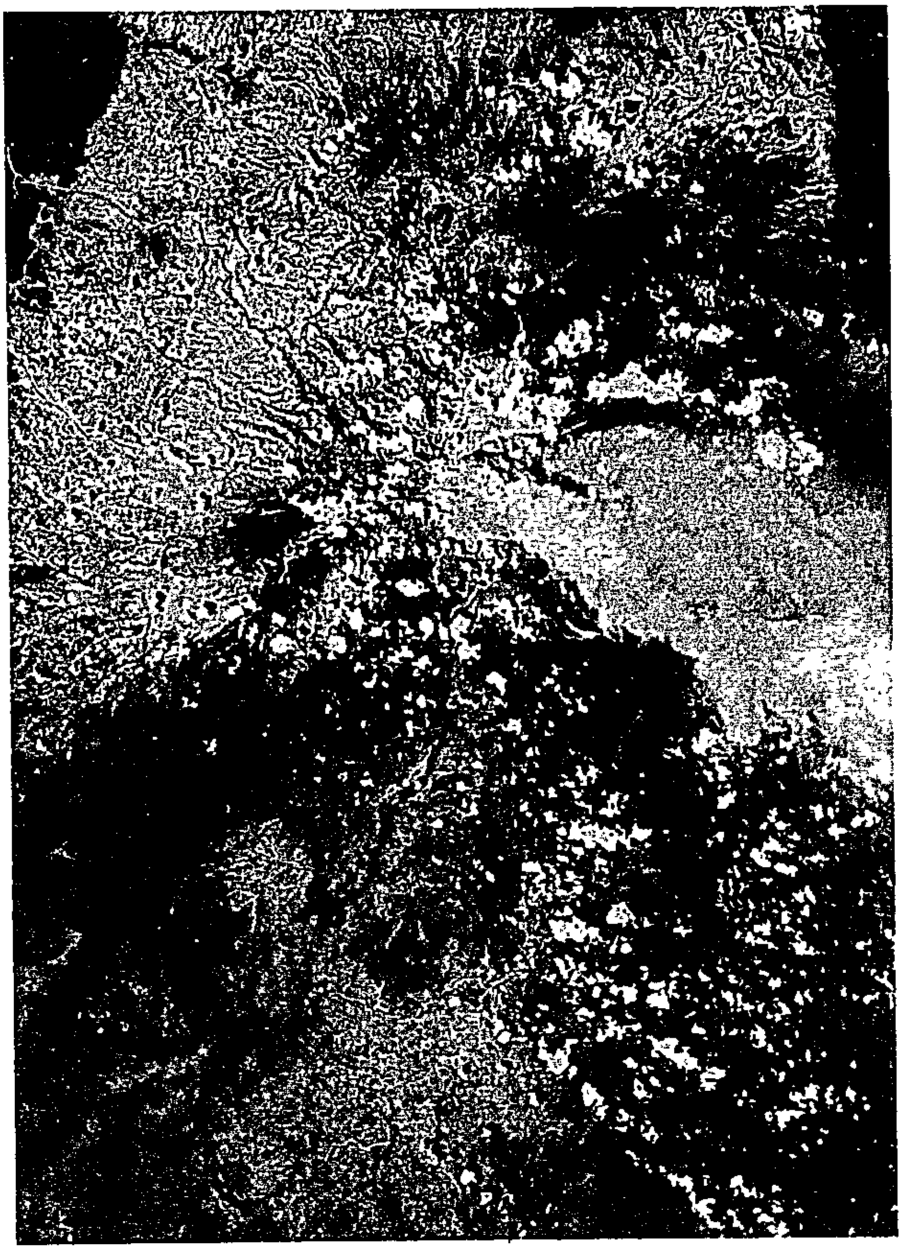
4. *Mt. Pinatubo Disaster Mitigation Program*



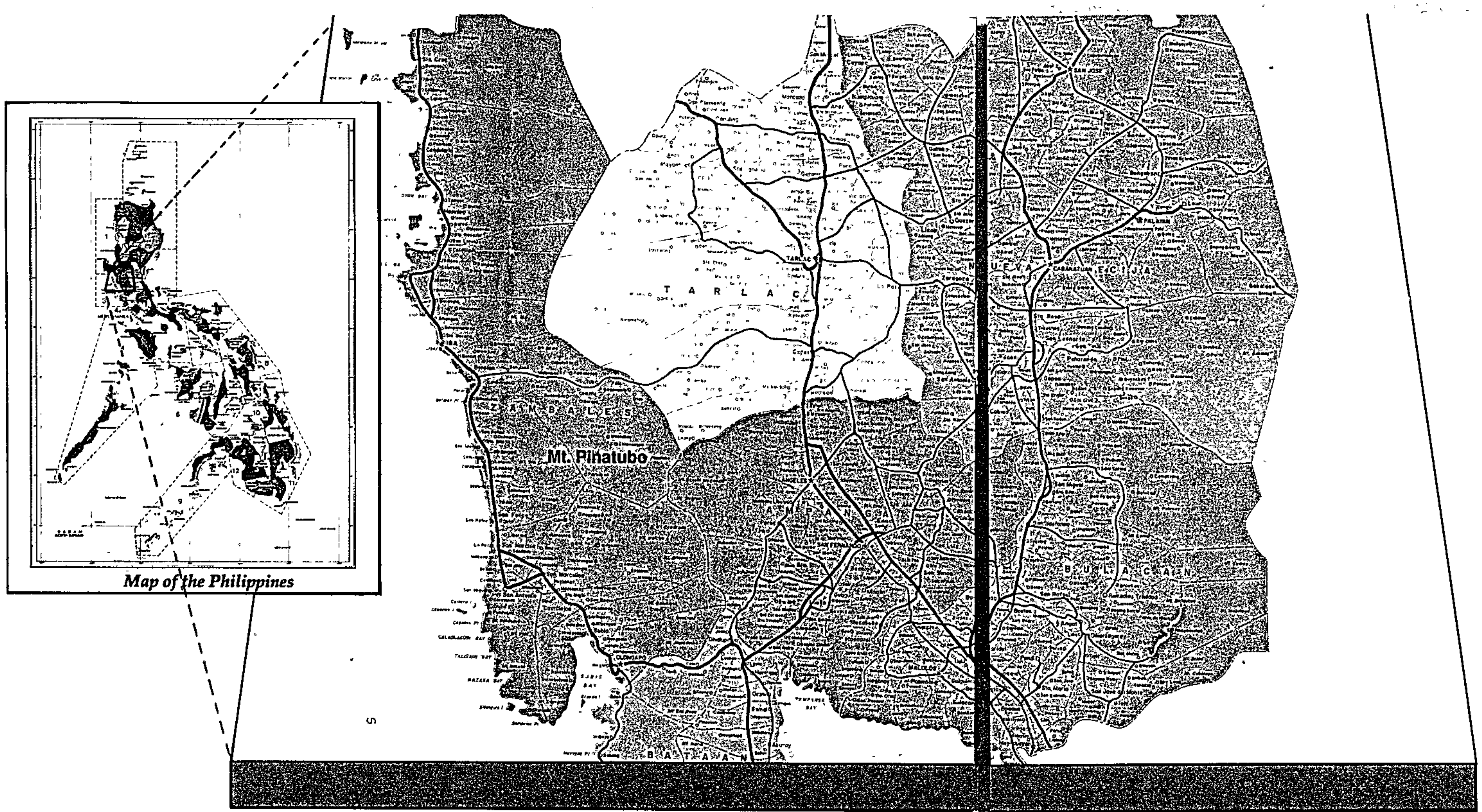
Satellite photo of Mt. Pinatubo eruption on June 12, 1991

Mt. Pinatubo in West Central Luzon, Philippines lay dormant for nearly 600 years. Until it started acting up on April 2, 1991 when it let off steam and ash emissions, followed by high frequency volcanic earthquakes.

Nine weeks later, on June 12, the volcano unleased a series of major explosive eruptions that culminated with final explosive bursts starting at 2:00 P.M. on June 15, 1991.

Millions of cubic meters of volcanic debris fell within 50 kilometers of the volcano. Hundreds of people were killed, thousands more were injured or missing, and hundreds of thousands of families were rendered homeless.

Strong winds induced by Typhoon "Diding" on June 15 aggravated the situation, scattering volcanic ash over thousands of square kilometers, including Metro Manila, about 90 kilometers away.



Map of the Philippines

Mt. Pinatubo Vicinity Map

Water-soaked ash deposits caused roofs of hundreds of houses and buildings in Zambales, Bataan and Pampanga to collapse. On-rushing lahar caused by the heavy rains buried whole villages and thousands of agricultural lands along its path, with a number of persons swept away and declared missing. Some 250,000 families have to abandon their homes, villages and sources of livelihood.

Bridges collapsed while roads disappeared. Damage to agriculture was overwhelming, destroying or burying crops and fruit-yielding trees. Some 77,000 hectares of farm lands were buried under 6-12 inches of volcanic ash.

Total damage to public infrastructure, agriculture, trade and industry, and natural resources caused by the eruptions and the ensuing lahar floods during the succeeding weeks was initially estimated at P10.6 billion (approx. US$366 mllion).

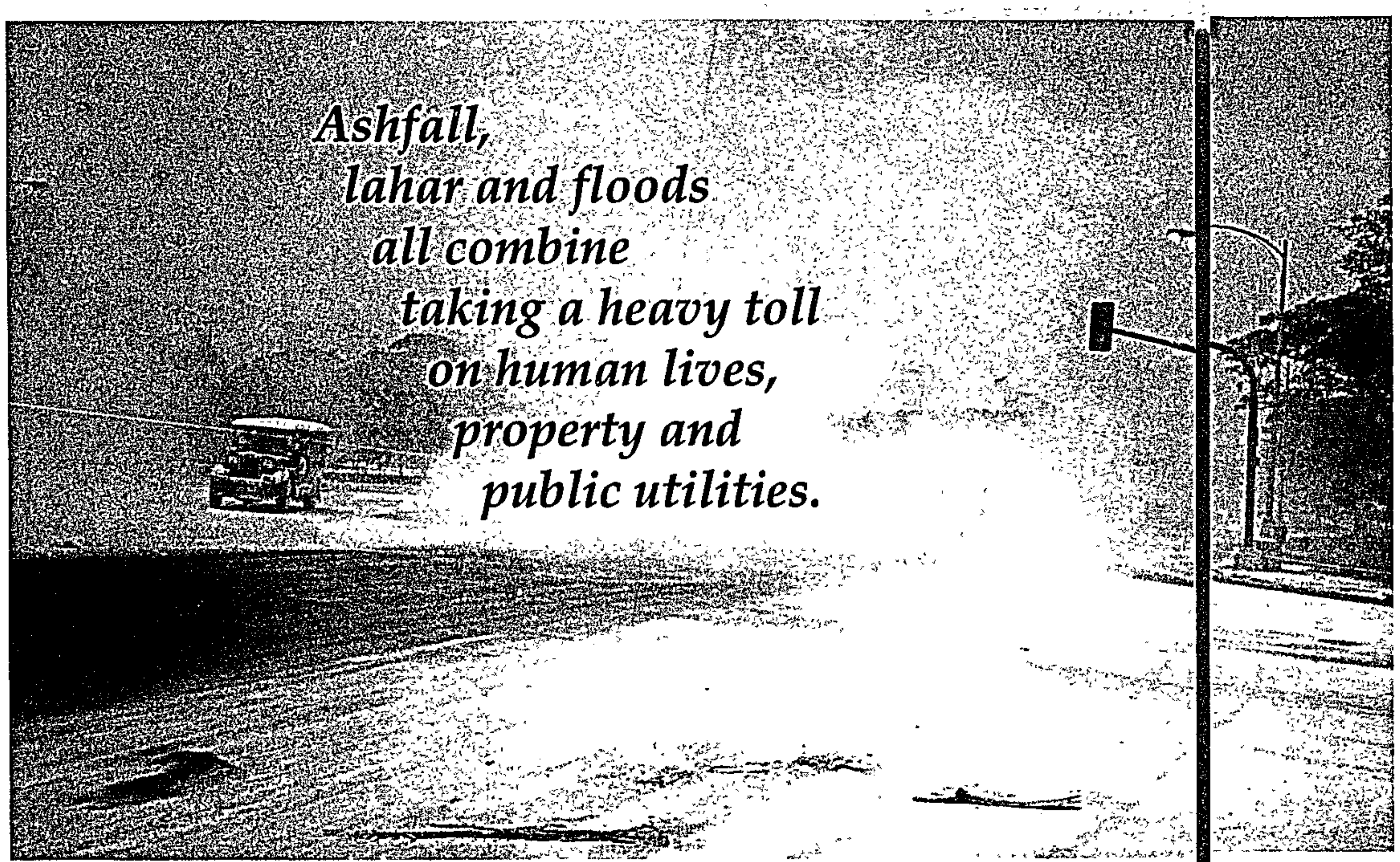
The Philippine Department of Social Welfare and Development (DSWD) had reported a total of 932 persons dead, 184 injured and 23 missing as a result of the Mt. Pinatubo disaster.

The DSWD also reported that 41,979 houses were totally destroyed, while 70,257 houses were partially damaged. A total of 1,180,132 persons were tallied to have been adversely affected. A total of 7,841 Aeta* families were displaced and have to be relocated. Zambales and Pampanga suffered the most casualties and damage.

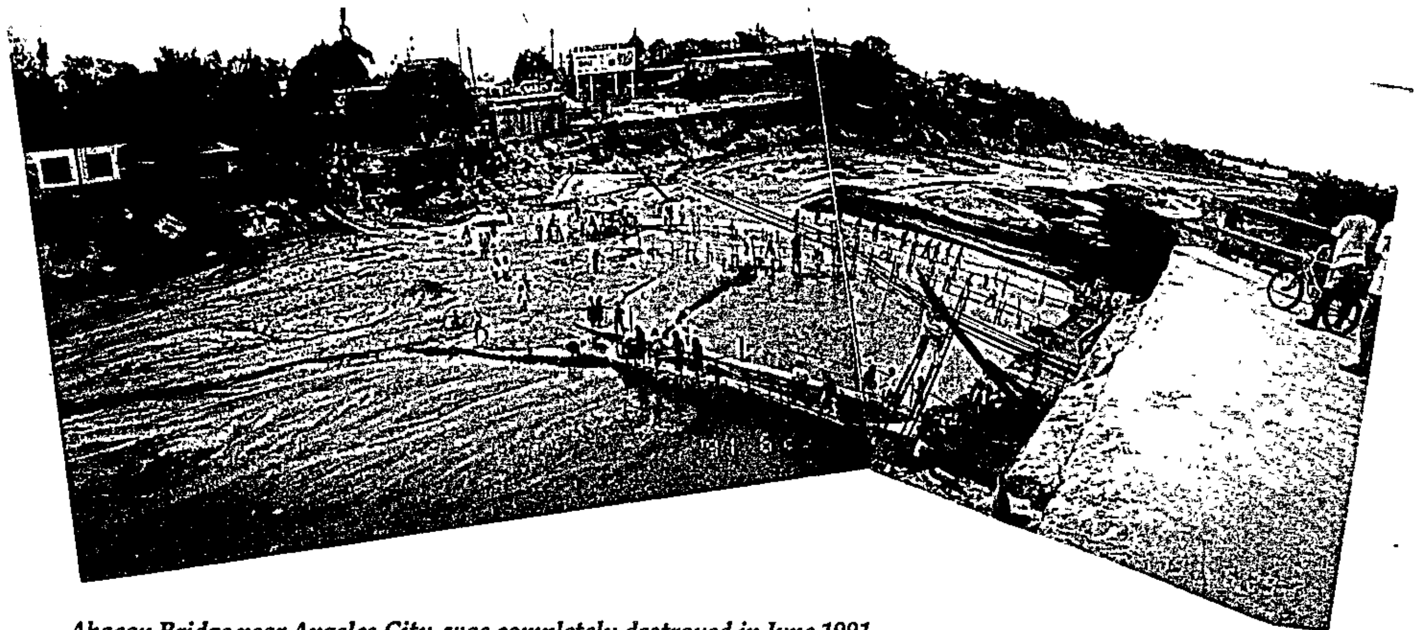
* An ethnic tribe living on the slopes of Mt. Pinatubo.

