FIGURES

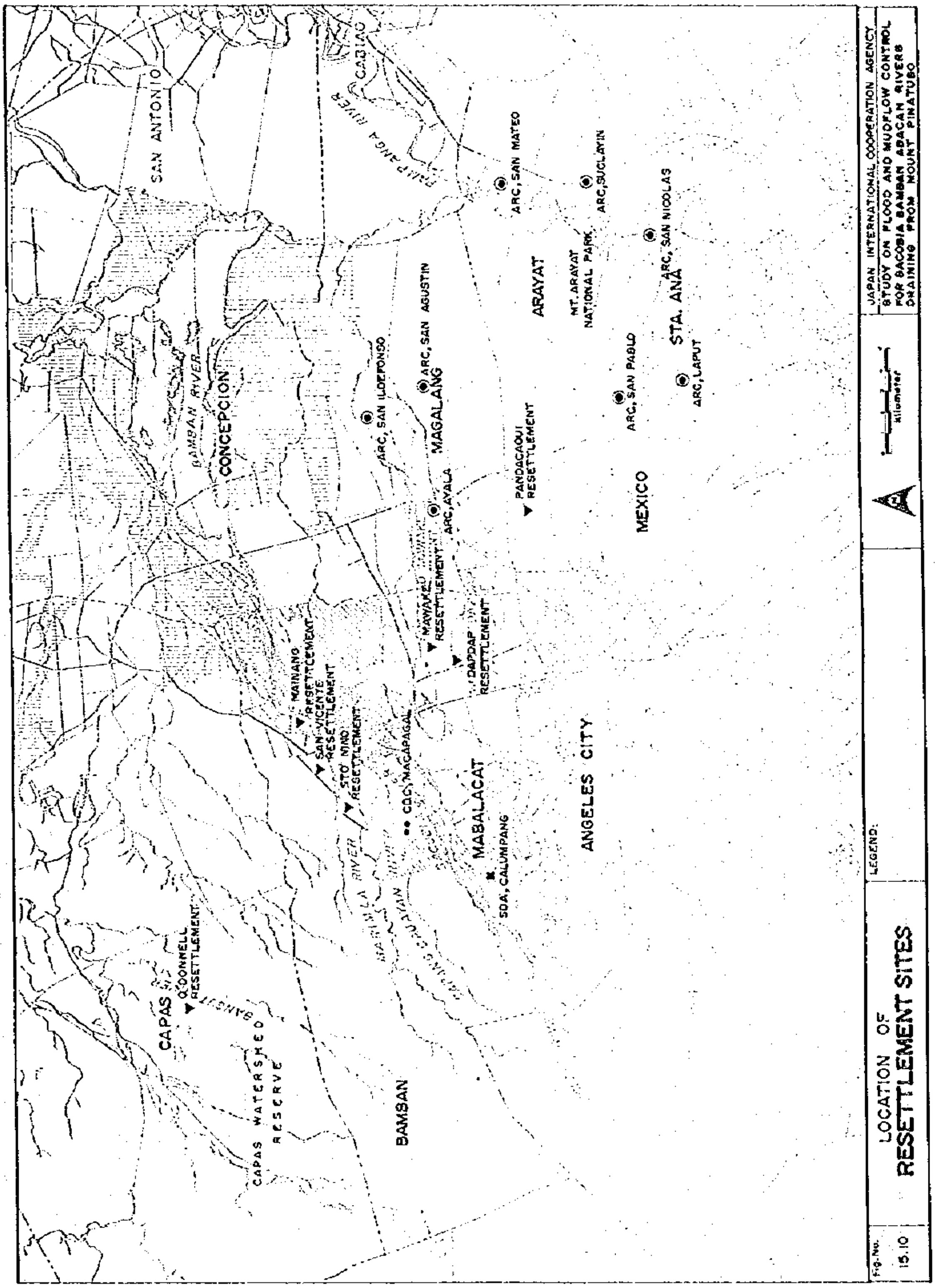


Figure M.1
Resettlement Sites in the Study Area

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

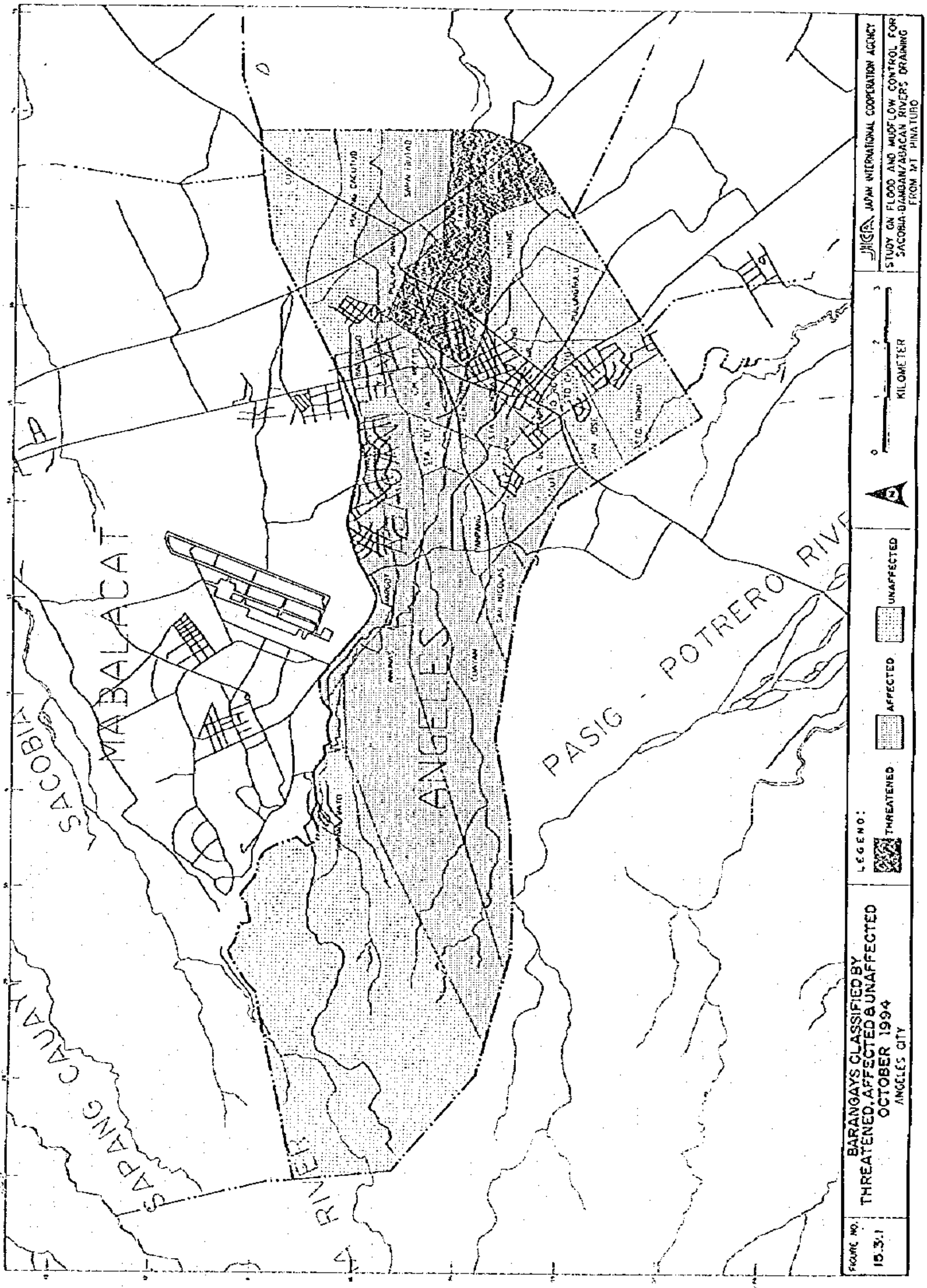


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (1/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

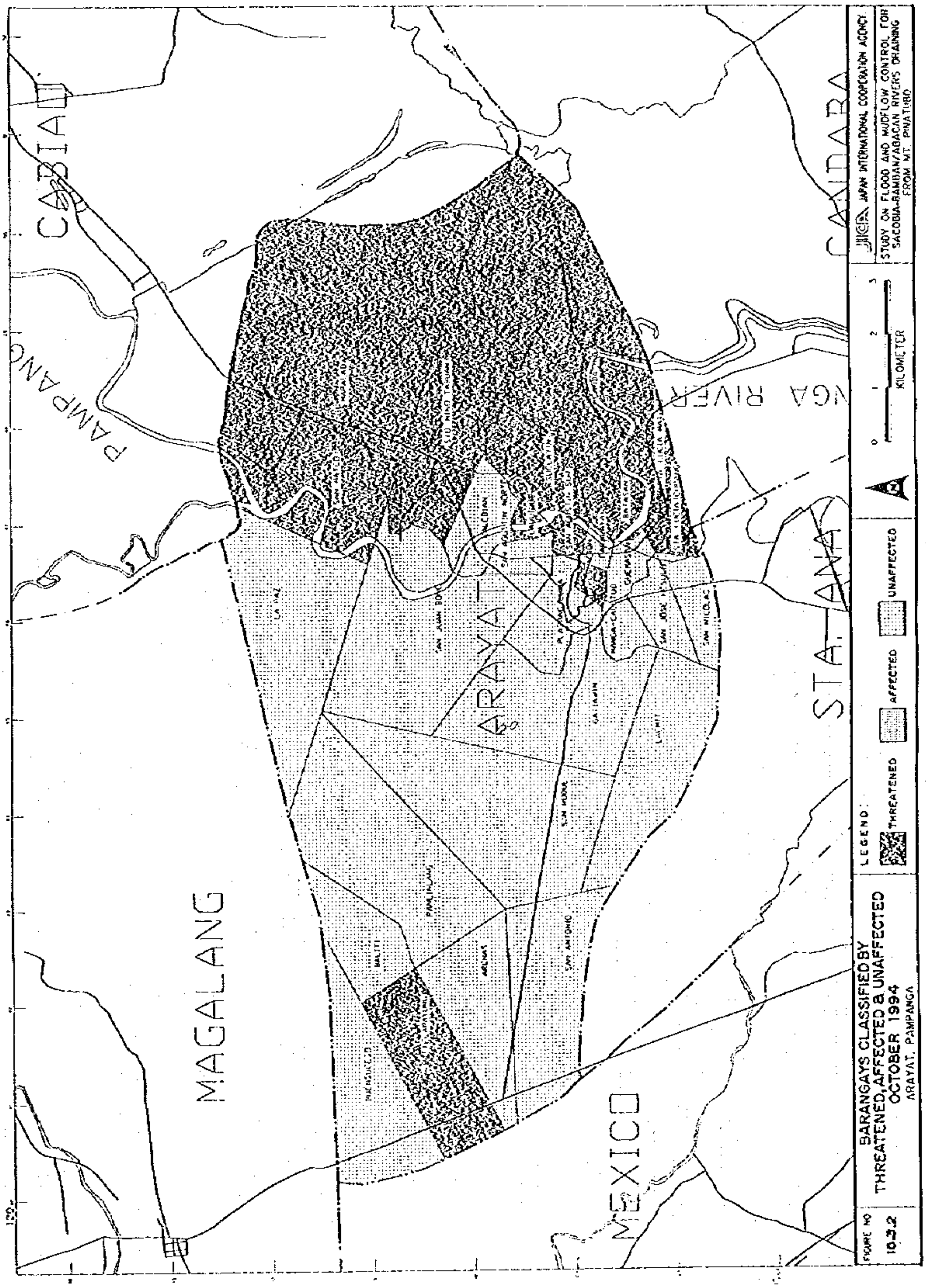


Figure M.2
Threatened, Affected and Unaffected Barangays by Municipality (2/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

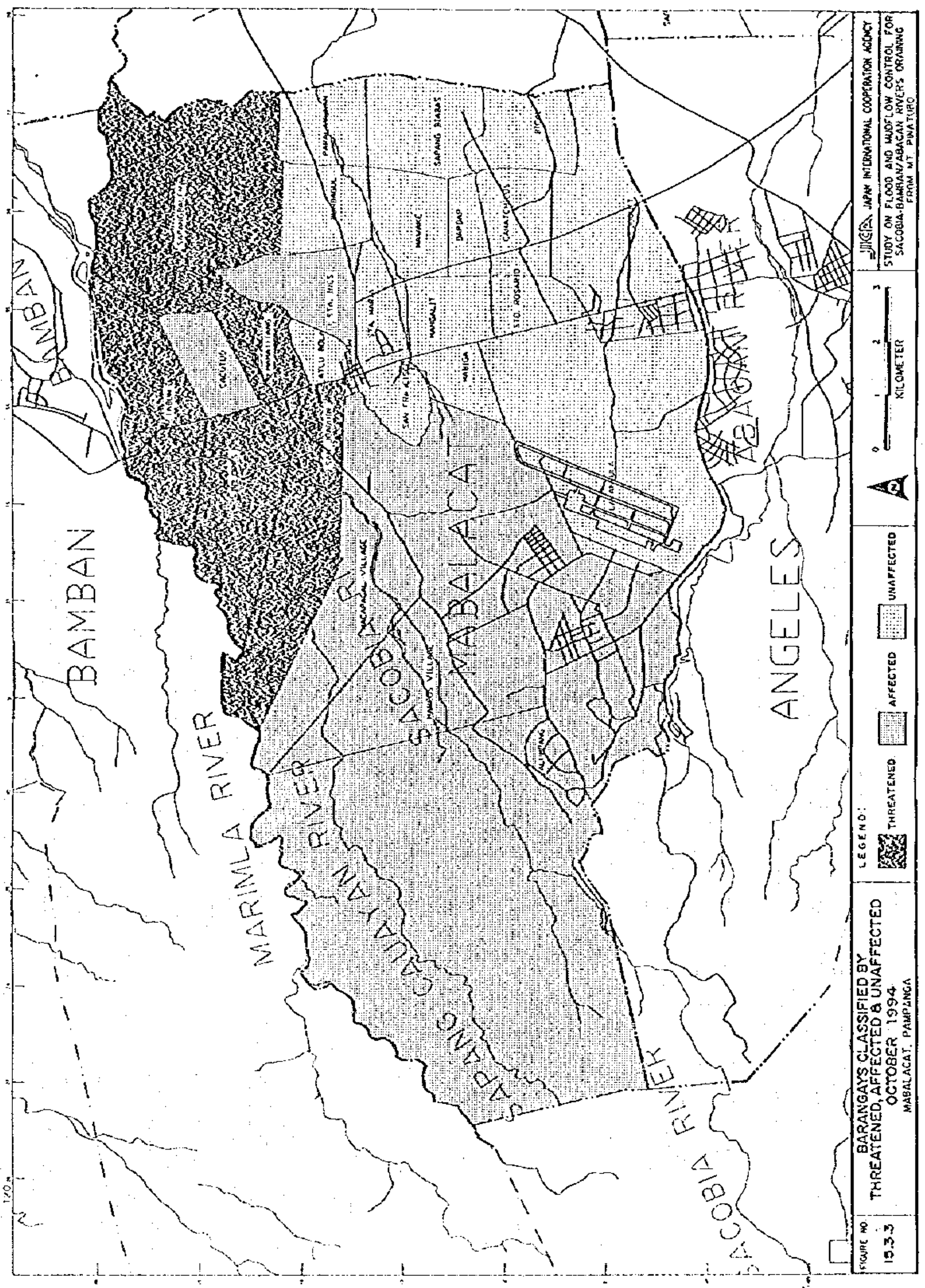


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (3/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

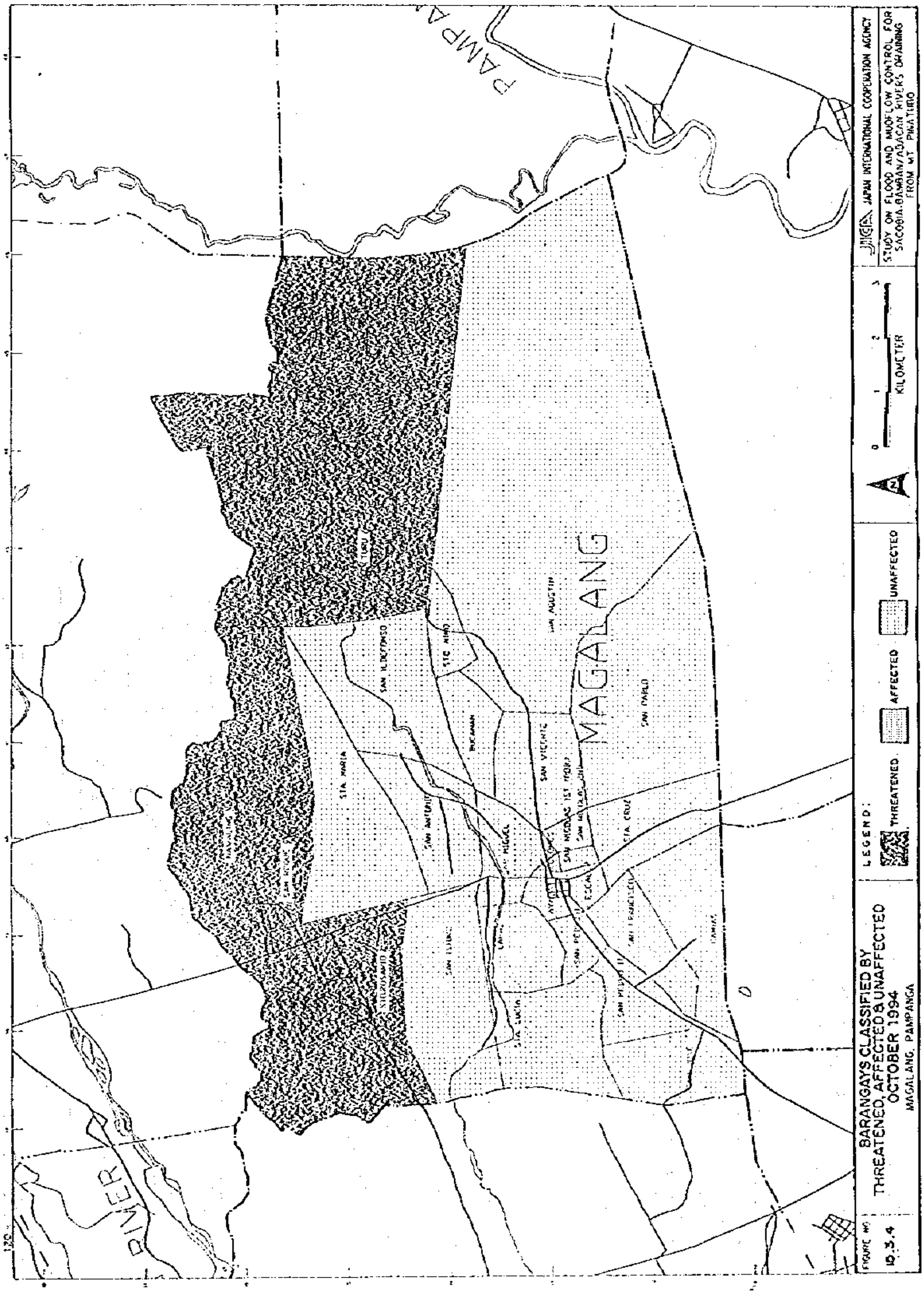


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (4/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

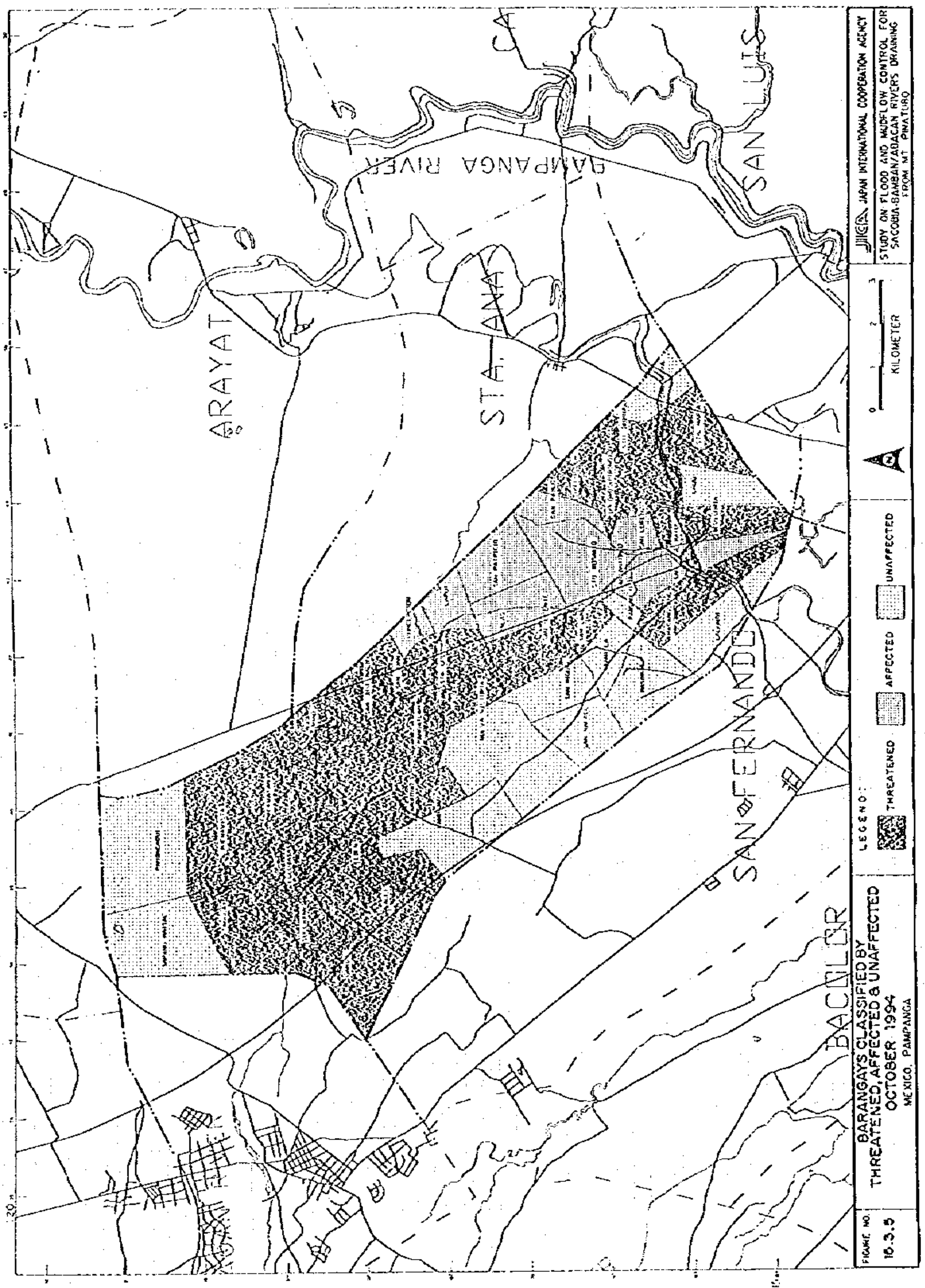


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (5/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

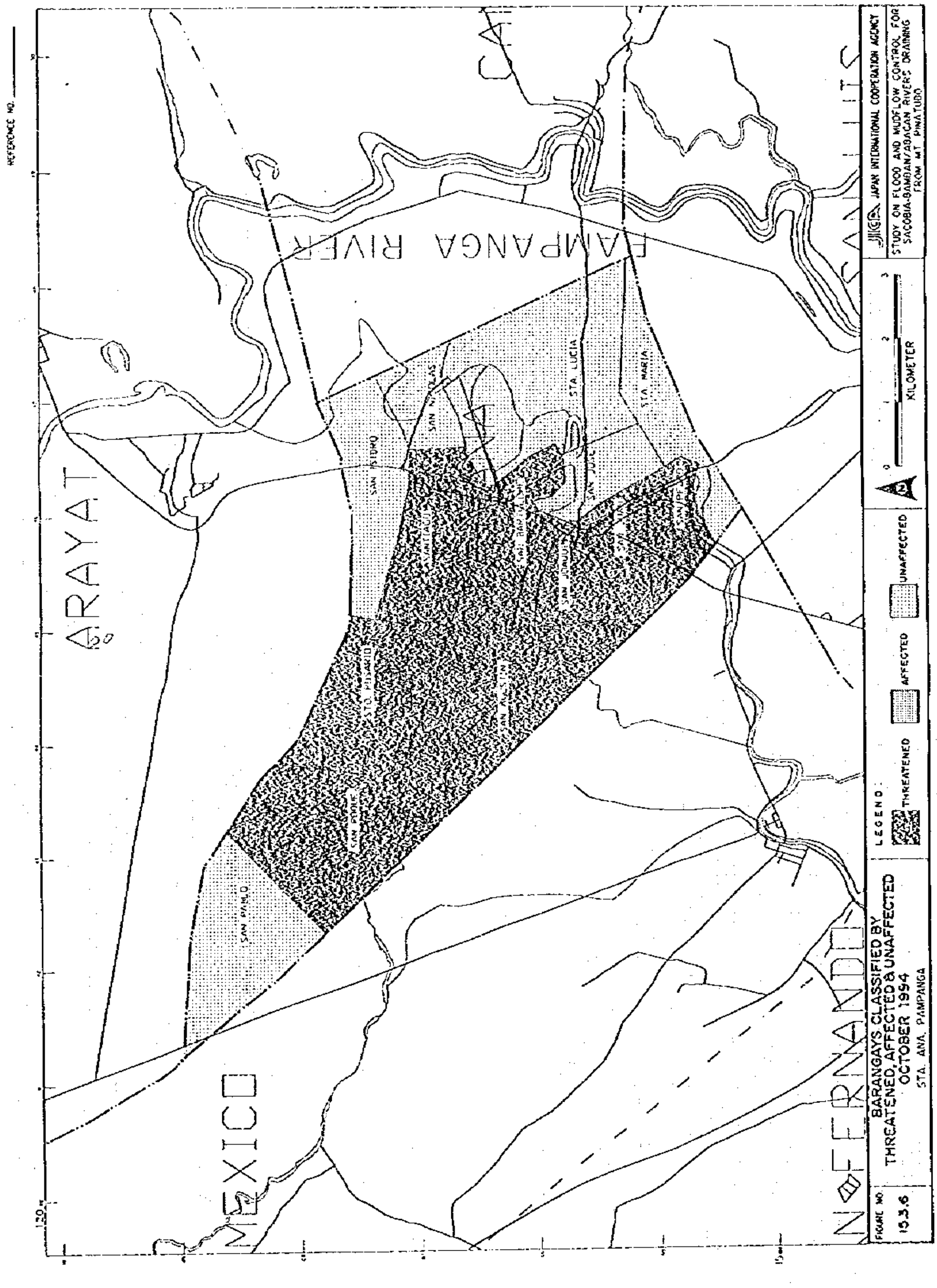


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (6/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

