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THE KINGDOM OF THAILAND  
MINISTRY OF AGRICULTURE AND COOPERATIVES  
DEPARTMENT OF LAND DEVELOPMENT

THE MASTER PLAN STUDY  
ON  
THE INTEGRATED RURAL DEVELOPMENT  
OF SALT-AFFECTED LAND IN NORTHEAST THAILAND

MAIN REPORT

OCTOBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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## P R E F A C E

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a master plan study on the Integrated Rural Development of Salt-Affected Land in Northeast Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

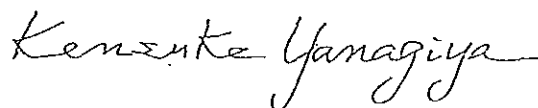
JICA sent to Thailand a study team headed by Mr. Fumimichi Obu, Sanyu Consultants Inc., four times between March 1990 and August 1991.

The team held discussions with the officials concerned of the Government of Thailand and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

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

October, 1991



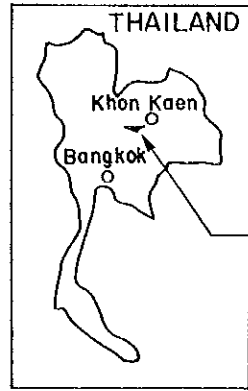
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Kensuke Yanagiya

President

Japan International Cooperation Agency

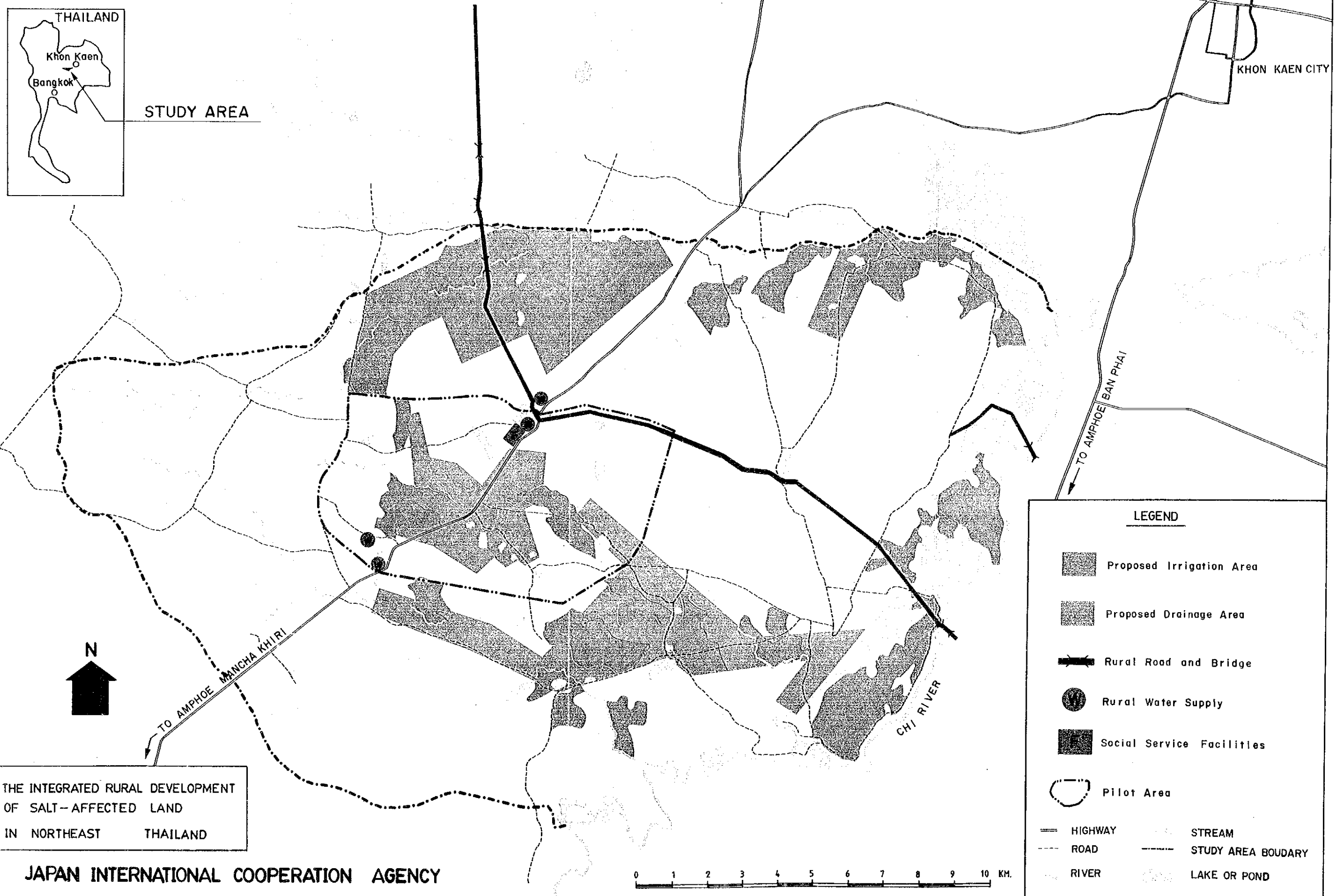
# GENERAL PLAN



STUDY AREA

← TO AMPHOE BAN FANG

KHON KAEN CITY



THE INTEGRATED RURAL DEVELOPMENT  
OF SALT-AFFECTED LAND  
IN NORTHEAST THAILAND

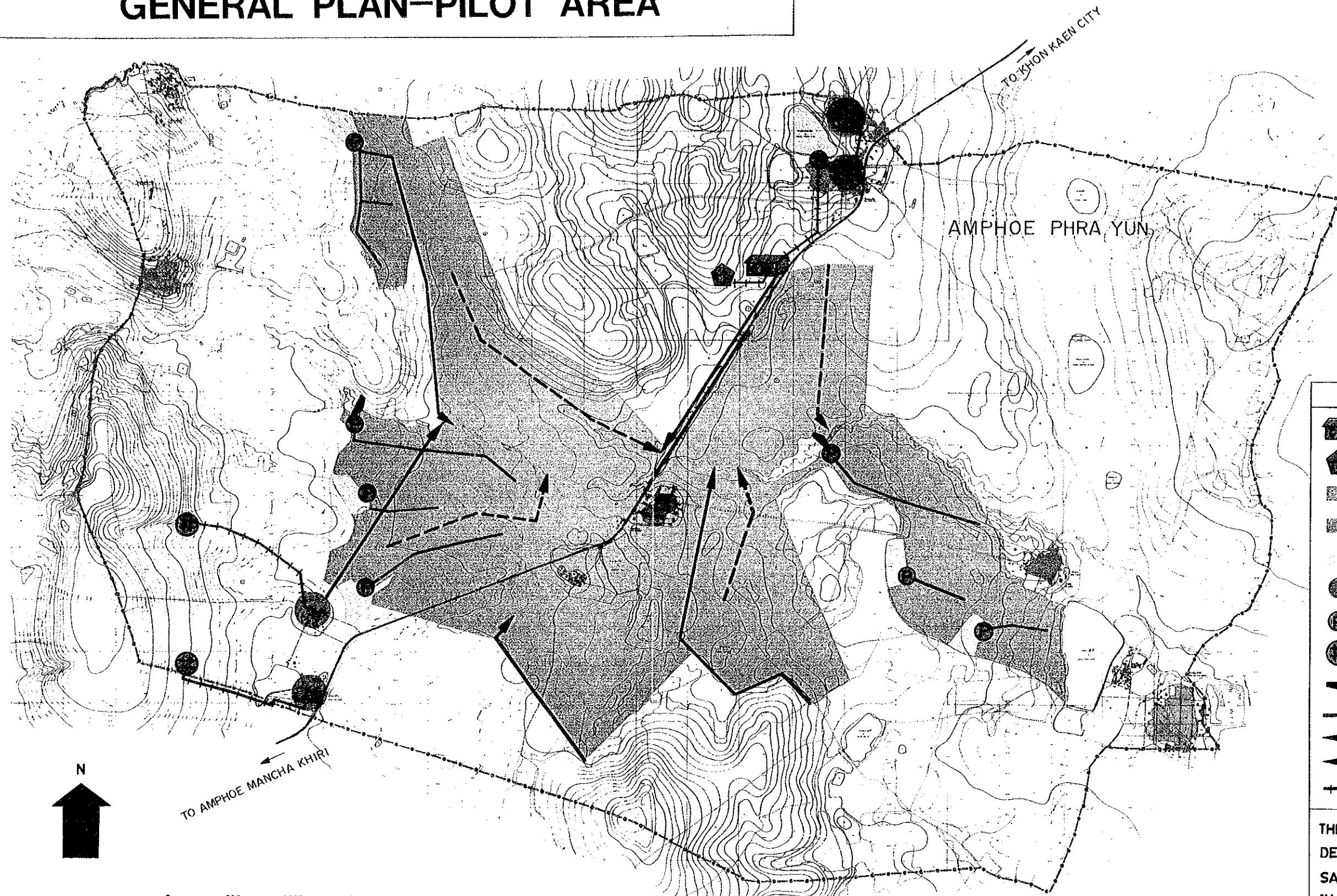
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**LEGEND**

- Proposed Irrigation Area
- Proposed Drainage Area
- Rural Road and Bridge
- Rural Water Supply
- Social Service Facilities
- Pilot Area
- HIGHWAY
- ROAD
- RIVER
- STREAM
- STUDY AREA BOUDARY
- LAKE OR POND

# GENERAL PLAN-PILOT AREA



## LEGEND

- Central Market
- Training Facilities
- Proposed Irrigation Area
- Proposed Drainage Area
- Storage Pond
- Water Supply Area
- Pumping Station
- Well
- Weir
- Irrigation Canal
- Interceptor Drain
- Field Drain
- Pipe Line

THE INTEGRATED RURAL  
DEVELOPMENT OF  
SALT-AFFECTED LAND  
IN NORTHEAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY  
( J I C A )

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## ABBREVIATIONS, UNITS AND GLOSSARIES

### ABBREVIATIONS

#### (Thai Organization)

ADRC	:	Agricultural Development Research Center
ARD	:	Accelerated Rural Development
BAAC	:	Bank of Agriculture & Agricultural Cooperatives
DLD	:	Department of Land Development
DMR	:	Department of Mineral Resources
DOA	:	Department of Agriculture
DOAE	:	Department of Agriculture Extension
DOF	:	Department of Fisheries
DTEC	:	Department of Technical and Economic Cooperation
KKU	:	Khon Kaen University
LDD	:	Livestock Development Department
MOAC	:	Ministry of Agriculture & Cooperatives
MOI	:	Ministry of Interior
NEA	:	National Energy Authority
NEB	:	National Environmental Board
NESDB	:	National Economics and Social Development Board
RFD	:	Royal Forestry Department
RID	:	Royal Irrigation Department

#### (General)

EL	:	Elevation
F/S	:	Feasibility Study
GDP	:	Gross Domestic Product
GNP	:	Gross National Product
M/P	:	Master Plan
NPV	:	Net Present Value
MSL	:	Mean Sea Level

### UNITS

B	:	Baht
mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
ha	:	hectare
sq.km	:	square kilometer
sq.m	:	square meter
cu.m	:	cubic meter
MCM	:	million cubic meter

kg : kilogram  
mbgs : meter below ground surface  
ton : metric ton  
l : liter  
hr : hour  
min : minute  
sec : second  
°C : degree centigrade  
mS/cm : millisiemens per centimeter (=m.mho/cm)  
ppm : parts per million (=mg/l)

#### GLOSSARIES

Changwat : Province  
Amphoe : District  
Tambon : Sub-District  
Ban : Village  
Huai : Creek  
Nong : Reservoir/Pond

#### CONVERSION

1 rai = 0.16 ha = 1,600 sq.m  
1 ha = 6.25 rai = 10,000 sq.m  
1 kg/rai = 6.25 kg/ha



## SUMMARY

### A. MASTER PLAN STUDY

#### A-1 Introduction

The Northeast region of Thailand has been considered as the least developed compared with the other regions of the country. Major constraints are irregular rainfall, lack of irrigation and poor quality of soils.

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement the Master Plan Study on the Integrated Rural Development of Salt-Affected Land in Northeast Thailand. The study area covers an area of 341.5 sq.km at Amphoe Phra Yun in Changwat Khon Kaen of the Northeast Thailand.

#### A-2 Background

The agriculture share in GDP ranked second place in 1984, and third in 1985. The uneven economic development of Thailand causes a demographic migration especially from the North and the Northeast toward the capital region. In order to solve this problem, a rural development programme was created in the last two national plans aiming at improving the quality of life, socially and economically, of the deprived rural people, and promoting self-reliance.

More than 2.7 million ha in the Northeast were affected by the problem of soil salinity, and more than 4.6 million ha of land throughout the whole country still suffer from lack of fertile soil.

As a result of forest destruction and expansion of agriculture fields, exposure of soil surface which triggered rapid runoff and subsequent soil erosion had made the salt-affected soil problems more tangible to human society.

#### A-3 The Study Area

##### (1) Natural Condition

The study area is located at 30 km south-west of the city of Khon Kaen. The area covers the whole Amphoe Phra Yun and partly other three Amphoes in which more than 45,000 inhabitants are living.

Topography in the area is composed of mountainous terrain, undulating rolling hill, terrace and alluvial floodplain. Geology in

the area is formed of the Korat Group, the Pleistocene and the Holocene.

The climate of the area is categorized as monsoon type. Average annual rainfall is about 900 mm at Amphoe Phra Yun. The mean temperature is 27°C.

There are three rivers, Huai Yai, Huai Yang and Huai Phra Nao with the drainage area of 260 sq.km. Total annual river runoff amounts to 50 MCM.

The soils in the study area have inferior chemical properties as acidic, low natural fertility, low nutrient holding capacity and partly salt-accumulated and also inferior physical properties. These soils are unfavorable to crop cultivation, therefore, proper amelioration and conservation measures are required for furthering development.