Chronology of Volcanic Activity of Mount Pinatubo (April 2 to June 15, 1991)

April 2	Volcanic activity of Mt. Pinatubo began with a relatively small steam and ash explosion at 1.5 km northwest of the summit.
April 5	High-frequency volcanic earthquakes were observed by the PHILVOLCS. The PHILVOLCS recommended precautionary evacuation of areas within a 10 km radius of the summit.
May 13	The volcano was in alert level 2. (Moderate level of seismic, other unrest with positive evidence for involvement of magma.)
June 9	The alert level was raised to 5 (eruption in progress). The radius of evacuation was increased to 15 km, then 20 km and 20,000 people moved in evacuation camps.
June 10	At the Clark Air Base, more than 14,000 military personnel were evacuated from Clark to Subic Bay Naval Station.
June 12	Major explosive eruptions produced substantial pyroclastic fall and pyroclastic flow deposits on the slope of Mt. Pinatubo. Lahars occurred as soon as the major eruptions began; one was recorded on the Sacobia River, another on the northeast side of the mountain.
June 15	The climactic phase of explosive eruptions began at approximately 2:00 P.M. and continued through late evening. These eruptions ejected about 11 km³ of ashfall and pyroclastic flows, and produced a caldera summit with a diameter of 2 km. The ashfall was also observed in Manila which is located at about 90 km southeast from Mt. Pinatubo.

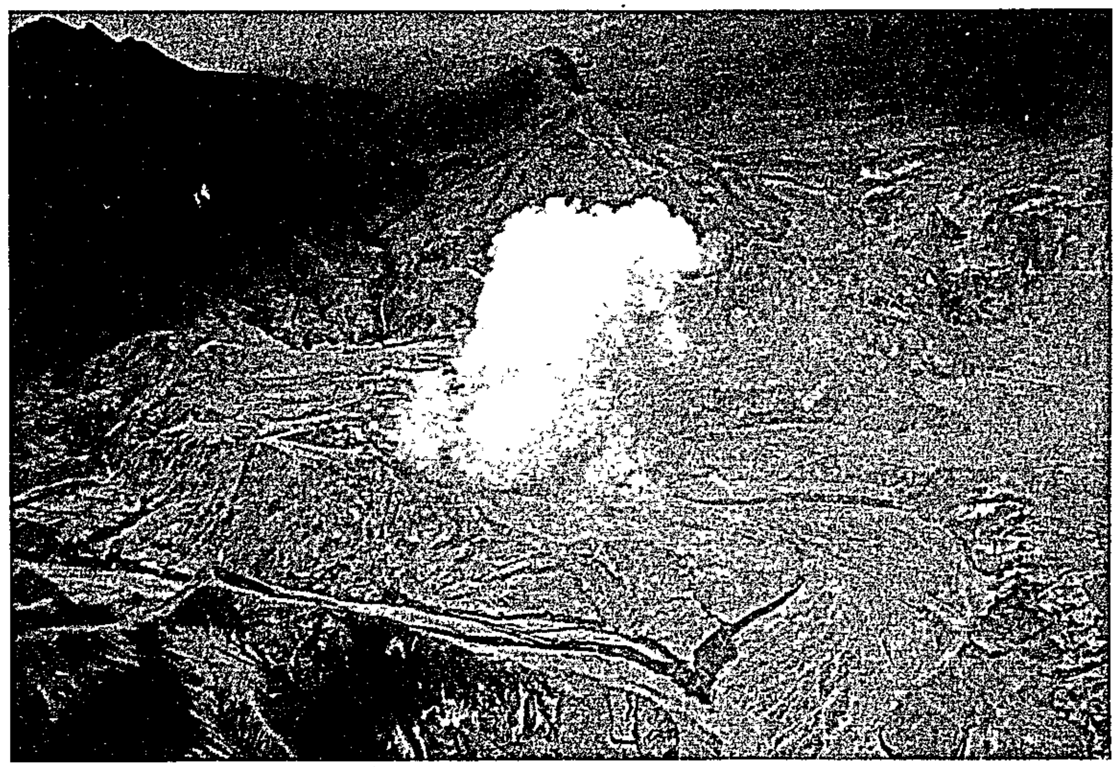


Ashfall in Metro Manila on June 16, 1991



Abacan Bridge near Angeles City was completely destroyed in June 1991. Restoration work was completed in November 1992.

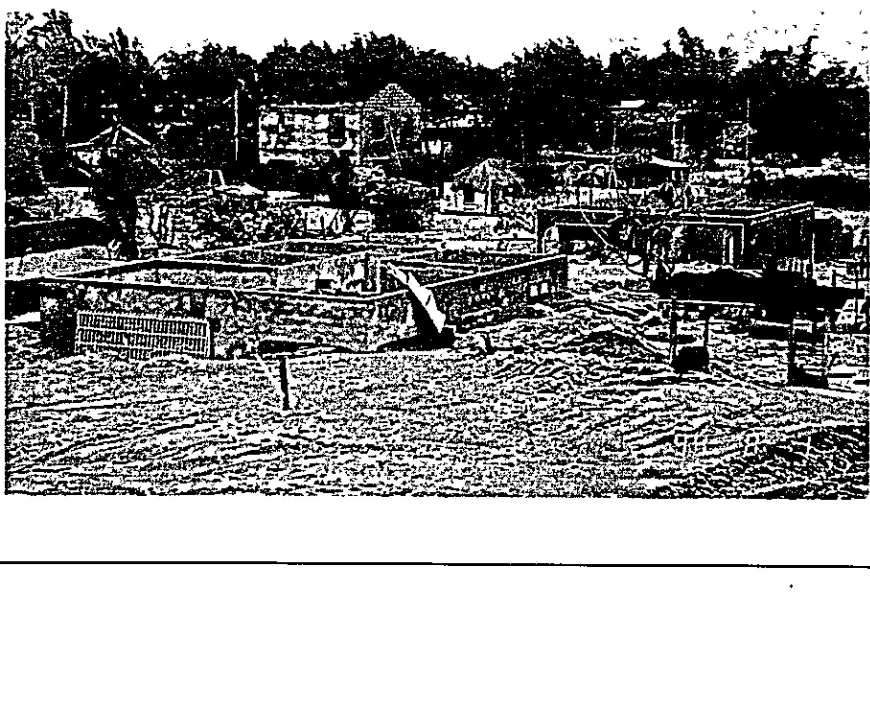
Bank erosion at Sapang Bato in upstream Abacan River (March 1993).

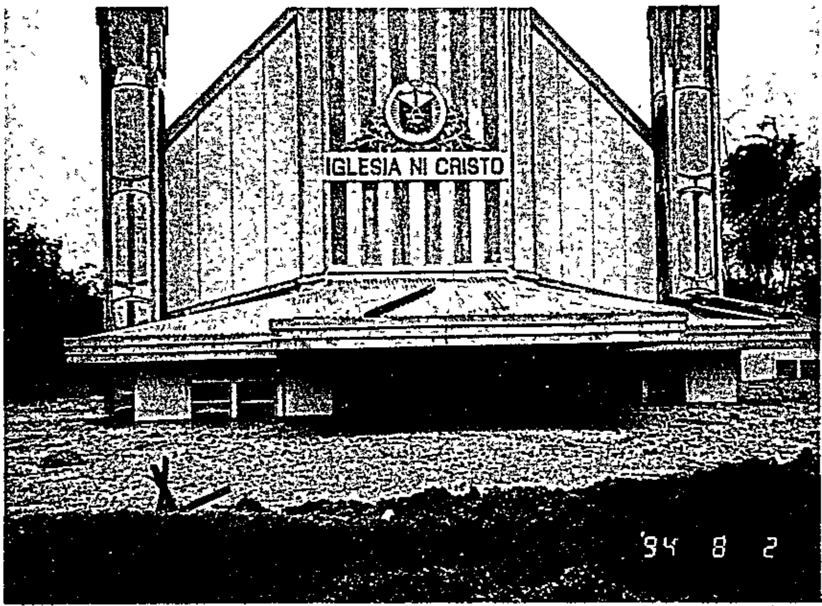


Ash Cloud due to Lateral Erosion in Pyroclastic Flow Deposit Field of the Pasig River

A devastated land and people

No other disaster in this century has wrought so much destruction and suffering. Its exact socio-economic and environmental impact may not be exactly measured for some time. But ash clouds from its explosive volcanic activity were detected as far as Cambodia to the west and Australia to the south. It is feared that climatic conditions all over the world have been altered due to the volume of volcanic ash, heat and gasses released to the atmosphere by the eruptions.





Homes, churches, and public infrastructure buried under tons of debris and mud

Lahar and Pyroclastic Flows: Threat to Human Lives and Property

Lahar and pyroclastic flows from the slopes of Mt. Pinatubo pose continuing and grave danger to human lives and property in low-lying areas around the volcano, especially during the rainy season (May-October). Based on the average annual rainfall for the region, it is estimated that it will take 8-10 years to wash away some 5-7 cubic kilometers of pyroclastic materials still deposited on Mt. Pinatubo's slopes.

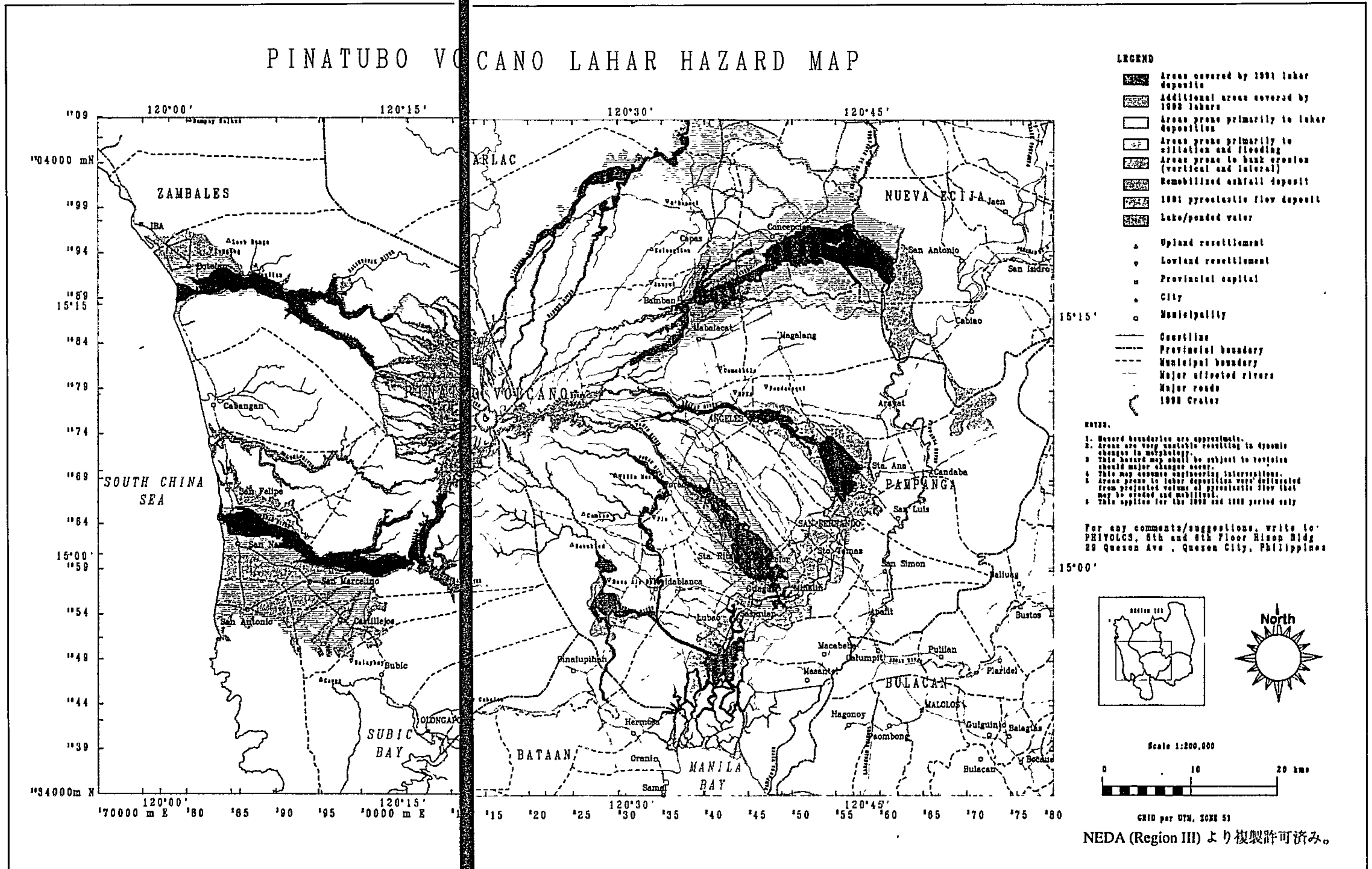
Pyroclastic flows are hot avalanches of volcanic fragments and hot gases that sweep downslope close to the ground with great speed, sometimes as fast as 100 kilometers per hour. These usually follow topographic depressions and rivers. Because of their high density, mobility, high temperature and abundant load of toxic gases, pyroclastic flows are fatal to nearly all lifeforms that lie along their path.

The pyroclastic flows produced during the June 1991 explosive eruptions, partly filled valleys and topographic depressions around the volcano with debris as much as 200 meters thick. Emplacement temperatures of the pyroclastic flows are estimated to be around 600 degrees.

