REPORT
ON
AERIAL PHOTOGRAPHY AND FOREST MANAGEMENT PLAN IN THE ENCROACHED NATIONAL RESERVE FOREST
IN
THE KINGDOM OF THAILAND

MARCH 1988

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

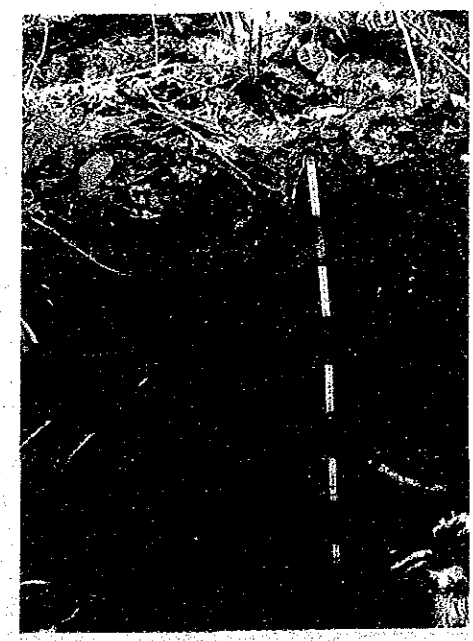
Prospect of the model area

Natural forest encroached by shifting cultivation

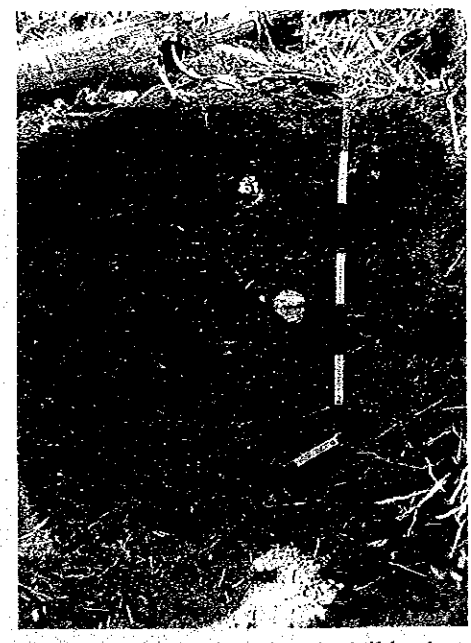
A typical farmers' house in the model area

Scene on the field survey by interview

(Survey on the Forest Villages and Tropical Farming)



Highly productive Nitosols is distributed in the flat land.
[Soil profile of Eutric Nitosols (Ne-s)]



Cambisols is distributed in the hill land zone.
[Soil profile of Eutric Cambisols (Be-c)]

Mixed deciduous forest (MD)
has a wide distribution in the model area.

Tropical evergreen forest (TE)
is distributed mainly in the flat land.

Deciduous dipterocarp forest (DD)

Bamboo forest (BF)

Teak (*Tectona grandis* L.) artificial forest
[Stand age 4 years, Planted by RFD]

Eucalyptus camaldulensis DEHN. • *Melia azedarach* L.
artificial forest (Fast growing species)
[Stand age 3 years, Planted by FIO]

PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan has decided to conduct a survey on the project for the development of aerial photography and forest management plan in the encroached national reserve forest in Thailand and entrusted the survey to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a survey team headed by Dr. Mitsuma Matsui representing a Japanese joint venture in charge of the said survey several times in the period from December 11, 1985 to December 24, 1987.

The team had discussions on the project with the officials concerned of the Government of Thailand and conducted field survey in the project area. After the team returned to Japan, further studies were made and a draft report was prepared and a mission to explain and discuss it was dispatched to Thailand. As a result, the present report has been prepared.

I hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the teams.

March, 1988

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

ABBREVIATION

Item	Abbreviation	Explanation
Organi-zations	RFD	Royal Forest Department
	RTSD	Royal Thai Survey Department
	FIO	Forest Industry Organization
	JICA	Japan International Cooperation Agency
Projects	FV	Forest Village Project
	STK	Sor Tor Kor Project
Units	ha	hectare(s), 1ha=6.25rais
	G. B. H.	Girth Breast Height (cm)
	T. H.	Total Tree Height (m)
	C. L.	Clear Length (m)
Forest type	TE	Tropical Evergreen Forest
	MD	Mixed Deciduous Forest
	DD	Deciduous Dipterocarp Forest
	BF	Bamboo Forest
	SF	Secondary Forest
Tree species	teak	*Tectona grandis* L.
	eucalyptus	*Eucalyptus camaldulensis* DEHN.
Planning Area	KBR	Kanchanaburi

CONTENTS

LIST OF FIGURES AND TABLES

SUMMARY

1. Background and Objectives of the Study

Forest area in Thailand is decreasing rapidly these days. If it is allowed to continue, it is obvious that this situation will affect the land conservation and socio-economic development plans seriously.

Forest destruction by the slash and burn agriculture of farmers within the national reserve forest is thought to be one of the contributory factors in the depletion of the forest. In order to obtain guidelines of countermeasures against this, an aerial photographic survey was carried out over a study area covering 2 million hectares. A model area of 20,000 hectares in the study area was established and the forest management plan was formulated.

2. General Situation

① The objective area for aerial photography covers 2 million hectares extending over 5 provinces, which consist of Tak, Utai Thani, Kampheng Phet, Suphan Buri and Kanchanaburi, in the western part of the central region of Thailand adjacent to the border with Burma.

② The model area of approximately 21,647 hectares for the formulation of the national reserve forest management plan was selected in Logging Block No. 1 to 5 of the KBR No. 3 Planning Area covering 86,700 hectares approximately under the supervision of the Ban Pong Regional Forest Office.

The model area was divided into 2 working areas as follows.

i) Khao Praleusri Bor Rae Working Area	8,898 ha
ii) Srinagarind Working Area	12,749 ha

③ A soil profile survey was carried out at 89 spots and the simplified survey was added in order to decide on the distribution boundaries of classified soils. As a result it was found that outcropping rocks and boulders are found in the steep mountainous zone which is distributed with Lithosols (I) and Rendzinas (E) of quite shallow layers. The hill land zone is distributed with Cambisols (B) and Luvisols (L) while the flat land zone is distributed with highly productive Nitosols (N) with thick soil layers.

④ According to the geological map of Thailand, lime stone is basically distributed.

⑤ The climate of the study area is that of mountainous areas, with a cool dry season and in the valleys of a tropical monsoon climate with long rainy season (6.5-8 humid months).The annual average rainfall is between 900 mm and 1,450 mm (by the Srinagarind Dam Met. Office, 1981-1985). The rainy season is recorded during May through October.

⑥ The total population of the Province of Kanchanaburi amounts to 607,171 persons with the population density of 31.16 persons/㎢. That of the Amphoe of Thong Pha Phum and Si Sawat where the KBR No. 3 Planning Area is located is 26,310 persons.

⑦ The KBR No. 3 Planning Area is situated between the Mae Klong River (Mae Nam Mae Klong) and the Khwai Noi River (Mae Nam Khwai Noi) which feed the Srinagarind Dam and the Khao Laem Dam respectively.

⑧ The KBR No. 3 Planning Area is located approximately 100 km to the north-west of Kanchanaburi, which is the provincial capital and is located approximately 126 km to the north-west of Bangkok, the capital of Thailand.
Access from the city of Kanchanaburi to the model area can be made via the national road No. 323 which goes through Thong Pha Phum, or the provincial road 3199 which go through the Erawan National Park.

3. Basic Survey and Main Survey

① The situation of land use in the province of Kanchanaburi (including a total area of 19,483㎢) is that the forest area (12,125 ㎢ occupying 62.2 % of the total area) is well left compared with the forest ratio of 30 % for the whole country. The speed of deforestation, however, tends to have accelerated recently. (Refer to Table 4-1 and Table 4-2 in the report).The whole model area of 21,647 ha belongs to the national reserve forest area and consist of the following land uses : forest area 19,899 ha (91.9%), left-over area 1, 096 ha (5.1%), farm land and grass land 479 ha (2.2 %), bare land 107 ha (0.5 %), river and others 66 ha (0.3 %), at present.

The table below shows the contents of the forest area of 19,899 ha.

(Unit: ha)

Working Area / Forest Type	Khao Praleusri Bor Rae	Srinagarind	Total
Tropical Evergreen Forest (T_E)	497	1,050	1,547
Mixed Deciduous Forest (M_D)	7,509	10,109	17,618
Deciduous Dipterocarp Forest (D_D)	0	427	427
Secondary Forest (S_F)	101	79	180
Bamboo Forest (B_F)	60	67	127
Total	8,167	11,732	19,899

② In order to clarify the actual state of the forest an inventory was executed by means of sample plots (250 m × 40 m each), which were set up with 50 plots inside and 12 plots outside the model area, a total of 62 plots. The findings are mentioned in brief as follows.

It was found that forest type T_E is distributed mainly on flat land, and M_D and D_D are widely distributed in the whole model area. Tree species composition findings were that DIPTEROCAR-

PACEAE trees amount to 48 % in D_D, and bamboo is widely distributed. The number of saplings by forest type was found to be 17,645 trees/ha in T_E, 12,875 trees/ha in M_D and 16,768 trees/ha in D_D.

③ The results of the survey on the forest villages and tropical farming show that there are about 100 families living in nine villages which amounts to 500 inhabitants. The average living space is 0.7 rai per family. The average area of farmland is 15.6 rais per cultivating farm household. The annual consumption of solid wood for fire wood and charcoal per capita is 0.705 m³.

The average annual cash income of all the families surveyed is 9,520 bahts, consisting of 4,530 bahts from the sales of farm products and 4,990 bahts from non-farm employment. On the other hand, the average cash income of FV and STK is 24,280 bahts, consisting of 12,410 bahts from sales of farm products and 11,870 bahts from non-farm employment, which amounts to approximately 2.4-2.7 times as much as the said income (refer to Table 4-7 in the report).

Note : 1. 1 rai = 0.16 ha
2. 1 baht = 5.5 yen (1987)

4. Site Analysis and Land Use Classification

Land type classification, land use capability classification and land use classification were carried out and established based on topographical analysis of altitude, aspect of slope, gradient, microtopography and valley density. (Also taken into consideration were other basic factors such as climate, geological structure, macrotopography, forest types and soil types.

Conclusively land use capability classification by agriculture, forestry and livestock raising could be evaluated by the 2 factors of soil type and gradient. This was because the model area wasn't very large and its quality in view of the infrastructural factors was not very diversified.

Table of the Judgement of Land Use Capability for Agriculture, Forestry and Livestock Raising

Soil type	Division	Gradient						
		~5°	6~8°	9~13°	14~18°	19~23°	24~30°	31°~
Ne	A	1	1	3		×	×	×
	F	1	1			2	3	×
	L	1	1		2	3	×	×
Be-c	A	1	2		3		×	×
	F	1	1		2		3	×
	L	1	1			2	3	×
L_V. Be-r	A	2		3		×	×	×
	F	2	2			3	×	×
	L	2	2			3		×
E·I	A	3	3		×	×	×	×
	F	3	3			×	×	×
	L	3	3				×	×

(Note) Suitability for agriculture(A), forestry(F) and livestock raising(L)
1 : Large, 2 : Medium, 3 : Small, × : Unsuitable

Land classification was established on the basis of a land use priority rating in view of agricultural, forestry and livestock production purposes taking the socio-economic conditions into consideration. This was in order to further elaborate the suitability classes of the land, based on the natural conditions of the site. The land use classification was then determined on the basis of the land classification shown as follows.

(Unit: ha)

Land capability classification	Land use classification	Acreage within the model area
Agriculture 1 Forestry 1 A_1F_1 Agriculture 2 Forestry 1 A_2F_1 Agriculture 2 Forestry 2 A_2F_2	Expressed by AF Suitable for both forestry and agriculture	3,779
Agriculture 3 Forestry 1 A_3F_1 Agriculture 3 Forestry 2 A_3F_2 Agriculture 3 Forestry 3 A_3F_3 Agriculture 0 Forestry 1 A_0F_1 Agriculture 0 Forestry 2 A_0F_2 Agriculture 0 Forestry 3 A_0F_3	Expressed by F Suitable for forestry	8,147
Agriculture 0 Forestry 0 A_0F_0	Expressed by NANF Unsuitable for both forestry and agriculture	5,424
Conservation of mountainous forest and basin conservation forest	Preserve area	4,297
Total		21,647

5. National Forest Management Plan

(1) Forest land use plan

① Basic policy for preparation

The purpose of formulating a national forest management plan in the model area is to highly upgrade and harmonize the various functions of the forest ; functions such as sustainable production of timber, environment conservation, erosion control,water source, scenic beauty, etc. The main items of the model area will be summarized as follows.

1) The increase the productivity of the natural forest.
2) Certain amounts of the area will be converted to artificial plantation to increase the production of timber.
3) To establish the settlement of the farmers illegally living in several parts of the forest.
4) Settled farmers will be mobilized to assist in the establishment of the plantations.
5) Those farmers thus familiarized with forestry will be expected to make good partners in the conservation of forests.

The following basic policy has been determined.

i) In principle, forest areas shall be excluded from agricultural land use.

ii) Reforestation efforts shall be introduced as soon as possible at such sites as farmland, poorly regenerated natural forest and bare land in forest areas.

iii) Due consideration shall be given to the protection of forests, including national parks and those required for the conservation of mountains and river basins.

iv) Those forests designated as reference forests in view of their importance in terms of ecology and those required for the preservation of genes shall be protected.

v) The boundaries of existing rights shall be clarified.

vi) The Forest village Plan shall be promoted in addition to the promotion of the relocation of those farmers scattered in national reserve forests in order to form local communities of an appropriate size.

vii) Reforestation and the conservation of forests shall be promoted in forest areas by introducing agroforestry in appropriate areas.

viii) Coordination with the existing plan of the Royal Forest Department (RFD) shall be promoted.

The model area of 21,647 ha is classified into the following forest land types based on the survey results of the site analysis and the basic policy for planning as shown on the table below.

Forest Land Type and Acreage

(Unit: ha)

Forest land use classification	Forest land type	Purpose of utilization	Acreage		Remarks
Forestry Area	Artificial forest	Area for timber production by artificial forest works	*1,614	6,065	
	Natural forest	Area for timber production by selective cutting method	*1,206		
	Bamboo forest	Area for bamboo production by bamboo forest works	17		
	Reserved forest	Reserving area for forest works in future	900		
	Left-over area, etc.	Unsuitable area for forest works, etc.	2,328		
Agroforestry Area	Artificial forest	Area for timber production by artificial forest works	*510	911	
	Communal forest	Area for fire wood production	30		
	Farming land	Area for cultivated land, housing & public facilities	270		
	Bamboo forest	Area for bamboo material	29		
	Natural forest	Reserving forest	72		
Preserve Area	National park	Area for national park in model area	12,749	14,671	Including river
	Conservation area	Area for conservation of mountainous forest & basin conservation forest	1,922		
Total			21,647	21,647	

* including forest road, fire break and left-over area.

(2) Forestry area plan

This plan deals with the 6,065 ha of forestry area described in forest land use.

① Sustained yield

The KBR No. 3 Planning Area of approximately 87,000 ha, including the model area, is considered as one subject area. This is due to the model area in itself seeming to be too small for the idea of sustained yield to be applied.

This subject area for the sustained yield calculation was divided into 3 units, i.e. artificial forest work units inside and outside the model area and natural forest work units.

② Standard of working method

Artificial forest work should be carried out with careful consideration to the conservation of the natural environment.

The planting sites within the model area will be selected from those sites which are classified as F_1 and/or F_2 (including part of F_3) and also classified as having a soil type of N_e, B_e, B_g and/or L_v when the forest condition is poor after selective felling or land that is bare.

A single tree selective cutting system for natural forests with a usable stand volume of up to 20% will be introduced with a cutting cycle of 40 years. Depending on the forest type, forest improvement work by under-planting will be carried out. The natural forest work sites in the model area will be selected from those sites which are classified as either F_1, F_2 and/or F_3 and have a soil type of N_e, B_e, B_g and/or L_v (including parts of E and I).

The bamboo forest management will be basically selected on those sites which are classified as the B_F type rich in good bamboo trees.

③ Standard yield

The calculation methods to determine the standard yield are made taking the feasibility of the relevant work into consideration using both the area allotment method and the volume-period method as a rule because of the absence of accurate growth data. In the case of natural forest work, the yields could not be designated in the first working period since the concession had already finished felling and the stand volume has not been recovered yet.

The total yield of natural trees felled on the land designated as the artificial forest work sites and that of newly created artificial forests

(fast growing tree species) is calculated as the yield for the first working period (10 years).

