JAPAN INTERNATIONAL COOPERATION AGENCY
MINISTRY OF AGRICULTURE AND FORESTRY, LAO P.D.R.

# THE STUDY ON WATERSHED MANAGEMENT PLAN FOR FOREST CONSERVATION IN VANGVIENG DISTRICT IN LAO PEOPLE'S DEMOCRATIC REPUBLIC

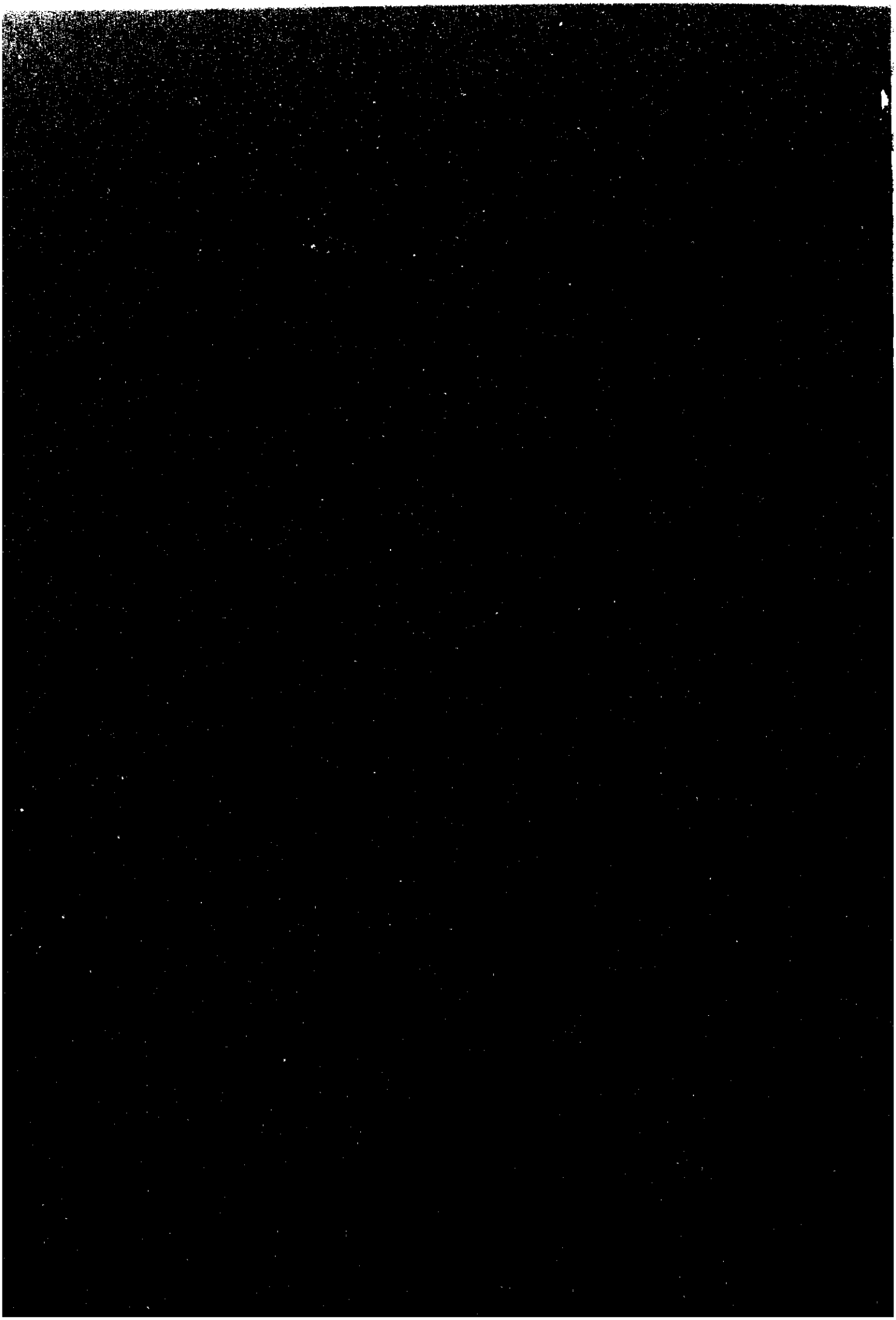
## GUIDELINE FOR FORMULATION OF WATERSHED MANAGEMENT PLAN FOR FOREST CONSERVATION

SEPTEMBER, 1998



JAPAN FOREST TECHNICAL ASSOCIATION (JAFTA)

KOKUSAI KOGYO CO., LTD.



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# PREFACE

The Japan International Cooperation Agency has carried out the Study on Watershed Management Plan for Forest Conservation in Vangvieng District in Lao People's Democratic Republic over a roughly two-year period from September 1996. Under the Study, a watershed management plan for forest conservation has been formulated specifically for the Model Area, comprising one portion of the overall Study Area. These Guidelines accordingly set out an orientation and approach which can be applied to subsequent shaping of watershed management plans in the remaining parts of the Study Area. Toward this end, the necessary work procedure in watershed management plan formulation has been set out in detail from the preparatory stage through the actual planning stages. It is anticipated that these Guidelines will be applied in conceiving projects by the staff of the District Agriculture and Forestry Office (Vangvieng DAFO) and the Provincial Agriculture and Forestry Service Office (Vientiane PAFSO), the government agencies with direct jurisdiction over the Study Area, with the close cooperation of the Department of Forestry under the Ministry of Agriculture and Forestry in Lao PDR.

It is sincerely hoped that these Guidelines can be effectively utilized by the concerned officials and personnel of the relevant agencies of Vientiane province and Vangvieng district in the smooth formulation of appropriate watershed management planning for forest conservation in the Study Area.

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## 1. Outline Flow for Formulating the Plan

A flow for watershed management plan formulation is outlined in Fig. 1-1.

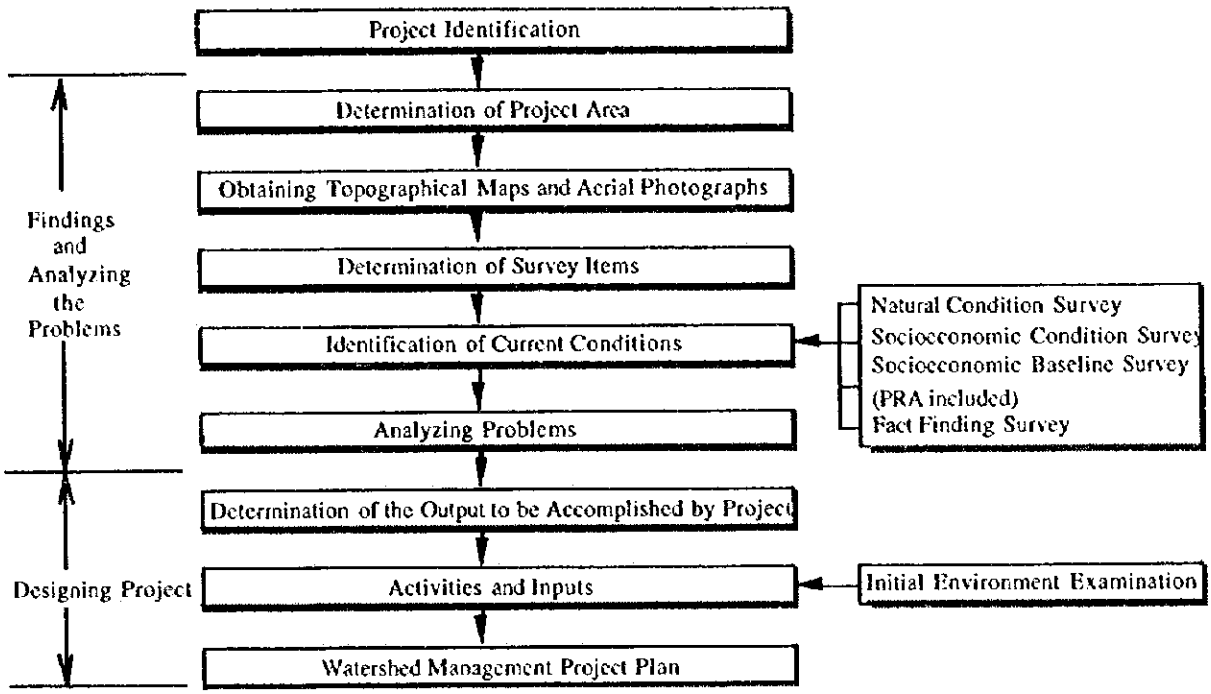



Fig. 1-1 Outline Flow for Plan Formulation

## 2. Preparation Stage

### 2.1 Selection of Project Areas

The Study Area for the study on Watershed Management Plan for Forest Conservation in Vangvieng District is shown in Fig. 2-1. The study was already made for the Model Area by JICA. But for the rest, it is requested to prepare a study by Lao PDR. It is necessary to scope an area according to restrictions of geography and time allocation, existing problems, local people activities, their interrelationship and so on. It is recommendable to make a plan from downstream side neighboring on the Model Area.

### 2.2 Aerial Photographs

Aerial color photographs with a scale of 1 to 20,000 taken by JICA (taken in November to December of 1996) are available at Department of Forestry(DOF). The index map is shown in Fig. 2-2.

### 2.3 Maps

The range of topographical maps with a scale of 1 to 20,000 prepared by JICA is limited to the Model Area. For the region upstream* from the Model Area, the existing maps must be used as follows.

| | | |
|---|---|---|
| Purchase Place of the Maps | : | National Geographic Department of Lao PDR |
| Kinds of maps | : | with a scale 1 to 50,000 (Information as of 1965) |
| | : | with a scale 1 to 100,000 (Information as of 1984) |
| | : | with a scale 1 to 200,000 (Information as of 1985) |
| | : | with a scale 1 to 500,000 (Information as of 1987) |

* When a new topographical map is to be prepared using aerial photographs, level surveying and mapping work will be required. The cost of level surveying for the Study Area of some 110,000 ha, is estimated to be US$ 150,000 - 160,000 and the mapping cost is estimated to be approximately US$ 440,000.

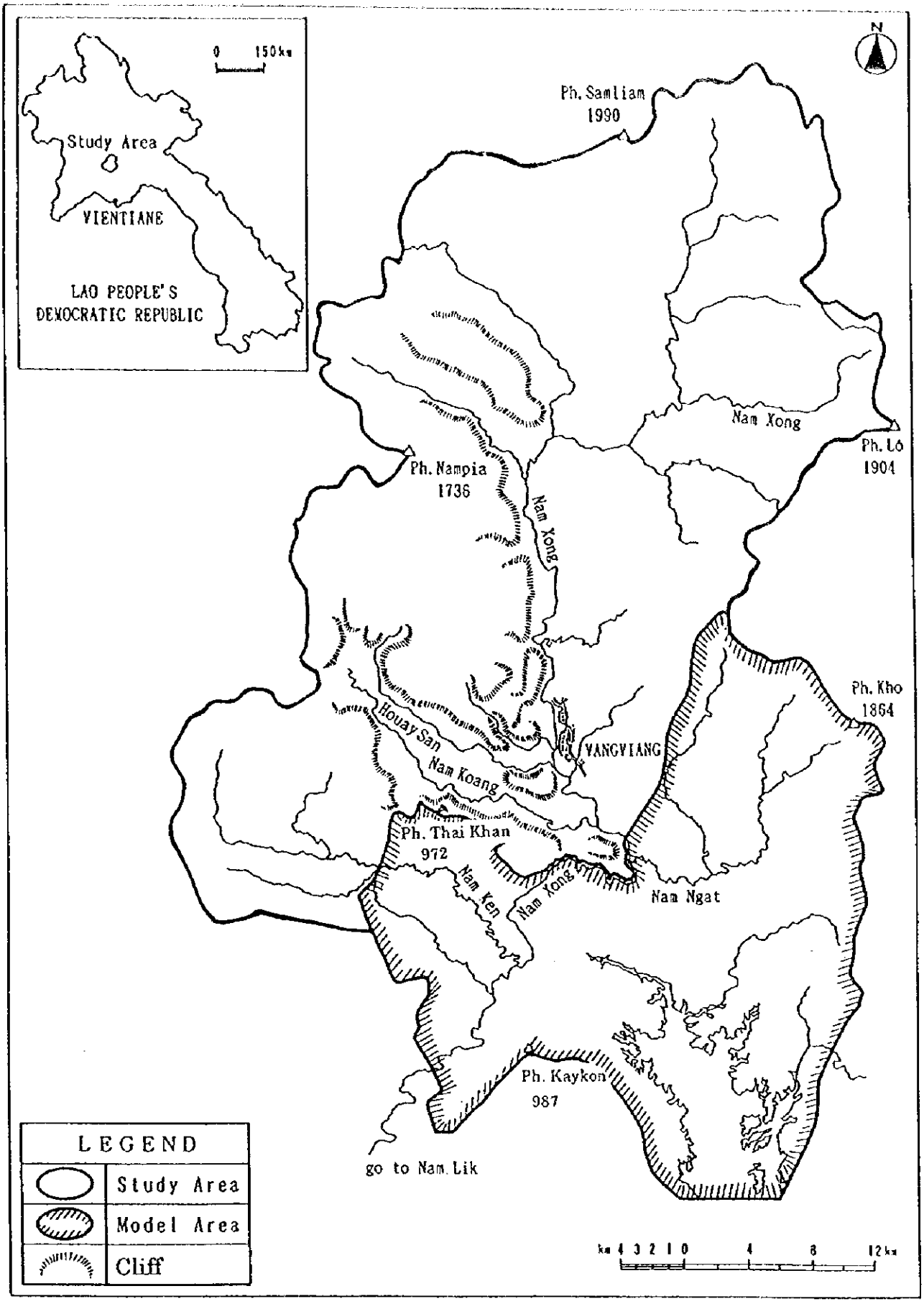



Fig. 2-1 Study Area

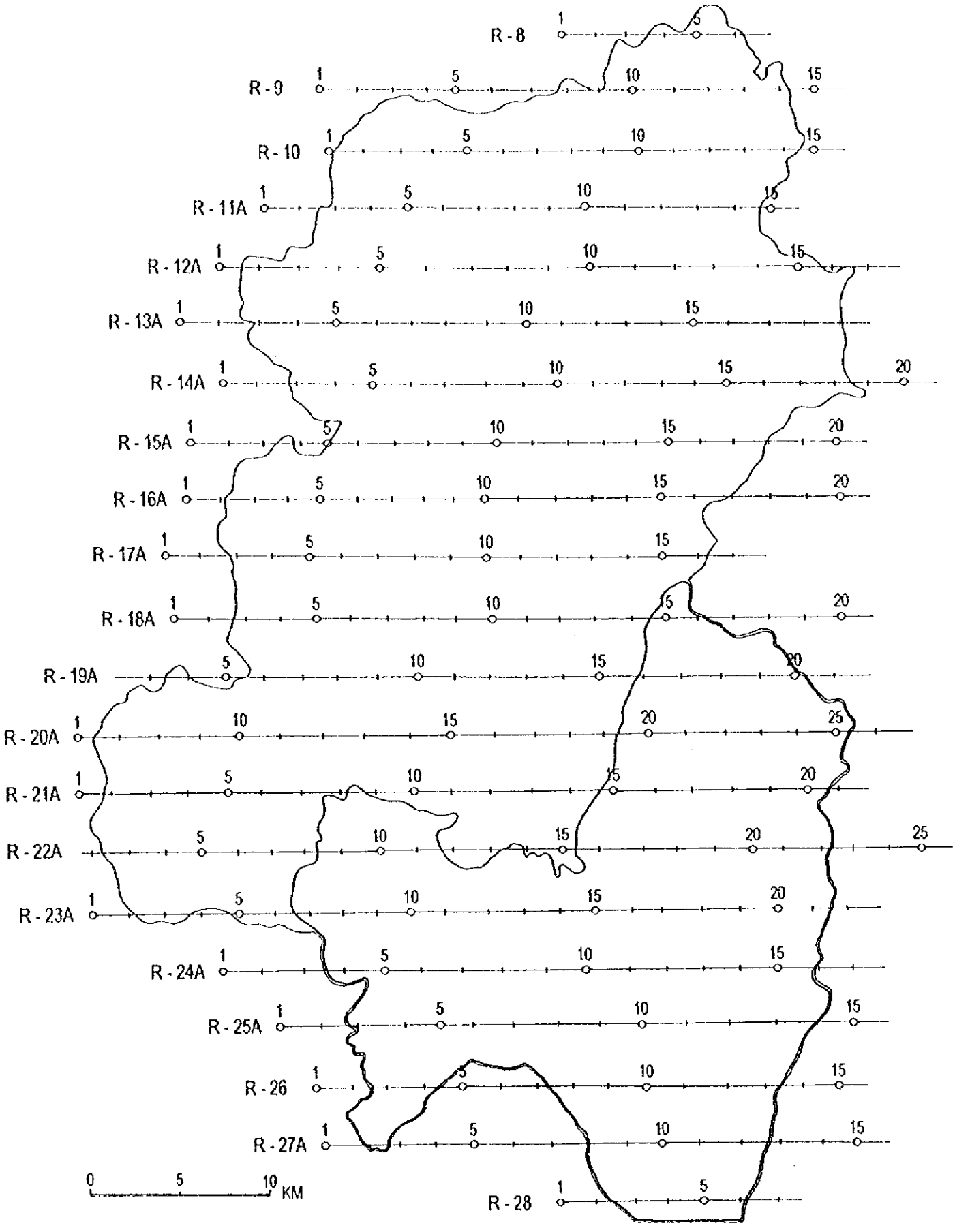



Fig. 2-2 Aerial Photography Index Map

## 3. Finding Stage

### 3.1 Natural Conditions

The present natural conditions are determined based on field survey, existing data, aerial photographs and topographical maps. The following data is suggested to be collected.

