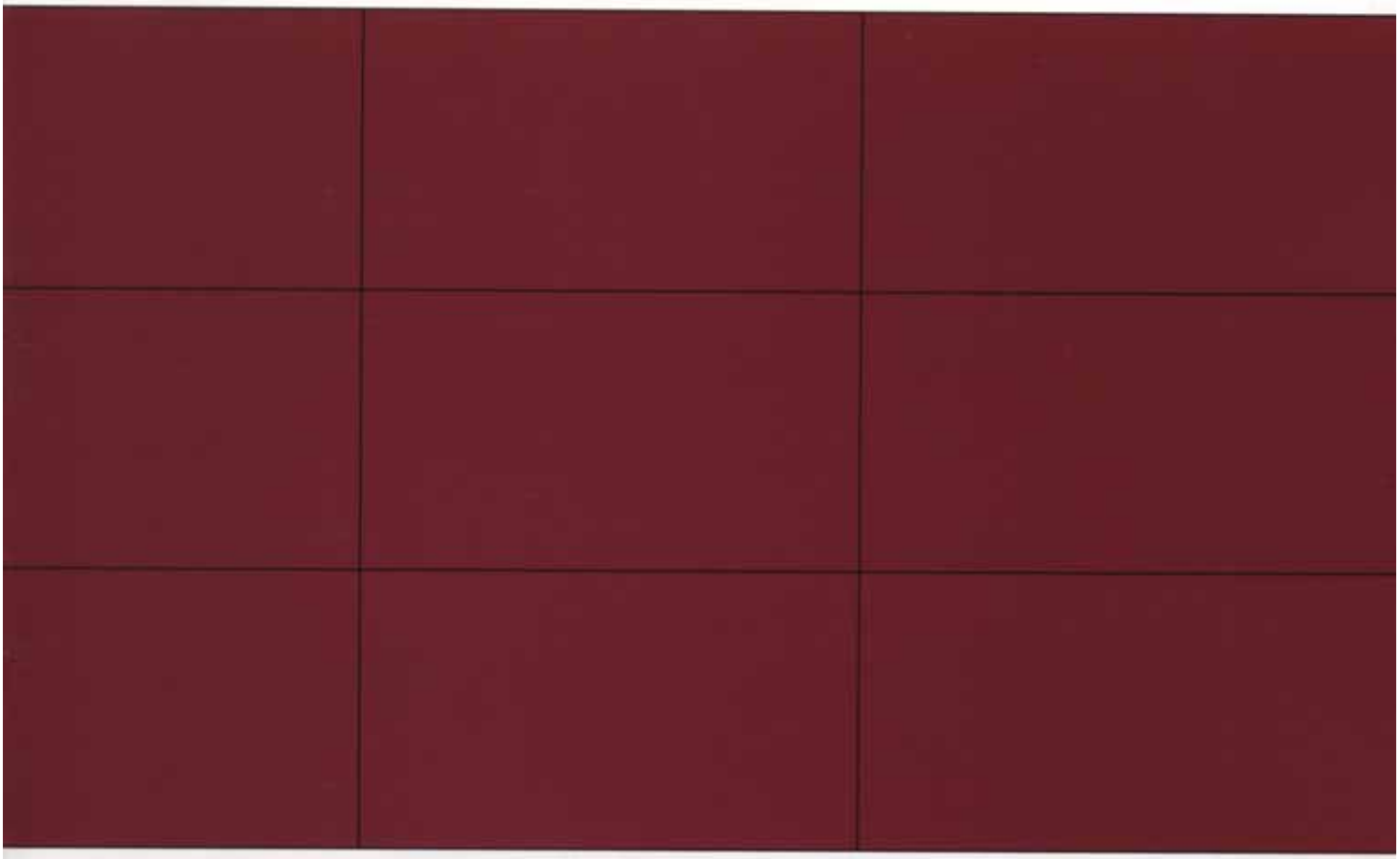
1986 TDRI Year-End Conference on

Resources Management

Natural Resources Management



TDRI 1986 YEAR-END CONFERENCE ON

NATURAL RESOURCES MANAGEMENT

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Thailand
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Profile

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Contents

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Preamble

This is the abridged version of the book "Thailand Natural Resources Profile" to be published by Thailand Development Research Institute (TDRI) in early 1987. It is the result of the concerted research of 19 specialists working together in the past ten months.

This paper is divided into four parts. Part I is the introduction, leading the readers through the contents of the following chapters. Part II highlights the trends and issues of natural resources management in Thailand -- land resources, water resources, forest resources, nature conservation, mineral resources, mangrove, and fishery resources. Part III covers the major issues of environmental quality management, namely: air and noise quality management, water quality management, solid wastes and toxic substances management, and occupational safety and health and accident prevention. Part IV articulates on the recommended national strategy to solve the problems elaborated in the earlier chapters.

This research was made possible through the financial support of the National Environment Board, the Department of Technical Cooperation (DTEC), USAID, and the International Institute for Environment and Development (Washington D.C.).

บทย่อ

ประเทศไทยเคยเป็นประเทศที่อุดมด้วยทรัพยากรธรรมชาติ ทั้งดิน น้ำ ป่าไม้ แร่ธาตุ รวมไปถึงแก๊สธรรมชาติ และทรัพยากรทางทะเลอื่น ๆ

เท่าที่ผ่านมา เศรษฐกิจของประเทศเติบโตขึ้น เพราะได้ทรัพยากรธรรมชาติเป็นปัจจัยสำคัญ ตัวอย่างเช่น ภาคเกษตร ซึ่งเป็นภาคเศรษฐกิจที่ให้ผลผลิตมวลรวมภายในประเทศ(GDP) สูง การเพิ่มผลผลิตที่ผ่านมาอาศัยการขยายที่ดินออกไปเรื่อย ๆ จนเกิดปัญหาที่ดินทำกินไม่เพียงพอ ต้องบุกรุกเข้าไปในเขตป่าสงวน ยิ่งเมื่อพลเมืองเพิ่มจำนวนขึ้นอย่างรวดเร็วจาก 8 ล้านคนในปี ค.ศ. 1911 จนถึงปัจจุบันกว่า 52 ล้านคน การจัดสรรทรัพยากรต่าง ๆ ก็เริ่มมีปัญหามากขึ้นเป็นลำดับ ดังจะเห็นได้ว่าปัจจุบันมีชาวบ้านประมาณ500,000 ครอบครัว ซึ่งไม่มีที่ดินทำกินซึ่งจำนวนนี้ไม่รวมอีกประมาณ 1 ล้านครอบครัว ซึ่งบุกรุกเข้าไปอยู่ในเขตป่าสงวน

ปัญหาการขาดแคลนที่ดินทำกินมีส่วนทำให้อัตราการทำลายป่าสูงขึ้นในช่วงระหว่างปี ค.ศ. 1961 ถึง 1985 ป่าไม้ประมาณ 78 ล้านไร่ ได้ถูกบุกรุกทำลายไปหรือเท่ากับเป็นการสูญเสียพื้นที่ป่าไม้ประมาณ 24 % ของพื้นที่ทั้งหมดของประเทศ

ในด้านอื่น ๆ เช่นทรัพยากรประมง ก็มีการจับปลาในอ่าวไทยเกินปริมาณที่ธรรมชาติจะทดแทนได้(Maximum sustainable yield) เป็นผลให้ปลาทะเลที่หาเทียบเรือ 40% ถูกนำไปทำเป็นปลาเป็ด ซึ่งในจำนวนนี้กว่าครึ่งเป็นลูกปลาที่ยังโตไม่ได้ขนาด

ทางด้านทรัพยากรน้ำนั้น ปัจจุบันก็เริ่มมีความขัดแย้งกัน แย่งกันใช้น้ำ ในกรุงเทพมหานครได้มีการสูบน้ำบาดาลมาใช้จนเกิดปัญหาแผ่นดินทรุด เป็นผลให้น้ำท่วมตามมาอีกด้วย

คุณภาพสิ่งแวดล้อมในกรุงเทพมหานครก็เสื่อมโทรมลงตามลำดับ โดยเฉพาะน้ำเน่าในคลองได้มีการประมาณไว้ว่าจะต้องใช้งบถึง 36,000 ล้านบาท ถ้าต้องการสร้างระบบกำจัดน้ำทิ้งให้ได้มาตรฐาน

ปัญหาต่าง ๆ ที่กล่าวมานี้ส่วนใหญ่เกิดจากการขาดการบริหารและจัดการทรัพยากรที่ถูกต้อง โครงการ Natural Resource Profile มีจุดประสงค์จะศึกษาเพื่อให้ได้ภาพรวมทั้งหมดของสถานการณ์ทางด้านทรัพยากรและสิ่งแวดล้อม ทั้งในอดีต ปัจจุบัน และแนวโน้มในอนาคต

โครงการนี้ได้รับความร่วมมือจากผู้เชี่ยวชาญคนไทยในแต่ละสาขา จำนวน 19 คน เข้ามาทำงานร่วมกันเป็นเวลา 10 เดือน ผลสรุปออกมาชัดว่าถึงเวลาแล้วหรือยังที่ประเทศไทยต้องคำนึงถึงการนำทรัพยากรธรรมชาติไปใช้ในการพัฒนาประเทศในอัตราที่จะสามารถจรรโลงและเร่งรัดให้ประเทศของเราก้าวหน้าต่อไปได้

FOREWORD

Just over ten years ago, in 1976, the Royal Thai Government clearly stated its concern about the developing pressures on Thailand's natural resource base. *"The deterioration in the environmental condition of major natural resources, particularly our forest, land, water and mineral resources,"* the Third National Economic and Social Development Plan concluded, *"is a fundamental problem which has considerable consequences both for national survival and Thailand's future development potential."*

One reason for embarking on the present Natural Resources Profile was to clearly identify what those consequences are likely to be. This has been done, with the help of leading experts in the various fields. Successive chapters review the current status of our land, water, forest, nature conservation, mineral, mangrove and fishery resources. These chapters also look at the legal and institutional framework influencing resource management in each area, and highlight some of the most important emerging trends and issues. The environmental quality dimension is then explored in four further chapters, focusing on air and noise, water, wastes, and accident prevention.

Following this careful scrutiny of the current status of Thailand's natural resources and environment, the final section of the Profile considers the strategies that are now needed to begin the transition toward sustainable forms of development. But what is sustainable development? The basic idea is that natural resource management and development projects can be designed in such a way that the social, economic and ecological benefits which flow from those resources can be sustained into the foreseeable future. As for practical guidance on how to achieve sustainable development, there are many sources of advice to call upon, but in many areas Thailand will be pioneering approaches which will find much wider application around the world.

By building the resulting programs around local people in specific areas, we must not only convince them that development and conservation can go hand in hand, but provide practical, working examples. People are more inclined to believe what they have seen with their own eyes and experienced in their own lives, rather than what they are told in massive public education programs.

The days of carefree exploitation and destruction of Thailand's natural resources are numbered. The ultimate test of the sustainability of Thai development, however, will be the extent to which a fair, equitable and acceptable balance can be struck between the needs of the country's urban populations, particularly the population of Bangkok, and the needs of the rural populations. This represents a most formidable challenge, but one we must face up to and tackle.

The most uncomfortable element is time. Our population growth, though slowing somewhat during the last decade, will not wait for us to catch up. Its momentum is strong and getting stronger. A growing

population is demanding increased living standards and real hope for the future. We cannot return the babies born to us in order to enjoy more resources per capita. We can aim to implement more effective population control programs, but we also must investigate the potential for using technologies which are less polluting and more efficient in converting natural resources, whether they be energy, water or raw materials, into the goods and services we all need.

The following chapters underscore the fact that the challenge we now face is more serious than at any previous time in our country's history. We should not be overwhelmed by these problems, seeking instead to anticipate them and react in good time.

Our future is in our own hands. It can be a sustainable future, if that is what we decide we want. But it is vital that we are all committed to the transition that is clearly now needed. Only if sustainable development wins the support of the broad mass of the public will Thailand have a real chance of moving progressively into the twenty-first century and beyond.

Part I Overview and Perspective

1 Introduction

1.1 INTRODUCTION

Thais are proud of their heritage, of their land and their natural environment. Long before the age of the now infamous "Golden Triangle", this fertile country was known as the "Golden Land", in recognition of the high productivity of its farmlands and forests, and of its rich mineral wealth. A thirteenth century stone pillar inscription, dating from the Sukhothai period of King Ramkhamhaeng the Great, proclaims that *"this Muang Sukhothai is good; in the water there are fish, in the fields there is rice; whoever wants to trade in gold or silver I can do so; people are contented..."*

A succession of Siamese kingdoms saw the waxing and waning of a series of 'golden ages', underpinned by agricultural and technological development, by commerce and the slow infusion and mixing of many peoples and cultures. This long cultural history, together with the interplay of technology and the country's natural resources, has molded today's Thailand, with all its exciting economic potential and its undoubted social and environmental problems.

Modern Thailand can be proud of many achievements, whether in terms of its comparatively good transport and communication networks, its irrigation canals, its agricultural productivity, its commercial banking system or its manufacturing capability. But there are other features of today's scene which are worthy of comment.

Population growth, for example, continues apace. From a scant eight million in 1911, the country's population grew rapidly, surpassing the 50 million mark in 1984. The pace of urbanization has also been very rapid. At least 10 percent of Thais live in a single urban concentration, the Bangkok Metropolis. This covers over 1,500 square kilometers, about 0.30 percent of Thailand's total surface area. Despite population control programmes, the country's population continues to increase, imposing ever-growing pressures on its agricultural land and other natural resources.

Now, as the twenty-first century draws closer, there are warning signs that the present pattern of development may prove unsustainable. The fish catch per capita, from both inland and coastal waters, is falling. A few species are raised in aquaculture ponds or by mariculture methods, supplementing the catches from the sea and inland waters. This sector now accounts for about 2.5 percent of the total volume of fish consumed, with its share increasing steadily as the extension of unilateral exclusive economic zones exclude Thai fishermen from previously international waters. But even in the aquaculture sector, it is impossible to miss the signals of stress. As temperatures drop - and other factors converge - following the cool dry season, severe damage to pond fish recurs, resulting in crippling financial losses for some fish farmers.

As far as traditional agriculture is concerned, Thais regard yields of paddy rice as the primary index of food security. Many regions of the country are remarkably productive, with rice farmers now harvesting over one ton of rice per rai in several irrigated areas, compared with about one-fifth that figure in areas of traditional rainfed agriculture. Overall, the country's total annual rive harvest increased from less than 10 million ton in 1966 to over 18 million tons in 1982. That is not to say, however, that Thai farmers are uniformly contented. Problems of farm debt and surplus production impose severe pressures in some quarters.

The country's water resources are under strain, too. The Bangkok Metropolis alone consumes over three million cubic metres of water daily, requiring an enormous investment in water treatment and distribution facilities. Irrigation water is costly to provide, although the users often do not pay for it. Industrial water users do pay, but release tremendous quantities of waste water, much of inadequately treated. It is no longer possible to say, as the inscription writer did, that Thailand's river waters are *"as good to drink as Maekhong water in the dry season"*. Water conservation measures are increasingly needed to ensure a sustainable match between demand and supply, both in terms of quantity and quality.

On the health front, the statistics show marked progress, with major successes in the reduction of infant and adult mortality, significant improvements in life expectancy and significant achievement in the field of industrial health and safety. At the same time, the statistics also show that a high proportion of children under five are suffering from protein and calorie malnutrition. It is distressing to note that the proportions for the North and Northeast are 54 percent and 60 percent respectively. Adults, too, are showing high levels of ill-health in these regions, with anemia a particular problem. Other regions report similar, if less severe, trends.

In these circumstances, it would be difficult to argue that "people are contented". Many are, of course, but many more are hemmed in by increasing problems. So what happened to the Golden Land's bounty? How well have we managed our endowment of natural and human resources? How successful are we likely to be in marrying the twin objectives of conservation and development? And what changes are needed to ensure that Thailand increasingly achieves sustainable development?

Before attempting to answer these questions, and more, we need to have access to the latest information on our renewable and nonrenewable resources. We need an impartial assessment of the interactions between Thais and their natural environment, of our successes - and failures - in environmental management. The aim of this Natural Resources Profile is to supply much of the information needed to ensure that appropriate, integrated environment and development policies can be formulated and adopted nationally, regionally and locally.

1.2 NATURAL RESOURCES AND ENVIRONMENT

Our natural resources, diverse as they may appear, are always interrelated. Any exploitation effect related to one resource area may not be confined within that area alone, but may eventually affect the quality of nearby areas and resources. The main linkage is through man, the consumer, and the exploiter.

Man often admires the beauty of the sunrise, and of the sunset, without being aware of the enormous amount of energy that comes with it, an energy that sets everything in motion, the energy of life upon which mankind depends. There are oceans, the storehouse of water so essential to a living system, as well as

many forms of marine life that benefit man. There are mountains, and hills; their formations were often bringing up mineral-rich veins within reach of miners. From these mountains, through slow and time consuming processes, soils for the land resource are derived. The wind, and storms, play a key role in providing man with life-giving rainwater, which feeds the streams and rivers, fills ponds, lakes and underground aquifers, and replenishes air moisture. Without water, there would be no life.

Our covering of Rain Forests, lush and mighty as they appear, is very vulnerable to any disturbance of its many inter-relationships. Its nutrient cycle is all-important. Once burned over and cleared, it supports far less plant growth, nowhere comparable to the original biomass cover. If its soils were shallow on steep slopes, they will be eroded away in a very short time. The resulting silt's next destination is the alluvial plains downstream, or the reservoir bottom, or further down into the Gulf. Thailand's rich topsoil, accumulated over thousands of years, is eroding and depleting, being lost far faster than it was formed. It could still be saved for future generations, however, if we decide to do so, wisely and in good time.

The Soil and Land Use

Thailand is well endowed with cultivable land, which represents some 65 percent of the country's total area. This is a theoretical maximum, however, inclusive of land unutilized, not yet utilized or abandoned. Although not all arable land is available to private ownership and utilization, Thai citizens can buy and inherit land. Land is therefore an asset, property, as well as a place to work and earn a living.

Land use and land rights under population pressure

In past years, when population pressures were less intense, there seemed to be adequate land for every purpose -- agriculture, human settlements, water bodies and so on. People felt that forest land was abundant, and could be cleared whenever and wherever needed. Presently, the per capita arable land is down to only 3.103 rai, plus some 0.958 rai of marginal land, and this area is getting smaller with each child born - almost two per minute. Our fertile arable land is also being converted into new urban settlements and industrial sites. Under mounting population pressure, we must produce more food and industrial crops for internal consumption, as well as for export earning, for an ever increasing and more demanding population.

Land rights

Thailand has long recognized and granted land rights to the citizen, yet the question of land rights remains unfinished business. Up to 1985 only 12 percent of the 152 million rai of agricultural land carried title deeds; some 48 percent was covered by a certificate of utilization or other papers; and 40 percent had no legal papers whatsoever. Yet the extent of "undocumented" land is in reality much larger due to an additional huge area of illegally occupied land carved out of the forest reserves, and pre-reserves, amounting to over 43 million rai by 1985. This is still expanding. The multitude of landless farm families will ensure that this remains a highly controversial area.

The RTG recognizes this potential discontent and has been attempting to alleviate the problem through various programs of land allocation, land conservation, land consolidation, land reform and land use planning, in addition to accelerated land titling. Chapter 2

provides insight into the legal and institutional mechanisms underpinning for such programs. Overall, it suggests that government efforts on the land right problems may have been handicapped by the lack of a coherent land policy framework, laying down coordinated guidelines for the 24 agencies and some 10 committees involved in this important area.

Land use planning

Of equal importance will be land use planning. It is imperative, with ever-increasing population pressures, to optimize the benefit from our diminishing per capita arable land. Land misuse is much more prevalent than is generally recognized, to an extent of some 28 million rai, not counting land which has been cleared and abandoned. Under-utilization, as well as unnecessary fallow land, are also evident. Several factors -- human, economic, biological, climatic -- are all involved. An initial key to the problem is information on land capability, to put this already limited land to its best use, for sustained maximum return.

To decide, agronomically, which land use is most appropriate, scientists need information about the soils, water and other climatic factors. The soil map provides soil classification for every parcel of land. The designation of soil unit helps to determine land suitability for various purposes, agricultural as well as nonagricultural. An accurate soil map, to scientists, is as necessary as a land title deed is to the ordinary Thai.

Most soil formations may have begun rather similarly, but there are differences in quantity and time, as well as in physical and chemical quality, depending on the soil's precursors and the manner in which it was formed. Such differences give a basis for soil classifications, and guide the selection of the best possible plant types to grow on any particular soil.

Soil scientists have developed soil classification systems over many years. For Thailand, the pioneer was Dr. Robert L. Pendleton, who produced the first general soil map (1946) of the country. The soil units used were "soil group", each being named after type and location, such as the Bangkok Dark Heavy Clay, Sithammarat Sandy and Coarse Sandy Loams, and so on. These are useful for a local reference, but present some difficulties for any universal reference system. A succeeding soil map, dating from 1967 and prepared by Drs. Moormann and Rojanasoonthon, utilized the soil unit that is based on the great soil groups of the world, or combinations thereof, in order to provide the required universal reference. This system, however, still does not quite meet the demand of scientists who need more comprehensive information from a soil designation.

A "soil taxonomy" classification system was adopted by the Department of Land Development. The system has been developed by the USDA scientists, and is regarded as the most suitable to facilitate technology transfer across different regions. A revised publication (1979) of the Thailand general soil map, which based its soil unit on the soil taxonomy classification, provides an improved basis for work on land suitability. This is a major consideration in land use planning, and details are provided in Chapter 2.

Land use planning will be based primarily on land suitability, and modified by relevant socioeconomic criteria. For example, paddy acreage is declining in the Central Plain, in contrast to a gradual expansion in other regions. Its conversion to more profitable uses such as industrial sites, new residential development, orchards, vegetable farms and aquafarms for shrimps and fishes, is responsible for the declining trend. The projected contraction of rural household numbers for the Central Plain may well accelerate this phenomenon. Land use planning in such circumstances will be difficult, but

is likely to prove essential.

Forest Resources

Forests supply mankind with many resources and services: wood, fuelwood, medicinal plants, animals, genetic resources, and so on. The ecosystem as a whole is sustained by forest. The air's oxygen supply is recycled constantly through the photosynthetic process in green leaves. The rainfall over the watershed, with adequate forest cover and grasslands, is partially infiltrated into the ground and released slowly to streamlets and headwaters. The plant nutrients to maintain the natural soil fertility are supplied in part, by forest cover upstream. Man is sheltered and supported by forest products; yet now, man threatens to destroy that forest. Without forest cover, life could go on; but the hardship would be tremendous, both for rural and urban communities.

What is a forest?

Forest land, in its legal sense, could be a rangeland void of any tree, or having a few trees, or be crowded with trees and vegetation. Biologically, a forest is thought of as a stand of trees with not less than a certain tree population density, say 10 or more trees per rai. Ecologically, a forest is a community of living trees and associated organisms covering a considerable area, with productive characteristics as described in Chapters 4 and 5. Insects, birds, reptiles and mammals, plus myriad other living organisms -- plants and animals -- make their home in the forest. Many of them are potential genetic resources for our domestic plants and animals. It is truly a living community.

A forest is subject to depletion, or ecological deficit, if the amount of wood removed from it by whatever means, becomes larger than the new growth. If the deficit continues, the forest will shrink and, finally, disappear. Encroachment simply, and effectively, accelerates the shrinkage of the forest cover, and its eventual disappearance. The loss of forest cover disrupts several basic cycles that provide and maintain the life supporting capacity of the land and water resources.

What about the mangrove?

The mangrove, by virtue of its unique position in a transitional zone, shelters a rather complex community of plant and animals that have adapted to the littoral environment. Yet the full development of the mangrove forest still depends on an adequate fresh water supply. At the same time, its ecosystem suffers if seawater circulation is obstructed. The right balance must be struck and maintained.

While good estimates exist for mangrove wood production, at some 0.75 million cubic meters annually, mostly "mai kongkang" (Rhizophora spp.), whose charcoal product is of a premium quality, the mangrove's economic contribution to offshore fishery resources is difficult to assess. It is known that the mangrove provides enough primary food source in the form of detritus, a decomposition product of mangrove forest litter, for primary consumers. They in turn attract the secondary consumer and tertiary consumer levels. A food web is thus generated, with extensive aquatic populations dependent upon the mangrove. There are over 300 resident mangrove species identified so far. Not all are of economic value, but every single one is part of our natural heritage.

A few of them are rather important, economically. For example, mangroves feed and shelter, during a certain part of their life, "pla kapong-kao" (white sea bass), "pla kao" (grouper), "pla ka-bok" (mullet) "pla nuan-chan-tha-le" (milk fish), "kung ku-la-dam" (jumbo shrimp), "kung chae-buay" (white shrimp), "hoi lai" (baby clam), and "pu tha-le" (mud crab). These are only some of the species of local importance, and their

continued presence on the Thai table will partly hinge upon the proper management of the existing mangrove forest.

Considering the extent and pace of mangrove forest destruction, with some 0.62 million rai lost, over one-quarter of the total area, during the period 1961-1986, and the evident damage by pollution to mollusc productivity within the last decade on mud flats adjacent to mangrove areas, it is urgent that proper management programs be agreed upon by concerned agencies. The Royal Forest Department has adopted a management system which involves franchising some 1.1 million rai of productive mangrove forest to private concessionaires, applying a logging system based on rotation zone clear-cutting and replanting, and initiating a programme designed to replant up to one-half of the degraded areas in six years. The Department of Fisheries has agreed that the areas taken out of the mangrove forest for shrimp farming, now amount to around 0.24 million rai, should be adequate to meet further expanded productivity requirements, if intensive farming technologies are adopted. These technologies are available, and should be used, wherever possible.

Whither the land forest?

The land forests are still huge and diverse, with some 93 million rai remaining. Their variability reflects the locality, altitude and local climatic conditions, giving Thailand four main forest types: Evergreen Forest, mixed Deciduous Forest, Dry Dipterocarp Forest, and Pine Forest. The Evergreen Forest is the most productive in term of tree volume per unit area and annual growth capacity.

The land forests are struggling to perform a number of tasks to meet man's expectations, under a very harsh and contradictory set of conditions. The forests are expected to meet an increasing demand for lumber and fuelwood that now stands at 1.25 cubic meters per capita, while the resource base is diminishing. Already, timber must be imported to meet this demand. We have turned from a longstanding net-exporter into a net-importer of timber. A projected demand for pulp and paper that rises rapidly with the new age of information -- books, newsprint and myriad other paper products -- will more than triple, from 0.79 to 2.80 million tons, between 1985 and 1990.

