

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

THE STUDY ON
AGRICULTURAL LAND CONSERVATION
FOR
INTEGRATED RURAL DEVELOPMENT IN THE EAST

Vol. IV APPENDIX FOR B/P

SEPTEMBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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ABBREVIATIONS AND UNIT

Agencies

AC	Agricultural Cooperative
ADB	Asian Development Bank
ALRO	Agricultural Land Reform Office, MOAC
ARDO	Accelerated Rural Development Office, MOI
BMA	Bangkok Metropolitan Administration, MOI
DA	Department of Agriculture, MOAC
DH	Department of Health, MPH
DLD	Department of Land Development, MOAC
DMR	Department of Mineral Resources, MI
DOAE	Department of Agricultural Extension, MOAC
DTEC	Department of Technical and Economic Cooperation
EGAT	Electricity Generating Authority of Thailand
FAO	Food and Agriculture Organization of the United Nation
JICA	Japan International Cooperation Agency
LWCB	Land and Water Conservation Board
MD	Meteorology Department
MI	Ministry of Industry
MOAC	Ministry of Agriculture and Cooperative
MOI	Ministry of Interior
MPH	Ministry of Public Health
MWWA	Metropolitan Water Works Authority
NESDB	National Economic and Social Development Board, PMO
PMO	Prime Minister's Office
PWD	Public Welfare Department, MOI
RFD	Royal Forestry Department, MOAC
RID	Royal Irrigation Department, MOAC

Other abbreviations

CS	Chachoengsao
CN	Chonburi
RY	Rayong
CT	Chanthaburi
B/P	Basic Plan
F/S	Feasibility Study
GDP	Gross Domestic Product
GRP	Gross Regional Product
GPP	Gross Provincial Product
HYV	High Yield Varieties
LV	Local Varieties
EIRR	Economic Internal Rate of Return
NPV	Net Present Value / Net Production Value
B/C	Benefit Cost Ratio
GPV	Gross Production Value
F. C	Foreign Currency
L. C	Local Currency
C. I. F	Cost, Insurance and Freight
F. O. B	Free on Board
O & M	Operation and Maintenance
H. W. S	High Water Surface
N. W. S	Normal Water Surface
L. W. S	Low Water Surface

Glossary

Park	Region
Changwat	Province
Muang	Capital of Province
Amphoe	District
Tambon	Sub-district
Muban	Village
Mae Nam	Large river
Nam	A medium-size river
Lam	A small river
Kwae	A tributary of a river
Huai	A rivulet

Unit

Rai	Unit of land measurement
Baht	Unit of Thai Currency
mm	Millimeter
cm	Centimeter
m	Meter
cu. m	Cubic meter
MCM	Million Cubic Meter
cu. m/s	Cubic meter per second
km	Kilometer
sq. km	Square kilometer
g	Gram
kg	Kilogram
ton	Metric ton
ha	Hectare
El	Elevation above mean sea level
MSL	Mean Sea Level
°C	Degree Centigrade
mmho/cm	Millimho per centimeter
HP	Horsepower
ppm	Parts per million

Units of Measurement

Rai	=	0.16 hectares	=	1,600 sq.m
Hectare	=	6.25 rais	=	10,000 sq.m

Currency Equivalent (Average of March, 1988)

US Dollar	US\$ 1.00 = 25.52 Baht = ¥ 128.92
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Definition of Words

The Sixth Plan or the Sixth NESD Plan	The Sixth National Economic and Social Development Plan (1987~1991) published by NESDB
Survey area or Study area	19,604 km ² (12,252,500 rais) covering the whole area of 4 provinces (Chachoengsao, Chonburi, Rayong and Chanthaburi)
Project area	15,248 km ² (9,530,000 rais) covering 3 whole provinces (Chachoengsao, Chonburi and Rayong) and a part of Chanthaburi province (approximately one third of the western side of the province)
Planning area	The net area of 8,840 km ² (5,525,000 rais) out of the Project area excluding paddy and forest land, residential and industrial area, etc.

Annex 1.

BACKGROUND OF THE PROJECT

ANNEX 1 BACKGROUND OF THE PROJECT

1-1 Country and Characteristics

Thailand is a large country covering 513,000 km² and having a population of 51.3 million persons. The country can be divided into 5 regions owing to its topographic and geographic structure, namely the northern mountainous region, the northeastern plateau region, the central plain region, the eastern coastal region and the southern peninsular region. Their characteristics are described as follows.

(1) Northern mountainous region

In this region there are continuous mountain ranges which are 1,500~1,800 m in elevation in the western part. These mountain ranges form the water resources area of the Chao Phraya River.

Between the mountains there is a valley spreading out along the river where Chiang Mai and many other rural communities have developed. The alluvial land which lies along the river and the valley has fertile soil and good water resources, and transplanted paddy cultivation is prosperous.

Natural forests remain in the high mountain areas, however, most of the hilly areas have been burned down for farmland.

(2) Northeastern highland region

This region mainly consists of highlands with an average elevation of 120~200 m, although there are low mountain ranges to the west and the south having about a 500 m elevation.

In general, the soil is sandy soil having poor moisture retention which causes it to dry up easily and as a result of the expansion of deforestation, floods have occurred several times in the rainy season. Consequently, there is a lot of barren land and agricultural productivity is low.

Furthermore, a big problem in the Northeastern Region is the existence of saline soil. Saline soils are caused by the surface accumulation of salt through the capillary action of groundwater,

such soil is unsuitable for crop cultivation.

In the lowlands, transplanted paddy is being cultivated but the productivity is low. The main upland crops are cassava, kenaf, sugarcane, etc., however, due to the area of saline soil and the lack of water the productivity is low.

Agricultural land on slopes is affected by severe soil erosion caused by the large amount of heavy rainfall during the rainy season.

(3) Central plain region

This region includes the Bangkok metropolitan area and is the plain at the lower reaches of large rivers such as the Chao Phrya, the Mae Klong, etc. It is an important region which produces half of the domestic product and has a high population density.

Although in the northern part there are elevations which reach 140 m, this becomes lower towards the south with Bangkok having an elevation of 2 m. Also, in Bangkok land subsidence caused by pumping of groundwater has become a problem.

In the southern part, mud has accumulated in the river delta, and rice cultivated on swampy land is the main crop. Due to completion of the irrigation facilities along the Chao Phrya river basin, second season high yielding rice cultivation is being carried out.

(4) Eastern seaboard region

This region consists of a mountain range varying in elevation from 1,000~1,600 m in the northern part, a plateau with undulating topography in the central part and a swampy plain along the coast.

The future development of this region is very promising due to its close location to Bangkok, the promotion of the Eastern Seaboard Development Programme along its coast and, moreover, it is favored with an advantageous coastal line and the Pattaya resort area.

On the other hand, the disorderly development of forest area into upland fields has caused severe soil erosion and conservation measures are urgently required. On the swampy flat land of the river basins transplanted paddy is being cultivated.

The four provinces of this study, namely Chachoengsao, Chonburi, Rayong and Chanthaburi are located in this region.

(5) Southern peninsular region

This region is connected to Malaysia by a long narrow peninsula and has a mountain range 700~1,000 m in elevation cutting vertically in the central area of the peninsula dividing it into eastern and western parts. Mineral resources such as tin exist underground but their development has been delayed due to poor transportation conditions among other reasons.

1-2 National Economy

For the 20 years since the implementation of the First Economic and Social Development Plan in 1961, the Thai economy maintained an average annual rate of growth in real terms of 7%, however, due to several factors including the effects of the the Second Oil Crisis the economic rate of growth since then has been 5.8% in 1980, 6.3% in 1981, 4.1% in 1982, 5.8% in 1983, 6.2% in 1984, 4.0% in 1985 and about 4.0% in 1986. The formerly high growth rate has been converted to one of economic stability. During this period, the industrial sector's percentage of GDP has grown from 10.5% in 1960 to 16.0% in 1970, 19.6% in 1980 and 19.8% in 1985, on the contrary, the agriculture sector's percentage was 38.9% in 1960, 28.5% in 1970, 25.4% in 1980, and was surpassed by the industrial sector in 1985 when its percentage of GDP was 17.4%.

In 1984, the GNP was 40.6 billion dollars and the per capita GNP 806 dollars showing a steady rate of growth each year. However, regional disparity is great, compared to the 2,173 dollar per capita GDP of the capital, the Eastern Region's per capita GDP is 943 dollars (43%) and the Northeastern Region's per capita GDP is 299 dollars (14%).

Although the agriculture sector's percentage of GNP is declining, agricultural products still occupy approximately 50% of the export volume.

The principal items are rice, tapioca, natural rubber, maize, sugar, etc., and especially since tapioca (a starch extracted from cassava) is an important export item it is given special attention from its relationship to agricultural land conservation.

The dominant factors behind the stable growth of the Thai economy are; 1) construction of infrastructure such as roads, electricity, etc., 2) progress in the diversification of agricultural products, and 3) progress in industrialization.

Construction of infrastructure became the basis for the resultant development of agriculture and industry. Agriculture developed from the monoculture type production of paddy to production of new upland crops such as maize, cassava, sugarcane, kenaf, etc., which contributed to the improvement in farmer's income and at the same time earned foreign

currency as an export item. Industrialization succeeded through a policy of gradually developing the import substitution based light industries.

The Thai economy passed through a stormy period of increasing financial deficit, external debt, etc. during the upheaval of the world's economy caused by the oil crises among others. However, in recent years penetration of economic policies such as devaluation of the Baht, reduction in overseas interest rates, etc. have resulted in a bright outlook.

1-3 Agriculture

(1) Agricultural land

In 1984, the agricultural land area was 20,121 thousand hectares and the forest area was 15,151 thousand hectares which was equal to 39.2% and 29.5% respectively of the national area. Looking at the change in respective areas over the past 10 years, agricultural land has increased from 35% to 39.2% of the national area and on the contrary the forest area has declined from 40.8% to 29.5%.

Of the reduction in forest area of 5,770 thousand hectares, 25.6% or 1,475 thousand hectares is presumed to be utilized for the cultivation of cassava, sugarcane, pineapple, etc. These upland fields on slopes are one of the main causes of soil erosion in recent years.

The paddy area is 11,986 thousand hectares or 23.4% of the national area and has hardly increased over the years. Second crop rice cultivation has become possible in certain regions through the construction of irrigation facilities.

Agricultural land utilized for fruit tree crops, vegetable cultivation and grassland covers an area of 2,159 thousand hectares or 4.2% of the national area.

In other principal Southeast Asian countries the percentage of forest area to the respective national area is 66% in Japan, 64% in Indonesia and 40% in the Philippines.

The forest area in Thailand is extremely low and its increase is urgently required for conservation of land and water.

(2) Agricultural production

Previously, Thai agriculture centered on paddy cultivation in the Central Region, in recent years this has rapidly diversified to upland cultivation of cash crops.

Looking at the production volume of the main crops for 1985/86 gives the following order, rice 19,568 thousand tons, sugarcane 24,776 thousand tons, cassava 17,226 thousand tons and maize 4,686 thousand tons. These crops are for domestic consumption and at the same time are main

agricultural products for export which also include natural rubber, coconuts, etc.

(3) Agricultural population and agricultural organizations

In 1984, the number of agricultural households in Thailand was 4,750 thousand and the agricultural population was 33,540 thousand persons and continues to increase. Compared to the whole country, agricultural households accounted for 54.7% of the total number of households and agricultural population accounted for 64.7% of the total population.

This population increase has created a hindrance to the growth of the rural economy due to the lack of employment opportunities.

Agricultural cooperatives are established at the district level carrying out purchasing and marketing activities, however, their financial base is weak and membership does not exceed 17.5% of the agricultural households.

1-4 The Sixth Five Year National Economic and Social Development Plan

(1) Previous national development plans

A quarter of a century has passed since the birth of the first plan, during this time the economy attained an average annual growth rate of nearly 7%. As a result, the GDP of 58.9 million Baht in 1961 increased 18 times by 1985 to 147.5 million Baht and the per capita income increased 10 times from 2,150 Baht to 20,420 Baht over the same period. In the field of social development, taking education as an example, an elementary school has been established in almost every Tambon (sub-district) and a high school has been established in almost every Amphoe (district). Also, in the field of public health, District Hospitals cover 86% of the Amphoes, public health clinics have been established in 98% of the Tambons and basic public health clinics have been established in 90% of the country's villages.

Along with the steady progress in socio-economic development several problems have been revealed, they are;

- slowing down of the economic rate of growth
- increase in the labor force population and lack of employment opportunities
- deficit in trade and finances
- increase in the congestion of the capital area and regional disparity
- deterioration of natural resources and environment
- continuing to promote improvement in living standards and social development

Included among these is the deterioration of natural resources (forest, land, water and mineral) and the environment which is a serious problem having a direct influence on socio-economic development.

In the process of economic growth until now the disorderly development of forest areas has caused the percentage of forest area to national land to drop below 30% in 1985. Recovery of the balance between development of land, water, forests, minerals, etc. and conservation is urgently required.

(2) Components of the Sixth Development Plan

The Sixth Development Plan, based on development results and imminent problems, contains two objectives, three strategies and ten programmes which will be explained in the following and takes into consideration the possibilities of future development.

The two objectives are the economic objective and the social objective. The economic objective is the continuation of an average growth of more than 5% during the plan period and includes increases in employment and income distribution giving serious consideration to the improvement in the economic balance. The social objective is continued promotion of social development to improve the quality of living and to maintain peace and equality.

In order to accomplish the two objectives, the necessity of the three strategies, namely improvement in the efficiency of development, reorganization of the production structure and suitable regional distribution of income and prosperity is recognized.

Ten programmes have been prepared to materialize the three strategies. Since each programme has its own importance, a detailed explanation has been given. Of the ten programmes, two are closely connected to the Agricultural Land Conservation Project in the East, namely the National Resources and Environment Development Programme and the Rural Development Programme.

The National Resources and Environment Development Programme has the objective of restoring the balance between development and conservation through such measures as promotion of fruit tree cultivation, issuance of land right certificates, land reform and protection of the forests. Also, a master plan for natural resources development and environmental protection shall be prepared.

The Rural Development Programme is the most important programme to be carried over from the Fifth Development Plan, it takes measures to increase income of the rural population and improve the standard of living through expansion of social services.

(3) Forest conservation

From analysis of aerial photographs it is estimated that 230.90 million rai or 72.00% of the total area of 320.70 million rai was covered by forests in 1961. In 1985, data derived from Landsat imagery revealed that only 93.16 million rai or 29.05% of the total area remained forested.

The present policy concerning public forest areas was announced by the Cabinet in 1985. It divides forest areas into two categories as follows.

- 1) Conservation area - this area covers approximately 48 million rai or 15% of the total area of 320.7 million rai. It includes watershed areas, wildlife sanctuaries and national parks. In future, these will be gazetted as restricted areas except in national parks where the private sector may be asked to join in development of recreational facilities. Approximately 9 million rai or 18.75% of this area has already been encroached and will require reforestation.

In 1987, the government through the Ministry of Agriculture and Cooperatives (MOAC) officially announced that all squatters must move out of the wildlife sanctuaries within one year as a first step toward forest conservation.

- 2) Commercial forest - this area covers approximately 80 million rai or 25% of the total area of 320.7 million rai. It is estimated that from 80 to 90% of this area has already been encroached. The government has a plan to reforest this area through private sector investment using long-term land leases. In support of this plan the Royal Forestry Department (RFD) has established the Private Reforestation Promotion Office whose duties are to i) demarcate and provide the location of encroached forest areas, ii) explain procedures for investment and iii) outline the opportunities for marketing of timber produced. The Government is also under preparation of a new act -Private Reforestation Act- to clarify and support reforestation activities in the Commercial Forest area. RFD through its own budget plans to reforest 300,000 rai annually.

These two categories combined will mean that 128 million rai or 40% of total area is to be conserved as forest areas.

1-5 Eastern Seaboard Development Programme

(1) Background

The Eastern Seaboard Development Programme is Thailand's first full-scale industrial development programme and extends across the three provinces of Chachoengsao, Chonburi and Rayong.

The outline of the short-term plan of the Programme which shall be implemented by 1991 creating 34,680 new employment opportunities and at the same time measure the promotion of agriculture in the rural area is explained as follows.

After the discovery of natural gas in the Gulf of Siam in 1973 the Eastern Seaboard Development Programme emerged quickly with the objective of utilizing the gas for development of heavy industries.

In 1980 the Eastern Seaboard Industrial Development Committee was established with the Prime Minister as Chairman and the Programme was ranked as a top priority project of the 5th Five Year Plan enacted in 1981.

However, since the entire Programme would require a total investment of more than 100,000 MB by the year 2001 several review and revisions have been carried out in relation to tight government finances among others.

In 1985, the Development Committee decided that for the present only a limited number of new projects would be started and after that construction would be continued step by step.

(2) Objectives of the programme

The Eastern Seaboard Development Programme has the following four main objectives.

- 1) The first objective is the effective utilization of domestic resources. This is a plan to utilize the natural gas from the Gulf of Siam as industrial and household fuel in order to reduce imports of energy resources.
- 2) The second objective is the decentralization of economic activities from Bangkok metropolis. This is a plan to eliminate the concentration of Thai industries which have become excessively dense in the Bangkok area due to Klong Toey Port.

- 3) The third objective is the development of basic industries such as petro-chemical, fertilizer, etc. This is a plan to construct the base for the until now nearly undeveloped heavy industries.
- 4) The fourth objective is the development of export oriented industries. This is a plan to promote light export industries instead of the light import substitution industries supported until now and to emerge as one of the Newly Industrialized Economies (NIES).

(3) Outline of the programme

1) Programme area

The Eastern Seaboard Development Programme covers the three provinces of Chachoengsao, Chonburi and Rayong which have an area of 13,215 km² and a population of 1.6 million persons, respectively about 3% of the whole country. The topography is mostly plain of less than 100 m in elevation and the area's key industry is agriculture producing such main crops as paddy, cassava, sugarcane, pineapple, etc. and others such as fruit, para-rubber, etc. Besides agriculture, there is marine products processing, petroleum refining, sugar refining, tapioca production, tourism, etc.

However, the employed population is a lowly 35% of The labor force population (15~59 years old) and the efflux of population to Bangkok is a big problem. Because of this, great expectations have been placed on the creation of employment opportunities and the promotion of agriculture in the rural area as a result of implementation of the Eastern Seaboard Development Programme.

2) Map Ta Phut area development

Map Ta Phut area along with the Laem Chabang area is a strategic point of the Eastern Seaboard Development Programme. The Map Ta Phut area centers on Rayong Province's Map Ta Phut Port, the target is the utilization of processed natural gas for the promotion of capital intensive import substitution industries. The main items are as follows.

- i) Natural gas related industrial project
 - a) Natural gas separation plant
Construction of the first stage was completed in 1985. The plant has a capacity to process 3.5M cu. ft. of natural gas per day.
 - b) Petro-chemical plant
The tender for construction was carried out in 1985.
 - c) Fertilizer plant
The tender for construction was carried out in 1984.
 - ii) Map Ta Phut deep sea port
The present plan for the first stage of construction shall enable the port to handle 2.5 million tons of goods annually. The plan was completed and financing agreed to in 1983.
 - iii) Map Ta Phut industrial complex
The plan for the first stage of construction includes a 378 ha industrial site, a 40 ha urban area and supporting infrastructure such as roads, water supply system, sewer system, electricity, etc. The plan was completed and financing agreed to in 1983.
- 3) Laem Chabang area development
- The Laem Chabang area is about 10 km north of Pattaya City, and the plan centers on Chonburi Province's Laem Chabang Port. The target is the promotion of labor intensive export oriented light industries. The details of the development plan of Laem Chabang area are as follows, the plans have been completed and some have financing for construction.
- i) Industrial complex
The short term plan includes a 286 ha industrial complex, a 130 ha living complex and a 370 ha harbor site.
 - ii) Laem Chabang port
The plan calls for a container handling capacity of 4 million tons annually as a substitute port for Bangkok's Klong Toey Port. The plan has been completed and financing agreed to.

