FOREST MANAGEMENT GUIDELINES FOR SAN MARTIN BUENAVISTA

San Martin Buenavista

In San Martin Buenavista, a forest fire which started in May, 1998 destroyed some 80% of the forests owned by the comunidad, making the formulation of a forest management plan based on data obtained upto the third field survey impossible.

In addition, the loss of so much forest has caused many problems, making it essential for the comunidad to deal with both damaged and undamaged forests in the post-fire period in an appropriate manner to address these problems and to minimise the adverse impacts of forest damage. Under these circumstances, forest management guidelines have been formulated for the comunidad, taking the post-fire conditions of forests into consideration, as an alternative to the originally envisaged forest management plan.

Forest Management Guidelines for San Martin Buenavista

1. State of Forest Damage

(1) Outbreak of Forest Fire

The forest fire started on 7th May, 1998 following burning at farmland below San Juan Quiotepec located to the south of San Martin Buenavista. It subsequently spread to Santa Maria Totomoxtla, Santa Maria Las Nieves and San Francisco La Reforma and then further to San Martin Buenavista after three o'clock in the afternoon of 9th May, two days later. The fire spread throughout the entire comunidad within one day because of the dry season, the area's steep topography and blowing of southerly winds which helped the fire spread to upper parts of steep slopes. It lasted almost one week and eventually died out after reaching Rio San Mateo and the mountainous mesofilo forest forming the western and northern boundaries of the comunidad respectively.

(2) State of Forest Fire Damage

① Damage Categories

Before preparing a forest fire damage map, the following three damage categories were established, taking such forest functions as timber production, headwater conservation and soil conservation, etc. into consideration.

a. Area of Light Damage

The death rate of forest trees is generally 40% or less. Because of the relatively minor decline of the forest functions, forestry operations in accordance with the

principles adopted for the common plan under the Forest Management Plan are still feasible at many sites.

b. Area of Medium Damage

The death rate of forest trees is generally more than 40% but not more than 80%. While the forest functions have substantially declined, forestry operations in accordance with the principles adopted for the common plan under the Forest Management Plan are still feasible at many sites.

c. Area of Severe Damage

The death rate of forest trees is generally 80% or more and the forest functions have been virtually lost. As a result, erosion is occurring in many areas, making the quick restoration of the undergrowth and forest vegetation highly desirable. Given the fact that the ground has become bare, regeneration could prove difficult at some sites and/or could require a long time.

A forest damage classification map (scale: 1/10,000) was prepared based on the above three damage categories. The map on a reduced scale is shown in Fig. Bu-1.

② Area by Damage Category

The area by damage category is shown in Table Bu-1.

Table Bu-1 Area by Damage Category

Area of Light Damage	Area of Medium Damage	Area of Severe Damage	Total
2,690 ha	440 ha	870 ha	4,000 ha
(67%)	(11%)	(22%)	(100%)

③ Characteristics of Damage

The survey on the state of the damage due to the forest fire in question revealed that areas of severe damage are frequently found in the following types of forest.

- Forest on a south-facing steep slope

- Forest along a ridgeline

- Forest with a high level of combustible matters, such as undergrowth and litter layer and humus layer on the ground

- High density pine forest

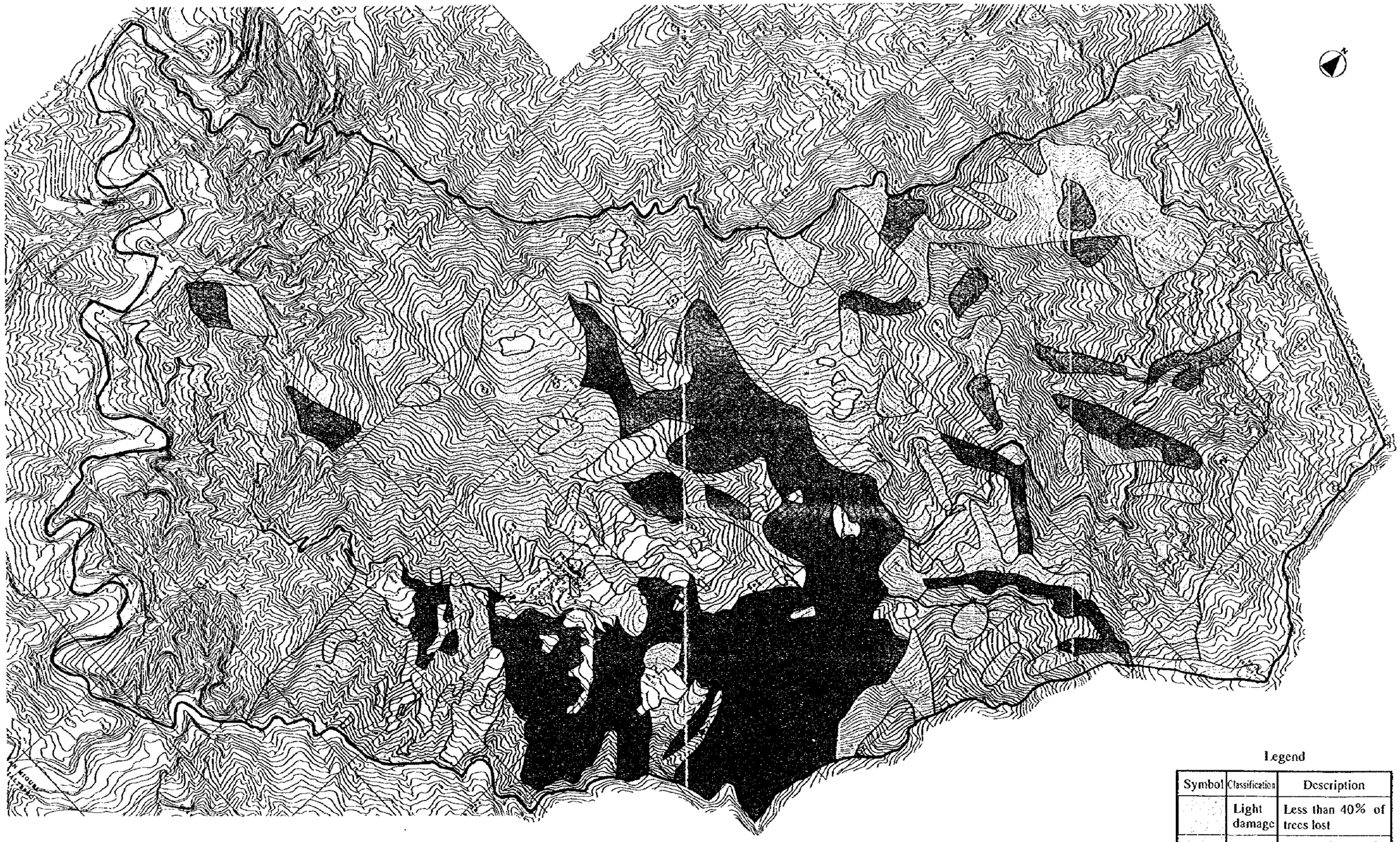
The extent of the damage was found to be relatively small in forests along rivers where the humidity is high, mountain mesofilo forests and selva baja which is dry but which has little undergrowth or litter layer and humus layer on the ground.

The following observations are made based on comparison between the findings regarding fire-damaged areas of the survey conducted in June and July (during the rainy season) in 1998 and those of the survey conducted in October (after the rainy season) in 1998.

- During the first survey, four damage categories were employed, i.e. (i) minor damage (possible death of upto 10% of the standing trees), (ii) light damage (possible death of 10 - 40% of the standing trees, (iii) medium damage (possible death of 40 - 80% of the standing trees) and (iv) heavy damage (possible death of more than 80% of the standing trees), and these categories accounted for some 10%, 45%, 10% and 35% respectively of the total forest area surveyed. At the time of the second survey, it was found that in some 10% of the damaged area the damage is one rank (category) lower because some trees of which the crown had been burned by the fire (particularly encino and other broad-leaved trees) have actually survived to restore their foliage.

- Areas classified in the category of either minor or light damage in the first survey are showing a very quick recovery of the litter layer and undergrowth.

- Even in those areas where the forest trees, undergrowth, litter layer and humus layer were all destroyed, recovery of the vegetation is faster than expected at some sites due to the sprouting of encino, the re-appearance of such herbs as ferns and the natural regeneration of pine provided that the soil conditions are stable.



Legend

Symbol	Classification	Description
	Light damage	Less than 40% of trees lost
	Medium damage	From 40% to 80% of trees lost
	Heavy damage	More than 80% of trees lost

Fig. Bu-1 Forest Damage Distribution Map

2. Impacts of Forest Fire

The forest fire in 1998 had the following highly noticeable impacts.

① Forests which constituted the most important economic resources for the comunidad were lost.

② A large quantity of firewood resources which are vital for daily life were lost.

③ Many forests in areas of severe damage completely lost not only the upper-story trees but also the undergrowth as well as the litter and humus layers on the ground, making the ground bare. As a result, their soil and water conservation functions have significantly deteriorated, leading to the discharge of a large quantity of runoff water immediately after rain which caused soil erosion.

Because of these impacts, the following problems have arisen, directly or indirectly affecting local life.

① Due to the loss of many timber resources which constituted a major source of revenue for development of the public infrastructure of the comunidad, forests cannot be expected to provide the necessary funds for the development of the comunidad in the near future.

② Due to the loss of most forests providing firewood near the settlement, there is serious concern in regard to the depletion of firewood resources in 2 - 3 years time during which time the fire-damaged trees can be used as firewood. At present, local people use (i) encino from forests on the southwestern slope near the settlement where the fire damage was light and (ii) fire-damaged trees as firewood but a firewood shortage is already felt. While people with their own vehicles or those who are rich enough to rent a vehicle use encino standing at sites far from the settlement, almost half of the local people do not have this option and are forced to use low quality, fire-damaged trees near the settlement. This gap in terms of firewood collection could further widen in the future.

③ The considerable deterioration of the water retaining capacity of forests is making it difficult to secure a stable supply of domestic water.

④ The notable occurrence of soil erosion is causing the following problems.

i. The discharge of a large quantity of sediment into the stream and bank erosion. As a result, the water intake weir has been destroyed, causing a serious water shortage.

The small quantity of water supplied by the temporary water intake weir is suffering from a deterioration of its quality and cannot deal with the water shortage during the dry season.

ii. The use of many areas of farmland has become difficult due to the deposit of a large quantity of debris discharged from forest land. Other farmland has been destroyed by the huge quantity of rainwater which could not be held by forests to slow down its discharge.

iii. The soil erosion has made it impossible to prevent a decline of the productivity of forest land.

iv. Road damage can be witnessed at some sites where a road crosses a river, causing concern in regard to more extensive road damage in the near future.

v. The sediment discharged due to rapid bank erosion has destroyed the suspension bridge which provides a local link to S.J. Quiotepec, making it difficult to reach this neighbouring comunidad on foot.

vi. The rapid bank erosion has made the mountain foot unstable and, therefore, there is a high risk of the occurrence of many landslides on slopes along rivers.

⑤ Some of the damaged pine trees which have simply been left unattended are already showing signs of pest damage. If they are left unattended for much longer, there is a risk of the pest damage and/or disease spreading over a wide area.

3. Proposal for Projects (proposal from the inhabitants participated in workshop)

There have occurred a series of secondary disasters since the forest fire in May, 1998. From 16th to 20th of October, 1998, the Study Team held a workshop to analyze daily problems in the community; to discuss measures for rehabilitation with inhabitants and to incorporate these information in the forest management guidelines. Six representatives, selected by the village authorities, participated in this process.

In the workshop, the members firstly analyzed current problems and potential problems, then identified the two major issues[1].

The first issue discussed was shortage of drinking water in the community. The forests capacity to conserve soil and water had been deteriorated by the loss of trees. This in turn, caused erosion which destroyed the drinking water intake weir. Inhabitants constructed new intake weir in other place to tide over the shortage of water. But the quality of the water was not good, and quantity was not enough. The following problems related to the shortage of the water were identified:

① Difficulty with the daily life activities.

② Potential outbreak of epidemic due to contaminated water.

③ Potential outbreak of epidemic for the livestock.

④ Purchase of vegetable outside of the community due to the lack of the water for home garden.

In addition, serious water shortage in dry season was expected due to the decrease of the water in the stream.

The second issue discussed was shortage of firewood in near future. Firewood is the main fuel in the community. The following problems related to the shortage of firewood were identified.

① Widen the gap of the access to firewood between the better off families and their poorer counterparts.

② Increased need to buy electric stove. Traditional cooking will become difficult.

③ Increased need to use more time in collecting firewood. Due to this the family members may have less time to dedicate themselves in their daily routines and may occur trouble in the family.

④ Some may opt for invading other's land to collect firewood, which might provoke dispute among the community.

[1] The problem of erosion, which had occurred in many places in the community, was also pointed out. But, the members were not been sure of the actual situation. Thus it was decided to wait for the result of erosion control survey.

⑤ Some families may emigrate due to the difficulties associated with the shortage of firewood.

Eight projects, related to drinking water and firewood, were proposed (annex 1). But in the workshop, participants discussed extensively three projects. The selection of projects was based on the factors such as cost (personnel expenses and material cost), technical viablities, social risk and project impact. At the end of workshop, participants made annual action plan for these three projects based on available human and economic resources, degree of urgency and possible project impact.

(1) Project Proposal

① Project 1: Improved Stove Project

a. Background

In San Martin Buenavista all households use wood as a fuel. The estimated amount of consumption, for one household with six members, is equivalent to four loads of 3tons truck. This implies that 360 trucks loads of firewood is required for the entire community. The community lost major part of firewood production forest. Also the quality of remained forest nearby the settlement is not good, since the quality of this forest had been deteriorating even before the forest fire in May, 1998.

Currently the inhabitants are using firewood from unharmed firewood production forest located in southwest of the settlement as well as damaged trees from the forest fire. If the consumption rate remains at the present level, considering the conditions mentioned below, serious shortage of firewood is sure to come within two to three years.

i. Major part of firewood production forest was burned.

ii. Excessive felling of the firewood production forest located in the southwest of the settlement, will reduce the productivity of this forest.

iii. The use of trees damaged by forest fire will be possible only within one to two years.

b. Objectives

Superior goal: Achieve sustainable use of firewood to improve the living condition.

Project goal: Keep the consumption of firewood to a minimum.

c. Project Component

Installation of improved stove in each household.

d. Project Activities

- Convoke community council with participation of women and men. Obtain approval of the project.
- Establish a committee, which will be responsible for the project execution, at the community council. Establish rules related to the installation of improved stove.
- Visit another village, such as Benito Juarez, which could minimize the consumption of firewood by introducing improved stove. Then, women and men will discuss about the use of the stove with the people in that village.
- Seek organizations which provide an engineer who knows how to construct improved stove. Make request for the engineer.
- Install improved stove

e. Cost (if installed in all households in the community)

Cost: Material 5,400-7,200 pesos Personnel expense : Engineer (no data)

Basis for calculation:

- Tube for chimney

  (2-3m for each household) × (20pesos/m) × (90households) ≒ 5,400-7,200pesos

- Materials available in the community

  30bricks, 6 carts of soil, 3 carts of sand, Machete, Lead line, Measure, Level Lead, Wood board for 1m×60cm

- Personnel expenses

  Personnel expense for engineer no data

  Tequio 3mandays for constructing one stove

f. Follow-up and Evaluation

Indicators

- Once the organization which can provide the engineer is identified, the community will reach consensus within one week and make formal request.

- Complete the construction of improved stove in all households within 6 months, since the arrival of the engineer.

- The amount of consumption of firewood will decrease by 50%.

Evaluation body

- The Committee and authorities of the community.

