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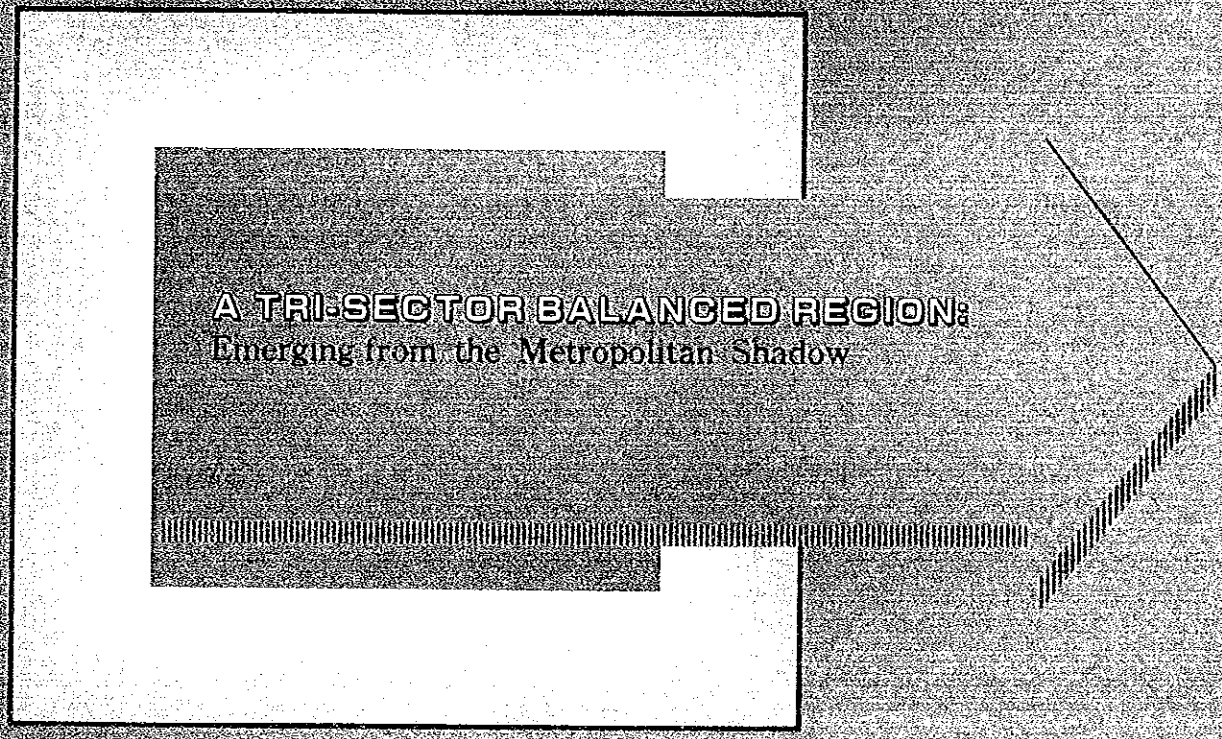
THE ROYAL THAI GOVERNMENT
NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD

UPPER CENTRAL REGION STUDY

SECTOR REPORT Vol. 3: ENVIRONMENTAL MANAGEMENT



FINAL REPORT NOVEMBER 1990

JAPAN INTERNATIONAL COOPERATION AGENCY

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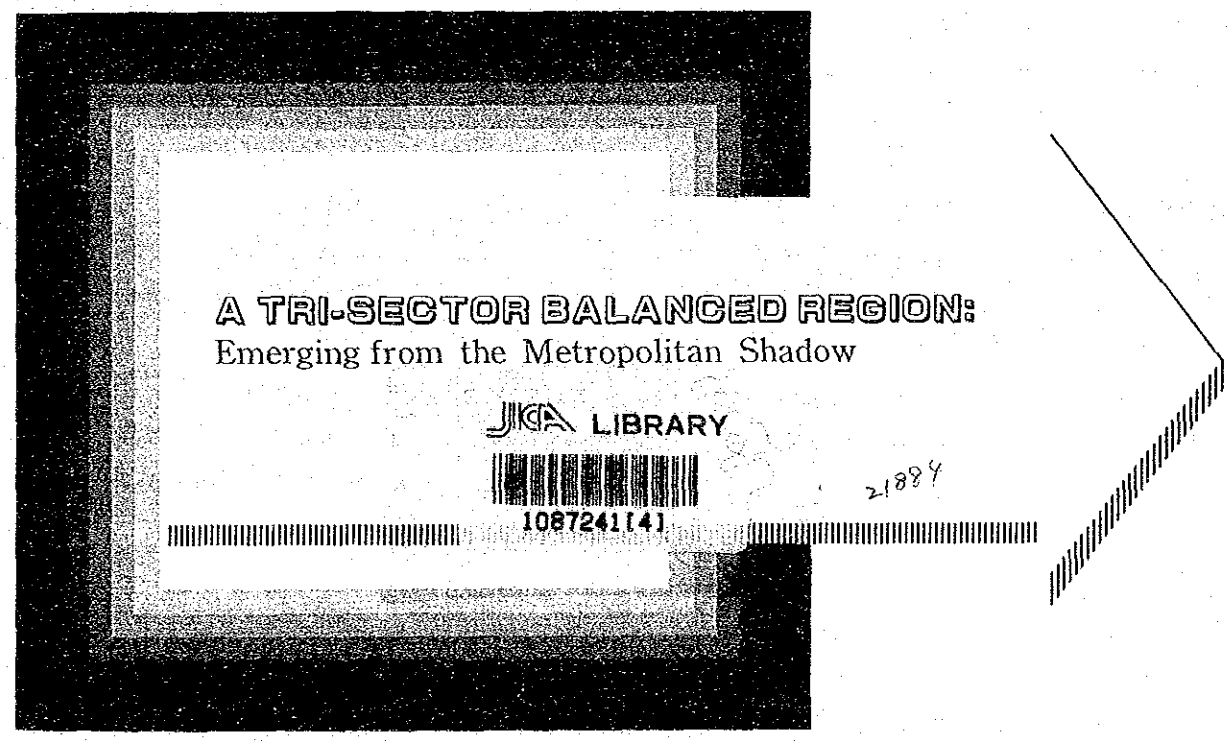

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Japanese Government decided to conduct the Upper Central Region Study and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Jinichiro Yabuta, and composed of members from International Development Center of Japan and Pacific Consultants International Inc., from December 1988 to July 1990.

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

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

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

November 1990

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

ACKNOWLEDGEMENT

The impetus for this study was the intention of the Royal Thai Government to revitalize the Upper Central Region (UCR), which had been stagnant under the shadow of the growing Bangkok Metropolitan Region (BMR). The rationale was the need to adjust the agricultural-based economic and spatial structure of the UCR to the rapidly industrializing national economy, and thus to create the tri-sector balanced economy (agriculture, industry and services) in this region.

The main task of this study was to examine whether, and in what way, the UCR could respond to the national intent. The results of the study thus far are summarized in this report and suggest that the UCR will play an important role in the following aspects:

- Retaining the strategic agricultural and forestry space for food self-sufficiency and disaster control

- Decentralizing the BMR systematically for the economies of scale to be maintained

- Developing the agricultural-industrial linkages for high value resource utilization and diversified rural nonfarm employment opportunities

Under the proposed strategies above, the Study Team recommends the incorporation of four priority project packages, which include an Integrated Pasak River Basin Development, Agro-Industrial Linkage Development, the Greater Sara Buri Industrial Core (GSIC) Development, and Human Resource Development.

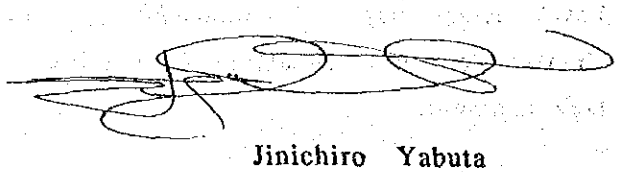
In order to be useful, these strategies need to be supported by continuous improvement in development administration. This effort for the UCR could accelerate an overall reform of regional development administration in Thailand, because the UCR is an early region which will address itself to the growing national need of balancing industry against

agriculture, development against environmental considerations, and urban development against rural development. Bearing this in mind, the Study Team recommends improvements in conventional development administration, with a focus on water resource management, environmental management, and urban management.

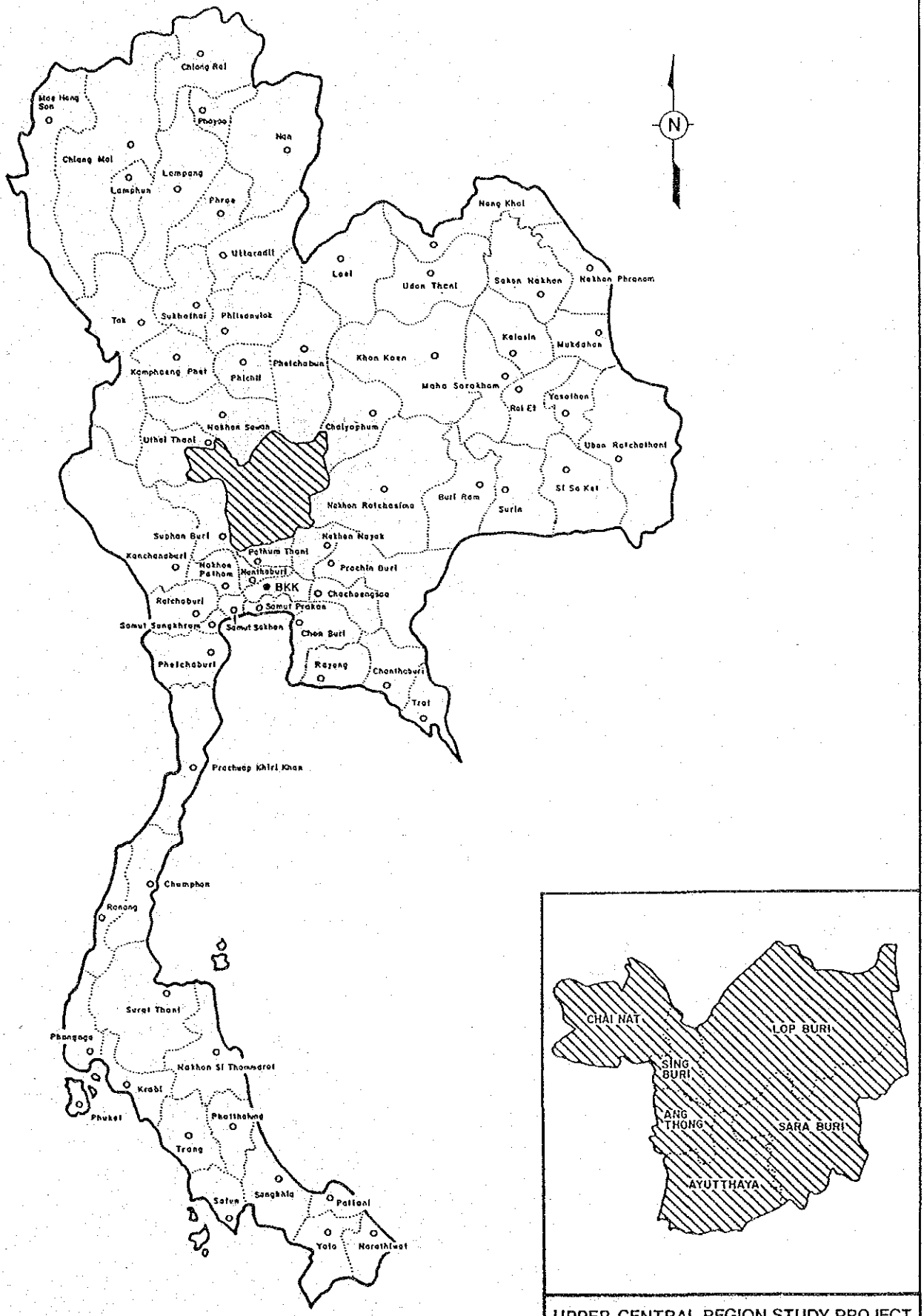
The Study Team acknowledges that its study has been guided by many past studies, such as the Bangkok Metropolitan Region Study by the National Economic and Social Development Board (NESDB), the Upper Central Region Planning Study by the Department of Town and Country Planning, the Road Development Study in the Central Region by the Japan International Cooperation Agency (JICA), and the Rural Industries and Employment in Thailand Study by The Thailand Development Research Institute. In preparing this report, the team was supported by the staff of the NESDB, other central ministries, and local authorities in the UCR throughout its stay in Thailand for nearly fourteen months. Equally important, the team benefited a great deal from cooperation extended by the officers in charge and the advisory committee members of the JICA and other concerned agencies of the Government of Japan. The team also wishes to recognize with gratitude the contributions of the participants in the National Seminar on the Upper Central Region Development: Policies and Programs, held on 28 and 29 July 1990 in Jomtien, Chonburi, to the wide-ranging discussions on the proposals contained in the draft final report of the Study Team.