Annex 2.

THE EASTERN REGION

ANNEX 2 THE EASTERN REGION

2-1 Natural Conditions

2-1-1 Topography and Geology

Thailand is situated between the parallels of 5 and 21 degrees north latitude and between the meridians of 97 and 105 east longitude, the area of the country is about 514,000 km², 1.4 times larger than Japan.

The country is conveniently divided into 5 regions; Central, Northeastern, Northern, Southern and Eastern. The Northern, Northeastern and Eastern Regions of Thailand are bounded on the west and northwest by Burma and Kampuchea. The Central, Eastern and Southern Regions of Thailand are bounded on the south and east by the Gulf of Thailand and on the west by the Andaman Sea, and the Southern Region is bounded at the extreme south by Malaysia.

The direction of the main mountain ranges in Thailand are closely related with the geological zonal structure and the topographic characteristics of each region mentioned above are divided into 2 types by the mountain ranges. One division is the north-south mountain range consisting of old bedrocks and showing a zonal structure, this range forms the boundary between Thailand and Burma from the Northern to the Southern Regions. The other is the mountain range which forms the margin of Khorat plateau located in northeastern Thailand and the range changes direction from north-south to east-west in accordance with the geological structure of the Mesozoic strata.

The country is classified into 5 regions by the main mountain ranges and each one has geological and topographical characteristics as follows.

- Major part of the Northern Region is step terrain consisting of old bedrocks.
- Central Region, generally called the Central Plain, consists of alluvium.
- Northeastern Region is located in Khorat plateau consisting mainly of Mesozoic strata.

- Southern Region consists of a slender range showing zonal structure of old bedrocks, and of upland and fan.
- Eastern Region is an independent upland (monadnocks) on a table land consisting of bedrocks and granite.

Details of geology and topography in Eastern Thailand are mentioned as follows.

(1) Topography

Based on characteristics and topographic features, this area is roughly classified into the following 4 types.

- 1) Steep terrain ;
monadnocks, weathered bedrocks area, with elevation of more than 100 ~ 200 m.
- 2) Undulating lands ;
weathered bedrocks, decomposed granite area including high terrace with elevation of more than 50 ~ 100 m, the majority of the candidate areas is included in this type.
- 3) Low-high terraces ;
unconsolidated deposits such as sand, clay and gravel with elevation of less than 50 ~ 60 m.
- 4) Fluvial and coastal plain ;
alluvial deposits, central plain with elevation of less than 50 m.

(2) Geology

The geology of Eastern Thailand belongs to that of the eastern mountain ranges. The said mountain range exhibits distinctive subparallel ridges in a north-westerly direction. This direction indicates a major orogenic belt which has been affected by many cycles of orogenic movement, the mountain area consists of Precambrian basement complex and rocks of high grade metamorphics. Along the basement complex, sedimentary rocks of the lower Paleozoic to Mesozoic era are arranged in the parallel zone.

At present, these old rocks are dissected by weathering and remain here and there as monadnocks.

After such orogenic movements, in the era of Mesozoic, igneous rocks including granite and ultrabasic intruded into the bedrocks which had experienced tectonic evolution. In addition, in the age of Quaternary, basaltic activity took place in the Chanthaburi area, lower elevation parts of the upland areas are covered with Quaternary terrace deposits, and the coastal region with alluvial deposits.

As a result, geological units from Mesozoic to Quaternary are not found in this area. During this geologic period, either no strata were deposited there because the land was being eroded, or, if any deposits were laid down, they were eroded away completely before the overlying beds were deposited.

2-1-2 Meteorology and Hydrology

(1) Meteorological Characteristics

Thailand is divided into three kinds of climatic regions, namely tropical rain forest climate (Af), tropical savanna climate (Aw) and tropical monsoon climate (Am), by Köppen's climatic division. The Eastern Region belongs to the tropical savanna climatic region except for the eastern part of Chanthaburi province which belongs to the tropical monsoon climatic region.

The most remarkable difference, between tropical monsoon climatic and tropical savanna climate is the amount of rainfall. There are over 3,000 mm of annual rainfall in the tropical monsoon climatic region, however, the tropical savanna climatic region's annual rainfall is from 1,400 mm to 2,500 mm.

Thailand's climate can be divided into three seasons, the rainy season, the cold season and the hot season. It is divided into the rainy season by the existence of rainfall and the dry season is divided again into the cold and hot seasons. The characteristics of each season are as mentioned in the following.

- 1) Rainy season : the rainy season is influenced by the Southwest monsoon which contains humid air from the Indian Ocean. This season begins in the middle of May and ends in the middle of October in the Northern Region and November in the Southern Region. In the rainy season, squalls occur for 1 or 2 hours every day, with the greatest amount of rainfall in September. Typhoons in June and small scale cyclones from the Indian Ocean during the rainy season assail the Eastern Region, this raises the water level of rivers, however, damage from wind is not a problem.
- 2) Cold season : the cold season is influenced by the Northeast monsoon. This season begins in the middle of November and ends in February. There is little rainfall during this season because the Northeast monsoon from the continent carries dry winds over Thailand and the temperature is lowered especially in the Northern Region. However, in the Southern Region the

temperature is lowered only a few degrees. There is much rainfall on the eastern sea side of Peninsular Malaysia as the Northeast monsoon becomes very humid when crossing the Gulf of Thailand.

- 3) Hot season : In the hot season, the Northeast monsoon is uninfluential, since the sun's orbit transfers from the equator to just above Thailand, therefore, this season is the most humid for about three months from March to May and April is the most humid month in the year.

Each characteristic of these seasons is made clear by the average amount of rainfall, temperature and relative humidity over a 30 year period as shown in Figures 2.1.2-1 ~ 2.1.2-3. According to the results of the analysis of these figures, climatical characteristics are mentioned as follows.

- 1) Isohyetal map of annual rainfall and monthly rainfall is shown in Figure 2.1.2-1 for September which is the rainiest month and December which is the driest month, therefore, the Eastern Region is one of the regions with the most rainfall receiving from 1,400 mm to 3,000 mm per annum. There is much rain in the tropical rain forest in the Southern Region during the whole year. But all across the country, the difference between the rainy season and the dry season monthly rainfall is from 300 mm to 400 mm in September, however, it rains only 15 mm in December.
- 2) The isothermal map for average monthly temperature in April, August and December is shown in Figure 2.1.2-2, and the annual difference of average monthly temperature in the Eastern Region is about 4° C less than the Central and Northern Regions whose annual difference is from 6° C to 8° C.
- 3) The Isohomal map for average annual relative humidity and average monthly relative humidity in September and March, shows that September's monthly relative humidity is the highest and March's is the lowest, as shown in Figure 2.1.2-3.

As can be seen from this Isohomal map, relative humidity in the

Eastern Region is higher by about 10% than in the Central and Northern Regions and this is unchanged during the whole year.

According to the above mentioned factors the meteorological characteristics of the Eastern Region are as follows.

- There is much rainfall.
- The difference between the rainy and the dry seasons is distinct.
- Annual difference in temperature and relative humidity is small.
- The difference between the hot season and the cold season is indistinct which is not the case in other regions.

(2) Hydrological Characteristics

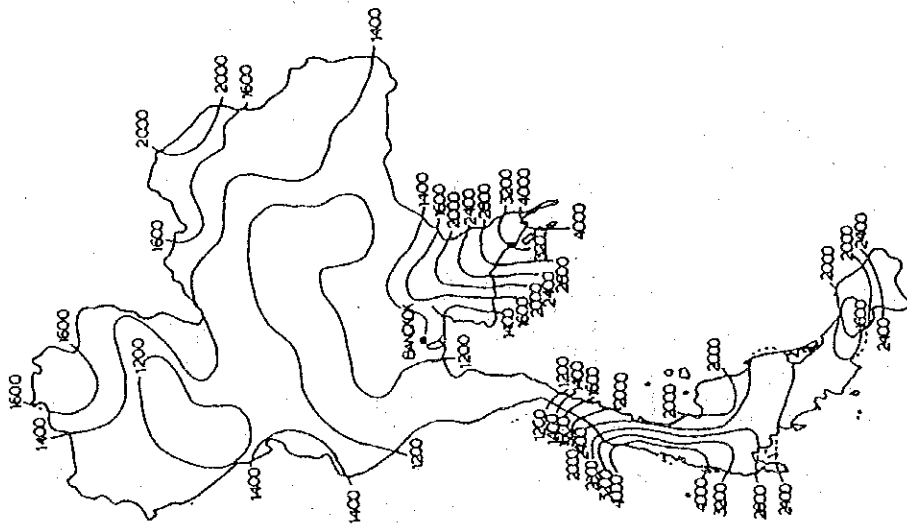
There are no rivers having large basins in Eastern Thailand. The Bang Pakong has the largest basin at 17,000 km² (7,400 km² within the Study Area) see Table 2.1.2-1. Other river basins have only 2,000 km². As a result, rainfall within the basins flows out to the ocean in a short period of time. Also, discharge volume is naturally large during the rainy season concentrated in the period from August to September and the volume is very small during the dry season.

Table 2.1.2-1 Watershed of Some Rivers in Thailand

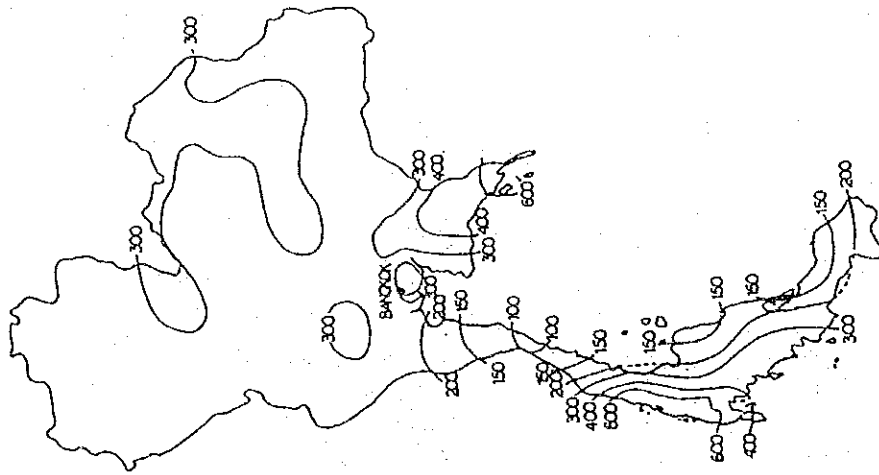
River	Basin (km ²)
Mekong	185,000
Chao Phraya	170,000
Mae Klong	30,000
Bang Pakong	17,000

The river and stream gauging stations in the Eastern Region under operation of R.I.D are shown in Figure 2.1.2-4.

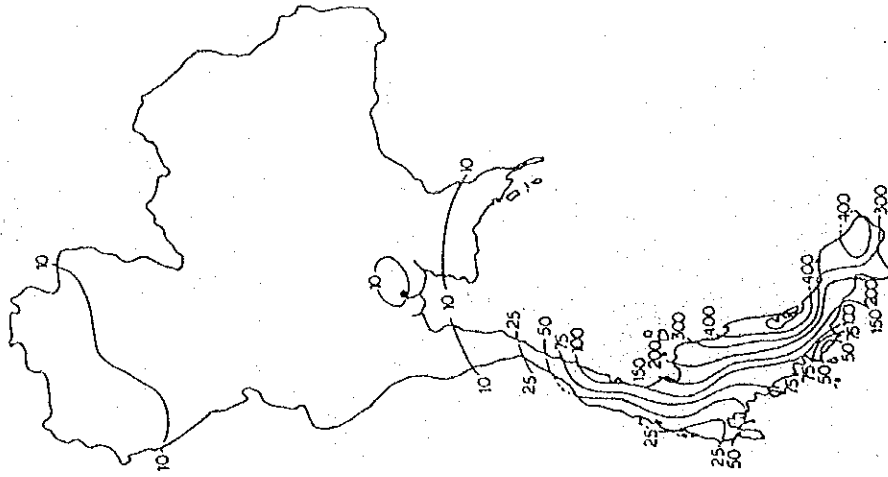
ANNUAL



SEPTEMBER



DECEMBER

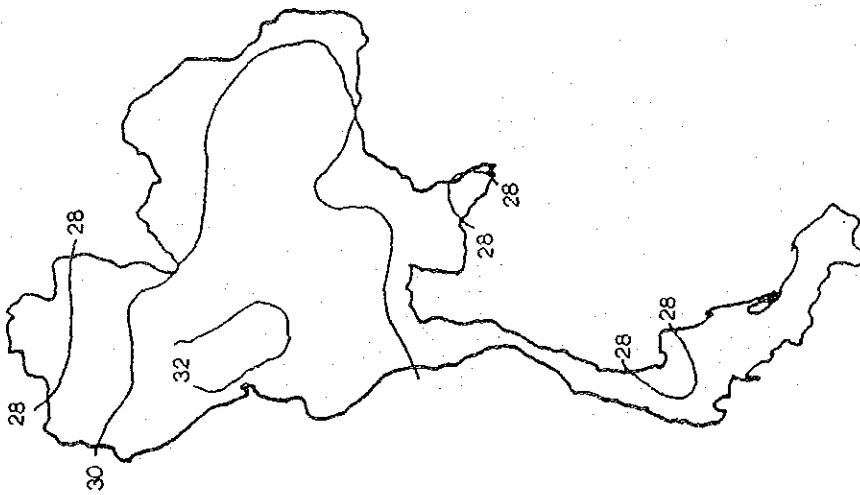


UNIT (mm)

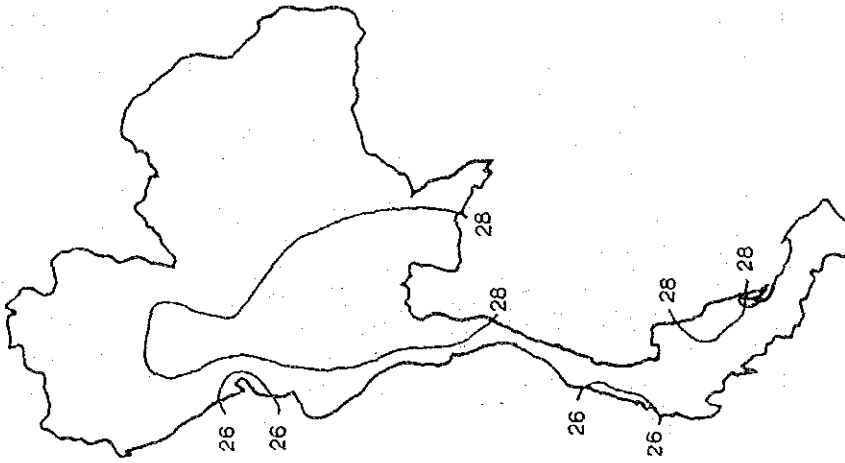
Figure 2.1.2-1 Isohyetal Map in Thailand

Data source : Mean Annual and Monthly Rainfall over Thailand

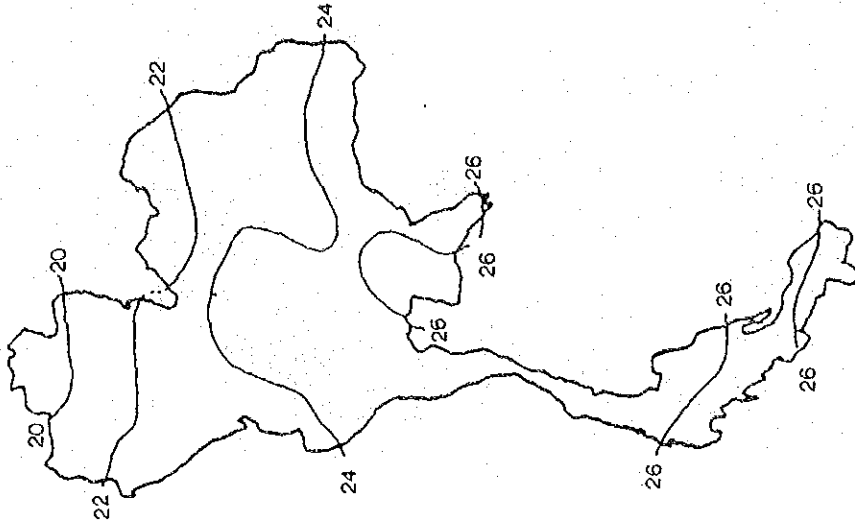
APRIL



AUGUST



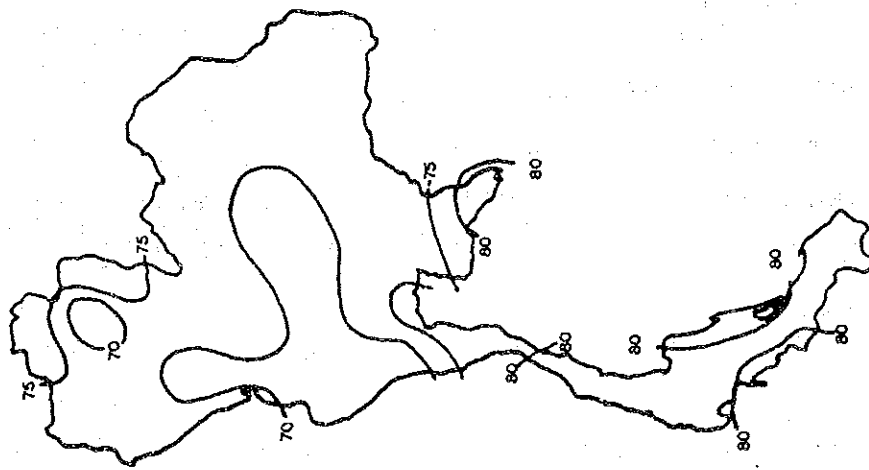
DECEMBER



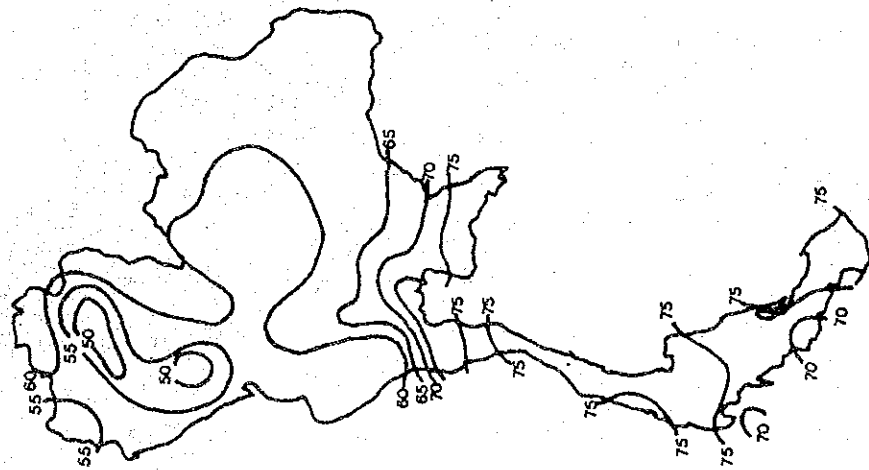
UNIT (°C)

Figure 2.1.2-2 Mean Annual and Monthly Temperature of Thailand,
Meteorological Department

AVERAGE
RELATIVE HUMIDITY



MARCH



SEPTEMBER



UNIT (%)

Figure 2.1.2-3 Mean Annual and Monthly Relative Humidity of Thailand,
Meteorological Department



LEGEND

- DISCONTINUED STREAMFLOW RATING STATION
- STREAMFLOW RATING STATION WITH STAFF GAGE
- STREAMFLOW RATING STATION WITH RECORDER (R) SEDIMENT SAMPLING (S) & METEOROLOGY (M)
- STAFF GAGE WITH DISCONTINUED STREAMFLOW RATING
- RECORDER WITH DISCONTINUED STREAMFLOW RATING
- DISCONTINUED RECORDING GAGE
- RECORDING GAGE
- DISCONTINUED STAFF GAGE
- STAFF GAGE
- STORAGE DAM COMPLETED

Figure 2.1.2-4 Location of Hydrologic Observation Stations in the Eastern Region

2-1-3 Soils and Land-use

(1) Soils of Thailand and soil maps

In 1979, DLD prepared the general soil map of Thailand at a scale of 1 : 1,000,000 based on the Soil Taxonomy developed by the United States Department of Agriculture. The mapping units of this soil map were phases of great group and their associations.