DATA ON PYROCLASTIC DEPOSITS

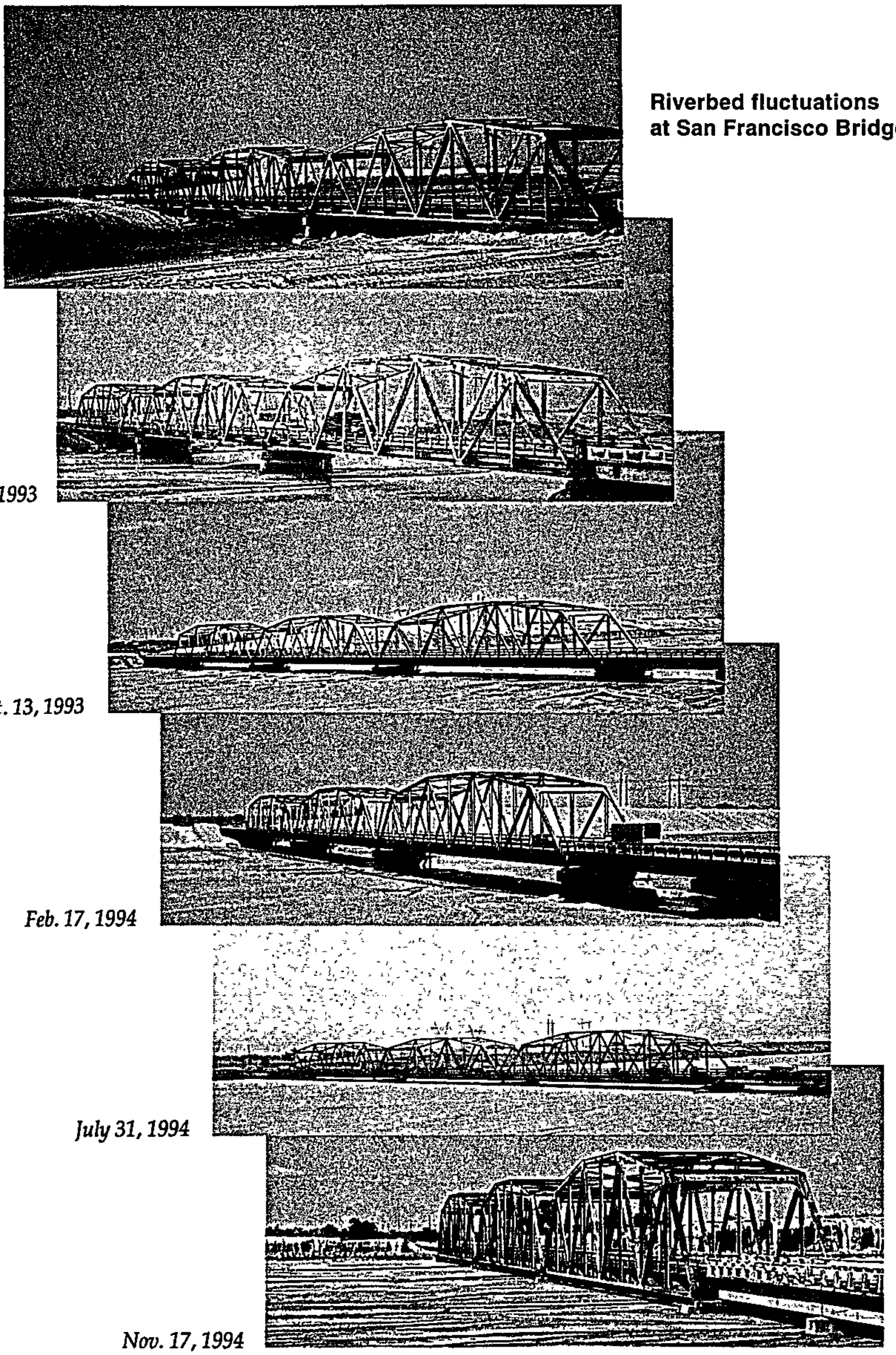
Drainage System	Drainage Area (Approx. in Km^2)	Estimated Volume of Pyroclastic Deposits (in Km^3)*
O'donnell	360 (San Luis)	300 - 1,000
Sacobia-Bamban	230 (Chico R. Junction	600 - 900
Abacan	80 (Mexico)	100 - 200
Pasig-Potrero	110 (Bacolor)	300 - 500
Porac/Gumain	310 (Cabancalan)	30 - 100
Santo Tomas	310 (San Felipe)	1,000 - 1,300
Bucao	660 (Botolan Br.)	2,500 - 3,100
Total	2,060	4,800 - 7,100

* Estimates given by PHIVOLCS



Source: National Economic and Development Authority (NEDA) Regional Office III and Philippine Institute of Volcanology and Seismology (PHILVOLCS)

Lahar Hazard Map



Riverbed fluctuations at San Francisco Bridge

Feb. 18, 1993

July 21, 1993

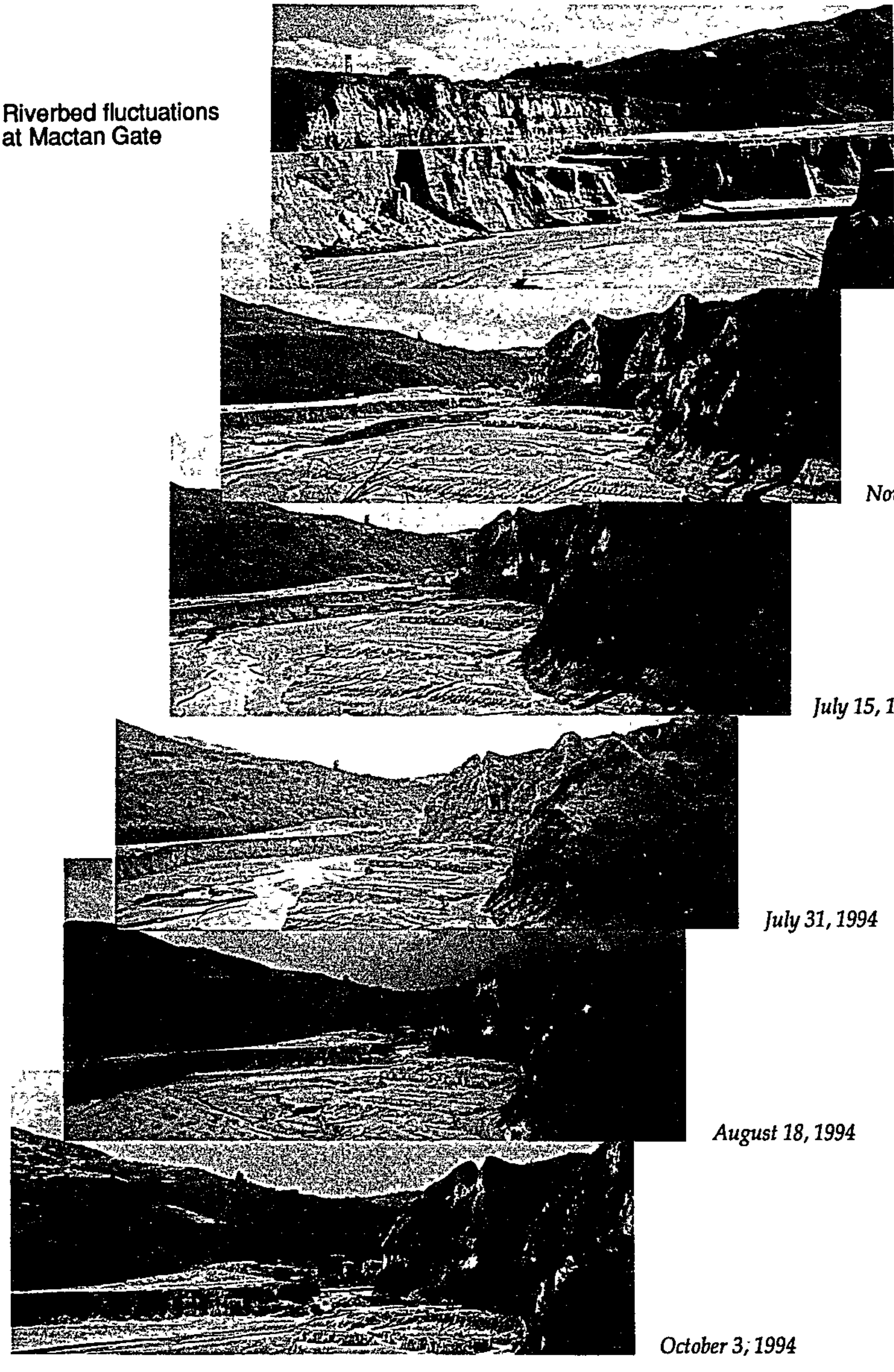
Oct. 13, 1993

Feb. 17, 1994

July 31, 1994

Nov. 17, 1994

Riverbed fluctuations at Mactan Gate



Feb. 25, 1993

Nov. 29, 1993

July 15, 1994

July 31, 1994

August 18, 1994

October 3, 1994

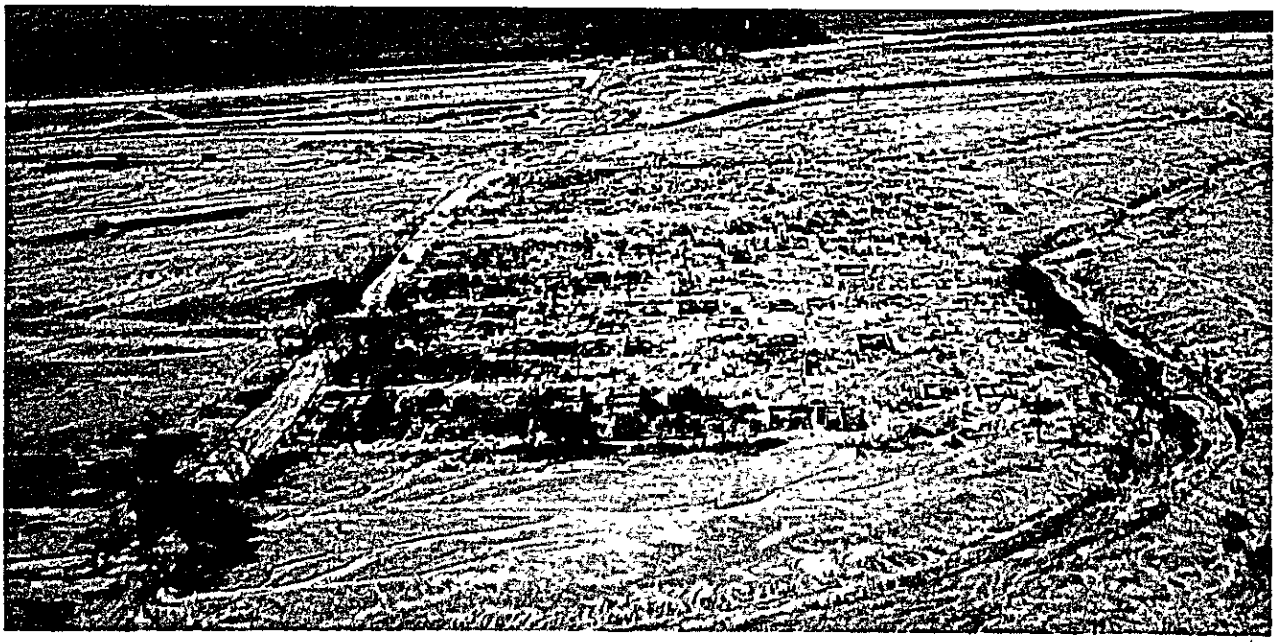
Cost of Damage

The massive damage caused by the Mt. Pinatubo eruptions and the lahar flows that followed was placed at P10.6 billion at the end of 1991. The heaviest toll was on public infrastructure, including power, telecommunications, water resources and school and health facilities, estimated at P3.8 billion. Losses to agriculture was estimated at P1.8 billion; to commerce and industry, P851 million; and natural resources, P120 million.

The total cost for relief operations, evacuation and resettlement, rehabilitation and reconstruction was estimated at P30 billion (US$1.034 billion). The cost of reconstruction and rehabilitation alone of vital public infrastructure like roads, bridges and other facilities was placed at P9.5 billion. About 489 kilometers of major national roads and 163 kilomters of municipal roads in Pampanga, Zambales, Bataan and Tarlac, were covered under 6-12 inches of ash and sand.

Six major bridges, namely Abacan, Pandan (Sapang Maraqui), Mancatian and Pabanlag in Pampanga, and Sta. Fe and Umaya in Zambales collapsed immadiately after the eruption. Later, lahar flows destroyed the Bamban bridge in Tarlac, and a portion of Capaya bridge along the North Expressway in Angeles City. Two bridges along the Botolan-Capas road in Botolan, Zambales were inundated while the approaches of several bridges were also damaged. In all, 13 major bridges were destroyed or damaged.

Spans of four railway bridges in Angeles, Dau and between Mabalacat and Bamban were washed away by cascading lahar. Ten telegraph stations in Zambales, 13 in Pampanga, and 3 in Tarlac had either collapsed buildings or damaged telecommunication and office equipment and telephone lines.



Highways and river systems are covered with 1 to 12 feet of volcanic debris.

Summary of Damage

(Public Infrastructure)

Sector/Facility	Amount (In Thousand Pesos)	Percent Share
TRANSPORTATION	1,149,908	30.00
Roads and Bridges	1,064,908	27.79
1. National System	797,588	20.81
- Roads	180,064	4.70
- Bridges	617,524	16.11
2. Local Roads and Bridges	267,320	6.98
- Provincial City	79,914	2.09
- Municipal	44,680	1.17
- Barangay	142,726	3.72
Railway Facilities	70,000	1.83
Airport Facilities	15,000	0.39
COMMUNICATION	13,215	0.34
Telecommunications Facilities	11,625	0.30
Postal Communications Facilities	1,590	0.04
POWER AND ELECTRIFICATION	54,918	1.43
NPC Facilities	7,627	0.20
Electric Cooperatives	47,291	1.23
WATER RESOURCES	1,568,642	40.93
Water Supply Facilities	122,957	3.21
1. Water District Facilities	116,927	3.05
2. Level I systems	6,030	0.16
Irrigation Facilities	184,311	4.81
1. National Irrigation Sytems	66,209	1.73
2. Communal Irrigation Systems	118,102	3.08
Flood Control/Drainage	1,261,374	32.91
SOCIAL INFRASTRUCTURE	1,045,708	27.29
School Buildings	748,102	19.52
Health Facilities	70,660	1.84
LTO Buildings	1,396	0.04
Other Public Buildings/Structures	225,550	5.89
Grand Total	3,832,390	100.00

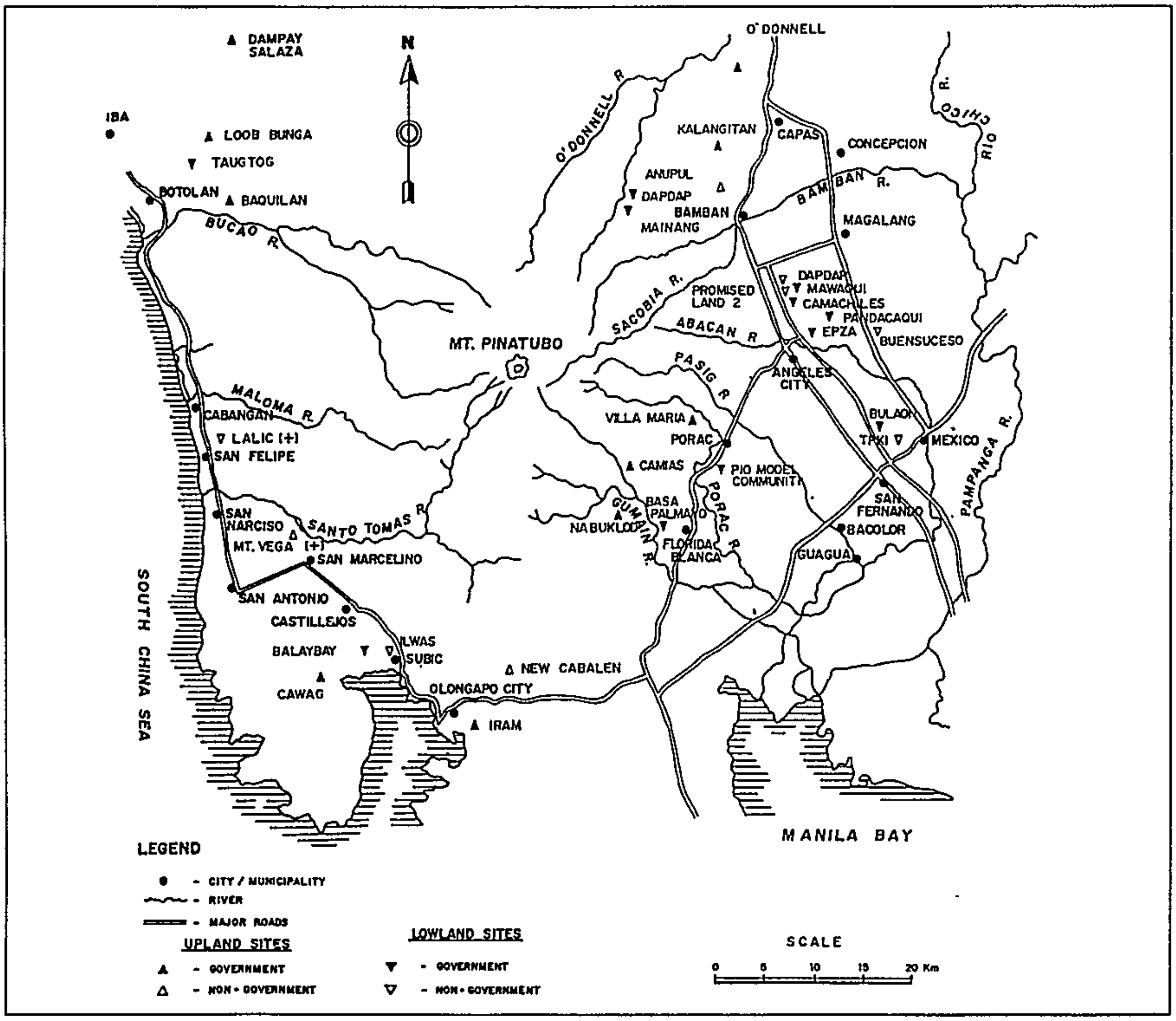
Source: Regional Task Force Secretariat/NEDA Regional Office III.

