increase of sand retarding capacity.

Masarawag River: No.2, No.3 and No.4 spur dikes are scheduled to be constructed in place of the earth embankment washed out during typhoon "Daling". They protect Maninila, increase the sand retarding capacity and help to form the main river course along the east course.

Budiao River: No.4 spur dike is scheduled to be constructed to protect Budiao.

Nasisi River: No.2 consolidation dam will be constructed subsequent to the third year construction.

The engineering services and contract awarding for the fifth year program will be completed by the end of 1986.

(e) Fifth Year (1987)

Anuling 2 River: No.1 Sabo dam is scheduled to be constructed to control long-term sediment runoff. No.1 and No.2 spur dikes will be constructed to prevent the middle reaches from meandering.

Pawa-Burabod River: The construction of No.1 Sabo dam will be continued and completed. No.1 and No.2 spur dikes are scheduled to be constructed based on the changes in river conditions after the previous construction works. They avoid left-ward shift of the river channel.

Quirangay River: No.1 training levee is scheduled to be constructed based on the changes in the river channel. It protects the town of Camalig.

Masarawag River: No.2 - No.4 spur dikes will be constructed subsequent to the fourth year construction.

Nasisi River: No.3 ground sill and the right bank half of No.2 ground sill are scheduled to be constructed to control the unstable river bed sediment.

Budiao River: Left bank half of No.3 spur dike is scheduled to be constructed to protect Banadero.

3.2.2 Project Operation

The Ministry of Public Works and Highways (MPWH) will have overall responsibility for the implementation of the Sabo project. Prior to the commencement of the implementation activities, the MPWH will create and/or establish an adequately staffed and well-equipped Project Management Office under the Office of the Minister, with the MPWH Regional Office in assisting capacity. The Project Management Office will be responsible for all designs and construction of the Project. The Project Management Office will be headed by a Project Manager, to be appointed by the MPWH, who will be assisted by a Project Engineer, who will also be the MPWH staff member, and full-time experienced staff engaged by the MPWH.

The project operation will be assisted by selected Philippine consultant employed by the MPWH, to provied the following services: technical assistance and consulting services including topographic survey, plans, detailed design, preparation of specifications, tender documents and construction supervision of the Project.

The MPWH Regional Office, V will be responsible for, the operation and maintenance of the Sabo facilities after the construction is finished.

The organization chart for the implementation of the Project is illustrated in FIG.-3.2.2.