#### 3.1.1 Weather Conditions / Hydrology

(1) Weather

The latest weather data are obtained at the Vangvieng Meteorological Observatory, the closest meteorological station. Long-term data is to be collected at the Meteorology and Hydrology Department in the central government. Data of approximately 10 years concerning the following items are collected.

- Precipitation: annual precipitation, monthly precipitation, daily precipitation
- Temperature, Humidity

Annual rainfall and monthly rainfall data for the period 1989-1995, and average values for temperature and relative humidity for the period 1972-1983 are shown below.

Table 3.1 Annual Rainfall and Monthly Rainfall (Vangvieng)

Unit : mm

| Year | Jan. | Feb. | March | April | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | 156.8 | 0.0 | 175.9 | 133.9 | 258.6 | 493.4 | 725.3 | 316.5 | 404.7 | 145.1 | 10.0 | 10.2 | 2830.4 |
| 1990 | 10.0 | 26.0 | 146.7 | 81.5 | 425.4 | 1054.9 | 878.9 | 538.1 | 282.4 | 151.0 | 203.5 | 10.2 | 3808.6 |
| 1991 | 0.0 | 0.0 | 83.7 | 9.1 | 259.1 | 615.1 | 537.4 | 815.8 | 482.7 | 182.7 | 0.0 | 10.2 | 2995.8 |
| 1992 | 93.2 | 63.6 | 0.0 | 18.8 | 191.4 | 634.6 | 803.4 | 481.0 | 385.8 | 137.9 | 6.3 | 55.4 | 2871.4 |
| 1993 | 0.0 | 80.7 | 25.6 | 119.2 | 428.7 | 781.3 | 965.8 | 396.5 | 304.7 | 39.2 | 0.0 | 0.0 | 3141.7 |
| 1994 | 0.0 | 40.9 | 118.2 | 121.7 | 189.8 | 667.8 | 841.2 | 716.3 | 529.6 | 158.2 | 0.0 | 0.0 | 3383.7 |
| 1995 | 0.0 | 0.0 | 66.8 | 66.0 | 184.7 | 761.8 | 701.2 | 1336.7 | 407.4 | 136.5 | 37.5 | 0.0 | 3698.6 |
| Average | 37.1 | 30.2 | 88.1 | 78.6 | 276.8 | 715.6 | 779.0 | 657.3 | 399.6 | 135.8 | 36.8 | 12.3 | 3247.2 |

Table 3.2 Average Monthly Temperature (Vangvieng)

Unit: (°C)

| | | Jan. | Feb. | March | April | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Annual Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1972-1983 Average | Max. Temp. | 26.6 | 29.2 | 31.9 | 33.1 | 31.8 | 32.0 | 30.0 | 29.3 | 30.6 | 30.5 | 28.9 | 27.0 | 30.1 |
| | Mean Temp. | 20.7 | 22.7 | 25.8 | 27.6 | 27.5 | 27.6 | 26.8 | 26.6 | 27.0 | 26.4 | 24.2 | 21.5 | 25.4 |
| | Min. Temp. | 14.9 | 16.7 | 18.4 | 22.0 | 23.3 | 24.1 | 23.8 | 24.0 | 23.5 | 22.0 | 19.1 | 16.3 | 20.7 |

Table 3.3 Average Monthly Relative Humidity (Vangvieng)

(%)

| | Jan. | Feb. | March | April | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Relative Humidity | 67 | 64 | 63 | 65 | 74 | 79 | 82 | 84 | 78 | 73 | 69 | 67 |

(2) Water Flow

The Vangvieng Meteorological Observatory has observed the water level of Nam Xong and its major tributaries but not water flow. A simplified flow rate survey is done in the Study. Survey in the dry season is recommended because the flow in the dry season indicates the water holding capacity of the catchment. The procedure of simplified flow rate survey is as follows.

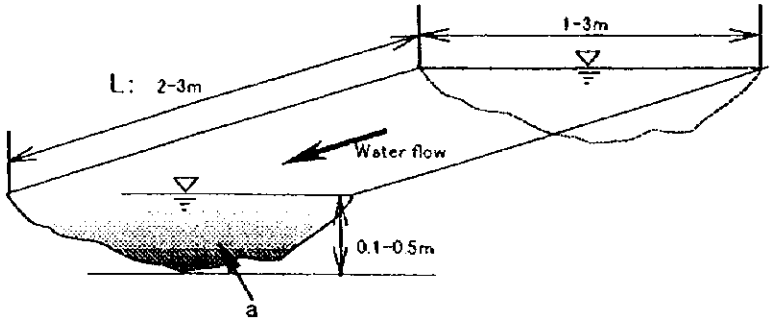



Fig.3.1 Image of Stream

- Measure the flow passage sectional area (a) in average flow passage. a:$m^2$
- Float a buoy from the upper point for 2-3 meters.
- Measure the time (T) by a stop watch for the buoy to flow down. T:sec

- Calculate the flow velocity (V) from the flow length (L) and the flow time (T). L:m V:m/sec
- Calculate the flow quantity (q) from the flow passage sectional area and the velocity. q:$m^3$/sec
- Calculate the flow quantity per unit area (Q) from the flow quantity (q) and the catchment area (A). A:$km^2$ Q:lit/sec/$km^2$

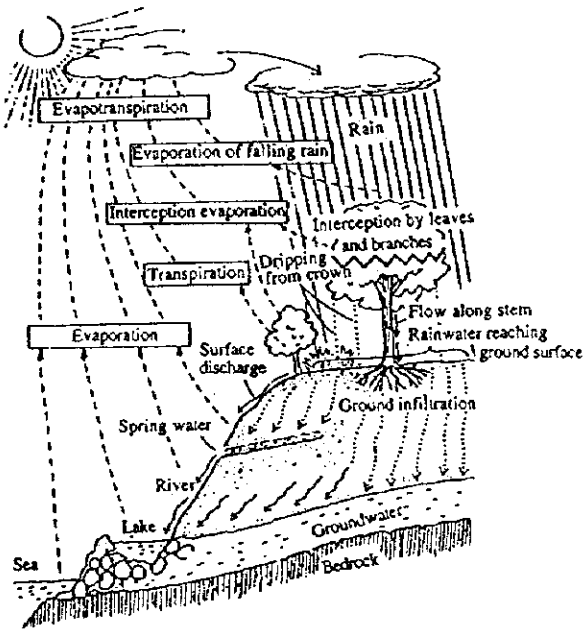
$V=L/T$

$q=a\times V$

$Q=1{,}000\times q/A$

**(Reference)**

The hydrology of a forest, consisting of evaporation, transpiration and flow following rain is shown in the next figure.




Hydrology of Forest

Note: Prepared based on "the Relationship Between Forests and Living Environment" in Bulletin of the Forestry and Forest Product Research Institute, Ministry of Agriculture, Forestry and Fisheries, No. 104, 1997 (Japan).

### 3.1.2 Topography/Landslide

Surveys of topography and landslide are conducted by using topographical maps and aerial photographs and through field survey. Before visiting the field, a preparatory reading of maps and photographs is necessary. The aerial photographs are necessary to compare with the actual topography on the spot. Survey items are as follows:

a. topography: inclination, elevation, river system;
b. conditions of landslide site: scale (width, length), topography, vegetation;
c. conditions of devastated mountain streams: types of unstable sediments (mud, sand, gravel), size of gravel, scale of devastated mountain streams (width, extension);
d. existing erosion control facilities: type, site, scale;
e. records of landslide and flood damages in the past (interviewing local people if records are not kept at public offices).

### 3.1.3 Land Use / Vegetation

Through interpretation of aerial photographs and field survey, the land use and vegetation in the Model Area was classified as shown in Table 3-4 in the Study.

Table 3-4 Land Use Classification of the Model Area

| Landuse/Vegetation Type | | | Code | Criteria |
|---|---|---|---|---|
| Forest | Man-Made Forest | | Mf | teak forest ; brown on photograph |
| | Natural Forest | Primary | Npd1 | |
| | | | Npd2 | forest with high |
| | | | Npd3 | and large diameter trees |
| | | | Npd4 | |
| | | Secondary | Nsd1 | regeneration forest on former |
| | | | Nsd2 | slash and burn site with tree |
| | | | Nsd3 | high of 5m or more |
| | | | Nsd4 | |
| | Bamboo Forest(1) | | B1 | mixed with primary natural forest or along river banks |
| | Shrub Land | | | mainly distributed along ridge lines |
| S/B Site and Former S/B site | Slash and Burn Site | | Hy | exposed ground surface with dotted small hats |
| | Bush | | Bh | regenerated bush on former slash and burn site with a tree heigh of less than 5m |
| | Bamboo Forest(2) | | B2 | bamboo forest on former slash and burn site; yellow green on photograph |
| | Grassland | | G | covers a large area on a former slash and burn site; liver brown color on photograph |
| Permanent Farmland | Lowland Paddy Field | | Lp | flat area with compartmented by ridge |
| | Dry Farmland | | Df | located near houses and encircled by fencing |
| | Orchard | | Od | located near houses with banana and pineaples, etc |
| Settlement | | | Co | group of houses |
| Bare Land | | | Br | |
| Water Body | | | W | |

Note: The following crown density categories have been adopted based on the area covered by the crown of dominant trees of Natural Primary Forest (Np) and Natural Secondary Forest (Ns).

20% or lower: d1, 21%-39%: d2, 40%-69%: d3, 70% or higher: d4

### 3.1.4 Soil

(1) Survey Method

1) To grasp the relationship between land use/vegetation and soil, soil profile surveys and sample pit surveys should be conducted. The number of soil profile survey sites depends on the travelling distance but, in general, two to three sites per day per surveyor can be conducted. It is difficult to state the total number of soil profile survey sites as this depends on the number of soil types. Two workers are required for digging as well as at least one guide.

2) To check the following:
classification of layer / thickness of each layer / changing conditions of layers / humus / color / conditions of Ao layer / pore / structure / hardness / texture / moisture / gravel / mycorhiza and mycelium / root system / pH / leaching, accumulation

3) To sketch the soil profiles. Examples of typical soil profiles in the Model Area are given in the Annex.

4) The survey items are described above and also in the reference field notebook (shown in the Annex). The main items are outlined below.

a. Soil Profile

The size of each profile is approximately 0.8 m wide and 1 m deep. Special care is required not to break the upper section and the surface of the profile.

b. Horizons

Fig. 3-2 is a schematic drawing of the horizons of the soil profile.

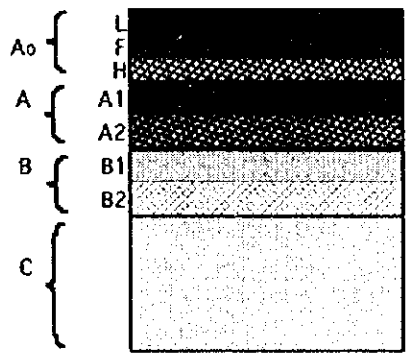



Fig. 3-2 Schematic Drawing of Horizons of Soil Profile

The $A_0$ horizon is a layer of such organic matters as litter. Depending on the degree of decomposition, it is further classified into the L, F and H horizons. The L horizon is the uppermost layer and consists of undecomposed organic matters. The F horizon shows a medium level of decomposition. While the original shape of the litter is lost, the original tissues can still be distinguished by the naked eye. The H horizon shows much more advanced decomposition and the original tissues cannot be visually distinguished.

The A horizon is an accumulated layer of humus which is produced through the decomposition of organic matters. Depending on the degree of humus accumulation and degree of structural development, it is further classified into the A1, A2 and A3 horizons.

The B horizon is a soil layer with little humus and has a reddish brown, brown or yellowish brown colour because of iron compounds generated through the weathering of the parent materials. Depending on the degree of structural development and other criteria, it is further classified into the B1, B2 and B3 horizons.

The C horizon is a layer of the soil's parent materials. As the soil formation process is little advanced, it contains many stones and gravel. Depending on the degree of weathering, it is further classified into the C1, C2 and C3 layers from top to bottom.

c. Soil Color

Although the soil color is slightly different depending on it being wet or dry, it is generally described as the color shown at the moisture level at the time of soil survey. The soil color is judged using the standard soil color chart.

d. Humus

As the quantity of humus contained in mineral soil shows a high correlation to the soil color, the approximate humus content is estimated using the level of darkness of the soil color. The humus content is classified into four categories, i.e. few, common, rich and very rich.

| Humus Content | Soil Color | Carbon Content |
|---|---|---|
| Few | Light Brown | 0 - 3% |
| Common | Dark Brown | 3 - 6% |
| Rich | Blackish Brown | 6 - 12% |
| Very Rich | Black | 12% or higher |

e. Texture

Mineral matters which are the major element of soil mainly consist of grains produced by the weathering of rocks. The size of mineral grains is classified into the following categories pursuant to the international code.

Grain Diameter

2 mm or larger
Less than 2 mm but not less than 0.2 mm
Less than 0.2 mm but not less than 0.02 mm
Less than 0.02 mm but not less than 0.002 mm
Less than 0.002 mm

Soil texture means the classification of the soil coarseness based on the ratio of grains of which the size is less than 2 mm. The soil texture is closely related to the air permeability, water permeability and retention of water and nutrients in the soil. In the field, the soil texture is judged based on the feel of the soil by the finger tips.

| Soil Texture | |
|---|---|
| Sand | Almost entirely sand |
| Sandy loam | Sand accounting for approximately 1/3 to 2/3 |
| Loam | A little sand (sand content of less than 1/3) |
| Silt loam | Little sand and presence of less sticky clay |
| Clay loam | Sticky clay with a little sand |
| Clay | Predominantly sticky clay |

f. Structure

Such soil grains as sand and clay form a coherent mass called the soil structure which significantly affects the physical properties of the soil.

Soil Structure

| | |
|---|---|
| Loose granular | Powdery or fine grains bound by spawns |
| Granular | Round, hard and tight grains (2 - 5 mm) |
| Nutty | Glossy surface with distinctive angular shape |
| Blocky | Relatively round and slightly glossy surface |
| Crumb | Soft, small grains of several mm with rich water content |
| Single grain | Noncoherent grains like sand |
| Massive | Tightly coagulated soil layer |

g. Gravel

Mineral grains with a diameter of 2 mm or more in the soil are classified into the category of gravel to separate them from those with a diameter of 2 mm or less. Gravel significantly affects the physical properties of the soil as the coarse voids created by gravel in the soil improve the air and water permeability of the soil.

