


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. I MAIN REPORT

SEPTEMBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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PREFACE

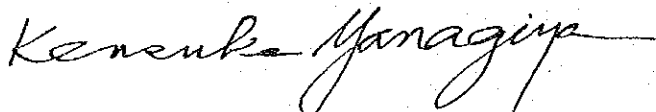
In response to the request of the Government of the Kingdom of Thailand, the Japanese Government decided to conduct The Study on Agricultural Land Conservation for Integrated Rural Development in the East and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Thailand a survey team headed by Dr. Yoshizo Mochizuki, Taiyo Consultants Co., Ltd., from September 1987 to March 1988.

The team exchanged views with the officials concerned of the Government of the Kingdom of Thailand and conducted field surveys in the study area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will provide support and guidance for the development of the Project and further contribute to the promotion of friendly relations between our two countries.

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

September 1988

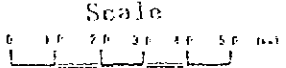
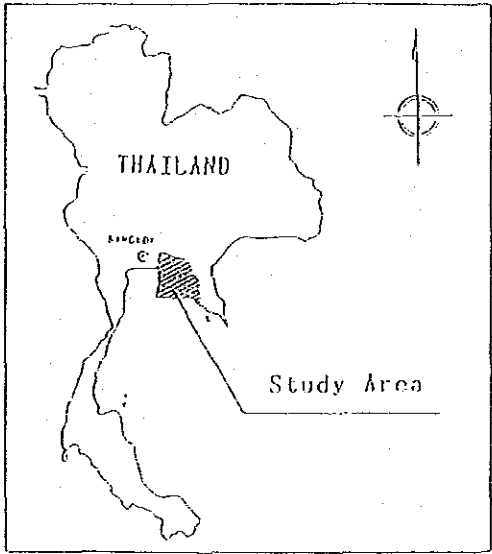
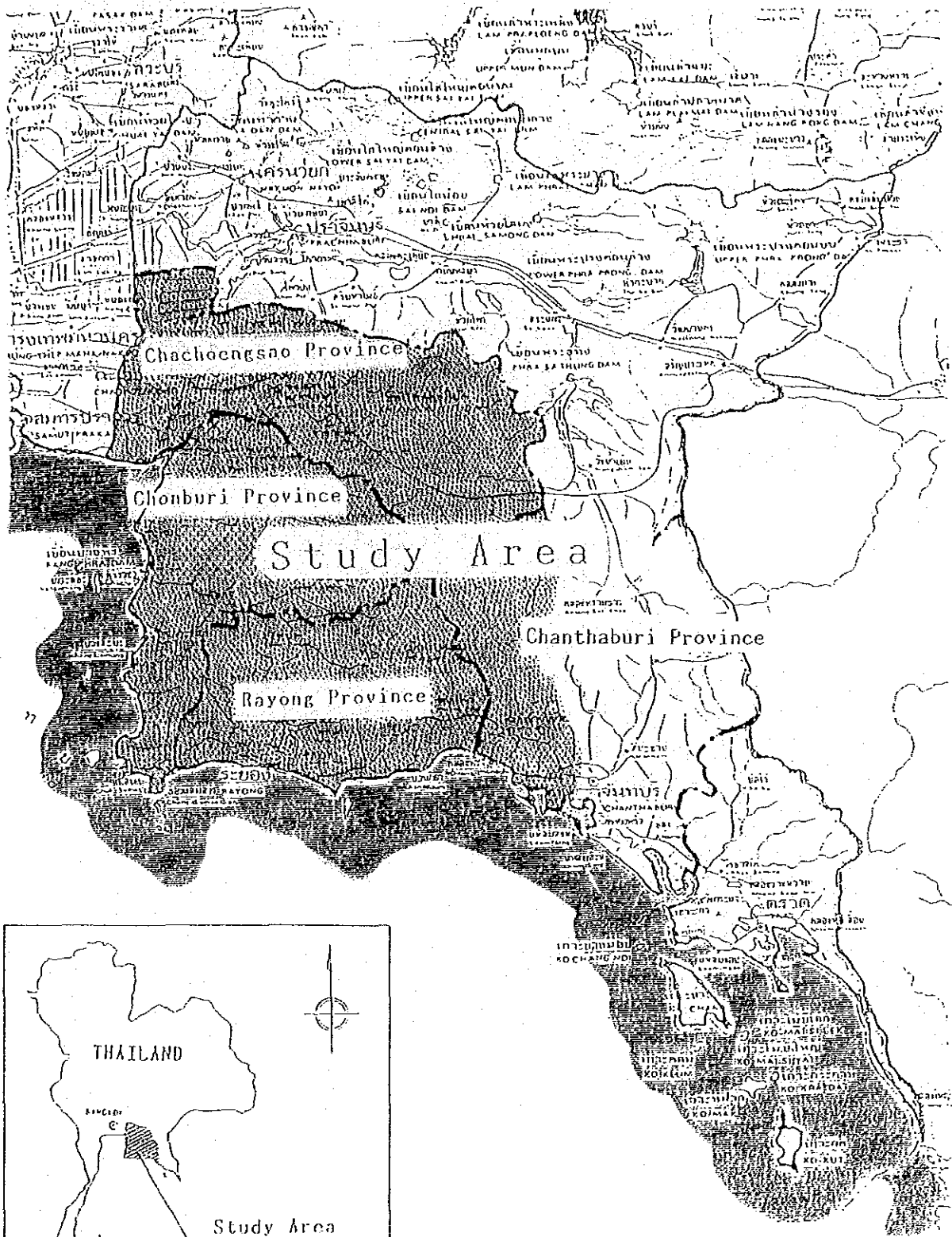


Kensuke YANAGIYA

President

Japan International Cooperation Agency

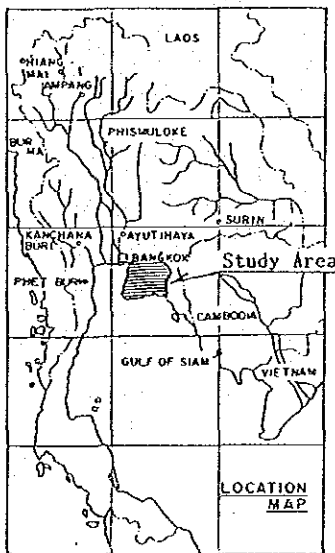
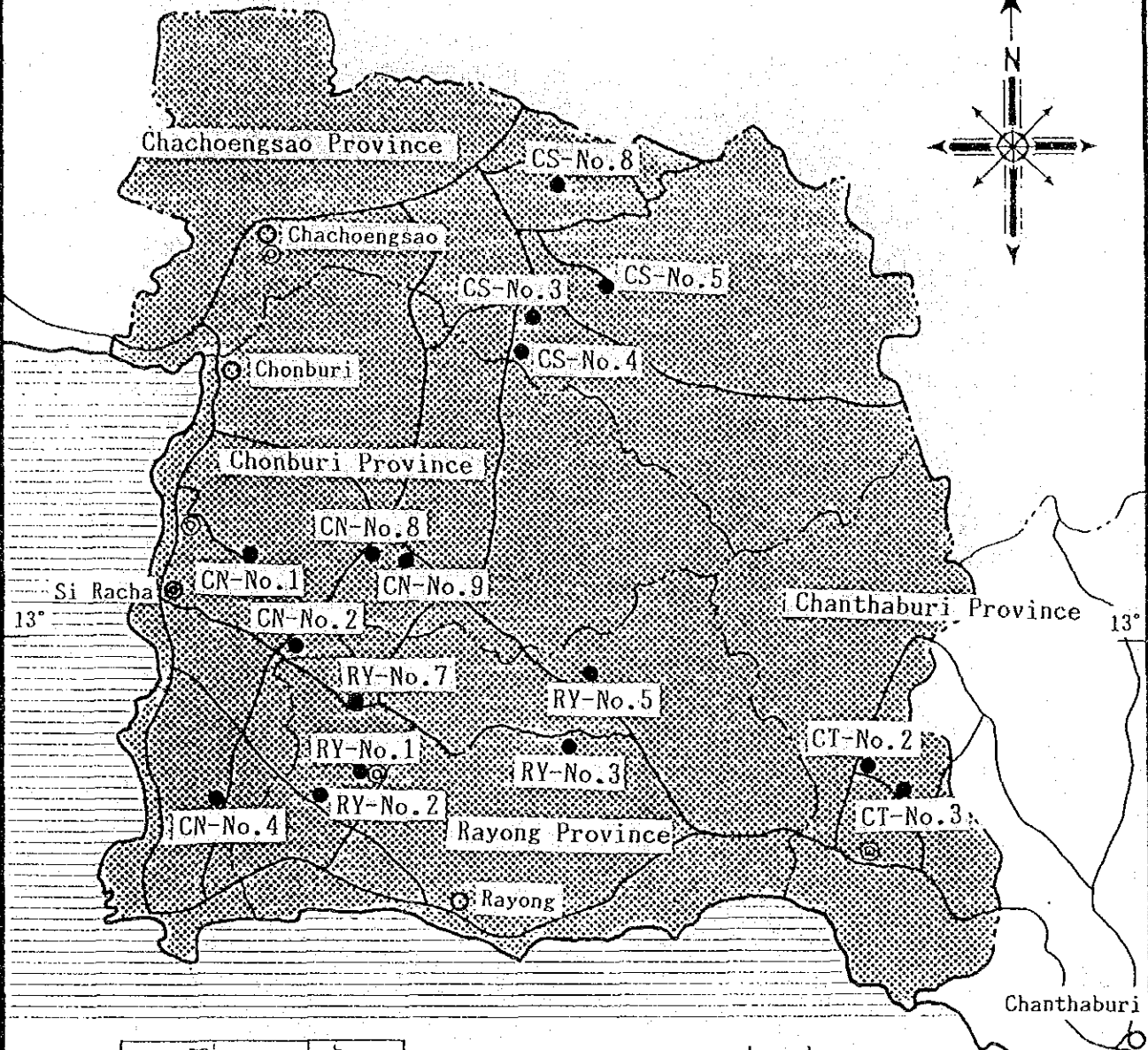
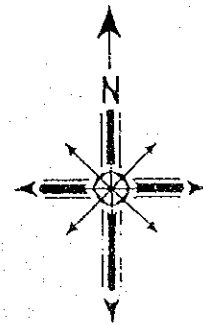
Location Map





