Chapter I

INTRODUCTION

Chapter I

INTRODUCTION

1-1 FACTORS LEADING TO THE STUDY

An important objective of the Fourth National Economic and Social Development Plan (1977-1981) is to accelerate the recovery from the last economic recession. To achieve this, the strengthening of the production base in the major economic sectors, particularly in the agricultural sector, is emphasized in the Plan. Since one of the basic requirements to ensure the agricultural development is the improvement of the transportation system, the Plan is putting emphasis on the construction of provincial and rural roads reaching to the remote area for agricultural development.

The development of rural infrastructure is also one of the important aims in the Fourth Plan to reduce the economic disparities between urban and rural areas. Especially, the improvement of road networks is most effective for redressing of the regional balance and the consequent raising up of incomes and living standard of the rural area. In this sense, attention for the regional development is paid more to the improvement of regional road networks which link rural areas with major centers of provinces than the piecemeal development of rural roads.

The southeast part of the Northern Region and the northern part of the Central Region, though they are generally situated in a hilly terrain with

low fertility, have still potentials for the development of upland crops such as maize, beans, etc. Especially for maize, which is the fifth foreign exchange earning product of Thailand following to rice, sugar, tapioca and rubber, the intensive development areas are selected in Phetchabun, Lop Buri, Nakhon Sawan and Sara Buri Provinces and the construction of productivity roads in these areas are planned.

The east bank area of the Pasak River between Phetchabun in Phetchabun Province and Chai Badan in Lop Buri Province (hereinafter referred to as the Project Area and its location is shown in the attached "PROJECT LOCATION") has no all-weather road network. In rainy seasons, the land communication in the Project Area is interfered almost entirely by flood, and it makes difficult to transport the agricultural products in the area to the outside markets. Being such the circumstance, the construction of all-weather road network linking the Project Area with the major centers in the outer area is indispensable for the further development of the subject area.

Based on the above-mentioned background, the Department of Highways (hereinafter referred to as DOH) of the Royal Government of Thailand listed up the road construction project between Phetchabun and Chai Badan as Route No. 2260 (hereinafter referred to as the Project) with high priority in its Plan for Provincial Road Construction and Improvement (1977-1981).

In response to the request of the Royal Government of Thailand, the Japanese Government decided to conduct the feasibility study of the said project and entrusted the Japan International Cooperation Agency (hereinafter referred to as JICA), the official agency responsible for the implementation of technical cooperation programs of the Japanese Government, with the carrying out of the study.

JICA dispatched to Thailand a fact-finding mission in February 1978 for the purpose of the field reconnaissance and discussions with the authorities concerned of the Royal Government of Thailand on the scope of the study. After the return of the said mission, JICA organized a team of experts to carry out the feasibility study. The study team started the work in Bangkok on July 17, 1978.

1-2 SCOPE OF STUDY

The overall objective of the study is to formulate the most economical artery road network on the east bank area of the Pasak River between Phetchabun and Chai Badan.

The study was made in three stages, namely Inception stage, Interim stage and Final stage.

The Inception stage, a half month in Japan covered preliminary studies of available data and information collected by the fact-finding mission, and preparation of the Inception Report.

The Interim stage, three months after the submission of the Inception Report to DOH, covered engineering surveys and investigations, economic and traffic surveys, formulation of route alternatives, traffic forecast, preliminary estimate of costs and benefits, preliminary economic evaluation, determination of the optimum route and preparation of the Interim Report.

The Final stage, the succeeding five months in Japan, covered the refinement of the optimum route selection based on DOH's comments on the Interim Report and the more detailed study on the optimum route and preparation of the Final Report.

The Final Report describes all the findings, study results and recommendations of the optimum route and the scale of the Project. The full report is presented in the following two volumes:

Volume 1 : Text
Volume 2 : Appendixes and Drawings

Volume 1 describes the procedures of the study and the results of optimum route selection and detailed study on the optimum route. Volume 2 contains technical details relating to agriculture, traffic forecast, designs, plan and profile of the optimum route, typical cross section and standard drawings of bridges and culverts.

1-3 STUDY PROCEDURE

The whole study is broadly divided into two parts; i) Selection of the optimum route, and ii) Detailed study on the optimum route. The main components of each part are itemized below.

1) Selection of the Optimum Route

a) Formulation of route alternatives in consideration of development potentials and regional impacts, and division of each route into road links

b) Agricultural development forecast for each alternative with and without project

c) Traffic forecast on each road link based on the route search assuming soil aggregate road construction for every link

d) Selection of design standard for each link based on the forecasted traffic volume and DOH's standards

e) Preliminary engineering design and cost estimates based on the 1/50,000 scale topographic maps and field reconnaissance

f) Quantification of agricultural development benefits and road users' cost savings

g) Economic comparison of route alternatives

h) Selection of optimum route taking technical and social advantages and disadvantages of each route alternative into account

2) Detailed Study on the Optimum Route

a) Refinement of traffic forecast based on the route search applying the selected standard for respective road links

b) Refinement of engineering design and cost estimates based on the results of topographic survey and soil & material investigation

c) Refinement of economic evaluation of the Project

The general work flow of the study is illustrated in Figure 1-1.