Relief and Resettlement

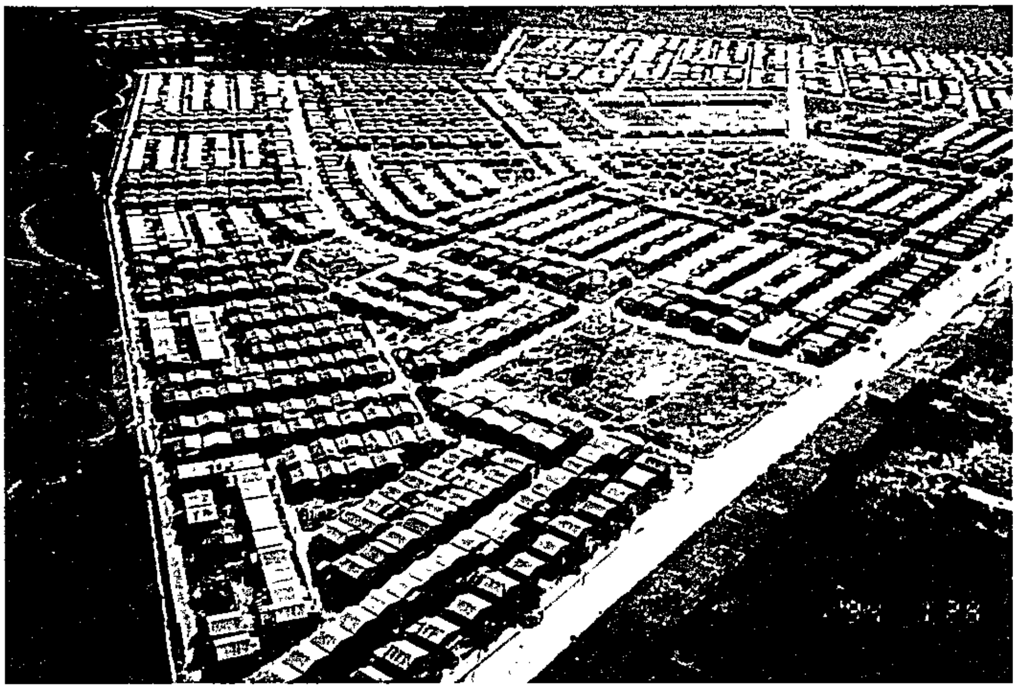
Immediately after the volcanic eruptions, on June 26, 1991, then President Corazon C. Aquino issued Memorandum Order No. 369 creating the Task Force on the Rehabilitation of Areas Affected by the Eruption of Mt. Pinatubo and Its Effects, called "Task Force Mt. Pinatubo" for short.

Subsequently on October 20, 1992, President Fidel V. Ramos signed into law Republic Act No. 7637 creating the Mt. Pinatubo Assistance, Resettlement, and Development Commission, also known as the "Mt. Pinatubo Commission" (MPC). On December 8, 1992, the MPC took over the functions of "Task Force Mt. Pinatubo."

As of May 1992, direct food, health and livelihood assistance had been extended to some 1 million persons, representing about 250,000 families. A massive relief and resettlement program was implemented both for the Aetas, an ethnic group living on the slopes of Mt. Pinatubo, and heavily affected lowland communities. As of the end of 1993, a total of 34 resettlement sites for the Mt. Pinatubo displaced victims have been established in Pampanga (15), Zambalales (8), Tarlac (6), Nueva Ecija (3), and two (2) offsite resettlements in Mindoro and Bukidnon. Of these, 21 are classified as lowland, and the rest are upland resettlements.



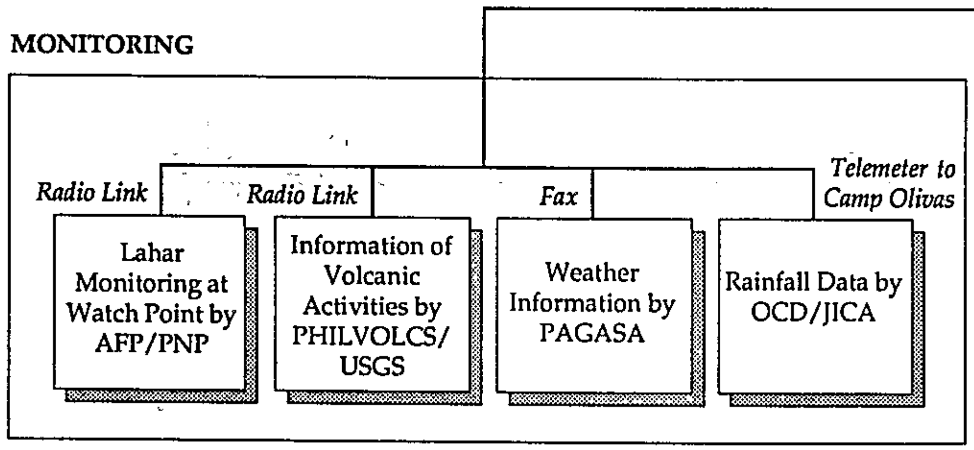
Location of resettlement areas
Source: Mount Pinatubo Commission

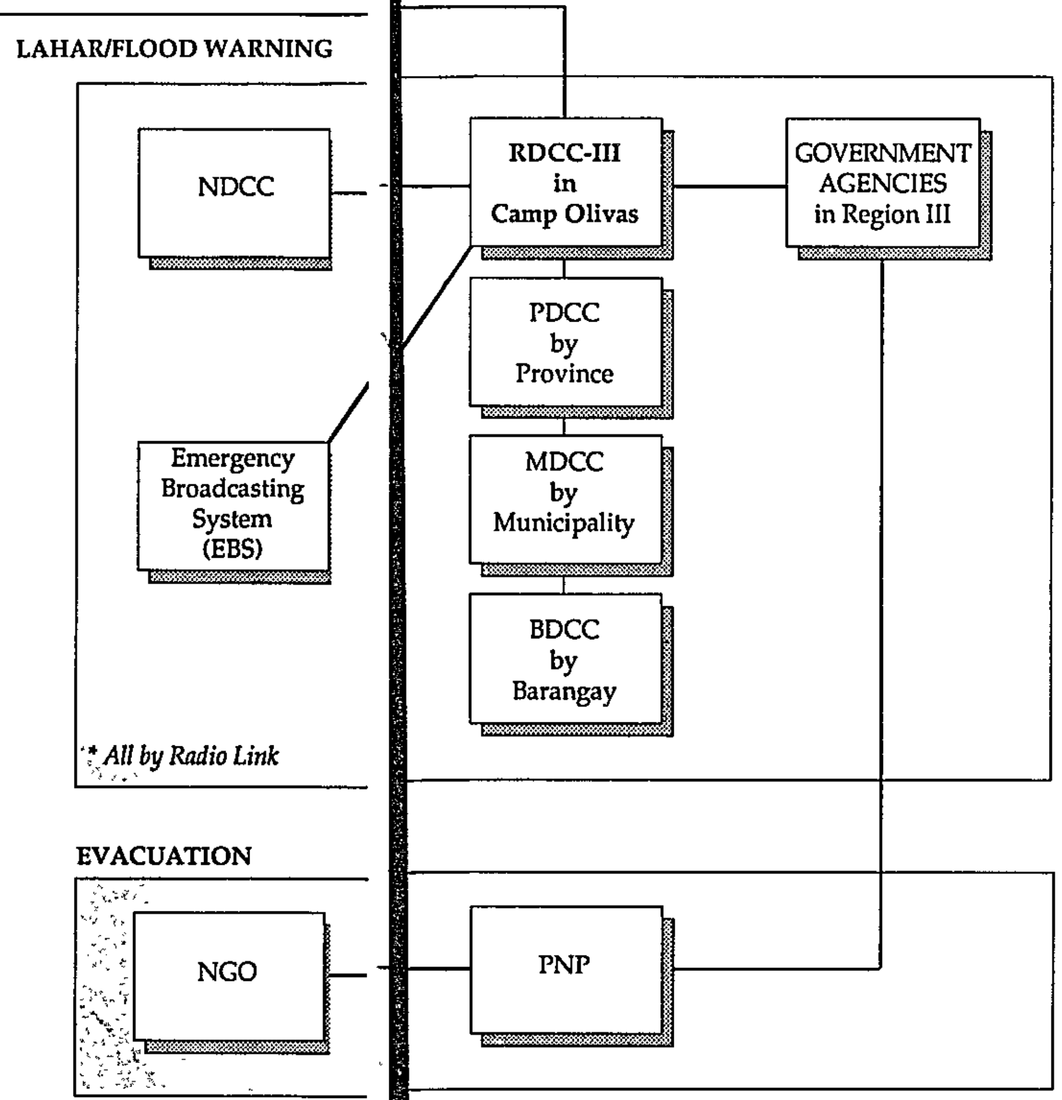


Resettlement village in Pampanga.

Lahar Flood Monitoring/ Warning System

An elaborate lahar flood monitoring and warning system has been set up among various government and non-government organizations to ensure maximum safety and security for residents in the affected areas. At the nerve center of the system is the Regional Disaster Coordinating Council (RDCC) Regional Office based in Camp Olivas, Pampanga.

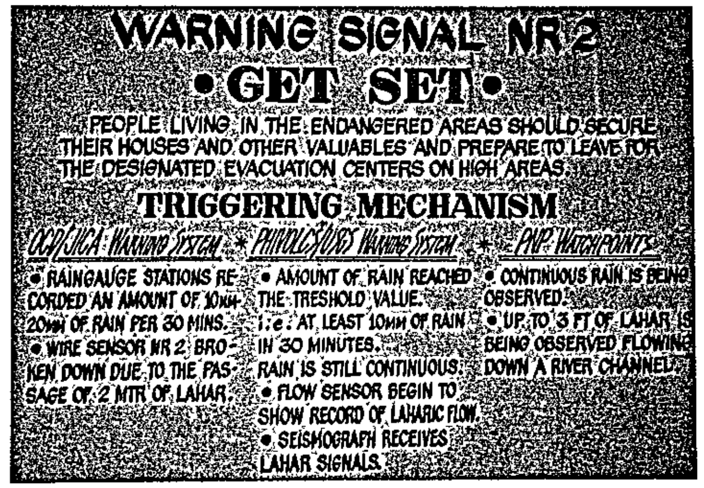




ACRONYMS:

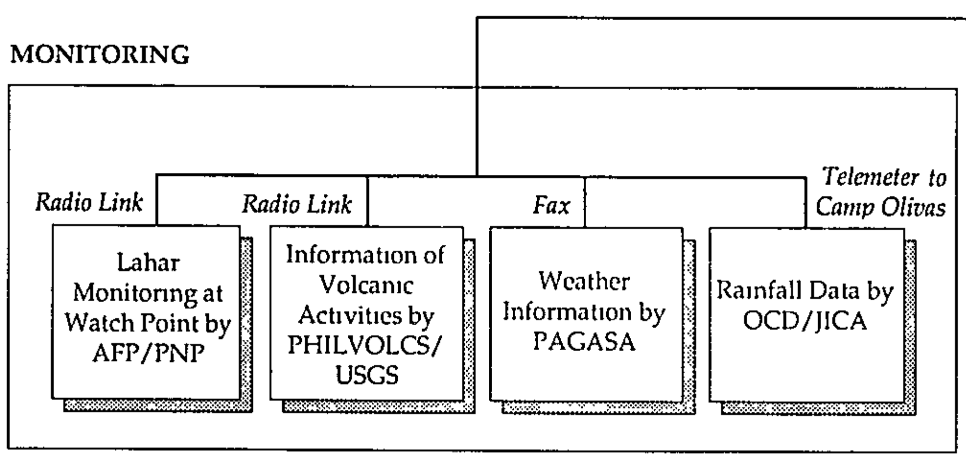
PNP	-	Philippine National Police
PHILVOLCS	-	Philippine Institute of Volcanology and Seismology
PAGASA	-	Philippine Atmoshperic, Geophysical and Astronimical Services Administration
OCD	-	Office of Civil Defense
NDCC	-	National Disaster Coordinating Council
RDCC-III	-	Regional Disaster Coordinating Council
PDCC	-	Provincial Disaster Coordinating Council
MDCC	-	Municipal Disaster Coordinating Council
BDCC	-	Barangay Disaster Coordinating Council
NGO	-	Non-Government

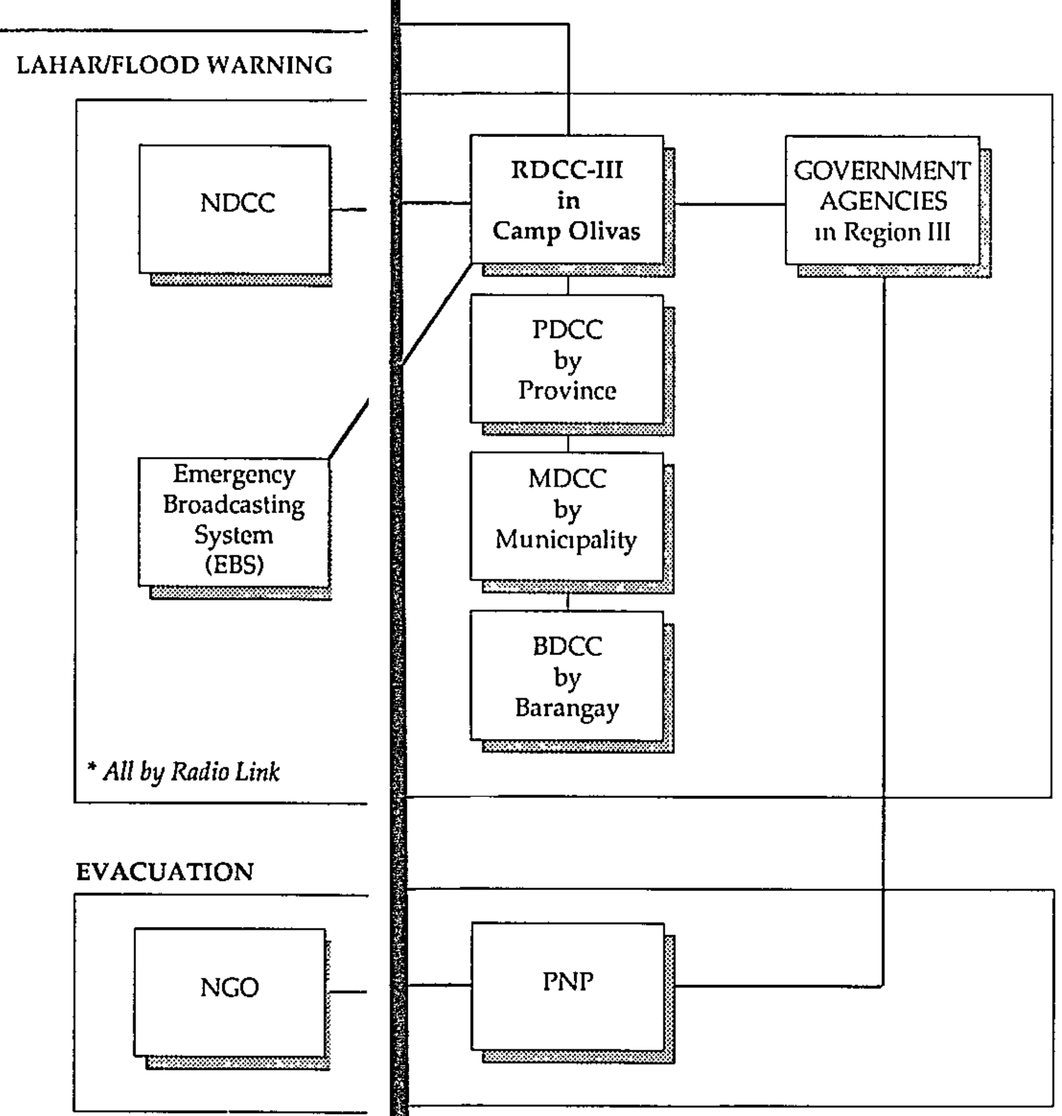
Bulletin boards like these, as well as radio and television announcements and leaflets are used to instruct residents of necessary precautionary measures to be taken in case of danger due to lahar floods.