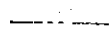



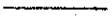
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LOCATION MAP

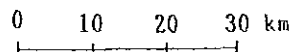
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Legend

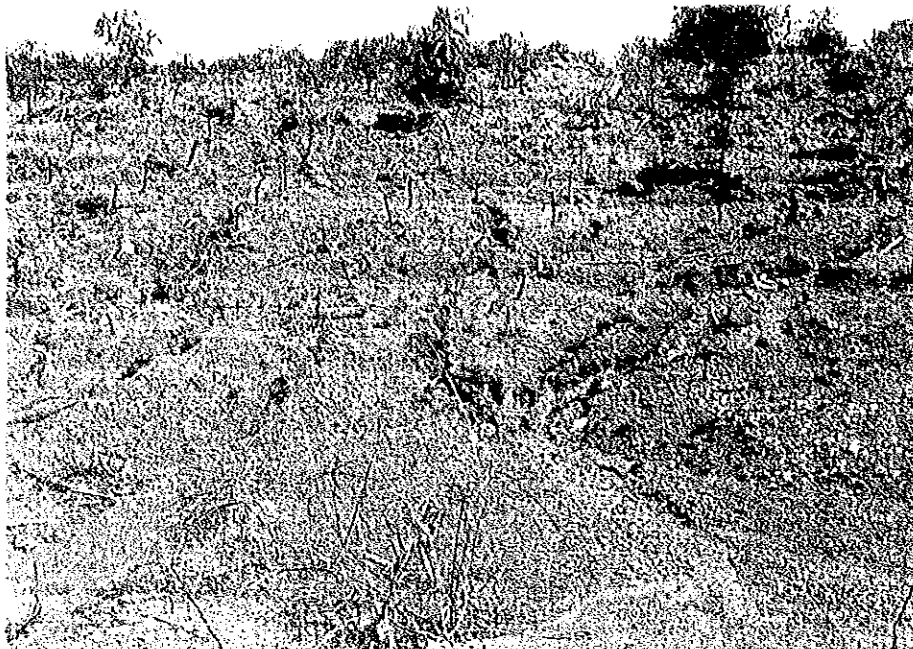
-  Project Area
-  Pilot Area
-  Provincial Boundary
-  Provincial Headquarters
-  L.D. Regional Office II
-  L.D. Station
-  Road

Scale



102°

101°



Field condition showing erosion caused by rainfall



Field condition showing erosion caused by rainfall



Field under pineapple cultivation showing rill and gully erosion

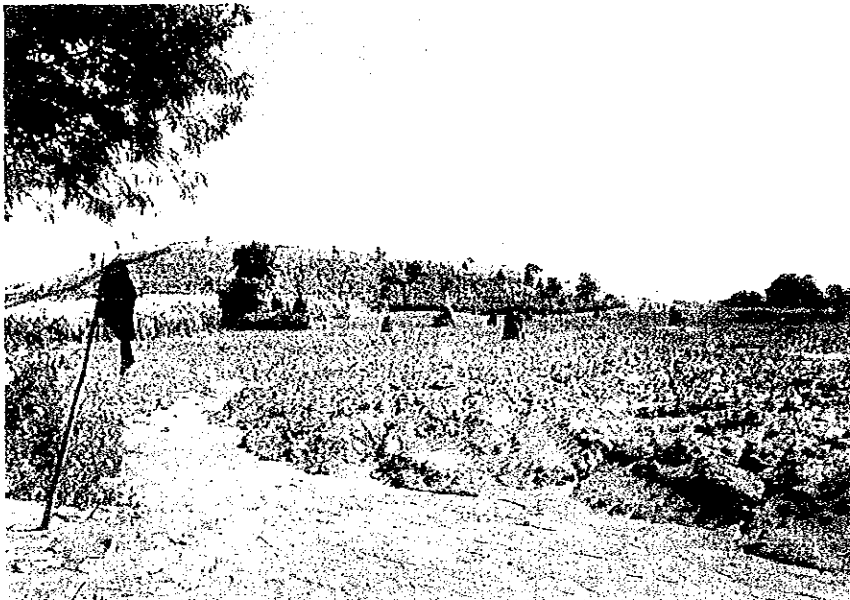




Severe erosion — poor soil condition, limited crop selection, cassava, etc.



Field under cassava cultivation showing sheet erosion





Collapse of concrete structure due to the effects of erosion



Road collapse caused by erosion

SUMMARY

1. GENERAL

• Report

(1) This report contains seven volumes, and this is Volume I Main Report.

• Purpose of the Study

(2) The study was carried out in conformity with the agreement concluded between JICA and DLD on February 17, 1987. The study period was from September 24, 1987 to July 12, 1988.

(3) The purpose of the study is to formulate the Basic Plan (B/P) for the 4 provinces and to carry out a Feasibility Study (F/S) on the 16 Pilot Areas for Agricultural Land and Water Conservation in the Eastern Region.

• Necessity and Importance of the Project

(4) Implementation of the Project will assist the government, under the policy of the Sixth NESD Plan, in ensuring further regional and national development as follows;

- preventing destruction of natural resources, particularly land affected by disorderly development, through introduction of land and water conservation projects
- supplying food and raw material to the industrial sector, especially the Eastern Seaboard, from the rural area which will also stabilize the farmers income and improve living standards
- reducing the disparity in income between the people living in the industrial and rural area
- protecting national security particularly in the area near the border between Cambodia and Thailand

● Socio-economic and Environmental Impacts

(5) In addition to the quantitative benefits expected, this Project would entail large intangible socio-economic and environmental impacts.

(6) The major socio-economic impacts foreseen are as follows;

- creation of employment opportunities
- reduction of regional disparity
- saving and earning of foreign exchange
- enhancement of cooperation among farmers

(7) The major environmental impacts foreseen are as follows;

- prevention of disorderly deforestation, thereby retaining existing ecosystems (e.g. to retard the occurrence of erratic rainfall and extinction of wildlife)
- conservation of surface run-off and groundwater
- alleviation from flooding and drainage damage in lower reaches

● Location and Acreage

(8) Project Area 15,247 sq.km is located in the 4 provinces of Chachoengsao, Chonburi, Rayong and Chanthaburi in the Eastern Seaboard Region, of which 884 thousand ha is Planning Area.

● Meteorology

(9) As climatic regions, 4 provinces belong to the tropical savanna climate or tropical monsoon climate. Annual rainfall is 1,400 mm to 3,000 mm, the rainy season is from May to October and the dry season is from November to April. Annual average temperature is 28°C and monthly average temperature is a maximum 30°C in April and minimum 26°C in December. Monthly average humidity is maximum 85% in October and minimum 74% in January. This region's climate, therefore, exhibits little change and is moderate.

● Geology

(10) In relation to soil erosion status, rocks and deposits in the pilot areas are classified into the following 3 types:

Geology and deposit type	Erosion status
a) Decomposed granite (very coarse sand)	Very severe
b) Old basement (loam, clay)	Severe
c) Terrace deposits (sand, gravel, clay)	Moderate to severe

● Soil

(11) 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.

● Population

(12) Population of the 4 provinces in 1985 are shown below.

Chachoengsao	525,717	Persons
Chonburi	806,396	
Rayong	418,814	
Chanthaburi	390,348	
Total	2,141,275	

2. BASIC PLAN (B/P) OF 4 PROVINCES

• Objective of B/P

(13) In relation with the objectives, strategies and programmes of the Sixth NESD Plan, this B/P will lay down the long-term integrated rural development plan centering on agricultural land conservation for the four provinces located in the Eastern Region. Integrated rural development has two aspects, improvement in both the productivity of agriculture and agricultural land, and the living condition of the rural community and farmers.