## (2) Socio-Economic Condition

Most of population are living upon small-scale farming in paddy cultivation with partly upland crops. The unexpectable rainfall pattern has caused a considerably low productivity in rice production. In the area there is no proper installation for product-distribution such as a market. Some small-scaled rural industries are practiced such as the production of plastic sun-shades. These industries contribute a proper measure for generating rural incomes in these rural areas.

The questionnaire survey was carried out to clear up the present situation of farm management and cropping plan in the future. The average land area of total sampled farmers was 4 ha. The average paddy yield was 288 kg/rai based on the harvested area or 185 kg/rai based on the holding area. 30 percent of rice growing farmers are willing to increase rice production and the same tendency was appeared to cassava and kenaf. Sericulture and livestock farmers have high tendency for increasing production.

## (3) Present Agriculture

The cultivated land area is 23,770 ha. The number of the farm household is 8,120 and the average cultivated land area per household is 2.9 ha. The paddy field area is 15,680 ha or 66% of the cultivated land and 1.9 ha per house. The cropping area of field crops is 4,460 ha and cassava is a main crop.

The average paddy yield is estimated at 280 kg/rai. Most of rice produced in the area is used for self consumption. Cassava is a

typical cash crop, but its price fluctuates. Kenaf production is decreasing year by year because of low price and the difficulty of getting water for processing. Recently it is used for the material of pulp production. In some Tambon farmers cultivate vegetables and pasture for seeds. In Amphoe Phra Yun there are 2,470 sericultural household cultivating 320 ha of mulberry fields. The average cocoon production per household is only 22 kg.

Sixty three percent of total farmers uses tractors and 59% of farmers uses buffaloes. The utilization of farming machines will be increased in future. The amount of input materials for agriculture is low. For paddy fields farmers put a nitrogen fertilizer of 2.4 kg/rai.

Seventy five to 95% of farmers cultivate their own land and 2~12% cultivate both of own and leased land, 3~13% of farmers depend on the leased land only.

Amphoe Phra Yun has two cooperatives servicing credit, marketing, collection of paddy rice. Agricultural research institutes for field crop, fishery, animal husbandry, forestry, sericulture are standing around Khon Kaen city.

The numbers of livestock are 11,170 buffaloes (1.5 head/household) and 6,670 cattles (0.8 head/household). Buffaloes are mainly used for agricultural works.

In the Northeast, the self supply of fish is only 7% with a share of raising fish for only 0.5%. Every village has a pond for fish raising.

Forest land occupies a few portion of the study area at about 1,500 ha equivalent to 4% of the total area. The present reserved forest shows a sign of deteriorated bearing with sparse stand density. This may cause the problem of soil salinity in the middle and east of the study area due to rapid increase of surface runoff coupled with groundwater. The demand for fuelwood in this area exceeds over the supply almost 1.5 times.

Regarding farm economy, the major cause of low farm incomes in the Northeast as well as the study area is in the mainly rainfed rice cultivation which most local inhabitants practice for producing this stable crop for self consumption and capital in case of surplus.

#### (4) Agricultural and Rural Infrastructure

There are six small scale irrigation projects covering 200 ha of irrigation area. The other 12 projects are being constructed and designed. Along the Chi river and swamps, there exist four pumping stations to supply irrigation water to 560 ha of farm land.

Drainage facilities are not provided due to no floodings and inundation problems in the area.

Rural roads are generally narrow in the village area. As these roads are unpaved or partly sediment paved with small embankment height. At the present time, bus-routes from Khon Kaen passing through Amphoe Phra Yun are provided for outside and inside linkage.

The electricity is supplied to all parts of the area. Regarding water supply for domestic use, people collect water in ceramic/concrete tanks for drinking and water nearby shallow wells for other purposes.

Some small-scaled rural industries are practiced such as the production of plastic sunshades and mats. The production of "Madmee" is also made in the area. These small-scaled rural industries contribute a proper measure for generating rural incomes although existing for some specific Bans only and having in lack of a sufficient supporting system.

#### A-4 Development Plan

##### (1) Development Concept

Objectives of development in this Master Plan are as follows:

- To increase income and employment.
- To conserve and improve natural resources and the environment.
- To raise the quality of life of the people.

The following development strategy is established in order to attain the above objectives:

- To provide the optimum land use plan.
- To manage available water resources.
- To undertake overall measures to salinity mitigation of salt-affected soils.
- To stabilize and diversify agriculture and to increase land utility.
- To strength agricultural supporting services.



- To promote reforestation, to improve rural infrastructures, to support economic activities and to make a more communicative society.
- To demonstrate the technical, economic and social feasibility of selected agricultural systems in the salt-affected lands

Within the frame work of the master plan study, the following development programmes and projects are taken into consideration:

Six National Economic and Social Development plan  
 Green E-Sarn Five Year Plan  
 Khon Kaen Water Supply System, PWA  
 Mahasarakam Diversion Weir, NEA

(2) Land Use Plan

In the low land, the paddy fields will be used more intensively to sure the self-supply of glutinous rice. Severely salt-affected land will be used for cattle grazing on salt-tolerant pasture, sport and recreation area, processing and marketing center. Moderately or slightly salt-affected areas will be used for paddy fields after leaching or improvement of cultivation practices.

In the hills surrounding salt-affected and potentially salt-affected area, reforestation will be considered to lower the groundwater table as preventive measures against expansion of salt-affected area.

Proposed Land Use

	<u>Present</u>	<u>Plan</u>
Paddy	18,720 ha	13,030 ha
(Irrigated)	( 560 )	( 3,540 )
Pasture	—	390
Agroforestry	12,120	15,830
Reserved Forest	1,490	2,950
Village, Swamp etc.	1,820	1,950
Total	<u>34,150</u>	<u>34,150</u>

### (3) Water Utilization Plan

Annual total runoff of three rivers in the study area is 66 MCM in a normal year. Existing ponds and reservoirs have a capacity of 25 MCM in dry season, 35 MCM in wet season in total.

The recommendable well site for potable sources is probably located at its center or slightly eastward of the hill. Estimated well depth and maximum yield are more than 30 m and 50 cu.m/day, respectively.

The siltstone aquifer underlying terrace terrain extending about 3 km east of Ban Phra Yun is acceptable for the medium salt tolerance vegetables and field crops. Groundwater exploitation for the Alluvial Formation requires a careful assessment of quality.

The quality of groundwater from the Terrace Deposit is generally acceptable for industrial use.

### (4) Soil Conservation

There are short-term and long term countermeasures for salt-affected soils. Severely salt-affected area is not used for cultivation, but for agricultural processing/marketing center, grassing land. Slightly-moderately salt-affected area is used for paddy fields after improvement of drainage conditions. Potentially salt-affected area is used for paddy field as it is. As the long-term countermeasure, reforestation under agroforestry system will be conducted in surrounding upland.

In middle to high terrace, skeletal soils should be used for forest or pasture land to cover the ground surface with vegetation.

### (5) Agricultural Development Plan

Objectives of agricultural development are as follows:

- Stabilization and increasing of the rice yield
- Establishment of the sustainable field crop production
- Promotion of the crop diversification

Proposed farming systems are as follows ;

(Land use)	(Irrigation)	(Farming System)
Paddy field	Irrigation	1. Stabilization of rice production and introduction of double cropping
	Rainfed	2. Integrated farming system using small farm pond
Upland field	Rainfed	3. Sustainable upland crop production
		4. Development of sericulture
Grazing land	Rainfed	5. Forage production in the common and vest land

Future crop production is expected as follows ;

Paddy	450 kg/rai
Cassava	3,000 kg/rai
Mulberry (cocoon yield)	50 kg/rai
Livestock Feedstaff	0.38 cattle/rai

Mulberry is tolerant to the severe conditions, getting high income per land area. Sericulture and reeling give women opportunities for work. To promote the bivoltine sericulture, 4 rai of mulberry per farmer are necessary. The mulberry field area become 1,690 ha in the future.

The potential of raising livestock will be 15,000 heads in the dry season, 28,000 heads in the wet season which are equivalent to 1.2 times of the present heads. The average number of heads will be 2.7 per farm household through a year.

The post -harvest treatment of cocoon, vegetables, fruit and, animal products will be dealt with. A central market will be provided as first priority for the distribution of products. Five Tambon markets will be provided as second priority.

New cooperatives regarding related aspects i.e. sericulture, dress-making, food-processing, livestock raising should be formed with technical and financial supports from the technical training facilities to be installed.

## (6) Reforestation Plan

The forestation plan for this area can be subdivided into two major scheme, first is the enrichment planting scheme for forest reserve land, another is the agroforestry scheme for non-forest reserve land or farmer-owned lands.

The target area for the enrichment planting scheme is in Pa Khok-Laung situating in the west direction of the study covering about 320 ha. The scheme is recommended planting with dipterocarps and other valuable species. To establish reforestation programme in the forest reserve land, forest land encroachment and forest fire are constraints to be aware, solved and prevented.

In accordance with compatibility to the area to be implemented, the agroforestry scheme can be grouped into hedgerow intercropping, shading/fodder tree planting, and multistory planting.

Hedgerow intercropping scheme is a form of intercropping several rows of crops in between rows of fast-growing trees, fruit trees shrub. The target area for this scheme is farm land on the upper area.

Shading/fodder tree planting scheme may be applicable for the combination of tree-forage. The target area for this planting scheme is common land or public land.

Multistory planting scheme is the mixture of several patterns of agroforestry. Main idea of the scheme in particular to this area is to create the performance of marginal farmland to be most like that of natural forest.

The total area to be implemented as a reforestation programme is 16,150 ha equivalent to 47% of the total area. In order to accept the programme to farmers, guidance and support have to be provided. Demonstration and pilot projects also are required. Nursery operation is necessarily established to produce seedling or distributing to interested farmers.

## (7) Rural Infrastructure Plan

The irrigation area by pumping in Chi river and natural swamps is 1,230 ha. The river water from three river basins in the area are available for irrigation by provisions of weir, storage pond canal and pump. The total irrigation area is planned at 2,480 ha.

The Water User's Group have to be associated by farmers when this new irrigation system is implemented.

The proposed drainage area covers two sub-areas with a total area of 5,000 ha. The first area of 1,500 ha is classified as moderately salt-affected land and the second area of 3,500 ha is as slightly salt-affected land. Since leaching water is not available, rainwater will be used for natural leaching. Open drains, interceptor drain and evaporation pond are installed.

Three routes are planned as the improvement of rural roads with 30 km length. Improvements are planned for these three roads with a laterite pavement with 6-meter width. Along the routes, three bridges are to be repaired.

Rural water supply is planned at two villages, Pa san 1 and 2. Water supply facilities for drinking and washing are to be provided to the center of Amphoe Phra Yun and the central market.

Regarding rural industry, handicraft factory and food processing factory are proposed. Technical training facilities and recreation facilities are proposed as one of social service plan.

#### (8) Project Cost

The project cost is to be composed of costs for construction, land acquisition, administration, consulting services, and physical and price contingencies. The construction cost consists of irrigation and drainage facilities, rural road, rural water supply facilities, reforestation, social service facilities.

The total project cost amounts to 1,255 million Baht, of which 570 million Baht are local currency component and 685 million Baht are foreign currency component.

#### (9) Environmental Aspect

Salt-affected soils are improved through natural leaching and cultivation practices. Applied measures do not affect the environment of the area and regenerate vegetation. Intrusion of saline groundwater from upstream into the drainage area should be prevented by interceptor drains to relief the farmland from expansion of salt affection. The evaporation ponds are connected to interceptor drain. This means rivers, streams and ponds located in the downstream of the study area are not affected by drained water.

The natural forest should be kept in the study area in order to protect surface runoff and soil erosion which cause damages to the

land. The agroforestry scheme is requisite to proceed the sustainable development with soundness such as soil and water conservation.

Small-scale development for irrigation has a merit to make local people participate in development but not to bear large land acquisition and submersion under water. Rural water supply and other social services contribute to rural quality of life and communication. Promotion of rural industry is subjected to employ idle labor-forces and generate incomes in the area. This makes a healthy rural society for future generation.

#### A-5 Project Implementation Programme

##### (1) Organization and Management

In the context of implementing the project, ministerial level committee, sub-committee for project level, and DLD working committee. The five governmental agencies under committees should be responsible.

Department of Land Development (DLD), MOAC  
Office of Accelerated Rural Development (ARD), MOI  
Royal Forestry Department (RFD), MOAC  
Amphoe Office, MOI  
Department of Agricultural Extension (DOAE), MOAC

The implementation of construction works requires six years-period.

##### (2) Operation and Maintenance

Operation and maintenance for each facilities will be done by following agencies.

Irrigation and drainage . . . . .	Water user's group
Rural road . . . . .	ARD
Rural water supply (village) . . . . .	Water user's group
(compound, market) . . . . .	Amphoe Office
Reforestation . . . . .	RFD, producer group
Social service . . . . .	Amphoe Office

To operate and maintain such facilities, 15 million Baht will be born every year.

## A-6 Project Evaluation

### (1) Introduction

The economic evaluation has been made by calculating an economic internal rate of return (EIRR) with sensitivity analysis, in which a project cost and tangible benefit are to be calculated by applying an economic price. Project cost and benefits were estimated for 50 years as the project life by constant price as of 1990.

### (2) Financial and Economic Cost

The total project cost for the study area is estimated at 1,037.5 million Baht in financial value, which is equivalent to 901.7 million Baht in economic value.

### (3) Project Benefits

The quantifiable benefit of the project is as follows:

Agriculture	78.1 (million Baht)
Fishery	4.7
Domestic Water supply	0.8
Rural road	3.7
Total	87.3

In addition to the above benefits, the following benefits are expected to be realized with the Project.

- The Project will improve the rural people's living standard.
- The Project will contribute to not only promotion of rural welfare but also alleviation of the disparity in living standards between the regions.

### (4) Economic Evaluation of the Project

EIRR of the project is estimated at 8.1 percent. The comparison of benefit and cost was made without taking into account the cost needed for salt wash -out.

The farm budget analysis was made for the average size at 3.0 ha of the owner farmers. The farm income with-Project becomes 10,790 Baht/year per household in case of irrigated paddy farm, comparing with 2,710 Baht/year per household in case of future without-Project.