Lahar Flood Monitoring/ Warning System

An elaborate lahar flood monitoring and warning system has been set up among various government and non-government organizations to ensure maximum safety and security for residents in the affected areas. At the nerve center of the system is the Regional Disaster Coordinating Council (RDCC) Regional Office based in Camp Olivas, Pampanga.

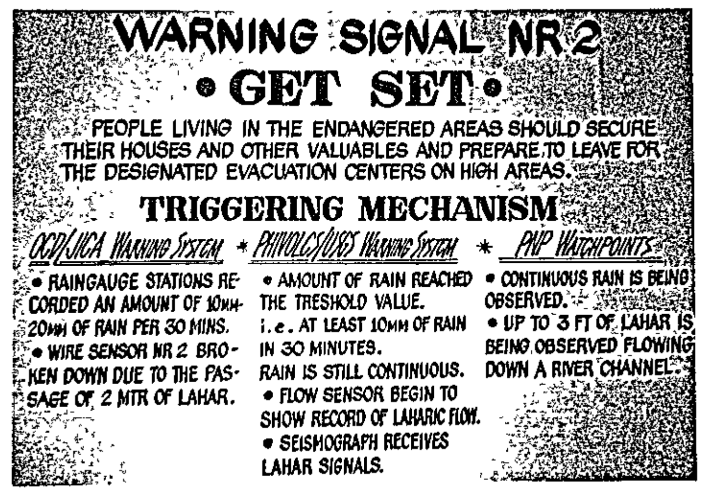


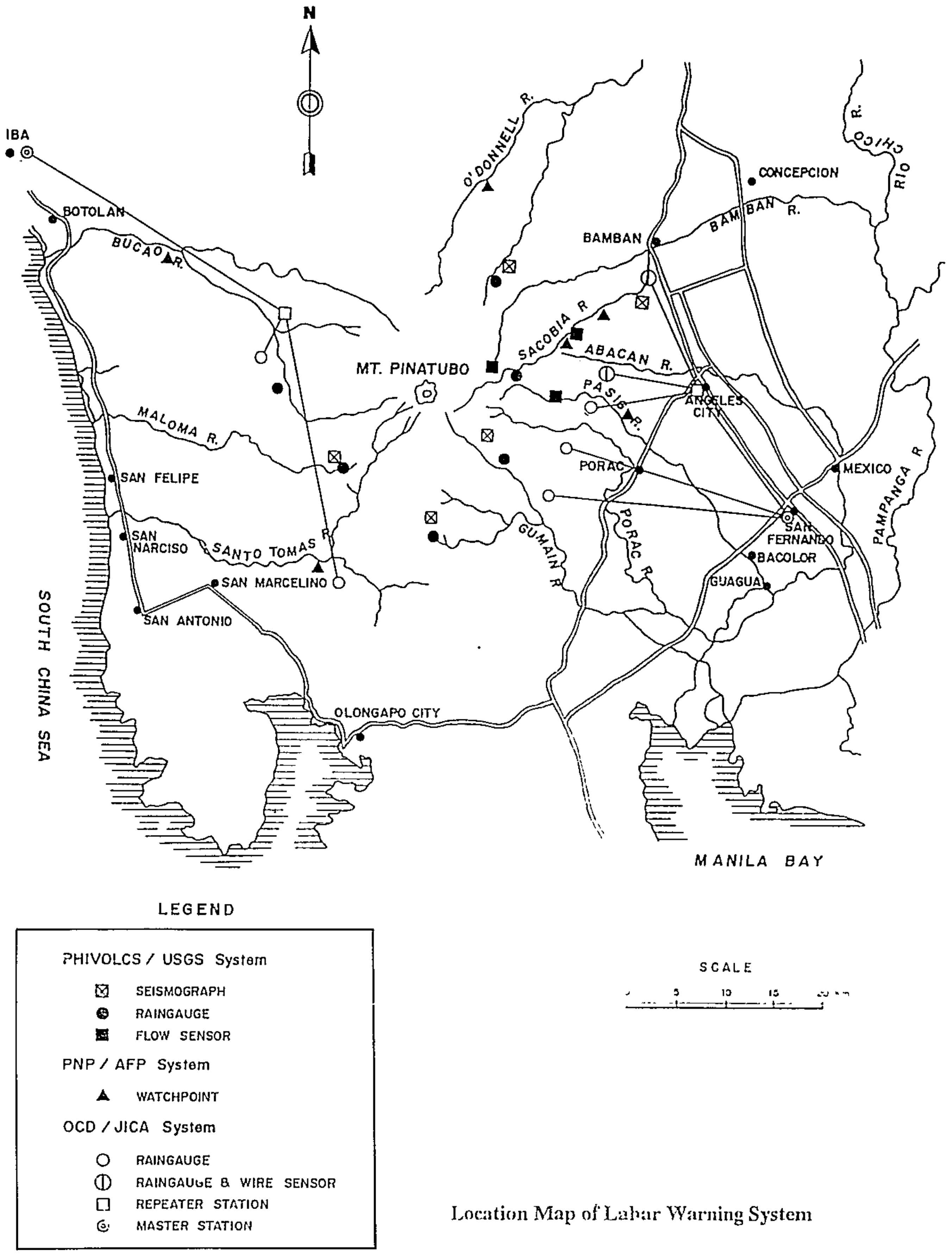


ACRONYMS:

PNP	-	Philippine National Police
PHILVOLCS	-	Philippine Institute of Volcanology and Seismology
PAGASA	-	Philippine Atmoshperic, Geophysical and Astronimical Services Administration
OCD	-	Office of Civil Defense
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

Bulletin boards like these, as well as radio and television announcements and leaflets are used to instruct residents of necessary precautionary measures to be taken in case of danger due to lahar floods

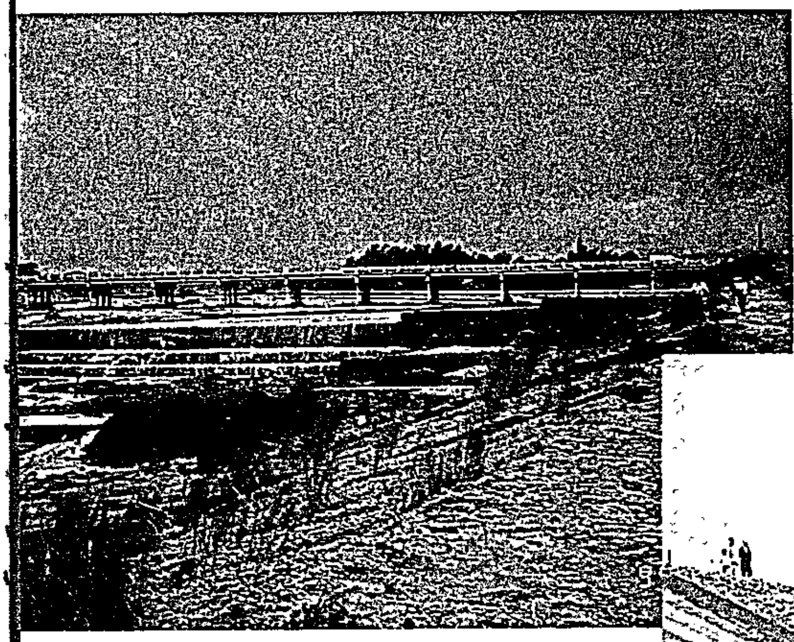




Location Map of Lahar Warning System

Rehabilitation and Reconstruction

Based on an assessment made during the Mt. Pinatubo Multisectoral Consultative Congress held last December 7, 1993 at the Development Bank of the Philippines in Makati, Philippines, initial efforts at the rehabilitation and reconstruction of Mt. Pinatubo affected areas have been largely successful. Priority was given to (1) keeping transport systems open to ensure the continuous flow of goods and services; (2) the protection of life, communities and infrastructures from further destruction; (3) rehabilitation of schools, health centers, telecommunications and other public facilities; and (4) support to resettlement, livelihood and other social services. The construction of protective dikes and other infrastructures were also reported to have been highly effective in mitigating lahar flows. Completed sabo dams and similar flood and lahar containing structures have been able to function as planned and designed.



Dike along the Bamban River

No. 9 Check Dam and Friendship Bridge along the Abacan River

Japanese Assistance

In June 1991, within a few days after the disaster struck, Japanese relief goods amounting to US$200,000 were immediately dispatched to the affected areas. Within the same month, the Government of Japan (GOJ) also immediately sent a survey team to the calamity area to assist the Philippine government in assessing the damage. From July to September of the same year, the GOJ donated and helped install a Lahar Warning System worth Y86 million (approx. US$ 9 M) in cooperation with the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the National Disaster Coordinating Council (NDCC), and other Philippine Government agencies.

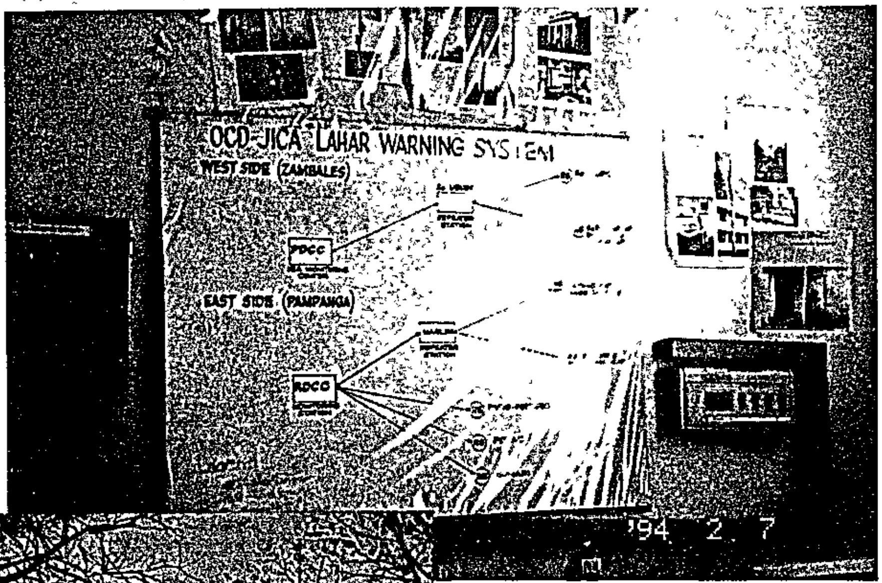
Total worth of Japanese aid, grants and technical services and assistance, including medical equipment and supplies, and public works and farm machineries, and a commodity loan (OECF) of Y25.380 billion extended by GOJ in connection with the calamity has now breached the US$5 billion mark.

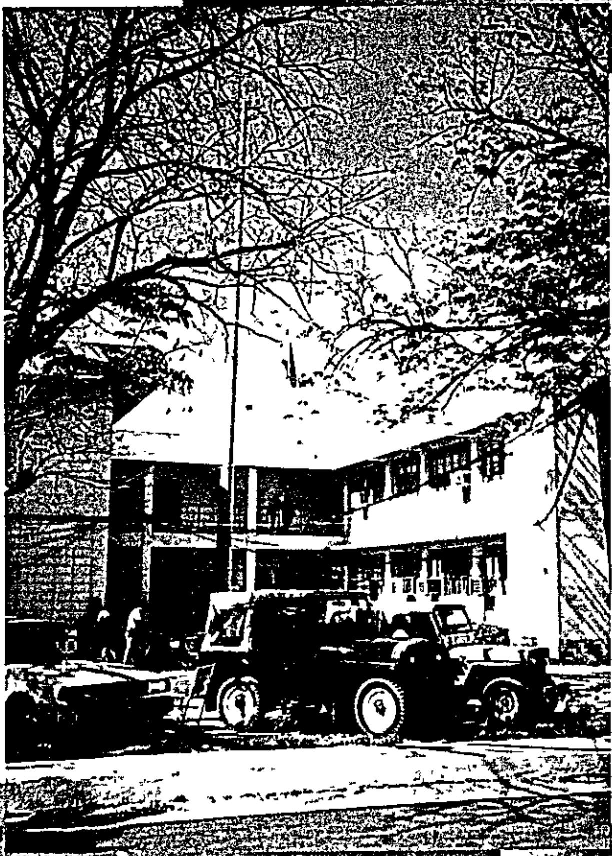
This amount does not yet include the cost of the on-going preparation of a Master Plan and Feasibility Study for flood and lahar control works in the Sacobia and Abacan Rivers, which started in November 1993 and is expected to be completed in March 1996.