Figure 1-1 GENERAL WORK FLOW OF THE STUDY

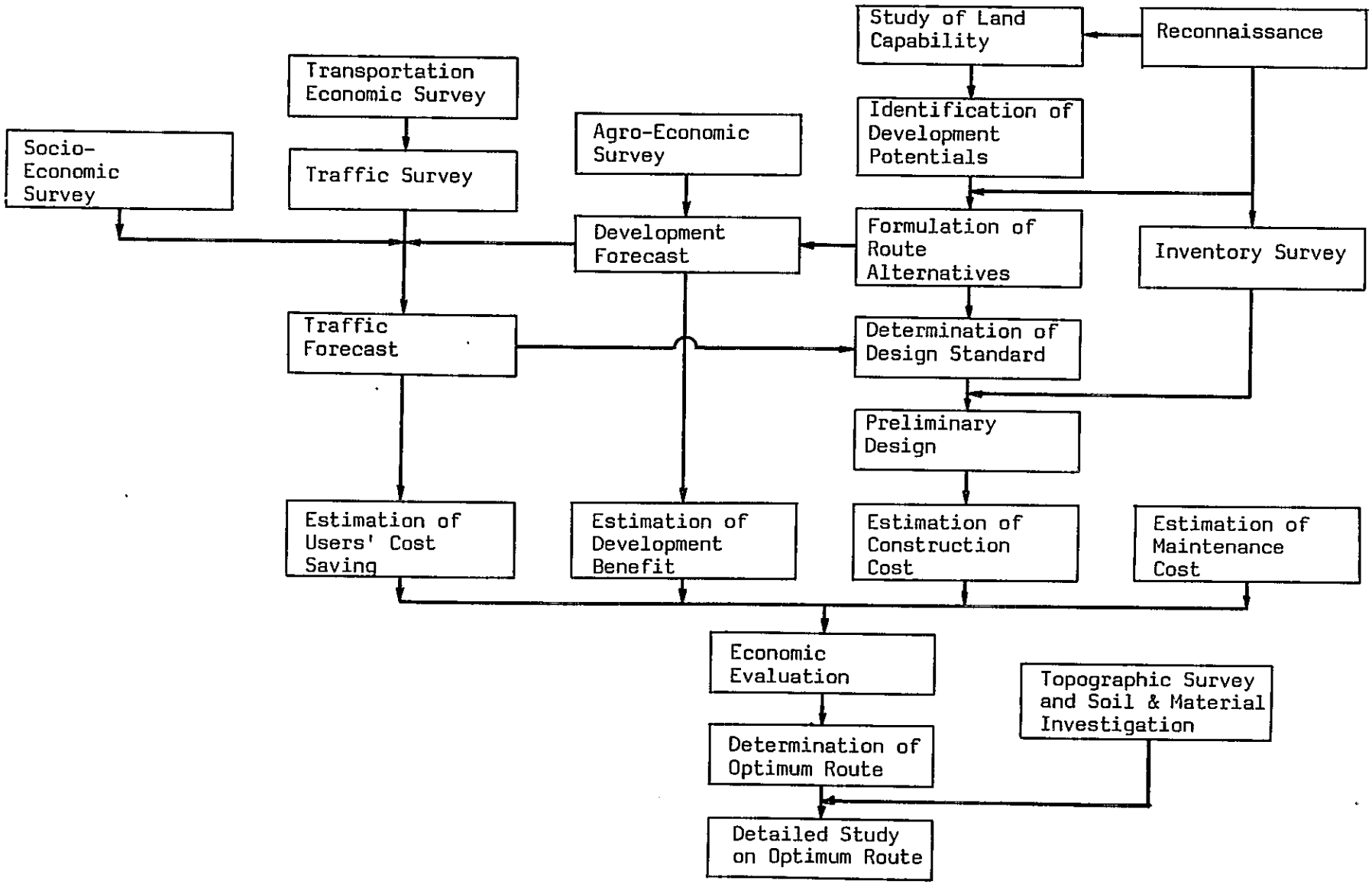


FIGURE 1-1

Chapter – II

BACKGROUND OF THE PROJECT

Chapter II

BACKGROUND OF THE PROJECT

2-1 ECONOMIC BACKGROUND

Thailand has a population of about 44 million in 1977 and an area of 514,000 square kilometers. Although average population density in 1977 was 81 persons per square kilometer and 85 percent of population is in the rural area, the growth of urban population, especially in Bangkok, was as high as about 5 percent while the national average was 2.7 percent.

The average rate of growth of the economy in 1970's has been decreased to 6 percent from 9 percent in 1960's. However, growth rate in 1976 showed a recovery from that in 1974 affected by oil crisis. Out of GDP in 1977, 370 billion Bahts, 20.1 percent was earned by the agricultural sector.

Agriculture is still predominant economic sector, having 63 percent of total labor force and sharing 50 to 60 percent of total value of exports. Major exported crops include rice, sugar, tapioca, rubber and maize. Despite the great importance of agriculture in the national economy, recent growth of the sector has been decreased. The average growth in the Third Plan period was 3.9 percent against the planning target of 5 percent. Thus, in the future regional development program, much attention is paid to the recovery of agricultural production in order to redress the regional balance.

In the Fourth National Economic and Social Development Plan (1977-81), particular emphasis is placed on the objective of regional balance and the Plan seeks to achieve: decentralization of public investment, development of rural infrastructure, reduction of rate of population growth and dispersion of industries away from Bangkok so as to increase employment opportunities and regional incomes in rural area. From the viewpoint of the redressing of regional balance, much attention is paid to the recovery of the agricultural production together with the improvement of rural road networks.

In the Plan, which sets the target of annual growth of GDP at 7 percent, the recovery of agriculture is planned setting target rate of growth at 5 percent. To achieve the target, more attention is paid to productivity improvement than increase of planting area which is limited by the forest reservation policy. All measures to improve the rural productivity are to be seeked. They include effective water control, greater application of agricultural inputs, increase of double cropping, efficient processing and handling of crops, etc. The improvement of rural infrastructure, especially road networks, is indispensable requirement to ease the application of these measures for productivity improvement.

2-2 ROADS IN THAILAND

2-2-1 Road Networks

More than 10 percent of population of Thailand centers in the Bangkok Metropolitan Area. At the end of 1977, the population in Bangkok was 4,743,000, nearly fifty times of that in Nakhon Ratchasima, the second largest town. The pattern of movement for goods and passengers reflects this dominant position of Bangkok in the economy of Thailand. Primary and agricultural products are carried to Bangkok for export, processing and local consumption, while imported and locally manufactured industrial products are moved in the opposite direction. To accommodate these flows, a radial transportation system has evolved with Bangkok at the center. The road transport is a dominant mode in the system with rail and water transportations following.

The public road networks had about 12,700 kilometers of national roads and about 8,900 kilometers of provincial roads in 1976 as seen in Table 2-1. The national road system connects the main towns and regional centers throughout the country. The provincial road system links districts and other important centers or areas to provincial capitals. Since 1963 to date, the national road system has expanded from 9,100 to 12,700 kilometers, and the percentage of paved sections has increased from 46 to 94 percent. At the same time, the provincial road system has expanded from 2,200 to 8,900 kilometers, and the percentage of paved sections has increased from 9 to 48 percent. Besides the above 8,900 kilometers of provincial roads, there are 13,000 kilometers of unimproved provincial roads which receive only minimum maintenance or are under construction or improvement. As they were not constructed to a sufficient standards, many sections become impassable in rainy seasons. About 60,000 kilometers of local roads, which connect villages with national and provincial road systems, are also included in the public road networks.

The networks of national and provincial roads are illustrated in Figure 2-1.

2-2-2 Traffic

The motor vehicle fleet in whole Thailand grew at an average rate of about 12 percent per annum during 1966 - 1976 period. About 1,150,000 vehicles were registered in the country at the end of 1976 as shown in Table 2-2. Traffic distribution on the road networks reflects Bangkok's dominant situation in the economy. Traffic is highest on the approach roads to Bangkok, where it ranges from 15,000 to 30,000 in annual average daily traffic (AADT), and it decreases sharply as the distance increases from the capital. Traffic on some provincial road is over 1,000 in AADT. Traffic on local roads is generally less than 100 in AADT. Traffic growth rates on individual roads have widely varied, but have been generally higher than the increase in motor vehicle fleet.

The regulations on vehicle weights are 9.1 tons for maximum axle load, and 21 tons for gross weight of 3-axle vehicles, 37.4 tons for semi-trailer and 43.4 tons for a truck and trailer combination.