## B. FEASIBILITY STUDY ON PILOT AREA

### B-1 Selection of Pilot Area

The Pilot Area has been selected, basing on development priority given by regional agencies and inhabitants, development components covering those in the study area and the scale of the area to be selected.

The selected Pilot Area is located at the central part of Amphoe Phra Yun. It has an area of 45.6 sq.km.

### B-2 Pilot Area

#### (1) Social Conditions

The Pilot Area consists of 15 villages in two Tambon, Phra Yun and Kham Pom. Most of the people are living upon agriculture, mostly paddy cultivation. Villages are suffering from insufficient water and salt-affected lands. Every year, during the dry season, many farmers have to go to other regions for works such as migrant laborers in sugarcane/rubber plantations.

#### (2) Natural Conditions

The area consists of undulating rolling hill, terrace and recent flood plain which is generally ranging in altitude from 160 to 220 m. The Huai Yai, only a river in the area, flows to the southeast.

The area is under by thick and well consolidated siltstone, gravel beds, terrace deposits and recent river beds. Most of soils in the area are composed of sandy and loamy strata. At the depression, saline-sodic soils occupy 200 ha or 4.4% of the Pilot Area.

Rainfed paddy fields expand most of low terrace. Severely salt-affected lands are abandoned crop cultivation and left as barren. Middle and high terraces are mainly occupied by cassava fields or secondary forests.

There exist 2,000 farm household. One household has 2.9 ha of farm land, of which 2.2 ha is paddy field and 0.4 ha is upland land. Depending upon rainfall, the paddy yield ranges 50-400 kg/rai. Farmers grow one rai of mulberry field and sell the raw silk. The average raising number of buffalo is 1.2 heads per household. There is no pasture land and the supply of feedstuff is unstable. Fishes are being raisen at private small farm ponds and communal village ponds.



Four weirs and 14 storage ponds are constructed in the area. These ponds are located at lower lands than that of paddy fields. Water management is practiced by the village committee.

A network of seven main rural roads connects to its 15 related villages. These rural roads are unpaved or partly paved with a width of four to seven meters. Villagers in the Pilot Area collect rain water in concrete jars and tanks for using through the year.

The electricity is supplied from the Nam Phong power station to all villages in the area.

The production of paddy is for self-consumption. Recently, some farmers have produced tomato, watermelon, chilli and eggplant under contracts of some seed firms, but these areas are very limited by available sources of agricultural water.

### B-3 Development Plan

#### (1) Land Use Plan

Severely salt-affected land will be used as pasture with salt-tolerant grasses occupying 210 ha or 5% of total area (4,560 ha). Most land in low terrace will be used for paddy fields occupying 2,150 ha or 47% of the total area. In upland surrounding the lowland, agroforestry will be widely introduced with 1,840 ha or 40% of the total area.

#### (2) Agricultural Development Plan

The target rice production is set at 3,000 ton, which is about two times of the present production. About 30% of it will be produced in the irrigated area. The present population of the Pilot Area is estimated at 7,000 people and the rice production per person will be 430 kg. At the 10% of the irrigated areas, tomato and water melon will be intensively grown after harvest of the rainy season rice.

The projected number of cattle or buffalo is 2,600 heads. This is 1.7 times of present number. Mulberry field area is proposed at 360 ha, which is 4.3 times of areas in 1989.

#### (3) Countermeasures for Salt-Affected Area

A drainage on the terminal of the gravel beds can play the most important role to prevent dispersion of the saline groundwater. To accelerate seepage, a drainage should be excavated until the surface of siltstone. In the irrigation plan, leaching on salt-affected areas have to be made.

#### (4) Irrigation and Drainage Plan

The proposed irrigation areas are located in the upper and lower reaches of Huai Yang river. The total irrigation area is 380 ha. Weirs, ponds, canals, check gate structures are provided at each irrigation block. Water management for irrigation water, facilities and water quality are necessary to be done by farmers.

The drainage plan covers an area of 820 ha including moderately salt-affected land (300 ha) and slightly salt-affected land (520 ha). Drainage facilities such as interceptor drains, evaporation ponds and field drains are proposed.

#### (5) Rural Infrastructure Plan

Earth filling for road embankment is planned at topographically low parts in order to prevent flooding during the rainy season. Drainage culverts also will be provided under these portions. The rural water supply is planned for four villages, Amphoe-office compound and the proposed central market. As a social service plan, sports and recreation facilities, training facilities and markets are proposed.

#### (6) Implementation Programme

The construction works for the Pilot Area are composed of irrigation and drainage facilities, rural roads, rural water supply facilities, social service facilities, reforestation. The implementation period for these construction works including detailed design works is scheduled for three years.

#### (7) Project Cost

The project cost for the pilot area amounts to 315 million Baht of which 120 million Baht are local currency component and 195 million Baht are foreign currency component.

#### (8) Project Evaluation

The economic evaluation of the Pilot Area has been made by calculating an economic internal rate of return (EIRR) with sensitivity analysis. The farmers financial condition with the project is almost as the study area.

The economic cost has been estimated at 143 million Baht by applying the conversion factor of construction. Tangible benefits in monetary terms in the Pilot Area are those arising mainly from crop sector.

The EIRR of the Pilot Area is calculated at 9.5 percent. The alternative EIRR of the pilot project of which cost of salt-wash-out are excluded is estimated at 13.3 percent.

## C. CONCLUSION AND RECOMMENDATION

### C-1 Conclusion

Development of water resources have to concentrate on developing small-scale water resources existing in the study area in which inhabitants will be easily able to participate in the development implemented by DLD and to conserve natural environment without causing troubles on large-scale land acquisition and land submersion under water.

The overall land use system proposed in this study should be introduced with combination of soil and water conservation measures including reforestation and agroforestry to proceed the sustainable development with environment soundness.

Countermeasures to mitigate salinity problems in the salt-affected land are requisite to be executed basing on full understanding of mechanism on salt emergence from hydrogeological aspect and precise analysis of problem soils.

Project implementation of the Pilot Area selected in the study lead to demonstrate the technical, economic and social feasibility of proposed agriculture systems in the salt-affected lands and to play a role as a model in solving salt-affected problems in the Northeast Thailand.

Promotion of sericulture and provisions of the agricultural processing/marketing center, training center and recreation facilities create employment opportunities as well as attract women and youth in development.

Although the economic feasibility of the Pilot Area is a little lower than the other projects, the project have strong impacts upon socio-economic activities in the area and induces to alleviate the poverty and raise up the living standard of inhabitants.

## C-2 Recommendation

It is recommendable to promptly implement the Pilot Area with duly attention to the followings.

- (1) The observation networks provided by the JICA Study Team such as wells, piezometers and staff gauges on rivers and ponds have to be kept monitoring by DLD.
- (2) DLD have to demonstrate the technical feasibility of soil conservation works in this project as a model to solve salt-affected problems, applying the results of recent research and equipments listed in the study.

Organization of DLD have to be strengthened for the smooth implementation of this soil and water conservation project in salt-affected areas in respect to software and hardware with technical and economic assistance of experts and equipments.

- (3) To realize prompt commencement of the project implementation, the proposed committees have to be provided soonest possible.
- (4) Project implementing agencies have to give farmers employment opportunity in the implementation of the project.

To attain the full development of the study area, and to mitigate salt-affected land by means of sufficient supply of leaching water in both seasons, available water resources existing outside the study area is recommendable to be transmitted to the area in future in cooperation with related agencies from a view point of overall water resources management in the region.

## CHAPTER 1. INTRODUCTION

### 1-1 Background of the Study

The Northeast region of Thailand has been considered as the least developed compared with the other regions of the country. Its population is 19 million, which is about one-third of the country's population, while the products coming from this region is only one-fifth of the GNP. It is said that the low income of the people in the Northeast is primarily due to poor agricultural production. Major constraints limiting crop yields are irregular rainfall, lack of irrigation and poor quality of soils.

In 1987, the Northeast experienced a severe drought and serious shortage of water for drinking. To conserve water, emphasis was placed on reforestation of the region where forest area reduced and cover only 14% of the regional total area. Toward this end, the so-called "Green Northeast" plan was conceived with His Majesty's initiative and immediate implementation efforts are being exerted by various government agencies concerned.

The Sixth National Economic and Social Development Plan of 1987-1991 created a national resources and environment development programme which envisions to improve the salt-affected land through conservation of forests and water resources.

The Department of Land Development (DLD) of the Ministry of Agriculture & Cooperatives (MOAC) has been assigned as a task force to be responsible for land conservation and optimum land use through participation in a number of agricultural/rural development projects. One of the major concerns of the DLD is to take into consideration the urgent need for alleviating the difficult conditions of the people in salt-affected land of the Northeast.

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement the Master Plan Study on the Integrated Rural Development of Salt-Affected Land in Northeast Thailand and conducted a preliminary survey, through which the Scope of Work was concluded between both governments in October 1989.

## 1-2 Objectives of the Study

The objective of the Study is to conduct the Master Plan Study on the Integrated Rural Development of Salt-Affected Area at Amphoe Phra Yun and its surroundings in the Northeast Thailand.

## 1-3 Agencies Involved in the Study

JICA organized the Advisory Committee and the Study Team as shown in the following list.

### Advisory Committee

Mr. Akihiko KUBOTA	Chairman Ministry of Agriculture, Forestry and Fisheries, JAPAN
Mr. Shin HIROSE	Irrigation and Drainage Ministry of Agriculture, Forestry and Fisheries, JAPAN
Mr. Noriaki SHIOJIRI	Agronomy Ministry of Agriculture, Forestry and Fisheries, JAPAN
Mr. Shoji SUZUKI	Soil Ministry of Agriculture, Forestry and Fisheries, JAPAN

### Study Team

Mr. Fumimichi OBU	Team Leader
Mr. Takao KUME	Deputy Team Leader/Drainage
Mr. Atsushi KIKUOKI	Meteorology/Hydrology
Mr. Kazuo NAKABAYASHI	Soil/Land Use
Mr. Hisao ANDO	Hydrogeology/Groundwater
Mr. Akira IWAMOTO	Irrigation/Water Management
Mr. Kiyoto HASEGAWA	Agriculture
Dr. Monton JAMROENPRUCKSA	Forestry
Mr. Bogo ABE	Agro-Socio Economy
Mr. Shusuke MINATO	Environment
Mr. Shinwa HORI	Structure Planning/Cost Estimate
Mr. Mitsutomo ANAI	Project Evaluation

DLD established the Counterpart Committee to facilitate the smooth conduct of the Study as shown in the following list.

Counterpart Committee

Mr. Boonyaruk Suebsiri	Deputy Director-General(Chairman)
Mr. Chaleo Changprai	Expert in Soil Survey and Classification (Vice Chairman)
Mr. Rungroj Puengpan	Director, Land Development Regional Office 5
Mr. Manu Omakupt	Director, Land Use Planning Division
Mr. Lek Moncharoen	Chief, Soil Classification Research Section, Soil Survey and Classification Division
Mr. Pichai Wichaidit	Chief, Soil Survey and Classification Sub- section, Soil Survey Classification Division
Mr. Narong Atsilarat	Chief, Engineering and Technology Section, Engineering Division
Mrs. Pantee Rungsangchan	Chief, Statistics Section, Planning Division
Mr. Sudjit Suanmalee	Chief, Land Development Station Khon Kaen, Land Development Regional Office 5
Miss Bhatra Chindanon	Chief, Foreign Relations Section, Planning Division
Dr. Somsri Arunin	Chief, Soil Salinity Section, Soil and Water Conservation Division
Mr. Prajiad Buasri	Economist, Land Use Planning Division
Mrs. Arunee Yuvaniyama	Agronomist, Soil Salinity Section





## CHAPTER 2. BACKGROUND

### 2-1 National Economy

Since the First Economic and Social Development Plan (1961-65), Thai economy has been grown substantially, emphasizing two sectors of manufacturing and business sectors instead of agricultural sector as major economic activity. After the implementation of this Plan during the Fifth National Plan (1982-86), the agriculture share in GDP ranked second place in 1984, and third in 1985. This performance has given the national economy an average annual growth rate of 7% in real terms during the last two decades.

Meanwhile, this implementation has resulted in the uneven economic development of Thailand in which the Capital region has a leading growth rate of 12.3%, while in the Central Plains, 10.9%; 6% in the North, 5.3% in the East, 3.2% in the South and 1.6% in the Northeast. In 1984, the GNP was US\$40.6 billion. Compared with the GDP per capita, US\$810 for the whole country, in the Northeast it was approximately US\$250 only. Basically, this situation affects the socio-economic conditions of the rural population which is approximately 70% of the total population, causing a demographic migration especially from the North and the Northeast toward the Capital region.

In order to solve this problem, a rural development programme was created in the last two national plans (Fifth and Sixth Plans), aiming at an early recovery from the present socio-economic situation.

Although the agriculture share to GNP is declining, agricultural products still occupy approximately 50% of the total export volume. The principal items are rice, tapioca (a starch extracted from cassava), natural rubber, corn, fruits, marine products, etc. Agriculture, therefore, has maintained a steady contribution to the national economy.

The Sixth National Plan observed that little progress was made in land development particularly in solving the problems of soil salinity, erosion and deterioration of environment. More than 2.7 million ha in the Northeast were affected by the problem of soil salinity, and more than 4.6 million ha of land throughout the whole country still suffer from lack of fertile soil. All of these problems must be alleviated.

From this background which inquires a harmony in socio-economic development for the whole country, especially from this present

situation where the national economy has obtained its basic growth for further development, depressed areas such as the Northeast should be considered as subject to an effective contribution to the balance in national development.

## 2-2 Government's Rural Development Policies

Rural development is accorded high priority under the Sixth National Economic and Social Development Plan in order to improve the quality of life, socially and economically, of the deprived rural people, to promote self-reliance and to increase its adaptability to economic and environmental conditions of the country. In order to attain these objectives, rural development has been carried out in line with the following major guidelines:

- 1) To develop the basic factors in rural production and marketing.
- 2) To increase the efficiency and capabilities of the public sector in solving rural problems.
- 3) To improve the system for administering rural development in order to integrate and systematise the efforts of each agency.
- 4) To increase the participation of the private sector and people's organization in rural development.