Up to the present time, DLD has published a number of soil maps of different scales. Based on the soil maps, the area covered by soils in each soil order in the whole country and the Eastern Region are summarized in Table 2.1.3-1.

The main soils in Thailand and the Eastern Region are Ultisols which occupy 42% of the total area of Thailand and 60% of that of the Eastern Region. They are highly weathered soils with low base status and generally not fertile soils.

(2) Soils of the Eastern Region

The most extensive soils in the Eastern Region are Ultisols which occupy 60% of the total area, followed by Inceptisols (11% of the total area) and Entisols (7.5% of the total area). Various kinds of Ultisols, such as Aquults, Udults, Ustults are found in the East. Aquults are somewhat poorly drained soils occurring on flat terraces and are used as paddy fields. Udults are found in the areas with high rainfall - Chanthaburi, Trat and the eastern half of Rayong- and are mainly used for fruit trees and rubber. On the contrary, Ustults occur in the areas with low rainfall and are mainly used for growing cassava and sugarcane.

Inceptisols are mostly found on recent alluvial plain along the Bang Pakong River. They are clayey textured soils and mainly used as paddy fields.

Entisols are sandy textured soils derived from granite. They occur on terraces and lowlands along rivers and coasts, and are used for upland crops.

The soil maps of the province series were published by DLD at a scale of 1 : 100,000. In these maps, soil series were used as mapping units. Main soil series occurring in the project area and their characteristics

are shown in Table 2.1.3-2.

The special problem soils occurring in the Eastern Region are sandy texture soils and skeletal soils. The former is predominantly composed of quartz sands and the latter has a layer containing many rock fragments, gravel or laterite at shallow depth which impedes root growth as well as water percolation. Both of these soils have low holding capacities of water and nutrients. At present, they are mainly used for growing cassava. Consequently, these soils when occurring on slopes are under severe erosion conditions from the viewpoint of growing crops as well as soil characteristics and slope. They tend to suffer from a high degree of soil erosion and declining soil fertility.

(3) Soil characteristics and erosion

In 1980, DLD investigated the soil loss in Thailand and prepared a soil erosion map based on the Universal Soil-Loss Equation (A=RKLSCP).

According to this map, the areas being susceptible to very severe erosion occur in the Eastern Region and at the southern, eastern and central parts of the Northeastern Region and small areas at the southern parts of the Northern Region.

The soils found in these areas are mainly Ustults and Udults followed by Slope complex, Ustalfs, Tropepts, Psamment, etc. The textures of these soils except for the last one are mainly Loamy or Skeletal. These soils mostly occur on dissected erosion surfaces and high alluvial terraces which are undulating or gently undulating topography. The erosion of these soils is very severe being influenced by both the effects of soil characteristics and slopes.

In the Northern Region, these erodible soils which occur on the steep slopes have been covered mostly by virgin forests and did not show the occurrences of severe erosion. However, recently a part of the woodlands on the steep slopes has been cultivated for growing upland crops, which has caused soil erosion to become an important problem in the region.

On the contrary, these soils in the Northeastern and Eastern Region have been mostly used for growing cassava. Besides, most of these soils in the East have a LS-SL textured surface soil whose sand fraction is mainly composed of fine to medium sands. (Table 2.1.3-3) They are highly

erodible.

The slope of the lands in the East mainly ranges from 2-6 percent which is not so steep.

(4) Land suitability for agriculture

Based on the information from the soil survey, the lands were grouped into suitability classes for upland crops, paddy rice and other crops. (Table 2.1.3-4)

The percentage of area suitable for upland crops to total area in the East is higher than that of the whole country. The extent of area suitable for perennial crops in the East is larger than any other region except for the South. These figures show the agricultural characteristics of the lands in the East.

(5) Land capability classification

Table 2.1.3-5 gives the land capability classes for upland crops of the soils in the study area with their extent and percentage.

The soils are mostly placed in U-III and IV which are moderately or poorly suited for upland crops. The main limitations are soil texture, effective depth and erosion.

(6) Losses of plant nutrient by soil erosion

Nutrient losses from cultivated land are closely related to soil losses by runoff water.

If agricultural soil losses can be measured or its rate can be predicted, losses of nitrogen, phosphorus, potassium and organic carbon may be estimated with fairly high confidence.

For this purpose, we must estimate the nutrient contents in the soils of the Eastern Region and the ratio* of the concentration of a nutrient in the eroded soil to that in the surface soil from which it was eroded. (* Enrichment ratio)

These values are estimated based on some data as follows ;

Texture of Surface Soil	N	P	k	organic-C	
	%	%	%	%	
1. (SL - LS)	0.25	0.014	0.06	0.43	} *
2. (SCL)	0.65	0.053	0.12	0.96	
Enrichment ratio	2.1	2.4	2.4	1.9	- **
Sediment	%	%	%	%	
from 1.	0.53	0.034	0.14	0.82	
from 2.	1.37	0.127	0.29	1.82	

Sources : * Ogawa, K., Samnao, P. and Orapin, S. (1980) Misc. Pub., TARC, JAPAN, (Annex 5) Soil analysis of this study

** Ueno, Y., Kamrop, B. et al. (1983) The report of the cooperative research work between Thailand and Japan
 Stocking, M. (1988) Paper to 5th Int. Soil Conserv. Conf. BKK. Thailand

The amounts of nutrient losses are obtained from the percent of each nutrient in sediments and the predicted amount of sediments.

(7) Present land-use

The land-use of the East is given in Table 2.1.3-6 and Table 2.1.3-7. The land-use in the East is characterized by a larger extent of land under field crops, fruit trees and rubber, and a smaller extent of paddy field.

During the period of 1961 - 1985, more than 60% of the forest area of the Eastern Region was cleared which brought a great increase to the amount of agricultural land. (Table 2.1.3-8)

Cassava, sugarcane, pineapple and corn are the most important upland crops and coconut is also grown throughout the region. Rice is grown on somewhat poorly drained soils of nearly flat areas. Rubber is another main crop in the region covering about one million rai and is grown on soils occurring on dissected erosion surfaces and alluvial terraces.

Rubber and fruit trees are mostly found in Rayong and Chanthaburi, which have a higher level of rainfall.

Table 2.1.3-1 Soils of Thailand

Soil Order	Whole Country		East	
	Km ²	%	Km ²	%
Entisols	16,860	3.3	2,627	7.7
Vertisols	4,156	0.8	-	-
Inceptisols	48,253	9.4	3,729	10.8
Mollisols	6,003	1.2	140	0.4
Spodosols	615	0.1	84	0.2
Alfisols	46,991	9.2	1,074	3.1
Ultisols	216,192	42.1	20,585	59.9
Oxisols	153	0.0	140	0.4
Histosols	718	0.1	54	0.2
Unclassified	173,174	33.8	5,947	17.3
Total	513,115	100.0	34,380	100.0

Sources: DLD (1979), General Soil Map of Thailand
 DLD (1985), Soil Map of the Eastern Region

Table 2.1.3-2 Characteristics of Main Soil Series Occurring in Upland Area

No.	Soil Series	Parent Rock	Landform	Slope	Soil Texture	Drainage, Permeability	Run-off	Legend of Soil Map (1:500,000)	Area
	CHACHOENGSAO			%					%
22	Ko Khanum (Kkn)	T	Terrace, fan	0-2	SiL/SiL	SvP-V Mode.	slow	27 L. Paleoaquults	4.7
25-36	Bang Khia (Bka)	T	Terrace, fan	1-2	SL/SL	V. Mode.	medi-slow	30 L. Paleustults	11.2
30-32	Satuk (Suk)	G	Terrace, fan	2-8	SL/SCL	V. Mode.	rapid	30 L. Paleustults	3.8
37	Pang Rai (Pg)	T	Terrace, fan	0-1	SCL/SC	V. Mode.	rapid	29 C. Paleustults	3.4
42,43	Sattahip (Sh)	G	Erosion surface	2-4	SL/LS	Sv.Ex. Rap.	rapid	6 S. Quartzipsamment	1.9
48-51	Kabin (Kb)	O	Erosion surface	2-4	CL/C	V. Mode-Slow	medi.	29 C. Paleustults	9.7
3-14	Soils on former tidal flat								
54	Slope complex (SC)	G+O							33.9
	Others								4.2
									27.2
									100.0
							100 % = 3,344,375 rei = 5,351 Km ²		
	CHONBURI			%					
16	Chonburi (Cb)	T		0-2	SCL/SCL	SvP-P Mode.	slow	(L. Paleoaqualf)	4.7
18	Kleang (Kl)	T	Lower Terrace	0-1	CL-C/C	SvP-P Slow.	slow	23 C. Plinthaqualls	1.8
26	Ban-Bung (Bbg)	G		0-2	SL/LS	SvP Rap.	slow	45 L. Eutropepts	8.5
28	Sattahip (Sh)	G		2-4	SL/LS	SvEx Rap.	rapid	6 S. Quartzipsamment	10.4
32	Satuk (Suk)	G	Higher Terrace	2-8	SL/SCL	V. Mode.	rapid	30 L. Paleustults	5.0
36	Phon Phisai (Pp)	T		2-4	SL-L/GCL	Mod V. Mod Slow	slow	28 L-Sk Plinthustults	5.5
38-42	Satuk (var) → 32								5.0
63	Tha Yang (Ty)	O		4-8	SL-L/GL-GCL	V. Rap.		30 L. Paleustults	1.4
64-66	Hup Kapon (Hg)	G		2-4	SL/SL	Mode W. Rap.	medi-slow	16 L. Dystropepts	7.5
67	Satuk (gr) → 32		Footslope						8.6
71	Hap Bon (Hb)	G	Hill	2-8	SL/SCL-CL	V. Rap.	rapid	38 L. Paleustults	3.7
72-74	Nong Mot (Nb)	G	(Granitic Rocks)	8-16	SCL/SC	V. Mode.	rapid	29 C. Paleustults	3.8
75	Slope complex (Sc)	G							8.4
	Others								25.4
									100.0
							100 % = 2,805,899 rei = 4,491 Km ²		

Table 2.1.3-2 Characteristics of Main Soil Series Occurring in Upland Area (Cont'd)

No.	Soil Series	Parent Rock	Landform	Slope	Soil Texture	Drainage, Permeability	Run-off	Legend of Soil Map (1:500,000)	Area %
RAYONG									
19,20	Ta Saa (Te)	0	Plat. surface	3-8	SL/SCL	V. Mode.	rapid	16 L. Dystropepts	3.3
27	Khlong Chak (Kc)	0	Erosion surface	4-16	L-CL/CL-C	V. Rap.	rapid	37 C. Paleudults	3.2
28	Nong Khla (Nk)	0	Erosion surface	2-8	L-CL/C	V. Rap.	rapid(V.shallow)	37-39 C-Sk Paleudults	0.4
35	Ban Bung (Bbg)	G	Locally wash surface	0-2	SL/LS	V-Svp Rap.	slow	45 L(S) Eutropepts	2.1
36	Satteship (Sh)	G	Erosion surface	2-4	SL/LS	Sv.Ex. Rap.	rapid	6 S. Quartzipsaments	4.1
39	Thung Ya (Tg)	G	Erosion surface	2-8	SL/SCL	V. Mode-Rap	rapid	16 L. Dystropepts	3.3
42-45	Chalong (Chl)	G	Erosion surface	1-3	SL/SCL	V. Rap.	medi.	38 L. Paleudults	4.0
46	Huai Pong(Hp)	G	Erosion surface	2-4	SCL/SC	V. Mode.	medi.	37 C. Paleudults	5.0
48	Phangnga (Pga)	G	Erosion surface	3-8	SL-LS/SCL	V. Mode.	medi-rapid	38 L. Paleudults	9.0
51	Map Bon (Mb)	G	Erosion surface	2-8	SL/SCL-CL	V. Rap.	rapid	38 L. Paleudults	4.4
52	Thai Muang (Tlm)	G	Erosion surface	2-4	CoSCL/CoSC-C	V. Mode.	medi.	37 C. Paleudults	2.3
29	Khlong Chale ⁺ Nong Khla (Kc & Nok)	0							8.2
60	Slope complex (Sc)	0+G							13.7
	Others						100% = 2,253,080 rai = 3,621 Km ²		37.0
CHANTHABURI									
33	Chumphon (Cp)	T	Terrace	2-8	GSL/GC	Mode V. Mode-Slow	rapid	33-39 L-Sk Paleudults	8.3
39,40	Huai Pong (Hp)	T	Fan, Local All.	2-4	SCL/SCL	V. Mode	medi.	37 C. Paleudults	4.1
56,57	Phuket (Pk)	0	Fan, Foot slope	8-16	SCL/SC	V. Mode	medi-rapid	37 C. Paleudults	8.6
59	Ranong (Rg)	0	Hill, Foot slope	5-30	SL/vGL-vGSCL	V. Rap.	rapid(shallow)	9 Sk Troorthent	2.8
61	Slope complex (Sc)	0					100% = 3,870,498 rai = 6,193 Km ²		25.2
	Others								51.0
									100.0

* T: Terrace deposit G: Granite 0: Old basement

Source: DLD, Description of Soil Series

Table 2.1.3-3 Proportionate Extent of Soil Textural Classes in the Project Area

Land-form, Soil Texture	Chachoengsao	Chonburi	Rayong	Chanthaburi
Recent Alluvial Plain	34.5%	8.3%	12.8%	6.0%
Piedmont, Terrace, Erosion Surface and Hill				
SL-LS/SL-LS	15.3 } 33.4 (55)	28.5 } 54.3 (66)	11.3 } 44.9 (62)	13.1 } 31.1 (39)
SL-LS/SCL-CL	18.1 }	25.8 }	33.6 }	18.0 }
SCL-CL/SCL-C	27.3 (45)	27.9 (34)	27.0 (38)	48.3 (61)
Slop complex	4.2	8.6	13.7	13.6
Others (Rivers, Ponds,.....)	0.6	0.9	1.6	1.0
Total	100 = 5351 Km ²	100 = 4363 Km ²	100 = 3552 Km ²	100 = 1981 Km ²

Sources: DLD (1977-81), Detailed Reconnaissance Soil Maps (Scale 1:100,000)
 --CS, CN, RY and CT Provinces

Table 2.1.3-4 Land Suitability for Agriculture

Unit : 1000 rai (%)

	North	Northeast	Central	East	South	Total
Area suitable for upland crops	20,036	30,694	11,485	5,307	161	67,683 (12.1)
Area suitable for paddy	16,435	40,521	14,873	5,583	7,057	84,469 (26.3)
Area suitable for perennial crops	0	0	703	961	14,696	16,360 (5.1)
Area generally unsuitable for economic crops but can be suitable for special crops	14,724	21,250	3,356	5,564	4,934	49,828 (15.5)
Area unsuitable for agriculture	54,241	12,092	12,846	3,988	16,708	99,875 (31.2)
Water body	591	976	188	85	641	2,481 (0.8)
Grand Total	106,027	105,533	43,451	21,488	44,197	320,696 (100.0)

Sources: DLD (1982), Potential Land Use Map - Eastern Region (1:500:000)

Table 2.1.3-5 Land Capability Classification for Upland Crops in the Study Area

Capability Class	Chachoengsao		Chonburi		Rayong		Chanthaburi	
	Subclass*1	Area 1000 rai %	Subclass	Area 1000 rai %	Subclass	Area 1000 rai %	Subclass	Area 1000 rai %
U - II*2	III s	299.1	III sm	570.4	III s	559.0	II s	119.1
	III d	210.1	III ds	94.4	III sm	52.6	III s	537.2
	III t	72.3	III es	983.8	III se	457.4	III es	300.3
	Others	11.4	Others	33.1	III s/III es	156.7	Other	86.6
U - IV	III/IV	72.8	III/IV	286.7	Others	70.9		
	IV s	1028.7	IV d	144.3	III/IV	228.7	IV d	151.7
	IV a	534.3	IV ds	174.1	IV s	61.4	IV s	255.1
	IV df	613.5	IV es	72.5	IV d	145.6	IV fx	164.3
	Others	97.4	Others	66.6	Others	45.9	IV es	468.5
	IV/VI	191.4			IV/VI	20.4	Other	68.9
U - V	V	25.8	V	32.9	V	57.7	IV s/VI es	281.6
	VI	1.8	VI	26.6	VI	65.8	V	44.3
	VII es	114.4	VII es	244.4	VII es	242.5	VI es	229.2
U - VI					VIII	44.7	VII es	888.5
U - VII								
U - VIII								
Unclassified								
Total		3344.4		2761.3		2239.4		3783.2
		100.0		100.0		100.0		100.0

Kinds of limitation for subclass; e- erosion, s- soil limitation, m- lack of moisture, t- unfavorable topography, f- flooding, d- impeded drainage, x- salinity, a- soil acidity

U- II Soils well suited for upland crops U- III Soils moderately suited for upland crops

U- IV Soils poorly suited for upland crops U- V -VIII Soils unsuited for upland crops

Source : DLD (1980-1982), Land Capability and Soil Suitability Maps (Scale 1:100,000)

--CS, CN, RY and CT Provinces

Table 2.1.3-6 Land Utilization of the Study Area (1985)

(1,000 rai)

	Total land	Forest land	Housing area	Paddy land	Under field crops	Fruit tree, tree crops	Vegetable flowers	Grass land	Idle land	Other land	Unclassified land
Whole country	320,696.9	93,158.3	3,031.2	73,902.4	31,604.9	13,463.5	473.5	847.5	3,749.8	1,530.6	98,935.1
Eastern region	21,487.9	4,680.2	194.9	3,732.4	3,827.9	1,433.8	18.8	51.8	288.5	159.7	7,099.9
Chachoengsao	3,344.4	845.0	40.2	977.7	437.7	139.1	3.6	1.8	24.8	40.7	833.8
ChonBuri	2,726.9	161.6	36.3	360.0	1,281.2	189.1	3.3	2.0	5.4	37.4	650.5
Rayong	2,220.0	150.3	27.8	176.7	812.0	244.5	2.8	7.8	6.3	8.3	783.4
Chanthaburi	3,961.3	1,209.1	27.4	223.5	288.4	517.2	3.8	1.9	163.0	110.4	1,516.5

Source : Agri. Statistics of Thailand (Crop Year 1986/87)

Table 2.1.3-7 Land-use of the Eastern Region

Land-use	Area	
	1000 rai	%
Community	96.2	0.4
Agricultural Area	14,238.5	66.6
Mixed fruit trees	51.6	0.2
Mixed fruit trees with others	247.0	1.1
Para rubber	751.7	3.7
Para rubber with others	576.4	2.9
Coconut tree	33.7	0.2
Upland crops	4,685.5	21.8
Upland crops with others	3,370.7	15.7
Rice	3,424.9	16.0
Rice with Others	1,097.2	5.0
Water farming	17.1	0.1
Water farming with rice	76.1	0.4
Unused area	153.1	0.7
Unused area with others	1,572.2	7.2
Forest, Mangrove forest	5,192.3	23.9
Water resources	142.3	0.7
Total	21,487.8	100.0

Source: DLD (1987), Land-use Map of the Eastern Region (1:500,000)

Table 2.1.3-8 Forest Area in Various Regions of Thailand

Region	Total land (1,000 rai)	Forest Area							1985	
		1961	1973	1976	1978	1982	1985	1985	1961	
		%	%	%	%	%	%	%	%	
North	106,028 (100)	68.5	67.0	60.3	56.0	51.7	49.6	73		
East	22,814 (100)	58.0	41.2	34.6	30.2	21.9	21.8	38		
Northeast	105,534 (100)	42.0	30.0	24.6	18.5	15.3	14.4	34		
Central Plain	42,124 (100)	52.9	35.6	32.4	30.5	24.5	25.6	48		
South	44,197 (100)	41.9	26.1	28.5	24.9	23.3	21.9	52		
Whole Country	320,697 (100)	171,018 (53.3)	138,567 (43.2)	124,011 (38.7)	109,515 (34.2)	97,875 (30.5)	93,158 (29.1)	55		

Note: Values of Forest Area are as percentage of total area in each region.