We wish to add that we sincerely hope that this report will provide an important basis for planning and implementation in the Upper Central Region of Thailand.

November 20, 1990



Jinichiro Yabuta
Study Team Leader



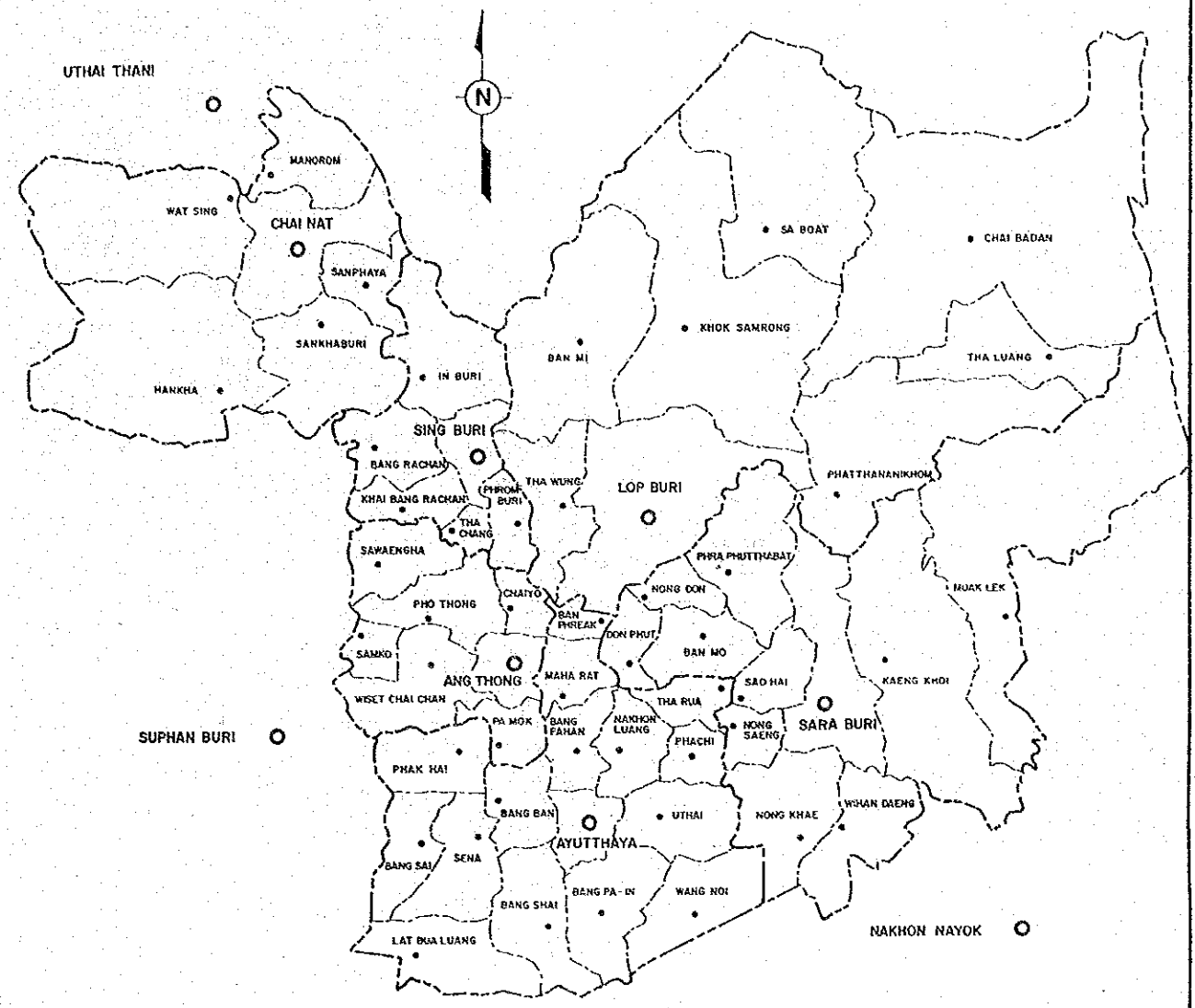
UPPER CENTRAL REGION STUDY PROJECT

SHOW:

LOCATION MAP

SCALE:

Fig.



LEGEND:

- CHANGWAT LOCATION
- AMPHOE LOCATION
- CHANGWAT BOUNDARY
- AMPHOE BOUNDARY

UPPER CENTRAL REGION STUDY PROJECT

SHOW:

ADMINISTRATIVE BOUNDARY OF STUDY AREA

SCALE:

Fig.

A Summary :
Policies and Strategies

Upper Central Region Development

Why Upper Central Region (UCR)

Toward the year 2010, Thailand will have to get through the challenges of :
(1) shifting export-led to domestic market-based growth,
(2) balancing development and environment, and
(3) smoothly transitioning rural to urban employment.

In the national space, these challenges call particularly for :
(1) decentralizing the capital region systematically, and
(2) strengthening the linkages between ESB, SSB and other parts of the country, and
(3) sustaining strategic agricultural and forestry space.

Under these national perspectives, it is the UCR that potentially plays a combined role of :
(1) National Food Supply Center,
(2) Subnational Distribution Center, and
(3) A New Inland Industrial Base,

if this region can overcome :
(1) the presently unstable rural sector,
(2) the weak urban sector, and
(3) consequent regional out-migration.

The UCR is at a crossroads between a tri-sector (agriculture, industry and services) balanced region or a mere transit region over-ridden by sporadic external industrial investments.

Development Policies & Strategies

Objectives of the UCR development are :
1. Maintaining and restoring the ecological environment,
2. Deepening and widening of regional economy, and
3. Enhancing regional human resource base to support the two objectives above.

Recommended policies and strategies are thus as follows:

Agriculture
1. Strengthen capability and willingness of rice farmers,
2. Rehabilitate upland agricultural environment, and
3. Promote linkages between production, processing and market.

Industry
1. Build-up, step-by-step, an industrial development core at Sara Buri,
2. Intensify agro-industrial linkages within the UCR,
3. Foster local entrepreneurship of potential business men, and
4. Control rapidly dispersing industries in Ayutthaya.

Services
1. Develop secondary order centers
2. Develop extensive urban, technological and managerial supporting services at sub-regional urban centers,
3. Strengthen hierarchical system of agricultural distribution, processing and transport network, and
4. Promote tourism especially at Ayutthaya, Lop Buri and Chai Nat.

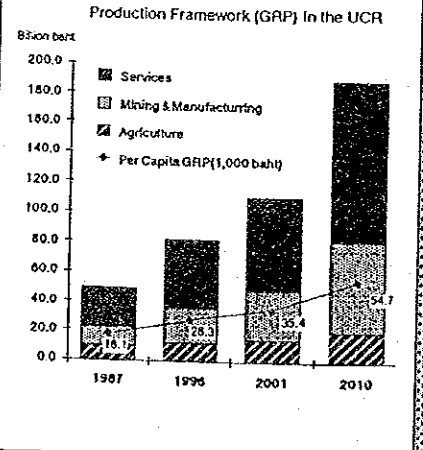
Development Target

Economic Growth: Toward 2010, it is targeted that per capita GPP growth of the UCR will be accelerated up to that of national average growth rate, 5% p.a. The GPP growth rate will be 6.1% p.a. toward 2010, and sector growth rates are: Agriculture : 1.3%; Manufacturing : 7.0%; and Services : 6.3%.

Population Growth: Population is targeted to growth at a rate of 1.0% so that the targeted per capita GPP will be attained. It will be 3.46 million in 2010, compared with 2.74 million in 1987.

Urbanization: Urban population will increase at a 2.5% growth rate, compared with 1.1% p.a between 1981 and 1987. The urban population ratio will be 37.2% in 2010.

Employments: Additional 421 thousand job opportunities will newly be created, and a total will be 1.9 million in 2010. The employments in both manufacturing and service sectors shall increase by 568 thousand, while that in agriculture sector will decrease by 147 thousand.



Profile of Upper Central Region

The Upper Central Region (the UCR) consists of 6 Changwats: Ayutthaya, Sara Buri, Ang Thong, Sing Buri, Lop Buri and Chai Nat, having the population of about 2.7 million and the area of 16,6 thousand sq. km. The UCR is located in the Chao Phraya River Basin Area, an agricultural (particularly rice) advanced region in the Kingdom, and environmentally sensitive.

The UCR is on a frontage of the expanding Bangkok economy, and has been pressured by urbanization and industrialization. Thus, the UCR is a pioneer to the national challenge of agro-industrial coexistence by widening and deepening the UCR economy. For the second generation development of the Thai economy, the UCR's gateway function would be more significant.