Evaluation Material

- Minutes of the community council and reports of the committee.

g. Special Issues

Consensus of women, who will be the user of the improved stove, is indispensable for successful introduction of the improved stove to the community. Therefore, the participation of the women in planning stage and implementation stage is very important. The aspect of women's participation was already taken into account in the planning stage.

② Project 2: Creation and Improvement of Firewood Production Forest and Preservation of the Firewood

a. Background

The shortage of firewood is predicted in the near future in San Martin Buenavista. Therefore, the creation and improvement of firewood production forest is as urgent as keeping the consumption of firewood down.

In some part of damaged firewood production forest, it is possible to observe encino with sprouts. It is important to ensure the selection of sprouts, selective cutting of pine trees while preserving encino with diameter less than 20cm, to improve the firewood production forest. If there is no sprout, it is necessary to sow acorns. Although these measures are taken, it may take five to seven years for the trees to grow to adequate diameter. Moreover the damaged trees only can be used in the coming one or two years. Therefore, in near future, the inhabitants may be forced to go far from the settlement to collect the firewood.

In case there were no firewood near the settlement, only the car owners or the persons who can rent the car would be able to collect firewood. But in general, it is considered that it is not adequate that only one part of the people have access to the benefit of the forest, because forest is the communal resource.

On the other hand, there is pine forest which did not receive severe damage from the forest fire, in the northwest part of the community. It is necessary to carry stand improvement to improve the economic value of the pine. By doing stand improvement and cutting encino, it is expected that the felling volume of encino will become sufficient for the consumption of the firewood in the community in the future.

b. Objectives

Superior goal: Equal distribution of firewood.

Project goal: Improvement of firewood production forest and secure the firewood.

c. Project Components

- Creation of firewood production forest nearby the settlement.

- Improvement of the quality of firewood production forest.
- Implementation of stand improvement and thinning in pine forest.

d. Project Activities

(a) Community Council

- Convoke community council with participation of women and men.
- Obtain approval of the project.
- Establish a committee, which will be responsible for the project.
- Enhance the understanding about the forest management guidelines among the people.

(b) Creation of commercial timber production forest by conducting thinning and stand improvement in pine forest. Utilization of encino cut during thinning and stand improvement operations.

- Request the engineer to make forest management plan.
- Plan the forest activities plan according to the forest management plan.
- Obtain approval of the plan from SEMARNAP.
- Implement stand improvement and thinning.
- Distribute encino, which will be cut by above activities, within the community.

If use encino only for firewood, there will be no need to make forest management plan.

(c) Creation of firewood production forest and quality improvement of the forest

- Implement the selection of sprouts of encino.
- Cut pine trees in the firewood production forest. (working load is not supposed to be heavy, as there are no large pine trees at this moment)
- Inform the people not to cut encino with diameter less than 20cm.
- Sow acorns where encino does not grow.

e. Cost

Activity (a): no cost

Activity (b):

In case the community prepare the forest management plan

They have to pay for the forest management plan, but also they can earn money by selling the pine wood. It is important to estimate the cost and profit generated during the planning stage.

- Cost for forest management plan
- Transportation
- Gasoline and oil
- Rental cost of crane and chain sow.
- Machete and ox (individually owned)
- Manpower (tequio)

In case the community does not prepare the forest management plan

It will be possible to acquire firewood by cutting encino. But there will be no income because inhabitants will not be able to cut pine trees.

- Transportation (if the communal car is used, the cost will be only for gasoline)

  Gasoline 9,000pesos annual 100 pesos for each household[2]

  Estimation bases:

  360 return trips (for 90 households) × 5 liters (for one return trip) × 5 pesos/liter = 9,000pesos

- Rental chain saw.
- Machete and ox (individually owned)
- Manpower (tequio)

Activity (c):

- Machete (individually owned)
- Manpower (tequio)

[2] It is estimated that one household has six members. And consume four truck loads (each 3 tons) of firewood in a year.

f. Follow-up and Evaluation

Indicators

- Number of operations in pine forest.
- Number of firewood collection.
- Degree to which the inhabitants are allowed to collect firewood nearby the settlement.
- Decrease of the number of complains about collecting firewood.
- Equal participation of the community member in tequio.

Evaluation body

- Committee and authorities of the community

Evaluation material

- Minutes of the community council and reports of the committee

g. Special Issues

For the implementation of the stand improvement and thinning, the people need to have minimum knowledge about its operational method. Therefore, it is important that the inhabitants understand the chapter of stand improvement in forest management guidelines and receive skill training.

③ Project3: Construction of Drinking Water Intake Weir

a. Background

Deterioration of soil and water conservation function of forest due to the loss of trees, induced slope failure, streambank erosion, etc. which destroyed the drinking water intake weir. Actually, inhabitants are using a temporary intake weir to tide over the shortage of water. But the quality of water is not good and the quantity is not enough. In addition, serious shortage of water in dry season is predicted due to the decrease of the water in the stream.

The upper stream of Rio Negro is considered to be a suitable place for new intake weir which maintain good quality and sufficient quantity of water. Also the upper part of intake weir was slightly damaged by the forest fires.

b. Objectives

Superior goal: Improvement of living condition and health condition.

Project goal: Sufficient supply of water for the community.

c. Project Components

- Construction of new intake weir in upper part of Rio Negro and pipe the water to the community.
- Establishment of regulation to guarantee rational water use.

d. Project Activities

- Convoke community council with participation of women and men. Obtain approval of the project.
- Identify organizations which can provide subsidy for the construction of new intake weir and piping.
- Seek engineer to complete above works.
- Establish the water committee at community council.
- Establishment of regulation for water use.

e. Cost (if a tank to lower the water pressure is constructed)

Cost: Material 128,515pesos

Personnel expenses Engineer no data, Plasterer 18,000pesos

Estimation bases: applied the prices cost in construction tank in the first half of 1998

- Cement 8tons 8,800pesos • Cal 1tons 500pesos • Wire 1ton 2,000pesos
- Steel 4tons 14,400pesos • Hardening wire 300kg 4,500pesos
- Nails 330kg 450pesos • Nipples 110pieces 165pesos

- Valves 4 pieces 1,000pesos • Water pipe 11km 84,700pesos
- Transportation fee 12,000 pesos

Materials available within the community

- 4 trucks of sand, gravel and stone
- Personnel expenses

  Engineer: no data

  Plasterer: 120days 18,000 pesos

  Manpower: 800times of tequio with 8-10 people in each

f. Follow-up and Evaluation

Indicators

- Establishment of regulation and committee.
- Water supply in the community.
- Decrease of complains related to water.

Evaluation body

- The Committee and authorities of the community.

Evaluation material

- Minutes of the community council and reports of the committee.
- Household survey.

g. Special Issues

It is impossible for the community to pay all cost for this project. Even though no subsidies for the tank construction is available, it is recommended the community establish the water use regulation.

The cost estimated in this report is tentative and is subject to modification.

(2) Implementation of the Projects

All three projects mentioned above are important for the community.

But due to the limitation of human and economic resources, the community may not be able to implement three projects at the same time. The following annual action plan was suggested considering the project impact and inputs.

The second half of 1998 and first half of 1999
Invest the human resources to erosion control measures. Start preparation for project1 to carry out the construction of improved stove in the middle of 1999. Start creation and improvement of firewood production forest, which requires fewer manpower (project 2). Seek subsidy for project3.
Year 1999
The danger of sediment related disaster may be reduced. The community continues to invest manpower in this measure but less than 1998. Invest the manpower in construction of stoves (project1) and finish the construction before the end of the year. Continue the creation and improvement of firewood (project2). If subsidy is available, invest the manpower and terminate the construction.
Year 2000
In 2000, serious shortage of firewood nearby the settlement may occur. Also the firewood production forest may not grow. Therefore, start stand improvement in the pine forest and distribute the encino as a firewood to the community (project2). Maintenance of erosion control structures. Investment of manpower is expected to decrease constantly.
After the year 2001
More emphasis on project 2: stand improvement and distribution of encino as firewood. Continue to invest the resources in creation and improvement of firewood production forest. Depending on the needs, continue maintenance of erosion control structures.

Kind of Activity		Year 1998	Year 1999			Year 2000			Year 2001 and after
		Third quarter	First quarter	Second quarter	Third quarter	First quarter	Second quarter	Third quarter	
Immediate Measures	Implementation of erosion control measures	———	———	- - -	- - -				
	Maintenance and management of structures built for control of erosion					- - -	- - -	- - -	- - -
Project 1	Preparations for installation of improved stoves		———						
	Installation of improved stoves			———	———				
Project 2	Creation of firewood production forest	———	———	———	———	———	———	———	———
	Improvement of pine forest					———	———	———	———
	Distribution of encino					———	———	———	———
Project 3	Search for financial assistance	———	———						
	Employment of personnel			———	———				

——— will be implemented - - - - - will be implemented when necessary

ANNEX 1

1-1 Firewood Project

Name of project		Improved stove	Creation and improvement of firewood production forest	Preservation of firewood by stand improvement in pine forest	Establishment of water use regulation
Cost	Material	Medium	Low	High	Low
	Personnel	Medium	High	High	Low
Technical difficulty		High	High (Medium)[1]	High (Medium)[1]	Medium
Social risk		Medium	High	High	Medium
Project impact on improvement of firewood availability		Decrease consumption of firewood Has significant impact	Increase volume of firewood Has significant impact	① Obtain good quality of firewood in future ② Secure firewood and equal distribution to the community. Has significant impact	Facilitate the implementation of other projects. Has significant impact

1-2 Drinking Water Project

Name of project		Drinking water intake weir construction	Drinking water management	Capacity building of fire brigade	Communication improvement
Cost	Material	High	Low	Medium	High
	Personnel	High	Low	Medium	High
Technical difficulty		High	Low	Medium	High
Social risk		Low	Medium	Medium	Low
Project impact on water shortage		Obtain water Has significant impact	Utilize water efficiently Has medium impact	Protect headwater conservation forest Has little impact	React immediately in case of forest fire Has little impact

1-3 Other Projects

Negotiations with S.J. Quiotepec	
High	
High	
High	
Internal	Low
External	High
Receive compensation and prevent re-occurrence of the fire Has little impact	

[1] If inhabitants can understand technical parts of the development study's reports, it will be reduced to medium.

ANNEX2 LIST OF THE ORGANIZATIONS WHICH MAY PROVIDE THE ENGINEER FOR IMPROVEMENT STOVE

Organization	Cost	Response	Feasibility
SEMARNAP	Low	Relatevely fast[3]	High
SEDAF	Low	Slow	High
SAGAR	No data	No data	No data
Non-governmental organization (NGO)	Normal	Fast	High
Private Organzation	High	Fast	High

[3] The community already has established good relationship with SEMARNAP.

4. Forest Management Guidelines

(1) Basic Concept

The forest management guidelines described here indicate the basic concept of how to deal with forests, including the rehabilitation of fire-damaged forests.

Immediately after the forest fire, it was believed that trees exposed to the fire would all eventually die. Since the rainy season, however, the leaves of many trees have re-appeared except in the case of those trees which had been completely burned upto the crown, showing better recovery than anticipated. In the case of pine trees whose leaves are only seen at the top, their survival cannot be confirmed for a year as they must still undergo the dry season. The general trend of recovery, however, appears to suggest the forest functions at each stand may well recover to the pre-fire situation in several years time in those areas of light or medium damage even though odd single trees may die in the meantime. In contrast, in areas of severe damage, the urgent implementation of forest rehabilitation measures is essential as most of the trees have already died. If an optimistic view is allowed, there is a strong likelihood that the areas surveyed will recover because of the vigorous natural regeneration by seed of pine trees as well as the regeneration by sprouting of encino trees.

Various problems arising from the fire damage which have already been discussed in 2. - Impacts of Forest Fire are summarised as follows.

① Many of the commercial timber forests which constituted economic resources for the comunidad have been lost due to the fire, causing grave concern in regard to a future shortage of economic resources.

② There was a shortage of firewood around the settlement even before the fire due to excessive felling. Further aggravation of the firewood shortage may well occur in the near future.

③ Soil erosion in the aftermath of the fire has caused the following problems.

a. The water intake weir has been destroyed. The temporary water intake weir currently in place may be unable to prevent a water shortage during the dry season.

b. Some farmland has been buried by sediment eroded from forest land while inside some farmland gullies which are expanding have been formed

c. Road damage can be seen in some areas where a road and stream cross each other.

Forest categorisation has been conducted in order to solve these problems, taking the forest distribution, extent of forest fire damage, site conditions, possibility of forest use by local people and intentions of local people, etc. into consideration. Forest management for each forest type and forest restoration principles are discussed next based on the categorisation results.

(2) Forest Categorisation

① State of Forest Fire Damage by Forest Distribution

- Mesofilo forests consisting of broad-leaved trees with rare wildlife are distributed from the northern ridgeline linking Mt. Cerro Manta, Mt. Cerro Hueso and Mt. Cerro Mirador (elevation of approximately 2,600 m) to areas with an elevation of 2,400 m. The fire burned pine-quercus forests and came to an end at the boundary between pine-quercus forests and mesofilo forests which escaped fire damage due to their high level of humidity.

- Pine-quercus forests are distributed below mesofilo forests towards an elevation of approximately 1,400 m. Most of these forests were damaged by the fire. Those forests on the southeastern slope descending from the settlement area towards San Martin River and facing S.J. Quiotepec and those on the ridgeline with an elevation of 2,000 m were severely damaged.

- The pine-quercus forest area is further divided into a higher semi-moist area and a lower semi-arid area with the dividing line around an elevation of 2,000 m. In the semi-moist area, forests containing high trees are in the majority due to the high productivity of the area. On the other hand, most forests in the semi-arid area tend to be sparse or have many low trees due to the low productivity of the area. As described earlier, most of these pine-quercus forests were damaged by the fire.

- Steep slopes and sites with thin soil generally require soil conservation measures. The fire damage has made the implementation of soil conservation measures at these sites even more urgent.

- The low elevation area below the semi-arid area is an arid area of selva baja where shrubs and low trees grow. As there was little vegetation in this area to start with, the fire damage is negligible or very small.

In short, except in southeastern slopes of Mt. Cerro Manta, fire damage mainly occurred at the pine-quercus forests.

② State of Forest Fire Damage by Forest Utilization Type

- Before the fire, excellent pine trees were used for commercial purposes. Damaged commercial forests are distributed along the westward ridgeline from the crossing point of roads linking the trunk road and the settlement and also along the ridgeline branching from the above ridgeline towards Mt. Cerro Toro. Extensive damage over a wide area occurred in these areas and sites of severe damage can also be found along other ridgelines. In areas along these ridgelines, however, many sites suffered only light or medium damage rather than severe damage. Consequently, those forests with light or medium damage should be dealt with in accordance with the common plan for all comunidads while severely damaged sites should be designated rehabilitation sites for urgent rehabilitation.

- While a water intake weir was set up at a tributary of Rio La Escopeta to obtain drinking water, this intake has been destroyed due to soil erosion and sedimentation. As the temporary intake which has been constructed will be unable to cope with the water shortage during the dry season, a new water supply source must be secured. Local people hope that a new intake will be constructed in the upstream of Rio Negro. As drinking water supply is an urgent matter, it was raised as a primary issue at the workshop.

- Local people use forests to obtain construction timber for their homes and firewood for daily use and the loss of firewood is expected to create a firewood shortage in the near future. Many firewood forests should be created in view of the facts that the area around the settlement did not have much firewood even prior to the fire because of excessive collection, that extensive damage occurred at the southeastern slope extending from the settlement towards Rio San Martin while the slope was suitable as a firewood production forest and that there will be firewood supply shortage even if firewood can be obtained during the process of rehabilitating firewood forests. Projects were proposed at the workshop to alleviate the anticipated firewood shortage.

