



MAE SA INTEGRATED WATERSHED
AND FOREST LAND USE PROJECT
CHIANGMAI, THAILAND

SEMI-DETAILED LAND USE PLANNING
on
SUBWATERSHED LEVEL
(Huai Mae Langun/Ban Hang as a Model)



by
Jack Kraayenhagen

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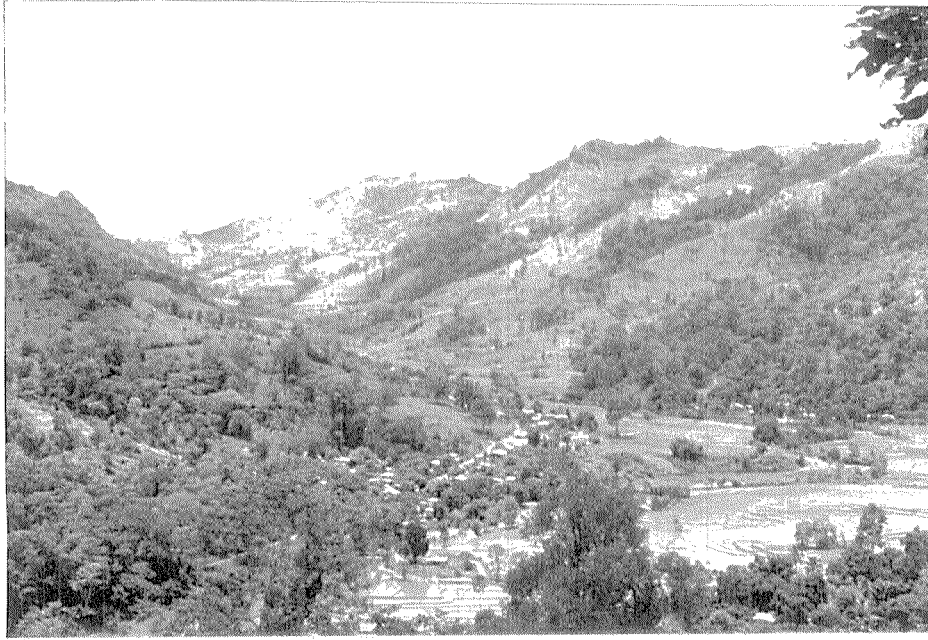
Mae Sa Integrated Watershed and
Forest Land Use Project
(THA/76/001)

Watershed Management Division
Royal Forest Department

Food and Agriculture Organization of
the United Nations.

Chiang Mai, Thailand

October, 1981



HUAI MAE LANGUN/BAN HANG
SUBWATERSHED

" We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong we may begin to use it with love and respect".

Aldo Leopold

This working paper is one of a series of reports prepared during the course of the Mae Sa Integrated Watershed and Forest Land Use Project (THA/76/001). The conclusions and recommendations given in this report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the Project.

ABSTRACT

This Semi-detailed land use plan made for one subwatershed of 750 ha within the Mae Sa project is an attempt to develop the selected drainage area to its optimum by utilizing the land resources to its capability and suitability through integrated development.

All possible aspects are considered in order to increase agricultural productivity for the ever increasing population, to meet their demands on food, job opportunity, living standards, (land) security and to have the ecological balance restored through stable land use and maximum utilization of its natural resources.

The plan involves active participation, cooperation and coordination of its inhabitants, together with technical and financial support of the Government through RFD (Mae Sa project staff) to implement the proposed workcomponents and/or planned activities. The activities consist of reforestation, forest management, conservation farming, horticulture, pasture development, road construction, dam construction and human resources development. The plan is spread out over a period of 10 years with a total input cost of Baht 5,911,708 and is having a cost/benefit ratio of 1.7, combined with security of land tenure.

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ABBREVIATIONS

FAO	Food and Agriculture Organization of the United Nations
HAMP	Highland Agricultural Marketing and Production Project
HML	Huai Mae Langun Subwatershed
NFR	National Forest Reserve
RFD	Royal Forest Department
SDC	Subwatershed Development Committee
UNDP	United Nations Development Programme
VDC	Village Development Committee
VPF	Village Protection Forest
WPF	Watershed Protection Forest

1. INTRODUCTION

Recently, widespread attention has been paid to integrated area development to increase crop production. Government, national and international organizations and finance institutions have recognized that the development of unrelated individual components, like irrigation improvements in lower laying areas or terraces on some upper cultivation land only bring about partial solutions. Development of such unrelated activities will neither maximise nor optimize total benefits, if they are not related to other activities and subjects in the framework of a comprehensive or integrated development plan, backed up and supported by the wishes of the land occupiers within the area (e.g, forest development, agricultural extension water supplies, improved infra-structure etc).

The ultimate goal in (land use) development activities is to improve its economy and living conditions of its people within the area and to safeguard natural resources.

There may be political or other constraints to these development activities, however consideration should always be given to the two basic principles stated above.

This paper deals with selective area development within the Mae Sa Project area, based on a subwatershed approach, within the Kingdom of Thailand. The Project's targets are limited to certain aspects of physical and human resource development, in which it is actively involved. It is obvious that the limited manpower resources, the specific nature of forest and agricultural development and the relative short time left within the Project could not permit all aspects of this task to be completed. However the inter-relationship of various components became evident during the last years of activities and consequently, it is essential to establish their importance and close connection.

This plan is a follow-up on the indicative land use plan (broad outline) of the total Mae Sa Project area, from which a selected subwatershed has been chosen for semi-detailed land use planning.

Area development can be implemented within any boundary selected by planners. However it soon becomes evident that planning of physical improvements and even of human resources and infrastructure will suffer, if it is not carried out within the natural boundaries of a watershed or its independent tributaries, i.e. subwatersheds.

As the indicative land use plan, which was mainly based on aerial photo-interpretation and corresponding topographical maps, was oriented on the possibilities of various types of development with in the project area as whole, this semi-detailed plan provides a more accurate assessment of the present situation, backed-up by extensive field surveys towards an integrated development land use plan.

The main purpose of the semi-detailed land use plan for a selected area, in the form of a subwatershed, is:-

- to check and update the information of previous surveys, maps and reports.
- to present the project personnel, Government authorities and land occupiers with an integrated land use development plan, which will serve as a guideline for future integrated implementation work and proper land utilization.
- to serve as a model for any future land use planning activities.

2. OBJECTIVES

The following objectives are proposed for the semi-detailed land use plan of selected subwatersheds within the Mae Sa project area, being:-

1. To ensure sound land use practices so that the needs of local people are met, especially from forestry and agriculture.
2. To implement a conservation programme to maintain erosion losses of soil and nutrients within defined "tolerable" limits. This includes the protection of planned downstream investments such as hydro-electric and irrigation facilities from excessive sedimentation.
3. To manage the natural resources for the maximum rate of production and economic return (consistent with conservation objectives).
4. To establish a near self sustaining upward trend in real income, in food production and access to socio-economic services for all the people within the subwatershed area, including the landless and poor.

3. DEVELOPMENT STRATEGY

All feasible, economically and technically, attempts will be made to reverse the present negative trends in land-use practices, with the prime aim at reforestation and sustained yield in forest management, without fear of further encroachment or firing by subsistence swidden cultivators.

Land resources available will be used with greater care and efficiency from now on, in order to support an increasing population. Improved land use practices will lead to increased yields and diminish clearing of more forest areas for shifting cultivation and reduce losses of topsoil and nutrients.

Forests will be allowed to regain and unfold its regenerative capacity, in order to provide, products needed by the population as a whole. Damages done to national resources, that have already occurred, will be repaired and protective measures undertaken to reduce further losses. The farming family will be put into a position to utilize the available labour more efficiently, than at present.

If the individual farm is accepted as the basic operational unit, both in an economic--and ecological sense, than it would be necessary to gear the individual operational measures of the strategy to this level. For instance, measures to improve agricultural practices will be adopted at the level of the individual farm, and the strategy will therefore entail methods to reach, persuade and support the many agricultural and forestry decision-makers at their level.

The measures proposed to improve agricultural practices in cultivation, pasture improvement, road construction, community development, horticulture and forestry, the supporting measures designed to make valuable labour more productive in peak periods and the conservation of soil, water and forests will therefore be seen as an integrated package, that must be administrated in its entirety to the recipient farmer. The integrated approach is the most important precondition for attaining the desired impact of the project. A complete coordination of activities will be achieved, while putting the strategy into effect. This particularly applies to the organization of the project and its management. Apart from the fields of agriculture, forestry, community development and economics, this programme package also entails engineering technical components.

Competent personnel from each of these fields are required to plan in detail, implement and evaluate these aspects of the strategy. The development and coordination of an efficient integrated extension service to inform, persuade and support the farmers through their own village development committees, in the drive to improve land utilization is the central and most important component of the semi-detailed land use plan.

4. SURVEY AND ASSESSMENT

4.1 Level of Intensity

An inventory has to be made of the present conditions and the inherent suitability and land capabilities which can be developed.

The semi-detailed survey/investigation deals with the following activities:-

- i) checking and/or modifying/updating, where necessary the existing maps, through detailed intensive aerialphoto-interpretation, followed by extensive field checks,
- ii) arranging/grouping of land use patterns with the updated socio-economic information
- iii) preparing the basis for a development plan which can be used in village discussions or official meetings identifying detailed surveys and design work for some workcomponents.

* A separate comprehensive socio-economic survey is presently in progress of the total project area of Mae Sa.

- iv) Providing estimated figures of inputs and outputs supported by incentives, for the establishment of costs and return for each activity separately and for the whole complex of activities together, using realistic standard inputs in quantities and cost for budget purposes.

4.2 Criteria for Land-use suitability

Land use suitability will be based on the information collected during the field surveys and transferred onto the prepared field maps, with particular interest on (abandoned) swidden areas suitable for settled agriculture and fruit crops. The surveyed land will be subdivided into mapping units, each with specific homogeneous characteristics for future land use, mainly based on its soil type and slopes.

4.2.1 Soils

The adopted texture, stoniness, and depth of the soils have a major influence on the land suitability classification and selection of related crop groups. In planning for improved and sustained yield, a minimum depth of 40 cm is the limit set for arable short-term seasonal crops (see for further reference and codes Technical Note 37).

4.2.2 Slope

Slope has major implications for land-use. Fairly level of slightly undulating soils tend to be located in low-laying areas and generally have deep to medium depths with heavier soil texture. They are less limited to cultivation and generally easy to irrigate. Steep slopes generally are well drained, but cultivation is more restricted, the soils tend to be shallow and erosion is more severe. The degree of slopes sets limits on land use for annual crops, plantations and even on land reclamation, depending on soil depth, stoniness etc.

The slope codes to be adopted for the project area in assessing land suitability for the purposes of land use planning, as a preliminary step towards (agricultural) development will be:-

<u>Codes</u>	<u>Slope in percentage</u>	<u>Suitability for symbol</u>
1	12	C ₁ , C ₂ , P with FT, F, FN
2	12 - 35	C ₂ , P with FT, F, FN
3	35 - 50	P with FT, F, FN
4	50	F, FN

As cropping for subsistence is the main requirement of the farmers preference will be given to the cultivation symbols.

4.3 Present and Potential Land Use

In the inventory surveys in the field, the present land use pattern will be recorded in symbols and are as follows:-

<u>Symbol</u>	<u>Description</u>
FN	- Natural Forest (Hill Evergreen, Lower Montane, Dry Dipterocarp, and Mixed Deciduous).
F	- Planted Forest
II	- Hiang tea interplanted/grown within FN
P	- Pasture and/or rangeland
O	- Orchards outside village area
S	- Swidden land presently or abandoned** cultivation
R	- Residential area (village)
SPC	- Semi-permanent cultivation, land which has been more or less continuously cultivated with annual crop for a number of years and which appears likely to continue to be used in this manner (Sometimes no clear distinction can be made between it and swidden land).
PC	- Permanent cultivation (rainfed) land, which has been in use for a number of years and has been treated with conservation measures to safeguard its permanent use, but is not used for irrigation.
I	- Irrigated rice land.
FI	- Fully irrigated rice land.

* C₁ = Cultivation with minor Soil and Water Conservation works required

C₂ = Cultivation on terraced land

P = Pasture

FT = Fruit tree, F = Forest planted, FN = Forest natural

** Abandoned swidden cultivation would still retain a non-forest character i.e the vegetation consist of grasses and/or shrubs, rather than trees. In distinction to permanent rainfed cultivation, it is expected that agricultural practices on swidden land will cease after a certain period, pending on population pressure.

The potential land use will be recorded as:

<u>Symbol</u>	<u>Description</u>
FN	- Natural forest, land to be kept as watershed protection forest.
F/S	- Land presently under swidden which should be replanted with forest or fuel-wood trees.
FT/S	- Land presently under swidden, which is suitable for the planting of fruit trees or perennial cash crops.
P/S	- Land presently under swidden, which can be suitable for pasture, Note: Pasture development can best be carried out in conjunction with fruit trees or other perennial cash crops, after their establishment period.
C ₁ /S	- Land presently under swidden, which can be used for permanent cultivation with limited soil and water conservation requirements
C ₂ /S	- Land presently under swidden, which can be used for permanent cultivation but needs to be intensively protected against erosion.
FT/N	- Land presently under natural forest, but whenever gets cleared, only suitable for the planting of fruit trees and/or perennial cash crop trees and the growing of grasses and legumes for livestock.
C ₁ /N	- Land presently under natural forest, but when ever gets cleared, suitable for permanent cultivation with limited soil and water conservation requirements.
C ₂ /N	- Land presently under natural forest, but whenever gets cleared, suitable for permanent cultivation, but needs to be intensively protected/terraced against erosion.
R/N	- Land presently under natural forest, but whenever gets cleared, suitable for the establishment of a residential (village) area.

The present land use of a mapping unit and its suitability class (symbol) will be recorded. This suitability class may not confirm with the present land use, but an evaluation will be made of each specific land unit as to its possible improvement and its projected suitability should such improvements be carried out.

Local constraints or requirements will be taken into consideration in selecting the potential suitability and land use.

4.4 Procedures after the field surveys:

Two distinct situations can be drawn from the indicative land use plan of the total project area, being;

- i) village areas with little or no surplus, unused or unintensively used land to cultivate, and
- ii) village areas with a considerable surplus of land available for development.

In both cases, before looking for alternative resources elsewhere, existing used land would be more intensively developed i.e. double cropping, intercropping practices, proper fertilization, improved crop varieties, combined with improved supplementary/or permanent irrigation and drainage facilities where-ever possible and other conservation measures like ridging, hill-side ditches, contour bunds and/or intermittent terraces on sloping areas.

Farmers, cultivating steep and/or shallow land will be encouraged to plant such land with tree/fruit crops, by helping them to obtain planting material etc., or negatively by refusing help/or refusing titles to those areas.

Conversion of forest land to be considered for other purposes will only be carried out, when this land is of high agricultural quality and there are abundant forests still left in the drainage area.

The procedures adopted will be the following:-

- i) to check this information on the ground, bring the maps etc. upto date. Reconnaissance soil maps to be made of land suitable for agriculture,
- ii) villagers-meetings (long term contacts) to be arranged in areas where projects of development and cooperatives are high, to explain the proposed developments and changes suggested. The meetings with villagers will also be used to update the socioeconomic data, specially on land use.
- iii) The final semi-detailed development land-use plan will be drawn up in close consultation with the villagers, supported through their development committees, showing demarcated areas for different land-use purposes, mainly based on slope, soil type and depth. Both land capabilities and local needs and/or wishes will be considered and in-cooperated in the (final) plan preparation.

- iv) village development committees will be set up to discuss the proposed plan and to arrange the suggested allocation of agricultural and tree/fruit crop lands. They will be involved to the fullest extent possible in the planning and executing development of their own area. The reallocation of land where necessary in accordance with the semi-detailed land use plan, will be left to the villagers them-selves, through their committees, taken into account existing cultivators, size and/or needs of families. Boundaries of the different land classes will be demarcated on the ground, the same for forest, and village woodlots reserves.
- v) Each land occupier will have to sign a written agreement to cooperate to the fullest in the implementation of the plan as a whole for the village area, and to participate in the necessary work to be carried out, supported by government donations or incentives on labour costs. The signed agreement will also be a prerequisite in obtaining other assistance from the project, such as fertilizer, plants seeds and credit facilities.
- vi) After conservation works has been implemented and required trees have been planted to the satisfaction of the responsible government official and committee representatives, land lease permits will be issued invidually (or collectively to the village) on presently illegally cleared forest areas.

This semi-detailed land-use plan meets the requirements for an integrated subwatershed development approach, and is a follow-up on the indicative land use plan, which was based on village areas only, without regard to drainage and other common characteristics.

This survey intends to lead to the implementation of the plan on the ground with particular interest to land allocations, proper utilization or management of natural resources through soil and water conservation activities, supported by selected village development committees representing the community of the area (subwatershed).