Key Concepts for the Upper Central Region Development

Agricultural Diversification and Agro-Industrial Linkage

In order to stabilize income of the farmers, being the leading players in sustaining agricultural and ecological environment, a must is the agricultural diversification at the farmer level. With good access to the expanding and diversifying market in Bangkok, the agricultural diversification should be supported by the intensified linkages among crop production, livestock and processing networks as well as by the improved urban and transport infrastructures.

Industrialization for A New Industrial Base

The country will call in the UCR a strong magnet as (1) one of the centers to facilitate deconcentration of Bangkok, (2) a means to prevent extensive industrial pollution and agro-industrial conflicts, (3) a base to attain agro-processing agglomeration, and (4) an inland supporting base for the Eastern Sea-Board to maximize its spread effect.

Sara Buri offers the best seat of this magnet. Local infrastructure, urban and human resource development should be integrated in timely response to ongoing and forthcoming national projects.

Gateway as A Subnational Distribution Center

The UCR is situated at the gateway of Bangkok to the North and Northeast Regions. In other wards, the UCR is in a best position to make use of development in other regions. In addition to traditional concentration of agricultural products, new transport and energy infrastructure inputs will boost various industrial and business opportunities.

Integrated Urbanization and Service Sector Encouragement

Urban and service sector encouragement is strategic to regional development especially in the UCR in order to (1) support externally dependent and thus unstable rural sector, (2) provide nonagricultural job opportunities for decelerating out-migration to Bangkok and (3) offset a missing link existing between foreign-investment-led industrial expansion and regional economic development.

Of particular importance are to meet Basic Urban Needs (BUNs), encourage local entrepreneurship and improve goods distribution functions in selected urban centers at regional level.

Human Resource Development

Focusing on (1) Middle level manpower for industries, (2) Community leaders for environmental management and (3) potential local entrepreneurs.

Environment and Water Resources Management

Special importance lies in (1) keeping the Chao Phraya River clean and conserving flood retarding areas for the survival of Bangkok and (2) maximizing water use efficiency and rehabilitating upland soils for the UCR's agriculture of national importance to be maintained. High priority should be given to (1) the integrated management of water and land use for two river basins of Chao Phraya and the Pasak and (2) the strengthened institutions at not only central but local levels to explore environmental control.

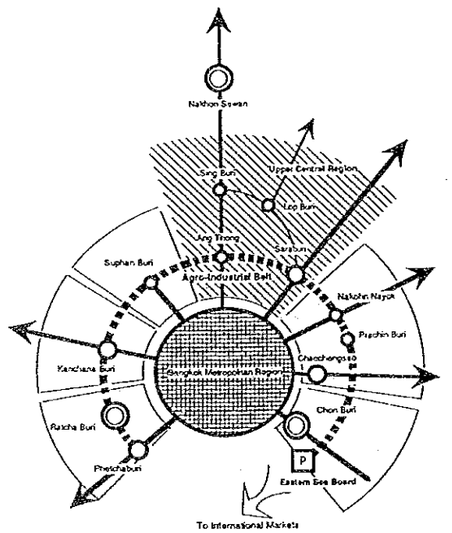
Implementation & Development Management Systems

Unlike the regional development triggered by intensive central government investments, the UCR development will need not only central initiative but effective management particularly at the local level. Of particular importance are (1) local planning system to meet the cross-boundary expansion of urban and industrial activities, (2) institutional measures to realize the scale of economy in urban services and (3) strengthened financial base of local authorities so as to encourage local initiatives in public investments and business promotion.

Spatial Setting

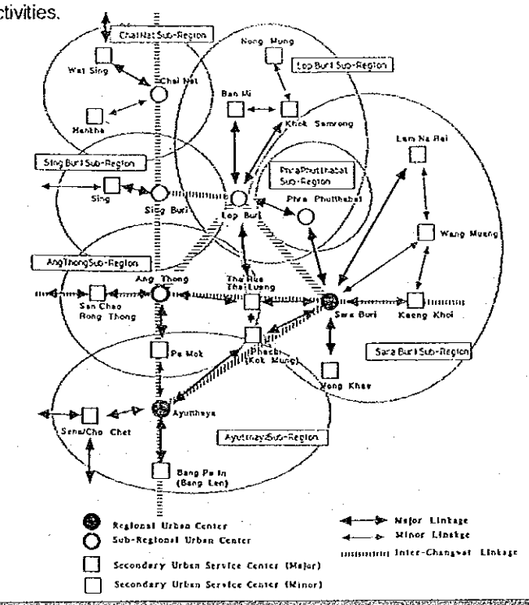
Macro-Spatial Framework

To assure effective economic links between major urban centers centering on Bangkok and the Eastern Sea-Board functions, a well organized macro-spatial network is necessary. The UCR may be situated in the Suburban Agro-Industrial Belt.



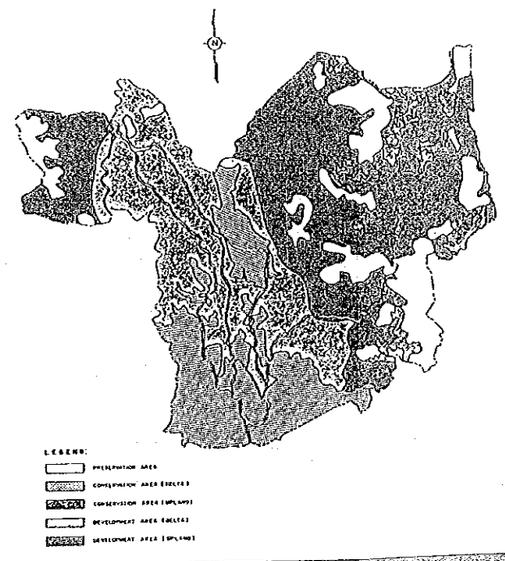
Human Settlement System

Sub-regional system with a urban center hierarchy should be formulated as a basis of regional development. This system assure relations between urban functions and their hinterland activities.



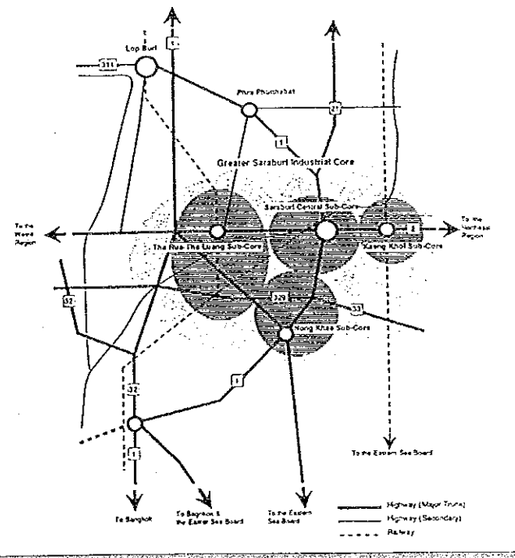
Appropriate Land Use

A clear-cut land use zoning system is essential for a balanced development with an appropriate use of natural environmental resources.



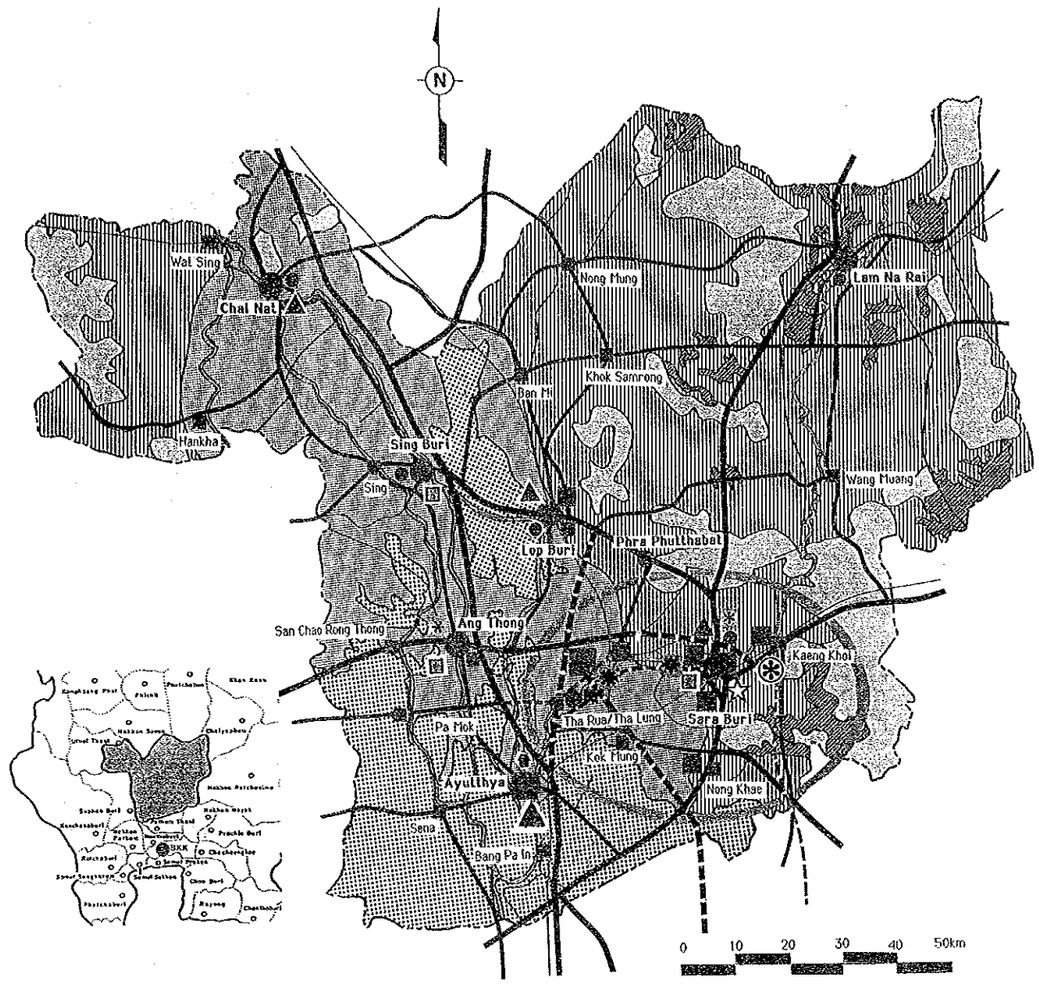
Greater Sara Buri Industrial Core (GSIC) Development

The GSIC development is recommended to receive the potential activities for industrialization and urbanization, being a new inland industrial basis linking with the sea-board development.