The yields for this period assuming an annual plantation area of 64 ha (32 ha teak, 32 ha eucalyptus) are shown as follows.

Yield from Natural Forest	61,184 m³
Yield from Artificial Forest	22,560 m³
Total	83,744 m³

The plantation is planned to be completed in 30 years.

Note: The yield from the natural forest includes not only the useful tree species but also others.

④ Planting tree species, final felling age, cutting cycle

Teak has been chosen as the main commercial tree species with a rotation period of as long as 50 years.

In order to supply chip, firewood, charcoal and simple construction materials in a short period, a rotation period of 5 years has been decided for a fast growing species assuming 2 times of coppice rotation for each reforestation.

A cutting cycle of 40 years and a felling ratio of 20 % areassumed for the natural forest where selective cutting methods are to be used.

(3) Agroforestry area plan

This is the plan for agroforestry area of 911 ha designated in the forest land use classification.

54 households (71 households including those outside the model area) have already been located in the agroforestry area (AF), forming is an independent local community. Though most of them have no land use right, the establishment of such places as the Forest Village was planned in order to invite the scattered families into the present community area. This will cease further destruction and depletion of the forests through the initiation of the agro-silviculture system by those farmers.

The Forest Village Plan aims for the permanent relocation of the scattered farmers in the national reserve forest, to the present community area.

The Forest Village is planned in part of Compartment 1 and 3. The area which is planned to accommodate 100 households comprises of 240

ha (1,500 rais) of residential and farming area and 30 ha of public facility site.

In the communal firewood forest of 30 ha, the planting species of tree will be *Eucalyptus* sp. with a cutting age of 5 years and the successive 5 years of rotation by coppicing will be repeated twice.

The necessary areas for each item of the Forest Village area shown as follows.

Item	Acreage (ha)	Remarks
Residential plot and farm land	240	Residential plot per family 0.5 ~1.0 rai, Farm land per family 14.0 ~14.5 rais, Total 15.0 rais (2.4ha)
Public institution plot	30	Roads 15 ha, Structures 15 ha
Sub-total	270	
Bamboo forest	29	To supply bamboo for inhabitants
Communal forest for fuelwood	30	To supply fuelwood for inhabitants
Natural forest	72	To remain as natural forest for reserve land
Sub-total	131	
Total	401	

Reforestation activities in the agroforestry area will be implemented by planting after clear cutting and intercropping between planting rows.

The planting species will be teak which has a long cutting period and the fast growing *Eucalyptus* sp. The annual reforestation area will be 32 ha for teak and 32 ha for eucalyptus, totalling 64 ha.

The area of agrosilviculture is 510 ha consisting of 320 ha of reforestation area by teak, 160 ha by eucalyptus and 30 ha are allotted for forest roads, fire breaks and others.

The spacings for each species area 4 m × 3 m and 4 m × 4 m for teak and 4 m × 2 m and 8 m × 2 m for eucalyptus.

(4) Conservation area plan

This is the plan for a conservation area of 14,671 ha designated in the forest land use classification.

This conservation area is divided into a national park area, and a land and water conservation area (a mountain conservation area and water basin conservation area) outside the national park.

① National park area

12,749 ha of the southern half of the model area belongs to the Srinagarind National Park. As felling and the conversion of forest land to farmland are prohibited within national parks, positive forestry activities will not be executed in this area. However the following exceptions apply i.e., the rehabilitation of land in bare condition at present, construction of roads and public facilities for the utilization of the national parks, provision of notice boards and signs and the setting up of research forests.

② Land and water conservation area

The mountainous area in the east of the model area will be designated and preserved with no operation since it is located directly in the upstream area of the Srinagarind Dam and has steep slopes.

1.0 INTRODUCTION

1.1 Background of the Study

In Thailand the forest area of the country was 273,600km^2, accounting for 53.3% of land area in 1961, but in 1985, it had been reduced to 149,100 km^2, 29.0% of the country's land area. A forest area, as large as 124,500 km^2, that accounted for 45.5% of the country's forest area has been lost in the last 25 years. If it is left unattended, a forest area of 6,000 km^2 is bound to be lost annually in future.

From the viewpoint of land preservation and socio-economic development planning, the decrease of forest is a serious influence. The prevention of forest destruction and the rehabilitation of forest are rapidly becomming critical problems.

This rapid decrease is primarily attributed to the unrestrained destruction of the forest by the field-burning agriculture that is practiced by the farmers who have been illegally entering the national forests.

Thailand has incorporated countermeasures against the intruding farmers in order to advance the Forest Village Plan, through the practice of agroforestry, thus bringing together and setting the intruding farmers who live dispersed throughout the forest. (The 4th Socio-economic Development Plan in 1979-1981)

In the 5th Socio-economic Development Plan (1982-1987), the Sor Tor Kor Plan has been adopted, while the Forest Village Plan continues to the advance. The prerequisite for making both plans successful is execution of reasonable classification of land use and the formulation of forest management plans.

1.2 Objectives of the Study

The objectives of the study are to take aerial photographs of the study area, and formulate a forest management plan for the intensive study area.

1.3 Study Area

The study area lies in the western part of the central region of Thailand adjacent to the border with Burma and covers an area of two million hectares extending over five provinces of Tak, Utai Thani, Kampheng Phet, Suphan Buri and Kanchanaburi, including the model area of twenty thousand hectares established in the selected zone of the model area (86,700 ha of KBR №3 Planning Area under the control of the Ban Pong Regional Forest Office). (Refer to Fig. 1−1∼2)

In order to formulate the forest management plan as each forest work plan, the model area was selected in a place consisting of three kinds of forest land by use and state (encroached area, logging operation area and preserve area), with different site conditions, uses and forest conditions. (Refer to Fig. 1−3)

1.4 Basic Policy for the Study Execution

The present study was executed in accordance with the Scope of Work concluded by and between the Japan International Cooperation Agency (JICA) and the Royal Forest Department (RFD) of the Government of the Kingdom of Thailand in July, 1985. The detailed contents of the study had been discussed in consultation with the RFD staff.

In particular, the formulation of the forest management plan takes into consideration the handling of settlement in the model area.

Although the study team examined on measure to freeze the present state of the encroachment and to improve forest condition through reforestation work with a view to prevent new settlement, the RFD expressed that any residence in national reserve forest without possessing a certificate would be illegal.

As a result of discussion and consultation between the study team and the RFD, both finally agreed to fomulate the Forest Village Plan in the model area excluding national park areas.

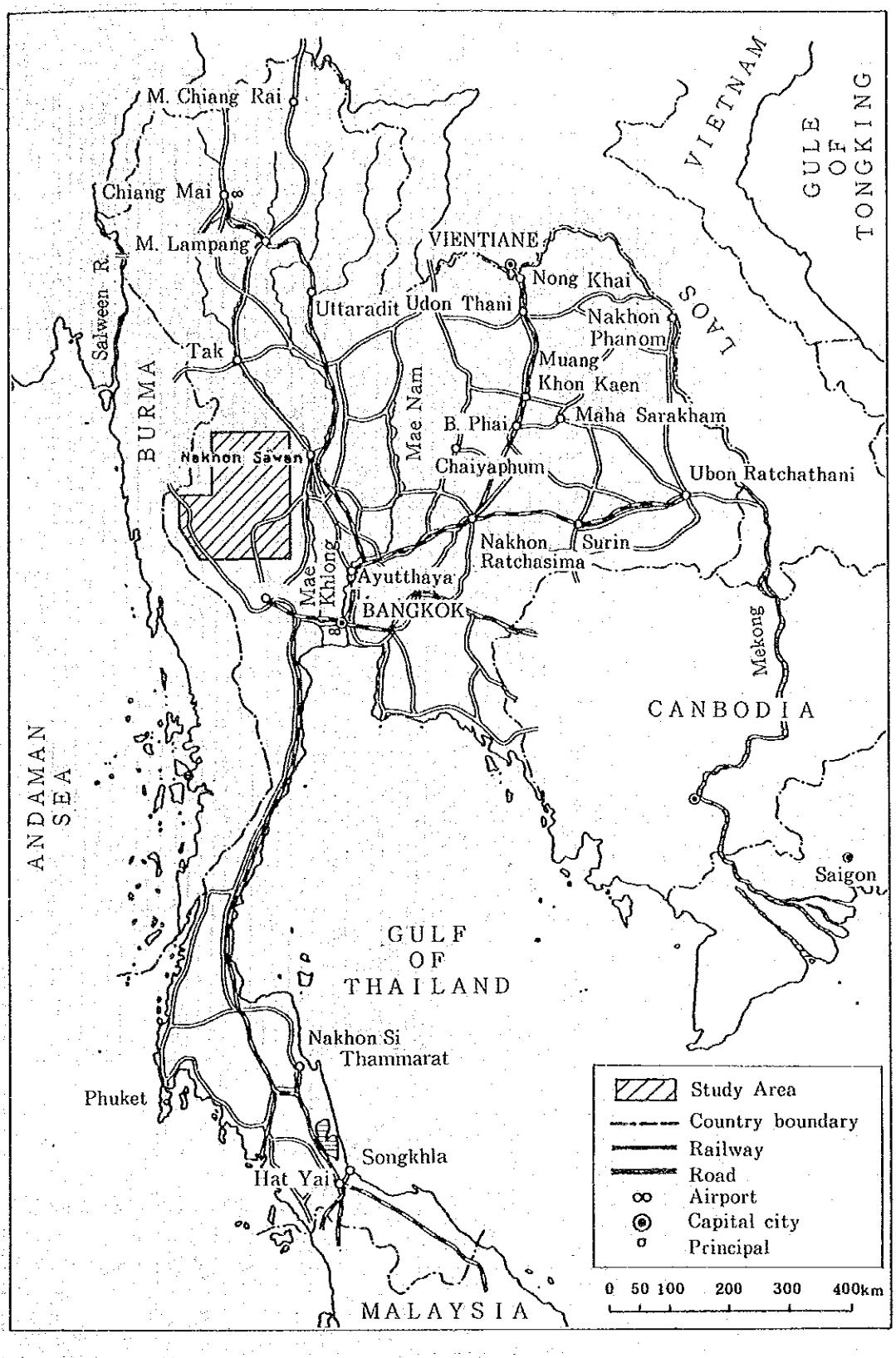


Fig. 1−1 Study Area

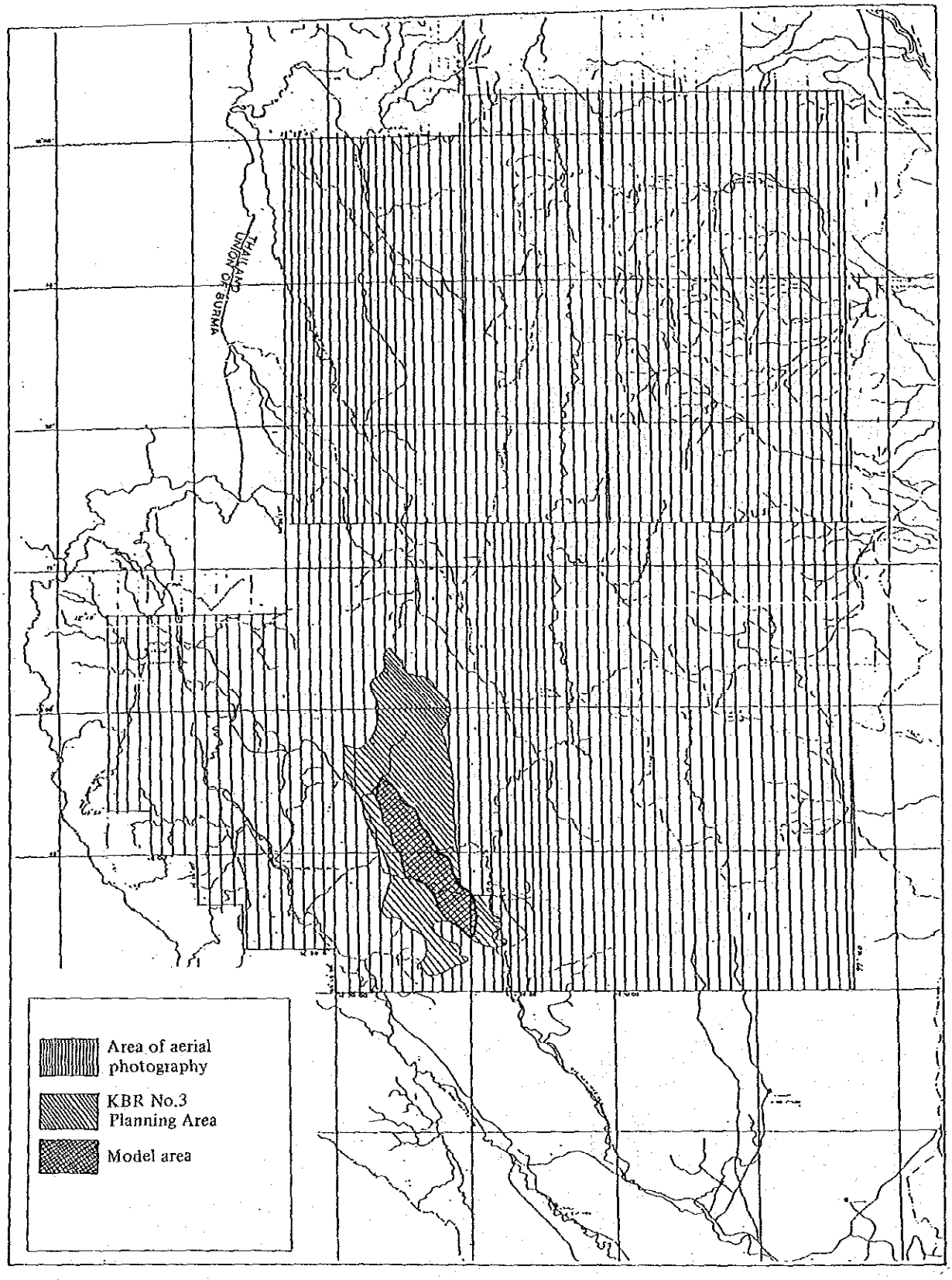


Fig. 1−2 Model Area

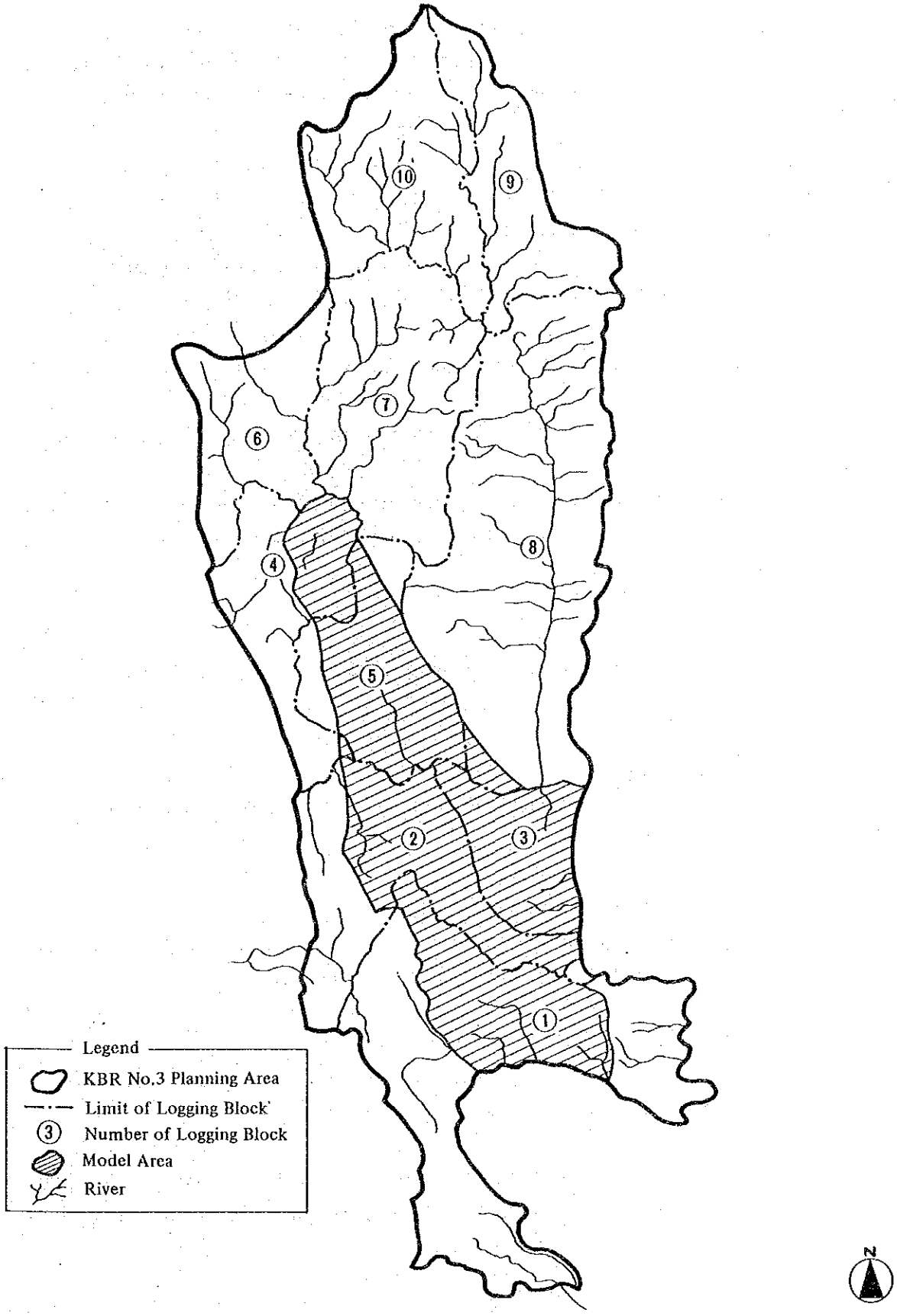


Fig. 1−3 Establishment of the Model Area

1.5 Outline of the Study

The fundamental study was executed for the formulation of national reserve forest management plan on the items described below over 3 years between 1985/86 and 1987/88.

