

10.3 Warning and Evacuation System

Outline of System

The warning and evacuation system proposed in the master plan is designed as a local one to be established, operated and maintained by the LGUs; the necessary investment and maintenance costs should be minimal. The warning system uses the inexpensive and easily accessible GSM cellular phone transmission network as shown in Figure 10.16. The evacuation system would consist of an upgrading of the existing system through renovation of existing evacuation centers and establishment of new ones along with dissemination of hazard maps.

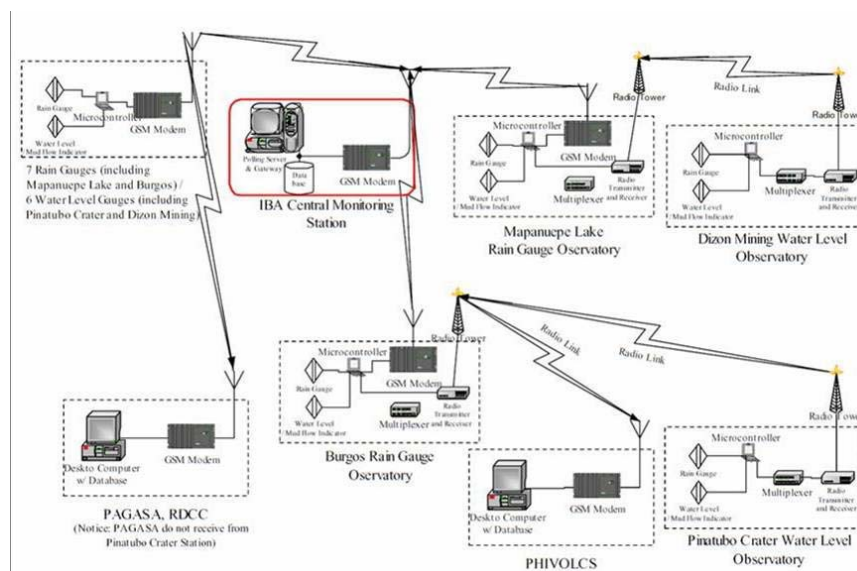


Figure 10.16 Proposed Warning System

The priority warning and evacuation system includes observation of hydrological data at the existing stations, observation at the existing watch points and the Dizon dam site, introduction of GSM designation of an additional 10 evacuation centers, and dissemination of hazard maps. The observation of rainfall, lake water level and ground water level at the Maraunot Notch of the Pinatubo Crater is a part of the priority system.

Detailed Investigation of Warning System

An investigation was carried out in the study area to identify the coverage area of the existing GSM cellular phone network. Figure 10.17 shows the results of investigation. The investigation revealed that the existing phone network provides coverage for all the hydrological observation station sites of seven raingauges and six water level gauges with the exception of the Pinatubo Crater Lake and Dizon dam site. Since observations from the Pinatubo Crater Lake and Dizon dam site are an essential part of an effective warning and evacuation system, ordinary radio wave transmission is proposed for these sites to transmit the observed data to the nearest observation stations such as Burgos and Mapanuepe. All the observed data are designed to be transmitted to the Iba monitoring center.

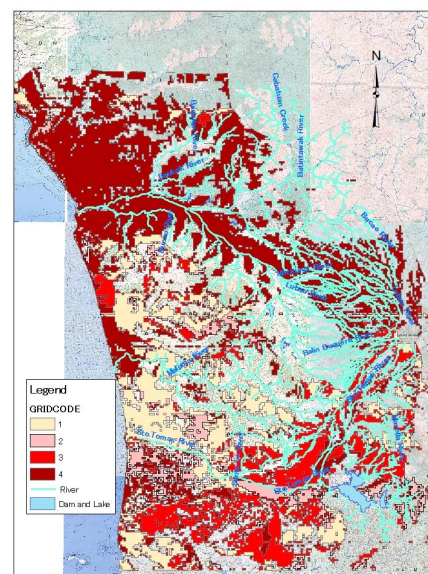


Figure 10.17 Coverage Area of Existing Cellular Phone Network

Dissemination of Hazard Map

The master plan proposed the renovation of existing evacuation centers and establishment of an additional 60 centers with the dissemination of hazard maps. The total investment cost amounts to 1.4 billion pesos. Implementation of such a high cost system was considered not realistic for LGUs, one of which, Zambales Province, has an annual calamity fund of only 18 million pesos.