• Classification of Area

(14) Study Area means the area in which reconnaissance surveys and data collection is carried out, Project Area means the gross area including the other existing areas such as road, forest, villages, etc. as well as the Planning Area, and the Planning Area is the area under upland crop production.

	(Km ²)		
Province	Study Area	Project Area	Planning Area
Chachoengsao	5,351	5,351	2,200
Chonburi	4,363	4,363	3,041
Rayong	3,552	3,552	2,634
Chanthaburi	6,338	1,981	965
Total	19,604	15,247	8,840

• Soil Erosion Map

(15) For the formulation of the Basic Plan and the selection of the pilot areas, a Soil Erosion Map of the Study Area was established.

No.	Classification	Soil Loss
		(ton/ha/year)
1	Top Urgent	more than 50
2	Urgent	50 - 30
3	Necessary	30 - 20
4	Normal	20 - 5
5	Not necessary	less than 5

This classification was proposed by the JICA Study Team.

● Basic Formula

(16) For calculation of soil loss volume, Universal Soil Loss Equation (USLE) shall be used, namely

$$A = R \cdot K \cdot Ls \cdot C \cdot P$$

where A : Total Soil Loss Volume (ton/ha/year)
 R : Rainfall Factor
 K : Soil Erodibility Factor
 Ls : Slope and Slope Length Factor
 C : Crop Management Factor
 P : Soil Conservation Measures

● Erodible Area

(17) According to the result of calculation of soil loss volume, Planning Area which is used for crops at present is a total of 8,840 sq.km of which 7,162 sq.km or 81 percent require land conservation measures.

		(km ²)				
Classification		Chachoengsao	Chonburi	Rayong	Chanthaburi	Total
	ton/ha/yr.					
1. Top Urgent	(50 <)	388	1,245	923	331	2,887
2. Urgent	(50 - 30)	553	521	170	268	1,512
3. Necessary	(30 - 20)	523	439	864	328	2,154
4. Normal	(20 - 5)	351	23	223	12	609
1 - 4	Total (Erodible Area)	1,815	2,228	2,180	939	7,162
5. Not Necessary	(5 >)	385	813	454	26	1,678
1 - 5	Total (Planning Area)	2,200	3,041	2,634	965	8,840

• Soil Conservation Measures

(18) As the soil and water conservation measures four approaches such as agricultural measures, mechanical measures, irrigation facilities and supporting measures have been selected for this project. The first three measures are directly and the last one indirectly connected with the topic. These should be the four main measures in the East in future and their priority will depend on the environmental conditions of each project area.

• Agricultural Measures for Soil Conservation

(19) In this context, agricultural measures mean the biological measures and/or farm management or practices to protect land from soil degradation as well as to preserve both surface and groundwater.

1. Mulching	1) Live mulching
	2) Non-live mulching
2. Cropping Method	
3. Cultivation method	1) Contour ploughing
	2) Contour ridging
	3) Contour strip cultivation
4. Canopy improvement	
5. Soil management	1) Tillage
	2) Soil property improvement

● Mechanical Measures for Soil Conservation

(20) Mechanical measures shall be applied in accordance to the actual physical condition of the area such as topography, climate, crop, soil as well as the farmers current ability. Such measures are:

1. Soil management system
2. Terracing system
3. Drainage system
4. Farm road system
5. Farm pond or reservoir
6. Check dam (sediment pond)
7. Slope protection
8. Others

● Irrigation for Soil Conservation

(21) At present most of the upland cultivation including upland vegetable and tree crops are rainfed due to poor water resources development. Taking into account such poor water resources development and undulating topographical condition, an irrigation system with small reservoirs should be introduced to the project area.

(22) About 530 km² of irrigable area for upland crops will be possible by constructing a total of about 212.0 MCM of reservoir capacity as shown below.

Province	Area	Plan	Possibility of Irrigable Area		Required Water Resources
			Rate	Acreage	
	(km ²)		(%)	(km ²)	(1000 m ³)
Chachoengsao	2,200	II	6	132	52,800
Chonburi	3,041	II	6	182	72,800
Rayong	2,634	II	6	158	63,200
Chanthaburi	965	II	6	58	23,200
Total	<u>8,840</u>			<u>530</u>	<u>212,000</u>

● Supporting Measures

(23) For the promotion of agriculture the arrangement of a supporting system can be emphasized as well as the development of farm land itself. As a supporting system infrastructure such as roads, water supply, electrification, communication, etc. are considered. Farmers' organization and the extension of marketing are also important matters. In Vol. II of this report, together with the infrastructure mentioned above, agro-industry, education of farmers and institutional cooperation among the agencies concerned, are specially discussed to be emphasized as the components of supporting measures.

● Implementation Plan

(24) For the implementation of land conservation works of 884 thousand ha, the total project period is planned at 30 years divided into 5 year blocks. The first 5-year plan, 1991-1995, is allotted only 10,000 ha per year in each of the 4 provinces. The first 5 years are spent on the preparation works for the implementation of the long term plan and to gain various types of experience. From the second 5-year plan, conservation works of approximately 35,000 ha per year shall be completed annually in each province.

● Project Cost for B/P

(25) The project cost for the conservation area of 884 thousand ha has been estimated as follows.

Province	Area	Plan	Unit Project Cost	Total Project Cost
	(km ²)		(Baht/rai)	(10 ⁶ Baht)
Chachoengsao	2,200	II	12,825	17,633
Chonburi	3,041	II	"	24,373
Rayong	2,634	II	"	21,111
Chanthaburi	965	II	"	7,734
Total	<u>8,840</u>			<u>70,851</u>

● Project Evaluation

(26) On the basis of the estimated economic cost and benefit by province, the EIRR has been worked out for the four (4) provinces. The economic indicators including the net present value and benefit cost ratio which have also been calculated by province are summarized as follows.

Items	Province	(%)				
		CS	CN	RY	CT	Overall
1. EIRR		8.9	12.3	9.8	11.9	10.8
2. B/C Ratio						
a) discount rate	8	1.09	1.42	1.19	1.34	1.27
b) discount rate	10	0.90	1.20	0.98	1.15	1.07
c) discount rate	12	0.74	1.02	0.82	0.99	0.90

● Implementation Organization

(27) For the completion of such a huge area for land conservation, strengthening the DLD organization is indispensable, namely

- 1) TIC (Technology Introducing Center) should be established in DLD Headquarters in Bangkok to collect data and information on land and water conservation technology, and technical standards, etc.
- 2) LWCC (Land and Water Conservation Center) should be established in Chonburi Province to carry out planning,

design and implementation of the project in the Eastern Region.

- 3) LWCS (Land and Water Conservation Station) should be established in each province to carry out the supervision of the project implementation, operation and maintenance, monitoring and agricultural extension of the Project.

3. FEASIBILITY STUDY (F/S) OF 16 PILOT AREAS

• Selection of Pilot Areas

(28) The 16 pilot areas were selected with parameters of topography, soil, crop and climate based on the soil erosion classification of the B/P. One pilot area is approximately 50 - 250 ha in size.

Chachoengsao	4 sites	Rayong	5 sites
Chonburi	5 sites	Chanthaburi	2 sites

• Development Grade

(29) Development grade is classified into the following 3 classes which are adopted according to the field condition as well as farmers ability to pay.

Class	Grade	Soil Loss Prevention	Unit Cost
		(%)	(Baht/rai)
Plan I	High grade	90	16,800
Plan II	Medium grade	85	12,800
Plan III	Common grade	80	7,500

• Project Cost

(30) Project cost and other conditions of each pilot area are shown in the next table. The lowest project cost is 4,184 thousand Baht in CS NO.5 and the highest one is 23,108 thousand Baht in RY NO.2 and the total project cost for the 16 pilot areas is 169,692 thousand Baht.

Province and Pilot Area NO.	Area	Soil Loss Volume	Class	Project Cost	EIRR
	(ha)	(ton/ha/yr.)		(000 Baht)	(%)
Chachoengsao					
CS NO.3	186.9	63.8	Top urgent	7,473	8.5
NO.4	79.0	16.8	Necessary	8,097	8.3
NO.5	92.0	34.7	Urgent	4,184	8.1
NO.8	115.5	34.7	"	6,318	8.2
Chonburi					
CN NO.1	94.4	41.1	Urgent	12,741	8.3
NO.2	116.8	75.3	Top urgent	9,075	18.6
NO.4	94.1	86.9	"	6,311	9.4
NO.8	130.6	33.2	Urgent	16,104	9.3
NO.9	127.2	34.7	"	11,415	8.6
Rayong					
RY NO.1	173.7	83.2	Top urgent	8,638	9.8
NO.2	219.5	62.8	"	23,108	11.6
NO.3	96.7	167.6	"	9,638	8.5
NO.5	155.8	68.6	"	12,953	8.5
NO.7	89.9	64.0	"	7,392	8.1
Chanthaburi					
CT NO.2	143.1	142.6	Top urgent	11,789	10.8
NO.3	146.8	99.2	"	14,456	9.3
Total	2,062.0			169,692	10.1

● Project Evaluation

(31) From the result of the economic analysis, EIRR are as shown in the above table. The minimum EIRR is 8.1% of CS NO.4 and RY NO.7. Average EIRR of the 16 pilot areas is 10.1%. These EIRR values should be evaluated rather higher for this type of conservation project.