Followings are target areas for rural development in this region taking into account the problems and needs of these areas:

- 1) Backward areas are areas in which most of the people are economically deprived and the problems facing these areas are poor communications, inadequate land tenure, low production/incomes, poor health, shortage of water for domestic consumption. These areas require immediate development. Fifty percent of the total (5,800) villages throughout Thailand are situated in the Northeast.
- 2) Middle-level areas, the second priority for development, are areas in which most people are economically deprived and affected by 1 to 3 of the said problems. Such areas comprise 35,000 villages, of which 18,000 are in the Northeast.
- 3) Progressive areas are those in which most of the people have high production potential. Such areas enjoy reasonably favorable economic conditions but suffering from some of the problems mentioned above. In the Northeast, 15% of the total (1,800) villages belong to these areas.

To increase opportunities for greater productivity, income and employment, development of basic factors including the number of population and quality of labor force, land and water resources, appropriate science and technology and the improvement of management efficiency by supporting the creation and strengthening of farmers' institutions should be promoted.

Land and water resources are important factors in agricultural production. The government has attempted to achieve the fullest possible use of available land and water resources. The development of rural water resources must concentrate on improving water utilization and developing small-scale water resources in all potential areas.

Emphasis has been made on appropriate technology for agricultural development as well as for promotion of small-scale and medium-scale industries. In order to achieve this, foundations of rural technology will be strengthened, suitable modern technology will be applied and traditional technology will be modernized, and its efficiency improved.

## 2-3 Existence of Salt-Affected Land

### (1) Geographical Conditions

The change of geographical conditions within the study area may be one of the reasons for the existence of salt-affected land. No changes in geological conditions had been observed in the past. Thus the salt-affected soil may have existed for thousand years.

The rapid changes of geographical conditions within the study area, such as the expansion of agricultural fields for upland crops and construction of road networks, occurred during the past several decades. As a result, the exposure of soil surface which triggered rapid run-off and subsequent soil erosion had made the salt-affected soil problem more tangible to human society.

Any further attempt to conduct intensive economic development projects within the framework of the government economic development plans may worsen the salt-affected land problem unless careful implementation of the projects are done. In general, any activity to increase the ground cover with forest, grass, forage, mulching, paddy fields, etc. for most parts of the year will reduce the problem.

### (2) Deforestation

While the forest cover in the study area has been 65-75% per unit of area during the 1950s, important area with forest cover had disappeared in the 1960s. During this period nearly 5-10% per unit of area was made. This figure represents the present condition of the forest cover.

Deforestation serves two social factors: provisions of fuel wood and agricultural fields. The past changes of land use in the Northeast is shown in Figure 2-1. The increase of agricultural holdings and the decrease of forest cover are compatible with each other.

On the other hand, cutting forest provides short-term fuel supply and some cash income from sale of timbers. This is important until their agricultural production begins to yield. However, for a long-term supply of fuelwood, villagers would have to maintain trees on the acquired land for their supply.

NEA's survey result on the fuelwood is shown in Table 2-1. RFD also made a similar study on consumption of fuelwood as shown in Table 2-2.

Average rural household (a family of six) consumes approximately 13 cu.m of wood energy yearly. It requires 0.07 ha of densely forested dry evergreen woodlot yearly for fuel energy supply. Alternatively, villagers would need 0.64 ha of woodlot with 10% of forest cover for fuel supply yearly. If long term supply of fuelwood is made from the family's farmland, 19.2 to 32 ha of 10% forest land is required, provided that the natural regeneration of woods will be 30 to 50 years, for obtaining fuelwood without changing the land use patterns. If there are various places to obtain fuelwood, as shown in Table 2-2, a household would need 6.9 ha to 11.4 ha of the 10% forest land.

Despite the fact that most of the farmers have attempted to leave trees on their farmland for fuelwood, majority of the holding within the study area (4 ha), there has been a severe shortage of fuelwood supply for most of the families within the study area. Since the mid-1970s, as is shown in Figure 2-1, the shortage of wood energy has been worsening due to the imbalance between the increase of farmland and the available forest land. Consequently, the exposure of the ground surface by falling trees triggered the existence of salt-affected land problem.

TABLE 2-1 Fuelwood Consumption in the Northeast

Source of Fuelwood	Percentage of Consumption
<u>Collection</u>	
Forest Area (more than 5km)	26.9
Forest Area (less than 5km)	14.6
Household Areas	35.7
Neighboring Areas	21.4
Sub-Total	98.6
<u>Purchased</u>	
Within Village	0.2
Outside Village	0.2
Retailers	1.0
Sub-Total	1.4
Total	100.0

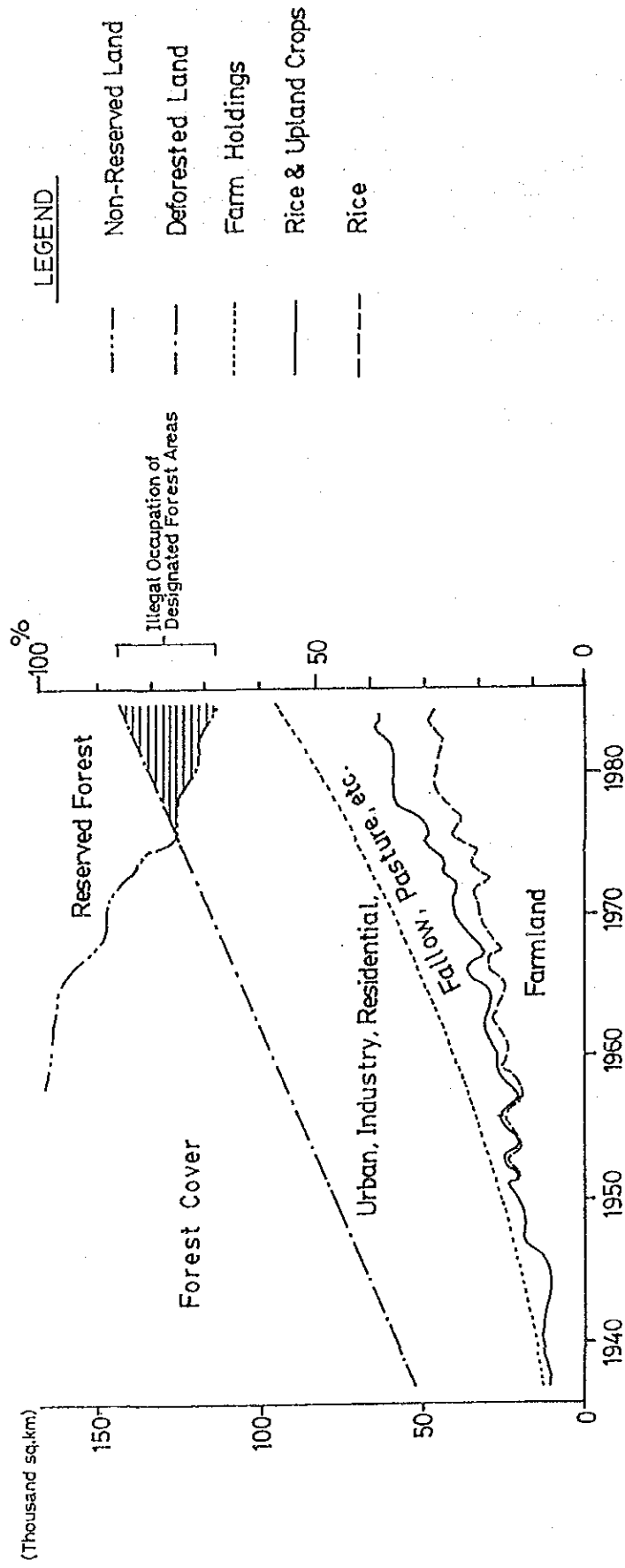
(Source: The Report on Energy Consumption in Rural Household, NEA 1980)

TABLE 2-2 Fuelwood Consumption in Thailand

Area	Household (%)	Consumption (cum.m/annum)	
		Fuelwood	Charcoal
Urban	89.9	4.7	3.4
Rural	97.6	9.6	3.4

(Source: A Survey on Charcoal Production, Distribution and Consumption, Planning Division, RFD 1983)

FIGURE 2-1 LAND USE CHANGE IN NORTHEAST THAILAND (1937 - 1985)



(Source : D.E. Thomas, 1988. Community Forestry in Rural Development)

## CHAPTER 3. THE STUDY AREA

### 3-1 Natural Condition

#### 3-1-1 Location

The study area is located at 30 km south-west of the city of Khon Kaen, the heart-part of the Northeast Thailand. The study area covers an area of 341.5 sq.km which is surrounded by the Huai Yai and the Huai Phra Nao river basins. The national highway No.2062 passes through the middle of the study area and joins national highway No.12 at a distance of 14 km from Khon Kaen. The area is bordered by the Chi river in the east, river basins of Huai Phra Nao in the south and Huai Yai in the north and the foot area of mountain Phu Mring in the west.

Regarding the administrative aspect, the area covers the whole Amphoe Phra Yun in its middle and partly other Amphoe, Muang, Ban Fang and Manja Khiri in which more than 45,000 inhabitants are living. The main administrative office and installations such as hospital, post office, agricultural bank, cooperative headquarters are located in Amphoe Phra Yun.

#### 3-1-2 Topography and Geology

The study area can be subdivided into four physiographic units: mountainous terrain, undulating rolling hill, terrace and alluvial flood plain. The mountainous terrain extends along the western edge of the study area with a width of less than 500 m and an altitude attains a maximum of more than 260 m. The undulating rolling hill is distributed both west and east sides of the study area with an altitude ranging from 180 to 220 MSL. In general, it shows monotonous to gentle undulating terrain, but small-scale, shallow and broad valleys are also observed in various places. The terrace largely covers in a center of the study area with an altitude ranges from 160 to 180 MSL and it forms two distinct flat topographic features, an upper terrace and a lower terrace. The alluvial flood plain extends along the river courses in the undulating rolling hill and the eastern edge of the study area.

The study area comprises of three main geologic units: the Korat Group, the Pleistocene and the Holocene.

The Korat Group in the area are divided into the Soa Khua, Phu Phan, Khok Kruat and Maha Sarakham Formations in ascending order and the last is overlain by the gravel bed and terrace deposits of Pleistocene age. The Group consists of mudstone, siltstone and sandstone, and it crops

out in the western edge of the study area.

Although the question arises whether the Maha Sarakham Formation includes the rock salt beds is assigned to the Khorat Group or more younger formation, no out-crops of the rock salt have been observed in the study area.

The terrace deposits consist of fine grained sediments of clay, silt and fine sand, but contain some intercalated laterite gravel beds. The deposits are extensively overlain by thick loam. From the lithological point of view, the question arises whether this sediments are of terracial origin or lake deposits, this study adopts a term of the terrace deposits for the convenience of future discussion.

The alluvial deposits are distributed in the recent flood plain of Lam Chi, Huai Yai, Huai Yang and Huai Phra Nao. The deposits consist of organic clay with laterite gravels in the base, clayey fine sand and fine to medium siliceous sand in the middle, and loam in the uppermost.

The geological map of the study area are shown in Figure 3-1.

### 3-1-3 Meteorology and Hydrology

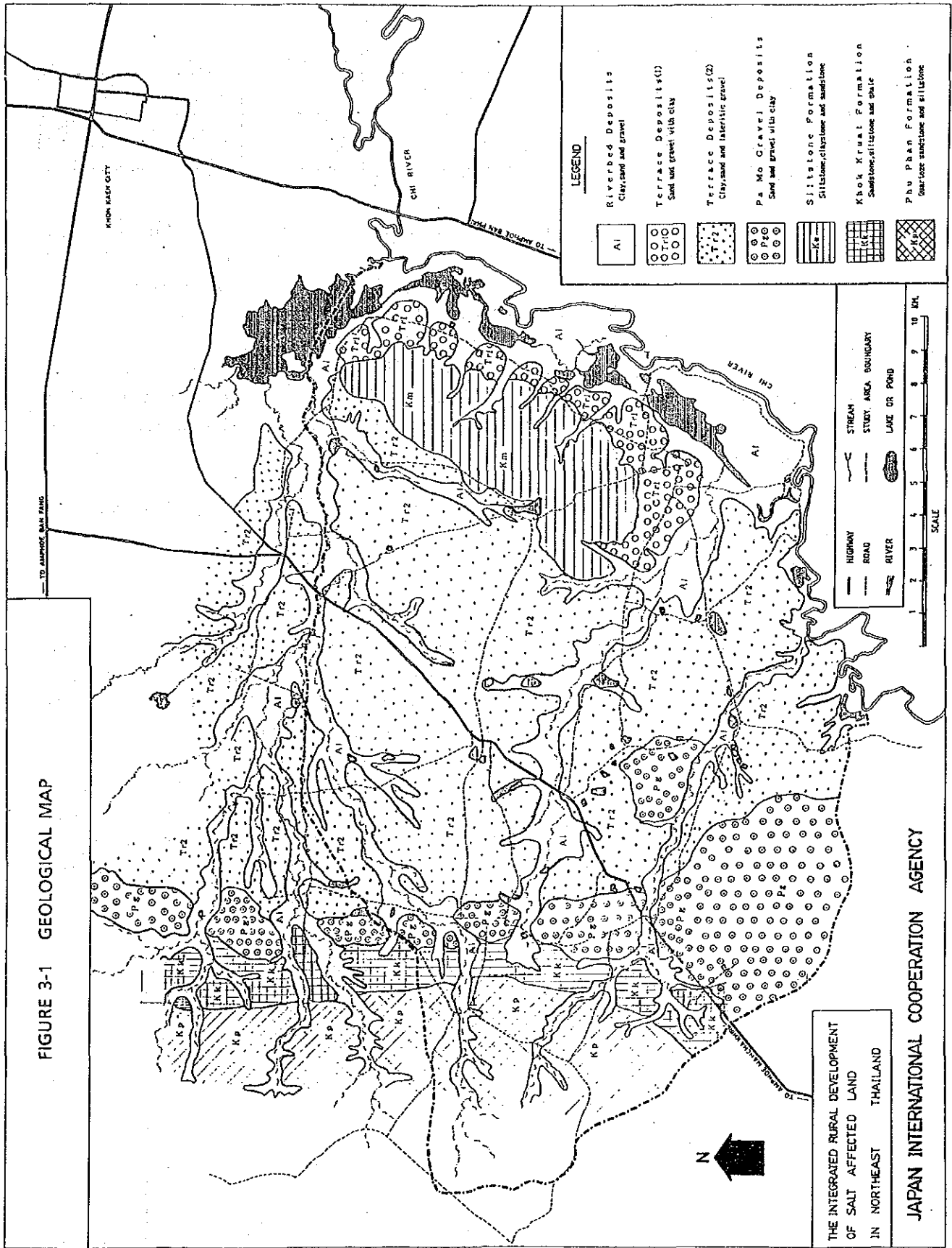
#### (1) Meteorology

The climate of the study area can be categorized as monsoon type. There are four distinct seasons and they are (1) Dry season from November through February, (2) Hot from March to April, (3) Wet from May through September and (4) Transitional season in October, transition from wet to dry season.