Development Strategies & Phasing

	1996	2001	2010
	Short-Term	Medium-Term	Long-Term
National Development			
Economy	Export-led Industrialization Back-supported by Regional Economy	Expanding Development Opportunities All Over the Country	Domestic Market Based Economic Diversification
	Strengthening Human Resource Base		
Space	Infrastructure Investments to Debottleneck Growth	Development-Environmental Balance	National Space Integration with Locally managed environment
UCR Development			
Agriculture	Reinforcing Natural Resource Base and Marketing Capabilities	Upland Development by Agricultural Diversification	Distribution/Processing Network Development
Industry	Agro-based industrialization & Local Entrepreneurship Development	Inducement of Modern & High Technology Types of Industries	Formation of Industrial Base Linked with ESB & BMR Industries
Urban & Services	Meeting Basic Urban Needs in Subregional Urban Centers		Establishing Urban Agglomeration as Business Incubator
	Tourism Development in Ayutthaya and Lop Buri	Regional Center (Sara Buri) Urban development	Inducing Higher Urban Functions, R & D, and Amenities
Key Integrated Projects			
	Integrated Pasak River Basin Development		
	Greater Sara Buri Industrial Core (GSIC) Development		
	Agro-Industrial Linkage Development		
National Management Issues			
	Environmental and Water Resource Management of Chao Phraya River Basin		
	National Land Use Zoning for Development and Conservation		
	Reinforcement of Planning and Financial Instruments for Urban Management		
	Short-Term	Medium-Term	Long-Term



Legend

Land Use Zoning
- Development Area (Delta)
- Conservation Area (Delta)
- Development Area (Upland)
- Conservation Area (Upland)
- Preservation Area

Human Settlement Center
- Regional Urban Center
- Sub-Regional Urban Center
- Secondary Major Center

Transportation & Energy
- Arterial Road (Existing)
- Arterial Road (Proposed)
- Collector Road (Existing)
- Collector Road (Proposed)
- Railway (Existing)
- Railway (Planned)
- Goods Distribution Center
- Inter-Modal Transport Facilities (Container Yard & Inland Depot)
- Energy Center

Industrial and Urban Facilities
- Industrial Estates
- Agro-Industrial Park
- Business Incubator Center
- Agro-Tech Center
- Handicraft Promotion Center
- Wholesale Food Market
- Higher Educational Facility
- Regional Medical Center
- Regional Tourism Center
- Tourism Promotion Areas
- Greater Sara Buri Industrial Core

General Development Plan 2010 in the Upper Central Region

LIST OF FINAL REPORTS

(This volume is indicated by [redacted].)

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Master Plan Report

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Vol. 4	Water Resource Management, Agricultural Development and Land Use Management
Vol. 5	Industrial Development
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LIST OF ABBREVIATIONS USED

BOD	Biochemical Oxygen Demand
BOI	Board of Investment
BOT	Built Operation Transfer
BMR	Bangkok Metropolitan Region
CAO	Changwat Administrative Office
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
NEB	National Environment Board
NGO	Non-Governmental Organization
ONEB	Office of National Environment Board
PWD	Public Works Department
R&D	Research and Development

1. ENVIRONMENTAL OUTLOOK AND FEATURES OF THE CHAO PHRAYA RIVER BASIN

1.1 Chao Phraya River Basin

1.1.1 Outlook

1) Meteorology

Thailand is a tropical country with high temperature and humidity throughout the year and with a seasonal rainfall distribution of a monsoon climate. These characteristics are shown in Fig. 1.1. Annual rainfall is from 1,000 to 1,300 mm with 60 to 90% occurring during the rainy season. The annual mean temperature ranges between 26° and 28° C. and the mean relative humidity between 70% and 75%.

2) Topography

The topography of the Chao Phraya River basin is shown in Fig. 1.2. The Chao Phraya River basin is divided into three areas: the upper, middle, and lower basins. The upper basin is mountainous and includes several valleys or sub-basins. The middle basin is the main flood retarding area and is surrounded by a large alluvial fan and terrace. The upper part of lower basin is an ancient delta and is another important flood retarding area. Other principal geologic features of the upper part of the lower basin are its alluvial fan, terrace, and mountainous areas.

3) Drainage pattern

The Chao Phraya River basin covers an area of 162,600 sq. km. which is equivalent to 32% of the total national territory. The annual average run-off from the Chao Phraya River basin is 30,300 million cubic meters (MCM). However, the actual amount of runoff fluctuates from 14,500

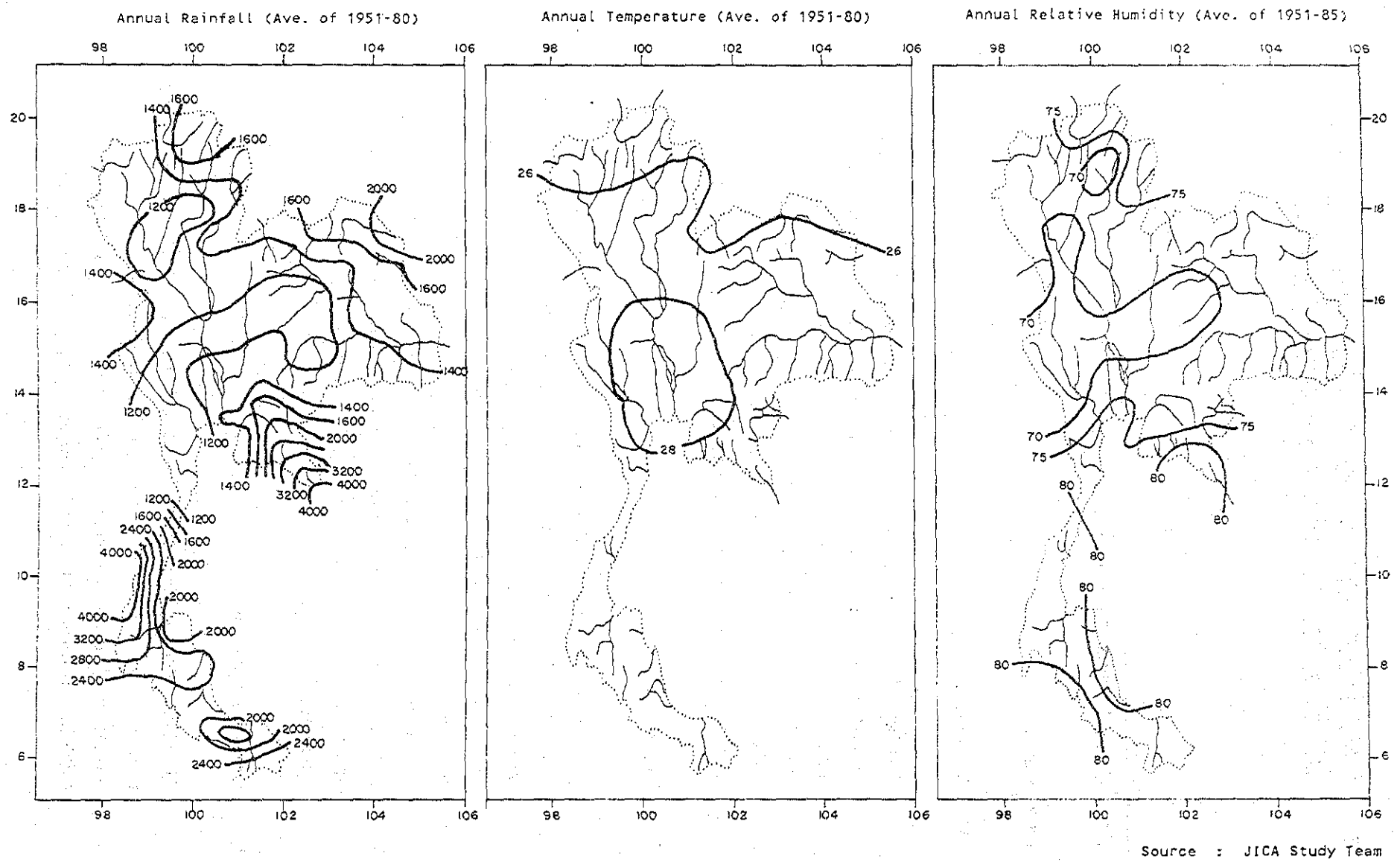


Fig. 1.1 Meteorology in Thailand

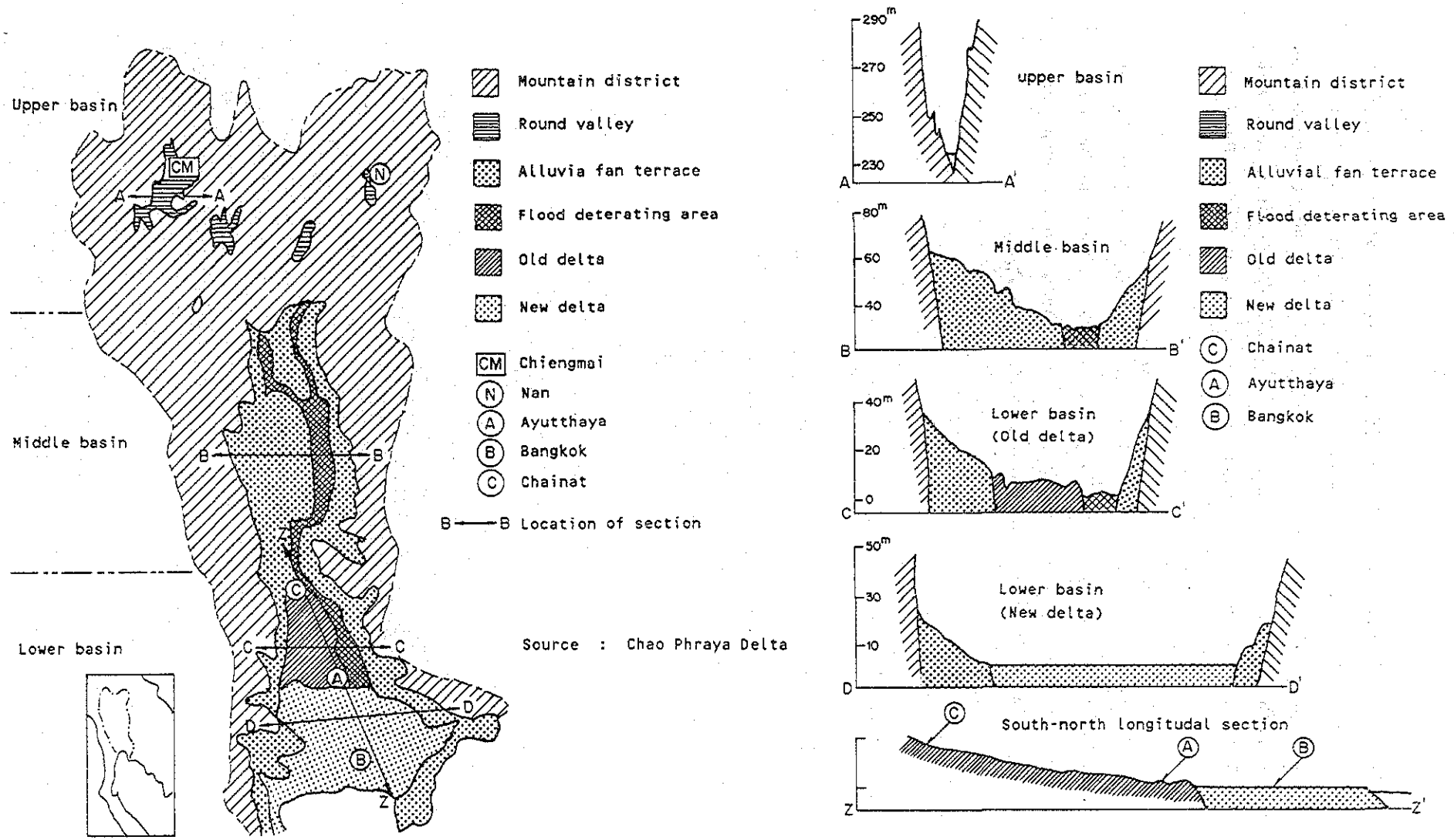


Fig. 1.2 Topography of Chao Phraya River Basin

MCM in draught years to 47,500 MCM in wet years. Water resources of Chao Phraya River basin are shown in Figure 1.3. The Ping River, Wang River, Yom River, and Nan River pass independently through the upper basin. In the middle basin, the Ping and Wang Rivers join with the Yom River at Nakhon Sawan, where they form the Chao Phraya River.