For the first step of the implementation, existing public and/or private buildings are to be selected for designation as evacuation centers. Dissemination and explanation of the hazard maps to the people and conduct of drills were also proposed as the first step action to improve and strengthen the existing evacuation system. The hazard map shows the extent and depth of inundation, location of the evacuation centers, and location of the evacuation routes and dangerous points. Figure 10.18 shows the hazard map of the municipality of San Felipe as an example. The hazard maps for the study area are compiled in Figures 9.3.5 to 9.3.9 in the main report.

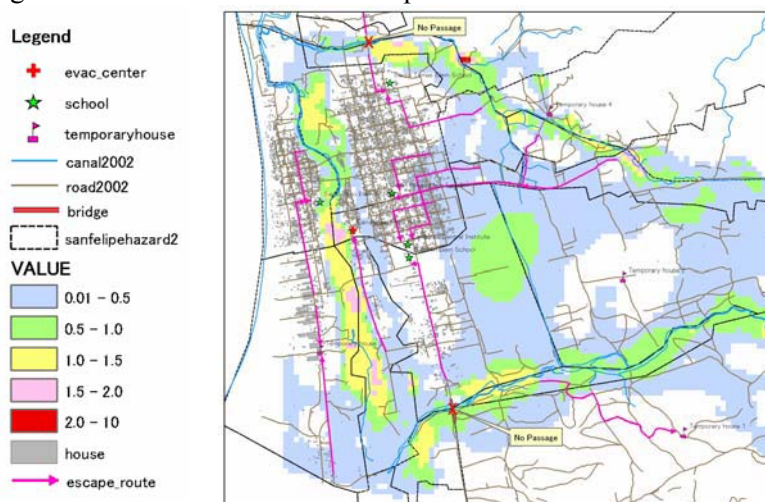


Figure 10.18 Example of Hazard Map for San Felipe (Right Bank of the Sto. Tomas River)

Project Cost and Stage-wise Development

The initial investment cost of the warning system using the GSM cellular phone transmission network was estimated at 82 million pesos, which is more than four times the annual calamity fund of Zambales Province. Therefore, introduction of the full scale warning system with the GSM cellular phone network was considered premature and not proposed for the first phase implementation. The warning system for the first phase implementation consists of the observation of hydrological data at the existing stations and the observation and transmission of information from the existing watch points and the Dizon dam site. The observation of rainfall, lake water level and ground water level at the Maraunot Notch of the Pinatubo Crater is included in the hydrological observation.

No initial investment cost is needed for the implementation of priority projects for the evacuation system above, since neither renovation nor new construction of evacuation centers are proposed.

Institutional Arrangement for Project Implementation

Provincial Disaster Coordinating Council (PDCC) of Zambales should be responsible for the project implementation. The system should be based on the existing system for mudflow monitoring and warning system. The mudflow monitoring system is currently under the responsibility of OCD Region-III. However, there is no activity of OCD on mudflow monitoring at present as time passes after the eruption because mudflow has hardly occurred recently and the current condition is judged as not critical. PDCC shall mobilize the warning system by means of the existing observatory and dissemination facilities under the technical support of OCD, PAGASA, PHIVOLCS, and DPWH.

For the evacuation system, PDCC, MDCC and BDCC are currently responsible for the operation. Improvement of the existing evacuation system should be conducted by PDCC in collaboration with MDCC and BDCC with a technical assistance by OCD. Dissemination of the hazard map to the people would be the first action to improve the system.