Average annual rainfalls vary widely from about 900 mm at Amphoe Phra Yun Station in the central part to about 1,200 mm at Amphoe Muang Station in the northeastern part of the study area. The peak occurs during August and September is at the later part of the wet season. Mean monthly rainfall of Amphoe Phra Yun station is presented below:



FIGURE 3-1 GEOLOGICAL MAP



THE INTEGRATED RURAL DEVELOPMENT  
OF SALT AFFECTED LAND  
IN NORTHEAST  
THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY

Mean Monthly Rainfall at Amphoe Phra Yun (1983-1988)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
0.0	20.4	8.1	70.0	161.0	115.8	109.4	171.5	182.4	87.7	9.4	0.0	935.7 mm

Temperature shows slight variations with the seasons. The minimum temperature occurs during the dry season with a mean minimum of 15.7°C in January. In the hot season in April, the mean maximum temperature is computed as 36.5°C with a mean minimum of 24.4°C.

According to Koppen's climate classification of the world, the study area falls within the Aw-type climate, which is characterized by high rainfalls with distinct wet and dry seasons, and the driest month having less than 5 mm of rain.

General climatic data recorded at the Amphoe Muang Station are presented in Figure 3-2.

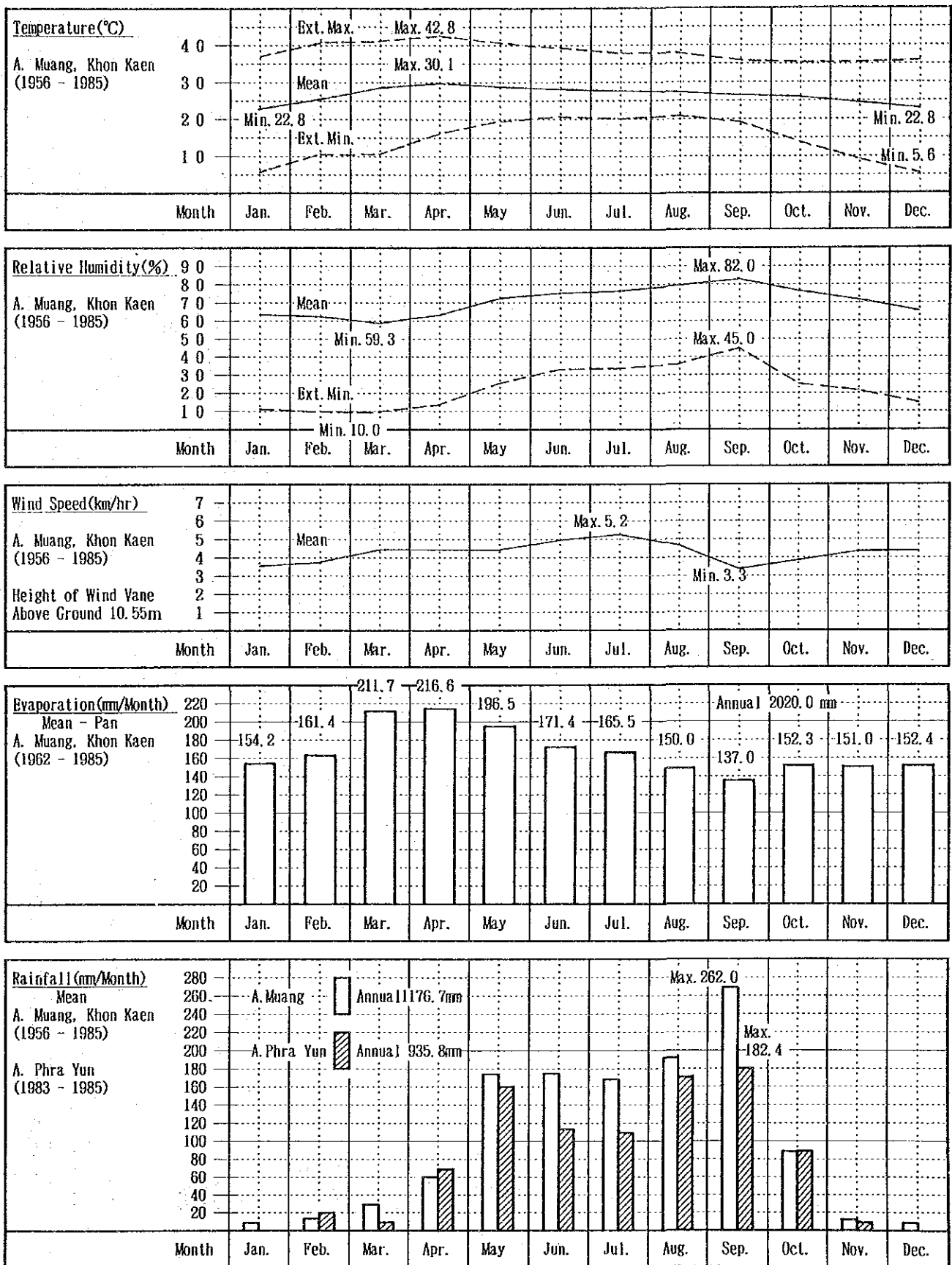
(2) Hydrology

There are three main rivers that traverse the study area from the west to the east. (Figure 3-3) The Huai Yai has a length of 30 km with a drainage area of 227.8 sq.km. The Huai Yang and Huai Phra Nao have lengths of 22 km and cover 80.3 and 79.4 sq.km respectively. These rivers have relatively steep longitudinal slope of about 1/500. After traversing terracial terrain of paddy fields and ponds, meeting other smaller tributaries, these rivers ultimately fall into the Chi River just outside of the eastern boundary of the study area. The drainage area of these rivers in the study area with their average annual runoff is presented in the following Table;

Drainage Area and Average Annual Runoff

Rivers	Drainage Area (sq.km)	Average Annual Runoff (MCM)
Huai Yai	101.0	19.49
Huai Yang	80.3	15.50
Huai Phra Nao	79.4	15.32
Sub-total	(260.7)	(50.31)
Swamp	80.8	15.59
Total	(341.5)	(65.90)

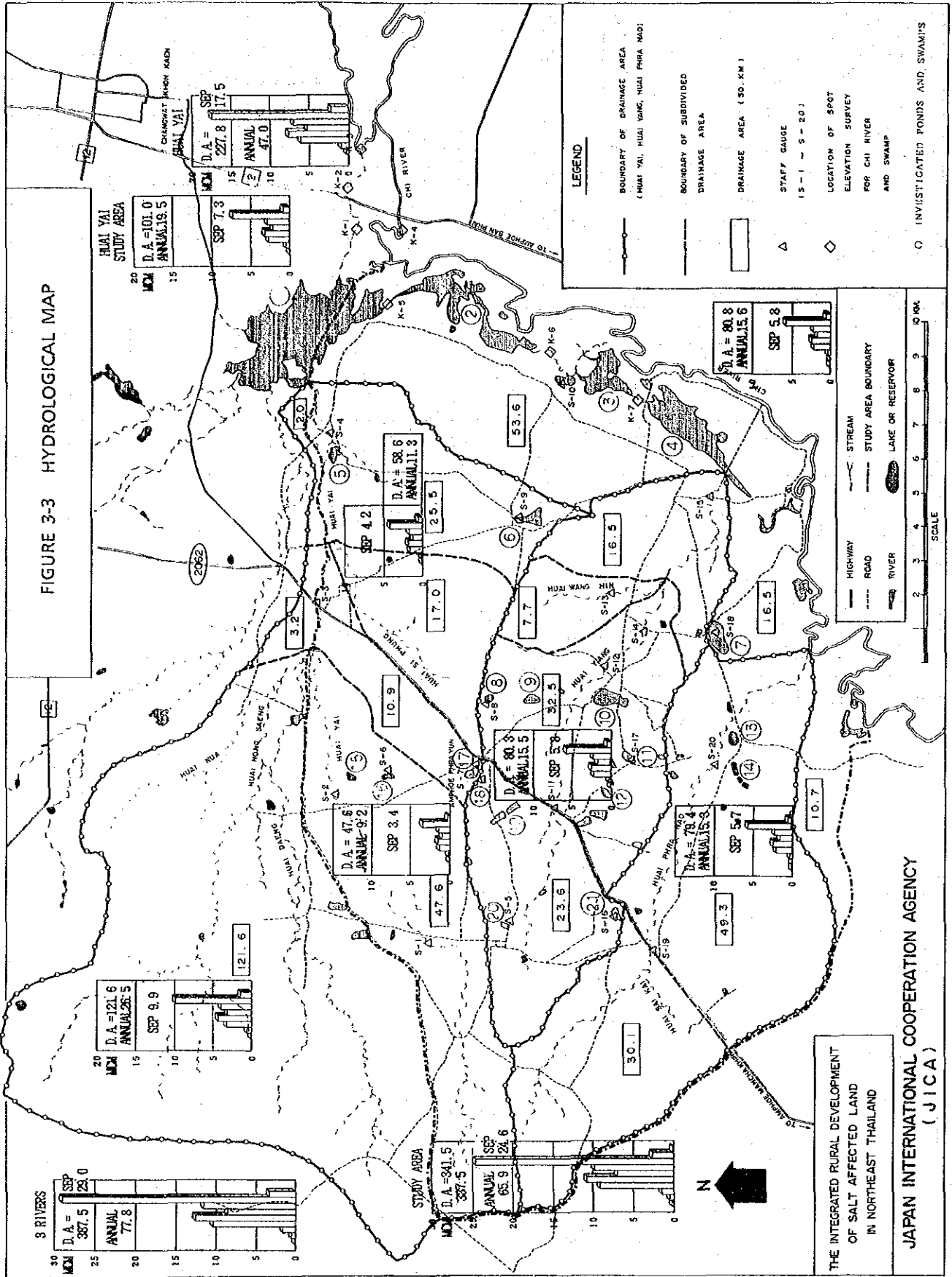
FIGURE 3-2 VARIATION IN GENERAL CLIMATE FACTOR



Source A. Muang, Khon Kaen : Climatological Data of Thailand 30-Year Period [1956-1985], Meteorological Department

A. Phra Yun : A. Phra Yun Agricultural Extension Office

FIGURE 3-3 HYDROLOGICAL MAP



### 3-1-4 Soils

#### (1) Soil Distribution

Soil profiles of representative site were studied to review and modify the existing detailed reconnaissance soil map scaled 1:100,000 prepared by DLD. Soil profiles were investigated by using hand auger to 6 ~ 8 m deep in upland area and to 4 m deep in lowland area. From each layer, samples were taken to measure EC and pH. (refer to APPENDIX C-2) Soil distribution in the study area is shown in Figure 3-4, and the coverage of each soil series is given in Table 3-1. As shown in this map, the distribution of soils is generally related to the landform sequence, however, saline soils are locally distributed according to the micro-relief, groundwater condition and change in land use. Figure 3-5 shows the representative soil profiles in upland and lowland areas.

##### 1) Soils on Floodplain

In the alluvial floodplain along the Chi river, the relatively fertile soils formed of recent alluvium are found. These soils are distributed as a belt along the river and identified as Phimai Series, Ratchaburi Series and their associations (Tropaquepts and partly Pelluderts in USDA Soil Taxonomy). These soils have clayey texture and are flooded during the rainy seasons due to their poor drainability. These soils occupy 2,630 ha or 7.7% of the entire study area and mainly used for paddy fields or cattle grazing.

##### 2) Soils on Terrace

Major portion of the study area is located on the undulating or gently undulating terraces which are covered with Ultisols formed of old alluvium. These soils are acidic and infertile because their parent rock is sandstone or siltstone which has less nutrient for plants and the bases have been leached out in the process of intensive weathering. These soils are further divided into Paleaquults and Paleustults in accordance with their moisture regime.

In the low terraces which cover 13,550 ha or 39.7% of the study area, moist soils, namely Paleaquults represented by Roi Et Series are distributed. These soils are mainly used for paddy fields under rain-fed condition. Partly, saline-sodic soils (Natraqualfs or Halaquepts) which accumulate soluble salts in the surface and show high pH values are found in the depressions. The severely salt-affected lands are barren at present after abandonment of crop cultivation.