Meanwhile, satellite imagery registers the opposite trend in existing forest cover. The forested area of 171.02 million rai in 1961 had shrunk by over 32.45 million rai (18.9 percent) by 1973, and 45.40 million rai more (26.5 percent) by 1985. The average annual loss between 1961-1985 was about 3.24 million rai. The most damaging periods were between 1973-1976, and 1976-1978, when the annual rate of destruction reached 4.85 and 7.25 million rai respectively. This accelerated destruction is closely linked with the development of infrastructure, including the road network.

Environmental considerations

Equal in importance to economic considerations are several demands that can never be easily equated in terms of cost and benefit -- since only the loss side would be felt in normal circumstances. Watershed quality and headwater management must be actively pursued to ensure water resource quality. We are losing annually an estimated 47.5 million tons of sediment into the Gulf, mostly topsoil, from the catchment areas of the North and Central regions, and half of the South. This process cannot be prevented completely, but could have been reduced.

Nature conservation also relates to the aesthetic and educational values of living organisms and of the living communities that can benefit humankind in so many ways. Their communities need protection by the forests that, in turn,

need protection by man against unwise use or misuse. This represents another high priority need which is being served by our protected forests -- the national parks and wildlife preserves -- system. Altogether, the system covers an area of some 21.9 million rai, in 79 parcels. The Khao Yai National Park is a prime example of a protected area that stands to provide multiple benefits from the point of view of conservation as well as of recreation. But even Khao Yai is subject to regular encroachment and poaching. Details are given and discussed in Chapter 5.

The extent and status, of our land and mangrove forests are discussed in Chapter 4 and 7. Unless Thailand conserves these resources, ensuing sustainable development rather than ruthless destruction, Thais may experience "environmental bankruptcy" along the lines of Africa's Sahel and Ethiopian highlands.

Water Resources

Thailand receives a good rainfall, at an average volume of some 800,000 million cubic meters each year. That is enough water to keep a standing surface of 1.7 meter depth throughout Thailand, provided it was not absorbed or evaporated. But evaporation and infiltration are important factors, leading to about 171,206 million cubic meters of surface runoff, distributed unevenly among the regions and between seasons.

The surface water quantity for each river basin is determined as the annual runoff volume in million cubic meters at the river mouth, or expressed in terms of depth in millimeter of water over the basin area it covers. The Chao Phraya Basin of the Central Plain is Thailand's largest, with an annual runoff of 170 millimeters. The Maeklong Basin, west of Bangkok, has an annual runoff of 406 millimeters; the Mun Basin of the Northeast, 238 millimeters. These runoff figures provide a simple indicator that the runoff from Maeklong is very large indeed and could perhaps be diverted to the Central Plain, which requires more water for its economy.

Groundwater is another resource that exists throughout the country, but varies considerably in quantity and quality. Large and high yielding aquifers occur in alluvium and terrace deposits. That favors the Bangkok Plain. In the Northeast, the groundwater from most wells is salty. In the Bangkok area the abstraction rate of groundwater is exceedingly high, surpassing the estimated safe yield by at least 0.5 million m^3/day, or more, bringing the prospect of salt water contamination, in addition to the land subsidence problems already experienced.

Water resource development

The status of water resource development is indicated by the land area covered by irrigation projects. The current figure stands at 25 million rai, out of 152 million rai of agricultural land. The actual irrigated acreage and the extent to which cropping under irrigation control can be practiced at different seasons are influenced by several factors, for there are other essential demands for the water.

Potable water from groundwater supplies the needs of the use without access to piped water. The 1984 abstraction estimates were 880 million cubic meters, about half of that used in the Metropolis.

Another important aspect is hydropower development, to satisfy increasing public demand for electricity. The 1985 status is a total of 1,513 MW operational, and 753 MW under construction. In addition, there are several microhydropower projects, with a combined capacity of 1,123 kW, and more in progress. Hydropower meets only one-fifth of total demand.

Our water resource development activities are implemented and supervised by no fewer than 30 agencies and 17 committees, costing an estimated 402,608.4 million baht over the 55 years between 1928 and 1983. Yet Thailand still does not have a national master plan, nor a national agency for water resources.

Regional differences

The North's rainfall pattern is fairly reliable and its lowland area is only 10 percent of the total. This makes for a very bountiful supply of surface water, and also for exaggerated flooding downstream from the slash-and-burned areas used for shifting cultivation. The region's irrigation system is well developed, and there is an intensive diversified cropping system. The North's water is also crucially needed to meet the water demand of the Central Plain, where economic activity and urban development are intense. A time will come when there must be a decision for fair appropriation of water, perhaps quite soon.

The Northeast receives comparable annual rainfall to the North, but with a somewhat unreliable pattern. Flooding alternates with water shortages. The regions's sandy soils hold water poorly, and are also generally poor in plant nutrients. Cassava is the crop that best suits these conditions. Only about eight percent of the area is in the river flood plains and has good alluvial soils. This smaller area provides the Northeast with a more diversified crop production. The annual water runoff from the Mun-Chi river system is higher than that of the Chao Phraya, but there are no extensive reservoirs and water distribution systems to improve water utilization.

The Central Plain has more farm land and the largest irrigated area, almost one-fourth, that has helped increase the rice production through dry season cropping. Its two major river basins -- the Chao Phraya and Maeklong -- represent a good water supply, but water demand is increasing rapidly. The increase is due mainly to industrial expansion, more dry season crop production, urban needs, and to the extra supplies needed to combat saltwater intrusion.

What the future holds

In 1986, the question of whether or not to build the Nam Choan Project was highly controversial. There have been arguments about details now known, not yet known, and not really known. The outcome will affect the public, either way. Yet there are larger questions ahead. The Central Plain, for example, requires an increasing supply of raw water for its essential activities, all important. The North, too, will find that it requires to keep more water for its own expanding economy. Will the North have first right to this precious water?

The Greater Chao Phraya Project supplies irrigation water to 7.5 million rai in the wet season, and some 3 million rai in the dry season. But when all factors are considered, there will be, at most, water enough for 2.5 million rai of dry season crops. When Bangkok demands a greater volume of raw water for its huge urban population, the dry season acreage could be upset. Clearly, there are many pressing issues, and certain ways in which they could be resolved. These are discussed in Chapter 3.

To resolve such issues peacefully and in good time, it would be to our benefit to prepare and adopt a master plan for water resource development, under which multipurpose projects could be planned and implemented. Given the impending shortages of water, such multipurpose projects are the best choice. At the same time, the new concept of rights and duties of water users cannot be put off. The days of free water are numbered.

Mineral Resources

Thailand lies within the metallogenic belt of Southeast Asia, containing a wide complement of mineral deposits, some 40 of which have been produced to date. Among them, the discovery and mining of large scale tin deposits, both onshore and offshore in the peninsular South, started the modern mining industry. Subsequently, exploration and extraction followed for other mineral ores notably zinc, fluorite, gypsum, lead, barite, tungsten, columbite-tantalite, antimony, and some 30 others. Such development brought this country a foreign exchange earning of some 14,934 million baht in 1980, about three-quarters of which was from tin. With the weakening of the world economy, however, 1985 earnings dropped to 7,779 million baht, a trend which seemed likely to continue through 1986. All key economic minerals seemed to be affected by this demand slowdown.

Local consumption

To soften any adverse effect of the world market on Thai commodities, a sound basic strategy would be to boost local consumption at the expense of the export of primary products. There is a bright prospect for minerals. The local consumption is becoming significant. Its share of value increased from 873 million baht in 1981 to 4,187 million baht in 1985, excluding petroleum products, but including lignite, which accounted for 60 percent of the domestic mineral consumption value. Generally, it can be anticipated that local consumption is indicative of a value-added utilization through the growth of local manufacturing industries, encouraging the expansion of local employment.

Gas and oil

The natural gas, condensate or "natural gasoline" and crude oil industries are more recent in origin. At present, local energy production satisfies 40 percent of the country needs. The combined value, from both offshore and onshore sites, rose from 6,066.5 million baht in 1983 to 17,010.5 million baht in 1985. The condensate is not utilized locally, for Thailand has a surplus from its refineries due, in part, to the national pricing policy. It must be exported. Reassessment is needed, however.

The future for tin

Tin will continue to meet the needs of the tin-plate industry, which supplies the canned food manufacturers. There is as yet no efficient substitute for the tin-plate can. In the past, both supply and demand were "artificial", to the benefit of non-producing exporters. There are real possibilities for Thailand to adopt new marketing and trade strategies to give tin a continuing strong export role as well as an increasing role in local manufacturing industry.

...and tantalum

Thailand holds the largest share of tantalum production at 46 percent, unrefined. World production appears to be declining, but the electronics industry is the biggest consumer, and its appetite is growing. Tantalum is essential for space-age weapon systems. Barring another disaster, the prospects for Thailand in the tantalum market are good.

The environmental costs of mining

The mining industry possesses adequate technologies to make ore extraction, recovery and processing a "clean" business, legally and environmentally. Yet there are widespread cases of "dirty" operations that have damaged the environment, as well as the honest citizen, or which have spoiled mineral reserves with the poor extraction that came with illegal operation. What is

needed is a systems approach to mining, which safeguards the health both of the industry and of the environment. These issues are discussed in Chapter 6.

Fishery Resources

Thailand's fishery resources are harvested from the Gulf of Thailand, the Andaman Sea, rivers, lakes and reservoirs. The harvest includes fish, crustaceans, molluscs and other marine fauna and flora. Pond aquaculture, coastal brackish water culture, and mariculture are recent additions. Their market shares by weight are very small compared to fish capture by the established marine fisheries. However, in terms of value, the products of aquaculture and mariculture normally command premium prices, thereby encouraging further development. The new industry is vulnerable because of its close proximity to polluted water sources that could produce a real threat to its survival. The development and introduction of new technologies would assist aquaculture as it has done so with the marine fisheries.

Overall, the country's marine fisheries have demonstrated an impressive growth record of production in terms of fish capture -- at a current annual rate of some 2 million tons, placing Thailand within the top eight countries worldwide. This achievement came with hard work during the past 24 years, with credit to be shared by both the public and private sectors, with equal attention to new technologies, new training and new investment. Details are provided in Chapter 8.

Fish utilization

Annual per capita consumption of fish is some 22.5 kg, leaving a sizable amount (roughly a million tons) for other purposes, including export. When the total captures were small, most of the catch went to the fresh fish markets, and almost none to the fishmeal factory. With greater capture tonnages, the fishmeal factories have taken a large share, reaching 49 percent in 1980, but currently down to about 38 percent. The changing pattern also affected the post-harvest industry that manufactures traditional preserves, as well as newly introduced product lines. Shrimp, bivalves, squid and cuttlefish also share significantly in a new market structure. However, fish and fish product imports also show a small increasing trend, commensurate with the expanding economy.

The maximum sustainable yield (MSY)

Compilation of fish capture data, and of the effort and time expended in sea fishing over the years, provides a fair basis for the estimation of a maximum sustainable yield (MSY) for each area of water, such as the Gulf and the Andaman Sea. The estimated MSY provides a guide to a safe level of exploitation of fishery resources, whether pelagic (surface dwelling) or demersal (bottom dwelling) fishes. The past records indicate safe levels of exploitation in the Andaman Sea, but over-exploitation in the Gulf. It could be anticipated that, the effect of over-exploitation would show up in diminishing return per effort at sea -- unless the trawlers add to their catch by fishing in international waters.

The human elements of technologies

The phenomenal growth of the fishery harvest since the 1960s reflects an efficiency improved by the introduction of new technology -- such as the trawl net fishing -- with subsequent adaptation and modification of the techniques, more powerful trawlers, new training and the addition of needed infrastructures, plus growing consumer demand. But this great improvement through technology also creates a danger of over-exploitation, unless people's awareness of the resource situation and self-control assist any

legal measures. There are other areas of concern, such as the use of explosives underwater. New technologies entrain important social, economic and ecological implications which need to be identified and evaluated.

The victims of pollution

The freshwater aquaculture industry's problems with polluted water and disease are widely recognized, but its growth pattern remains strong. The same is true of brackish water culture. The silent sufferer has been the mariculture of bivalves -- oysters, mussels and blood cockles -- in certain areas of the inner Gulf receiving water-flow through large urban and industrial centers. Much of this water is heavily infused with untreated wastewater (see Chapter 10). The problem can be corrected, not at the mollusc breeding site, but investment in and proper operation of waste and wastewater treatment plants.

The exclusive economic zone (EEZ)

The Thai fishing fleet has so far suffered damage estimated at 2,000 million baht since neighboring countries enforced their EEZ. The other expenses incurred must be also sizable, not counting life and family loss. Thai trawlers are handicapped in modern navigation and international communication, but are capable of venturing into the high seas. Certain international joint ventures have been suggested, and are being actively pursued by various agencies. Further appropriate training, equipment and other technology will be required for successful ventures outside Thai waters. This strategy may also help keep the level of exploitation in the Gulf within the MSY, ensuring a share of this wealth for future generations. Another approach would be expanded further in the aquaculture, brackish water culture and mariculture sectors, with investment, technology support and proper environmental studies linked into development planning.

Environment

The natural resource base of Thailand is considerable : its utilization, interacting with population trends and needs, dictates the prevailing environmental quality. Concerns about the degradation of forest, land and water resources has been increasingly evident and has accelerated with growing population pressure. Of more immediate concern is the deteriorating environmental quality around most urban centers and industrial sites, as discussed in Chapter 9, 10, 11 and 12.

Air

Air pollution may be familiar to urban residents because of their closeness to a major emission source, vehicles or factories burning petroleum products. Industry is now a minor contributor to air pollution and noise, compared to motor vehicles. Rural areas also have their problems, but the greater dispersion cuts down the nuisance. Lignite is a new energy source that threatens to contribute relatively greater share of emission with its projected increase for the industrial uses -- especially for power generation in the future (see Chapter 9).

Technologies are available to clean up or cut down polluting emission and noise. The observed reduction of lead oxide in the air is a result of the decision to regulate and reduce the lead content in gasoline. The emissions from lignite burning also could be reduced significantly, at a cost. The airport noise problem could be made less of a nuisance, provided effective zoning discouraged new housing development near the established airport. Too often, however, the housing envelopes already established noise sources, such as Don Muang International Airport, or hazardous gas and chemical depots in the City's

suburban area.

Water

The Bangkok Metropolis consumes a disproportionately large amount of water that must be taken from the Chao Phraya and from groundwater at a combined rate approaching one cubic meter per person daily, which is believed to be in excess of the safe limit. The problems are twofold: inadequate clean water supply and inappropriate waste treatment threatening the clean water supply -- both the surface and groundwater. Increased pumping capacity can be purchased, but naturally clean water supply cannot. The treatment cost of raw water prior to distribution is rising. Contamination of the aquifer by leachate from city garbage, and by high chloride content, forcing well closure, is increasing. Saltwater encroachment into freshwater aquifers is facilitated by over-pumping. Once ruined, such aquifer pollution may not be reversible.

Wastes

Solid wastes and wastewater, created by urban consumers, are taxing environmental quality at an accelerated rate in heavily populated cities and towns. Technologies to treat them are available, at a cost to consumers - who are used to free resources. It is up to the public to decide how much they will pay - and how much they will put up with. The requirement of a wastewater treatment system for Bangkok Metropolis, and other urban centers, can be met in several ways. The major cost component is not the treatment plant itself, but the delivery or piping system needed to transport wastewater from the multitude of households, factories, hospitals, and so on. Meanwhile the detectable cases of acute diarrhea increased eightfold during the past decade, despite advancing public health care. This is but a small indicator of Thailand's changing environmental status, which requires contemplation and appropriate action.

Nontoxic solid waste output per capita ranges from 0.56 to 1.27 kg/day, increasing with income. The trend is for increasing output with further economic development, and for increasing treatment costs. Current treatment is minimal, certainly not adequate to safeguard the quality of rivers or aquifers. Solid waste and its leachate are pushing up the oxygen demand level in river water, and crippling the life-support capacity of the water. Dumping of solid wastes from factories and drainage of agricultural wastes into the upstream flow, contribute to cumulative pollution problems, especially in the lower section of the Chao Phraya and Thachin rivers feeding into the upper Gulf.

Toxic substances

Some toxic substances from factories, farms and homes, including heavy metals, pesticides and toxic chemicals, are non-biodegradable under natural conditions, biologically accumulated and magnified, and lethal or capable of producing detrimental cumulative effects. These are being detected in variable concentrations. Though their concentrations in any particular commodity are regarded as being still within the safety limits, their accumulation in the sediment layers of major rivers and the Gulf needs regular monitoring and proper management.

There are suggestions for special precautions to be taken when locating chemical industry sites in order to cope with any inadvertent toxic pollution of major rivers. A city like Bangkok should not absorb any chemical pollution upstream into its intake of raw water for its potable water supply. A careful reassessment of this possible effect is needed after the Bhopal accident. There also is a need for a contingency plan to counter any possible accidental release of toxic chemicals from stockpiles and factory waste dumps.

Accidents and health

Accident prevention is also applicable to some 25 million workers who are now exposed to new dangers in industry and agriculture. Presently the rate of accidents and injuries is considerable, especially in industry (see Chapter 12). The death rate from accidents is in the region of 32 per 100,000 workers, with a disproportionately large share in the construction industry. The 1985 injury claims disbursed, that partly covered industrial workers, amounted to 232 million baht. There are recognized to be more unreported or nonregistered cases in industries not now covered by the Workmen's Compensation Fund, in certain agricultural sub-sectors with over reliance on pesticides, and also in certain high risk mining operations underground or underwater.

Some aspects of hazardous work conditions are being camouflaged by the quick turnover of workers and by the absence of continuing health surveillance. Those workers being exposed, for example, to lead or manganese poisoning in manufacturing factories, to toxic chemicals in certain farming operations, to silicosis in the mines, generally do not die on the job. They succumb following "quick retirement", hence the impacts are difficult to assess accurately. Health surveillance on a continuing basis would help all parties.

The future

To safeguard the overall environment, including the working environment, in order to assure healthy living for every citizen, there is a need for a positive assessment of the legal controls and supervising agencies related to all the intermixed components of the environment and resource utilization. The public needs accurate information on the situation and on what can be done. A label displaying the same level of hazard warning for "Folidol", a lethal formula, and "Sevin", an all-purpose formula, misleads the less informed into treating the lethal one too lightly, and they may pay dearly for it. The workforce needs appropriate training -- for the job and for accident prevention. Integrated planning to realize such targets set within the national development plan, is essential.

Some Interrelationships

The foregoing brief reviews of Thailand's natural resources -- soils and land use, forest resources, water resources, mineral resources, fishery resources, and environment -- express a series of tangible interrelationships among resources, environment and man. Man exploits these resources, shapes the environment and either benefits or suffers, often both, because of his own activities. The benefits and costs are rarely shared equitably.

The country's natural resource base supports its citizens with wealth in food production and consumer goods. All production activities can be made sustainable with good management and effective cost control. The products, in turn, support the well-being of the population; the production processes reshape the environment that affects man as well as the resource base. The resource base is at the mercy of man's habits and actions. With discipline, this base can be kept alive and well; without it, the ecological deficit begins to soar.

Why an ecological deficit?

An ecological deficit results from extracting more from a "living" system than can be replenished with new growth. The demand exceeds the "carrying capacity". The topsoil loss is greater than the new soil formation; the land becomes less and less productive, and without correction will become finally

unproductive. The trees are harvested in larger numbers than new growth permits, out pacing the new trees planted; the forest diminishes in area and in its capacity to support other living plants and animals. The fish harvest is in excess of the maximum sustainable yield; the fish stocks decline, and in time collapses.

The ecological deficit reduces the resource base upon which man depends. A reduced base supports less people, at the very same moment that the population is expanding and the average citizen is demanding a better standard of living.

1.3 KEY ISSUES

There are large numbers of important issues relating to the exploitation of natural resources, and to the degradation of the environment. The links with the potential for sustainable economic and human development are discussed in each chapter. But with their interrelated effects, linking each of them to a common factor -- population needs -- there is in reality only one main issue: how to meet the population needs of 2001 A.D. and beyond.

Thailand's projected population in 2001 is likely to be between 65 and 69 millions depending on the outcome of predicted growth patterns. To feed this population, the annual food needs in term of all cereals and coarse grains (at approximately 180 kg per capita) will amount to 11.7 - 12.4 million tons, supplying barely enough energy to meet the minimum requirement just to keep people from hunger. If an affluent standard for all is desired, the annual grain needs will amount to 50.7 - 53.8 million tons, half of which will be food grains, while the others half will be used to raise fish, poultry and livestock, and in certain industrial uses.

How will Thailand fare?

Future considerations

To provide for future population needs, assuming a mid-level standard of living, or better, for more people by 2001 and beyond, the following considerations among many others, require further scrutiny:

a) Land use planning and zoning to increase land productivity. There is a need to refine the agro-ecological zones based upon current land suitability work, agro-economic zones, conserved and protected forest area requirements, economic forest areas, freshwater and brackish water aquafarm areas, and potential water resource development for specific zones. Agro-ecological zoning can greatly assist in ensuring the required production volume, as well as sustainable production. The zoning for agricultural land, industrial sites, human settlements and recreational areas will become increasingly critical to future efforts to feed and house more people to improved standards.

b) Forest cover conservation and maintenance. A step beyond declaration of intent will be needed to be able to demarcate the forest cover boundaries additional to the parks and wildlife refuges, which need effective protection, replanting and maintenance (see Chapter 5). Watershed classification and protection, the practicable operation of economic forest, social forestry and agro-forestry program : all these are essential contributors to successful land use planning and also contribute towards an acceptable environment. The package will have a greater chance of being successful if the sacrifices and benefits are well understood and accepted by the people who must participate. The current integrated management planning of the mangroves, parks and wildlife refuges, if fully implemented and expanded, can be adopted and tailored to fit other zones.

c) Water use and availability. The effort to achieve sustainable maximum productivity from the land depends

heavily on the efficiency of water use. Water use technologies involve both technical and social considerations. Appropriate technologies need much development effort to achieve the desired sustainable productivity. The sharing out of water supplies -- e.g. rural vs. urban needs; regional vs. subregional shares -- needs attention and clear guidelines. Proper water economy awareness, among farmers as well as urban industries and dwellers, must be created to ensure a reasonably adequate distribution to relieve the pressure on new supplies of water. The public needs to be informed and convinced of the possibly disastrous effects arising from abuses, such as over-abstraction from artesian wells, or irrigation without adequate drainage systems in critical crop land.

d) Expanded employment. The noneconomic aspects of creating more jobs for the coming population are related to the necessary exploitation of natural resources -- minerals, water, fisheries, forests, mangrove forests, land, and so on -- and, inevitably, to environmental quality. The fiber and food industries influence, and are in turn influenced by, the land use pattern. Diversification into livestock and fisheries, inclusive of aquaculture, add jobs and other benefits. The manufacturing industries are linked to better return from mineral resource exploitation, providing more jobs. But expanded employment, it is important to remember, also often adds more pollutants.

Is it possible to optimize all these components in an integrated package of area-oriented planning and implementation?

e) Environmental cleanup costs. Environmental quality affects human health and also the productivity of natural resources. And all processes, from exploitation through consumption to waste disposal, affect the environment. This effect could be prevented, corrected or minimized at a cost -- the cost for environmental cleanliness -- that will be both monetary and social.

The problems and needs of more expanding urban centers, of more crowded rural settlements, can only increase with more industrial activities, more intensive farming, more consumers' wastes. Old and new pollutants demand management and control, at a cost that was never fully paid before.

The cost must be paid to ensure the survival of future generations, to ensure their health, and the longest possible benefits from all life-supporting resources.

Are we willing to pay this cost to provide a clean, healthy and sustainable future, or do we elect to pass on the deficits by taking no action?

To prepare to meet the demand of the future, we need to look into a concept of "sustainable development", that will assist the planners and implementors of Thailand's natural resource management programs in boosting the sustainable rate of exploitation and benefits, as well as keeping environmental quantity within acceptance limits for us all. Key facts and thoughts are presented in the following chapters of this Profile. They provide the facts needed to think about - and plan for - our future.

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Part II Natural Resources Management

2 Land Resources

2.1 PRESENT STATUS

Land use

The land use of Thailand in 1985 is given in Table 2.1. As indicated, the total area of agricultural land is 152,041,555 rai. Agricultural land use can be classified by the following types of crops: (1) paddy, 84,250,816 rai (55.42 percent); upland crops, 51,411,432 rai (33.82 percent); vegetables, 101,262 rai (0.06 percent); para rubber, 10,541,957 rai (6.93 percent); oil palm, 386,421 rai (0.25 percent); and fruit and perennial crops, 5,349,667 rai (3.52 percent).

Changes in land use

Land use is a dynamic process. It changes over time due to a number of factors, including increasing population and changes in cropping system and technology. It is a well-known fact that prior to the mid-1950s agriculture in Thailand was characterized by mono-cropping, with rice as the only major crop. Indeed, in 1960, rice took almost 60 percent of the total cultivated area, compared to 12 percent and 16 percent for upland and tree crops, respectively, while forest covered almost 60 percent During the period of 1960-1984, rice remained predominant as its share of acreage increased to 63.5 percent in 1975, then dropped slightly to 61.8 percent in 1980 and to 59.6 percent in 1984. Upland crops gained substantially in terms of cultivated area, increasing from 7.5 million rai in 1960 to 29.2 million rai in 1984. In terms of proportion, upland crops increased from 12 percent to 23 percent during the period. Tree crops (including fruit trees) dropped sharply during 1960 and 1975, then increased slightly in later years. Forest land changed drastically, however, decreasing from 189.5 million rai (58.5 percent of the total area) to only 93.2 million rai (29.5 percent) between 1960 and 1985. Obviously, the great expansion of cultivated land during the period has been made possible due to the tremendous reduction in the forest area.

On a regional basis, during the past decade, a remarkable change in land use is observed in field crops in all regions, except the South, where fruit trees and tree crops are most important (see Table 2.2). It can also be seen that forest lands were heavily encroached in the Northeast. During this period (1975-1983) fram size remained rather stable (Table 2.3).