(1) Study in 1985/86

① Aerial photography

To carry out the aerial photography of one million hectares on the southern half of the study area including the model area.

② Control point survey

To conduct traversing and levelling in the model area.

③ Basic survey for the national reserve forest management plan

To collect and analyze the existing data and execute the field survey.

(2) Study in 1986/87

① Aerial photography

To carry out the aerial photography of one million hectares on the northern half of the study area.

② Mapping

To carry out the aerotriangulation and prepare the basic map of the model area.

③ Preparation of the forest type map

To carry out the aerial photo-interpretation and prepare the forest type map and forest inventory book of the model area.

④ Preparation of the site analysis map

To carry out the topographic analysis and site analysis and prepare the site analysis map of the model area.

⑤ Main survey for the national reserve forest management plan

To carry out the field survey and examine the proposed land use classification of the model area.

(3) Study in 1987/88

① Formulation of the national forest management plan

To formulate the forest land use plan and the forest work plan of the model area.

② Field verification

To verify and examine the formulated national reserve forest management plan in the field.

③ Preparation of the guidelines and the manual

To prepare guidelines for formulating a forest management plan and a manual for the monitoring of the forest land use by means of remote sensing.

④ Preparation of the reports

To prepare the final report and produce the map of forest management plan and the forest register.

1.6 Despatch of the Field Survey Team

The following field survey team was despatched for three years from 1985/86 until 1987/88.

(1) In 1985/86

① Survey team

Team	Role & position	Name	Survey period	Days
Basic survey for forest management plan	Project leader & team leader	Mitsuma MATSUI	Dec.11 '85-Dec.30 '85	20
	Land use plan	Yasuo MURAMATSU	Dec.11 '85-Feb.3 '86	55
	Forest management	Shigeki KOIKE	〃	〃
	Forest village	Tadao OHARA	〃	〃
	Tropical farming	Sumio ICHIKAWA	〃	〃
	Environment & site condition	Kozo KATO	〃	〃
	Soil	Teruji NAKAMURA	〃	〃
	Forest type	Kota SHIMOKAWA	〃	〃
Aerial photography	Team leader, planning, supervision, inspection	Takehiko HIRANO	Nov.26 '85-Apr.7 '86	133
	Air photo signal	Katsuyuki KONDOH	Dec.1 '85-Dec.30 '85	30
	Developing & processing	Tsutomu INUI	Nov.26 '85-Apr.7 '86	133
	Photography	Masao IWATA	Dec.16 '85-Mar.28 '86	103
	Pilot	Hideki KIDANI	Dec.1 '85-Mar.28 '86	118
	Ground staff	Yohji EBARA	〃	〃
Control point survey	Team leader	Tamami IMAI	Jan.20 '86-Mar.10 '86	50
	Control point survey	Ryosuke ITOH	〃	〃
	〃	Katsuyuki KONDOH	〃	〃
	〃	Shozo SHIMODA	〃	〃
	〃	Masahiro ASAI	〃	〃

② Advisory team

Role & position	Name	Period	Days
Leader	Toshiaki TSUCHIYA	Jan.20 '86-Jan.31 '86	12
Aerial photogrammetry	Yasuo ITO	〃	〃
Forest management plan	Tadashi MATSUI	〃	〃

(2) In 1986/87

① Survey team

Team	Role & position	Name	Survey period	Days
Main survey for the national forest management plan	Project leader & team leader	Mitsuma MATSUI	Jan.10 '87-Jan.29'87	20
	Land use plan	Kazushi YUMOTO	Dec.11 '86-Jan.29'87	50
	Forest management	Shigeki KOIKE	〃	〃
	Forest village	Tadao OHARA	〃	〃
	Tropical farming	Sumio ICHIKAWA	〃	〃
	Soil	Teruji NAKAMURA	〃	〃
	Forest type	Kota SHIMOKAWA	〃	〃
Aerial photography	Team leader	Takehiko HIRANO	Aug.12 '86-Aug.31'86	20
			Nov.11 '86-Feb.28'87	110
	Photo processing	Akira NAGASE	Dec.11 '86-Feb.28'87	80
	Photographing	Masao IWATA	Nov.24 '86-Feb.17'87	86
	Pilot	Kiyoshi ONO	Nov.24 '86-Feb.17'87	86
	Ground staff	Yoji EBARA	Dec.1 '86-Feb.17'87	79
Photo-interpretation and forest type map preparation	Team leader, Photo-interpretation and data collection	Tadao OHARA	Aug.12 '86-Sep.20'86	40
	Photo-interpretation and data collection	Sumio ICHIKAWA	〃	〃
	〃	Kozo KATO	〃	〃
	〃	Kota SHIMOKAWA	〃	〃

② Advisory team

Role & position	Name	Survey period	Days
Leader	Toshiaki TSUCHIYA	Jan.15 '87-Jan.24 '87	10
Land utilization planning	Hiroaki KATO	〃	〃
Aerial photogrammetry	Hiroshi WATANABE	〃	〃
Forest management plan	Tadashi MATSUI	〃	〃

(3) In 1987/88

① Survey team

Team	Role & position	Name	Survey period	Days
Field verification	Project leader & team leader	Mitsuma MATSUI	Nov.25 '87-Dec.24 '87	30
	Land use plan	Kazushi YUMOTO	〃	〃
	Forest management	Shigeki KOIKE	〃	〃
	Forest village	Tadao OHARA	〃	〃
	Tropical farming	Sumio ICHIKAWA	〃	〃
	Soil	Teruji NAKAMURA	〃	〃
Explanation of draft final report		Mitsuma MATSUI	Feb.21 '88-Feb.27 '88	7
		Tadao OHARA	〃	〃

② Advisory team

Item	Role & position	Name	Survey period	Days
Field verification	Leader	Hiroaki KATO	Dec.10 '87-Dec.19 '87	10
	Coordinator	Hidekazu SHIRAISHI	〃	〃
Explanation of draft final report	Leader	Hiroaki KATO	Feb.21 '88-Feb.27 '88	7
	Coordinator	Toshibumi SERIZAWA	〃	〃

2.0 AERIAL PHOTOGRAPHY AND PREPARATION OF THE BASIC MAP

2.1 Aerial Photography

(1) The base office for the aerial photography

The base office for the aerial photography was established at the Don Muang Airport in Bangkok in 1985/86 and at the airfield attached to the Ministry of Agriculture and Co-operatives that was located in Nakhon Sawan city in 1986/87.

(2) Equipment used for the aerial photography and processing

a. Airplane
   Cessna TU 206F
b. Survey camera
   WILD RC-10 15/23
c. Film development
   Kodak Film Processor
   Bathamat 1140
d. Contact print
   ZEISS Contact Printer KG-30
e. Contact processor
   Kodak Royal Print Processor
f. Rectifier
   Zeiss Automatic Rectifier SEG-V
g. Aerial film
   Kodak Plus-S 2402

(3) Aerial photography

Aerial photography at a scale of 1:20,000 was carried out covering one million hectares of the southern half of the study area in 1985/86 and one million hectares of the northern half of the study area in 1986/87.

The results obtained are listed in the Appendix Table-1 and the outline of the photographed area is shown in the Appendix Fig.-1.

(4) Photograph processing and inspection

Photograph processing was carried out at the RTSD (Royal Thai Survey Department), the aerial photographs obtained were examined for overlap, sidelap, deviation from the course, cloud image, etc., and the photo index map was drawn to a 1:250,000 scale.

(5) Results

The following products were obtained as a result of the works mentioned in (3) and (4)

a. Negative film 1 set

b. Contact prints 2 sets

c. Photo index 1 set

d. Enlarged photos 1 set

2.2 Control Point Survey

(1) Conditions related to the execution of the work

① Arrangements (headquarters and base camp)

The headquarters and base camp for the control point survey were set up at the Srinagarind National Park Office, located at the southern extremity of the model area.

② Equipment used

a. Transit WILD−T2

b. Distance meter H.P.−3808A

c. Level AUTO LEVEL (Nikon)

(2) Traversing

① Planning and reconnaissance

The traverse points were arranged at 13 places in total, consisting of 9 places where signals are located and 4 places where traverse turning points are located, based on the 1:50,000 topographical map drawn up in 1964. So as not to obstruct the mapping work of the model area and by taking care to maintain the required accuracy, reconnaissance was carried out at these places to examine the topography on the spot, and note the existence of obstacles and other relevant particulars. The location of the signals and traverse turning points is shown in Fig. 2−1.

② Selection and erection of stations

The selection of the stations was quite troublesome, in view of the conspicuous secular changes in the old 1:50,000 topographic map.

As for the signals set up in December 1985, it became necessary to

change 7 of the 9 points because the model area was fixed in late December. Under the circumstances, an arbitrary coordinate system, obtained from the plane rectangular coordinates of the 1:50,000 topographic map was used in this study, because no national control point was comprised within the model area and moreover authorization to use the results of the survey was not given by the Government of Thailand.

③ Distance survey

Two sets of measurements were carried out at each side, by using a Hewlett Packard 3808A distance meter. The discrepancy between these sets was limited to within 1/40,000.

④ Horizontal angle survey

Angles of 2 sets (0°and 90°)were measured at the various observation points by means of the double angle method. The restrictions referring to the observation are 20" in terms of double angle difference and 15" in terms of observed angle difference.

⑤ Vertical angle survey

The restriction referring to the vertical angle survey was assumed to be 1 set in each direction, and the discrepancy in terms of altitude constant is assumed to be 15".

Both the horizontal angle survey and the vertical angle survey were carried out with a Wild-T2 (1" reading) transit, and measuring plate, flashlight and mirror were used as the sight sign.

(3) Levelling

The altitudes of the signal points A-4, A-8 and A-9 were determined by direct levelling, by using the Srinagarind Dam water level (W.L.) as a reference plane.The survey was started at the W. L. and was closed at the W. L. after passing through A-9 and A-8, and moreover a round trip survey was carried out between a bench mark set up halfway through the said survey route and the point A-4. The discrepancy throughout the round trip is assumed to be 6 cm$\sqrt{S}$ (S=one-way distance).As for the signal points A-1, A-2, A-3, A-5, A-6 and A-7, their altitudes are determined by indirect levelling, which consists of regarding the points A-4, A-8 and A-9 as datum points, and calculating the differences of elevation between the signal points in question and the datum points by measuring the corresponding vertical angles with a transit.

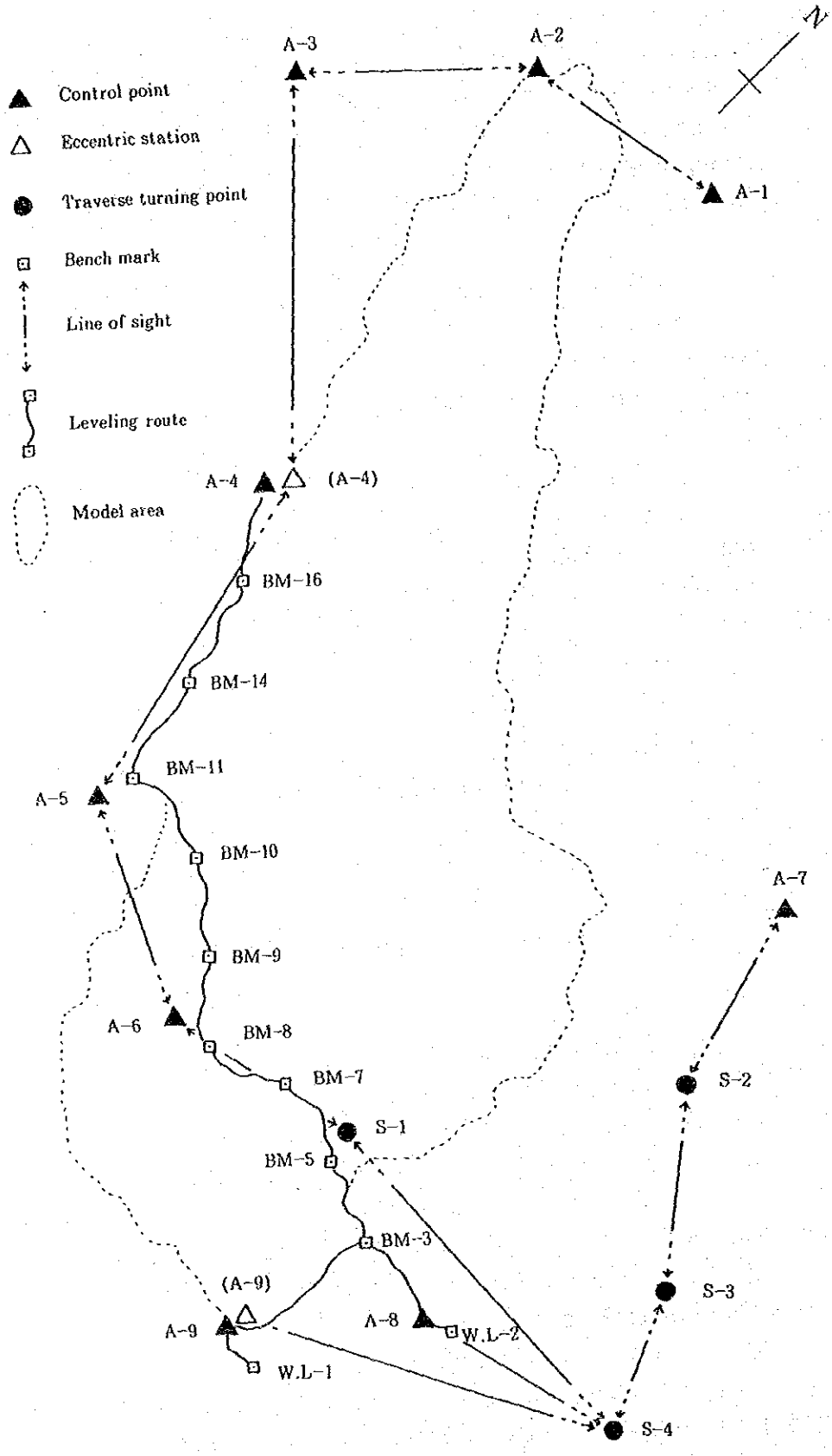


Fig. 2-1 Control Point Network

(4) Final results

The results referring to the various datum points and traverse turning points obtained as a result of the steps of procedure described in 2 above are shown in the Control Data List of Table 2−1.