4.5 Technical aids:

4.5.1 Maps and Aerial-Photographs

The present indicative land use maps, with a scale of 1:15,000 prepared from aerial photographs (dry season 1976 - 1977) and corresponding topographical maps, with a contour interval of 20 meters, were used which are covering the upland area of Mae Sa (332 sq kilometer), as a basis for more realistic surveys and inventories.

Subwatershed boundaries enclosing one or more village areas were firstly drawn on the topographical maps and later transferred onto the corresponding aerial-photographs, together with the one square kilometer grid-system of the topo-maps.

Detailed photo-interpretation was done identifying the existing land use patterns, together with possible potential development of arable land, reforestation and/or fruit trees areas, sites for dams or weirs, for irrigation development, hydro-electric plants, locations for future village settlements, roads and other infrastructures requirements.

Field maps were prepared of one selected subwatershed (scale 1:15,000), whereby the one square kilometer grid-system from the topo/photo-maps together with the above information was projected upon.

One flight, by a small plane over the selected subwatershed area, during which colour slides were taken, permitted updating from existing aerial-photos and limited inventory field work. The slides were superimposed on the prepared field maps to come as close as possible to realistic field conditions.

4.5.2 Equipment

One Landrover was required for the main transportation into the area (subwatershed), but most of the surveys were done on foot through difficult terrains. The surveyor used a clinometer, soil auger, compass and prepared fieldmaps, together with aerial photographs in a special plastic holder and his field note-book.

4.5.3 Time

A total of two weeks full-time was spent within the area 750 ha to survey the physical characteristics on the ground and to compare/check the information obtained through detailed photo-interpretation.

5. Description of the Subwatershed:

5.1 Geographical situation

The Huai Mae Langun (HML) or Ban Hang subwatershed, within the Mae Sa Project, located in the Mae Rim District of the Chiang Mai Province, is 28 km North-West of Chiang Mai city (see Map 5). The subwatershed has an area of 750 ha (4,688 rai) and its main stream, with the same name, is a tributary of the Mae Sa River, which runs into the Mae Ping River. With the exception of the lower rice fields, the topography is steep (slope average 40 per cent), with elevations ranging from 800 m at the junction Huai Mae Langun stream and Mae Sa River, to 1,350 m at Doi Doen and Doi Pha Dam located in the southern upper end of the drainage area. The subwatershed has a near rectangular shape with its length being two times its width (4 x 2 km).

5.2 Climate and vegetation

The climate is humid-tropical with temperatures varying between 9.5°C in the winter, (dry spell) to 35°C in the beginning of the summer (April) at Ban Hang, a village located in the subwatershed on the foot of the hilly slopes just up stream from the junction with the Mae Sa river. Average annual precipitation at Ban Hang is 1,540 mm. At higher elevation 1,300 m the mean temperature very between 12.4°C in January to 29°C in April, and precipitation is 1,650 mm (drawn from isohyets and isotherms from Mae Sa project recordings 1976 - 1980). The rainfall pattern is monsoonal, with 90 per cent of the annual precipitation falling during mid-May and the end of October. (see figure 2, section 5.5)

A relative cool period follows after the main rains, lasting until early March, followed by hot dry spell until the rains break. The subwatershed, is facing North - North West, with its highest elevations in the South-South East. Its location is parallel to the prevailing storm-direction during the monsoon period. At the lower altitudes the natural vegetation on the moister sites is Evergreen Dipterocarp forest, with Mixed Deciduous forest on somewhat drier sites. At higher altitudes abandoned cultivation is colonized by bamboo, while higher a dense shrubby tangle of Eupatorium odoratum and other species come in; however areas which have had intensive cultivation for a long period are dominated by Imperata grasses. The present land use map (Map No. 1) indicates 38 per cent to the remaining forest.

Only 77 ha or 450 rai (25 per cent) of natural forest, out of the total of 306 ha (1,913 rai), lies outside the National Forest Reserve, of which 23 hectares (144 rai) are interplanted/cultivated with Miang tea.

1/ Mae Sa Project recordings, Khun Pichar Watanaprateep.

5.3 Topography

An analysis of slope categories indicates that 44 per cent of the drainage area has slopes between 10 - 50 per cent, with an average slope of 35 per cent. About 9 per cent of the subwatershed is flat to rolling (0 - 10 per cent slope), while 47 per cent of the area is very steep 50 - 100 per cent slope. The largest area with the steepest and shortest slopes is covering the West-facing slopes at the South-West part of the watershed.

The East-facing slopes are generally less steeper, but their lengths are much longer resulting in more defined depressions in which surface run-off and spring water is gathered.

5.4 Geology and Soils

The bottom part of wide-floored valley (upto 600 m) is U-shaped and stretches steeper up slope in narrow V-sloped valleys in which some have water falls or rapids. Where the valley widens out, the bottom area has been made into irrigated rice fields, and is the most densely populated part of the subwatershed.

The metamorphic rocks are mainly gneiss and schists; the ridge on the East is largely lime stone, the western side is gneiss. The most common soils on the hillsides are classified as Reddish-brown Lateritic soils, or Typic Paleustults which are often fairly deep (upto 2 meter). Their texture varies from sandy clay loam to clay loam, with a pH from 5.5 to 6.2. The soils have a high infiltration rate (a constant of 26 mm/hour) and good water absorption capacity, together with a reasonable fertility if properly managed.

The valley bottom especially the lower-end consists mainly of alluvial soils, which have been deposited through surface run-off from higher elevations and is mostly under irrigated rice, as the main crop to be grown.

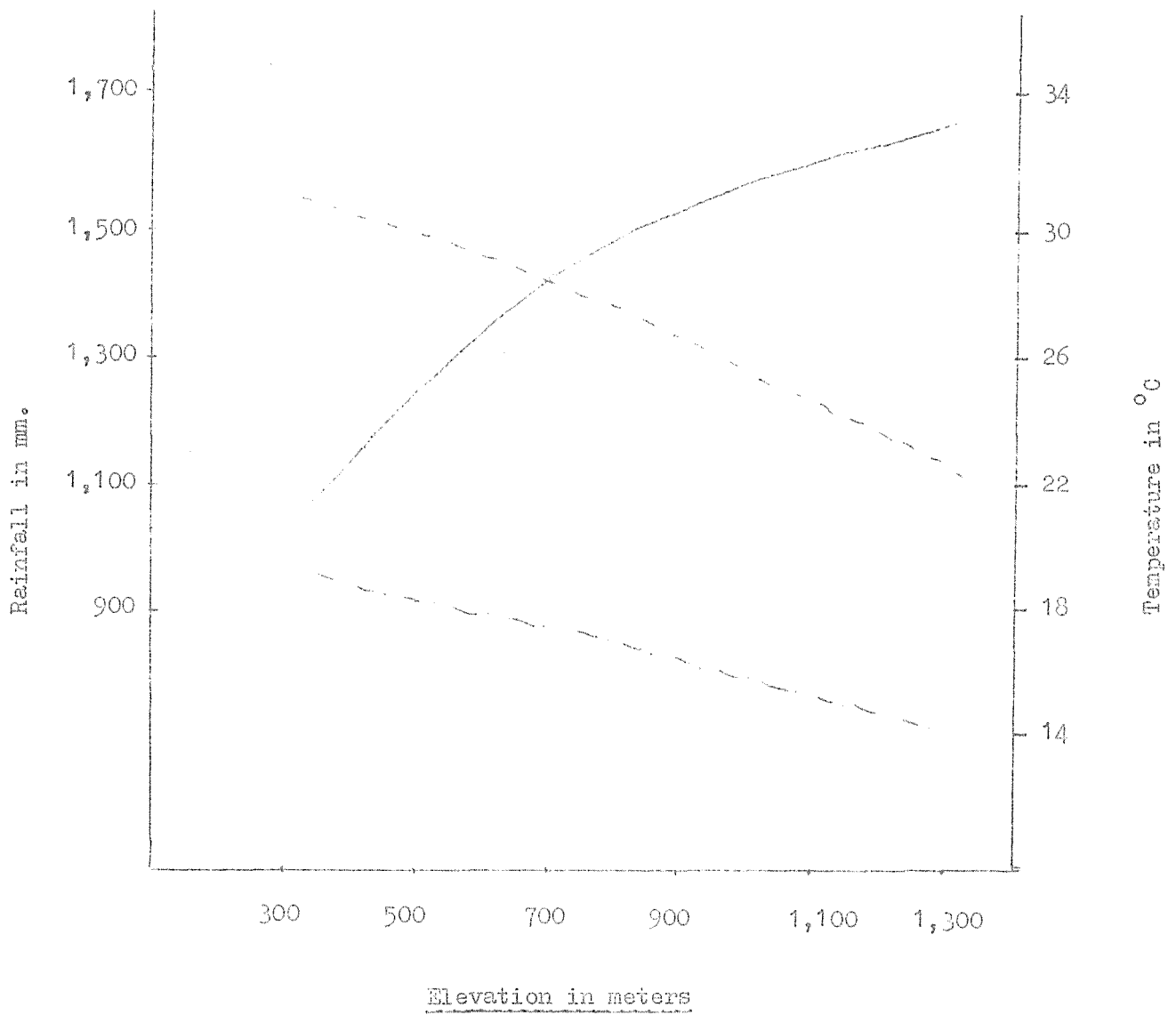
5.5 Hydrology

5.5.1 Precipitation

Recorded annual average rainfall in millimeters, together with maximum and minimum temperatures in Celsius have been projected against corresponding elevations and is illustrated in figure 1; indicating from the rainfall for the first few hundred meters (300 up to 700 meters) elevation a corresponding 100 mm per 100 meter; from 700 meter to 1,300 meter an average increase of 40 mm for each one hundred meter is observed.

Figure 1.

Relation between annual rain-fall, maximum,
 minnum temperature and
 elevation.

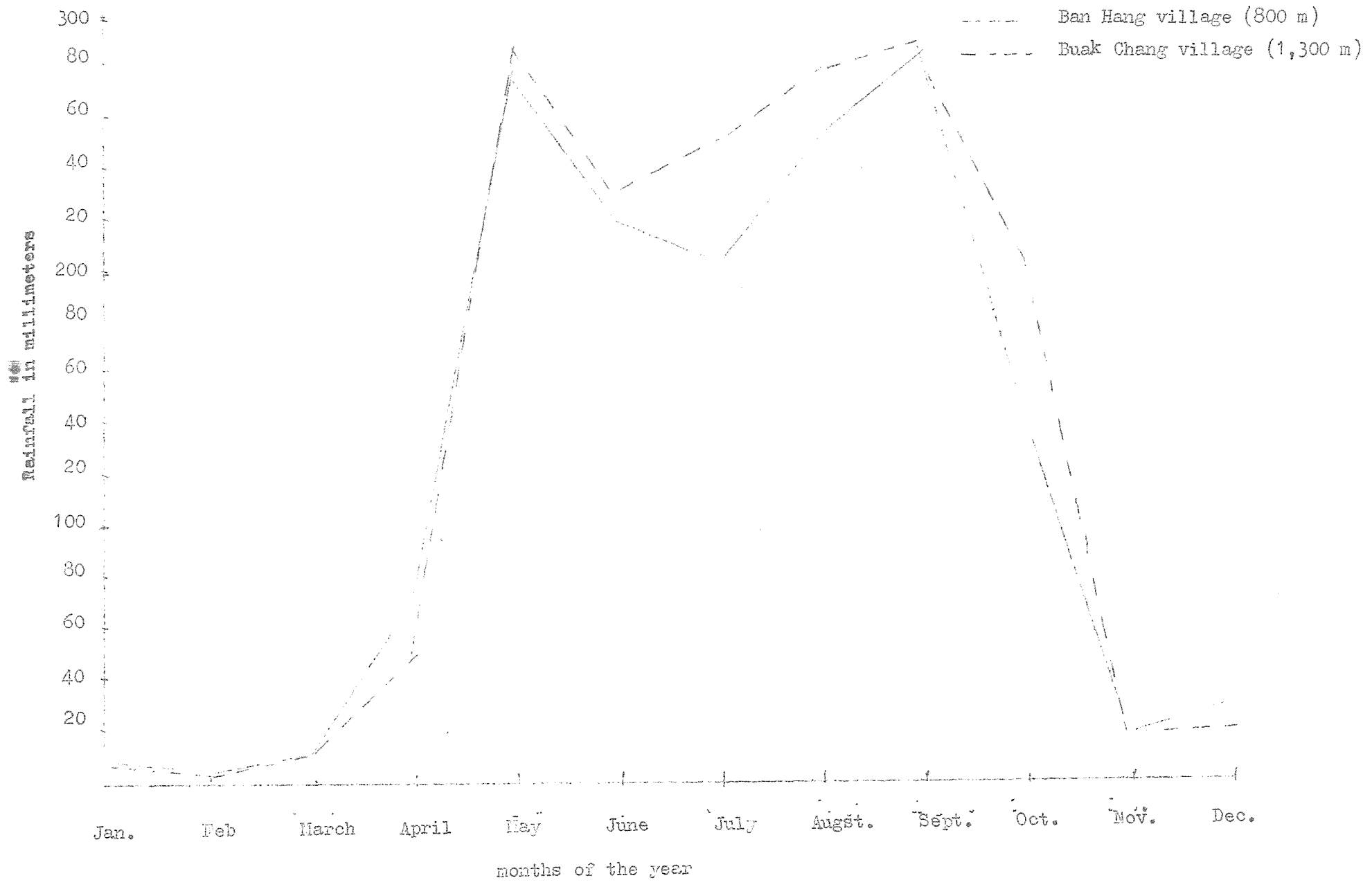


- - - maximum temperature (average)
- . - minimum temperature (average)
- rainfall (average)

Source: Mae Sa Project recordings, Khun Pichart Watanaprteep

Figure 2

Monthly Average Rainfall and Distribution



The monthly recorded average rainfall figures at Ban Hang (elevation 800 m) and at Buak Chan (elevation 1,300 m), but located 3 km outside the subwatershed, are illustrated in figure 2, showing its yearly distribution and fluctuation at different altitudes. Figure 2 clearly shows that the rainy-season starts in the middle of the month of May and lasts till the end of October. The highest rainfall is recorded in both stations during the months of May and September. The month of May - June is also the time that maximum soil disturbance is carried out, in order to plant the required crops, causing the highest recordings on soil loss (section 9.3). Rainfall intensity data for short storms are important for planning soil and water conservation activities and to measure erosion rates. This data has been collected since 1979 at Pong Khrai (height 1,050 m) located in the middle of the Mae Sa Project area 4 km away from Ban Hang on the same lateritic soils and average slopes.

All storms with an intensity greater than 12.5 mm per 30 minutes have been listed and recorded, as these storms can be considered erosive in tropical climates (Hudson 1971). Results from these erosion plots confirm this assumption. This data indicate that Pong Khrai had 191 mm of erosive rain in 1979, which represents 16 per cent of the total for the year (1,160 mm). During the months of May 1979, 24 per cent of the monthly rainfall was erosive (greater than 12.5 mm/30 minutes). During 1980 the percentage of erosive rain was only 6 per cent of the total year (1232 mm) with the highest intensity of only 19 mm per 30 minutes. Intensity recordings have also been maintained at Di Ni (700 m elevation). There appears to be an indication that the frequency of erosive rain storms is significantly greater in the upper parts of the Mae Sa watershed than in the lower areas (Mae Rim), the same can be said for this subwatershed.

5.5.2 Run-off

The minimum flow recording surveys carried out during the last two dry seasons give an annual discharge of 27 liter per second at the outlet of Huai Mae Langum. This water is primarily released from springs in forested area, after having been diverted over some low-laying areas in the valley bottom for irrigation. The main perennial tributaries each with its minimum discharge are marked on map No. 3 and its recording data compiled below:

Records of Minimum Water Resources Survey

<u>Name or Number of Stream</u>	<u>Minimum Discharge in Liters per second</u>
Huay Mai Langun (1)	21
Huay Haung Chang (2)	11.6
No. 3	3
No. 4	0.5
Huay Ton Pung (5)	2
No. 6	0.5
No. 7	1.0
Pha Nok Kok (8)	2.3

No maximum flow discharges have been measured during the period of planning, but local observations from inhabitants revealed that fluctuations between high and medium discharges is increasing over the last ten years combined with periodic flooding of valuable arable fields, low-laying roads and bridge, mainly due to deforestation. Also due to deforestation, various perennial hill-streams have already dried up, decreasing the reliability on irrigation and drinking water.

In general run-off is low, compared with the run-off plots at Pong Khrai for cleared swidden areas, averaging 2 per cent of the annual rainfall. The highest percentage of run-off at Pong Khrai after one day's rain was nearly 20 per cent.

5.5.3 Infiltration

Infiltration rates measured on cleared swidden area with similar soil type, at Pong Khrai, varied between 2.6 cm/hr after three hours on wet soil, to 6.4 cm/hr as initial rate on locations with a 30 per cent slope.