Source: RFD (1985), Forest Area of Thailand

2-1-4 Soil Erosion

(1) Soil erosion in Thailand

Thailand is climatically classified as being located in the Humid Tropics zone. In the zone, occurrence of serious soil erosion is recognized all over the world.

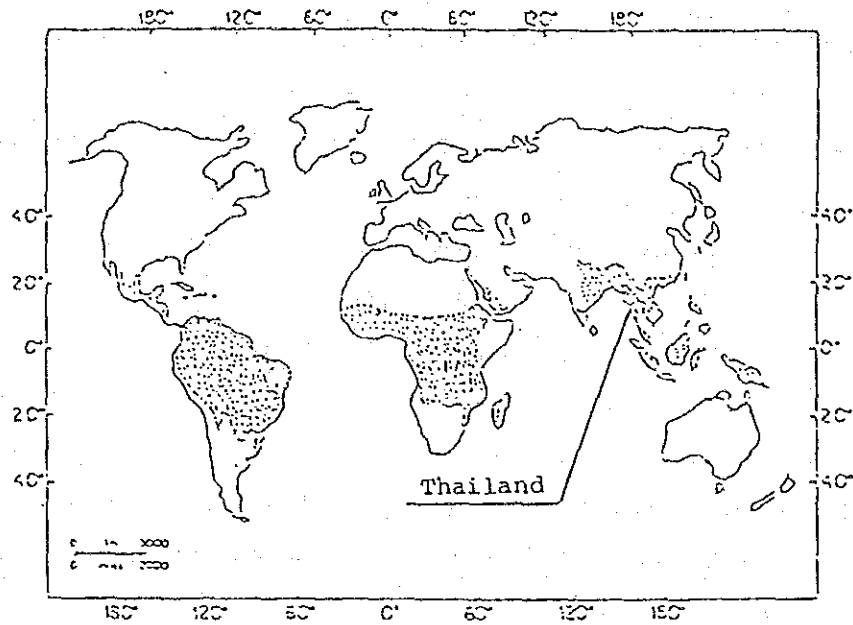


Figure 2.1.4-1 Humid Tropics Areas

Areas of the tropics with five or more humid months. Derived from Map 5, 'Seasonal climates of the earth', in Landsberg et al. (1963)

There are many reasons for the acceleration of soil erosion. Among them one of the most important reasons why the visible effects of soil erosion are so much more pronounced in the humid tropics is the very high erosivity of rainfall. The intensity of a tropical rainstorm is much greater than that of rainfall in more temperate areas. Namely, the rainfall range of Thailand is 1,000 mm ~ 4,700 mm/year and the average is 1,550 mm/year except for Trat in the East and the Southern part of Thailand.

There are two typical seasons, one is the rainy season from April ~ May to October, 90 percent of annual rainfall occurs in this season, the other is the dry season from November to April or May.

Rainfall days, more than 10 mm/day, are about 20% and more than 20 mm/day are about 10% of the total of this season.

The features of rainfall are as follows;

- Very heavy but short time (1 ~ 2 hours in a day)
- 10 mm ~ 30 mm within 30 minutes

Compared with Japan, annual rainfall and rainfall intensity are much greater but rainfall time is shorter in Thailand.

On the contrary, annual evaporation is 1,600 mm ~ 1,800 mm and the average is 4.4 ~ 5.5 mm/day.

The features of soil erosion in Thailand under this climate are as follows;

- 1) Soil erosion mainly occurs in the rainy season.
- 2) Soil is exhausted from repeatedly being wetted (expansion by rainfall) and dried (contraction by drought).
- 3) After extensive farming such as shifting agriculture, the soil has become depleted, therefore, it has no resistance against soil erosion.
- 4) Countermeasures for soil conservation are insufficient in such areas.
- 5) Under these conditions, the soil is seriously eroded from continuous heavy rain.

From the site observations, heavy rainstorms and serious soil erosion have been confirmed in the East.

(2) Soil erosion in the East

Soil erosion areas in Thailand (from moderate level to very severe level in each part) are shown in Table 2.1.4-1.

Table 2.1.4-1 Soil Erosion Area in Thailand

Unit : '000 ha ('000 rai)

Region	No. of Province	Soil Erosion Area		Farm Land		Total Area	
			%		%		%
North	17	4,684 (29,276)	27	3,191	19	16,966	33
Northeast	16	6,872 (42,948)	41	6,481	38	16,885	33
Central	9	612 (3,825)	30	1,243	61	2,031	4
East *	7	1,841 (11,507)	49	1,207	32	3,751	7
West	8	1,416 (8,847)	31	1,070	23	4,607	9
South	14	1,906 (11,912)	27	1,763	25	7,072	14
TOTAL		17,231 (107,691)	34	14,955	29	51,312	100

Source : Soil Erosion in Thailand, DLD 1981

Where : Soil Erosion Area More than 5 ton /rai/year in 1980

Farm Land Farm holding land in 1978 consisting of rice, upland crops, permanent crops and others.

Rai 0.16 ha

East * Study Area

In the Table, the soil erosion area is estimated as more than the farm land area. This is because there is a large amount of land in the forest being illegally cultivated by squatters.

The feature of soil erosion of each region in Thailand is as follows;

1) North

The westward and eastward areas around Amphoe Mae Rim at Amphoe Jamthong in Chiangmai and Amphoe Muang, Amphoe Tron and Amphoe Nam Pard in Utaradit are in the very severe soil erosion ratio

of 111-179 ton/rai/year due to forest encroachment around the footslope and mountain for cultivation of both upland crops and rice. The value of soil erosion will decrease respectively from slope area to forest condition and plain statically at 0.51-3.64 ton/rai/year.

2) Northeast

In the upper part of Udonthani, Khon Kaen and Kalasin the maximum value of soil erosion is 319-508 ton/rai/year because of the condition of agriculture and slope. This is the same as in the Northern Region and almost the same condition exists in the Eastern Region and the Southern Region. In Roi-Et, Nakornrajasima, Surin and Ubolrajadhani, the amount of soil erosion has increased from 110 to 503 ton/rai/year. The soil erosion of permanent paddy fields is at a low level and the central region in general has a soil loss at a moderate level of 5.20 ton/rai/year.

3) Central

Soil erosion on the Chao Phraya Plain is at a slight level. However, in the west and southeast part of the region due to the rolling areas which have been cultivated the soil erosion occurs at a level of 230-253 ton/rai/year.

4) East

Soil erosion is at a high level especially on the footslope and mountain which are cultivated with upland crops in Chonburi, Rayong and some parts of Chanthaburi, the value is between 238-316 ton/rai/year. Soil erosion in Trad and the major part of Chanthaburi is between 1-29 ton/rai/year due to the land-use condition of rubber plantation and orchard.

5) West

Generally, the maximum average soil erosion in this region which covers the mountainous area of Mae Klong River at the upper Kwai Yai and Kwai Noi is estimated at 276 ton/rai/year. The rolling area and footslope are cultivated with sugarcane and soil erosion is between 72-76 ton/rai/year.

6) South

Severe soil erosion occurs in the lower part of Ratchaburi and a large part of Prajuabkirikan between 159-241 ton/rai/year. The lower part from Prajuabkirikan on is nearly the same as Trat which is in the Eastern Region.

In the East, social and economic circumstances are comparatively good since Bangkok metropolis is very close, there are many sightseeing places such as Pattaya and plans for a modern factory zone under the Eastern Seaboard Development Programme. Population pressure, however, caused encroachment of the forests and extensive agriculture. This is the physical pattern of the occurrence of soil erosion in Thailand.

The formulation of the Integrated Rural Development Plan based on soil and water conservation in the East shall also contribute to the development of the Northeast and other areas in Thailand.

(3) Estimated annual sediment yield

Table 2.1.4-2 shows estimated annual sediment yield in the Gulf of Thailand. From the table it is clear that soil erosion in Thailand is occurring on a serious and large scale.

Table 2.1.4-2 Estimated Annual Sediment Yields from the Central, Eastern and Southern Regions to the Gulf of Thailand

Region	Watershed Area (km ²)	Average Sediment (tons/km ² /year)			Average Sediment (million tons/year)		
		suspension	bedload	Total	suspension	bedload	Total
Central *	67,189	183.0	36.6	219.6	12.3	2.5	14.6
East	36,394	190.0	38.0	228.0	6.9	1.4	8.3
South	70,188	295.0	59.0	354.0	20.4	4.1	24.5
Total		668.0	133.6	801.6	39.6	8.0	47.6

Note : * including headwaters from the North.

Source : Department of Conservation, Faculty of Forest, Kasetsart University, 1984.

Cited from : Thailand, Natural Resources Profile, 1987.

The volume of sediment to the Gulf of Thailand from its catchment areas was estimated as 48 million tons. This is approximately 27 million-m³ and equivalent to 13,500 ha/year of farm land when the unit weight of soil is 1.8 ton/m³ and the top soil of farm land is presumed to be 20 cm. Such a large area of farmland has been lost every year.

(4) Soil erosion and deforestation

It is obvious and has been proven throughout the world that deforestation is a direct cause of soil erosion and destruction of water resources. Thailand is facing a typical pattern of the above mentioned situation. Table 2.1.4-3, 2.1.4-4 and Figure 2.1.4-2 show the trend of deforestation in Thailand. The features of forest encroachment during the 25 years from 1961 to 1985 is as follows;

<u>Region</u>	<u>Encroached area</u> ('000 rai)	<u>Percent</u>
North	20,092	27.6%
East	8,233	62.2
Northeast	29,175	65.8
Central	11,520	51.7
South	8,838	47.7
Total	77,860	45.5

The most deforested area was the Northeast, the next was the East. This is a coincidence with the trend of soil erosion as mentioned before.

Table 2.1.4-3 Forested Areas in Various Regions of Thailand, 1961, 1973, 1976, 1978, 1982 and 1985

Unit : rai

Region	Total Land Area	Forest Area					
		1961	1973	1976	1978	1982	1985
North	106,027,680	72,671,875 (68.54)	70,996,875 (66.96)	63,954,375 (60.32)	59,335,625 (55.96)	54,847,500 (51.73)	52,578,750 (49.59)
East	22,814,063	13,226,875 (57.98)	9,397,500 (41.19)	7,894,375 (34.60)	6,898,125 (30.24)	5,000,000 (21.92)	4,993,750 (21.89)
Northeast	105,533,958	44,315,000 (41.99)	31,669,375 (30.01)	25,933,750 (24.57)	19,513,125 (18.49)	16,178,750 (15.33)	15,140,000 (14.35)
Central Plain	42,124,189	22,287,812 (52.91)	14,981,250 (35.56)	13,641,250 (32.38)	12,766,250 (30.31)	11,572,500 (24.47)	10,767,500 (25.56)
South	44,195,992	18,516,250 (41.89)	11,521,875 (26.07)	12,586,875 (28.48)	11,001,875 (24.89)	10,276,250 (23.25)	9,678,125 (21.90)
Whole Country	320,696,882	171,017,812 (53.33)	138,566,875 (43.21)	124,010,625 (38.67)	109,515,000 (34.15)	97,875,000 (30.52)	93,158,125 (29.05)

Notes : All data derived from LANDSAT except 1961 data from aerial survey.
Values in parenthesis are percents of total land area in each region.

Source : RFD, 1985a, P. 20-24

Cited from : Same as Table 2. 1. 4-2

Table 2.1.4-4 Forest Encroachment, 1961 - 1985

	1961 - 1973	1973 - 1976	1976 - 1978	1978 - 1982	1982 - 1984	1961 - 1985
Total Forest Encroachment During Period (rai)	32,450,625	14,556,250	14,495,625	11,640,000	4,716,726	77,859,538
Average Annual Forest Encroachment During Period (rai/yr.)	2,704,219	4,852,081	7,247,813	2,910,000	1,527,242	3,244,147

Cited from : Same as Table 2. 1. 4-2

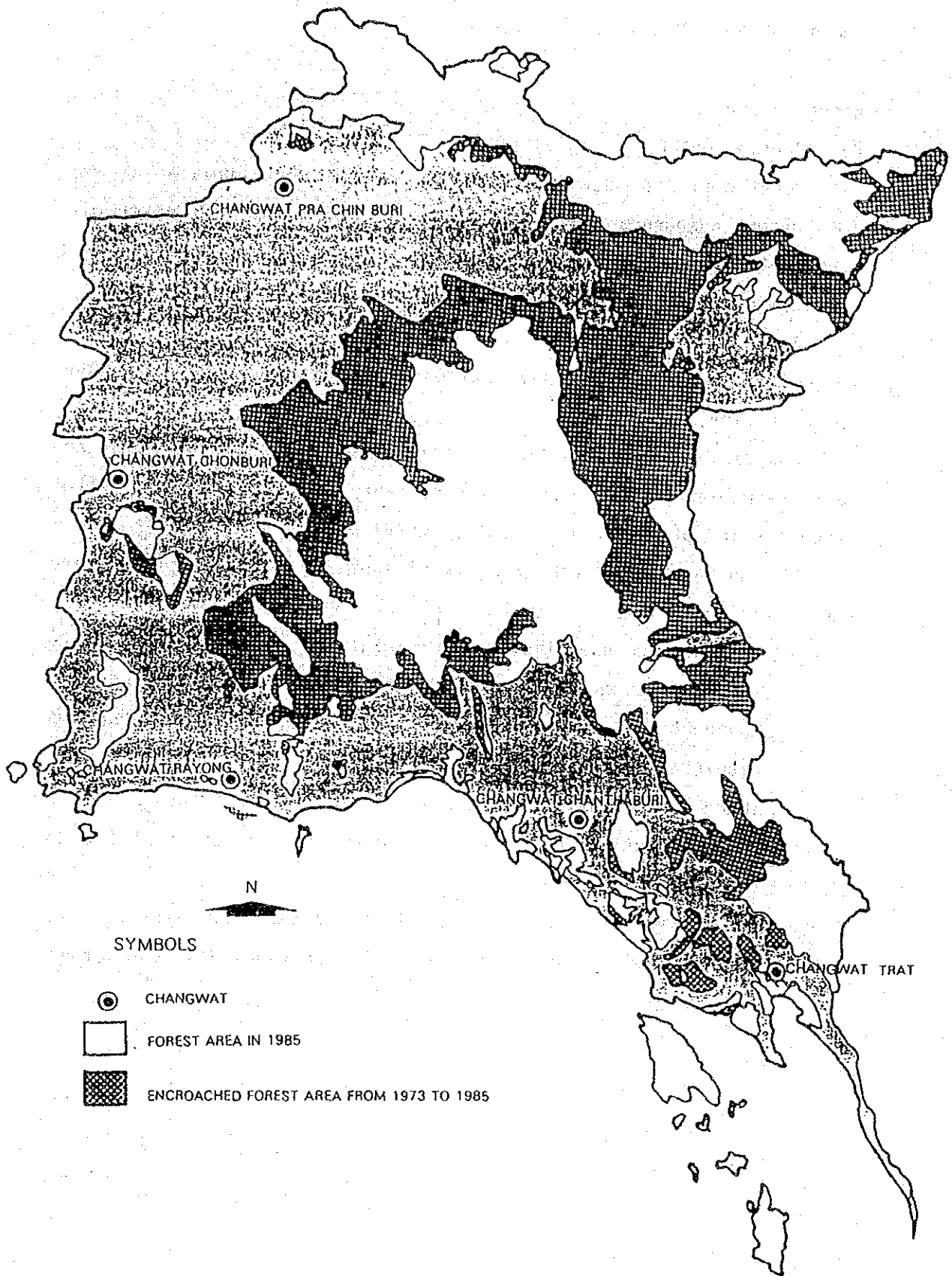


Figure 2.1.4-2 Encroached Forest Area in the East, 1973 - 1986

2-1-5 Land and Water Resources

(1) Water resources

1) Surface water

Construction of reservoirs is one of the most applicable means for water resources development. The capacity of reservoirs constructed by the RID and EGAT which are leading agencies of such development in Thailand is shown in Table 2.1.5-1.

From this it may be said that about 30% of the total surface run-off in Thailand is utilized effectively through storage of water in reservoirs.

However, the utilization rates of run-off in the Southern and Eastern Regions are 13 and 1% respectively. In other words, water resources in both regions are poorly developed.

The reasons for such poor conditions as mentioned above are considered as follows :

- They have comparatively rich rainfall.
- The land is rather steeply sloped due to its location near or adjacent to mountainous areas. Rain water flows into the sea within a short time.
- There are no large river basins except for Bang Pakong.

The construction of large scale reservoir is difficult due to the small watershed area.

- Depending on rainfed cultivation, local inhabitants have little knowledge or experience in water resources development and irrigation.

Table 2.1.5-1 Reservoir Capacity in Thailand
(Completed to the end of 1985 and under construction in 1986)

Region	L/M Project $\Delta 1$	S.I. Project $\Delta 1$	M.S. Project $\Delta 1$	EGAT Project $\Delta 2$	(MCM) Total	%
Northern	23,419.28	127.83	17.41	-	23,564.52	34
Northeastern	4,100.11	490.22	7.80	4,900.00	9,498.13	14
Central	1,685.75	50.39	4.38	26,458.40	28,198.92	41
Eastern	277.71	23.42	8.28	-	309.41	1
Southern	46.10	4.72	20.85	7,004.10	7,075.77	10
Total	29,528.95	696.58	58.72	38,362.50	68,646.75	100

Note:

- a) Data source : $\Delta 1$: RID $\Delta 2$: Material obtained from EGAT, Oct. '87
- b) Project definition
L/M Project : Large and medium scale project (RID)
S.I Project : Small scale irrigation project (RID)
M.S Project : Medium scale project (office of Coordinating Committee for Royal Development Project)
- c) Regional definition
Northern Region : RID Region 1, 2, 3 Eastern Region : RID Region 9
Northeastern Region : RID Region 4, 5, 6 Southern Region : RID Region 11, 12
Central Region : RID Region 7, 8, 10

2) Groundwater

The regional characteristic of groundwater is as shown in Table 2.1.5-2.