③ Site Classification for Each Forest Category

Based on the observation results of the fire damage by forest distribution and forest category, those sites of severe damage are designated rehabilitation areas while those of light or medium damage are mainly classified in accordance with the forest

categories adopted by the common plan. Taking the opinions/intentions of local people and other relevant matters into consideration, the finalised forest categories are shown in Table Bu-2 and Fig. Bu-2. Those forests which do not fall in any category at the moment and where, therefore, no forestry activities are planned are classified in the category of left-over forest. In the case of forests in one category being scattered or existing in small areas within a forest of another category, these forests are incorporated in the latter from the viewpoint of uniform forestry operations. The classification details are shown on the forest management map (scale: 1/10,000).

Table Bu-2 Site Distribution by Forest Category

Forest Category		Relevant Sites
< Production Area >		
Timber Production Forest	Commercial	- Sites with excellent pine growth in the semi-moist area (along the trunk road and forest roads)
	Non-Commercial	- Sites with predominantly pine trees in the semi-arid area (between an elevation of 2,000 m and 1,400 m along the road linking the settlement to the trunk road
Firewood Production Forest		- Forests around the settlement
< Protection Area >		
Nature Conservation Forest		- Mesofilo forest area between the ridgeline linking Mt. Cerro Manta, Mt. Cerro Hueso and Mt. Mirador to the north and the area around an elevation of 2,400 m
Soil Conservation Forest		- Steeply sloping sites on the southeastern slope above Rio S.M. Buenavista facing the comunidad of S. J. Quiotepec - Steeply sloping sites on the western slope above Rio Ariero facing the comunidad of San Mateo
Headwater Conservation Forest		- Upper reaches of Rio Aroyo Negro from the point where the trunk road crosses Rio Aroyo Negro, assuming the construction of a new water intake weir on this river
Other Conservation Forests		- Selva baja areas
< Restoration Area >		- Severely damaged sites by the fire; after restoration, each site will be classified in one of the forest categories
< Left-Over Area >		- Sites not subject to forestry activities for the time being

④ Forest Division

The existing forests were divided to establish compartments and sub-compartments. The established compartments are shown in Fig. Bu-2 and the sub-compartments are shown on the forest management map.

⑤ Area by Forest Category

The area by forest category and by compartment is shown in Table Bu-3.

(3) Principles of Forestry Activities by Forest Category

Here, the principles of forest categorisation for each category of forest fire damage are firstly explained, followed by the explanation of the forest improvement work for each category. The principles of forestry activities for each forest category are basically the same as those adopted for the common plan.

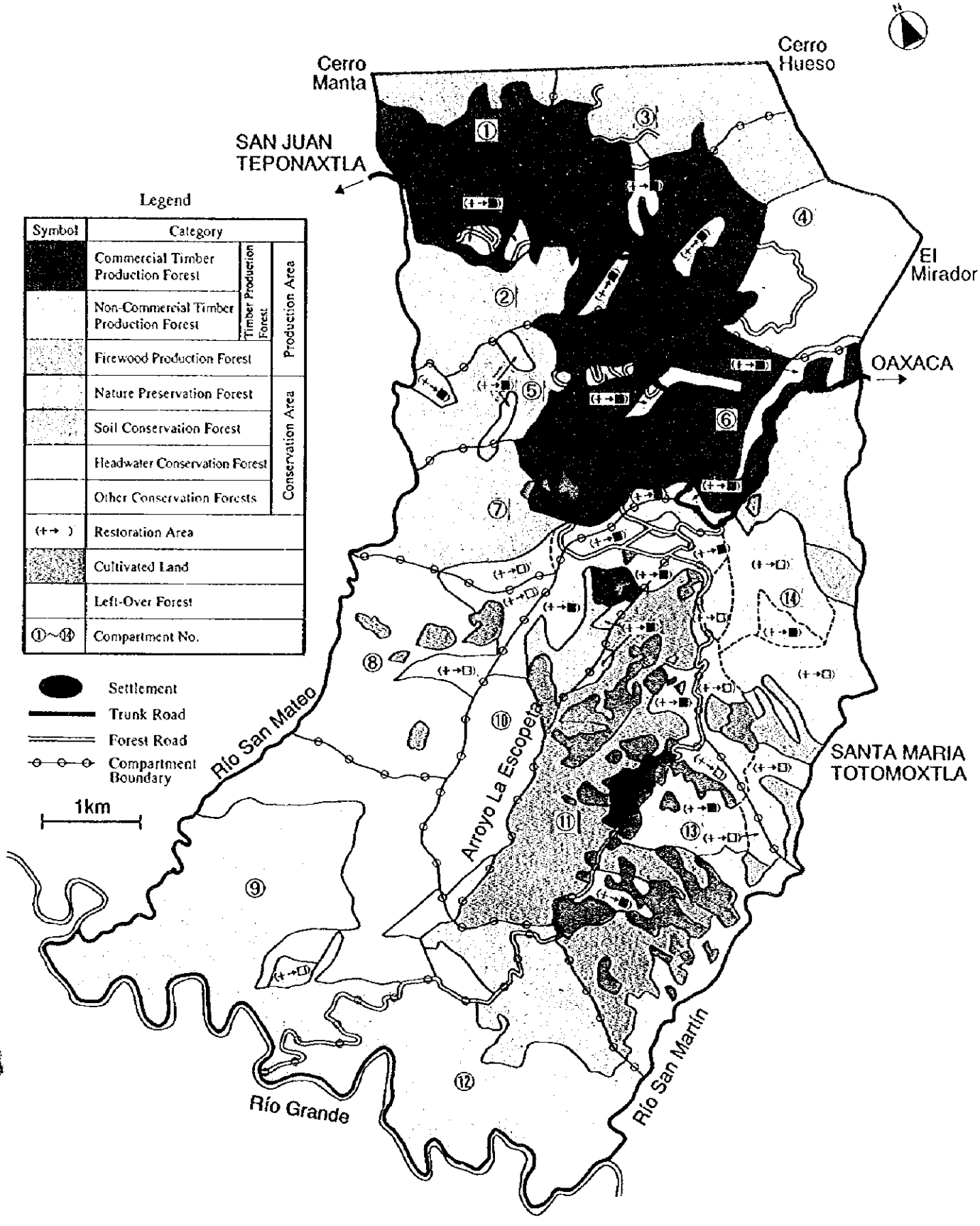


Fig. Bu-2 Forest Categorisation of San Martín Buenavista

① Principles of Forestry Activities by Fire Damage Category

a. Areas of Light or Medium Damage

Forests in areas of light damage are showing excellent recovery while those in areas of medium damage promise forest restoration by natural regeneration. In view of these favourable conditions, these forests are categorised based on the categorisation principles adopted by the common plan. Although forest restoration will basically be left to nature, planting will be considered for those areas of medium damage where natural regeneration is less than favourable.

b. Areas of Severe Damage

Forests in areas of severe damage are placed in the restoration area category. Efforts will be made to restore their expected functions in the future while protecting the recovering forest floor vegetation. As it is possible to establish a post-restoration forest category for each area of severe damage, this post-restoration category is shown on both the forest management map and in the forest inventory book. Within the restoration area, those areas classified as either commercial timber production forests or firewood production forests will be provided with assistance to facilitate their early restoration. In the case of the conservation area, forest restoration will, in principle, be left to nature although measures to prevent damage to the emerging vegetation due to cattle grazing, etc. will be introduced to assist the early recovery of the vegetation. In addition, planting will be considered for those areas where recovery of the vegetation is less favourable. The target restoration figure for the restoration area is shown in Table Bu-4.

② Development of Production Area

a. Firewood Production Forests

The encino reserves found in pine-quercus forests and quercus forests near the settlement showed a decline before the forest fire due to excessive felling and the damage to encino by the fire has now made it increasingly difficult for the firewood demand of local people to be met near the settlement, causing concern in regard to a serious firewood shortage in the near future. The creation of firewood production forests of which the total area exceeds the area required to supply a sufficient quantity of firewood to meet the demand of local people is planned to alleviate this situation.

(a) Improvement Targets

The target is the creation of firewood production forests of a sufficient area to produce the quantity of firewood required by the comunidad in a sustainable manner.

(b) Area of Firewood Production Forests

San Martin Buenavista has 90 households. Assuming that the annual firewood consumption per household is 6 m^3, the total annual consumption is 540 m^3. Assuming a mean annual growth of firewood production forests and a firewood production yield of 4.9 m^3/ha and 75% respectively, the area of firewood production forests must be at least 147 ha. As described above, the number of encino trees in forests designated firewood production forests was not large to start with. The loss of these trees due to the fire means that it will probably take 15-20 years for these forests to re-establish the sustainable production of firewood. In reality, as the felling of small diameter trees during the period of restoration is anticipated, the proper establishment of firewood production forests will take much longer. Given the likely population increase in the coming years, the area of firewood production forests should be two to three times larger than the minimum requirement. Accordingly, 438 ha of firewood production forests will be established, including those to be restored in the restoration area near the settlement.

(c) Development Method

- When the efficient use of encino as firewood is intended, those trees with a DBH of 20 cm or more are suitable. Consequently, the felling of any encino tree with a DBH of less than 20 cm should, in principle, be suspended. Because of the virtual loss of all firewood production forests near the settlement due to the fire, the felling of small diameter encino trees in some cases may be unavoidable. Nevertheless, any temptation to fell small diameter encino trees must be resisted as much as possible and, instead, partially burned encino and pine trees should be used even though the supply of these trees is only expected to last for 2 - 3 years.

- Any supply shortage should be supplemented by the encino trees to be produced by stand improvement work in areas not affected by the forest fire to meet the actual demand.

- Many shoots are observed near the base of encino trees burned by the fire. 3 - 5 vigorous shoots should be selected while pruning others to encourage the growth of the selected shoots.

- As the demand for species other than encino for use as firewood is low, these species should gradually be felled in view of conversion to encino forests.

- When no encino seed trees exist, making regeneration difficult, acorns should be collected elsewhere for seeding in desirable areas.

Fig. Bu-3 shows the forestry operation model for stands which were severely damaged and which will be developed as firewood production forests. Also, for the effective establishment of firewood forest it is desirable to begin implementation work for areas of good access, such as the areas near roads, etc.

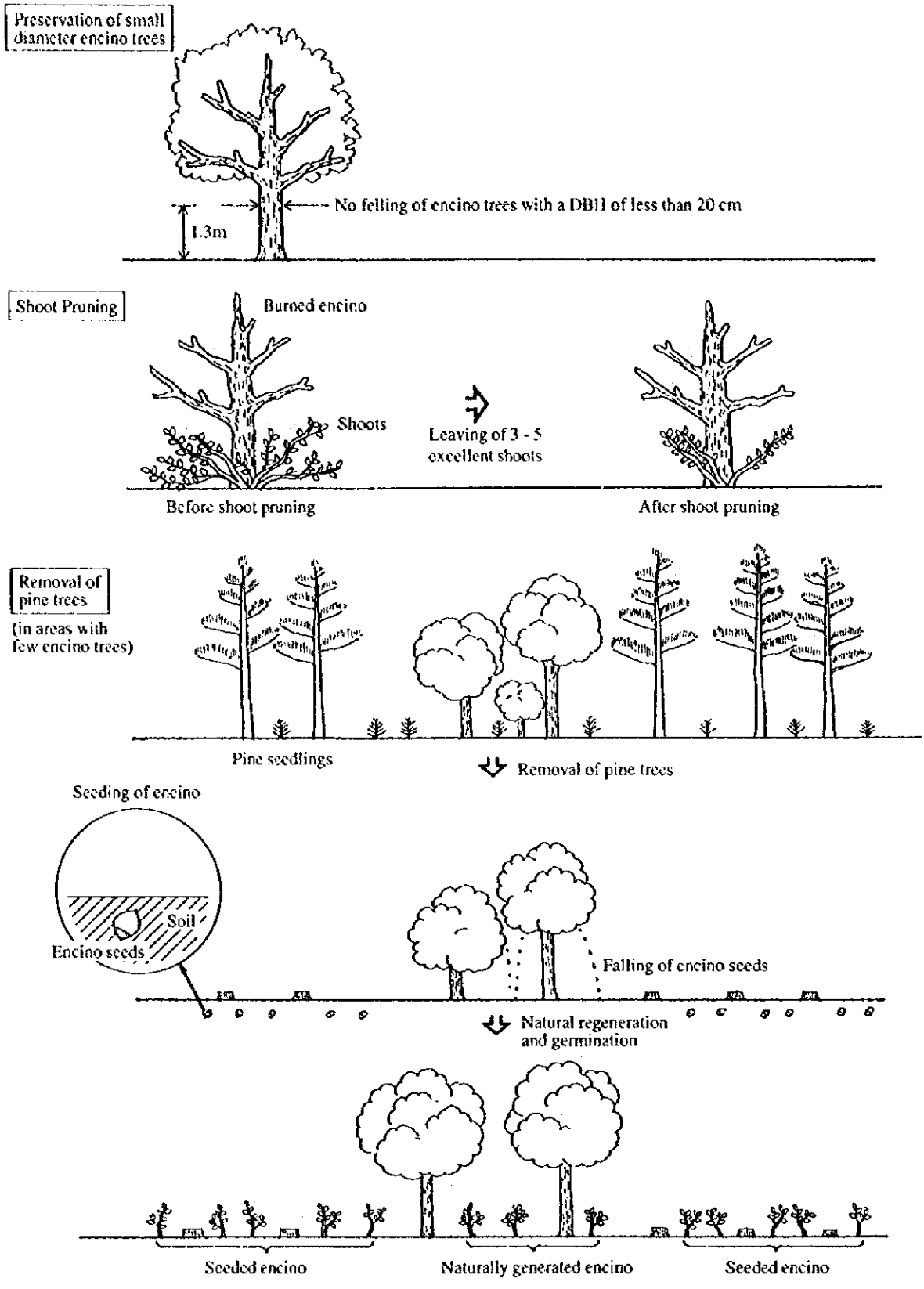


Fig. Bu-3 Forestry Operations for Severely Damaged Stands (Restoration Area) to be Developed as Firewood Production Forests

b. Timber Production Forests

(a) Commercial Timber Production Forests

Forestry operations to restore commercial timber production forests in the future are classified as those for areas of severe damage and those for areas of minor or no damage. Here, the general development targets for commercial timber production forests are firstly described, followed by a description of the forestry operations for each damage category and the long-term perspective.

Table Bu-3 Area by Forest Category

(Unit: ha)

Forest Category \ Compartment No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
< Production Area >																
Timber Production Forest	Commercial Timber Production Forest	77	213 (239)	135 (150)	81 (96)	197 (212)	143 (190)	93 (111)	-	-	18 (128)	- (15)	-	-	- (15)	957 (1,233)
	Non-Commercial Timber Production Forest	-	155	-	-	128 (150)	-	159 (190)	-	43	41	63	114	83 (96)	141 (234)	927 (1,086)
Firewood Production Forest		-	-	-	-	-	-	-	-	-	-	212 (240)	-	39 (140)	9 (58)	260 (438)
< Protection Area >																
Nature Conservation Forest		63	-	159	64	-	-	-	-	-	-	-	-	-	-	286 (286)
Soil Conservation Forest		-	-	-	-	-	-	-	-	-	-	-	-	-	65 (235)	65 (235)
Headwater Conservation Forest		-	-	-	235 (238)	-	-	-	-	-	-	-	-	-	-	235 (238)
Other Conservation Forests		-	-	-	-	-	-	-	-	502	11	-	390	79	-	982 (982)
< Restoration Area >		-	26 (0)	15 (0)	18 (0)	37 (0)	47 (0)	49 (0)	55 (0)	9 (0)	110 (0)	43 (0)	-	114 (0)	327 (0)	850 (0)
< Left-Over Forest >		-	-	-	-	-	-	-	261 (316)	288	156	-	-	-	-	681 (745)
Total		140	394	309	398	362	190	301	316	825	329	318	504	315	542	5,242

Note: Figures in brackets indicate the area after the restoration of forests in the restoration area. The difference in the figure for total is due to round off.