Shape

| | |
|---|---|
| Angular | Sharp corners |
| Sub-angular | Slightly sharp corners |
| Rounded | Mostly rounded corners |

Quantity

| | |
|---|---|
| Abundant | 50% or higher |
| Many | 30 - 50% |
| Common | 10 - 30% |
| Few | 5 - 10% |
| Very few | 1 - 5% |
| None | 0% |

h. Hardness

Hardness can be measured by either pressing the surface of the soil to check the state of indentation or using a soil hardness meter. In the case of the latter, a measured value of 27 mm or more indicates a level of hardness which deters invasion of the root system of plants.

i. Moisture

Various types of water are contained in soil, ranging from freely moving water between the soil grains to water which tightly adheres to the soil grains. Among

these, those closely related to the moisture level of the soil and plant growth are capillary water and gravity water, etc. which do not tightly adhere to the soil grains.

Moisture

| | |
|---|---|
| Dry | No feeling of moisture registers on the palm when a lump of soil is tightly held |
| Moderately moist | Feeling of moisture registers on the palm when a lump of soil is tightly held |
| Wet | While no water drips when a lump of soil is tightly held, water runs when the lump of soil is squeezed between the thumb and index finger |
| Over wet | Water runs when a lump of soil is tightly held |

5) To classify soil types by the FAO/UNESCO method**

6) Nine major soil groups and 13 soil units were identified in the Model Area as shown in Table 3-5. The properties of these soil units are described below.

Table 3-5 Soil Units Found in Model Area

| Major Soil Groups | Soil Units |
|---|---|
| 1. Fluvisols (FL) | (1) Dystric Fluvisols (FLd) |
| 2. Gleysols (GL) | (1) Dystric Gleysols (GLd) |
| 3. Regosols (RG) | (1) Dystric Regosols (RGd) |
| 4. Leptosols (LP) | (1) Dystric Leptosols (LPd) |
| | (2) Eutric Leptosols (LPe) |
| | (3) Rendzic Leptosols (LPk) |
| 5. Cambisols (CM) | (1) Eutric Cambisols (CMe) |
| | (2) Dystric Cambisols (CMd) |
| 6. Ferralsols (FR) | (1) Haplic Ferralsols (FRh) |
| | (2) Rhodic Ferralsols (FRr) |
| 7. Acrisols (AC) | (1) Haplic Acrisols (ACh) |
| 8. Alisols (AL) | (1) Haplic Alisols (ALh) |
| 9. Luvisols (LV) | (1) Chromic Luvisols (LVx) |

** FAO/UNESCO Soil map of the world Revised Legend World Soil Resources Report 60, FAO, 1990

a. Fluvisols (FL)

This soil group is formed by the sedimentation of parent materials transported by flowing water and is distributed at flood plains along rivers and at flat or gently sloping land. It is immature soil with a generally low organic content and no diagnostic horizon. Within the same profile, materials with different properties ranging from gravelly to clayey-loamy are often observed in the layers. Dystric Fluvisols (FLd) with a base saturation of less than 50% and a pH value of less than approximately 5.5 are distributed in the Model Area.

b. Gleysols (GL)

This soil group indicates a reduced state due to an excessive water content and has an Ag horizon or Bg horizon, showing a yellowish grey or bluish grey colour. In general, this soil group is distributed at low wetlands along minor streams in hilly areas and at paddy fields. Small areas of Dystric Gleysols (GLd) are distributed at gently sloping valleys in the southwestern hilly areas in the Model Area. The A horizon of this soil group has a minor quantity of organic matters but the degree of base saturation is low.

c. Regosols (RG)

Regosols are a very immature soil formed by the loose sedimentation of relatively coarse textured materials and gravel produced by soil erosion or landslides. The clay content, base content and degree of base saturation are all extremely low. In the Model Area, very small areas of Dystric Regosols (RGd) are distributed at steep slopes of both mountain summits and piedmont areas.

d. Leptosols (LP)

In the case of this soil group, the thickness of the soil is limited to a maximum of 30 cm because of the presence of a hard rock layer or consolidated layer. Alternatively, the thickness of the top soil layer can exceed 75 cm with a fine soil content of less than 20%, presenting inferior soil conditions. In the Model Area, Dystric Leptosols (LPd) with a shallow soil horizon due to soil erosion and poor nutrients are distributed at steeply sloping land, the upper parts of slopes and in ridge areas while Rendzic Leptosols (LPk) with a shallow layer, an umbric or mollic A horizon and pH value of approximately 6.8 or higher are distributed in limestone areas. In areas adjacent to a limestone zone, shallow Eutric Leptosols, consisting of a mixture of weathered limestone and other stones, with a high pH value and base saturation are found.

e. Cambisols (CM)

This soil group has an umbric or mollic A horizon with rich humous and a brown B horizon and the base saturation is 50% or less. This soil group is distributed in forests, at the lower parts of slopes or in piedmont areas where soil sedimentation is likely to occur due to the stable ground. Acid Dystric Cambisols (CMd) with a pH value of 5.5 or less are distributed in the Model Area at old secondary forests with a stable ground surface while Eutric Cambisols (CMe) with a pH value of 6.8 or more are distributed in piedmont areas and at gentle slopes in limestone areas.

f. Ferralsols (FR)

The B horizon of this soil group contains sesquioxides (mainly iron oxide and aluminium oxide). The soil layer is thick. This soil is extremely old and, therefore, the reserve of weatherable minerals is extremely low due to strong weathering. The soil colour is mainly yellowy orange to red and the exchangeable cation capacity is small. In the Model Area, Haplic Ferralsols (FRh) with a yellow to orange colour and Rhodic Ferralsols (FRr) with a red colour are distributed in hilly areas. The former tend to appear at steep slopes land while the latter tend to appear at flat to gently sloping land.

g. Acrisols (AC)

The clay accumulation in the B horizon is the classification characteristic for this soil group. Apart from Acrisols (AC), Alisols (AL), Lixisols (LX) and Luvisols (LV) share the same characteristic. Acrisols are formed as a result of clay transfer and accumulation with a low base saturation. It is also a strongly acidic soil due to leaching. Acrisols often have a strong brownish or yellowish colour. The Acrisols distributed in the Model Area are Haplic Acrisols (ACh) with a low humus content, low fertility and a yellowish A horizon. The pH value showing strong soil acidity is in the range of 3.8 - 4.5. This soil group is widely distributed in the Model Area at slopes in mountainous areas and hilly areas.

h. Alisols (AL)

The classification characteristic of Alisols is the accumulation of clay in the B horizon. The exchangeable cation capacity is larger than that of Acrisols although the degree of base saturation is lower than that of Acrisols. They contain a fair amount of exchangeable aluminium. The Alisols distributed in the Model Area are Haplic Alisols (ALh) with a low humus content and low fertility, showing strong acidity with a pH value in the range of 4.0 - 5.0. The colour is yellowish brown to

yellowish orange. The main distribution areas are gently undulating hilly areas with a low elevation.

i. Luvisols (LV)

The classification characteristic of Luvisols is the accumulation of clay in the B horizon. In the case of Luvisols, however, the degree of clay accumulation is particularly high. Both the exchangeable cation capacity and degree of base saturation are higher than those of Acrisols and Alisols. The Luvisols distributed in the Model Area are Chromic Luvisols (LVx) with a reddy brown to red colour and a B horizon with a particularly high clay content. This soil is distributed in small patches, mainly in hilly areas.

**(Reference)**

**Slash and Burn Cultivation and Shift to Grassland**

There is vast grassland of gramineous grasses in the Study Area resulting from the repetitive practice of slash and burn cultivation. The following observation is made on the relationship between slash and burn cultivation and shift to grassland from the viewpoint of the soil environment for reference purposes.

Slash and burn cultivation, and grassland in Southeast Asia are closely interrelated. In the case of grassland with deep clayey soil which has a relatively long wet period due to proximity to a slope bottom or river system, Nya Ka (*Imperata cyrindrica*) is dominant. Slopes which are liable to become dry because of shallow, rocky and extremely firm soil, in turn caused by severe erosion which exposes the lower layers, tend to become grassland dominated by such large gramineous grasses as Kok Lao (Penisetum spp.) and Kok Hken (*Thysanolaena maxinia*). Kok Lao-type grassland is widely distributed in the Model Area at the middle to the upper parts of slopes.

The soil characteristics determined by observation of the soil profile indicate that, in the case of the soil profile of Kok Lao-type grassland, the soil of the present top layer is equivalent to the lower layer soil (C horizon). Large gravel which usually appears in the lower parts of the soil profile can be observed near the surface. There are no organic deposits, such as fallen leaves, on the surface and the equal tightness from the top layer to the bottom layer suggests the progress of severe soil erosion. Former slash and burn

sites may be replaced by regenerated forest or grassland. In general, grassland appears when the soil conditions are highly deteriorated. Even though the process of changing from forest to grassland due to slash and burn cultivation has not been sufficiently explained, the following inferences can be made based on the knowledge obtained so far.

1) Nutrient Balance at Slash and Burn Site

Table3-6 shows the trends of nutritive elements in a two year period at an experimental slash and burn site. This table is taken from Tropical Forestry (1985, No.2). Firstly, the cutting and burning of a forest with an existing dry weight of 330 tons/ha added some 54 kg/ha of nitrogen, 72 kg/ha of phosphorous, 455 kg/ha of potassium, 1,913 kg/ha of calcium and 288 kg/ha of magnesium to the soil. These inorganic nutrients were produced by the burning of organic matters accumulated in the forest. The nutrients produced by the decomposition of organic matters are those supplied by organic matters accumulated in the forest soil and organic matters newly produced at the slash and burn site. The considerable tree cutting reduces the shading effect and increases the ground temperature to facilitate decomposition of the organic matters in the soil, releasing a large quantity of nutrients in a short period of time.

In regard to nutrient loss, strong rain at the initial cultivation stage washes away the top soil and the ash produced by the slash and burn cultivation. The quantity of initial nutrient loss is much larger than that of nutrient loss which occurs by crop harvesting in two years. In general, slash and burn cultivation involves the cutting, drying and burning of trees in the dry season, followed by crop planting with the arrival of the rainy season. This practice means that the ground surface, which becomes unstable due to cutting and other activities, is totally defenseless vis-a-vis rainwater in the first two or three weeks of initial plant growth and is liable to heavy erosion. In the case of the experimental site, nearly half of the nutrients added to the soil by burning was lost before the seeding season. Although Table 3-6 appears to suggest an overall increase of the nutrient balance, this can be attributed to the overwhelmingly large supply of nutrients by burning. The quick repetition of slash and burn cultivation definitely reduces the supply of nutrients each time. The seemingly increased quantity of nutrients in the soil is simply a different form of the organic matters accumulated in a forest after their rapid decomposition. The total quantity of nutrients of the local soil never increases and the accumulated nutrients in the local soil permanently move outside the nutrition circulation system of the local soil, steadily reducing the quantity of nutrients.

Table 3-6 Nutrient Balance at Slash and Burn Site

(Unit: kg/ha)

| | | | N | P | K | Ca | Ng |
|---|---|---|---|---|---|---|---|
| Nutrient Increase | Burning | | 54 | 72 | 455 | 1,913 | 288 |
| | Decomposition of Organic Matters | First year of Cultivation | 240 | 20 | 80 | 420 | 170 |
| | | Second year of Cultivation | 160 | 13 | 54 | 280 | 110 |
| | Sub Total (a) | | 454 | 105 | 589 | 2,613 | 568 |
| Nutrient Loss | Initial Erosion | | - | 35 | 233 | 2,540 | 411 |
| | Crop Production | First year of Cultivation | 68 | 11 | 19 | 1 | 4 |
| | | Second year of Cultivation | 72 | 16 | 13 | 1 | 3 |
| | Sub Total (b) | | 140 | 62 | 265 | 2,542 | 418 |
| Balance (a)-(b) | | | 314 | 43 | 324 | 71 | 150 |

Source: Kazutake Kyuma: Tropical Forestry 2, Tokyo, Japan, 1985

2) Mechanism of Soil Fertility Decline

a. Leaching of Base Elements

In the course of its infiltration into the ground, rainwater leaches the base elements in the soil. Therefore, unless new base elements are supplied, there is a shortage of such base elements as calcium (Ca), magnesium (Mg) and potassium (K), all of which are required for plant growth. The shortage of base elements in the soil causes poor plant growth.

b. Harmful Elements

As clay granules are electrically negatively charged, they absorb cations to maintain the electrical balance. This ability to absorb cations is called the cation exchange capacity (CEC), the level of which varies depending on the quantity and type of clay and also on the quantity and quality of the organic matters contained in the clay. In general, soil with a large CEC is considered to be fertile soil. When such base elements as Ca, Mg and K are leached, the clay granules begin to absorb hydrogen (H) and aluminium (Al), etc. to preserve the electrical balance. A higher hydrogen ion concentration means a higher acidity level, increasing the absorption rate of Al which is a harmful element and which damages the growth of a plant's root system. Under a high level of acidity, manganese (Mn) is also leached and harms plants. In short, an increase of the soil acidity leads to an increase of harmful elements which disrupt plant growth.

c. Qualitative Deterioration of Clay and Organic Matters in Soil

An increase of the soil acidity transforms the properties of clay and lowers the CEC level as clay minerals are changed from the 2:1 type (Montmorillonite type) to the 1:1

type (Kaolinite type), reducing the level of soil fertility. In the case of organic matters, these tend to produce mor (raw humus) rather than mull (mild humus) with an increase of the soil acidity, the CEC level is reduced and soil structure development is adversely affected.

d. Declined Activities of Soil Fauna

Acid soil decreases the number of soil fauna, such as earthworms, resulting in the disruption of the initial decomposition process of leaves and branches on the forest floor. Decrease of the number of soil fauna is then followed by a decrease of bacteria, which is extremely efficient in decomposing organic matters, with a relative increase of mould. This delays the decomposition of organic matters, producing low molecule organic acids as intermediate products. These organic acids infiltrate the soil and increase the soil acidity level. Under the condition of strong acidity, such useful bacteria as nitrogen fixing bacteria become inactive, further reducing the soil fertility.

3) Soil Deterioration and Shift to Grassland

Former slash and burn sites may be replaced by regenerated forest or grassland. In general, grassland appears when the soil conditions are highly deteriorated. The observation results that a forest can grow at a very gravelly site if there is no human interference. If a forest is used for slash and burn cultivation or eroded severely, the soil's physical and chemical properties may have been deteriorated by the following process. This process is assumed to be observed in the Study Area, too.

a. The quick repetition of slash and burn cultivation repeatedly removes the coppice shoots sprouting from stumps, weakening and eventually killing the stumps with the loss of succeeding stems by sprouting.

b. The spread of a slash and burn area wipes out seed trees, eliminating the supply of seeds of woody plants. Compared to such woody plants, the seeds of such large gramineous grasses as Kok Lao are easily transported by wind over long distances to supply seeds over a wide area.

c. As the eroded ground surface is very firm, small seeds of Kok Lao which are spread in a large quantity have a better survival rate than the larger seeds of woody plants. Therefore, grass seeds have a better chance of germination.

d. As the root systems of gramineous grasses are fine and hard, they can easily invade

minor pores or cracks in the soil, enjoying better survival prospects. In contrast, the root systems of woody plants are soft and bulky and newly germinated seedlings realistically require a moisture-retentive environment characterised by wet and soft top soil or decomposed wood and leaves, etc.

e. In the case of gramineous grasses and woody plants growing side by side in highly eroded and leached soil, gramineous grasses with strong nutrient absorption power and numerical superiority due to a higher survival rate are in a much better position to grow. While the eutrophication of aluminium, a harmful element, caused by acidic soil disrupts the growth of a plant's root system, gramineous grasses have a higher level of resistance to aluminium than woody plants. Once grasses have begun to dominate, photosynthesis by germinated woody plants is disturbed by densely growing grasses, leading to the death of woody plants.

## 3.2 Socioeconomic Conditions

### 3.2.1 Preliminary Survey of Rural Society

The present status of local government administration, population, economy, social services, roads, water and electricity supply, irrigation, public facilities (public offices, schools, hospital and health facilities) in the Study Area was surveyed. The survey results (as of 1996) of the Study Area are described in the Final Report (September 1998).

### 3.2.2 Socioeconomic Baseline Survey

(1) Village Boundary Survey

Under the village boundary survey, village heads are to be interviewed and village boundaries entered on the 1/50,000 scale topographical map. Due to the anticipated unfamiliarity of village heads in deciphering topographical maps, it is important to reconnaissance village areas along with the village heads including visual identification of the lay of the land from good vantage points. Although there are still many cases where the precise boundaries are unclear, the survey grasps the general territorial extent of specific villages. The results of village boundary surveys are applied to the preparation of the topographical maps and aerial photographs to be used in the PRA.