(32) Values of EIRR for the representative pilot areas are shown below.

CS NO.3	8.5 %	Plan III
CN NO.8	9.3 %	Plan I
RY NO.2	11.6 %	Plan I
CT NO.2	10.8 %	Plan II

These 4 pilot areas show a moderate value of EIRR, in other words these are appropriate for the representative pilot areas, therefore, these four representative pilot areas should be realized with top priority.

(33) It is estimated that the monetary loss from the effects of erosion in the four representative pilot areas under without project conditions is 12,000 Baht per hectare per year (1,920 Baht/rai/year). This is reduced to 1,885 Baht per hectare per year (302 Baht/rai/year) under with project conditions. This reduction is not all included in farmers' benefit but is deemed to be a benefit to the whole country in resources conservation.

Based on the Project evaluation, maximum cost recovery ratio of farmers in this project is considered to be approximately 50%.

CONCLUSION AND RECOMMENDATION

1. CONCLUSION

This land and water conservation project has an important role not only to prevent the degradation of agricultural land but also to preserve the national land.

To complete this purpose it is requested that DLD's organization should be strengthened and DLD should act as coordinator of government agencies concerning land and water conservation.

As the first step establishment of the Land and Water Conservation Center and operation of the 16 pilot project areas are urgently required.

2. RECOMMENDATION

JICA Study Team recommends strongly that DLD shall commence this project as soon as possible as the responsible agency of the Thai Government.

The Thai government has been promoting the soil and water conservation project centering on DLD, however, the government allocated budget is insufficient to achieve such an enormous amount of conservation work. Therefore, as a supplementary measure the Thai government should introduce international support as required due to the urgency and importance of the Project.

LOCATION MAP
SUMMARY
CONTENTS
LIST OF TABLES
LIST OF FIGURES
ABBREVIATION AND UNIT
DEFINITION OF WORDS

CONTENTS

	<u>Page</u>
Chapter 1. INTRODUCTION	1-1
1-1. General	1-1
1-2. Compilation of Reports	1-2
1-3. Members of the Study	1-3
Chapter 2. BACKGROUND	2-1
2-1. Country and Characteristics	2-1
2-2. National Economy	2-4
2-3. Agriculture	2-6
2-4. The Sixth National Economic and Social Development Plan	2-8
Chapter 3. PROJECT CONCEPT	3-1
3-1. Land and Water Conservation	3-1
3-2. Scope of the Project	3-2
Chapter 4. PROJECT AREA	4-1
4-1. Natural Conditions	4-1
4-1-1. Location and Topography	4-1
4-1-2. Meteorology and Hydrology	4-2
4-1-3. Geology and Soil	4-3

	<u>Page</u>
4-2. Socio - Economy	4-5
4-2-1. Overview	4-5
4-2-2. Population	4-5
4-2-3. Labor Force and Employment	4-6
4-2-4. Income	4-7
4-2-5. Title to Holdings and Size of Holdings	4-7
4-3. Agriculture	4-9
4-4. Infrastructure	4-11
4-4-1. Road Networks	4-11
4-4-2. Water Supply	4-11
4-4-3. Electricity	4-12
4-5. Farmers Organization	4-13
 Chapter 5. BASIC PLAN FOR LAND AND WATER CONSERVATION IN THE FOUR PROVINCES OF THE EAST	 5-1
5-1. Characteristics and Objectives of B/P	5-1
5-2. Study Area	5-3
5-3. Soil Erosion in the Study Area	5-5
5-3-1. Target and Classification of Soil Erosion Map	5-5
5-3-2. Basic Formula	5-5
5-3-3. Result of Soil Erosion Map	5-6
5-4. Soil Conservation Measures	5-8
5-4-1. General	5-8
5-4-2. Agricultural Measures	5-9
5-4-3. Mechanical Measures	5-11
5-4-4. Irrigation Facilities	5-14
5-4-5. Supporting Measures	5-16
5-5. Implementation and Project Cost	5-19
5-5-1. Implementation Plan	5-19
5-5-2. Project Cost Estimation	5-23

5-6. Project Evaluation	5-24
5-6-1. Introduction	5-24
5-6-2. Methodology	5-24
5-6-3. Economic Evaluation	5-25
5-6-4. Environmental Impact	5-26
5-7. Implementation Organization	5-27
5-7-1. Role of DLD	5-27
5-7-2. Land and Water Conservation Center	5-28
5-7-3. Implementation Organization	5-29
5-7-4. Project Management and Monitoring	5-32
Chapter 6. FEASIBILITY STUDY OF 16 PILOT AREAS	6-1
6-1. Necessity and Role of Pilot Areas	6-1
6-2. Selection of Pilot Areas	6-3
6-2-1. General	6-3
6-2-2. Selection Criteria	6-3
6-2-3. Selection of 16 Pilot Areas	6-4
6-3. Project Formulation	6-10
6-3-1. Present Condition of Soil Erosion	6-10
6-3-2. Alternative Plan of Development Grade and Classification of Pilot Areas	6-10
6-3-3. Soil Conservation Plan	6-16
6-4. Cost Estimation	6-25
6-4-1. Unit Cost and Efficiency per Unit Cost	6-25
6-4-2. Project Cost	6-27
6-5. Implementation	6-28
6-5-1. Construction Schedule	6-28
6-5-2. Construction Equipment	6-30
6-6. Project Evaluation	6-32
6-6-1. General	6-32
6-6-2. Project Evaluation	6-33

	<u>Page</u>
Chapter 7. CONCLUSION AND RECOMMENDATION	7-1
7-1. Conclusion	7-1
7-2. Recommendation	7-2

LIST OF TABLES

- Table 5.2-1 : Present and Plan of Land Use
- Table 5.3.3-1 : Erodible Area in 4 provinces
- Table 5.5.1-1 : Long Term Implementation Schedule (Tentative)
- Table 6.2.3-1 : Present General Conditions of Pilot Areas (1/4 - 4/4)
- Table 6.3.2-1 : Alternatives of Soil Conservation Plan
- Table 6.3.3-1 : Major Mechanical Measures Applied to Pilot Areas
- Table 6.3.3-2 : Gross Cultivable Area of Pilot Areas
- Table 6.3.3-3 : Effects of Soil Conservation
- Table 6.3.3-4 : Irrigable Area of 16 Pilot Areas
- Table 6.5.2-1 : List of Construction Equipment for Pilot Project (2 Crews)
- Table 6.6-1 : Summary of Economic Analysis for the Representative Pilot Areas
- Table 6.6-2 : Summary of Farm Budget Analysis for the Representative Pilot Areas
- Table 6.6-3 : Summary of Cost Recovery Analysis for the Representative Pilot Areas
- Table 6.6-4 : Summary of Economic Analysis for the 16 Pilot Areas

LIST OF FIGURES

- Figure 5.5.1-1 : 10 Year Implementation Plan
- Figure 5.7.3-1 : Organization Chart of DLD Existing and Recommended
- Figure 5.7.4-1 : Project Management and Monitoring System
- Figure 6.5.1-1 : Construction Schedule for 16 Pilot Areas

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 Yielding 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