GOJ Aid for Mt. Pinatubo Disaster Relief and Rehabilitation

1991	June	Donation of urgent disaster relief goods	$	0.49	million
	June	Survey of the extent of damage to agriculture			
	July-Sept.	Installation of Lahar Warning System	$	0.86	million
	July	Donation of Urgent Disaster Relief Goods	$	0.54	million
		Dispatch of 8 persons from JOCV	$	0.101	million
		Donation of medical appliances, and tractor, etc.			
	Sept-Nov	Survey of the bridges of local roads			
	Oct.	Survey of the damages for the irrigation project			
1992	Feb	Grant Aid			
		Donation of heavy equipment for the rehabilitation of damaged infrastructure	$	14.55	million
	June	Seminar/Workshop on Mt. Pinatubo Volcanic Disaster Migration and Debris Flow Control			
	Aug.	Minimizing Ash-Fall Deposition in the western Barrios	$	4.92	million
		Impounding Irrigation			
	Sept.	Urgent Disaster Relief Goods			
		Donation in Cash	$	0.20	million
		Donation in kind	$	0.15	million
	Sept.	Commodity Loan by OECF	$	253.8	million
1993	Jan	Dispatch of JICA Sabo expert			
	March	Project for Development of Shallow Groundwater for Irrigation Areas	$	5.80	million
	July	Urgent Water Supply Project for the Resettlement Area and Barangays	$	10.77	million
	Oct	Disaster Relief Program in cash	$	0.20	million
		Disaster Relief Program in kind	$	0.20	million
	Nov.	Implementation of the Master Plan and Feasibility Study for Flood and Lahar/Mudflow Control Works in Sacobia, Bamban, and Abacan Rivers			
1994	July	Water Supply in Mt. Pinatubo Resettlement Areas	$	2.65	million

Source: JICA



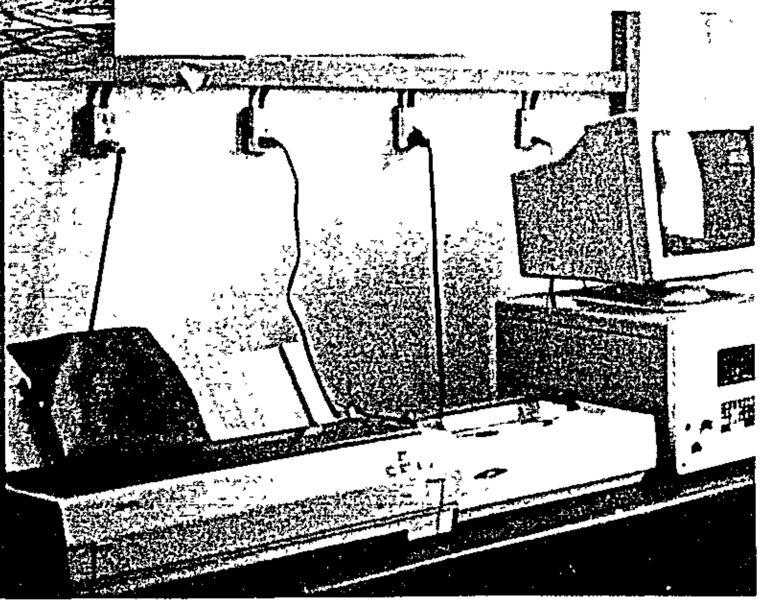


Top Photo: Chart of OCD-JICA - lahar warning system showing the specific location of the monitoring/repeater/ warning stations.

Middle Photo: Antenna of the RDCC Monitoring Station inCamp Olivas. Information from the different repeater/rain gauge and warning from the different stations are relayed to the monitoring stations through this antenna.

Right Bottom Photo: Monitoring equipment with standard accessories - installed in Camp Olivas, San Fernando, Pampanga (the other one is in Iba, Zambales)

Left Bottom Photo: Equipment for excavation of lahar deposits

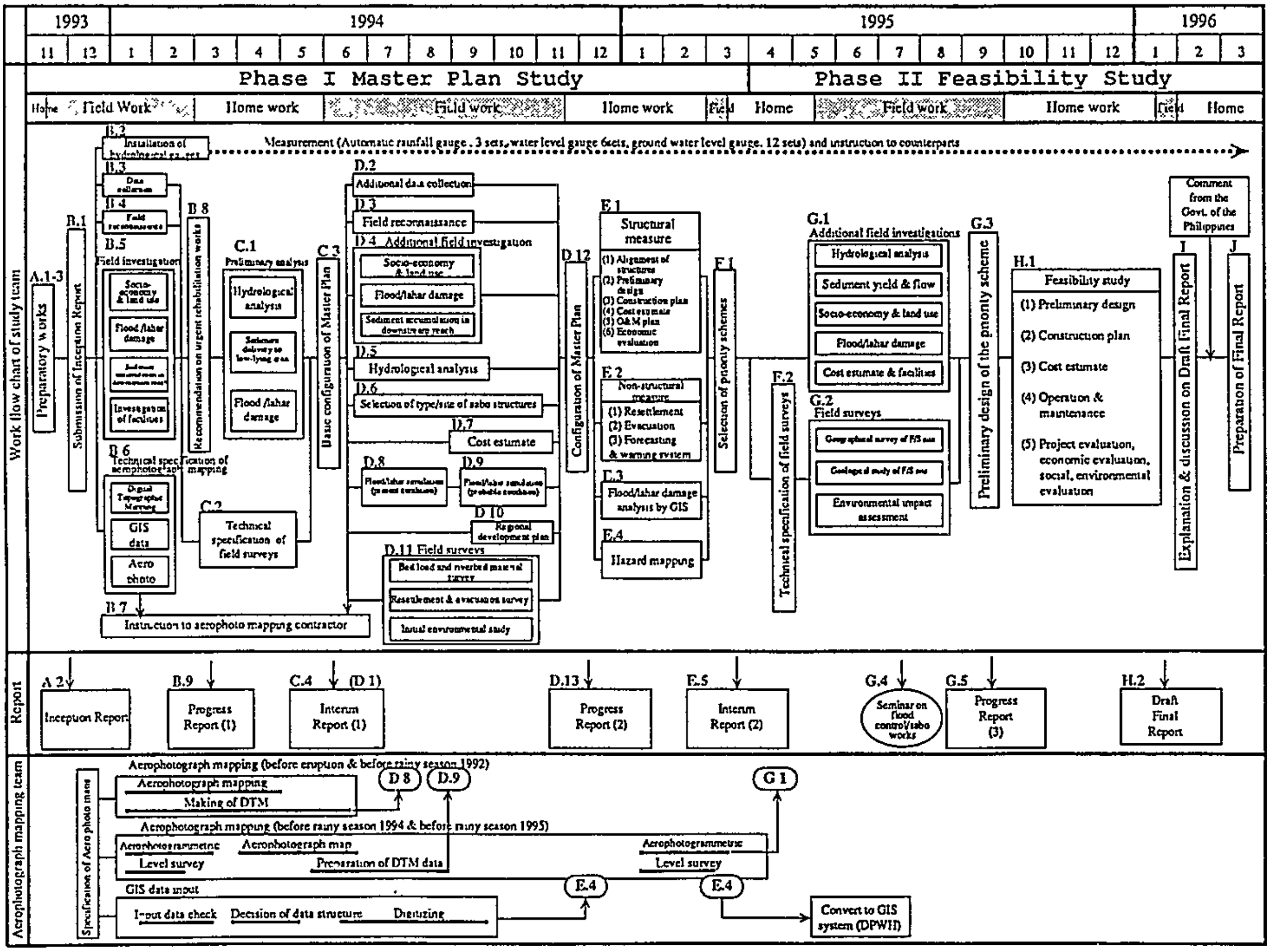


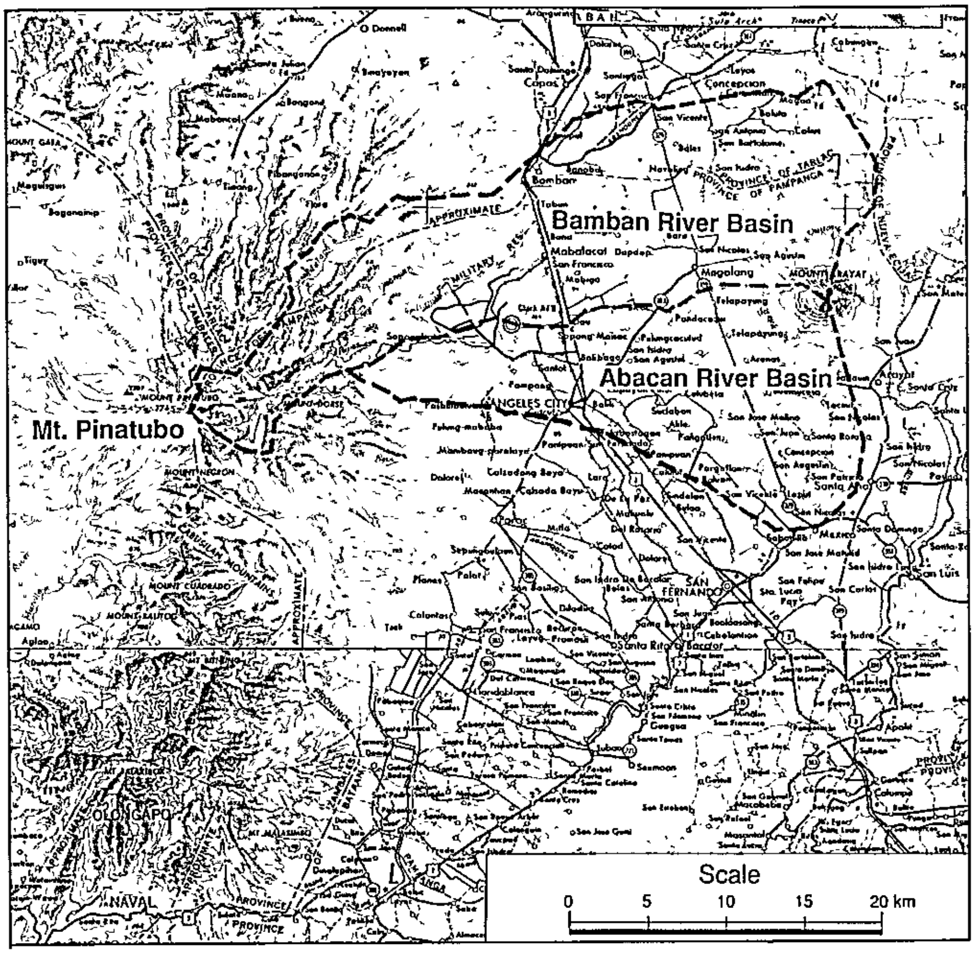
JICA Master Plan Study

Upon the official request of the Government of the Philippines, the Government of Japan agreed to organize a study team under the Japanese International Cooperation Agency (JICA) to conduct a Master Plan Study for flood and lahar control Works in Sacobia and Abacan rivers.

Master Plan and Feasibility Study

November 1993 - March 1996





Project Area

The Philippine Department of Public Works and Highways (DPWH) serves as the executing and coordinating agency for the study.

The specific objectives of the Study are as follows:

1. To formulate a master plan for the control of flood and mudflow in the Abacan and Sacobia-Bamban River Basins; and

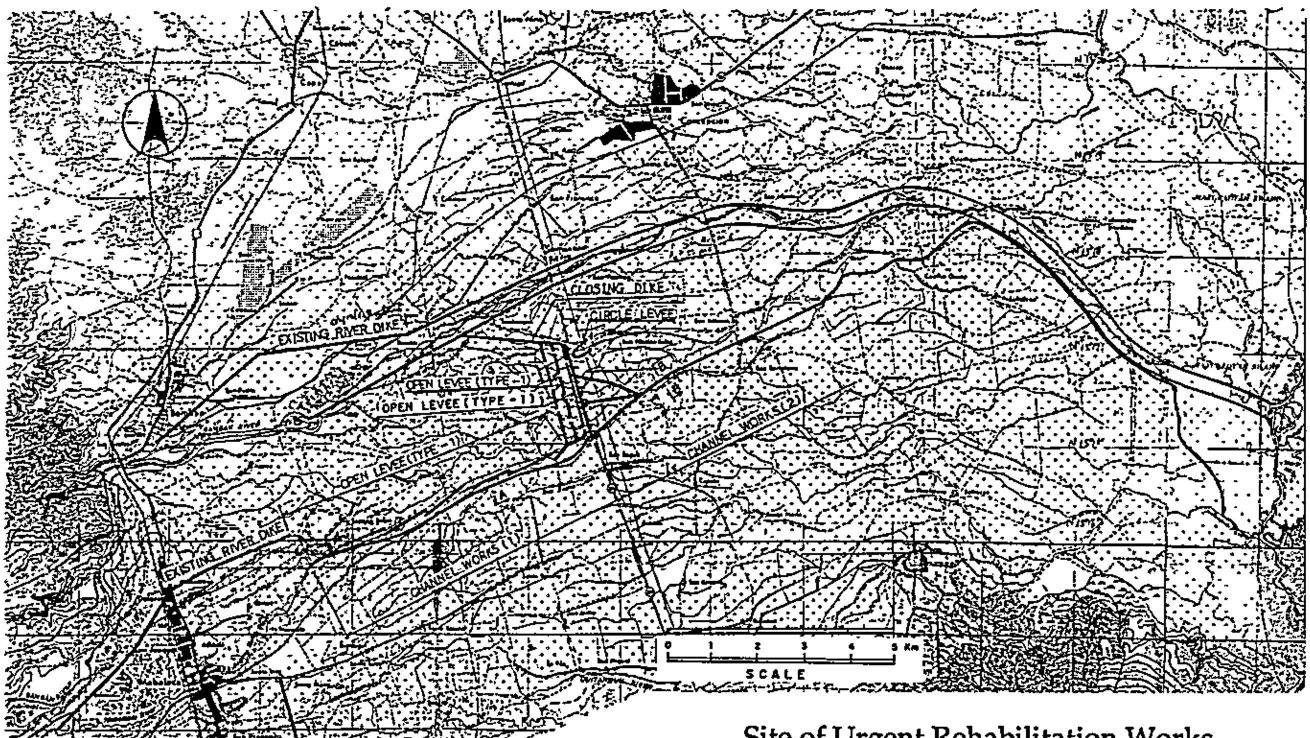
2. To identify and select urgent projects and conduct feasibility studies on the said projects.

Urgent Rehabilitation Works

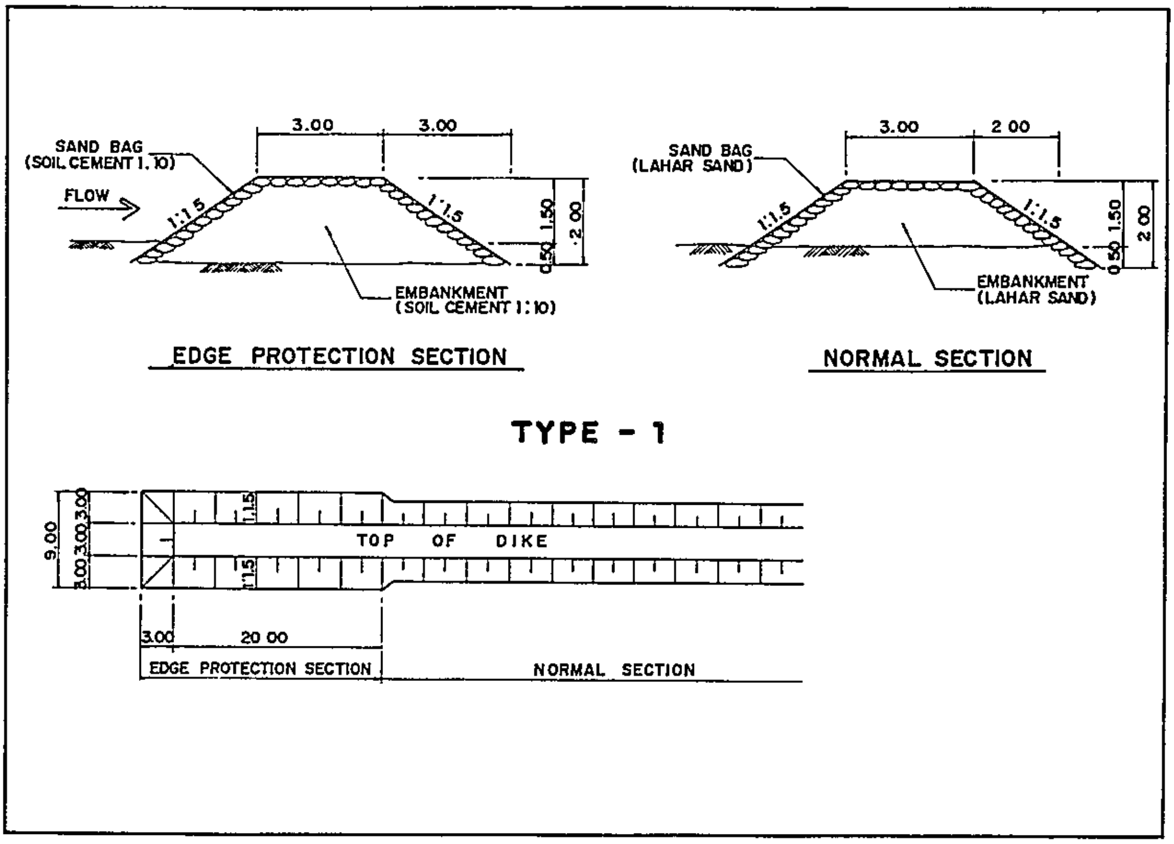
Initial rehabilitation of existing structures and other public works are being rushed in 1994 before the onset of the rainy season in May-June. These include (1) protection against severe mudflows along MacArthur Highway, Route 329, one of the main roadways connecting Metro Manila and the northern Luzon regions; and (2) prevention of mudflows from spreading over the areas already affected by providing sand-arresting levees.