5.6 Social and Economic Status

The population within the subwatershed is divided in two different locations and ethnic groups. The upper, steeper slopes within the National Forest Reserve (NFR) on the north-facing southern part of the drainage area are occupied by a Hmong (White Neo) village (Pha Nok Kok) established in 1954, with an estimated population of about 220. The lower slopes, together with all the irrigable fields are occupied by Thais. The last ones are mainly living in a string of villages on the eastern side of the valley

along the only main road leading into the drainage area, which are from north to south Ban Hang, Ban Luang, Ban Tung, Ban Dong, Ban Dong Nok and Ban Dong Nai. As they all belong to the same Muban, further reference will be made to this group of villages as the Ban Hang/Don Village. The total population is presently estimated at 520. While the average population density of the subwatershed is 1 person per ha or 6.25 rai over the entire area, it would give a density per person of cultivated area of 0.6 ha or 3.75 rai. The socio-economic survey for 1981, which is still in progress, would show a much greater pressure on existing resources in the most populous lowlands.

Nearly all inhabitants within the area are directly concerned with agriculture. This is the resource base of the watershed, with the cultivation of rice, corn, peanuts, sweet potatoes, onions and other vegetables. Mostly all cultivation practices, especially on the steeper slopes, are carried out by hand with simple tools. Animal power in the form of buffaloes, is used for initial land preparation, before the planting of rice on the irrigated fields. The on-going comprehensive socio-economic survey will reveal many aspects on present agricultural and other related practices and condition in general for each village. Presently a summary can be given on land use, based on previous surveys (1974 and 1978 the last one did not prove to be very useful, as figures were grouped together on Muban only and not on each individual village) and own observations during field trips being:

Pha Nok Kok: the Hmong (White Meo) village, with its 220 inhabitants, is spread over 16 houses giving an average density of 13 people to one home. There is no irrigated land available due to its steep topography and lack of irrigation water. Limited area for shifting cultivation is available for the local people, due to this 80 per cent of the farmers are obliged to have their fields outside the subwatershed, some of the fields are a distance of five hours walk away from home. A spring, up slope south of the settlement provides the village with drinking water, which is piped and distributed to several locations within the settlement. A Seven-Day Adventist Chapel has been constructed with aid of the mission and the drinking water scheme has been installed through H.M the King's Project in 1976. With the present deforestation going on near and within the forest area (MFR) which supplies and supplement the spring with replenishable water, a short life of reliable drinking water is expected.

In general the clearing of natural forest slopes should be stopped altogether, if the village likes to keep its existence. The present areas cleared for swidden should be used more intensively, whereby soil depth and slope should form the criteriy for its use. Most of the area presently under annual cultivation should be put under perennial tree crops, as has been successfully demonstrated by the Hill Agriculture and Marketing Project (HAMP). Slopes exceeding 50 per cent. should be put under protective forest cover, with the areas near the village planted with fuel-wood trees to provide the necessary wood for cooking.

The village has one school with two teachers, of whom one is a native to the village, with classes going to four years of schooling. The village is connected by only one road into the valley bottom, past Ban Dong/Hang, which links up with the main road Samoeng/Mae Rim. Its total length is 5 km and its condition is fair to very poor, pending on the season of the year. Horses are kept for transportation of supplies. Two people are in possession of a Pick-Up car to provide local transport on private basis. The women are involved in embroidery and are mainly responsible for the planting, weeding and harvesting of crops next to the daily household activities. They are having more difficulties by integrating themselves with the Thai custom and language, due to the less contact they have with the people lower down in the valley.

An agricultural extension officer of the HAMP Project pays regular visits to a local field office within the village with a small demonstration area, on which various crops and fruit trees are grown.

Ban Dong/Hong: the 520 people living in Ban Dong/Hang are all Thai nationals and occupy the main valley area with the irrigable rice fields and utilize the swidden areas located on the hillside slopes outside the NEFR for semi-permanent rain-fed cropland, and the swidden area within the NEFR for internal shifting cultivation practices. (see section 6.2)

The group of villages has a temple, but no school; the children are walking daily, some for a few kilometres, to Pong Yaeng Nai to attend to school. No drinking water scheme exist in the villages, apart from a few deep wells water is collected from irrigation canals and streams further upslope.

In the subwatershed of Huai Mae Langun no electricity is introduced yet. The whole drainage area falls under the administrative Government system of one Muban, under the chairmanship of a Phuyai Ban (village leader), which could give it an excellent opportunity to share the common problems and to identify land use needs and to discuss village and/or other developments on a watershed basis, in accordance with the wishes of the people and the semi-detailed plan based on physical characteristics and limitations of the area.

The farmers are not very sure about their own proposed land use plan in the next 3 to 5 years. The small farmer, especially located on rain-fed cropland, relies much on marketing and does not possess long range plans. Nevertheless, the land use trends can be interpreted in such a way that although more intensive use of the lands is intended by reducing the fallow period, they prefer crops requiring less labour inputs. Their prime concern is first to increase the production of upland rice to meet their own requirements, either by more intensive methods or by extensive ones by increasing the area involved.

Most of the farmers within the subwatershed area are interested in conservation work to be applied on their claimed land, but lack the support.

No precise information on annual income per family can be given at this stage, but generally the following may be quoted for a family with 5 person. A family of 5 has been taken as the average for people residing in the one family, but the actual the number should be higher by one or even two persons, as they are working outside the family and subwatershed, and are forwarding their earnings back home.

Total average annual income is 8,000 Baht per family; the lowest is 800 and the highest 17,000 Baht. "On farm income" average only $\text{฿} 3,000$ per family or only 38 per cent of the annual income. The majority of income (62 per cent) is coming from sources e.g. hired labour, growing of opium outside the subwatershed and unspecified work. The average work/labour force 2.2 persons per family, will earn per day an average of $\text{฿} 18$ per person by being self-employed.

Source: A Case Study of inputs and outputs by private farmers on terraced and unterraced land, 1981, Su Ki Kang.

5.7 Land Use

The basis for a rational management programme must be information on locations and areas of land use categories. Air photographs-interpretation, followed by extensive field trips, provided the essential data for Map 1 of the subwatershed, and is summarized in Table 1.

Areas of land use have been calculated from Map 1, which were compiled from aerial photographs, topographical maps and aerial slides, super-imposed on a field map with a scale of 1:15,000.

Table 1
Present Land Use Categories in the HML/Ban Hang Subwatershed

<u>Outside the National Forest Reserve (NFR)</u>	Symbol	In ha	In rai	In %
Irrigated Rice Fields	I	62	388	8
Swidden	S	177	1106	24
Miang tea under natural forest	M	23	144	3
Forest	FN	49	306	6.5
Fruit trees	FT	9	56	1.3
Residential area	R	13	81	1.7
Sub-Total		333	2081	44.5
<hr/>				
<u>Inside the National Forest Reserve (NFR)</u>				
Swidden	S	174	1087	23.1
Fruit trees	FT	4	25	0.5
Forest	FN	234	1463	31
Residential area	R	3	19	0.4
Sub-Total		415	2594	55.5
Total		748	4675	100

The land use analysis indicates that over 45 per cent of the total area consists of steep swidden, of which half is located within the National Forest Reserve (NFR), together with the Meo village (Pha Nok Kok), which has a population of over 220 people. This swidden area is claimed and utilized, for about 90 per cent by Thai villagers residing in the bottom valley (Ban Hang/Ban Dong), who are carrying out internal shifting cultivation, whereby areas of active cultivation are rotated with areas under fallow, within a selected block of land. Additional clearing of natural forest continues on an increasing yearly scale (presently a minimum of 3 ha or 20 rai). The excuse of fires to burn regrowth or weeds, which accidentally get out of control, gives the farmers more reason to annex forest area to their existing swidden (see also section 6.2 on use of swidden land). The Meo farmers of Pha Nok Kok are limited in their annual cultivation area, which is restricted to steeper, rocky slopes often with shallow soil depths.

The UNDP Project for Highland Agriculture Marketing and Production (HAMP) is successfully establishing trial plots, particularly of coffee, to utilize those steep slopes to the optimum with tree crops, for which they should be used. It is important to note that the forest is also used for grazing.

Most of the 177 ha (1,106 rai) of swidden, outside the NFR, can be classified as semi-permanent rain-fed cultivation, and most would probably become permanent if the farmers could maintain the fertility of the soil and have it protected with conservation measures, those activities are mainly dependent on the legal usehold title of the land of the occupier. The Thais are sedentary, and are traditionally irrigated rice cultivators, but increased pressure of population is inducing them to move up the hillsides to grow crops on rain-fed land. On the upland area rice is the principal crop, but the main one may instead be a cash crop of groundnuts, taro, sweet potatoes or cabbages. When rice is planted as an upland crop almost invariably only one crop per year is grown, but with other crops two harvests per season are frequently obtained. Just over half of this upland area (96 ha or 600 rai) outside the NFR, has already been protected with various types of engineering conservation measures, under supervision of the Mae Sa Project staff. A total of nearly 3 ha, near or below mountain springs, has been developed by various farmers into hill agricultural systems with irrigation practices on terraces, consisting of simple diversion weirs and excavated drains or bamboo-pipes, and are cultivating valuable cash crops and fruit trees. On some locations within the NFR where water is diverted, the irrigated fields have no conservation measures applied and are causing extensive erosion (see section 6.3).

One sixteenth of the subwatershed area (62 ha or 388 rai) is covered with irrigated rice fields, located mainly in the bottom of the valley, 16 ha or 100 rai of this is presently under near full irrigation, by having up-stream rapids tapped and diverted to existing irrigation canals.

A total of 13 ha or 81 rai has been planted with fruit trees of which one third within the MFR. Thirty seven per cent of the total subwatershed area is still under a forest cover, which in quite a few places has been logged for building and fuelwood material.

An area of 23 ha (144 rai), spread over two different locations is under miang tea production, which grows under natural forest cover and provides an excellent protection of ground cover out of a conservation point of view. As swidden areas are increasing, at/or near the edges of this natural forest, a decrease in the miang cultivation is expected, especially as demand for this product is diminishing.

5.8 Past Work in the subwatershed

Seven years of work in the Mae Sa Project Area has contributed to about 600 rai (100 ha) of cultivation on swidden land, which has been protected with conservation structures. Two hill-irrigation systems have been improved under the guidance of the project staff; the establishment of a nursery plantation located just over the southern edge of the subwatershed and yearly bulldozer-maintenance of the only road in and out of the drainage basin. Several hundred fruit trees have been distributed to various farmers, and a few locations on the west-facing slopes have been replanted with forest trees. All this work has been implemented on an ad-hoc basis, where each section within the project planned and under took its own activity without concern to an overall development plan or land use policy. This piece-meal approach has led to a confusion between the local people in accepting general over-all land use planning and execution. The heavy subsidies in the form of labour and kind contributions have certainly provided some farmers with additional income, but without much concern to the rest of the community in the subwatershed and its natural resources, as still too many farmers are encroaching the forest reserve or forest areas, creating an unjust atmosphere and desperate land use situation. The activities of the HAMP project in Pha Nok Kok village are concentrated only in establishing mainly perennial cash crops/trees, like coffee, which are performing very well, but very limited attention is given to the treatment of soil and selection of areas to be planted or treated, when it comes to soil conservation and land use planning. As most of these villagers are having their agricultural fields outside the watershed, special attention is therefore required on the preservation of the steep slopes under cultivation, where e.g. orchard terraces should be introduced during the establishment period, followed by planting of the recommended fruit trees/crops interplanted by annual cash crops. No treatment on existing annual cultivation is carried out to preserve the soil and avoid erosion.

5.9 Projected Land Use With Present Growth Rates and No Management

Assuming present growth rate (population increase of 2.2 per cent/yr) for the next 20 years, the projected land use situation is shown in Figure 3 for the subwatershed. Presently no management scheme is operational, and as the human and animal population increase, forest land is diminishing for cultivation, fuelwood and building material production etc. At the present rate of use and without management, the forest land is likely to disappear over the next 20 years. Land use progressively changes from forest to swidden to wasteland. The total of swidden areas will increase right up into 1990, during which more conservation farming practices will be adopted by more farmers to preserve the remaining soil. As the waste land areas will increase due to erosion on steeper cleared slopes, more damage will occur on areas treated with engineering structures causing a collapse of the system, as the work is implemented on individual farm basis without much concern to maintenance and common water-disposal areas.

As destruction of forest cover goes on, less regular water from springs will be released; and direct run-off will increase; excessive floods will deposit silt on irrigated areas and distribution canals in the valley bottom, thereby decreasing sharply the fields for irrigation practices by the year 1,995 or 2,000. The results will be obvious:- "abandoning of land and migration to new areas outside the subwatershed".

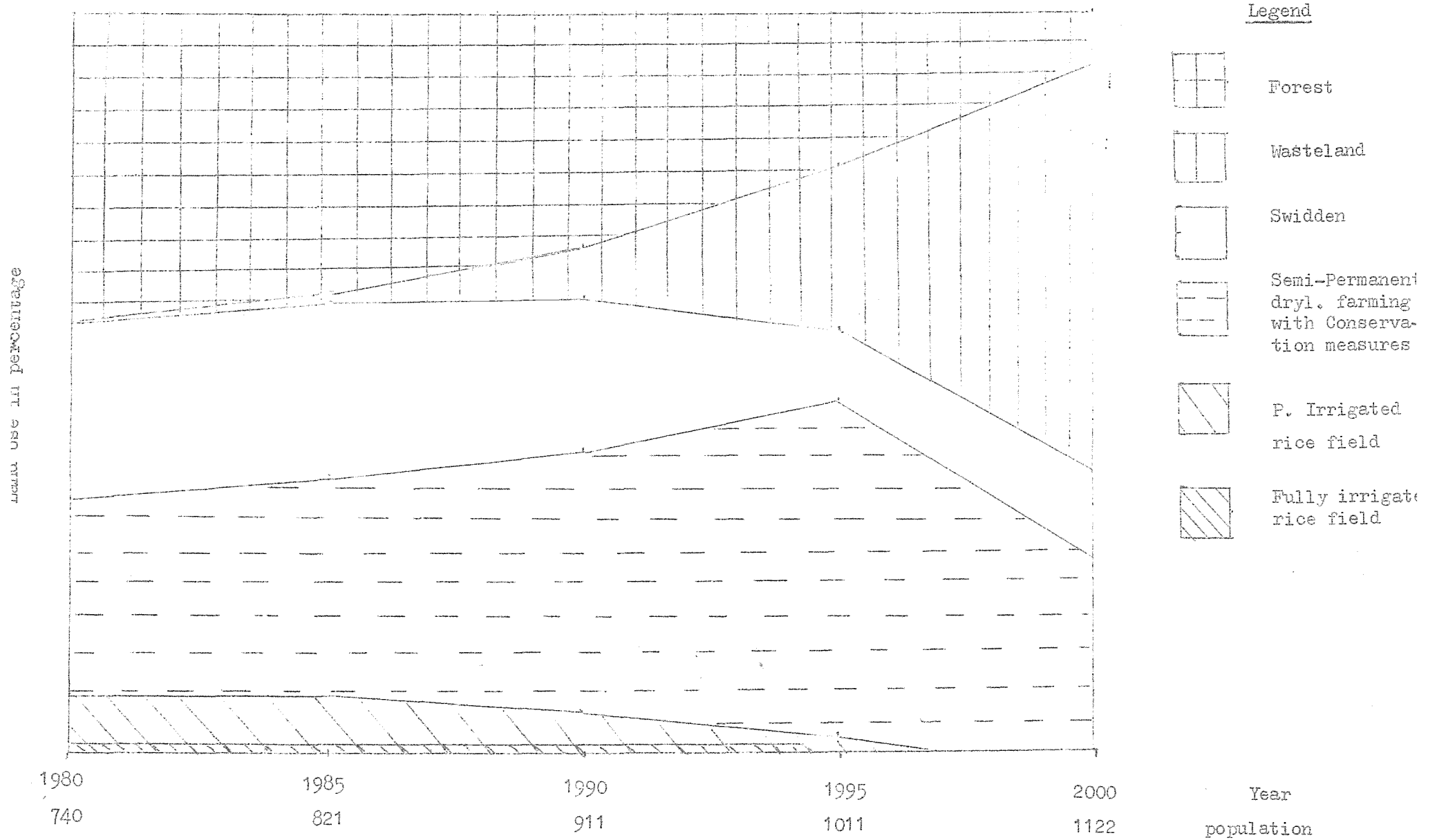
The situation in some individual villages will be far more serious, in particular the village of Pha Nok Kok, as no legal ownership of land exists on any of the steep slopes presently under cultivation to justify input in conservation farming.

The following assumptions for their prediction are made:-

- 1) Agricultural productivity per ha does not increase
- 2) Animal population increases at the same rate as human population (2.2 per cent/yr)
- 3) Based on an annual forest clearing to supply the demand for fuelwood, building material next to grazing and new swidden areas, increased by a population rate of 2.2 per cent/yr.
- 4) Swidden land to increase from forest areas mainly to compensate for the loss in areas due to erosion experienced of previous years. This loss would be particularly noticed by many farmers between the year 1,990 and 1,995.