(2) Questionnaire Survey

A questionnaire survey of local people in the area is conducted. Surveys of families and individuals can be conducted. In either case, sampling surveys are done. It is important to minimise the sampling number because it costs both time and money.

The number of samples should be determined with reference to the population indicated in Table 3-7. Baseline survey results will not only be applied to planning, but also provide a basis in the course of future monitoring for identifying changes between conditions before and after project implementation. A sample questionnaire form is attached (Annex 2).

Table 3-7 Population and Sample Numbers

| Population | Sample | Population | Sample | Population | Sample |
|---|---|---|---|---|---|
| 5 | 5 | 190 | 127 | 850 | 265 |
| 10 | 10 | 200 | 132 | 900 | 269 |
| 15 | 14 | 210 | 136 | 950 | 274 |
| 20 | 19 | 220 | 140 | 1000 | 278 |
| 25 | 24 | 230 | 144 | 1100 | 285 |
| 30 | 28 | 240 | 148 | 1200 | 291 |
| 35 | 32 | 250 | 152 | 1300 | 297 |
| 40 | 36 | 260 | 155 | 1400 | 302 |
| 45 | 40 | 270 | 159 | 1500 | 306 |
| 50 | 44 | 280 | 162 | 1600 | 310 |
| 55 | 48 | 290 | 165 | 1700 | 313 |
| 60 | 52 | 300 | 169 | 1800 | 317 |
| 65 | 56 | 320 | 175 | 1900 | 320 |
| 70 | 59 | 340 | 181 | 2000 | 322 |
| 75 | 63 | 360 | 186 | 2200 | 327 |
| 80 | 66 | 380 | 191 | 2400 | 331 |
| 85 | 70 | 400 | 196 | 2600 | 335 |
| 90 | 73 | 420 | 201 | 2800 | 338 |
| 95 | 76 | 440 | 205 | 3000 | 341 |
| 100 | 80 | 460 | 210 | 3500 | 346 |
| 110 | 86 | 480 | 214 | 4000 | 351 |
| 120 | 92 | 500 | 217 | 4500 | 354 |
| 130 | 97 | 550 | 226 | 5000 | 357 |
| 140 | 103 | 600 | 234 | 6000 | 361 |
| 150 | 108 | 650 | 242 | 7000 | 364 |
| 160 | 113 | 700 | 248 | 8000 | 367 |
| 170 | 118 | 750 | 254 | 9000 | 368 |
| 180 | 123 | 800 | 260 | 10000 | 370 |

* Robert V. Krejcia and Daryle W. Margan
Determining sample size for research activities.
Prepared from Education and Psychological Measurement. Vol.30, 1970.

1) Survey Items

a. General Information

family composition / main income source / landholding size of land / land ownership

b. Living Conditions

drinking water / electricity / fuel / food

c. Agriculture

farmland size / type of farming (permanent or slash and burn farming) /crop production

d. Livestock Raising

number of animals / usage / raising method

e. Forest

timber availability / experience of plantation

f. Survey on Individual Needs

sample three individuals from each sampled family of each village and conduct survey on improvement of living standard and environment

(3) PRA (Participatory Rural Appraisal)

In managing a watershed where local people live, it is required to have local people's understanding and cooperation for the watershed management. Living patterns of local people may be changed by implementation of the watershed management. It is difficult to formulate and implement a watershed management plan without local people's participation. In the survey of the Model Area, the future land use expected by local people and land use problems were identified through the PRA. The flow of the procedure is shown in Fig.3-3. For the PRA, topographical maps, aerial photographs, 3-D topographical models, and land use vegetation maps are utilized. For this purpose, the scale of the topographical map of 1:20,000 is enlarged to 1:10,000 and 1:5,000. However, as no topographical maps with a scale of 1:20,000 currently exist for the Study Area, the most economical method is enlargement of the existing map with a scale of 1:50,000 for use together with the aerial photographs.

(4) Fact Finding

Identifications of local people's living conditions, agricultural conditions, and forest use conditions are done through socioeconomic baseline surveys and the PRA. However, people in charge of general examination and plan formulation at the final stage of watershed management plan formulation must directly contact with local people to identify the current conditions of local people's forest use, land use, and expectations for the future, which are important materials for judging the plan formulation. At this point, questions about information identified by the socioeconomic baseline survey should be checked.

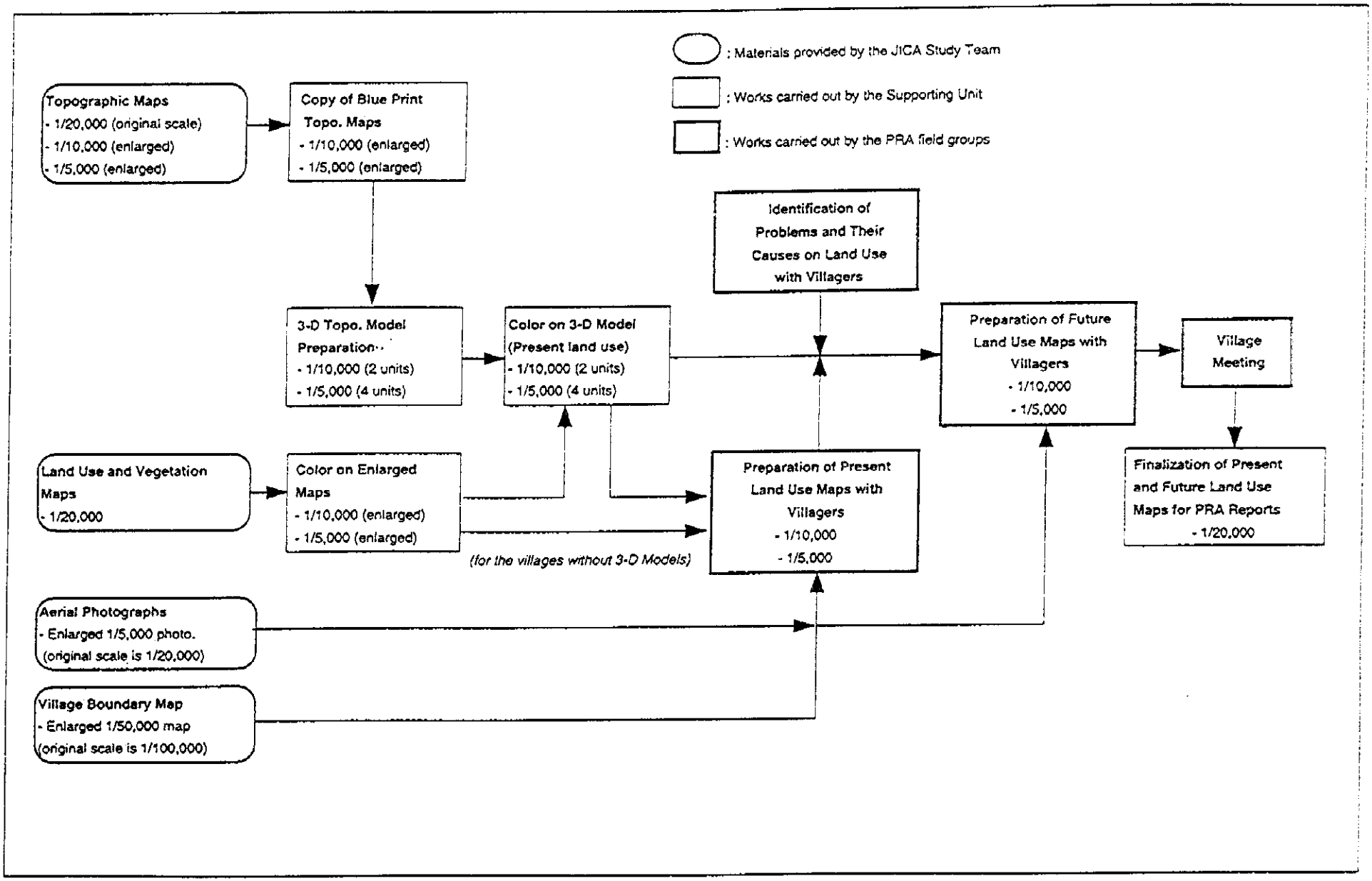



Fig. 3-3 Flow of Land Use Planning in PRA

## 4. Analyzing Problems

Problems regarding watershed management are identified using the findings of the natural condition survey, socioeconomic baseline survey and PRA survey. The expansion and excessive use of slash and burn sites are the main problems in the Model Area. And the main causes have been identified as being farmland shortage, population increase, low labour absorption capacity of industries other than agriculture and insufficient forest management as shown in Fig.4-1. Other causes include limited species for cultivation, absence of social infrastructure development, absence of agricultural and forestry extension systems and insufficient educational facilities.

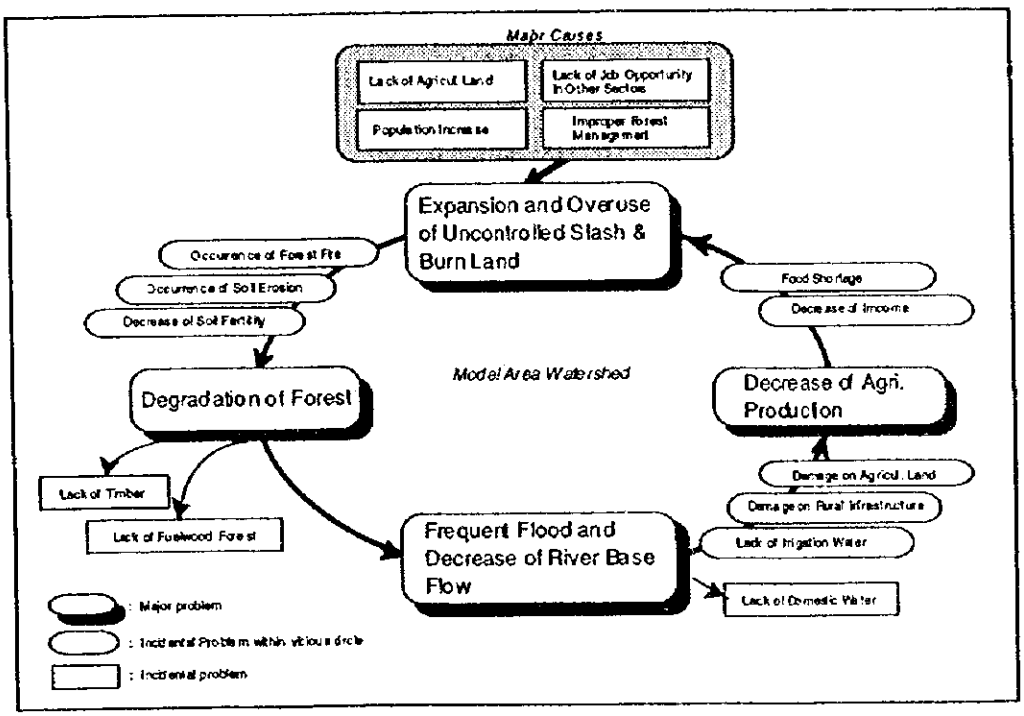



Fig. 4-1 Vicious Circle of Watershed Environment Degradation in the Model Area

## 5. Designing Project

A watershed management plan which is appropriate for the natural and social environmental conditions in the Study Area and which is also in line with the development policies of the government for the agriculture and forestry sector, is formulated taking the identified local problems into consideration.

It has been decided that the objective of watershed management in the Model Area is "conservation of the watershed environment by stabilization of slash and burn cultivation". This objective cannot be achieved only by forest improvement and also demands conscious efforts to strengthen the agricultural production system and village support system and to develop rural infrastructure. The following principles are, therefore, adopted to achieve the objective of the watershed management.

- Introduction of a sustainable production system to replace slash and burn cultivation
- Improvement of the standard of living of local people and their living environment
- Rehabilitation of forests degraded by slash and burn cultivation
- Strengthening of the rural community support system

1) A watershed management plan should be formulated using the results of the bottom-up approach with the participation of local people. The participation of local people is also an essential feature of the implementation of the plan.

2) The basic concept of the plan formulation process is illustrated below.

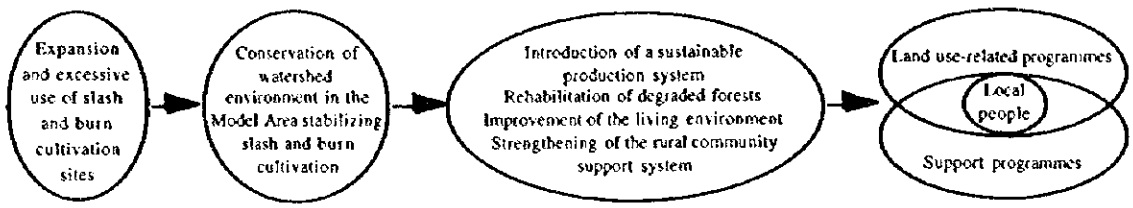



Fig. 5-1 Plan Formulation Image

## 6. Formulation of Watershed Management Plan

### 6.1 Land Use Plan

What is crucial for watershed management is ensuring the co-existence of watershed conservation by means of appropriate land use with local production activities. The appropriate land use must be planned based on the expectations of local people and legal restrictions of land use as well as the natural conditions. The flow of classifying appropriate land use is shown in Fig. 6-1.

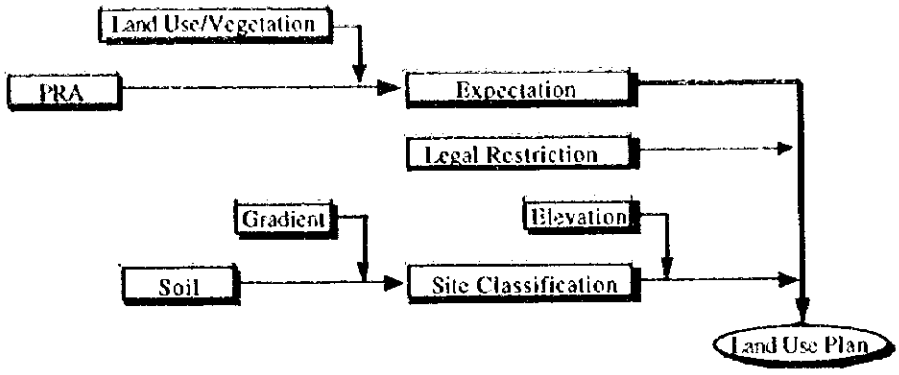



Fig. 6-1 Flow of Appropriate Land Use Classification Work

Site suitability is classified by gradient (indicating the level of workability at a site for agricultural and/or forestry purposes) and soil (indicating the productivity). For the Model Area, gradient is classified in terms of a basic unit of 5° or 10° (Table 6-1) and soil is classified in five categories based on the perceived productivity of specific soil types (Table 6-2). A land use suitability score table is then separately prepared for agriculture and forestry based on a combination of gradient and soil as shown in Table 6-3 and 6-4 respectively. Using the multiplication result of the gradient score and soil score, each site is classified in I to V categories. The classification results for the Model Area are given in Table 6-5.