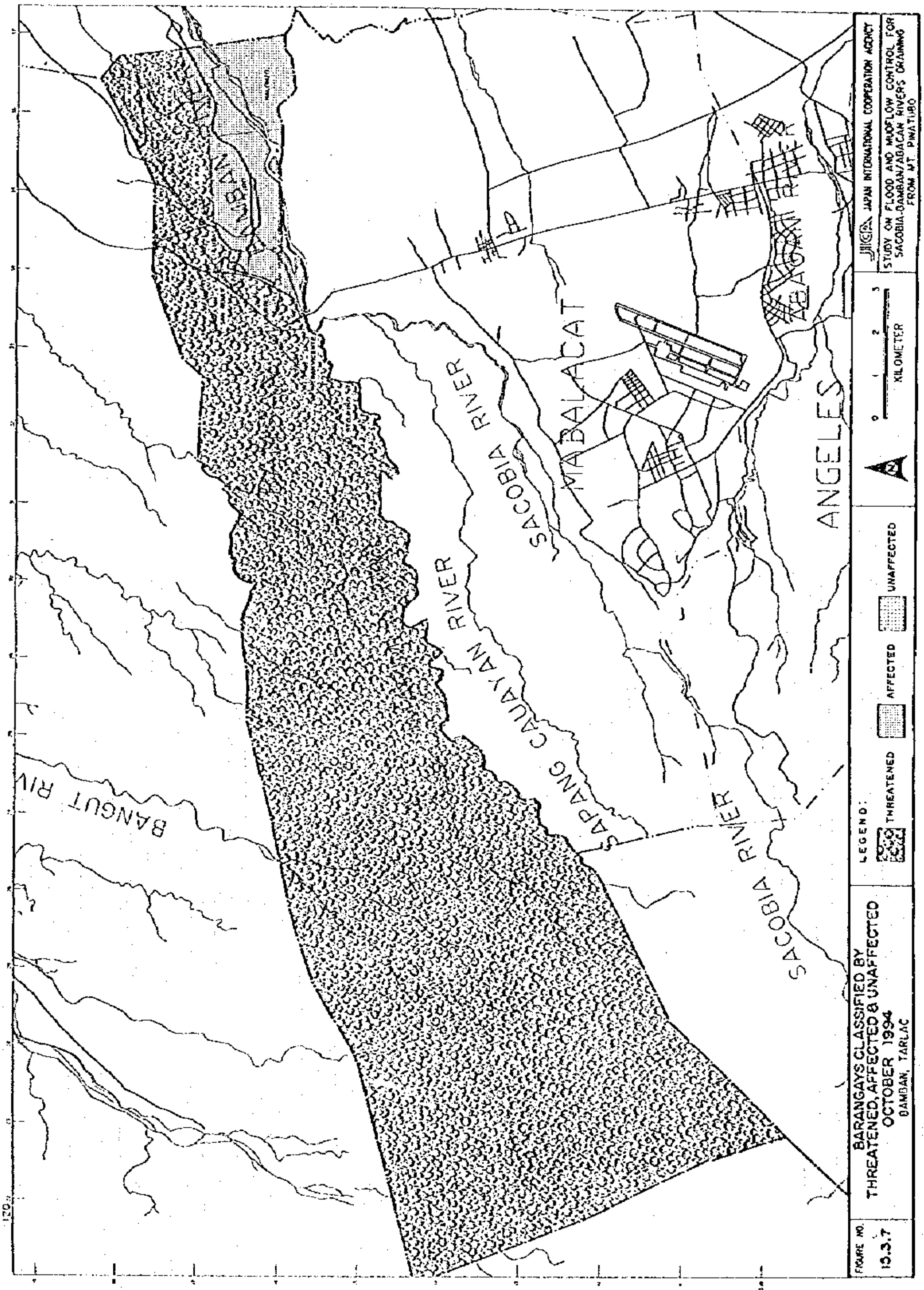


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (7/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

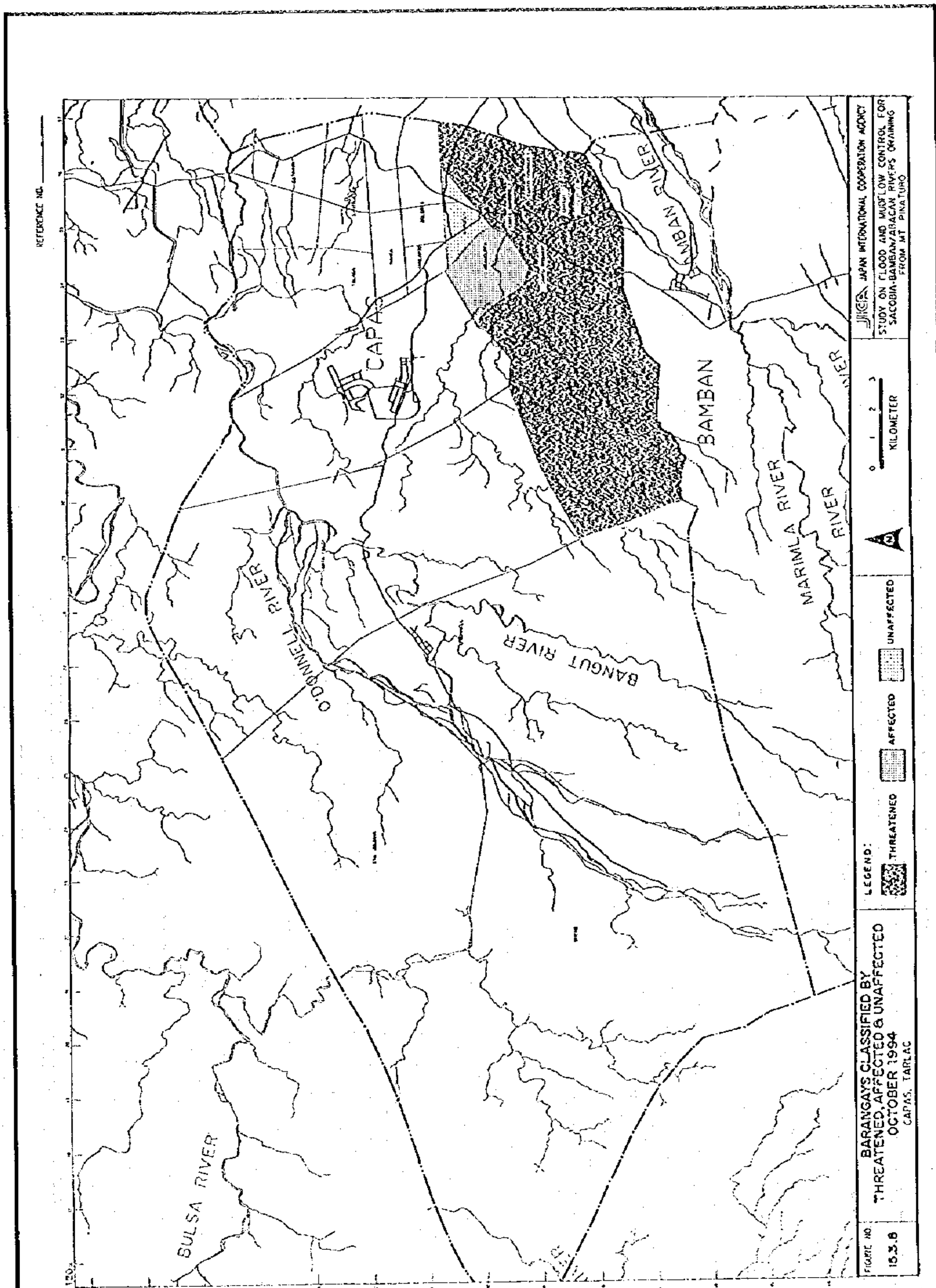


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (8/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

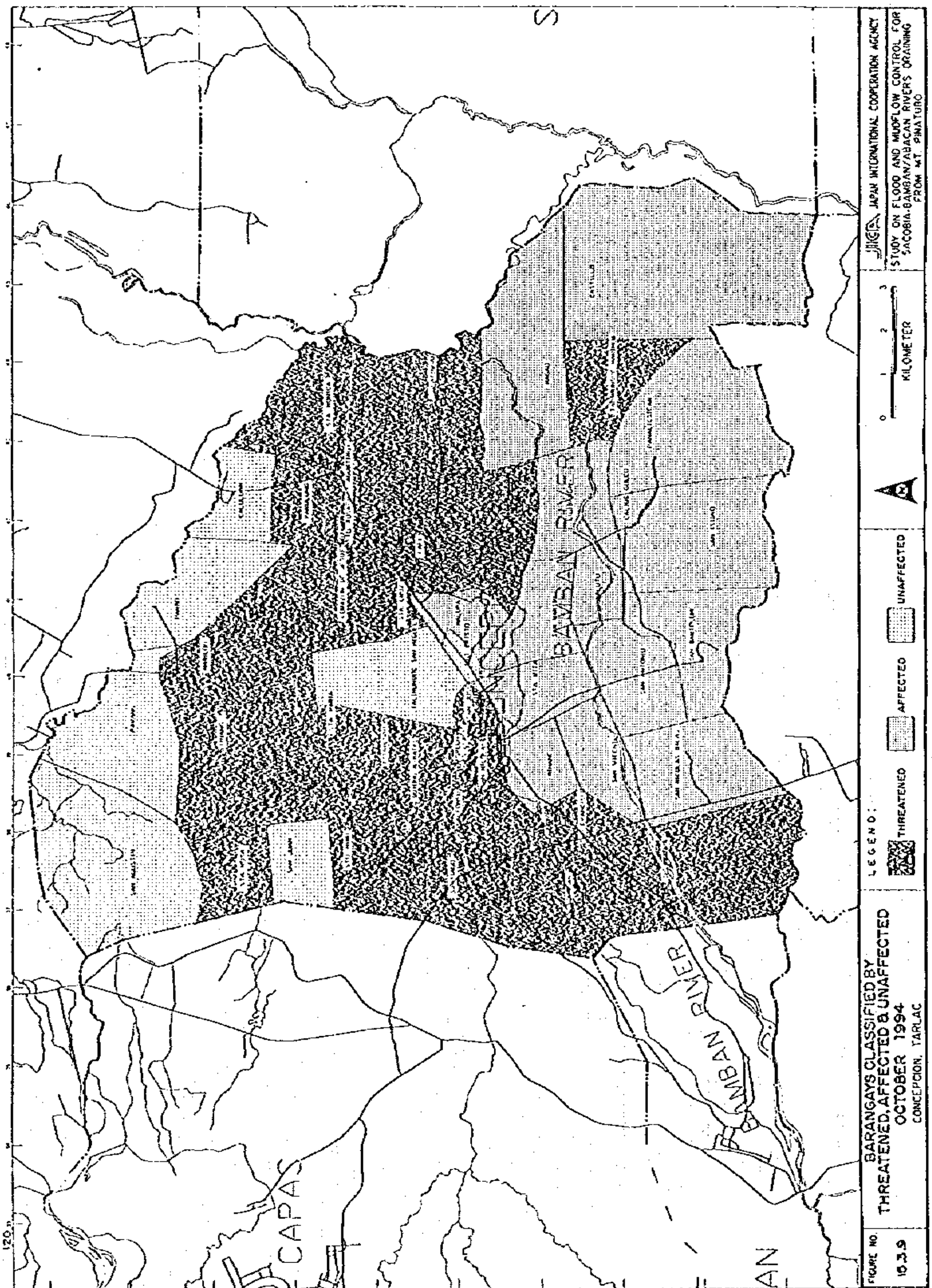


Figure M.2

Threatened, Affected and Unaffected Barangays by Municipality (9/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

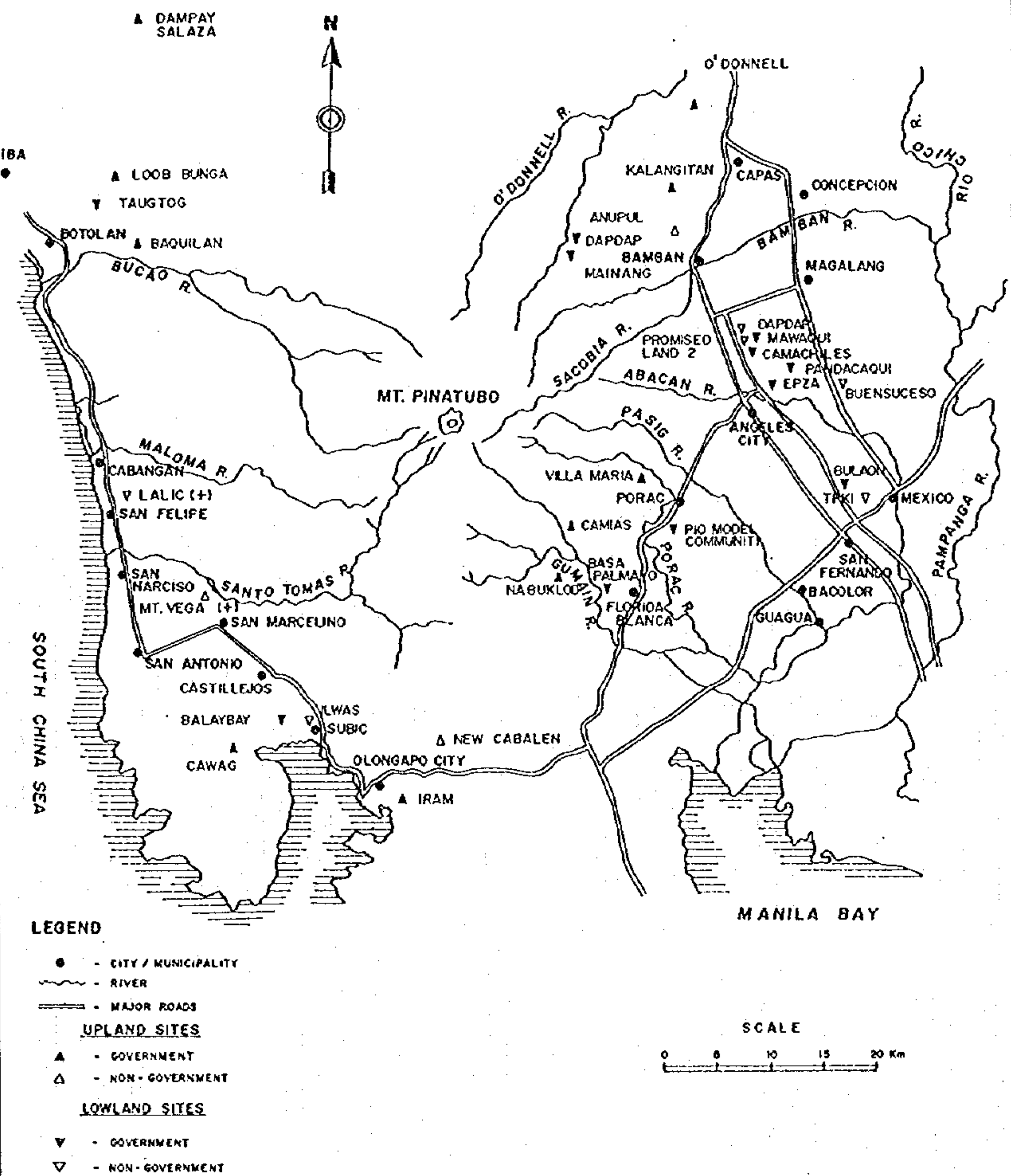
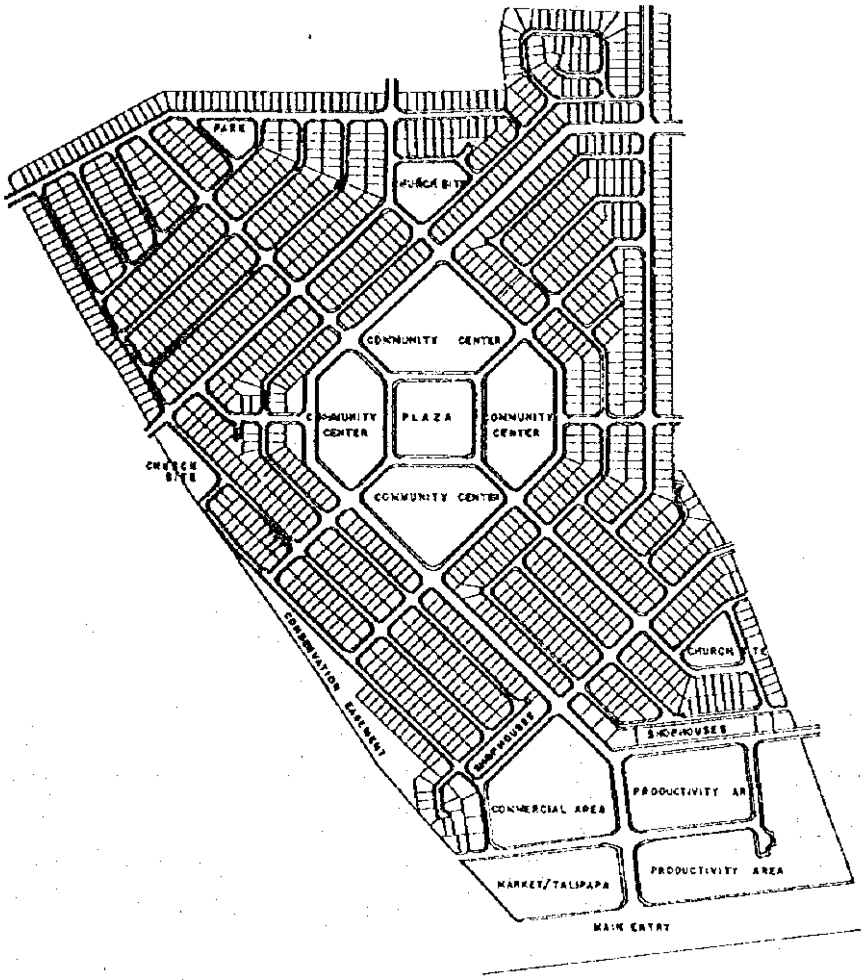


Figure M.3
Location Map of Resettlement Sites

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

SOURCE: PRESIDENTIAL TASK FORCE PINATUBO,
NEW SETTLEMENT PROGRAM, ANNEX [illegible]
TECHNICAL DESCRIPTION OF RESETTLEMENT
SITES [illegible] - 1997, SEPTEMBER [illegible]



SCALE:

FIGURE NO.	TITLE	LEGEND:		
15.II.1	CONCEPTUAL SITE PLAN BASA AIR BASE, FLORIDABLANCA PAMPANGA		TOTAL AREA	85.28 HECTARES
			NO. OF LOTS	1308
			DIMENSION (AREA)	12 X 25 M (300 SQ.M)
			NO. OF SHOPHOUSES	66
			AREA	800 SQ.M.
			DENSITY	15 LOTS / HAS.

Figure M.4

Conceptual Resettlement Site Plan (1/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL
FOR SACOBIA-BAMBAN/ABACAN RIVER
DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

SOURCE: PRESIDENTIAL TASK FORCE PINATUBO
NEW SETTLEMENT PROGRAM ANNEX I-4,
TECHNICAL DESCRIPTION OF RESETTLEMENT
SITES 1992-1997, SEPTEMBER 1992

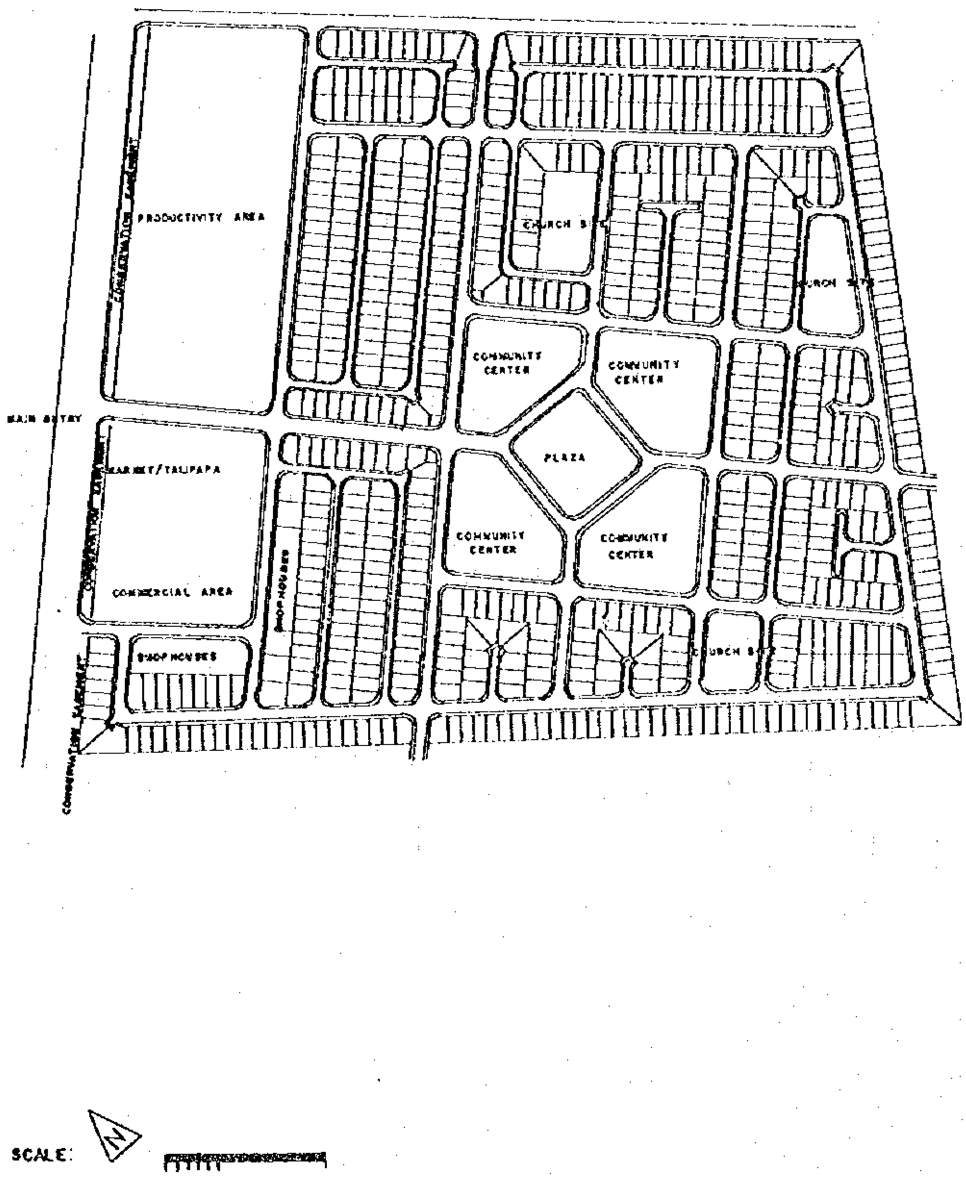


FIGURE NO.	TITLE	LEGEND:		
15.II.2	CONCEPTUAL SITE PLAN. PORAC, PAMPANGA		TOTAL AREA	50 HECTARES
			NO. OF LOTS	880
			DIMENSION (AREA)	12 X 25 M (300 SQ. M.)
			NO. OF SHOPHOUSES	13
			AREA	600 SQ. M.
			DENSITY	16 LOTS / HAS.