2-2-3 Administration

DOH of the Ministry of Communications is responsible for administration, planning, construction and maintenance of national and provincial roads. Provincial administrative organizations and municipal public works agencies are responsible for local roads, with assistance from the Office for Accelerated Rural Development (hereinafter referred to as ARD) and the Public and Municipal Works Department, both in the Ministry of Interior. In addition, other central government departments and agencies build and maintain roads. For example, the Royal Irrigation Department in the Ministry of Agriculture builds and maintains roads serving irrigation projects, and the Mobile Development Unit (hereinafter referred to as MDU) in the Ministry of Defence and the Army also build roads for national defence and internal security.

2-2-4 Future Road Development

The Fourth National Economic and Social Development Plan (1977-1981) includes an allocation of about 31 billion Bahts for transport sector, or about 12 percent of the total development expenditure. Road investments are about 22.3 billion Bahts, or about 73 percent of the transport allocation.

Having completed construction and improvement works on the major arterial roads, DOH is now putting emphasis on the construction of the provincial and feeder roads reaching into the remote areas. The Plans for Highway and Provincial Road Construction and Improvement (1977-1981) call for construction of 3,135.8 kilometers of national roads and 7,959.1 kilometers of provincial roads. By 1981, the length of the improved provincial road system will exceed that of national road system.

Within the context of the improvement of rural infrastructure, the Fourth National Plan is placing emphasis on the necessity of the construction of networks of rural roads, such as inter-rural roads, farm-to-market roads and roads linking rural areas with towns. Although a notable progress was achieved during the Third Plan period, the ratio of road length to acreage of cultivated land is still low comparing with international standard. In 1975, Thailand had only 145 meters of road per one square

kilometer of cultivated land while the standard recommended by IBRD was 1,500 meters. Improvement of networks of rural roads will play a crucial role in enhancing the more effective production in rural area.

The Accelerated Agricultural Roads Office, organized by DOH under co-ordination of other governmental agencies, is promoting the construction and improvement of rural roads to ease the delivery of farm products to market places.

2-3 AGRICULTURE

2-3-1 Agriculture Dominated National Economy

Agriculture in the Kingdom has significantly developed since 1960 and it has dominated the national economy of the Kingdom. In 1976, around 63 percent of total labor force belonged to the farm household population and around 80 percent of total working population engaged in agriculture. Though the growth of agricultural sector slowed down somewhat recently, it shared 20.1 percent of total GDP of 370,445 million Bahts, the biggest sector in 1977.

2-3-2 Development of Export Crops

Traditionally, rice has been the most important and principal crop in the Kingdom. Since around 1960, however, the patterns of agriculture has much changed and upland crops such as maize, cassava, beans has increased rapidly owing to the export demands. They are planted mostly in the new area of hillside of northern part of the country. This tendency has been much promoted by the road development programs in less developed area of the country as well as by the increased demand of world markets. Trends of expansion of cultivated area for 16 years from 1960 to 1976 show the rapid increase for upland crops. For example, maize area in 1976 was 4.5 times of that in 1960 and 10 times for cassava while the increased ratio for rice field was only 1.45 times.

2-3-3 Target of Agricultural Development

1) Fourth National Economic and Social Development Plan

Under the Fourth National Economic and Social Development Plan (1977-81), the target rate of growth for agriculture sector during the Plan period is set at 5 percent per annum to generate more income in rural areas. The target rate of output expansion at 5 percent per annum is rather high comparing with the rate of increase in the past (3.9% in 1971-76). Nevertheless, the Plan emphasizes the necessity of rapid recovery of agriculture in view of the need to distribute development benefits to rural areas and to raise the living standard of farmers in accordance with the plan objective. Among major agricultural crops, the Plan pays attention to maize, mung beans, tobacco, cotton and soy beans giving higher target rate of annual growth of over 8 percent. At the same time, for export of crops, the Plan gives priority to the increase of the export amounts of rice, maize, tapioca products, sorghum and beans. Among them, maize has the highest target amount of 700 thousands tons and the annual average growth target rate of 5 percent during the Plan period.

2) Intensive Development Districts of Maize Production

Among major cash crops, maize attained remarkable increase of production since 1960 and its total amount of production reached 2.7 million tons in 1976. Around 10 percent of total export income has been earned by maize. The Royal Government has encouraged the farmers to produce maize as one of the most prosperous cash crops. Under the Government's policy, intensive development districts for maize production are designated in the north-eastern part of the central plain and hillside of northern districts. The major districts include provinces of Lop Buri, Nakon Sawan, Phitsanulok, Sara Buri, Phetchabun, Nakhon Ratchasima and Loei. The total maize production amount of these 7 provinces was 74 percent of the total national production in 1976. Among them, production in Phetchabun Province was the biggest, 23 percent of total national production of maize in 1976.

3) Measures to Achieve Target

To meet the target, it is quite necessary to extend and open the isolated and uncultivated new land as well as to introduce new agricultural techniques for improvement of productivity per acreage. In the experience of the past 15 years, it was realized that the construction or improvement of all-weather roads had much contributed to the rapid development of arable lands in isolated area even in the mountain areas. Furthermore, improvement of roads has encouraged the intensive agricultural extension services and the consequent improvement of farming practices. It is quite important to improve and construct all-weather road to enable the smooth and timely transportation of agricultural products and agricultural inputs to markets or to farm lands.

TABLE 2-1

Table 2-1 NATIONAL AND PROVINCIAL ROADS

(km)

Year	National roads			Provincial roads		
	Paved	Gravel	Total	Paved	Gravel	Total
1963	4,157	4,917	9,074	202	1,998	2,200
1964	4,702	4,702	9,404	257	1,957	2,214
1965	5,046	4,436	9,482	405	2,389	2,794
1966	5,008	4,490	9,498	427	2,569	2,996
1967	5,507	4,011	9,518	581	3,311	3,892
1968	6,613	3,131	9,744	1,131	4,078	5,209
1969	7,822	2,146	9,968	1,281	4,448	5,729
1970	8,620	1,781	10,401	1,479	4,413	5,892
1971	9,681	1,296	10,977	1,781	4,347	6,128
1972	10,493	1,014	11,507	2,288	3,891	6,179
1973	11,065	1,008	12,073	2,560	4,039	6,599
1974	11,750	747	12,497	3,025	3,986	7,011
1975	11,840	818	12,658	3,396	4,043	7,439
1976	11,968	752	12,720	4,276	4,601	8,877

Source : Department of Highways

Table 2-2 MOTOR VEHICLE REGISTRATION IN THAILAND

(1,000 vehicles)

Year	Vehicle Type				Total
	Cars	Buses	Trucks	Motorcycles and Others	
1966	97.1	18.5	78.6	178.4	372.6
1970	221.8	18.7	135.7	361.4	737.6
1971	235.0	18.3	147.2	389.2	789.7
1972	240.1	20.2	159.1	413.9	833.3
1973	250.7	21.6	179.4	435.3	887.0
1974	300.9	22.7	232.4	489.9	1,045.9
1975	290.4	22.7	238.1	510.0	1,061.2
1976 /1	307.2	24.0	269.5	545.7	1,146.4