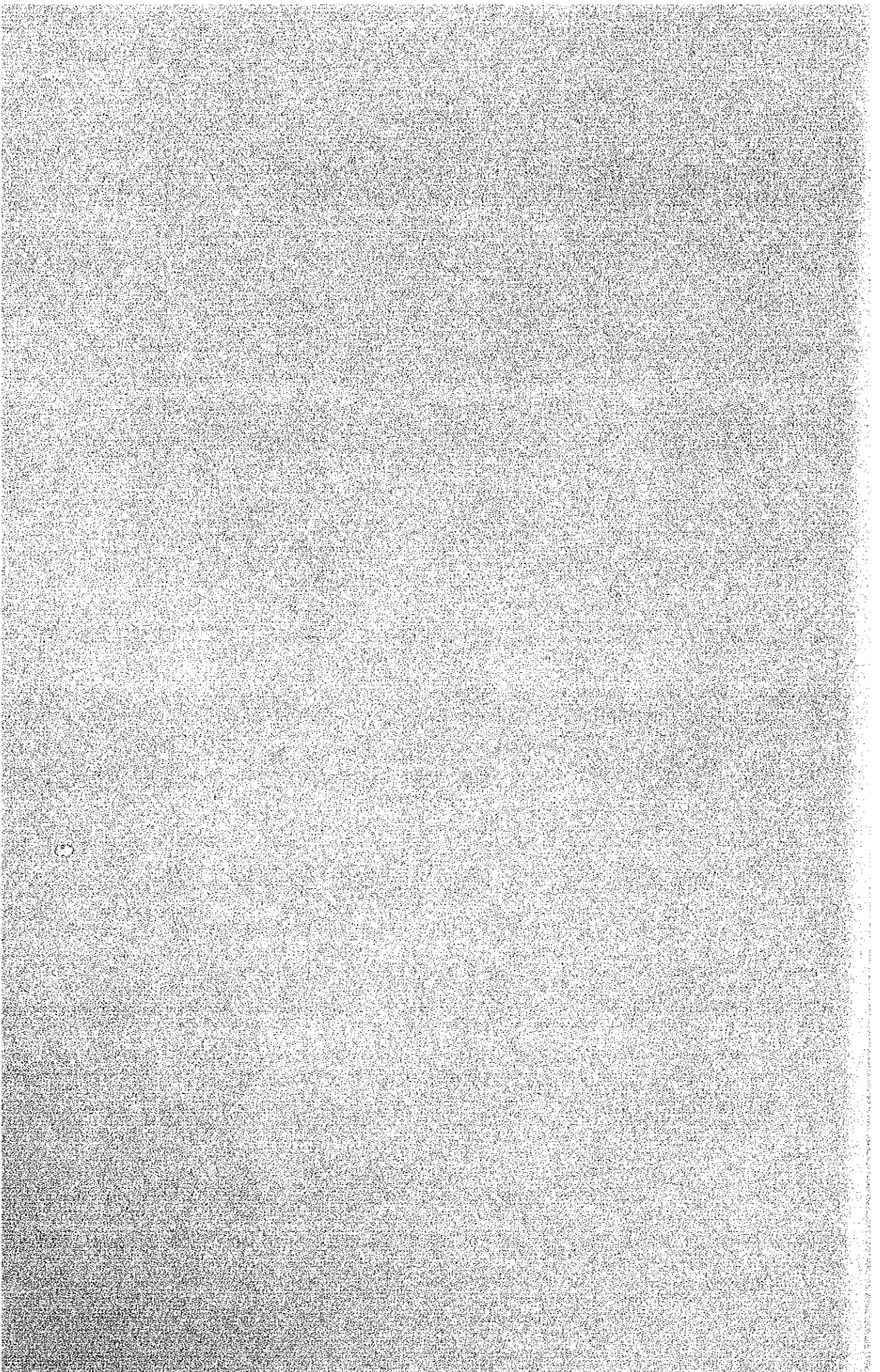
Hectare = 6.25 rais = 10,000 sq.m

Currency Equivalents (Average of March, 1988)

US Dollar US\$ 1.00 = 25.52 Baht = ¥ 128.92

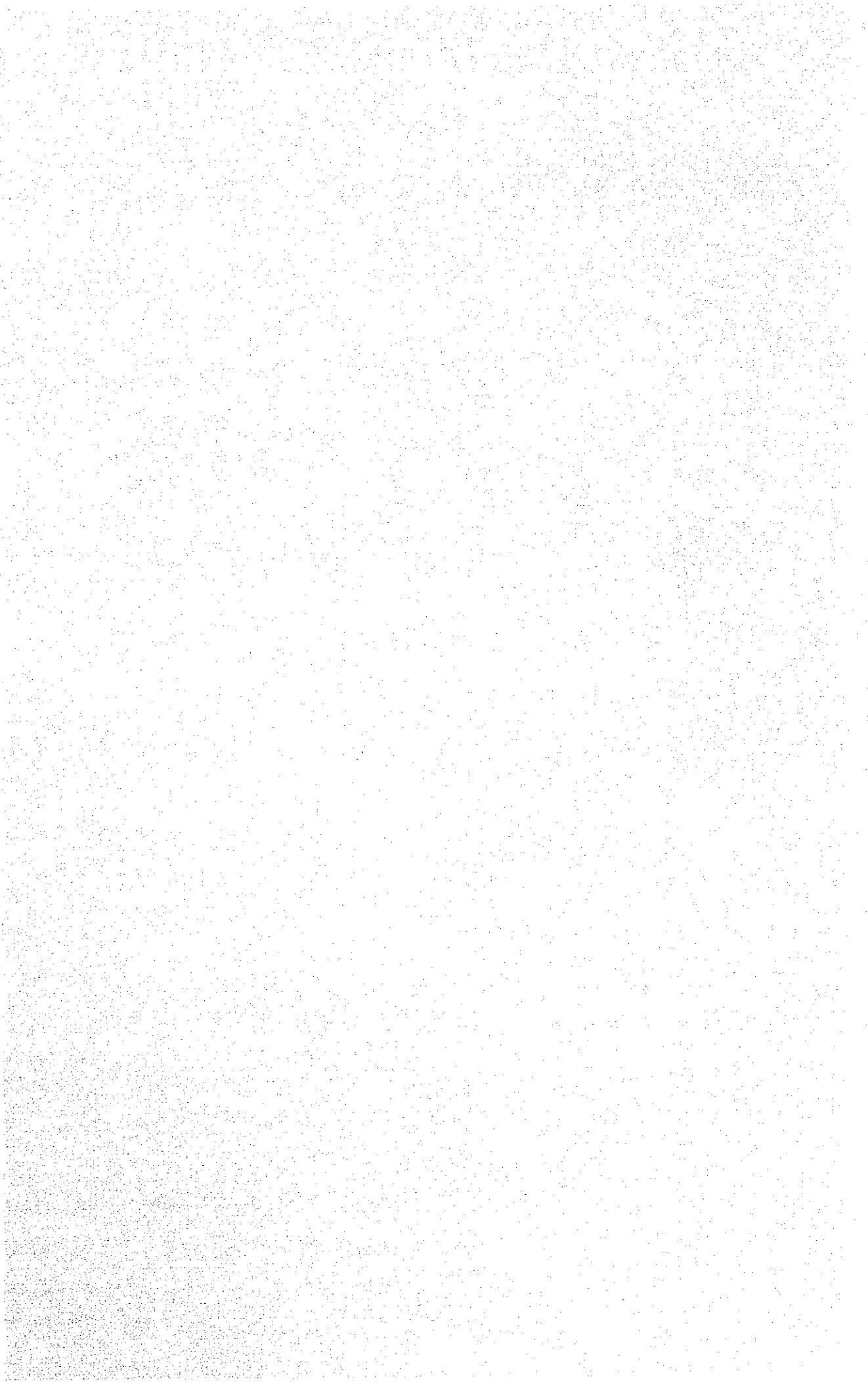
Definition of Words

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 (Chachoengasao, 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.



Chapter 1.

INTRODUCTION



CHAPTER I INTRODUCTION

1-1 General

The agreement for the Study on Agricultural Land Conservation for Integrated Rural Development in the East was concluded between the Japan International Cooperation Agency (JICA) and the Department of Land Development (DLD), Ministry of Agriculture and Cooperatives (MOAC) of Thailand on February 17, 1987. The Study is divided into two phases, Phase I and II, with each respective phase consisting of field survey works and home analysis works.

The Phase I field survey and home analysis works were carried out from September 24 to November 23, 1987 and from December 18, 1987 to January 13, 1988 respectively. The Phase II field survey and home analysis works were carried out from December 24, 1987 to March 28 and from May 14 to July 12, 1988 respectively.

For the survey and study JICA assigned and dispatched a study team composed of twelve (12) experts.

The purpose of the study is to formulate the Basic Plan for the 4 provinces and to carry out a Feasibility Study on the 16 pilot areas for agricultural land and water conservation in the Eastern Region.

As for the basic plan, the necessity of rural development in the East is understood to be as follows;

- To prevent destruction of natural resources, particularly land affected by disorderly development, through introduction of land and water conservation projects.
- To supply food and raw materials to the industrial areas, especially the Eastern Seaboard, from the rural area. This will also stabilize the farmers income and improve living standards.
- To reduce the disparity in income between the people living in the industrial and rural areas.
- To protect national security particularly in the area near the border between Cambodia and Thailand.

1-2 Compilation of Reports

This Report consists of seven (7) volumes as follows.

- Vol. I . Main Report
- Vol. II . Basic Plan for Land and Water Conservation in the 4 Provinces of the East
- Vol. III . Feasibility Study of 16 Pilot Areas
- Vol. IV . Appendix for B/P
- Vol. V . Appendix for F/S
- Vol. VI . Guideline for Planning, Design and Construction of Land and Water Conservation
- Vol. VII . Drawings

1-3 Members of the Study

This Study has been successfully completed with DLD's cooperation.

The JICA Study Team wishes to express their deepest gratitude to Director General Mr. Sanarn Rimwanich and all his staff at DLD.

Members of the JICA Study Team and the DLD Counterparts are listed as follows.