Table Bu-4 Target Restoration Figure by Forest Category in Restoration Area

(Unit: ha)

Forest Category \ Compartment No.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
< Production Area >																
Timber Production Forest	Commercial Timber Production Forest	-	26	15	15	15	47	18	-	-	110	15	-	-	15	276
	Non-Commercial Timber Production Forest	-	-	-	-	22	-	31	-	-	-	-	-	13	93	159
Firewood Production Forest		-	-	-	-	-	-	-	-	-	-	28	-	101	49	178
< Protection Area >																
Nature Conservation Forest		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Soil Conservation Forest		-	-	-	-	-	-	-	-	-	-	-	-	-	170	170
Headwater Conservation Forest		-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Other Conservation Forests		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
< Left-Over Forest >		-	-	-	-	-	-	-	55	9	-	-	-	-	-	64
Total		-	26	15	18	37	47	49	55	9	110	43	-	114	327	850

Note: The total figure corresponds to the size of the restoration area in Table Bu-3.

i. Development Targets

The development target is the establishment of a forest composition capable of sustained timber production for all commercial timber production forests, including areas to be restored from the state of severe damage.

ii. Forestry Operations in Areas of Severe Damage

(Restoration Areas ⇒ Future Commercial Timber Production Forests)

Forestry operations in areas of severe damage will be given top priority.

(i) Felling of Damaged Trees

The felling of damaged trees is currently in progress. It is desirable for this work to be completed as soon as possible. Signs of pest damage are already observed at some damaged trees. As pests invade weakened trees, the felling of such trees is essential to maintain the health of the remaining stand.

The present felling situation emphasises felling while delayed hauling means that some of the stacked logs along forest roads have begun to suffer from rotting, etc. These logs are, therefore, rendered unusable despite their early felling. The hauling of logs as soon as the trees are felled is, therefore, necessary to avoid such waste.

(ii) Regeneration

Pine will be regenerated through natural regeneration in view of the pine's current state of vigorous natural regeneration. While there are few areas requiring planting, steep slopes present a situation where regeneration by means of natural seeding appears difficult, partly because of movement of the surface soil. Planting will be conducted when poor regeneration is observed at these slopes or in other areas. For this purpose, seedlings supplied by the SEMARNAP and SEDAF, etc. will be used.

Planting has been conducted in areas of severe damage but the work conducted is not necessarily sufficient. Planting should be properly

conducted in accordance with the model planting process shown in Fig. Bu-4.

(iii) Tending

Forestry operations (tending) after regeneration should follow the process from the clearance of limbs, etc. of forestry operation model for commercial timber production forests shown in the common plan. Fig. Bu-5 shows the forestry operation model for stands which are severely damaged, i.e. restoration forests, and which will be included in the commercial timber production forest category in the future.

iii. Forestry Activities in Areas of Minor or No Damage

(i) Principles of Forestry Operations

- Stands where the regeneration of pine is less apparent than the vigorous growth of encino due to the felling of pine trees in the past will be improved to high value forests with many pine trees.

- Stands with an excessive density of pine trees will be subject to thinning so that larger diameter logs can be produced sooner rather than later.

(ii) Stand Improvement

Almost all of the commercial timber production forests which suffered either little damage or no damage have, in fact, many encino trees which invaded after several fellings of excellent pine trees in the past and their composition is not capable of producing high quality pine timber. Here, stand improvement work will be conducted to develop pine-dominated stands by means of clearing encino and other broad-leaved trees and the remaining poor pine trees except for seed trees.

(iii) Thinning

Thinning will be necessary at those stands with excessively dense pine trees. In accordance with the clear cutting of the preserved seed tree model, the age of the stands subject to thinning with small diameter trees is considered to be 20 years and thinning equivalent to

the first thinning of this model will be conducted. In the case of subject stands to thinning with large diameter trees, the stand age is considered to be 35 years and thinning equivalent to the second thinning of the model will be conducted.

In regard to stands with a particularly high density among the subject stands of thinning, a thinning intensity of some 30% at once could adversely affect the growth of the remaining trees. In the case of these stands, a thinning intensity of some 20% will be adopted and thinning will be conducted twice at an interval of approximately five years.

Areas of compartments requiring stand improvement and thinning are shown in Table Bu-5.

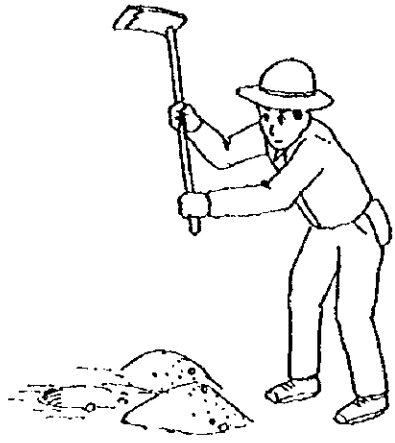
As described later, stand improvement will not be conducted at some 40% of the subject stands because of their classification in a conservation area or poor hauling conditions. It will also not be conducted throughout the subject stands. Assuming that stand improvement is actually conducted in 80% of the area of the subject stands (763 × 0.6 × 0.8 = 366ha), the actual area for stand improvement will be approximately 370 ha.

Both stand improvement and thinning will be conducted following the completed restoration of severely damaged areas. The adoption of a target work completion period of more than 30 years for stand improvement and less than 10 years for thinning is desirable.

Table Bu-5 Areas of Compartments Requiring Stand Improvement and Thinning

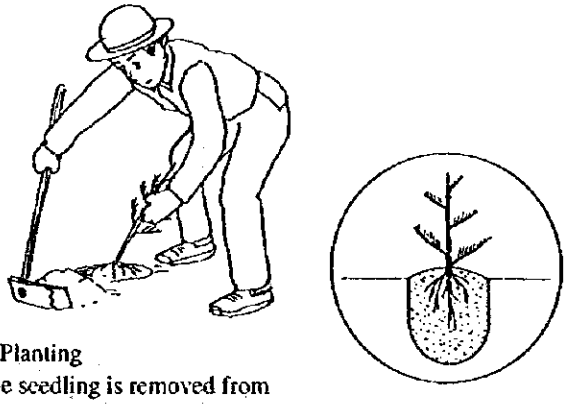
(Unit: ha)

Forest Category \ Compartment No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
<Production Area>	Timber Production Forest	Stand Improvement	77	185	132	65	145	76	78	-	-	5	-	-	-	-	763
		Thinning	-	28	3	16	52	67	15	-	-	13	-	-	-	-	194
Total			77	213	135	81	197	143	93	-	-	18	-	-	-	-	957

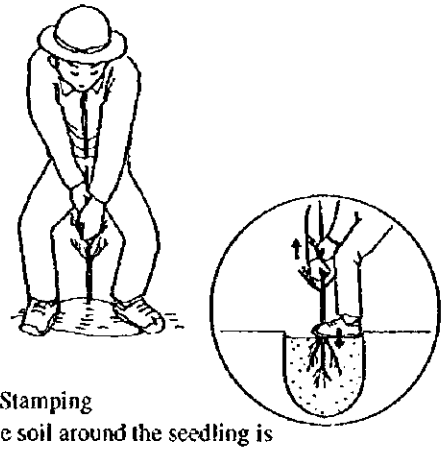


① Preparation of planting hole (1)
A planting hole is dug and the soil from the hole is crushed and piled around the hole

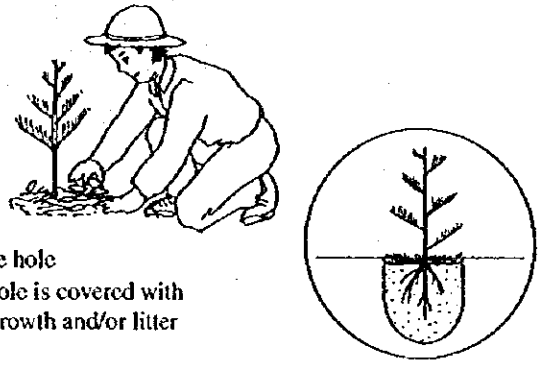
② Preparation of planting hole (2)
Stones around the planting hole are removed and placed at a distance from the hole



③ Planting
The seedling is removed from the pot and is placed at the centre of the hole and the foot or a hoe is used to replace soil in the hole, slightly above the ground



④ Stamping
The soil around the seedling is stamped while the seedling is upwardly held by the hands to a point where the stamped soil is slightly lower than the ground



⑤ Covering the hole
The planting hole is covered with cleared undergrowth and/or litter

<Work Flow>

①→②→③→④→⑤

Fig. Bu-4 Model Planting Process

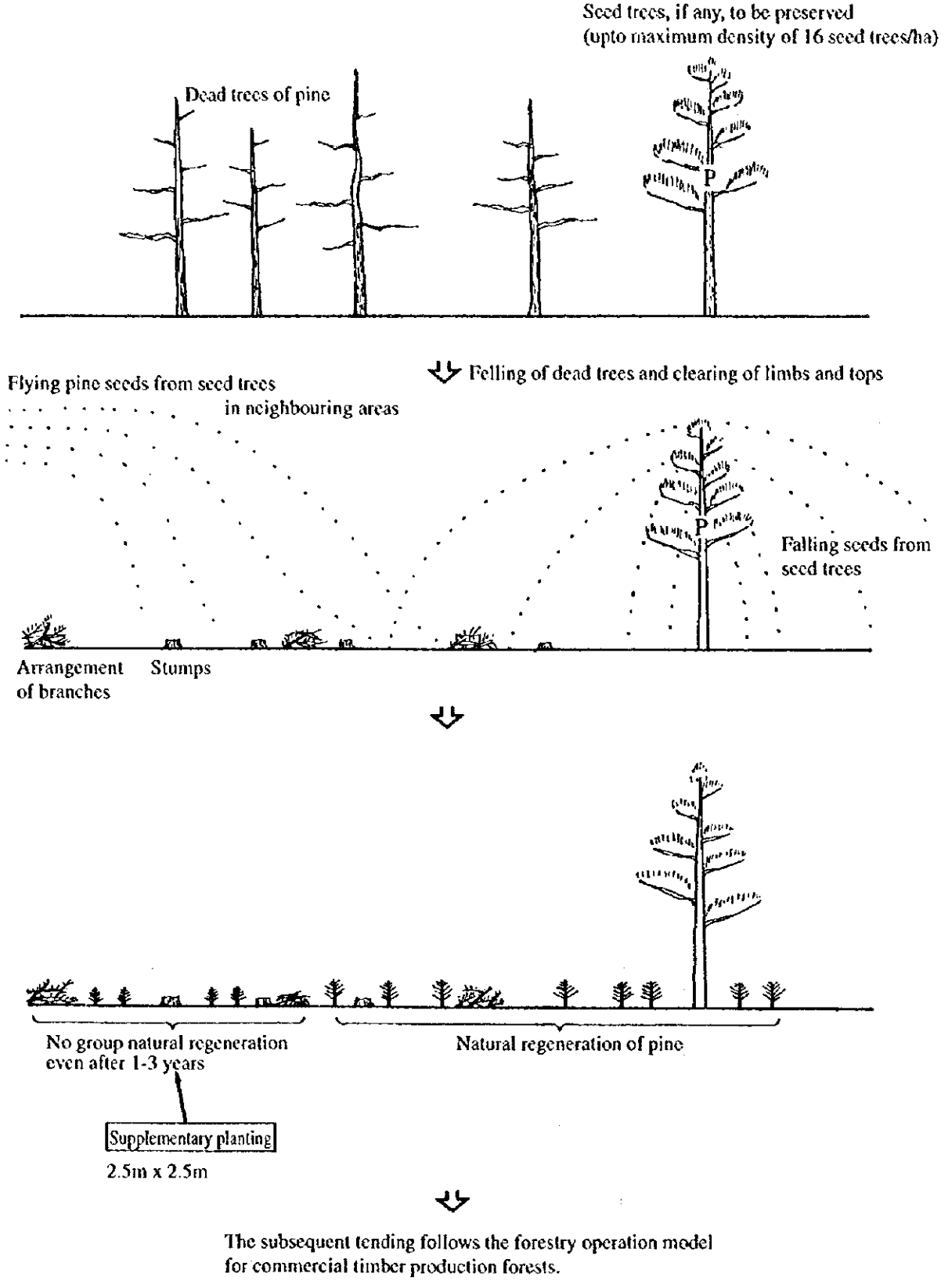


Fig. Bu-5 (1) Forestry Operations at Severely Damaged Stands to be Restored as Commercial Timber Production Forests in the Future (gentle slopes)

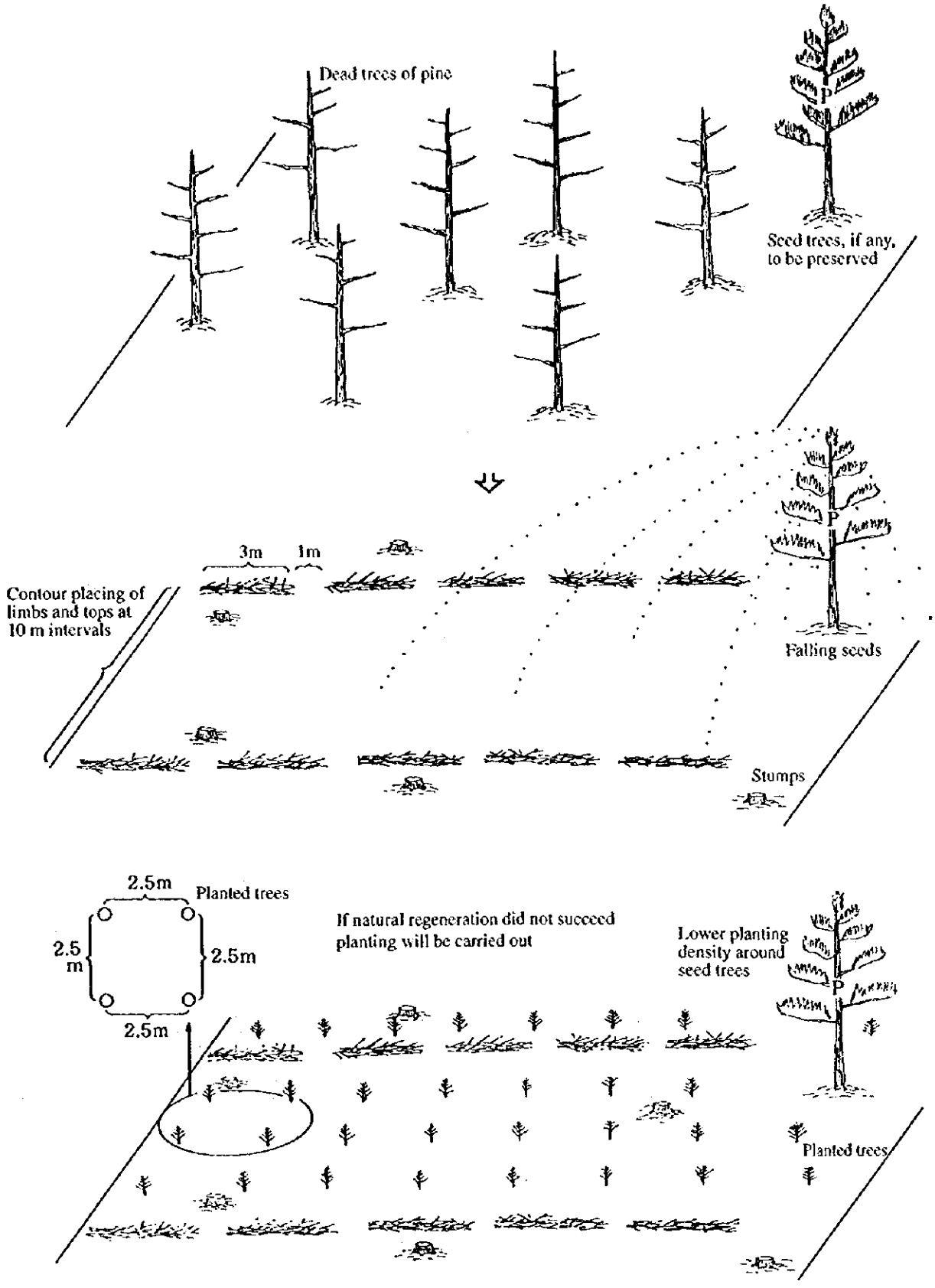


Fig. Bu-5 (2) Forestry Operations at Severely Damaged Stands to be Restored as Commercial Timber Production Forests in the Future (steep slopes)

iv. Long-Term Perspective

(i) Rotation

The rotation age from regeneration after felling to the arrival of the next final felling age is assumed to be 60 years and forestry operations will be conducted on this basis.