Below Nakhon Sawan, the Suphan River, the Noi River, and the Lop Buri River are tributaries of Chao Phraya River, and separate in the lower basin. The Lop Buri and Noi River rejoin at Ayutthaya and then join with the Pasak River to make up the lower Chao Phraya.

4) Soil

The soil of Chao Phraya River basin is shown in Table 1.1.

Table 1.1 Structure of Soil of Chao Phraya River Basin

Area	Typical Soil
New Delta Flood Deterrence Area	Alluvial soils
Old Delta	Non calcic brown soil Low humic gray soil
Fan	Non calcic brown soil Gray podzolic soil
Terrace	Laterite Gray podzolic soil
Mountain	Laterite

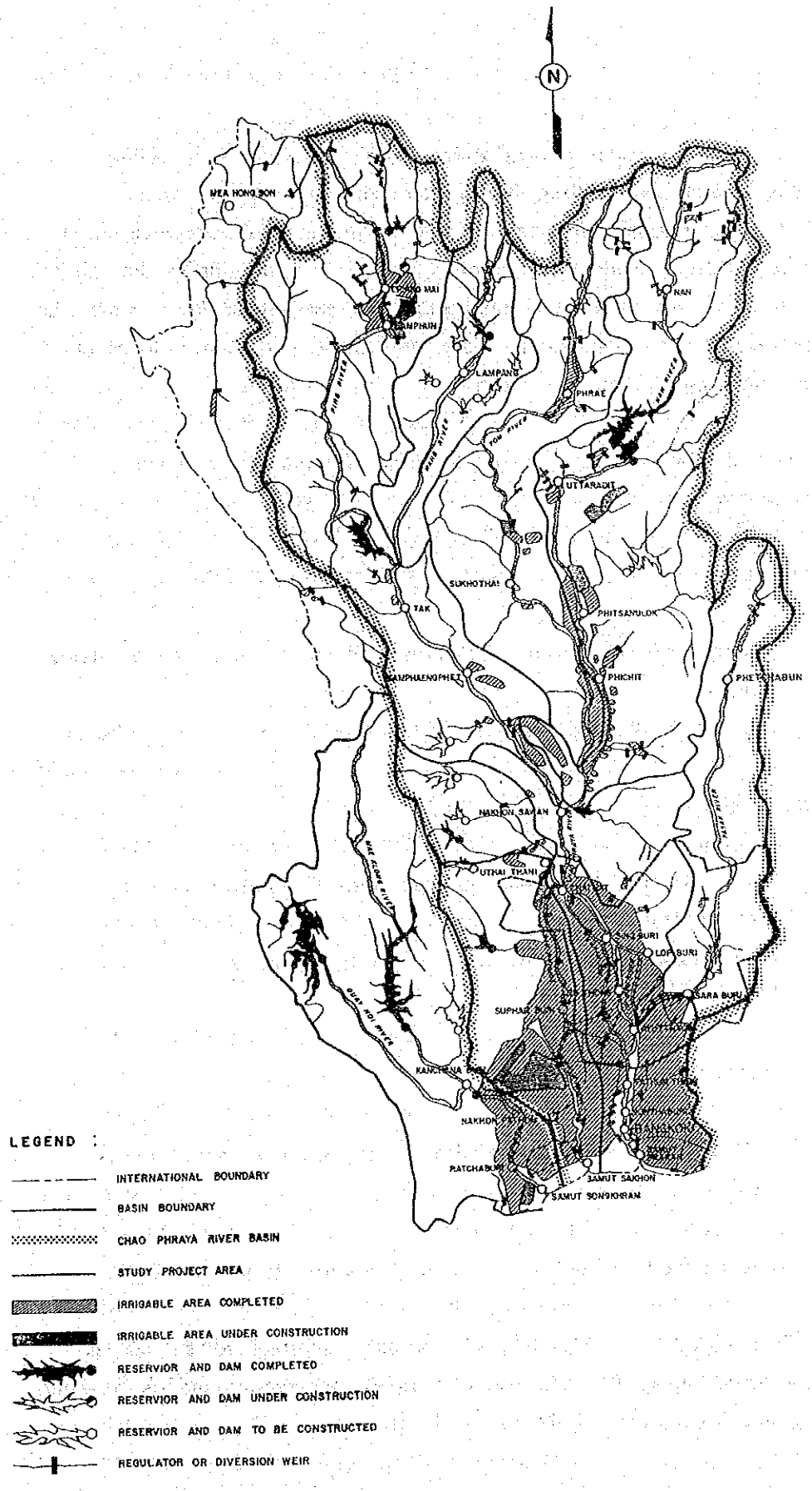


Fig. 1.3 Water Resources Projects in Chao Phraya River Basin

1.1.2 Features

The environment of the Chao Phraya River basin is greatly affected by seasonal changes such as flooding during the rainy season and water shortages in the dry season. It is a sensitive environment as is typical in a tropical climate. Much of the land is prone to soil erosion during the rainy season due to the high temperature and during the rest of the year when the land is not covered with vegetation. This problem is particularly acute in mountainous areas and other dry areas.

The environmental features peculiar to the Chao Phraya River basin are summarized below.

1) Upper basin

   (1) Water resource conservation area (catchment basin of 2 major dams)
   (2) Limited agricultural activities (less potential for agriculture)

2) Middle basin

   (1) Large watershed without enough run-off control (storage facilities)
   (2) Agricultural areas with less irrigation capacity
   (3) Flood deterrence area

3) Lower basin

   (1) Well irrigated delta area and best rice growing area
   (2) Erosion in upland
   (3) Flood deterrence area of delta
   (4) Industrialization and urbanization pressure from the BMR

   The Chao Phraya River itself plays various important roles such as serving as a supply of fish, water transport, recreation, and as a water supply for agriculture, industry, and urban use.

1.2 The Upper Central Region (UCR)

1.2.1 Outline and Features

The UCR is a part of the upper area of the lower basin of the Chao Phraya River. The soil of the UCR is formed by the alluvium of the ancient delta. The old delta is used mainly for paddy fields while the fan and terrace are used mainly for field crops. Factories are typically found near the urban areas and along the river. The main types of factories are rice mills, cement plants, and ceramic manufacturers at present.

Within the UCR, the Chao Phraya River branches into the Suphan, Noi, and Lop Buri Rivers at Chai Nat on the northern edge of old delta. At Ayutthaya, they rejoin to form the lower Chao Phraya.

1.2.2. Main Roles of the UCR as a Part of Chao Phraya River Basin

The main roles of the UCR, from an environmental point of view, are summarized as follows :

1) Water supply for agriculture, particularly rice farming

2) Water supply for urban industry and agriculture in the Bangkok Metropolitan Region (BMR)

3) Flood retention for the BMR

The Chao Phraya River and its tributaries supply water essential for the irrigation of rice paddies. A stable supply of water is critical to agriculture in the UCR which is the most productive rice farming area in Thailand.

Moreover, the water supplied by the river for urban use in the BMR is also essential. The Metropolitan Waterworks Authority (MWA) supplies 2.3 MCM/day of water at Sam Lae, Pathum Thani Province. The future demand for water in the year 2012 is forecasted as 5.6 MCM/day by MWA, or about 2.4 times the present level as shown in Table 1.2.

Table 1.2 MWA Forecast Water Demand -- 1987-2017

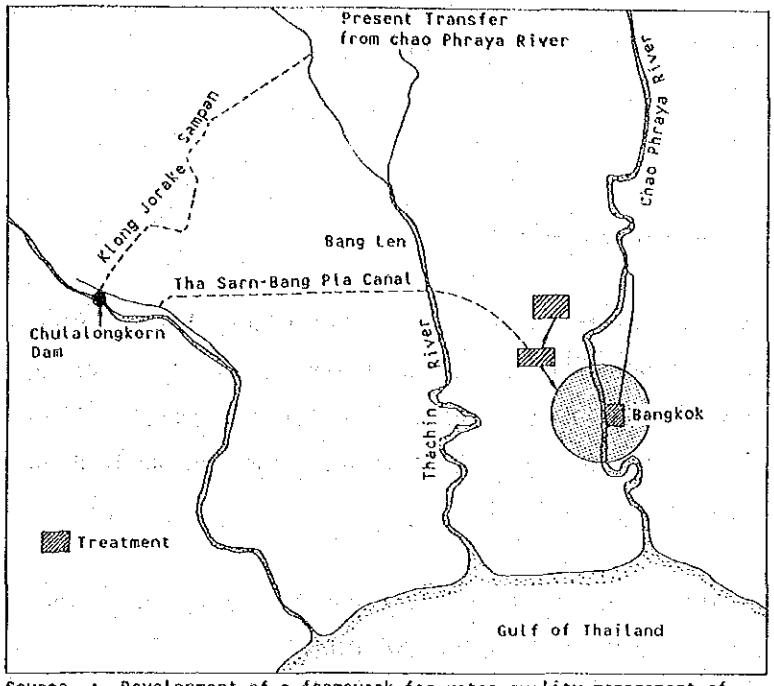
year	Water Demand (MCM/day) East side of the Chao Phraya River	West side of the Chao Phraya River	Total
1987	2.1	0.7	2.8
1992	2.5	0.9	3.4
1997	3.0	1.1	4.1
2000	3.3	1.2	4.5
2002	3.4	1.3	4.7
2007	3.8	1.4	5.2
2012	4.1	1.5	5.6
2017	4.5	1.7	6.2

Source : Development of a frame work for water quality management of Chao Phraya and Tha Chin River (1988, TDRI)

The Royal Irrigation Department (RID) has a plan in which the water of the Mae Klong River is transferred to the Tachin and Chao Phraya rivers by a channel so that they may increase water supply to the BMR. According to this plan, an additional 2.16 MCM/day of water will be made available for BMR use. Fig. 1.4 shows a general outline of plan.