Table 2-1 Control Data List

(Unit:m)

No.	X	Y	H	Remarks
A−1	+1645 581.63	+487 206.88	781.84	
A−2	+1644 755.72	+482 037.73	621.52	
A−3	+1640 550.00	+477 660.00	895.79	
P-1	+1640 555.36	+477 656.26	895.91	
P-2	+1640 555.69	+477 660.39	895.91	
A−4	+1633 549.44	+484 740.57	848.94	
(A-4)	+1632 974.05	+484 357.71	723.613	Air Photo Signal
A−5	+1624 533.09	+487 175.10	871.93	
(A-5)	+1624 532.02	+487 172.81	872.80	Air Photo Signal
A−6	+1622 281.30	+392 411.18	825.39	
A−7	+1635 042.12	+501 016.65	276.37	
(A-7)	+1635 038.81	+501 004.12	279.87	Air Photo Signal
A−8	+1621 774.82	+502 075.99	191.61	
(A-8)	+1621 775.67	+502 062.44	192.418	Air Photo Signal
P	+1621 750.80	+502 080.15	190.21	
A−9	+1618 134.38	+498 832.12	263.033	
(A-9)	+1618 114.97	+498 867.48	260.235	Air Photo Signal

2.3 Preparation of the Basic Map

(1) Aerotriangulation survey

Aerial photographs for preparing the basic map of the model area were 76 models (refer to Table 2-2), with respect to which the aerotriangulation survey was carried out. Using as reference the results of the field work (control point survey, levelling) and spot heights on the existing 1: 50,000 map, primary calculation was carried out with respect to the planimetric locations and elevations, and after examining the results of the calculations, the aerotriangulation survey was executed by means of the block adjustment technique. The residual calculation at control points is as listed on Appendix Table-2.

Principal equipment used was as follows.

a. Dot engraver : Wild PUG II
b. Comparator : ZEISS Stereo Comparator
c. Computer : FUJI FACOM M150-F System

Table 2-2 Aerial Photographs for Preparation of the Basic Map

Course	Photo	No. of photographs	Number of models
C4	20 - 25	6	5
C5	20 - 26	7	6
C6A	22 - 29	8	7
C7A	21 - 30	10	9
C8	21 - 32	12	11
C9	25 - 36	12	11
C10B-1	5 - 13	9	8
C11	25 - 31	7	6
C12A	27 - 33	7	6
C13	28 - 32	5	4
C14A	29 - 32	4	3
Total	11 courses	87	76

(2) Preparation of the topographical map

Using the results obtained by the aerotriangulation survey, a topographical map of the model area of 20,000 ha was prepared on a reduced scale of 1:10,000 with the contour interval of 10 m and auxiliary contour of 5 m by going through such processes as mechanical plotting of details, compilation and drawing. The adjoining sheet is as shown on Appendix Fig.-2

① Major equipment used

Precision stereo plotter : Wild Stereo Plotter AS

Co-ordenatograph : Daini-Seikosha Xynetics 1100

② Accuracy of the topographical map

Planimetric location of features: 2.0 mm on the map

Elevation of spot height : 4/3 of the contour interval

Contour line : 2/1 of the contour interval

3.0 FOREST ANALYSIS

3.1 Aerial Photo-interpretation

(1) Photo-interpretation for land use

The aerial photographs were interpreted for the land use of areas other than forest in the model area according to the following standard table for the classification of land use. (Refer to Table 3-1)

Division lines were drawn to demarcate each land use which was interpreted and classified and the applicable symbols were entered.

Table 3−1 Standard Table for Classification of Land Use

Classification	Symbol	Remarks
Farm land	A	
Grass land, grazing land	G	
Village	V	
River	R	
Bare land,	B	including quarry
Plantation, orchard	P	
Others	O	telecommunication station

(2) Photo-interpretation for forest type and forest form

The forest area was interpreted for forest type and forest form, and demarcated on the map according to the standard of classification. (Refer to Table 3−2)

Table 3−2 Standard Table for Classification of Forest Type and Forest Form

1. Forest type

Classification	Symbol
Tropical Evergreen Forest	T_E
Mixed Deciduous Forest	M_D
Deciduous Dipterocarp Forest	D_D
Bamboo Forest	B_F
Secondary Forest	S_F

2. Forest form

Classification by terrain	Mountainous terrain Hilly terrain Flat terrain	M H F	
Classification by crown diameter class	Large diameter tree Middle diameter tree Small diameter tree	La Mi Sm	Crown diameter of upper story tree 17m and more from 11m to under 17m less than 11m
Classification by tree height class	High Middle Low	H_3 H_2 H_1	Mean tree height of upper story trees 23m and more from 18m to under 23m 17m and less
Classification by crown density class	Dense Intermediate Scattered Thin	D_4 D_3 D_2 D_1	Crown density of upper story trees 61% and more 51% - 60% 41% - 50% 40% and less

Interpreted demarcations were revised or corrected based on the foregoing criteria.

3.2 Preparation of the Aerial Photo Stand Volume Table

An aerial photo stand volume table was prepared to estimate the stand volume of each forest stand classified by forest type and forest form. The stand factor used the crown density of the upper story trees which are measurable on the photograph.

(Refer to Table−3 and Fig. −3 for data used in preparing the aerial photo stand volume table in the Appendix.)

Formula for estimating the stand volume by aerial photo:

$$\log V = -0.932 + 1.632 \log R \quad (r = 0.87910)$$

or

$$V = 0.117\ R^{1.632}$$

wherein: V: Stand volume per ha, m^3/ha

R: Crown density of the upper story trees, by the unit of 5%.

The formula for correcting the estimated stand volume V_E to actual stand volume V_A is as follows.

$V_A = -3.29 + 1.073\ V_E$ ($r = 0.88727$)

The following table summarizes all of the foregoing.

Table 3−3 stand Volume Table

R (%)	V_E (m^3/ha)	V_A (m^3/ha)	R (%)	V_E (m^3/ha)	V_A (m^3/ha)
5	2	−	40	48	48
10	5	2	45	58	59
15	10	7	50	69	71
20	16	14	55	81	84
25	22	20	60	93	96
30	30	29	65	106	110
35	39	39	70	120	125

R(%)	V_E (m^3/ha)	V_A (m^3/ha)
75	134	141
80	149	157
85	165	174
90	181	191
95	198	209
100	215	227

3.3 Preparation of the Forest Type Map and the Forest Inventory Book

(1) Preparation of the forest type map

The interpreted division lines by land use, forest type and forest form were transcribed onto the 1:10,000 topographical map to prepare the draft of forest type. Compartments by the natural borders such as ridge, river and road were set up and numbered respectively. Sections by land use, forest type and forest form were established as sub-compartments and were also respectively numbered. The forest type map was prepared by the fair draughting of the draft forest type map.

(2) Area measurement and growing stock estimation

The area for each sub-compartment was measured on the basis of the draft forest type map. The crown density of each sub-compartment was measured on the applicable aerial photograph, and the growing stock was estimated from the volume per ha according to the aerial photo stand volume table. The result of area measurement on existing land use is as shown on Table 3—4.

(3) Preparation of the forest inventory book

The forest inventory book was prepared by putting together the results of the interpretation, area measurement and growing stock estimation and other data.

Table 3 – 4 Result of Area Measurement on Existing Land Use

(Unit : ha)

Working Area	Compartment No.	Forest Land		Non-forest Area								Sub-total	Total
		Forest Area	Left-over Area	Farm Land A	Plantation P	Village V	Barren Land B	Grass Land G	River R	Others O	Grass Land & Farm Land G/A		
Khao Praleusri Bor Rae	1	481.24		76.39		3.27	23.71	2.95				106.32	587.56
	2	1,135.18		29.85			16.38	0.46				46.69	1,181.87
	3	1,249.49	53.79	16.88		2.11	2.56	23.64				45.19	1,348.47
	4	1,298.59	62.88				3.71					3.71	1,365.18
	5	1,125.93	70.49		10.99	0.29		4.39				15.67	1,212.09
	6	1,125.57	141.03										1,266.60
	7	1,160.57	181.29										1,341.86
	8	590.15							4.11			4.11	594.26
	Sub-total	8,166.72	509.48	123.12	10.99	5.67	46.36	31.44	4.11			221.69	8,897.89
Srinagarind	1	934.67		41.24	17.48	1.69	1.02					61.43	996.10
	2	800.76											800.76
	3	773.26	39.72										813.00
	4	1,029.48	12.30					13.04			1.26	14.30	1,056.08
	5	733.62	20.83	123.12		0.40	30.81			4.90		159.23	913.68
	6	1,019.09	77.22	14.41		1.32					19.02	34.75	1,131.06
	7	838.35	7.17	60.24		1.29	24.76			1.07		87.36	932.88
	8	694.85	195.67				2.42					2.42	892.94
	9	715.26	102.51				1.91					1.91	819.68
	10	750.61							12.70			12.70	763.31
	11	1,056.11							43.22			43.22	1,099.33
	12	1,262.62											1,262.62
	13	1,123.14	131.58					12.87				12.87	1,267.59
	Sub-total	11,731.84	587.00	239.01	17.48	4.70	60.92	25.91	55.92	5.97	20.28	430.19	12,749.03
Total		19,898.56	1,096.48	362.13	28.47	10.37	107.28	57.35	60.03	5.97	20.28	651.88	21,646.92

4.0 BASIC SURVEY AND MAIN SURVEY

4.1 Environmental Element Survey

(1) Weather

Meteorological data of a period of 5 years, collected at the Srinagarind Met. Office located in the vicinity of the survey area, are described in the followings, and are summarized in the Appendix Table- 4.

① Temperature

The average temperature of the 5-year period in question is 26.5°C, and the monthly average temperature ranges from 22.6°C (December) to 29.7°C (April). The annual average value of the minimum temperatures is 22°C, and the lowest monthly average of 17.5°C occurs in December. The annual average value of the maximum temperatures is 31 °C, and the highest monthly average of 34.9 °C occurs in April.

② Rainfall

The annual average rainfall is 998.1 mm, and this value is conspicuously small compared with the annual average rainfall all over Thailand which amounts to approximately 1,600 mm.

The monthly distribution of the rainfall (759.9 mm, which corresponds to 76% of the total annual rainfall), is recorded during the May to October rainy season, with particularly large values recorded in September (201.2 mm) are October (187.2 mm). On the other hand particularly small values are recorded inJanuary (3.9 mm) and February (12.6 mm).

The annual average number of rainy days averages 133, with the monthly average amounting to between 15 and 20 days during the rainy season of May to October, and 1 to 7 days during the dry season of November to April. The maximum daily rainfall per month recorded so far was 134.9 mm on the 18th October 1983.

③ Humidity

The average humidity recorded during the 5-year period in question was 91%, and the monthly average humidity reaches its minimum with 87% in April and its maximum with 96% in October.

④ Meteorological disasters

No disaster worth recording has occured so far in the region in question.

(2) Population

① Population and number of households in the province of Kanchanaburi

The total population of the province of Kanchanaburi as of December 1984 amounts to 607,171 (95,449 households), with an average of 6.4 persons per household (refer to Appendix Table−5). Male population of the province amounts to 308,628 which corresponds to 50.8% of the total, and female population amounts to 298,543 which corresponds to 49.2% of the total. The average demographic growth recorded in the 4-year period from 1981 to 1984 was 1.85%, which. corresponds to 10,228 persons.

② Population of the model area

The total population of the districts of Thong Pha Phum and Si Sawat, where the survey area was located , amounts to 26,310 (5,218 households), as of December 1984, with an average of 5.0 persons per household, which is smaller compared with the average of 6.4 persons per household record in the province as a whole. The distribution by sex consists of 13,812 male population corresponding to 52% of the total and 12,498 female population corresponding to 48% of the total. The demographic growth during the 1 year period extending from 1983 to 1984 was 1.7%, which corresponds to 438 persons and is slightly larger than the average of 1.5% recorded in the province as a whole.

According to the results of the field survey executed in 1985/86 and 1986/87, the total estimated population of the model area amounts to approximately 500 (9 villagaes, 100 households) with an average of 5.0 persons household.

(3) Transportation and the state of the roads

The model area is located approximately 100 km to the north-west of Kanchanaburi, which is a provincial city located approximately 126 km to the west of Bangkok, the capital city of Thailand.

Access from the city of Kanchanaburi to the model area can be made via a paved road as far as Srinagarind Dam, but the road on the west bank of the reservoir is quite poor in many places and cannot function as an industrial road as it is. The mining company which passes through the model area use their own private ferryboat to take their trucks across the

reservoir to the east bank, instead of using this road.

Thong Pha Phum located in the northwestern part of the province is a base for the wood industry in this area.A road from the model area leads to this area, but this road is unpaved and poorly aligned and requires large scale improvement in the future. At any rate, the transportation of timber is possible during the dry season but difficult during the rainy season due to the existing road conditions.

4.2 Survey for the Land Use Plan

(1) Existing land use

Data on land use were collected during the current survey as a premise for preparing a proposed land use plan. According to these data, the ratio of the forests to the total land area in the province of Kanchanaburi, where the survey area is located, is quite high compared to the national average and the average for the central region. This indicating that forests are still preserved there while the ratio of the agriculture-related land such as paddy fields and orchards is low, suggesting that the province of Kanchanaburi is an exceptional area in the central region of Thailand. (Refer to Table 4−1)

Table 4−1 Existing Land Use (1983/84)

(Unit:km²)

Region / Kind of land use	Whole Kingdom		Central Plain Region		Kanchanaburi Province	
	Acreage	%	Acreage	%	Acreage	%
Total	513,115.0	100.0	67,398.7	100.0	19,483.2	100.0
Forest	154,027.9	30.0	18,075.7	26.8	12,125.2	62.2
Living land	4,143.5	0.8	694.3	1.0	76.0	0.4
Paddy field	117,815.5	23.0	16,994.6	25.2	751.5	3.9
Cash crop	47,084.8	9.2	8,607.6	12.8	1,739.6	8.9
Orchard	19,050.4	3.7	1,803.8	2.7	91.3	0.5
Horticulture	548.8	0.1	209.3	0.3	10.6	0
Grass land	1,225.3	0.2	222.1	0.3	8.7	0
Barren land	6,256.9	1.2	264.0	0.4	29.7	0.2
Others	2,643.0	0.5	227.9	0.4	33.1	0.2
Unclassified	160,318.9	31.3	20,299.4	30.1	4,617.5	23.7

(Source) Forestry Statistics of Thailand 1985. RFD

(2) Attrition of forests

The attrition in the size of forest areas is as shown in Table 4−2. Every figure follows a sharp declining trend, from which it is easily understood why the priority in formulating the land use plan lies in preventing the decrease in the size of the forest areas.

Table 4−2 Annual Attrition of Forest Areas

(Unit:km²)

Region / Year	Whole Kingdom		Central Plain Region		Kanchanaburi Province	
	Acreage	%	Acreage	%	Acreage	%
Total	513,115	100.0	67,399	100.0	19,483	100.0
1961	273,629	53.3	35,661	52.9	17,793	91.3
1973	221,707	43.2	23,970	35.6	13,549	70.0
1976	198,417	38.7	21,826	32.4	13,417	68.9
1978	175,224	34.2	20,426	30.3	13,329	68.4
1982	156,600	30.5	18,516	24.5	12,417	63.7
1985	149,053	29.0	17.228	25.6	11,562	59.3

(Source) Forestry Statistics of Thailand 1986. RFD

(3) Existing condition of land use in the model area

Existing land use of the model area, where placed in the national reserve forest area, is as shown in Table 4−3.

Table 4−3 Acreage of Existing Land Use in the Model Area

Item	Acreage (ha)		Ratio(%)	
Forest	19,898.56		91.92	
Left-over area	1,096.48		5.07	
Farm land	362.13		1.67	
Plantation	28.47		0.13	
Village	10.37		0.05	
Bare land	107.28	651.88	0.50	3.01
Grass land	77.63		0.35	
River	60.03		0.28	
Others	5.97		0.03	
Total	21,646.92		100.00	

The land of the model area is extracted forest (natural forest, secondary forest and bamboo forest) of 92%, rocky land of 5% and agricultural land other than forest of 3%.

4.3 Survey on the Forest Villages and Tropical Farming

(1) Implementation of the survey

The survey aims to clarify family compostion, kinds of farm crops, planting area, yield, prices of farm products, income, etc. The survey was conducted on the inhabitants in the project of Forest Village and Sor Tor Kor and in the model area.

The locations where the survey was conducted and the number of families surveyed at each location are as shown on Fig. 4−1∼2 and Table 4−4∼5.

Project areas	Model area
The actual state of the Forest Village Project (FV) and Sor Tor Kor Project (STK) were examined. (These projects are outlined in Table 4−6.) The fact-finding survey was carried out in connection with projects being implemented in 4 areas, Chiang Mai, Prachin Buri, Saraburi and Kanchanaburi.	The inhabitants living in the model area (20,000 ha) were surveyed as a part of the survey on forest villages and tropical farming. The survey was conducted on 86 families of 9 villages of Klong-Ngu, Huai Ban Kao, Phu Toei, Dong Yai, Dong Glang, Dong Lek, Pak Muang, Phu Muang, and Phu Ta Ma.