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5. Mr. Yoshiyuki MORIMOTO	Topography & Geology
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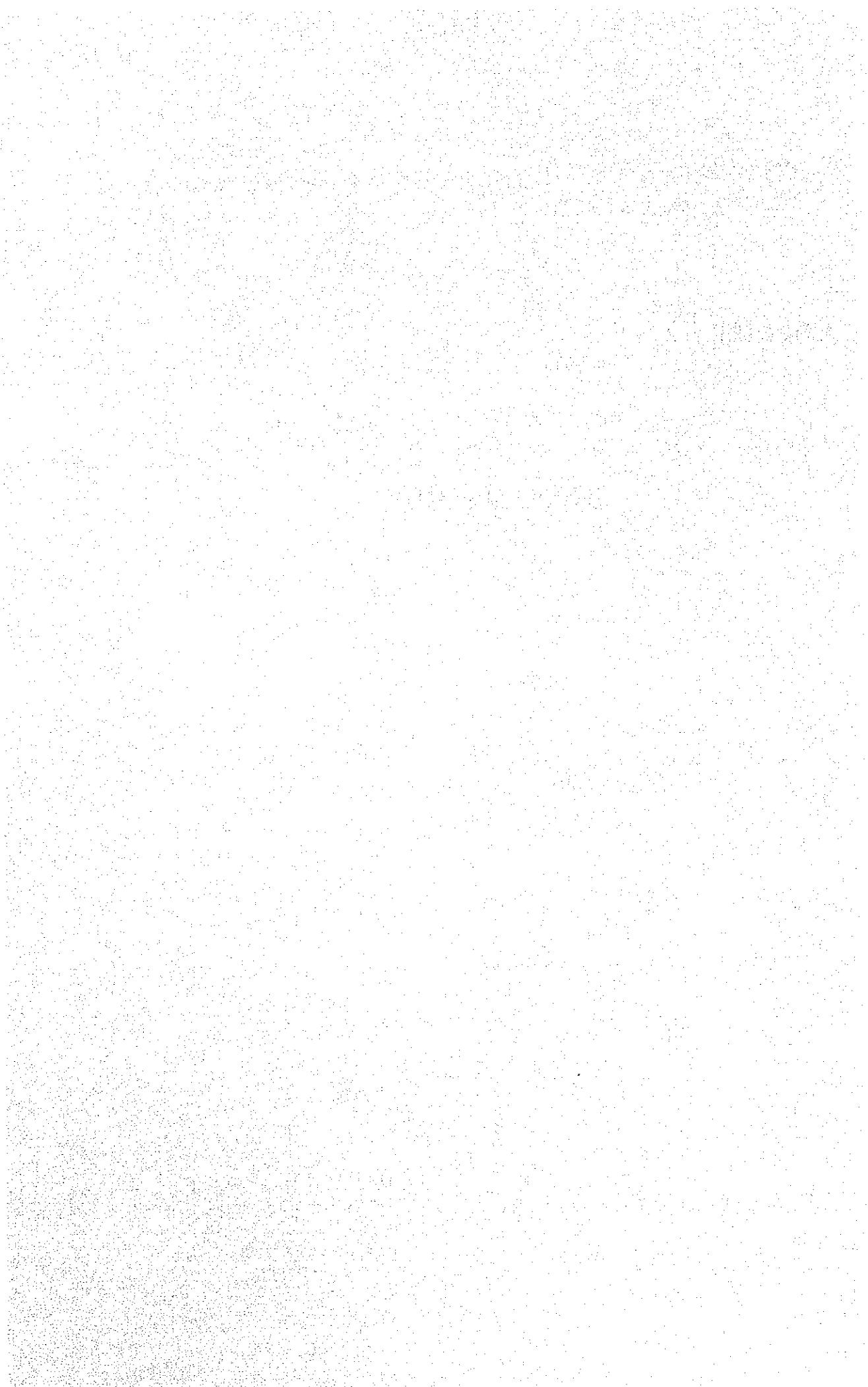
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| 27. Mr. Montri Leignsakul | Soil Survey and Land Classification |

Chapter 2.

BACKGROUND



CHAPTER 2 BACKGROUND

2-1 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 by its topographic feature and geographic structure, namely the northern mountainous region, the northeastern plateau region, the central plain region, the eastern seaboard 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 for farmland.

(2) Northeastern plateau region

This region mainly consists of highland 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. As a result, 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 Chao Phraya, 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 Phraya river basin, high yielding rice cultivation in dry season 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.

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.

2-2 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 agricultural 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 dollars 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 agricultural 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 cultivation of 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 import substitution based on 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.

2-3 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 40% of the national area and on the contrary the forest area has declined from 40% to 29%.

Out of the reduction in forest area of 5,770 thousand hectares, 25.6% or 1,475 thousand hectares are 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 comparison with 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 percentage of 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.

2-4 The Sixth 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 have been established in 98% of the Tambons and basic public health clinics in 98% of the country's villages.

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

- 1) slowing down of the economic rate of growth
- 2) increase in the labor force population and lack of employment opportunities
- 3) deficit in trade and finances
- 4) increase of the congestion in the capital area and regional disparity
- 5) deterioration of natural resources and environment
- 6) 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 in the past and imminent problems in future, 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. Out 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.

Since 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 230.9 million rais or 72.0% of the total area of 320.7 million rai was covered by forests in 1961. In 1985, data derived from Landsat imagery revealed that only 93.16 million rais 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 rais 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 rais or 18.75% of this area has already been encroached and will require reforestation.

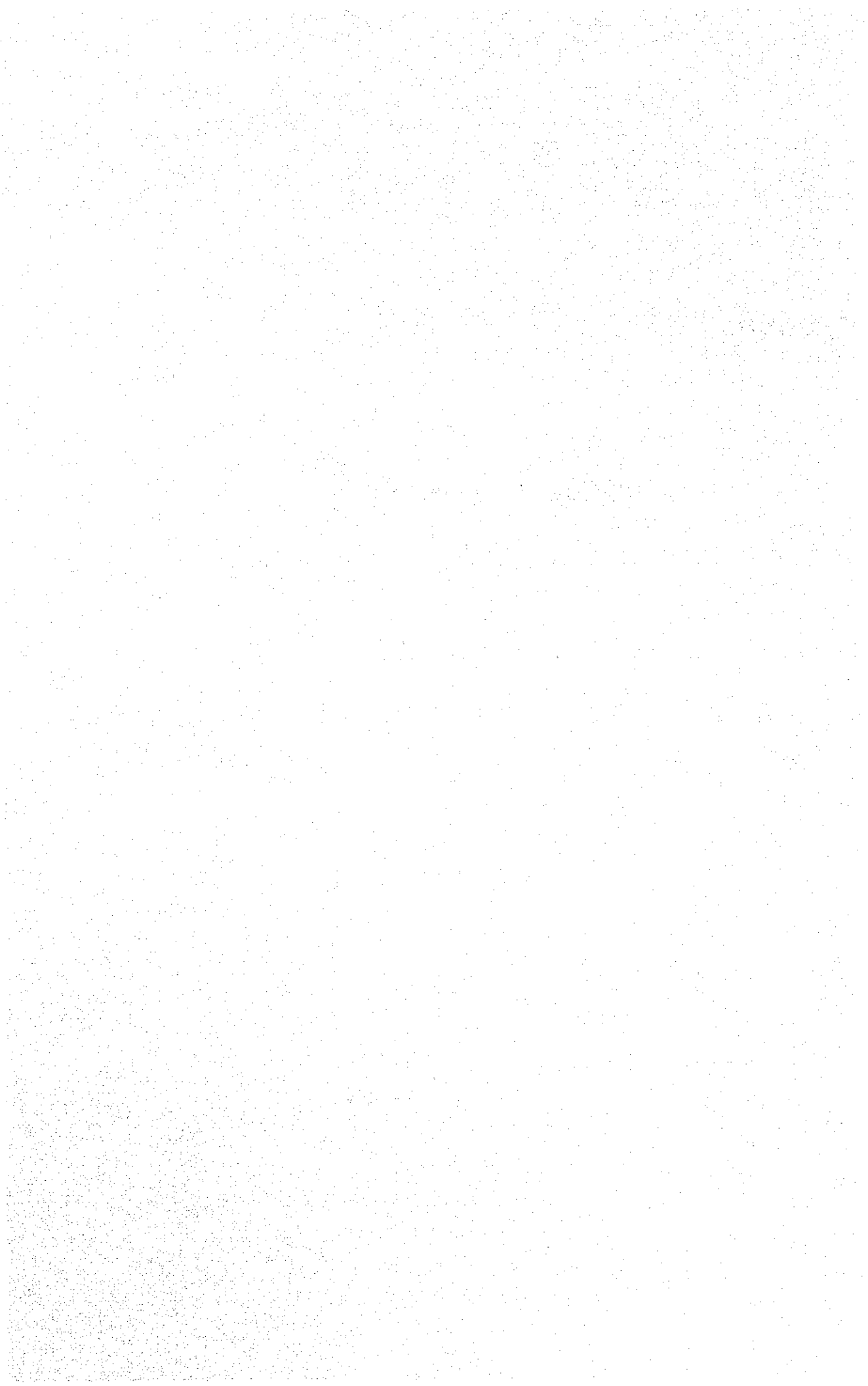
In 1987, the government through the Ministry of Agriculture and Cooperatives (MOAC) officially announced that all squatters must move out of the wildlife sanctuaries within one year as the first step toward forest conservation.