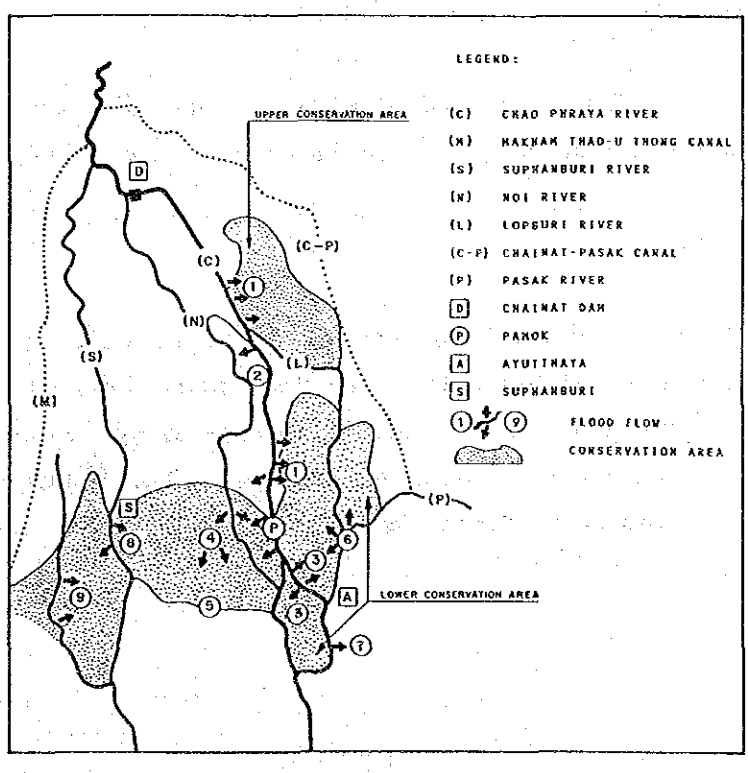
However, in spite of additional resources, the BMR will have to continue to take water from the Chao Phraya River because of the rapid increase in water demand and limits on the amount of available ground water due to the problem of land subsidence.

The problems of land subsidence in the BMR increase the need for the UCR to act as a flood retarding zone for the new delta area downstream of the Chao Phraya River. Fig.1.5 shows the present flood retarding pattern of Chao Phraya River. In addition to the benefit to the BMR, the flood retention benefit irrigation in the UCR. On the other hand, if for some reason the flood retarding capacity of the UCR decreases, it will be necessary to build flood mitigation infrastructure in the BMR itself, which will be extremely expensive in terms of both cost and danger.



Source : Development of a framework for water quality management of Chao Phraya and Tachin River

Fig. 1.4 Schematic Diagram of Mae Klong-Chao Phraya Interbasin Transfer



Source: Quoted from Agricultural Development in Tropical Delta (Japanese)

Fig. 1.5 Flood of Chao Phraya River

1.2.3 Environmental Facts and Findings

1) Water pollution

(1) Chao Phraya River

Water quality monitoring of the Chao Phraya River has been carried out by ONEB on a periodic basis. The average of observations during the period between 1986 and 1988 are shown in Fig. 1.6 to 1.13. The findings from the analysis of these data are summarized below:

- Within 100 km of the river mouth, the closer to the mouth the more severe the water pollution
- The water is more polluted during dry season than the rainy season
- Although water quality in the UCR is better than downstream, some stations in the UCR have recorded values exceeding the ONEB environmental standard for water quality. Pollution has especially accelerated in Ayutthaya.

Water pollution, in terms of BOD, is estimated to come from both domestic sources (75%) and industrial sources (25%).

(2) Tributaries

Tributaries to the Chao Phraya River in the UCR are the Pasak, Lop Buri, and Noi rivers. The Pasak River flows into Sara Buri Province where river water is used by many factories which discharge the water back into the river. The average DO value of the Pasak River during the 1985/86 and 1986/87 is shown in Table 1.3.

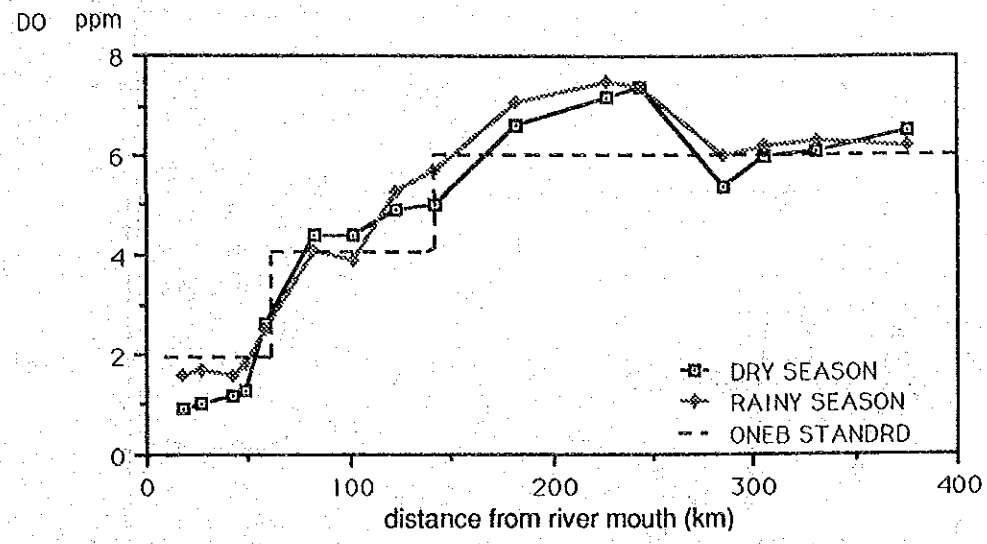


Fig. 1.6 Water Quality in Chao Phraya River: DO Average Value (1986-1988)

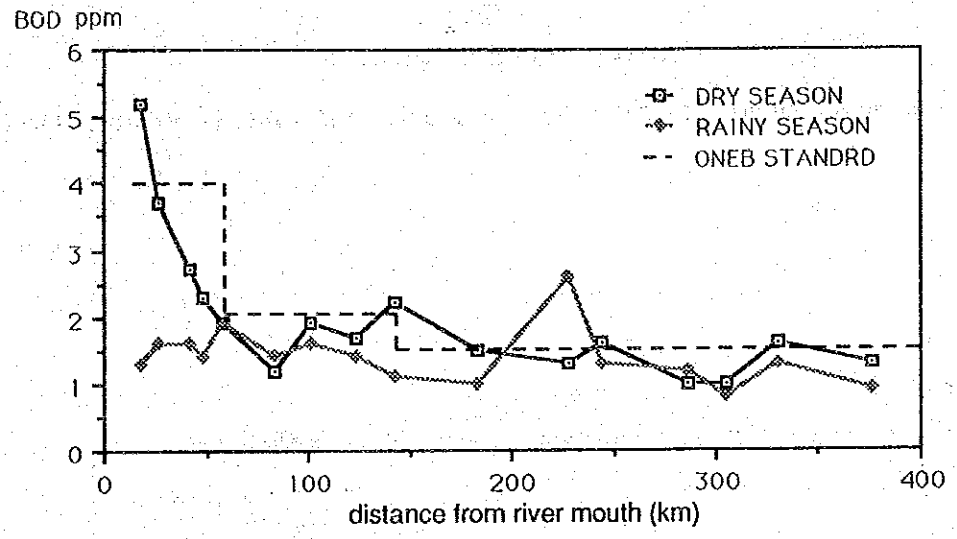


Fig. 1.7 Water Quality in Chao Phraya River: BDO Average Value (1986-1988)

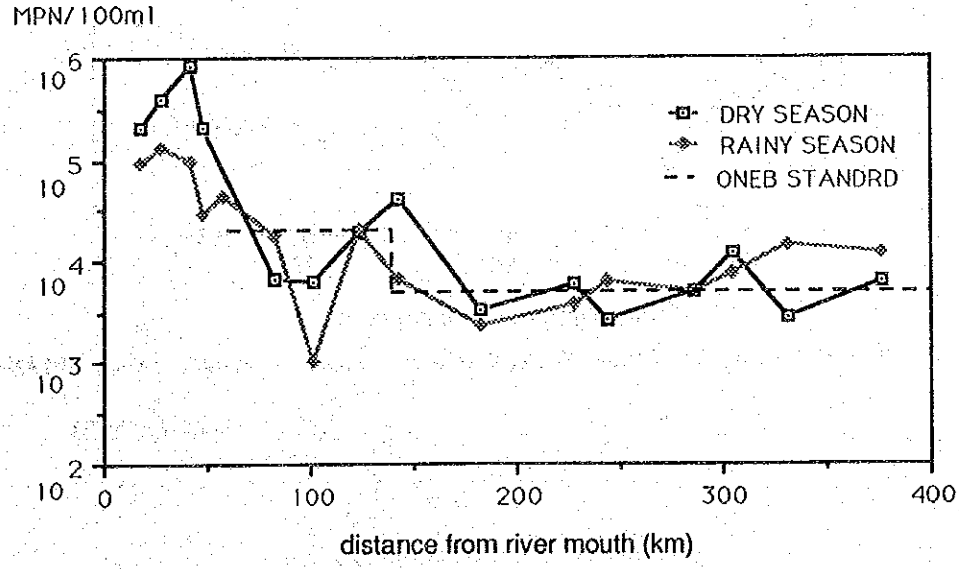


Fig. 1.8 Water Quality in Chao Phraya River: Coliform Average Value (1986-1988)