Remarks: /1 Estimation

Sources: Licenses Division, Police Department, February 1977

Figure 2-1 ROAD NETWORKS IN THAILAND

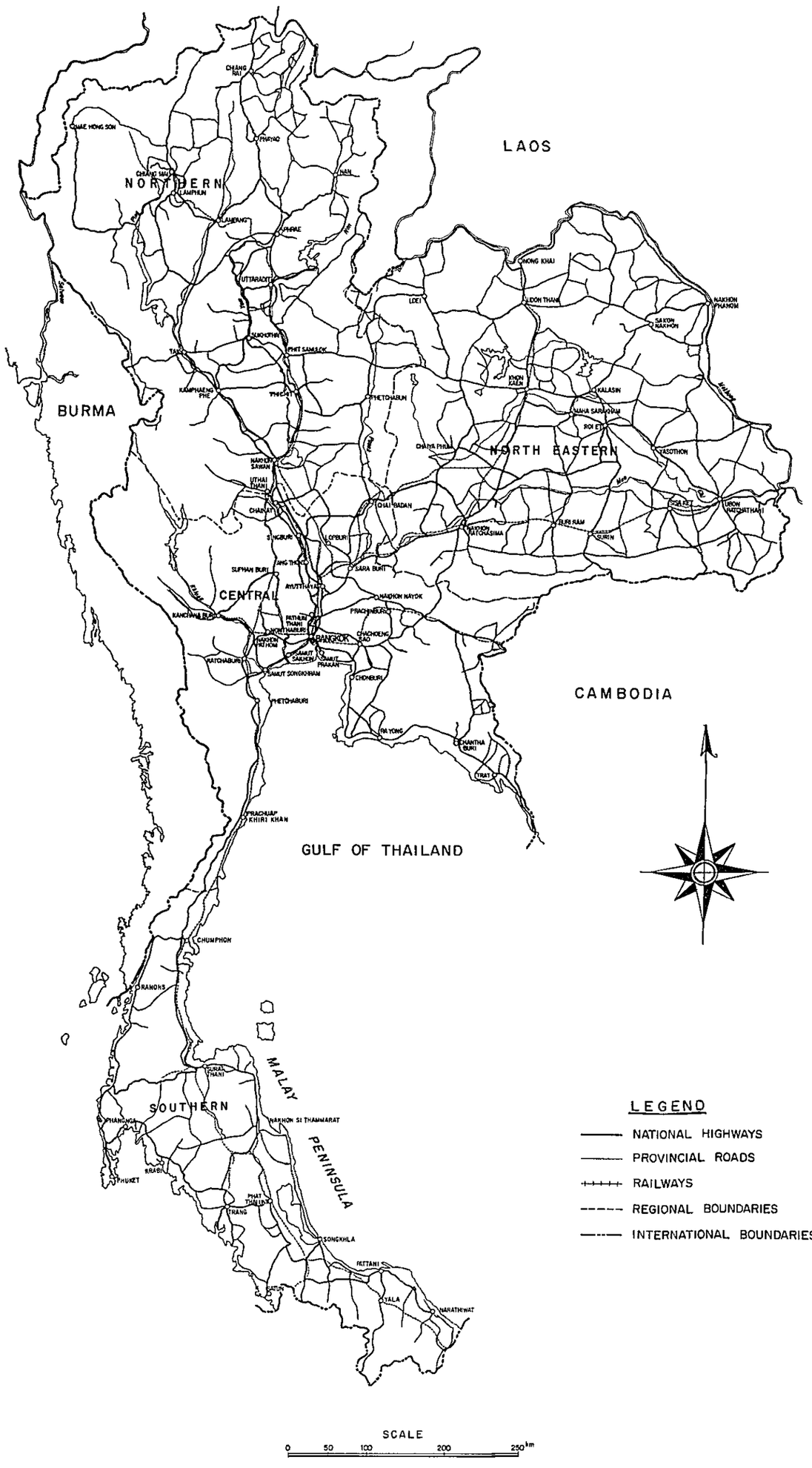


FIGURE 2-1

Chapter III

THE STUDY AREA

Chapter III

THE STUDY AREA

3-1 GEOGRAPHY

The area subject to the study extends over two Changwats (provinces); the Changwat Phetchabun in the southeastern end of the Northern Region and the Changwat Lop Buri in the northeastern end of the Central Region of the Kingdom.

Out of total 14 Amphoes (districts) in the Changwats, only the following six Amphoes are related to the Project Area: Amphoe Muang Phetchabun, Amphoe Non Phai, King Amphoe Bung Sam Phan, Amphoe Wichian Buri, King Amphoe Si Thep and Amphoe Chai Badan. The area covered by these six related Amphoes (hereinafter called as the "Study Area") occupies 9,475 square kilometers extending around 70 kilometers in the east-west direction and stretching about 150 kilometers from the north to the south.

Amphoes in the Study Area are divided into many Tambons (sub-districts). Out of them, only the following Tambons are involved in the Project Area:

Related Amphoes and Tambons

Amphoe	Tambons
Muang Phetchabun	Chon Prai, Na Yon, Na Pa, Tha Bo, Nam Ron, Huai Sakae
Nong Phai	Bo Thai, Tha Dang, Phet Lakhon
Bung Sam Phan	Kanchu
Wichian Buri	Tha Rong, Bo Rang, Kok Prong, Nam Ron
Si Thep	Si Thep, Na Sanin, Nong Yai Toai
Chai Badan	Koa Rang

In the middle of the Study Area, the Pasak River meanders down from the north to the south. The national Highway Route 21 runs in parallel with the west bank of the Pasak River. The topography of the Study Area is flat in the western part of the Pasak while the east side consists of flat and undulating terrain. In the southern part, the average elevation of low land is about 60 meters above sea level and it gradually ascends to 100 meters in the northern part.

3-2 CLIMATE

The climate of the Study Area is tropical and monsoonal. It is characterized by a distinct wet season (May-October) and dry season (November-April). Temperature is warm and hot throughout the year, ranging from 30°C in April to 23°C in December, and suitable for growing crops. Almost 90 percent of annual rainfall, 1,100 millimeters in average, concentrates in wet season. For example, the mean monthly rainfall varies from 1.0 millimeter in December and more than 232 millimeters in September averaged in the year of 1973-75. Hence, little dry season cropping is possible without irrigation system.

3-3 LAND CAPABILITY AND LAND USE

3-3-1 Land Capability

In preparing the land capability map, the following factors were taken into consideration: i) topography (refer to Figure 1A-1 of Appendix 1), ii) physical and chemical properties of soil (refer to Figure 1A-2 of Appendix 1), iii) possibility and degree of flood, iv) possibility of erosion, v) availability of irrigation water supply. The prepared land capability maps for upland crops and for paddy of the Project Area are given in Figures 1A-3 and 1A-4 of Appendix 1.