Land Productivity

Productivity of some of the more important crops in Thailand are discussed in this section. It is generally known that land productivity in Thailand has been rather low and, in some cases, has been declining. For example, average yield per rai of major rice from 1982 to 1986 is only 302.8 kilograms per rai. This is about three times less than that of Japan, U.S.A. and Taiwan. Yield of rice also varies by region, ranging from 242, 272, 364 to 387 kilograms per rai in

Table 2.1 Land Use of Thailand in 1985

Land Use	North	Northeast	Central	East	South	Total	%
National Forest Reserve	64,813,044	33,795,752	12,745,989	8,792,759	16,088,625	136,236,169[a]	42.48
Agricultural Land	34,800,024	62,253,054	23,462,167	11,958,351	19,567,950	152,041,555	47.41
Rice	21,421,217	38,912,126	13,224,632	3,491,216	7,201,625	84,250,816	
Upland Crops	12,618,243	23,268,231	8,461,206	6,742,125	321,627	51,411,432	
Horticulture	37,644		63,618			101,262	
Para Rubber				1,011,352	9,530,605	10,541,957	
Oil Palm					386,421	386,421	
Perennial crops	722,920	72,697	1,712,711	713,658	2,127,681	5,349,667	
Urban	466,321	494,399	1,131,627	212,611	431,627	2,736,585	0.86
Water Bodies	601,249	992,113	632,616	181,661	651,617	3,059,256	0.95
Others (abandoned land, marsh, swamp, rock-outcrop, beach, pasture)	5,347,042	7,925,948	5,478,104	342,430	7,457,164	26,623,385	8.30
Total	106,027,680	105,533,963	43,450,503	21,487,812	44,196,992	320,696,950	100.00

Note: a. including already encroached forest lands.
Source: TDRI, 1986.

Table 2.2 Land Utilization by Region, 1975, 1980 and 1983
(1,000 rai)

Year	Region	Total Land	Forest Land	Farm Holdings					Unclassified Land
				Total	Paddy Land	Field Crops	Fruit Tree & Tree Crops	Others[a]	
1975	Northeast	105,534.0	28,823.7	47,497.2	34,090.3	7,526.7	467.2	5,413.1	29,213.0
	North	106,027.7	66,186.6	23,954.6	15,831.1	6,061.0	617.5	1,444.9	15,886.5
	Central	64,938.3	22,403.8	27,520.0	16,823.1	6,256.3	2,134.2	2,306.4	15,014.5
	South	44,197.0	13,348.2	13,239.6	4,494.8	108.5	7,193.7	1,442.6	17,609.2
	Whole Country	320,696.9	130,762.3	112,211.3	71,239.2	19,952.6	10,412.5	10,607.0	77,723.2
1980	Northeast	105,534.0	17,748.5	50,093.0	35,886.4	9,901.0	461.0	3,844.6	37,692.5
	North	106,027.7	57,028.2	26,025.2	16,783.0	7,182.0	757.8	1,302.4	22,974.3
	Central	64,938.3	18,010.8	29,063.0	16,054.7	8,571.6	2,280.1	2,156.5	17,864.4
	South	44,197.0	10,631.2	13,817.7	4,838.9	103.1	7,643.4	1,232.3	19,748.1
	Whole Country	320,696.9	103,418.7	118,998.9	73,563.0	25,757.8	11,142.4	8,538.8	98,279.2
1983	Northeast	105,534.0	15,822.3	53,270.1	36,576.1	11,477.2	614.6	4,602.1	36,441.6
	North	106,027.7	54,077.5	27,939.9	16,913.9	8,561.0	870.6	1,594.4	24,010.3
	Central	64,938.3	16,295.3	28,665.5	15,193.8	9,257.0	2,322.5	1,892.3	19,977.4
	South	44,197.0	10,072.3	14,354.7	9,450.8	132.9	8,098.8	1,172.2	19,769.9
	Whole Country	320,696.9	96,267.4	124,230.3	73,634.7	29,428.1	11,906.5	9,261.0	100,199.3

Note: a. Including lands for housing, vegetable and flowers, grass land, idle land and other lands.
Source: Center for Agricultural Statistics, "Agricultural Statistics of Thailand Crop Year 1983/84 and 1984/85."

Table 2.3 Farm Size and Number of Farm 1975, 1980 and 1983

Year	Region	Farm Size (rai)	Number of Farm
1975	Northeast	28.3	1,675.7
	North	22.7	1,054.5
	Central	33.3	826.5
	South	23.5	563.4
	Whole Country	27.2	4,120.0
1980	Northeast	28.0	1,786.5
	North	22.4	1,162.2
	Central	32.6	891.6
	South	22.0	626.8
	Whole Country	26.6	4,467.5
1983	Northeast	27.4	1,944.3
	North	22.3	1,253.5
	Central	22.6	880.0
	South	22.6	635.3
	Whole Country	26.4	4,713.0

Source: Center for Agricultural Statistics, "Agricultural Statistics of Thailand Crop Year 1983/84 and 1984/85."

the Northeast, South, Central and North respectively (Table 2.4). As for the second (dry- season) rice, yield per rai is much greater. The average yield from 1982 to 1986 is 578 kilograms per rai. Most of these (80 percent) are produced in the Central Region, however.

On the otherhand, yield of rubber has been increasing rapidly since 1966, i.e. from about 30 kilograms per rai in 1966 to almost 88 kilograms per in 1984. This might have been attributed to the rubber replanting scheme in the South (Table 2.5).

The case of maize is also similar to that of rubber. Maize yield is rather uniform in the three producing regions namely, Northeast, North and Central, averaging about 385 kilograms per rai during the period 1982-1986 (Table 2.5).

Yield of cassava (tapioca) shows a declining trend. The yield was rather high in early 1960s, when cassava was planted in the relatively new and fertile lands then. The average yields from 1982 to 1986 are 2,301, 2,531 and 2,732 kilograms per rai in the Northeast, North and the Central regions respectively. While the Northeast, although the most important producing region, has the lowest yield (Table 2.6).

The yield of sugarcane, another important crop of Thailand, varies slightly between the regions. The average yield from 1982 to 1986 is 7,126 kilograms per rai. The Central is the most important region, producing 70 percent of sugarcane in the country (Table 2.6).

2.2 Trends and Issues

Although a coherent national land policy has not been formulated during the past two decades, guidelines underpinning the administration of national land use have been formulated by various National Economic and Social Development Plans. The major focus of each Plan can be summarized as follows:

a) The First National Economic and Social Development Plan (1961-1966) emphasized land classification and land allocation.

b) The Second National Economic and Social Development Plan (1967-1971) emphasized the improvement of landownership for agriculture, land-leasing systems for agriculture and agricultural productivity.

c) The Third Plan (1972-1976) emphasized ownership, the need to prevent or eliminate the loss of landownership by farmers and to increase farmer land-holding, land productivity and, increasingly, land conservation.

d) The Fourth Plan (1977-1981) emphasized land reform as a primary component of agricultural development.

Table 2.4 Harvested Area, Production, and Farm Value of Major Rice and Second Rice in Thailand, 1977 to 1986

Year	Major Rice[a]			Second Rice[b]		
	Harvest area (10^6 rai)	Production (10^6 tons)	Farm Value (10^6 baht)	Harvest area (10^6 rai)	Production (10^6 tons)	Farm Value (10^6 baht)
1977	48.3	13.7	25,218	2.7	1.4	2,644
1978	51.8	12.3	28,652	2.9	1.6	3,399
1979	51.9	15.2	33,256	3.9	2.3	4,898
1980	52.1	14.6	38,217	2.0	1.1	2,827
1981	54.3	15.4	47,263	3.2	2.0	6,270
1982	53.3	15.8	44,691	3.6	2.0	5,766
1983	52.0	14.8	43,378	3.9	2.1	6,108
1984	55.6	16.9	46,847	4.4	2.6	7,741
1985	55.8	17.3	42,842	4.4	2.6	6,572
1986	57.5	17.9	41,579	4.0	2.3	4,344

Notes:
a. Wet Season
b. Dry Season
Source: OAE, 1986 p.14-15.

Table 2.5 Harvested Area, Production and Farm Value of Rubber and Maize in Thailand, 1976 to 1985

Year	Rubber			Maize		
	Harvest area (10^6 rai)	Production (10^6 ton)	Farm Value (10^6 baht)	Harvest area (10^6 rai)	Production (10^6 ton)	Farm Value (10^6 baht)
1976/77	6.8	0.394	3,591	7.0	2.7	4,468
1977/78	6.8	0.431	4,287	6.1	1.7	2,750
1978/79	6.8	0.467	5,889	8.2	2.8	4,493
1979/80	8.9	0.534	7,673	8.9	2.9	5,984
1980/81	7.8	0.465	7,434	8.4	3.0	7,285
1981/82	7.9	0.508	6,717	9.2	3.4	7,518
1982/83	8.9	0.576	9,567	8.2	3.0	6,125
1983/84	8.9	0.594	8,688	9.8	3.6	8,846
1984/85	8.6	0.617	9,109	10.9	4.2	9,846
1985/86	8.8	0.773	11,711	12.0	4.9	8,832

Source: OAE, 1986 p. 30 and 104.

Table 2.6 Harvested Area, Production and Farm Value of Cassava and Sugarcane in Thailand, 1977 to 1986

Year	Cassava			Sugarcane		
	Harvest area (10^6 rai)	Production (10^6 ton)	Farm Value (10^6 baht)	Harvest area (10^6 rai)	Production (10^6 ton)	Farm Value (10^6 baht)
1976/77	5.2	11.8	5,565	3.1	26.1	7,509
1977/78	6.6	16.4	6,052	3.5	18.9	5,453
1978/79	5.0	11.1	8,548	3.2	20.6	5,493
1979/80	7.0	16.5	12,405	2.7	12.8	4,968
1980/81	7.8	17.7	8,162	2.9	19.9	12,623
1981/82	6.8	17.8	9,072	3.8	30.2	14,427
1982/83	6.4	19.0	14,052	3.6	24.4	7,517
1983/84	8.3	20.0	13,190	3.3	23.9	8,282
1984/85	8.6	19.3	7,705	3.3	25.1	7,642
1985/86	7.5	15.3	11,899	3.4	24.1	5,710

Source: OAE, 1986 p. 38 and 46.

Additionally, the appropriate land use regulations were to be made more responsive to economic, social, political and natural environmental considerations.

e) The Fifth Plan (1982-1986) emphasized the following: (1) the need to accelerate land use policy formulation; (2) the holding limit not to exceed 50 rai for private individual landholders for agriculture and the establishment of the Land Bank; (3) the acceleration of land reform, emphasizing the central and the lower northern regions; (4) the surveying of fertile soils in deteriorating forest areas, to be allocated for settlement to farmers; (5) the upgrading of legislation to regulate the rate of land-leasing; (6) the improvement of special problem soils e.g. saline and alkaline soils, acid sulfate soils; (7) increased regulation for the protection and preservation of agricultural land.

(f) The Sixth Plan (1987-1991) emphasizes the following: (1) improving efficiency in land use by means of preparing land use development plan and land information system; (2) speeding up land ownership distribution by setting up land bank and accelerating land reform program; (3) improving land taxation system and land valuation; (4) accelerating the classification of suitable land for agriculture from forest lands; and (5) accelerating land allocation and land titling programs.

Land Administration

Land Administration in Thailand has long been established and gradually developed as follows:

a) Sukhothai Period (1238-1350)

A part of King Ramkhamhaeng's stone inscription of 1292 says:

"This Sukhothai is good. In the water there are fish, in the field there is rice. The King does not levy a tax on his people... whoever wants to trade in elephants can do so. Whoever wants to trade in horses can do so. Whoever wants to trade in silver or gold can do so. The face of the people shines bright..."

The policy of land management was alsc

implicitly stated in the first inscripting stone, a part of which says:

"...everywhere in this Kingdom there are betel vine and betel nut forests. There are also in this Kingdom many coconut, jackfruit, mango, and tamarind forests. Whoever plants them, unto him they shall belong..."

From this inscription, it is clear that there was a policy encouraging people to utilize the vacant and unused land by granting ownership rights. It is assumed that there was no land for sale at that time.

b) Ayutthaya Period (1350-1767)

In 1360, due to disputes in land ownership, the Land Code of 1360 of the Comprehensive Law (Kod Mai Beth Seth) was issued. All land now belonged to the King. A private land holder was entitled to possession, not ownership. He could neither alienate his land nor did his heirs inherit it after him. Towards the end of the Ayutthya period, however, land holders were absolute owners and land became alienable quite freely. There was no issuance of land right documents at that time.

c) Rattanakosin Period (1782-present)

Early Rattanakosin Period (1782-1932)

Before 1899, most of the forest land in the country belonged to the feudal chiefs. The forests in the northern part of the country were divided up among the five feudal chiefs of Chiang Mai, Lampoon, Lampang, Phrae and Nan. They were recognized as properties to be maintained by these chiefs and passed on to their heirs (RFD, 1968).

In 1896, the Royal Forest Department was established by King Chulalongkorn and was attached to the Ministry of Interior. It was entrusted with the function of dealing with forest activities in the Kingdom (RFD, 1968). Three years later, in 1899, ownership and control of all forest were transferred from the feudal chiefs to the Government.

In 1901, the Department of Lands was established in the Ministry of Agriculture, and undertook a national land survey on which a new system of land registration was based. The Torrens System, the system for land tenure and transfer, was introduced into Thailand. The major procedures of the Torrens System are as follows: the government staff examine claims, register the documents, issue the land titles, and the government subsequently guarantees the accuracy of them. In 1908, the Land Title Deed Issuance Act was promulgated.

1932-Present

On 24 June 1932 there was a revolution and Thailand changed from an absolute monarchy to a constitutional monarchy. A constitution was adopted in March 1933. The new Government tried to modernize the country in social, economic, political, educational, and other ways. An economic plan was prepared and it was intended that the Government should decide how the nation's land should be classified (Vella, 1955). But such plans were not implemented until 1961.

Between 1932 and 1960 there were many laws and regulations related directly or indirectly to land resources. In 1954, for example, the government issued a Land Code by collating several land laws. It covered land survey, registration, issuance of land right documents, land allocation, control of state land and land preservation. The enactment of the Land Code provided the Government with an effective legal framework to control land uses, determine ownership and generate revenues from land. The Department of Lands has the prime responsibility for execution of the Code.

In the Rattanakosin period, several government agencies involved with land

administration have been established. The First National Economic Development Plan began in 1961. In this plan, a policy for land classification was stated for the first time. A program of land allocation to the landless farmers was also launched by the Government.

Land Classification

Article 7 of the Land Code of 1954, states that all land will be classified by soil fertility and land suitability. In order to ensure that the forests will be protected for the national benefit, the First Plan (1960-1964) stated explicitly that it would be necessary to reserve 256,000 square kilometers (or 50 percent) of Thailand as national forest. At that time there were about 300,000 square kilometers (58 percent) of forest lands. The plan allowed for a possible decrease of forest area to 200,000 square kilometers (40 percent). These targets for forest land have remained unchanged since the first Five Year Plan.

In 1960, the Government established the National Land Classification Committee to carry out soil survey and subsequent land classification. It began the implementation of land classification by establishing a center attached to the Department of Lands in 1961. Since 1964, this task has been transferred to the Land Development Department by a cabinet resolution.

During the period 1962 to 1966, a total area of 162,209,668 rai or 259,535 square kilometers was classified as permanent forest (LDD, 1977). The permanent forests were to be gazetted by royal decree as forest reserves under the National Reserve Forest Act of 1964. By the end of December 1985, about 136,236,169 rai or 217,977 square kilometers had been declared as forest reserves (RFD, 1986).

The growth of population at a relatively high rate during the 1960-1975 period put considerable pressure on the limited amount of available land. The Land Development Department estimates that only 168 million rai or 268,800 square kilometers (52 percent of total land area) are suitable for agriculture, and most of that land has already been utilized (AIT, 1983).

In 1960, the structure of agriculture in Thailand changed from subsistence to commercial farming. Rice is the most important crop with the planted area increasing from 40 million rai or 64,000 square kilometers in 1960 (OAE, 1984), to 83 million rai or 132,800 square kilometers in 1983 (AIT, 1983). The planted area of other export-oriented upland crops, such as cassava, sugar cane and corn, has also increased. Cassava and sugarcane have had a very high growth rate in terms of area cultivated and quantity produced because of the high returns.

Since the First Plan, the Government has used the land classification systems as a basis for issuing land titles to private individuals. However, the granting of land titles has not kept pace with demand of a rapidly expanding population over the last two decades. As a result, the land occupant often lacks a legal title and, thus, the opportunity and incentive to use his land for investment. Rather, the search for new land becomes the principal method of raising income. As a result of the uncontrolled expansion of cultivation and encroachment upon forest reserves, the forest area of the country decreased from 50 percent in 1960, to 29 percent in 1985 (RFD, 1985).

Land Reclassification

The forest areas have been encroached for agriculture both in the national forest reserves and the pre-reserve forest areas (areas to be surveyed and mapped prior to gazettement). But the policy of the Government on the national forest reserve did not change until June, 1982. Land suitable for agriculture in the national

forest reserve and pre-reserve areas is still considered forest land. Degazettement of national forest reserves for other activities could be done through complicated procedures under the National Forest Reserve Act, of 1964. For the pre-reserve areas, land reclassified for other activities has to be approved by the Land Classification Committee and the Cabinet.

In June 1982, the Cabinet approved a land use and ownership policy as a first step towards consolidating and rationalizing land use related activities. This policy was prepared by the Land Subcommittee of the National Rural Development Committee. The main objective was to legalize squatters. Land unsuitable for agriculture will remain gazetted as part of the national forest reserves.

Land originally classified as pre-reserve or permanent forest which is now being degazetted will be reclassified. If the land is for agriculture, a form of land ownership would be issued to the squatters. Land unsuitable for agriculture will remain gazetted as part of the national forest reserve. In gazetted national forest reserves, about 30 million rai (encroached figure in 1980) of the encroached land will be reclassified. Land suitable for agriculture will be distributed to the farmer by issuing a STK certificate. Unlike the situation in the pre-reserve areas, full ownership titles would not be readily provided to the farmers. Instead, they would receive the privilege to legally utilize the land which they already held. If land is reclassified as unsuitable for agriculture, a reforestation program will be implemented.

Beginning in 1982, LDD engaged a private firm to prepare new aerial photographs of the forest areas in Northern Thailand. NESDB also allocated funds to the Royal Thai Survey Department to prepare new aerial photographs of the forest areas in the Northeast, East, Central and Southern regions of Thailand, covering a total area of about 200,000 square kilometers. The aerial photograph operations were completed in 1985, and were used for the land reclassification program. At the end of September 1985, 20 million rai of pre-reserve forest had been classified and 75,806 rai had been documented by issuing Nor Sor 3 Kor certificates to farmers by DOL.

Soil Survey and Classification

Soil survey and classification techniques were first introduced into Thailand in 1935. To begin with, soil survey activity was scattered among different departments of the Ministry of Agriculture and Cooperatives. Later, soil survey and classification were transferred to the Land Development Department, following its establishment in 1963.

The first general soil map of Thailand was prepared and published in 1953, at a scale of 1:2,500,000, by Dr. R.L. Pendleton, an American soil scientist who was the agriculture and soil technology advisor to the Department of Agriculture and Fisheries. The soil units, commonly called "soil series", shown on the map were limited. These soil units were by no means as sophisticated as today's "soil series", as defined in the Soil Survey Manual (USDA, 1951). Rather, they were broad generalizations, usually on the level of the great soil group, or of the association of two or more such groups.

In 1968, the second general soil map of Thailand was prepared and published, at a scale of 1:1,2500,000, by Moormann and Rojanasoonthon (1968). The map units were based on the soil classification outlined by Dudal and Moormann (1964). Twenty-three basic map units were distinguished. The elements used in defining the map units were threefold : i.e. the dominant soil or association of soils; the broad group of parent material; and the land form, as expressed by the general topography of the unit

area.

Since 1970, the Soil Survey Division of the Department of Land Development has adopted the "Soil Taxonomy of the National Cooperative Soil Survey" developed by the soil survey, staff of the U.S. Department of Agriculture. All soil series established in the country were placed into soil families using this classification system. A revision of the general soil map by Moormann and Rojanasoonthon (1968) was carried out by the Soil Survey Division and was published, at a scale 1:1,000,000, in 1979. The soil units shown on the map were great groups and associations of great groups. A total of thirty eight great groups were recognized in Thailand in 1983 (Changprai, 1983).

At the same time, the Land Development Department published a number of soil maps at different scales, such as 1:500,000 for the regional soil maps, 1:100,000 for the provincial soil maps and 1:10,000-20,000 for specific projects. At present, the Land Development Department has completed detailed reconnaissance soil surveys of the whole country. 58 provincial soil maps at a scale of 1:100,000 were published, with maps of a further 15 provinces under preparation.

Land Allocation and Land Reform

The Government has supported land allocation programs on public land since 1938. These were designed to establish new villages on virgin lands, primarily to settle landless families or to resettle those displaced from sensitive areas by flood, dam inundation or other factors. In 1975, the Agricultural Land Reform Office was established to improve land distribution and security of tenure on both public and private land. At the same time, the Royal Forest Department has been implementing its forest village program, aiming to reforest denuded uplands which have been encroached upon by squatters. A key feature of the program is the regrouping of farmers into villages on the borders of forest reserves. Moreover, there are other projects on land allocation which are undertaken by a number of other government agencies. Land allocation is empowered by the Land Code (1954); the Land Allocation for Livelihood Act (1968); the Land Reform Act (1975); and Cabinet Resolutions.

At present there are 14 government agencies involved with land allocation. The various programs have not been well coordinated and differ widely in terms of their objectives, scale, management and benefits to settlers. The land- related agencies can be separated into two groups. There are five key agencies : the Department of Lands, the Department of Public Welfare, the Department of Cooperative Promotion, the Office of Agricultural Land Reform, and the Royal Forest Department

Nine other agencies also play a lesser role : the Office of Accelerated Rural Development, the Office of Policy and Planning, Ministry of Interior, the Provincial Committee, the Land Development Department, the Forest Industry Organization, the Royal Irrigation Department, the Electricity Generating Authority of Thailand; the National Security Command, and the War eterans' Organization. Since 1938, some 16.3 million rai have been allocated, and the number of beneficiaries was 1.2 million families. The results of land settlement land reform and other activities by major agencies are given in Table 2.7.

Land Tenure

In Thailand, land may be divided into land owned privately and land owned by the state. The status of land tenure indicates the rights of the land holder. The extent and conditions of these rights depend on ownership rights, holding rights, laws and regulations, as well as local custom.

BOX 2.1 Competing Titles to Land

"Everywhere in this Kingdom there are betel vine and betel nut forests," declared a stone inscription of 1292. *"There are also in this Kingdom many coconut, jackfruit, mango, and tamarind forests. Whoever plants them, unto him they shall belong..."*

Property rights clearly extend far back into Thailand's history, although the Land Code of 1360 subsequently made all land the property of the king. Private land holders were entitled to possession, but not to ownership. They could not transfer property to another person nor pass it on to their descendents. Later, however, this position changed, and in the early 1900s new systems of land tenure and transfer were introduced, under which land titles were granted to private individuals - and guaranteed by the government.

A profusion of laws and regulations was issued following 1932, when the era of constitutional monarchy began. In 1954, however, a new Land Code was enacted, providing a much more effective legal framework for controling land use, determining ownership and generating revenues from land. The Department of Land (DOL) has the prime responsibility for ensuring that the Land Code is implemented.

But, because the pace of land titling has not kept up with the growth in Thailand's population, land occupants today often lack any effective legal title to the land they use. This means that there is little incentive to invest in the land, while the main method of raising income becomes the acquisition of new land. In addition, there are the landless, estimated several years ago to number 500,000 households, or over 10 percent of total households. The government has supported land allocation programs on public land since 1938, whether to settle such landless families or to resettle those displaced by major projects like reservoirs.

In recent years, a growing number of other agencies have become involved in land allocation, including the Agricultural Land Reform Office (ALRO), the Department of Public Welfare (DPW) and the Royal Forest Department (RFD). The different agencies involved in allocation have tended to give different types of document to those allocated land.

The Land Code of 1954 recognized four different types of private land ownership documents confirming legal title. These were a title deed (Nor Sor 4, or Chanode), indicating full ownership; a certificate of utilization (Nor Sor 3, or Nor Sor 3 Kor), proving that the holder has put the land to use; a pre-emptive certificate (Bai Chong, or Nor Sor 2), authorizing the temporary occupation of land; and a claim certificate (Sor Kor Neung, or S.K.1), indicating that the holder had used the land prior to 1954.

There are currently some 14 government agencies involved in land allocation programs. The DOL is the only one which can give full title, in the form of Nor Sor 4. The DPW, which carries out self-help land settlement projects, issues Nor Kor certificates to settlers, while the Department of Cooperative Promotion (DCP) issues Kor Sor Nor certificates. Only about 16 percent of the cultivated area in Thailand is covered by such title deeds, while a further 47 percent is covered by certificates of utilization.

The other major form of land tenure

for private land is tenancy. On public or state land, especially in the forest reserves, squatters have been given land use permits by two different government agencies. The Royal Forest Department (RFD) began its Sor Tor Kor (STK) program in 1979, which allows squatters in encroached national forest reserves to claim not more than 15 rai of land, and to lease any additional land from the RFD, up to a total of 50 rai. The STK permit cannot be used as collateral for a loan, however, or as a guarantee. And the ALRO issues the Sor Por Kor 4-01 land use permit, which is similar to the STK permit.

In such circumstances, overlaps of jurisdiction, administrative conflicts and lack of coordination are unavoidable. Overall, one must conclude, land allocation, as currently practised, is ineffective, inefficient and inequitable. If Thailand's land-based natural resources are to be properly managed, these problems will need to be recognized and tackled. The obvious -- if politically problematic -- solution would be to pull all land allocation activities together under a single bureau.

Table 2.7 Land Allocation by Major Settlement Programs, 1984

Name of Program	Agencies	Source of Authority	Total[a]	
			Area (ha)	Families
Self-help land settlement	DPW	Land Allocation Act 2511	2,097,882	128,972
Land co-operatives	DCP	Land Allocation Act 2511	2,029,886	69,485
Land reform	ALRO	Land Feform Act 2518	1,812,131	81,257
Land allocation	DOL	Land Code 2497	3,281,471	274,100
War veterans	WVO	Cabinet resolution	32,221	1,633
Land development projects	LDD	Cabinet resolution	178,962	14,359
Forest villages	RFD	Cabinet resolution	334,493	2,089
Forest community development	RFD	Cabinet resolution	199,918	23,129
Sor Tor Kor (Cultivation rights)	RFD	Cabinet resolution	6,360,449	624,048
		Total	16,327,413	1,219,072

Source:

a. Division of Research and planning, Agricultural Land Reform Office, Ministry of Agriculture and Cooperatives, 1986.