(ii) Desirable Forest Composition

The desirable forest composition is one where stands of different ages cover a similar area so that the stock can produce an equal volumetric yield every year.

(iii) Future Forest Composition

If the existing stand composition is successfully improved to the desirable forest composition as a result of forestry operations, forests will have the composition shown in Table Bu-7 and Fig. Bu-5.

The mean tree height, mean DBH, mean volume and mean growth rate, etc. of this desirable forest composition are estimated as shown in Table Bu-6 based on 4-1-(8)-① - Clear Felling Leaving Seed Trees Model.

Table Bu-6 Tree Height, DBH and Volume, etc. of Desirable Forest Composition

Age Class	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Stand Age (years)	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 - 35	36 - 40	41 - 45	46 - 50	51 - 55	56 - 60
Mean Tree Height (m)	1	5	8	12	13	16	20	23	25	26	28	29
Mean DBH (cm)	-	-	-	17	19	22	26	31	33	35	37	39
Mean Volume (m^3/ha)	-	-	-	17	92	140	205	217	228	276	321	362
Mean Growth Rate (%)	-	-	-	-	25.3	11.1	8.2	4.5	4.3	4.1	2.7	2.4

(iv) Sustainable Felling Volume in Future

As the actual forests include riparian forests, forest edges, ridgeline forests, forests with poor hauling conditions and forests on steep slopes with a gradient of 40° or more, all of which are subject to protection, the total area of these forests is assumed to be 40%. The resulting ideal pine resource composition of the forests subject to forestry operations, taking Table Bu-6 into consideration, is shown in Table Bu-7 and Fig. Bu-6.

Following forest improvement, the possible felling volume per year will be approximately 4,700 m^3 (mean volume at the final cutting age of 380 m^3/ha over an area of 13.3 ha; the volume of seed trees is not considered as it exists from the beginning).

(v) Timing of Final Felling in Future

The timing of the final felling in the case of the stands subject to thinning is determined by subtracting the age of the subject stand from the rotation age, i.e. 60 years. As many of the stands subject to thinning appear to be suited to first thinning at a stand age of 20 years, final felling should be conducted some 40 years after thinning. Some stands are suited to second felling at a stand age of 35 years, final felling should be conducted some 25 years after felling in the case of these stands. In the case of the stands subject to improvement work, the improved stands are considered to be the same as those stands which have undergone final felling and, therefore, their final felling should be conducted 60 years after stand improvement.

(b) Non-Commercial Timber Production Forests

Basically, mainly natural regeneration will be carried out. However, planting will be considered in the case of those forests which should be restored as non-commercial timber production forests where recovery of the vegetation is poor. Given the poor forest productivity, aggressive forestry operations will not be conducted and only selective felling to provide timber for personal use will be permitted.

Table Bu-7 Ideal Composition of Pine Forests Subject to Forestry Operations in San Martin Buenavista

Age Class	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total
Area (ha)	62	62	62	62	62	62	62	62	62	62	62	62	740
Stand volume (m^3/ha)	1	7	16	29	92	140	205	217	228	276	321	362	-
Stand volume (m^3)	62	434	992	1,798	5,704	8,680	12,170	13,454	14,136	17,112	19,902	22,444	117,428

Note: The difference in the figure for title is due to round off.

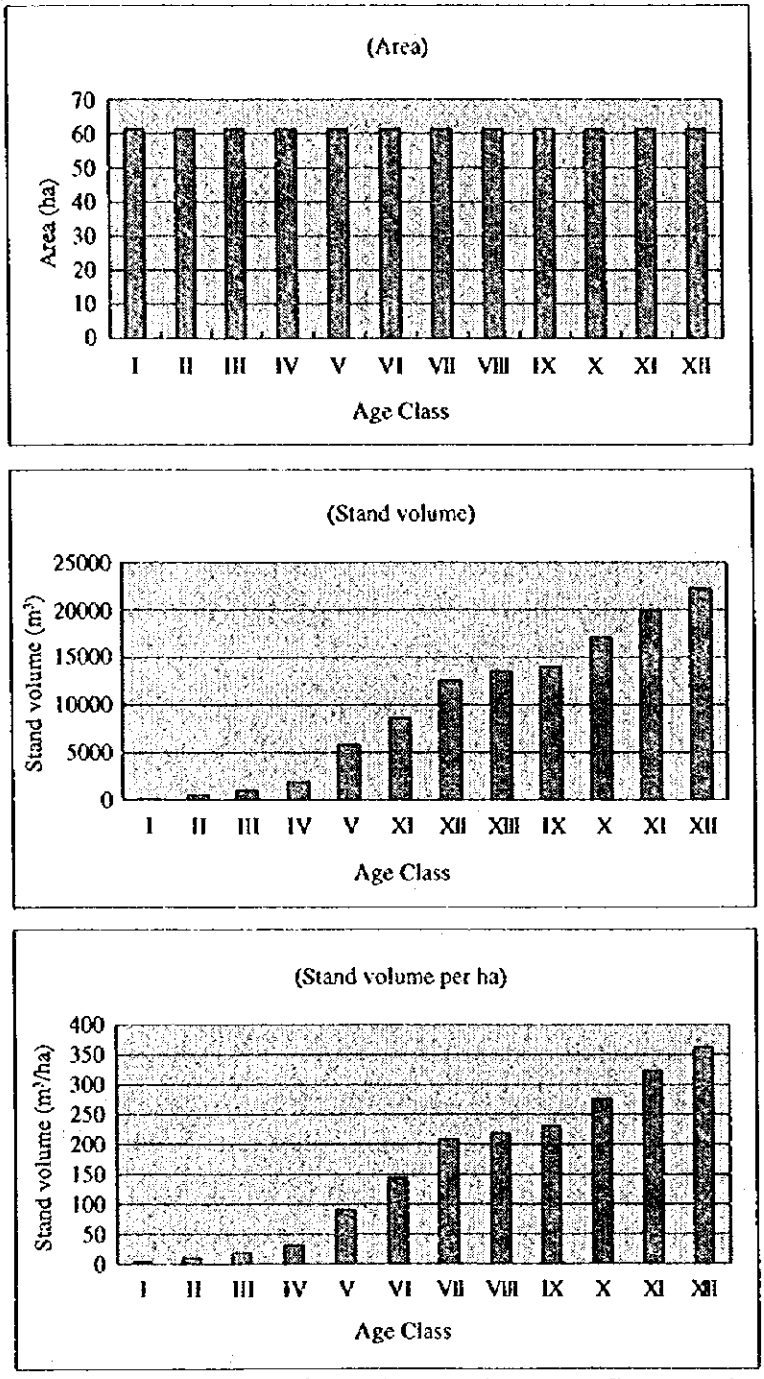


Fig. Bu-6 Ideal Composition of Pine Forests Subject to Forestry Operations in San Martin Buenavista

③ Protection Area

a. Headwater Conservation Forest

In regard to headwater conservation forests, a new area marked for such forests has been established in the upperstream of Rio Negro because of the facts that the bank erosion in the upperstream of the destroyed water intake weir and newly established temporary intake is so severe that early rehabilitation of the site will be very difficult and that the muddy water at the site is not of a suitable quality for drinking purposes. Local people also hope to see a new water intake weir on Rio Negro. One shortcoming of constructing a new water intake weir on Rio Negro is the long piping distance from the intake to the settlement. However, the newly selected site for water intake weir appears to be the best option under the present circumstances because of the large size of the catchment area and the expected constant supply of water throughout the dry season due to the presence of moist mesofilo forests in the upper reaches.

Forestry operations in the headwater conservation forest will follow those adopted by the common plan. In the case of a small number of areas which suffered severe damage and which will be restored to headwater conservation areas, planting will be conducted if the state of natural regeneration at these sites is poor.

b. Other Protection Areas

Forestry operation in other conservation forests will follow those adopted by the common plan. However, in restoration areas planting will be conducted if the state of natural regeneration at these areas appears to be poor, Moreover, recovery of the vegetation is particularly important for soil conservation forests as conservation of the soil by means of vegetation recovery is intended at these forests. For this purpose, no human interference, ranging from the collection of timber for personal use and the collection of firewood (including leaves and branches) to stock raising, will be permitted to ensure the recovery of the vegetation.

(4) Erosion Control

① Background of the Problem of Erosion in the Comunidad

Prior to the forest fire of May, 1998, which damaged or destroyed large areas of forests in the comunidad and in its surrounding areas, the comunidad's forests, due to the existence of a vegetation cover consisting of trees and undergrowth as well as litter

and humus on the forest floor, were fully performing their soil and water conservation functions: 1) by protecting the ground surface against the direct impact of rain 2) by retaining or infiltrating a part of the rain water and releasing its remaining part gradually into the stream and regulating the surface runoff by reducing its velocity. In short, the ground was protected by vegetation and a balance existed between the amount of surface runoff that flowed from the forest and the capacity of slopes and streams to handle the runoff. Therefore, erosion was minimum and it did not affect the area in a serious way.

However, after the forest fire, which destroyed the vegetation cover, the forests could not perform their protective and runoff regulating functions fully. As a result, during the rainy season the amount of surface runoff increased considerably. And given the relatively steep topography of the area, erosion of various types and degrees started occurring in the comunidad, creating problems for local inhabitants by damaging farmlands, an orchard, roads and the drinking water intake facility of the comunidad.

② Damage Condition

The condition of damage by erosion after the forest fire is as stated in Table Bu-8. Distribution of erosion type is shown in Fig. Bu-7.

Table Bu-8 Condition of Damage by Erosion

Type	Main Damage
Gully erosion	• Gullies formed in the cut and fill slopes of roads; • Sediment deposition on farmlands from gullies occurred inside forest; • Gullies formed inside farmlands;
Slope failure	• Slope failures occurred in the cut and fill slopes of roads; • Sediment deposition on an orchard from slope failures occurred in the upstream areas of the orchard;
Streambank erosion	• Destruction of drinking water facility (intake and tank) due to flooding and sedimentation; • Damage to a farmland in the upper part of the destroyed drinking water facility due to bank collapse;
Road erosion	• Erosion of road drainage channels due to increased runoff water and sedimentation;

In case of a heavy rainfall, the possibility exist of further damages due to erosion in the sites with specifications as mentioned below.

- Sites where forest trees and understorey vegetation are totally destroyed;
- Sites where soil is unconsolidated and is deep (in some locations the depth of unconsolidated soil is more than 10 meters);
- Slope failures and eroded streambanks near the crowns of which tension cracks exist;
- Slope failures in the toe area of which seepage points exist;
- Roads without proper drainage facilities;

③ People's Perception of the Problem of Erosion

People's perception of the problem of erosion and their interest in controlling it are important from the view point of people's participation in erosion control activities, future maintenance of erosion control facilities and, thus, sustainability of conservation activities.

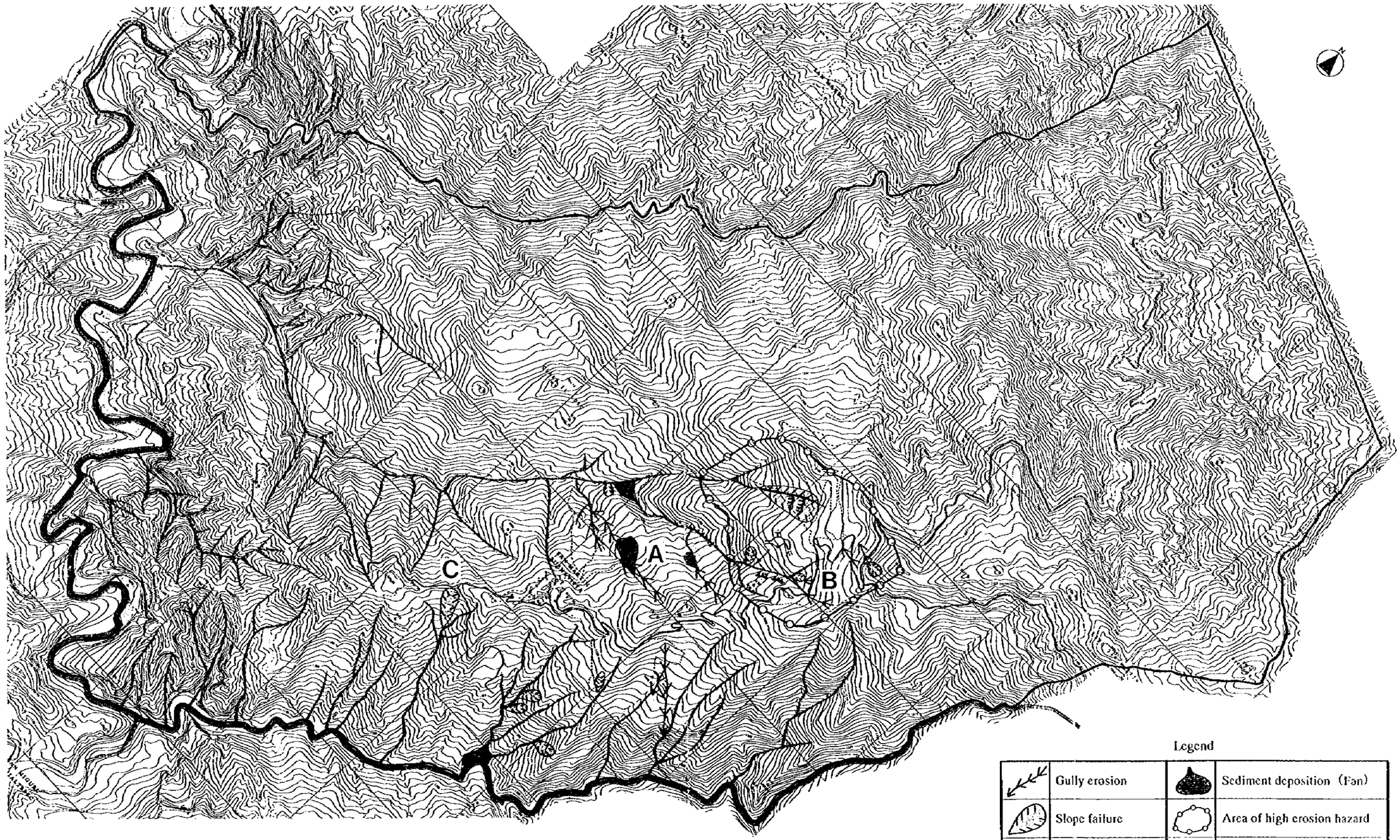
There was a general awareness among the local inhabitants in regard to the problem of erosion and the damage caused by erosion after the forest fire. People mentioned six sites affected by erosion to be surveyed. The sites were farmlands, an orchard and drinking water facility of the comunidad damaged by gully erosion, sedimentation and streambank erosion.