Project areas

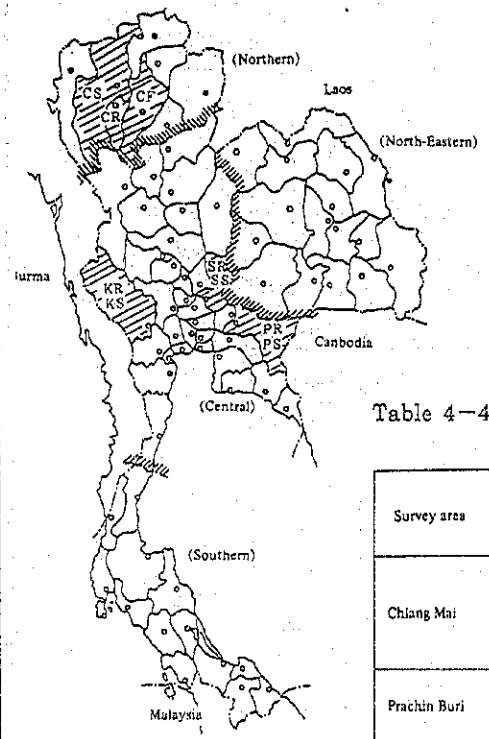


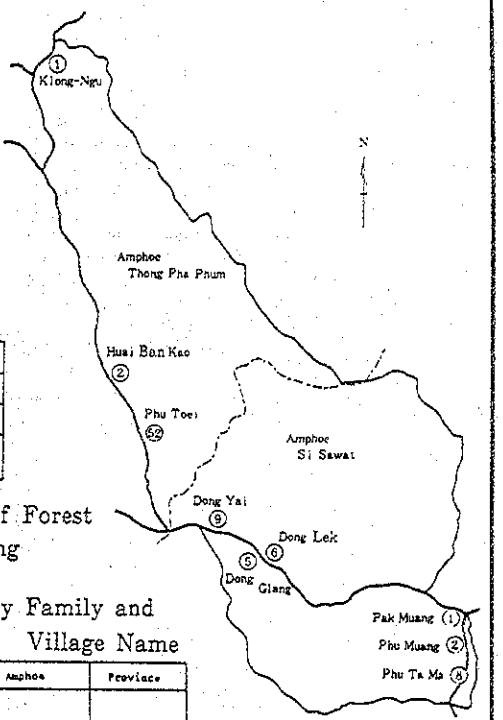
Fig. 4−1 Study Location of Forest Village and Tropical Farming

Table 4−4 Survey Number of Each Project and Area

Survey area	Symbol	Number of surveyed family. RFD Forest village	FIO Forest village	RFD Sor Tor Kor
Chiang Mai	CR	6		
	CF		5	
	CS			3
Prachin Buri	PR	20		
	PS			11
Saraburi	SR	20		
	SS			10
Kanchanaburi	KR	30		
	KS			20
Total		76	5	44
		125		

RFD: Royal Forestry Department
FIO: Forest Industry Organization

Model area



Legend

Model Area	⬭
Roads	———
Boundary of Amphoe	- - - -
Number of surveyed family and village name	○

Fig. 4−2 Study Location of Forest Village and Tropical Farming

Table 4−5 Number of Survey Family and Village Name

Number of interviewed family (sampling)	Village	District	Amphoe	Province
1 (No.1)	Klong−Ngu	Chalee	Thong Pha Phum	Kanchanaburi
2 (No.2, 3)	Huai Ban Kao			
52 (No.4−55)	Phu Toei			
9 (No.56−64)	Dong Yai	Dan Mae Chalaep	Si Sawat	
5 (No.65−69)	Dong Giang			
6 (No.70−75)	Dong Lek			
1 (No.76)	Pak Muang			
2 (No.77, 78)	Phu Muang			
8 (No.79−86)	Phu Ta Ma			
Total 86				

All inhabitants of the model area: Estimated to be about 100 families.

Project areas

Table 4−6 Outlines of Each Project

Item \ Project			Forest Village		Sor Tor Kor
			RFD	FIO	RFD
Started year			1975	1967	1981
No. of established village (present)			100	53	300,000 families in the national reserve forest (1,049 sites) (Target: 1,500,000 families)
No. of family per village (schedule)			150	100	
Provided land	rai / Family	Living area	0.5 ~ 1.0	1.0	15.0
		Agricultural land	14.0 ~ 14.5 It is possible to do temporary farming in the forest by promise.	It will be allotted 10.0 rais gross each year in the area designated for reforestation and where they may clear land and grow farm crops between tree rows, and the farming land 5.0 rais for home-consuming crop.	It is possible to expand the family land by purchase.
	Title	Yes/No	No	No	Yes
Wages by reforestation			Yes	Each family gets paid a fixed amount for each type of forestry work, which totals 200 bahts/rai. When any family works continuously for 3 years over 30.0 rais, it will be paid a bonus of 1,500 bahts	
Public institution			Running water, school, clinic, other facilities	Electricity, running water, school, temple	
Objectives			Establishment of forest village to rehabilitate national forest reserve aims at: 1. Maintaining national forest reserve area for timber production and protection of environment of the country in the long-run and perpetuity, 2. Rehabilitation of the degraded watershed and unsuitable for agriculture areas within the forest reserve with artificial regeneration for a timely result; 3. Resettlement of landless farmers and squatters scattered all over the reserve to facilitate government assistances and services; 4. Stemming the expansion of forest reserve destruction.	1. To group and settle shifting cultivators in a delimitated place to prevent them from further land clearing, 2. to make the Forest Village a source of labour for the reforestation, using the shifting cultivators' extra labour capacity to improve the forest condition of the country.	1. To stop further forest destruction from land clearing for agricultural purpose, 2. to stop the rapid increasing amount of encroachers in the nation reserve forest, 3. to issue STK permit to the land holders who have permanent residences and permanent farming in the national reserve forests.

(Note) Prepared by the data of RFD and FIO

(2) Survey method

Project areas	Model area
The method of survey consists of selecting at random the residents to be surveyed, and carrying out individual interviews with each one of the selected residents by using the prescribed questionnaire.	The survey was conducted by interviewing all inhabitants (estimated to be about 100 families) within the model area using a pre-determined questionnaire similar to that used in the fact-finding survey of project areas. The actual sample size covered, however, was 86 families, as 14 families (particularly those in Dong Yai, Dong Glang and Dong Lek) were out of the model area during the dry season and could not be interviewed.

The contents of the questionnaire were as follows.

- Family composition (family size, sex, age)
- Living environment (house, assets, fuel, food)
- Actual operating conditions
  (area cultivated, agricultural implements used, kinds of crops grown, crop yield, income, etc.)
- Others

Besides the questions included in the questionnaire, the inhabitants were asked what they intended to do from now on, and how the living conditions were before they moved to the present place, etc. if necessary.

(3) Survey results

Based on the entries in questionnaire sheets, answers were summarized by survey item. The survey findings are as presented in Table 4−7. Findings on each survey item are as outlined below.

Table 4−7 Outline of Survey Results (Mean value per family of each survey area)

( ) : Number of surveyed family

Survey area			Project areas of Forest Village and Sor Tor Kor Jan., 1986										Model area Dec., 1986−Jan., 1987 (86)
			Chiang Mai			Prachin Buri		Saraburi		Kanchanaburi		Weighted mean	
			CR (6)	CF (5)	CS (3)	PR (20)	PS (11)	SR (20)	SS (10)	KR (30)	KS (20)		
Period of settlement (year)			6.7	14.4	19.0	11.8	15.7	11.8	14.0	8.8	9.9	11.3	4.8
Member of household (person)	Total		3.8	5.0	6.3	6.3	5.2	4.3	5.0	5.1	5.3	5.1	5.0
	Sex	Male	2.0	2.6	2.7	3.1	2.3	1.9	2.3	2.6	2.8	2.5	2.7
		Female	1.8	2.4	3.6	3.2	2.9	2.4	2.7	2.5	2.5	2.6	2.3
Living area & agricultural land per family (rai)			8.4	5.8	7.7	31.0	44.9	16.8	29.1	20.0	21.8	24.6	28.0
Annual cash income (bahts)	Total		14,173	37,600	35,534	17,748	11,894	25,700	27,339	15,193	46,314	24,282	9,514
	Agriculture		11,173	2,520	2,967	13,518	9,376	10,285	19,089	6,803	24,454	12,414	4,529
	Other than agriculture	RFD/FIO	0	25,760		1,660		14,210		1,940		11,867	4,985
		Others	3,000	9,320	32,667	2,570	2,518	1,205	8,250	6,450	21,860		
Household	Rice consumption (kg/week)		15.0	18.2	19.9	29.0	24.0	15.0	18.8	16.2	14.7	18.8	16.2
	Cash expenditure in food (bahts/week)		108.2	205.9	201.2	93.2	140.2	153.5	173.0	174.5	226.7	162.1	162.9
	Fuel consumption (m³/year)	Fire wood	3.233	2.555	4.328	1.564	0.469	0.313	0	0.626	1.043	1.020	1.632*
		Charcoal	0	—	4.432	5.840	4.849	1.512	2.607	1.877	2.555	2.777	2.460*
Agricultural annual cash income (bahts)		Livestock	5,567	2,520	500	290	0	0	450	300	810	664	93
		Crop	5,606	0	2,467	13,228	9,376	10,285	18,639	6,503	23,644	11,750	4,436
Main Crop			Rice Tobacco Ground nut	Rice	Rice Maize Ground nut	Rice Maize Kenaf Sorghum Mungbean	Rice Maize Cotton	Maize Cassava Rice	Maize Soybean Cassava	Maize Cotton Castor bean Rice Cassava Sorghum	Maize Sugar cane Cotton Caster bean		Maize Rice Castor bean

* Surveyed in Dec., 1987.
Number of surveyed families : 61
Members of household : 5.8 persons

Project areas	Model area
①Settlement duration The projects of the various surveyed areas started at distinct dates but the average period of settlement is 10.4 years in the FV and 12.9 years in the STK.	①Settlement duration The average settlement duration of 86 families is 4.8 years, from which it can be seen that many of them have moved in recently.
②Working forms The residents are classified into 3 types in terms of form of occupation, full-time farmer, part-time farmer and non-farmer. Of these occupational types, full-time farmers account for barely 10 % of the total, and approximately 80 % are part-time farmers. As for FV and STK, part-time farmers account for 80% and 86% of the total, respectively.	②Working forms The inhabitants were classified by the working form into full-time farmers, part-time farmers and non-farmers. Full time farmers accounted for 29.1 % of the total, part-time farmers the majority of 62.8% and non-farmers 8.1%.
③Family composition Each household consists of 5.1 persons in average, and households with 5 members account for 25% of the total, as shown in Fig. 4−3. Moreover, the composition in terms of age groups at intervals of 5 years is shown in Fig. 4−4.	③Family composition The total number of members of 86 families is 429 persons, which means that the average family size is 5.0 persons. When the distribution of families by family size is reviewed, the families with three to six members are the largest in number as shown in Fig. 4−5, with families with six members in particular accounting for 23.3% of the total. The population distribution by age group of every five years is as shown in Fig. 4 −6. The age composition of family members shows that the age group of 15−19 accounts for 14.9% of the total, the age group of 10−14 of 13.3% and the age group of 5−9 for 11.9%, with the three groups of between 5 and 19 which represent the younger generation jointly accounting for about 40% of the total.

Project areas

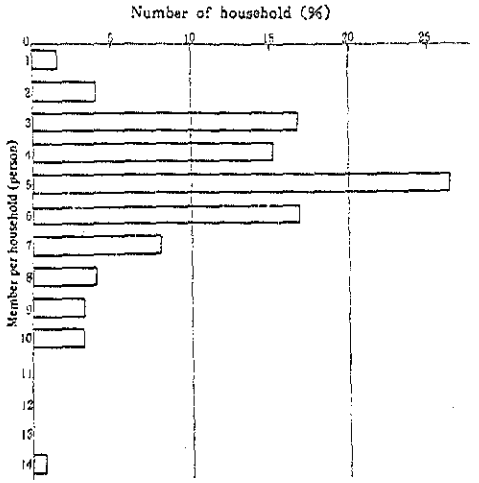


Fig. 4—3 Household Number of Each Member (125 families) Jan., 1986

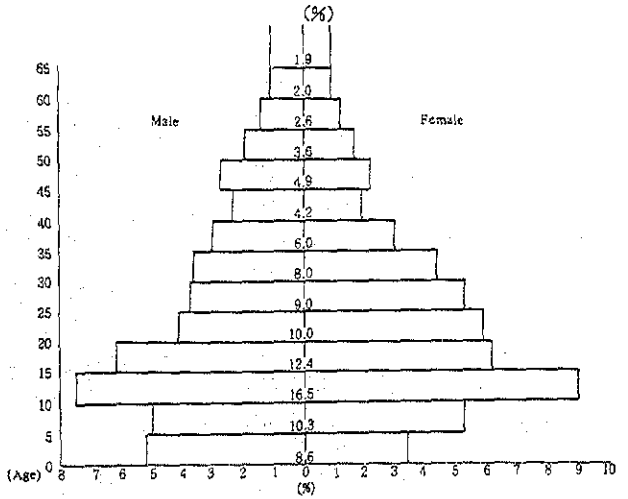


Fig. 4—4 Household Composition of Each Age Group (125 families, Total 642 persons) Jan., 1986

Model area

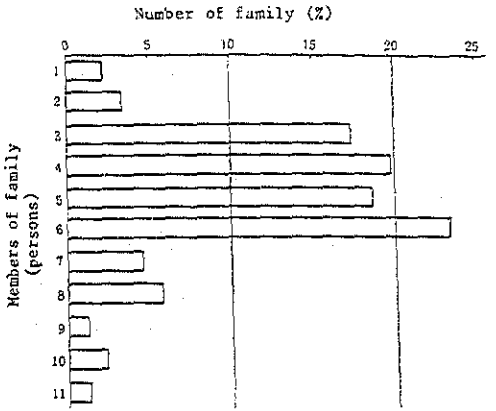


Fig. 4—5 Distribution of Families by Family size (86 families) Dec., 1986 — Jan., 1987

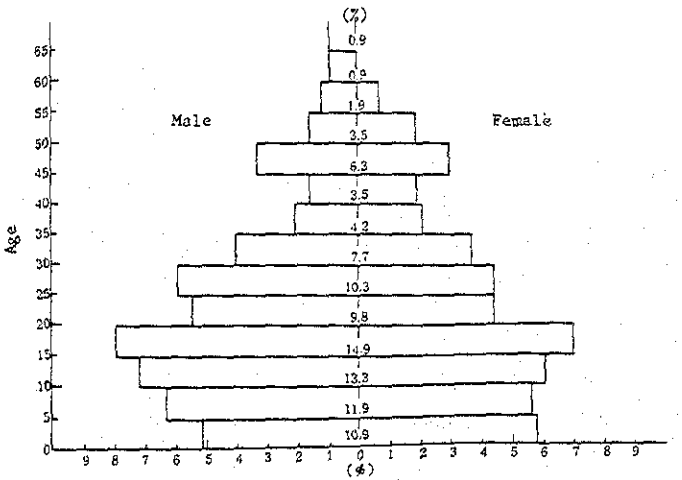


Fig. 4—6 Age Composition of Family Members (86 families, 429 persons) Dec., 1986 — Jan., 1987

Project areas	Model area
④Areas of living space and farmland The area of the residential lot of each hosehold averages 0.7 rai in the FV and 1.2 rais in the STK. As for arable land, the area taken charge of by each household (including idle land) averages approximately 19.5 rais in the FV and 32.6 rais in the STK.	④Areas of living space and farmland The average living space is 267.7 wah² (0.67 rai) per family. Altogether 69 farm households own farmland totalling 3,085 rais, averaging 44.7 rais per household. 11 families operate farming on leased farmland totalling 125 rais, averaging 11.4 rais per family. Of all the families surveyed (86 families), 78 families actually cultivate their farmland. The total area of farmland actually cultivated by owner farmers and tenant farmers is 1,216.1 rais, averaging 15.6 rais per cultivating farm household. Most of the farm land is upland fields, with only a few water paddy fields.
⑤Annual cash income The breakdown of the annual average cash income of each household of the FV consists of 9,380 bahts of farming income, 6,227 bahts of labour wage income (RFD, FIO), and 4,119 bahts of other incomes. On the other hand, in the STK farming income amounts to 18,000 bahts and other incomes amounts to 14,668 bahts.	⑤Annual cash income The average annual cash income of all the families surveyed (86 families) is 9,514.3 bahts, consisting of 4,529.4 bahts from sales of farm products and 4,984.9 bahts from non-farm employment. The average annual cash farm income of 79 farm households is 4,930.8 bahts, consisting of 4,829.5 bahts from sales of farm products and 101.3 bahts from sales of livestock products.