Privately-owned land can be issued with land titles. The Land Code 1954 recognizes four forms of private ownership document. A Title Deed (Nor Sor 4 or Chanode) indicates full ownership, and is supported by a deed plan showing the position of boundary mark stones. A Certificate of Utilization (Nor Sor 3 or Nor Sor 3 Kor) proves that the person named as owner has put the land to use. A Preemptive Certificate (Bai Chong-N.S.2) authorizes temporary occupation of land. And a Claim Certificate (Sor Kor Neung S.K 1) indicates a claim lodged by a person who was in possession and had made use of the land prior to 1954, the effective date of the Land Code.

The most recent study by TDRI (1986b) found that the cultivated area in Thailand totals about 152 million rai or

47.5 percent of the country area, suggesting that about half of the country is now permanently occupied by private individuals. Only about 23.7 million rai of this total are covered by title deeds (Nor Sor 4 or Chanode), while a further 70.9 million rai are covered by certificates of utilization (Nor Sor 3 and Nor Sor 3 Kor). The rest are "undocumented" private lands.

In the area where the government agencies are implementing land allocation projects, there are many forms of land documentation. The Department of Public Welfare, which carries out self-help land settlement projects, issues Nor Kor certificates to settlers. The Department of Cooperative Promotion, which develops cooperative settlements, issues Kor Sor Nor certificates to the settlers.

Since these two Departments carry out the land allocation program under the Land Settlement Act 1968, after a period of time the settlers and the members can apply for certificates of utilization - and later title deeds - from the Department of Lands. The land allocation program of the Department of Lands is carried out under the Land Code 1954. Since the Department of Lands is the authorized agency to issue land documents, therefore the N.S. 3 has been issued to the farmers at the end of the project.

The other form of land tenure for private land is land tenancy. The control of land tenancy is governed by the Agricultural Land Rent Control Act 1981 and the Agricultural Land Reform Act 1975. In the public or state land, especially in the national forest reserves, land rights have been given to squatters in the form of land use permits. There are two major government agencies which carry out the land allocation program in this area.

In accordance with the cabinet resolution on 28 August, 1979, the Royal Forest Department began the Sor Tor Kor (STK) program in the encroached national forest reserve areas. The program permits squatters occupying land in national forest reserves to claim cultivation rights to fifteen rai of land, and to lease from the Royal Forest Department any additional area, up to a combined total area of fifty rais. The Royal Forest Department issues the STK certificate to squatters, but this type of document cannot be used as collateral for a loan or as a guarantee.

In the public land sector, the land document Sor Por Kor 4-01, issued by the Agricultural Land Reform Office, is a land use permit similar to STK. It takes at least two years to issue after land is distributed. This land document, like STK cannot be used as collateral for a loan. Because of these differences in land ownership security, problems arise with regard to the degree of inequity and inequality among holders of land documents issued by different government agencies. This is an important policy issue which should be of concern to the government.

Land Consolidation

Land consolidation is an integrated, technical method of land development at the inter-farm and farm level, with emphasis on water management. Typical activities in land consolidation are: (1) construction of a minor irrigation system to supply water to each farm; (2) construction of a minor drainage system to evacuate excess water from each field; (3) construction of farm roads along the irrigation ditches to improve the accessibility of the farmer's fields; (4) rearrangement of farm holdings in between the newly constructed irrigation ditches and drains; and (5) clearance and levelling of arable land to improve the on-field water control.

After completion of land consolidation, every holding has an irrigation inlet, a drainage outlet and access to a farm road. The plots are levelled and have a rectangular shape to allow for modern agricultural practices, such as the mechanization of land preparation. It can be summarized that land consolidation results in improved physical production conditions which are needed to achieve the agricultural development objectives of increasing the wet season rice

production, initiating dry season cultivation and creating additional rural employment opportunities.

Land consolidation began in Thailand in 1968 as a pilot project in the Central Plain at Amphur Bang Rachan, Changwat Singburi. An area of 7,400 rai in the Chanasutr Irrigation Project, which is one area of the Greater Chao Phraya Project, was selected as a pilot project and another 4,200 rai was extended to nearby area, totaling 11,600 rai.

In 1972, after the implementation of some 11,600 rai in Chanasutr Irrigation Project was completed, the pilot stage of the land consolidation program come to an end.

Based on the encouraging results in the land consolidation pilot area and on the favorable outcome, the Royal Thai Government decided to continue the land consolidation program on a large scale.

In 1974, the Royal Thai Government launched a Land Consolidation Act as a tool to support the implementation of land consolidation. To implement the Act, the Central Land Consolidation Office was established in 1975. In 1986, land consolidation project covers an area of about one million rai throughout the country. Therefore, much remains to be done, with about 20 million rai of irrigated areas potentially needing similar arrangements.

Soil Conservation

Soil and water conservation policies were included in the Second National Economic and Social Development Plan in 1967. Prior to the establishment of the Land Development Department, in 1963, soil and water conservation was carried out by several agencies. Later, the Land Development Department's Soil Conservation Division became responsible for the task. In 1984, after the reorganization of the Department, its name was changed to the Soil and Water Conservation Division.

Since its inception, the Land Development Department has emphasized research and experiment on the causes of soil erosion and protection measures. At the same time, the transfer of technology to farmers has been achieved by several methods, including demonstration, training, general meetings and public relations.

During 1966-1971, soil and water conservation programs were implemented in the Northeast, assisted by USAID. A prime objective was to train local technicians to use soil information in conservation planning and to show farmers how to practice soil and water conservation. Eight land development centers were established during 1963-1967 in the Northeast. Mobile units were also set up to work closely with the farmers.

Soil and water conservation have been carried out by LDD since 1963. Fifty-three Land Development Centres, located in different provinces of the country representing different agro-climatic regions, have been established. The major responsibility of land development stations is soil and water conservation. In fiscal 1986, LDD was allocated 114.7 million baht for soil and water conservation activity.

At present, the Land Development Department emphasizes three approaches for the implementation of soil and water conservation.

a) Technology transfer: This includes six activities, namely public relations, training of local government officers, training of farmer leaders, farmers' meetings, demonstration, regular visiting and communications.

b) Services: Four activities are involved here, namely land use planning, soil and water conservation system survey and design, distribution of cover crops seed and tree crops seedling, and mechanical control structure construction.

c) Establishment of local groups: In order to insure greater farmer participation in soil and water conservation, including the maintenance of the mechanical structures after the withdrawal of government agencies, local support groups should be established.

Land Use Planning

The Royal Thai Government has long realized the importance of land use planning. The First Plan (1960-1966) stated that half the country should be kept as forest or preservation areas, the rest being progressively developed for agriculture and other activities. Forest preservation has been carried forward since 1960 under the following Acts: the National Forest Reserves Act 1964, Wildlife Reserves and Conservation Act 1960 and National Parks Act 1961.

Land use planning for agriculture has been the responsibility of the Land Development Department since 1973. Currently, three regional land use plans have been published, for the Northeast, East and Central regions. At the provincial level, 49 provincial land use plans have been published. The main objective of land use plans is to recommend suitable crops so that land can be better utilized.

However, the implementation procedures are weak. To overcome this problem, the Land Use Planning Subcommittee was established in 1984 by the Land Development Board. After the completion of the regional or provincial land use plan by LDD, the plan is submitted to the Land Use Planning Subcommittee, Land Development Board and to the Cabinet for approval. Even so, there may still be problems in implementing such plans. Without strong support from the government, it seems that land use planning will not be a priority. Land use for town planning is carried out by the Office of Town and Country Planning. Under the Town and Country Planning Act 1975, several town plans have been prepared and implemented.

Soil Degradation and Erosion

There is evidence both of degradation and erosion of Thai soils. The degradation of soils can be caused by physical, chemical, biological, socioeconomic and institutional factors. In isolation or in combination, directly or indirectly, such factors alter the soil's potential for sustained or increased agricultural production.

Soils supporting undisturbed tropical forests are characterized by low soil bulk density and high macro-porosity, partly due to the relatively high activity of the soil fauna. Once the forest cover is removed, however, the soil characteristics begin to change. Their bulk density increases in the wake of deforestation and cultivation, as do a number of their other physical and chemical properties. Norman (1984) compared the physical properties of new and old development areas and showed a gradual process of change. The total infiltration capacity of soils in the older development areas had fallen by 62 percent, when compared with the original forest values. The soil chemistry had also changed. The organic carbon content of the soils in the older areas had dropped by 18 percent, while their calcium, magnesium and potassium content tended to be lower too.

These changes can have a significant influence on the erodability of soils. Soil erosion, in fact, is one of the most pressing natural resource problems in Thailand. A theoretical study by Srikhajon et al. (1980) indicated that about 107 million rai nationwide suffer from a medium or high degree of soil erosion, particularly upland areas where slopes are greater than five percent (Table 2.8). Data from three years of small plot experimentation at the Sa Land Development Station, in Nan Province, indicated that in many areas the average soil loss may exceed 16 tons per rai per

Table 2.8 Areas Affected by Soil Erosion in Thailand

Category	Soil Loss (ton/rai/year)	Area (rai)	Land Use
Very slight	0.01-1.00	118,721,990	forest, paddy
Slight	1.01-5.00	90,276,175	forest, rubber, orchards, paddy
Moderate	5.01-20.00	25,912,308	rubber, orchards, field crops, forest+field crops
Severe	20.01-100.00	42,620,676	rubber, orchards, field crops, forest+field crops, shifting cultivation
Very severe	100.01-966.65	39,157,090	filed crops, forest+shifting cultivation field crops
Others	-	4,561,761	coastal area, mangrove forest, shrimp farms etc.
Total	-	321,250,000	

Source: Srikhajon et al. 1980.

annum (Marston, 1984). This, it is worth pointing out, is at least 20 times the recommended tolerable annual soil loss (Arnoldus, 1977).

In Phetchabun province, on Ultic Paleustalfs with a nine percent slope, soil losses of 162.6 tons per hectare of soil were reported for 1983 (Chaisiri et al., 1984). 110 tons of soil per hectare per year were being lost from three percent slope bare soil in Chonburi province in 1983 (Lekakul, 1984). By contrast, in the Northeast's Kalasin province', on six percent slope bare soil, a lower figure of 20.8 tons per hectare was reported (Pairintra et al., 1982).

A study on cumulative soil loss on various land management plots at Rong Kwang, Phrae and at Chiang Rai, showed that soil loss from forest management is less than from swiddening and continuous rice cultivation. The effect of producing one crop of rice every ten years was to increase soil loss by 1.5-1.7 times the losses typical in a Dry Dipterocarp Forest (Attaviroj, 1986). The effect of shortening the swiddening rotation from once in 10 years to once in two years, was a 1.6-fold increase in soil loss at Rong Kwang and a 1.8 fold increase at Chiang Rai.

Chomchan and Panichapong (1986) reported that soil loss in the Ping and Nan river basins is averaging about 2-10 ton/rai/year. If land use changes from forest to row crop cultivation without soil and water conservation measures, soil loss will increase about 6-10 times.

Soil erosion and soil degradation inevitably result in declining yields. Norman (1984) indicated that in the NADP areas, grain yields of corn on newly cleared areas ranged between 130-423 kg/rai and averaged 262 kg/rai, while those in old development areas averaged 166 kg/rai. In the same area, grain yield of upland rice average a 221 kg/rai on newly cleared areas but only 114 kg/rai on old development areas.

Attaviroj (1986) made the assumption that in Northern Thailand, of a total area of 1.4 million rai of encroached forest each year, about 0.2 million rai per year are used to replace land that is seriously eroded and degraded. These degraded areas will be allowed to revert to bush fallow.

The effects of siltation from soil erosion on dams and from sedimentation

Box 2.2 WHEN SOILS TURNS TO SALT

Travel through the Middle East's "Fertile Crescent", where the early Sumerian, Babylonian, Assyrian, Pheonician and Hebrew civilizations flourished, and you will find entire landscapes turned to salt. The use of irrigation without adequate drainage encouraged evaporation and salt crystallization, sterilizing the soil for all time. Thailand may not have produced the shining white saltscapes you can see in some parts of the world, but Thai soil scientists argue that the problem of saline soils is increasingly urgent.

Saline soils may be found in some southern coastal areas, but these tend to be caused by seawater flooding, rather than by irrigation. According to data published by the Department of Land Development (DLD), the problem of saline soils is worst in the northeast of Thailand. Here, an estimated 17.8 million rai of land, or around 17 percent of the total Northeastern region, have been affected to some extent. Of this affected area, about a third (5.8 million rai) is considered to be worryingly saline. Some four million rai are considered "mildly" saline, with salt crusts affecting up to 10 percent of their surface area; 1.3 million rai are classified as "moderately" salty, with salt crust coverage of 10-50 percent; and nearly 210,000 rai are "severely" saline, with salt crust coverage of more than 50 percent.

Two-thirds of the 17.8 million rai of saline soils can still produce quantities of a salt-tolerant crop like rice, but the farmer typically achieves much lower yields than on non-saline soils. Yields on moderately saline soils tend to be halved. Overall, the resulting losses to Thai farmers have been estimated at some 500 million baht (US$19 million), and the evidence suggests that the probles is likely to get worse.

Apart from the linkage between irrigation, poor drainage and salinization, a number of other factors may also be at work in Thailand. For example, it is now recognized that the construction of dams can raise the water-table in downstream areas. Where there are deeper saline layers, the result may be to flush the salt up into the surface soils.

Another possible contributor is salt production, an important economic activity in the Northeast. Wastewater from salt production operations may either be discharged direct to paddy fields, or discharged to rivers and extracted lower down. Either way, the problem of saline soils is aggravated. More tentatively, some researchers suspect a link between the deforestation of major watershed areas, which may influence the rate at which salts leach out of upland deposits.

Whatever the causes of salinization in particular areas, however, the evidence of depressed crop yields signals the need to carefully consider the suitability of land proposed for irrigation. If a decision is made to invest in irrigation, then sufficient funds will need to be made available to ensure that poor drainage does not raise soil salinity to unacceptable levels. The farmer should be aware that this is a cumulative problem, with each generation leaving an increased salt burden in the soil it passes on to the next.

along water courses result in a sediment load at the mouth of the Chao Phraya River of about 104 tons, per square kilometer. This represents 11 million tons, or about 8.5 million cubic meters, of sediment (El-Swaify, 1982; quoted by Attaviroj, 1986).

The Land Development Department (1985) reported that plant nutrients were leached by runoff water in every region of Thailand, representing a total nutrient loss of about 27.4 million tons per year. These losses might include 24.1 million tons per year of potassium (K), 3.1 million tons per year of nitrogen (N) and 0.2 million tons per year of phosphorus (P).

Another type of soil degradation is salinization. There are two hypotheses on the causes of dry land salinization in Northeast Thailand. The first suggests that the salt originates in deep rock salt beds, with deep groundwater circulation bringing the salt up to or near the soil surface. The second, hypothesis proposed by Sinanuwong and Takaya (1974), suggests an origin of the salt in the weathered zone of the shales and siltstones beneath upland areas. It is believed that salt was distributed to lowland areas by interflow. In this view, salt not only occurs in the rock salt, but also in the shales and siltstone of the Maha Sarakham Formation.

Forest clearing for agriculture, is commonly identified as a prime cause of soil salinization (ADAB, 1977; Moormann and van Bremen, 1978). In the past decade, upland areas in the Northeast have been cleared for major crops such as cassava, corn and kenaf. This might be expected to cause an increase in upland groundwater recharge and a rise in groundwater levels in lowland areas. At present, there is no information to indicate which of these two hypotheses is right, but studies are in progress in several provinces of the Northeast to test them.

Currently, the Royal Thai Government's human and financial resources are insufficient to deal with the scale of these problems - and will probably remain insufficient. The implication is that soil degradation and erosion problems will become even more pressing in the future.

Landlessness

It was estimated a few years ago that the landless amounted to 500,000 households in Thailand (NESDB). The problem is serious in the Central Plain and the North. While the data on this aspect of land are very limited and incomplete, it is expected that the situation will deteriorate further as the potential for land expansion is constrained and population pressures increase.

Since 1979, the problem of landlessness has received considerable attention in Thailand. The first survey was conducted in selected provinces of the North, Northeast and Central Plain. Other surveys were undertaken in other provinces in 1981, 1982 and 1983. The results from these surveys shed some light on the seriousness of the problem (Table 2.9).

In all the surveys, landlessness accounted for over 10 percent of total households. The problem is particularly serious in the Upper North, where the percentage of the landless is the highest. Almost 60 percent of those studied were near-landless or small farmers. The main reason given for having no land, or less land than before, is also reported in the surveys. Most landless farmers sold and/or lost their lands through mortgages. Landlessness has aggravated the poverty problem which is widespread in the Upper North, where land and population pressures have been acute.

Intensity of Land Use

Land use in Thailand is traditionally extensive rather than intensive. Mono-

Table 2.9 Number and Percentage of the Landless, Near-landless and Small Farmers

Area	Type of Farmers				
	Landless[a]	Near-landless[b]	Small[c]	Other[d]	Total
Selected Provinces[e]	10.59	3.25	4.53	81.63	100
	(92,034)	(28,287)	(39,354)	(709,469)	(869,144)
Upper North[f]	13,48	31.37	27.51	27.64	100
	(12,245)	(28,511)	(25,002)	(25,116)	(90,874)
Lower North and Some[g]	10.11	8.16	9.61	72.12	100
Parts of Central Plain	(74,977)	(60,503)	(71,275)	(534,948)	(741,723)
East and Some Parts[h]	13.03	7.4	7.86	71.71	100
of Central Plain	(39,802)	(22,593)	(24,006)	(218,973)	(305,374)

Figures in parentheses mean the estimated number of farms from the survey.
Notes:

a. Those who do not own any land (excluding homelot) and do not rent any land from other people. They are mainly farm labours.
b. Those who own less than 5 rai of land and have a net cultivated area of not more than 5 rai (including own land and rented land).
c. Those who own less than 10 rai and have a net cultivated area of not more than 10 rai.
d. Other means those holding over 10 rai of land.
e. The survey, conducted in 1979, covered 3 provinces in lower North one (Korat) in the Northeast, and 8 provinces in the Central Plain.
f. 1981, covered 8 provinces.
g. 1982, covered 13 provinces (3 in lower North).
h. 1983, covered 9 provinces (6 in Central Plain).

Source: Agricultural Land Reform Office.

cropping is very common, especially in rainfed areas. Land use has been less intensive mainly due to the lack of irrigation facilities. Even though there has been considerable investment in irrigation, only about 15 percent of the total cultivated area is under irrigation. Furthermore, the area is concentrated in the Central Plain, where the larger projects are located. Extensive agriculture has also been possible because, over the past two decades, the rate of expansion of agricultural land was higher than that of the population growth. However, this cannot long continue into the future. If agricultural production is to be increased, improvements in land productivity are essential. As the Fifth Plan recognized, this implies that land must be used more intensively.

As regards future trends, it is likely that cropping intensity will increase, albeit gradually to begin with. The major potential for increased cropping intensity will be in irrigated areas in the Central Plain and in the North. Another factor influencing land use intensity are the farm-gate prices of major crops such as rice, soybean, and vegetables. As for rainfed areas, particularly in the Northeast, new cropping systems are required if increased cropping intensity is to be realized. Research on this area has been recently intensified in the Northeast.

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3 Water Resources

3.1 PRESENT STATUS

Irrigation

Evidence exists to indicate that the first reservoir was built about 700 years ago, during the reign of King Ramkhamhaeng in Sukhothai. Systems of diversion weirs and canals were also built in the state of Lanna Thai in the North, under the suzerainty of Phya Mengrai, the founder of Chiang Mai. The first storage irrigation system in the Central region was built around 1633, in the Ayutthaya Dynasty.

In modern times, water resources development can be said to have begun about 80 years ago, during the reign of H.M. King Rama V. His Majesty gave concessions to a private company, called Khu Na Siam, to build canals, locks and gates in Thung Rangsit. The purpose was to keep water in the canals and to drain the paddy in times of flood, especially towards the end of the cropping season. In addition, the canals also served as inland waterways for transportation. This network is still being maintained by the Royal Irrigation Department (RID).

The RID was established in 1903 by H.M. King Rama V. It was first called the Khlong (Canal) Department. Its main responsibility was to maintain inland waterway transportation and to plan irrigation projects to aid cropping in the Central Plain. The first Director-General of the RID was a Dutch irrigation engineer named Mr. J. Howan van de Heide, from Indonesia. The project to build a barrage across the Chao Phraya River at Chai Nat, to divert water for irrigation, was first suggested during this period. But the project was deferred indefinitely, due to its high cost. In 1912, the name of the department was changed to Thang (Passage Way) Department.

Two severe droughts occurred in 1911 and 1914, early in the reign of H.M. King Rama VI. Sir Thomas Ward, an irrigation engineer from India, was commissioned to review the Chai Nat project. It was concluded that the original proposal was appropriate, but nothing happened. The name of the department was later changed to Thod Nam (Water Diversion) Department and finally it became the Royal Irrigation Department (RID) on 21 March 1927, during the reign of H.M. King Rama VII. In the early days, the RID was responsible for water conservation, irrigation, drainage, land reclamation, flood control, hydropower, inland navigation and river training.

The first project in carried out modern times by the RID involved the construction of a diversion dam, called Rama VII Dam, on the Pa Sak River, at Tha Luang in Saraburi province, and the excavation of the Rapheephat canal. Its purpose was to divert water for rice paddy in the provinces of Saraburi and Ayutthaya, and thence to Thung Rangsit, to join the canal system. Construction began in 1915 and was completed in 1924. After that, 20 more irrigation projects were constructed during the period of the Great Depression and World War II. The Chai Nat project was reconsidered

once again after the war. This time, the construction of the project went ahead in 1952, financed by a US $18 million loan from the World Bank. The project was completed in 1957 and was the largest irrigation project in east Asia at that time. The barrage at Chai Nat was named the Chao Phraya Dam.

The RID was also responsible for the construction of the Bhumiphol Dam, on the Ping River in Tak province. It was the first multipurpose dam with large- scale hydropower generation in Thailand. The dam was completed in 1964. Another similar project, the Sirikit Dam on the Nan River, was completed in 1971. These two projects enabled the RID to control about 22 percent of the flow into the Chao Phraya Basin. It should be noted that the Electricity Generation Authority of Thailand (EGAT) took over the responsibility for hydropower development from the RID in 1969.

Throughout the Fourth and the Fifth National Economic and Social Development Plans (1977-1981, 1982-1986) the emphasis of water resources development by the RID has shifted towards small- scale projects, to spread the benefit over all areas of the country, as a greater priority has been given to water development in low income areas.

Hydropower

Since the beginning of the First National Economic and Social Development Plan in 1960, the country's energy requirements have increased tremendously, from 1.6 million tons of oil equivalent (TOE) in 1960 to 18 million TOE in 1983. Approximately 75 percent of Thailand's energy currently comes from petroleum products.

Hydropower, meanwhile, has also played an important role. EGAT was entrusted with the responsibility for power production, and in 1969 became responsible for nearly all hydropower development in the country. Although hydropower requires a costly investment (about 7,400 baht/kW compared to 3,500 baht/kW for thermal generation or 2,300 baht/kW for gas turbine and diesel generation), the operating cost is much lower. It is estimated (based on 1981 prices) that hydropower costs 0.04 baht/kWh, while thermal power costs 0.41 baht/kWh, and gas turbine and diesel power costs about 1.60 baht/kWh. Another benefit is that hydropower is a renewable energy resource.

Large hydropower projects have been constructed continuously since the completion of the Bhumiphol Dam, which has an installed capacity of 535 MW. Examples of other projects are the Sirikit Dam, with an installed capacity of 375 MW, and the Srinagarind Dam, with an installed capacity of 360 MW. The latest large-scale project, which has been operational since mid-1985, is the Khao Laem Dam. This has an installed capacity of 300 MW. At present, hydropower accounts for approximately 22 percent of EGAT's total power output.

In addition to EGAT, the National Energy Administration (NEA) and the Provincial Electricity Authority (PEA) have been active in carrying out minihydropower and microhydropower projects. These are projects which have an installed capacity of less than 6 MW per project. The rationale for these projects is to provide electricity to outlying areas in the country. In general, the construction of transmission lines to small communities which are far away from the power grid network involves very costly capital investment. In some geographically suitable areas, the provision of a small weir and a generator with a capacity of 10-200 kW costs much less than a transmission line, while the hydropower generated is sufficient for domestic use in the community. This is an important avenue through which development can reach people who are remote from urban areas. In most cases, the community participates in the

construction and maintenance of such projects.

Groundwater

The utilization of groundwater for domestic water supply began in Bangkok as early as 1914. At that time, bamboo rigs were used for drilling and were operated by the private sector. Government involvement in groundwater development at a national scale started in 1955. The Department of Mineral Resources (DMR), through its Groundwater Division, started a groundwater investigation program with the help of the United States Geological Survey (USGS). The goal was to provide groundwater for domestic water supply and sanitation for the Northeastern region, where a shortage of water is always critical for at least six months of the year. In 1965 the investigation was expanded to cover all regions of the country. In 1969, the Metropolitan Water Works Authority (MWWA) began a study focusing on the groundwater resources of the Bangkok Metropolitan Area. The RID has also frequently commissioned consulting firms to undertake studies of groundwater resources for irrigation projects, with the most significant study being that of the Yom Basin, carried out in 1971.

The DMR began using geophysical survey techniques in its groundwater investigation program in 1962. The results of these investigations have been compiled and hydrogeological maps have been published, e.g. the *Hydrogeological Map of Northeastern Thailand*, published in 1975. Maps for other regions have also been published. The *Hydrogeological Map of Thailand* was published by the DMR in 1983. The enormous amount of data collected is being computerized in order to establish a groundwater data center.

3.2 TREND

Up until recently, water resources in Thailand have been abundant and in excess of the need for water utilization. Development in the past has gone full steam ahead, subject only to limitations of budget. Since the country has become more industrialized and the population has increased rapidly, the need for water has grown, while the amount of water available has remained roughly constant. This has given rise to problems resulting from conflicts over water use between various sectors, such as agriculture, domestic consumption, hydropower, flood protection and inland waterway transportation. Another noticeable problem is that nearly all the suitable sites for large-scale projects, especially storage reservoirs, have already been exploited. The remaining undeveloped potential sites are either in the heavily populated areas or in the national park reserves. This poses difficulties for the development of large-scale projects, either in terms of population resettlement or environmental conservation. A prime example is the proposed Nam Choan project (See Box 5,2, Chapter 5), which has been the center of conflict between developers and conservationists. It is increasingly obvious that there will be less scope for the development of such large-scale projects in future.