Sabo facilities within the Bamban River Basin and the upper reaches of the Abacan River will also be rehabilitated. Enchancement of existing levees along the main stream of the Abacan and Bamban Rivers are also proposed to minimize further loss of lives and property within the affected areas.

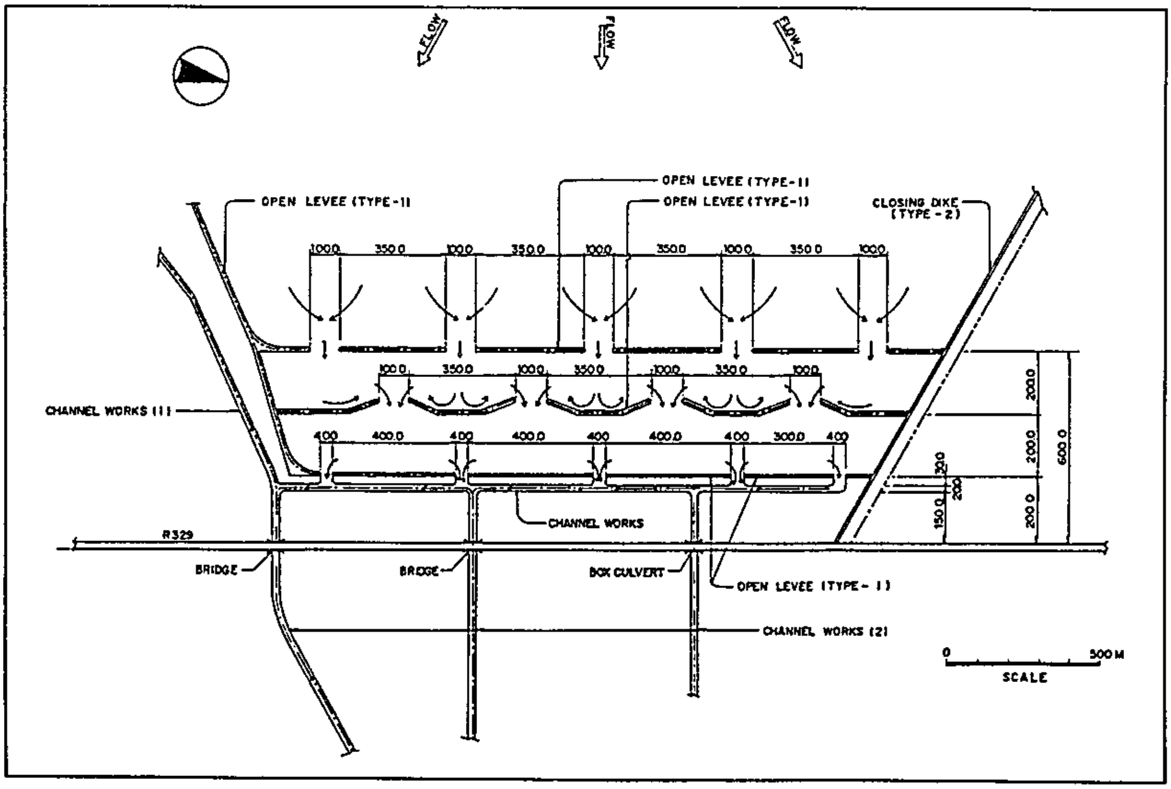
The facilities for immediate rehabilitation are not expected to differ very much from the those for redesign or reconstruction as a result of the Master Plan under study. Limitations of time and budget, as well as expected flood and lahar volume due to future natural conditions such as volcanic activity, river morphological changes and storms, will be the major determinants of the nature and extent of urgent rehabilitation work to be undertaken during the interim period.

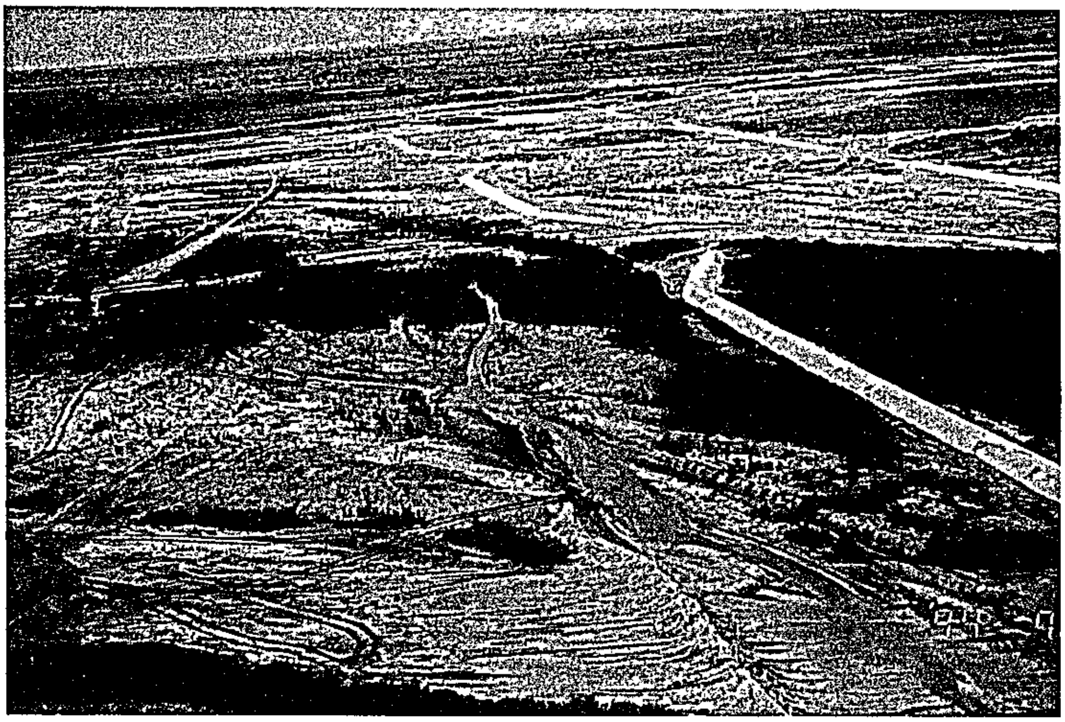


Site of Urgent Rehabilitation Works

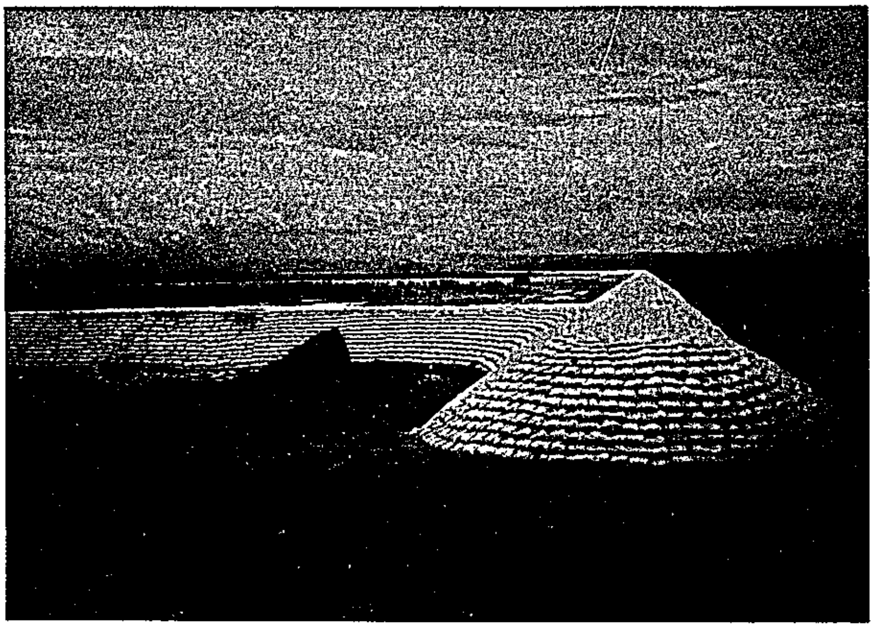


Detailed Design of Flood/Lahar Control Works





Sand pockets constructed along the Magalang-Concepcion Highway according to plans and design. These counter-measures functioned as envisioned.

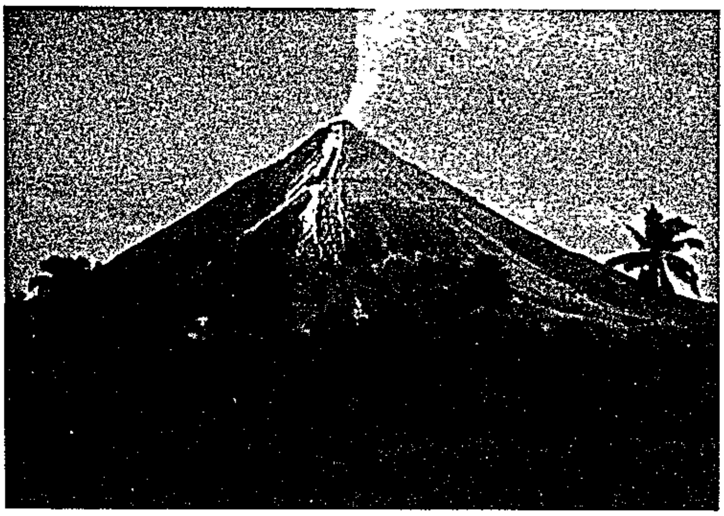


Sand pockets along the Magalang-Concepcion Highway

5. Mayon Volcano Sabo Works and Other Related Projects

5.1 Mayon Volcano in the Philippines

Mayon Volcano, which has the world's most perfect cone, is also the Philippines' most active volcano. It has an elevation of 2,469 meters and is located in the province of Albay at the Southeastern tip of Luzon. It is situated in a region most frequented by typhoons and heavy rains, especially during the months of August to November.



Mayon Volcano eruptions in 1993

Typhoon Daling in 1981 caused massive mud and other sediment flows on the southern slopes of the volcano leaving 159 persons dead and 52 missing. Mayon's eruption in September 1984, followed by heavy rainfall, further precipitated large-scale debris flows causing heavy damage to infrastructure and property.

5.2 The Mayon Volcano Eruptions

On February 2, 1993, Mayon Volcano again erupted causing pyroclastic flows along the Bonga Gully at its southern sector. This was followed by other smaller pyroclastic and debris flows on February 12 and 13 and again on March 3, 1993.

Mayon's explosive eruptions on March 21, 1993 started at 7:00 A.M., with light gray ash-laden columns rising to heights ranging from 2.5 to 5 kilometers above the rim. These were followed by large emissions of lava and numerous ash puffs. These continued intermittently until April 27 when volcanic activity intensified, with strong emissions of steam and the continuous flow of lava along the Bonga Gully. These were accompanied by the continued occurrence of audible rumbling sounds and low frequency volcanic earthquakes that lasted for several months.

Although the alert level in the area has since been lowered, low frequency earthquakes and intermittent ash puffs, crater glow, and lava trickles have continued, indicating high unrest which could trigger explosive eruptions any time.

5.3 *History of Master Planning and Sabo Works in the Mayon Area*

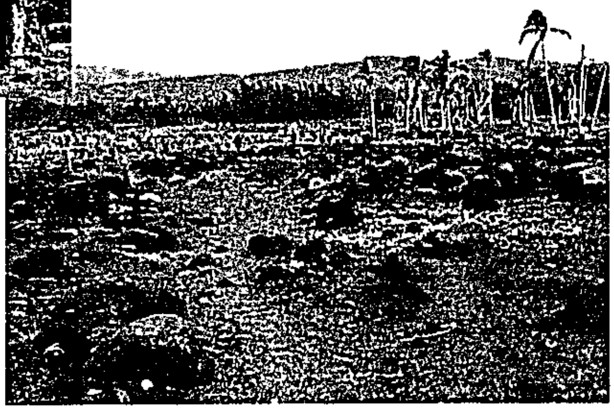
The above-described situation basically characterize Mayon's volcanic activities over the decades. Its most destructive activity was recorded in 1840 when the whole community of Cagsawa in Daraga, Albay was completely buried. The only remnant of that disaster is the belfry of a Spanish-built church which now serves as a tourist attraction with the majestic near-perfect cone of Mayon volcano as the backdrop.

Cagsawa Church was buried by a Mayon Volcano eruption in 1840. Only the Church belfry remains visible to this day

The potential threat to human lives and property in and around Mayon's vicinity has therefore prompted the Philippine Government to request last August 1977 for Japanese Government assistance for the preparation of a master plan to prevent or mitigate similar disasters that may occur in the future.

From the study conducted in 1978-1979, a master plan was submitted to the Philippine Government in March 1981. The Plan included detailed designs for Sabo works and river-flow control and irrigation works in areas around the volcano which are prone to mud and debris flows. However, due to lack of funds, no significant disaster control measure had been undertaken based on this initial Plan.

Following the disaster caused by Typhoon Daling in 1981, a Re-Study of the Mayon Volcano Sabo and Flood Control Project was made with Japanese assistance. The Plan submitted in March 1983 by the Japanese Study Team provided the basis for the start of Sabo works in the area. Again, due to lack of funds, only small-scale Sabo facilities were undertaken by the regional office of the Department of Public Works and Highways (DPWH). These facilities, described as mere stop-gap measures, consisted of temporary spurdikes, earthdikes revetments, consolidation dams, ground sills, boulder dikes, spillways, and some water channeling and dredging works which proved inadequate in mitigating the disasters that occurred in 1993.



Budiao river turned surrounding area into a valueless devastated land due to mud and debris

5.4 *The 1993 Mayon Volcano Survey Report*

The disaster that occurred following Mayon's explosive eruptions in February 1993 again prompted the Philippine Government to request for further technical assistance from the Japanese Government. The Survey Report submitted in March 1993 by a composite DPWH and Japanese Study Team strongly recommended the full implementation of the 1983 Master Plan, with some modifications. These modifications were due to the considerable changes in Mayon's topography following the February 1993 eruptions and the massive lava and pyroclastic flows that pose grave danger to Legaspi City in Albay.

Lava flow deposits from Mayon Volcano

Bonga Gully after massive debris flow

The 1993 Survey Report further recommended the implementation of a Lahar and Flood Warning System, a Relocation and Resettlement Plan for affected residents in the vicinity, and the conduct of Sabo Works seminars. The Study Team then felt that technology transfer on Sabo Works planning and detailed engineering design was necessary to develop a corps of Filipino Sabo experts and engineers.