Figure M.4
Conceptual Resettlement Site Plan (2/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

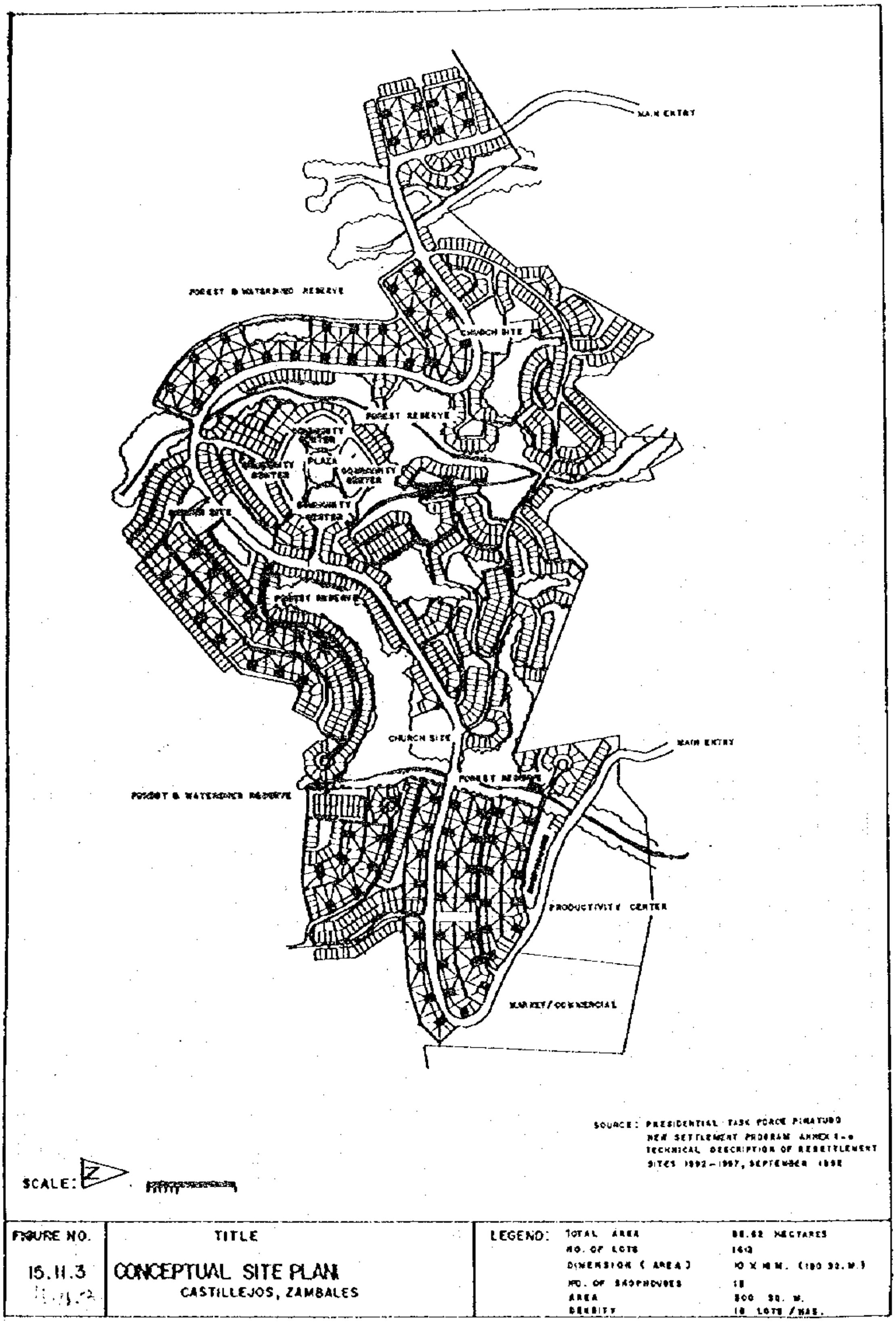


Figure M.4

Conceptual Resettlement Site Plan (3/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

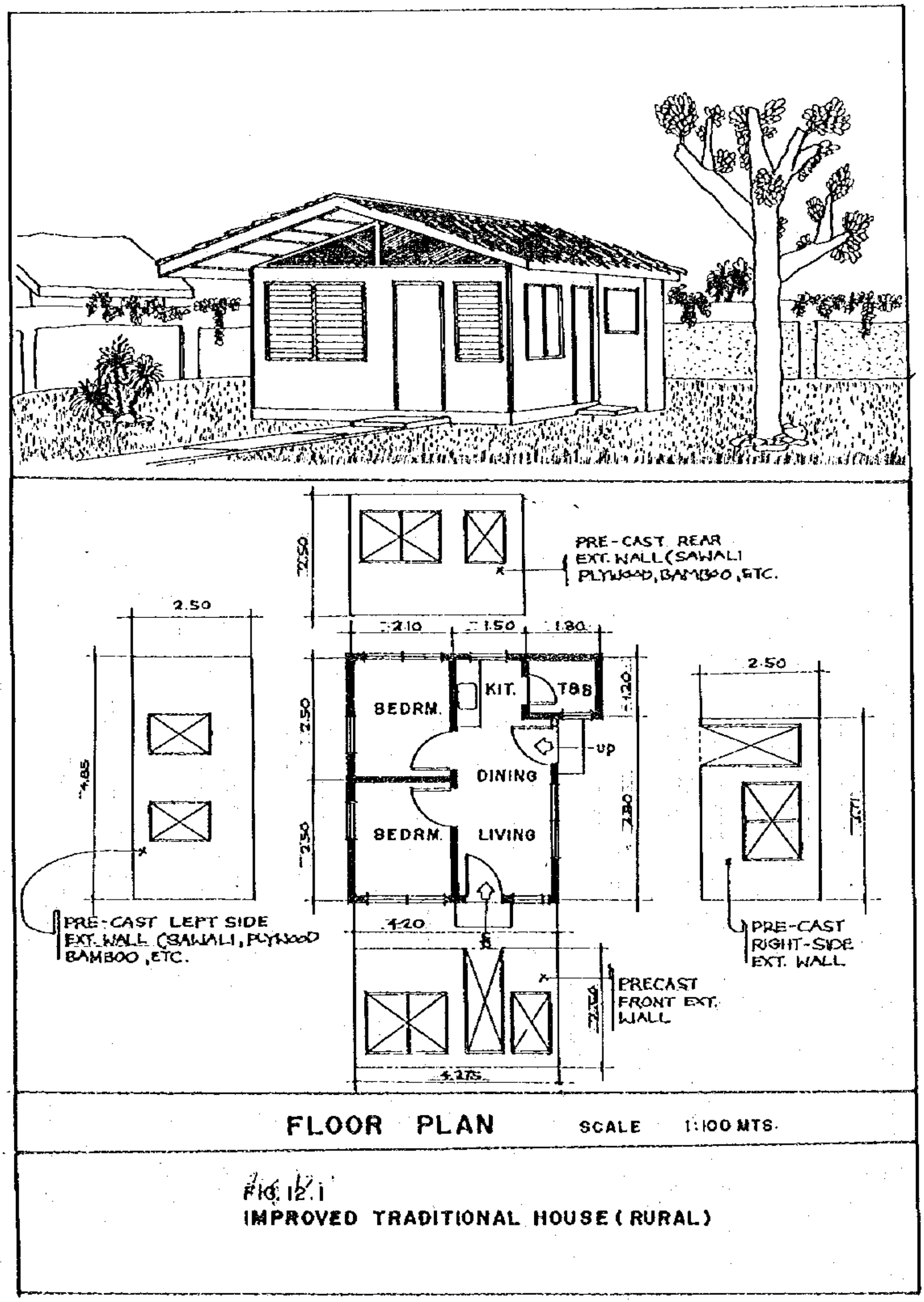
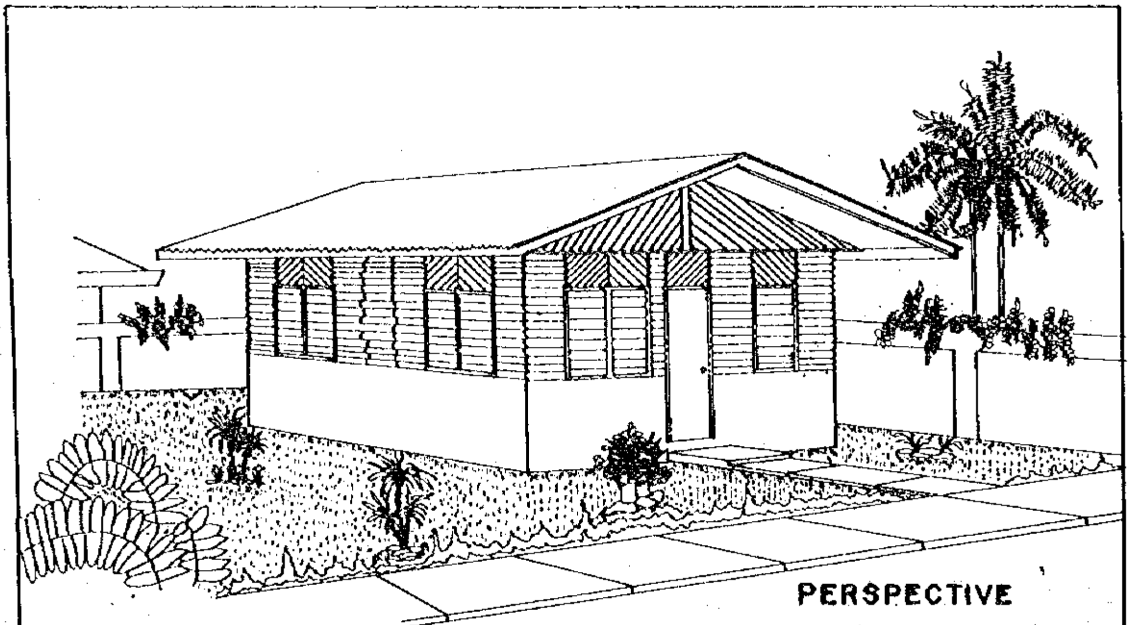
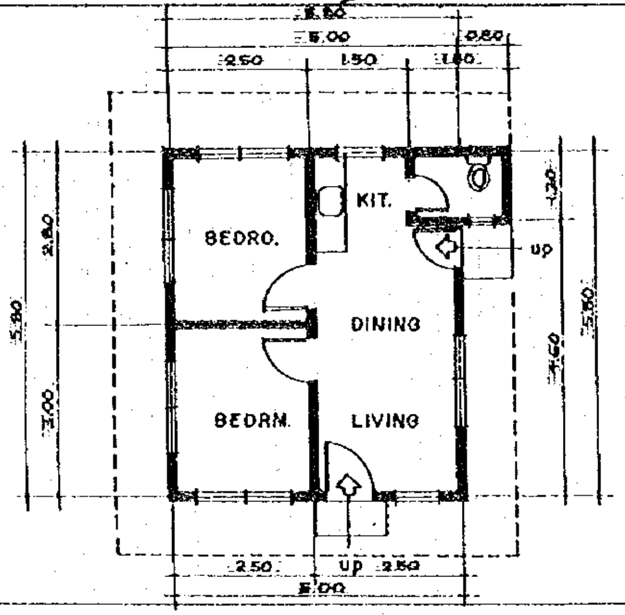


Figure M.5
Improved Traditional House (1/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



PERSPECTIVE



FLOOR PLAN SCALE 1:100 MTS

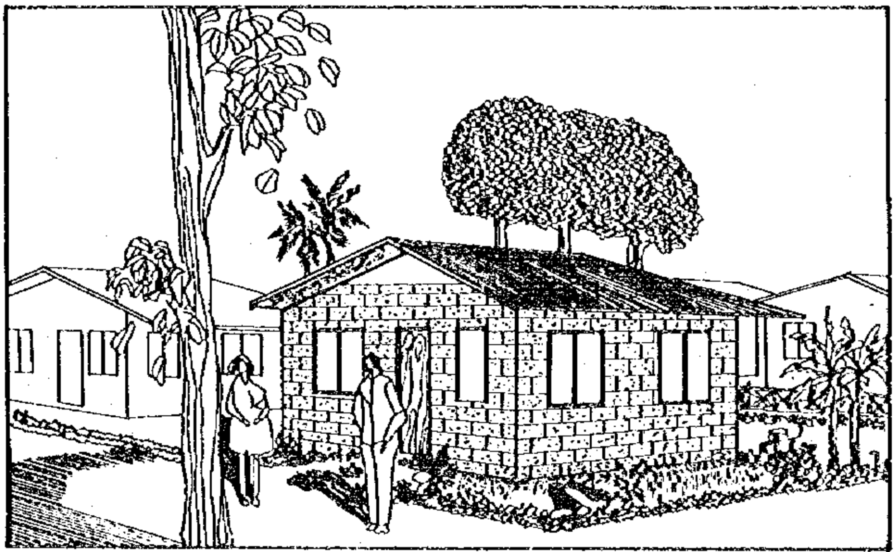
SPECIFICATION:

- CONC. FLOOR SLAB
- BAMBOO EXTERIOR SIDINGS (above window sill level)
- PLYWOOD INTERIOR PARTITION (optional)
- PLYWOOD CEILING INSIDE ONLY, NO CEILING OUTSIDE
- WOOD JAL. WINDOWS
- NO LAVATORY, BOLTON TYPE WATER CLOSET & FAUCET ONLY FOR SHOWER STALL
- NO ROOF GUTTER & DOWNSPOUT

FIG. 12.2
IMPROVED TRADITIONAL HOUSE (URBAN)

Figure M.5
Improved Traditional House (2/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



PERSPECTIVE

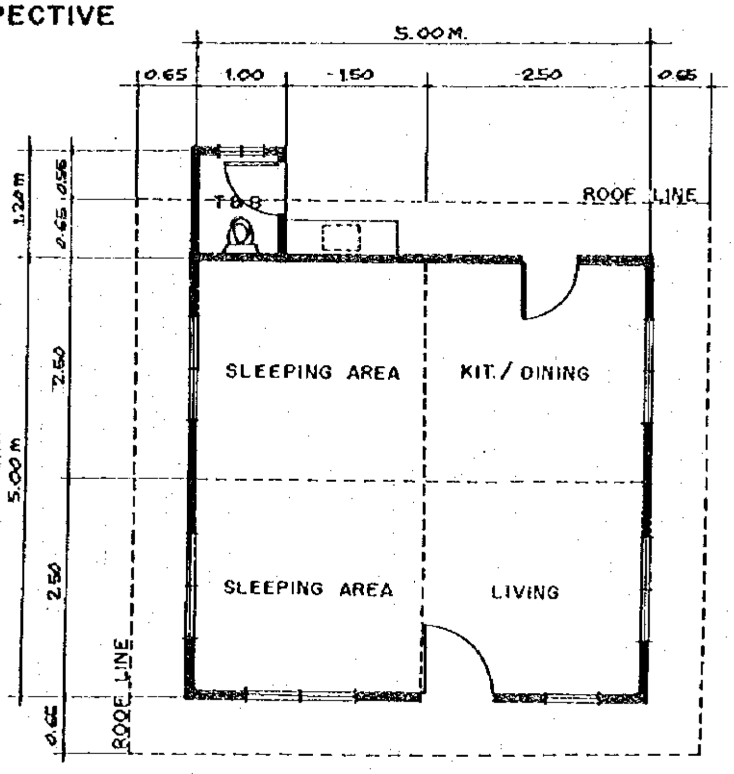


FIG.12.3 PROTOTYPE URBAN HOUSE

GROUND FLOOR PLAN

SCALE 1:50 mts.

Figure M.5

Improved Traditional House (3/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

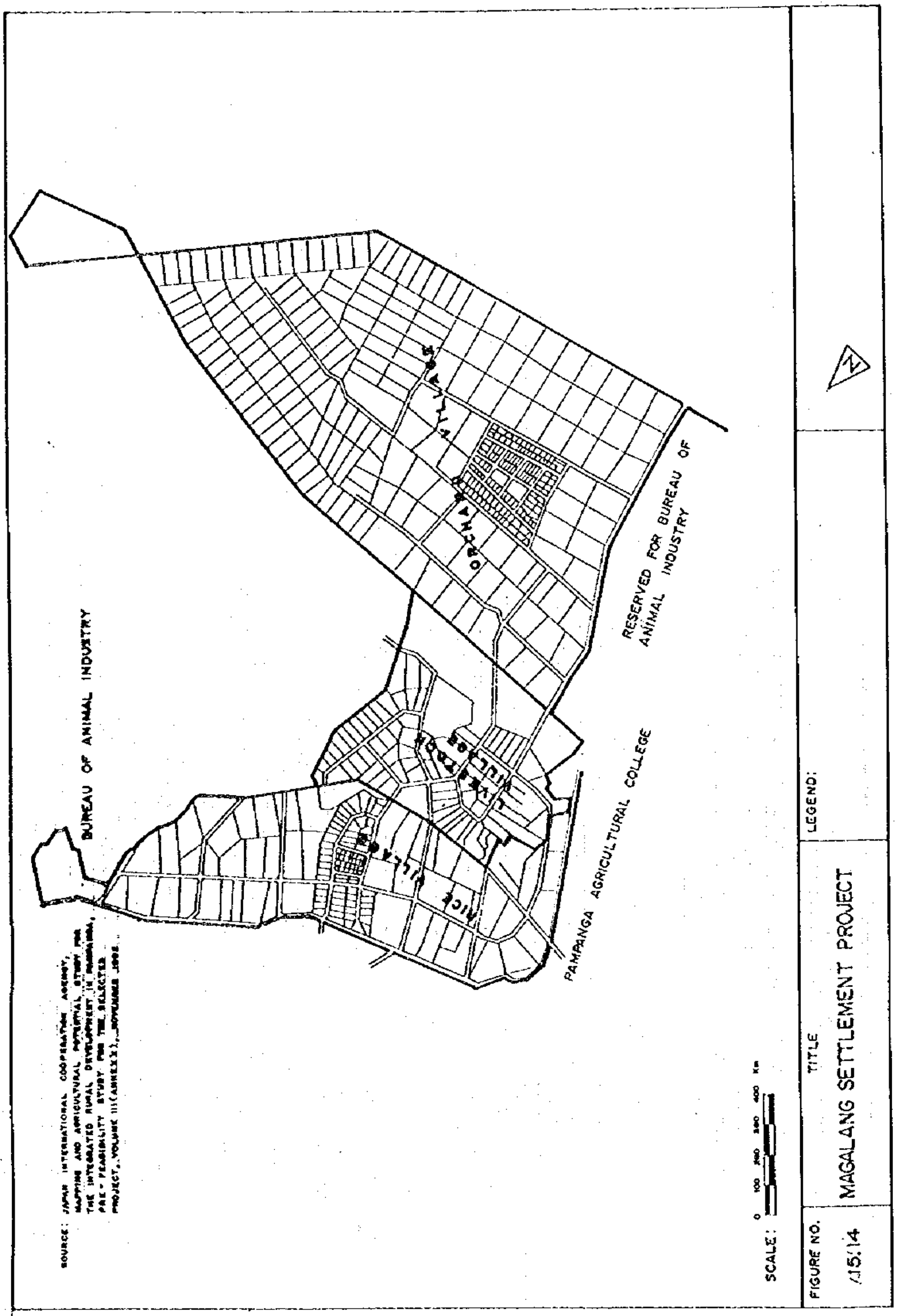
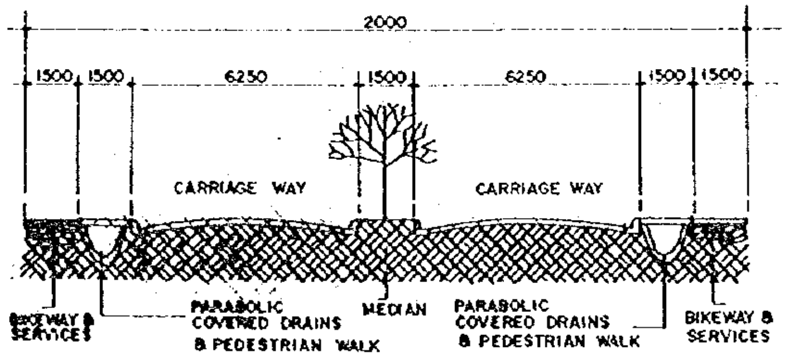


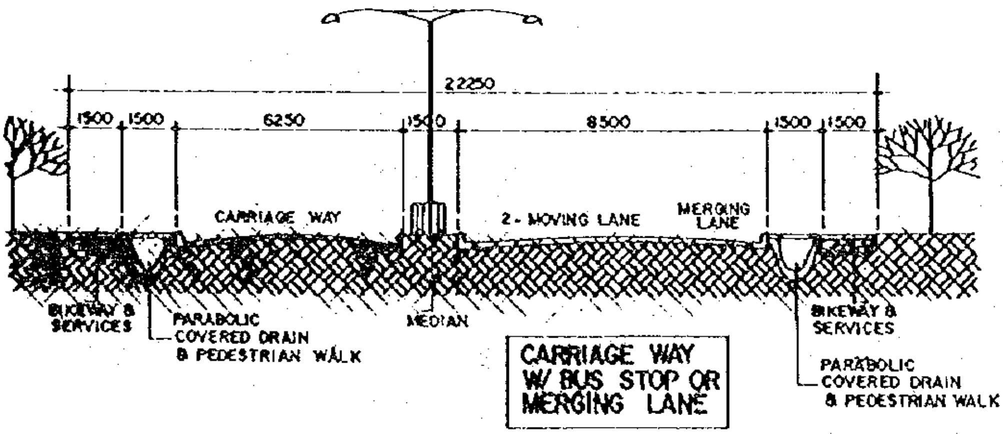
Figure M.6
Magalang Settlement Project Plan

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

SOURCE: PRESIDENTIAL TASK FORCE PINATUBO
NEW RESETTLEMENT PROGRAM ANNEX 1-B,
TECHNICAL DESCRIPTION OF RESETTLEMENT
SITES 1992-1997, SEPTEMBER 1992



PRIMARY ROAD: DUAL CARRIAGE DIVIDED ROAD



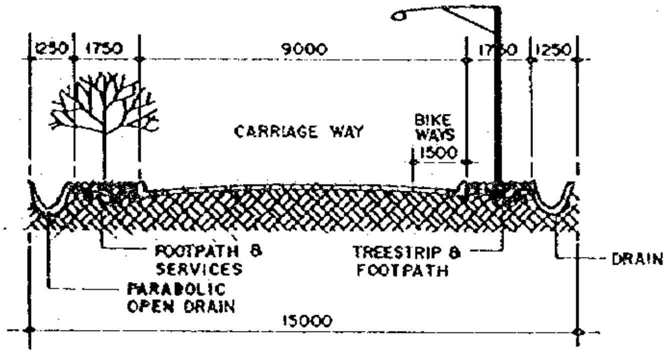
CARRIAGE WAY W/ BUS STOP OR MERGING LANE

FIGURE NO.	TITLE	LEGEND:
15.15	PROPOSED SECTION OF PRIMARY ROAD	

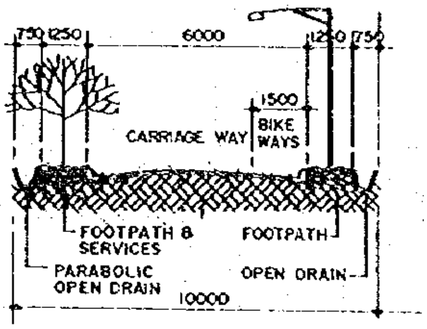
Figure M.7
Proposed Road in Resettlement Site (1/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

SOURCE: PRESIDENTIAL TASK FORCE PINATUBO,
NEW SETTLEMENT PROGRAM ANNEX 1-a,
TECHNICAL DESCRIPTION OF RESETTLEMENT
SITES 1992 - 1997, SEPTEMBER 1992



SECONDARY ROAD: UNDIVIDED 2-WAY WITH ONE PARALLEL PARKING BAY



TERTIARY ROAD: UNDIVIDED 2-WAY

FIGURE NO.	TITLE	LEGEND:
15.16	PROPOSED SECTIONS OF SECONDARY & TERTIARY ROADS	

Figure M.7
Proposed Road in Resettlement Site (2/2)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

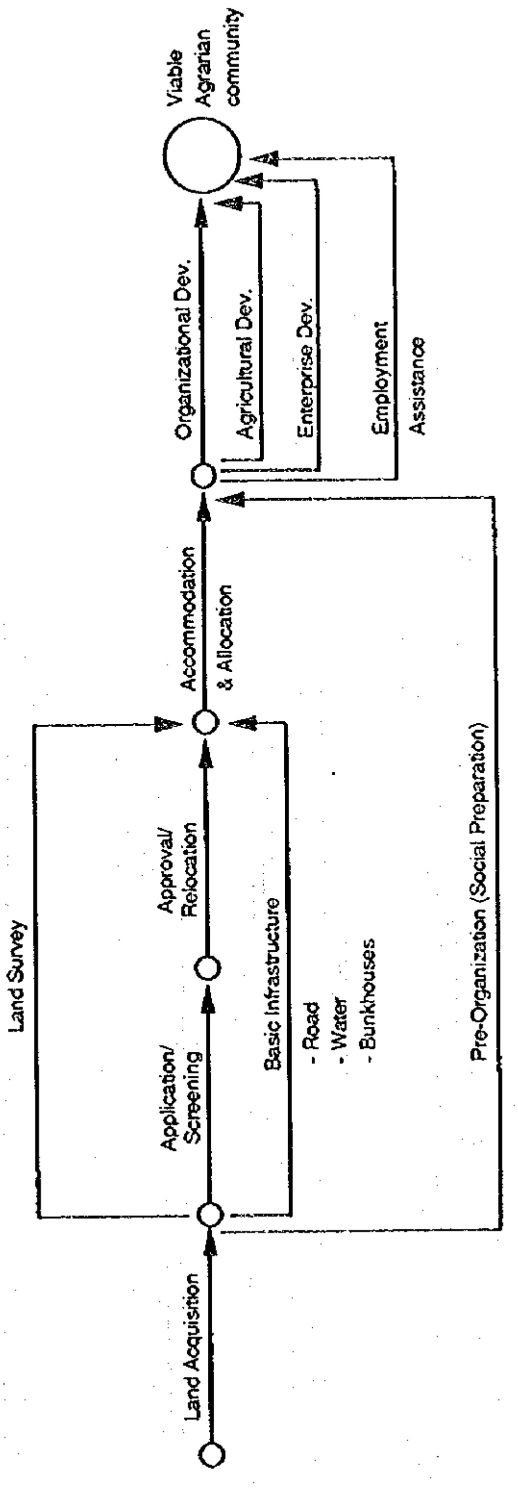


Figure M.8
Resettlement Process (1/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