Irrigation

From the agricultural sector's point of view, the most developed irrigation systems are found in the Central Plain. The irrigated area in the Central region in 1983 covered 1,854,965 hectares, compared to 823,994 hectares in the North, 473,950 hectares in the Northeast, and 318,742 hectares in the South (MOAC, 1986). Figure 3.1 shows the increase in irrigated area for all regions from 1976 to 1983. It is most interesting to compare the Northern and the Central regions, since the latter relies on water that flows from the former. The irrigated area is increasing at a greater rate in the Northern region than in the Central region. Assuming that this trend

Figure 3.1 Accumulated Irrigated Area in Various Regions

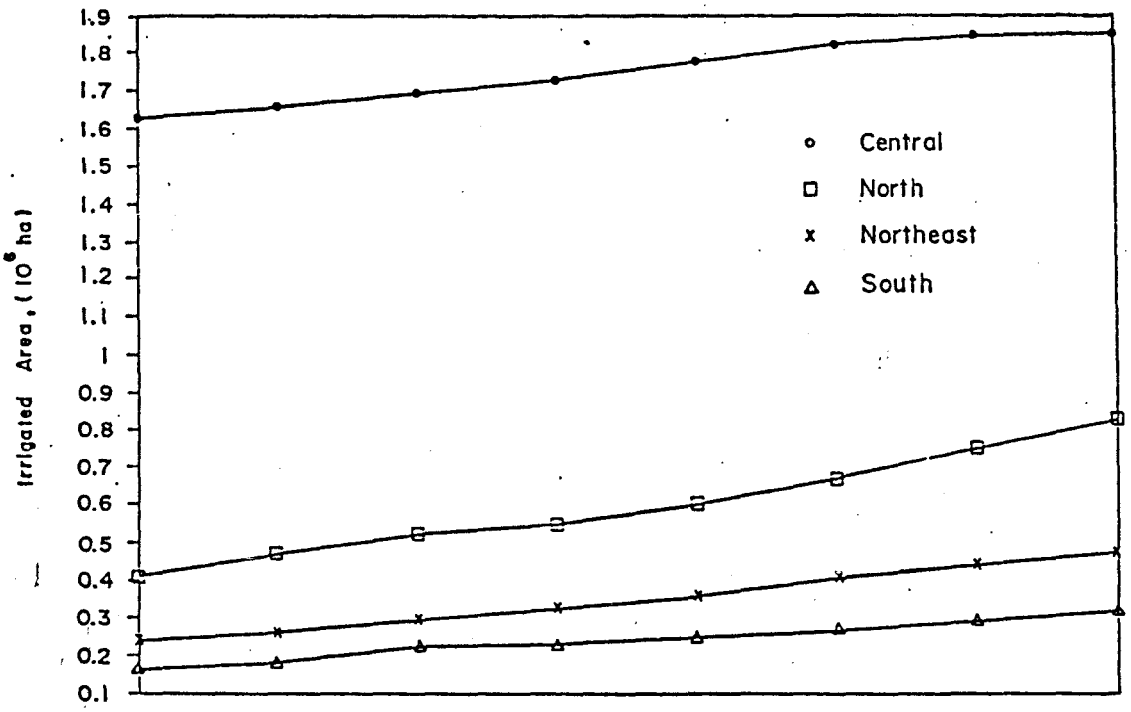
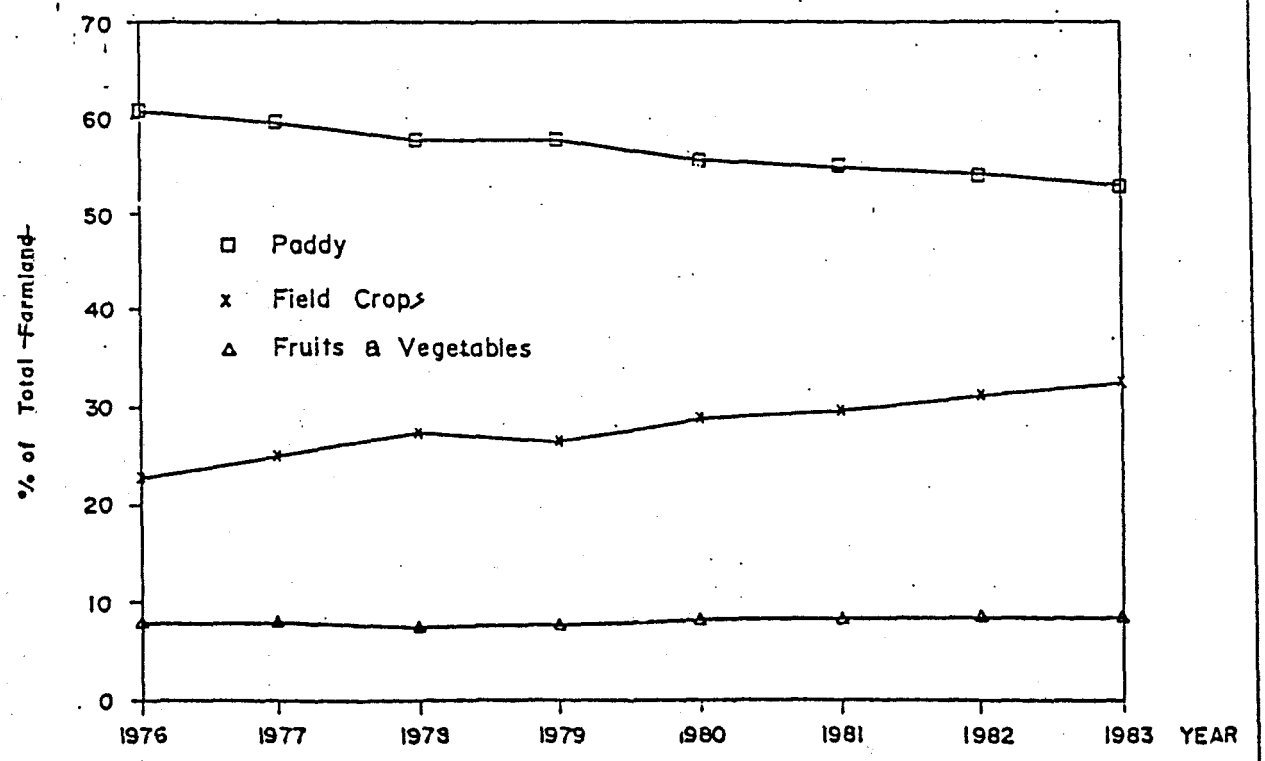


Figure 3.2 Crop Types in Central Region



continues, a point will be reached in the near future where water released from the Northern region, after satisfying its own requirements, will be less than at present. As a consequence, the demand for irrigation water in the Central region will not be fulfilled.

In fact, the shortage of water for irrigation in the dry season is quite evident in the Greater Chao Phraya project (i.e. area under the control of the Chao Phraya Dam). According to the RID Division of Operation and Maintenance, the irrigated area in the Greater Chao Phraya project in the wet season is about 1.2 million hectares. In the dry season (February to May), the area of suitable land for dry season paddy is about 0.5 million hectares. To irrigate 0.5 million hectares in the dry season requires 6,000 million cubic meters of water. In 1986, EGAT set a target release from the Bhumiphol and Sirikit dams of 5,050 million cubic meters from February to May. Of this amount, approximately 1,500 million cubic meters are required for water supply in Bangkok and to prevent salt water intrusion into the Chao Phraya River. From these data, the RID estimated that about 3,500 - 4,000 million cubic meters of water would be available for irrigation during February to May in 1986 (RID, 1986). This amount of water permitted the target for dry season paddy area to be set at only 0.4 million hectares, instead of the full potential of 0.5 million hectares.

The water deficiency which prevents dry season irrigation from operating at its full potential and the ever- decreasing market price for rice are forcing farmers in the Central Plain to switch from paddy to field crops. This trend is clearly shown in Figure 3.2. Although field crops use less water (e.g. 6,200 m^3/ha for soybean and 12,200 m^3/ha for dry season transplanted rice), they require much better water control and drainage than rice. Most of the present irrigation systems cannot provide such control, since they have been designed specifically to irrigate rice paddy.

Figure 3.3 also shows the increasing trend for dry season rice crops. This is because the higher yield of dry season rice crops is more attractive to farmers. Figure 3.4 shows the approximate total inflows (i.e. total outflows + changes in storage) of the Bhumiphol and Sirikit dams between 1975 and 1984. It shows that the approximate inflows of the two dams are roughly constant in recent years. This means that the two dams cannot supply additional water to meet the increasing demand of the Central region. The problem of water deficiency will inevitably worsen, with increasing population and cultivation generating increasing demands on water. Transbasin projects, such as the diversion of water from the Maeklong Basin to the Chao Phraya Basin, and the diversion of water from the Mae Kok and Mae Ing to the Yom and Nan will inevitably aggravate the water deficit in the Central Plain.

In the Northeastern and the Southern regions, water shortages usually result from inadequate water regulation, rather than from insufficient rainfall input. Figure 3.5 shows the water release for the Ubonratana Dam from 1975 to 1984. It does not show any trend of decreasing release, apart from fluctuations due to annual rainfall variation. The small-scale water resources development projects initiated by the government in the Fourth Five- Year National Development Plan have improved water regulation in the Northeast to a considerable extent. Stream flows in the Northeast are characterized by rapid rises and falls. The construction of large storage reservoirs is appropriate in these circumstances. However, the cost of resettling large communities does not make such projects feasible. The development trend in the future will probably shift more towards regulating and maintaining water levels in rivers, to facilitate pumped irrigation. The Nam Mong project under construction at Nong Khai is the first such project. When completed, it should provide water for

Figure 3.3 Dry Season Paddy Area

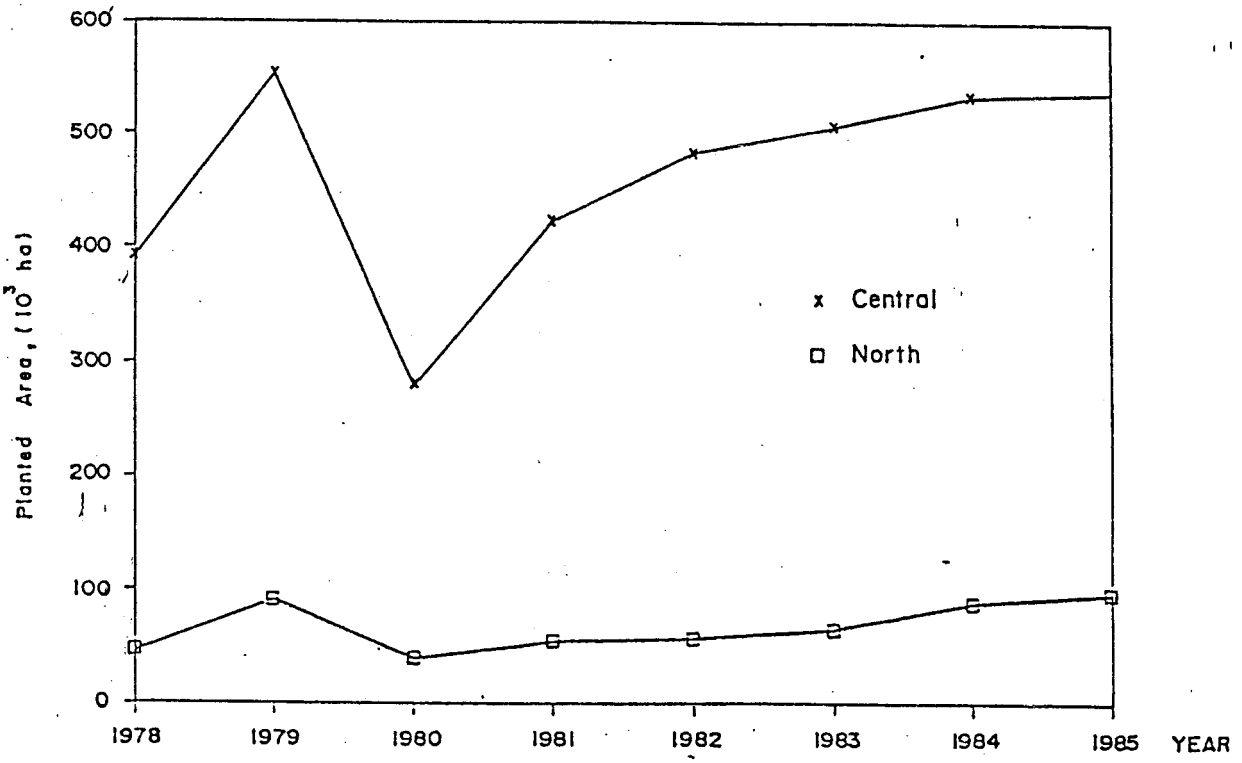


Figure 3.4 Approximate Inflows to Sirikit and Bhumiphol Dams.

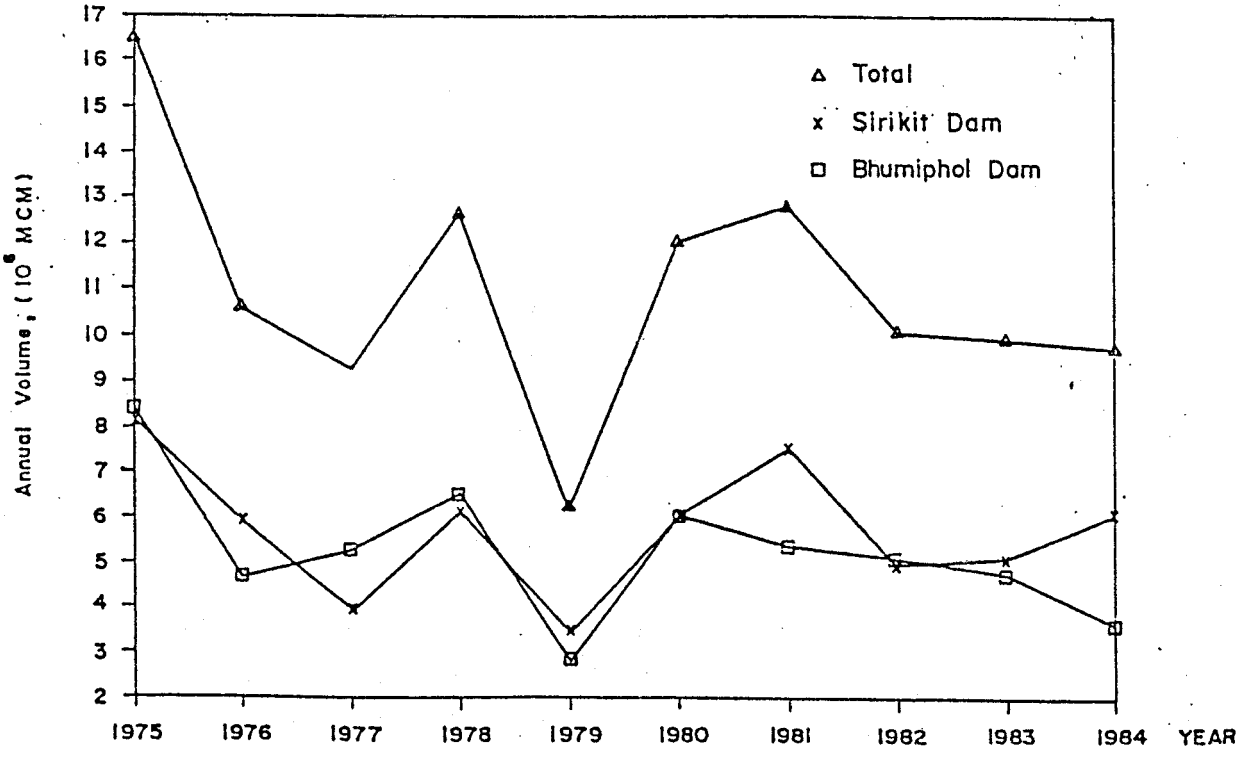


Figure 3.5 Approximate Inflows to Ubon Ratana Dam

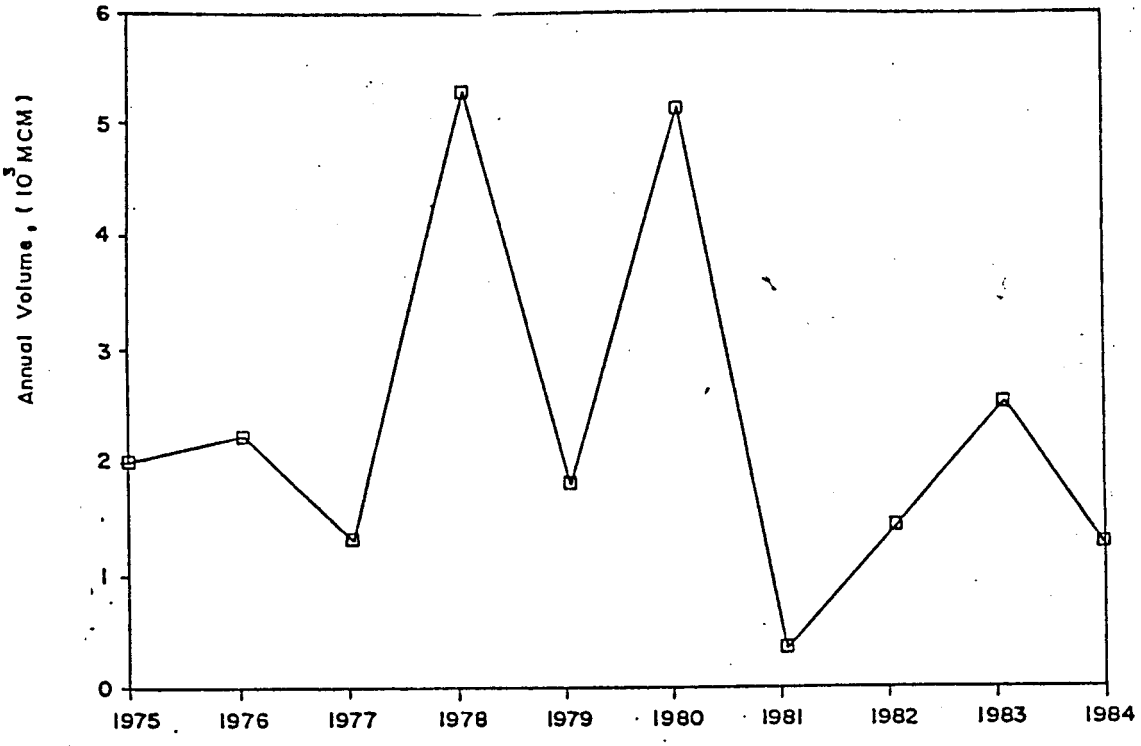
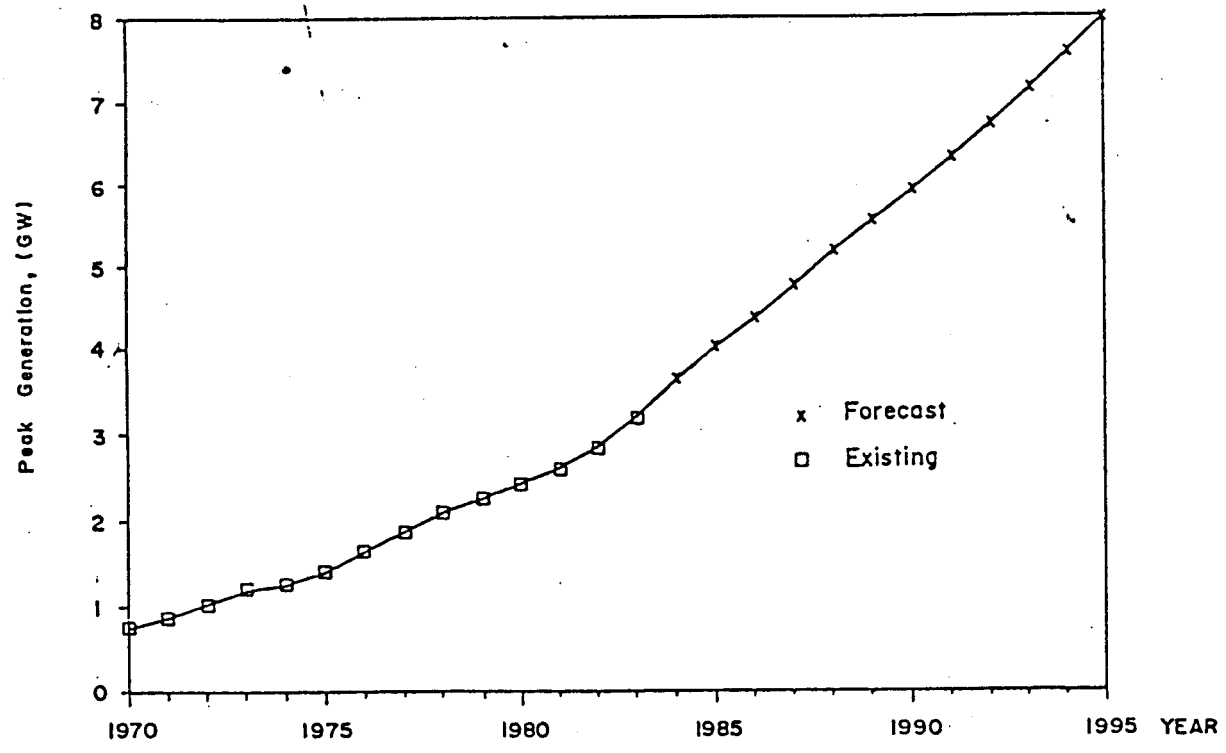


Figure 3.6 EGAT Generation Requirements



pumped irrigation for areas far away from the banks of the Maekhong River.

Hydropower

Hydropower development will continue to play an important part in national development. The present electricity requirement is about 3,800 MW and is expected to increase at an estimated rate of 10 percent annually. Figure 3.6 shows the power requirement forecast by EGAT and the NESDB. At present, hydropower contributes about 22 percent of the total electricity requirement. To at least maintain this portion of hydropower contribution, hydropower development must continue, despite the diminishing number of sites for large- scale projects. EGAT (1984) estimates the total hydropower potential of the country, excluding international projects, to be 10,626 MW. It can be concluded that future hydropower development will focus on pumped storage from existing dams, and on small hydropower plants at irrigation dams.

Groundwater

As for groundwater development, drilling will continue. However, more attention will need to be paid to the quantitative aspects of groundwater, such as the establishment of an appropriate hydrogeological network to monitor groundwater movement, flow direction and water level fluctuation. When better quantitative data are available, it can be expected that more areas will be designated as groundwater areas under the 1977 Groundwater Act. Groundwater will play an increasing role as a water resource for domestic consumption, small-scale irrigation and industrial water supply.

The key water resource-related problems in the Bangkok Metropolitan Area (BMA) are insufficient piped water supply, flooding and land subsidence. These problems are very much interrelated. The MWWA is responsible for providing piped water to the BMA, Samut Prakan and Nonthaburi. It draws about 2.16 million m^3/day from the Chao Phraya River for its water treatment plants. The MWWA also abstracts groundwater for its plants. In 1982, it abstracted 447,000 m^3/day of groundwater. In the same year, private abstraction of groundwater was estimated at 944,305 m^3/day. Since then, the MWWA has decreased its abstraction of groundwater, private sector abstraction has increased keeping total abstraction roughly constant at 1.3 million m^3/day. The increase in groundwater abstraction by the private sector is a result of the inability of the MWWA to meet the demand for piped water, especially in the eastern suburbs, where housing estates and industrial plants are growing at a very rapid rate. This groundwater abstraction rate far exceeds the estimated safe yield of 0.8 million m^3/day. Furthermore, unlicensed abstraction of groundwater may be as high as 50 percent of the legal licensed total of 1.3 million m^3/day.

Various studies have indicated that the major cause of land subsidence in the BMA is excessive groundwater abstraction. The Army Department of Survey has found that the subsidence rate in the eastern suburbs is 10 cm/year, while that of the inner city is 5-10 cm/year and that of the western suburbs is less than 5 cm/year. The area of Hua Mark subsided 1.4 meters between 1940 and 1980 (Ramnarong, 1985). The subsidence has caused some parts of the drainage systems to be below normal water level and has rendered them ineffective. These factors, together with high intensity rainfall, result in the frequent flooding of the BMA.

The policy guidelines of the MWWA for the Sixth National Development Plan (NESDB, 1985) are to reduce groundwater abstraction by both public and private users to a level below the natural

aquifer recharge rate; to cut losses in the water supply from 40 to 30 percent by the end of the Sixth National Development Plan; and to increase water production capacity by 0.5 million m^3/day. Considering the past record, it is doubtful if such a goal can be achieved within the time specified. As a consequence, private abstraction of groundwater will continue, though at a reduced rate. Therefore, it may not be possible to arrest land subsidence completely in the near future. Even with the optimistic assumption that the MWWA can increase its production by 0.5 million m^3/day over the present 2.2 million m^3/day, the MWWA will require 2.7 million m^3/day from the Chao Phraya River in order to eliminate groundwater abstraction from its wells. To supply 2.7 million m^3/day to the MWWA and to prevent saltwater intrusion, the Bhumiphol and the Sirikit dams will have to release more water. This, as we have seen, is very unlikely. Therefore, it can be predicted that the interrelated problems of water supply, flooding, and land subsidence will not be totally eradicated unless some drastic remedial actions are undertaken in the near future.

Box 3.1 Water -- An Abundant Resource?

The fact that Thailand receives something like 800 billion cubic meters of rainfall a year suggests that water is unlikely to be in short supply. However, some 85 percent of that rainfall comes in the rainy season, from May to October. In the south of the country, meanwhile, over 50 percent of the annual rainfall may come between October and January. The main problem here is not a shortage of water, but flooding. So Thailand's relatively abundant rainfall is concentrated both in time and in space. Some regions of the country, in short, get more than others.

The Southern region receives the highest rainfall, while the Northern and Central regions receive the lowest. Indeed, the South receives almost twice as much rain as do either the North or Central regions. Nonetheless, Thailand's largest river basin, the Chao Phraya Basin, originates in the north and covers virtually all of the North and Central regions, draining a total of some 178,000 square kilometers. Most of Thailand's agricultural products are grown in this one basin.