10.4 Community Infrastructure Development at Tektek Resettlement Center

Necessity of Development

Investigations conducted for the master plan stage on the existing resettlement center showed that three NGO resettlement centers, Bantay-Carmen, Lalek and Tektek, suffer from a lack of community infrastructure such as elementary schools, electricity supply and community roads. Improvement and development of the community infrastructure for the said resettlement centers were, therefore, recommended as one of the priority projects. The Tektek resettlement center has the widest area among the three centers and there are no issues on land registration, so that the idea of integration of the three centers with Tektek and efficient development of the community infrastructure was proposed for further investigation and study. Detailed investigation and feasibility study were conducted as outlined below.

Detailed Investigation

A perception survey was conducted for the residents in the three NGO resettlement centers. A total number of 105 families responded, which is equivalent to 53% of the total families in the centers. The survey result showed that more than 90% of the residents opposed integrating the centers for the following reasons:

- They prefer the integration to be done to their resettlement center without their moving.
- There is no available agricultural land in the Tektek center.
- There is no livelihood in the Tektek center, so residents would have to earn outside the center.
- Residents in the Bantay-Carmen center prefer to stay because of good access to the national highway.
- Residents have established their own lives in their respective centers.

Although the residents of the three resettlement centers are not satisfied with their present lives, they are not willing to move to the integrated Tektek center unless they also receive access to livelihood such as agricultural lands.

Another particular issue revealed in the survey was that relating to land registration in the Bantay-Carmen and Lalek resettlement centers. The residents in these centers are apprehensive about whether they can remain permanently.

Feasibility Study

The idea of integration was not accepted by the residents of the resettlement centers examined. From this social viewpoint, the integration of the resettlement centers and development of infrastructures are not included in the priority projects. Further discussion and study will be needed for the issues of center integration and land registration.

10.5 Extension of Community-Based Forest Management Program

Outline of CBFM

The nationwide Community-based Forest Management (CBFM) program is currently being conducted by DENR as a measures for more effective forest management following the concept, “People first and sustainable forestry will follow”. The CBFM program is not a simple forestry program but an integrated one with livelihood development for upland communities. Since livelihood development is identified as the most urgent and essential issue for sustainable community-based disaster management activities, extension of the CBFM program to the severely affected communities in the mountainous areas was proposed. A pilot CBFM development of 2,200 ha was proposed as a priority project.

Selection of Priority Development Area

Priority development area of the CBFM extension was selected in the study area as follows:

- 1) Based on the poverty assessment for 124 barangays located in the study area, a poverty ranking map was prepared and the low-ranked barangays were selected to delineate the priority development area; this follows the basic idea that the community-based disaster management program through CBFM contributes to poverty alleviation.
- 2) The priority development area was delineated in the forest lands with land slope of less than 30%, which is where agriculture and agro-forestry can be performed.

The delineated priority development area is 22,044 ha in a total of 14 barangays located in the upstream of the Bucao and Sto. Tomas River basins. The area is shown in Figure 10.19. Based on the guidelines for CBFM prepared by DENR, 20% of the total CBFM area is allowed to be utilized for agriculture and agro-forestry.