Although, in BMA, such problems as land subsidence and frequent flooding are said to be caused by excessive groundwater abstraction, groundwater will play an increasing role as a water resource for domestic consumption, small scale irrigation and industrial water supply in future.

However, the Eastern Region has the least potential for groundwater development among all regions except along the river deposit of Ban Phakong due to the hydrogeological characteristics. Wells drilled in alluvium and terrace deposit yield only 7-10 m³/hr of portable water. The limestone aquifer near the Kampuchean border yields about 10-20 m³/hr.

3) Flood

Table 2.1.5-3 shows that in most years, flood and drought problems occur on hundreds of thousands of hectares. The flood phenomena is said to be concentrated in the latter period of the wet season due to the rising groundwater table. But relatively little attention has been given to flood problems in the rural area because floods were one of the water resources for agricultural production.

However, high yield variety crops have recently been introduced to the country, so that the importance of flood control is recognized even in the rural area.

Flood problems in the Eastern Region are relatively few except for certain areas in the low lands of Khlong Luang, Rayong and Chanthaburi river basins.

Table 2.1.5-2 Regional Characteristic of Groundwater

Region	Major Aquifer	Typical Field	Quality	Remarks
(1) Northern Highlands	Alluvium deposit and old terrace deposit/Chiang Mai, Lampang, Mae Chan and Phra	- Shallow well 25 m ³ /hr (10 m drawdown) - Deep well (50 m depth) 50 m ³ /hr - Old terrace (200 m depth) 150-200 m ³ /hr (30m drawdown)	Good for drinking and agriculture	
(2) Upper Central Plain	- Alluvium deposit/Ping, Yom and Nan rivers - Old terrace deposit (200-300 m thickness)	- Depth : 60 m / 10-70 m ³ /hr Northwest-west / 30 m ³ /hr Central-west / 250 m ³ /hr	Available as potable water Good	
(3) Lower Central Plain	Flood Plain (150 x 200 km) /Chao Phraya and Tha Chin rivers	Depth : 120 m / 300-400 m ³ /hr		- Land subsidence - Flood problem
(4) Khorat, Plateau (Northeastern)	(4-1) Upper Khorat/ Flood plain (4-2) Lower Khorat (4-3) Western side of Plateau Carbonate aquifer (4-4) Alluvium deposit/Chin, Mun river (4-5) Alluvium deposit/Mae Khong river	Fresh water Depth : 60 m / 5-50 m ³ /hr Depth : 30-60 m / 5-25 m ³ /hr 10-100 m ³ /hr 25 m ³ /hr (50 m drawdown) Depth : 40 m / 100 m ³ /hr	Mostly salty water Good Good	
(5) Mae Klong Basin	Lower part of basin Alluvium plain	40 m ³ /hr	Available for agriculture	- Shallow unconfined aquifer
(6) Peninsula	Coastal plain (450 x 22 km ²)	10-200 m ³ /hr		
(7) Eastern	- Alluvium and terrace deposit - Limestone aquifer (near Cambodia)	7-10 m ³ /hr 10-20 m ³ /hr	Good as potable water	Least groundwater potential

Note : Compiled from Thailand Natural Resources Profile, TDRI, May 1987

Table 2.1.5-3 Flood and Drought Damage (1977 - 83)

(1,000 ha)

Region	1977		1978		1979		1980		1981		1982		1983		Average	
	Flood	Drought	Flood	Drought	Flood	Drought	Flood	Drought	Flood	Drought	Flood	Drought	Flood	Drought	Flood	Drought
Northern	0	987.8	195.7	0	9.1	342.5	354.4	36.9	111.1	62.3	42.2	494.4	95.8	71.6	115.5	285.1
North-Eastern	0	1,069.7	651.7	0	60.0	182.3	274.8	15.2	81.2	237.9	256.5	252.0	178.4	32.3	218.9	255.6
Central**	0	298.3	262.6	0	0	44.7	159.7	0	1.4	3.3	2.0	68.0	153.6	83.2	82.8	71.1
Eastern**	0	15.4	7.7	0	0.3	58.5	3.9	0	2.1	2.0	8.7	0	183.4	8.7	29.4	12.1
Western**	0	100.9	1.1	0	0.1	90.0	17.1	0	52.6	38.1	7.8	44.2	117.8	110.7	28.1	54.8
Southern	36.9	34.9	0	0	9.3	8.4	1.5	1.0	95.4	89.9	5.1	0.1	21.6	0.6	24.3	19.3
Total	36.9	2,507.0	1,118.8	0	78.8	726.3	811.5	53.1	343.8	433.5	352.3	858.7	750.7	307.1	498.9	697.9

Source : Department of Agricultural Extension Service

Note : * Including the damaged area caused by other natural disasters

** Subdivisions of the Central Plain Region

(2) Irrigation

The total cultivated area both of paddy and upland crops in Thailand is about 16,880,000 ha. About 22% of the cultivated area is irrigated (3,940,000 ha) as of 1985.

The most developed irrigation systems are found in the central plain and the irrigated area in the Central Region in 1985 covered 1,707,600 ha, compared to 895,800 ha in the East and 378,400 ha in the South. As for the characteristics of irrigation systems in the Eastern Region, the share of upland crop area (44% of cultivated land) in the Region is the highest of any other Region. However, the irrigated area has not increased due to the high elevation of agricultural land. The existing irrigation water is mostly conveyed to paddy land.

(3) Land and water resources development plan

The MOAC has prepared an operation plan (1988-1991) relevant to land and water resources development in association with the Sixth Five Year National Economic and Social Development Plan.

1) Water resources

Although the government has tried hard to develop water resources for agricultural purposes for many years, cultivated land still relies on rain water which is an obstacle in production and income of the farmers in about 80% of the cultivated area. The major factors which restrict the expansion of the irrigated area are considered to be as follows :

- Limitation of the potentiality of water resources development
- Ineffective utilization of previously constructed large scale irrigation projects

Therefore, large scale projects need to have more efficient administration and management including a suitable project construction plan which needs to be coordinated with the production plan, marketing plan and job creation plan.

The measures of development are conducted as follows :

- To expand the watershed area to support the implementation and construction of medium scale irrigation projects in order to increase the irrigable area at an average of 200,000 rai

per year from only medium scale irrigation projects not including large scale irrigation projects and small scale irrigation projects.

- To improve and increase the sufficiency of the large scale irrigation project's utilization by encouraging the private sector to participate in agricultural development, providing a suitable project administration system for increased cooperation between the concerned government agencies.
- To develop and rehabilitate small scale irrigation projects including groundwater projects into the basin development system in line with necessity and potentiality by considering the relation among the SSIP projects within the same basin.

2) Land resources

Remarkable increase in population and disorderly development of land in recent years has caused limitation of land resources and decaying of land. Therefore, the following measures shall be taken for land conservation.

- To make a plan of land utilization by surveying and mapping of undeveloped areas such as drought and coarse areas in the provinces and classifying land for more effective use.
- To accelerate classifying of land use such as national park areas and areas suitable for agriculture from the forest land.
- To promote land banks and financing activities.
Accelerate the consolidation of land with the purpose of redistributing land rights.
- To preserve land and environment by accelerating development of low land which will have an influence on the prevention of soil erosion and social and economic development.
- To encourage systematic and coordinative development for the suitable arrangement of land, water and plants.
- To accelerate the training of government officers, farmer's leaders and farmers for the purpose of land preservation and restoration.

(4) Irrigation project development plan

RID which is the leading agency for irrigation projects as well as water resources development projects is scheduled to implement a total of 95 projects in Thailand during the next four years from 1988 to 1991 in association with the Sixth Five Year National Economic and Social Development Plan as shown in Table 2.1.5-4.

By completion of the projects, a total land area of 804,500 ha (5,028,100 rai) will be irrigated and the total irrigated area will increase from 22% to 27% of the cultivated area.

The number of large scale irrigation projects is set up to be smaller than that of medium scale irrigation projects in conformity with the National Development policy.

The share of the development plan of the Northeastern and Southern Regions is about 55% of the total projects, while that of the Eastern Region is the smallest of all regions.

Table 2.1.5-4 Irrigation Project Development Plan, RID Large and Medium Scale Project, 1988 - 1991

Description	Region	North	North-east	Central	East	South	Total
1) Medium Scale Irrigation Project (new project)		5	15	8	1	11	40 Projects (735,000 rai)
2) Bang Nara Basin Development Project (new project)		-	-	-	-	1	1 (62,350 rai)
3) Nong Pla Lai Project (new project)		-	-	-	1	-	1 (21,875 rai)
4) Large Scale Irrigation Project (continuation)		2	1	1	-	1	5 (3,357,000 rai)
5) Medium Scale Irrigation Project (continuation)		12	16	7	6	7	48 (851,870 rai)
Total		19	32	16	8	20	95 (5,029,095 rai)

Source : Operation plan, MOAC (1988-1991)

(5) Administration coordination policy and guideline for small water resources development

There are 16 agencies concerned including DLD concerned with small water resources development. In order to reduce the duplication of development plans and implementation, the office of coordination and acceleration of water resources development laid down the policy and guideline for small water resources development in March 1986.

The policy of coordination is described as follows ;

- To establish the administration and management for water resources development projects so that there will be full water utilization as a continued activity.
- To support the water-user organization and promote the water-user group to have more participation in the project especially in project maintenance and continued activity.
- To accelerate the development of water resource for domestic use both qualitatively and quantitatively so that the farmers in rural areas can have clean and safe water for drinking.

The detailed functions of the major agencies are presented in Table 2.1.5-5.

Table 2.1.5-5 Major Agencies for Small Water Resources Project

Agency	Type of Water Resources Project
<u>MOAC</u>	
1. RID	<ul style="list-style-type: none"> - Low land water drainage project (digging drainage canal with appurtenant structure) - Reservoir (Embankment 6-10 m height, project cost not more than 4 million Baht) - Irrigation canal or canal improvement (with weir type structure, regulator) - Weir (project cost not more than 4 million Baht) - Salinity protection and improvement of the area near seashore for cultivation (construct the dike and appurtenant structure)
2. Mobile Agricultural Service Center	<ul style="list-style-type: none"> - Natural swamp redredging - Canal construction or improvement (with weir type structure, regulator)
3. Department of Land Development (DLD)	<ul style="list-style-type: none"> - Salinity protection project and Improvement development of the area near seashore for cultivation (construct dike and appurtenant structure) - Reservoir (very small, height of embankment is not more than 6 meter)

Major Agencies for Small Water Resources Project (cont'd)

Agency	Type of Water Resources Project
<u>MOI (Ministry of Interior)</u>	
1. Department of Local Administration	<ul style="list-style-type: none"> - Reservoir (very small, height of embankment is not more than 6 meter) - Natural swamp and pond redredging - Farm Pond - Weir (very small) - Shallow well - Repair and improvement of water resources (by three cooperation with the budget of 5,000 - 100,000 Baht)
2. Accelerated Rural Development Office (ARDO)	<ul style="list-style-type: none"> - Reservoir (height 6-10 m, project cost no more than 4 million Baht) - Natural swamp, pond redredging - Farm pond - Weir (project cost not more than 4 million Baht) - Deep well - Shallow well
3. Department of Civil Works	<ul style="list-style-type: none"> - Deep well
<u>Ministry of Health</u>	
1. Department of Health	<ul style="list-style-type: none"> - Deep well
<u>Ministry of Industry</u>	
1. Department of Mineral Resources	<ul style="list-style-type: none"> - Deep well

2-2 Socio-Economy

2-2-1 Population Statistics

In 1981 the Eastern Region accounted for 6.2% of the total population of Thailand and in 1985 accounted for 6.4% (Figure 2.2.1-1). During the same period the population of the Eastern Region increased at an average annual rate of 2.9% from 2,944,955 persons in 1981 to 3,300,499 persons in 1985 while the total population of Thailand increased at an average annual rate of 1.9% from 47.48 million persons in 1981 to 51.30 million persons in 1985.

Also, the average natural (birth/death) increase in population in the Eastern Region over the 8 year period of 1977 - 1984 was 1.84%. This means that more than one-third of the total increase in population has come from in-migration (Table 2.2.1-2).

2-2-2 Labor Force and Employment

According to the Labor Force Survey conducted by the National Statistical Office (NSO) the Thai Labor force was 26,661,233 persons or 51.30% of the total population in 1986.

The said Survey was carried out during three periods, namely Period 1 - February, Period 2 - May and Period 3 - August of 1986. From the data it can be seen that fluctuation in the number of employed persons is directly related to the agricultural season. In Period 1 - February, crop harvesting has been completed so labor demand is at its lowest, in Period 2 - May land preparation activities are begun so labor demand is at its peak and in Period 3 - August planting and caring for crops maintains the demand for labor. The percentage of the total labor force employed by the agriculture sector in the three periods is as follows :

Percentage of Labor Force Employed by the Agri-Sector

Period	Percentage	Change %
1 (Feb.)	57.6%	-
2 (May)	65.9%	8.3
3 (Aug.)	66.8%	0.9

Source : NSO, 1986

Changes during the periods in the total labor force, employed and unemployed are as follows ;

Period	Total Labor Force	Total Employed	Total Unemployed	Change		
				Total Labor Force	Total Employed	Total Unemployed
1	25,571,700	23,480,800	2,090,800	-	-	-
2	26,765,100	25,488,400	1,276,700	1,193,400	2,007,600	- 814,100
3	27,646,900	26,678,600	968,200	881,800	1,190,200	- 308,500

Source : NSO, 1986

According to the 1980 Population and Housing Census conducted by the National Statistical Office the labor force of the Eastern Region was 1,421,133 persons or 52.7% of the total population of 2,696,736 persons. A total of 959,569 persons or 67.5% were engaged in agricultural-related jobs.

2-2-3 Income Level

The per capita Gross Regional Product (GRP) of the Eastern Region (7 Changwat) has averaged 1.29 times the per capita Gross Domestic Product (GDP) over the four year period from 1982 to 1985.

Also, at current market prices the per capita GRP has over the same period increased from 23,284 Baht in 1982 to 25,603 Baht in 1985, while the per capita GDP has increased from 17,450 Baht in 1982 to 20,299 Baht in 1985.

From 1982 to 1985 the Eastern Region's GRP has increased at an average annual rate of 5.55% per annum, although its percentage share (7.95% average per annum 1982-1985) of total GDP has slightly decreased during the period : 8.16% in 1982 and 7.80% in 1985 (see Table 2.2.3-1). The main sectors of production have been agriculture followed by manufacturing. However, in 1985 the agricultural sector produced 18,928 million Baht or 22.54% of total GRP while the manufacturing sector produced 18,056 million Baht or 22.24%, a difference of only 872 million Baht or 0.30%. Another sector of special interest is Mining and Quarrying which has grown from 1,167 million Baht or 1.84% in 1981 to 7,410 million Baht or 9.13% of total GRP in 1985.

The annual income level of households in the rural area of the Eastern Region was reported in the village survey of 1984 by the National Statistical Office. The survey revealed that of the 55% of the households surveyed in the rural area 26.9% had annual incomes of under 6,000 Baht, 31.3% had annual incomes of 6,000-10,000 Baht, 25.2% had annual incomes of 10,001-20,000 Baht and 16.6% had annual incomes of more than 20,000 Baht (Table 2.2.3-1).

2-2-4 Nature of Title to Holdings and Size and Distribution of Holdings

(1) Title to holdings

Land rights play an important economic role in encouraging farmers to invest both physically and monetarily in the development of their holdings. In the case where farmers are unable to obtain such rights or rights they have received are not clearly defined, farmers will be reluctant to invest time and money for benefits which they may not receive.

There are various forms of land right being issued in Thailand and the following are examples of those prevalent in the Study Area.

- 1) Nor Sor Sam (N.S.3) issued by the Department of Lands for private lands, this Certificate of Utilization can be upgraded to Chanode (N.S.4) Title Deed. Transfer of ownership and collateral for loans are two of the immediate benefits to be derived from receiving such a right to a holding. It is

estimated that of the total 320.7 million rai of land in Thailand 23.7 million rai have been issued N.S.4 certificates and 70.9 million rai have been issued N.S.3 certificates.

- 2) Sor Tor Kor (STK) are right to farm certificates issued by the Royal Forestry Department (RFD) since 1982. This certificate allows squatters in national forest reserves to acquire holdings of up to 15 rai per household, any additional land being cultivated contiguous to the STK holding may be leased from the RFD. STK certificates are non-transferable except in the case of inheritance and cannot be used as loan collateral. STK certificates are signed by the Provincial Forestry Officer and the Governor of the Province concerned, and are valid for 5 years with the condition that the farmer build a house on the land and not leave his land uncultivated for a consecutive period of 2 years. All certificates are due to expire in the near future and a programme to issue STK-2 certificates is now under consideration. According to estimates of the RFD in 1986 a total of 624,048 STK certificates had been issued covering 6,360,449 rai and 175,771 households were leasing an additional 3,412,968 rai. The STK programme exists in all four Provinces of the Study Area.
- 3) Sor Por Kor 4-01 (SPK 4-01) is a land use permit issued by the Agricultural Land Reform Office (ALRO). It allows squatters to have holdings in areas which were formerly National Forest Reserves of up to 50 rai per household. SPK 4-01 permits are non-transferable except by inheritance and according to the ALRO officer in Chachoengsao may be used as collateral for loans from the BAAC. As of June, 1986 a total of 17,967 SPK 4-01 permits had been issued covering an area of 361,200 rai. In the Study Area, only Chachoengsao has lands under this programme.
- 4) There are two other types of land utilization certificates covering public lands (mainly National Forest Reserves which have been encroached and released by the government as suitable for cultivation) one is the Nor Kor (NK) certificate issued by the Department of Public Welfare (Ministry of Interior) and the

other the Kor Sor Nor (KSN) issued by the Cooperatives Promotion Department. Both certificates are non-transferable except by inheritance and cannot be used as collateral for loans. In the Study Area, only Rayong has lands under these two programmes.

(2) Size and distribution of holdings

Distribution by size of farm holdings in the four Provinces of the Study Area as of 1983 is as shown in Table 2.2.4-1. From the Table it can be seen that the majority of farm holdings are in the 10-39.9 rai size range which concurs with the national statistics.

In the Study Area holdings of 40 rai and over occur at a higher percentage than the national average, especially in Chachoengsao where the number of such holdings is 12,181 or 31% which is more than double the national percentage in 1983 (see Table 2.2.4-2). However, the percentage of holdings of 6-9.9 rai are consistently lower than the national average of 12.3% with Chachoengsao the lowest of the four changwat at 7%.

(3) Landless

At present, it is estimated that approximately 2.5 million households in the rural area can be classified as landless, in other words do not own the land they cultivate. Of this total, one million households occupy lands illegally, one million households are renting land from others and a half million households are completely landless.