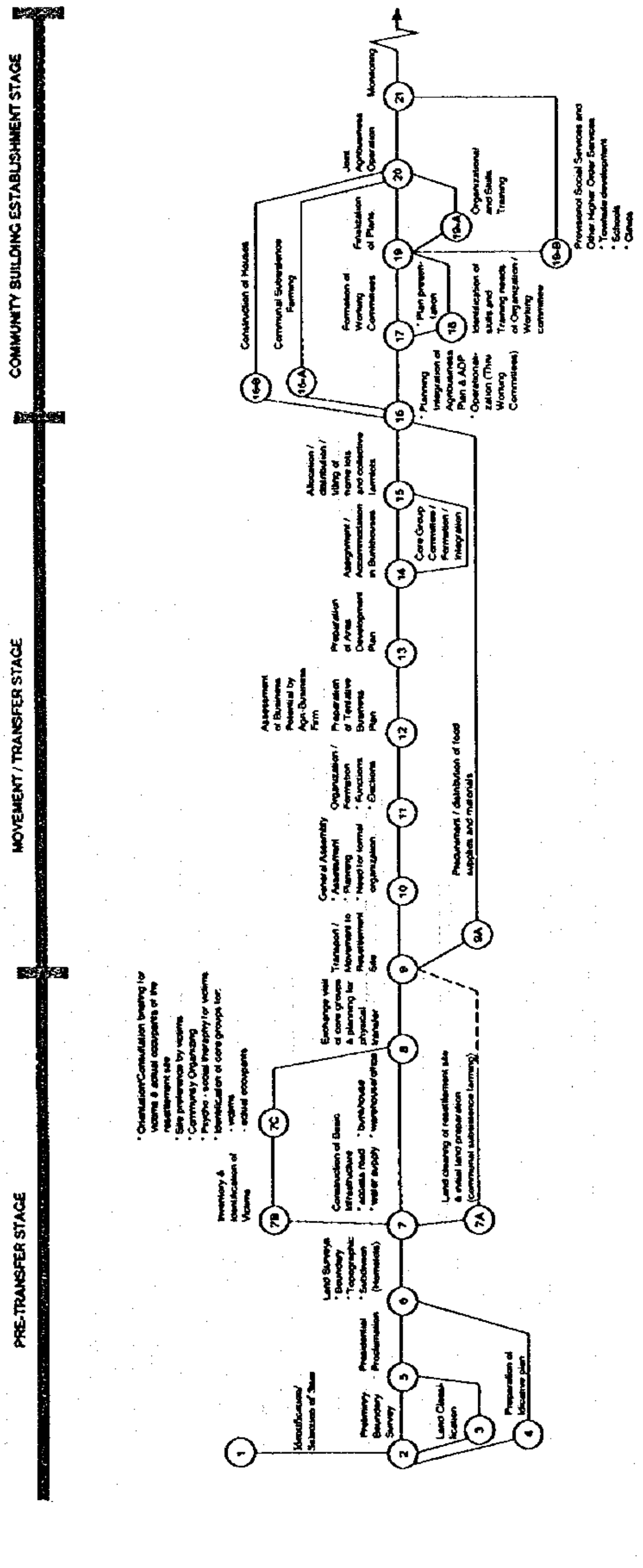


Figure M.8

Resettlement Process (2/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

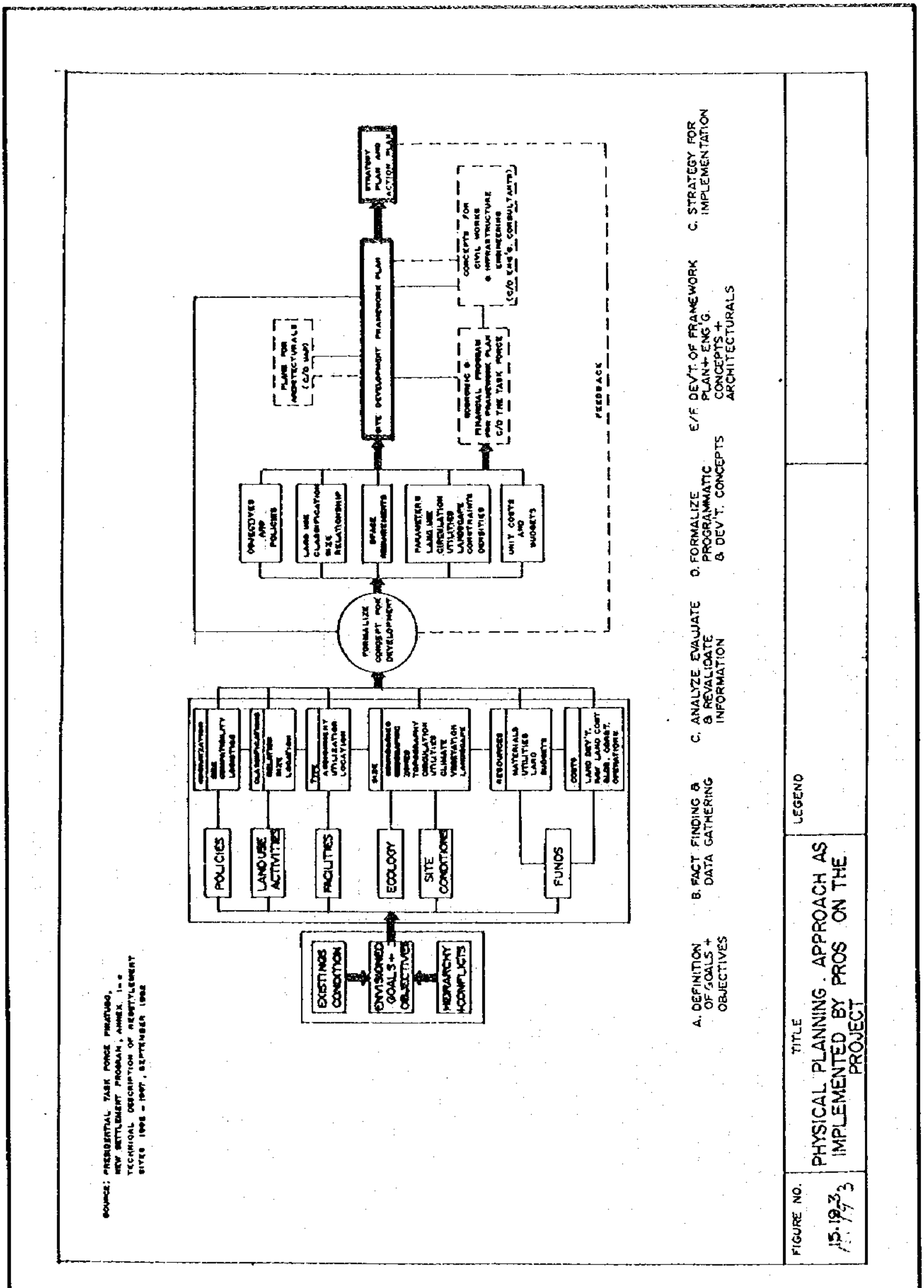


Figure M.8
Resettlement Process (3/3)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

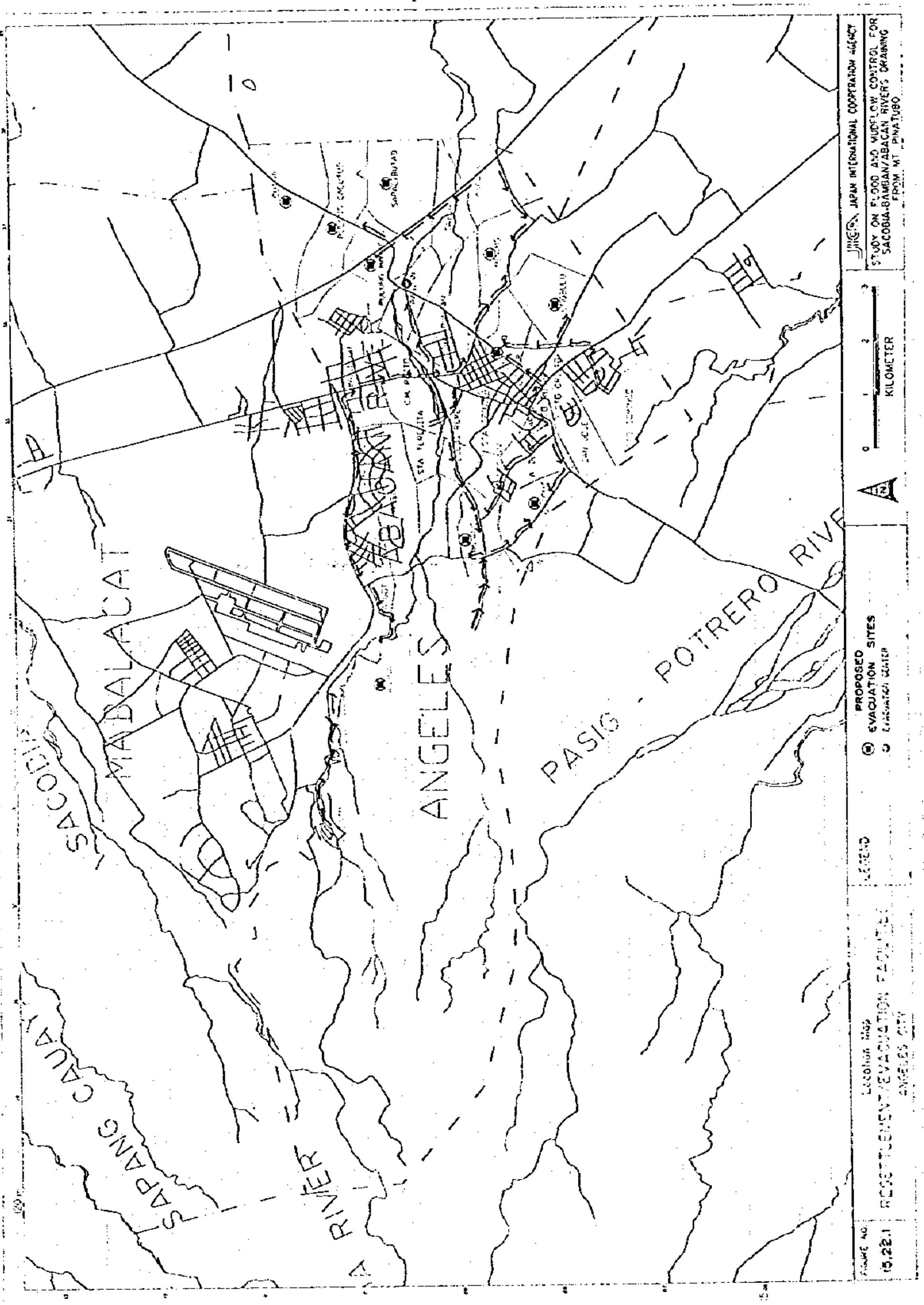


Figure M.9
Evacuation Route (1/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

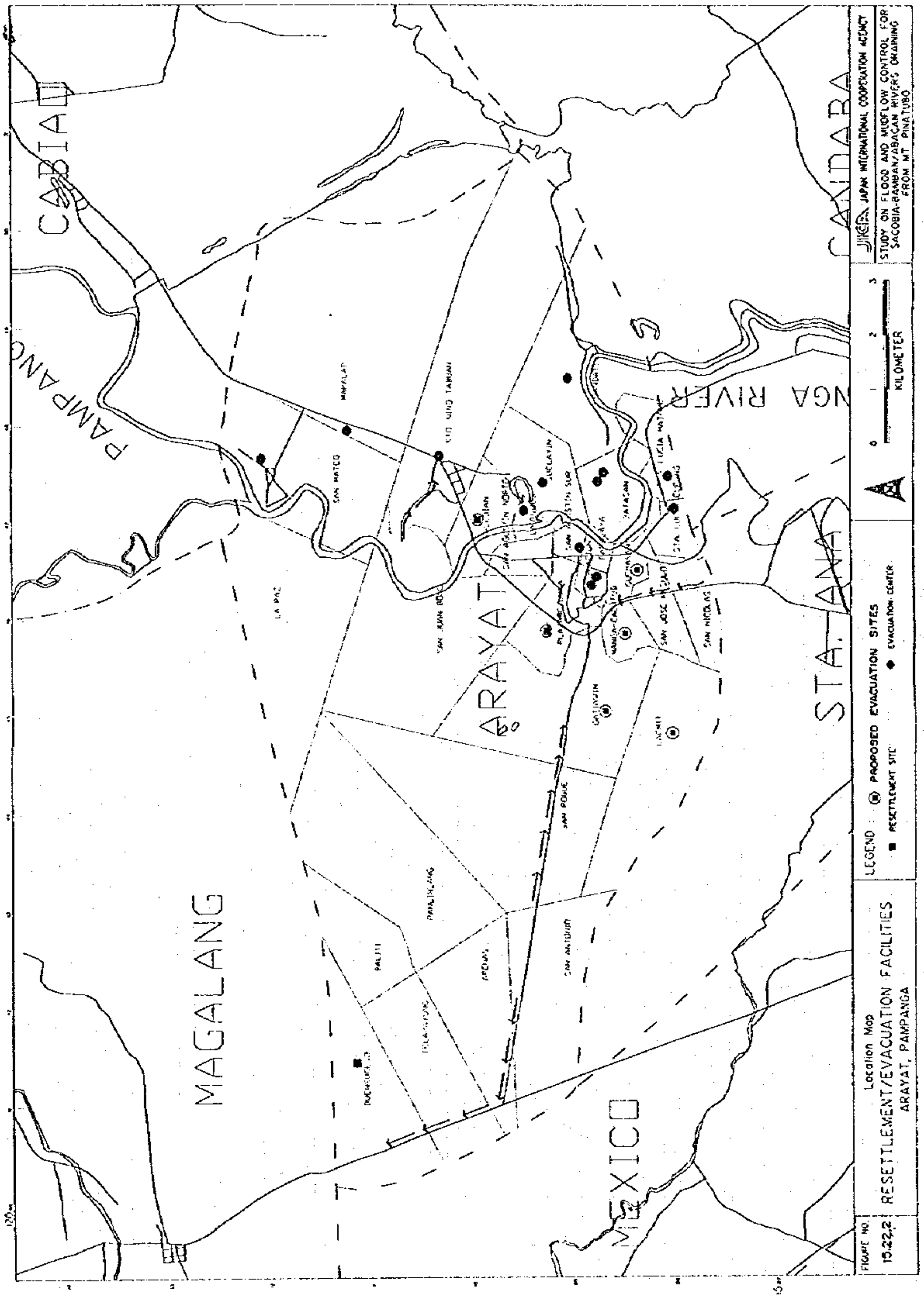


Figure M.9
Evacuation Route (2/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

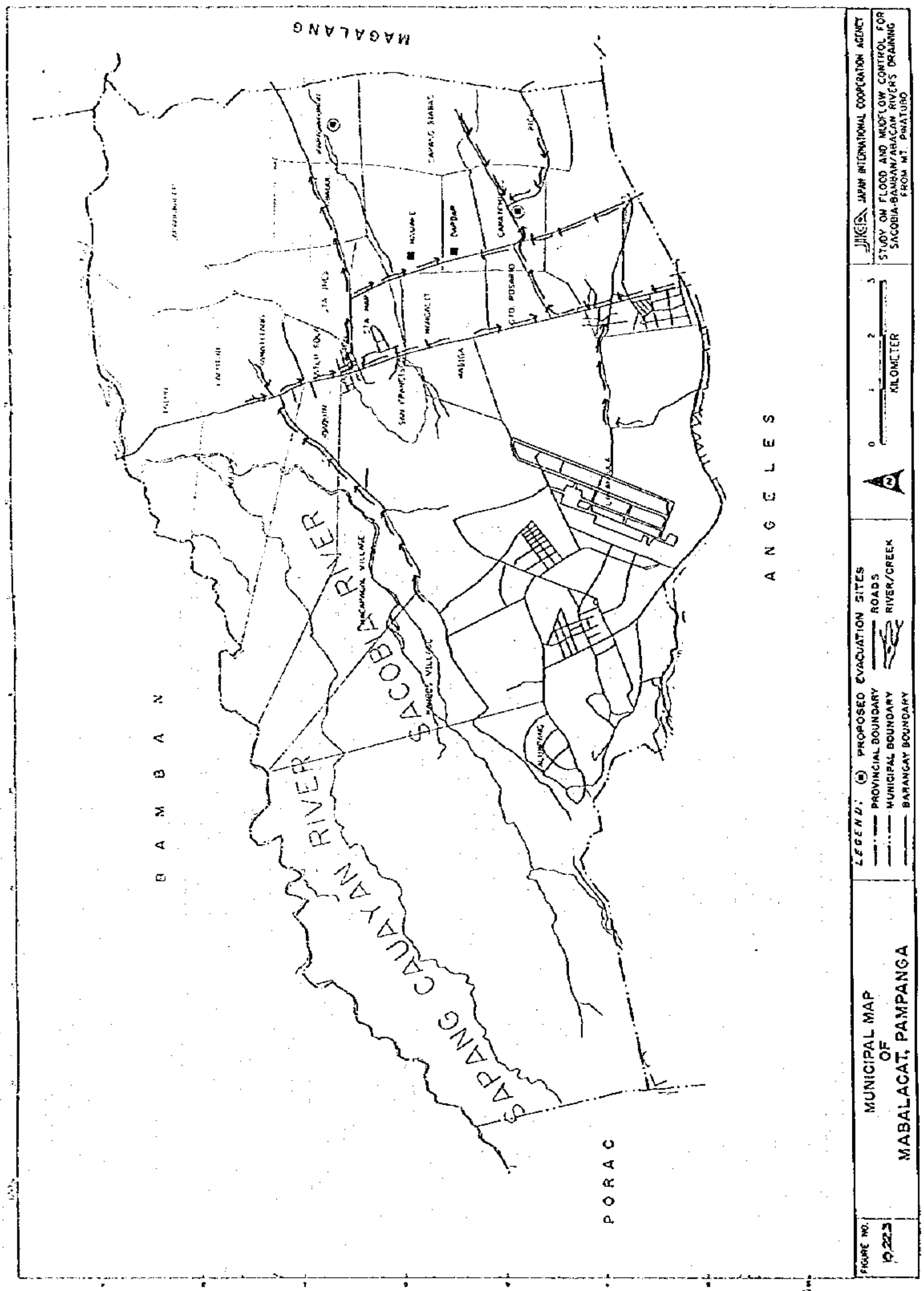


Figure M.9
Evacuation Route (3/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

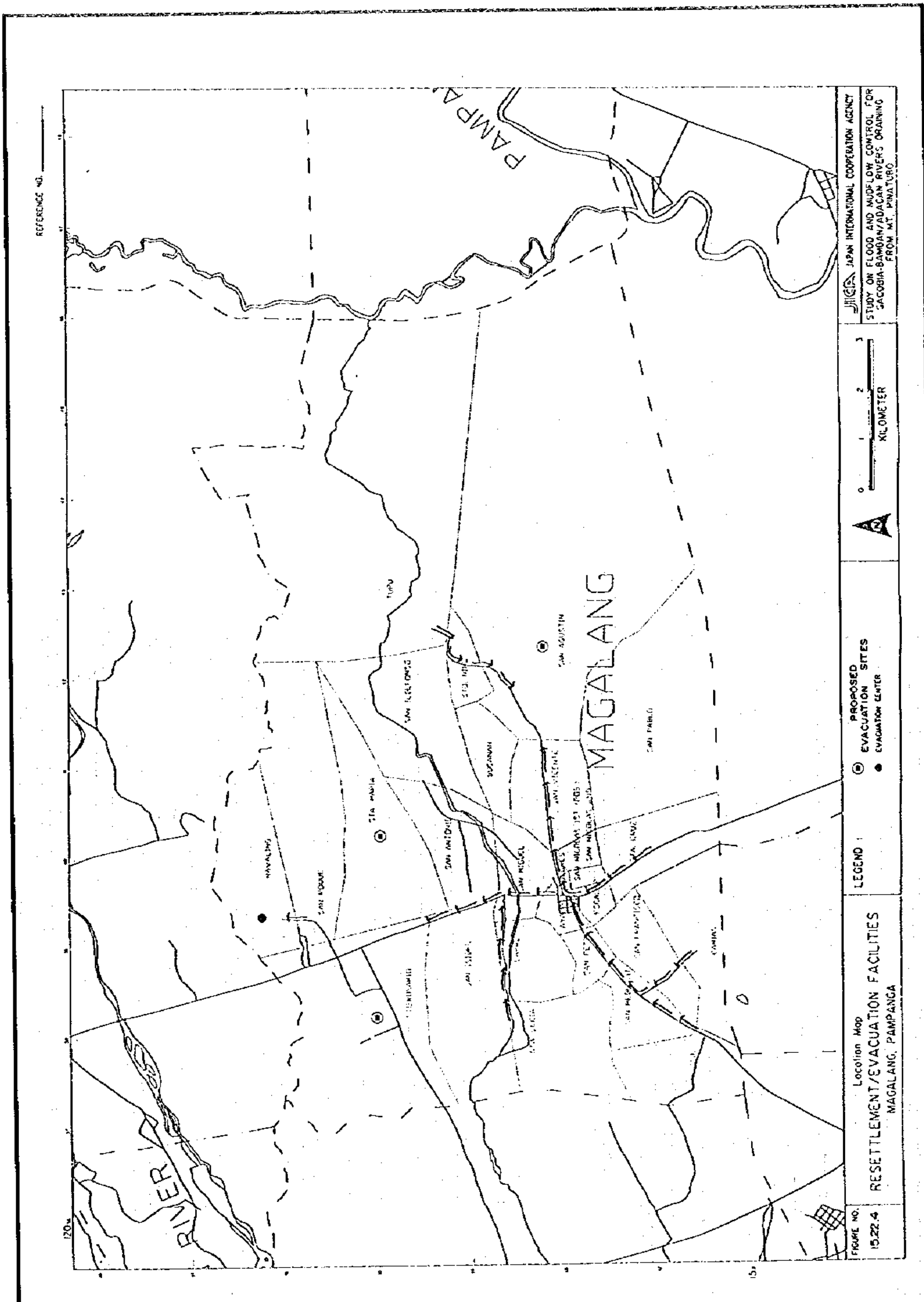


Figure M.9
Evacuation Route (4/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

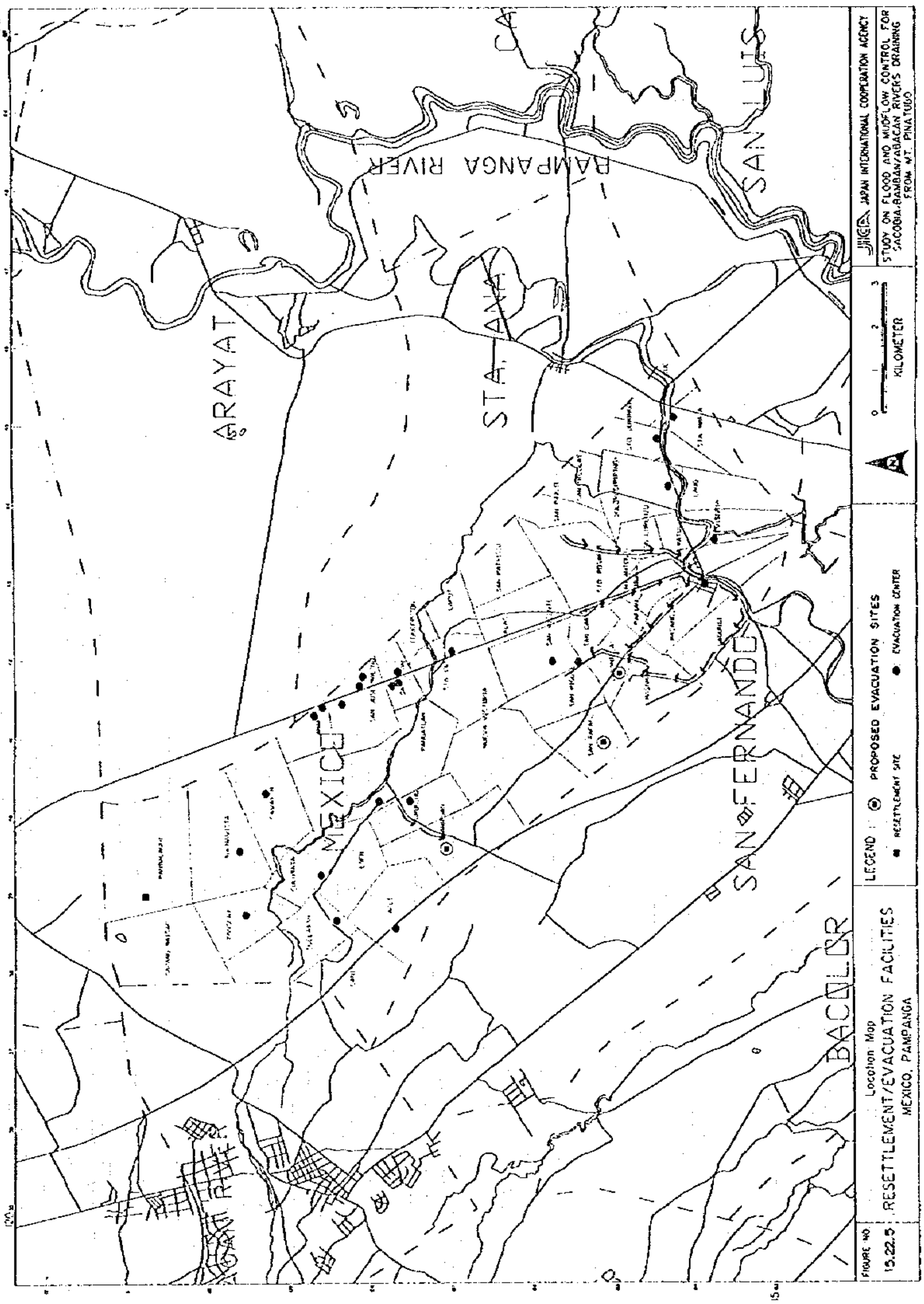


Figure M.9
Evacuation Route (5/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