Figure No. 3

Projected Land Use 1,980 - 2,000 in the Hrai Mae Langun or Ban Hang Subwatershed with present growth-rates and present absence of management



6. Resource Management Problems

In this section the major resource management problems of the subwatershed are briefly presented, being:

6.1 Deforestation and Forest Fires

Many hectares of presently swidden areas were firstly covered by good stands of natural forest, providing soil protection and stimulating regular discharges of rainfall. Destruction of this forest cover followed by burning practices, specially on steep slopes are causing removal of soil and rapid run-off of rainwater, in other words loss of natural resources so valuable to our people for generations to come.

As no village in this subwatershed has its own forest area officially allocated, everybody is regarding the forest as a common ground for fuelwood, supply of building material, hunting, grazing of livestock and a collection place for various exotic plants. The results are specially noticeable in the locations near the villages, all possible fuel wood and building material has been removed, leaving behind areas overgrown by Imperata grasses and shrub.

The most critical sector of watershed management, and also the most damaged is the forest cover, it covers only 37 per cent of the total area and its importance is not only in its values and contributions to the economy and well being of the rural population, but it is also essential for the ecological balance, the water regime, the prevention of floods, water erosion and sedimentation and for the maintenance of sustained yields on the cultivation lands below.

No additional forest can and should be cleared within the subwatershed as all capable land to produce arable crops with sustained yields has already been cultivated or destroyed.

No forest management exists, neither community control on fire to safeguard this valuable natural resource.

6.2 Swidden

Yearly at least 2 hectares are broken up and partly utilized for annual cultivation, whereby original forest cover is destroyed, without regard to slope, soil depth and ownership. Most of the areas within the NPR are too steep for this kind of practice and should be kept under protective cover of trees to safeguard natural resources and avoid rapid run - off and soil loss. Even some of the fields outside the NPR should be put back to a near original cover in the form of fruit trees or perennial tree crops, intermixed with grasses and legumes, to provide maximum ground cover and to minimize the loss of income of the occupier or farmer.

Nearly 1,600 rai of upland cultivation is farmed without any conservation measures applied, specially within the NFR, resulting in massive erosion of valuable topsoil, which is deposited lower down or finishes up in streambeds causing siltation and flood problems further down streams. To aggravate the erosion problems, cultivation techniques are carried out in the form of monoculture, no use of fertilizers or compost, and straight up and down cropping of row crops. No cover crop or interplanting is done on any of the abandoned areas to restore its soil fertility and protection. Fortunately the soil is worked by hand with simple tools, limiting its working depth to 10 cm or less, and most the time stumps of trees are left in the ground holding the soil together, except when the area has been cleared by the Meo people of Pha Nok Kok who prefer clear cultivation. Initial clearing of big trees which were felled straight down the slope, getting only partly burned, are causing accelerated erosion in the form of deep rills and gullies. Most areas cleared for swidden are having a rectangular shape, whereby its longest length is running parallel with the slope, encouraging overlandflow to concentrate into streamflow, resulting in increased soil losses (rill erosion). Annual burning is destroying soil organisms and structure causing accelerated erosion. Observations during the field surveys supported by aerial colour-slides showed that 4/5 of the swidden area outside the NFR is yearly under cultivation (semi-permanent), being 142 ha., together with about 1/3 of the area within the NFR; making it a total of near 220 ha (1,250 rai) or 60 per cent of recorded swidden. This total area is subject to water erosion as it is located on steep hill sides which have been formerly covered by forest. With the increase in population and the pressure on the land, they are now constantly kept under cultivation, of which nearly half without any significant measures in soil conservation. Most of these lands are on fairly steep to very steep slopes and should not have been cultivated at all. Up till now about 96 ha (600 rai) has been protected under supervision of the Mae Sa Project staff. Over 80 per cent of the people living in Pha Nok Kok are cultivating their swidden areas outside the watershed area (see Section 5.6).

6.3 Hill Irrigation

Several farmers have selected areas near ^{or} below rapids or mountain springs in order to use the run-off water for irrigation practices. These areas are located on very steep hill lands cleared from forest. Most of them within the NFR, quite a distance from their residential area, limiting the accessibility to the land and supervision on on-going irrigation practices. Run-off is trapped by erecting primitive diversion weirs and diverting the water into simple delivery canals to the areas concerned. Before any assistance was given by the Project, this water was spread out wildly and uncontrollable over the natural slopes wildly and uncontrollable over the natural slopes without any distribution system, neither a collection or drainage ditch at the bottom of the field, to divert excess run-off back to its original course.

No terraces, like the ones used for rice production under irrigation were constructed. The results were and still are disastrous, showing bad signs of sheet and rill erosion, where valuable top soil is washed away. Only on a few locations the Project could convince some farmers to accept the required soil and water conservation measures to avoid further losses and introduce better distribution systems. No direct control can be exercised on a sudden increase of discharge, resulting in overtopping of primitive supply canals and causing devastating damage to natural resources below.

6.4 Run-off

As the subwatershed is steep in slope and is located in the main pass of prevailing storms (see Section 5.3), a short overlandflow can be expected, which very quickly will develop into streamflows accelerating run-off, which only partly can be use as irrigation water to the valley bottom, where 60 ha of paddy-fields are waiting to be irrigated. The quick run-off is not only causing a shartage of available irrigation water, but also causing periodic floodings to lower laying areas, road and bridge, resulting in drainage problems, crop and communication losses. The lower laying areas in the valley bottom are collecting yearly so much silt, that their drainage canals are running higher than some the surrounding fields.

During the dry season (October-Mid May) only a maximum of up to 13 ha (31 rai) can be used under near full irrigation, by trapping run-off from rapids and diverting it into the existing irrigation systems. Uncontrolled forest clearing of hillsides and particular the forest cover near depressions and streams is aggravating and accelerating the run-off characteristics.

6.5 Lowlands

The lowlands are the most valuable land resources. They are almost exclusively used for the production of rice followed by cash crops. Consequently much more attention has been paid to their management and to increases in their yields. However, very little thoughts has been given to the facts that these lands, being a part of the subwatershed, are highly influenced by the activities and the conditions prevailing in the upper parts of the drainage basin. The crop losses resulting from floods, sedimentation and water shortages may often off-set the increased yields achieved by better management and improved practices on the adjacent non-affected areas. In fact if detailed investigations are made, it will be evident that the difference between planted and harvested area will, often be considerable and the total production of the lowlands may actually decrease each/year in the subwatershed, which is subject to erosion.

6.6 Infra-structure

Only one road (5 km) runs through the watershed connecting all villages, and which only at its lowest point in the valley is linked up with a secondary system (main road) leading to markets at Mae Rim, Amphoe Sa Moeng and Chiang Mai. The road is partly graveled, but most of it (75 per cent) is constructed from local subsoil material, making it rather slippery and impossible to drive during the rainy season. Some places are too narrow, steep and slippery making it difficult to use ordinary Pick-Ups, the most common transport facility. The width of the road varies from 4 to 2 $\frac{1}{2}$ meter, with its narrowest sections located in the upper parts of the watershed, where it ends (Pha Nok Kok village). Insufficient drainage, mainly cross-drainage, is causing frequent wash-outs of road surface, making driving extremely difficult and dangerous. The connection road Ban Hang to Pong Yeang Nai is subject to yearly flooding, being the daily road for school - going children.

6.7 Human Resources

The physical development activities to improve the economic situation can become effective only if human resources are developed simultaneously. Physical development will often depend on the socio-economic situation in the subwatershed, and decisions on possible alternative improvements will have to be made according to human resources, the abilities and the special wishes of the village communities.

Presently a socio-economic survey is in progress, collecting information on villages within the subwatershed and the Mae Sa watershed as whole. It is hoped to have a separated extract made for this drainage basin and to have it attached to this report as an Annex.

For the time being restricted information, specially problems related to landuse, are quoted to come as close as possible to the reality, being:

The community within the area consists of two ethnic groups (Meo and Thai), the Thais are occupying the bottom valley and the white Meo (Hmong) the upper parts of the subwatershed.

The total present population of 740 inhabitants, which would require a minimum need for subsistence rice production 1 rai per head of irrigated land or 2 rai per head of rain-fed land, and 1 rai per head for cash crop (as quoted in the indicative land-use plan of the Mae Sa project area), can presently feed itself from the arable lands available outside the NFR, but is experiencing a deficit in the area required for cash crops, as is illustrated in Table 2.

Considering the total area of arable land presently used within the subwatershed a surplus of nearly 30 rai (4 ha) can be found. In other words the present total area of cultivation is sufficient to meet the minimum requirements for each inhabitant within the subwatershed, if no increase in population is experienced, but goes against the preservation of natural resources. An annual present population growth of 2.2 is predicted, which would require a heavier pressure on existing land, as no more surplus of land for cultivation is available. The ultimate consequences to cope with this situation is to increase the effect on family planning, crop intensification and crop diversification or migration to areas outside the subwatershed. The last one would create problems somewhere else again, repeating the same mistakes, unless selected areas are allocated for them under a controlled land use policy and plan. Possible activities to accomplish crop intensification and diversification will be discussed in the proposed development plan for the area concerned (Section 8). Present monoculture, whereby subsistence rice production is the main activity to be carried out by the available labour force, acute shortages are experienced during planting and harvesting times and labour surpluses in off-season. Farm activities on the lowlands, when it comes to irrigated rice-culture are commonly shared, as the contrast can be seen on the upland/rain-fed areas, which are more on an individual basis. Swiddeners can be classified as nomadic agriculturists who live a pioneer style of life and do not want to lose their independence, this applies in particular to the inhabitants of Pha Nok Kok village, which is occupied by Meo (Hmong). Although all the villagers fall under the same Muban for local Government administration, under the chairmanship of one Phuyai Ban (village leader) a limited respect feeling of the inhabitants towards him can be noticed or observed, making a social integrated system with reference to watershed management difficult. Sometimes decisions are taken by the Phuyai Ban without consultations or direct involvement of the majority of the people, which afterwards clashes with their wishes and desires.

No significant participation or cooperation of villagers towards agricultural development schemes is noticeable within the drainage area. Two rich absentee landholders, residing outside the subwatershed bought properties within the subwatershed area, eliminating good arable land from present land users or farmers. Even if an integrated land use policy exists, which is very doubtful, the community and its drainage area are threatened by outside invaders (Mae Sa Hai villagers) as can be observed on the western-facing slopes on top of the subwatershed, where scattered areas of active swidden are destroying the protective forest cover necessary to stabilize the steep slopes.

Although there is sufficient run-off from the various springs and rapids, no drinking water distribution system exists for 70 per cent of its population. None of the existing streamflows has sufficient discharge to develop a hydro-electric system, although the topography would lend itself to such an undertaking. When more control can be exercised on deforestation probably enough constant discharge can be maintained to make such an undertaking a just-fied proposition. The most likely place for a hydro-electric installation would be in the Huai Muang Chang 400 meters upstream from its junction with Huai Mae Langun, the main stream within the subwatershed. Many of the farmers do not have sufficient financial income or the legal ownership of land they occupy, or farm, to carry out or introduce the required conservation measures to protect the land from further destruction of erosion.

No effective agricultural extension service exists to advise all the farmers on crop management practices, except within Pha Nok Kok which is mainly concentrated and oriented on perennial cash crops, like coffee, which are giving promising results.

Conservation measures already adopted by some of the farmers were heavily subsidised by supplying construction labour for 50 per cent or higher, to make land-users apply them on their sloping rainfed area. The input costs of the farmers residing in (original) forest areas are extremely low, as they are living on and from natural and national resources, this applies in particular to the swiddeners.

If the landoccupier or user can gain from any project/Government input, he will cooperate, in other words if the farmer's economy and social conditions are improved, they will cooperate in the planned activities and in the purpose of the Project.

6.3 Specific Development Constraints

The following are specific development constraints:-

- Less than half (44.5 per cent) the watershed is claimed to be in legal private ownership, even in some location in the NFR, making registration very difficult.
- The present population is 740, with a birth rate of 2.2, living in a subwatershed which has an average slope of 35 per cent, occupying 60 per cent of the total area for agriculture of which only 53 per cent is classified as being suitable for such development.
- The population consists of two ethnic groups, having different customs, religious convictions and contrasting land use systems, of which one occupies the steep hillside slopes without any legal land-right, hampering stability and security towards private initiative.

- Forest areas, only 37 per cent is still left, are regarded by the people as a common public and private place for agriculture, grazing of livestock, hunting, firewood/charcoal/plant collection next to building supplies, without any district or village management or direct control or supervision, resulting in an uncontrolled destruction of natural forest resource, causing soil erosion and frequent flooding at lower laying areas.
- No common policy, plan, and coordinating agency exists dealing with integrated land use planning and development.
- No coordination, participation, cooperation and respect between the villagers to the existing Government administrative system is noticable within the subwatershed towards an overall development approach.
- Migration into the subwatershed from outsiders (absentee land-holders and Moo from Mae Sa Hai) by taking up large agricultural areas, thereby reducing the land available for its own people (by pressing them more up in the hills) and by interfering in proposed development planning and implementation work.
- No coordinated integrated development programme by the various Government departments or agencies, nor within the Mae Sa project, is carried out in this subwatershed; neither in the Mae Sa project area as a whole.
- The limited area available for cultivation is forcing the people to occupy more illegal land (steep), without concern to its suitability and capability (National Forest Reserve).
- The main constraint to production in this area is projected overpopulation coupled with severe forest destruction, followed by shifting cultivation (swidden) on steep sloping land, which is followed by erosion of soil, flood damage in the valley bottom and on the lower flood plains further down streams.
- No availability of money for the coming budget's year (Mae Sa Project) to start with the implementation work, after the plan has been agreed upon.
- No organizational structure or institution, which can cope with or handle the required implementation work in a well coordinated frame-work.

7. Classification and Analysis of Critical Land Use Areas

7.1 Criteria for Identification of Critical Areas

Slope and soil stability are generally considered the two most important factors in the identification of critical land use areas (Hudson 1971). While many complicated schemes have been suggested for the classification of various types of recommended land use on a combination of slope and soil stability variables, none are particularly suited for implementation in regions of the country with intensive agriculture on steep slopes. Many land use investigations in tropical climates conclude that land steeper than 50 per cent is not suited for any type of agriculture (terraced cultivation or grazing), and should have permanent protection of vegetation preferable forest cover (Hudson 1971, Eren 1971, Sheng 1973, Jackson 1980). Field observations within the planned subwatershed of Huai Mae Langun confirm that land steeper than 35 per cent be excluded from annual cropping and be used for fruit trees/crop intermixed with improved grasses and legumes for grazing purposes or woodlots for fuel (See map of critical areas No. 4). Soil stability on different land use types is another important criteria in the identification of critical areas. In the Mae Sa watershed it has been shown that shifting cultivation practices (swidden) have the highest rate of soil loss (18 tonnes/ha/yr on 30 per cent slope), and is the only land use type which appears to exceed a "tolerable" soil loss, apart from the massive soil loss caused by improper road construction estimated to be 250 tonnes/km/yr). Although other schemes for identifying unstable areas susceptible to erosion could be used, slope and soil stability will be used for the subwatershed of Huai Mae Langun. It is assumed that land steeper than 35 per cent under annual cultivation are the "Critical" areas of the watershed.

7.2 Identification of Critical Areas

Swiddenland steeper than 50 per cent comprises of 48 ha (300 rai) or 6.4 per cent of the watershed. On overlay analysis of the topographical map indicates that most of this very steep land is presently in the forest reserve (NFR) in the southern upper parts of the subwatershed, monthly occupied by inhabitants of Pha Nok Kok village. Management of the subwatershed will ensure the protection of this land towards forest, and not allow clearance for agricultural uses. Swidden areas with a slope between 35 and 50 per cent, presently occupying 60 ha (437 rai) or 8.3 per cent of the watershed, of which 25 ha are outside the NFR, is too steep for continuous cultivation practices and should be allocated to perennial cash crops /^{and/or} fruit trees or wood lots for fuel. Both critical categories of land together comprise about 118 ha or 16 per cent of the subwatershed (this accounts for some overlap of the categories). These areas should be considered "critical", and should receive the highest priority for protection and rehabilitation (See Map 4 for their locations). The remaining area of swidden, some 233 ha (1,456 rai) or 13 per cent, with a slope less than 35 per cent can be allocated to the use of permanent cultivation, provided that these areas are well protected with conservation measures.

Other critical areas are several locations totaling 5 ha or 31 rai within the swidden land presently used for hill agricultural practices under primitive irrigation (section 5.7 and 6.3).