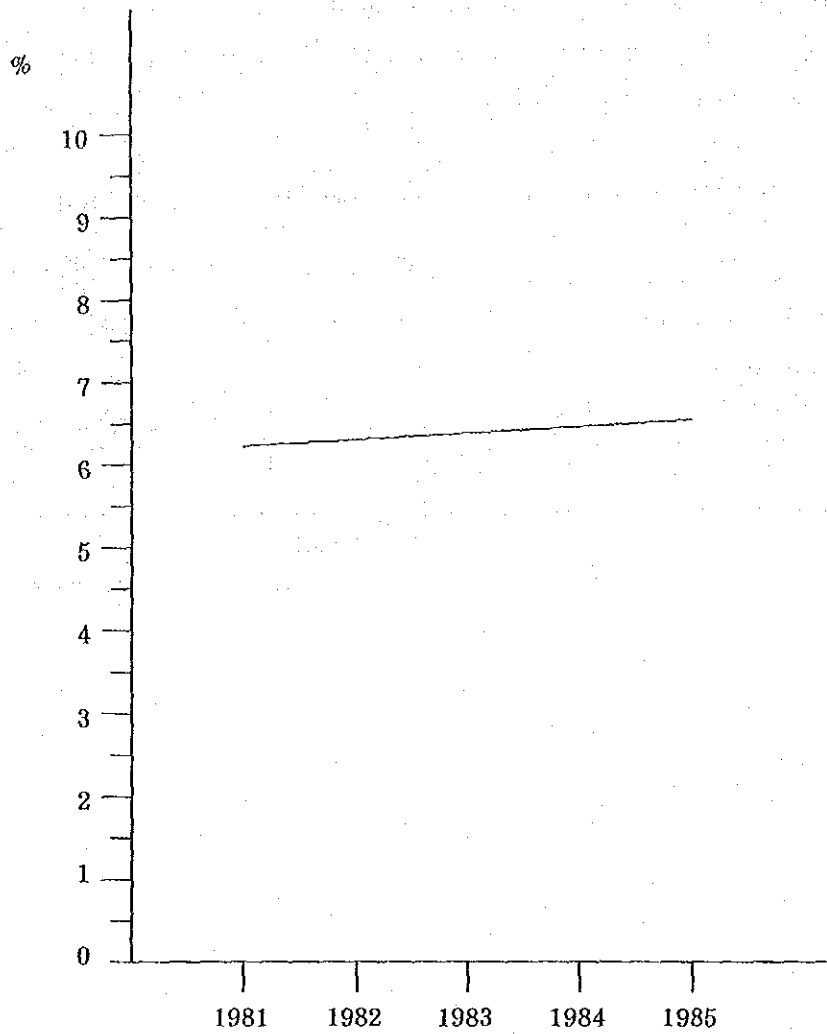
At roughly 6 persons per household this means that 15 million persons or 28.9% of the total population are landless.

Landless by Type, Number of Households (HH) and Population

Type	HH (million)	Persons (million)
Illegal occupant	1.0	6.0
Landless	0.5	3.0
Rental	1.5	6.0
Total	2.5	15.0

Source : DLD 1987

Note : HH --- Number of Household



Source : NSO, 1985

Figure 2.2.1-1 Eastern Region % of Thai Population

Table 2.2.1-1 Basic Statistics - National, Eastern Region, 4 Provinces

Population *1		1981	1982	1983	1984	1985	1986 E
Kingdom '000 persons		47,488	48,490	49,459	50,396	51,301	52,094
Eastern Region		2,944,955	3,037,921	3,122,439	3,185,096	3,300,499	-
Province							
Chachoengsao		498,092	507,422	503,184	510,308	525,717	-
Chonburi		738,221	754,329	769,581	780,091	806,396	-
Rayong		337,063	376,244	392,554	406,222	418,814	-
Chanthaburi		340,341	350,283	364,440	374,560	390,348	-
Total 4 Provinces		1,953,717	1,988,278	2,029,759	2,071,181	2,141,275	-
Economy *2							
GNP	M/B	-	819,750	899,543	957,087	1,000,435	1,055,762
-per capita	B	-	16,906	18,188	18,991	19,501	20,266
GDP	M/B	-	846,126	924,913	988,863	1,041,354	1,098,363
-per capita	B	-	17,450	18,701	19,622	20,299	21,084
GRP	M/B	63,577	69,063	73,148	78,505	81,188	-
-per capita	B	21,968	23,284	24,038	25,210	25,603	-
GPP --							
Chachoengsao	M/B	8,064	9,638	9,747	11,141	13,828	-
-per capita	B	16,291	19,354	19,533	22,283	27,168	-
Chonburi	M/B	32,285	32,877	34,265	36,740	36,713	-
-per capita	B	44,470	44,368	45,505	47,963	47,068	-
Rayong	M/B	6,315	8,036	8,765	9,418	9,173	-
-per capita	B	17,255	21,546	23,067	23,904	22,875	-
Chanthaburi	M/B	5,486	5,902	6,089	6,323	6,329	-
-per capita	B	16,476	17,258	17,251	17,323	17,014	-

Source : *1 National Statistical Office, Office of the Prime Minister

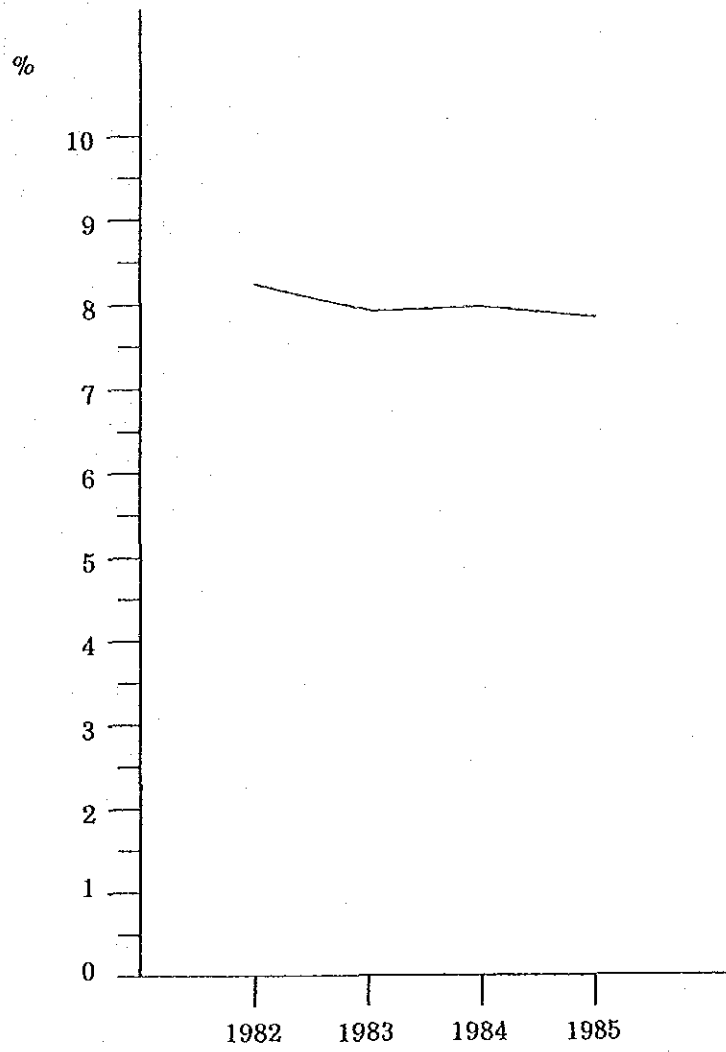
*2 NESDB

* At current market prices

Table 2.2.1-2 Net Population Movement 1981 - 1985

	Population	Change	%	Births	Deaths	Net Migration	
						Number	%
Eastern Region							
1981	2,944,955						
1982	3,037,921	92,966	3.16	71,798	15,778	39,946	1.22
1983	3,122,439	84,518	2.78	68,273	16,229	32,474	1.04
1984	3,185,096	62,657	2.01	58,237	12,714	17,134	0.54
1985	3,300,499	115,353	3.62	59,178	10,282	66,457	2.05
Chachoengsao							
1981	498,092						
1982	507,422	9,330	1.87	10,233	2,480	1,577	0.31
1983	503,184	-4,238	-0.84	9,568	2,688	-11,118	-2.21
1984	510,308	7,124	1.42	8,352	2,146	918	0.18
1985	525,717	15,409	3.02	8,487	1,682	8,604	1.64
Chonburi							
1981	738,221						
1982	754,329	16,108	2.18	18,225	4,370	2,253	0.30
1983	769,581	15,252	2.02	17,853	4,428	1,827	0.24
1984	780,091	10,510	1.37	15,001	3,217	-1,274	-0.16
1985	806,396	26,305	3.37	15,154	2,773	13,924	1.73
Rayong							
1981	377,063						
1982	376,244	-819	-0.22	9,165	1,939	-8,045	-2.14
1983	392,554	16,310	4.33	8,644	2,057	9,703	2.47
1984	406,222	13,658	3.48	7,373	1,143	7,438	1.83
1985	418,814	12,592	3.10	7,488	1,039	6,143	1.47
Chanthaburi							
1981	340,341						
1982	350,283	9,942	2.92	8,914	1,753	2,781	0.79
1983	364,440	14,157	4.04	8,916	1,894	7,135	1.96
1984	374,560	10,120	2.78	7,875	1,681	3,926	1.05
1985	390,348	15,788	4.22	8,028	1,374	9,134	2.35

Source : Registration Division, Local Administration Department,
Ministry of Interior



Source : NESDB, 1986

Figure 2.2.3-1 Eastern Region % of Thai GDP

Table 2.2.3-1 Annual Income Level in the Rural Area 1984

	% of households surveyed	% of Owners			
		under 6,000 B	6,000 - 10,000 B	10,001 - 20,000 B	over 20,000 B
Eastern Region	55.0	26.9	31.3	25.2	16.6
Chachoengsao	55.0	26.3	29.4	26.0	18.3
Chonburi	45.0	24.0	31.0	26.2	18.8
Rayong	61.0	16.8	32.7	30.4	20.1
Chanthaburi	49.0	23.4	32.0	25.9	18.7

Source: 1984 Report of the Village Survey
National Statistical Office

Table 2.2.4-1 Size and Distribution of Farm Holding 1983

Province	Total Number of holdings	Number of holding by size rai (%)				Total Farm holding area (rai)
		under 6 rai	6 - 9.9 rai	10 - 39.9 rai	40 rai and over	
Chachoengsao	39,760 (100)	5,921 (14.9)	2,795 (7.0)	18,863 (47.5)	12,181 (30.6)	1,184,348
Chonburi	33,233 (100)	4,714 (14.2)	3,042 (9.2)	18,388 (55.3)	7,089 (21.3)	1,109,245
Rayong	35,154 (100)	4,263 (12.1)	2,953 (8.4)	20,123 (57.2)	7,815 (22.3)	1,093,000
Chanthaburi	33,711 (100)	5,252 (15.6)	3,996 (11.9)	17,305 (51.3)	7,158 (21.2)	916,802

Source : 1983 Intercensal Survey of Agriculture

Table 2.2.4-2 Distribution of Landholdings, Whole Kingdom 1978, 1983

Size of Holding	% of Owners		% of Area Owned	
	1978	1983	1978	1983
Less than 6	14.9	14.7	2.5	2.6
6 - 9.9	12.2	12.3	4.0	4.2
10 - 39.9	56.5	57.8	50.7	54.0
over 40	16.4	15.2	42.9	39.2
Total	100.0	100.0	100.0	100.0

Source : National Statistical Office, 1978 and 1983

2-3 Agriculture

2-3-1 Agricultural Production

Present condition of agricultural production in Thailand is shown in Table 2.3.1-1 and 2.3.1-2.

Table 2.3.1-1 shows the present agricultural land-use in Thailand.

Characteristics of the Eastern Region in this respect are 1) areal percentage of field crops is highest in five regions and 2) percentage of the area of tree and tree crops is second following the South, the rubber area.

Table 2.3.1-2 shows cultivation area, production and productivity of some main crops of Thailand in the last ten years.

The breakdown of national agricultural production into six regions is shown in Table 2.3.1-3. Main features of the Eastern Region are summarized as follows.

1. Cassava is the main upland crop in the region and no other dominant food crops are observed.
2. Industrial crops such as pineapple, sugarcane and coconut are another main crop and the share of these crops (% in national production) is, 30, 15, and 13 respectively.

Although 88% of the rubber production in Thailand is from the South, the remainder is from the Eastern Region. Therefore, Para-rubber is one of the main crops in the region.

3. No specific vegetable crops worth mention are observed.
4. Fruit production has a high priority in the region. The production of some fruit such as mango, rambutan, durian, etc. has a big share in that of the whole country.
5. In conclusion, it may be possible to say that lots of upland farms in the Eastern Region are occupied by fruit trees, rubber, sugarcane and pineapple. The other arable lands are mainly for cassava and industrial crop cultivation.

2-3-2 Animal Husbandry

The outline of animal husbandry in Thailand is shown in Table 2.3.2-1.

Large livestock such as buffaloes are mainly located in the Northeastern and Northern Regions.

The increase in the number of swine and duck is mainly due to high domestic demand. Especially, duck feeding has become very popular and 1,510,000 head in 1986 is two times that of 1965.

The number of chicken was 79,260,000 in 1986, which is 170% of that of 1965. This rapid increase is due to increased export of chicken in recent years.

There small livestock have more importance than large one in the Eastern Region under present conditions.

Milk production in Thailand is increased greatly, reaching 70,000 tons in 1986 which is four times that of 1980.

Technical cooperation and the trend toward urban life style has accelerated the production. Eventually, the development of dairy farming will save foreign currency which is now being used to import dairy products.

2-3-3 Forestry

Forest covered 53% of the total area of Thailand in 1961 but only 30% in 1985 as a result of destruction of the natural environment. The Eastern Region is one of the worst areas in the country in this respect.

Forest resources are also decreasing and Thailand is a timber importing country (Table 2.3.3-1). The government has prohibited log exportation since 1977 and has started forest conservation and reforestation activities.

In case of export, manufactured timber products have been strongly recommended by the government.

Timber production has decreased since 1977, when the total amount of production was 3,340 m³, and it became 2,015 m³ in 1986, which is 60% of the former amount. Reforestation has been one of the policies in the Five Year Plans of past and present.

2-3-4 Fishery

The total amount of fish catches in Thailand was 2,230,000 tons in 1985, of which 2,060,000 tons was from marine fishing.

Fresh water fishing which has a close relationship with agriculture, harvested 170,000 tons (4.1 billion Baht) as shown in Table 2.3.4-1.

Species of fresh water catches are snake-head fish, cat fish and local carp, etc.

The Central Region produces around 60% of the total harvest since the area has lots of rivers and ponds. All of this production is utilized in the form of either fresh fish (70%) or dried fish (12%).

Fish culture is one of the directions of the fisheries industry in future.

Table 2.3.1-1 Agricultural Land-Use in Thailand

(1000 ha)

Region & Province	Total Farm Land	Paddy	Field Crop	Fruit Tree and Tree	Vegetable	Others ²⁾
North Eastern Region	8858 (100%)	5953 (67.2)	2002 (22.6)	128 (1.4)	20 (0.2)	756 (8.5)
North	4667 (100)	2714 (58.1)	1527 (32.7)	160 (3.4)	19 (0.4)	246 (5.3)
Central	2944 (100)	1656 (56.2)	890 (30.2)	210 (7.1)	28 (1.0)	160 (5.4)
East ¹⁾	1694 (100)	724 (42.7)	614 (36.2)	236 (13.9)	3 (0.2)	117 (6.9)
Southern	2413 (100)	777 (32.2)	24 (1.0)	1420 (58.8)	6 (0.2)	187 (7.7)

Source : Agricultural Statistics of Thailand 1986/87 Crop. year
DOAE

Note : 1) 7 provinces : Nakhon Nayok, Chachoengsao, Prachinburi, Chonburi, Rayong, Chanthaburi and Trat

2) housing area, grassland, idle land and other land

Table 2.3.1-2 Acreage, Production and Productivity of Main Crops in Thailand, 1977/78 ~ 1986/87

Crop	Year Item	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87
Rice (Total)	1	56,444	62,667	58,971	60,110	60,110	60,134	62,596	62,329	63,422	61,571
	2	13,921	17,470	15,758	17,368	17,774	16,879	19,549	19,905	20,264	18,868
	3	255	313	291	302	312	302	326	331	330	328
Rice (Major)	1	53,465	58,410	56,868	56,882	56,392	56,171	58,114	57,914	59,436	57,943
	2	12,335	15,206	14,646	15,405	15,758	14,774	16,943	17,275	17,930	16,825
	3	231	260	258	271	279	284	305	310	312	313
Rice (Second)	1	2,979	4,257	2,103	3,228	3,578	3,963	4,481	4,415	3,985	3,628
	2	1,586	2,264	1,111	1,963	2,017	2,104	2,606	2,630	2,334	2,042
	3	551	579	566	613	568	539	591	596	586	563
Maize	1	7,534	8,661	9,529	8,960	9,796	10,494	10,552	11,355	12,377	12,194
	2	1,677	2,791	2,863	2,998	3,449	3,002	3,552	4,226	4,934	4,308
	3	275	340	322	357	377	368	363	389	412	380
Sorghum	1	1,062	1,098	1,182	1,546	1,749	1,534	1,657	1,838	1,936	1,212
	2	126	216	199	237	274	236	327	374	404	211
	3	134	229	199	162	164	160	209	211	222	184
Mungbean	1	2,720	2,638	2,652	2,796	3,040	3,034	3,022	3,280	3,426	3,172
	2	207	259	251	261	284	281	288	352	323	301
	3	88	111	113	106	99	101	103	117	98	98
Cassava	1	7,282	5,286	7,250	7,940	7,726	8,552	8,780	9,230	7,748	8,820
	2	16,358	11,101	16,540	17,744	17,788	18,989	19,985	19,263	15,255	19,554
	3	2,482	2,235	2,360	1,184	2,618	2,985	2,395	2,239	2,026	2,283
Chilli	1	218	239	226	219	221	231	196	228	171	138
	2 ²⁾	66	63	62	59	61	61	54	64	56	35
	3 ²⁾	304	262	273	271	275	266	275	280	327	255
Shallot & Onions	1	145	141	145	146	150	82	97	98	94	94
	2 ²⁾	142	140	128	119	124	153	159	167	163	166
	3 ²⁾	976	987	879	816	832	1,860	1,650	1,698	1,738	1,770
Garlic	1	168	167	163	167	192	200	229	229	172	177
	2	107	99	122	124	119	114	108	125	108	97
	3	637	596	748	742	619	572	470	547	627	550