- 2) Commercial Forest - this area covers approximately 80 million rais 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 a) to demarcate and provide the location of encroached forest areas, b) to explain procedures for investment and c) to outline the opportunities for marketing of timber produced. The Government is also preparing of 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 rais annually.

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

Chapter 3.

PROJECT CONCEPT



CHAPTER 3 PROJECT CONCEPT

3-1 Land and Water Conservation

As mentioned in Chapter 1, land conservation is an important problem for the Thai government to prevent destruction of natural resources, particularly affected by disorderly development, through introduction of land and water conservation projects.

However, in the case where land conservation is the core of the project, benefit calculation is a perplexity. The economic benefit of national land conservation which can be calculated monetarily is small but even if the internal rate of return is low it must be implemented as a national project. In this relation, evaluation will not be limited to only the internal rate of return, but other indirect benefits will be given careful consideration in carrying out an overall evaluation. In this respect, the farmer's burden will be eliminated from project costs which shall come only from government funds.

On the other hand, there are several organizations related to land conservation and rural development. Government ministries and agencies include the Ministry of Agriculture and Cooperatives (MOAC), the Ministry of Interior, the Prime Minister's Office, etc. The main ministry is the MOAC and starting with DLD the following agencies also participate; Royal Irrigation Department (RID), Royal Forestry Department (RFD), Cooperative Promotion Department (CPD), Department of Agriculture (DA), Department of Agricultural Extension (DOAE), Agricultural Land Reform Office (ALRO) and Office of Agro-economics (OAE).

In order to promote the project and coordinate various ministries and departments, DLD should be the most suitable organization. However, this does not mean that DLD must carry out the project alone. The project shall be implemented by each agency according to its allotted task.

3-2 Scope of the Project

Scope of the project is basically according to the Scope of Work for the Study agreed upon between DLD and JICA on February 17, 1987. The scope of the project can briefly be explained as follows.

(1) Classification of land conservation area

- At first, the upland field which requires land conservation works is classified in the project area. Necessity of conservation works is classified into five categories namely top urgent, urgent, necessary, normal and not necessary.
- Simultaneously, actual conditions of the rural area and agriculture are surveyed in the 4 provinces for the study of integrated agricultural development.
- At the same time, natural conditions for farming such as meteorology, hydrology, soil, topography, etc. are surveyed for preparation of planning and design.

(2) Study of conservation works

- For calculation of soil loss volume, the Universal Soil Loss Equation (USLE) shall be applied.

$$A = R \cdot K \cdot Ls \cdot C \cdot P$$

Where A : Total Soil Loss Volume (ton/ha/year)

R : Rainfall Factor

K : Soil Erodibility Factor

Ls : Slope and Slope Length Factor

C : Crop Management Factor

P : Soil Conservation Measures

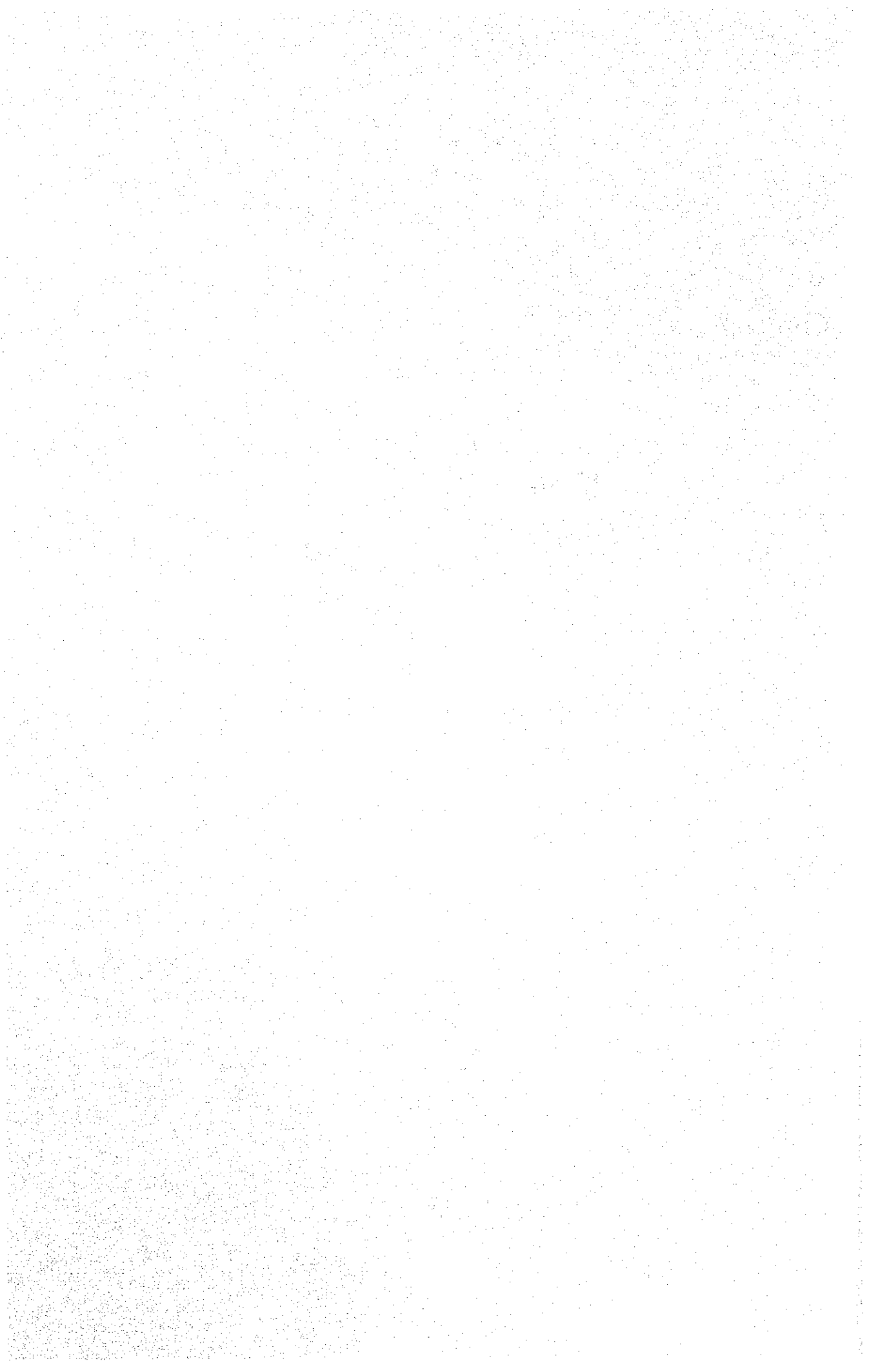
- Following four conservation measures may be adoptable to the project area namely agricultural measures, mechanical measures, irrigation facilities and supporting measures, while it is most effective that these four measures should be adopted comprehensively. To get more effective results, it is much better to adopt rural development works with conservation works intensively.

(3) Implementation

- Land and water conservation projects are not productive works as such, therefore, the major parts of conservation projects should be done as a public project.
- Land and water conservation projects shall be carried out by the government agency in principle. In the Thai government, however, there are many agencies related to land conservation works, and each agency has its role and responsibilities. In case of implementation of big conservation projects, this system may sometimes interrupt smooth execution. Therefore, an implementation organization and coordinating agency shall be considered in the study.
- Each region has its natural condition concerning land conservation, therefore, some regional organizations for land conservation implementation may be needed. This matter has been considered in the study.

Chapter 4.

PROJECT AREA



CHAPTER 4 PROJECT AREA

4-1 Natural Conditions

4-1-1 Location and Topography

(1) Location

Project area is located in four (4) provinces of the Eastern Seaboard Region. Total project area of 15,247 sq.km occupies the whole province of Chachoengsao, Chonburi, Rayong and approximately the western one third of Chanthaburi, whose areas are 5,351 sq.km, 4,363 sq.km, 3,552 sq.km, and 1,981 sq.km respectively.

In the project area there are 884,000 hectares of planning area of which 716,200 hectares require land conservation works.

(2) Topography

- 1) Topographic characteristics can be roughly classified into 3 types, namely, flat plain, monadnocks and younger high terraces. Most of the candidate areas are situated in a flat but somewhat undulated zone with elevation ranging from 50 to 100 m.
- 2) The topographical characteristics are closely related to the geological structure. In the Eastern Region, tertiary members are lacking, so old rocks such as Mesozoic group have been exposed to the air for a very long time. This fact shows that various agents of weathering, erosion and deepening continued during this long geological period, so that the original high mountains were progressively destroyed, topographically dissected and flat plain was formed.

4-1-2 Meteorology and Hydrology

(1) Meteorological characteristics

Thailand's climate is divided into three kinds of climatic regions, namely tropical rain forest climate (Af), tropical savanna climate (Aw) and tropical monsoon climate (Am), by Koppen'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.