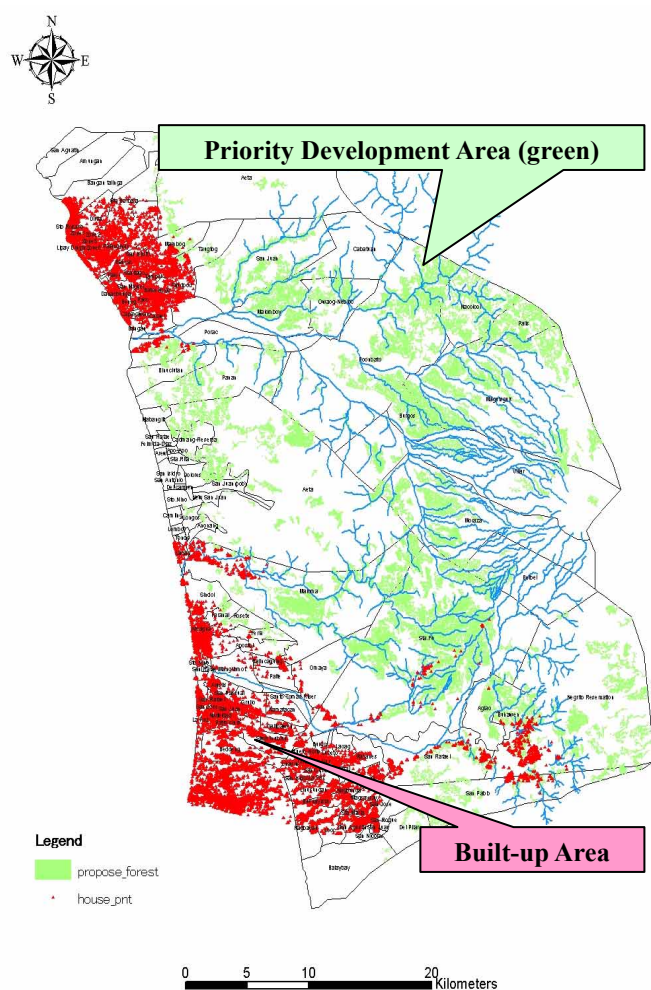


Figure 10.19 Priority Development Area of CBFM (Green)

Development Cost

The development cost of the CBFM program with an area of 22,044 ha, which is composed of the plantation cost of agro-forestry and re-forestation, was estimated to be 755 million pesos as shown in Table 10.10. Unit prices obtained from the JBIC Forest Sector Project and provincial governmental office were applied to prepare the estimate.

Table 10.10 CBFM Development Cost for Priority Development Area (Unit: 1,000 Pesos)

No.	Description	Amount
1	Plantation cost	576,895
2	Administration cost	17,307
3	Engineering services cost	92,303
	Sub total	686,505
4	Contingency	68,651
	Total	755,156

Benefit of CBFM

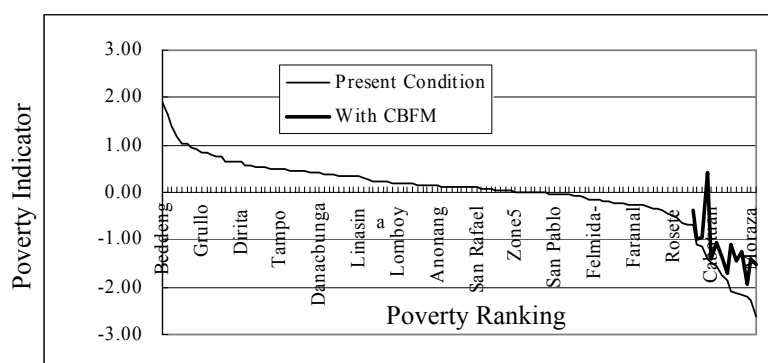
Forest and its sound management contribute to disaster prevention through effects such as improvement of water retention capacity, flood peak reduction, mitigation of sediment yield and reduction of CO₂ as well as timber production. Among the various benefits, the following three were examined for evaluating effects of the CBFM:

- Stumpage value of controlled tree cutting: The value of pesos 119,144/ha obtained from the Forest Sector Project was applied for the examination under the condition that tree harvesting is to be carried out every 10 years after the re-forestation.
- Sales of agro-forestry products: The sales benefit was estimated under the plantation condition of 40% of mango (annual net income from the Forest Sector Project: Pesos 188,721/ha/year), 40% of cashew (Pesos 31,793/ha/year) and 30% of corn (Pesos 36,226/ha/year).
- Reduction of sediment yield in the watershed: It was assumed that the sediment yield will reduce to 50% of the present rate. The reduction volume was computed to be 661,576 m³/year in the Bucao River basin and 390,339 m³/year in the Sto.Tomas River basin. The unit benefit of the reduction, Pesos 43.73/m³, was derived from costs of the alternative sediment reduction measures by excavation of river channel.