8. Suggested Management Plan

To provide needed forest and agriculture resources within the subwatershed to all its people they must manage forest, upland (dry-farming) farming, grazing methods and irrigation practices on a village basis within an overall development plan. The suggested plan for the subwatershed unit has the capacity to provide forest fuelwood and agriculture needs for all its people, but is pending on the attitude of its people and the alternative proposal which can last for 20 years or more (see figure 4, section 8.6 and Map No. 2). One of the villages (Pha Nok Kok does not have sufficient arable land for annual cropping available within the subwatershed, but this can be obtained by requesting rental leasepermits from RFD, when more intensive agricultural practices are introduced on existing suitable swidden land, which is possible. To achieve this, internal shifting cultivation practices should be replaced, thereby making more land available for permanent settled dry-land farming practices. Any swidden land suitable for cultivation should be made legally available, on a rental basis, specially to those people who do not have enough land to feed their families with the basic minimum requirements. The soil conditions on the marked areas, see Map No. 2, can stand continuous cultivation practices, provided the selected areas are treated with the required conservation measures to make them suitable. No more forest land, presently 283 ha (or 1764 rai), should be cleared for additional cultivation practices. All available forest will be put directly under the supervision of the villages through their development committees, Village Development Committees (VDC). Areas already cleared of forest (60 ha or 375 rai) specially those having a slope of 50 per cent or more (48 ha or 300 rai), will be replanted with fast growing tree species to keep the very steep slopes protected with forest cover in order to avoid excessive soil loss and to stimulate regular release of run-off, which can be used for drinking - and irrigation purposes next to a possible mini hydro-electric plant (reference, see section 5,6 and 7).

8.1 Technical Implementation:

Technical implementations involves afforestation of very steep swidden land (50 per cent slope), planting of fruit trees on orchard terraces on steep swidden land (slope 35 - 50 per cent): protection of existing forest; sustained yield forest management; conversion of swidden land with slope of less than 35 per cent to settled permanent dry-land (upland) cultivation; the establishment of pasture areas and temporarily cash crop between planted fruit trees (taungya system) whereby the boundaries of the land capability classes will be demarcated on the ground; the establishment of a water supply system for 520 people; and the construction of a dam to provide full irrigation to the 313 rai in the valley-bottom; and the widening and improvement of the main road in the subwatershed.

All above activities divided into yearly targets are shown in Table No. 8.

8.1.1 Forest Management

By transferring the forest land legally by change of law, on a rental agreement, together with its management to the Subwatershed Development Committee (SDC), whereby each village through their VDC will be responsible to protect, guide and supervise closely the required activities laid down to them by the Royal Forest Department (RFD), the forest can be preserved from further destruction and be used properly.

The system of management would ^{be} selection combined with improvement in felling. Timber trees would be marked for felling when over the official girth limit at a rate not exceeding 80 trees per year. Trees of less valuable species competing with valuable species would be felled for fire-wood.

The present demand on the forest fuelwood products within the subwatershed, based on actual measurements, is 1,413 m³ per year, or 1.9 m³/head/year, which is 0.6 m³ higher than the highest demand for humid tropics species of 0.5 - 1.3 m³/head/year*.

The 1,413 m³ of fuelwood demand/consumption is calculated as follows:

Meo burn per year 25.5 m ³ /household	+)			612 m ³
Thai burn per year 7.7 m ³ /household	+)			801 m ³
			Total	1,413 m ³

The present area of forest (283 ha or 1769 rai) produces a maximum annual volume on timber (3.5 m³/ha) of 990.5 m³, which is running 422.5 m³ short of its total requirement on fuelwood. If the population within the subwatershed wants to survive within the restricted area of 750 ha, with less than one third cover of forest, a desperate need is created to improve the existing management procedures on standing forest, the planting of very steep slopes with fast growing fuelwood species and a more economical/efficient use of wood to be burned. All needed timber for building construction has to be obtained (legally), preferable from outside the area. This means that no more NFR would exist in the planned subwatershed. The name of NFR would be changed, the forest would be called Watershed Protection Forest (WPF). It is suggested that afforestation could take place at 30 ha/yr, completing the required areas of 60 ha (375 rai), see Map No. 2 and 4, within two years. Afforestation costs are estimated at Baht 7,000/ha (Baht 1,120 per rai), (RFD), which include clearing, nursery costs and planting of required (2,500) seedlings, together with other aspects of site preparation. Other nurseries in the Mae Sa watershed may provide the required additional seedlings. Forest plantation maintenance (weeding, replanting etc.) is estimated at Baht 1,250.00/ha (Baht 200.00 per rai) for the first

* Myers, N. 1980 Conversion of Tropical Moist Forest. National Academy of Sciences, Washington D.C. 205 pp.)

+) Source: Socio-economic Survey. Mae Sa Project area 1974.

3 years. Forest village guards will be provided through the VDC and all illegal forest cutting in the form of fuelwood, charcoal and building material will be halted and placed under the responsibility of the SDC. It is recommended that at least 2 Forest Guards are appointed for this activity, and during the fire-season their number be doubled for the first 4 years. It is recommended that national forest land be converted to management forest at the rate of Baht 30 per rai. By the end of the 6 year period the existing forest land would be in managable stage. Costs of management, include protection of existing forest management and training of village technicians, is estimated at Baht 200/ha/yr. The transfered forest areas to the villages under their management will be called "Village Protection Forests" (VPF). Special attention would be given to the location of woodlots, within the areas to be reforested, that they are to be placed very near to the villages; areas marked on the Map 2 suggest possible locations. Demarcation of forest areas (boundaries) will be done by means of concrete posts, placed at an interval of 100 meters.

3.1.2 Soil and Water Conservation Management

Soil and Water Conservation management will focus on four main activities, being:-

- A. Conservation farming on pre-selected areas, as marked on Map 2, for annual cultivation whereby the required engineering as well agronomic conservation measures will be applied.
- B. The construction of required terraces (eg. orchard terraces) for areas to be planted with fruit/cash crop trees and the application of required agronomic measures to maintain the soil fertility, including the horticulture and pasture management activities, as those two section are closely related.
- C. The construction of a dam in the Huai Mae Langun stream for irrigation purposes of 50 ha. (313 rai).
- D. The installation of a drinking water system to supply 520 people with piped water to their houses.

All four activities are focused on the first three objectives of this report, being:-

- 1) to ensure sound land use
- 2) to prevent erosion losses, protect and improve downstream facilities.
- 3) to manage resources for the maximum rate of production and economic return.

8.1.2.1 Proposed Land Use

The analysis of erosion problems in the subwatershed (section 6 and 7) indicate that from the swidden land 233 ha (1,456 rai) can be continuously used for cultivation, provided the land is farmed in accordance with the conservation requirements and/or specifications (reference Technical Note No. 22 and 34). To avoid dispute over right of land, or land ownership, it is strongly suggested that all marked land for the settled dry-land farming activities, as indicated on Map 2, located within the present NFR, having a total of 70 ha, be legally transferred to the Pha Nok Kok village and the rest, a total of 163 ha, be allocated on a rental basis (reference the recent passed Farm Rent Bill, Bangkok Post 17/7/81) to the Ban Hang/Don village, giving an equal distribution according to the population of the areas.

Note: This land allocation procedure fits also in with the present total population of Pha Nok Kok, whereby for each person 1.5 rai will be available for settled agriculture, and 1.5 rai for fruit/cash crop trees. Swidden areas with a slope varying between 35 and 50 per cent, being 60 ha (375 rai), will be used for the planting of additional fruit trees, together with perennial cash crops and intersown with annual cash crop or pastures and/or legumes for livestock food (agro-forestry). The intersowing of livestock food will also be done under already established orchards (13 ha or 81 rai). The Miang Tea growing presently under natural forest cover can be slowly replaced by improved plants to produce the green/black tea, for which there is a national and international demand.

On the selected areas allocated for the planting and production of perennial cash crops or fruit trees, reference Map No. 2, which have firstly been treated with the required conservation engineering structures, various types for suitable species will be introduced to provide the farmers with the highest income possible. Some areas may primarily be interplanted with short cash crops, during the establishment period or with improved grasses.

8.1.2.2 Staff requirement

Two more (junior) Technical Assitants will be locally recruited and trained for at least one month per year (preferable three times) to assist in the implementation programme, bringing the total number to 4, to handle the first two activities listed.

8.1.2.3 Cost Input

The costs of conservation engineering works, for terrace construction on settled agriculture areas and fruit tree land, is estimated to be about Baht 1,600 rai or 530 man/days (฿ 30 per day).

As about 600 rai is already protected with most of the required engineering conservation structures, a total budget allocation for the remaining 1,456 rai of (which 1/3 is located in the NFR) is estimated to be about Baht 2 million (table No. 9)

Establishment costs for seedlings and planting will vary according to the species to be planted, therefore only minimum and maximum cost per rai will be quoted, being Baht 150 (Min.) to Baht 1,600 (Max. for coffee). If a mixture of fruit trees interplanted with short growing cash crops or pasture be planted over the total area of 83 ha (520 rai), including the area of improved (Miang) tea, an average cost per rai would fall on Baht 750/rai. The total estimated average price for the above management will be Baht 390,000.

8.1.2.4 Method of payment for conservation work

Farmers contribution/compensation towards the activities listed under A and B will be recommended as follows:-

- the land-less farmers, registered as being living in the subwatershed and engaged in this operation will receive half of their daily wages as a cash contribution, and half will be paid to them in the form of a lease-hold of treated arable land.
- private farmers, who will be engaged in the construction of required terraces on their own legal land (Registered and supported by maps of the Land Department) will be compensated for the total cost of structures (Baht 1,600/rai), when their work has been carried out satisfactorily and be checked or approved by the Senior Technical Officer (Project Coordinator) appointed to the area, up to the limits of registered members in his family living and/or working with him in the subwatershed.

8.1.2.5 Legal transfer or rental of land

Due to the existence of the National Forest Reserve there are two cases:

- i. Outside forest reserve (as it is at present). Where land is suitable, farmers will be encouraged (pay them) to terrace it, and if they have no land title they will be assisted in getting one through the District Office.
- ii. Inside forest reserve. If the farmer occupies suitable land (not in excess of his needs), he will be assisted in having the land terraced and be issued with a lease. If he does not have land, unused land shall be made available.

8.1.3 Dam construction

A large irrigation-dam is planned to be located in the mainstream of the subwatershed just south of the existing paddyfields, which will have enough storage capacity to supply permanent irrigation water to 50 ha (313 rai) of lower laying fields. The present irrigation distribution system can be used to supply each field with sufficient water, without going into additional expenses. The total drainage area above the proposed dam is approximately 260 ha (1,625 rai), making it a ratio of 5:1.

If a shortage of water will be experienced, it is feasible to divert additional water from the Huay Haung Chang stream into the reservoir, through the construction of an open diversion canal with weir made of masonry over 350 meters, (cost Baht 30,000) whereby a minimum discharge of 11 L/S can be supplemented (see Map 3). The following preliminary specification and cost-figures on this dam can be quoted, being:

Storage Capacity (Minimum) in m ³	26,000
Embankment in m ³	4,350
Soil movement in m ³	5,000
Cost (D6-50 m ³ /Baht 300/hr)	฿ 80,000
Spillway excavation on rocklayer	
and lined with masonry	- 5,000
Outlet-pipe for irrigation and valve	- 6,000
	<hr/>
Total estimated cost for dam	฿ 91,000
with Diversion canal	- 30,000
	<hr/>
Total	฿ 121,000

The construction of the irrigation dam will be done under close supervision of a field engineer for the time of construction at an estimated cost of Baht 21,000 (3 months).

8.1.4 Drinking water system

The installation of a drinking water distribution system from a spring, located on the eastern side of the road 3 km south from Ban Hang, (see Map No. 3) whereby discharge will be collected, having a minimum flow of 2L/S, into a night-storage tank of 30 m³ and further transported by a piped (PVC) system with 8 distribution points for the string of villages will be constructed for a total planned population of 500. The estimated total cost would be Baht 250,000 being:-

- 3 km of 4 inch PVC piping	฿	240,000
- 8 distribution points (masonry with stand pipe and taps)		4,000
- 1 storage tank 30 m ³		<u>16,000</u>
- 1 storage tank 30 m ³	฿	260,000

Labour for its installation is planned on a "selfhelp" (voluntary) basis.

8.1.5 Road Construction

The only road in and out of the subwatershed needs to be improved by widening and more cross-drainage structures, a gravel all weather surface is required to make the road passable the whole year through. Also the connection road between the main road Mae Rim Amphoe Samoeng from the turn-off at Pong Yaeng Nai, to Ban Hang village needs to be raised in height to have the road above flood-level.

The estimated costs are the following:

- Increasing the width of the Ban Hang/Pha Nok Kok road	฿	64,000
- Drainage for the above road		158,000
- Gravel cover for the above road		<u>20,000</u>
Total cost for road management	฿	<u>242,000</u>
Raising Section Ban Hang - Pong Yeang Nai road	฿	150,000
Gravel surface for the above road	฿	<u>20,000</u>
Sub-Total	฿	<u>170,000</u>
Total	฿	<u>412,000</u>

8.1.6 Administration of the Development Programme

The Division of Watershed Management of the RFD should provide funds to meet project costs until the subwatershed development committee, consisting of selected members of each village development committee (VDC), is in a position to manage its own resources through the Tambon Assembly and district authorities. Results of initial forest and conservation efforts in the area indicate that hiring local employees to manage local resources is more effective than bringing technicians from outside project area to manage government programmes. It is therefore recommended that the following staff, (with the exception of the project coordinator or liaison officer), one agricultural extension officer and field engineer, be recruited locally to work in the subwatershed, as illustrated in table 3.

Table 3

Management Programme Administrative Costs (Annual)

Position Title	Number of Monthly Positions	Monthly Salary ₹	Annual Salary (30 %)	Travel	Total per Position	Total
Subwatershed						
Coordinator/Senior						
Technical Officer	1	4,500	54,000	16,200	70,200	70,200
Agric. Extension						
Officer	1	3,000	36,000	10,800	46,800	46,800
Jr. Technical						
Assistant	4	1,050	12,600	—	12,600	50,400
Field Engineer	1 ^{++/}	7,000	21,000	6,300	27,300	27,300
Forest Guards	2	750	9,000	—	9,000	18,000
Forest Fire C. Off.	4	750	4,500	—	4,500	18,000
Total						Baht 230,700
Operating Costs (20% of total) ^{++/}						<u>46,140</u>
						Baht <u>276,840</u>

^{±/} Operating costs includes material, local labour, transport of supplies, fuel and personnel, maintenance of facilities, publicity, etc. The 20 per cent estimate is a realistic figure currently used by service-oriented programmes. One land rover will be ^{provide} to the Subwatershed Coordinator.

^{++/} Only for a period of three months.

8.1.7 Summary of Total Costs for Suggested Management Plan

The costs of the proposed 6 to ~~8~~ year management/development programme are divided into the following components:

Forest Management

Reforestation 375 rai (฿ 1,120) within 2 years	฿	420,000
Plantation maintenance 375 rai, 3 years (฿ 200/rai)		225,000
Forest management, incl. training of village tech. (฿ 30/rai) for 6 years		56,608
Demarcation cement posts, 122 x 4" x 4" x 5', ฿ 80 including ฿ 30 labour		9,760
	Baht	<u>711,368</u>

Soil and Water Conservation Management

Hill-side ditches for settled dry-land annual farming		
437 rai ฿ 800/rai in the NFR (Pha Nok Kok)	฿	349,600
419 rai ฿ 1,600/rai in the valey outside GFR (Ban Hang Dong)	฿	670,400
600 rai already constructed		
<u>1,456 rai</u>		<u>฿1,020,000</u>
Perennial cultivation (orchard terraces) 600 rai ฿ 1,600/rai		960,000
Drinking water distribution system		260,000
Dam construction for 50 ha (313 rai) of permanent irrigation		121,000
	Sub-Total	<u>2,351,000</u>
520 rai planted with fruit trees, intermixed with pastures (฿ 750/rai)		390,000
Demarcation cement posts 85, (4" x 4" x 5') is ฿ 80 (including labour ฿ 30)		6,800
	Sub-Total	฿ 396,800
	Total	<u>฿ 3,767,800</u>

Road construction Management

฿ 412,000

Administrative Management Costs:Personnel to supervise the implementation work etc. (8/10 yrs) ฿ 1,756,000Total Costs ฿ 5,911,708

All activities divided into yearly targets as shown in Table 8, are calculated into costs figures for its implementation programme: by utilizing Table 3 and 4, together with cost figures obtained from actual work carried out in the field, and are shown in Table No. 9 in Section 9.

8.2 Proposed Land Use for Subwatershed

All the above mentioned major land use development proposals are summarised in Table No. 4 and their locations marked on Map No. 2.

By carrying out agricultural development on selected areas in accordance with its suitability and capability, which can stand continuous and intensified cropping practices, a reduction can be made on the minimum land required for the subsistence (rice) production, as previously mentioned in section 6.7.

Collected figures from field-surveys within the subwatershed with reference to net-income per rai (table 7, section 9) recommend the following land use distribution system for the various classes or categories available, to achieve proportional equality in income. This is illustrated in Table 5.

Figure 4. illustrates the projected land use 1980-2000 for the planned subwatershed with present growth-rates and proposed development programme.