Table 6-1 Suitability Classification of Gradient

| Slope (°) | Suitability | |
|---|---|---|
| | Agriculture | Forestry |
| ~ 10 | 5 | 5 |
| 11 ~ 15 | 4 | 5 |
| 16 ~ 20 | 3 | 5 |
| 21 ~ 25 | 2 | 4 |
| 25 ~ 30 | 1 | 3 |
| 31 ~ 40 | 1 | 2 |
| 41~ | 1 | 1 |

Table 6-2 Suitability Classification of Soil Type

| Soil Type | Suitability |
|---|---|
| Eutric Cambisols (CMe)<br>Dystric Cambisols (CMd) | 5 |
| Dystric Fluvisols (FLd)<br>Rendzic Leptosols (LPk)<br>Haplic Ferralsols (FRh) | 4 |
| Eutric Leptosols (LPe)<br>Rhodic Ferralsols (FRr)<br>Haplic Acrisols (ACh) | 3 |
| Dystric Gleysols (GLd)<br>Haplic Alisols (ALh)<br>Chromic Luvisols (LVx) | 2 |
| Dystric Regosols (RGd)<br>Dystric Leptosols (LPd) | 1 |

Table 6-3 Site Suitability Score for Agricultural Use

| Gradient | | CMe, CMd 5 | FLd,LPk,FRh 4 | Lpc,FRh,Ach 3 | GLd,Alh,LVx 2 | RGd,LPd 1 |
|---|---|---|---|---|---|---|
| -10 | 5 | 25 | 20 | 15 | 10 | 5 |
| 11-15 | 4 | 20 | 16 | 12 | 8 | 4 |
| 16-20 | 3 | 15 | 12 | 9 | 6 | 3 |
| 21-25 | 2 | 10 | 8 | 6 | 4 | 2 |
| 26-30 | 1 | 5 | 4 | 3 | 2 | 1 |
| 31-40 | 1 | 5 | 4 | 3 | 2 | 1 |
| 41- | 1 | 5 | 4 | 3 | 2 | 1 |

Table 6-4 Site Suitability Score for Forestry Use

| Gradient | | CMe, CMd 5 | FLd,LPk,FRh 4 | Lpc,FRh,Ach 3 | GLd,Alh,LVx 2 | RGd,LPd 1 |
|---|---|---|---|---|---|---|
| -10 | 5 | 25 | 20 | 15 | 10 | 5 |
| 11-15 | 5 | 25 | 20 | 15 | 10 | 5 |
| 16-20 | 5 | 25 | 20 | 15 | 10 | 5 |
| 21-25 | 4 | 20 | 16 | 12 | 8 | 4 |
| 26-30 | 3 | 15 | 12 | 9 | 6 | 3 |
| 31-40 | 2 | 10 | 8 | 6 | 4 | 2 |
| 41- | 1 | 5 | 4 | 3 | 2 | 1 |

Table 6-5 Site Suitability Judgement for Agricultural and Forestry Use

| Slope (°) | Soil Type | | | | |
|---|---|---|---|---|---|
| | Cme,CMd | FLd,LPk,FRh | Lpc,FRr,Ach | GLd,Alh,LVx | RGd,LPd |
| ~ | A Ⅴ/F Ⅴ | | | | |
| 10~15 | A Ⅳ/F Ⅴ | A Ⅳ/F Ⅳ | A Ⅲ/F Ⅲ | A Ⅱ/F Ⅱ | |
| 16~20 | A Ⅲ/F Ⅴ | A Ⅲ/F Ⅳ | | | |
| 21~25 | A Ⅱ/F Ⅳ | | A Ⅱ/F Ⅲ | | |
| 26~30 | A Ⅰ/F Ⅲ | | | | |
| 31~40 | | | A Ⅰ/F Ⅱ | | |
| 41~ | | | | | A Ⅰ/F Ⅰ |
| A:Agriculture F:Forestry | | Suitability | Ⅴ : High<br>Ⅳ : Rather high<br>Ⅲ : Moderate<br>Ⅱ : Rather low<br>Ⅰ : Low | | |

Based on the site suitability judgement results in Table 6-5, the four zones indicated in Table6-6 can generally be identified, i.e. suitable zone for agriculture, suitable zone for forestry, reasonably suitable zone for both agriculture and forestry and unsuitable zone for both agriculture and forestry.

Table 6-6 Zoning of Site Categories

| | |
|---|---|
| - Suitable zone for agriculture | : AV/FV; AIV/FV; AIV/FIV |
| - Reasonably suitable zone for both agriculture and forestry | : AIII/FIV; AIII/FIII; AII/FIII |
| - Suitable zone for forestry | : AIII/FV; AII/FIV; AI/FIII |
| - Unsuitable zone for both agriculture and forestry | : AII/FII; AI/FII; AI/FI |

An Agriculture Zone (Suitable zone for agriculture), Symbiosis Zone (Reasonably suitable zone for both agriculture and forestry) and Forest Zone (Suitable zone for forestry, Unsuitable zone for both agriculture and forestry) are roughly classified for the Model Area based on Table 6-6. This type of zoning is used as an indicator for land suitability judgement when dealing with the types of land use expressed by local people. The land use plan was made according to Table 6-7 in the Model Area.

Table 6-7 Land Use Plan

| Land Use | | | Code | Forest Zone | Symbiosis Zone | Agriculture Zone |
|---|---|---|---|---|---|---|
| Forest | Man-Made Forest | | Mf | | Man-Made Forest (Mfc) | |
| | Natural | Primary | Npd1 | Natural Forest (Nn) | Natural Forest (Nu) | |
| | | | Npd2 | | | |
| | | | Npd3 | | | |
| | | | Npd4 | | | |
| | | Secondary | Nsd1 | | Agroforestry (Ag)<br>Slope Land Agriculture (Sa) | Dry Farmland (F1) |
| | | | Nsd2 | | | |
| | | | Nsd3 | | Natural Forest (Nu) | |
| | | | Nsd4 | | | |
| | Bamboo Forest (1) | | B1 | | Bamboo Forest (B) | |
| | Shrub Land | | S | Natural Forest (Nr) | Agroforestry (Ag)<br>Slope Land Agriculture (Sa)<br>Man-Made Forest (R) | Dry Farmland (F1) |
| S/B Site & Former S/B Site | Slash and Burn Site | | Hy | Man-Made Forest (R) | | |
| | Bush | | Bh | Natural Forest (Nr) | | |
| | Bamboo (2) | | B2 | Man-Made Forest (R) | Improved Bamboo Forest (BI) | |
| | Grassland | | G | | Agroforestry (Ag)<br>Slope Land Agriculture (Sa)<br>Man-Made Forest (R) | Dry Farmland (F1) |
| Permanent Farmland | Lowland Paddy | | Lp | | Preservation of present state | |
| | Dry Farmland | | Df | | | |
| | Orchard | | Od | | | |
| Settlement | | | Co | | | |
| Bare Land | | | Br | Man-Made Forest (R) | Agroforestry (Ag)<br>Slope Land Agriculture (Sa)<br>Man-Made Forest (R) | Dry Farmland (F1) |

## 6.2 Development Programmes

Development programmes are needed to meet the expectations of local people and the basic principles of watershed management. These programmes should be in line with the land use plan. The important point is implementation of the programmes with the participation of local people. The following programmes have been formulated for the Model Area.

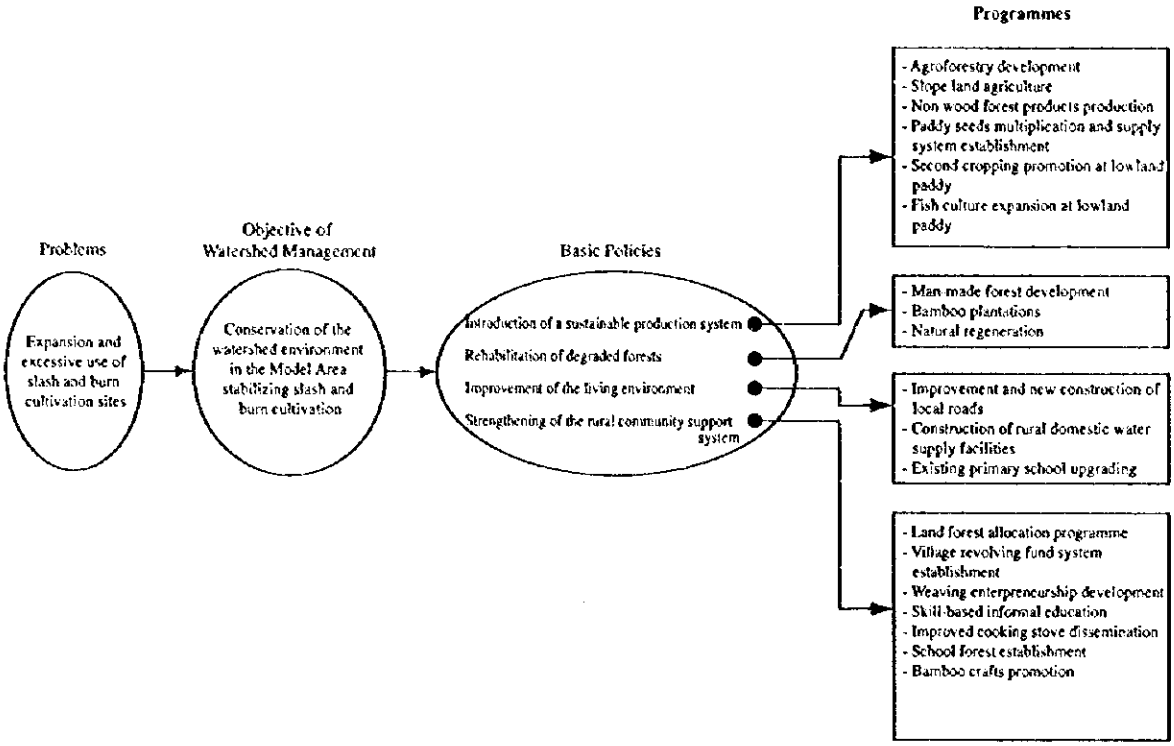



Fig. 6-2 Basic Policies and Programmes

The basic concept underlying each programme for the Model Area is described below as a reference in project formulation for the Study Area.

a. Agroforestry Development (Ag)

Many farmers in all of the villages have so far relied on slash and burn cultivation to produce dry field paddy. This traditional farming method used to be an ideal way of obtaining grains from land other than lowland paddy fields when a long fallow period was possible. However, the repeated use of this method with a short rotation period in recent years has made it difficult for the vegetation to recover, causing loss of the top soil and lack of nutrient supply. In the worst case, destruction of the environment has resulted. The lack of trees and ground vegetation in particular has adversely affected the continuous supply of water, necessitating the introduction of appropriate forest conservation measures from the viewpoint of effective watershed management. As a production area of grains and other

agricultural products, any attempt at farming or stock raising must make the best use of the existing trees to achieve the required objectives. The introduction of an agroforestry system is envisaged based on such local conditions. Two patterns of agroforestry are considered, i.e. silvi-agriculture which combines the planting of trees and crops (including fruit trees) and silvo-pastoral which combines the planting of trees and stock raising. The subject agroforestry sites are shrub land, bush, grassland, bare land and sparse secondary natural forests with a slope gradient of 10° - 25°.

b. Slope Land Agriculture (Sa)

Relatively gentle slopes with a gradient of less than 10° will be used as permanent farmland and these gentle slopes will still require soil loss prevention measures. To be more precise, the contour planting of grass at a 3-m interval on the slope will be conducted to create simplified terraces. The agricultural products to be grown on these terraces will be dry field paddy, pulses, peppers, tomatoes, cabbages, melons, cassava and sweet potatoes, etc.

**(Reference)**

**Process of Conversion From Slash and Burn to Permanent Farmland Cultivation**

This model farming household has three slash and burn cultivation sites, i.e. A,B and C, of 1 ha each, which is the average size of this type of site, as shown in Fig. 6-3. It is also assumed that a different site is cultivated each year under the slash and burn cultivation cycle, that slash and burn cultivation will come to an end after five years and that cultivation at a permanent farmland of 1 ha will produce the same yield as the present slash and burn cultivation.

As farmers will find it is difficult to accept the outright conversion of 1 ha of land to permanent farmland in a single year, the permanent farmland should be increased by 20 % annually while conducting slash and burn cultivation on a diminishing scale over a five-year period.

1st Year: Assuming commencement of permanent cultivation at location A, 20% of the area of A would be converted to terrace farm land and cultivated upland rice. Nevertheless, in order for the farmer to achieve his usual annual yield, slash and burn cultivation of 80% of the area of location B would be permitted.

2nd Year: Terrace farm land would be expanded to 40% of the area of A and upland rice cultivated. Cultivation of upland rice by slash and burn would be carried out in location C to provide the remaining 60% of usual annual yield. This year,

the farmer would plant 20% of location B with bamboo in addition to upland rice.

3rd Year: Terrace farm land would be expanded to 60% of the area of A and upland rice cultivated. Cultivation of upland rice by slash and burn would be carried out in another location of C to provide the remaining 40% of usual annual yield. Bamboo plantation would be expanded to 40% of the area of B.

4th Year: Terrace farm land would be expanded to 80% of the area of A and upland rice cultivated. Cultivation of upland rice by slash and burn would be carried out in location B to provide the remaining 20% of usual annual yield. In the remaining area of B, fruit trees would be planted. From this year, slash and burn cultivation would be completely stopped in location C to allow for natural forest regeneration.

5th Year: Terrace farm land would be further expanded to cover the entire area of location A, and upland rice cultivated. This would mark the end of the farmer's need to engage in slash and burn cultivation, and the remaining area of location B would accordingly be planted with trees.

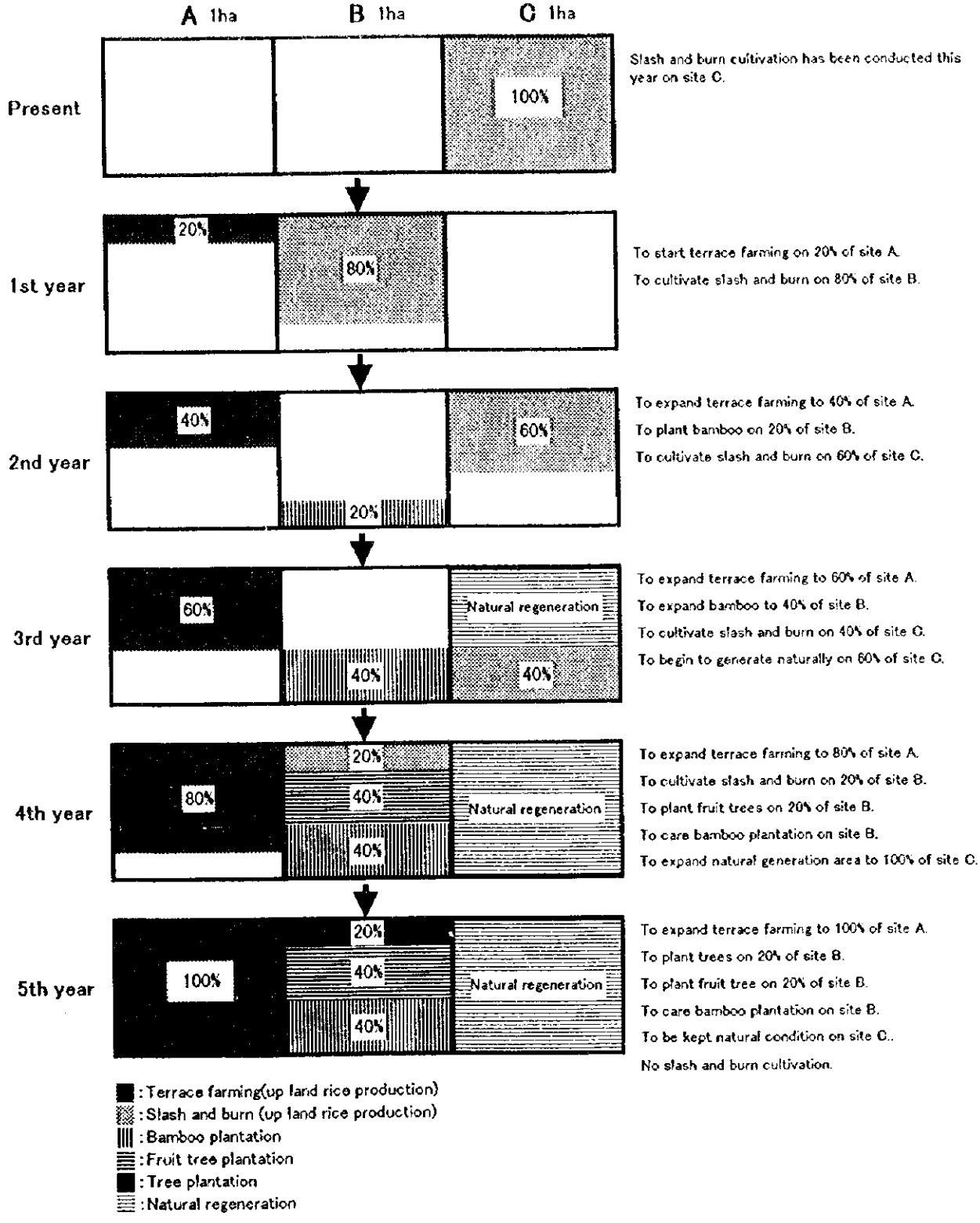



Fig.6-3 Process from Slash and Burn Cultivation to Permanent Farmland Cultivation

c. Non Wood Forest Products Production

There are seven key points to be considered for the extension of non-wood forest product cultivation as listed below.

| | | |
|---|---|---|
| ① Site suitability | : | suitable for the climatic, soil and topographical conditions of the cultivation site |
| ② Cultivation techniques | : | clarification of the cultivation requirements of each product and the systematic establishment of cultivation techniques |
| ③ Labor | : | availability and combination of labor required for complex management |
| ④ Profitability | : | production cost and profitability |
| ⑤ Distribution system | : | buyers, shipment channels and transportation distance |
| ⑥ Marketability | : | future marketing prospects |
| ⑦ Growth potential | : | promising potential to form a special production area in the future |

d. Lowland Paddy Seeds Multiplication and Supply System Establishment

The Lowland Paddy Seeds Multiplication and Supply System Establishment will increase the unit yield of lowland paddy through utilization of improved seeds recommended by the Ministry of Agriculture and Forestry instead of deteriorated self-produced seeds. According to the result of the first trial made by the Agricultural and Rural Development Project in Vientiane Province in 1997, unit yield of the improved seeds was about 10% higher than that of farmers' self-produced seeds.

e. Second Cropping Promotion in Lowland Paddy Land

The Second Cropping Promotion in Lowland Paddy Land will diversify crops in the existing lowland by introducing of short-growing crops which will be cultivable with limited available irrigation water in the dry season. In the short term, objective crops will be mainly for home consumption and/or local markets. With such crops, farmers are expected to learn cultivation and marketing techniques. In the medium term, the objective crops will gradually be converted aiming at larger markets, e.g. Vientiane.

f. Afforestation (R)

The feasible species for planting are *Tectona grandis* (teak) and *Pterocarpus macrocarpus* , *Afzelia xilocarpa* and *Terminalia catappa*. Suitable species for planting in the Model Area are currently being examined by the FORCAP and no final decision has yet been made. For the present purposes, teak is assumed to be the planting species as teak is a high value species for timber and is a local species which is popularly used for afforestation in the Model Area.