Local people were assisted in deepening their understanding of how and why erosion occurs after forest fire, its consequences if not controlled and basic simple methods for erosion control by conducting actual explanations in some of the affected areas.

④ Proposed Guidelines for Control of Erosion

a. Basic Principles of Proposed Guidelines

- Only those eroded sites which create problems for local inhabitants and which have conservation objects nearby to be protected will be controlled. Conservation objects will be mainly farmlands and roads of the comunidad.



Legend

	Gully erosion		Sediment deposition (Fan)
	Slope failure		Area of high erosion hazard
	Tension crack		Destroyed drinking water intake weir
	Streambank erosion		River

Fig. Bu-7 Erosion Distribution Map

- Simple and low cost structural measures such as loose stone check dam, log check dam, wattling, etc., the material for construction of which is available in the village and can be constructed by local inhabitants using simple techniques, will be proposed. These are temporary measures that, depending on how they are built and maintained, may last for up to 4 or 5 years during which time the re-establishment of vegetation cover through the steady forest recovery is expected to considerably slow down the erosion process.

- All treated sites will be protected against grazing, cutting and fire to preserve the structures and to encourage regeneration and growth of plants. Also in view of sustainability of conservation work and for erosion control structures to function efficiently, maintenance of all structures will be carried out regularly.

b. Erosion Type and Proposed Control Measures

Some typical erosion types and proposed measures for their control are shown in Fig. Bu-8. State of erosion and content of control measures are as mentioned below.

(a) Gully Erosion* Control

i. State of Gully Erosion

The main factor affecting gully formation in the comunidad is the forest fire which, as stated earlier, destroyed the vegetation cover. This resulted in substantial increase of surface runoff during the rainy season and thus gullying. As was observed in the field, backward progress (advancement) of gully head (head cutting), as shown in Fig. Bu-9,

* In the process of water erosion the first stage is splash erosion which occurs due to the impact effect of the raindrops which breaks down soil aggregates. The second stage is rill erosion as the water concentrates into small channels. The third stage, which is advanced stage of rill erosion, is gully erosion when many rills join and the eroded channels are larger. And finally streambank erosion when rivers and streams are cutting into the banks. A simple classification from the view point of size defines rill erosion as small washes and channels which can be eliminated by nonnal tillage and gullies when the channels are so large and well established that they cannot be crossed by farm implements and cannot be obliterated by tillage. A more precise classification based on size by FAO (Conservation Guide 13/2) states rills to be channels not deeper than 30 cm and gullies as:

Gully Class	Gully Depth (m)	Gully Drainage Area (ha)
Small	less than 1	less than 2
Medium	1 to 5	2 to 20
Large	More than 5	more than 20

Gullies are also classified based on shape (U shaped, V shaped, Trapezoidal) and based on continuation (continuous or branchy, discontinuous or independent).

collapse of gully sides and down cutting are taking place in all gullies occurred in the comunidad, which indicate that the gullies are expanding and are currently active. This situation could continue until measures are taken to control the gully erosion, or until forests are fully recovered. However, a gradual recovery of forests, if takes place, will have a positive effect on the gully erosion and could slow down gully expansion.

The significance of gully erosion for the comunidad is that it has become a source of sediment in streams, has already damaged the main road and farmlands by depositing sand and gravel (forming fan) on their surfaces and has formed several gully channels (measuring in size from 0.5m to 2.0m deep, from 0.6m to 4.0m wide and several hundreds of meters long) inside farmlands.

ii. Proposed Control Measures

The main aim of gully control in the comunidad will be to prevent further expansion of gully erosion and thus reduce damage to farmlands and infrastructure to the minimum. Control measures will be applied by following the steps as mentioned below. Implementation of control measures in each step should begin from the upper areas of a gully to prevent the flow of sediment to lower areas.

Step 1. On the slopes above the gully head and around the gully

On the steep slopes, branches of trees, damaged or died due to the forest fire, will be laid along the contour at a distance of some 10 meters. Generally 3 or 4 layers of branches will be placed above one another. The branches will be pressed firmly to the ground to contact the ground tightly. The branches will be anchored by stakes driven into the ground every 10 to 15m meters, when judged in the field that the branches may slide down the slope, such as on very steep slopes of 30° or more. On more gentle slopes (10° to 15° or less) brush mulching will be conducted by spreading branches over the slope, which will create a degree of cover for the ground surface (Fig. Bu-10 A, B).

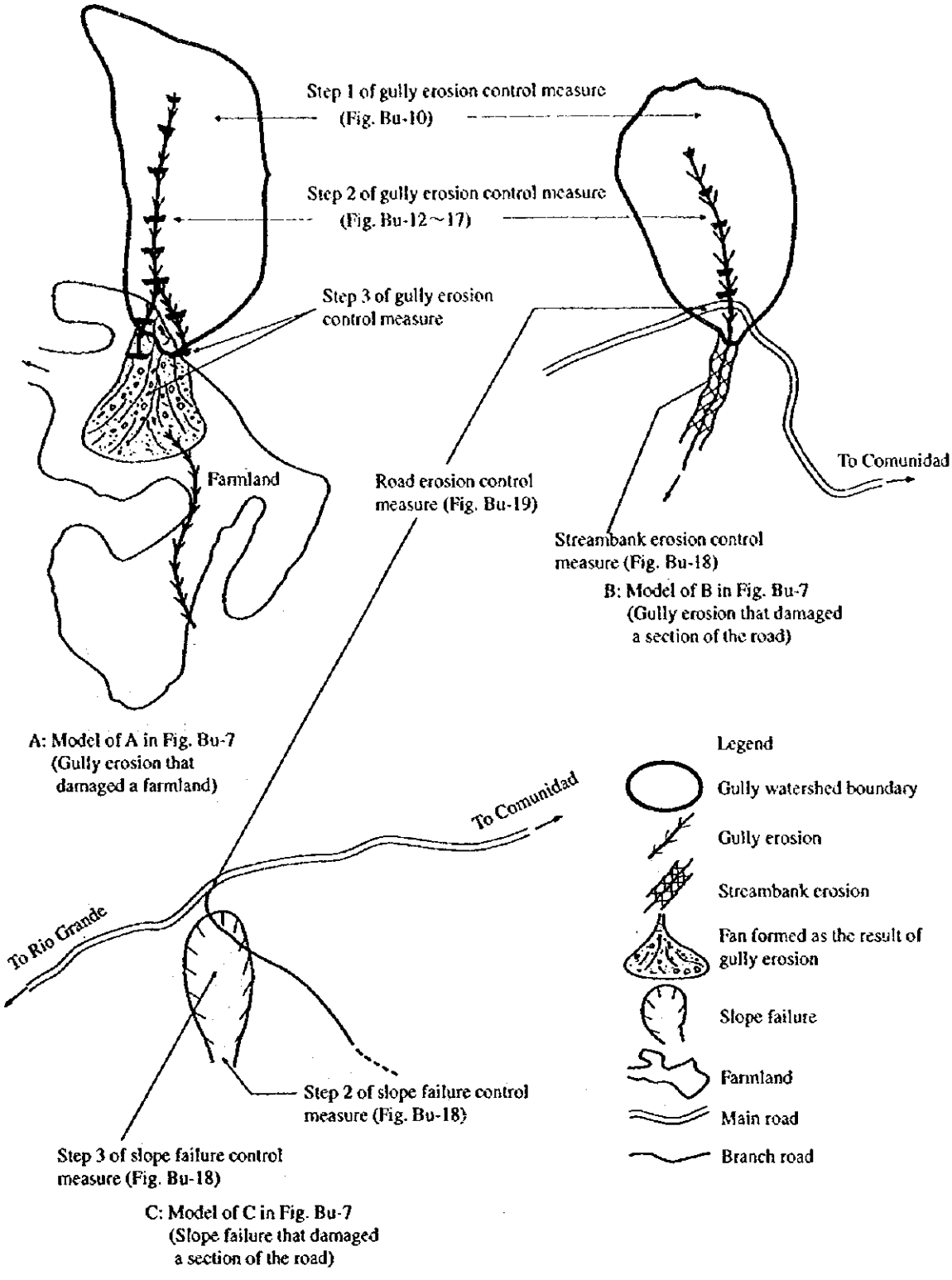


Fig. Bu-8 Some Typical Erosion Types that Occurred in the Comunidad and Proposed Measures for Their Control

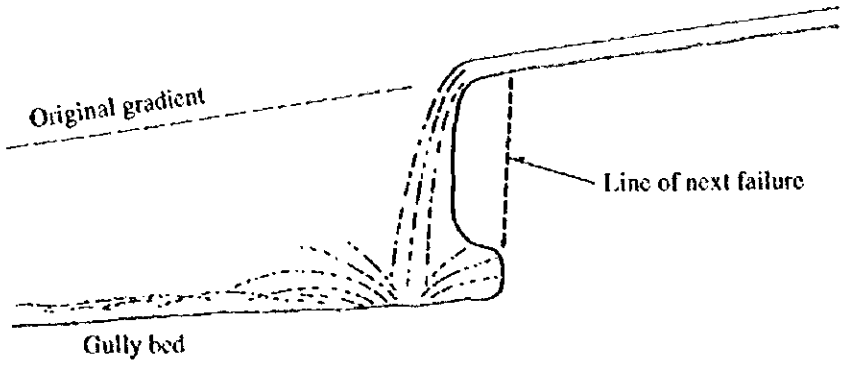


Fig. Bu-9 The Progressive Development of Gully Head

One of the functions of measures as mentioned in step 1 will be to reduce the velocity and concentration of runoff water by creating barriers at its flow path and reducing its energy. However, the branches will not block the flow of runoff water totally and instead will act as permeable barriers across which runoff water will flow, albeit at a greatly reduced speed and most of the sediment (sand and small stones) carried by the runoff will be deposited on the slope. This will stabilize the land surface between the barriers and in mulched areas and will facilitate natural regeneration by providing a relatively stable site for seeds to grow. To achieve the maximum possible results from the practice, it is very important to protect the treated areas against fire and grazing.

Step 2. Inside the gully

Inside the gully a series of check dams (approx. 8 to 12 dams per 100m of gully) will be constructed, either by using stones or logs, depending on which material is available and how stony or hard the ground of the gully floor is. If the ground is so hard that logs or posts cannot be driven, then stone check dams will have to be built, otherwise log check dams could be constructed.

For this type of low cost simple dams built by local people, the first dam could consist, for example, of a few stones of 10cm or more in diameter constructed at the head of the gully with a depth and width of less than 0.5m. The subsequent dams should be constructed on stable points in the gully, such as the points with rock outcrops on both

sides. Also preference should be given to the narrowest part of the gully in order to reduce construction work and cost.

Check dams are not necessary on those gully portions which consist of continuous rock outcrops because no channel and lateral erosion is expected in such sections.

A very important point will be the installation of aprons on the gully bottom and protective works on the gully side slopes below each check dam, otherwise flow may easily undercut the structure from downstream and destroy it. Also, spillway crest of the dam must be kept lower than the ends, allowing water to flow over the dam rather than around it.

Small undercut parts on the gully sides (walls) could be stabilized by building retaining wall of stones or logs along them. Large and hanging undercuts in danger of crumbling should be re-sloped (re-shaped) as shown in Fig. Bu-11 and soil from them deposited behind dams (Fig. Bu-12 to Bu-17).

The function of the check dams constructed across the gully bed will be to stop channel and lateral erosion. By reducing the original gradient of the gully channel, check dams diminish the velocity of flow and erosive power of runoff water. Also check dams hold soil and moisture in the bottom of the gully. This will help the growth of plants in gullies without being washed away by the flowing water. Thus a permanent vegetation cover can be established in a short time.

– Specifications of Log Check Dams

- The maximum height of the dam will be 1.0m from the ground (effective height);
- Logs are set in one or two rows across the gully to a depth of about 1/3 to 1/2 of the log length and about 0.3m to 0.4m apart;
- The length of the log will be 1.5m and their top end diameter will be 8cm to 12cm;

- Interlink material consisting of flexible brunches are woven between wooden logs driven into the ground;

- The ends of interlink material should enter at least 30cm into the sides of the gully;

- Both its downstream and upstream face inclination will be some 30% backwards;

- The wings on each side should be protected against flush water by wing walls. Dry rock walls or log wing walls can be built;

- Rock or brush may be used for the apron. If brush is used it should be anchored by inserting it in both sides of the gully or by stakes. Apron should be at least 1.0m to 1.2m long;

– Specifications of Loose Stone Check Dams

- The maximum effective height (above ground) of the dam will be 1.5m;

- Foundation depth will be 0.5m to 0.8m;

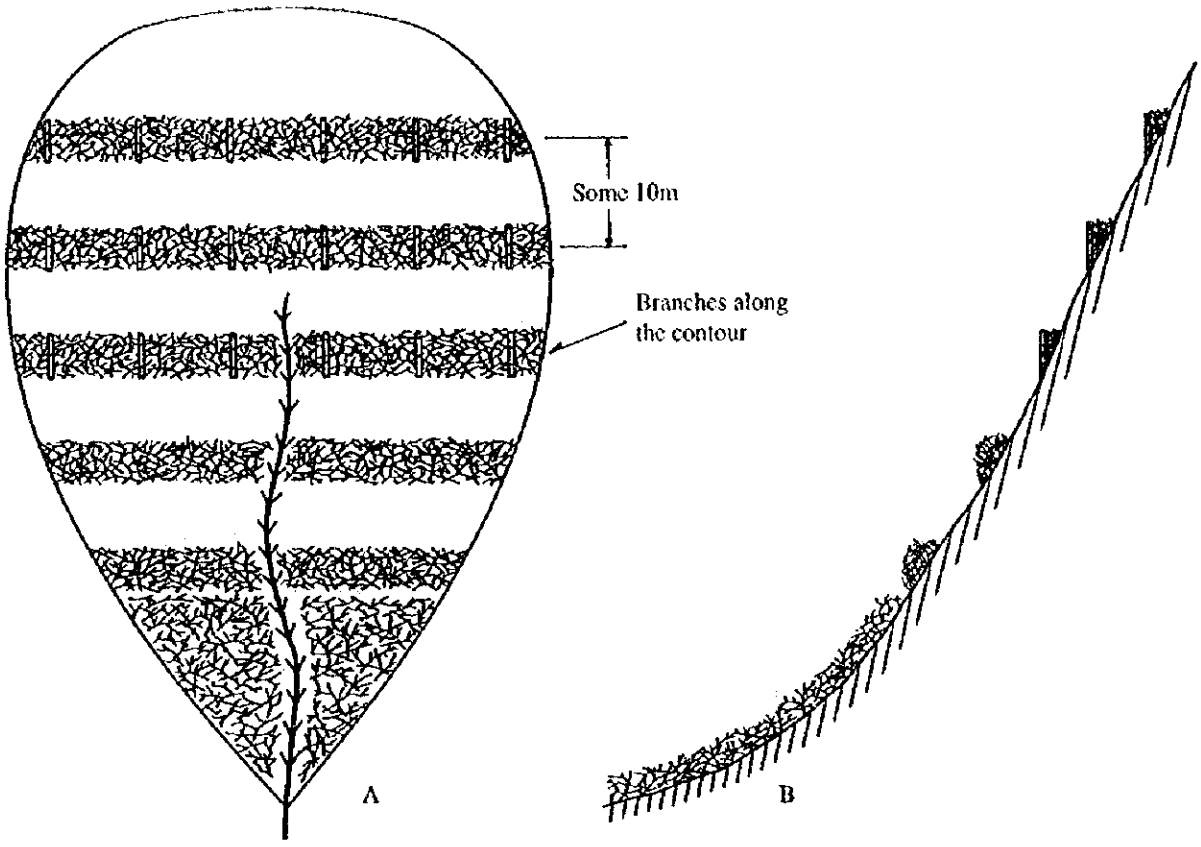
- The thickness of the dam will be 0.5m to 0.7m at the crest and some 1.0m at the base;