Table 4

Land Development Proposals for the HML/Ban Hang Subwatershed

	<u>Symbol</u>	<u>In Ha</u>	<u>In rai</u>	<u>In %</u>
Full/Permanent Irrigated Rice Fields	PI	50	313	6.7
Rain-fed irrigated Rice fields	RI	12	75	1.6
Settled agriculture (dry-farming)	S/A	233	1456	31.1
Improved Miang Tea	MT	23	144	3.1
Existing Fruit trees with Pasture	FT/P	13	81	1.7
New Fruit trees, or Perennial Cash crops (or comb. with pasture development)	S/FT/P	60	375	8
New forest	S/F	60	375	8
Existing forest (under management)	FN	283	1769	37.8
Residential area	R	16	100	2.1
		750	4688	100

Note: S = Areas marked as presently swidden.

Figure 4. Projected Land Use 1980 - 2000 in the Huai Mae Langum or Ban Hang Subwatershed with present growth rate and proposed development Programme.

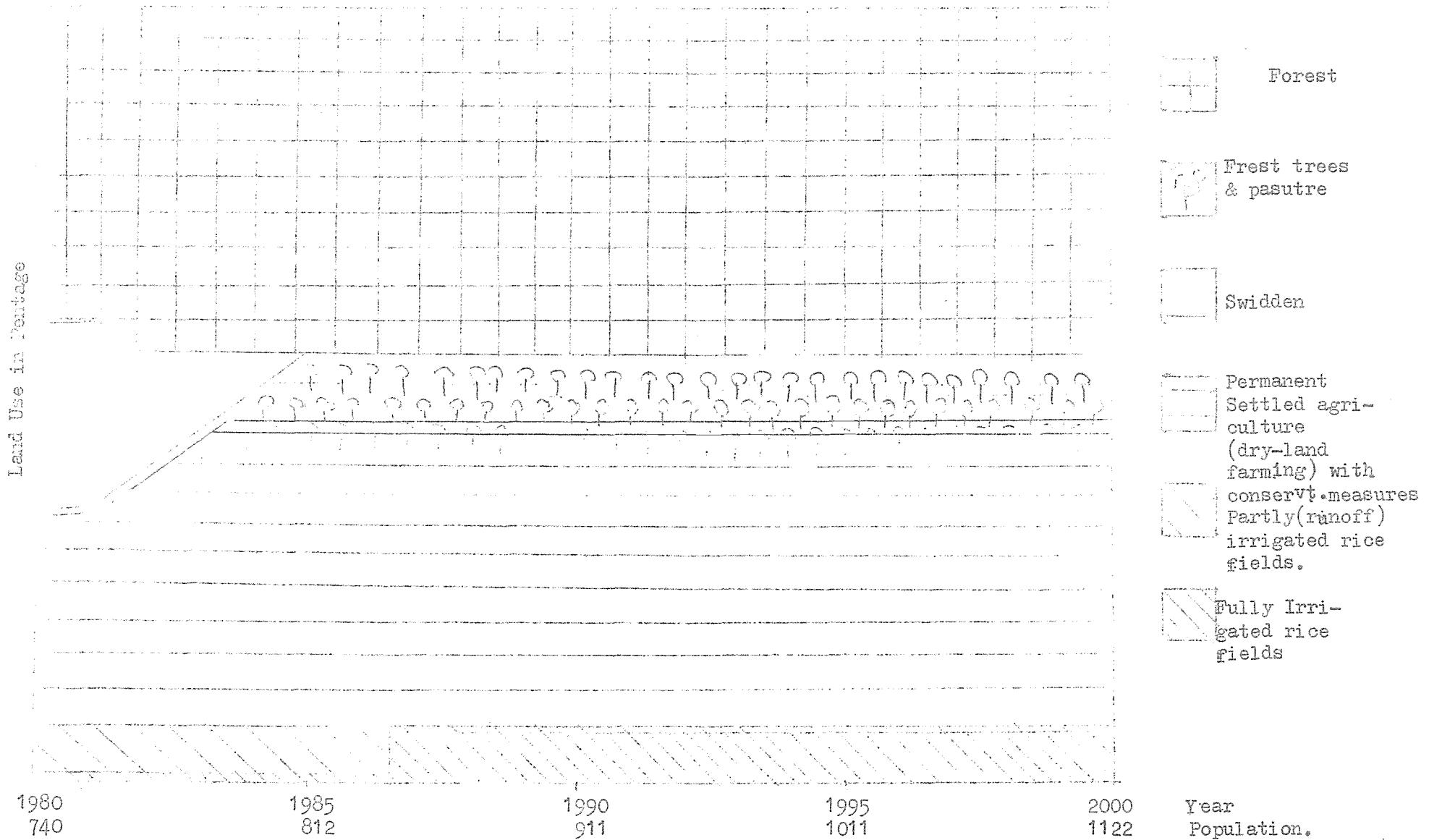


Table 5

Net Income in Comparison with Land Use Classes (Categories) (year 1980)

System	Total Income in Baht	Full. Irrigated land (FI)	Part. Irrigated land (PI)	Rainfed Land (RF)	Fruit/crop tree land (FT)
I	2,400	1/2 rai (1,600)	-	1 rai (800)	-
II	2,300	-	1 rai (2,000)	-	1/2 rai (300)
III	2,100	-	-	1½ rai (1,200)	1½ rai (900)

Note: The figures between brackets represent separate income from each class. By projecting the population figures of the year 1985 and 2,000 (figure 4) onto the available land use classes or categories (table 4) and its distribution system according to near equal income based on land use classes (table 5), the following surpluses on land can be expected in the above mentioned years to come. These are shown in table 6.

Table 6

Future Population Distribution over Selected arable Land Use Categories
in HML Subwatershed

Population		Full Irrig. L			Part. Irrig. L			Rainfed Up L.			Fruit /crop trees		
No.	Need	A	S	D	A	S	D	A	S	D	A	S	D
821 in year 1985		313	-		75			1456			600		
	626	-	-	313	-	-	-	-	-	626	-	-	-
		-	-	-	-	75	-	-	830	-	-	600	-
	75	-	-	-	-	-	75	-	-	-	-	-	38
		-	-	-	-	-	-	-	830	-	-	562	-
	120	-	-	-	-	-	-	-	180	-	-	180	
		-	-	-	-	-	-	-	650	-	-	380	-
1122 in year 2000		313			75			1456			600		
	626	-	-	313	-	-	-	-	-	626	-	-	-
		-	-	-	-	75	-	-	830	-	-	600	-
	75	-	-	-	-	-	75	-	-	-	-	-	38
		421	-	-	-	-	-	-	830	-	-	562	-
		-	-	-	-	-	-	-	632	-	-	632	
		-	-	-	-	-	-	-	198	-	-	-	70

A = available land
S = Surplus of land
D = Deficit of land

The surplus of 198 is enough to compensate for the 70 deficit on perennial crops/trees.

Table 6 shows that from the total population (812) expected in 1986, 626 persons can be fed from the 313 rai of full irrigation, thereby leaving a surplus of 75 rai of partial irrigatable land available for another 75 persons, the remaining 830 rai can feed 120 persons quite easily leaving a surplus of 650 rai together with 405 rai for fruit/crop tree development. The same can be seen for the year 2,000 when the population is increased to a total of 1122 and still having a surplus of 198 rai for rainfed upland which compensates for the deficit of 70 rai required for fruit tree/crops.

When all mentioned major land use development proposals are carried out or are implemented in accordance with the suggested plan and fully supported by the majority of the people residing in the subwatershed, the projected land use for the year 1980 to 2,000 can support its total population.

The difference between with management and no management can be observed from Figures 3 and 4, Table 1 and 4, and related maps of the subwatershed, Map 1 and 2, of which the following observations can be underlined:-

- no occurrence of waste land;
- an increase in forest land, supported by proper management;
- an increase in fruit/crop tree land to utilize and protect the steeper cleared slopes and to diversify crop production;
- a decrease in swidden land towards intensive agricultural development on suitable and capable areas, which can support permanent dry-land farming practices, when the correct conservation measures are applied;
- an increase in fully irrigated land;
- no migration of its population away from the subwatershed in surge for (more)land.

8.3 Project Development Schedule and Recommendations;

The following activities to be carried out in order of sequence (see Table 8)

- 1^o The first priority should be given to discuss with most of the occupants within the subwatershed the proposals made within this plan, and to have their general agreement of acceptance.
- 2^o Secondly during the first year of implementation to have Village Development Committees (VDC) established and to have the people registered who live on, and farm, land within the planned subwatershed. This to be followed by the formation of the Subwatershed Development Committee (SDC), and to establish legal recognition at Tambon Assembly and District Office.
- 3^o As not to delay the implementation of the development programme of this subwatershed by one or more years due to budget regulations to have the work programme agreed upon for the 1981/1982 budget year, by making internal shifts of the work programmes within the project area of Mae Sa possible.

- 4° To reforest identified swidden areas with quick growing forest trees primarily for fuelwood purposes within the first two years.
- 5° To protect the allocated land for permanent dry-land farming and fruit/crop trees with the required conservation measures against soil erosion and have the recommended cropping practices applied to intensify crop production.
- 6° Reallocate land, whereby the villagers from the valley-bottom will vacate their upland (swidden areas) presently within the NFR, to the people of Pha Nok Kok. This should be arranged through their own VDC, coordinated by the SDC and registered by the District office.
- 7° RFD to arrange for lease-hold permits to rent arable areas to the landless people or to the ones who have insufficient land to produce the minimum crop requirements within the present NFR and for Village Protection Forests (VPP) within the subwatershed forest areas.
- 8° To construct the dam to supply 313 rai with permanent irrigation water.
- 9° Reference should be made to the time schedule and annual budget allocations of development projected in Table 8 and Cost Allocation in Table 9.
- 10° Conditions to be met by the villagers:
 - To select representatives to the VDC and SDC
 - No more forest clearing for agriculture
 - No more forest fires
 - No more forest grazing, wood cutting or extraction of any kind without written permission of the VDC through the SDC.
 - All timber wood for buildings taken out of the forest be paid for, and all wood brought into the area be legally obtained.
 - A very strong social feeling towards multilateral development, trust, acceptance and respect towards each other.

9. Benefit/Cost Analysis of the Development Programme

9.1 Reasons for an Economic Analysis

It is useful to predict the economic effects of a watershed management project, and then to compare these benefits with project costs. In this way decision makers can better assess the merits of allocating monetary resources. A benefit/cost analysis also provides a framework for more specific parts of the proposed programmes.

The following section attempts to assign monetary value on land production of different types of land use. The analysis will compare the productivity value of land without the programme to the productivity value with the suggested development programme.

The difference between the two values will be assumed to approximate the monetary benefits of the programme. Some benefits are difficult to quantify e.g. floodcontrol on down-stream areas located outside the project area, domestic water supply, savings on man-hours through crop intensification and associated health benefits. Hence, these aspects have not been included.

9.2 Values of Productivity of Land Use Types (categories)

9.2.1 Unmanaged Forest

Land classified as forest in the subwatershed is presently unmanaged, meaning it is open to grazing and other utilization, such as cutting of fuelwood and timber, and stripping of its cover to have it converted into swidden. Present utilization in many areas is removing the natural standing stock, rather than harvesting on a sustained yield basis. The average yield of this unmanaged forest area within the subwatershed is estimated to produce $1.2 \text{ m}^3 \text{ ha}^{\pm}/\text{yr}$ for fuelwood consumption.

9.2.2 Managed Forest

The application of sustained yield management practices from presently unmanaged existing forest (not plantation) for fuelwood could result in an increase in annual productivity from $1.2 \text{ m}^3/\text{ha}$ to $3.4 \text{ m}^3/\text{ha}^{++}$ over a period of 30 years.

For the Hwai Mae Lungam subwatershed it will be assumed that the proposed management plan results in a fuelwood productivity of $2 \text{ m}^3/\text{ha}/\text{yr}$ after a waiting period of six years.

Note: No trees for timber will be used directly for fuelwood.

$\pm/$ Overall timber production including protected species is $3.5 \text{ m}^3/\text{ha}$, of which only 30 per cent is available for fuelwood if harvested properly.

$++/$ 30 per cent of timber trees over girth limit $32/\text{ha}$, volume 94.4 m^3 timber trees, which will reach girth limit in next 30 year, $12/\text{ha}$, volume 7.2 m^3 , allowable annual cut in numbers of trees

= $32 + 12/2 = 1.3 \text{ tree}/\text{ha}$, volume $3.5 \text{ m}^3/\text{ha} =$	1.2	m^3/ha
Firewood obtained from these trees from branches =	1.5	m^3/ha
Increment of trees grown for firewood only =	0.7	m^3/ha

Total	<u>3.4</u>	m^3/ha
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(1 ha = 2,000 cu C of wood = 0.002)

The fuelwood value in (1981) Mae Sa Project for cut wood in bundles of 3 kg is one kg one Baht.

9.2.3 Plantation Fuelwood Forest

Planted seedlings from seedbeds on abandoned swidden areas on very steep slopes, have grown after five years to a height of 7-10 meter in good locations, and 5-8 meter on dryer slopes (east facing). It can be assumed that after five years the plantation will yield 7 m³/ha/yr of fuelwood, and after 10 years the yield will be 12 m³/ha/yr (1981 price). Cost estimated of present labour wage for cutting Baht 300/rai.

9.2.4 Swidden Areas

Forest land cleared by slash and burn operations, planted with one crop (mainly up-land rice) during the season, is producing an average net-income of Baht 2,600 ha/yr. As internal shifting cultivation is practiced only on 60 per cent of the total swidden the over-all net productivity is reduced to Baht 1,560 ha/yr or Baht 250 rai/yr. Cost estimated by present labour wage and material are Baht 120 rai/yr.

9.2.5 Semi Permanent Cultivation

Swidden areas used more on an intensive basis, where on the average two crops are grown within 3 years, giving a net-income of Baht 3,800 ha/yr or Baht 600 rai/yr. Cost estimated for present labour wage and material is Baht 350 rai/yr.

9.2.6 Settled Cultivation (dry-land farming)

Agricultural fields treated with the required conservation measures and the cultivation of short-growing crops to maximise available soil moisture during the rainy season to produce two crops per year is giving a productivity (net-income) of Baht 5,000 ha/yr or Baht 800 rai/yr. Cost estimated for present labour wage and material is Baht 500 rai/yr.

9.2.7 Partially Irrigated Areas (local run-off)

Agricultural fields in permanent use on which run-off and/or rainfall is stored to produce two crops per year at the maximum, as no insurance can be given on its required watersupply are having a productivity (net income) of Baht 12,500 ha/yr or Baht 2,000 rai/yr. Cost estimated for present labour wage and material is Baht 800 rai/yr.

9.2.8 Fully Irrigated Areas

Agricultural fields in permanent use on which cropping practices can be carried out the whole year as permanent water for irrigation application is available. The productivity (net-income) of these areas can be very high, pending on the inputs and crops to be grown, presently the following average is recorded as Baht 20,000 ha/yr or Baht 3,200 rai/yr. The cost of present labour wage and material is estimated Baht 1,000 rai/yr.

9.2.9 Untreated Fruit/cash Crop Tree Areas

Fields planted with fruit trees or perennial crops, without the recommended conservation practices having much slower growth and lower yields, averaging an net-income of Baht 2,813 ha/yr or Baht 460 rai/yr. The cost of present labour wage and material is estimated at Baht 350 rai/yr.

9.2.10 Treated Fruit/cash Crop Tree Areas

Field planted with fruit trees or perennial crops, or intersown with pasture, treated with the recommended conservation measures, are producing an average net-income of Baht 3,800 ha/yr or Baht 600 rai/yr. The cost of present labour wage and material is estimated at Baht 350 rai/yr.

9.2.11 Summary of Productivity Values from different Land Uses

Table 7 summarizes the results of the analysis on net-income (productivity) per rai/yr based upon actual field surveys carried out in the Mae Sa Project area (Jackson, Keen and Su Ki Kang).

Table 7.