Thailand has made increasing use of its water resources. The country's first reservoir was built some 700 years ago and irrigation has since become an essential component of the country's agricultural economy. Even so, there are significant water shortages in some regions. The Central region, for example, suffers from a paradox: many areas are inundated in the rainy season, but in the dry season very considerable volumes of water have to be imported from the Northern region. Only 30 percent of the irrigable area covered by the Greater Chao Phraya project has adequate irrigation in the dry season, in contrast to the situation in the Maeklong Basin, also part of this region, where about 70 percent of potentially irrigable land is adequately irrigated.

Water demand is increasing rapidly in the Central region, which is the most populous and prosperous region in Thailand, due to the pace of industrialization and the growing area devoted to dry season crop production.

Inevitably, there is growing competition for water resources, both within and between regions. Water

Box 3.1 (contd.)

demand grows constantly, while the actual amount of water available is relatively static. Agricultural, industrial, urban and inland waterway transportation users all want more water and increasingly compete for existing water resources. Unfortunately, most of the obvious reservoir sites have already been used, with many of the remaining sites either found in densely populated areas or in environmental conservation areas.

Clearly, Thailand needs to adopt a more coordinated approach to water resource management. Yet, as this chapter shows, a very considerable number of different government agencies have overlapping - and in some cases competing - objectives in this area. Increasing friction between water users will only be avoided if Thailand can move towards comprehensive planning and the integrated management of its water resources.

There is an increasingly urgent need, for example, for master plans covering groundwater exploitation and interbasin water transfers. More also needs to be done to transfer responsibility for the maintenance of irrigation systems from the Royal Irrigation Department to the farmers who use - and sometimes abuse - these systems. The developing water shortages in certain regions will need to be tackled, with growing interest in groundwater resources and further interbasin transfers, but there is also a need for more work designed to improve the efficiency of water use in various sectors of the economy. Many farmers, for example, continue to think of water as a free, virtually unlimited resource, whereas the facts increasingly suggest otherwise.

3.3 ISSUES

There are many important issues that require attention when discussing Thailand's water resources, such as: the maintenance of irrigation systems; the efficient use of existing water; the adoption of measures to prevent flood and drought; the development of future water supplies for the Central Plain and other regions; the supply of water to rural areas; the implementation and enforcement of new and existing water laws; the establishment of a national agency for water resources development; the formulation of a master plan for river basin development; and the formulation of a master plan for groundwater development. These issues are discussed below.

Maintenance of Irrigation Systems

One reason for the failure of irrigation projects to live up to their design potential is the lack of adequate maintenance. The most common, severe maintenance problems are the siltation of canals, the failure of canal linings, the incursion of aquatic weeds, and damage to minor control structures. These problems seem to be prevalent among medium and small-scale projects. The Royal Irrigation Department (RID) has insufficient manpower, equipment and funds to properly maintain all its irrigation systems. To make matters worse, farmers sometimes intentionally damage irrigation structures, as a protest against the inability of the systems to deliver water in times of

need. The government's involvement in the past has led farmers to take it for granted that the government must provide for all irrigation needs. It is practically impossible for the RID, with its limited resources, to carry out all maintenance work required at all levels in the system.

To date, the RID has not been successful in the task of preventive maintenance. Preventive maintenance requires a systematic program of inspection of facilities and routine maintenance, so that breakdowns will not occur too frequently. With a good preventive maintenance program, breakdowns will still occur, but less often. The RID has no comprehensive preventive maintenance program, nor a system of regular inspection of facilities. Consequently, the RID Operation and Maintenance Division constantly has to carry out work on breakdowns and failures. The RID budget and the Bureau of Budget norms for maintenance work should be reviewed with particular emphasis on preventive maintenance, as well as on breakdown maintenance.

Perhaps some of these maintenance problems can be partially solved at the tertiary level, such as farm turnouts. Farmers could be encouraged to form user groups or user associations to look after the maintenance of tertiary structures at the farm level. User groups can be educated and guided on maintenance matters. Efforts could be made to convince farmers that they stand to benefit greatly from this action. Regular maintenance, both preventive and breakdown-related, carried out by user groups, with periodic supervision from officials, would emancipate the RID from having to maintain systems at farm level. This concept of user group maintenance for some parts of the system is not new. It has been practiced for a long time in the North, in People's Irrigation projects (Surarerks, 1985). Farmer cooperatives in pumped irrigation systems along the bank of the Maekhong River are another example of users' responsibility towards the maintenance of the systems. Widespread implementation of this scheme would benefit farmer and official alike.

Efficient Use of Water

Given a constant supply of water and increasing demand for water resources, inefficiency in the usage of water resources is one of the most important issues. The efficiency of irrigation systems leaves a good deal to be desired. This is the result of incomplete systems, unregulated flow, inadequate or outdated control structures, and wasteful use of water for irrigation. Many incomplete systems have resulted from insufficient budget allocation to provide conveyance and distribution systems. This is particularly true for medium and small-scale projects. The unregulated flow problem is the result of damage to - or removal of - control gates at farm turnouts. In addition, some farmers have installed their own farm turnout gates. These factors make the control of flow impossible and result in irregular supply. Consequently, some farmers protect themselves by hoarding water. Another cause of the problem is the inequity of supply. Areas near the head regulator receive an excess of water most of the time, while those at the end of the delivery system face shortages.

In the past, the RID has concentrated on building large and medium-scale projects. Considering the uncertain future, the present low price of rice in the international market, and the increasing scarcity of good vacant land for agriculture, new investment, especially in large-scale projects, may not be economical. On the other hand, making better use of the potential of existing projects by means of modernization and/or rehabilitation of the infrastructure is definitely a better alternative. Some of the main and lateral canal systems were originally designed to provide supplemental wet season irrigation. The majority of

control structures from the water source to the farm level are manually operated. This puts a great burden on RID operations staff. The present staffing level of RID can manage the routine operation of the head and main regulators in the Chao Phraya projects quite successfully, but this is not the case in other projects.

In addition, the early systems were designed to operate at full capacity only in the wet season. The canal capacities and control regulators are inadequate for today's increasing demand for dry season irrigation. Most turnouts are unable to deliver adequate water supply in the dry season because the water levels are often too low! The On-Farm Development, Ditches and Dikes, and Land Consolidation projects have improved the efficiency of water usage to a certain degree, but they do not solve the fundamental problem of inadequate water control in the main and secondary canal systems. The modernization of main and secondary canal systems will enable more intensive use of irrigated areas, since water can be delivered more reliably and be more easily controlled. The modernization effort should give primary attention to reliable and self-controlling regulators which can be easily implemented using present day technology. The modernization of main and secondary canal systems should also be complemented by the improvement of tertiary systems and by on-farm development.

Another significant factor contributing to the inefficient use of water is that most farmers think that water is free and unlimited. Water pricing would definitely reduce wastage. Most farmers are willing to pay water charges if the supply is dependable. However, a water pricing policy will have to be carefully formulated and assessed in terms of dependability and equity of supply. There are two ways of charging for water. One is the area- based charge and the other is the volumetric charge. In terms of equity and efficiency, the latter is preferred. However, the method would require the costly installation of metering systems. The area-based charge thus raises the question of equity, because different crops yield different income. No matter what charging method is finally selected, the RID will have to provide dependable irrigation. A water pricing policy is urgently needed if water shortages are to be avoided. Revenues collected could increase the capacity of the RID for maintaining and expanding irrigation systems. The so called farm development charge applied to the pilot on-farm development projects is a move in the right direction.

Flood and Drought Protection Measures

Studies are being carried out to find the most effective means of flood protection for the Bangkok Metropolitan Area, but relatively little attention has been given to flood and drought problems in rural areas. There are four major aspects involved in dealing with the flooding phenomenon: flood prediction, flood protection, flood warning and flood relief. In the rural areas, flood prediction and flood protection are not economically justified. However, a well organized flood warning and flood relief system could greatly alleviate the flood damage in these areas. As time is crucial in the event of a flood, relief work can be carried out faster and more effectively by provincial governments. The government should establish standard guidelines or procedures for provincial governors to help them coordinate flood relief work. In each province prone to flooding, an emergency relief fund should be made available at all times. This would at least ensure that local governments could start relief work immediately, without having to wait for the arrival of external aid.

The measures adopted for drought relief in 1980 are a good example of what can be done. The experience gained from the relief work could serve as a model for basic guidelines in formulating a standard procedure for drought relief in

the future. A special release rule for all major dams in times of drought should be planned ahead of time to alleviate the problems that could arise from future droughts. Planning for groundwater utilization, to cater for domestic water supply and augment irrigation during a drought period, is another area which should be carefully considered.

Future Water Supply Options

As previously discussed, the Central Plain is facing a shortage of water for dry season irrigation. Not all suitable dry season cropping land can be irrigated. Certain areas receive dry season irrigation on a rotational basis. On average, only 0.4 million hectares out of 0.5 million hectares of potential dry season cropping land receive adequate irrigation. This water shortage will become more severe with the planned expansion of the Metropolitan Water Works Authority (MWWA). Water availability from the Bhumiphol and Sirikit dams, which control the flow of the Chao Phraya River, is unlikely to increase unless other new water sources can augment their inflows. The maximum volume of water flow the MWWA can extract from the Chao Phraya River, as agreed by MWWA, EGAT and RID, is about 2.6 MCM/day (30 m^3/s). It has been estimated that, by the year 2002, the MWWA will require raw water for its treatment plants on the order of 5.2 MCM/day (60 m^3/s), and perhaps even as high as 6 MCM/day (70 m^3/s), to supply piped water to the BMA, Samut Prakan and Nonthaburi (Srisathit, Nimkulrat, and Anutampai, 1983).

It is of utmost importance that supplementary dry season water sources be found for the Chao Phraya Plain as soon as possible. There are two possible options available. The first is the transbasin project, which can divert excess water from other basins into the Chao Phraya Plain. The other is the development of ground-water as a supplementary water source for the dry season.

Various studies have shown that there may be approximately 50 m^3/s of excess water in the Maeklong Basin which could be diverted to the Chao Phraya Plain (e.g., Acres International, 1979). This amount is approximately equal to the amount that has to be supplied by the Chao Phraya River to the Tha Chin River to control salinity. The diversion of water from the Maeklong Basin will make an additional 40-50 m^3/s available to the Chao Phraya River for the lower Chao Phraya and the MWWA. This water could provide sufficient dry season irrigation for approximately 50,000 hectares in the lower Chao Phraya. However, the government has not yet made a decision on this transbasin project. Indeed, the feasibility study for this project has not yet been carried out.

For the Upper Chao Phraya, the Kaeng Sua Ten project on the Yom River is the first stage of the Kok-Ing-Yom-Nan transbasin project (EGAT, 1984). The first phase of the Kaeng Sua Ten project is the construction of a dam to a height of 72 meters, mainly for agricultural purposes, which can supply dry season irrigation to some 50,000 hectares in the Yom Basin. The second phase will increase the dam height to 96 meters for hydropower generation of 230 MW capacity. Other stages of the Kok-Ing-Yom-Nan project are to divert water by pumping and by gravity from the Kok and Ing basins to the Kaeng Sua Ten reservoir. Some of the storage in the reservoir will then be diverted to the Sirikit reservoir on the Nan River. This means that the Sirikit Dam will receive more inflow and hence will be able to increase its releases for the Central Plain. It has been estimated that the first phase of the Kaeng Sua Ten Dam will cost 4,200 million baht (unpublished data from Project Planning Division, RID). About 900 families will have to be resettled in the first phase and 5,000 families in the second phase.

As with the Maeklong transbasin option, the government has not made a decision on the Kaeng Sua Ten project. The longer

the government delays its decision, the greater the likelihood of additional population moving into the reservoir area. Resettlement of families is a sensitive socio-political issue. The increasing number of families to be resettled may eventually make the option unfeasible. Considering the importance of future water supply for the Central Plain, especially for the agricultural sector, and the fact that Kaeng Sua Ten is one of the last feasible sites for major storage reservoirs remaining in the Upper Chao Phraya, an early decision should be made by the government.

In selected parts of the country, the use of groundwater seems to have good potential as a supplementary dry season water supply. Until now, however, the role of groundwater development in agriculture has been relatively small. There are only two experimental projects in operation, at Sukhothai and Phichit. In all cases, groundwater is used only in the dry season. In favorable areas where the aquifer yield is high, the use of groundwater to augment the flow in irrigation canals would be economical. The use of groundwater for supplementary dry season water for irrigation would also be very beneficial to the Northeastern region, where the shortage of water for dry season irrigation is most severe: the available water in some parts of the Northeast can hardly meet domestic requirements. Transbasin projects are impractical in the Northeast. This leaves groundwater as the only available option to supplement the numerous small-scale projects and to provide pumped irrigation in this region.

The government could encourage the utilization of groundwater in appropriate areas by providing credits, subsidies and technical assistance. The Department of Mineral Resources (DMR) should also closely monitor groundwater utilization to prevent overpumping.

Development of a Rural Water Supply

Recently the NESDB has commissioned the Asian Institute of Technology (AIT) to prepare the Master Plan for Rural Water Supply and Sanitation in Thailand (AIT,1985). According to the Master Plan, only 15 percent of the rural population in 1983 had access to a safe water supply, such as piped water, deep wells and sanitized shallow wells. It was also noted that 85 percent of the rural population did not have an adequate water supply year round. Based on a targeted household coverage of 75 percent, the Plan concentrates on unpiped water supply, such as wells and rainwater jars. The construction of approximately 4 million jars of 2 m^3 capacity and 377,000 thousand jars of 1 m^3 capacity during the decade plan was recommended. Other recommendations are the construction of 25,053 sanitary shallow wells, 21,805 deep wells, plus over 1,000 small-scale piped water systems. To implement the Master Plan, it has been estimated that the government will need to invest about 1,500 million baht annually until the year 1991.

The construction of rainwater jars is perhaps the most effective means of providing potable water to the rural people over a wide geographic area, especially in areas of low population density, where the provision of piped water supply is not economically feasible. The implementation of the jar construction program is within the remit of many government agencies active in rural development programs. However, efforts should be made right from the beginning to alleviate problems faced by the rural water subsector in the past, such as uncoordinated activities, duplication of effort and competition.

For the rural piped water supply, the responsibility has rested on the Provincial Water Works Authority (PWWA), established by the Provincial Water Works Authority Act of 1979. At present there are 674 rural water supply service areas, which only serve about 5.1 percent of the rural population (PWWA/GTZ, 1986). There are also approximately 20,000 small-scale

piped rural water supply schemes serving an additional four million people, which increases the total of rural population served to 14.9 percent.

In its Rural Water Supply Decade Plan (1985-1995), the PWWA has set the target of providing 75 percent of the population in the 674 rural water supply service areas with safe water by 1990, and of increasing this percentage to 90 percent by 1995. The consultant's report (PWWA/GTZ, 1986) estimates the cost of the Decade Plan to be 1,468.5 million baht, at 1985 prices. The report assumes that part of the cost will be covered by community contributions, at a ratio of 35 percent for rehabilitation and 40 percent for new construction. About 27 percent of the cost will come from government loans and the balance will be financed by a revolving fund and foreign donors. The Plan also calls for an increase of PWWA staff from 161 at present to 3,265 by 1995.

On the legal side, the government has reaffirmed the 1979 PWWA Act by a Cabinet resolution. It has ruled that all piped water supply schemes (urban, except BMA, and rural), not yet operated by PWWA, are to be handed over to PWWA. Considering the cost implications of the Act and the PWWA Decade Plan, the government is obliged to give full financial support to the PWWA. The PWWA Act is the beginning of steps to solve the problems faced by the rural water supply sector in the past and to improve the chance that the government's goal for the International Drinking Water and Sanitation Decade can be achieved.

Water Law and its Implementation

We have seen that existing water laws are inadequate. To achieve better maintenance of irrigation systems and to attain efficient use of water, Thailand needs a water law which clearly defines the right to the use of water, especially the use of irrigation water at the farm level, the forming of irrigation water user groups, and the charging of water prices. On the administrative side, some laws are incoherent and ambiguous. There are many agencies with mandates in the administration of water usage. For example, the Public Irrigation Act applies to irrigation canals; the Ditch and Dike Act applies to ditches and dikes; and the Land Consolidation for Agriculture Act applies to land within the irrigated area. This example clearly demonstrates that there are three different laws exercised by different government agencies within a single irrigation system. This situation often leads to a lack of continuity in policy and planning, lack of coordination, and financial waste.

Another important issue is law enforcement. There are cases where a law exists, but where the mechanism of law enforcement is ambiguous. For example, in the case of natural water resources boundaries, there is no single government agency which has the authority to define the extent of the natural water boundaries. As a consequence, families move in and settle within the preserved natural watersheds.

The increasing competition for water resources may create conflicts among users because of the equity issue. The situation calls for a major review of all laws concerning water resources and irrigation. The review should attempt to solve the problems of the coverage of the laws and their enforcement. Perhaps the National Agency for Water Resources Development, as discussed in the next section, could be the enforcing authority for the revised laws.

National Agency for Water Resources Development

There are many agencies carrying out work on water resources development. This situation, plus the complicated budget allocation system within each agency, has resulted in uncoordinated planning of water resources development. Sometimes

the apparent benefit gained by one agency's project may, be canceled out by the negative effect it has on another project of another agency. Water is becoming scarce and the demand for it is increasing. This has given rise to the formation of the National Water Resources Board (NWRB), under the NESDB, in 1983. However, the NWRB has limited authority and resources for planning and implementing water resources development effectively on a national scale. Its mandate emphasizes an advisory role, rather than an administrative one.

As a solution, a national agency for water resources development should be established to plan and coordinate the work of RID, EGAT and other government agencies. An example of such coordination work could be the formulation of release rules for all RID and EGAT reservoirs so that maximum benefit can be gained by all sectors. The agency should have at least a departmental status (Kiravanich, 1983), and preferably ministerial status. The authority of the agency could be strengthened by enacting a law to define its role, function, organization and resources. It can make more efficient use of available resources and budget, and eliminate duplication of work, through programmed budgeting of all water resources development in the country. This agency could carry out the drafting of the master plan for river basin development, as discussed below.

A national agency could also assist in coordinating a network of water resources information. Hydrological, meteorological and hydrogeological data have been collected for a long time by various agencies, but there has been no standard format for the measurement, recording, archiving, analysis or dissemination of data. Consequently some agencies are doing duplicate work. Although an attempt has been made by the Project Planning Division of EGAT to establish a Water Resources Information System for Thailand, the acquisition of data for use in various projects is difficult and time consuming. Progress so far has been slow due to insufficient staff. However, a national agency with specifically allocated resources could act as a center for coordinating a network of water resources information. This agency could be responsible for setting a standard format for the interchange of data collected by various agencies. It could act as a network information center for all variables related to water resources and disseminate information to the public.

Master Plan for River Basin Development

On a national scale, water resources development lacks a master plan to cover development in all river basins as a whole. Thus, collectively, no priorities are defined with respect to overall national benefits. In the past, the construction of a particular project was usually planned for its own benefit and did not take into account completed and still-to-be constructed projects. Development in one basin often went ahead without any consideration of what impact it might have on other basins. In view of the transbasin project options, as previously discussed, the alleviation of the shortage of water in the Central Plain will affect several river basins at once. Therefore, it is necessary to have a master plan for river basin development to identify priorities in all river basins, to safeguard for the interests of the nation as a whole. A master plan would also enable efficient water resource utilization and management, and could begin to eliminate conflicts among the beneficiaries.

Development should be planned for benefits from all aspects, i.e., hydropower, irrigation and flood protection, in an integrated manner. This includes the service infrastructures, environmental impact and conservation aspects. Other related activities, such as land development and agricultural technology, should be planned in parallel with water resources

development from the outset.

Groundwater Development Master Plan

The increasing utilization of groundwater for both domestic consumption and for supplementary irrigation in the dry season raises the prospect of uncontrolled groundwater development. The enactment of the 1977 Groundwater Act represented an attempt to ensure that groundwater abstraction does not exceed the safe yield of the aquifer, which may subsequently lead to problems of land subsidence and saltwater encroachment. However, the enforcement of the Act only applies to the BMA and adjacent provinces at present. There is still no direct government control of groundwater abstraction elsewhere in the country. Recently more and more government agencies have become involved in groundwater development for various reasons. Some of the agencies involved are the DMR, the Office of Accelerated Rural Development (ARD), the Department of Public Works (DPW), the Department of Health (DOH), and the National Security Command (NSC).

Development carried out so far seems to be very much localized, with no consideration given to the adverse effects which might result from such development in the long run. In some areas, saltwater encroachment and the pollution of groundwater by pesticides, fertilizers and underground waste dumping have been observed. Such situations cannot be allowed to go unchecked if groundwater is to remain a valuable water resource.

Farmers have shown an increasing interest in groundwater development and are aware of its benefits, especially in the dry season. It can be predicted, in the light of the dry season shortage of water for irrigation, that private irrigation wells will become more popular in the Central Plain. With favorable results from the experimental projects at Sukhothai and Phichit, the use of groundwater for irrigation is expected to increase in the future. The DMR (which has the power to control the exploitation of groundwater under the 1977 Groundwater Act), the NESDB and the NWRB should begin formulating a master plan for groundwater development. The RID, with its experience in developing groundwater for irrigation, could also cooperate in the formulation of the master plan. This master plan could ensure that the adverse effects of groundwater exploitation, such as those experienced by BMA, would not be repeated in the future.

Box 3.2 Bangkok is Sinking

Like Venice, Thailand's capital is "sinking into the sea", to use a phrase often on the lips of Bangkok residents. Located on alluvial soils near the mouth of the Chao Phraya river, Bangkok is a city of some six million people and covers some 500 square kilometers. Its name, literally translated, means "The City of Angels". All the evidence suggests, however, that the city is going down, not up.

The combination of a sinking city located almost at sea level and heavy monsoon rains, which frequently over-tax the capacity of the Chao Phraya river, has resulted in frequent flooding. The 1982 flood caused damage valued at 6,600 million baht (roughly US$253 million), while the damage caused by the flood in May 1986 is still being calculated.

When flooding occurs, the citizens of Bangkok tend to blame the

Box 3.2 (contd.)

authorities, and particularly the Bangkok Metropolitan Administration (BMA). But the real cause of flooding, apart from meteorological and geological factors, is the land subsidence caused by the over-pumping of groundwater in the region.

Groundwater has been used in Bangkok for over 70 years. Early on, there were only private wells, which tended to be very shallow - since the water table was high. The Metropolitan Water Works Authority (MWWA) began pumping groundwater for its piped water supply in 1954, at a rate of about 8,000 cubic meters a day. The MWWA's daily water usage increased to 370,000 cubic meters in 1974 and to 447,000 cubic meters in 1982. Private industry was also using ever-increasing quantities of groundwater. It was estimated, for example, that large hotels, massage parlors, factories and housing estates were using about 350,000 cubic meters a day by 1974, and this figure increased to 944,000 cubic meters a day in 1982.

This 1982 figure, however, was collected from licensed users of groundwater, whereas it is thought that the unlicensed use of groundwater could run as high as 50 percent of the licensed usage. Total groundwater abstraction by the private sector and the MWWA was running at around 1.4 million cubic meters a day by 1982, which was almost double the estimated safe aquifer yield of 0.8 million cubic metres a day. Although the MWWA has since tried to cut its groundwater pumping, the evidence suggests that the private sector's pumping rate has increased. Preliminary estimates of groundwater usage in 1985 suggest that the MWWA used about 0.26 million cubic meters a day, while the private sector used 1.03 million cubic meters. The total figure of 1.3 million cubic meters a day still exceeds the safe extraction rate by over 60 percent.

One symptom of this over-pumping is the falling level of the aquifers which underlie the city. On average, the water table lay 12 meters under the surface of central Bangkok in 1968, and 4 meters beneath the eastern suburbs. By 1979, the corresponding levels were 45 meters and 54 meters.

As the level of the water table slumps, a series of problems emerge. Apart from the obvious fact that wells have to be dug deeper and more effort has to be expended in pumping up water from the aquifer, using ever-larger pumps, saline water begins to intrude into the freshwater aquifers and, like a mattress with its springs removed, the land surface begins to subside.

Land subsidence has been a feature of Bangkok life since 1968. The most obvious evidence come in the form of the ubiquitous cracks between the steps of tall buildings and the footpaths with which the steps were meant to connect. Subsidence is also certainly caused by soil compaction resulting from the growing weight of tall buildings, vibration from pile, the sheer volume of traffic in the city's streets, and so on. But groundwater pumping is the real culprit.

Surveys conducted by the Army Survey Department, together with a four-year (1978-1982) monitoring program by the Asian Institute of Technology, have indicated that land subsidence has reached a critical stage in Bangkok. For example, between 1930 and 1940 the district of Bangkapi was 1.6 meters above mean sea level. The area subsided 50-85 centimeters between 1940 and 1978, and the center of Bangkok has also subsided 20-85

Box 3.2 (contd.)

centimeters during the same period.

The worst subsidence rates are found in the areas of greatest groundwater usage, the eastern suburbs. The areas of Ladprao, Hua Mark, Phrakhanong and Bang Na all have land subsidence rates exceeding 10 centimeters a year. The inner districts of Bangkok have been subsiding at a rate of 5-10 centimeters a year. The worst subsidence has been around Ramkhamhaeng University, an area which the Army Survey Department has shown is now below mean sea level. It has not been flooded so far simply because the surrounding areas are still above mean sea level.

The situation is aggravated by the fact that Bangkok's drainage system has not kept pace with the city's rapid development. Existing drains are meant to work by means of gravity, but the combination of flat land and further subsidence means that many of them are fully submerged for most of the time. As the city spreads, so greater quantities of water are collected by its impervious surfaces and discharged into the already overtaxed drainage system.

Studies using mathematical models suggest that unless the use of groundwater is greatly reduced in the Bangkok area, the city will subside by at least a further two meters by the year 2000. Flood prevention schemes are being considered for the eastern suburbs and some inner areas of Bangkok, with a new canal proposed from Pak Kred to Samut Prakan, to accelerate the flow of water into the sea. But the only real long-term solution is to cut the rate of groundwater extraction.

Recently, BMA has been seriously considering the Chao Phya II Project to divert water to a new man-made river, running in parallel and to the west of the present river. This idea follows the successful diversion of the Danube to prevent the city of Vienna from flooding. As is common to other mega-projects, the main obstacle seems to be its prohibitive cost- more than 21 billion baht (1986 estimate). However the local authority seems to be confident about raising the necessary fund from private investment in land development along both banks of the new river and from raising flood protection revenues either from direct taxation or the issuance of long term bonds.