Among them, soil capability is the most important factor. The soil map is prepared translating the available soil map with a scale of 1/100,000. Soils in the Project Area consists of eight classifications in the agricultural sense. Their characteristics are summarized in Table 1A-1 of Appendix 1. Except steep and rocky mountain area, most of the soils of the Project Area are suitable more or less for paddy or upland crops, especially maize.

Degree of land capability are classified into the following five categories in accordance with that of the Department of Land Development: Class I (most suitable, but not appear in the Project Area), Class II (well suitable), Class III (fairly suitable), Class IV (poorly suitable) and Class V (unsuitable). Brief description of each class of land capability is given below.

a) For Paddy

- Well suitable land (class II) is Hydromorphic Alluvial, Hydromorphic Non Calcic Brown, Low Humic Grey and Grumsol soil on the flood plains and low terraces.
- Fairly suitable land (class III) is Low Humic Grey Soil on the high terraces and semi-recent terraces in the central part of the Project Area and on the low terraces in the southern part. About 50 percent of fairly suitable land for paddy is already cultivated as paddy field.

- The high terraces and dissected erosion surfaces are mostly classified as poor or unsuitable (class IV and V) and hardly cultivable.

b) For Upland Crops

- Well suitable land (class II) is Reddish-Brown Lateritic, Brown Forest and Non Calcic Brown Soil on the dissected erosion surfaces by the width of 0.6 kilometer along the mountain skirts. Well suitable land in the northern part of the Project Area is already used for maize. However, those in the central and southern parts have higher potential of new cultivation.
- Fairly suitable land (class III) is Hydromorphic Alluvial, Low Humic Grey Soil on the semi-recent, low and high terraces in the southern part of the Project Area. Small percentage of this class of land is used as maize field, namely it has higher potential of new cultivation.
- Poorly suitable land (class IV) is Red-Yellow Podzolic, Hydromorphic Non Calcic Brown, Low Humic Grey Soil and Grumsol on the flood plain along the Pasak River and its tributaries. The yield of poorly suitable land for maize is low, mainly because of flood damage.
- Unsuitable land (class V) is located in steep mountainous areas. They should be maintained as forest reserve.

3-3-2 Land Use

The present land use map of the Project Area is shown in Figure 1A-5 of Appendix 1. This land use map was prepared basing on the available land use map with a scale of 1/100,000 and revising it by the field survey as well as aerial photographs taken in 1975-76.

Present land use in the Project Area is summarized as follows:

Present Land Use

	(km^2)
Paddy field	340 (16%)
Maize land	440 (21%)
Forest	510 (25%)
Idle (vacant) land	20 (1%)
Paddy and Maize land	50 (2%)
Forest and Maize land	720 (35%)
Total	2,080 (100%)

Major characteristics of the land use in the Project Area are briefly mentioned below.

- Paddy field occupies the alluvial plains.
- Around 8 percent of paddy field is cultivated for mung and soy beans and sesame as second crops.
- Maize land covers the terrace between the Pasak River and Mountains; more intensive for mountainous side in the northern part, and more intensive in lowland area in the central and southern part of the Project Area.
- The percentage of forest mixed with maize land is larger in southern part of the Project Area. Consequently, new cultivable land for upland crops, especially for maize, extends widely in the southern part.
- About 30 percent of maize land is cultivated for mung and soy beans and sesame as second crops.
- The forest land on undulating and rolling topography in the southern part of the Project Area is not yet used but has high potential for new cultivation.
- The forest land in mountainous area is not used for agricultural crops due to steep slope and shallow thickness of soil. It should be maintained as a forest reserve to protect from erosion, ecological distortion, etc.
- The forest land on isolated hills is also not used for agricultural crops, because those hill is mostly of weathered limestone.

3-4 POPULATION

The past records of population are available at Amphoe level. Those of the related Amphoes, in which the Project Area is included, are shown below.

Population of the Related Amphoes

(persons)

Amphoe	1972	1974	1977
Phetchabun	107,449	120,385	123,724
Nong Phai*	133,026	141,508	154,346
Wichian Buri	68,923	75,760	82,551
Si Thep	47,119	49,666	48,541
Sub-total	356,517	387,319	409,162
Chai Badan	86,224	94,641	n.a.
Total	442,741	481,960	-

* including King Amphoe Bung Sam Phan

The population density in the related Amphoes was, in average, 56 persons per square kilometer in 1977. Within the whole related Amphoes, the density of the east bank area of the Pasak River (the Project Area) is lower than that of the west bank area, because of the delay of development. The average population growth of the related Amphoes was 4.34 percent per annum in 1972-1974 period. In 1974-1977 period, it decreased to 1.85 percent, which was lower than the national average of 2.6 percent.

To find the population of the Project Area, further divided population data is required. Though the population data at Tambon level was collected from Amphoe offices (local governmental agencies), some discrepancies of the boundaries of Tambons were found in the information obtained from these offices. The population of the Project Area was estimated, therefore, based on the collected population data at Tambon level adjusting with the population of Amphoes as control total. The estimated population of the Project Area is 150,800 in 1977 as shown in Table 3-1.

3-5 ECONOMIC ACTIVITIES

As more than 95 percent of the Project Area belongs to the Changwat Phetchabun, the economic characteristics of the Area can be represented by those of the Changwat.

Agriculture is the most predominant sector in the economy of the Project Area. Gross Regional Product (GRP) of the Changwat in 1977 was estimated at 4,019.6 million Bahts of which 2,486.5 million Bahts or 62 percent came from agricultural sector. Agricultural sector absorbs about 84 percent of the total labor force. Although manufacturing sector shares 10 percent of the Changwat's GRP, almost none of manufacturing activities are seen in the Project Area. Per capita GRP of the Changwat was 5,500 Bahts in 1977.

As the Changwat produces big volume of cash crops such as maize and beans to be shipped to Bangkok, trading business is quite active in the Changwat. In the Study Area, major commercial centers are concentrated in the specific spots along the Route 21. Hence, the present economic activities between the inside of the Project Area and the outside of it are mainly in east-west movement crossing the Pasak River. However, in rainy season, due to the flooding of the Pasak and its tributaries and lack of complete route in north-south direction linking to Route 205, economic interchange between the Project Area and the outer area can hardly be performed. Under these circumstances, improvement of all-weather road network to connect the Project Area with outer area especially in north-south direction is quite necessitated to activate the economic movement in the Area.

3-6 AGRICULTURE

3-6-1 Agricultural Production

1) Cropping Pattern and Cultivated Area

Major crops in the Study Area are maize, rice, mung beans and soy beans. According to the statistical data in 1976, these crops covered more than 90 percent of the total cultivated area in the Study Area, 3.2 million rai. The other minor crops are sorghum, groundnuts, cotton, sesame,

vegetable and fruits. As same as beans, these crops except cotton are planted mainly as second crops of maize and paddy fields. A typical cropping calendar of the Changwat Phetchabun is illustrated in Figure 3-1.