- Inclination of downstream face will be 20%. The upstream face of the dam is generally vertical;

- The dam wings will enter at least 0.5m into each side of the gully;

- The middle part of the dam will be constructed with bigger rocks than the rest of the dam;

- The wings of the dam should be protected against flush water by wing walls;



A: Branches along the contour in the upper part of the slope and brush mulching in its lower section
B: A cross-section of A

Fig. Bu-10 Step 1 of Proposed Gully Control Measures

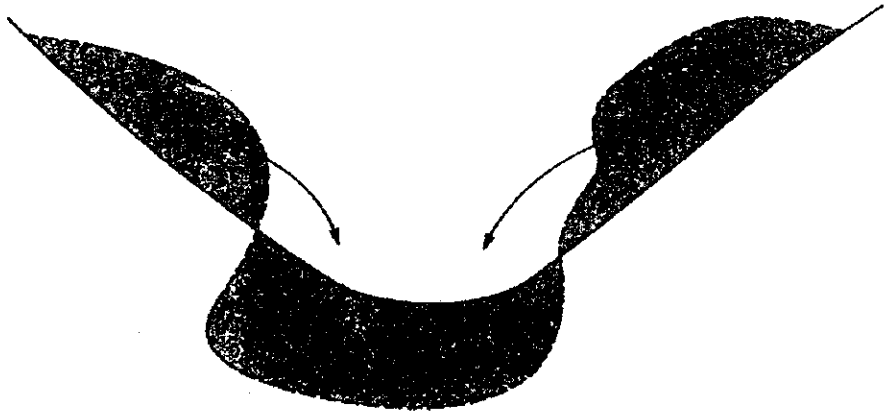


Fig. Bu-11 Re-sloping of the Crumbling Walls of Gully (before and after)

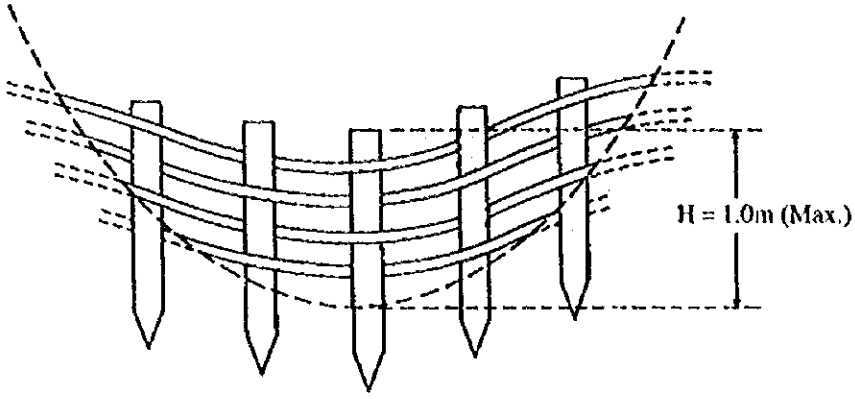


Fig. Bu-12 Front View of log Check Dam

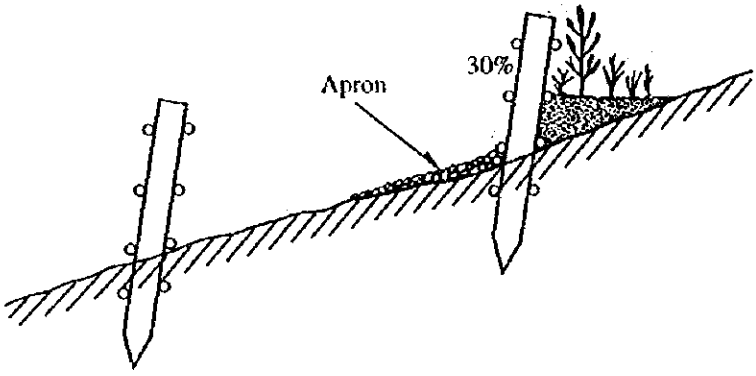


Fig. Bu-13 Cross-section of Log Check Dam

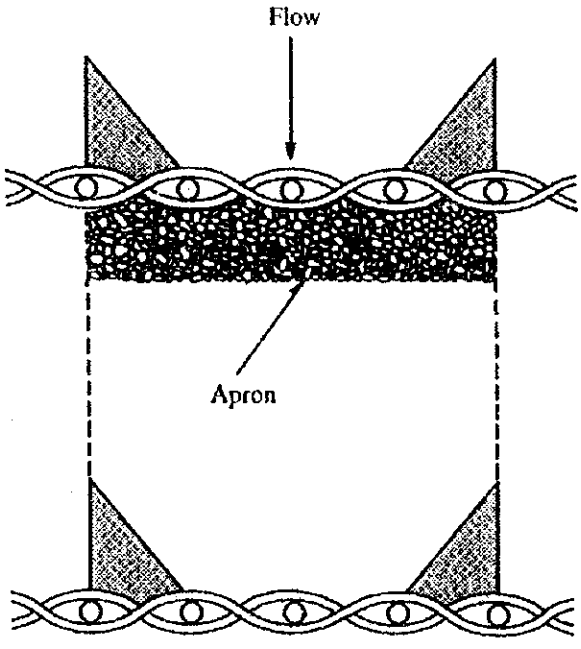


Fig. Bu-14 Top View of Log Check Dam

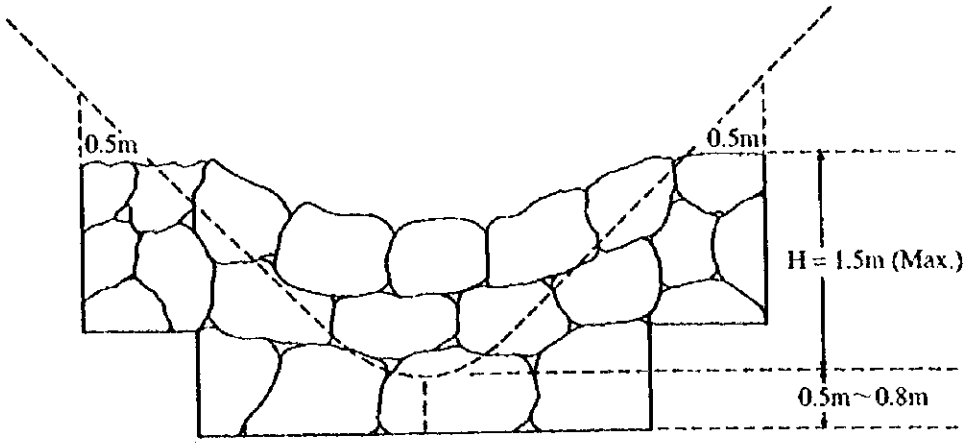


Fig. Bu-15 Front View of Loose Stone Check Dam

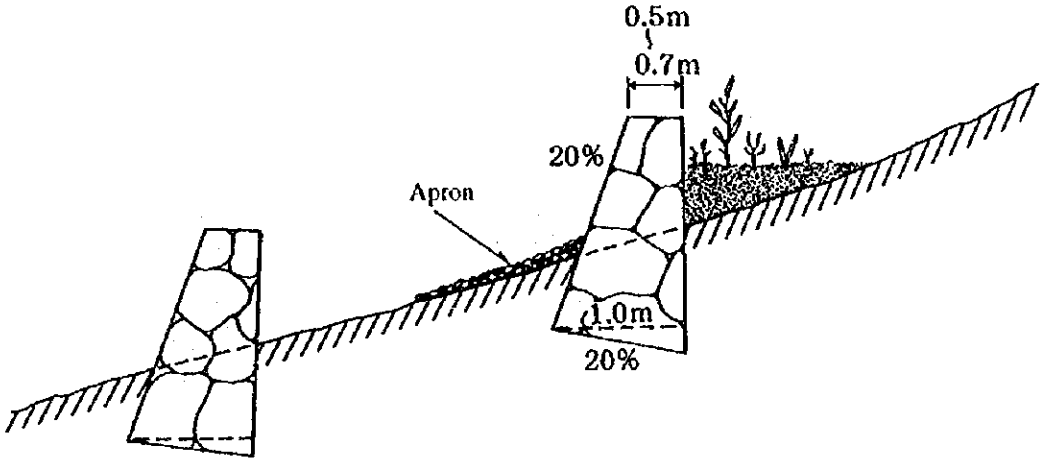


Fig. Bu-16 Cross-section of Loose Stone Check Dam

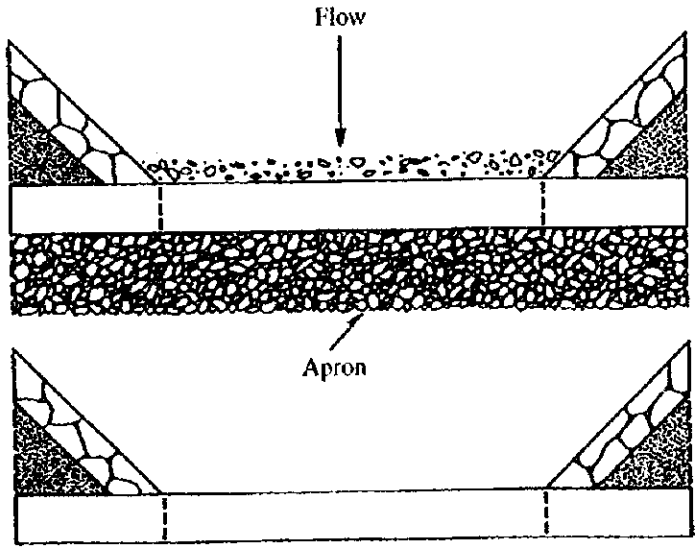


Fig. Bu-17 Top View of Loose Stone Check Dam

- The form of the spillway will be concave;

- Apron specification will be the same as the log check dam;

Step 3. To deal with the sediment deposited by gullies on the farmland

Where a major break in slope appeared, such as in the mountain foot, the velocity and energy of flow from the upper slope gully decreased considerably and this resulted in deposition of sediment (fan) carried by the flow on the flat land below, which are farmlands. Some of the stones deposited on the farmlands are as large as 1.4m in diameter but the majority are of 10cm to 30cm size class. The fan that is formed inside the farmland made the farmland unsuitable for farming.

To rehabilitate the farmlands, first the works that were mentioned in Steps 1 and 2 have to be carried-out. Then, since the gully mouth in the affected area is large (the largest one being 4m wide and 2m deep) a loose stone check dam could be constructed in the mouth of the gully and 2 or 3 dams behind it. The large and medium size stones from the dam could be used for construction of the check dams.

(b) Slope Failure Control

i. State of Slope Failure

Slope failure have occurred in several locations in the comunidad after the forest fire. The largest failure is in the upper stream of Rio Escopeta in the northern part of the comunidad inside a heavily burned forest. The failure is on deep unconsolidated soil and there are a number of tension cracks near the crown and inside the failure as well as many seepage points at its toe, which indicate that groundwater may have played an important role in the occurrence of this failure. There are no conservation objects near or in the downstream areas of the failure.

Small slope failures (measuring in size from 12m to 15m wide, 0.5m to 4.0m deep and estimated to be 50m to 120m long) have occurred in areas containing deep and unconsolidated soil mainly due to a high surface runoff from heavily burned forests, from roads with improper drainage and from roads without drainage facilities. Some of these failures occurred inside the forest and conservation objects nearby to be

protected do not exist. However, a slope failure destroyed some 15m section of a branch road between the comunidad and Rio Grande and could damage the main road if not controlled. Also sediment from some of the failures severely damaged a comunidad orchard along Rio San Martin.

ii. Proposed Control Measures

For an effective control of small scale slope failures in the comunidad, application of the following measures in 3 steps as mentioned below are proposed.

Step 1. Diversion of surface runoff from the crown area of the failure

- Where the source of surface runoff is a road, located above a failure, the road's existing drainage facilities have to be improved. If such facilities do not exist they have to be constructed. For road drainage improvement see (d).

- If there are any tension cracks near the crown they should be filled and covered using clayey soil to prevent infiltration of runoff water.

Step 2. Stabilization of the whole failure

A soil retaining wall made of stones could be constructed at the toe of the failure. Specifications of the wall will be the same as mentioned for loose stone check dam in gully control. However, when the size of the failure is large (deeper than 1.0m, for example) wet masonry wall is preferred. If this cannot be constructed, then larger stones should be used for construction of the retaining wall and the wall's foundation depth should be half of its height.

Step 3. Stabilization of the scar surface

Usually rills and gullies develop on the scars of newly occurred slope failures. These have to be obliterated and the scar surface smoothened. Then wattling will be conducted on the scar using posts or logs and branches (Fig. Bu-18). The following specifications are proposed.

- Post top end diameter will be some 10cm and set in one row 0.3m to 0.4m apart;

- Post length will be 1.5m (some 0.5m of which driven into the ground);

- The distance between the rows will be 3m to 5m;

- Interlink material consisting of branches are woven between the posts. The ends of interlinks will be driven at least 30cm into the failure's sides;

The function of measures as mentioned in steps 1 to 3 will be to prevent expansion of a failure and to stabilize it. This will provide a suitable ground for the growth of plants which, together with structural measures, are necessary for rehabilitation of slope failures. After completion of the measures, two options could be considered.

Option 1. Protect the treated slope failure from human and animal entry and wait for natural regeneration of plants to occur.

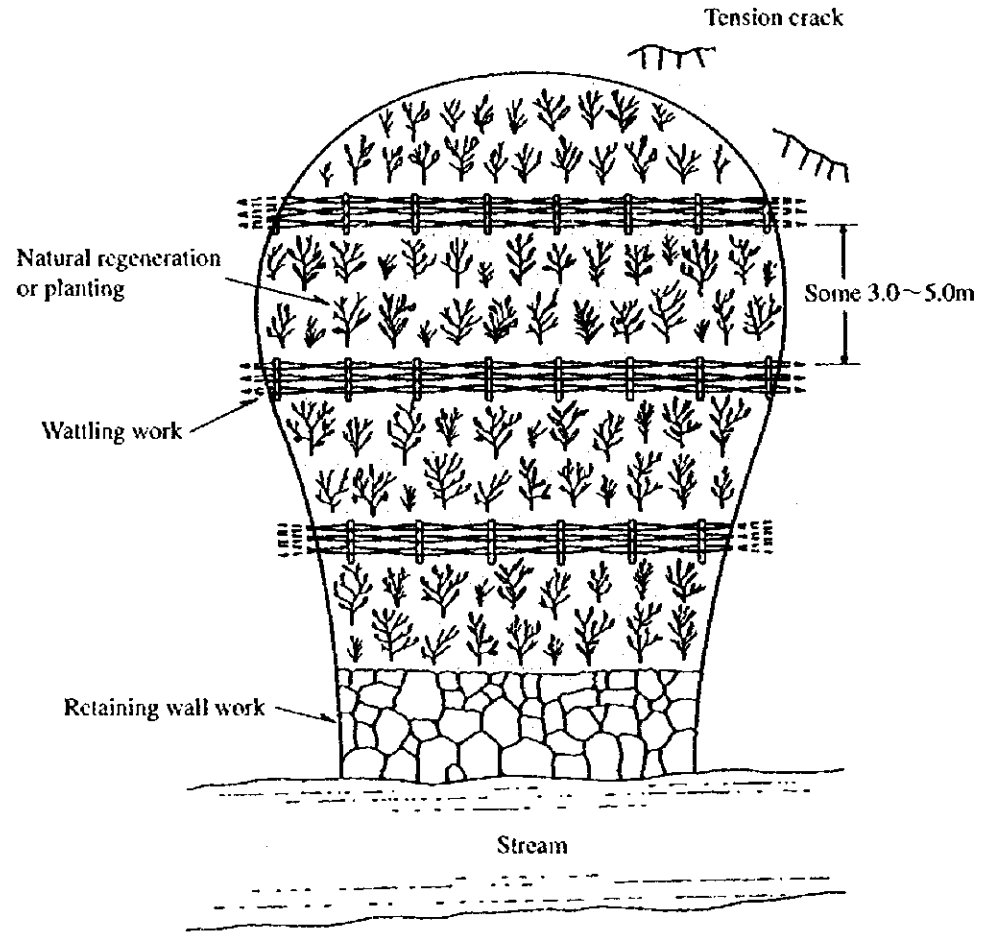


Fig. Bu-18 Steps 2 and 3 of Slope Failure and Streambank Erosion Control Measures

Option 2. To accelerate plant recovery by growing the seeds of Palo de aquila (*Alnus* spp.) and Guaje (*Leucaena* spp.) in between the rows of wattlings. Both of these are soil improving species and grow well in severe environments such as in scars of slope failures.