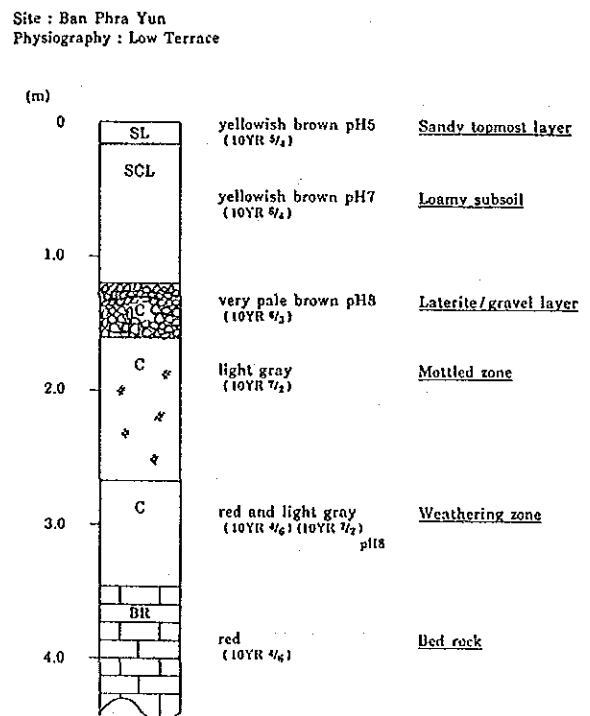
In the middle terraces (10,810 ha or 31.6% of the study area), on the other hand, drier soils, namely Paleustults such as Korat Series, and so-called Skeletal Soils, having a layer of laterite concretions (ironstones) and gravels within shallow depth, namely Phon Phisai Series and Phen Series (Plinthustults and Plinthaquults) are distributed. Generally, these soils have a mottled clay derived from shale or siltstone beneath the laterite layer. In addition, Sandy Soils consisting of quartz sand in the entire profile, namely Nam Phong Series (Ustoxic Quartzipsamments) are found in some parts. These soils are presently used for upland crop fields or grazing land.

In the middle to high terrace (6,110 ha or 17.9% of the study area), Satuk Series, Warin Series and Yasothon Series (Oxic Paleustults) are distributed in accordance with the elevation. They have sandy topsoil and the soil color changes from yellowish brown to reddish brown in higher elevation. These soils are used for mainly cassava field or forest.

(2) Soil Characteristics

Major characteristics of each soil series are summarized in APPENDIX C-3, C-4. And columnar sections of soil profile are shown in APPENDIX C-7, C-8. According to the moisture balance of Khon Kaen soils calculated by ADRC, the rainfall exceeds the evapotranspiration only two months (August and September) in the late rainy season. Besides, annual rainfall fluctuates widely and dry spells occur during the rainy seasons. Typical soil stratigraphy of the study area is given right. Various thickness of laterite/gravel layer exists beneath yellowish brown loamy sand or sandy loam topsoil. Mottled grayish clay layer underlain the laterite/gravel layer. The deepest layer is weathering layer from red siltstone.

TYPICAL SOIL STRATIGRAPHY



Soil in the study area have sandy topsoil and less organic matter. The clay content is generally as low as 5 - 10% and inactive kaolinite is predominant in the clay fraction. The cation exchange capacity (CEC) is very low, namely 5me/100g soil on an average. Soil reaction is acidic in general. Most sand is quartz and the soils have no potential to release any more plant nutrients through weathering.

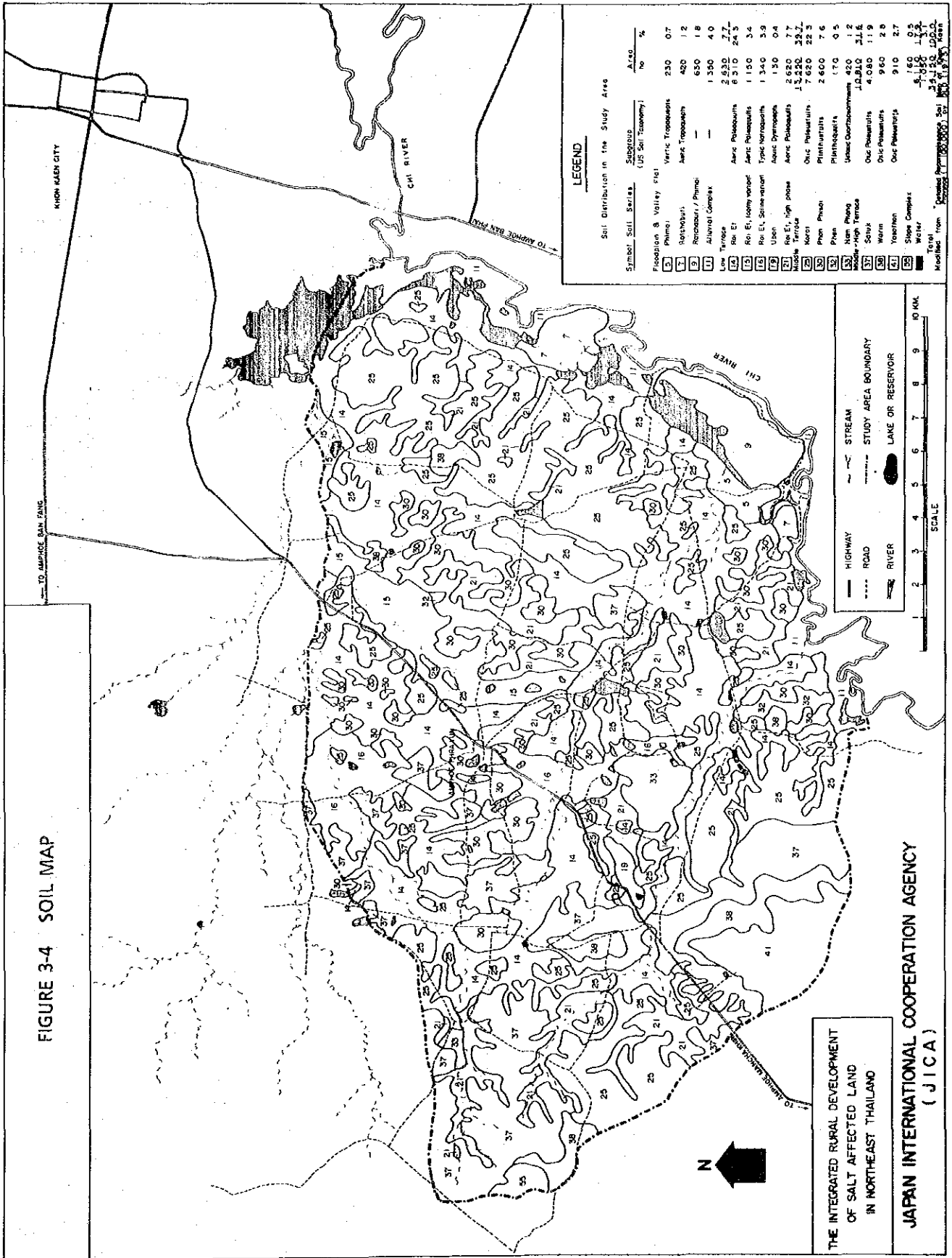
Thus, the soils in the study area have inferior chemical properties as acidic, low natural fertility, low nutrient holding capacity and partly salt-accumulated and also inferior physical properties as sandy texture, low water holding capacity, and partly having laterite layer at shallow depth. Furthermore, these soils are susceptible to erosion. Consequently, these soils are unfavorable to crop cultivation, therefore, proper amelioration and conservation measures are required for furthering agricultural development (refer to APPENDIX C-16, C-17).

Table 3-1 Soil Classification and Distribution

No.	Soil Series	Soil Taxonomy (Subgroup)	Area		
			ha	rai	%
<u>Floodplain and Valley Flat</u>					
5	Phimai	Vertic Tropaquepts	230	1,440	0.7
7	Ratchaburi	Aeric Tropaquepts	420	2,620	1.2
9	Ratchaburi/Phimai	-	630	3,940	1.8
11	Alluvial Complex	-	1,350	8,440	4.0
	(Sub-total)		(2,630)		(7.7)
<u>Low Terrace</u>					
14	Roi Et	Aeric Paleaquults	8,310	51,940	24.3
15	Roi Et, loamy variant	Aeric Paleaquults	1,150	7,190	3.4
16	Roi Et, saline variant	Typic Natraqualfs	1,340	8,370	3.9
19	Ubon	Aquic Dystropepts	130	810	0.4
21	Roi Et, high phase	Aeric Paleaquults	2,620	16,380	7.7
	(Sub-total)		(13,550)		(39.7)
<u>Middle Terrace</u>					
25	Korat	Oxic Paleustults	7,620	47,620	22.3
30	Phon Phisai	Typic Plinthustults	2,600	16,250	7.6
32	Phen	Typic Plinthaquults	170	1,060	0.5
33	Nam Phong	Ustoxic Quartzipsamments	420	2,630	1.2
	(Sub-total)		(10,810)		(31.6)
<u>Middle-High Terrace</u>					
37	Satuk	Oxic Paleustults	4,080	25,500	11.9
38	Warin	Oxic Paleustults	960	6,000	2.8
41	Yasothon	Oxic Paleustults	910	5,690	2.7
55	Slope Complex	-	160	1,000	0.5
	(Sub-total)		(6,110)		(17.9)
W	Water		1,050	6,560	3.1
	<u>Total</u>		<u>34,150</u>	<u>213,440</u>	<u>100.1</u>



FIGURE 3-4 SOIL MAP



**LEGEND**  
Soil Distribution in the Study Area

Symbol	Soil Series (US Soil Taxonomy)	Subgroup	Area, ha	%
1	Floodplain & Valley (Fl)	Vertic Tropoquolls	230	0.7
2	Phumoi	Vertic Tropoquolls	420	1.2
3	Rathviburi	Vertic Tropoquolls	650	1.8
4	Roroburi / Phumoi	Vertic Tropoquolls	1,300	4.0
5	Aluvial Complex	Vertic Tropoquolls	2,595	7.7
6	Loess	Vertic Tropoquolls	6,310	18.5
7	Ro E1	Vertic Tropoquolls	1,150	3.4
8	Ro E1, loamy variant	Vertic Tropoquolls	1,340	3.9
9	Ro E1, Silice variant	Vertic Tropoquolls	130	0.4
10	Ubon	Vertic Tropoquolls	2,620	7.7
11	Ro E1, high phase	Vertic Tropoquolls	13,250	38.7
12	Middle Terrace	Vertic Tropoquolls	7,620	22.3
13	Moai	Vertic Tropoquolls	2,600	7.6
14	Phan Phun	Vertic Tropoquolls	170	0.5
15	Phan	Vertic Tropoquolls	420	1.2
16	Non Phong	Vertic Tropoquolls	10,810	31.6
17	Lower High Terrace	Vertic Tropoquolls	4,080	11.9
18	Sauk	Vertic Tropoquolls	960	2.8
19	Warm	Vertic Tropoquolls	910	2.7
20	Yonnon	Vertic Tropoquolls	160	0.5
21	Slope Complex	Vertic Tropoquolls	7,050	20.4
22	Water	Vertic Tropoquolls	3,430	10.0
23	Water	Vertic Tropoquolls	1,150	3.4
24	Water	Vertic Tropoquolls	1,150	3.4
25	Water	Vertic Tropoquolls	1,150	3.4
26	Water	Vertic Tropoquolls	1,150	3.4
27	Water	Vertic Tropoquolls	1,150	3.4
28	Water	Vertic Tropoquolls	1,150	3.4
29	Water	Vertic Tropoquolls	1,150	3.4
30	Water	Vertic Tropoquolls	1,150	3.4
31	Water	Vertic Tropoquolls	1,150	3.4
32	Water	Vertic Tropoquolls	1,150	3.4
33	Water	Vertic Tropoquolls	1,150	3.4
34	Water	Vertic Tropoquolls	1,150	3.4
35	Water	Vertic Tropoquolls	1,150	3.4
36	Water	Vertic Tropoquolls	1,150	3.4
37	Water	Vertic Tropoquolls	1,150	3.4
38	Water	Vertic Tropoquolls	1,150	3.4
39	Water	Vertic Tropoquolls	1,150	3.4

HIGHWAY  
 ROAD  
 RIVER  
 STREAM  
 STUDY AREA BOUNDARY  
 LAKE OR RESERVOIR

SCALE  
0 1 2 3 4 5 6 7 8 9 10 KM

THE INTEGRATED RURAL DEVELOPMENT  
OF SALT AFFECTED LAND  
IN NORTHEAST THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY  
(JICA)



## 3-2 Socio-Economic Condition

### 3-2-1 Population and Social Aspects

Amphoe Phra Yun, the main administrative unit in the study area, was formulated in 1988. Formerly this area belonged to Amphoe Muang Khon Kaen. In 1976 it was firstly formed as a King Amphoe. Amphoe Phra Yun has a population of approximately 31,000 in 1988 according to the survey by Ministry of Interior.

Most of local people in Phra Yun are living upon rice cultivation, raising animals and sometimes, paddy farming mixing with raising animals etc. Their second professions are growing mulberry, hamata peas, weaving mats, producing cocoons and plastic sunshades as sub-incomes.

Due to low income premises, the situation of habitation in the study area is underdeveloped, especially sanitary and sewerage. Other social aspects in the study area are considered proper to some extent such as schools, health-clinics, roads and electric power, except lack of recreation installations to be used as communication places for young farmers.

Apart from Amphoe Phra Yun, other areas included in the study area cover parts of three Amphoe, Muang, Ban Fang and Manja Khiri. These areas cover approximately 170 sq.km, half of the study area, in which approximately 85% are subjected to agriculture land with paddy as the main crop.

The total population in these areas is approximately 15,000, living upon rainfed paddy cultivation as the main job with other side-jobs such as weaving mats and making clothes etc. The socio-economic situation in these areas is briefly shown in APPENDIX I-1.

As water is a very important factor in living conditions, existence of numerous swamps/ponds is another specific socio-economic aspect in the study area. Due to the topographic aspect and dwelling situation, more natural swamps and artificial ponds are located in the east than in the west. Almost dwelling agglomerations are located at nearby roads and swamps/ponds which are considered as two main factors effecting living conditions of local inhabitants.

From our survey, these swamps and ponds, however, are affected by saline concentration at various degrees. Drinking purpose, therefore, could not be used as a preferable source (Most of local people drink collected rain water.) Some have been used for irrigation purpose.

Since the Northeast has been frequently affected by drought, the existence of these swamps and ponds has contributed as a relief source for domestic use, especially during the drought period. Most of swamps and ponds have been used for cattle, mainly buffalo, taking bath.

A survey of 21 main swamps and ponds was carried out during the field study, its result is notified in Table 3-2.

### 3-2-2 Economic Aspects

The main economic activity in the study area is characterized by low rice production. Every year more than half of paddy fields in Amphoe Phra Yun is considered as uncultivated due to unexpectable rainfall pattern combined with the insufficient water resources.