Estimated Net-Productivity from different Land Uses within HMLS

Land Use	Net Income/Productivity in Baht/rai/year		
	1 ^o crop	2 ^o crop	Total
- Forest fuelwood (disturbed/unmanaged)	1,800	-	1,800
- Forest fuelwood (undisturbed/managed)	3,000	-	3,000
- Swidden	250	-	250
- Semi-settled (swidden) dry-land farming with 2 crops in 3 years	450	150	600
- Settled cultivation (dry-land farming) with conservation measures applied	600	200	800
- Partly irrigation (run-off)	950	1,050	2,000
- Fully irrigation with two crops of rice followed by vegetables	1,900	1,300	3,200
- Fuelwood plantations (in 5 years)	1,680	-	1,680
- Fruit trees without conservation measures	400	-	400
- Fruit trees with conservation measures	500	100	600

Table 8

Implementation Programme/on Yearly Targets for the MHL/Ban Hang Subwatershed

Year		1 ^o	2 ^o	3 ^o	4 ^o	5 ^o	6 ^o
Activities:	Unit						
<u>Forest Management</u>							
reforestation	rai	188	188	-	-	-	-
plantation maint.	rai	-	188	375	375	188	-
forest management	rai	300	300	300	300	300	269
forest protection	guards	2	2	2	2	2	2
fire control	officer	4	4	4	4	-	-
demarcation	100 m.	60	62	-	-	-	-
<u>Soil and Watercon. Management:</u>							
annual cult.	rai	300	400	156	-	-	-
perennial cult.	rai	-	-	300	300	-	-
drinking water s.	No.	-	1	-	-	-	-
dam construction	No.	-	-	-	-	-	1
<u>Horticulture/Past. Management:</u>							
planting	rai	-	-	-	400	200	-
demarcation	100 m.	-	-	-	40	40	-
<u>Road constr. Manag.</u>							
Ban Hang/Pha Nok Kok	km	5	-	-	-	-	-
Ban Hang/Phong Yeang Nai	km	-	-	-	-	-	1

Table 9 (2)

Year	6°		7°		8°		9°		10°		Total
Activities:	Imple- mentation Cost	Adm.	Imple- mentation Cost	Adm.	Imple- mentation Cost	Adm.	Imple- mentation Cost	Adm.	Imple- mentation Cost	Adm.	
<u>Forest Mangt.</u>											
reforest:	-	-	-	-	-	-	-	-	-	-	-
plant. m	-	-	-	-	-	-	-	-	-	-	-
managem.	8,608	-	-	-	-	-	-	-	-	-	-
protect.	-	18,000	-	18,000	-	18,000	-	18,000	-	18,000	-
fire cont.	-	-	-	-	-	-	-	-	-	-	-
demarcation	-	-	-	-	-	-	-	-	-	-	-
	8,608	18,000	-	18,000	-	18,000	-	18,000	-	18,000	-
<u>Soil and W.M:</u>											
annual c.	-	-	-	-	-	-	-	-	-	-	-
per. cul.	-	-	-	-	-	-	-	-	-	-	-
planting&dem	-	-	-	-	-	-	-	-	-	-	-
drink. s.	-	-	-	-	-	-	-	-	-	-	-
dam cons.	121,000	27,300	-	-	-	-	-	-	-	-	-
	121,000	27,300	-	-	-	-	-	-	-	-	-
<u>Ag/Hort/past M:</u>											
extension off.	-	46,800	-	46,800	-	46,800	-	46,800	-	46,800	-
demarcation	-	-	-	-	-	-	-	-	-	-	-
	-	46,800	-	-	-	-	-	-	-	-	-
Road Constr.	170,000	-	-	-	-	-	-	-	-	-	-
<u>Adminstr. M</u>											
Project Coord. and operation	-	-	-	27,000	-	27,000	-	27,000	-	27,000	-
	46,140	70,200	-	70,200	-	70,200	-	70,200	-	70,200	-
Total	345,748	160,300	-	162,000	-	162,000	-	162,000	-	162,000	-
Total per year	506,048			162,000		162,000		162,000		162,000	15,911.708

9.3 Economic Benefits

The analysis of the productivity/net-income values of the different land use types indicates that the benefits accrue with management development programmes by converting:

- unmanaged forest to managed forest;
- swidden to permanent cultivated dry-land agriculture and fruit/crop tree plantations or orchards;
- partially irrigated land to fully irrigated land.

Without forest management the present forest (37 per cent of the sub-watershed) would disappear over, ⁺20 years. Without erosion control, soil losses will continue to increase⁺.

The benefits of the development/management programme are calculated by comparing the value of agriculture and forest products from present unmanaged land with the value of the same products under the recommended management plan. Productivity values for the unmanaged and managed situations are presented in Table 7. By multiplying the productivity values and their costs, even development costs, to the number of rai of each type of land classification (Table 4) the total annual values can be obtained, as illustrated in Appendix 1. and summarised in Table 10.

⁺/ It is demonstrated at Pong Khrai that the erosion rate of 18 tonnes/ha/yr on hilly agricultural fields with a slope of 30 per cent can be reduced by 75 per cent to 5 tonnes/ha/yr, by introducing simple conservation measures which can be applied by the local farmers, when they are supported by incentives in the form of paid labour or cash contribution (compensation). This would result in a reduction of an annual soil loss of $(1315 \times 13) = 2,736$ tonnes of the present area of cultivation in hectares. 6.25

Source: Technical Notes 34, 35 and 36.

Table 10

Total Productivity Values for Without and With Management

(thousand of Baht)

No Management (present situation)With ManagementAnnual ValuesAnnual Values

Year	<u>No Management (present situation)</u>			<u>With Management</u>					
	<u>Output no Management</u>	<u>Costs</u>	<u>Net Value of Output</u>	<u>Present Value</u>	<u>Output Managt.</u>	<u>Costs</u>	<u>Net value of Output</u>	<u>Present Value</u>	
1 ^o	6022	1281 ^{±/}	4741	4741	6013	1073	1281 ^{±/}	3659	3659
2 ^o	5985	1278	4707	4093	6358	1238	1414	3706	3223
3 ^o	5897	1271	4626	3498	6805	1000	1590	4215	3187
4 ^o	5741	1250	4491	2953	6972	982	1656	4324	2843
5 ^o	5549	1248	4301	2459	6935	380	1644	5011	2865
6 ^o	5328	1183	4145	2061	9727	506	1965	7254	3606
7 ^o	5068	1134	3934	1701	10245	162	2079	8004	3460
8 ^o	4827	1091	3736	1615	10245	162	2079	8004	3009
9 ^o	4640	1001	3579	1170	10545	162	2199	8184	2504
10 ^o	4481	1039	3442	978	10545	162	2199	8184	2326
Total				25269					30682

±/ farmers input

I Cost of implementation of project

The economical benefits of the development programme equal the land productivity values with management minus the land productivity values with no management (present situation). Therefore over the 10 year time span the benefits equal Baht 30,682,000 - 25,269,000 = Baht 5,413,000.

During the sixth year of the programme the costs starts to equal the benefits, but to maintain agricultural output at its projected level a continuation of technical staff (project coordinator, forest guards and agriculture extension officer) is necessary for an other three and a half years, making it a 10 year project.

The Project Coordinator may be withdrawn during the seventh year making a contingency budget available for any devaluation of the planned currency and or other unforeseeable expenses.

Calculation of The Benefit -- To -- Cost (B/C) Ratio

The Benefit/Cost ratio has been calculated as follows:-

The total of the present value of gross income with project support minus the total of the present value of total costs (farmers and project) with management minus the total of the present value of the total costs without management.

$$\frac{\text{Benefit}}{\text{Costs}} = \frac{12,649}{7,152} = 1.7$$

Benefit for the farmer or land occupier

If the farmers do like to continue their present operations or activities without any land use improvement concerning the development of their watershed, their average net-income per capita will be reduced by Baht 1,747 to a net income of only Baht 4,615 per year in 10 years time (1981 price).

Should the farmers accept the proposed development plan and cooperate fully towards the implementation programme, participate actively in village development committees, the annual income per capital can be increase to a net return or net-income of Baht 3,093 in 10 years time, together with a security on land (rent-leased or legally registered) for continued maximum crop production to feed their families with the basic food requirements and even more.

"If the farmer can look after the water the soil will look after itself"

10. Conclusion/Recommendations

10.1 Major Technical Implications

1. Approximately 16 per cent of the subwatershed can be considered "critical" from a soil and water conservation point of view. This land is either eroded or still eroding swiddenland, or has slopes greater than 50 per cent, and should receive the highest priority for tree protection and rehabilitation.
2. To provide forest and agricultural needs on a sustained yield basis, no more forest should be cleared for agriculture purposes, it should be properly managed and protected; swidden (upto 35 per cent slopes) should be converted to permanent settled agriculture in accordance with its land capability and suitability, protected with the required soil and water conservation measures to safeguard its resources from erosion and for the (planned) future, so that in the year 2,000 a total population of 1,122 can still be supported.
3. Because of the high rainfall intensities recorded at higher altitudes (greater than 12.5 mm per 30 minutes) and unstable soils on very steep slopes (greater than 50 per cent), all swidden areas or cleared forest land should be replanted with quick growing trees for watershed protection purposes. Erosion from sloping swidden areas, presently recorded at 18 tonnes/ha/yr can be reduced by 75 per cent to within acceptable limits, thereby reducing present soil losses and/or sedimentation of 2,736 tonnes/ha/year.
4. In order to continue or accelerate with land use planning on a semi-detailed scale, with the emphasis on subwatershed level, it would be recommendable to have forms established with codes and symbols (section 4) for easier recording of collected data, and to have a special survey-teams appointed with technicians of various disciplines.

10.2 Major Policy Implications

1. The proposed development plan for the subwatershed, introduced as an integrated package, should be implemented as a whole, and in the sequence of yearly targets as projected in the programme (Table No. 8).
2. Because the major erosion problems and land misuse occurring in the forest, and cleared forest areas (swidden), the Division of Watershed Management within the Royal Forest Department should be the leading agency in the implementation programme.

3. A policy of hiring and training local individuals as junior technical assistants, to carry out extension and management activities for the Division of Watershed Management, should be initiated.
4. Cooperation and coordination on land use practices and development policies with other agencies (e.g. HAMP project, District authorities and administration Office) is essential, this task should be allocated to the appointed Senior Technical Officer, who is also the Project Subwatershed Coordinator.
5. Villagers, through their village development committees (VDC), supported through the Subwatershed Development Committee (SDC), would be legally linked-up with the Tambon Assembly and directly to the District Authorities. They should manage their own forest resources. A programme is recommended which would protect and manage existing forest land (37 per cent of the subwatershed) and would convert an additional 8 per cent of the subwatershed (now in swidden) to Village Protection Forests for fuelwood. The Subwatershed Development Committee, as a legal body, should eventually be in a position to manage their forest, agriculture and water resources.
6. It is recommended that semi-detailed integrated area development be carried out in the framework of a subwatershed and that both physical and human resources development be included in a coordinated manner in these activities. Special attention should be paid to the adequate development of all components of infrastructure to make physical and human resources effective and improve the rural environment.

10.3 Specific Implications

The proposed integrated management programme for the subwatershed of Huai Mae Langum/Ban Hang is visible and economical, and can serve as development model on land use planning for many areas within the Mae Sa Project and the Northern Regions of Thailand as well, providing the sociological constraints can be overcome. The best, and possibly, the only way to convince people or farmers within the planned physiographical areas to accept the processes of land degradation, ecological imbalance and human impact on erosion and sedimentation, is to accept and respect each other. The same applies to the Government Agencies, specially the Royal Forest Department, in accepting the farmers within the Government Land (Reserve).

Land occupiers (legally or illegally), by being grouped together into Village Development Committees (VDC), will have a much better chance to be recognised or heard, to have their wishes or desires implemented, committees can improve relations with the Authorities and give the peasant farmers a sense of greater security.

Successful development of the subwatershed of Huai Mae Langum/Ban Hang is for its major part dependent on the support of all its occupiers, thereby stressing the direct involvement, participation, cooperation, coordination in all social aspects and the acceptance, and tolerance of each other. Next to the economic benefits, it may prove to be the answer in solving the ecological and sociological problems of the inhabitants by granting the occupiers a security in the form of rental-lease agreement.

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If the basic requirements in food and security of its population can be guaranteed and preserve the ecological balance can be maintained, as outlined in this plan. The government should fulfill their obligations to this development plan by accepting it to finance and to reformulate their regulations to make it a combined success. There is a need for appropriate types of technical development of soil and water resources, (the economic burning of fuelwood etc.), but also into the resulting of necessary social changes which must accompany such development. In the past, technical developments tended to ignore the social and economic structure. Innovations need to fit existing structures or cause the minimum disruption. The successful dissemination of land use development on subwatershed basis will depend on an effective political and administrative framework which allows the transmission of change from the central government to the local or "grass-roots" level. Effective transmission of the views of the peasant farmer up through the hierarchy is just as important if any change is to be successful. When innovations are introduced at the local grass-roots level, the people are perhaps more likely to be motivated and willing to engage in self-help projects as the installation of a drinking water scheme.

10.4 Special Conditions:

- If, during the first year of implementation of the development programme, no full cooperation, coordination and/or participation of local villagers is noticeable, in the formation of established workable Village Development Committees and Subwatershed Development Committee, no further planned work for the coming years (see Table No. 8) should be carried out.
- Royal Forest Department should transfer the management activities of all its forests to the Subwatershed Development Committee, which will become responsible for all its activities under a hand-over rent-lease agreement through the District Government Office (any revenue will be used towards an agricultural revolving funds).
- All land claimed by the individual farmers and/or occupiers should be legally registered within the first six months through the established Subwatershed Development Committee, by the Land Survey Department and possibly supported by a location map.
- All swidden land, cultivated or not, within the Government Forest Reserve, allocated to be suitable for annual or perennial cropping, should be issued with a rental-lease agreement from RFD, within six months after the areas have been protected with the required conservation measures and cropping practices.
- No land without the written agreement of the SDC, through the District Office, can be sold or transferred to people outside the subwatershed.

- No refund of development-expenditure will have to be paid back to the Government, only hospitality will be expected from its people when visitors from other areas will tour their subwatershed, as the Huai Mai Langun Subwatershed will serve as a model for future Integrated Subwatershed Management/Development.
- An evaluation mission (survey) has to be carried out by an independent body to study the effects of the implemented programme together with the improvements on socio-economic matters.
- Reallocation of land should be left to, and be solved by the Subwatershed Development Committee, to meet the needs of the inhabitants.
- The RFD has to accept that people utilize the forest for their own need, but in accordance with the approved management plan.

The people within the forest should accept and respect the forest as a National Protection Forest, belonging to the nation as a whole.

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Detail productivity values for with. Management

on Land Use

(in thousand of Baht)

FOR WITH

Year	Full irrig.		Part Irrig.		Rainfed Cons.		Swidden		Forest	Fuel wood	Fruit		Total
	rai	4,200	rai	2,800	rai	1,300	rai	370	rai	3,300	rai	1,000	
1°	30	126	358	1,002	600	780	647	239	1,770	3,737	225	158	6,013
2°	30	126	358	1,002	900	1,170	500	185	1,770	3,717	225	158	6,358
3°	30	126	358	1,002	1,300	1,690	300	111	1,770	3,717	227	159	6,805
4°	30	126	358	1,002	1,456	1,893	200	74	1,770	3,717	228	160	6,972
5°	30	126	358	1,002	1,456	1,893	100	37	1,770	3,717	229	160	6,935
6°	30	126	358	1,002	1,456	1,893	50	18	2,144	6,528	230	160	9,727
7°	313	1,314	75	210	1,456	1,893	0	-	2,144	6,528	300	300	10,245
8°	313	1,314	75	210	1,456	1,893	-	-	2,144	6,528	300	300	10,245
9°	313	1,315	75	210	1,456	1,893	-	-	2,144	6,528	600	600	10,545
10°	313	1,314	75	210	1,456	1,893	-	-	2,144	6,528	600	600	10,545

Cost values of with management

(thousand of Baths)

Admist year	rai	1,000	rai	800	rai	500	rai	120	rai	300	rai	250	Total	
										450		1,100		
1°	7,073	30	30	358	286	600	300	649	78	1,770	531	225	56	1,781
2°	1,238	30	30	358	286	900	450	500	60	1,770	531	226	57	1,414
3°	1,200	30	30	358	286	1,300	650	300	36	1,770	531	227	57	1,590
4°	982	30	30	358	286	1,456	728	200	24	1,770	531	228	57	1,656
5°	380	30	30	358	286	1,456	728	100	12	1,770	531	229	57	1,644
6°	508	30	30	358	286	1,456	728	50	6	2,144	858	230	57	1,965
7°	162	313	313	75	60	1,456	728	0	-	2,144	858	300	120	2,079
8°	162	313	313	75	60	1,456	728	-	-	2,144	858	300	120	2,079
9°	162	313	313	75	60	1,456	728	-	-	2,144	858	600	240	2,199
10°	162	313	313	75	60	1,456	728	-	-	2,144	858	600	240	2,199

66
Detailed productivity values for without Management
on Land Use
(in thousand of Baht)

WITHOUT

Year	Full irrig.		Part Irrig.		Rainfed Cons		Swidden		Forest seed wood		Fruit T.		Total Income
	rai	4,200	rai	2,800	rai	1,300	rai	370	rai	2,100	rai	700	
1° (1981/ 1982)	30	126	358	1,002	600	780	647	239	1,770	3,717	225	158	6,022
2°	30	126	355	994	610	793	640	239	1,750	3,675	226	158	5,985
3°	30	126	350	980	640	832	620	230	1,700	3,570	227	159	5,897
4°	30	126	340	952	660	858	600	222	1,630	3,423	228	160	5,741
5°	29	122	320	896	680	884	570	211	1,560	3,276	229	160	5,549
6°	29	122	300	840	700	910	540	200	1,474	3,095	230	161	5,328
7°	28	118	260	728	720	936	500	185	1,400	2,940	230	161	5,068
8°	27	113	230	644	740	962	470	174	1,320	2,772	232	162	4,827
9°	26	109	210	588	760	988	450	166	1,250	2,625	234	164	4,640
10°	26	109	200	560	780	1,014	420	155	1,180	2,478	235	165	4,481