The common planting density is 1,100 trees/ha based on a planting distance of 3 m × 3 m or 625 trees/ha based on a planting distance of 4 m × 4 m. A planting density of 1,100 trees/ha is adopted under the plan, taking the planting density recommended by the Forest Regulation into consideration. The total number of trees to be planted will be approximately one million.

g. Improvement of Bamboo Forests (BI)

Bamboo, often Mai Shoth, often start to grow at former slash and burn sites. Under the Study, these bamboo growing sites are classified in the category of Bamboo Forest (2) and the resulting area of this category totals some 10,000 ha in the Model Area. As monsoon areas in Southeast Asia provide the best habitat for bamboo growth in the world, there is no factor impeding the planting and growth of bamboo in the Model Area. Mai Shoth is characterised by a thin and slender culm and is considered to have little use value. Bamboo forests of low quality bamboo will be improved to high quality bamboo forests by means of increasing the diameter of culm of Mai Shoth or introducing other large bamboo species to replace Mai Shoth.

1) Enlargement of Mai Shoth

Bamboo shoots appear approximately three times a year in the Model Area and the diameter class and length of the bamboo shoots increase each time they regenerate. To encourage this process, the number of clumps will be reduced to 350 - 400 in the fourth or fifth year in accordance with the state of growth. By cutting older, small diameter bamboo previously regenerated, usable culms can be produced in the fourth or fifth year. When the culms reach a usable diameter, they will be cut for use at a rate of approximately 25%.

2) Conversion to other large diameter species

Suitable species for the conversion of low quality bamboo forests to large diameter, high quality forests are Mai Hock and Mai Phaibaan, both of which are observed in the Model Area.

The propagation of bamboo can be conducted using seeds obtained after flowering or using cuttings. For the present purpose, the use of cuttings is selected in view of the easier process. A thick section of a 1 - 2 year old culm is used as a cutting after removing the thin end. This should be horizontally planted some 30 cm below the surface of the ground. An original cutting can be cut into sections with one or two nodes each for planting in the above manner. After the cutting has been covered by soil, it should be well watered. Young new culms start to appear approximately one month later but should be left for another two months or so and can then be dug up for use as bamboo seedlings.

The planting density should be 400 seedlings/ha. After tending for four years, they will grow sufficiently large enough for use as building materials for hedging, walls and roofs.

h. Natural regeneration (Nr)

All primary natural forests and secondary natural forests with a crown density of 40% or more will be made usable by local people for the collection of firewood and other purposes. When trees are cut to serve local people, the sites will be restored through natural regeneration by sprouting. Rules on the diameter of trees subject to cutting to produce firewood and also on the handling of protection forests to be established by villagers will be introduced to meet the intentions of villagers so that these forests can be protected by the villagers themselves.

i. Land- Forest Allocation Programme

The on-going Land- Forest Allocation Programme will be implemented so as to support the forest conservation and development of upland farming in a permanent agricultural land through clarification of the village boundaries and granting land use rights to individual families.

j. Construction of Rural Domestic Water Supply System

The target of this programme is to ensure the supply of domestic water to villagers in the Model area by means of either a gravity fed pipe water supply system (the pipe system) or

dug wells/shallow tube well. Where possible, the pipe system will first be examined in accordance with guidelines of Water Supply and Environmental Sanitation Programme, then construction of the wells will be considered for the villages where the pipe system is not feasible or not applicable.

k. Other Programmes

1. Fish Culture Expansion in Lowland Paddy Land

Fish Culture Expansion in Lowland Paddy Land will increase the land productivity of lowland paddy land in which fish cultivation will be combined. It will bring an additional income to the farmers and improve their nutrition. The existing production system practiced in Namon-Nua village will be applicable for the expansion. Since recent fish marketing prices are increasing due to the decreasing trend of fish catches in the Nam Ngum reservoir, this program is expected to generate higher cash income for the farmers.

2. Improvement and new construction of local road

The objective of this programme is to expand the economic activities in the Model area through upgrading the existing local roads and constructing new ones, connecting the remote villages with Route 13. The programme consists of three main components of : i) gravelling the existing earth roads; ii) upgrading the existing cart road by gravelling; and iii) constructing new local roads, and bridges or crossing structures related to those roads. The improvement programme is planned and designed in accordance with the Road Design Manual.

3. Existing primary school upgrading

Under this programme, the existing primary schools in the Model area would be upgraded to the national standard level applied by the Ministry of Education.

4. Revolving Fund System Development

The Revolving Fund System Development will basically support the expansion of agroforestry development in permanent land through provision of investment and production loans to the farmers who lack funds for their land development and crop production. Under the programme, a village organization responsible for the management of the revolving fund system will firstly be established in each village. The Project will train management staff for the system management in detail. The Project will then provide the initial fund of the organization, may be in kind particularly at the initial stage based on the requirement of the member farmers. The management

staff will have to examine the propriety of members' loan requirements before making loans. The member farmers will have to repay the loan under certain conditions to be established. The repayment amounts will be loaned again to other member farmers.

5. Weaving Entrepreneurship Development

The Weaving Entrepreneurship Development will strengthen the village weaving system by providing training of trainers to selected village weavers. Under the programme, a capable weaver for the special training programme will be selected from each village. The training will cover various fields including quality control, book keeping, marketing, etc. The trained weaver will then take responsibility for training of other weavers in her village. With this programme, village women are expected to increase their cash income and improve vocational skills in wider activities relevant to weaving.

6. Skill-Based Informal Education

Skill-Based Informal Education will be implemented to improve the adult literacy rate particularly of women and improve women's technical skills in the management of village level small projects. Under the programme, villagers interested in attending literacy classes will be organized into a group. Teaching on writing and reading will be made by selected villagers or school teachers on a voluntary basis using materials to be provided by the Project. As an incentive, the Project will provide several training courses to the group members beside the literacy class. As one of the most important training courses, improved cookstove making is proposed to be undertaken by the program as described in the next paragraph. As an alternative, training on home garden management is also proposed to be taken into account in order to improve the nutrition level of villagers, improve their technical level for crop diversification and increase their cash income.

7. Improved Cookstove Dissemination

The Improved Cookstove Dissemination will support the above programme of Skill-Based Informal Education. However, this programme alone can be promoted in villages having higher potential for development (may be in availability of materials) and expectation of villagers' participation.

8. School Forest Establishment

The School Forest Establishment will be implemented as one of the environmental education programmes mainly for primary school children and their parents. It will

enlighten them the importance of the forest through school forest establishment and its operation in cooperation with the Project. Tree planting and forest management techniques will be provided to them by the Project. Such techniques will possibly be utilized for the recovery of degraded forests existing in and around the villages in the future. Timber to be produced in the forests (after about 20 years) will possibly be utilized for school renovation, and fruits will possibly be consumed among the pupils or sold for cash income also for school renovation.

9. Promotion of bamboo crafts and wood crafts

The main purpose will be to increase cash income by selling bamboo and wood crafts. Promotion of wood crafts such as carving is a way of income generation for the local people using the forest resources usefully.

## 6.3 Implementation Process

As existing administrative bodies which are involved in wide-ranging activities may find it difficult to implement the Project in addition to their existing activities, the Project will be established as an administrative body principally responsible for implementation of the Project. This Project Office will introduce field extension teams (provisional name) which will visit villages and which will conduct various programmes together with local people.

Meanwhile, there appears to be a general tendency for farmers to cling to their traditional pattern of life in the face of these new programmes and difficulties in programme extension work are anticipated. To alleviate such difficulties, a group of farmers showing understanding of and interest in the programmes will be formed in each village to play a leading role in programme implementation.

The Project Office will provide intensive technical guidance and support for these groups and sub-groups in order to disseminate new techniques from farmers' groups to villages and finally throughout the entire Model Area. The technical guidance provided by the Project Office will mainly focus on farmers' groups even though there will be occasions on which similar guidance will be provided for other farmers in the subject villages in the process of extension activities.

In regard to such land use-related plans as the slope land agriculture, agroforestry development, bamboo plantation and lowland productivity improvement, demonstration farms will be introduced in each village in addition to the formation of farmers' groups to provide extension models.

The imagined expansion of the extension effects and the relationship between the Project Office and villages are shown in Fig. 6-4 and Fig. 6-5 respectively.

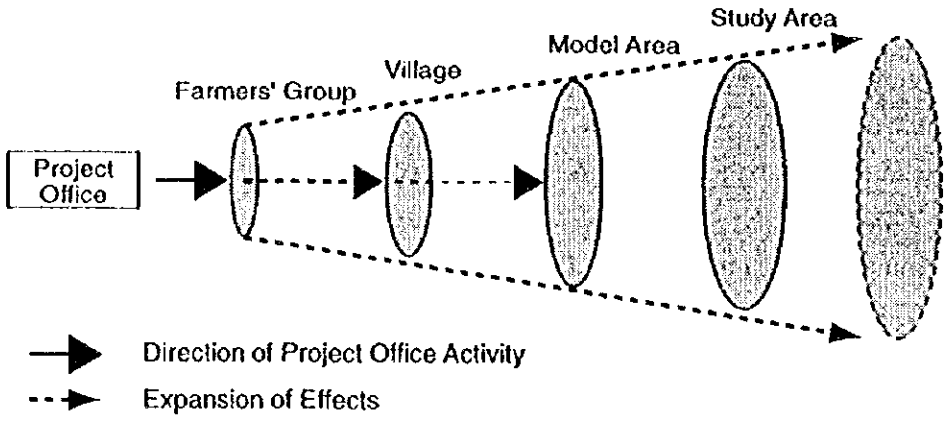



Fig. 6-4 Expansion Image of Extension Effects

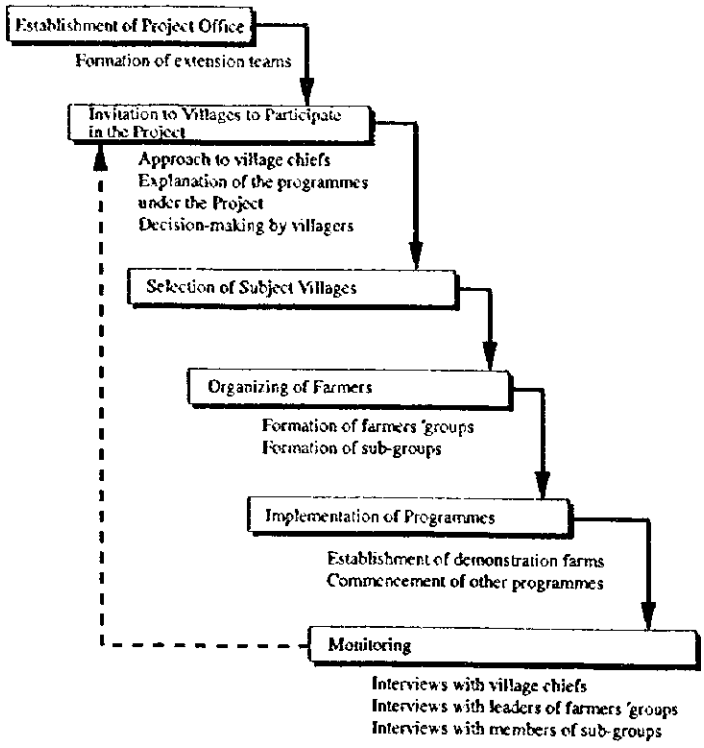



Fig. 6-5 Work Flow of Project Office

## 6.4 Selection of Subject Village

Within a framework of respect for the aspirations of each village with regard to programme implementation, programme execution will commence with villages accorded highest priority on the basis of a comprehensive consideration of land use conditions, degree of reliance on slash and burn cultivation, village location, access, human resources, etc.

## 6.5 Formation of Farmers' Groups

Each village will form a farmers' group (provisional name) under the deputy chief in charge of economy with a view to implementing the planned programmes. This farmers' group will be divided into programme-based sub-groups consisting of farmers who are interested in participating in specific programmes. The size of a sub-group should be restricted to nine members per extension worker to ensure group unity and close communication with the extension worker while the optimal size is 3 - 5 members.

## 6.6 Demonstration Farms

In the Model Area, Demonstration Farms were planned to be established prior to the actual practice of agroforestry to facilitate the extension activities. Farmers' practice of the agroforestry in the Model Area will be used as farming samples for the people in the rest of the Study Area. Although demonstration farms are assumed not to be needed in the rest of the Study Area, an outline of demonstration farms is described below for reference.

The size of the demonstration farms will be decided by the number of households participating in the sub-groups. In the case of silvi-agriculture, the farm size per household will be 120% of the slash and burn cultivation area per household. In the case of silvo-pasture, the farm size per household will be 0.5ha/head

The principles used to determine the demonstration farm size for the slope land agriculture programme are similar to those for the agroforestry development programme. The farm size per participating household will be 1.2 ha, i.e. 120% of the slash and burn cultivation area per household.

In regard to the paddy seeds multiplication and supply system establishment programme, second cropping promotion in the lowland paddy programme and fish culture expansion in the lowland paddy programme under the lowland productivity improvement project, 0.15 ha, 0.5 ha and 0.5 ha of paddy fields will be converted as the respective demonstration farms in each village.

## 6.7 Implementation Order

The ownership of land use rights and village boundaries are often unclear in regard to forest land. Consequently, there are cases of land use disputes between neighboring villages. Such programmes as the Agroforestry Development Programme, Slope Land Agriculture Programme and Bamboo Plantation Programme must only be implemented after solution of disputes between local people. This requirement makes it necessary to firstly implement the Land-Forest Allocation Programme prior to the implementation of land use-related programmes.

In reality, the land use rights at some of the current or former slash and burn sites are not always clear. At some villages, there is land which is commonly accessible by villagers. At this land, it will be possible to implement various programmes without implementation of the Forest Land Allocation Programme.