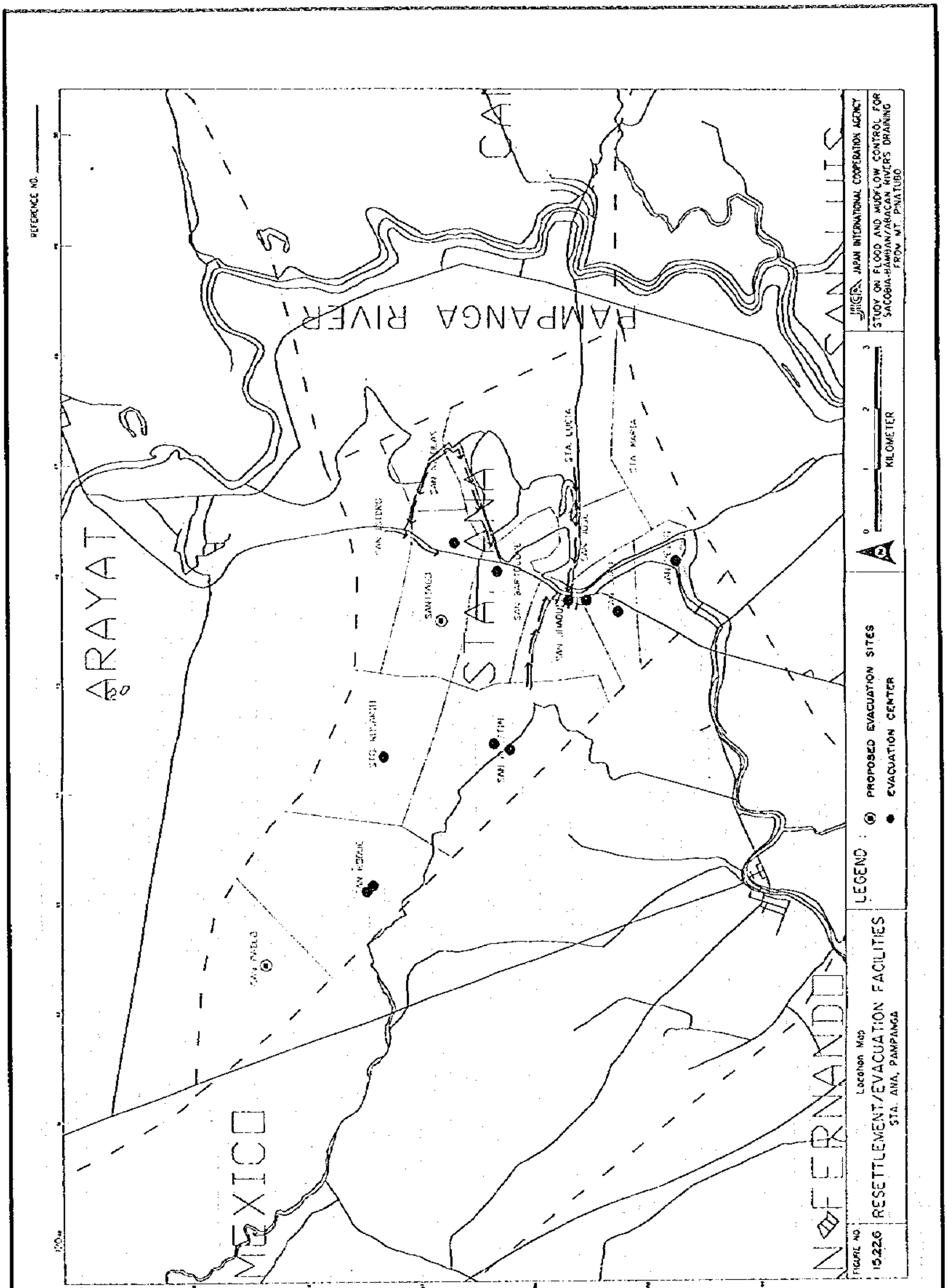


Figure M.9
Evacuation Route (6/9)

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

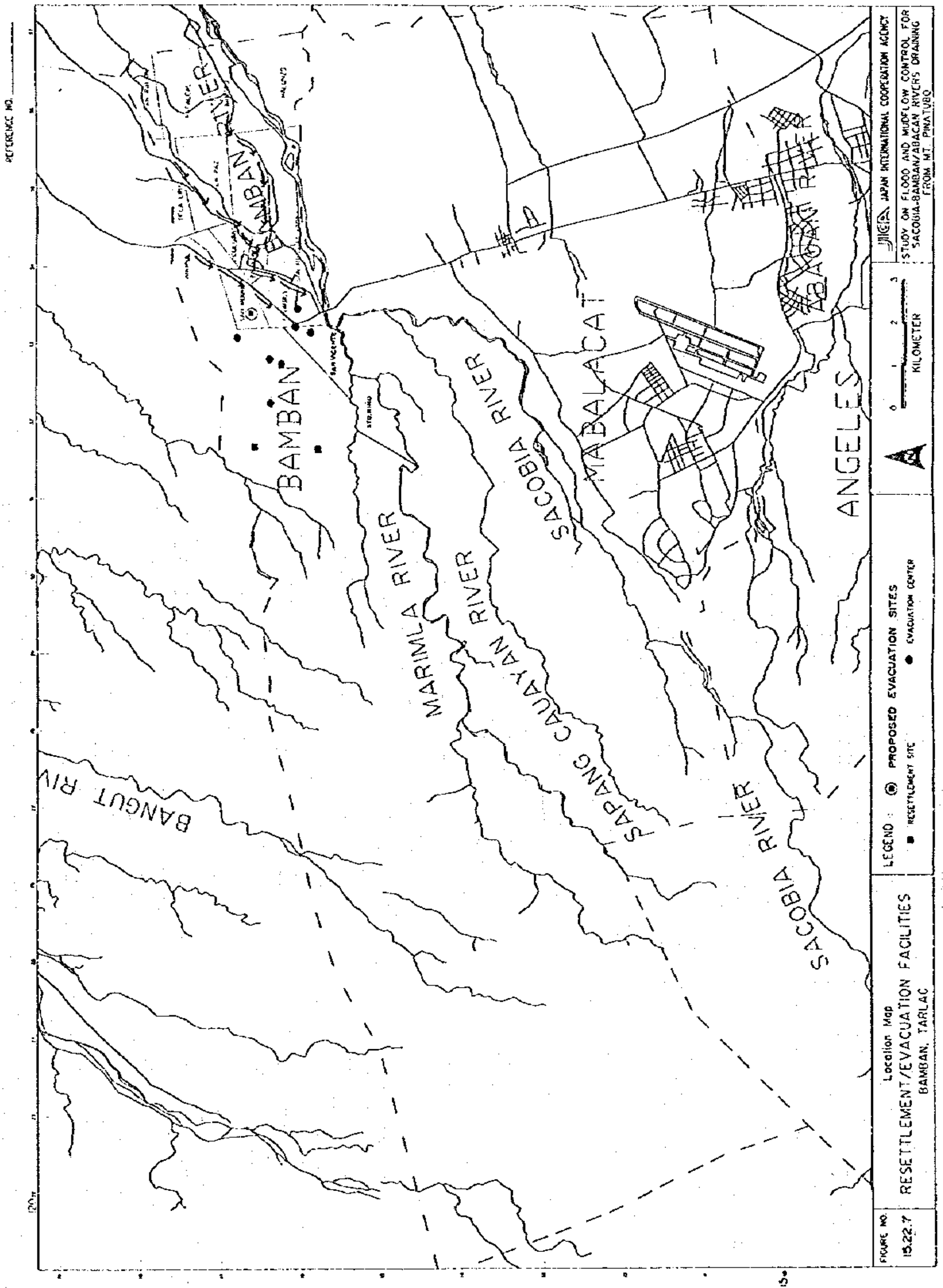


Figure M.9
Evacuation Route (7/9)

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

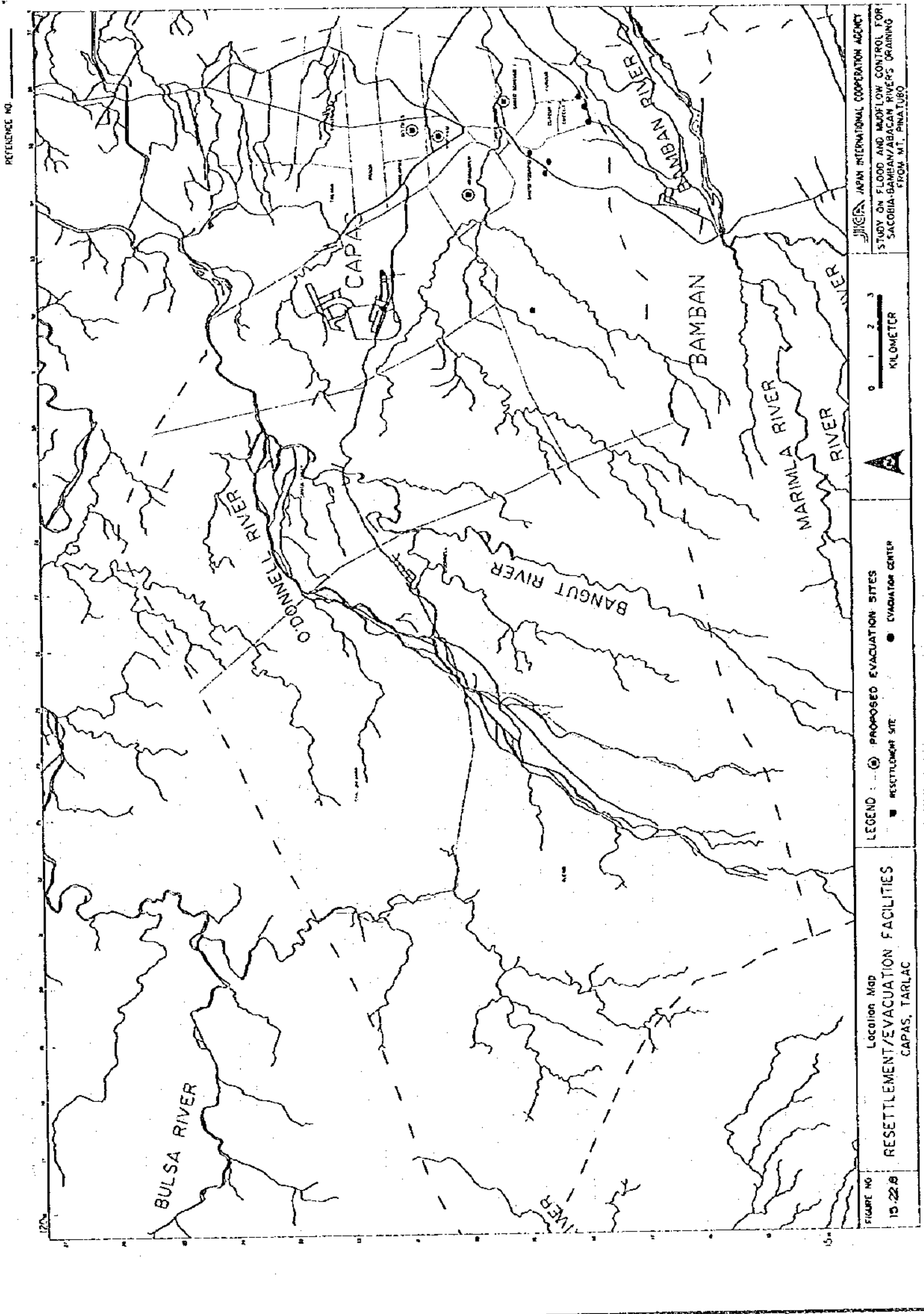


Figure M.9
Evacuation Route (8/9)

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

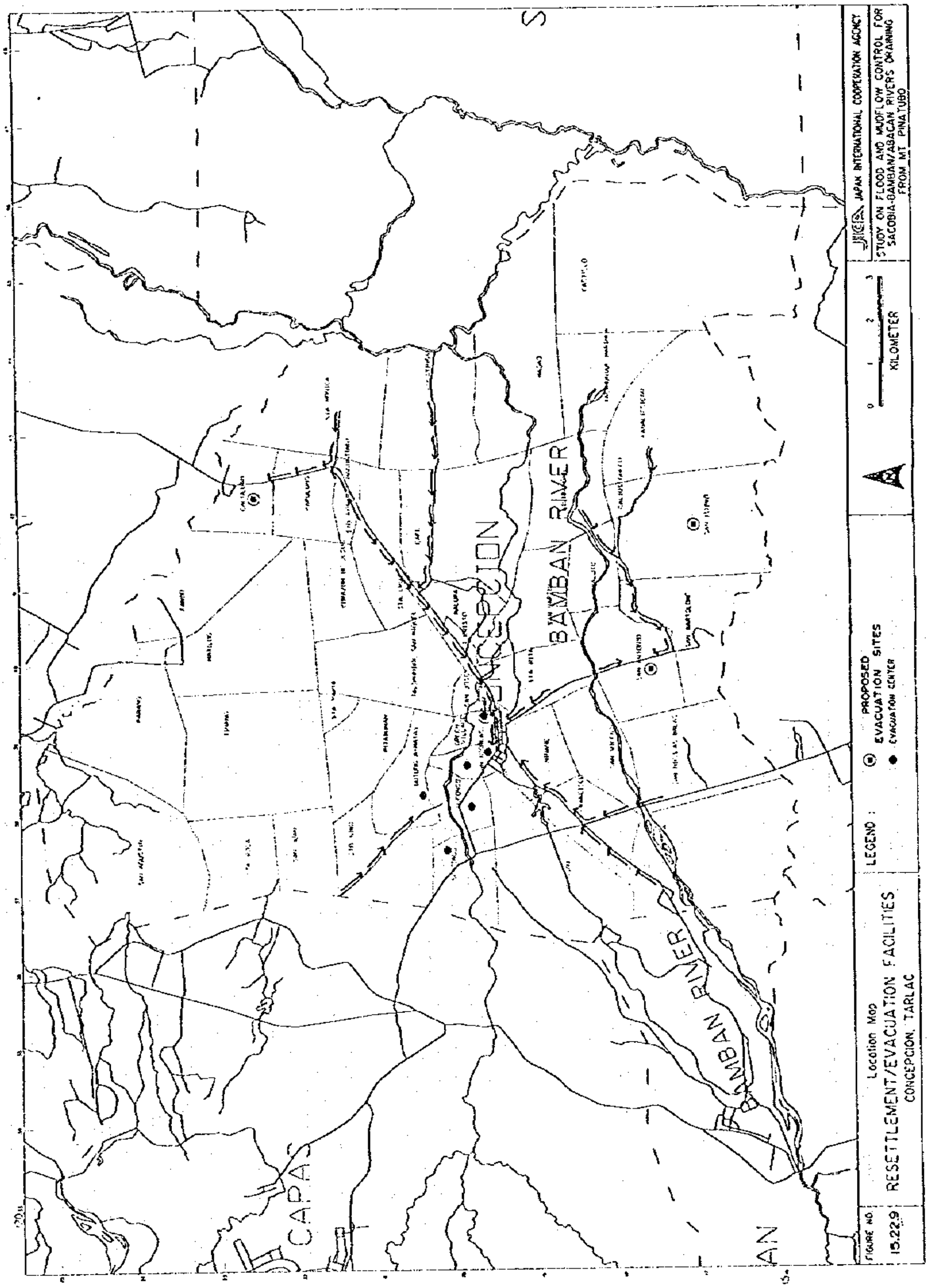


Figure M.9
Evacuation Route (9/9)

THE GOVERNMENT OF THE PHILIPPINES   THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX N

FLOOD WARNING SYSTEM

APPENDIX N

FLOOD WARNING SYSTEM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

N.1 *DISASTER MANAGEMENT SYSTEM*

The organization chart of disaster management system in the Philippines are illustrated in Figure N.1 (Ref.N.1).

(1) National Disaster Coordinating Council (NDCC)

NDCC serves the highest policy making body for all disaster in the country. The NDCC is headed by the Secretary of National Defense with the heads of 18 Department/Agencies as members to include the chief of staff of Armed Force of the Philippines. Secretary General of Philippine National Red Cross and Office of Civil Defense's administrator also serves as the NDCC's executive officer.

It is through the NDCC member-agencies that disaster response are carried out with the performing by each implementing agency.

(2) Office of Civil Defense (OCD)

OCD is a government agency under the Department of National Defense. It has a responsibility to coordinate disaster preparedness and prevention activities of concerned government and private agencies.

(3) Regional Disaster Coordinating Council (RDCC)

There is a RDCC in each of the 15 administrative regions of the Philippines, to include the Autonomous Region of Muslim Mindanao (ARMM) and Cordillera Administrative Region (CAR). The RDCC staff/service teams and functions are similar of those of the NDCC, except that they function only within the regions and serve as advisers to the local DCCs on disaster management. The RDCC does not have a budget of their own, and operates through its member-agencies under the principle of coordination.

(4) Local Disaster Coordinating Council (LDCC)

LDCC exist at the provincial, city, municipal and barangay levels and are known as the Provincial Disaster Coordinating Council (PDCC), City/Municipal Disaster Coordinating Council (C/MDCC), and Barangay Disaster Coordinating Council (BDCC). The LDCC implement the disaster preparedness and prevention program of the government at these levels. The provincial governors, city/municipal mayors and barangay captains serve as the chairman and vice-chairman of the PDCC, C/MDCC and RDCC, respectively.

The staff and service team of LDCC are similar with those of NDCC and RDCC, except that in the barangay level. A damage control unit is added as one of the BDCC operating teams.

N.2 *IMMEDIATELY BEFORE THE ERUPTION*

2.1 *ACTIVITIES BY PHIVOLCS/USGS TEAM*

PHIVOLCS became a member of NDCC in 1990 with responsibility for warning of earthquake and volcanic eruptions. There are no counterparts of PHIVOLCS on lower level bodies such as PDCC, MDCC and BDCC, the PHIVOLCS staff are called to provide technical advice at all levels. Figure N.2 shows the communication flow chart for Mt. Pinatubo warning and information dissemination. In April 1991, with Taal volcano also restless at the same time, PHIVOLCS asked USAID/Philippines to obtain the assistance of the Volcano Crisis Assistance Team (VCAT) of the USGS (Ref.N.2).

Immediately before the eruption on May 13, 1991, a simple, multi-level description of unrest, and a 5-level scheme was introduced by PHIVOLCS/USGS team. One intent of the scheme was to provide a simple set of steps to which the OCD and military commanders could establish their response plans. Concerned agencies began to prepare contingency plan, each of which was loosely tied to alert levels. Most of the evacuations that were eventually ordered, including those of Aetas living on the lower flanks of Mt. Pinatubo, were based on a preliminary hazard map prepared by USGS as shown in Figure N.3 and PHIVOLCS' recommendation of zones 10, 20, 30 and 40 km radius from the volcano.

On May 17, 1991, a probability tree as shown in Figure N.4 was introduced by PHIVOLCS/USGS team to review the present situation and possible scenarios in the future (Ref.N.2).

The tragedy of Nevado del Ruiz occurred because a perfectly good scientific identification of hazard was poorly understood or not believed by key officials, who were accordingly slow to order precaution to the people. Therefore, it was necessary to undertake an intensive public education to the eruption of Mt. Pinatubo.

PHIVOLCS/USGS team prepared the videotape which entitled "Understanding Volcanic Hazards", and delivered to as many people including government officers as possible. Consequently, people did start to plan for a possible eruption.

2.2 HAZARD MAPPING

In the warning of eruption of Mt. Pinatubo, the evacuation zone was defined not by predicted hazard map but by circular evacuation zone with the radius from the summit of Mt. Pinatubo under the following reasons.

PHIVOLCS has recommended traditionally evacuations around volcano's based upon radius from the summit of volcano. In a crisis situation, it is easier to use a familiar procedure than to develop new ones. In addition, officials and the general public really did not understand the nature of the hazards or hazard maps well enough to be confident that they were evacuating the right areas. RDCC-III also agreed that a radial hazard zone would be the easiest zone to implement. In fact, the circular evacuation zones could be easily expanded and seemed to be the only other portion.

N.3 POST ERUPTION PERIOD

3.1 LAHAR OCCURRENCE

First lahars were triggered by the rainfall on preclimatic eruption deposits on the afternoon of June 14, almost 24-hour before the climactic eruption. Much larger lahars occurred during climactic eruption on June 15, triggered by heavy rain from passing Tropical Storm Yunya. On and immediately after June 15, people learned first-hand that lahars were raging torrents that destroyed bridges, eroded river banks, and flooded fields where river banks were overtopped.

It was stressed by PHIVOLCS/USGS that past eruptions at Pinatubo and similar volcanoes had been followed by large lahars and volumes of deposited sediment that equally or more serious hazards lay ahead. DPWH also prepared a ranking of barangays at risk and the estimation of the volumes of sediment that could be expected.

3.2 PUBLIC EDUCATION ABOUT LAHAR HAZARD

For barangay leaders and the general public, illustrated flyers, posters, and leaflets were prepared and distributed by RDCC-III. One poster as shown in Figure N.5 entitled

"How to avoid becoming a victim of a mudflow", offered suggestions for what residents should do before, and when, they are warned of lahar (Ref.N.2).

The above poster emphasized the following points:

1. Stay away from potential mudflow channels when it is raining at Mt. Pinatubo and nearby hills,
2. If you live in a low-lying place, move immediately to high ground, keeping in mind that mudflows go to areas that are usually flooded during the rainy season,
3. Make your own "hill" at least 4 m high, and widen the top to serve as an evacuation center,
4. Make barriers, if possible, but be aware that mudflows can be fast and strong,
5. Each group of houses should have a watch-person on a nearby hill to sound mudflow alarms,
6. Be ready with flashlights and a radio,
7. Listen for warnings and pay attention to the authorities, and
8. Stay calm and do not be fooled by false news or rumors.

As well as the above poster, the relatively large scale of hazard map, as described hereinafter, enabled officials and residents to judge whether their barangays, town streets, and secondary roads were in relatively high or relatively low danger.

3.3 HAZARD MAPPING

(1) PHIVOLCS

The first hazard map, released in August, showed a zone judged to be "subject to mudflows" as of July 30. The second, released in October, showed lahars that had occurred as of September 15 and a significantly larger zone of "subject to mudflows".

The map in October was the first of the lahar hazard maps to be printed and widely distributed and was very influential even though the evolving crisis required later expansion of its hazard zones. Many of the evacuation sites, resettlement sites, and other elements of recovery were based on that map and its subsequent revisions (Ref.N.3).

In July 1992, PHIVOLCS released a revised lahar hazard map with a scale of 1:50,000 on the basis of the assessment on barangay level.

(2) Pinatubo Lahar Hazards Taskforce (PLHT)

Detailed hazard maps for the Santo Tomas and Bucao rivers were issued by PLHT in August and September 1991. The map for Santo Tomas river basin showed lahar disaster areas as of July, and organized into four hazard zones; (i) subject to lahars and moderate to heavy flooding, (ii) subject to overbank lahars and moderate to heavy flooding, (iii) prone to minor or moderate flooding, and (iv) subject to lahars escaping from filled irrigation canals. The another map for Bucao river basin in September 1991 used the similar zoning.

(3) Bureau of Soil and Water Management (BSWM)

BSWM issued a GIS-based map of "Mudflow and Siltation Risk" in October 1991 showing three zones; they are, (i) a high risk area subject to moderate to severe mudflows and/or siltation, (ii) low risk area subject to low siltation and (iii) a non-risk area.

(4) National Economic Development Agency (NEDA)

In August 1992, NEDA published a set of GIS-based maps of lahar hazard on the basis of the lahar observation data by PHIVOLCS. The map was substantially improved by delineating administrative boundaries, even those of barangays. Updating of the above map was carried out by NEDA/PHIVOLCS in December, 1992.

N.4 DISASTER MANAGEMENT SYSTEM IN REGION-III

4.1 ORGANIZATION

In 1994, the RDCC-III is the inter-agency organization for flood/mudflow warning in the Mt. Pinatubo affected area. The office of RDCC-III was established at the Camp Olivas in San Fernando, Pampanga. The organizational set-up and role by agency are shown in Figure N.6.

4.2 MONITORING SYSTEM

Flood/Lahar monitoring by RDCC-III is organized into four (4) systems;

1) AFP/PNP lahar watchpoint,

2) PHIVOLCS/USGS lahar monitoring system,

3) PAGASA weather information, and

4) OCD/JICA lahar monitoring system

The RDCC-III in coordination with AFP/PNP established ten (10) lahar watchpoints in 1991. The watchpoint serves as an observation post especially for lahar. All stations are equipped with two-way radios and night vision devices. The communication link was established between the watchpoints and the RDCC-III including municipalities which are most likely affected in the event of lahar.

PHIVOLCS/USGS warning system is organized into radio-telemetered seismograph, rainfall gauge and flow sensor. Five (5) seismographs, six (6) rain gauges and six (6) flow sensors were installed on the slope of Mt. Pinatubo. The flow sensor detects the occurrence of lahar flowing down river channels.

The RDCC-III also receives the weather information from the PAGASA by facsimile including typhoon tracks.

OCD/JICA lahar monitoring system is organized into wire station and rainfall gauges. The monitoring station in RDCC-III receives the data transmitted from the remote gauging stations. The location of above sensors is shown in Figure N.7.

4.3 DISSEMINATION OF WARNING MESSAGE

After receipt of the monitored information on lahar and heavy rainfall, the RDCC-III disseminates the lahar/flood warning information to government agencies in Region III, PDCC, MDCC and BDCC. The warning message is also transmitted by hot-line telephone linking the radio stations in Manila. The schematic diagram of flood/mudflow warning system is shown in Figure N.8.

N.5 PRESENT SITUATION OF DISASTER MANAGEMENT SYSTEM

5.1 DISASTER MANAGEMENT IN DEVELOPMENT AND PLANNING STAGE

(1) Zoning of Hazard Area — Several hazard maps were released from related agencies such as PHIVOLCS, BSWM, and NEDA showing the lahar disaster and prone areas. However, the disaster record and topographic map are insufficient over the Pinatubo hazard areas.

(2) Land Use — DPWH prepared a ranking of barangays at risk classified into three categories; (i) high risk area, (ii) medium risk area and (iii) low risk area. However, the above classification is used only for the selection of priority structural schemes and the budgetary allocation for structural measures.

5.2 EDUCATION OF THREAT

(1) Education in School — Lessons about volcanic eruptions and flooding were carried out a few hours a year in the elementary school. However, no lesson is over high school.

(2) Propagation — In general, the material such as illustrated flyers, posters, and leaflets were prepared and distributed by NDCC and/or RDCC-III. However, people in hazard areas does not concern the risk of hazard. One of the reason, the above materials are usually prepared in English, and the layman does not understand well without the knowledge of topographic map.

5.3 ACTIVITIES AGAINST NATURAL DISASTER

(2) Legal Organization — Legal organization for disaster management is set up with the NDCC (OCD) as the center of disaster preparedness and prevention activities.

(3) Organization — The organizational setup for disaster preparedness is shown in Figure N.1. However, before the eruption, the activities in local levels were inactive, while after eruption the activities in barangay levels has been reinforced under the umbrella body of RDCC-III.