Effects on Poverty Alleviation

The effect of the CBFM program on poverty alleviation was analyzed for each barangay through a poverty assessment incorporating 15 poverty-related factors and principal components. The CBFM program leads to an increase in the agricultural land area and is, therefore, expected to contribute to the alleviation of poverty as indicated in Figure 10.20.

Although there is no standard to quantify the effect on poverty alleviation and the figure shows only a sample of the poverty analysis, an indication of the effect of the CBFM program is provided.

**Figure 10.20 Effect of CBFM on Poverty Alleviation**

Evaluation of Program

Although the CBFM program for the priority development area of 22,044 ha has a high EIRR of 21.5% showing economic feasibility, the investment cost amounts to Pesos 755 million, which is more than nine times the annual development fund of Zambales Province. Implementation of the program seems quite difficult because of such a high investment cost.

It is therefore recommended to implement a pilot project for the area of 2,200 ha, which is 10% of the total priority development area.

10.6 Agricultural Development on Lahar Area

Outline of Development

About 8,000 ha of the agricultural land has been buried by lahar and lakes created after the eruption of Mount Pinatubo. The buried area is equivalent to 30% of the total agricultural land in Zambales Province before the eruption. The development of agriculture on the lahar area is one of the priority projects to recover the agricultural activities and contribute to livelihood generation. The development image is shown in Figure 10.21.

It is noted that the utilization of lahar high water channel is recommended only for agriculture purpose. No residential use is recommended due to high potential hazard area by the flood and mudflow compared to the other residential areas. Proper arrangement by LGUs for the zoning regulation will be essential for the appropriate development of lahar agriculture.

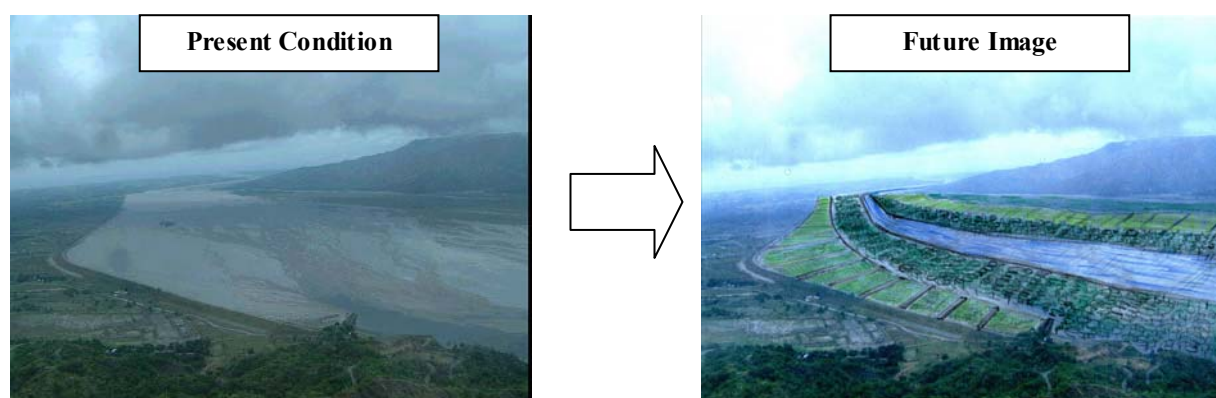


Figure 10.21 Development Image for Lahar Agriculture
(Sto.Tomas Middle Reach)

Appropriate Crops for Lahar Agriculture

A soil investigation carried out for this study indicated that fertility of the lahar is low for crops. Planning of the agricultural development on the lahar area requires analyses of soil properties and studies of fertility needed for crops, fertilizer to be applied, and overall planning on the agricultural development. The following table shows a summary of the soil investigation carried out on the lahar at 20 sites in the western area and 5 sites in the eastern area of Mount Pinatubo:

Table 10.11 Soil Investigation for Lahar

	Description	Nitrogen (N) (%)	Phosphorus (P) (ppm)	Potassium (K) (cmol(+)/kg.soil)
	Minimum requirement	0.1	6	0.15
1	Botolan Municipality	0.09	49.5	0.11
2	San Felipe Municipality	0.03	25.7	0.11
3	San Marcelino Municipality	0.08	112.7	0.10

Application of fertilizers is required to correct deficiencies such as nitrogen and potassium shown in the above table. Crops appropriate for the lahar are enumerated below, which were adopted from the study, “Crop Production Technologies in Ash and Lahar Laden Areas, 1995” published by Central Luzon University:

- Rice, corn, onion, garlic, tomato, squash, water melon, mungbean, peanut, sweet potato, cassava, gabi,

Table 10.12 shows required expenses, revenue, and net income for each appropriate crop.

Table 10.12 Appropriate Crops on Lahar Area

Category	Season	Crops	Expenses (Peso/ha)	Revenue (Peso/ha)	Net income (Peso/ha)	Remarks
Cereals	Wet season	Rice	21,972	58,800	36,828	
	Dry season	Corn	26,973	40,670	13,697	
Vegetable	Dry season	Onion	79,056	375,000	295,944	*1)
	Dry season	Garlic	102,640	300,000	197,360	
	Dry season	Tomato	49,429	405,000	355,571	*1)
	Dry season	Squash	31,056	72,000	40,944	*1)
Fruits	Dry Season	Water melon	28,042	225,000	196,958	*1)
Legumes	Dry Season	Mungbean	17,566	30,000	12,434	
	Dry Season	Peanut	22,615	50,000	27,385	
Root-crops	Annual	Sweet potato	33,741	223,200	189,459	*2)
	Annual	Cassava	48,966	180,000	131,034	*2)
	Annual	Gabi	45,371	225,000	179,629	*2)

Notes: *1) Crops are not appropriate in areas with poor access to market such as middle reaches of Bucao and upper reaches of the Sto. Tomas River basin.

*2) Crops are not appropriate in areas where share tenancy is the dominant land tenure.

Development Potential Area

The potential lahar area for agricultural development was delineated considering the following points:

- 1) Areas where the lahar expands widely in the river courses of the Bucao, Maloma and Sto. Tomas Rivers,
- 2) Areas where flood flow and inundation can be controlled by simple river structures such as gabion and masonry,
- 3) Areas where the use of high water channels does not induce negative impacts on sabo and flood control,

A potential area with a total of 1,726 ha was selected at seven sites in the Bucao and Sto. Tomas Rivers as shown in Figure 10.22.