Maize is mainly produced as export products and is shipped through Tha Rua or Bangkok to the foreign countries. Its value of production was around one third of the total values of the crops produced in the Study Area in 1976. Maize is planted in around May and harvested during August to September. Its planted area has expanded over the Study Area, even in the hillside slopes, and reached about 1.84 million rai, 57 percent of total cultivated area of the Study Area in 1976. As maize cultivation is rather simple in planting and farm management, it will expand in the Project Area rapidly when the new land become available owing to the road improvement.

Rice is the second valuable crop in the Study Area. After consumed for family own use and local market consumptions, rice is shipped to the other local markets outside of the Project Area. Paddy is planted in July, transplanted in August to September and harvested in November to December. Its planted area, mainly lowland paddy field, has gradually increased in the flat area where the water is available, accordingly the area of paddy fields tends to expand into the maize fields. The paddy area covered 0.51 million rai, around 16 percent of total cultivated area, in 1976 in the Study Area.

Mung beans and soy beans (hereinafter called as "beans") are major second crops for maize and rice areas. Beans are cultivated either after harvesting of maize in upland fields or before transplanting of paddy in lowland fields. But sometimes beans and other food crops are planted at the same time of the growing seasons for paddy and maize in the separate fields complying with market and weather conditions. The cultivated area of beans covered 0.56 million rai, 23.9 percent of rice and maize areas and 18 percent of total cultivated area of the Study Area in 1976.

2) Crop Production and Average Yield

A great majority of crop production volume in the Changwat Phetchabun is shared by maize, rice and beans. Their production volumes in 1976 were 624,000 tons, 340,000 tons and 90,000 tons, respectively, and their share in the total production in whole Kingdom were 23 percent, 2.3 percent and 36 percent, respectively. Details of the past trends are given in Appendix 2. These figures prove the significance of the said Changwat especially in the production of maize and beans to the total supply of them in the Kingdom.

Average annual yield per rai of the main crops in the Project Area are shown below.

Average Yield of Major Crops in Project Area/1

	(kg/rai)
Paddy	344
Maize/2	321
Mung Bean/Soy Bean	133

/1 1975-1977 Average

/2 Guatemala and local variety

Judging from the past trend and the field survey information, the average unit yield, to be used for the study, of maize (Guatemala and local variety), rice and beans in the Project Area were presumed as 320, 350 and 135 kilograms per rai, respectively.

Recently the Government has been promoting to introduce to the farmers the new variety of maize "Hybrid Suwan I", the insect resistant variety. It may be getting popular to plant in the future. The average yield of this new variety was presumed at 400 kilograms per rai.

3-6-2 Farm Economy

1) Crop Production Cost

Referring to the information obtained in the field survey in 1978, the current production costs of major crops in the Study Area were estimated as follows:

Maize	
Guatemala or Local Variety	B 440/rai
Suwan I	B 470/rai
Paddy	B 485/rai
Beans	B 540/rai

Detailed breakdown of the costs is provided in Appendix 2.

2) Farm Income

Average holding of cultivation land by one household with six persons in the Project Area is about 25 rai. Under the above conditions, the current farm incomes of typical maize farm and rice farm in the Study Area were estimated as follows and details are given in Appendix 2.

Farm Incomes of Typical Farms

	Cultivation Area (rai)	Net Value of Production (Baht)
Maize Farm		
Maize		
Guatemala & local	20	1,440
Suwan I	5	850
Beans	7	1,323
Other second crops	3	546
Total		4,159
Rice Farm		
Paddy	25	5,375
Beans	2	378
Other second crops	1	182
Total		5,935

As shown in the above, income of farms, even rice farm, is quite low. Reduction of transportation costs brought by a construction of new road and introduction of new varieties, fertilizer and agro-chemicals will contribute to the increment of farm incomes.

3-6-3 Marketing

1) Market for Maize

Three major market groups are concerned with the marketing and distributing of maize. They include local markets, assembly markets and terminal markets.

a) Local Markets

Usually farmers bring their products to local assembling spots in the centers of villages to sell them to middlemen. Sometimes middlemen go to farm to buy crops at the farm site. Threshing and sacking are done at the trading spots, usually by tractors with threshing machine brought by middlemen.

Prices at local markets are lower than those at assembly markets on the trunk roads. Transportation cost to be included in the prices varies depending on road conditions between farms to markets. Improvement of road network will shorten the economic distance between farms and markets and consequently bring about savings of transportation cost.

b) Assembly Markets

Assembly markets in the Project Area are established along Route 21: Phetchabun, Na Chaliang, Nong Phai, Sap Samo Thot, Wichian Buri, Phu Toei and Lam Narai. Most of middlemen in the assembly markets collect products from farmers and collecting agents and send them to Tha Rua or Bangkok after grading and re-sacking.

Price difference between the assembly markets and production spots varies depending on road conditions. The field survey found that a little more than ten Baht of difference per bag (100 kg) was revealed between selling prices of farmers near to the markets and those of farmers in remote places, over 10 kilometers away from the markets on an average.

c) Terminal Markets

Terminal markets are in Tha Rua, about 20 kilometers west of Sara Buri, and in Bangkok. As merchants in terminal markets have big silos and stores, they are able to control by themselves the timing of shipment according to the export market situation.

From Tha Rua, around 90 percent of maize is sent by barge on the river to Bangkok, and remaining only 10 percent is transported by trucks.

2) Markets for Rice

a) Local Mills

After threshing, paddy is sent by farmers or village rice merchants to local rice millers who are also sometime middle merchants.

There are several rice mills of various sizes at the center of each rice area along Route 21 and main road side. However, very few mills are set up in the Project Area at present because of lack of good road network. Most of farmers sell their products to village merchants who send the products to millers with some margin and transportation charges. These village merchants are usually dealers of cereals or groceries to sell agricultural materials and sundry goods to farmers.

After road network is arranged and several mills are set up in each rice area in the Project Area, the farmers bring their products directly to the millers to save village middlemen's charges and to sell their products in higher prices than through village merchants.

b) Assembly Markets and Terminal Markets

Milled rice is distributed from mills to assembly markets and terminal markets. Assembly markets for rice are almost the same as in case of maize. However, except export rice to be sent to Bangkok, majority of rice from the Study Area are sold at the markets in the surrounding districts or cities in the northward of Bangkok.

3) Markets for Beans and Other Crops

Marketing system for mung beans and soy beans are mostly same as the case of maize. Shipping times of beans from farms to local markets are both rainy and dry seasons. The unit amount of shipment of beans is not large comparing with maize and rice, and accordingly handling charges of middlemen for beans are rather high. Furthermore, purchase prices of beans from farmers are quite flexible according to the market conditions in each production season.

Other minor second crops, vegetables and fruits are mainly produced for self-consumption of farmers or sold to neighboring local markets directly by farmers or by village merchants except the fruits productions in big orchards.