(4) Preparedness — Before the eruption, the activities of RDCC-III had not anything definite about volcanic eruption.

(5) Training of Planner — Seminar of disaster management has been hold in countrywide and local levels. Although the necessity of disaster management and the organization in foreign countries are understood well by participants, the actual training for disaster preparedness did not carried out.

5.4 COMMUNICATION SYSTEM

(1)	Government Agency	Every government agencies have their own telemetered system. However, the telemetering equipment were deteriorated in some monitoring stations, and its maintenance cost is usually not sufficient.
(2)	Local Government	Telephone linkage is not in common use in the local government unit, especially between MDCC and BDCC.
(3)	Private Sector	People who has a private radio communication equipment cooperates well with the disaster management operation by the government. Although the urgent warning dissemination system by utilizing a network of private radio communication is studied by the government, the system is not yet realized because of the budgetary constraint of the government.

5.5 WARNING DISSEMINATION/EVACUATION

(1)	Forecasting	"Typhoon Information" by PAGASA is well known to the people. However, the PAGASA's forecast is not a rainfall amount but the wind velocity. It is necessary to carry out the effective rainstorm forecast.
(2)	Dissemination	People in hazard area usually received the information on natural disaster through radio broadcast. The communication link between NDCC central and RDCC-III is well developed, while the dissemination from RDCC-III to local government units takes relatively long time. There is no transmit system of satellite data, and local government units can not received a visual information on typhoon.
(3)	Evacuation	Although the evacuation center and resettlement sites are designated by RDCC-III and MPC, some of those are located within the hazard areas.

N.6 PROBLEMS ENCOUNTERED

6.1 HAZARD MAP

Local government officials and disaster response officials complained that they could not appreciate the 2-dimensional lahar hazard map many if not most of people do not know how to read maps. They would very much prefer a 3-dimensional presentation of lahar hazards (Ref.N.4).

6.2 DISSEMINATION OF WARNING MESSAGE

In a series of fora held by the PHIVOLCS in 1992, some participants from Zambales expressed satisfaction with the RDCC-III's lahar warning system, others from Tarlac and Pampanga were not satisfied. They cited instances wherein the endangered inhabitants received the warning after, not before the arrival of the lahar.

6.3 DETERIORATION OF MONITORING EQUIPMENT

Almost three (3) years have passed since the monitoring equipment were installed in the lahar hazard areas. The telemetering equipment were deteriorated in some monitoring stations. One of the major reasons for deterioration is the exposure of monitoring equipment to frequent thick ashfall due to secondary explosions.

6.4 LACK OF COMMUNICATION FACILITIES

The restoration/supply of communication facilities should be given priority not only for the communication system among the monitoring station and operation centers but also for the dissemination of warning messages.

6.5 NECESSITY OF RAINFALL WARNING

Accurate forecast of rainfall amount, intensity and areas results in diminishing the magnitude of disasters because of sufficient time for preparation of warning announcement. However, the PAGASA, which has responsibility for the country's weather forecast has not carried out the effective rainstorm forecast due to insufficient rainfall observation systems.

The PAGASA has a plan to establish a Radar Rain gauge System in order to improve the rainfall monitoring and forecasting capability under the following phased implementation schedule.

1) Short Term Plan : Mitigation of flood/mudflow damage in low-lying areas of Central Luzon especially Mt. Pinatubo hazard areas and Metro Manila.

2) Medium/Long Term Plans : Upgrading of flood/mudflow forecasting and warning system in the Central Luzon.

The system will give more accurate forecast of the time, range and scale of rainfalls in the low-lying areas of Central Luzon, especially Mt. Pinatubo hazard areas and Metro Manila. Eventually, the system will result in mitigating the magnitude of disasters and securing adequate time for preparation of evacuation plans by RDCC-III. On the other hand, it will also enhance the effective control of dams/reservoirs for the purpose of the supply of irrigation water and hydropower generation.

N.7 RECOMMENDATION

7.1 URGENT MEASURE

(1) Needs of Expansion of NDCC

NDCC will have an increasingly important role, since the disaster preparedness and prevention will apparently need more skilled government agency/personnel. However, the OCD, as the center of NDCC, has not at the moment enough capacity of personnel and enough capability in establishing of disaster management plan because of the financial constraint and shortage of the numbers of personnel. Although the long-term expansion plan of NDCC should be based on a more detailed projection, the number of personnel will presumably have to be doubled within several years. The expansion of NDCC will need the additions of equipment, building spaces and numbers of officials as the tutor to the local government units.

(2) Training of the Officials of Local Government Unit

The officials in charge of the disaster preparedness and prevention shall have sound knowledge with regard to the implication of the activities concerning to disaster mitigation. The extent of their capabilities and also the effective procedures lead to a successful evacuation. In this context, training is very important for the officials in local government units. The training program is the form of periodical (not in ad-hoc basis) seminars should be established in the activities of NDCC (OCD). One of the examples for training are as follows:

(i) Certificate course (2 years duration) in disaster preparedness and prevention

- Natural hazard
- Disaster preparedness
- Preparation of hazard map
- Disaster prevention
- Evacuation/Resettlement

(ii) Operation course (annual basis) by Local Government Unit to barangay level

- Natural hazard
- Disaster preparedness referring to hazard map
- Disaster prevention referring to evacuation route/resettlement

(3) Integrated Database for Rainfall Observation Network

Pinatubo hazard is characterized by the predominant secondary disaster which is triggered by heavy rainfall due to northeasterly monsoon and typhoon. At present, in and around Mt. Pinatubo hazard area, the rainfall observation stations are managed by PAGASA, DPWH, NIA and OCD. Among the agencies, the representative one should have an integrated database system of rainfall data which retrieve all the rainfall data, and disseminate the warning message for heavy rainfall.

Major problem on rainfall observation network in the Philippines is the maintenance of the equipment, especially in case of telemetered equipment. The rainfall radar system which covers Pinatubo hazard area will be one of the solution taking into account an advantage to maintain at specified location and to collect all rainfall data by representative agency.

(4) Coordination with International Organization

Bilateral and multilateral assistance and OCD's staff training by the international organizations related to disaster preparedness and prevention are of great help to the government especially in alleviating the suffering of people.

(5) Coordination with the network of NGO

Remarkable activities in evacuation and resettlement have been carried out by NGOs in and around Mt. Pinatubo hazard areas. Recently, a NGO's network of disaster prevention is being expanded not only to Pinatubo hazard area but also to countrywide. An interchange of information among NGOs is very active in Metro Manila, and the relief operation under the instruction through the headquarters of NGO are fairly appreciated by the people in the Pinatubo hazard area. Another disaster management system, different from Government one, is being organized by the NGO's countrywide network. It is necessary for government agencies, especially for NDCC and OCD, to coordinate with such an network for efficient relief operation and evacuation.

7.2 PRIORITY SCHEMES FOR EFFECTIVE WARNING SYSTEM

The development plan of non-structural measure including warning dissemination and evacuation is divided into three categories, they are, (i) Short/Medium term, (ii) Long Term, and (iii) Continued Activities. The plans are enumerated in Table N.1.

REFERENCES

Ref.No.	Title
N.1	OCD, " The Philippine Disaster Management System"
N.2	Punongbayan, R.S, et al., "Eruption Hazard Assessment and Warnings", PHIVOLCS/USGS
N.3	Janda, R.J., et al., "Assessment and Response to Lahar Hazard around Mount Pinatubo 1991 to 1993", PHIVOLCS/USGS
N.4	PHIVOLCS/UNESCO, "Lahar Studies", 1994

TABLES

Table N.1 Integrated Plan for Warning System in Region-III

Items for Disaster Management		Disaster Management Activities (a) : Government, (b) Local Govenment Unit, (c) Public	Managed by Gov't	Managed by LGU	Managed by Public
A.	Policy and Disaster -related Laws and Institution	(a) Formulation of disaster management policy (a) Formulation of national disaster management plan (a) Establishment of disaster-related laws	●		
B.	Investigation, Research and Development	(a) Development of disaster-related technique/know-how (a) Flood/mudflow damage survey (a) Database system development (a) Technical assistance to Local Government Units	●	●	
C.	Training	(a) Training of experts of disaster management (b) Training of experts of disaster management (b) Training of BDCC and self-disaster prevention organization	○	●	●
D.	Public Education	(a) Public education and preparation of texts for public awareness (b) Public education and preparation of texts for public awareness (c) Programs of public education and awareness	○	●	●
E.	Rescue and Evacuation	(a) Arrangement of possible rescue against large-scale disaster (b) Coordination of disaster-related evacuation activities (c) Cooperation with BDCC/NGO's activities	■	●	●
F.	Warning and Evacuation	(a) Dissemination of in-country warning message (b) Transmission of warning message to local community level (c) Reciept of warning and evacuation	■	●	●
G.	Disaster Management in Development Activities	(a) Disaster management for land use and nation-wide development (b) Disaster management for land use and regional development (c) Realization of land use and regional development	■	■	■

Note : ● Short and Medium Term, ■ Long Term ○ Continuous

FIGURES

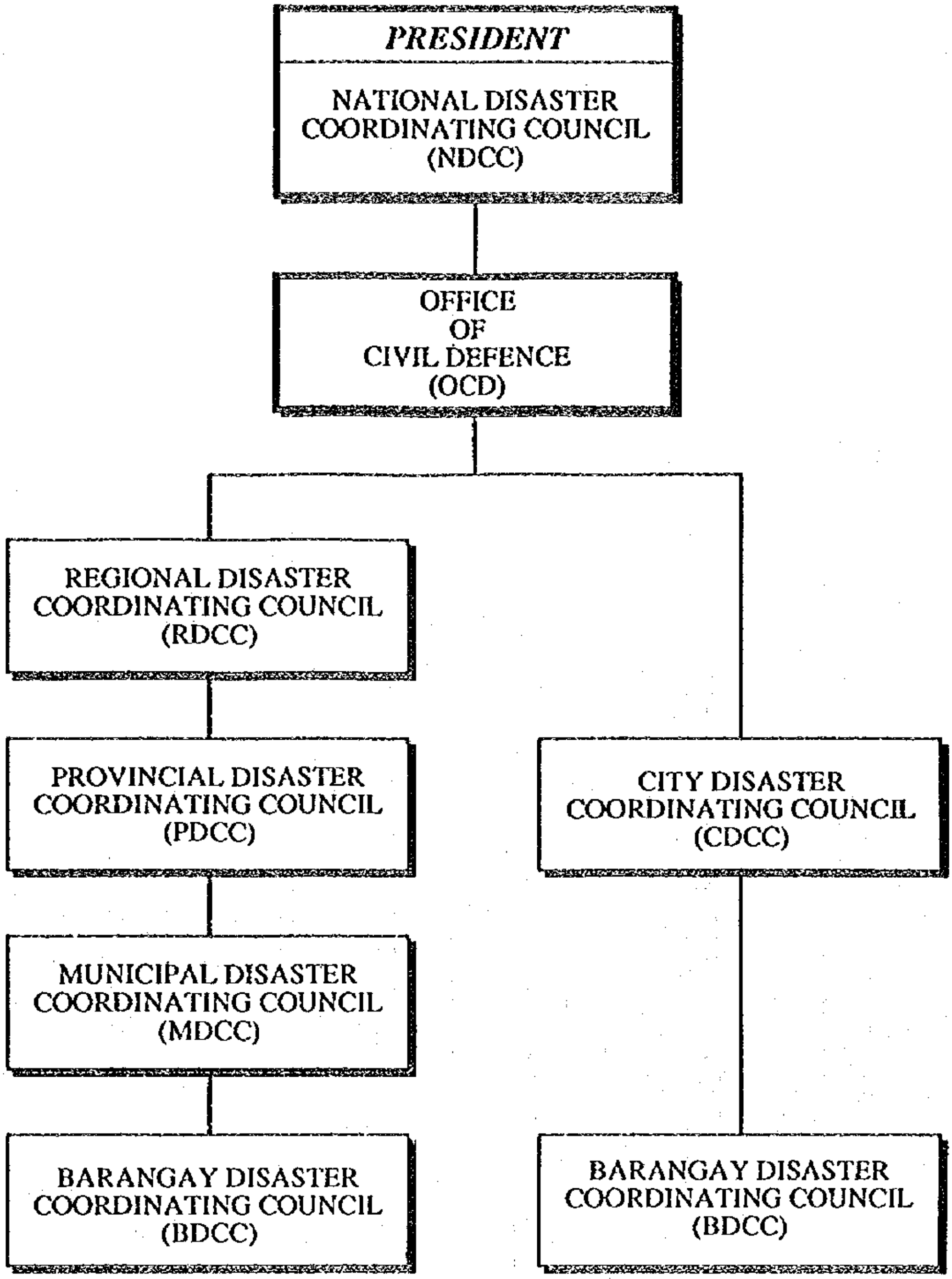


Figure N.1 Disaster Management Organization in the Philippines

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

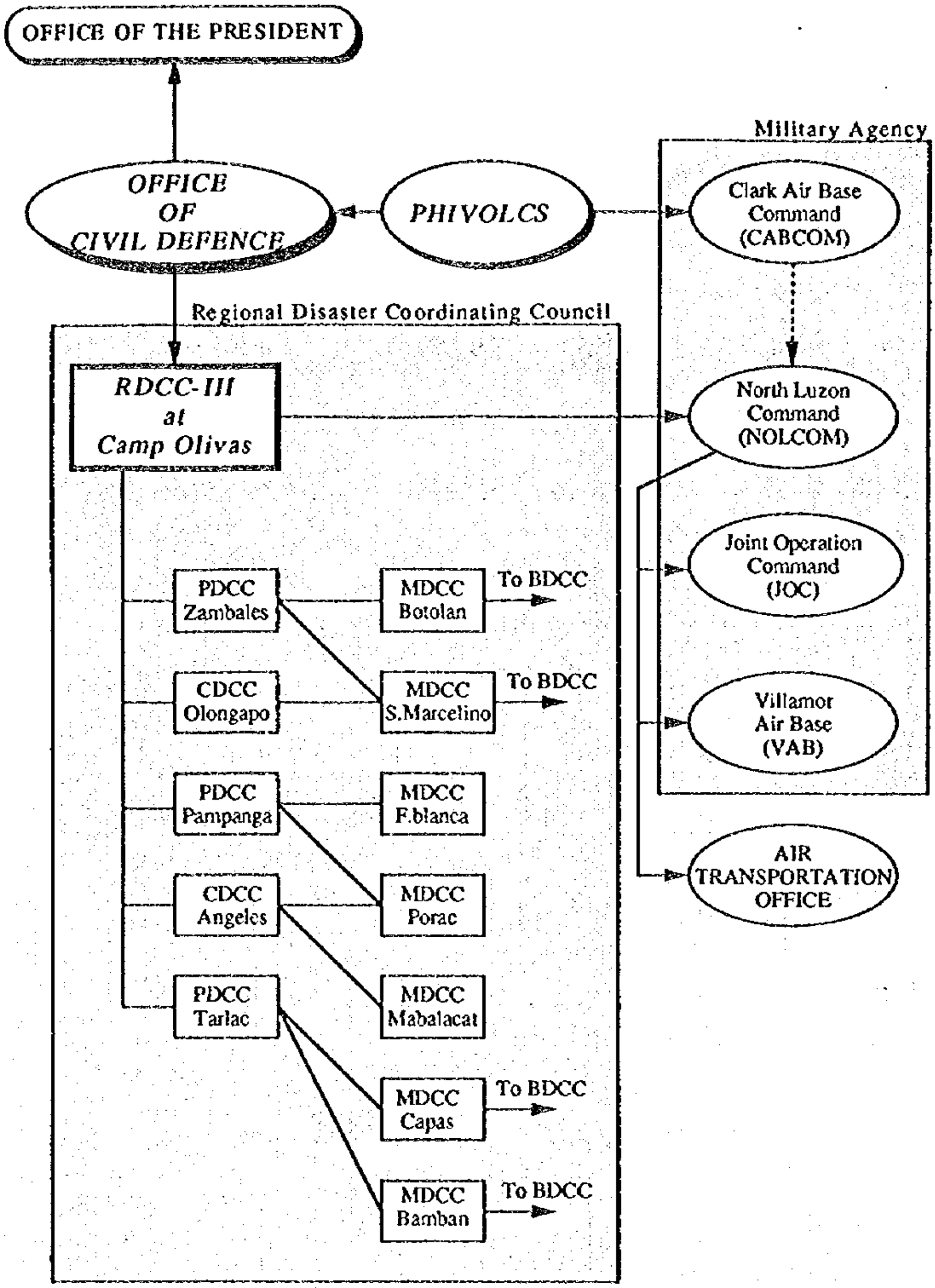


Figure N.2 Communication Flow Chart for Mt.Pinatubo Warning/Information Dissemination

THE GOVERNMENT OF THE PHILIPPINES THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

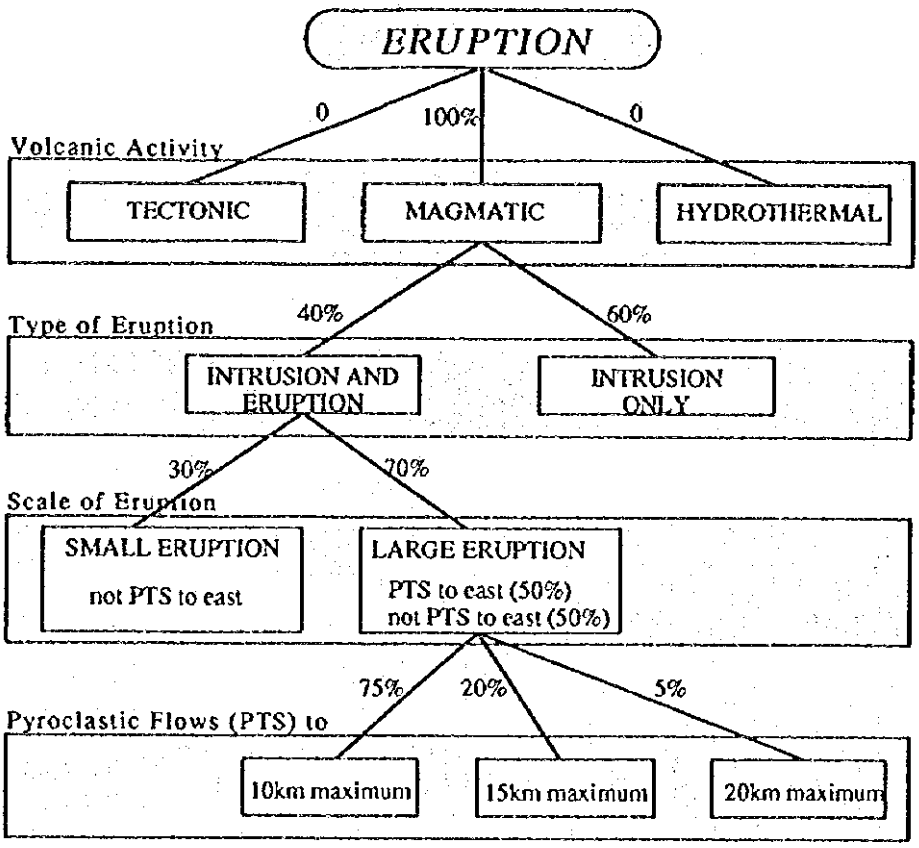


Figure N.3 Probability Tree for Hot Pyroclastic Flow Deposits

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

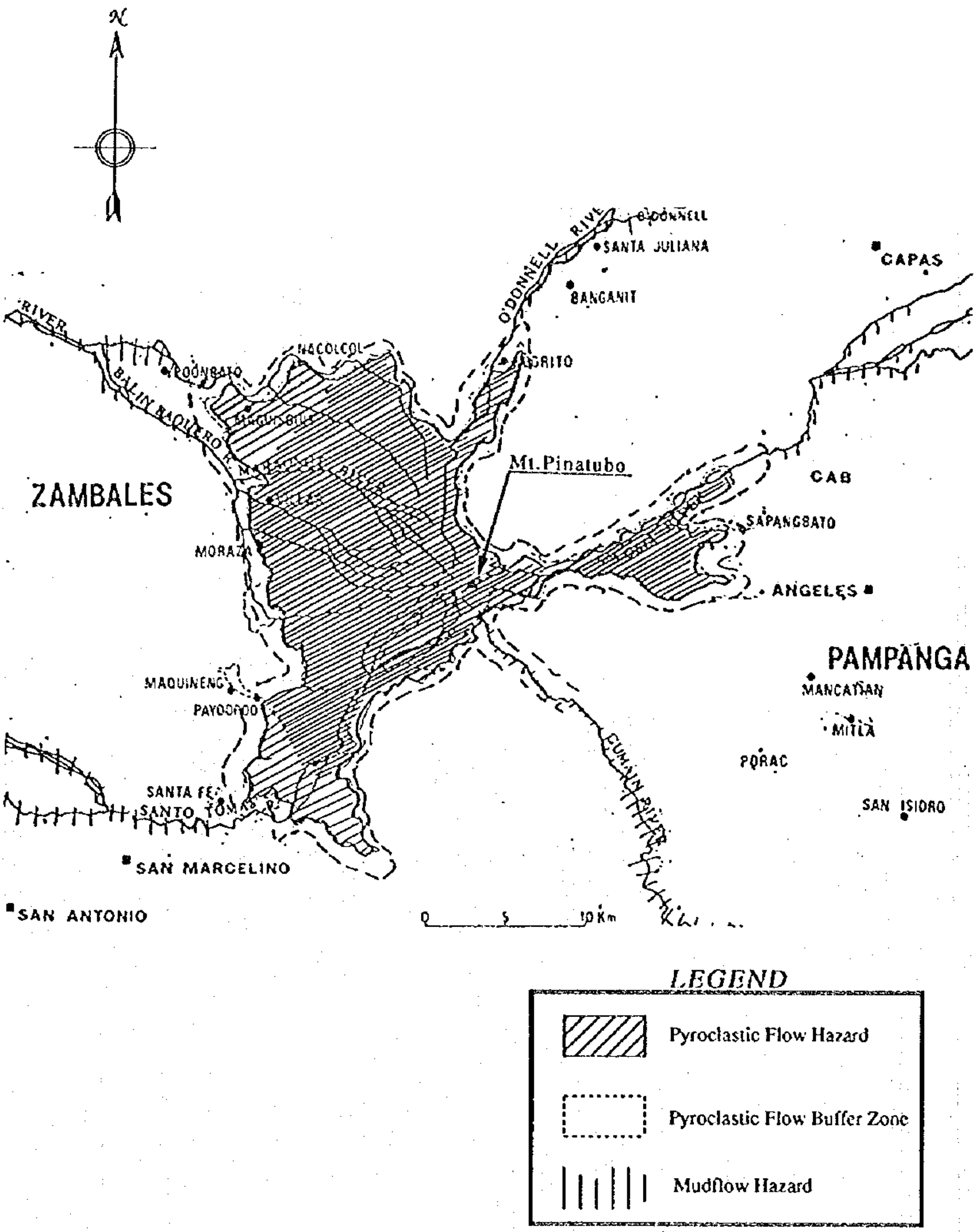


Figure N.4 Hazard Map before Eruption by USGS

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL
FOR SACOBIA-BAMBAN/ABACAN RIVER
DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

MGA DAPAT GAWIN UPANG MAIWASAN ANG PAGIGING BIKTIMA NG MUDFLOW:

1. Iwasan ang mga lugar na malapit sa mga maaaring daanan ng mudflow sa tuwing umuulan ng malakas sa ibabaw ng Mt. Pinatubo at mga bulubundukin na malapit dito;
2. Kung nakatira sa mababang lugar, lumikas kaagad sa mataas na lugar, tandaan na ang pinatutunguhan ng mudflow ay yaong kadalasan na ring binabaha sa panahon ng tag-ulan, ngunit dapat ring isaisip na dahil sa pagbabaw ng mga ilog at sapa na dinaluyan na ng mga bagay-bagay mula sa Mt. Pinatubo sa mga naunang pagputok nito, posibleng mas lumawak pa ang abutin ng mudflow kaysa sa mga dati nang binabaha sa panahon ng tag-ulan;
3. Maaari ring gumawa ng sariling "bundok" na puwedeng tunguhan kung may bantang mudflow. Ang mga buhanging dulot ng pagsabog ng Mt. Pinatubo noong Hunyo 14-15 ay maaaring itambak ng mga magkakapit-bahay sa taas na apat (4) na metro o higit pa sa pinakamataas na lugar na maaaring tambakan sa kanilang barangay. Ang tuktok nito ay dapat patagin upang magsilbing "evacuation center" sa oras ng panganib;
4. May pagkakataon ding maaaring gumawa ng "barriers" o sagabal sa maaaring daanan ng mudflow, ngunit dapat isaisip na ang mudflow ay mabilis at maaaring may puwersa;
5. Ang mga magkakapit-bahay ay dapat magkaroon ng tanod sa isang nalalapit na mataas na lugar at siya ang mamamahala sa anumang "alarm system" (tulad ng sirena o kampana) na maghuhudyat ng anumang panganib na maaaring idulot ng mudflow;
6. Laging maghanda ng flashlight o de bateryang radyo;
7. Palagiang makinig sa radyo sa mahahalagang balita, at babala mula sa mga nakaaalam na mga awtoridad;
8. Manatiling mahinahon sa lahat ng sandali at huwag padala sa mga maling balita o tsismis.