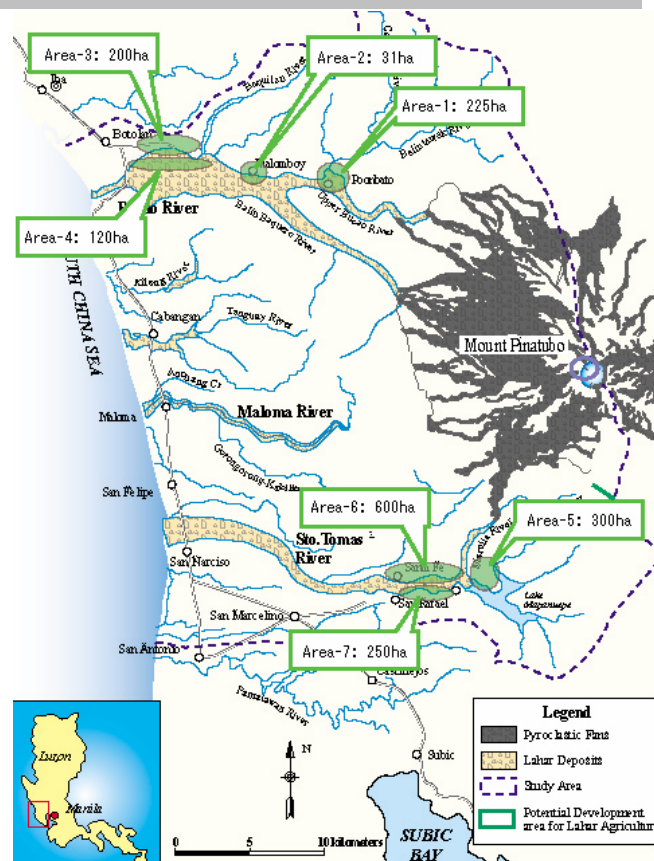


Figure 10.22 Agricultural Development Potential Area

Proposed Agricultural Development Plan and Evaluation

The agricultural development plan on the lahar high water channel has been formulated with installation of small-scale river structures such as gabion spur dikes and training/separation dikes without using heavy equipment for construction. Land development works have been incorporated in the plan, which consists of the establishment of boundaries, foot paths and drainage canals, selection of well points, and scraping and deep plowing. Costs of the above activities, benefits (sales amounts) and EIRR are summarized below for each development site.

Table 10.13 Economic Evaluation of Agricultural Development Plan on Lahar

No.	Location	Barangay	Area (ha)	Cost (Pesos million)	Benefit (Pesos million)	EIRR	Crops	Remarks
1	Buca, middle, right	Poonbato	225	92.5	30.7	3.7%	Rice, legume	No access road exists.
2	Buca, middle, right	Malombo	31	77.5	13.2	-0.9%	Cassava	No access road exists.
3	Buca, D/S, right	San Juan	200	75.7	203.1	33.3%	Onion	Swamp resort development plan is formulated by Botolan.
4	Buca, D/S, right	San Juan	120	105.8	81.3	11.6%	Sweet potato	Selected as pilot area because of the accessibility.
5	Marela, left	Aglao	300	79.1	40.9	7.6%	Rice, legume	No access road exists.
6	Sto. Tomas, middle, right	Santa Fe	600	55.1	81.8	22.5%	Rice, legume	No access road exists for development.
7	Sto. Tomas, middle, left	San Rafael	250	220.5	253.9	16.9%	Onion	Selected as pilot area because of the accessibility.

The above table shows that the areas of rather high economic viability are areas No. 3, 4, 6 and 7. This fact is caused by the low construction cost for river structures and the ability to plant cash crops owing to good access to the markets. Among these four areas, No. 4 and 7 were selected as the priority areas in view of their better access. Their development cost is 326 million pesos for the development area of 370 ha. The general plan for Areas 3 and 4 is shown in Figure 10.23, and Areas 6 and 7 is in Figure 10.24 respectively.

It seems, however, to be difficult for Zambales Province to implement the said agricultural development costing 326 million pesos for the priority areas of 370 ha by their own funds. Furthermore, the implementation requires careful monitoring on river flows and floods in the high water channel in which the agricultural development is to be implemented.

The recommended project is, therefore, a pilot development of 10 ha for each of areas No. 4 and 7. By accumulating the results of the experiments in the pilot development areas, full development in the priority areas is expected with the financial assistance of the national government and lending institutes.