Crop	Year	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87
	Item										
Pineapple	1 ⁴⁾	551	512	629	800	519	434	423	382	466	441
	2	2,141	2,154	2,889	3,688	1,993	1,439	1,341	1,463	1,769	1,636
	3 ⁵⁾	3,914	4,212	4,593	4,611	3,837	3,314	3,168	3,835	3,798	3,711
Sugarcane	1	3,541	3,190	2,730	2,927	3,857	3,645	3,607	3,424	3,443	3,370
	2	18,941	20,561	12,827	19,854	30,200	24,407	23,869	25,055	24,093	24,450
	3	5,415	6,523	4,823	6,958	7,878	6,766	7,127	7,549	7,061	7,521
Soybean	1	958	1,010	679	788	797	788	1,008	1,253	1,524	1,799
	2	96	159	102	100	132	113	179	246	309	357
	3	118	175	163	152	168	180	184	204	206	202
Ground-nut	1	641	660	609	658	764	761	783	820	779	790
	2	106	128	109	290	147	145	147	172	171	169
	3	188	205	191	207	200	198	194	220	227	217
Castor Bean	1	241	271	312	264	277	276	268	267	267	279
	2	37	37	36	35	36	34	35	33	33	36
	3	154	137	114	131	130	130	129	122	123	129
Sesame	1	220	289	228	245	257	214	195	230	259	265
	2	23	30	22	27	29	22	16	22	25	27
	3	106	104	95	111	111	105	84	96	98	100
Coconut	1 ²⁾	2,560	2,334	2,347	2,363	2,373	2,443	2,451	2,511	2,593	2,586
	2	927	843	785	671	887	1,076	1,102	1,128	1,226	1,280
	3	665	665	544	462	516	619	628	609	640	626
Oil Palm	1 ²⁾	70	94	155	207	283	333	374	431	514	561
	2	46	58	78	107	153	254	303	394	610	695
	3	1,940	1,661	1,647	1,543	1,619	1,642	1,338	1,391	1,831	1,853
Cotton	1	528	429	750	949	967	715	638	451	519	315
	2	91	74	143	193	176	122	119	79	102	57
	3	182	189	194	213	185	182	191	182	201	188
Kenaf	1	1,603	2,003	1,418	1,068	1,166	1,357	1,343	1,022	1,454	1,284
	2	246	338	222	211	194	200	235	162	247	226
	3	159	195	167	201	174	155	177	180	180	179

Crop	Year i) item	77/78	78/79	79/80	80/81	81/82	82/83	83/84	84/85	85/86	86/87
		Kapok	1	357	314	335	347	353	357	355	385
	2	42	30	27	34	39	34	40	44	44	40
	3	167	131	113	140	156	133	160	162	174	160
Para-rubber	1	9,275	9,426	9,576	9,615	9,867	10,001	10,143	10,254	10,288	10,346
	2	431	467	534	465	508	576	594	617	773	811
	3	63	69	60	60	64	65	67	72	88	90
Tobacco	1	273	294	315	220	304	278	244	198	205	175
(Virginia)	2 ⁱⁱ	349	374	402	318	439	402	337	330	323	266
	3	1,277	1,274	1,275	1,445	1,445	1,445	1,382	1,691	1,580	1,527

Source : Agricultural Statistic of Thailand, 1986/87 OAE

Note : 1) 1 --- Planting area 1,000 rai

2 --- Total production 1,000 tons

3 --- Productivity kg/rai

2) Dried weight

3) Fresh weight

4) Harvested area

5) Estimated

Table 2.3.1-3 Acreage, Production and Productivity of Main Crops by Region in 1986/87 Cropping Season

Crop	Year	Item	Whole Country	North East	North	Central	East	West	South
Rice (Total)	1	1	61,571	28,887	13,857	6,578	4,411	4,062	3,776
		100 %		47	23	11	7	7	6
		2	18,868	6,435	5,303	2,906	1,462	1,817	946
Rice (Major)	1	100 %		34	28	15	8	10	5
		3	328	313	476	496	412	511	324
		100 %							
Rice (Second)	1	1	57,943	28,754	13,377	5,274	3,979	2,957	3,602
		100		50	23	9	7	5	6
		2	16,826	6,384	5,045	2,142	1,257	1,119	579
Rice (Second)	1	100		38	30	13	8	7	5
		3	313	240	414	406	340	389	262
		100		82	141	138	110	132	89
Maize	1	1	3,628	133	480	1,304	432	1,105	174
		100		4	13	36	12	31	5
		2	2,042	51	258	764	205	698	67
Sorghum	1	10		3	13	37	10	34	3
		3	563	385	538	586	475	632	385
		100		68	96	104	84	112	68
Mungbean	1	1	12,194	3,284	5,755	1,737	810	592	17
		100		27	47	14	7	5	-
		2	4,308	1,050	2,130	574	378	172	4
Cassava	1	100		24	49	13	9	4	-
		3	380	355	383	398	470	308	249
		100		93	101	105	124	81	66
Mungbean	1	1	1,212	73	595	497	4	44	-
		100		6	49	41	-	4	-
		2	211	13	100	88	1	9	-
Mungbean	1	100		6	47	42	-	4	-
		3	184	210	181	181	197	214	-
		100		114	98	98	107	116	-
Cassava	1	1	3,172	243	2,539	301	23	36	31
		100		8	80	10	1	1	1
		2	301	20	247	28	2	3	2
Cassava	1	100		7	82	9	1	1	1
		3	98	82	100	98	97	93	82
		100		84	102	100	99	95	84
Cassava	2	1	8,820	5,259	630	116	2,279	537	-
		100		60	7	1	26	6	-
		2	19,554	11,175	1,438	271	5,431	1,239	-
Cassava	2	100		57	7	1	28	6	-
		3	2,283	2,208	2,343	2,441	2,343	2,230	-
		100		97	103	107	103	98	-

Crop	Item	Whole Country	North East	North	Central	East	West	South
Chilli *	1	113	31	42	11	3	21	9
		100	27	37	10	3	19	8
	2	36	9	14	3	1	7	2
		100	25	39	8	3	19	6
	3	319	283	343	304	371	346	253
		100	89	108	95	116	109	79
Shallot * and Onion	1	116	51	56	1	1	7	-
		100	44	48	1	1	6	-
	2	258	126	122	1	1	8	-
		100	49	47	-	-	3	-
	3	2,516	1,716	2,513	878	924	1,518	651
		100	68	100	35	37	60	26
Garlic *	1	190	27	162	0.4	-	1	-
		100	14	85	-	-	1	-
	2	311	26	284	1	-	1	-
		100	8	91	-	-	-	-
	3	1,643	976	1,758	1,360	1,422	1,257	-
		100	59	107	83	87	64	-
Pineapple	1	760	10	23	3	98	600	26
		100	1	3	-	13	79	3
	2	1,356	22	33	-	431	834	36
		100	2	2	-	32	62	3
	3	4,133	3,327	5,015	1,500	5,051	3,811	3,480
		100	81	121	36	122	92	84
Sugarcane	1	3,370	472	544	89	579	1,686	-
		100	14	16	3	17	50	-
	2	24,450	1,836	4,041	710	3,760	13,102	-
		100	12	17	3	15	54	-
	3	7,521	6,545	7,692	8,875	6,655	7,955	-
		100	87	102	118	88	106	-
Soybean	1	1,799	202	1,447	99	34	18	-
		100	11	80	6	2	1	-
	2	357	40	288	19	6	4	-
		100	11	81	5	2	1	-
	3	202	202	203	200	185	197	-
		100	100	101	99	92	98	-
Ground-nut	1	790	214	434	23	70	13	37
		100	27	55	3	9	2	5
	2	169	42	97	6	15	3	7
		100	25	57	4	9	2	4
	3	217	201	224	261	212	226	194
		100	93	103	120	98	104	89

Crop	1) Item	Whole Country	North East	North	Central	East	West	South
Castorbean	1	172	50	60	16	6	39	-
		100	29	35	9	4	23	-
	2	26	8	9	3	1	6	-
		100	30	35	12	4	23	-
		157	157	150	153	179	165	-
Sesame	1	100	100	96	98	114	105	-
		195	59	111	3	10	9	3
	2	100	30	57	2	5	5	2
		19	6	11	0.3	1	0.7	0.3
		100	32	58	2	5	4	2
Coconut	3	97	93	98	102	111	88	90
		100	96	101	105	114	91	93
	1	2,840	269	239	85	375	516	1,356
		100	10	8	3	13	18	48
		1,351	92	91	39	184	269	678
Oil Palm	2	100	7	7	3	14	20	50
		608	515	491	622	610	614	640
	3	100	85	81	102	100	101	105
		452	-	-	-	2	9	442
		100	-	-	-	-	2	98
Cotton	2	584	-	-	-	-	5	578
		100	-	-	-	-	1	99
	3	2,363	-	-	-	-	1,400	2,378
		100	-	-	-	-	59	101
		315	48	160	22	27	58	-
Kenaf	1	100	15	51	7	9	18	-
		57	9	28	4	6	10	-
	2	100	16	49	7	11	18	-
		188	193	180	200	202	180	-
		100	103	96	106	107	96	-
Kapok	1	1,284	1,240	-	-	44	-	-
		100	97	-	-	3	-	-
	2	226	213	-	-	13	-	-
		100	94	-	-	6	-	-
		179	175	-	-	299	-	-
Kapok	3	100	98	-	-	167	-	-
		321	182	103	6	3	21	7
	1	100	57	32	2	1	7	2
		52	28	17	1	1	4	1
		100	54	33	2	2	8	2
3	226	225	225	238	232	249	190	
	100	100	100	105	103	110	84	

Crop	Item	Whole Country	North East	North	Central	East	West	South
Para-rubber	1	8,739	-	-	-	1,062	-	7,677
		100	-	-	-	12	-	88
	2	992	-	-	-	114	-	878
		100	-	-	-	12	-	88
	3	164	-	-	-	-	-	-
		100	-	-	-	-	-	-
Bird Pepper *	1	253	77	43	9	6	91	28
		100	30	17	4	2	36	11
	2	89	25	19	2	2	31	10
		100	28	21	2	2	35	11
	3	353	321	453	275	309	342	356
		100	91	128	78	88	97	101
Long Yard Bean *	1	126	35	20	10	7	27	27
		100	27	16	8	6	21	21
	2	99	27	15	9	5	24	20
		100	27	15	9	5	24	20
	3	791	775	761	865	666	889	743
		100	98	96	109	84	112	94
Short Cucumber *	1	101	24	20	8	9	20	20
		100	24	20	8	9	20	20
	2	124	29	24	9	9	31	21
		100	23	19	7	7	25	17
	3	1,231	1,202	1,172	1,143	1,089	1,583	1,078
		100	98	95	93	89	129	88
Long Cucumber *	1	64	37	4	-	1	3	19
		100	58	6	-	2	5	30
	2	83	53	4	-	1	3	23
		100	64	5	-	1	4	28
	3	1,297	1,411	1,023	1,022	936	1096	1,179
		100	109	79	79	72	85	91
Pumpkin *	1	64	27	13	2	3	9	11
		100	42	20	3	5	14	17
	2	134	61	25	2	6	18	22
		100	46	19	2	5	13	16
	3	2,123	2,274	1,970	1,263	2,376	2,147	1,992
		100	107	98	60	112	101	94
Chinese Kale *	1	62	18	10	13	4	9	9
		100	29	16	21	6	15	15
	2	84	25	12	18	3	16	10
		100	30	14	21	4	19	12
	3	1,358	1,395	1,208	1,392	918	1,835	1,123
		100	103	89	102	68	135	83

Crop	1) Item	Whole Country	North East	North	Central	East	West	South
Cabbage *	1	62	25	23	1	1	12	1
		100	40	37	2	2	19	2
	2	126	48	47	1	1	27	2
		100	38	37	1	1	21	2
	3	2,063	1,974	2,071	1,550	1,385	2,308	2
Klue Namwa *		100	96	100	75	67	112	1,799
	1	985	319	259	63	86	67	87
		100	32	26	6	9	7	191
	2	494	172	130	29	42	37	19
		100	35	26	6	9	8	85
Mango *	3	620	668	628	591	558	636	17
		100	108	101	95	90	103	561
	1	947	365	249	77	156	76	90
		100	39	26	8	17	8	25
	2	336	130	74	30	67	28	3
Rambutan *		100	39	22	9	20	8	8
	3	517	597	420	531	548	472	2
		100	116	81	103	106	91	399
	1	374	-	1	-	149	-	77
		100	-	-	-	40	-	224
Durian *	2	466	-	1	-	209	-	60
		100	-	-	-	45	-	256
	3	1,464	-	1,091	750	1,658	429	55
		100	-	75	51	113	29	1,338
	1	359	-	37	-	181	-	91
Sugar Apple *		100	-	10	-	50	-	141
	2	168	-	18	-	105	-	39
		100	-	11	-	63	-	44
	3	591	-	569	-	724	245	416
		100	-	96	-	123	41	70
Tangerine *	1	304	219	42	17	14	10	3
		100	72	14	6	5	3	1
	2	204	143	28	17	10	5	1
		100	70	14	8	5	3	1
	3	985	1,008	899	1,318	834	657	591
Tangerine *		100	102	91	134	85	67	60
	1	261	-	32	135	48	20	26
		100	-	12	52	18	8	10
	2	477	-	42	283	90	30	33
		100	-	9	53	19	6	7
Tangerine *	3	2,424	-	1,816	2,968	2,153	1,916	1,539
		100	-	75	122	89	76	64

Crop	1) Item	Whole Country	North East	North	Central	East	West	South
Tamarind *	1	221	107	79	8	8	10	9
		100	48	36	4	4	5	4
	2	98	47	33	2	4	7	6
Jack Fruit *	1	100	48	34	2	4	7	6
		660	679	622	626	4	778	664
	2	100	103	94	95	606	119	101
Cashew Nut *	1	212	63	64	6	892	13	27
		100	30	30	3	40	6	13
	2	45	12	12	1	19	3	5
Lime *	1	100	27	27	2	13	7	11
		304	321	285	318	29	253	223
	2	100	106	94	105	378	83	73
Mangosteen *	1	211	67	7	1	124	4	117
		100	32	3	-	16	2	55
	2	30	4	0.2	-	8	0.4	24
Pomelo *	1	100	13	-	-	2	-	80
		275	193	165	169	7	169	311
	2	100	70	60	62	189	61	113
Mangosteen *	1	163	34	38	9	69	31	40
		100	21	23	6	10	19	25
	2	45	6	9	2	6	13	12
Mangosteen *	1	100	13	20	4	3	29	27
		353	290	323	270	7	466	358
	2	100	82	92	77	312	132	101
Mangosteen *	1	72	-	2	-	878	-	49
		100	-	3	-	22	-	68
	2	62	-	0.2	-	31	-	40
Mangosteen *	1	100	-	-	-	34	-	65
		1,067	-	-	-	1,253	-	1,001
	2	100	-	-	-	117	-	94
Mangosteen *	1	68	6	23	3	5	12	18
		100	9	34	4	7	18	27
	2	30	1	9	1	2	7	10
Mangosteen *	1	100	3	30	3	7	23	33
		559	472	523	724	631	680	626
	2	100	84	94	130	113	122	112

Source : Same as Table 2.3. 1-1 but * same as Table
2.3. 1-2

Note :L 1) Same as Table 2.3. 1-1.

Table 2.3.2-1 Number of Buffaloes, Cattle and Swine By Region (April 3, 1986)

(10,000 head)

Livestock	Whole Country	North East	North	Central	East	South	South
Buffaloes	626 (100%)	443 (70.8)	109 (17.4)	16 (2.6)	24 (3.8)	12 (1.9)	22 (3.5)
Cattle	489 (100)	176 (36.0)	115 (23.65)	37 (7.6)	13 (2.7)	67 (13.7)	81 (16.6)
Swine	421 (100)	109 (205.9)	114 (27.1)	29 (6.9)	36 (8.6)	70 (16.6)	160 (5.4)
Duck	1510 (100)	491 (32.5)	171 (11.3)	247 (16.4)	240 (15.9)	234 (15.5)	127 (8.4)
Chicken	7926 (100)	2468 (31.1)	2123 (26.8)	487 (6.1)	1201 (15.2)	637 (8.0)	1010 (12.7)

Source : Same as Table 2.3.1-1

Table 2.3.3-1 Timber Production and Trade in Thailand

(1,000 m³)

	Total Production	Import	Export	Home Consumption
1980	2,544.2	434.3	1.5	2,977.0
1981	1,798.6	566.7	7.8	2,357.5
1982	1,769.4	488.5	1.5	2,256.4
1983	1,819.7	614.3	1.2	2,432.8
1984	2,031.7	584.6	7.4	2,608.9

Source : Outline of Thai Economy (1986-B7)

Table 2.3.4-1 Catches of Fresh Water Fishes, 1985

Species	Quantity (1,000 tons)	Value (mill, baths)
Snake-head fish	22	726
Cat fish (Pla-duk)	18	554
Climbing perch	168	1,348
Local carp	16	302
Tilapia	15	273
Common carp	4	99
Sepat siam	23	290
Cat fish (Pla-svai)	18	236
Swamp eel	3	79
Shrimp	3	16
Others	36	1,348
Total	168	4,135

Source : Agricultural Statistics
of Thailand 1986/87

2-4 Agro-Industry and Industry

2-4-1 Agro-Industry (Agricultural Products Processing)

Agricultural products processing factories in the Eastern Region and the four provinces of the Study Area are as follows.

Item	Eastern Region	4 Provinces	Chachoengsao	Chonburi	Rayong	Chanthaburi
Agro-industry	2,489	1,646	165	722	507	252
Rice mill	1,240	717	122	254	175	166
Cassava	1,143	836	42	407	313	74
Para rubber	18	17	-	-	11	6
Sugarcane	64	63	-	56	3	4
Others	24	13	1	5	5	2
Food	406	336	26	183	92	35
Wood	306	243	27	111	66	39
Leather	2	2	1	1	-	-
Paper	4	4	2	2	-	-
Total	3,207	2,231	221	1,019	665	326
Paddy field (000 ha)			156	58	28	36
Upland field (000 ha)			93	236	171	130
Field area/Agro-industry (ha)			1,510	410	390	660

The area covered by one agricultural products processing factory is 1,500 ha in Chachoengsao and 400-600 ha in the other three provinces, at any rate most of the factories are small and the facilities old.

However, processing of agricultural products gives added value and is one of the most effective methods of providing employment opportunities to the rural community. In this aspect, location of factories realizing the best processing efficiency of raw materials and an abundance of employment opportunities should be examined in formulating agro-industry development plans.

For example, the cultivated area of sugarcane in the four provinces is 97,600 ha with 63 sugar refineries covering 1,550 ha each, however, increasing this 3 or 4 times should be more efficient. These factories would be managed by agricultural cooperatives or agricultural cooperatives and private sector jointly managed with the profits returning to the local community as much as possible and should contribute to the rural development program of the 5 year plan.

2-4-2 Industry

(1) General

The main industries in the Eastern Region are a natural gas refinery at Rayong, petroleum refinery at Chonburi, electric production by natural gas power at Chanthaburi and Trat, center of international tourism in Chonburi including the center of industrial services such as car and ship assembly, cooking gas and furniture, etc. Also, the Eastern Region has good sites for deep seaports at Laem Chabang and Map Ta Phut which after development will create more efficient international shipping instead of having the only commercial port at Bangkok on the Chao Phya River.

The Eastern Region has a large quantity of natural resources which can be processed industrially for exportation or be consumed domestically as import substitutes, there will be continued processing of livestock, fruit, fishery and rubber production, and production of the furniture industry, ethanol gas industry, finished concrete industry, jewelry industry and other industries such as chemical fertilizer, petro-chemical, plastic, etc.

(2) Problems

There are few large water resources in the Eastern Region compared with other regions.

The use of water for agriculture, industry and domestic purposes relies on the existing small reservoirs. Besides, the geographical structure of the foundation is granite stone which cannot store water and causes lack of groundwater especially in the seaboard area.

Lack of water will prevent the expansion of industrialization and

communities, and in the future if there is more expansion of industrial development and the eastern seaboard community following government policy, including the development of the agricultural area next to the seaboard, there will be an increasing problem due to lack of water and this will be reflected in the limitation of long-term regional growth.