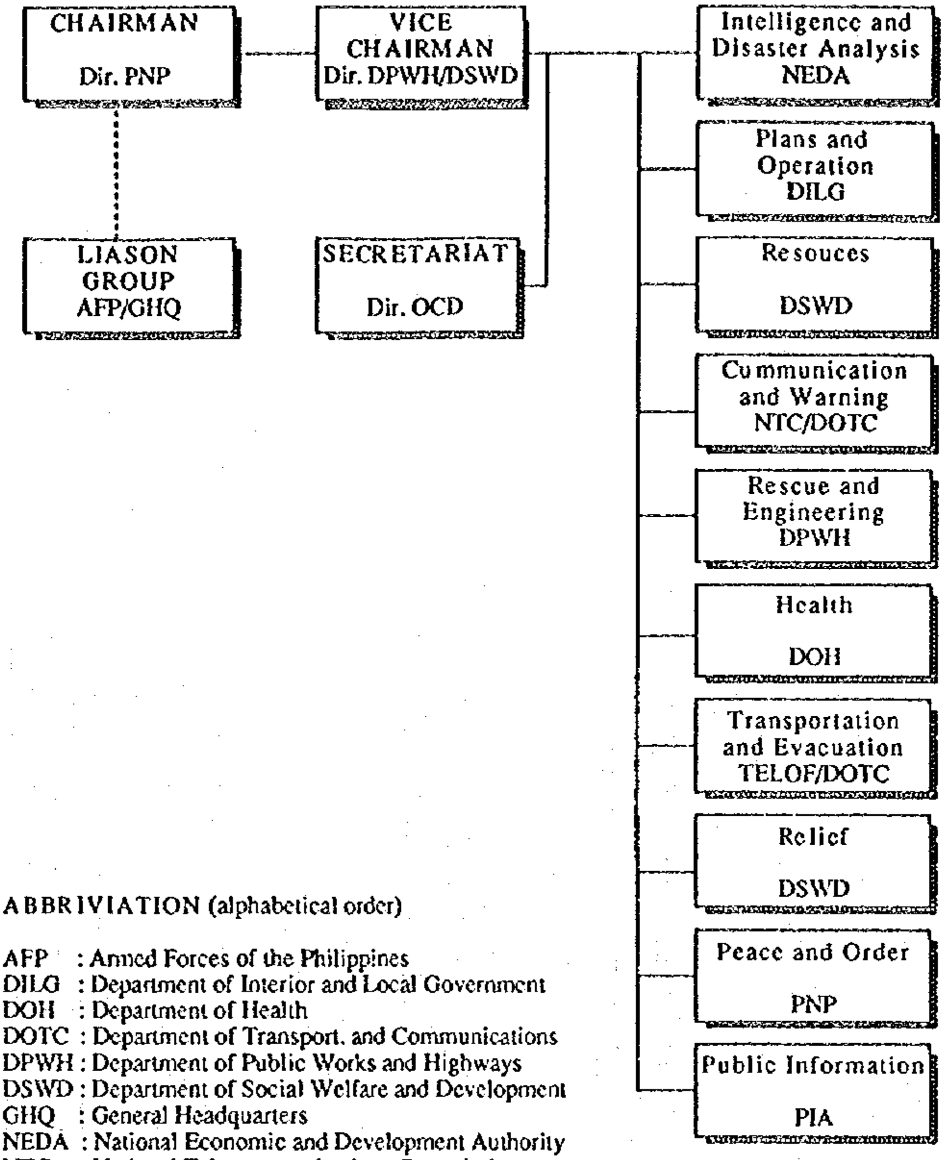
WALANG DAPAT IKABAHALA KUNG TAYO AY MAG-IINGAT AT MAGKAKAISA.

[illegible]
Regional Disaster Coordinating Council
Region 3
[illegible]
Philippine Information Agency
Region 3
[illegible]
Philippine Institute of Volcanology and Seismology

Figure N.5

Poster of Warning for Mt.Pinatubo Eruption

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



ABBRIVIATION (alphabetical order)

AFP : Armed Forces of the Philippines
DILG : Department of Interior and Local Government
DOH : Department of Health
DOTC : Department of Transport. and Communications
DPWH : Department of Public Works and Highways
DSWD : Department of Social Welfare and Development
GHQ : General Headquarters
NEDA : National Economic and Development Authority
NTC : National Telecommunications Commission
OCD : Office of Civil Defence
PNP : Philippine National Police
TELOF : Telecommunication Office

Source : RDCCIII

Figure N.6 Organization Chart of RDCC-III

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

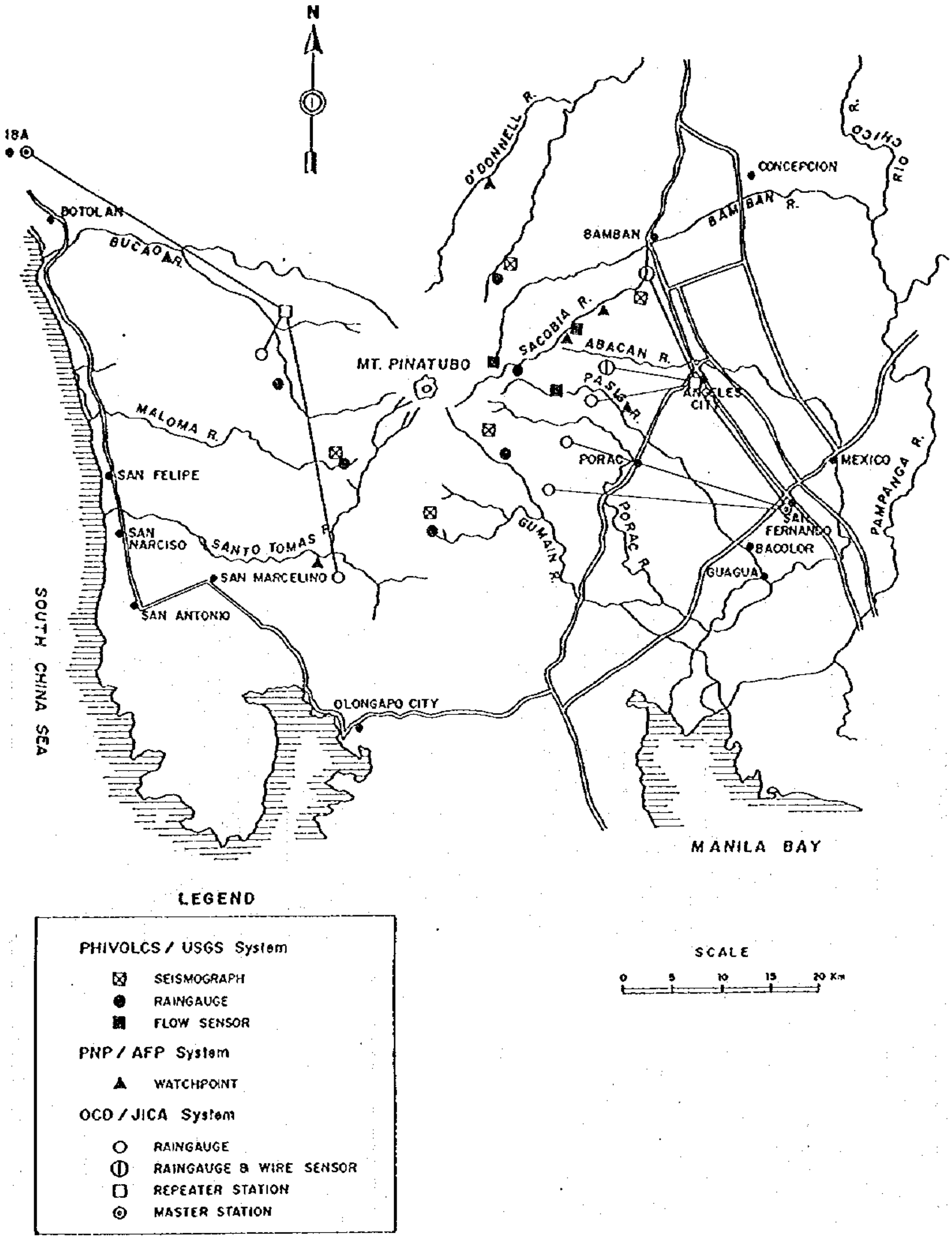
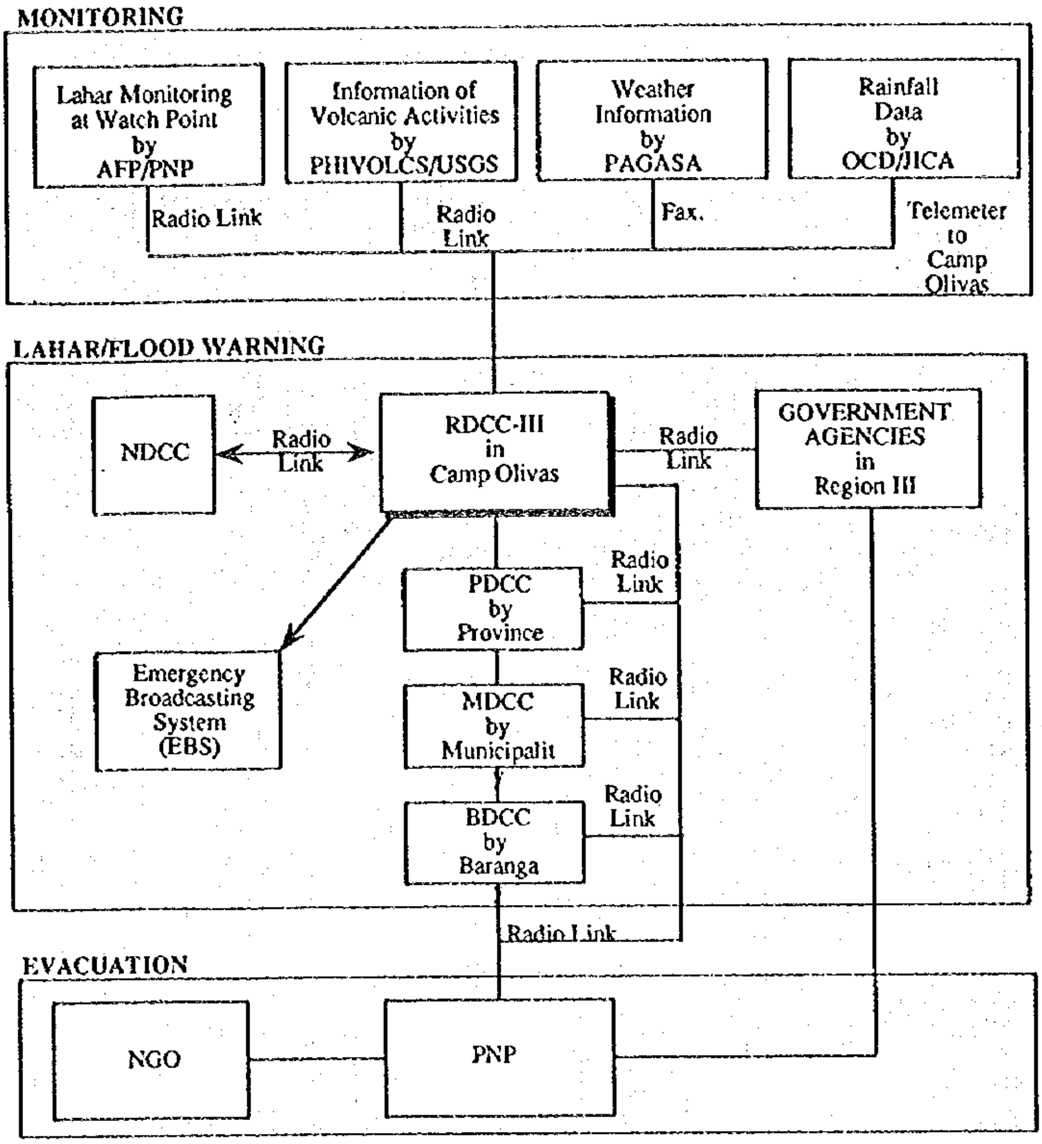


Figure N.7 Location Map of Monitoring Stations

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY



Note

PNP : Philippine National Police
PHIVOLCS : Philippine Institutes of Volcanology and Seismology
PAGASA : Philippine Atmospheric, Geophysical and Astronomical Services Administration
OCD : Office of Civil Defence
NDCC : National Disaster Coordinating Council
RDCC-III : Regional Disaster Coordinating Council
PDCC : Provincial Disaster Coordinating Council
MDCC : Municipal Disaster Coordinating Council
BDCC : Barangay Disaster Coordinating Council
NGO : Non-government Organization

Figure N.8 Lahar/Flood Warning and Evacuation System in Region III

THE GOVERNMENT OF THE PHILIPPINES
THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
THE STUDY ON FLOOD AND MUDFLOW CONTROL FOR SACOBIA-BAMBAN/ABACAN RIVER DRAINING FROM MT.PINATUBO
JAPAN INTERNATIONAL COOPERATION AGENCY

APPENDIX P

INITIAL ENVIRONMENT EXAMINATION

APPENDIX P

INITIAL ENVIRONMENTAL EXAMINATION

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P.1 PRE-ERUPTION ENVIRONMENTAL CONDITIONS

1.1 PHYSICO-CHEMICAL ENVIRONMENT

(1) Soil

1) Sacobia/Bamban River

Soil characteristic of the study area is termed as Angeles Soil. It is the most extensive soil associated with the land area in the Sacobia/Bamban and Abacan River. Selected result of the characteristics of soil in the Study Area is shown in the Table P.1.1.

There are several classes of the Sacobia/Bamban River watershed soils such as:

a. Angeles fine sand;

Angeles fine sand is located at the upper stream of the watershed. It is a deep, well-drained soil with loose and structureless fine sand surface with a small amount of silt and clay. Soil reaction is slightly acidic (pH 6.1). Subsoil is gravely sand (up to 80 m or deeper). Sugarcane and rice are commonly being grown on this soil.

b. Luisita fine sand;

Luisita fine sand at the mid-northern side of the river. Luisita fine sand is similar to Angeles fine sand except its soil reaction is very slightly acidic (pH 6.6) and the subsoil has no gravel. Land use is the same with Angeles fine sand.

c. Angeles sand;

Angeles sand in the mid-southern side of the river, Angeles sandy loam at the downstream of the watershed and the Angeles coarse sand at the terraces along the Sacobia/Bamban River and on the plain flood.

d. Angeles sandy loam;

Angeles sandy loam is a deep, well-drained soil. The surface soil consists of course and medium sand with little amount of clay and silt. Soil reaction is moderately acidic (pH 5.8). Rice is the most important soil crop along with sugarcane, root crops and vegetables on this soil.

e. Angeles coarse sand.

Angeles coarse sand has uniform texture from the surface up to a depth of more than one meter. Soil reaction is moderately acidic (pH 5.6). Natural vegetation on this soil is talahib, bamboo and camachile.

Sugarcane and rice are commonly grown on the soils in the Study Area. Subsoil is gravely sand and its thickness is more than 80 m deep.

In general, characteristics of the soils found in the Sacobia/Bamban River are:

- slightly acidic (pH, 6.70);
- low organic matter content (1.12%);
- high cation exchange capacity (24.12 meq/100 g soil);
- high base saturation (73.46%);
- moderately available phosphorus (11.6 ppm); and
- low exchangeable potassium (0.16 meq/100 g soil).

The general soil fertility is moderate. There are minor soil groups that occur on the plain in the Study Area. They are Quingua, La Paz, Bantog and Candaba Soils. The Candaba Soil occurs only in the Candaba swamp.

2) Abacan River

The Abacan River watershed soils are: Angeles fine sand, Angeles sand, La Paz fine sand, La Paz sand and Angeles coarse sand (see Figure P.1). Angeles fine sand and Angeles sand are located at the upper stream of the watershed while La Paz fine sand is located at the downstream of the watershed. Angeles coarse sand is located at the terraces adjacent to the river flood plain.

The physico-chemical properties and land use of Angeles fine sand, Angeles sand and Angeles coarse sands are similar to those found in Sacobia/Bamban River basin.

La Paz fine sand is a deep, well-drained soil. Soil reaction is strongly acidic (pH 5.4).

La Paz sand is similar to La Paz fine sand except that the soil texture's surface is medium to coarse sand. Soil reaction is moderately acidic (pH 5.6).

In general, the soils found in the Abacan River watershed are:

- acidic (pH 5.08);
- low organic matter (0.12%);
- moderate cation exchange capacity (14.75 meq/100 g soil);
- moderate base saturation (45.00%);
- high available phosphorus (30.33 ppm, P); and
- low exchangeable potassium (0.11 meq/100g).

The soils along Abacan River are moderately fertile.

(2) Water Quality

1) Surface Water

a. Past Records on the Rivers in the Study Area

The water quality standards of the Philippines, WHO and Australia are presented in Table P.1.2. Available information on the pre-eruption conditions of water quality on the surface and ground water around the Mt. Pinatubo is limited. The earliest reports were made by the GIRD (*P-1) in connection with an environmental assessment of the Sapang Bato River Resettlement Project, Angeles City as shown in the Table P.1.3 and P.1.4.

The National Water Resources Council (NWRC) and the Department of Pubic Works and Highways (DPWH) are the two government agencies that collect information on the water of the Central Luzon rivers including those in Pampanga and Tarlac. These data are shown in the Table P.1.5.

b. Water Temperatures

Water temperatures affect the odor and taste of water. Microflora and microfauna, by virtue of their size and sheer number, are among the first to respond to the changes in water temperatures because these organisms are temperature dependent in terms of their growth and survival rates, and in their ability to reproduce. Temperatures are therefore a primary determining factor of the composition of aquatic communities. The temperature tolerance and the optimum temperature requirements of the different organisms vary with species.

Sapang Bato River was reported to have average temperature of 28°C. There is no published information on the temperature characteristics of Central Luzon rivers prior to the eruption.

c. Total Dissolved Solids (TDS)

This parameter stands for a mixture of inorganic salts and organic substances dissolved in water. It is also referred to as the total filterable residue that is the material that passes through a standard glass fiber filter disk and remains on it after drying with the heat of 103-105 °C or 180°C to constant weight. TDS of the Class C water resources or those intended for fishery resources and industrial uses have a water quality standard of 1,000 ppm. This level of TDS is unsafe for drinking water as it can lead to gastrointestinal irritation. At the same time it causes taste problems. An excessive amount of dissolved minerals in water may influence the rate of growth of unwanted algae and bacteria.

The TDS levels of the Rio Chico River obtained from 1986 to 1990 study result had been below the recommended level.

d. pH

Majority of water bodies in Luzon exhibit value of pH between 5.5 and 9.6. Acidic pH increases the tendency for corrosion of metals.

Studies carried out in four rivers and one spring by GIRD (*P-1) in the Study Area indicates that the pH in those rivers is generally on the soft side. The same is true for the Abacan River and the rivers studied by the NWRC. Sapang Bato River was slightly on the acidic side. Rio Chico River had 6.6 to 7.5 pH.

e. Dissolved Oxygen (DO)

Natural bodies of water have a daytime DO range of 4.5 ppm to 8.5 ppm. Abnormalities in the productive capacity of waters related to photoautotrophy may be evident below and above this range. Some taste and odor problems in waters may occur from depressed DO. It is caused by anaerobic reactions i.e. reduction of nitrate to nitrite and sulfate to sulfide. In waters with fishery resources, the amount of DO determines the success of survival and growth of the various life stages of fish and other aquatic life.

The value of DO for the Philippine water quality standard for Class D (for agriculture, irrigation, livestock watering and industrial water supply) fresh surface water is 3 ppm while that for Class A (for the source of water supply with treatment as drinking water) to Class C (for aquaculture) is 5 ppm. GIRD (*P-1) reported DO range in Sapang Bato River ranging from 4.6 to 5.6 mg/l. San Jose River had a DO content of less than 1 ppm.

f. Chloride

Chloride is the ionic form of chlorine that forms a significant part of the anions in water. Excessive chlorides in water especially those formed with sodium result in a salty taste. Very high salt content in the water would increase occurrence of corrosive reactions in metallic pipes. The standard for chloride in surface waters is 200-600 mg/l, and 200 mg/l for ground water. The standard for Class A fresh surface water and Class GA ground water are 200 ppm.

Chloride in Sapang Bato River and the Abacan River was less than 30 mg/l. Sto. Niño and San Jose river exceeded the standard as their levels being 452 ppm and 226 ppm respectively. The Chico River did not exceed 100 ppm in 1986.

g. Calcium

Calcium is known as an essential element to the human body as it is involved in the formation of bone tissue. It is also one of the essential elements for both plant and animal life. Excessive intake of calcium could lead to formation of concretion in the human body and possible incidence of urinary tract disorders. Increasing level of calcium along with magnesium in water would lead to increased hardness of water.

Australian Water Quality Criteria indicates that recommended working level for calcium is 200 mg/l in surface waters. Philippine Water Quality Standards do not include calcium.

The report indicating calcium level in surface waters in the GIRD reports showed in general that the calcium level did not exceed a concentration of 33 mg/l. Rio Chico River had 76 ppm of $CaCO_3$ before the eruption . This level increased slightly in 1989 but remained below the standard, and followed the same trend up to 1994. The difference in readings between 1994 and 1986 is 54 ppm.

h. Magnesium

Magnesium, just like calcium, contributes to the hardness of water. Excessive magnesium in water imparts a peculiar taste. In combination with sulfate, excessive intake of magnesium should cause gastrointestinal irritation. The maximum permissible level of magnesium set out by the NSDW is 50 ppm for both ground water and for surface water.

The rivers examined by the GIRD had magnesium concentration ranging from 8 mg/l to 14 mg/l. The Rio Chico River was reported to have 0.25 mg/l before the eruption.

i. Hardness

Hardness is a measure of the ability of water for precipitating soap. Magnesium together with calcium is the principal ions that precipitate soap although other ions especially the polyvalent heavy metals do the same function. All of the rivers studied by GIRD except for one station along the Sapang Bato River have been found to be of soft waters. The 1986 data of 114 mg $CaCO_3$ /l for Rio Chico River places the river water as moderately hard category, while in 1989 it was in the hard water with the value of 122 mg/l. The WHO standard sets out the maximum permissible level of hardness at 500 ppm.

j. Heavy metals

Available reports on the heavy metal content in the water of Central Luzon rivers before the eruption of Mt. Pinatubo are very few (Table P.1.6). The Sto. Niño and San Jose River carried no detectable amounts of arsenic, cadmium and mercury in the early 1980s. Measurable amounts of iron and zinc in Sto. Niño and San Jose River have been below the maximum permissible levels of 5.0 and 2.0 mg/l, respectively. There is no secondary data on the heavy metal content of groundwater in Central Luzon before the eruption.

k. Microbiological Content

There is no data on the bacterial content of surface and ground waters in the study areas.

2) Groundwater Resources

The assessment of groundwater resources in the project area prior to Mt. Pinatubo eruption was based on the rapid assessment of water supply systems in the Philippines conducted by the then NWRC. Based on the NWRC's results for the provinces of Pampanga and Tarlac, the project area is generally a shallow well area, i.e., with the static water level generally within 6 m below the ground surface and wells with depths not greater than 20 m. Difficult areas, i.e. areas where the depths of groundwater vary considerably and about 25% of them may yield the amount not practical to use for any purpose, occur within the 20 km radius of the Mt. Pinatubo crater and within the area of Mt. Arayat.

On the basis of about 207 test wells within the project area, the average static water level ranges from 1.8 m in the town of Concepcion to 11.0 m in Angeles City. The average well drilling depth varies from 12 m to 83 m. The range of the average capacity is from 0.65 to 1.05 l/m. Table P.1.7 summarizes the average static water level, well depth and specific capacity of yield in the municipalities situated within the Study Area.

1.2 BIOLOGICAL ENVIRONMENT

(1) Flora

1) Historical Background of the Plant Species

Historical and present evidences show that the whole Sacobia area that covers some towns of Tarlac and Pampanga provinces was formerly covered by a lowland tropical rain forest before the population concentration in the region occurred.

Human settlements that later became cities and towns have been named after tropical rain forest species. Bamban is derived from an undergrowth of tropical rain forest species, Donax cannaeformis. Mabalacat is from balakat, a medium-sized tree, Ziziphus talanai. Culiat is an old name of Angeles City and this comes from Gnetum latifolium, a tropical forest species where young shoots and seeds are edible.

Significant removal of forest cover from the area have been conducted in the beginning in 1700. Agricultural activities, logging, and other human economic activities and frequent occurrence of fire have almost totally wiped out the forest cover of the area.

Sacobia's natural vegetation cover could be classified as secondary growth forest and grassland savanna, or Parang in the local language.

2) Tree Species

Very little forest vegetation is left in the area. The remaining forests are discontinuous and formed on very steep slopes of gullies and ravines. Trees are also found along the creeks and rivers. Dominant species along forest borders are Schizostachyum species. Medium-sized trees found in the inner forest area are anarium, Parkia, Alstonia, Ficus, Artocarpus and Diplodiscus. There are 55 tree species identified in the study area. Table P.1.47 shows the species observed on the Mt. Pinatubo slopes.

3) Grassland Species

There are 128 grassland species in the Study Area. They are distributed in 34 families as listed in the 1981 study. Dominant species are Imperata, Saccharum, Ophiurus and Sorghum nitidum. Fifteen species are woody species and the rest are herb and shrub species.

Chromolaena odorata was cited as pasture and upland agriculture invader. Listed also are woody species. However, common dominant shrub in the Central Luzon of wild sunflower (Tithonia diversifolia) was not found in the area. Table P.1.47 shows the grassland species observed in the Study Area.

4) Species used by the Aeta

Plant species on Mt. Pinatubo slopes are utilized by the Aeta for various purposes. Table P.1.8 shows the list of plant species that are of significance for the way the Aeta maintain their life style on the slopes of Mt. Pinatubo. Common names in their dialect are given together with the most important usage.

(2) Fauna

Data derived from the Environmental Impact Assessment of the proposed Bamban-Flora Access Highway made in October 1981, by GIRD Foundation Inc., indicates that there are 3 species of mammals, 30 species of birds, 12 species of reptiles and three amphibians. This species inventory covers three habitat types in Bamban-Flora area of Tarlac such as those that live within the human settlement, those that live in the grassland and those live in the secondary forest environment.

In the report of the Migratory Animals Pathological Survey (MAPS), in Migration and Survival of the Birds of Asia (*P-2), 10 species of birds were recorded in Candaba Swamp and its vicinity. On the other hand, based on the collection and on-sight records of birds of Candaba Swamp (*P-3), a total of 12 bird species were recorded as shown in the Tables P.1.45 and 46.

The overall wildlife record in the area are as follows: 3 mammals, 52 bird species, 12 reptiles and 3 amphibians.