Besides, there is no proper installations for products-distribution such as a market in the study area. Small family-type shops selling several daily necessities and foods are found in each village. Some small-scale rural industries are intensively practiced such as the production of plastic sunshades in Ban Non Bo, the production of plastic mats in Ban Ton and Ban Kham Pom. Besides, the production of "madmee" (a kind of Thai traditional silk cloth) is being made in Amphoe Chon Na Bot near the study area. These small-scale rural industries contribute a proper measure for generating rural incomes in these areas although existing for some specific villages only and lacking of a sufficient supporting system.

With the expansion of urban areas for the city of Khon Kaen recently, business-purposed lands move further from the city along national highways, soaring the land price in these areas covering partly the study area, especially lands bordering the national highway Khon Kaen-Manja Khiri.

### 3-2-3 Result from Farm Questionnaire Surveys

The questionnaire survey was carried out to clear up the present situation of farm management and cropping plan in the future.

From each village in the study area, 4 farm households were picked up, composed of 1 large-scale, 2 middle-scale and 1 small-scale. The number of sampled villages was 56 and a total of 224 households was surveyed. Distribution of the sampled villages is shown in APPENDIX D Figure D-1.

Table 3-2 Survey on Ponds Existing in Study Area

Pond Name	Location (Muban, Tambon, Amphoe)	Area (m <sup>2</sup> )	Depth Dry/Wet (m)	Reservation-Capacity (m <sup>3</sup> )		Water Quality EC(μS/cm/25°C)		Utilization				Remarks	
				Dry Season	Wet Season	Dry Season	Wet Season	Irrigation (ha)	Drink- ing	Domestic Water	Fishes		Live stock
Bang Kaeng Nam Ton T.	Amphoe Muang	6,777,000	2.0/2.5	13,554,000	16,942,500	910	1,976	Paddy=288 Upland=48/80					NEA Pumping Station Brakish
Kul Phan	Ban Non Waeng	2,027,000	3.0/4.0	6,081,000	8,108,000	544	472	Paddy=96 Upland=5/0					Good for irrigation
Kut Mak Theng	Ban Non Waeng	1,280,000	1.0/2.0	1,280,000	2,560,000	621	659	Paddy=96					Salar Pump Good for irrigation
Kut Khok	Ban Ton	2,560,000	1.0/2.0	2,560,000	5,120,000	770	430	Paddy=800 Upland=3.2/0					Cooperative Pumping Station Good for irrigation
Nong Hua Bung	Ban Hua Bung	15,000	0.4/1.5	1,000	22,500	n.a.	6,203	—					Brakish
Nong Waeng Hi	Ban Nong Waeng Hi	232,000	2.8/3.0	679,000	696,000	250	136	Paddy=480 Upland=16/16					Canal=1 km Good for irrigation
Nong Phra Bu	Ban Phra Bu	195,000	1.0/2.0	195,000	390,000	1,535	4,573	Paddy=320 Upland=32/0					Brakish
Nong Bua	Ban Phra Yun	49,600	0.0/1.0	0	49,600	239	224	—					Good for irrigation
Nong Waeng Klang	Ban Phra Yun	100,800	3.0/4.0	302,400	403,000	196	149	—					Community Pond Good for Potable
Nong Pan Nam	Ban Chat	216,000	0.6/2.0	129,600	432,200	n.a.	164	Paddy=240					Weir Canal Pipeline Spillway Good for Potable
Nong Chang To	Ban Kham Pom	100,800	0.5/2.0	50,400	201,600	2,699	2,343	—					Brakish
Nong Bai Si	Ban Bo Kae	15,000	0.5/2.0	2,000	0,000	2,571	4,704	—					Brakish
Nong Bo	Ban Dong Kheng Amphoe Manja Khiri	50,000	1.5/3.0	75,000	150,000	2,895	5,394	Paddy=24 Upland=4.8/8					Brakish
Nong Ban	Ban Non Ngiu Amphoe Manja Khiri	4,000	0.0/2.0	-	8,000x4	7,191	8,488	—					Brakish
Nong Bo	Ban Non Bo	3,500	0.0/1.2		4,200	669	858	—					Good for irrigation
Nong Bo Yai	Ban Non Bo	25,000	0.8/2.0	8,000	50,000	2,166	3,880	—					Brakish
Nong Phra Yun	Ban Phra Yun	22,500	0.5/1.0 (3.0)	5,000	67,500	334	294	—					Good for irrigation
Nong Phra Yun	Ban Phra Yun	2,500	2.0/5.0	1,800	12,500	332	570	—					Brakish
Nong Kung	Ban Phra Yun	10,000	1.0/2.5	3,000	25,000	878	1,311	—					Brakish
Nong Kam	Ban Pa Mo	13,000	0.5/2.0	1,500	26,000	1,651	2,367	—					Brakish
Nong Lat Khwai	Ban Pa San	10,000	0.6/1.5	1,500	15,000	n.a.	1,580	—					Brakish

(1) Situation of the farm management

The average cultivated land area is 6.6ha (41.5 rai), 3.6 ha (22.6 rai) and 1.9ha (11.7 rai) according to the large, middle and small, scales farms respectively. The average paddy field area per household is 2.7ha (17 rai) and glutinous rice is grown under rainfed conditions. The planted area ratio to the holding area is 89% and the harvested area ratio to the holding area is 62%. The average yield is 288 kg based on the harvested area or 185 kg based on the holding area.

Under the irregular rainfall condition, rice planting is started at early May. In 1989, planting lasted to the late October. Some farmers prepared their nursery twice a year to plant at a late season. Generally the nursery area is over 10% of the main field. Thirty seven farmers (17% of the all farmers) sell their produced rice. Most of them were distributed in Tambon Phra Bu, Don Chang and Ban Ton. But generally their main purpose of growing rice is to keep this staple food for their self consumption.

The area of upland fields holds 30% of the agricultural land. In Tambon Tha Sala this sharing is higher. Cassava has the highest share of 70% in upland fields, kenaf and sugarcane follow it. The growing of pasture for seed production is going on around Tambon Nong Waen under contract with the Livestock Department. Vegetables for seed production are also grown around Amphoe Muang Khon Kaen contracted with a private seed company. This kind of cultivation is bringing a considerable income to farmers. Around Tambon Phra Yun and Kham Pom there are many small scale sericultural farmers. 29% of inquired farmers harvest cocoon and reel raw silk in their home. A few farmers are making home made fabrics and get a well income.

In the study area especially in Tambon Tha Sala, Phra Bu, Ban Ton and Nong Waen, livestock raising is very popular. About 70% of the inquired farmers are raising buffalo or cattle. The average number of livestock heads per farmer is 3.3. The use of buffalo is for farming work and cattle is for meat. One fourth of these farmers sell their livestock. Some of large area holding farmers gave up cultivation and left a part of their land without cropping.

(2) Constraints in the agriculture

The highest constraint on the rice cultivation is shortage of water, followed by the salt-affected soil problem. Also in the raising fish the water shortage is the severe constraint. About 40% of these owners of small farm ponds gave up the raising fish by December. In the

livestock raising infectious diseases (especially in poultry raising) and shortage of feedstuff are presented as constraints.

(3) Expected crops

Farmers were questioned also on the tendency of farm production in the past five years and future five years (APPENDIX D Table D-16). Thirty percent of rice growing farmers are willing to increase rice production and the same tendency was appeared to cassava and kenaf. Most of the pasture growing farmers are willing to increase the production in future. Although income is very high for tomato growing, these farmers are not willing to expand their farming scale because of intensive works. On the sericulture 58% of raising farmers want to increase cocoon production. Livestock raising farmers have high tendency for increasing their livestock heads. More than half of buffalo raising farmers hope to increase their buffalo heads. About fish raising the share of farmers who want increase this production is highest for all items.

### 3-3 Land Use and Agriculture

#### 3-3-1 Land Use

##### (1) Present Land Use

Interpreting aerophotos scaled 1:15,000 taken in 1976 and 1983 and referring the satellite imagery from LANDSAT and SPOT, the present land use map was drawn. Finally, the map was checked on the field. Present land use is shown in Figure 3-6 and total area of each land use category is given in Table 3-3.

Paddy fields occupy more than a half of the study area, followed by upland crop fields which cover about one third of the study area. Most of land are owned by individuals and have been prepared for paddy fields or upland crop fields; however, considerable area of paddy fields lie idle due to lack of rainfall, accordingly, actual utilization rate is still as low as 50%.

##### 1) Land Use in Alluvial Floodplain and Low Terrace

In the alluvial floodplain along the Chi river, paddy fields are widely distributed owing to the favorable topographical and soil conditions. The limited extent of the paddy fields, that is, only 560 ha of land are irrigated. Most of paddy fields are susceptible to drought and flooding. In addition, some extent of land are used for cattle grazing.

In the low terrace, rain-fed paddy fields with scattered termite mounds cover the major portion, which occupy 18,720ha or 54.8% of the entire study area. Transplanting is done depending on the water availability; however, considerable portions of paddy fields remain fallow and are used for cattle grazing due to lack of rainfall.

In particular, the lower portion near the footslope of denuded forest and the vicinity of the reservoir pond or road construction sites, salt patches, where salts mainly consisting of NaCl have been accumulated on the surface, are locally distributed. Severely salt-affected land (170ha in total) has been abandoned to cultivate crops and lies barren with sparse halophitic thorny shrub of Nam Daeng (*Carissa cochinchinensis*) and Nam Phrom (*Maytenus mekongensis*). These lands are not used for rice cultivation. In the paddy fields adjoining the abandoned land, rice plants grow well if there is no salt patches. *Eucalyptus camaldulensis* having drought and salt tolerance are reforested for pulp making.

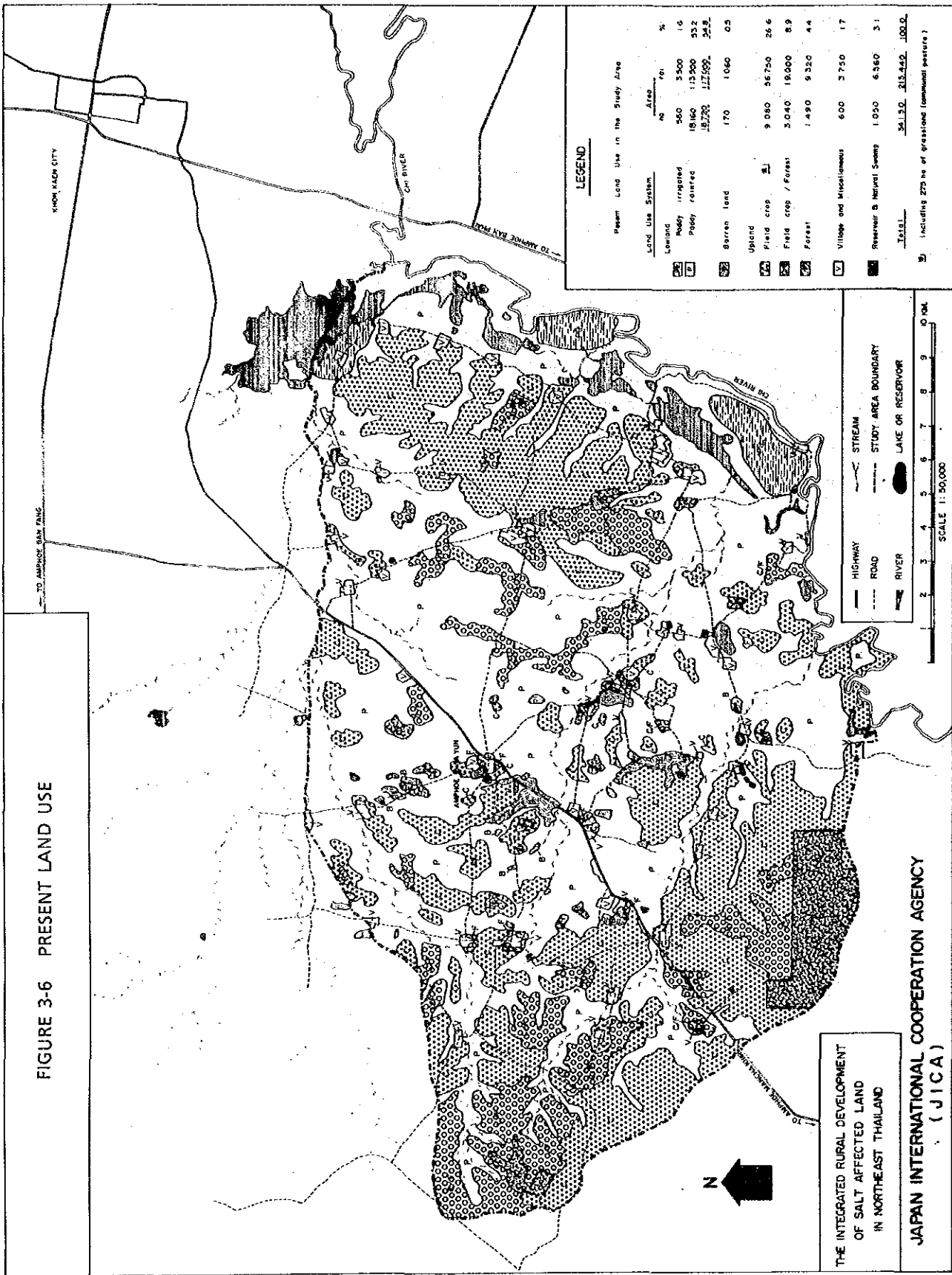


Table 3-3 Present Land Use in the Study Area

Land Use System	Area		
	ha	rai	%
Lowland			
Paddy, irrigated	560	3,500	1.6
"    rainfed	18,160	113,500	53.2
<u>Sub-total</u>	<u>18,720</u>	<u>117,000</u>	<u>54.8</u>
Barren land	170	1,060	0.5
Upland			
Field crop*	9,080	56,750	26.6
Field crop/Forest	3,040	19,000	8.9
Forest	1,490	9,320	4.4
Village and Miscellaneous	600	3,750	1.7
Reservoir & Natural swamp	1,050	6,560	3.1
<u>Total</u>	<u>34,150</u>	<u>213,440</u>	<u>100.1</u>

\* Including 275ha of grassland (communal pasture) and 440ha of mulberry farm.