Source: ONEB

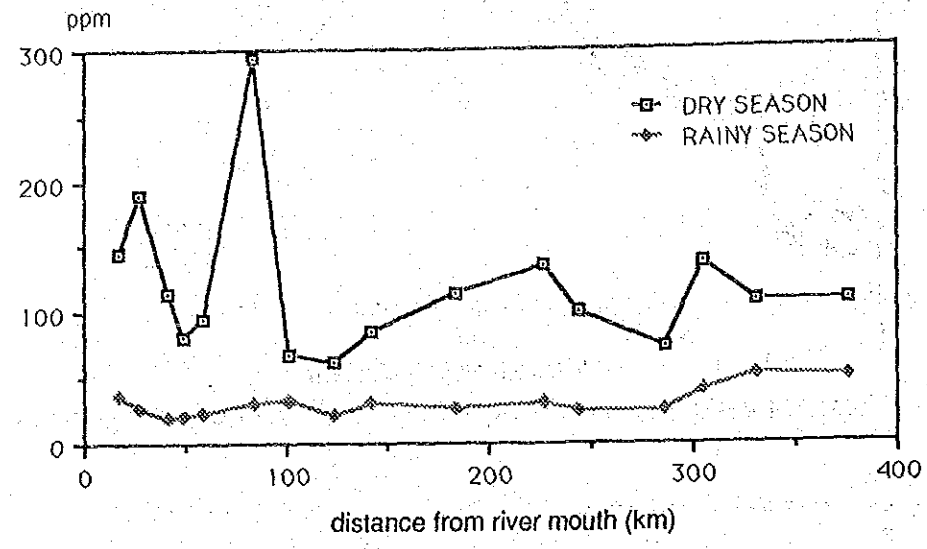


Fig. 1.9 Water Quality in Chao Phraya River: SS Average Value (1986-1988)

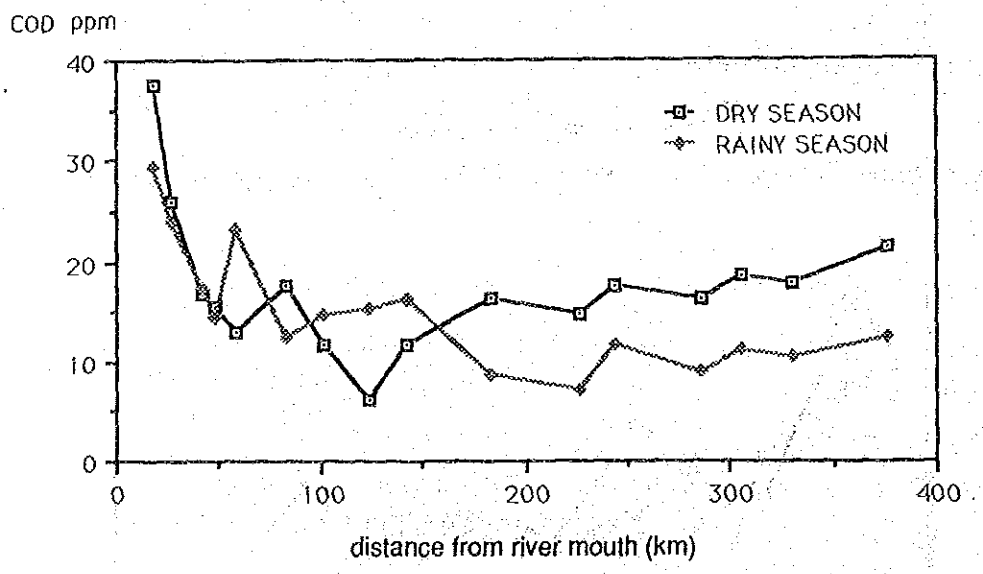


Fig. 1.10 Water Quality in Chao Phraya River: COD Average Value (1986-1988)

Source:ONEB

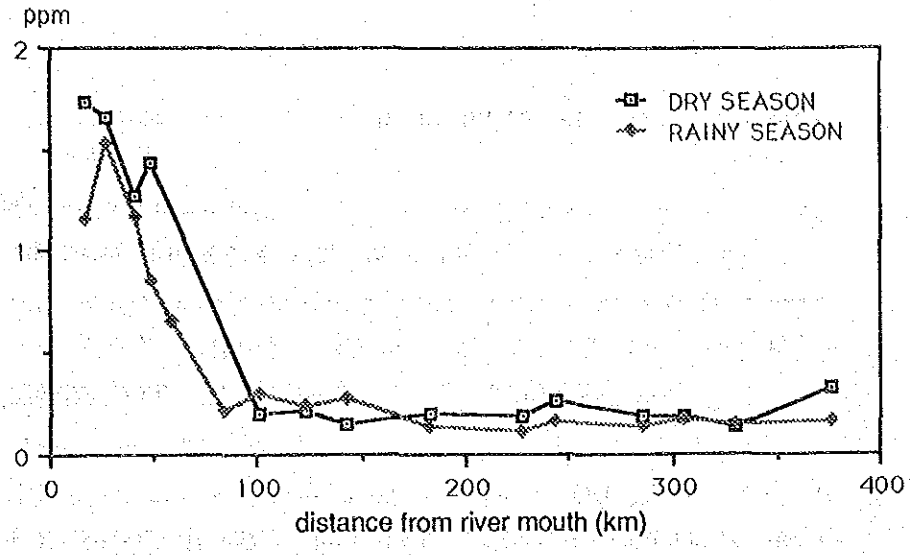


Fig. 1.11 Water Quality in Chao Phraya River: TIN Average Value (1986-1988)

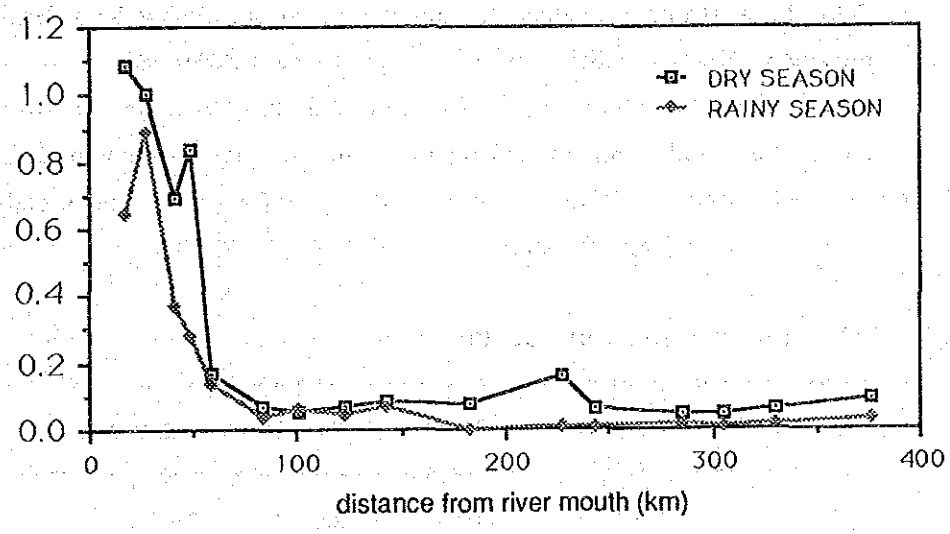


Fig. 1.12 Water Quality in Chao Phraya River: NH4 Average Value (1986-1988)

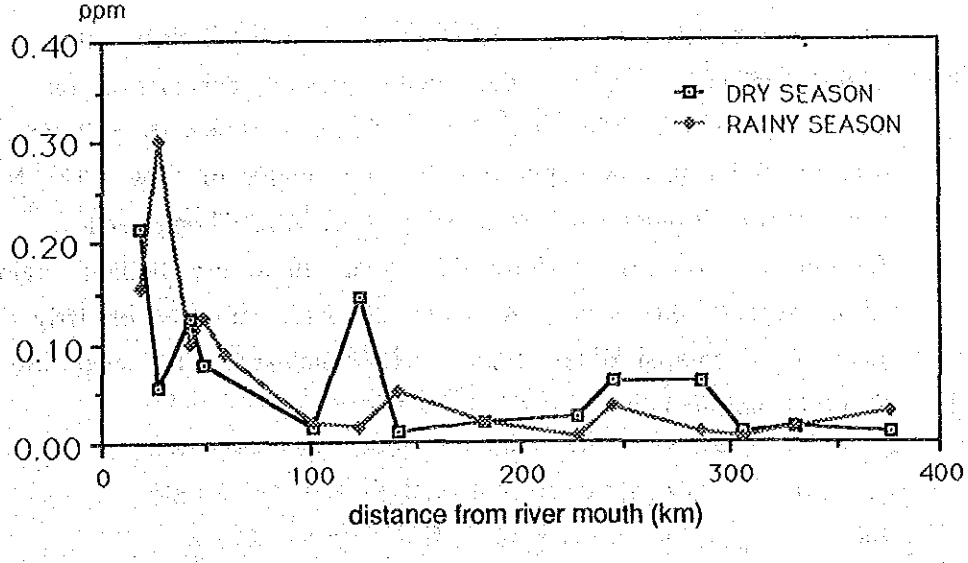


Fig. 1.13 Water Quality in Chao Phraya River: TP Average Value (1986-1988)

Source:ONEB

Table 1.3. DO Value of Pasak River

(Unit: mg/l)

Location	Nakon Luang	Tha Rua	Sara Buri	Kaeng Khoi	Chaibadan
DO value	6.1-7.8	6.4-8.0	7.7-7.9	8.1-8.4	7.4-8.5

Source : Ministry of Industry

In terms of the DO value, the water quality of the Pasak River is in an acceptable level now. According to the results of COD analysis by the study team, the pollution of the Pasak River is roughly the same as the lower Chao Phraya River in the UCR. As there is a strong tendency for industries to locate in Sara Buri province, water quality control of the Pasak River will increasingly be important. Therefore, a proper water quality monitoring and management system should be implemented as soon as possible. Water quality of the Lop Buri River is already at a low level as shown Table 1.4.

Table 1.4 DO Value of Lop Buri River

(Unit: mg/l)

Location	Bang Pahan	Maha Rat	Ban Phreak	Lop Buri
DO value	2.5-3.1	2.5-3.2	2.0-2.7	2.3-2.5

Source : Ministry of Industry

The water of the Lop Buri River, which is at the ONEB water quality standard Class 4, the lowest standard designation for dissolved oxygen. This river is particularly prone to pollution, because of its shallow depth and the low volume of flow. The Noi River flows through Chai Nat, Sing Buri, Ang Thong, and Ayutthaya provinces. Along this river, there are neither major urban centers nor many factories and water quality of irrigation channel is comparatively high. Nevertheless, water near urban areas is polluted.

2) Air pollution

Dust pollution due to rock crushing has been steadily increasing in both Lop Buri and Sara Buri provinces. According to ONEB, rock dust is an increasing cause of silicosis among the residents of these provinces. Appropriate measures should be taken immediately by the factories themselves. Furthermore, reuse of the land damaged by rock mining should be considered.

Environmental standards for exhaust gas from factories have been drafted by ONEB. The existing control system for factories is as follows:

- Establishing licence
- Operating licence
- Licence Renewal

Enforcement of the standards, periodic checks at short intervals and encouragement of self-control by factory owners should be considered.

3) Solid wastes

The existing situation of collection and treatment of solid wastes in municipalities of the UCR is shown in Table 1.5.

(1) Service level

Solid waste collection and treatment services in Sara Buri, Sing Buri, and Lop Buri serve from 80 to 85% of the total population. However, in Chai Nat only 23% of the population is served.