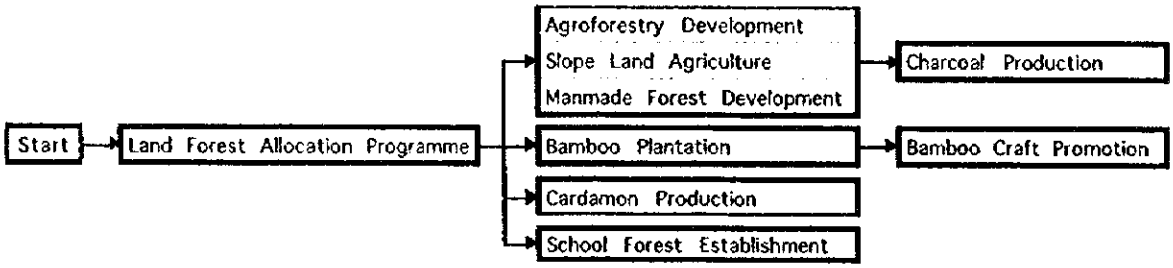



Fig.6-6 Implementation Order of Programmes

## 6.8 Implementation Structure

A Project Office will be established which will serve as a center for Project implementation activities. The Study Area is located in the Vangvieng district, and the Project Office will accordingly be set up at the Vangvieng DAFO. Close liaison will be required with the Agricultural and Forestry Section of Vientiane province, the Department of Forestry, and the Afforestation Center. Since the programmes under the Project are not only agriculture and forestry related but also affect the construction and education sectors, it will be important that the Department of Forestry act as a coordinating link to the central government ministries and agencies which are concerned with these other sectors.

In order to efficiently implement the Project, the staff size of the Project Office must be appropriate for the Project Area scale, number of targeted villages and population (number of households) residing therein. In the event that the Project is executed with limited manpower,

the overall Study Area should be divided into smaller units for step-wise implementation in the target areas.

## 6.9 Monitoring

Monitoring is carried out to identify the degree of impact of Project implementation on the natural and social environments, and the status of Project progress.

Items to be monitored will include all environmental items and project content other than that accorded an overall "no major adverse impact" evaluation under the Initial Environment Examination.

## 6.10 Initial Environment Examination

Prior to the implementation of these programmes, their possible environmental impacts must be examined. As the rules for environmental impact assessment (EIA) are under preparation in Lao PDR, the Environmental Assessment Guidelines for Development Studies (Forestry) suggested by JICA were used for the Model Area. The assessment results are described in Chapter 9 of the Main Report.

According to the result of the EIA of the Model Area, disputes concerning land use between neighboring villages were anticipated as a negative impact due to unclear land use rights and village boundaries.

# ANNEX 1

# SOIL SURVEY

| No. | Date<br>年月日 |
|---|---|
| Location<br>地形 | Inclination<br>傾斜 度 |
| Direction<br>方位 | Altitude<br>標高 m |
| Residual/Colluvial<br>堆積様式 | Parent material<br>母材・地質 |
| Land use<br>利用来歴・現況 | |
| Surveyor<br>調査者 | |

Site description
地形・記載

Comunity table / Comunity symbol
群落組成表 / 群落名

| Layer<br>階層 | Dominant<br>優占種 | Height<br>高さm | D.B.H<br>胸径cm | P.C.V.<br>植被率% | Spp Nos.<br>種数 |
|---|---|---|---|---|---|
| I Tree layer ($T_1$) | | ~ | ~ | | |
| II Sub tree layer ($T_2$) | | ~ | ~ | | |
| III Shrub layer (S) | | ~ | ~ | | |
| IV Herb layer (H) | | ~ | ~ | | |
| V Moss layer (M) | | ~ | ~ | | |

Area
面積 × $m^2$

Species'numbers
出現種数 種

P.C.V. : Percentage of vegetational cover
D.B.H. : Diameter brest high

| | L | C・S | SPP. | L | C・S | SPP. | L | C・S | SPP. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | |
| 2 | | | | | | | | | |
| 3 | | | | | | | | | |
| 4 | | | | | | | | | |
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | | | | | | | | | |
| 8 | | | | | | | | | |
| 9 | | | | | | | | | |
| 10 | | | | | | | | | |
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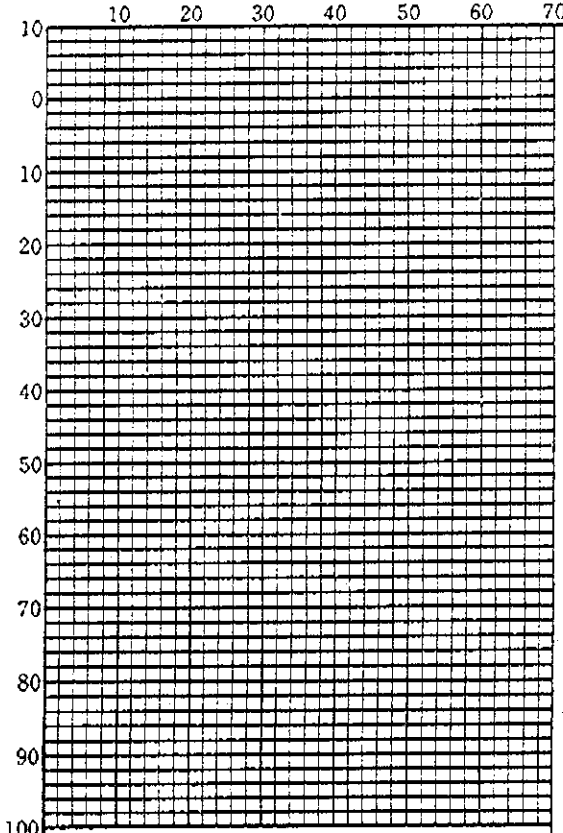
| 24 | | | | | | | | | |
| 25 | | | | | | | | | |
| 26 | | | | | | | | | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 | | | | | | | | | |

($T_1$) : Tree(high) ($T_2$) : Tree(Middle) (S) : Shrub (H) : Herb (M) : Moss
L : Layer 階層 C・S : Coverage・sociabilty 被度・群度 Spp. : Species 種

JAFTA

Soil Survey Field Note 1

| No. | Date 年月日 | Location 地形 | Ao L : | Pores 孔隙 |
|---|---|---|---|---|
| Type of Soil 土壌型 | Inclination 傾斜 度 | Direction 方位 | F : | Mottle, Concretion 斑紋・結核 |
| | Altitude 標高 m | Residual/Colluvial 堆積様式 | H : | Water level 湧水・地下水 |
| | Parent material 母材・地質 | Land use 利用来歴・現況 | | Gleying グライ |

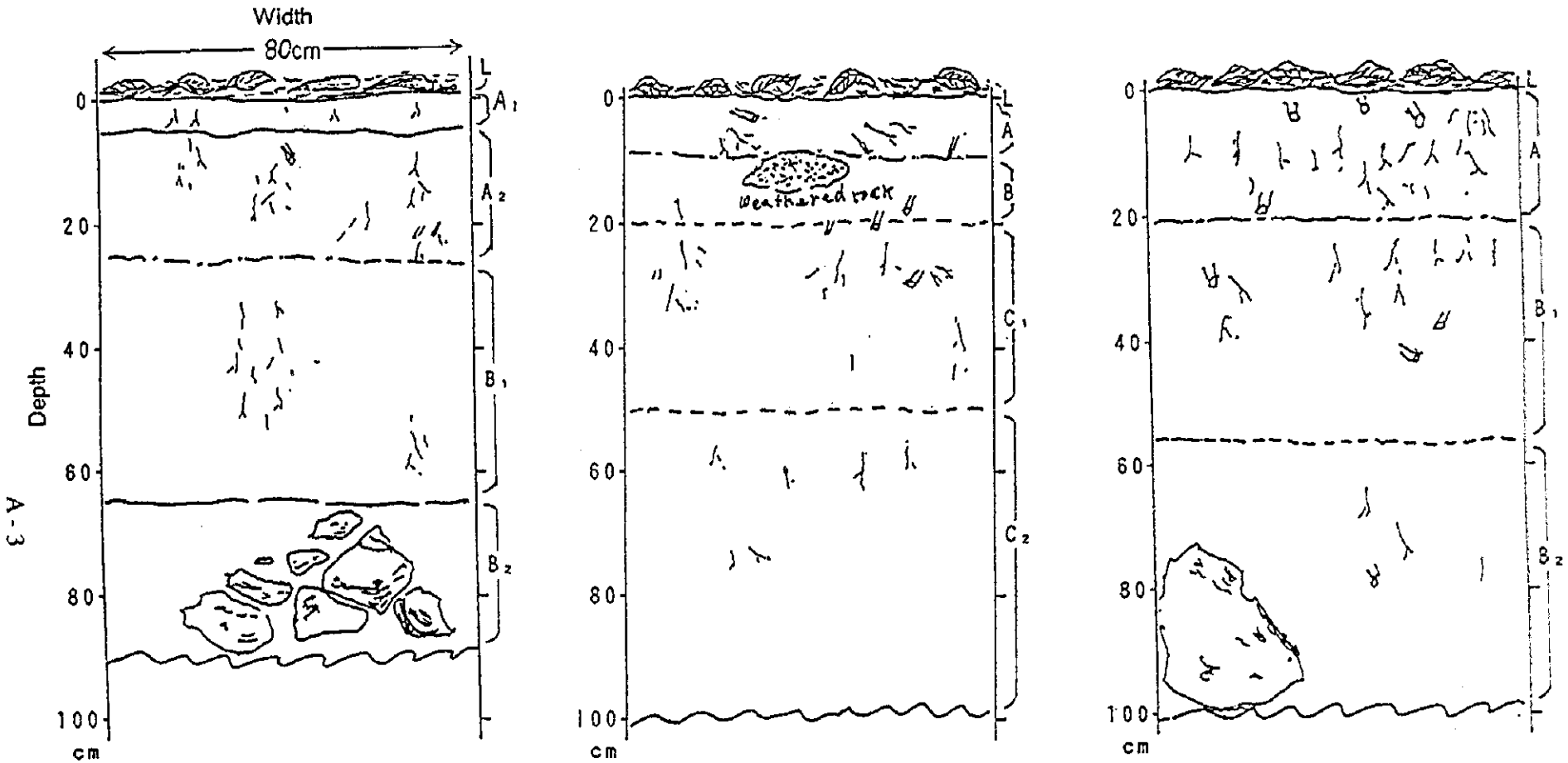



| Horizon 層位 | Color 色 | Humus 腐植 | Texture 土性 | Structure 構造 | 石礫 Gravel Size・Form 大きさ・形 | Weathering 風化度 | Content 含有量 | Hardness 堅密度 | Moisture 水湿状態 | Leaching Accumulation 溶脱・集積 | Mycorrhiza Mycelium 菌根・菌糸 | 根 Root Herb 草本 | Lingneous 木本 | Remarks その他 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |

A－2

JAFTA

Soil Survey Field Note 2




Index for Boundary Description

| Symbol | Width of Boundary | |
|---|---|---|
| ——— | Less than 3 cm | Abrupt |
| -·-·-·- | 3 – 5 cm wide | Clear |
| ——— | 5 cm or more | Gradual |

**Sample Soil Profiles**

No.13,No.7, No.37 indicate their plot No. shown on the Soil Map(1/20,000)

# ANNEX 2

# QUESTIONNAIRES

Sample No._____

# HOUSEHOLD SURVEY

M D Y

Date : ___/___/___

Enumerator : _____ Supervisor (Eng.) : _____

Village : _____ Sub-district : _____

Ethnic Group-A : _____ (see Code)

Code for Ethnic Group-A
1. Lao Sung 2. Lao Theung 3. Lao Lum

Ethnic Group-B (Specify) : ( _____ )

## SECTION I GENERAL INFORMATION

I-1 Name of interviewee (in Lao) _____ Sex: (M / F) _____ Age : _____

Name of interviewee (in Eng.) _____

I-2 Total number of household members _____ persons

I-3 Household members in the same house including the interviewee and temporal absentees.

| | *SEX* Sex | *AGE* Age | *EDU* Education (see Code) | *FARM* Farming #1 (Y / N) | *OCC* Main Occupation (see Code) | *PA* Present / Absent #2 | *ORG* Organization (see Code) | |
|---|---|---|---|---|---|---|---|---|
| 1. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | Head |
| 2. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 3. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 4. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 5. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 6. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 7. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 8 | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 9. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 10. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 11. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 12. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 13. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |
| 14. | M / F | _____ | _____ | _____ | _____ | P / A | _____ | |

Note: #1: Asking whether or not he / she engages in farming (including livestock raising, fishing and slash and burn (Hai)).
#2: "P" means he / she live in the house throughout the year.
"A" means he / she live in other places more than four months in a year.

**Code for education:**
1. No formal education
2. Some classes of primary sc.
3. Graduate of primary school
4. Some classes of secondary sc.
5. Graduate of secondary school
6. Some classes of high school
7. Graduate of high school
8. Some classes of profession. H
9. Graduate of professional high
10. More than high school

**Code for occupation:**
1. Salary worker
2. Wage labor
3. Private business
4. Farmer
5. Student
6. Child (below school age)
7. No job
8. Others

**Code for organization**
1. Member of Women's Union
2. Member of Youth Organization
3. Member of Elders' Group
4. Member of Water Users group
5. Member of Village Committee
6. Member of ethnic organization
7. Member of religious rganization
8. Member of other users' group (specify _____)
9. Member of other organization
10. Non-member

I-4 Cash income sources of the household.

Sample No._____

*(please indicate the order of cash income amount, 1, 2, 3 .... ).*

| | (Order) | (Amount) |
|---|---|---|
| 1. Selling Kao Na (paddy land rice) | _____ | _____ Kip/ Yr |
| 2. Selling Kao Hai (slash & burn rice) | _____ | _____ Kip/ Yr |
| 3. Selling vegetables (including beans) | _____ | _____ Kip/ Yr |
| 4. Selling fruits | _____ | _____ Kip/ Yr |
| 5. Selling livestock/ poultry | _____ | _____ Kip/ Yr |
| 6. Selling fishes | _____ | _____ Kip/ Yr |
| 7. Selling fuel wood | _____ | _____ Kip/ Yr |
| 8. Selling timber | _____ | _____ Kip/ Yr |
| 9. Selling forest vegetables/ crops | _____ | _____ Kip/ Yr |
| 10. Selling of handicraft products | _____ | _____ Kip/ Yr |
| 11. Salary from permanent job | _____ | _____ Kip/ Yr |
| 12. Wage from temporary jobs | _____ | _____ Kip/ Yr |
| 13. Private business (trading, shop, etc.) | _____ | _____ Kip/ Yr |
| 14. Remittance from family members | _____ | _____ Kip/ Yr |
| 15. Others | _____ | _____ Kip/ Yr |
| (Specify: _____ ) | | _____ Kip/ Yr |

I-5 When did your household settle in the village? _____ (see Code)

Code for answer:
1. Within the last 10 years
2. From 10 to 20 years ago
3. From 20 to 30 years ago
4. More than 30 years ago

## SECTION II LIVING CONDITION

II-1 Drinking Water

| | Main source (Choose one from Code) | Distance (go and back) (including time for waiting) | Sufficiency (see Code) |
|---|---|---|---|
| Dry Season | _____ | _____minutes | _____ |
| Wet Season | _____ | _____minutes | _____ |

Code for source :
1. Piped water
2. Springs (natural)
3. River
4. Reservoir
5. Wells
6. Rain water
7. Others

Code for sufficiency :
1. Sufficient
2. Just enough
3. Short
4. Very short

Sample No._____

II-2 Source of fuel for cooking/heating.
*(Choose up to 3 important items and answer the availability)*

| | Importance (1, 2, 3) | Availability (see Code) |
|---|---|---|
| 1. Fuel wood | 1_____ | 1_____ |
| 2. Charcoal | 2_____ | 2_____ |
| 3. Crop residue | 3_____ | 3_____ |
| 4. Gas cylinder | 4_____ | 4_____ |
| 5. Kerosine | 5_____ | 5_____ |

Code for availability
1. Easily available
2. Difficult to obtain
3. Very difficult to obtain

II-3 Annual consumption of fuel wood by source

1. Own harvest _____ La/ year
Charge, if any _____ Kip/ La

2. Purchased _____ La/ year
Price : _____ Kip/ La

3. Total _____ La/ year

II-4 Distance to main fuel wood forests including slash and burn areas for fuel wood collection

Source-1._____ minutes (one way)

Source-2._____ minutes (one way)

II-5 Food condition /availability of household (for your own products / harvest)

| | Condition (see Code) | Shortage in months in a year |
|---|---|---|
| 1. Cereals (paddy, maize, etc.) | _____ | _____ months/year |
| 2. Roots and tuber crops | _____ | _____ months/year |
| 3. Vegetables (including beans) | _____ | _____ months/year |
| 4. Meat | _____ | _____ months/year |
| 5. Fish | _____ | _____ months/year |
| 6. Forest vegetables/ crops | _____ | _____ months/year |

Code for condition:
1. Own harvest / product exceeds the household demand.
2. Own harvest / product is just enough to meet the household demand.
3. Purchased or exchanged to meet the household demand.