3-7 PRESENT ROAD CONDITIONS

Figure 3-2 shows the existing network of the major roads in the Project Area which have been constructed by several government organizations to suit different purposes.

DOH has constructed mainly trunk roads totalling about 130 kilometers in length, and has been responsible for the maintenance of the roads. Those are primarily intended for the economic and social development of the provinces.

The Accelerated Rural Development Office (ARD) has constructed rural roads connecting major villages. These roads, comprising of about 90 kilometers in total, mainly aim at the development of the rural area. The maintenance works are being transferred to the responsibility of DOH.

Considerably long sections of road are constructed by MDU for the purpose of the security in northern part. A part of which is now under construction and some sections already completed have been handed over to DOH for the maintenance.

The geometric figures of the above-mentioned roads are not all tolerable. Steep longitudinal grades exist in some portions. The road width varies from 6 meters to more than 9 meters between shoulder to shoulder for DOH and ARD roads and is nearly 6 meters for MDU road.

Except the National Highway Route 21 and Route 205, a greater part of existing roads are laterite surfaced roads in fair to bad conditions. Due to the lack of sufficient maintenance works, laterite surfaced roads are worsened with the development of pot holes, corrugations and ruts, particularly in low embankment sections. The primary factor of the deterioration of the roads, however, is due to the overflow of the water resulted from the flood of the Pasak River and its tributaries.

The flood is a yearly event in the Project Area in rainy season. It extends over fairly a wide range of lowland area along the main Pasak and other major rivers as shown in Figure 3-2. Water comes close to the surface of the existing road and sometimes overflows the road.

The overflow sections disperse more than 30 places in the Project Area depending on the terrain, embankment height and the distance from the Pasak and they vary from 100 meters to 8 kilometers in length. At some places, the flood comes up to one meter high above the road surface at least 3 times a year, each lasting for a week more or less.

There are still some river channels where obsolete timber bridges are serving. In dry season, vehicles can manage to pass the river by the use of the timber bridges or detour provided on the river bed. In rainy season, however, those are not utilizable any longer.

In the peak period of rainy season, no vehicle can pass the Pasak except on the route between Wichian Buri and Route 21. The boat services are the only transportation means for the passenger and freight traffic during flooded season. People and cargoes switch from vehicles to small wooden boat and take another vehicles waiting at the opposite side of the rivers. Sometimes waiting time reaches half a day.

3-8 TRANSPORTATION

Main transportation system in the Project Area is land transportation. In flooding season, however, tentative boat services supplement the unpassable roads crossing over the Pasak River and its tributaries.

Based on the hearing survey in the Project Area, the characteristics of present transportation are summarized as follows.

1) Freight Traffic

- Agricultural products are collected primarily to villages by carts or tractors. Average distance of primary transportation ranges from 1 to 3 kilometers.
- Agricultural products are transported secondarily to the assembly centers located along the Route 21 mainly by small trucks due to rather worse trafficability. The secondary transportation in rainy season has to take sometimes long trips using only certain better roads still depending on the weather conditions.
- Lacking any all-weather road in the Project Area, the traffic in rainy season, especially in heavy flooding period, is tremendously interfered. Sometimes cargoes have to be reloaded to small boat to cross over the flooded rivers. Further, they have to spend long time to pass there including waiting time and consequently they suffer losses by deterioration of products' quality and by missing sales opportunity in high prices.
- Averaged and maximum distance of secondary transportation is about 10 and 30 kilometers, respectively. The freight charge of secondary transportation of agricultural products per average 10 kilometers ranges from 3.5 Bahts per 100 kilograms on better conditioned roads to 14 Bahts on bad roads.
- Agricultural products are transported thirdly to the terminal markets in the outside of the Project Area, to Bangkok (10-30%) or Tha Rua (70-90%) in case of maize and beans, by large trucks on paved national highways including the Route 21.

- The freight charge of third transportation of agricultural products is about 4 Bahts per 100 kilograms per 100 kilometers. The freight charge of third transportation per kilometer is about 1/10 of that of secondary transportation.
- Necessary goods for living of inhabitants in the Project Area are being transported by the returning trucks from Bangkok to the Project Area. The tonnage of necessary goods is about 1/10 of the agricultural products transported to Bangkok only.
- Other products in the Project Area than crops, such as pigs, chicken, charcoal, firewood are being transported mainly together with the inhabitants in the same buses or trucks.

2) Passenger Traffic

- About 95 percent of passenger traffic going out and coming from the outside of the Project Area has its destination and origin in the towns along the Route 21 between Phetchabun and Lam Narai and Wichian Buri.
- The transportation mode of passenger is mainly light bus (or modified truck) of capacity for 8 to 20 persons. It allows to load some goods including charcoal, chicken and so on.
- In rainy season, many passengers are crossing the Pasak River and its tributaries partially on foot and partially on small wooden boats.

Table 3-1 POPULATION IN PROJECT AREA (1977)

CHANGWAT PHETCHABUN			146,200
AMPHOE PHETCHABUN		28,200	
Tambon Chon Prai	5,000		
" Na Yon	3,800		
" Na Pa	6,200		
" Tha Bo	5,100		
" Nam Ron	5,900		
" Huai Sakae	2,200		
AMPHOE NONG PHAI		47,600	
Tambon Bo Thai	9,400		
" Tha Dang	16,600		
" Phet Lakhon	11,200		
" Sap Bon	10,400		
AMPHOE WICHIAN BURI		42,500	
Tambon Tha Rong	17,500		
" Bo Rang	8,600		
" Kok Prong	9,300		
" Nam Ron	7,100		
AMPHOE SI THEP		27,900	
Tambon Si Thep	17,200		
" Na Sanim	6,500		
" Nong Yai Toai	4,200		
CHANGWAT LOP BURI			4,600
AMPHOE CHAI BADAN		4,600	
Tambon Koa Rang	4,600		
WHOLE PROJECT AREA			150,800