In addition to the foregoing, the Survey Report also recommended the following:

a. **Review of past surveys,** studies and plans, especially on the need to prepare new engineering designs;

b. **Topographic survey,** to include topographic mapping of major construction sites in a scale of 1:500, with contour interval of 0.2 meters, and aereal photo mapping in a scale of 1:25,000;

c. **Meteo-hydrological investigation,** that will include the collection of stream flow data and water and river deposit sampling and the conduct of laboratory tests for sediment transport analysis;

d. Geo-technical studies, which will include:

- core-boring operations and the conduct of standard penetration tests and examination of undisturbed portions of existing Sabo facilities in the area;
- identification of prospective borrow areas for embankment materials and survey sites for concrete aggregates;
- execution of test pitting and sampling in borrow areas and quarry sites;
- conduct of laboratory tests to determine the design requirements for foundation and embankment materials.

e. Hydrological analysis, to include:
- review of depth-area-duration analysis of rainfall in the area;
- calibration of flood and mud flow simulation model with or without the Sabo structures;
- estimation of pyroclastic and debris flow deposits.

f. Analysis of the extent of damage caused by past floods and pyroclastic and debris flows;

g. Structural design, including the:
- determination of the flow capacity of river channels and gullies under existing conditions and the flood and debris flow control effects of proposed designs;
- assessment of the technical and economic feasibility, as well as the socio-economic implication of the proposed plan and detailed designs.

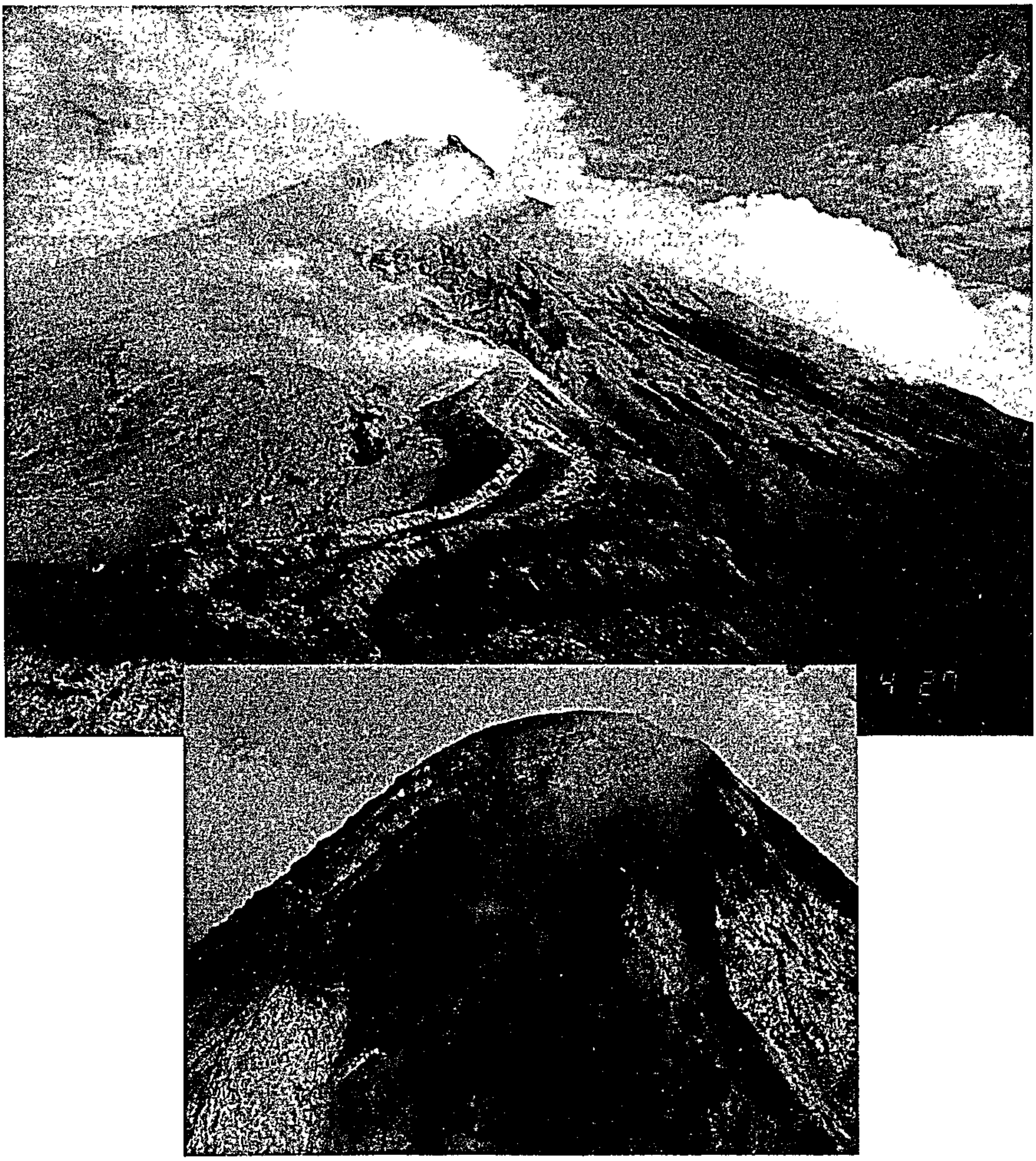
h. Review of existing institutional system for watershed management, land use, and government and private organizations involved in emergency relief, evacuation and resettlement operations;

i. Investigation of the present conditions of existing structures in the area such as bridges, weirs, etc., especially in debris flow vulnerable areas;

j. Socio-economic studies, including demographic and livelihood conditions in the area; and

k. Data collection on prices and availability of construction materials and the availability and technical capability of local contractors.

Sabo facilities along Arimbay River



Mayon Volcano crater

6. Other Urgent Sabo Requirements

While special attention has been given to areas around the Mt. Pinatubo and Mayon Volcano areas in the construction of Sabo and other disaster prevention projects, a number of other areas in the country, particularly in Luzon, also require urgent debris and other sediment control measures.

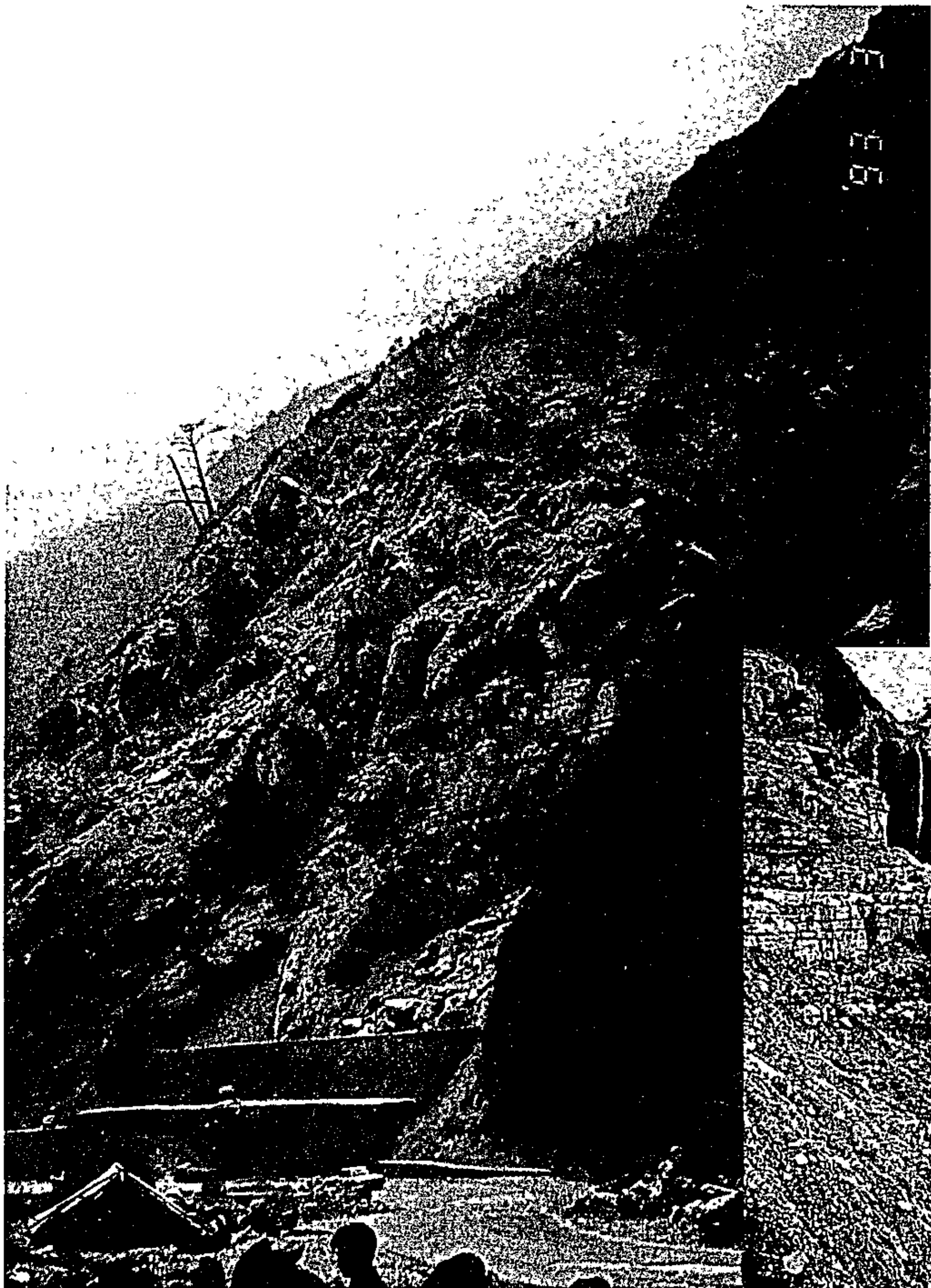
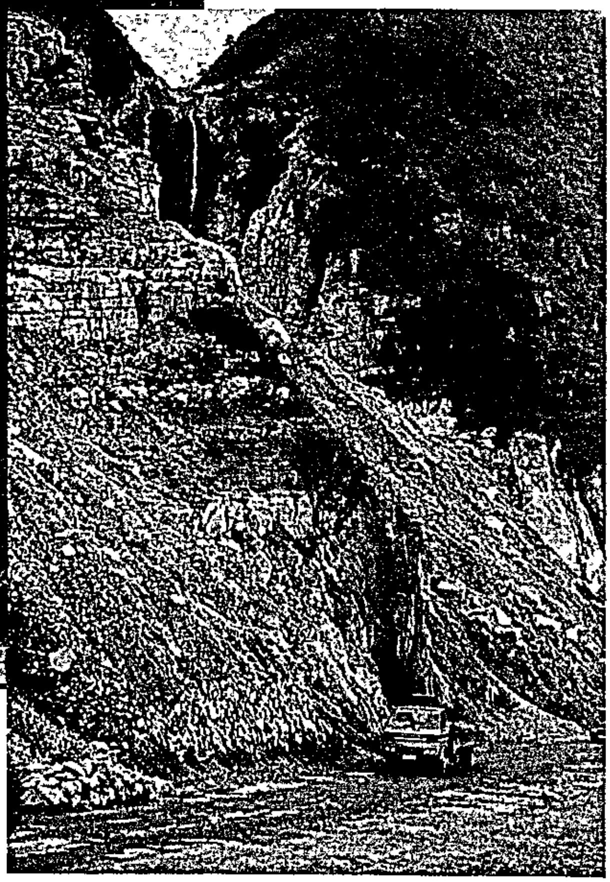
Sediment disasters pose grave danger to existing dams and highways

A number of such areas are prone to serious sediment problems which could lead to disaster and possible loss of lives and property if no immediate and timely interventions are instituted. Hence, in January 1994, President Fidel V. Ramos ordered all concerned agencies to conduct an extensive preliminary study for the implementation of necessary countermeasures to protect existing infrastructure facilities in the upstream of Magat Dam or restore them to at least their previous levels of effectivenss.

Other cases in point are the upstream areas of San Roque in the Agno River Basin, Talavera River close to the Pantabangan Dam and Kennon Road towards Baguio City.

Debris and sediment flows and landslides in these areas pose grave danger not only to nearby communities, but also to the dams, roads, bridges and other large infrastructures themselves. Heavy siltation of the dams mentioned due to unhampered sediment flow from upstream areas have severely affected these infrastructure facilities. Hence, timely intervention through the construction of needed Sabo facilities and other sediment and landslide mitigating works could prevent further disasters.

Other measures could include restoration of the effective storage capacities of the dams which are now seriously affected by heavy siltation. Frequent landslides along the Kennon Road has also rendered this scenic and historic roadway to the country's Summer Capital impassable to heavy vehicles.

Seriously devastated areas requiring urgent Sabo projects

Part V: List of References

1. Ministry of Construction-Infrastructure Development Institute, Japan, "Disaster Prevention in Japan," 1990

2. The Erosion Control Engineering Society of Japan, "Erosion Control Works in Japan," 1985

3. Sediment Control Department, River Bureau, Ministry of Construction, Japan, "Protecting Comfortable and Healthy Lives," Japan

4. Ohsumi Work Office, Ministry of Construction, Japan, "Debris Flow at Sokurajima," 1988

5. Sediment Control Department, Ministry of Construction, Japan, "Eruption of Mt. Fugendake of Unzen and Volcanic Sabo Projects," July 1992

6. Sediment Control Department, Ministry of Construction, Japan, "Debris Flow and Pyroclastic Flow Caused by the Eruption of Mt. Unzen, Prompt Report," July 1991

7. JICA and DPWH SURVEY TEAM, "Survey Report on the Mayon Volcano Eruption of February 1993," May 1993

8. T.C. Pierson, R.J. Janda, J.V. Umbal and A.S. Daag, "Immediate and Long-term Hazards from Lahars and Excess Sedimentation in Rivers Draining Mt. Pinatubo, Philippines," USGS

9. T. Koyaguchi, "Volume Estimation of the Ejecta of Pinatubo 1991 Eruption by Means of Fluid Dynamics Model and Geological Methods (Special Report for Mt. Pinatubo)," 1993

10. K.S. Rodolfo, et al. "Two Years of Lahars on the Western Flank of Mt. Pinatubo, Philippines: Initiation, Flow Processes, Deposits, and Attendant Geomorphic and Hydraulic Changes," 1992

11. BSWM, "Physico-Chemical Mineralogical and Hydrological Characterization of Volcanic Ash and Lahar and their Utilization and Management for Agricultural Crops," 1992

12. Tokudome, et al, "Extent and Some Properties of Mt. Pinatubo's ashfall Over Agricultural Land (JICA Technical report on the Soil Research and Development Center Project, BSWM)," 1994

13. T.C. Pierson, A.S. Daag, P.J.D. Reyes, T. Regalado, R. Solidum, and B. Tubianosa, "Flow and Deposition of Post-eruption Hot Lahars on the East Side of Mt. Pinatubo, July-October, 1991 (DRAFT)," PHIVOLCS

14. R. Torres, S. Self, M. Martinez, "Secondary Pyroclastic Flows from the 15 June 1991 Ignimbrite of Mount Pinatubo (DRAFT)," PHIVOLCS

15. R. A. Arboleda, A.S. Daag, P.J.D. Reyes, M. L. Martinez, T. M. Regalado, "1993 lahars on the Eastside Drainages of Pinatubo Volcano: An Overview (DRAFT)," PHIVOLCS

16. PHILVOLCS/USGE, "Serious but Rapidly Diminishing Hazards at Mount Pinatubo," August 1994

17. Dr. L. Kitanaar, "Climate of the Philippines," 1989

18. JICA, "Progress Report (No. 1), The Master Plan Study for West Central Luzon Development Program", March 1994

19. NEDA Region III Office, "Socio-Economic Impacts of Mount Pinatubo Eruption," 1993

20. Mount Pinatubo Commission, Office of the President, "1993 Year-End Report to the President", January 1994

21. Center for Research and Communications, "Business and Socio-Economic Prospects in Angeles City: With or Without Clark Air Base: 1947-2006", March 1990

22. Sabo Department, Ministry of Construction, Japan, "Technical Standards for Measures Against Debris Flow," June 1988

23. Ministry of Construction, Japan, "Outline of the Design Criteria for Sabo Dam and Channel Works."