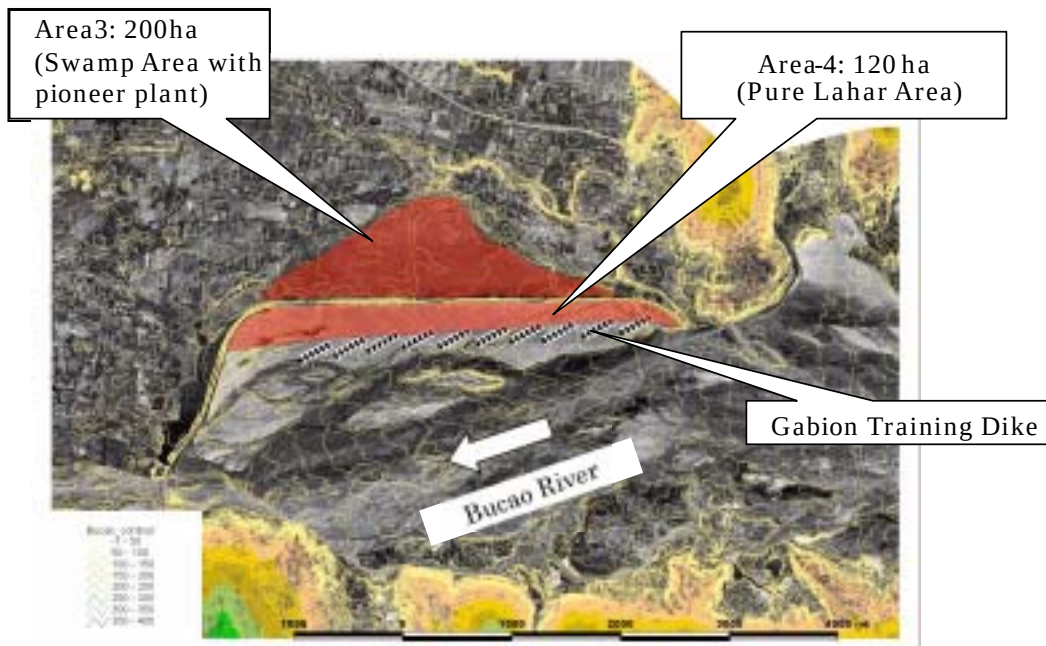


Figure 10.23 General Plan for the Bucao Lahar Agriculture Development

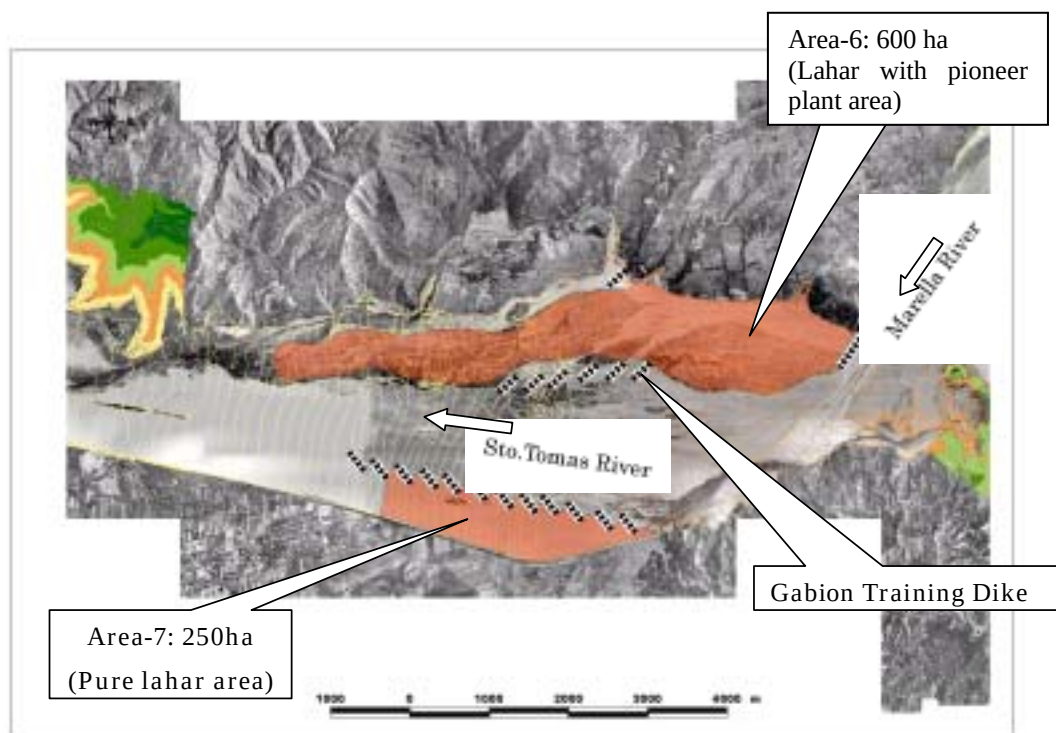


Figure 10.24 General Plan for the Sto. Tomas Lahar Agriculture Development