Each characteristic of these seasons is made clear by the average of rainfall, temperature and relative humidity over a 30 year period. According to the results of the analysis of these figures, climatological characteristics are mentioned as follows.

- 1) The isohyetal map of annual rainfall and monthly rainfall shows that September is the rainiest month and December 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. 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 shows that average monthly temperature in April, August and December 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, shows that September is the highest and March is the lowest. As can be seen from this 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 the Eastern Region. The Bang Pakong has the largest basin at 17,000 km² (7,400 km² within the Study Area). 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.

4-1-3 Geology and Soil

(1) Geology

- 1) Rocks and deposits in the candidate pilot areas are geologically classified into 3 types, every geological type has characteristics of erosion as shown below;

Geology	Erosion
i) decomposed granite (very coarse sand)	very severe erosion
ii) terrace deposits (sand, gravel, clay)	moderate --- severe
iii) weathered soil (derived from bedrock)	severe

- 2) There are several shallow wells in the pilot areas situated near the top of streams. Their catchment areas are very small, therefore, streams and shallow wells occasionally dry up during the dry season. Although such water resources are very limited,

they are very important as they are used for domestic supply in many places.

(2) Soil

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, Uduults, Ustults are found in the East. Aquults are somewhat poorly drained soils occurring on flat terraces and are used as paddy fields. Uduults 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 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.

4-2 Socio-Economy

4-2-1 Overview

Out of the four provinces located in the Study Area, only Chachoengsao has not shown a decline in its per capita Gross Provincial Product (GPP) during the five year period from 1981~1985. At current market prices the average annual percentage of increase in the GPP of each province over the same period was; Chachoengsao 14.77%, followed by Rayong at 10.29%, Chanthaburi at 3.67% and Chonburi at 3.14%. During the same period the Eastern Region's GRP grew at an average annual rate of 6.32%.

The total GPP of the four provinces was 82.0% of the Eastern Region's GRP in 1981 and 81.3% in 1985. Chonburi's GPP is of special interest since during the period it has continually produced 40-50% of the Eastern Region's GRP and has on average been 1.4 times that of the total GPP of the remaining three provinces in the Study Area. Chanthaburi's per capita GPP has been nearly 30% lower than the other 3 provinces on the average over the period and less than half of that of Chonburi.

4-2-2 Population

In 1985 approximately 65% of the Eastern Region's population lived in the four provinces of the Study Area with the largest population in Chonburi followed in order by Chachoengsao, Rayong and Chanthaburi.

In 1985, Chachoengsao, Chonburi and Chanthaburi received an influx of population which was greater than the natural (birth/death) population growth (Chachoengsao 8,604-6,805, Chonburi 13,924-12,381, Chanthaburi 9,134-6,654), and Chachoengsao and Chanthaburi had more new inhabitants than births. In the same year, Rayong's total population increase of 12,592 persons consisted of 6,143 new inhabitants or 47.4%. Out of the 66,457 persons moving into the Eastern Region in 1985, a total of 37,805 persons or 56.9% settled in the four provinces of the Study Area.

Population of 4 provinces in 1985 are shown below.

Chachoengsao	525,717
Chonburi	806,396
Rayong	418,814
Chanthaburi	390,348
Total	2,141,275

4-2-3 Labor Force and Employment

According to the Population and Housing Census conducted by the National Statistical Office in 1980 the four provinces in the Study Area employed a labor force (economically active population 11 years of age and over) of 919,926 persons or 64.7% of the Eastern Region's total.

The total number of persons employed and the number and percentage of persons employed by the agricultural sector was as follows;

Province	Employed persons	Agri-sector (%)
Chachoengsao	232,398	165,599 (71.3)
Chonburi	334,961	172,246 (51.4)
Rayong	181,351	128,699 (71.0)
Chanthaburi	171,216	121,317 (70.9)

4-2-4 Income

Average income per farm household in the four provinces of the Study Area was 1.65 to 1.82 times greater than the average for the whole Kingdom in Crop Year 1982/83. Off-farm income in monetary terms was greater than the average of 13,961.86 Baht for the whole Kingdom by 3,524.52 Baht in Chachoengsao, 5,556.46 Baht in Chonburi, 1,956.71 Baht in Rayong and 559.93 Baht in Chanthaburi.

The main source of farm income for each of the four provinces was as follows;

Province	Crop	Income (Baht)
Chachoengsao	rice	20,345.94
Chonburi	cassava	19,005.66
	sugarcane	14,536.16
Rayong	cassava	28,110.99
Chanthaburi	fruit	16,678.05

4-2-5 Title to Holdings and Size 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.

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.
- 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 rais per household, any additional land being

cultivated contiguous to the STK holding may be leased from the RFD.

- 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 holdings in areas which were formerly National Forest Reserves of up to 50 rais per household.
- 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.

(2) Size of holdings

The majority of farm holdings in the four provinces of the study area as of 1983 are in the range of 10~39.9 rais in size.

But farm holdings of more than 40 rais 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.

(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. Out 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.

4.3 Agriculture

(1) Cultivation

Agricultural land-use in the Project Area, viz., CS, CN, RY, provinces and the western part of CT province in 1985 are as shown below.

<u>Province</u>	<u>Rice</u>	<u>Upland Crop</u>	<u>Tree Crop</u>	<u>Others</u>	<u>Total Area</u>
CS	1983 (km ²) (37%)	1974 (37)	30 (1)	1364 (25)	5351 (100)
CN	668 (15)	2357 (54)	180 (4)	1158 (27)	4363 (100)
RY	297 (8)	2233 (63)	646 (18)	376 (11)	3552 (100)
CT (western part)	106 (5)	718 (36)	392 (20)	765 (39)	1981 (100)

Whole Country	(23)	(10)	(4)	(63)	(100)

Judging from these figures, it is possible to say that the project area is mainly upland crops area and the eastern two provinces, Rayong and Chanthaburi are tree crops areas as well.

In upland crops, cassava is the most important and its production is as much as 28% of that of the whole country. Though it remains the most adaptable crop to the area, it is going to be replaced by other crops such as Para rubber or fruit trees under the policy of crop diversification.

Pineapple and sugarcane are also important upland cash crops in the area and their production is 32% and 15%, respectively in recent statistics.

As for fruit tree crops, durian, rambutan, mangosteen and mango are most popular and their production have very high shares in that of the whole country. Para rubber is also an important tree crop in the area especially in RY and CT provinces since they have more rainfall resulting in higher production than other provinces.

The production of Para rubber is 12% following the 88% of the South and it has been promoted as the main crop in the crop diversification policy.

Details of these crops' production are shown in Vol. IV.

(2) Farm management

Judging from the present environmental condition, agriculture in the project area is well adapted to the surroundings but for improving living standards and to follow the national crop diversification policy, there are some conditions to be improved.

1) Water

The precipitation in the area is sufficient during ordinary years but due to topographical or geological conditions rainfall is not being utilized efficiently. If it is possible, higher levels of production, crop intensity or crop diversification are expected.

2) Soil

Generally speaking, the soil property in the area is sandy and fertility is very low. It is also erodible by torrential rainfall during the rainy season. To prevent erosion and maintain or improve soil fertility is the principle of crop production in the East.

3) Fertilizer

Thailand is famous for less application of chemical fertilizer in the world. Improving soil fertility in the tropics is a very difficult problem and it is necessary to apply enough fertilizer to achieve high yield. According to the survey carried out in the study period, cassava production depends on the amount of fertilizer applied with correlation of 0.8. Elimination of the obstacles for that is urgent for higher production.

4-4 Infrastructure

4-4-1 Road Networks

The density of highways in the project area is 114.1 m/km² compared with 86.1 m/km² in the whole country.

As a case study Rayong province was picked concerning the density of rural roads.

Constructed roads by various agencies are as follows; as of 1987

<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		0.785 km/km ²

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

However, farm road networks in each province, which have a very important role for crop production, are in extremely poor condition.

4-4-2 Water Supply

It can be said that the existing condition of the village water supply in the area and in the pilot areas is under serious condition especially water sources for agricultural use.

52 percent of the total number of villages in the study area are under the worst conditions.

The soil conservation project with small scale water resource development will contribute to solving this problem.

4-4-3 Electricity

According to the data from the PEA, electrified rate of the total number of villages in the Study Area as of 1987 is 82.4% in Chachoengsao, 95% in Chonburi, 86% in Rayong and 92% in Chanthaburi. On the other hand the pilot areas show a much lower rate.

The reason why a lot of farm houses have been left from electrification is that the farm houses are scattered. Then the cost of wiring becomes high, which they cannot burden.

4-5 Farmers Organization

(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). Provincial and district level CPD activities should be strengthened to increase the farmer's awareness of programmes available to him.

(2) Farmers' association

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

Out 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.

(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.

(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 popular activity supporting farmers in financial aspect.

The results of the Farm Survey reveal that 47 of the 123 or 38.21% of the households interviewed are clients of the BAAC.