FIGURE 3-1

Figure 3-1 CROPPING CALENDAR IN THE PROJECT AREA

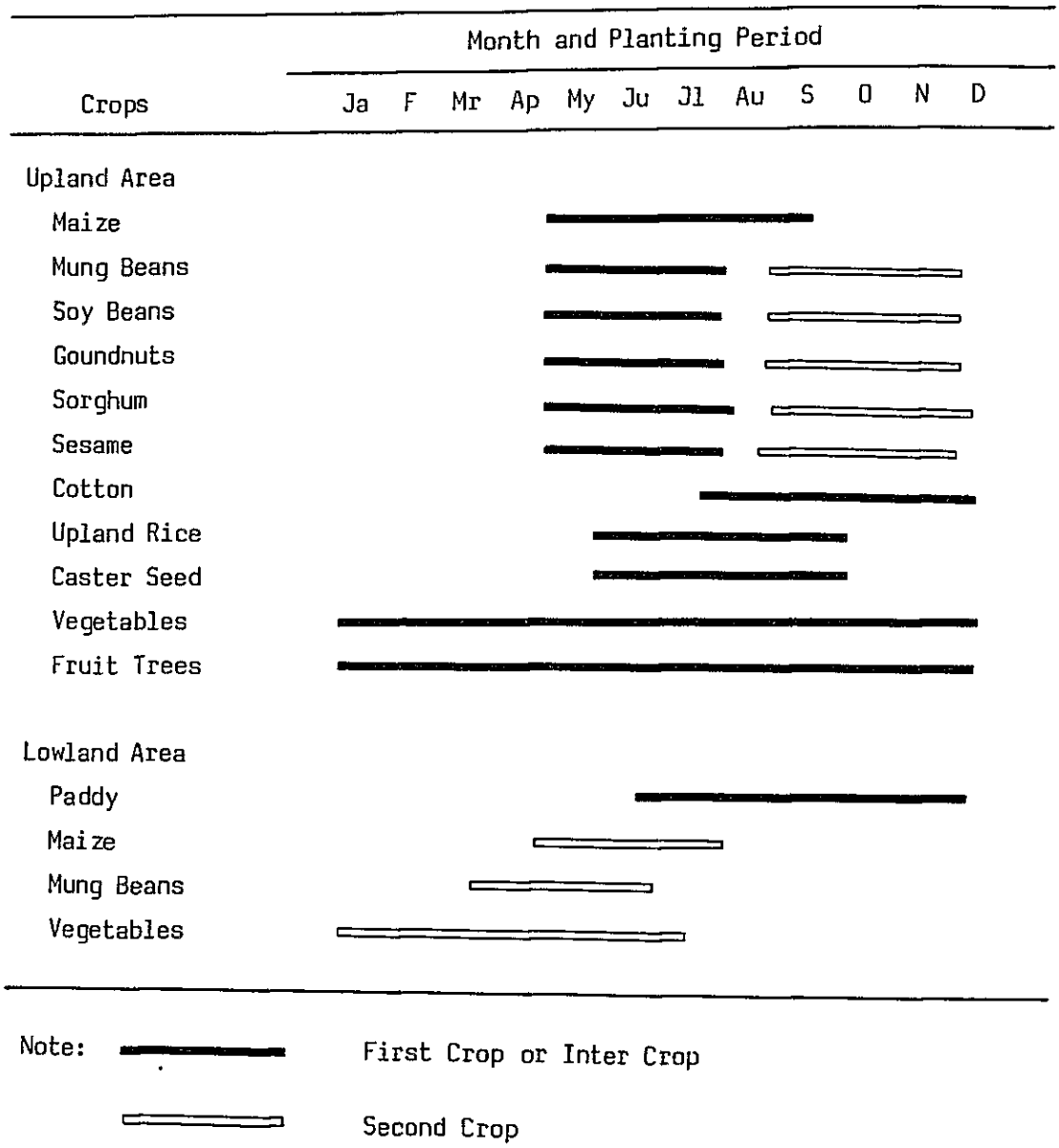
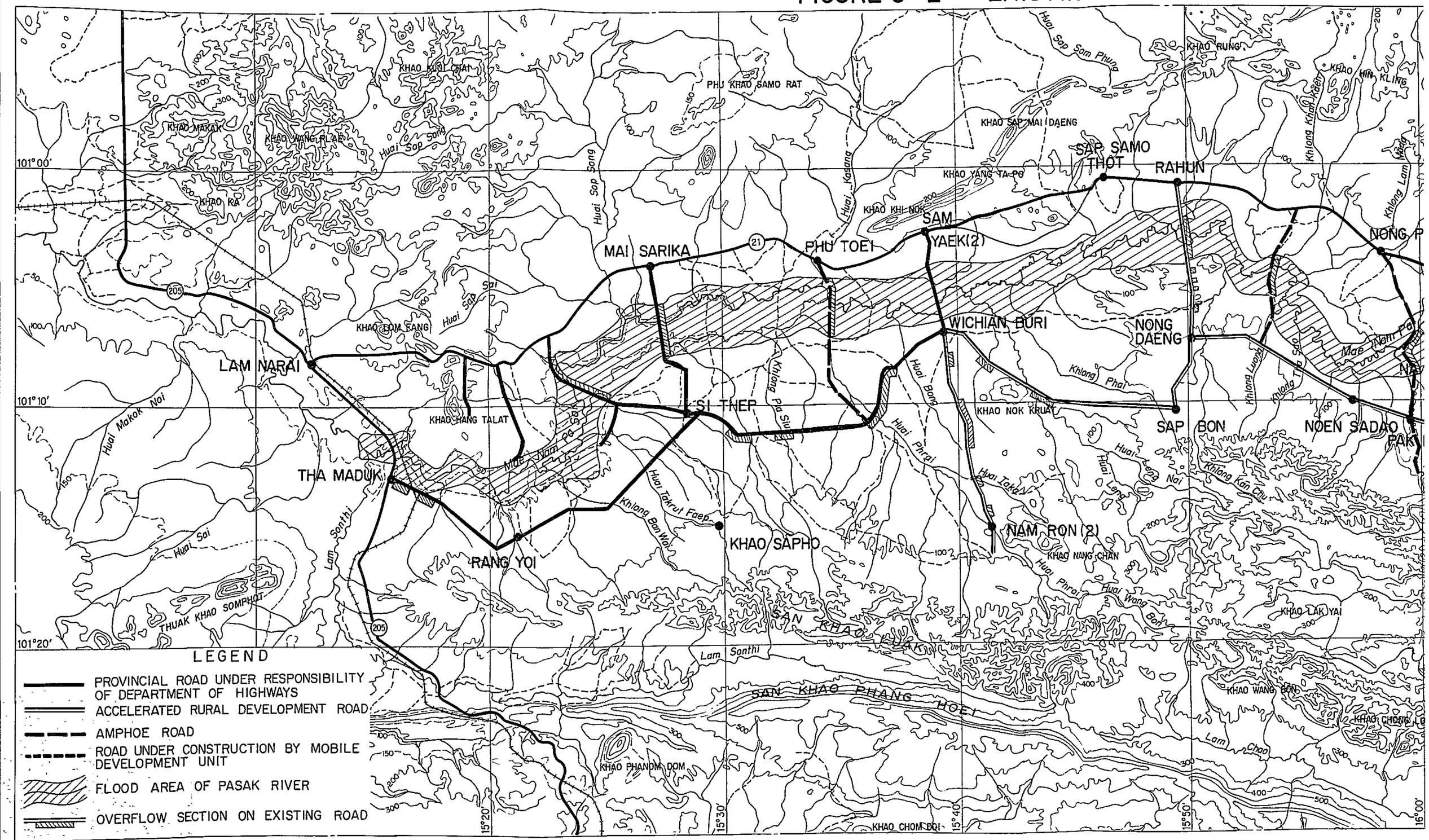


FIGURE 3-2 EXISTING ROADS AND FLOOD AREA



EXISTING ROADS AND FLOOD AREA

FIGURE 3 – 2