(c) Streambank Erosion

i. State of Streambank Erosion

Streambank erosion occurred mainly along Rio Escopeta and its tributaries and also along some tributaries of Rio San Martin (Rio Arriero). It occurred when a large amount of runoff water, produced for the same reasons as mentioned in the case of gully erosion and slope failure, entered into the streams and undercut streambanks which then collapsed. The undercutting took place because the amount of runoff water greatly exceeded the capacity of streams to accommodate it.

Along an upstream tributary of Rio Escopeta flooding and the resulting streambank collapse completely destroyed drinking water intake facility (intake weir and tank) of the comunidad and damaged a farmland in the upper part of the facility. Streambank erosion sites are roughly of the same sizes as of small slope failures.

ii. Proposed Control Measures

Where the drinking water intake facility was destroyed the streambanks are very steep and consist of deep unconsolidated soil, which make the banks susceptible to further undercutting and erosion by flood water during the rainy season. Therefore, a full rehabilitation of the intake area will be difficult, because it will require major engineering undertakings such as construction of concrete dams, retaining walls, etc. which will be costly. Moreover, the water is of poor quality at the intake area.

For mitigation of those eroded streambanks which have conservation objects nearby, the following measures are proposed.

- To apply the measures as mentioned in steps 1 and 2 of gully erosion to the upper slopes of the streams and to promote forest recovery

through protection activities in order to regulate the surface runoff flowing into the streams.

- For eroded streambanks of small sizes, for example of less than 1m depth and 15m width, the measures as mentioned in steps 2 and 3 for slope failure control plus filling of tension cracks, if exist, could be applied (Fig. Bu-18).

(d) Road Erosion Control

i. State of Road Erosion

After the forest fire, high runoff during the rainy season, which could not be discharged safely by road drainage channels not maintained properly or by roads lacking drainage channels, caused the following erosion in some sections of the main road as well as in branch roads of the comunidad.

- Gully erosion and slope failure in cut slopes and fill slopes;

- Gullying of the drainage channels;

ii. Proposed Control Measures

The following erosion control measures are proposed.

- Existing side drainage channels will be improved by clearing them of debris before the onset of the rainy season to prevent plugging and to facilitate the flow of runoff water;

- Where side drains do not exist, or are destroyed, drainage ways 0.5m wide and 0.3m deep have to be built. Where scouring of beds and sides of channels is expected or already occurred, steps (drop structures) have to be constructed inside channels using stones or logs. Where water concentration from side drains is expected, cross drains 0.3m wide and 0.3m deep will be constructed using logs. Water from the cross drains should be led to a stable stream (containing vegetation on both sides and without sings of active erosion), or onto the rock outcrop areas for safe draining (Fig. Bu-19).

- Gullies in the fill or cut slopes will be stabilized using measures as stated in steps 1 and 2 of gully control.

- Failed cut and fill slopes will be stabilized by applying the measures as stated in steps 2 and 3 of slope failure.

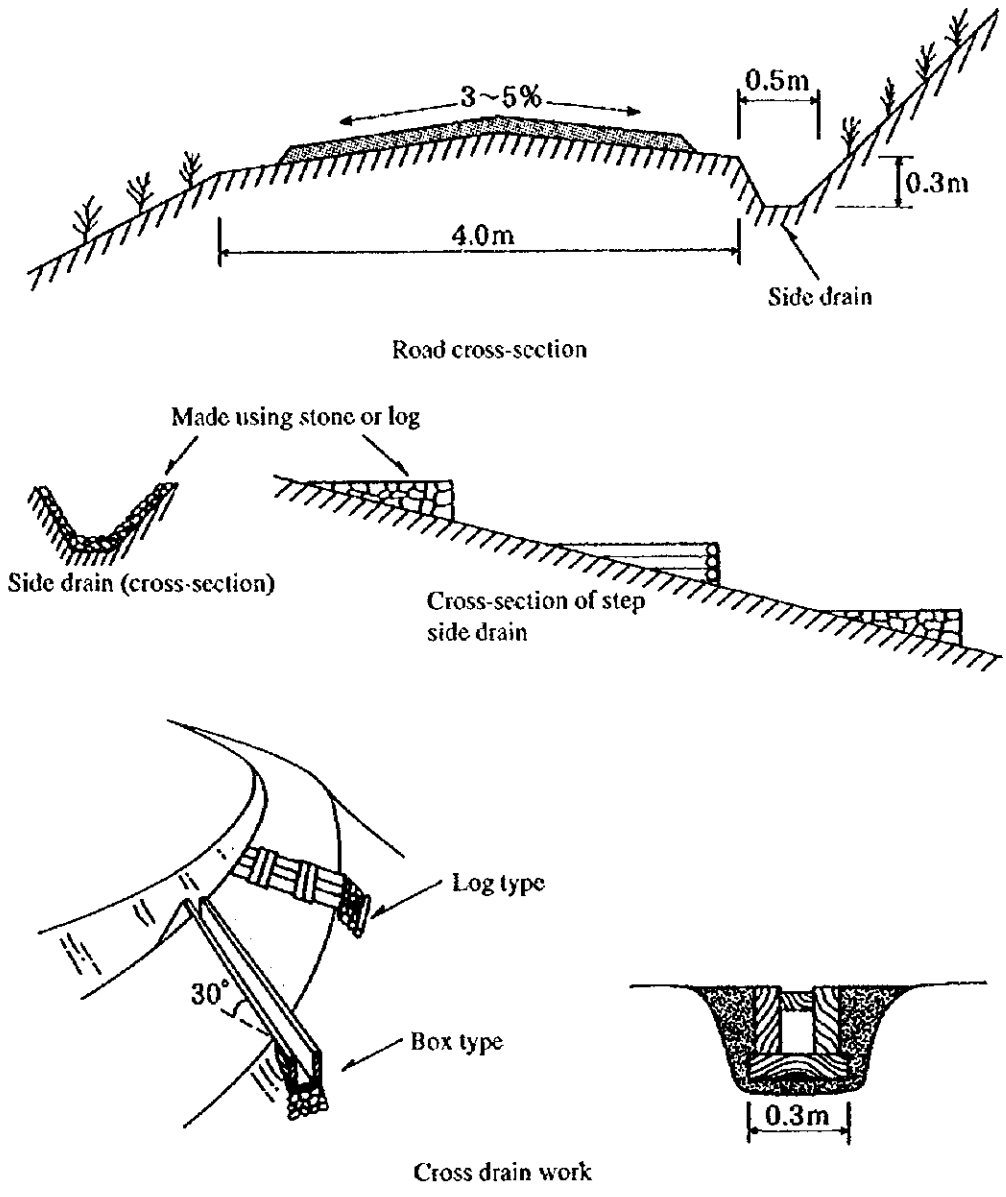


Fig. Bu-19 A Road Cross-section and Run-off Draining Facilities

APPENDIXES

APPENDIX 1 WORK ADVISORY COMMITTEE

The Japan International Cooperation Agency established the Advisory Committee in connection with the implementation of the Study. The Committee consists of the Chairman and two experts. The committee is assigned to provide technical advice for the Study Team in Japan and abroad in view of the smooth implementation of the Study. The members of the Committee are listed below.

Name	Assignment Field	Organization	Remarks
Hiroshi Masuko	Chairman/Social Forestry	Institute for International Cooperation, JICA	
Mikihiro Inoue	Forest Management Plan	Forestry Agency, Ministry of Agriculture, Forestry and Fisheries	
Taizo Yamada	Development of Mountain Villages	Institute for International Cooperation, JICA	Until 28th February, 1998
Yoshio Koyama	Development of Mountain Villages	Institute for International Cooperation, JICA	From 1st March, 1998

APPENDIX 2 MEMBERS OF THE STUDY TEAM

(1) Study Team

Name	Assignment Field	Field Survey Period(s)	Total Days	Organization
Noriyuki Anyoji	Team Leader/Forest Management Plan	09/01/1997 - 01/02/1997	24	JAFTA
		26/02/1997 - 24/03/1997	27	
		24/07/1997 - 02/08/1997	10	
		08/10/1997 - 06/11/1997	30	
		13/11/1997 - 30/11/1997	18	
		21/01/1998 - 28/02/1998	39	
		16/06/1998 - 18/07/1998	33	
		06/10/1998 - 28/10/1998	23	
Hiroaki Masui	Social Forestry/Forest Management	09/01/1997 - 24/03/1997	75	JAFTA
		24/07/1997 - 02/08/1997	10	
		08/10/1997 - 30/11/1997	54	
		21/01/1998 - 28/02/1998	39	
		16/06/1998 - 18/07/1998	33	
		06/10/1998 - 28/10/1998	23	
Atsushi Suzuki	Forest Operation/Forest Inventory	09/01/1997 - 09/03/1997	60	JAFTA
		08/10/1997 - 26/11/1997	50	
		21/01/1998 - 27/02/1998	38	
		16/06/1998 - 17/07/1998	32	
		06/10/1998 - 27/10/1998	22	
Sakiko Takasawa	Social Life in Mountain Villages	09/01/1997 - 09/03/1997	60	IC Net Co., Ltd.
		24/07/1997 - 02/08/1997	10	
		08/10/1997 - 29/11/1997	53	
		01/02/1998 - 05/02/1998	5	
		16/06/1998 - 17/07/1998	32	
		06/10/1998 - 27/10/1998	22	
Tomoo Mochida	Project Evaluation (Financial & Economic)	30/10/1997 - 29/11/1997	32	Overseas Project Management Consultant, Ltd.
		16/06/1998 - 15/07/1998	30	
		06/10/1998 - 17/10/1998	12	
Shuichi Kobayashi	Land Use and Vegetation/Forest Inventory	09/01/1997 - 24/03/1997	75	JAFTA
		08/10/1997 - 27/11/1997	51	
		21/01/1998 - 28/02/1998	39	
		16/06/1998 - 18/07/1998	33	
		09/10/1998 - 28/10/1998	20	
Teruji Nakamura	Soil Survey/ Environmental Impact	08/10/1997 - 27/11/1997	51	JAFTA
		21/01/1998 - 28/02/1998	39	
Yasuko Matsumi	Environmental Impacts	09/01/1997 - 12/02/1997	35	JAFTA
Osman Atif	Erosion Control	09/10/1998 - 28/10/1998	20	JAFTA
Hirohisa Okuhara	Aerial Photography Supervision	05/01/1997 - 20/03/1997	75	Pasco International, Inc.
Yutaka Nakada	Surveying and Mapping Supervision	08/05/1997 - 21/05/1997	14	Pasco International, Inc.
		01/09/1997 - 11/11/1997	72	
Hideaki Sakai	Coordination	05/01/1997 - 21/01/1997	17	Pasco International, Inc.
		08/05/1997 - 21/05/1997	14	
Tsutomu Yoshimura	Coordination	19/01/1997 - 01/02/1997	14	JAFTA

(2) Advisory Team

Name	Assignment Field	Field Survey Period(s)	Total Days	Organization
Hiroshi Masuko	Team Leader	09/01/1997 - 18/01/1997	10	JICA
Takamasa Hayase	Study Supervision	09/01/1997 - 18/01/1997	10	JICA
Hirohito Takata	Study Planning	09/01/1997 - 18/01/1997	10	JICA
Mikihiro Inoue	Forest Management	24/07/1997 - 02/08/1997	10	Forestry Agency
Taizo Yamada	Social Life in Mountain Villages/Local Development	24/07/1997 - 02/08/1997	10	JICA
Ayako Shibuya	Study Planning	24/07/1007 - 02/08/1997	10	JICA
Yoshio Koyama	Social Life in Mountain Villages/Local Development	16/06/1998 - 27/06/1998	12	JICA
Tasuku Ishibashi	Study Supervision	16/06/1998 - 27/06/1998	12	JICA
Tetsuya Kamijo	Study Supervision	06/10/1998 - 16/10/1998	11	JICA

APPENDIX 3 LIST OF MAIN CONCERNED PERSONS

(1) Mexican Side

1) SRE: Secretariat of Foreign Relation, General Directorate of Technical and Scientific Cooperation, Request for Technical Cooperation

Lic. Cristina Ruíz Ruíz: Director of Request for Technical Cooperation

2) SEMARNAP: Secretariat of Environment, Natural Resources and Fisheries

Ing. Víctor Sosa Cedillo: Director General of Forestry

Ing. Francisco J. Musalem López: Director of Forest Utilization

Ing. Mario Aguilar Hernández: Deputy Director of Forest Utilization

Ing. Saúl B. Monreal Rangel: Deputy Director of Promotion

Ing. Lorenzo Arzate Faurrieta: Chief of Department of Forest Resources (Timber) Utilization

Ing. Cuauhtémoc Tejeda Godínez:	Chief of Department of Non-Timber Forest Resources Utilization
Ing. Iván López Cartes:	In Charge of Sub-Directorate of International Policy

3) SEMARNAP Office in Oaxaca State

Biól. Salvador Anta Fonseca:	Federal Representative
Ing. Antonio Plancarte Barrera:	Deputy Federal Representative for Natural Resources
Biól. Ignacio Piña Espallargas:	Deputy Federal Representative for Environment
Ing. Mauricio Soberanes H.:	Deputy Federal Representative for Planning
Ing. Juan Carlos Lpez Bacerra:	Chief of Forest Protection Programme
Ing. Juan Manuel Barrera Teherán:	Chief of Forest Regulation and Management
Ing. Pedro Vidal Garcia:	Liaison Officer for Sierra Juárez
Lic. David Melendez:	Deputy Coordinator for Sierra Juárez
Ing. Samuel Caudillo:	Liaison Engineer
Ing. Carlos Ramón López:	Liaison Engineer
Ing. Miguel Angel Galeote Ruíz:	Liaison Engineer
Ing. Armando Vargas Ruíz:	Assistant for Sierra Juárez

4) Government of Oaxaca State

Secretariat of Agriculture, Livestock and Forestry Development: SEDAF

Ing. Raúl Alvarez Castillo:	Director of Forest Development
Ing. Wilfrido Rufz Pérez:	Chief of Forestry Promotion Department

T.F. Angel Matus Martínez:	Responsible for Non-Timber Products
T.F. Fortunato Hernández Martinez:	Responsible for Silviculture

(2) Japanese Side

1) Embassy of Japan in Mexico

Yasunobu Marui:	Secretary

2) JICA Mexico Office

Saburo Yamaguchi:	Director
Ken Kinoshita:	Ex.Director
Ryozo Hanya:	Assistant Director
Junko Mimaki:	Staff

3) JICA Expert

Takeshi Koide:	Assigned to work at the SEMARNAP (Forestry Planning)