Project areas

⑤Household economy

a. Rice consumption

The consumption of polished rice in each household amounts to 18.8 kg／week in average, which corresponds to an annual consumption of 980.8 kg.

b. Cash outlay on food

The cash expenditure on food of each household averages 162.1 bahts per week, which corresponds to 8,452.4 bahts per year.

c. Fuel consumption

Two types of fuel, firewood and charcoal, are being used in the surveyed areas. The form of use and form of acquisition of these types of fuel differ according to the area and the household.
The relevant data arranged by area are shown in Table 4−8.
The annual consumption of solid wood on average is 1.020 ㎥ per family for firewood and 2.777 ㎥ per family for charcoal. The annual consumption of firewood and charcoal per capita is 0.744 ㎥.

Table 4 − 8 Form of Acquisition of Each Fuel

Division		Number of surveyed family	Firewood			Charcoal		
			Total	Collection	Purchase	Total	Home-made	Purchase
Survey Area	Chiang Mai	14	13 92.9	13 92.9	0	6 42.8	4 28.6	2 14.3
	Prachin Buri	31	12 38.7	12 38.7	0	28 90.3	25 80.6	3 9.7
	Saraburi	30	3 10.0	3 10.0	0	27 90.0	25 83.3	2 6.7
	Kanchanaburi	50	8 16.0	8 16.0	0	48 96.0	39 78.0	9 18.0
Project	Forest Village	81	26 32.1	26 32.1	0	62 76.5	55 67.9	7 8.6
	Sor Tor Kor	44	10 22.7	10 22.7	0	47 106.9	38 86.4	9 20.5
Whole area		125	36 28.8	36 28.8	0	109 87.2	93 74.4	16 12.8

(Upper row : Household number)
Lower row : %
(Contain plural answer)

Model area

⑥Household economy

a. Rice consumption

Polished rice consumption per family is 16.3 kg per week on average, which is equivalent to 849.9 kg per year. Assuming that hulling yield is 80% and polishing yield is 94%, 849.9kg of polished rice is equivalent to 1,130.2 kg of unhulled rice.

b. Cash outlay on food

Cash outlay on food per family is 162.9 bahts per week on average, which is equivalent to 8,494.1 bahts per year.

c. Fuel consumption

Two kinds of fuel, firewood and charcoal, are used.
The usage mode and method of acquisition vary depending on each village and each family. As shown on Table 4 −9, some families use only charcoal, some use only firewood and some use both, but the families which use charcoal account for 70.9% of all the families surveyed which is much larger than the percentage of families which use firewood. Firewood is gathered by the families themselves, and charcoal is also produced domestically.
The annual consumption of solid wood on average is 1.632 ㎥ per family for firewood and 2.460 ㎥ per family for charcoal. The annual consumption of firewood and charcoal per capita is 0.705 ㎥.

Table 4 − 9 Method of acquisition of Each Fuel
(86 surveyed families)

Division	Firewood			Charcoal		
	Total	Collection	Purchase	Total	Home-made	Purchase
Number of family	29	29	0	61	57	4
%	33.7	33.7	0	70.9	66.3	4.6

Contain plural answer

Project areas

⑦Prevalent state of agriculture and livestock raising

a. Livestock production

The main types of livestock raised in the survey area are bovines, swines, gallinaceous, water buffaloes, and ducks. Of these livestocks, gallinaceous and ducks are raised mainly for home consumption, and water buffaloes are used as farming workforce. Bovines and swines are marketed and the income they bring about accounts for 90 % of the stockbreeding income of both FV and STK.
(Refer to Table 4−10 and Fig. 4−7)

Table 4−10 Production of Livestock Products in FV and STK.
(Number of surveyed families:125)

Kind of livestock	Actual raising quantity	Annual cash income	
		bahts	%
Bovine	172	52,900	63.7
Swine	26	22,900	27.6
Gallinaceous	1,872	4,200	5.1
Water buffalo	95	3,000	3.6
Duck	104	0	0
Other poultry	10	0	0
Total		83,000	100.0

Model area

⑦Prevalent state of agriculture and livestock raising

a. Livestock production

The major livestock in the model area are cattle, water buffaloes, chickens and ducks. As shown in Table 4−11, 67 families out of 86 families surveyed are raising chickens and ducks solely for self-consumption. Very few farm households raise cattle and water buffaloes. Inhabitants in this area are not strongly oriented towards stock raising.

Table 4−11 Livestock Production in the Model Area
(86 surveyed families)

Year:1986

Kind of livestock	Actual raising quantity	Annual cash income		Raising family	
		bahts	%	number	%
Cattle	2	8,000	100.0	1	1.2
Water buffalo	1	0	0	1	1.2
Chicken	902	0	0	59	68.6
Duck	42	0	0	8	9.3
Total		8,000	100.0	69	

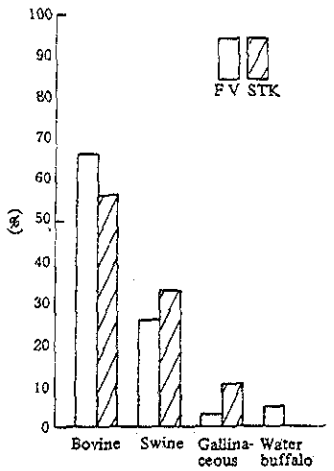
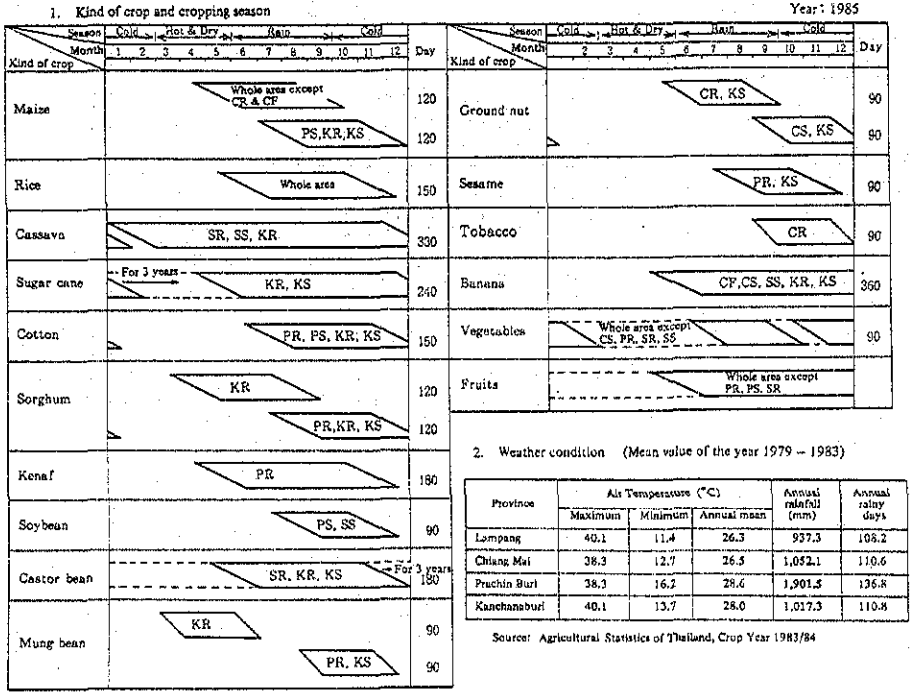
Project areas	Model area
 Fig. 4−7 Annual Cash Income from the Livestock Product of 125 Families (year 1985)	
b. Farm crop production The planting seasons of the crops and the weather conditions in the survey areas are shown in Table 4−12. The planting seasons of the crops are concentrated in the rainy season, because there is no irrigation in the survey areas, and there is a heavy reliance on natural water. In general, dry field crops such as maize, cassava, sorghum, etc., with small water requirement are planted in these areas. The main cash crop is maize, and it accounts for approximately half of the annual cash income of the farmers. As for the cash income per rai, tobacco outnumbers by far all other crops as shown in Fig. 4 −8, indicating the nature of its intensive-cultivation, but in general the amount of cash income brought about by other crops is poor, and the sums corresponding to rice, banana and fruits are conspicuously low because they are used mainly for home consumption.	b. Farm crop production The cropping seasons and the climatic conditions in the model area are as shown in Table 4 −13. As no irrigation facilities are available the only water supply that can be relied upon is that provided by natural conditions, the cropping seasons are concentrated in the rainy season. As can be seen from Table 4 −14, dry field crops such as maize and castor beans which require little water except in the case of rice are mostly planted. Major cash crops are maize and castor beans, which together account for most of the annual cash revenues from sales of farm products. As can be seen from Fig. 4−9, annual cash revenues per rai are extremely high for peppers and groundnuts but generally low for other crops. As only a very few fruit trees have reached the economically productive age, fruit production and income from them are quite low despite the large planted area.

Table 4—12 Cropping Seasons and Weather Conditions in the Survey Area

1. Kind of crop and cropping season

Year: 1985



2. Weather condition (Mean value of the year 1979 – 1983)

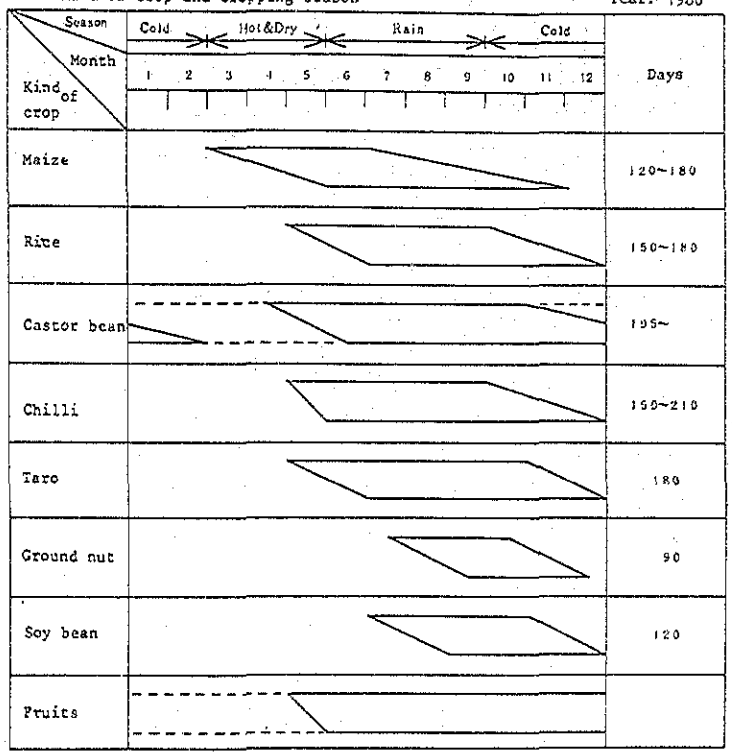
Province	Air Temperature (°C)			Annual rainfall (mm)	Annual rainy days
	Maximum	Minimum	Annual mean		
Lampang	40.1	11.4	26.3	937.3	108.2
Chiang Mai	38.3	12.7	26.5	1,052.1	110.6
Prachin Buri	38.3	16.2	28.6	1,901.5	136.8
Kanchanaburi	40.1	13.7	28.0	1,017.3	110.8

Source: Agricultural Statistics of Thailand, Crop Year 1983/84

Table 4—13 Cropping Seasons and Climatic Conditions in the Model Area

1. Kind of crop and cropping season

Year: 1986



2. Climatic Conditions

Met. office	Air Temperature (°C)			Annual rainfall (mm)	Annual rainy days (days)	Remarks
	Maximum	Minimum	Annual mean			
Srinagarind Dam	31.0	22.0	26.5	998.1	133	1981–1985
Si Sawat	33.2	19.6	26.5	998.2	122	1983–1985

Project areas

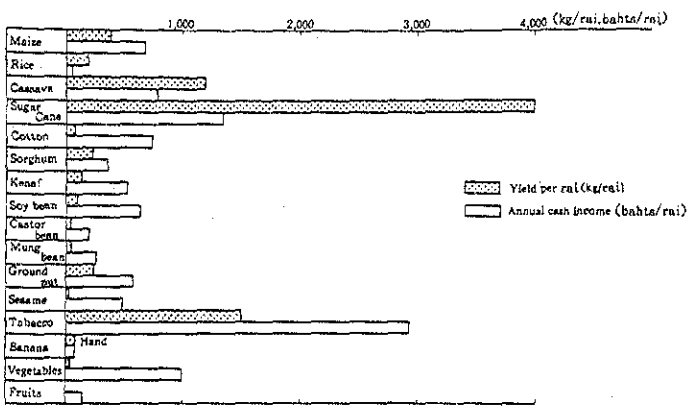


Fig. 4—8 Yield per rai and Annual Cash Income of Each Kind of Crop

Year: 1985

Model area

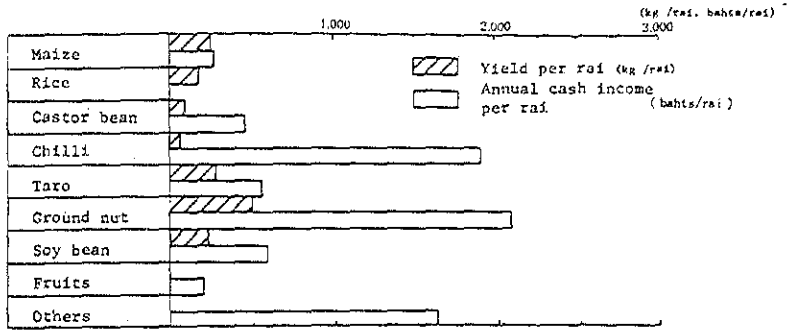


Fig. 4—9 Yield and Annual Cash Income per rai of Each Kind of Crop

Year: 1986

Table 4—14 Farm Crop Production in the Model Area (86 surveyed families)

Year: 1986

Kind of crop	Planted area (rais)	%	Seed quantity (Kg)	Seed cost (bahts)	%	Yield (Kg)	Annual cash income (bahts)	%	Yield per rai (Kg /rai)	Annual cash income per rai (bahts/rai)	Number of cropping family	%	Planted area per family (rais)
Maize	492.0	34.0	2,016.0	5,375	8.5	126,620	134,306	35.2	257.4	273.0	33	38.4	14.9
Rice	357.0	24.6	4,441.0	4,030	6.3	68,724	0	0	192.5	0	46	53.5	7.8
Castor bean	168.6	11.6	459.7	12	0.1	15,986	78,564	20.6	94.8	466.0	28	32.6	6.0
Chilli	20.5	1.4	20,550 plants	0	0	1,200	39,300	10.3	58.5	1,917.1	7	8.1	2.9
Taro	12.0	0.8	54.0	0	0	3,400	6,800	1.8	283.3	566.7	3	3.5	4.0
Ground nut	9.0	0.6	45.0	25	0.1	4,520	18,920	5.0	502.2	2,102.2	3	3.5	3.0
Soy bean	4.0	0.3	14.0	—	—	520	2,440	0.6	130.0	610.0	2	2.3	2.0
Fruits	372.0	25.7	—	52,224	82.5	—	78,200	20.5	—	210.2	6	7.0	62.0
Others	14.0	1.0	—	1,600	2.5	—	23,000	6.0	—	1,642.9	3	3.5	4.7
Total	1,449.1	100.0		63,266	100.0		381,530	100.0			131		

Planted area: Total planted area included intercrop and mixed cropping.

Project areas	Model area
⑧Awareness of inhabitants (Refer to Fig. 4−10)	⑧Awareness of inhabitants (Refer to Fig. 4−11)
a. Previous occupation	a. Previous occupation
The survey was carried out by assuming 3 types of previous occupations, farmer, worker and others. The survey results indicate that in FV formers account for 64.2% of the total in terms of farmer occupation of the residents, workers 27.1% and others 6.2%, while in STK these percentages are 63.6%, 18.2% and 2.3%, respectively.	Inhabitants' previous occupations were surveyed under the three classifications of full-time farmers, part-time farmers and non-farmers, indicating that full−time farmers accounted for 39.5%, part-time farmers for 41.9% and non-farmers for 17.4%.
b. Adequacy of the size of farmland	b. Adequacy of the size of farmland
The area of arable land taken charge of by the farmers in the survey area amounts to 19.5 rais per household in FV and 31.6 rais per household in STK. In FV 24.7% of the households possess 30.5 rais and regard the situation as satisfactory, while 65.4% regard the situation as insufficient and think that it is necessary to have 35.8 rais in average. On the other hand in STK 47.7% possess 41.6 rais and regard the situation as satisfactory, while the 36.4% regarding the situation as insufficient think that it is necessary to have an area of 35.0 rais.	To the question of whether the size of farmland was adequate, 55.8 of all the families surveyed answered that it was adequate whereas 43.0% answered inadequate. The average size of farmland desired by the inhabitants who answered inadequate is 41.1 rais per family.
c. Water supply for the cultivated land and living quarters	c. Water supply for the cultivated land and living quarters
Water for agricultural use consists of natural water brought about by rainfall, and there are no irrigation facilities. Under the present circumstances, the crops are influenced every year by the weather conditions, and there is no dry season crop in the various survey areas.	Most of the inhabitants answered that water supply for the cultivated land was ample. As for water supply to the living quarters 51.1% of the inhabitants answered that it was inadequate and 47.7% sufficient.