(3) Ecological Conditions of Candaba Swamp

Candaba Swamp is a mixture of fresh water pond, streams, swamps and marshes with surrounding areas of seasonally flooded grasslands, arable land and palm savanna on vast alluvial flood plains. The entire area is 29,000 ha located in Candaba, Pampanga at 11 m asl. It is a natural flood retention basin that holds wet season overflow from the Maasim, San Miguel, Garlang, Baler and Peñaranda River.

There is no detailed information available on the aquatic flora. There are patches of Nipa fruticans and mangrove in the surrounding area (*P-4). However, most part of the flood plains is used to cultivate rice and other agricultural crops.

1.3 SOCIAL ENVIRONMENT

(1) Demographic Characteristics

1) The Central Luzon Region

Region III or Central Luzon had a population of 6.2 million in 1990. It is the rice granary of the Philippines and it is accounted for 20 percent of national production. Other major agricultural crops are sugarcane, mango and vegetables.

The region has a large percentage of urbanized and urbanizing areas. Its proximity to Metro Manila makes it the second to the Southern Tagalog region in terms of the source of labor for Manila.

2) Provinces in Study Area

The Study Area is approximately same as the Sacobia/Bamban and Abacan River basin. This falls within the provinces of Pampanga and Tarlac. Table P.1.9 presents the summary of demographic information on the two provinces.

a. Pampanga

The size of population in Pampanga in 1990 was 1,657,979. Growth rate of the population for the period of 1980-1990 was 2.63 %. This is a slight increase over the previous decade of 2.54 %. Average population density of 610.3 persons/sq.km is considerably high. The urban population of the Study Area is almost double that of the rural population in 1980. Number of males have slightly exceeded females in 1990 (sex ratio = 102.4). The average household size was 5.39 and the literacy rate was 96.23 in 1990.

Based on the 1990 population census, Angeles and San Fernando have been the largest among cities and towns. Among the municipalities, Mabalacat was the largest in the size of population followed by Lubao and Guagua. Sasmuan was the smallest population among others. Mabalacat had the largest growth rate of 4.11 % while Sta. Rita had the smallest of 1.24 %.

The land area of Pampanga is 2,120.4 sq. km. Among the municipalities, Porac is the largest 343.1 sq.km followed by Candaba of 208.7 sq.km while Sto. Tomas is the smallest of 21.3 sq.km. Angeles and San Fernando had the highest population density in 1990 of 3,807 and 1,932 persons/sq.km respectively.

The urban-rural distribution for each municipality is shown in Table P.1.10. In 1990, the towns of Apalit, Guagua, Minalin, San Fernando and Sasmuan have already been urbanized while Floridablanca and Arayat have had the largest rural proportion.

The age distribution shown in the Table P.1.11 indicates that the population characteristics of the study area is relatively young. There is a slight shift from an excess of females in 1970 to an excess of males in 1990. Angeles and San Fernando have the highest number of households as is shown in the Table P.1.12. The average size of household for the province was 5.71. There are large families in Sta. Ana and Mexico while Angeles and Mabalacat have small families.

The vital health indicators for Pampanga are shown in Table P.1.13. The crude birth rate in 1990 was 27.8 while in 1993 it was 26.7. The crude death rate was 1.53 that dropped to 1.01 in 1993. The leading causes of morbidity have been acute respiratory infection, nutritional deficiencies and diarrhea in 1988 to 1992 while skin problems and intestinal parasites are more common in 1993. The leading causes of mortality have been cardiovascular disease, cancer, pneumonia and tuberculosis while the leading causes of infant mortality have been bronchopneumonia, prematurity, septicemia and congenital anomaly.

b. Tarlac

Table P.1.9 contains a summary of demographic information on Tarlac. The size of population is 859,222 in 1990 and the growth rate for the period 1980-1990 was 2.24. Average population density was 281.4 persons/sq.km and 70 percent of its area is classified as rural. Males exceeded females and the average household size was 5.71. Its literacy rate was 97.7 percent.

Table P.1.14 shows the population characteristics of the 18 towns in Tarlac. As of 1990 in Tarlac, the capital town of Tarlac Province, have had the largest population followed by Concepcion while Anao had the smallest population. Tarlac have had the largest land area followed by Capas. The town of Paniqui had the highest population density of 617.39 persons/sq.km while Mayantoc had the lowest 59.7 persons/sq.km.

The proportion of the area classified as urban is shown in Table P.1.15. Bamban had the largest urban area followed by Pura and Sta. Ignacia. Characteristics of the population of Tarlac was relatively young in 1990 as shown in the Table P.1.16. Females slightly exceeded males in 1970. However, this was not the case in 1980 and 1990 as the males exceeded the females. The capital town had the largest number of households in 1990. The average size of household for the province was 5.39. Concepcion had the largest size of household of 6.03 persons/house while Sta. Ignacia was the smallest of 4.95 persons/house.

The crude birth rate for the province in 1991 was 20.56; the crude death rate was 3.21. The infant mortality rate was 11.12 and the malnutrition rate was 16.85. The leading causes of mortality were cardiovascular disease, pneumonia, pulmonary tuberculosis and cancer in 1990 as shown in the Table P.1.17. In 1993, the leading causes of mortality have been myocardial infraction, artery sclerosis heart disease and cardio vascular disease. The leading causes of infant mortality were bronchopneumonia, congenital heart disease and prematurity in 1990.

Like in Pampanga, rice is the major crop in Tarlac (see Table 1.18). It produced 272,178 MT in 1990 and it increased to 300,533 MT in 1992. The area planted to rice was 105,100 ha in 1990 but this decreased to 92,720 ha in 1992.

3) City and Towns in the Study Area

Two towns and a city in Pampanga and two towns in Tarlac are identified as the areas to be directly affected by the project. These are Mabalacat, Mexico and Angeles City in Pampanga and Bamban and Concepcion in Tarlac.

a. Mabalacat

Table P.1.19 shows the distribution of population by barangay for Mabalacat. The size of population in Mabalacat is 121,115 in 1990 and this increased to 136,668 in 1993. Of the 27 barangays, Dau has the largest population of 47,180 and Sapang Balen has the smallest size of 347. Camatchile has the largest growth rate of 14.02 % and the highest population density 48,600 persons/sq.km. Duquit has the largest land area of 53.51 sq.km.

Dau has had the largest urban proportion in 1990 (see Table P.1.20). Only 9 of the 27 barangays have relatively large urban areas. The population is relatively young with males slightly exceeding females (see Table P.1.21) in 1990. Average literacy rate is 98.67. Cacutud has the largest family size while Dau had the smallest. The average size of the household for the municipality is 5.32.

The labor force of Mabalacat is comprised 45 percent of the population. The distribution of persons by major occupational group and major industry group is shown on Table P.1.22. Urban labor force such as industrial workers, operators and laborers composed of 36.30 percent of the total population while farmers and agricultural workers composed of 24.5 percent.

Mabalacat had 3 rural health units staffed by 3 doctors, 2 nurses, 13 midwives, 2 dentists and 5 sanitary inspectors. Leading causes of morbidity in 1992 were upper respiratory tract infection, acute gastroenteritis and urinary tract infection. Leading causes of mortality were heart disease, pneumonia and acute gastroenteritis. Congenital debility was the leading cause of infant mortality.

b. Mexico

The total population of the 43 barangays in Mexico was 69,441 in 1990. This increased to 75,040 in 1993 (see Table P1.23). The barangay with the largest population was Parian while Eden had the smallest. San Rafael was the barangay with the largest growth rate of 4.6 % between 1980 and 1990. Pangatlan had the largest land area of 5.91 sq.km. San Antonio had the highest population density of 13,985 persons/sq.km.

Mexico is predominantly rural with only 26.17 percent of its population residing in urban areas (see Table P.1.24). Parian and San Antonio are the most urbanized barangays. Parian had the largest number of households of 665 while Eden had the smallest 53 as shown in the Table 3.77. The average size of household for the entire municipality was

4.56. Sapang Maisac has the largest size of household of 11.88 and Sta. Maria is the smallest of 3.80.

Mexico has two rural health units. These are staffed by 3 doctors, 3 nurses, 1 dentist, 13 midwives and 3 sanitary inspectors. The leading causes of morbidity in 1992 are upper respiratory tract infection, avitaminosis and acute gastroenteritis (Table P.1.25). The leading causes of mortality have been cardiovascular diseases, senility, cancer and bronchopneumonia.

c. Angeles City

The total population of the city of Angeles was 236,685 in 1990. This increased to 253,299 in 1993 (Table P.1.26). The barangay with the largest growth rate from 1980 to 1990 was Cauayan of 11.31 % while Pandan had the largest negative growth rate of -5.49 %. Sapang Bato has had the largest land area of 10.96 sq.km. On the other hand, St. Trinidad has had the highest population density of 42,050 persons/sq.km.

Angeles City is predominantly urban with 28 of the 33 barangays classified as urban area (Table P.1.27) where ninety seven percent of its population reside. The population was relatively young (Table P.1.28). The number of females exceeded males in 1980 and 1990. Angeles has a very high literacy rate of 99.71 % in 1992. Balibago has 4,389 households and this is the largest among others as shown in the Table P.1.29. The average size of the household in the city is 5.08 and Sto. Domingo has the largest size of 7.13.

There are 5 rural health units in Angeles City, one general hospital and several private clinics. Of the health personnel in 1993, 165 are medical doctors, 32 nurses, 47 midwives, 12 sanitary inspectors, 8 medical technologists and 41 pharmacists. Crude birth rate in Angeles City in 1992 was 46.7 and the crude death rate was 5.04. The infant mortality rate was 9.60.

The leading causes of mortality in 1992 were heart diseases, senility causes, cancer, bronchopneumonia and pulmonary tuberculosis (Table P.1.30). The leading causes of infant mortality were prematurity, bronchopneumonia and sepsis.

The labor force of the city was economically active with 90.71 percent employed in 1990 and 89.05 percent in 1992. The distribution of population by occupational groups is shown in Table P.1.31. A large percentage of work force engages to craft making and related works, plant and machine operators, assemblers, and services.

d. Bamban

The total population of Bamban has been 35,639 in 1990 (Table P.1.32). This increased to 41,091 in 1993. The barangay with the largest population was San Nicolas. San Rafael had the highest growth rate of 5.94 % between 1980 and 1990. Anupul has the biggest land area of 74.27 sq.km. Banaba has the highest population density of 728.26 persons/ sq.km in 1990.

Six of the 15 barangays in Bamban have been classified as predominantly urban and they hold 65 percent of the total population as shown in the Table P.1.33. San Nicolas, the poblacion of Bamban, has the highest proportion of urban area of 15.43 %.

In 1987, the males slightly exceeded the females as indicated by the sex ratio of 101.5 (Table P.1.34). Eight of the 15 barangays has sex ratios of over 100. The population is relatively young and the literacy rate was 89.14 in 1980. The average size of household is 6.34.

Bamban has had one rural health unit in 1990 with 1 doctor, 1 nurse, 6 midwives, 1 dentist and 1 sanitary inspector. These public health personnel are complemented by private practitioners. Leading causes of morbidity in 1993 were upper respiratory infection, vitamin deficiency, dermatitis and gastritis (Table P.1.35). Leading causes of mortality were bronchopneumonia, Kock's pulmonary disease, myocardial infraction and congenital heart failure.

c. Concepcion

The total population of Concepcion was 97,776 in 1990. This increased to 115,138 in 1993 (see Table P.1.36). The barangay with the largest population was San Jose. It also had the highest population density of 13,555 persons/sq.km. Sta. Rosa had the largest population growth rate of 5.56% from 1980 to 1990. Magao had the largest land area of 7.20 sq.km.

Of the 45 barangays in Concepcion in 1990, only 2 were classified as urban; San Jose and San Nicolas (Table P.1.37). Almost 90 percent of the population resided in the rural areas. The sex ratio for all of the towns in Concepcion in 1993 was 101.79. Twenty five of the 45 barangays had sex ratio of over 100 (Table P.1.38). San Jose has had 1,320 households and this is the largest among others. The average size of household for the entire town was 5.55. San Juan was the barangay with the largest size of household of 9.47.

Concepcion has 1 district hospital and 2 rural health units. The 50 bed capacity hospital has 5 doctors, 8 nurses, 6 midwives, 1 dentist and 1 pharmacist. The rural health units are consisted of 2 doctors, 1 nurse, 15 midwives, 1 dentist, 2 sanitary inspectors and 2 medical technologists. There are also 28 day care centers in different barangays. The leading causes of morbidity were acute respiratory infection, gastrointestinal disease, intestinal parasitism and anemia (Table P.1.39). The leading causes of mortality were pulmonary tuberculosis, myocardial infarction, cardio vascular disorder, pneumonia and cancer. The crude birth rate was 21.8 while the crude death rate was 3.05.

(2) Land Use

Angeles City and San Fernando are the commercial and industrial centers in Pampanga. Major employment centers are Clark Air Force Base in Mabalacat and the Pampanga Sugar Development Company and Philippine Army Base in San Fernando. The Clark Air Force Base, was established during the early 20th century as the U.S. Cavalry base, known as Fort Stotsenberg. Classification of the land area at the time was known as grassland (*P-5).

Since then, most of the population centers are located on the broad alluvial plains, residual terrace and pyroclastic hills. In 1975, Angeles City came to occupy 43 percent of the grassland. The clusters of population concentration in Mabalacat are mainly situated around Clark Air Force Base while The Export Processing Zone in Angeles City is situated along the North Luzon Expressway. In Magalang, Bamban, Concepcion and Mexico, residential areas are located in the town center.

Forest areas are located in Mt. Arayat National Park and in the upper watershed area of Abacan and Sacobia/Bamban River. Mt. Arayat National Park is 3,715 ha found in the municipalities of Arayat and Magalang. It serves as a resort area and other recreational purposes for the local residents.

The watershed area of Marimla, Sapang Cauayan and Sacobia River are in the very well developed irrigated agricultural area. There is very little forest vegetation in the area, limited to very steep slopes of gullies and ravines.

Agriculture is the dominant land use in the study area. Rice and sugarcane are the major crops. Cassava, sweet potato, legume, fruits and commercial crops are also grown. Muskmelon and watermelon are grown at the Candaba swamp during the dry season. Rainfed and irrigated rice, sugarcane, root crops, vegetables and fruits are grown on the lower river terraces and in the wide alluvial plains in the downstream areas. Rainfed lowland rice is also grown on the lower portion of volcanic hills and moderately sloping pyroclastic hills.

Riverside terrace and broad alluvial plain with coarse to medium texture of soil and none to slightly flooded land management area (09D-EJ on Fig.P.5) is suitable to grow annual crops. Land management unit of broad alluvial plain with heavy texture of soil and none to slightly flooded land management area (09FJ on Fig. P.5) as well as the moderately flooded area (09FK on Fig.P.5) is moderately and marginally suitable for upland and annual crops respectively. The flooding area of land management unit (09FL on Fig.P.5) limits its use for rice. The area of residual terrace land management unit (23 on Fig.P.5) is moderately suitable to upland crops due to its poor drainage. Residual terrace, pyroclastic hills, foot slopes of volcanic hills, mountain and volcanic cones are in general moderately to highly suitable to grow fruit trees as well as to grow forest tree species. Overall land use before and after the Mt. Pinatubo eruption is shown in the Table P.1.40.

(3) Agriculture Activity

1) Agricultural Crops

Agriculture plays the most significant role in the economy of the provinces of Pampanga and Tarlac. Land in both provinces are extensively used for agriculture, inland fishing and pasture/grasslands. The two provinces belong to the Central Plain of Luzon Island known as the country's rice granary and contributes its regional share of the value to the overall national agricultural output.

The total area of cropland in Pampanga before the eruption of Mt. Pinatubo was 112,850 ha (see Table P.1.41). This was about 52% of the total land area of the province. As is shown in the Table P.1.42, irrigated paddy rice covered 56,874 ha and this is 50.4 % of the total agricultural land of the region. Rainfed paddy covers 25,170 ha (22.30%) and sugarcane covers 22,089 (19.57%). Upland rice (1,813 ha), cassava (2,691 ha), sweet potato (1,874 ha) and fruit trees (1,056 ha) are the secondary crops commercially grown in the region. The rest of the land are cultivated for corn, beans, vegetables and tobacco.

On the other hand, an area of approximately 140,140 ha are devoted to agriculture in Tarlac before the Mt. Pinatubo eruption. It is 43% of the province's total land area of 305,345 ha (Table P.1.41). Irrigated paddy rice occupies 59,328 ha. This is 42.3% of the total agricultural area. Rainfed paddy covers 52,236 ha (37.27%) and sugarcane 20,496 (14.62%). Sweet potato (5,108 ha) and corn (1,436 ha) are the second major crops while the rest of the land is planted to banana, vegetables, root crops, tobacco and fruit trees (Table P.1.42). Hilly slopes and foot hills are planted with perennial agricultural crops such as coffee, mangoes, coconut, jackfruit, cashew and bananas.

2) Livestock and Poultry Production

An area of about 13,937 ha has been devoted to pasture land in Pampanga before the eruption of Mt. Pinatubo (Table P.1.43). About 4,080 heads of cattle, 11,390 heads of goats and 31,570 heads of carabao have been raised in 1990 (Table P.1.44).

Chickens reached to 2,767,980 heads in 1990, ducks to 260,280 and hogs to 156,970 heads (Table P.1.44).

Tarlac province used about 68,704 ha of pasture land (Table P.1.43) to raise 64,350 heads of carabao, 59,820 heads of goat and 37,790 heads of cattle in 1990 (Table

P.1.44). Tarlac farmers also raise 1,204,890 heads of chicken, 508,700 heads of ducks and 118,020 heads of hogs (Table P.1.44).

3) Fishery

Freshwater and brackish water fishponds, swamps and lakes cover the wetland area of both Pampanga and Tarlac used for in-land freshwater fish production. These inland fish culture areas have been utilized for aquaculture of tilapia, bangus, catfish and mudfish. The wetland area of 40,681 ha in Pampanga, which is the largest in the region, and the area of 352 ha in Tarlac are used for aquaculture (Table P.1.44).

(4) Archaeological Resources

Considering historical data and actual field reconnaissance, archaeological resources may be unearthed in the Study Area as follows:

1) Abacan River Basin

- Barangay Sapang Bato River, Angeles;
- Barangay San Jose Matulid in Mexico.

2) Sacobia/Bamban River Basin

- Barangay Cacutud of Mabalacat in Pampanga;
- Bamban Town Proper;

Barangays of St. Rita, San Vicente, San Francisco, Culatingan, and Concepcion in Tarlac are considered that there will be no archaeological value in these barangays.

Excavations carried out in Porac within the vicinity of Hacienda Ramona by Beyer and Constenoble in 1937 revealed a third century Chinese burial urns made in Southern China. Other areas of Pampanga particularly the settlements along the river might yield materials of archaeological value.

According to the historical records on the Will of Pansunom baptized as the aforementioned Fernando Malang Balagtas, at the time of his grandfather Prince Balagtas and his father Kalangsic's reign between 1,335 and 1,380, the town of Mexico was mentioned that the town was already existing. This document and church records classifies Mexico as a settlement made in 14th century. The area within the vicinity of the four hundred years old chapel in San Jose Matulid have indicated that there are some pre-Hispanic settlements and might yield materials of archaeological value in the area.

Angeles, Mabalacat and Bamban as part of the Upper Pampanga region had an extensive forest cover inhabited by The Aeta.

Sapang Bato (Figure P.4), a barangay near Angeles and adjacent to Clark Air Force Base (formerly known as "Fort Stotsenberg") is recorded to be an old settlement established in 1902 according to a local historian, Mr. Felipe Espinosa. The river that flows in the western side of the Barangay contains large boulders. The upper portion of the barangay near the present cemetery was the original settlement as narrated by the old folks of the community. On the other hand, northwest of the barangay towards Mt. Pinatubo across Sapang Bato River is one of the old settlements of The Aeta. The place is now called Little Baguio. The settlement was established when the lowlanders took over the lower portion of the area prior to the Spanish invasion.

Barangay Cacutud in Mabalacat is a community proximate to Bamban River in the low-lying sugarcane growing area. Major portion of the farmlands was submerged and the settlement area was also submerged in the lahar flow of 1991. This barangay is located within the old church yard of the Spanish period and it is believed that some artifacts of pre-Hispanic, Hispanic may be unearthed.

The town of Bamban has been partly buried by lahar. Totally buried are barangays of San Pedro, Banaba, Malonzo and Lourdes. There are some indications of artifacts of the Central Azucarera de Bamban. Thus there is a high possibility of which artifacts of archaeological value might be unearthed in these areas.

(5) Ethnic Minority

1) Origin of the Aeta

The area Aeta used to live is the present provinces of Pampanga, Tarlac, Bataan, and Zambales. Their territory was once covered with thick tropical forest. When the first Hispanic invasion began in the Aeta Territory in the late 1775, Hispanic settlement has started from Culiat, or what is now Angeles. In the succeeding years between 1795 and 1846, the Hispanic settlements expanded quickly and moved far north towards Sapang Bato. The Aeta living in the foothills of Mt. Pinatubo and the surrounding flat areas of Pampanga and Tarlac quickly disintegrated by the growing Hispanic settlements. Hunting and gathering were, therefore, limited to mountain slopes far from the lowland settlements of the Aeta.

The early Aeta, therefore, left their hunting plots and began moving to the deeper forested areas of Mt. Pinatubo in order to continue hunting and gathering. Over the years, dispersed Aeta settlements grew larger and came closer to each other as their population increased (*P-6). According to the 1975 census, the Aeta population throughout the archipelago was roughly 20,000. More than half of these Aeta lived in the Zambales Mountain Range, especially around the Mt. Pinatubo area.

The southwestern slopes of Mt. Pinatubo are separated from the eastern slopes and the western slopes by several mountain ridges. The Aeta call the eastern slopes Pampanga because they are already within the boundary of the province. Despite the fact that the mountain ridges separate groups of Aeta, the Aeta living around Mt. Pinatubo recognize themselves as the same ethnic stock of Poon Pinatubo Aeta each other. In fact, several marriages have overcome the ridges separating them. However, groups of Aeta differentiate themselves from one another in terms of their life style (*P-7).

2) Life Style of the Aeta

Interviews with residents in Sapang Bato in Angeles revealed that, before the Mt. Pinatubo eruption, some families maintained "kaingin", or shifting agriculture. They planted permanent crops such as coffee, coconuts, bananas, mangoes, and jackfruits. There are also annual crops planted for food such as up-land rice, corn, sweet potatoes and other root crops.

Most areas above Sapang Bato are covered by secondary forest or savanna type of grassland at the moment. The Aeta also maintain domestic animals such as chickens for meat and eggs, goats and cattle for meat and milk as well as for cash, carabaos as farming animal and horses for transporting agricultural products.

The areas above Sapang Bato and Clark Air Base were also teeming with wildlife. They said that Wild Pigs (Sus philippensis) were relatively common that often raid the farmer's sweet potatoes and root crops. Rats were abundant and they cause damages to coconuts, corn and rice crops. Civet (Paradoxurus hermaphroditus and Viverra tangalunga) were also quite common, which often fed on ripe coffee berries and chickens. There has also been a good population of snakes, especially Philippine Cobra (Naja naja philippinensis), King Cobra (Ophiophagus hannah), Common Red-tailed Rat Snakes (Elaphe erythrura) and Monitor Lizard (Varanus salvator). Cobras and snakes are sold for cash in San Miguel, Tarlac.

Birds were also abundant, especially during the months of September and October, the migration season of bird species. The Aeta children catch Brown Shrike (Lanius cristatus) which they call "Tarat", with a trap using a bamboo pole. They also use snare to catch civet and monitor lizards. Adult Aeta hunt wild pigs using trained hunting dogs and kill pigs with spears or bow and arrow. All wildlife species that Aeta caught are eaten as their major protein source. For those who practice kaingin, hunting wild life by other members of the Aeta is a goodwill service because most wildlife species are considered pest to their crops and livestock.

3) Subdivisions of the Aeta

There are subdivisions of the Aeta living in the eastern portion of Mt. Pinatubo. Those of living in the Study Area are divided by municipality in which they live and named after the municipality such as Bamban Aeta, Mabalacat Aeta, and Angeles Aeta.

The settlement of Bamban Aeta is in the area to the west and north of Sacobia/ Bamban River and has a strong sense of community unique to the area.

The settlement of the Mabalacat Aeta is located at the northern periphery of Clark Air Base and called the area as Marcos Village. The Angeles Aeta has settled in the western portion of Barangay Sapang Bato and is popularly called the area as "Little Baguio". Historically, these Aeta has developed the relationships with the Americans in the early days as they Fort Stotsenberg in the middle of 1920s. Most of the Aeta living around the Clark Air Base have been working for the air base in different occupations. Some began producing hand craft. They also did farming in an area near the mountain, and built fishponds in the rivers.

(6) Community Perceptions on the Life Style

1) Pampanga

a. San Lorenzo & Mexico

The community has been blessed with abundant water from the Betis River and Abacan River Extension for agricultural use. As a result, rice farms in the area have been very productive. Almost everybody in the community have been economically stable and have enjoyed relatively high standard of life. This has been damaged as a result of Mt. Pinatubo eruption as Abacan River frequently flood the area and cause extensive damages. Thus, further measures under the Project is considered very welcome.

b. Sapang Bato

Contentment and economically comfort were the views of the people in Sapang Bato. As the barangay is near Clark Air Base, the community has grown since Fort Stotsenberg was built. Migrant workers from different parts of the country found the barangay a convenient place to stay and obtain jobs. A mixture of Tagalogs, Ilocanos, Pangasinan and Visayan people coexisted with the people in Pampanga.

Majority of the population in Sapang Bato worked for the Clark Air Force Base, including the Aeta. Very few undertook agriculture as main occupation. Majority of the community members could be classified as economically better-off. There have been relatively large number of the Aeta farmers who cultivated large portion of the foothills of Mt. Pinatubo. Their crops are gabi, camote, sugarcane and fruit trees. Handicraft was also thriving business among them.