## SECTION III CROP PRODUCTION

III-1 Total area for crop cultivation in 1995/96

| | Land Owned by the Family (*1) | Land Rented from Others (*2) | Land Leased to Others (*3) |
|---|---|---|---|
| Hai(slash and burn) | _____ ha | _____ ha | _____ ha |
| Na(paddy land) | _____ ha | _____ ha | _____ ha |
| Upland (fruits, vege. etc.) | _____ ha | _____ ha | _____ ha |

*1: Including the lands managed under the cultivation right.
(Note: 1 + 2 - 3 = land operated by the family)

III-2 Land title of the above "Owned Land"

Hai-A (only for paddy) _____

Hai-B (for other crops) _____

Na _____

Upland (fruits, vege. etc.) _____

Code for answer
1. Privately owned (you can sell it, if you want.)
2. Government land but you have a right to cultivate traditionally
3. Government land but allocated by the village committee
4. You don't know whose land that is, but you cultivate
5. Other (specify) _____

III-3 Are you going to use the above "Hai" area again for crop cultivation in near future ?

Hai-A (Y / N) : _____ Hai-B (Y / N) : _____

III-4 If your answer is "Yes" in the above, when are you going to use it again for paddy ?

Hai-A _____ year(s) later Hai-B _____ year(s) later

III-5 If your answer is "No" in the above, is it easy to find "Hai" area(s) in different places ?

(Y (easy) / N (not easy)) : _____

III-6 Total "Hai" area(s) of the Household in the last 4 years (including other crops)

1st year : _____ ha 2nd year : _____ ha

3rd year : _____ ha 4th year : _____ ha

III-7 Do you usually stay at "Hai" area during cultivation season ?
(Plural answers are acceptable, but not more than two answers.)

_____, _____

Code for answer
1. Stay during the season for slash and burn
2. Stay during the season for seeding
3. Stasy during the season for harvest
4. Stay continuously from slash/burn to harvest
5. Not stay, go there based on requirements

III-8 Crop production (excluding crops grown in home garden)

| Hai (Slash and burn) | (Crop code) | (Crop code) | (Crop code) |
|---|---|---|---|
| Wet season crops | _____ | _____ | _____ |
| Dry season crops | _____ | _____ | _____ |

(please answer for major crops you grow in "Hai")

Crop 1 Crop 2 Crop 3

Sample No._____

| | | | | |
|---|---|---|---|---|
| a. | Name of crops (crop code) | _____ | _____ | _____ |
| b. | Planted area | _____ ha | _____ ha | _____ ha |
| c. | Total production | _____ kg | _____ kg | _____ kg |
| d. | Production sold | _____ kg | _____ kg | _____ kg |
| e. | Price at sale | _____ Kip/kg | _____ Kip/kg | _____ Kip/kg |

| **Na (paddy land)** | Crop code | Crop code | Crop code |
|---|---|---|---|
| Wet season crops | _____ | _____ | _____ |
| Dry season crops | _____ | _____ | _____ |

(please answer for major 3 crops you grow in either wet or dry season in "Na")

| | | Crop 1 | Crop 2 | Crop 3 |
|---|---|---|---|---|
| a. | Name of crops (crop code) | _____ | _____ | _____ |
| b. | Planted area | _____ ha | _____ ha | _____ ha |
| c. | Total production | _____ kg | _____ kg | _____ kg |
| d. | Production sold | _____ kg | _____ kg | _____ kg |
| e. | Price at sale | _____ Kip/kg | _____ Kip/kg | _____ Kip/kg |

Code for crops

1. Paddy/ rice
2. Maize
3. Cassava
4. Potato
5. Groundnuts
6. Beans
7. Chile
8. Other vegetables
9. Other-1 (_____)
10. Other-2 (_____)

III-9 Annual paddy production and consumption of household

| | |
|---|---|
| 1. Paddy production in paddy land (Kao Na) | _____ kg/year |
| 2. Paddy production in slash and burn area (Kao Hai) | _____ kg/year |
| 3. Total paddy production (1 + 2) | _____ kg/year |
| 4. Total paddy consumption in a month (average) | _____ kg/month |
| 5. Total paddy consumption in a year (average) | _____ kg/year |
| 6. Balance of paddy in household (3 - 5) | _____ kg/year (- or + is needed) |

## SECTION IV LIVESTOCK / ANIMALS / FISHES

IV-1 Livestock and feed

| | | Numbers | Wet Season | | Dry Season | |
|---|---|---|---|---|---|---|
| | | | Main Feed (select major one) | Sufficiency | Main Feed (select major one) | Sufficiency |
| 1. | Cows / oxen | _____ | _____ | _____ | _____ | _____ |
| 2. | Buffalo | _____ | _____ | _____ | _____ | _____ |
| 3. | Goat/sheep | _____ | _____ | _____ | _____ | _____ |
| 4. | Pig | _____ | | | | |

5. Chicken _____
6. Duck _____
7. Turkey _____
8. Fish (please answer if you grow fish in pond or not) (Yes / No) _____

Code for main feed:
1. Grass
2. Tree fodder
3. Crop residue
4. Grain
5. Root & tuber crops

Code for sufficiency:
1. Sufficient
2. Just enough
3. Short
4. Very short

## SECTION V FOREST

V-1 Do you have forest that you have a right to use privately ? (Y / N) _____

If Yes, _____ ha

V-2 Horticultural trees privately owned

| | No. of trees | | No. of trees |
|---|---|---|---|
| 1. Orange trees | _____ | 9. Jackfruits trees | _____ |
| 2. Lime trees | _____ | 10. Leichi trees | _____ |
| 3. Lemon trees | _____ | 11. Guava | _____ |
| 4. Mango trees | _____ | 12. Coffee | _____ |
| 5. Papaya trees | _____ | 13.Rambutan | _____ |
| 6. Coconut trees | _____ | 14.Tamarind | _____ |
| 7. Banana trees | _____ | 15. _____ | _____ |
| 8. Mangosteen | _____ | 16. _____ | _____ |

Sample No._____

# SURVEY FOR HOUSEHOLD MEMBERS

M D Y

Date: ____/____/____

Enumerator: _____ Supervisor (Eng.): _____

Respondent: _____

Sex ( M / F ): _____, Age: _____

Village: _____, Sub-district: _____

## A. Participation / engagement of household members

| Home activities | Your participation / engagement (See "Code") | Activities you want to make easy |
|---|---|---|
| 1. Fetching of drinking water | 1: ____ | (Choose up to 5 activities with |
| 2. Cooking | 2: ____ | priority from the ones you |
| 3. Washing | 3: ____ | checked in the left line (1 - 50)) |
| 4. Sweeping the house | 4: ____ | 1st:_____ |
| 5. House repair | 5: ____ | 2nd:_____ |
| 6. Child / elderly care | 6: ____ | 3rd:_____ |
| 7. Kitchen gardening | 7: ____ | 4th:_____ |
| 8. Sewing and knitting | 8: ____ | 5th:_____ |
| 9. Shopping in market | 9: ____ | |
| **Farming activities** | | |
| 10. Plowing | 10: ____ | |
| 11. Seeding/ transplanting | 11: ____ | |
| 12. Weeding | 12: ____ | |
| 13. Application of chemical fertilizers | 13: ____ | |
| 14. Harvesting | 14: ____ | |
| 15. Repairing of farm | 15: ____ | |
| **Slash & burn activities** | | |
| 16. Slashing | 16: ____ | |
| 17. Burning | 17: ____ | |
| 18. Clearing | 18: ____ | |
| 19. Fencing | 19: ____ | |
| 20. Seeding | 20: ____ | |
| 21. Weeding | 21: ____ | |
| 22. Harvesting | 22: ____ | |
| **Livestock & poultry raising** | | |
| 23. Grazing control | 23:_____ | |
| 24. Feeding | 24:_____ | |

*(to be continued)*

**Code for answer:** 1. Usually 2. Sometimes 3. None

| | Your participation / engagement (See "Code") |
|---|---|
| 25. Watering | 25:_____ |
| 26. Collection/ production of fodder | 26:_____ |
| 27. Sweeping of livestock & poultry stall | 27:_____ |
| **Fishing activities** | |
| 28. Fish catching in river | 28:_____ |
| 29. Fish production in pond | 29:_____ |
| 30. Repairing of fishing gear | 30:_____ |
| 31. Maintenance of boat / engine | 31:_____ |
| 32. Maintenance of pond | 32:_____ |
| **Forestry activities** | |
| 33. Collection of fuel wood | 33:_____ |
| 34. Collection of forest vegetable/crops | 34:_____ |
| 35. Timber harvest | 35:_____ |
| 36. Charcoal production | 36:_____ |
| **Post-harvest & marketing activities** | |
| 37. Threshing of cereals | 37:_____ |
| 38. Processing livestock & poultry products | 38:_____ |
| 39. Processing fishes | 39:_____ |
| 40. Processing of forest vegetables/crops | 40:_____ |
| 41. Selling crops | 41:_____ |
| 42. Selling livestock & poultry products | 42:_____ |
| 43. Selling fishes & fishery products | 43:_____ |
| 44. Selling forest vegetables/crops | 44:_____ |
| 45. Selling of fuel wood/charcoal | 45:_____ |
| **Domestic business** | |
| 46. Rice mill | 46:_____ |
| 47. Trading | 47:_____ |
| 48. Shop keeping | 48:_____ |
| 49. Handicraft | 49:_____ |
| **Communication** | |
| 50. Attending community meetings | 50:_____ |
| 51. Resolving in-village conflicts | 51:_____ |
| 52. Getting information from TV | 52:_____ |
| 53. Getting information from Radio | 53:_____ |
| 54. Political discussion with others | 54:_____ |
| 55. Official letter writing | 55:_____ |

*(to be continued)*

**Code for answer:** 1. Usually 2. Sometimes 3. None

Your participation / engagement

(See "Code")

**Religious / cultural activities**

56. Dance party 56:_____
57. Picnic 57:_____
58. Worship ceremony 58:_____
59. Sport events 59:_____
60. Playing music 60:_____
61. Drawing 61:_____

**Code for answer:** 1. Usually 2. Sometimes 3. None

**B. Present concerns and collective actions related to them**

| | | Degree of concern | Actions / participation in the past? (Y / N) | External assistance in the past? (Y / N) | Willing to take actions / participation? (Y / N) |
|---|---|---|---|---|---|
| 1. | Food availability | 1_____ | 1_____ | 1_____ | 1_____ |
| 2. | Fodder availability | 2_____ | 2_____ | 2_____ | 2_____ |
| 3. | Fuel wood availability | 3_____ | 3_____ | 3_____ | 3_____ |
| 4. | Paddy land availability | 4_____ | 4_____ | 4_____ | 4_____ |
| 5. | Upland availability | 5_____ | 5_____ | 5_____ | 5_____ |
| 6. | Grazing land availability | 6_____ | 6_____ | 6_____ | 6_____ |
| 7. | Slash and burn land availability | 7_____ | 7_____ | 7_____ | 7_____ |
| 8. | Fishing pond availability | 8_____ | 8_____ | 8_____ | 8_____ |
| 9. | Forest resources | 9_____ | 9_____ | 9_____ | 9_____ |
| 10. | Disease of livestock | 10_____ | 10_____ | 10_____ | 10_____ |
| 11. | Drinking water availability | 11_____ | 11_____ | 11_____ | 11_____ |
| 12. | Crop productivity | 12_____ | 12_____ | 12_____ | 12_____ |
| 13. | Cash income | 13_____ | 13_____ | 13_____ | 13_____ |
| 14. | Motorable roads | 14_____ | 14_____ | 14_____ | 14_____ |
| 15. | Maintenance of farm | 15_____ | 15_____ | 15_____ | 15_____ |
| 16. | Irrigation | 16_____ | 16_____ | 16_____ | 16_____ |
| 17. | Electricity supply | 17_____ | 17_____ | 17_____ | 17_____ |
| 18 | Mailing system | 18_____ | 18_____ | 18_____ | 18_____ |

*(to be continued)*

**Code for degree of concerns:**

1. Strongly concerned
2. Concerned
3. Slightly concerned
4. Not concerned
5. No answer

Degree of Actions / External Willing to

Sample No._____

| | concern | participation in the past? (Y / N) | assistance in the past? (Y / N) | take actions / participation? (Y / N) |
|---|---|---|---|---|
| 19. Education of children | 19_____ | 19_____ | 19_____ | 19_____ |
| 20. Education of myself | 20_____ | 20_____ | 20_____ | 20_____ |
| 21. Health | 21_____ | 21_____ | 21_____ | 21_____ |
| 22. Family planning | 22_____ | 22_____ | 22_____ | 22_____ |
| 23. Sanitation | 23_____ | 23_____ | 23_____ | 23_____ |
| 24. Land slide & soil erosion | 24_____ | 24_____ | 24_____ | 24_____ |
| 25. Flood | 25_____ | 25_____ | 25_____ | 25_____ |
| 26. Draught | 26_____ | 26_____ | 26_____ | 26_____ |
| 27. Forest fire | 27_____ | 27_____ | 27_____ | 27_____ |
| 28. Degradation of soil fertility in slash and burn area | 28_____ | 28_____ | 28_____ | 28_____ |
| 29. Labor force availability | 29_____ | 29_____ | 29_____ | 29_____ |
| 30. Dance party | 30_____ | 30_____ | 30_____ | 30_____ |
| 31. Festival | 31_____ | 31_____ | 31_____ | 31_____ |
| 32. Worship of religion | 32_____ | 32_____ | 32_____ | 32_____ |
| 33. Political discussion | 33_____ | 33_____ | 33_____ | 33_____ |
| 34. Community development | 34_____ | 34_____ | 34_____ | 34_____ |
| 35. Security | 35_____ | 35_____ | 35_____ | 35_____ |

**Code for degree of concerns:**

1. Strongly concerned
2. Concerned
3. Slightly concerned
4. Not concerned
5. No answer

C. ***(This question is only for those who answered "concern" or "strongly concern" about cash income in Question B-13.)***

**What kind of income sources do you want to improve or develop in your village for increase of cash income ?**

(*Choose up to 3 items in order of importance*)

1. _____
2. _____
3. _____

**Code for answer**

1. Not applicable or no answer
2. Kao Na production
3. Kao Hai production
4. Vegetables production
5. Fruits production
6. Livestock/ poultry raising
7. Fish culture
8. Fuel wood production
9. Timber plant and production
10. Forest vegetables/ crops production
11. Coffee production
12. Handicraft
13. Sericulture
14. Trading
15. Manufacturing of goods
16. Others

**D.** ***(This question is only for those who answered "concern" or "strongly concern" about forest fire in Question B-27.)***

**What do you think could be done so as to prevent and/or stop forest fire ?**

(*Choose up to 3 items in order of importance*)

1. _____
2. _____
3. _____

Code for answer

1. Not applicable or no answer
2. Make buffer zone before burn
3. Watch during burning
4. Consider wind direction for burning
5. Establish a penal regulation
6. Other (please specify : _____)

**E. Importance of forest and measures to improve it.**

| Importance (Choose up to 5 items) | | Measures / ideas to improve it (Choose the most appropriate one) |
|---|---|---|
| 1._____ | -> | 1. _____ |
| 2._____ | -> | 2. _____ |
| 3._____ | -> | 3. _____ |
| 4._____ | -> | 4. _____ |
| 5._____ | -> | 5. _____ |

**Code for importance**

1. No answer
2. Source of Kao Hai
3. Source of fuel wood
4. Source of timber
5. Source of fodder/ grazing
6. Source of forest vegetables/ crops
7. Source of medicinal plants
8. Hunting sites
9. Function to conserve water
10. Function to conserve soils
11. Other (_____)

**Code for measures to improve:**

1. No answer
2. Tree planting in slash and burn areas
3. Tree planting in community forests
4. Determination of boundary for protection forest
5. Development of new paddy land
6. Increase of crops/ livestock productivity in the existing production system
7. Creation of new income sources
8. Use of improved stove to reduce fuel wood consumption
9. Use of other energy sources (gas, kerosene, etc.)
10. Other (_____)