(2) Collection efficiency

The efficiency of the collection of solid waste in Ayutthaya and Sara Buri is relatively high: 8,000-12,000 people are served by each truck. In Chai Nat and Lop Buri, the ratio is 5,000 persons/truck. The collection cost per ton in Sara Buri and Chai Nat is about 600 Baht/ton which is higher than that of other provinces in the UCR: 300 Baht/ton in Sing Buri and Ang Thong.

Table 1.5 Information on Solid Waste Management of the Municipalities in Upper Central Area of Thailand

Item	Units	Sara Buri	Sing Buri	Chai Nat	Lop Buri	Phranakorn Sri Ayutthaya	Ang Thong	Bangkok
Responsible Area	sq.km	20.15	7.81	6.06	6.85	14.00	3.73	1,568.74
Population	*1000	59.06	20.74	13.86	37.02	63.50	9.47	5,559.60
Population Served	%	80.00	85.00	23.00	80.00	53.00	68.21	83.80
No. of Solid Waste Collection vehicle	truck	7.00	3.00	3.00	8.00	5.00	3.00	732.00
Population per Solid Waste Collection vehicle	1000 pop/truck	8.43	6.71	4.62	4.63	12.70	3.15	7.60
No. of Trips per day	trip/d	14.00	8-10	4.00	16.00	11-13	10.00	1,099.00
Average Quantity of Solid Waste collected	ton/d	24.00	19.20	5.00	30.00	17.50	10.00	4,225.00
	cu.m/d	80.00	64.00	16.67	100.00	58.33	33.33	16,900.00
Solid Waste Disposal System		open dumping open burning	open dumping open burning	open burning	open burning	open dumping open burning	open dumping open burning	make fertilizer (10%) open dumping (90%)
No. of Personnel		86.00	88.00	29.00	42.00	99.00	51.00	7,263.00
Solid Waste Collection Cost	Baht/ton	605.70	311.55	623.45	472.81	537.12	322.30	197.00

Source : ONEB

(3) Disposal system

Open dumping and open burning systems are used in the UCR in disregard of the fact that both are unsanitary. Improved disposal systems such as sanitary land fill should be applied in the UCR. Garbage, sharing about 35% of the total of domestic waste, is not collected and is at present thrown onto vacant land and into the river, both of which adversely affect the environment.

4) Toxic substances

The main toxic substances which affect the UCR's environment are agricultural chemicals. As the chemical substances are non-point sources, the monitoring and control of these substances is difficult. The main problems caused by agricultural chemicals are:

- Accumulation in the agricultural produce
- Accumulation in the soil
- Accumulation in the human body
- Health risk to farmers due to inappropriate use

Of the agricultural chemicals applied in the Thailand, about twenty chemicals are characterized by a strong residual tendency and toxicity. Importation of chemicals such as organochlorine and organophosphorus has been forbidden since 1989. However, the application of these chemicals has not been restricted and as a consequence are still in use by farmers.

(1) Chemical residues in agricultural products

Chemical residue in agricultural produce was studied by the Agricultural Technology Department during the years 1979-81, in which three thousand samples of produce including vegetables, fruits, eggs, and meat were analyzed. 70 % of these samples showed the presence of organochlorine or organophosphorus and some samples were reported to exceed the FAO/WHO safety standard. The principle residues of agricultural chemicals were

organochlorine such as DDT, Dieldrin, Endrin, Aldrin and Heptachlor.

This study is contradicting with a more recent study by ONEB from 1987-88, which indicated that only in 61 out of 242 food samples were chemical contaminants detected. The study also reported that most residues were in trace amounts, which were under the FAO/WHO standard value.

(2) Chemical residues in the environment

Several studies on residual chemicals in the environment have been conducted in Thailand. Fig. 1.14 through 1.16 show the results of a study by ONEB in 1985. The main findings of the study were:

- The level of chemical and organic pollution of river water during the dry season is much higher than that during the rainy season.
- Agricultural chemical residue concentration in samples of river bottom sediment and field soil is ten to one hundred times as high as other chemical pollutants.

Another study by Department of Agricultural Technology was conducted between 1977 and 1981 and a third joint study by the Department of Agricultural Technology and ONEB (1987-88) had similar findings, showing that river water pollutants were found primarily in soil and river sediments.

(3) Chemical residues in the human body

According to a study by the Department of Agricultural Technology during 1976-82, residues from the organochlorine group were found in humans. These residues accumulate in blood, fat, liver, and mother's milk. Of particular importance, DDT was found in mother's milk at an average 3.12 ppm which is higher than the safety standard.

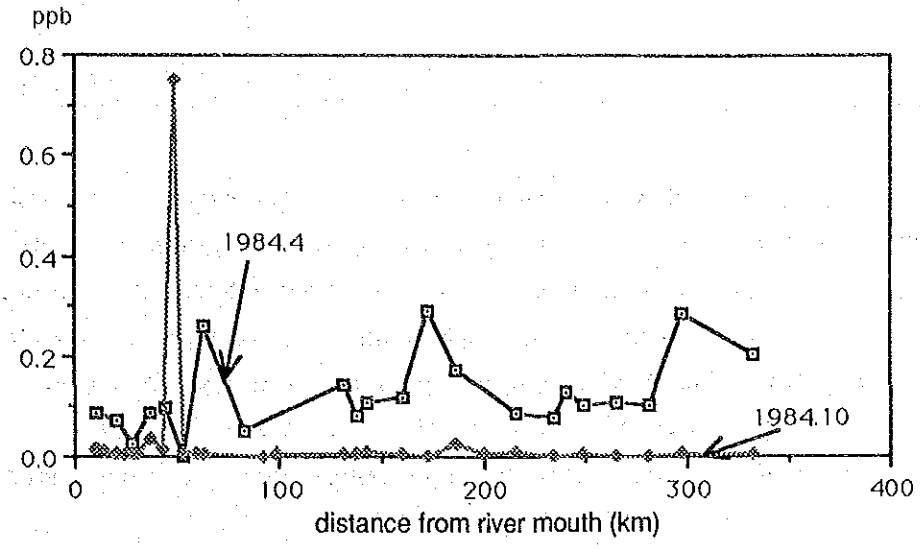


Fig.1.14 Organochloline Pesticide (ALDRIN) in Chao Phraya River

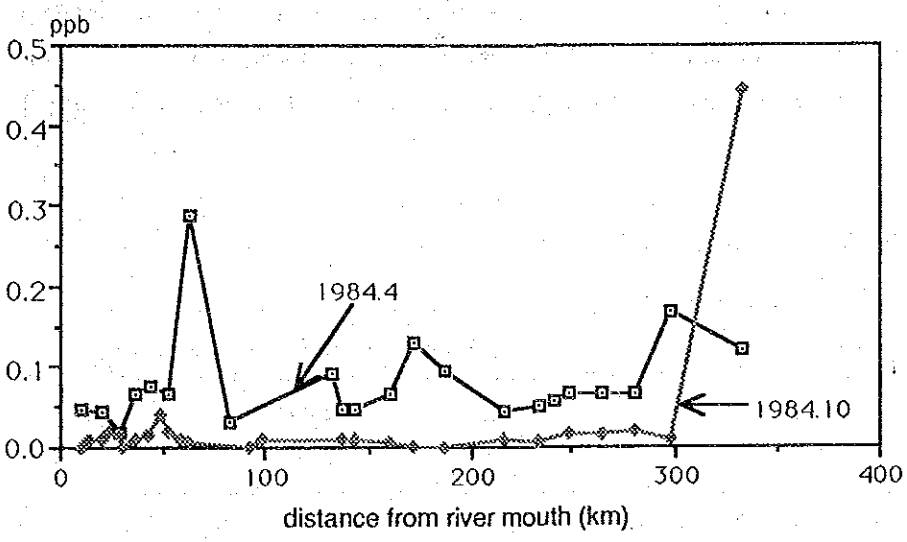


Fig.1.15 Organochloline Pesticide (DIELDRIN) in Chao Phraya River

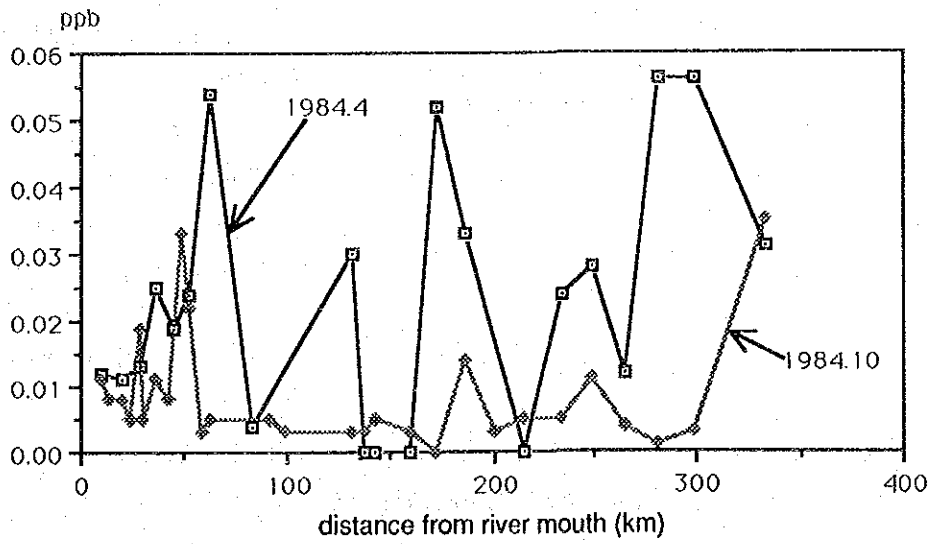


Fig.1.16 Organochloline Pesticide (BHC) in Chao Phraya River

Source:ONEB

5) Natural resources

The UCR is situated at the lower part of the Chao Phraya River basin, where its climate is under the influence of tropical monsoons. Its vegetation classifies it as savanna and its total rainfall is relatively small, at 1,100 mm/year, with high yearly and seasonal fluctuation and high intensity. The land is covered by a thin soil layer which is susceptible to erosion by intense rainfall. Soil fertility easily deteriorates due to the effects of high temperature and solar radiation.

Erosion problems in the UCR are observed in the upland area of Lop Buri and Sara Buri. The erosion prone area of the two provinces is about 370 thousand rai and the most is agricultural land. This area contains about 10% of the upland crop area in Lop Buri and 21% in Sara Buri.

Table 1.6 Potential Erosion Area

Name of Province	Area (1000 rai)	(% of Province)
Sara Buri	147.0	(6.6)
Lop Buri	223.3	(5.8)
Potential Erosion Area Total	370.3	

source: 1) "Statistical Reports of Changwat", National Statistical Office, Office of the Prime minister, 1981
2) Detailed soil reconnaissance soil map of Lop Buri and Sara Buri, Soil survay division, LDD