Water resources development and water conservation are urgently required in this region.

(3) Future development

1) Laem Chabang area development plan

The Laem Chabang complex is situated half way down the eastern gulf coast and will have a commercial deep-seaport, and industrial estate and an export processing zone backed up by a complete urban center and essential infrastructure. Improvements to the already substantial communication network will also link Laem Chabang to the hinterland from which the raw material for its agro-industries will come.

Again, the Thai government has taken responsibility for providing these facilities. The planned industries in Laem Chabang will be primarily small scale, labour-intensive and non-polluting.

2) Map Ta Phut area development plan

Map Ta Phut is situated to the west of Rayong and will be a gas-related and heavy industrial complex served by its own industrial deep-seaport. The Thai government has assumed the responsibility for providing a deep-seaport with a capacity for handling 60,000 DWT or carries (140,000 DWT dry bulk) and for building 870 ha of infrastructure and utilities.

In addition, the government has taken charge of providing an urban area with housing and complete social services comparable to Bangkok standards and will ensure pollution control.

Near MP Ta Phut the world's longest submarine gas pipeline (425 km) comes ashore before continuing through the entire Eastern seaboard region to deliver gas to Bangkok and even further north. Design of the deep-seaport and industrial complex/urban area was completed and financing has already been finalized.

Table 2.4.2-1 Eastern Region Factories by Type and Number as of 1988

Industry	Eastern Region	4 Provinces	Chacho- engsao	Chonburi	Rayong	Chantha- buri
Publishing	26	22	3	14	1	4
Beverage	16	12	-	7	1	4
Chemical	14	11	-	10	1	-
Petroleum	3	3	-	3	-	-
Non-metal mineral	140	117	3	70	13	31
Metal mineral	54	45	-	21	10	14
Machinery	338	287	43	141	52	51
Electricity	10	5	1	3	1	-
Transportation	272	180	5	90	18	67
Tire and Plastic	14	14	-	9	2	3
Mining	51	38	-	19	12	7
Others	11	6	1	-	2	3
Total	949	740	56	387	113	184

Source : Provincial Industrial Office

2-5 Rural Area and Infrastructure

2-5-1 Road and Transportation

(1) Development Policy and Guideline for Solving Problems

The policy of saving energy and reducing oil imports will form the basis for solving communications and transportation problems.

Existing roads will be repaired and maintained so that they can be used in any season while new roads will be constructed to connect villages, sub-districts and districts to the network of primary highways in order to facilitate transport of agricultural produce and rural commuters.

Operational guidelines are as follows:

- According priority to improving and maintaining existing rural highways, especially where there is an urgent need. New construction will be limited to missing links that are necessary to connect the network to national and provincial highways under the responsibility of the Department of Highways.
- Place special emphasis on the construction, improvement and maintenance of rural highways that directly support local and regional economic activities such as development of tourism and rural industry, transport of products to markets and exports. Routing priorities will be selected with due regard to other development activities.
- Prioritize backward areas that have communication problems, especially in areas where there is an urgent need and border areas where there are security problems. Construction and maintenance should aim at ensuring the availability of all-weather roads.
- Encourage people's participation in building roads that link villages with fields and thus facilitate work activities and the transport of produce. This would develop the sense of ownership and the desire to keep the roads in good repair.
- Avoid duplication of efforts and unconnected roads by basing the selection of routes for construction on the areas of responsibility of each agency involved in road construction and

maintenance. For example, there are 57 provinces under the Accelerated Rural Development Office, 35 provinces under the Public Works Department and the border areas come under the National Security Command Headquarters.

(2) Road Administration

1) Road classification

i) Special highways (Control of Access)

These are roads with especially high standards of design, particularly with respect to access to the carriageway and control of roadside activity and development. The standards for this category have been prepared only recently to cater for increasing traffic volume on the most important routes. So far only one road has been constructed to this standard, that being the 84 km Thonburi-Park Tho highway.

ii) National highways

Roads which are of primary importance to economic development, administration and defense of the Kingdom are designated national highways.

iii) Provincial highways

Roads in this category are of secondary importance to national development but essential to efficient provincial administration, linking provinces and other important centers or areas to provincial capitals.

iv) Rural roads

These are minor roads of local significance only.

v) Municipal roads

All major roads in areas governed by a municipal authority such as a city or town.

vi) Roads in small municipal areas

Roads in small municipal areas such as districts, sub-districts.

vii) Concession highways

A special category of road, little used, in which a developer contracts with the Government to provide a road for public use on which he has, for a specified period, sole transportation concession at agreed rates. At the expiration of the contract the facility becomes public property.

2) Road administration

i) National roads

The Department of Highways is responsible for the construction, maintenance and administration of the Special, National, Provincial and Concession Highways (4 out of 7 classifications of highways) throughout the Kingdom, for the purpose of national development in transportation, economics, education and administration as well as defense.

ii) Rural roads

Rural roads are built and maintained by the respective provincial administrative organization. Municipal roads (of both categories) are the responsibility of the appropriate municipal public works agencies. All the four remaining categories are administered by the Department of Highways, which is responsible for all construction, improvement and maintenance.

Organization agencies concerning rural roads are as follows :

- Office of Accelerated Rural Development (ARD)
- Public Works Department (PWD)
- National Security Command Headquarters (NSCH)
- Provincial Administration Organization (PAO)
- Community Development Department (CDD)
- Department of Local Administration (DOLA)
- Agricultural Land Reform Office (ALRO)
- Royal Irrigation Department (RID)
- Department of Public Welfare (DPW)

The responsibility of these agencies is divided as follows ;

- a) ARD
 - Construction of standard road and developed road type-1 (Developed road type-1 : access road between main road and village)
 - Construction work in the area approved by the committee to be ARD's provinces (25 provinces)
- b) PWD
 - Construction of rural road by using manpower
 - Construction of paved roads in villages
- c) DOLA
 - Construction of rural roads in provinces which were announced by DOLA to be in region of rural highways (36 provinces, in the Eastern Region, Chachoengsao and Chanthaburi province)
- d) DPW
 - Construction of main road and access road
 - Implementation in self-help land settlement (Eastern Region : Rayong)
- e) CDD
 - Maintenance of highways and rural roads
 - Making proposals for the Tambon development plan
 - Implementing road construction in all provinces
- f) ALRO
 - Constructing and maintaining agricultural land reform roads
- g) RID
 - Constructing and maintaining O&M roads for irrigation and drainage facilities

(3) Existing Roads in the Eastern Region

1) Highways in the Eastern Region

Length of Highways in the Eastern Region and Study Area

Province	Completed Highway (Km)	Survey Line (Km)	Total (Km)
Chachoengsao	578.816	42	620.816
Chonburi	513.526	42	555.526
Rayong	508.556	-	508.556
Chanthaburi	607.991	-	607.991
Sub-total	2,208.889	84	2,292.889
Eastern Region	3,704.858	84	3,788.858
Whole Kingdom	44,178.938		

Density of highways

Whole Kingdom 86.1 m/km²

Eastern Region 101.5 m/km²

Study Area 114.1 m/km²

2) Rural roads

A case study of Rayong Province concerning the density of rural roads was carried out.

Roads constructed by various agencies as of 1987 are as follows;

<u>Agencies</u>	<u>No. of lines</u>	<u>Length (km)</u>
ARD	3	65.858
PRD	9	94.393
RID	7	24.279
DPW	22	286.0
DOLA	132	2,318.46
Total	173	2,788.99

Density... $2,788.99 \text{ km} / 3,552.0 \text{ km}^2 = 0.785 \text{ km/km}^2$

Total length of rural roads in the Eastern Region can be estimated at 28,500km.

2-5-2 Water Supply and Electricity

(1) Water Supply

1) Development policy and guideline for solving problems

It is necessary to accelerate the development of small-scale water resources in remote areas that was implemented in the Fifth Plan period in order to satisfy the people's basic need for water. Water resources will be identified in order to ensure an adequate supply for the consumption of rural people and to constitute a supplementary water resource for agricultural use in areas dependent on rainwater. Moreover, a higher priority will be given to extension activities, project maintenance and people's participation in the development of small-scale water resources. Operational guidelines are as follows:

a) Accelerate construction of small-scale water resources throughout remote areas in order to eliminate the shortage of water for drinking and household consumption in the Sixth Plan period.

b) Accelerate implementation of the programme for ensuring clean water and tap water for villages.

Coordination and cooperation between the government and the private sector will be emphasized and people will be encouraged to participate in the form of foundations or village funds.

c) Allocate budgets for small-scale water resource development projects based on the actual problems and needs in each locality.

The ranking of priorities will be based on the problems of each region.

Project implementation should conform to the problems and needs of the people.

d) Promote extension activities and project maintenance.

Implementing agencies should ensure that people and officials cooperate in using small-scale water resources. Local authorities and people will be encouraged to make

financial contributions to augment the government budgetary allocations for maintenance of small-scale water resource development projects.

- e) Establish a monitoring and evaluation system to ensure that small-scale water resource development projects are implemented according to the government policy.

2) Small-scale water resources development administration

Implementation agencies are classified by the type of small water resources development project. (refer to Table 2.1.5-5 Major Agencies for Small Water Resources Project)

(2) Electricity

Rural electrification is a barometer of the level of development and also one of the important components for rural development.

In the Eastern Region, electric consumption for residence and industry has been steadily increasing year by year, although existing conditions in the rural area still reveal many problems.

One of the problems which is preventing rural electrification is the form of settlement. Since farmers' houses lie scattered, the efficiency of supplying electric power becomes very low and construction costs become high.

2-5-3 Facilities for Agriculture

(1) Major facilities

Major facilities for agriculture are rice mills.

Chachoengsao : There are 9 Agricultural Cooperatives

5 of them have warehouses for rice

- 5 in Muang Cooperative - capacity 2,500 tons
- 2 in Bang Nam Priew Cooperative - capacity 1,000 tons
- 3 in Bang Khla Cooperative - capacity 1,500 tons
- 1 in Bang Prakong Cooperative - capacity 500 tons

- 2 in Phanom Sarakham Cooperative - capacity 1,000 tons
- Chonburi : There are 9 Agricultural Cooperatives
 - 2 of them have warehouses for rice
 - 1 in Panas Nikhom Cooperative - capacity 500 tons
 - 1 in Pantong Cooperative - capacity 500 tons
- Rayong : There are 6 Agricultural Cooperatives
 - 2 of them have warehouses for rice
 - 1 in Klaeng Cooperative - capacity 500 tons
 - 1 in BanKhai Cooperative - capacity 500 tons
- Chanthaburi : There are 6 Agricultural Cooperatives
 - 5 of them have warehouses for rice
 - 1 in Laem Singh Cooperative - capacity 500 tons
 - 1 in Makam Cooperative* - capacity 300 tons
 - 1 in Thamai Cooperative* - capacity 500 tons
 - 1 in Khlung Cooperative - capacity 500 tons
 - 1 in Pong Nam Ron Cooperative - capacity 300 tons

* Multipurpose warehouse

Source : Marketing Promotion Section, Agricultural Cooperative Division, Cooperative Promotion Department

(2) Minor facilities

Maize warehouse. One existing warehouse for maize is the private silo at Amphoe Wangnamyen, Prachin Buri Province. Its structure is made of concrete with storage capacity of about 29,000 tons. Another one is a private go-down for storing maize in Chacheongsao Province. The study by the Bank of Thailand revealed that this go-down has a storage capacity of 15,021 tons. Other silos are situated in Samut Prakarn Province which is the terminal silo at the national level. The products stored in the silos are aimed for export.

As for the Eastern Region, so far no problem has ever been encountered regarding the existing maize warehouses. This is because most merchants always deliver maize directly to exporters who already own silos in Bangkok of Samut Prakarn. Besides, the volume of maize produced in this region is not so large.

Cassava warehouses. Besides the huge silo in Chonburi Province, there are numerous warehouses belonging to the exporters located in Amphoe Bang Prakong, Chacheongsao Province. These warehouses are go-downs or storehouses made of concrete blocks. Normally, tapioca chips produced in the East are sent to merchants or exporters who are trading tapioca pellets in Amphoe Bangprakong. As regards the demand for warehouses, no problem has ever arisen because the existing structures are privately-operated warehouses at the regional and national levels.

The study by the Bank of Thailand in 1980 revealed that the storage capacity of the go-downs specifically built for tapioca products in Chacheongsao and Prachin Buri were 257,101 and 65,250 tons, respectively. In 1983 it was estimated the storage capacity would be increased as a consequence of the expansion in cassava cultivation and trading.

In summary, the go-downs or warehouses of agricultural commodities found in the East are located in the main production areas of specific crops. For instance, in Chonburi there is private silo for tapioca products. In Chacheongsao and Prachin Buri go-downs for storing maize and tapioca products are in existence.

While most silos found in Samut Prakarn are those of maize exporters.

2-5-4 Social Services

(1) Communication

1) Postal service

Province	No. of post offices				Mailbox	Postman
	Urban area	Rural area	Total	Special post office		
Chachoengsao	1	8	9	-	192	31
Chonburi	2	15	17	3	377	89
Rayong	1	10	11	-	210	37
Chanthaburi	1	9	10	1	186	39
Total	5	42	47	4	965	196

Source : Communication Authority of Thailand, 1987

2) Telephone

Province	No. of telephone exchange	Telephone line
Chachoengsao	12	4,136
Chonburi	28	20,280
Rayong	13	4,872
Chanthaburi	11	6,000
Total	64	35,288

Source : Telephone Organization of Thailand, 1987

(2) Education

Number of Schools, Teachers and Students in the Eastern Region in 1986

Province	Educational Institutes	Teachers	Students	Teacher : Students
Nakhon Nayok	284	2,486	41,606	1 : 16
Prachin Buri	812	7,192	154,830	1 : 21
Chachoengsao	465	5,149	106,382	1 : 20
Chonburi	624	8,003	165,338	1 : 20
Rayong	368	3,854	73,892	1 : 19
Chanthaburi	373	3,494	71,515	1 : 20
Trat	189	1,929	28,528	1 : 14
Total	3,115	32,107	642,091	1 : 19

Source : Information Office on Educational Matter; Department of General Education

(3) Public health

1) Number of hospitals, beds, patients, physicians and nurses; 1984

Province	No. of Hospitals	No. of Beds	Population/ Bed	No. of Patients	No. of Physicians	No. of Nurses	Population/ Physician
Chachoengsao	1	268	1,904	130,225	18	81	28,350
Chonburi	1	695	1,122	257,729	63	187	12,382
Rayong	1	400	1,015	140,776	25	88	16,248
Chanthaburi	1	606	618	127,171	95	179	3,943
Total	4	1,969	4,659	660,560	201	535	-

Source : Department of Medical Services, Ministry of Public Health

2) Other medical facilities, 1984

Province	Community Hospital			Medical and Public Health Center	Public Health Center	Office of Community Public Health Service
	60 beds	30 beds	10 beds			
Chachoengsao	1	-	3	-	91	-
Chon buri	1	2	5	-	98	-
Rayong	1	1	2	-	65	3
Chanthaburi	-	-	3	1	83	6
Total	3	4	13	1	337	9

Source : Same as above

2-6 Farmers Organizations

2-6-1 Cooperatives

All cooperatives in Thailand are under the jurisdiction of the Cooperatives Promotion Department (CPD) of the MOAC. In the Study Area and the Eastern Region as a whole participation in cooperatives, especially, agricultural cooperatives is rather poor except for Prachin Buri (18 agri-coops., 13,403 members) and Chachoengsao (19 agri-coops., 10,063 members) see Table 2.6-1. Provincial and district level CPD activities should be strengthened to increase the farmer's awareness of programmes available to him.

Since the cooperatives are service cooperatives (mainly supplying crop production inputs, credit, etc.) they are lacking in management personnel to advise the farmers on crop production, management and marketing (except for rice) affairs. Also, the amount of credit available is very limited which compels the farmer to find other sources of financing.

In the Pilot Areas covered by the Farm Survey it was found that membership in cooperatives was very low except for Chachoengsao at 23.73%. Chonburi, Rayong and Chanthaburi had memberships of 0%, 10% and 13%, respectively. The main service farmers received was credit in cash and kind for production inputs, and the main activity of the farmers in the cooperatives was attending meetings. Of the farmers participating in cooperatives most felt the services were adequate but the amount of credit was felt to be insufficient.

2-6-2 Farmers' Associations

First organized in 1972, Farmers' Associations are very similar in organization to agricultural cooperatives.

Of the 10 Pilot Areas covered by the Farm Survey only RY-NO.2 had one farmer who was a member of such an association.

2-6-3 Agricultural Groups

Agricultural groups found in the Study Area are as follows, Paddy, Upland Crops, Horticultural Crops, Animal Husbandry, Fishermen and Aquatic.

Results of the Farm Survey reveal that there are no agricultural groups presently carrying out activities in the Pilot Areas.

2-6-4 Bank for Agriculture and Agricultural Cooperatives (BAAC) Client Group

Agricultural credit services provided to client farmers on a group security basis were found to be the most extensively widespread activity supporting farmers in the Study Area.

The results of the Farm Survey reveal that 47 of the 123 or 38.21% of the households interviewed are clients of the BAAC. By Province the figures show the extent of BAAC credit service utilization ; in Chachoengsao 13.56%, Chonburi 66.67%, Rayong 70% and Chanthaburi 52.17% of farmers surveyed were found to be BAAC clients on a group security basis.

Table 2.6-1 Number of Cooperatives and Members by Type - December 31, 1986

	Cooperative Federations		Agri. Cooperatives		Fishery Cooperatives		Land Settlement Cooperatives		Thrift and Credit Cooperatives		Consumer Cooperatives		Service Cooperatives	
	No. of Federations	No. of Cooperatives	No.	Member	No.	Member	No.	Member	No.	Member	No.	Member	No.	Member
Whole Kingdom	73	896	1,089	851,224	119	4,127	93	82,412	634	99,790	341	650,613	256	74,673
Eastern Region	7	85	77	58,837	2	602	19	14,065	41	44,164	26	21,267	14	2,516
Chachoengsao	1	22	19	10,063	-	-	-	-	3	5,274	4	2,193	-	-
Chonburi	1	10	10	7,038	-	-	-	-	15	12,736	9	4,516	4	1,372
Rayong	1	12	8	9,247	1	311	4	3,788	2	4,001	3	3,585	4	311
Chanthaburi	1	6	7	9,782	1	291	1	2,084	9	10,873	3	4,432	2	115

Source: OAE, MOAC

Table 2.6-2 Membership in Agriculture Related Organization in the Pilot Areas

Province	Chachoengsao						Chanburi		Rayong		Chanthaburi		Total	%
	3	4	5	8	1	8	1	2	2	2	3			
Pilot Area No.	3	4	5	8	1	8	1	2	2	2	3			
No. of Interviews	15	15	15	15	6	5	15	15	15	12	11	123		
Type														
1. BAAC	1	2	2	3	3	3	8	13	6	6	6	47	38.21	
2. Agri. - Coop.	10	-	-	4	-	-	-	3	-	-	3	20	16.26	
3. Farmers' Association	-	-	-	-	-	-	-	1	-	-	-	1	0.81	
4. Livestock Coop.	-	-	-	1	-	-	-	-	-	-	-	1	0.81	
5. Housewives Group	1	1	-	-	-	-	-	1	-	-	1	4	3.25	
												73	59.34	