Project areas

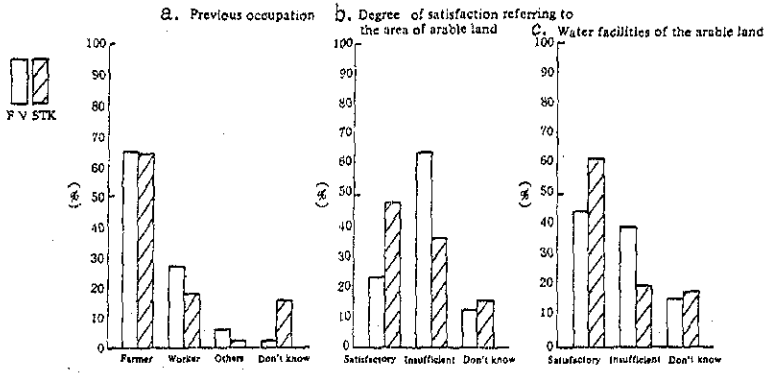


Fig. 4−10 Views of the Residents (Jan., 1986)

Model area

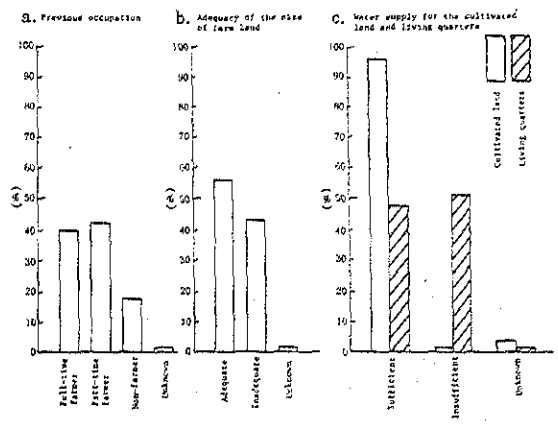


Fig. 4−11 Awareness of Inhabitants (Dec., 1986−Jan., 1987)

(4) Comments

Project areas

The points at issue and the required improvements indentified as a result of the study carried out this time are mentioned in the following.

From the standpoint of age groups of the household members, the existence of many youngsters from 10 to 14 is conspicuous both in FV and STK, and they are expected to become the mainstream of the rural workforce in the future. It must be borne in mind however that it will be difficult to retain this work force in the present place in the future. In view of the current form of operation of the agriculture and the absence of promising local industries, and therefore there is a risk of their outflow to the urban areas in season of jobs. As for cash crops cultivated in the survey area, they consist mostly of extensive farming products requiring a small workforce, with the exception of tobacco. Moreover, the distribution of work throughout the year is uneven, because the season of cultivation of the crops is concentrated in the rainy season.

Model area

For farm crop cultivation, flat land and gentle sloped land are used. In general, farm land is cultivated perennially, but if the size of land holdings is large, a part of it is fallowed after a few years of cropping and cultivation is shifted to some other new place within the holdings.

Inhabitants living inside the model area obtain cash income from cultivation of such crops as maize and castor beans and from hired labour during the dry season.

Agriculture in this area is operated by family labour which employs conventional farming methods so that its productivity is low. The daily wage of a hired labourer is around 30 to 40 bahts (1 US $ equals around 25 bahts). Also, no rice cropping for home consumption can be observed within the designated area of the National Park.

Project areas	Model area
From the results of the investigation into the views of the residents, it is presumed that the desired area of arable land is approximately 35 rais both in FV and STK. The rice cultivation area required to cope with the home consumption of each household, calculated from the rice consumption per household in terms of unhulled rice (1,303.6 kg) and the yield per rai (187.7 kg), is 6.9 rais. Under the circumstances it is necessary to introduce intensive-cultivation type crops and dry-season crops in order to increase the annual cash income per unit area and to make the demand of labour throughout the year more even. As for the production of livestock products, raising gallinaceous and swines, that become protein sources for home consumption, and water buffaloes, that are used in farming work, is desirable, but on the other hand raising cattle for meat production should be limited from the standpoint of efficient land use, because it requires large land areas. From the standpoint of previous occupations, the absolute majority of the residents of the survey area are former farmers, but on the other hand it must be borne in mind that 33.3% of residents of the FV were engaged in occupations other than agriculture, and therefore guidance and aid related to farming operation and cultivation techniques will be required after their settlement. Moreover, in connection with the cultivation method, it is desirable to avoid the burning of the vegetation in the dry season, which is presumed to cause losses of organic matters in the soil, because the degree of fertility of the soil is generally low.	As a result, the income level of the inhabitants of the model area is low, and the ratio of cash outlay for food to their annual cash income is extremely high. From the results of the current survey, it was found that the planted area of rice per rice cultivating family (46 families) is 7.8 rais while the necessary area for cultivating rice for home consumption is 5.9 rais when calculated from the unhulled rice requirement of 1,130.2 kg obtained by converting the annual rice consumption per family and yield per rai of 192.5 kg. The average area of cultivated land per farming family (79 families) is 15.6 rais, which is almost equal to the size of the farm land provided per family under the forest village program of RFD. When the age composition of the family members is reviewed, the younger generation between 5 and 19 years of age is large in number and is expected to provide the necessary labour force for the forest village program in the future. In order to distribute the annual work load more evenly and increase cash revenues, it is important to select crop species with high marketability and land productivity as well as dry season crop species and combine them properly or to induce the TAUNGYA system into the forest village program. Among the farm crops cultivated in the model area, chilli might be cited as a crop which generates high income per unit area and is also easy to cultivate. As for livestock production, raising of chickens and ducks which provide sources of protein for home consumption is desirable, but the raising of cattle which requires a large land space ought to be restricted from the viewpoint of promoting intensive use of land. As for cultivation methods, matters which ought to be considered are to avoid the burning of vegetation on the cultivated land because this practice causes the loss of organic matters in the soil, and to introduce perennial crops as they serve to retain the fertility of soils.

4.4 Forest Inventory

(1) Sample plot survey

The forest survey by sample plot survey was carried out with the object of clarifying the actual state of the forest, drawing up the criteria for forest classification in terms of type and form and obtaining the basic information for formulating the forest management plan.

① Sample plot allocation

The sample plots were set up at each stand belonging to distinct classes of forest type and form (according to the classification criteria) within the model area, a stand which was logged recently in a logging block outside the model area and a stand under operation of logging in a logging block outside the model area.

Number of sample plots in each logging block is as follows: (refer to Table 4-15)

Table 4−15 Number of Sample Plots Surveyed

(unit:plots)

	Logging block	1985/86 survey	1986/87 survey	Total	
inside model area	Logging block 1 (operated 24-26 years ago)	9 plots	4 plots	13	
	Logging block 2 (operated 21-23 years ago)	16 〃	3 〃	19	
	Logging block 3 (operated 18-20 years ago)	4 〃	1 〃	5	50
	Logging block 4 (operated 15-17 years ago)	6 〃	−	6	
	Logging block 5 (operated 12-14 years ago)	7 〃	−	7	
outside model area	Logging block 7 (operated 6- 8 years ago)	−	2 plots	12	
	Logging block 8 (operated 3- 5 years ago)	−	6 〃		
	Logging block 9 (operated 0- 2 years ago)	−	4 〃		

② Size and form of the sample plot

The sample plot has rectangular form with 250m ×40m (1 ha).

③ Survey method

All the standing trees with 46cm or more girth breast height (G.B.H.) in the sample plot was surveyed one by one. The investigation items are as follows.

a. Tree species

All the species of trees and bamboo existing in the sample plot were surveyed, and botanical names were listed by using the manual of the forest inventory in Thailand.

b. Girth breast height (G.B.H.)

The G.B.H.is measured in 1cm unit with a girth tape. (As for bamboo, the breast height circumference is measured on each stalk).

c. Total tree height and clear length

The tree height is measured in 1m units with a height meter. The clear length is the height up to the first major branch.

d. Timber quality

The existence and kind of defect of each tree was surveyed. Kinds of defects were as follows:

Decay, Crook, Twist, Knot, Folking, Cat face, etc.

e. Canopy horizon

The canopy horizon was classified into an upper story and lower story.

f. Calculation of volume

The volume is calculated for each sample plot. The volume tables used for of calculation are those of ones currently used in Thailand.

④ Results of the sample plot survey

The results of the sample plot survey are outlined in the following, and the relevant data are summarized in Appendix Table-6.

a. Five forest types, tropical evergreen forest (T_E), mixed deciduous forest (M_D), deciduous dipterocarp forest (D_D), secondary forest (S_F) and bamboo forest (B_F) were identified. T_E is distributed mainly in flat land, and M_D and D_D are widely distributed in the whole model area. Bamboo is widely distributed, but bamboo forest which was demarcated is scattered.

b. As for the tree species, there are 15 species of DIPTEROCARPACEAE, 5 main species of useful tree (*Afzelia xylocarpa, Pterocarpus macrocarpus, Delbergia dongnaiensis, Xylia kerrii, Sindora siamensis*), 78 species classified,"others"and bamboo.

Table 4－16 Tree Species Composition by Forest Type inside the Model Area

(trees/ha)

Forest type		Sample plot		DIPTEROCARP-ACEAE	Principal species other than DIPTEROCARPACEAE						Others	Total
		Num-ber	Size (ha)		*Afzelia xylocarpa* (302)	*Pterocarpus macrocarpus* (310)	*Dalbergia dongnaiensis* (518)	*Xylia kerrii* (564)	*Sindora siamensis* (628)	Sub-total		
T_E	F	13	12.6	24.0	–	0.4	0.5	–	–	0.9	216.5	241.4
	H	–	–	–	–	–	–	–	–	–	–	–
	M	–	–	–	–	–	–	–	–	–	–	–
	Ave-rage	13	12.6	24.0	–	0.4	0.5	–	–	0.9	216.5	241.4
M_D	F	19	16.8	18.4	–	1.7	3.1	4.0	–	8.8	128.5	155.7
	H	10	8.4	27.3	0.8	2.5	5.1	7.5	–	15.9	151.2	194.4
	M	–	–	–	–	–	–	–	–	–	–	–
	Ave-rage	29	25.2	21.3	0.3	1.9	3.8	5.2	–	11.2	136.1	168.6
D_D	F	5	4.8	110.6	0.4	1.7	2.7	11.3	–	16.1	112.3	239.0
	H	3	2.2	178.2	0.5	8.2	5.0	13.6	–	27.3	152.3	357.8
	M	–	–	–	–	–	–	–	–	–	–	–
	Ave-rage	8	7.0	131.9	0.4	3.7	3.4	12.0	–	19.5	124.9	276.3
Whole average		50	44.8	39.3	0.2	1.8	2.8	4.8	–	9.6	157.0	205.9

F : Flat Land Forest H : Hilly Forest M : Mountainous Forest

Table 4—17 Compostion of DIPTEROCARPACEAE by Forest Type inside the Model Area

(trees/ha)

Forest type		Sample plot		*Dipterocarpus*				*Hopea*				*Shorea*						*Anisoptera*			*Parashorea*	*Pentacme*	Total
		Number	Size (ha)	101	521	522	Subtotal	305	529	581	Subtotal	551	566	568	571	626	Subtotal	320	303	Subtotal	317	625	
T_S	F	13	12.6					8.0	4.5	0.1	12.6	0.2			10.2		10.4		0.7	0.7	0.3		24.0
	H																						
	M																						
	Average	13	12.6					8.0	4.5	0.1	12.6	0.2			0.2		10.4		0.7	0.7	0.3		24.0
M_D	F	19	16.8	0.1			0.1	0.4	0.3		0.7				0.5	0.8	1.3		0.1	0.1		16.2	18.4
	H	10	8.4			0.1	0.1								0.1	1.2	1.3				0.1	25.8	27.3
	M																						
	Average	29	25.2	0.05		0.05	0.1	0.3	0.2		0.5				0.3	0.9	1.2		0.05	0.05	0.05	19.4	21.3
D_D	F	5	4.8			10.4	10.4									44.6	44.6					55.6	110.6
	H	3	2.2									3.2				29.5	32.7					145.5	178.2
	M																						
	Average	8	7.0			17.1	17.1					1.0				39.9	40.9					83.9	131.9
Whole average		50	44.8	1.02		1.1	1.2	2.4	1.4	0.02	3.8	0.2			3.1	6.7	10.0		0.2	0.2	0.1	24.0	39.3

Note 101 : *Dipterocarpus* spp. 521 : *Dipterocarpus obtusifolius* 522 : *Dipterocarpus tuberculutus* 305 : *Hopea odorata* 529 : *Hopea ferrea*
581 : *Hopea* spp. 551 : *Shorea talura* 566 : *Shorea leprosula* 568 : *Shorea curtisii* 571 : *Shorea gratissima* 626 : *Shorea obtusa* 320 : *Anisoptera scaphula*
303 : *Anisoptera glaba* 317 : *Parashorea stellata* 625 : *Pentacme suavis*

The said tree species composition by forest type is shown in Table 4-4. In deciduous dipterocarp forest (D_D) there are DIPTEROCARPACEAE of 132 trees per ha, and they account for 48% of all trees (46 cm and up G.B.H). There is bamboo in all kinds of forest of T_E, M_D and D_D, and the proportion of bamboos compared with forest trees is 6% in T_E, 66% in M_D and 16% in D_D. (Refer to Table4-16 and 4-17)

(2) Regeneration survey

In order to grasp the state of regeneration of saplings and obtain the basic data for the formulation of the forest management plan, a regeneration survey was conducted in survey plot.

① Survey plot

The survey plots were set up in the sample plots for forest survey. The number of survey plots is shown in Table 4-18.

Table 4-18 Number of Sample Plots for Regeneration Survey

1. Inside the model area (49 sample plots) (Unit:plot)

Logging block	1985/86 survey	1986/87 survey	Total	
Logging block 1 (operated cut 24-26 years ago)	8 plots	4 plots	12	49
Logging block 2 (operated cut 21-23 years ago)	16 〃	3 〃	19	
Logging block 3 (operated cut 18-20 years ago)	4 〃	1 〃	5	
Logging block 4 (operated cut 15-17 years ago)	6 〃	–	6	
Logging block 5 (operated cut 12-14 years ago)	7 〃	–	7	

2. Outside the model area (12 sample plots) (Unit:plot)

Logging block	1986/87 survey	Total
Logging block 7 (operated cut 6-8 years ago)	2 plots	12
Logging block 8 (operated cut 3-5 years ago)	6 plots	
Logging block 9 (operated cut 0-2 years ago)	4 plots	

② Method of sapling survey

A survey belt of 1m x 40m(=40m²) was set up at the starting point and ending point of each sample plot, and the number of saplings classified by size into the following four categories were counted.

i) Tree height less than 30 cm
ii) Tree height above 30 cm but below 130 cm
iii) Tree height above 130 cm and G. B. H. below 14 cm
iv) G. B. H. above 15 cm but below 45 cm

③ Results of the sapling survey

The results of all sample plots surveyed (a total of 61 plots inside and outside the survey area) are as follows.

(Refer to Table 4−19)

○ The number of saplings per ha was 14,900. When reviewed by size, the smallest trees of category i), with tree heightsshorter than 30 cm, accounted for about 34%, category ii), trees with tree heights shorter than 130 cm, for about 53%, category iii), trees with tree heights above 130 cm but G. B. H. below 14 cm, for about11%, and category iv), trees withG. B. H. above 15 cm but below 45 cm, for about 2%.

○ The number of saplings classified by forest type varies widely among plots, but when reviewed in terms of overall averages of all the survey plots, it was 17,645 trees/ha in T_E, 12,875 trees/ha in M_D and 16, 768 trees/ha in D_D.

According to the Table 4−19, in T_E, the number of trees decreases as they grow from shrub stage to high trees, indicating a normal plant succession.

In M_D and D_D, however, the number of trees between 30 cm and 129 cm in height is larger than that of trees below 30 cm in height. There may be various reasons for this, but on the whole, M_D and D_D are more susceptible to invasion by weeds and bamboos than T_E as they are thinner, which inhibit the germination and the growth of the saplings.