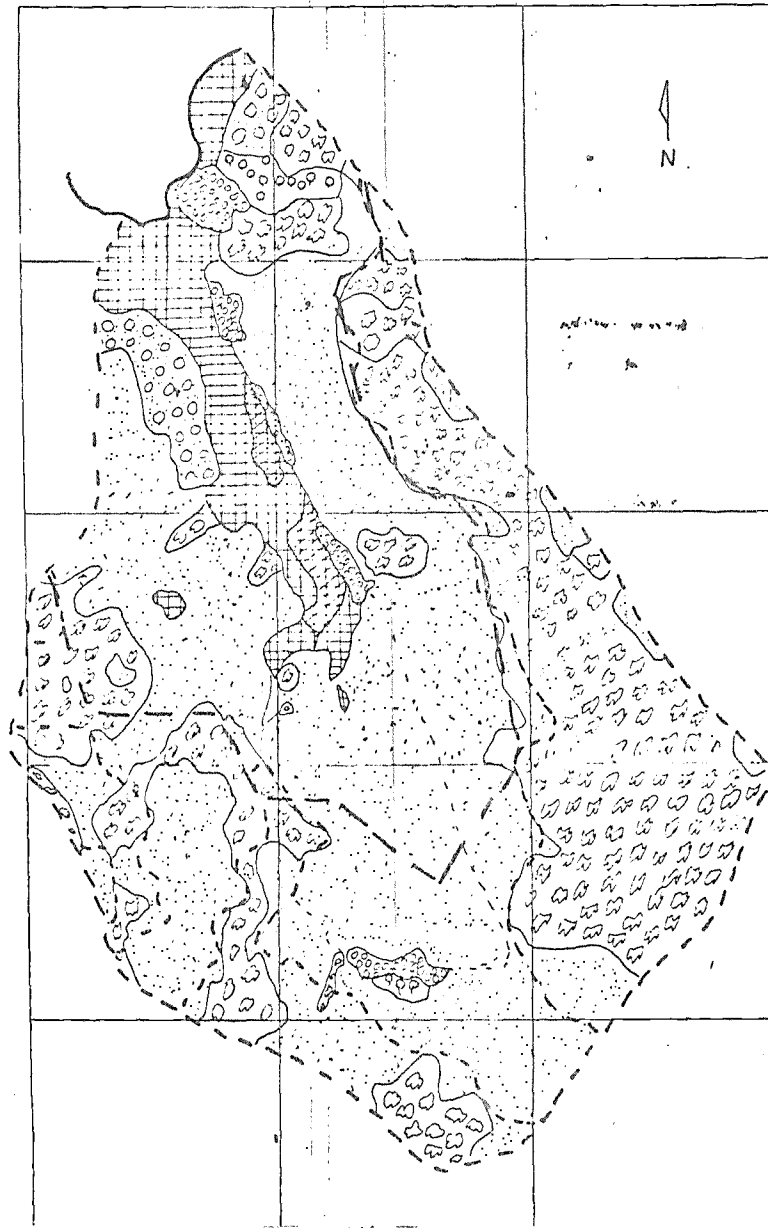
Cost values of without management (thousand of Baht)

Year	rai	1,000	rai	800	rai	500	rai	120	rai	300	rai	250	Total
1° (1981/ 1982)	30	30	358	286	600	300	647	78	1,770	531	225	56	1,281
2°	30	30	355	284	600	305	640	77	1,750	525	226	57	1,278
3°	30	30	350	280	640	320	620	74	1,700	510	227	57	1,271
4°	30	30	340	272	660	330	600	72	1,630	489	228	57	1,250
5°	29	29	320	256	680	340	570	68	1,560	468	229	57	1,218
6°	29	29	300	240	700	350	540	65	1,474	442	230	57	1,183
7°	28	28	260	208	720	360	500	60	1,400	420	230	58	1,134
8°	27	27	230	184	740	370	470	56	1,320	396	232	58	1,091
9°	26	26	210	168	760	380	450	54	1,250	375	234	58	1,061
10°	26	26	200	160	780	390	420	50	1,180	354	235	59	1,039

MAP No. 1

แผนที่ลุ่มน้ำห้วยแม่ละgun

PRESENT LAND USE CATEGORIES IN THE
HOUI MAE LANGUN/BAN HANG SUBWATERSHED
การใช้ประโยชน์ที่ดิน



มาตราส่วน 1 : 15,000

Symbol

FN



ป่าธรรมชาติ
Forest Natural

M



เมี่ยงในป่าธรรมชาติ
Miang Tea under forest

FT



ไม้ผล
Fruit Trees

FI



นา(ตลอดปี)
Fully Irrigated Rice Fields

Symbol

RI



นา
Irrigated Rice Fields

S



ไร่
Swidden

R



หมู่บ้าน
Residential Area

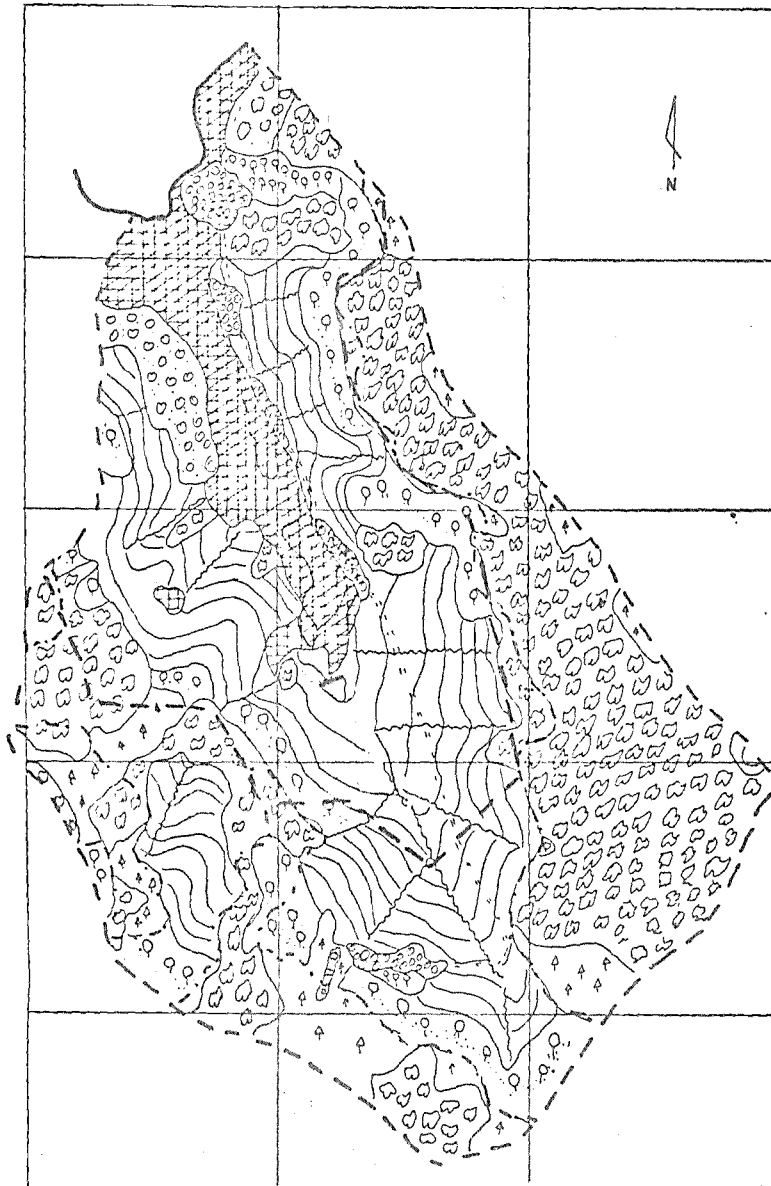
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







ป่าสงวน
Government Forest Reserve

แผนที่ลุ่มน้ำห้วยแม่ละgun

PROPOSED LAND USE PLAN FOR THE
 HOU MAE LANGUN/BAN HANG SUBWATERSHED
 แผนการใช้ประโยชน์ที่ดิน

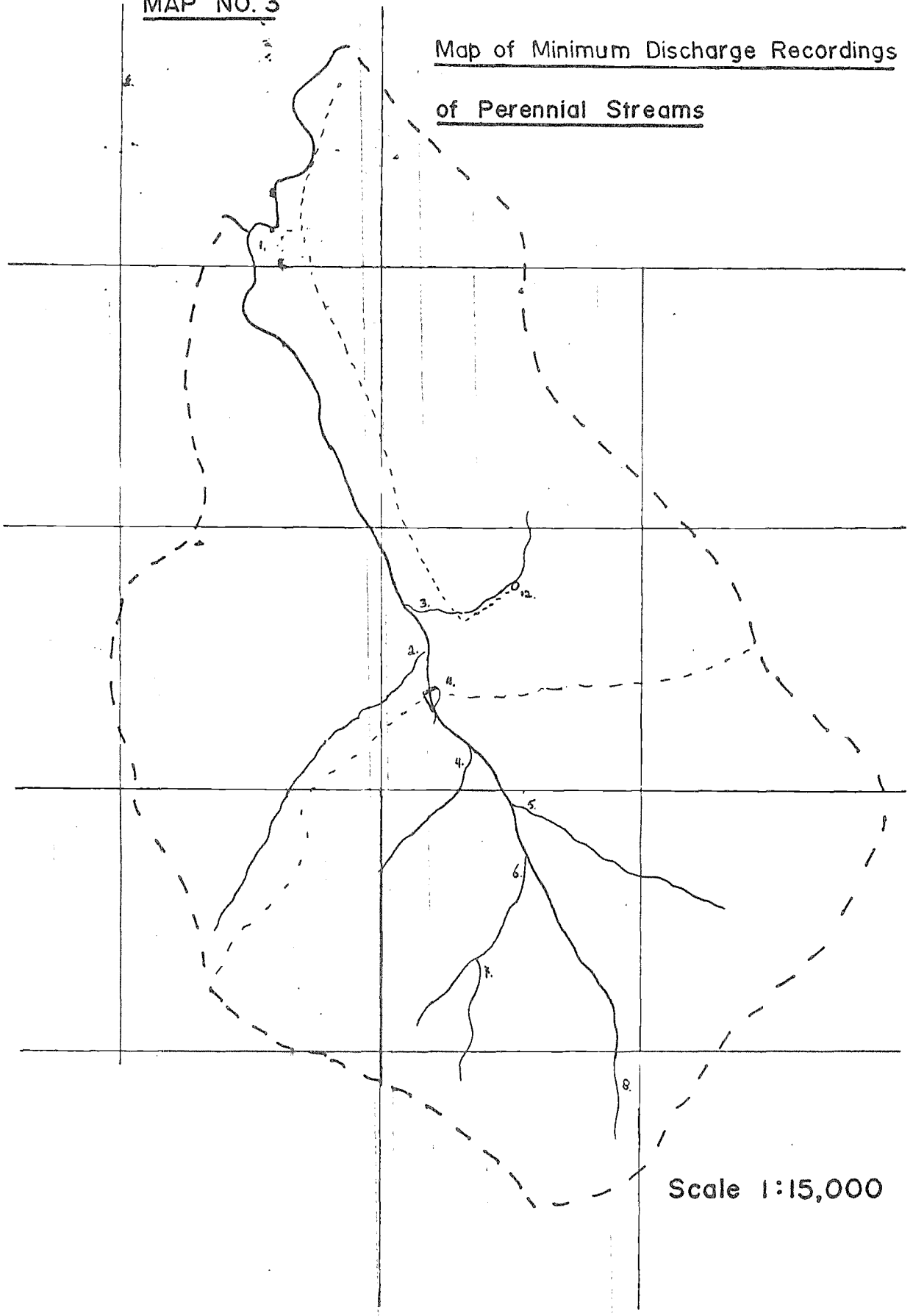


มาตราส่วน 1 : 15,000

Symbol		Symbol	
FN	 ป่าธรรมชาติ Forest Natural	S/F	 ไร่ที่จะเปลี่ยนเป็นสวนป่า Presently Swidden allocated for Forest
FT/P	 ไม้ผลที่เป็นอยู่ในเวลานี้กับทุ่งหญ้า Exist. Fruit Trees With Pasture	S/FT/P	 ไร่ที่จะเปลี่ยนเป็นสวนไม้ผล กับทุ่งหญ้า Presently Swidden allocated for Fruit Trees With Pasture
MT	 สวนชาที่ลงเสริมให้ดีขึ้น Improved Tea	S/SA	 ไร่ชั่วคราวที่จะเปลี่ยนเป็นไร่ประจำ Presently Swidden allocated for Settled Agriculture
RI	 ไร่ข้าวประจำ Rainfed Irrigated Rice Fields	D	 แหล่งน้ำ Dam for irrigation


MAP NO. 3


Map of Minimum Discharge Recordings
of Perennial Streams



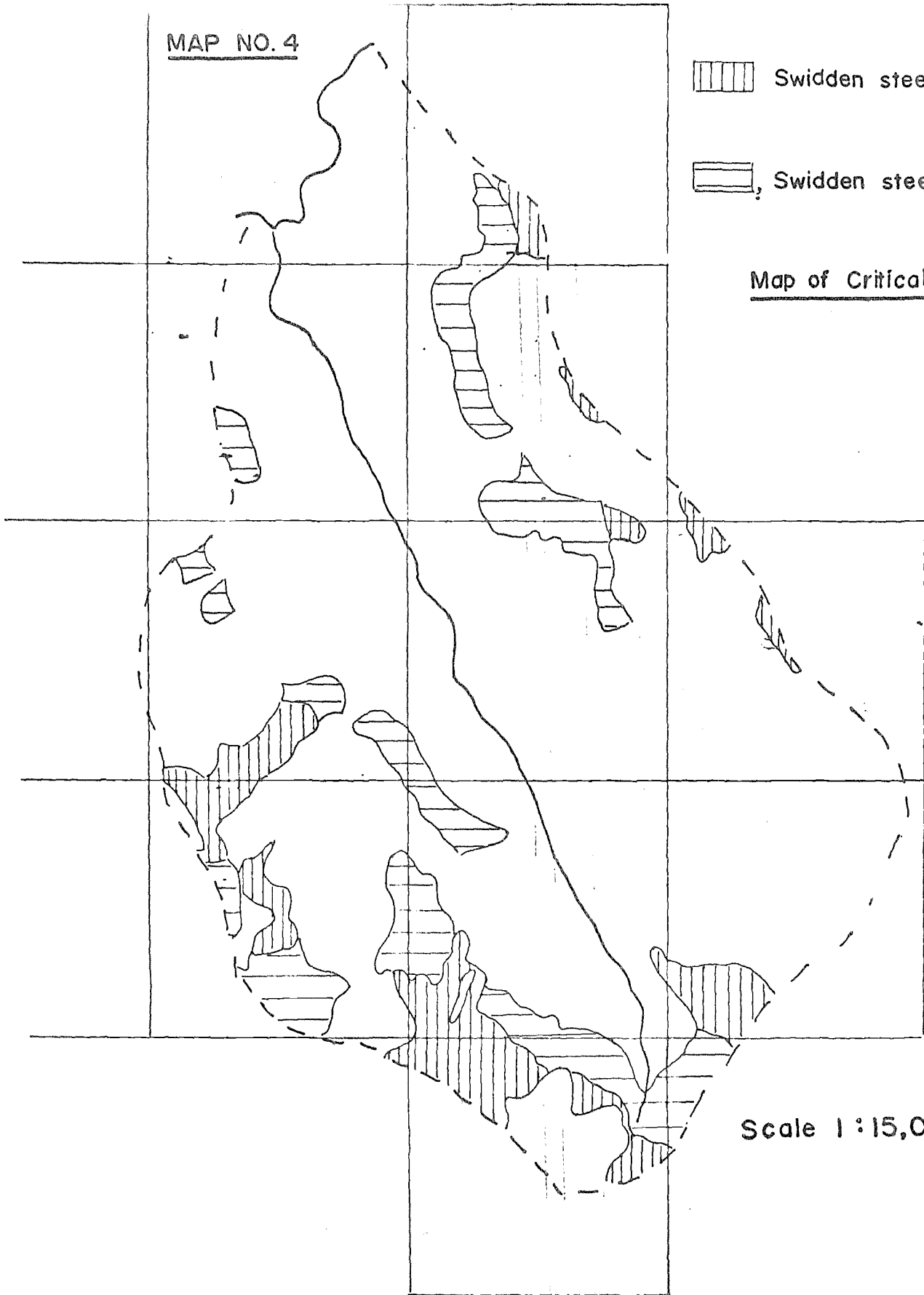
Scale 1:15,000

MAP NO. 4

 Swidden steeper than 50%

 Swidden steeper than 35%

Map of Critical Areas



Scale 1:15,000