A study was carried out in 1983 by the Bangkok Flood Control and Drainage Joint Venture (BFCD), to design a new master plan. Despite the fact that the internal rate of return on the new plan would be high, equalling the opportunity cost of capital in Bangkok even on pessimistic assumptions, the complete plan will not be carried forward. BMA is planning to implement flood protection only in the core city area, costing about 2,050 million baht. The costs will be borne equally by the BMA and the central government. About 57 percent of the project's cost has been secured in the form of loans from the World Bank. The MWWA is also pushing ahead with plans to extend piped-water supplies to more areas of the city, to cut the pressure on groundwater. But it is still anyone's guess as to what the eventual outcome will be.

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4 Forest Resources

4.1 STATUS AND TRENDS

Forest Destruction

The latest assessment of the status of forest areas in Thailand indicates that only about 29.05 percent of the country's total area remains under forest cover (Table 4.1). This represents a reduction in forest cover of around 45 percent between 1961 and 1985 (Table 4.2), and this trend is expected to continue

This dramatic depletion of Thai forests has occurred as a result of forest clearance after logging operations, crop cultivation in the highlands, and encroachment by hill tribe squatters. So far, at least, attempts to reverse the trend have failed. Some of the areas lost to forest is now permanently lost as far as the forest sector is concerned, because of its suitability for agriculture. But other areas will need to be rehabilitated and reforested for such purposes as watershed protection.

Reforestation and Forest Rehabilitation

When the First National Economic and Social Development Plan was drafted, the Royal Forest Department reserved 50 percent (161 million rai) of the country as forest land. This proportion fell to 40 percent (128 million rai) in the Second, Third, Fourth and Fifth Plans. Despite this target, however, only about 29 percent (93 million rai) of the nation's forest cover was left by 1985, of which nine million rai (or some 10 percent) are in headwater area.

The rate of reforestation has lagged behind the rate of deforestation. To date, as Table 4.3 shows, the total area reforested amounts to something over three million rai, while deforestation, as later sections explain, has been running at a similar rate - every year. As far as the reforestation of mountainous watershed areas is concerned, the rehabilitation units report having achieved a total of 661,334 rai of new plantations over a 21-year period, representing about 31,500 rai per year. The Royal Forest Department planted just over 200,000 rai a year from 1982 to 1984, with a figure of 300,000 rai reported for 1985. For the period covered in the Sixth National Development Plan (1987-1991), the RFD's target will be to plant 300,000 rai per year, in the following proportions: 17 percent for watershed protection, 40 percent for commercial purposes, and 43 percent for fuelwood and charcoal.

Land Pressure and Degazetting

Altogether, there were 1,157 units of forest reserve in 1985 (Table 4.4), an increase of 140 units since 1981. These units covered an area of 135.75 million rai, although only 95.16 million rai were forested. The 42.59 million rai difference is presumed to be occupied by squatters, as shown in Table 4.5.

Unfortunately, these forest reserves have decreased from the initial areas because the Royal Forest Department (RFD) had to grant STK (right to farm) certificates to squatters who live inside

Table 4.1 A Comparison of Forested Areas in Regions of Thailand, 1961, 1973, 1976, 1978, 1982 and 1985
(Unit: rai)

Region	Total Land Area	Forest Area					
		1961	1973	1976	1978	1982	1985
North	106,027,681.20	72,671,875 (68.54)	70,996,875 (66.96)	63,954,375 (60.32)	59,335,625 (55.96)	54,847,500 (51.73)	52,578,750 (49.59)
East	22,814,062.50	13,226,875 (57.98)	9,397,500 (41.19)	7,894,375 (34.60)	6,898,125 (30.24)	5,000,000 (21.92)	4,993,899 (21.89)
North east	105,533,962.50	44,315,000 (41.99)	31,669,375 (30.01)	25,933,750 (24.57)	19,513,125 (18.49)	16,178,750 (15.33)	15,140,000 (14.35)
Central Plain	42,124,187.50	22,287,812 (52.91)	14,981,250 (35.56)	13,641,250 (32.38)	12,766,250 (30.31)	11,572,500 (24.47)	10,767,500 (25.56)
South	44,196,933.75	18,516,250 (41.89)	11,521,875 (26.07)	12,568,875 (28.48)	11,011,875 (24.89)	10,276,250 (23.25)	9,678,125 (21.90)
Whole Country	320,696,877.45	171,017,812.00 (53.33)	138,566,875.00 (43.21)	124,010,625.00 (38.67)	109,515,000.00 (34.15)	95,875,000.00 (30.52)	93,158,274.00 (29.05)

Note: Data derived from LANDSAT.
Source: Remote sensing & Forest Mapping Sub-Division, Forest Management Division, Royal Forestry Department.

or near the reserves. The RFD's initial target was to implement the STK program to completion in all forest areas between 1982 and 1986. This target will not be met, as only 4.2 million rai had been degazetted in 574 national forest areas by 1984, as shown in Table 4.5. However, the RFD was expected to degazette about 6.36 million rai of national forest reserves in 1985. The RFD believes that the STK program area may also help in meeting forestry and rural development targets.

Table 4.2 Forest Encroachment, 1961-1985

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

Table 4.3 Reforestation in Thailand, 1961-1985

Year	Area	
	(rai)	(ha)
Up to 1979	1,597,450	255,592
1980	508,725	81,396
1981	329,500	52,720
1982	202,406	32,385
1983	201,588	32,254
1984	202,381	32,281
1985[a]	300,000	48,000
Total	3,342,050	534,728

Note: a. Estimated number
Source: Planning Division, Royal Forest Department, 1984.

Table 4.4 Number and Area of National Forest Reserves in the Whole Country, 1981 - 1985

Region	1981		1982		1983		1984		1985	
	No.of units	Area (rai)	No.of units	Area (rai)	No.of units	Area (rai)	No.of units	Area (rai)	No.of units	Area (rai)
Northern	205	58,289,437.50	211	59,714,625.00	220	62,115,218.75	228	61,814,600.00	NA	52,578,750.00
Northeastern	291	30,131,937.50	298	30,549,875.00	301	30,563,181.25	314	32,653,412.50	NA	15,140,000.00
Central + Eastern	119	20,002,875.00	119	19,643,250.00	121	19,674,606.25	133	22,294,100.00	NA	15,761,399.00
Southern	402	14,381,500.00	406	14,894,562.00	413	15,070,318.75	435	15,909,050.00	NA	9,678,125.00
Total	1,017	122,805,750.00	1,304	124,802,312.50	1,055	127,423,325.00	1,110	132,671,162.50	-	93,158,274.00

Note: NA = not available.
Source: Forest Statistics Sub-Division, Planning Division, Royal Forest Department.

Table 4.5 National Reserve Forest under the STK Program, 1982-1985

Year	No. of Forests	Total forest area (rai)	Area Under STK		Leased Area	
			HH	Rai	HH	Rai
1982	43	13,427,568	78,712	836,211	3,643	252,867
1983	122	24,383,678	169,197	1,736,132	54,863	1,089,315
1984	191	27,564,048	201,844	2,162,760	76,010	1,330,674
1985	218	40,806,694	174,295	1,625,346	41,255	740,112
Total	574	106,182,007	624,048	6,360,449	175,771	3,412,968

Notes:
a. STK allows 15 rai/family, additional land must be leased.
b. HH = No. of households.
Source: Royal Forest Department, 1986.

BOX 4.1 Thailand's Vanishing Forests

At a time when there is growing worldwide concern about the destruction of tropical forests, Thailand's forests continue to disappear at a considerable rate. The pace of deforestation has been accelerating since the early years of the century, but it has moved into a higher gear since the 1960s. In 1961, for example, some 53 percent of the country was still covered with forest, a proportion which declined dramatically to the 1986 figure of 29 percent. In other words, Thailand lost about 45 percent of her forests over this 25-year period.

There are many reasons why the country's forests are shrinking, but several key pressures stand out. An estimated 500,000 tribespeople practice shifting cultivation in the hills, removing forest cover for several years (see Box 4.2). On steep slopes, the result is soil erosion and sedimentation of downstream rivers. At the same time, the ability of watershed areas to absorb rainfall and release it slowly is degraded, often leading to flooding in downstream areas.

Meanwhile, lowland agriculture and the demand for new areas for settlement have severely cut into the remaining lowland areas of forest. The Royal Forest Department, for example, has had to grant STK (right to farm) certificates to the growing numbers of squatters living in or alongside Thailand's forest reserves. And these pressures have been further aggravated by illegal wood cutting and legal industrial wood consumption whether for construction timber, fuel or charcoal.

The environmental, economic and social costs involved are considerable and growing. The extensive denudation of critical watershed areas has led to widespread flooding, as described in Chapter 3, while severe impacts are also being reported in other key sectors, including wildlife management (see Chapter 5) and coastal fisheries (Chapters 7 and 8).

Strikingly, the value of Thailand's forest exports dropped from 354 million baht in 1978 to 104 million baht in 1984, a 70 percent fall. In 1967, Thailand was forced to begin importing timber, with the value of these imports growing by over 90 percent between 1973 and 1984, a 16-fold increase in just 12 years. All the signs suggest that Thailand's timber deficit will continue to worsen for the foreseeable future.

To counter these threats, the Royal Thai Government has stepped up the enforcement of existing laws, and launched reforestation programs in some of the worst affected areas. However, as this chapter shows, the scale and complexity of these problems have so far defied the government's best efforts. A new structure has been proposed for the Royal Forest Department, but in the meantime its efforts to accelerate reforestation are still hampered by the fact that its funding and manpower have not kept pace with the increasing responsibilities laid upon it.

The maintenance of forest cover at around 40 percent of Thailand's total area is the national Forest policy target, with 15 percent devoted to conservation forests and 25 percent to productive forests. A great deal of work remains to be done, however, in defining which areas of forest should be left intact, which should be converted to other uses, and where the priority areas for enrichment planting and commercial plantations need to be. The production of the National Forest Policy in December 1985, with the

support of all agencies involved in forests and forestry, was a positive step in this direction.

Clearly, the government cannot cope with this problem in isolation. There is growing interest in private sector forestry initiatives and in so-called "social forestry", with plantations of fast-growing trees developed under the control of local communities. Small-scale plantations, mainly of teak, started in the early years of the twentieth century by RFD, with large-scale replanting dating from the early 1960s by state and private sectors. The role of private sector was initiated from the 13 rai replanted with fast-growing trees in 1966. There has been a fair acceleration in the rate of replanting, with a 1985 figure of nearly 31,000 rai.

But even the total area of over three million rai replanted by the Royal Forest Department, the Forest Industry Organization, and private concessionaires between 1961 and 1985 looks precariously low when compared with the rate of forest encroachment during that 20-year period. Indeed, it effectively compensates for the average forest encroachment of <u>just one year</u>.

4.2 KEY ISSUES

The Royal Thai Government (RTG) is well aware of the damage that has been done - and is being done - to Thailand's forests. Badly managed official logging and illegal logging, and encroachment by landless farmers, hill tribesmen and other shifting cultivators are just some of the threats to the country's remaining forest cover. The RTG has devised and adopted a number of strategies designed to halt, or at least slow, the process of deforestation. These have included the 40 percent forest target; watershed classification; privatization programs; the fast-growing tree and social forestry programs; the STK program; management programs designed to tackle the side-effects of shifting cultivation; and investment in improved forest management techniques.

But, all too often, these strategies have been stalled because: (1) there is inadequate cooperation between government agencies, or between the public and private sectors; (2) the legal framework is inadequate, either because it is too old or too weak; (3) there is a lack of adequate land use planning; (4) research results are too rarely incorporated into practical forest management procedures; and (5) and by no means finally, but fairly fundamentally, there has been a lack of an effective enforcement program to deal with encroachments and illegal loggers of our national forests.

Preserving Forest Cover at 40 Percent

The National Forest Policy has set the minimum requirement for forest coverage at 40 percent of the whole country's land surface area. The area can be divided into two parts: (1) the conservation forest of about 15 percent, which is composed of headwater source areas (first class watersheds), national parks, wildlife sanctuaries, non-hunting areas, Reserved park, arboretums, botanical garden, and reserved areas for specific studies); and (2) the commercial forest or productive forest of about 25%, which is composed of forest reserves, plantations areas, community forests, private tree farms (forests), and timber concession areas.

As the forest coverage at the present time is about 29 percent, there will need to be an increase in forest coverage of about 11 percent or, about 35.3 million rai, to reach the target. If the government achieves about 300,000 rai per annum, as suggested by the current planting rate, it would still take about 118 years to reach the target. However, if the government increases its efforts

and budget, replanting about a million rai per year, then it will take about 35 years to reach the target, if, and only if, the preserves on the existing forest have been effectively controlled.

To accomplish the target and select suitable forest locations, the following strategies would be helpful. The government should: (1) clearly specify the location and size of the conservation forests throughout the whole country; (2) stake out the boundaries of productive forests, such as forest reserves, concession area, and areas of watershed class; (3) prepare an effective plan for reforestation in the shifting cultivation areas and denuded lands, and determine the areas of responsibility for the government, private sector, and community; and (4) assign responsibilities and set guidelines for other government agencies and for the local community on how to implement the forestry work. Furthermore, (5) future forest protection should be undertaken not only by the Royal Forest Department, but also by other agencies, such as local communities, schools and universities; (6) laws and regulatory improvement and development are urgently needed to help implement the National Forest Policy; and (7) wood utilization and conservation should be emphasized in relation to extension programs.

Watershed Classification and Management

Watershed management is defined as "the management of the land for desirable quality, and regulation of water flow along with soil erosion control, flood reduction and other resource utilization." The watershed area is synonymous with basin, drainage area, catchment area, hydrological unit or resource system.

Since the land in the watershed area varies from one place to another, watershed classification is needed. The term "watershed classification" is used here as synonymous with "land use planning for watershed areas". Land use planning or watershed classification is an effort to make man's uses of land as compatible as possible with the features of the environment and to mitigate any adverse effects. Watershed classification will help to achieve this goal by identifying which areas should be maintained as protected forests and by prescribing guidelines for associated areas which may be used for the culture of trees or crops. However, the watershed classification, as approved by the Cabinet, requires a system for establishing potential uses of land based on the physical characteristics of landscape units, namely elevation, slope, landform, geology, and soils.

(a) Watershed Class 1: Protected Forest (Conservation Forest)

Class 1A includes areas of protected forest and headwater source areas, usually at higher elevations with very steep slopes. These areas still remain under permanent forest cover. Class 1B are areas having similar physical features and environments as Watershed Class 1A, but where portions of the area have already been cleared for agricultural use or occupied by villages. These areas require special soil conservation protection measures and, where possible, should be reforested.

(b) Watershed Class 2: Commercial Forest

Class 2 comprises areas of protected and/or commercial forest (usually commercial forests). For the most part, these areas are located at higher elevations, with steep to very steep slopes. Landforms are less erosive than in Watershed Classes 1A or 1B. Areas may be used for grazing or for certain crops. Soil protection measures are required.

(c) Watershed Class 3: Fruit Tree Plantations

Class 3 covers upland areas with steep

slopes and less erosive landforms. These areas are usually used for fruit tree plantations or certain agricultural crops, and may be used for commercial forests, grazing or other uses. They require soil conservation measures.

(d) Watershed Class 4: Upland Farming

Class 4 describes areas of gently sloping lands, suitable for row crops, fruit trees, and grazing with a moderate need for soil conservation measures.

(e) Watershed Class 5: Lowland Farming

Class 5 groups gently sloping to flat areas, used for paddy fields or other agricultural uses, with few restrictions.

In 1985, the Government of Thailand extended the watershed classification program to the Ping and Wang river basins. The government is considering the Yom-Nan river basin next and plans to use this classification system for the whole country by the end of 1992.

Privatization of Forestry Works

The Sixth Plan calls for the RFD to continue its operations in highland watershed development by preparing annual plans, with objectively verifiable and reachable targets. For example, a feasible target figure would be 100,000 rai (16,000 ha) per year for watershed improvement and reforestation. In addition, a target of 300,000 rai (48,000 ha) per year is proposed for reforestation in highland areas. The RFD also proposes to establish mechanisms for the increased participation of the private sector in forest development. In addition, the Sixth Plan proposes to conduct forestry works in national parks. Another proposal is that conservation forests be run by the private sector, including hotel and tourism businesses.

Some obstruction of project plans would be expected due to the present forest laws and regulations. Delays for preparation of working documents for beginning the project and obtaining licenses for leasing the government forests have to be expected. Tax-exempt loans for investment would also be needed at the beginning.

It is believed that privatization of forestry works would help the National Forest Policy to reach the target of 40 percent forest coverage area and also to increase the protection measures of the forests in the whole country in the future. The situation in the past has shown that the government - or the Royal Forest Department - cannot protect and fulfill Thailand's forestry objectives in isolation. Besides the private sector, the community and other government agencies will need to participate in the forestry works proposed in the Sixth Plan. If all the agencies mentioned above can participate in reforestation, and in the preservation of the forest lands they occupy, the 40 percent forest coverage target could be achieved in less than 35 years.

Multipurpose Tree Programs and Social Forestry

Small-scale plantation work, mainly based on teak, started at the beginning of the century, but large-scale replanting only began in 1961. Due to developing wood shortages over the last decade, fast-growing tree plantations have been promoted. There are about 26 tree species such as pine, persian lilac, eucalypt, leucaena, casuarina, acacia, duabanga, acrocarpus and mahogany. The planting area for all these fast-growing tree species can be quantified as shown in Tables 4.6. Most plantings are in the western, eastern central and northern regions of Thailand. Although the increasing rate of planting has not quite approached the target, significant social development gains from this activity are already evident.

Table 4.6 Reforestation with Fast Growing Trees by Government Agencies in Various Regions, 1966-1985

No.	Tree Species	West & East		North		Northeast		South		Total	
		(rai)	%	(rai)	%	(rai)	%	(rai)	%	(rai)	%
1.	Eucalyptus camaldulensis	47,738.70	55.88	11,579.86	13.55	26,001.26	30.43	118.25	0.14	85,438.07	100.00
2.	Casuarina junghuhniana	30,425.39	78.26	710.75	1.83	7,373.25	18.97	366.50	0.94	38,875.89	100.00
3.	Rhizophora indica	8,534.25	99.59	-	-	-	-	35.00	0.41	8,569.25	100.00
4.	Anardiam occidentale	2,798.50	68.73	36.00	0.88	204.25	5.02	1,033.00	25.37	4,071.75	100.00
5.	Acacia auriculaefomis	-	-	896.00	96.27	34.75	3.73	-	-	930.75	100.00
6.	Leucaena glauca	491.00	31.68	891.75	57.54	167.00	10.78	-	-	1,549.75	100.00
7.	Casuarina equisetifolia	1,414.50	84.35	93.00	5.58	45.00	2.70	114.50	6.87	1,667.00	100.00
8.	Acrocarpus fraxinifolius	-	-	220.25	67.74	-	-	104.75	32.23	325.00	100.00
9.	Others	5,714.00	62.18	3,075.00	33.46	367.25	4.10	33.00	0.36	9,189.25	100.00
	Total	97,116.34	64.48	17,502.61	11.62	34,192.76	22.70	1,805.00	1.20	150,616.71	100.00

Source: Planning Division, Royal Forest Department.

The Sixth Plan emphasizes reforestation with fast-growing trees under community control. This could be expected to both increase the forest area and promote community development.

The STK Program

One of the Royal Forest Department's most important program is the granting of STK or "right to farm" certificates (usufruct licenses) to squatters in national reserve forest areas. In principle, the STK program is aimed at halting further encroachment of forest reserves located near squatter settlements. The granting of STK certificates gives affected farmers a sense of ownership they might not otherwise have had, and an incentive to settle on and invest in the land they occupy. The STK program also engages these individuals to work for RFD to replant forests and maintain standing forests in the STK designated areas that are for agriculture. The program serves to establish closer relations between squatters and the RFD, while providing a base upon which other RTG agencies can operate complementary development programs. Through the STK program, the RFD can apply the full strength of legal

Table 4.7 Plantation of Fast Growing Trees in Thailand, 1966-1985

Year	Area (rai)
1966	13.00
1967	793.25
1968	164.00
1969	185.75
1970	849.50
1971	99.00
1972	297.00
1973	590.25
1974	489.75
1975	396.50
1976	598.75
1977	3,480.50
1978	5,423.00
1979	9,188.25
1980	11,067.64
1981	18,863.25
1982	9,803.50
1983	21,097.25
1984	36,265.82
1985	30,951.00
Total	150,681.21

sanctions against individuals who continue to destroy unencroached forests.

The RFD's initial target was to implement the STK program to completion in all forest areas between 1982 and 1986. This target will not be met, as only 6.3 million rai had been allocated in 574 national reserve forest areas by 1985 (Table 4.5).

The operation of the STK program will also serve the purpose of meeting forestry and rural development targets. Within ten years of the initiation of the STK program, RFD anticipates that visual improvements will take place in the STK forest areas which can be verified using aerial photographs. Both the beneficiaries and the RFD will be involved in an organized, methodical reforestation program, with each RFD forest replanting unit planting at least 500 rai of trees per year. With the STK program serving as a base, the government's rural development effort can be expected to have a more significant impact, leading to a higher standard of living, linked to a decrease in forest destruction. The STK program is expected to affect the lives of one million families during the program's implementation. The government's Rural Work Generation Program will provide the infrastructure required in STK areas.

Shifting Cultivation

Forests are easily encroached once access roads are opened up to the forest concession areas. As Box 4.2 explains, hill tribespeople and other shifting cultivators have had a considerable impact on the highland forests, particularly where they have attempted to farm steeply sloping land.

The prevention of deforestation by shifting cultivators has been discussed for years. At the beginning, reforestation programs were seen as part of conventional rural development programs. However, as the pressures mounted, the objective was extended to include the reforestation of damaged forest reserves. But the replanting units ran into severe difficulties in areas where land had been encroached and the encroaching communities were still in residence. As a result, reforestation goals have rarely been met.

Increasingly, it is recognized that programs designed to achieve the reforestation of watershed areas should incorporate subprograms designed to promote the social and economic development of encroaching communities. This often requires that several agencies collaborate on the program, underscoring the need for a broad-based approach to this whole issue, with strong government backing for those involved.

Forest Management Practices

Forests are renewable natural resources. When wood timber is harvested from forest land, the resource should renew itself. In principle, if the harvest is undertaken in an amount equal to the annual increments, a year later the same amount of harvested wood timber could again be harvested. If over-exploitation has taken place, however, the forest cannot recover this quantity of cut timber. Thereafter, the status of the forest deteriorates, and finally the yield cannot be sustained.

From the standpoint of sustainable yield, Thailand has applied the selection cutting system for harvesting the wood timber even before the establishment of the Royal Forest Department in 1896. This method of forest management seems unlikely to meet the goal, because it can only be applied by disciplined forest users with technical know-how. In the past, the selective cutting system was highly efficient and productive. Since the population of the country increased from about 18 million in 1953 to 52 million in 1986, the selective cutting system seems out of date and needs improvement or replacement. The Royal

Forest Department recognizes the problems and the need to change from the selective cutting system to a clear-cutting system. The economic return on the clear-cutting system was found to produce better benefits. Clear-cutting is also easier require immediate tree planting in the cutting site to carry out, requires less investment, and is the best way to prevent encroachment.

Unfortunately, the forest laws are obsolescent and do not provide any way to alter the cutting method. Past experience in forestry has demonstrated that the change of cutting systems from selective cutting to clear-cutting should be implemented very soon, or else forest protection measures will fail.

BOX 4.2 The Hill Tribes

As far as the tourist visiting Thailand is concerned, the hill tribes of the northern highlands are exotic, exciting. The streets of bangkok are dotted with hill tribe craft shops, selling their colorful handiwork. But for the Royal Thai Government, the hill tribes pose a series of profound political, social and ecological problems. Much highland deforestation, for example, can be laid directly at their door.

It is only since the end of World War II that the Thai government has attempted to introduce a coherent administrative structure into the country's highlands, and the process has proved far from easy. Apart from the fact that these are marginal populations living outside the Thai mainstream, there is the additional complication that many of the hill tribes are often on the move. National borders mean little or nothing to them. The borders with Burma and Laos, for example, are hard to police, and there is much movement to and fro. This is not simply a matter of administrative tidiness: much of the opium grown in the infamous "Golden Triangle" is harvested in Burma and the processed derivatives are then smuggled into Thailand, which is much more international, for export.

The sheer number of hill tribespeople, about 500,000 is also exacting a growing toll on the highland environment. A high natural fertility rate among the hill tribes combines with influxes of refugees from politically troubled neighboring countries, and with the movement of landless lowland Thais into the mountains in search of land to farm. The end result is that large areas of forest are cut down, denuding important watershed areas. Forest reserves, which are protected for conservation purposes, are continually encroached. Soil erosion increases, as does sedimentation in rivers which originate in the highland areas, promoting downstream flooding and, by accelerating run-off, aggravating drought problems in the dry season.

A further factor in this worrying equation has been the change in the styles of farming used by some of the hill tribes. Traditionally, many of them practised "swiddening", an old English word meaning a "burned clearing in the forest." The surface soils in the highlands are poor, but by burning trees, whose roots have drawn up nutrients from deeper down, the hill farmer can release some of these nutrients into the soil and "capture" them in his crops. The fire temporarily rids the soil of pests, too, but the nutrients are soon exhausted and the pest populations build back up to troublesome levels. In the old swiddens, trees were left standing in the middle of cleared plots, to ensure natural regeneration when the plot was abandoned. Later, when the forest has recovered, the process was repeated.

This style of farming can support light population densities at best, but as long as it was practised in the traditional way, by reasonable numbers of people, the process was sustainable. Now, as populations increase and farmers become more interested in extracting as much as they possible can from a plot before moving on, many plots are totally cleared

Box 4.2 (Contd.)

of trees, and the natural regeneration process is much less effective.

The government, therefore, is presented with a series of extremely thorny dilemmas. If it wants to protect the highland watersheds, it will be forced to institute widespread resettlement of hill farmers from such areas, protecting the watersheds thereafter with force, if necessary. In a democratic society, even if vitally necessary, such programs can be hard to push through.

Increasingly, government agencies are looking for ways of combining watershed and other natural resource protection programs with projects designed to promote social and economic development in highland communities. The aim in forest reserves, for example, is to employ local people on the reserve, to give them a vested interest in maintaining it. If the goal of maintaining some 40 percent of Thailand's surface area is to have any chance of success, these programs must succeed first.