Table 4—19 Results of the Sapling Survey

1. Number of saplings for each forest type

(trees/ha)

Forest type		Sample plot		29 cm ≧ T.H.	129 cm ≧ T.H. ≧ 30 cm	T.H. ≧ 130 cm G.B.H. ≦ 14 cm	45 cm ≧ G. B. H. ≧ 15 cm	Total
		Number	Size (ha)					
T_E	F	15	0.112	9,518	5,786	2,938	643	18,883
	H	5	0.040	7,200	5,025	1,650	300	14,175
	M	—	—	—	—	—	—	—
	Ave- rage	20	0.152	8,908	5,585	2,599	553	17,645
M_D	F	23	0.172	3,477	10,732	1,419	203	15,831
	H	11	0.084	1,940	3,869	822	155	6,786
	M	—	—	—	—	—	—	—
	Ave- rage	34	0.256	2,973	8,484	1,227	191	12,875
D_D	F	5	0.040	4,425	15,300	1,375	375	21,475
	H	2	0.016	1,000	3,125	687	188	5,000
	M	—	—	—	—	—	—	—
	Ave- rage	7	0.056	3,446	11,821	1,179	322	16,768
Whole average		61	0.464	4,976	7,936	1,670	322	14,905

F : Flat Land Forest H : Hilly Forest M : Mountainous Forest

Table 4－19

2. Number of saplings for each forest type inside the model area

(trees/ha)

Forest type		Sample plot		29 cm ≧ T.H.	129 cm ≧ T.H. ≧ 30 cm	T.H. ≧130cm G.B.H. ≦ 14 cm	45 cm ≧ G.B.H. ≧ 15 cm	Total
		Number	Size (ha)					
T_B	F	13	0.096	8,846	5,528	2,923	653	17,951
	H	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—
	Average	13	0.096	8,846	5,528	2,923	653	17,951
M_D	F	19	0.140	2,868	9,875	1,151	223	14,117
	H	10	0.076	1,700	3,637	737	162	6,236
	M	—	—	—	—	—	—	—
	Average	29	0.216	2,465	7,728	1,012	206	11,411
D_D	F	5	0.040	4,425	15,300	1,375	375	21,475
	H	2	0.016	1,000	3,125	688	187	5,000
	M	—	—	—	—	—	—	—
	Average	7	0.056	3,446	11,821	1,179	321	16,767
Whole average		49	0.368	4,298	7,729	1,543	321	13,911

F : Flat Land Forest H : Hilly Forest M : Mountainous Forest

Table 4－19

3. Number of saplings for each forest type outside the model area (trees/ha)

Forest type		Sample plot		29 cm ≦ T.H.	129 cm ≦ T.H. ≦ 30 cm	T.H. ≧ 130cm G.B.H. ≦ 14cm	45 cm ≦ G.B.H. ≧ 15 cm	Total
		Number	Size (ha)					
T_S	F	2	0.016	9,125	4,562	1,562	250	15,499
	H	5	0.040	7,200	5,025	1,650	300	14,175
	M	—	—	—	—	—	—	—
	Average	7	0.056	7,750	4,892	1,625	285	14,552
M_D	F	4	0.032	5,062	10,781	2,156	31	18,030
	H	1	0.008	3,375	4,250	1,250	—	8,875
	M	—	—	—	—	—	—	—
	Average	5	0.040	4,725	9,475	1,975	31	16,206
D_D	F	—	—	—	—	—	—	—
	H	—	—	—	—	—	—	—
	M	—	—	—	—	—	—	—
	Average	—	—	—	—	—	—	—
Whole average		12	0.096	6,490	6,802	1,771	177	15,240

F : Flat Land Forest H : Hilly Forest M : Mountainous Forest

4.5 Soil Survey

(1) Survey outline

In order to classify the distribution of soil, a soil survey was conducted on the forest lands of the hillside slopes on the flat lands, on cultivated lands in the model area, in the planted forests, and the cultivated lands in neighbouring areas of the model area. The soil survey was a simple profile survey and was necessary to establish the boundaries of soil classification. The items of the soil profile survey are: The classification of horizon, thickness of horizon, state of transition of horizon, soil color, humus, texture, structure, gravel, hardness, moisture, leaching and accumulation, mycorrhiza and mycelium, roots, state of Ao horizon, pores, gleyzation, biological remains, mottle and concretion, water table and in addition the pH value was measured as needed.

The soil profile survey was conducted at 74 spots within the model area, 15 spots outside the model area, a total of 89 spots. The results of the soil profile survey are shown in Appendix Table－7.

In addition the texture and chemical properties of typical soil types were analyzed.(refer to Appendix Table－8)

(2) Approximate soil distribution in the model area

The topography of the model area may be roughly divided into the steep mountainous zone consisting of limestone, the flat land, and the gently sloped hill land.

Specifically, outcropping rocks and boulders are found everywhere in the steep mountainous zone which is distributed with quite shallow layers of Lithosols (I) and Rendzinas (E). The hill land zone is distributed with Cambisols (B) or Luvisols (L) with slight argillation, while the flat land is distributed with quite a thick layer of highly productive Nitosols (N). Their rough horizontal distribution is as shown on Fig. 4－12. Naturally, soils with intermediate characteristics occur near the boundaries of each type of soil. (Refer to Appendix Fig.-4 Soil Map)

Every one of these soils distributed in the model area is slightly clayey, but weakly acidic soil with a high degree of base saturation which contains a lot of weatherable minerals and organic matters which supply plant nutrients in abundance and which thus greatly affect the fertility and productivity of soil.

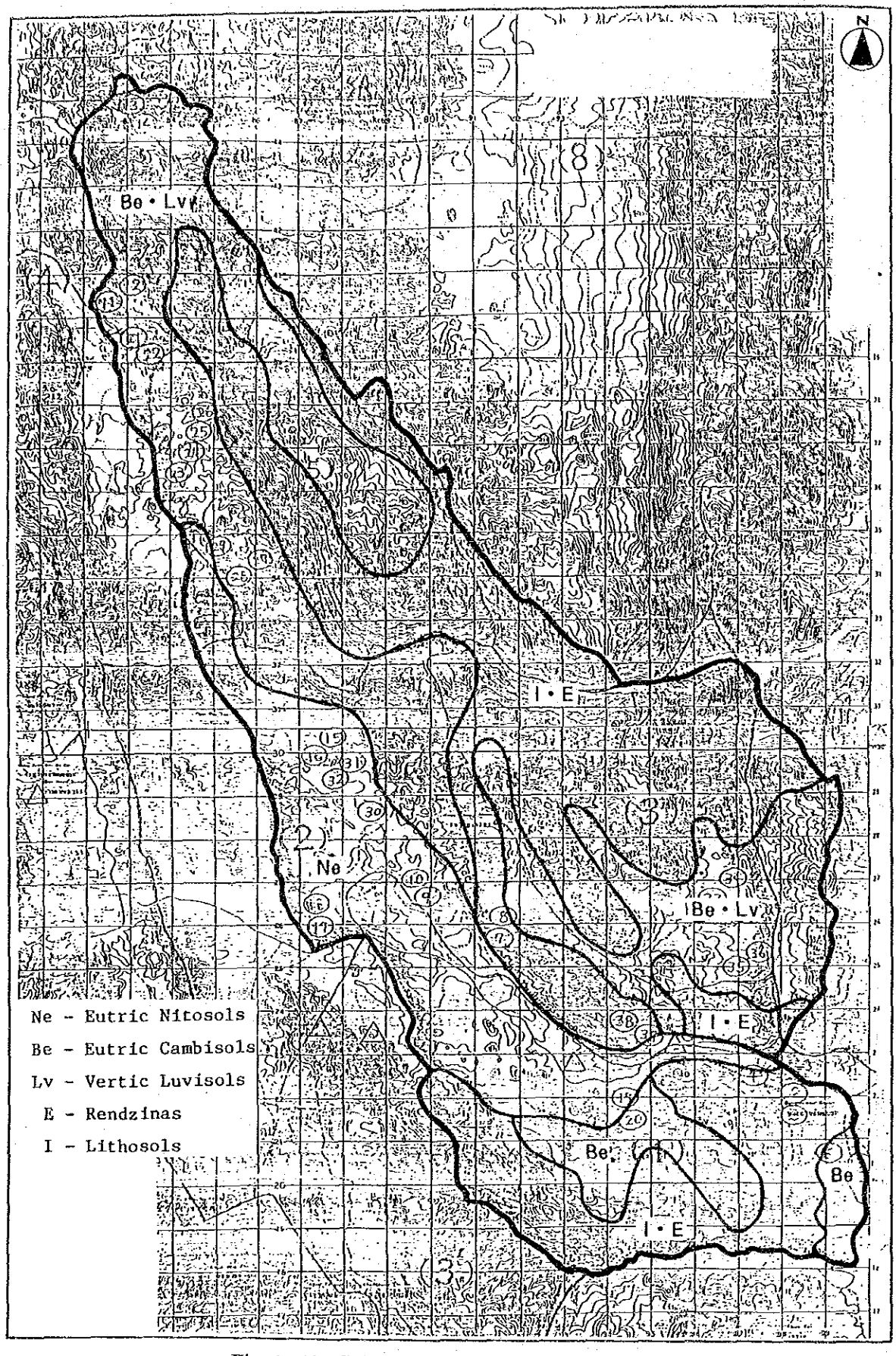


Fig. 4—12 Soil Distribution in the Model Area

(3) Characteristics of the soils distributed in the model area

① Nitosols (N) [USA Soil type - Rhodustalfs]

This soil is mainly distributed in the flat land in the southwestern part of the model area.

The parent materials of this soil are considered to be the thick sedimentary layer of weathered limestones added with shale, sandstone, chert, etc.

It has an extremely deep soil horizon, is red to red brown in color, is slightly clayey and has an argillic B horizon.

It shows a porous, well drained, deep and uniform profile. Its root system is deep, has a high water holding capacity and rich basic parent material and still retains weatherable minerals, so that it has good potential use for agriculture and forestry.

Nitosols is considered to be one of the best soils in the tropical zone and suitable for cultivation of a broad range of crops. It has a relatively high natural fertility, and Ne-s in particular has the largest potential for agriculture among soils distributed in the model area. In order to achieve high yield, however, fertilization is considered necessary in most cases, and its conservation is also considered necessary as it is slightly susceptible to erosion.

Here, Eutric Nitosols (Ne) which has a higher degree of base saturation than other types of Nitosols is distributed. Even among the same Eutric Nitosols (Ne), however, distinctive differences can be found in the color and firmness.

Firmness in particular is considered to have a large influence on farming, Eutric Nitosols is further subdivided into the two sub-groups. Characteristics of each sub-group are as follows.

a. Ne-soft(s)

- Mainly distributed in very flat land.
- It is of a strongly reddish color between 2.5 YR and 10R in hue.
- Its profile is homogeneous with hardly any change, and is soft overall.
- The value indicated by a hardness meter is around 10 mm for the soft layer and in the range of 26 to 29 mm even for the hardest layer.
- Its soil property is clayey and contains no stones.

b. Ne-firm (f)

○ Mainly distributed in places with slight topographical changes such as in the peripheries of flat land or in slightly undulating places of flat land.

○ Its hue ranges between 5 and 2.5 YR and is slightly more brownish than Ne-s, and its profile also shows some changes.

○ Ne-f deeper than 70 - 80 cm from the top soil is approximately the same as Ne-s but the shallower layers are harder than Ne-s.

○ The value indicated by a hardness meter ranges around 22 - 33 mm.

○ The soil property is clayey, but locally contains slightly more sandy layers sometimes. Stones are not contained.

② Cambisols

It is widely distributed in the hill land and mountainous zone throughout the entire model area. Cambisols display diverse profiles. Here, Eutric Cambisols (Be) with a high degree of base saturation and high organic contents is mainly distributed.

There are the residual type and the colluvial type of Eutric Cambisols, since these two types have greatly different profile and are considered to be considerably different in productivity, Eutric Cambisols were further subdivided into three sub-groups such as Cambisols-colluvial (Be-c), Cambisols-residual (Be-r) and Gleyic Cambisols (Bg) which is the type in between Be-c or Be-r and Gleysols. Characteristic of each sub-group are as follows.

a. Be-colluvial (c) (USA Soil type - Eutropepts)

○ Distributed from the lower part of the mountain slope toward the mountain spur in the steep mountainous zone.

○ It is a coulluvial type of soil

○ It has a high degree of base saturation and a well developed soil structure.

○ It has an A horizon (Mollic A horizon) which contains a lot of organic matters which have been completely blended with mineral substances and is black to dark brown in color and as thick as 30 to 50 cm, as well as a B horizon which is dark reddish brown to dark brown and contains a lot of organic matters.

○ Its textural classes are clay loam to clayey and it sometimes contains half-weathered or decayed fine stone but the quantity is small.

○ Value indicated by a hardness meter roughly ranges between 25

mm or about 14 kg/cm² to 32 mm or about 63 kg/cm²

o As its rooting system is deep and a lot of organic matters and weatherable minerals are contained, its productivity is high so that it is considered usable for both agriculture and forestry.

b. Be-residual (r) [USA Soil type - Eutrochrepts]

o Be-r is widely distributed in the hill land zone which is considered to be the remnants of old mountain tops, as stated already.

o It is a residual type of soil which was presumably formed by the in situ weathering of limestone parent material.

o It has a black-brown A horizon and a reddish brown B horizon.

o Soil horizon is relatively deep, and the whole profile is compact and quite firm particularly in the layer around 30 to 40 cm deep from the top soil which seems to be limiting the growth of roots.

o The value indicated by the hardness meter is around 26 mm in the soft layer and around 33 mm in the hard layer.

o The texture is clay loam to clayey and sand particles sometimes remain in part. Sometimes, it also contains half-weathered or decayed fine stone although the quantity is small.

o It is usable for both agriculture and forestry but as its rooting area is not large, its productivity is considered inferior to Ne-s, Ne-f and Be-c.

c. Gleyic Cambisols (Bg) [USA Soil type - Aquic Eutrochrepts]

o Gleyic Cambisols is cambisols with hydromorphic properties found in the topsoil and layers down to the depth of 100 cm, and is distributed in places where the ground water level is high or where there is plenty of water like dales and depressions.

o In agriculture, therefore, crop species that can be cultivated are slightly restricted. In forestry, however, no major restriction seems to exist.

③ Luvisols (L) [USA Soil type - Vertic Haploxeralfs]

This type of soil is distributed intermittently on flat or gently sloped areas of the hill land. Luvisols is a clayey soil characterized by having a distinctive argillic B horizon which occurs in accompaniment to the abrupt changes in the soil structure and by a high degree of base saturation. Here, vertic Luvisols (Lv) which belongs to the category of Luvisols is distributed.

Vertic Luvisols is a type of Luvisols in which cracks develop from the dark-brown A horizon to the reddish brown B horizon during the dry season and which has slightly vertic properties.

The soil texture of A horizon which is about 30 cm thick is clay loam while that of B horizon is clayey, both of which contain hardly any stone.

As it has a high degree of base saturation and abundant organic matters, its productivity is inferior to Nitosols and Cambisols since its permeability and drainability are lowered and the growth of roots is restricted by the argillic B horizon.

Since the growth of roots is restricted at around 30 cm in depth, its use for forestry becomes slightly disadvantageous compared to its use for agriculture or for livestock raising.

④ Rendzinas (E) and Lithosols (I) (USA Soil type
— Rendolls & Lithic subgrous)

Both of these soils are distributed in the steep mountainous zone and partly in the gently sloped area of the spur zone.

These are shallow soils which lie on calcareous rocks having Mollic A horizon only (refer to the section on Cambisols stated previously) and no B horizon, and contain rocks, boulders and a lot of stones.

Soils with soil horizon of less than 10 cm in thickness were defined as Lithosols and distinguished them from Rendzinas which were defined as soils having more than 10 cm thick soil horizon. Also, even if the thickness of soil horizon is less than 10 cm, if the base rock is neither rock nor rock bed but conglomerate, such soils were defined as Rendzinas. Although they are named differently, there is no difference between the two in terms of soil color, textural classes, soil structure and organic matter contents, etc. The distinction was made only because of the difference in the thickness of their soil horizon. It is only natural however that Lithosols should contain many more rocks and boulders than Rendzinas.

These soils have a high degree of base saturation and contain a lot of organic matters and weatherable minerals. But in the soil horizon is thin. Accordingly there is little hope for them to be utilized for agriculture and forestry and these soils can be utilized for grazing on gently sloped areas of land.

It is also considered possible to grow cotton and chilli in places which are gently solped and where the soil horizon is of a reasonable thickness (50 to 70 cm).