FIGURE 3-6 PRESENT LAND USE



THE INTEGRATED RURAL DEVELOPMENT  
OF SALT AFFECTED LAND  
IN NORTHEAST THAILAND  
JAPAN INTERNATIONAL COOPERATION AGENCY  
(JICA)

## 2) Land Use in Middle to High Terrace

In the middle to high terraces, upland crops predominantly cassava which can grow on moisture-stressed and infertile soils, followed by kenaf, maize and mulberry for sericulture are planted. In the upland crop fields which occupy 9,080ha or 26.6% of the study area, cassava is cropped without fertilization, accordingly, the soil fertility has been severely exhausted. The soils, in addition, are susceptible to soil erosion due to their loose sandy texture and lack of vegetative cover and tree canopy protection. Recently, some cassava fields have been converted to kenaf or mulberry fields.

Centering Ban Nong Waeng, seed multiplication farms of pasture grasses and legumes, that is, ruzi grass (*Brachiaria ruziziensis*) and hamata bean (*Stylosanthes hamata*) under the contract with LDD are located. Watermelon, cantalope and tomatoes are also cultivated intensively for seed multiplication in some places where irrigation water is available.

In addition, rain-fed paddy fields with deciduous dipterocarp trees which have been relatively recently prepared are found on middle terrace. These paddy fields have a small plot size due to the slope and are susceptible to drought.

Density of trees is increased in high terrace and the upland crop fields mixed intricately with deciduous dipterocarp forest are seen (3,040 ha or 8.9% of the study area). However, the large scaled forest area is limited. The forest reserve area exists in the southern periphery of the study area and *Eucalyptus camaldulensis* has been planted about 1,300ha under reforestation programme within 2,950ha of the reserved area.

## 3) Non-Agricultural Land Use

Most villages are generally located at the higher portion and various scale of reservoir ponds have been constructed by different agencies in the vicinity. Near villages, vegetables such as tomatoes and fruit trees such as mango and banana are planted for local consumption.

In the reservoir ponds as well as natural swamps along the Chi river (totally 1,050ha or 3.1% of the study area), small scale fishing is performed by inhabitants.

Near Ban Pa Mo village in the western part of the study area, the land rich in laterite, gravels and cobbles is used as a quarry for road construction.

## (2) Change in Land Use (Deforestation in the Past Decades)

The traditional land use pattern is closely related to the landform and soil distribution pattern. However, the traditional land use pattern has been changed by extension of cultivated land due to population pressure; for example, the paddy fields have been prepared in the upland area where the suitability for paddy fields was less.

Furthermore, the area of cassava fields has expanded rapidly at the expense of deciduous dipterocarp forest since 1950s. Original dense forests are hardly seen in the middle to high terraces at present (refer to Figure 2-1).

Recently, road networks and reservoir ponds have been vigorously constructed in the study area, accordingly, the land use pattern has been transformed gradually.

### 3-3-2 Crop and Agricultural Production

#### (1) Crop Production

The cultivated land area in the study area is 23,770 ha. The number of the household is 8,120 and the average cultivated land area per household is 2.9 ha (18.3 rai). The paddy field area is 15,680 ha, or 66% of the cultivated land and 1.9 ha (12.1 rai) per household. The cropping area of field crops is 4,460 ha and cassava is a main crop. Besides the unused land area is 3,640 ha, mainly in upland fields (APPENDIX D Table D-2).

In the paddy fields sticky rice is grown under rainfed conditions. The average yield is estimated at 280 kg/rai (production/harvested area) and is very unstable. For example, for Amphoe Phra Yun which covers 65% of the study area, the rice production fluctuated from 1,850 to 9,381 tons in the past three years. In 1986 the Northeast has suffered from a severe drought; during that time, at Phra Yun, the planted area was 26.4% and the harvest area was only 9.7% of the total paddy areas. In 1987 there was plenty of rainfall and the production was very high, but the planted area to the holding area was about 50%.

The average holding area of rice field per household at Amphoe Phra Yun is 2.2 ha (14 rai), but the rice production is only 1,240 kg, because of a low planted area. If the amount of rice consumption per year for one person is 360 kg (unhulled rice), this could feed only four persons. Therefore, most of the rice produced in this area has been used for self consumption.

In the upland fields cassava covers almost 50 ~ 80% of the total upland field areas (Phra Yun). This crop is a typical cash crop. Its fluctuation of price, however, is very large, linked to the annual amount of production.

In 1988 the planting area of cassava increased to more than twice of the past year due to the high price recorded in the previous year. Kenaf production is decreasing year by year because of its lower price and the difficulty of getting water for processing. Recently it becomes better for using kenaf as a material in pulp production.

The planting area of upland crops in the total upland field areas is estimated at 55-80%. This would be caused by the sudden increase of planting area for cassava in 1988. At some Tambon such as Nong Waeng, vegetables and pasture are grown for seeds production. This cultivation is bringing a good income to farmers.

In Amphha Phra Yun there are 2,470 sericultural households cultivating 320ha of mulberry fields. The average cocoon production per household is only 20 kg, but most of the harvested cocoon is reeled to raw silk and sold at 3,500 Baht. In the case of bivoltin sericulture, all produced cocoons are purchased by silk reeling company at 100 Baht per 1 kg. Reeling cocoon needs so much labour so that silkworm rearing size is usually limited by this reason. Besides, crops such as kapok and lai (used for material of sheet) are also grown. In the home-garden, banana, mango (100 ha), jack fruit, coconut (10 ha) and custard apple (160 ha) are grown, but mostly for self consumption.

## (2) Utilization of farming machines

In Tambon Phra Yun and Kham Pom 25% of farmers own hand tractors, and 32%, 6% and 3% of them own small sprayers, cars, irrigation pumps, respectively. 38 % of farmers lease tractors from others and 63% of total farmers use tractors. 59 % of farmers use buffaloes for farming works (APPENDIX D Table D-7).

## (3) Materials for agricultural production

Generally the amount of inputs is low. There is no application of fertilizers to cassava fields. For paddy fields most of farmers put a nitrogen fertilizer amount of 2.4 kg/rai. Insecticides are used by some rice growing farmers. These materials are mainly distributed from the Phra Yun Agricultural Cooperative. In livestock raising, there is no cash flow except for the purchase of calves. In polivoltine

sericulture farmers prepare eggs themselves without cash payment. Seed fish is purchased from the public or private seed fish centers.

#### (4) Land Ownership

The land ownership was surveyed in three Tambon for 22 villages. (APPENDIX D Table D-8). In Tambon Phra Yun, 95% of 1685 farmers cultivate only their own land and 2% of these farmers cultivate both of own and leased land, 3% of them depend on the leased land only.

In Tambon Ban Ton, 75% of farmers cultivate their own land, 12% of farmers cultivate both of own and leased land and 13% of farmers cultivate leased land only. In the study area to lease land is popular in farm management, especially for field cash crop cultivation.

#### 3-3-3 Marketing

Considerable marketing institutions are not existing in the study area. Amphoe Phra Yun, in particular, does not possess a central market for the distribution of goods. Small family-typed shops selling several daily necessities and foods are located in each Muban. A market is open on Saturday and Sunday on a road at Muban Phra Yun, the busiest part of Amphoe Phra Yun as well as the study area.

The Phra Yun Agricultural Cooperative purchases approximately 100 tons of rice per year from farmers and sells several goods to members. For other marketing activities, local inhabitants should go to Khon Kaen where exist many central markets and large shops.

#### 3-3-4 Supporting Services and Farmers' Organization

The major supporting service is extension and cooperative activity. Main extension office is established in the compound of Amphoe Office. In Amphoe Phra Yun there is one branch office in each Tambon. The extension officer stays at each office in Tambon. They cover all fields of agriculture except livestock and forestry. They are working as a technical consultant and sometimes as an administrator at this smallest unit.

Amphoe Phra Yun has two cooperative organizations (Phra Yun Agricultural Cooperative and Ban Chad Cooperative). Phra Yun Agricultural Cooperative has its main office at Tambon Phra Yun and two branch offices in Ken Pradu and Nalom. The business services implemented by the cooperative are;

- Credit by receiving loan from the Bank of Agriculture and

### Cooperatives,

- Marketing by selling fertilizer and rice,
- Collecting paddy rice and send to the rice mills belonged to the Agricultural Cooperative,
- Credit Union Cooperatives, saving purposed cooperatives.

This was formed since 15 years for promoting agricultural production with approximately 500 family-members of an asset capital of 2.8 million Baht. It's activities are mainly in agricultural business and loan. In agricultural business, it collects paddy from farmers for selling with a profit of 50 Baht per ton. An amount of approximately 100 ton has been done every year. The cooperative sells fertilizers and consuming goods to make profits also. An annual sale of approximately 600,000 Baht, making a profit of 5-6% from this business also. Its loan-interest is 13.5% per annum.

Ban Chat Cooperative is a local credit union cooperative for saving purpose. It was formed since 10 years with approximately 300 members. Sri Pi Mon Cooperative is formed for the utilization of irrigation-facilities which most of its members belong to Amphoe Muang.

### 3-3-5 Livestock

The numbers of livestock in the study area are 11,170 buffaloes (1.5 head/household) and 6,670 cattle (0.9 head/household). Besides, these are also 2,060 heads of swine and chicken and duck (APPENDIX D Table D-4).

Buffalo is mainly used for agricultural works, recognized as a labor force. In Thailand, swamp-typed buffalo is popular but unsuitable for milk production. There is a plan to introduce river-typed buffalo for milk production, but farmers have not so much interest to this plan because they have no such a custom up to now. Recently young buffalo is being used for meat and some farmers are raising them for meat production. Cattle, mostly Brahman type, is used for only meat. Buffalo and cattle are fed through grazing, but in the dry season they are fed with straw or other residue of agricultural products. The number of buffaloes is estimated to be decreasing with the increase in the agricultural machine use.

The livestock raising in the Northeast is expected to be more developed and the grazing land establishment is carried out as a government project (in the study area, 90ha (560 rai) in Ban Ton, 80ha

(500 rai) in Nong Waeng and 106ha (660 rai) in Tha-Sala are objective areas for this project). The Buffalo Bank system is carried for poor farmers.

Artificial insemination is promoted by livestock extension office to get Holstein's calves, and the breeding of these calves is bringing high income to farmers.

### 3-3-6 Fisheries

Capture and raising of fish is popular in the Northeast, considered as an important source of protein foods for inhabitants. In the study area there are many small farmponds raising fish. Furthermore, in paddy fields, fish is also raised under growing rice. The present state of fish raising at Amphoe Phra Yun is shown at APPENDIX D Table D-9.

Most of these ponds are rainfed ponds with an average size of about 1 rai. Usually in July to August, after some amount of water collected, fries are released for harvesting in the dry season. Products are sold to neighbors as there is no transportation to big markets. The farm gate price is about 25 Baht/kg. Therefore, the average income per 1 rai is estimated at 6,550 Baht. The feed is come from residues of agricultural products, meal leftover, sometimes discharges of pig, insects collected by light traps. At the Fresh Water Fisheries Center, the breeding and distribution of fish are going on. This Center prepares sets of machinery for making ponds and contracts with farmers to make ponds. 93% of the total fish consumption in the Northeast are imported from the Central Region and other districts. In the Northeast the self supply is only 7% with a share of raising fish for only 0.5%. But in the study area the share of raising fish is estimated to be much more.

Every village has a pond for multi-purposes. In many cases fish raising is one of the main purposes. In that case the management of fry fish release, manure input and the capture of fish are done by a committee of the village to get a good harvest.

### 3-3-7 Forestry

Forest land occupies a few portion of the study area at about 1,500 ha (9,375 rai, 4%) which is relatively small as compared to agricultural land of 31,000 ha (193,750 rai, 90 %).

This area is the reserved forest, so-called "Pa Khok-Laung", only the part overlapping with the study area in the south and west



direction as shown in Figure 3-7. This forest at the present condition shows a sign of deteriorated bearing with sparse stand density. The degraded condition may contribute to low capacity of canopy in intercepting of rainfall especially during the rainy season, May to October. As a result, surface runoff coupled with saline groundwater in the said season would raise up rapidly. This may cause the problem of soil salinity in the middle and east of the study area.

Today, with the depletion and deterioration of forest resources, opportunities to supply wood material can be considered from three main sources i.e natural forest (reserved forest land), Eucalyptus plantation and natural trees grown in paddy fields.

Natural forest situations on the south west of the study area. This forest is classified into degraded forest depending upon the presence of trees in the area. The degraded forest can be delineated further into two types with respect to the situation and existing use. They are so-called Economic Forest Zone 1 (Pa Setha-Kit 1) and Economic Forest Zone 2 (Pa Setha-Kit 2). Economic Forest Zone 1 is those presence of existing permanent community and agricultural land (but no legal ownership) and Zone 2 is those suitable for reforestation purpose.

The Zone 1 is in the west of the project, while the Zone 2 is in the south where large scale reforestation project of Forestry Industry Organization Exists.

Based on the aerial photograph taken in 1976, tree density of this degraded forest is about 30.5 trees/ha. It is lower than the average dry dipterocarp forest in the Northeast about 10 times. For natural regeneration, it is rather poor with the presence of sparse seedlings under the mother trees. The density of trees presenting in one-rai plot is ranging from 8 to 74 trees with the average of 36 trees. The main cause of poor regeneration may be attributed to grazing and forest fire in dry season spreading from adjacent area due to burning agriculture practice. If there is no any preventive measure against this destruction, the forest may loss its successive regeneration. Therefore, artificial regeneration like enrichment planting may be needed.

According to the survey, there are many small to medium plots (about 8 - 16 ha) of Eucalyptus plantation existing in the study area. Besides, there are large scale Eucalyptus plantations locating on the west of the study area in reserve forest. They belong to Forest Industry Organization (FIO), so-called 'Suan-Pa Manjakhiri.

FIGURE 3-7 MAP SHOWING FOREST RESERVE LAND