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5 Nature Conservation

Wildlife Protection Measures

Little need for special measures to protect wildlife was seen before World War II, when forest cover exceeded 60 percent of the kingdom and large herds of big game animals such as elephants, gaur, banteng, rhinoceros roamed the forests, and large flocks of storks, ibises and other large waders fed on the plains (Gairdner, 1915; Lekagul and McNeely, 1977; Jintanugool et al., 1982). After the war the increased availability of firearms, the demand for timber for export and a rapidly expanding human population caused a steady reduction of wildlife and habitat in every region of the country. To check these trends, the government enacted the Wild Animal Preservation and Protection Act (WARPA) in 1960, establishing hunting limitations, and capture and trade restrictions and making provision for the wildlife areas described above. Lists of protected species have been updated from time to time in response to increasing threats to their populations. For example, the export of monkeys was curtailed in 1976, in response to a growing demand for them (especially the stump-tailed macaque) for laboratory research. At present, the Forest Department lists 228 types of vertebrates on reserved and protected lists which prohibit or restrict hunting and trade (Jintanugool et al., 1982).

Nothing is done to prevent hunting of protected animals outside of the protected area system and most large species no longer survive in significant numbers outside of protected areas, except in a few remote regions. A considerable amount of subsistence hunting and trapping takes place in rural areas, both inside and outside of protected areas.

The local trade in wildlife species is extensive and it is uncertain if laws have much effect on it, especially in the case of small species which are easy to transport and conceal. It is virtually impossible to prevent animals from being bought and sold, even in the large markets, as almost any animal can be concealed, or be claimed by an owner not to be for sale. Trade in wild animals is carried out by hundreds of small vendors, pet stores, private zoos, large international dealers, game meat restaurants, and jewelry stores which sell endangered cat skins, teeth and claws, all of whom conspire to find loopholes in the laws or simply ignore them. Additionally, the present regulation allowing persons to own one pair of any protected species has been counterproductive in that it has created a convenient loophole for dealers and does nothing to aid captive propagation.

Some international wildlife dealers are influential and wealthy who use existing loopholes to trade in spite of the regulations.

There are many ways of getting animals past wildlife checkpoints which are difficult to stop: shipment in boxes labeled as poisonous snakes; carriage of young gibbons by airline passengers in the cabins (where there is no wildlife inspection) or hidden in boxes of

orchids; the use of smuggling routes to Vientiane, whence the animals are exported as Laotian wildlife; shipment in domestic airline cargo with connecting flights abroad; or smuggling by road or rail into Malaysia and Singapore.

Wildlife authorities lack the manpower and support from higher levels of the government to do their job effectively. Most officials do not regard hunting and smuggling of protected wildlife as a serious crime or a significant national problem.

Given the difficulty of suppressing the wildlife trade, great emphasis must be placed on improving direct protection of wildlife and habitats in sanctuaries and parks.

Trends in Wildlife Populations

The difficulty of censusing populations of most wildlife species makes it impossible to present statistics showing population trends. Some general conclusions are possible, however. Natural forests are shrinking in area very rapidly (see Chapter 4), and most species which depend on forests for survival will soon survive only within the protected area system. This system is nearly all forested and now contains nearly half of the natural forests remaining in the kingdom. There is an urgent need to search all remaining forests outside the protected area system for wildlife populations and habitat worthy of saving.

Even within protected areas, populations of some species are declining or have been extirpated. Large hornbill species have been eliminated from Doi Suthep - Doi Pui National Park (Round, 1984), and gibbons have been hunted out of many areas of national parks that are easily accessible to villagers. A recent survey of stump-tailed macaques in southern Thailand has failed to reveal more than a few scattered groups within protected areas, whereas they were once exported from Thailand in large numbers (Eudey, 1978). Recent surveys of elephants in Khao Yai National Park have revealed that elephants less commonly utilize parts of the park near boundaries close to villages that are more disturbed by poachers (Dobias, 1985).

Table 5.1 lists species of vertebrates that may not survive in Thailand due to their extreme rarity, caused by severe hunting pressure or disappearance of habitat. One species, Schomburgk's deer, is definitely extinct and many others have not been seen in recent years and may also be extinct. All the listed species could become extinct within the next decade or two, and many within the next five years.

Special habitats in particular need of conservation are lowland forest on level areas, freshwater swamp habitats and high altitude mountain or hill evergreen forest which harbors species of birds not found elsewhere (Round, 1985). Only small remnants of such habitats now remain.

The National Park System

Number and Area of Parks

The national park system increased at an accelerated rate after 1973, when new parks began to be created more rapidly. This growth has continued, and new parks will soon be approved to bring the total to 57 areas comprising 5.2 percent of the land area of the kingdom. Each park has a headquarters with living quarters for resident officials, workers and a permanent guard force. Most parks have a number of guard outposts to aid with law enforcement in addition to headquarters and main checkpoints on roads. Khao Yai, for example, has 13 such outstations.

In addition to national parks, the NPD manages 35 "forest parks" whose primary function is recreation. These areas are generally smaller and often more disturbed than national parks, and

Table 5.1 Endangered Vertebrate Species in Thailand

Species	IUCN Classification	Thailand status
FISHES:		
Scleropages formosus (Asian bonytongue fish)	vulnerable	prized in pet trade
Catlocarpio siamensis (Giant carp)	-	
Balantiocheilos melanopterus (Burnt-tail/carp)	-	probably extirpated
Xenocheilichthys gudgeri (Backwater fish)	-	endangered
Hemisilurus heterorhynchus (catfish)	-	endangered
REPTILES:		
Batagur baska (River terrapin)	endangered	endangered
Lepidochelys olivacea (Pacific Ridley's turtle)	endangered	nests on few beaches in South
Caretta caretta (Loggerhead turtle)	vulnerable	no longer nests
Dermochelys coriacea (Leatherback turtle)	endangered	nests on few beaches in South
Crocodylus porosus (Saltwater crocodile)	vulnerable	possibly extirpated
Crocodylus siamensis (Freshwater crocodile)	endangered	nearly extinct
Tomistoma schlegelii (false gavial)	endangered	probably extirpated
BIRDS, (Only species breeding in Thailand included)		
Pelecanus philippensis (Spot-billed Pelican)	-	no longer breeds
Sula leucogaster (Brown Booby)	-	no longer breeds
Anhinga melanogaster (Oriental Darter)	-	very rare
Mycteria leucocephalus (Painted Stork)	-	very rare
Ciconia episcopus (Woolly-necked Stork)	-	extirpated
Ephippiorhynchus asiaticus (Black-necked Stork)	-	extirpated
Leptoptilos dubius (Greater Adjutant)	-	no longer breeds
L. javanicus (Lesser Adjutant)	-	no longer breeds
Threskiornis melanocephalus (Black-headed Ibis)	-	no longer breeds

Table 5.1 (contd)

Species	IUCN Classification	Thailand status
Pseudibus davisoni (White-shouldered Ibis)	indeterminate	extirpated
P. gigantea (Giant Ibis)	rare	extirpated
Sarkidiornis melanotos (Comb Duck)	-	no longer breeds
Cairina scutulata (White-winged Duck)	vulnerable	very rare
Ichthyophaga ichthyaetus (Grey-headed Fish Eagle)	-	possibly extirpated
Gyps bengalensis (White-rumped Vulture)	-	no longer breeds
G. indicus (Long-billed Vulture)	-	no longer breeds
Aegypius calvus (Red-headed Vulture)	-	very rare
Arborophila charltonii (Chestnut-necklaced Partridge)	-	rare, lowland forest
Rollulus rouloul (Crested Wood Partridge)	-	rare, lowland forest
Lophura ignita (Crested Fireback)	-	rare, lowland forest
Syrmaticus humiae (Hume's Pheasant)	rare	no recent sightings, montane
Polyplectron malacense (Malaysian Peacock-Pheasant)	-	rare, lowland forest
Grus antigone (Sarus crane)	-	extirpated
Treron fulvicollis (Cinnamon-headed Pigeon)	-	rare, lowland forest
T. olax (Little Green Pigeon)	-	rare, lowland forest
T. capellei (Large Green Pigeon)	-	rare, lowland forest
Otus sagittatus (White-fronted Scops-Owl)	-	rare, lowland forest
O. rufescens (Reddish Scops-Owl)	-	rare, lowland forest
Batrachostomus auritus (Large Frogmouth)	-	rare, lowland forest
B. stellatus (Gould's Frogmouth)	-	rare, lowland forest
Harpactes orrhophaeus (Cinnamon-rumped Trogon)	-	rare, lowland forest
Megaceryle lugubris (Crested Kingfisher)	-	rare, lowland forest
Rhyticeros corrugatus (Wrinkled hornbill)	-	rare, lowland forest

Table 5.1 (contd)

Species	IUCN Classification	Thailand status
Authroceros malayanus (Black Hornbill)	-	rare, lowland forest
Megalaima rafflesii (Red-crowned Barbet)	-	rare, lowland forest
Gecinulus grantia (Pale-headed Woodpecker)	-	probably extirpated
Pitta gurneyi (Gurney's Pitta)	indeterminate	rare, lowland forest
Pseudochelidon sirintarae (White-eyed River Marten)	indeterminate	rare, breeding status uncertain
Pycnonotus zeylanicus (Straw-headed Bulbul)	-	rare, lowland forest
Malacopteron affine (Sooty-headed Babbler)	-	rare, lowland forest
M. magnum (Rufous-crowned Babbler)	-	rare, lowland forest
Napothera macrodactyla (Large Wren-Babbler)	-	rare, lowland forest
Stachyris maculata (Chestnut-rumped Babbler)	-	rare, lowland forest
S. nigricollis (Black-throated Babbler)	-	rare, lowland forest
Myacronous ptilosus (Fluffy-backed Tit-Babbler)	-	rare, lowland forest
Saxicola jerdoni (Jerdon's Bushchat)	-	rare, grassy flood-plains of North
MAMMALS:		
Dugong dugon (Dugong)	vulnerable	very rare
Rhinoceros sondiacus (Javan rhino)	endangered	probably extirpated
Dicerorhinus sumatrensis (Sumatran rhino)	endangered	very rare
Cervus porcinus (Hog deer)	-	very rare
Cervus schomburgki (Schomburgk's deer)	-	Extinct; lowland plains species
Cervus eldi (Eld's deer)	endangered	possibly extirpated
Bubalus bubalis (Wild water buffalo)	vulnerable	one small herd in Huai Kha Khaeng Wild-life Sanctuary
Bos sauveli (Kouprey)	endangered	possibly extirpated from Thailand

Sources: Bain and Humphrey, 1982; Phasuk, 1985; Round, 1985 and personal communication.

although they are protected from deforestation, mining, and other activities, the law is less stringent in this regard. Forest parks usually protect sites of outstanding recreational value such as waterfalls. Total area in forest parks is now 68,628 hectares. Several forest parks have been upgraded to national parks.

Each park is headed by a chief, aided by extra officials in larger and better established parks. Patrolling of parks is carried out by armed workers or guards, and a force of permanent guards. The NPD presently employs 406 permanent guards and hopes to increase this number. Without sufficient guards to man headquarters, checkpoints and outstations, patrolling cannot be carried out effectively, and poaching cannot be stopped.

After a relatively slow start, the number and total area of Thailand's national parks increased quite rapidly after 1980 (Figure 5.1). Proportional budget increases for the NPD followed during the next two years (Figure 5.2). The present budget received is in fact the amount required to manage only 20 national parks effectively, according to some park officials. This has required that resources be spread thin, with many parks not yet receiving adequate attention.

Tourism

The number of visitors to parks has increased tremendously during the last 10 years (Figure 5.3). Most visitors (about 66 percent) go to the best developed or accessible 10 parks (Table 5.2), but the number of visitors to all parks is increasing. Most visitors are day visitors who come on weekends. Waterfalls are the most popular attractions for these visitors. Overnight accommodations in most parks is booked to capacity on weekends. These figures illustrate the great demand for recreation facilities throughout the kingdom. Approximately 90 percent or more of all visitors are Thais, but exact data have not been kept on types of visitors. The demand for recreation in all parts of the kingdom is high. Income from visitors (mostly admission fees and bungalow rental fees) was about 13.7 million baht in the 1984 fiscal year.

The relatively low number of international tourists visiting national parks is due more to lack of promotion than to any lack of desire of foreigners to visit the parks. One guide to national parks in Thailand has been written (Dobias, 1982) and has sold out; most tourist guides make only brief mention of parks, and then only of the most prominent ones, such as Khao Yai, Doi Suthep, and Ko Tarutao. Lack of suitable transportation and reception facilities for English speaking tourists are the major limiting factors. Among resident foreigners there is active interest in parks and conservation areas, and organizations with educated Thais and resident foreigners such as The Siam Society, Wildlife Fund Thailand or the Bangkok Bird Club, which sponsor special tours to parks and conservation areas find that demand exceeds their ability to satisfy it.

The Tourism Authority of Thailand (TAT) manages extensive accommodations in Khao Yai Park, but tends to gear its promotion to the needs of "ordinary" tourists rather than those interested in nature or hiking. Consequently, the very large and growing numbers of young affluent Western tourists interested in nature and outdoor experiences throughout the world (e.g., Sobek's International Explorers Society, 1983) have not been attracted to these facilities.

Thus, there is a considerable gap in tourism promotion in national parks. By careful planning and development this gap could be filled to the benefit of the kingdom, regions where parks are located and the parks themselves.

Figure 5.1 The Growth of the Protected Conservation Area System in Thailand

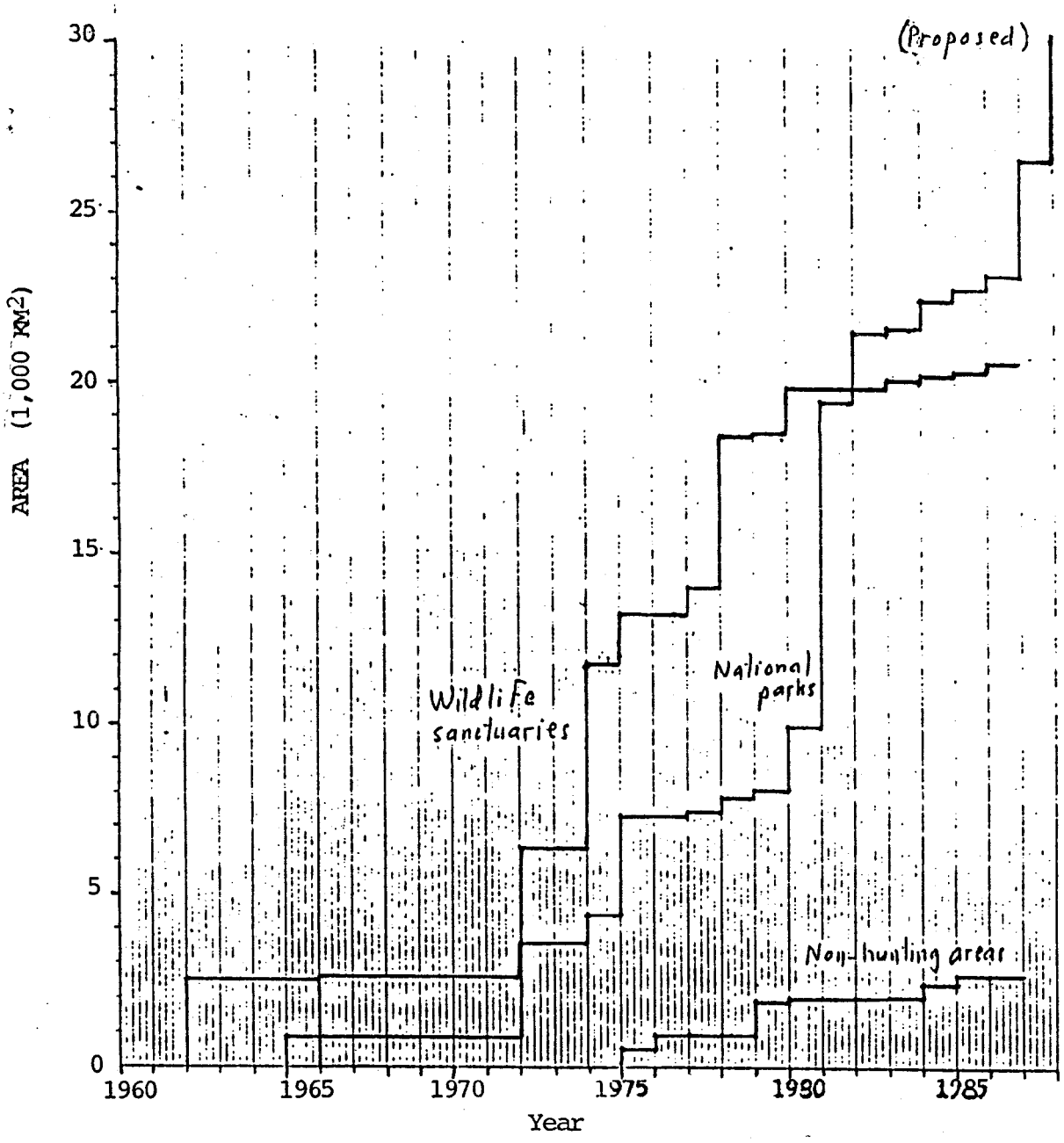
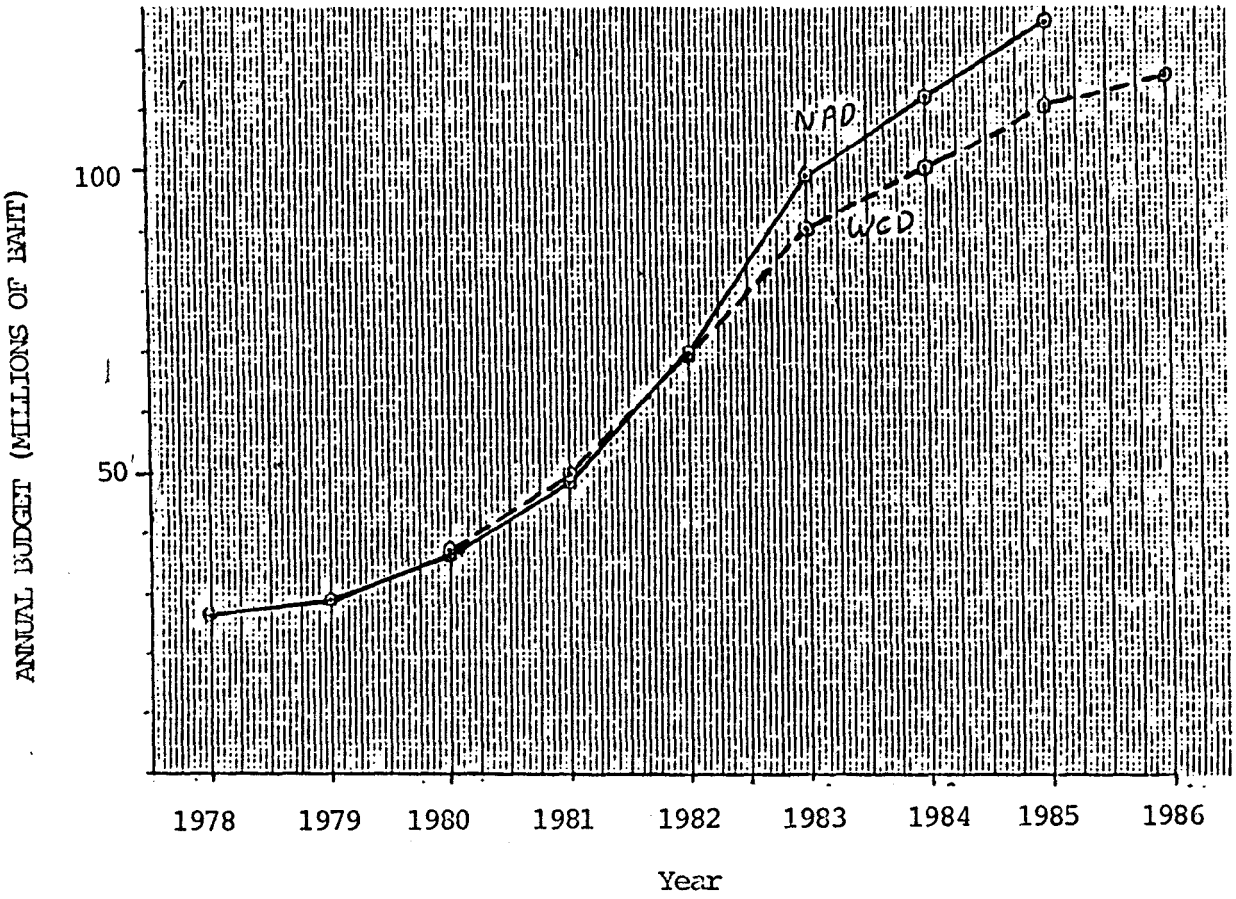


Figure 5.2 Growth of the Budgets of the National Park Division (since 1978) and the Wildife Conservation Division (since 1980) of the Royal Forest Department.



Wildlife Sanctuaries

Number and Area

The area included in wildlife sanctuaries has also greatly increased, especially since 1972 when five new sanctuaries were added, including three units exceeding 1,000 square kilometers. Although no large units have been added since 1983, several new sanctuaries are proposed.

Since the major purpose of wildlife sanctuaries is to protect wildlife, the sizes of areas are critical. Studies in the relatively new ecological field of "island biogeography" have revealed that large areas of forest are more effective in conserving species over the long term than small areas (MacArthur and Wilson, 1967; Terborgh, 1975: Diamond, 1974). Historically, large islands have retained a greater diversity of bird species than small islands; an increase in area by 10-fold is associated with an approximately 50 percent increase in the number of species. there is no "threshold" area beyond which the relation does not hold -- even the largest islands of many thousands of square kilometers show the

Figure 5.3 Growth in Annual Numbers of Vistors to National Parks since 1978.

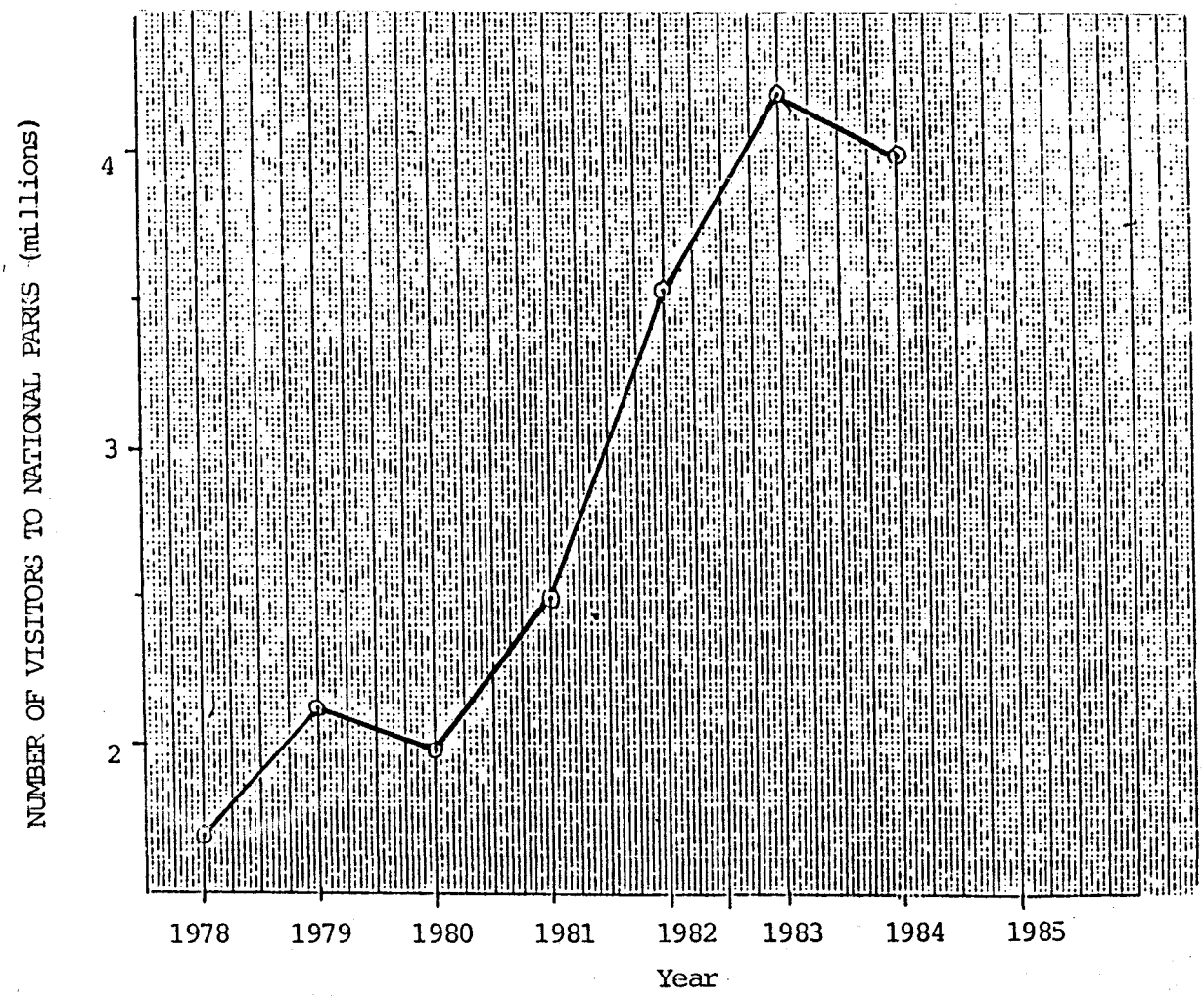


Table 5.2 Ten Most Visited National Parks in October 1983-September 1984 Season.

Name	Province	No. visitors
1. Erawan	Kanchanaburi	482,536
2. Doi Inthanon	Chiang Mai	330,553
3. Pliew Falls	Chanthaburi	318,769
4. Doi Suthep - Doi Pui	Chiang Mai	297,505
5. Aow Phangnga	Phangnga	278,820
6. Khao Yai	Nakhon Nayok, Saraburi, Khorat, Prachinburi	258,803
7. Khao Lam Ya - Mu Ko Samet	Rayong	225,915
8. Sai Yok	Kanchanaburi	165,506
9. Hat Nopparatthara - Mu Ko Pi Pi	Krabi	154,235
10.Khlong Lan	Kamphaeng Phet	122,160
Total, top 10		2,634,802
All other parks		1,344,692
Grand total		3,979,494

Source: National Park Division, Royal Forest Department

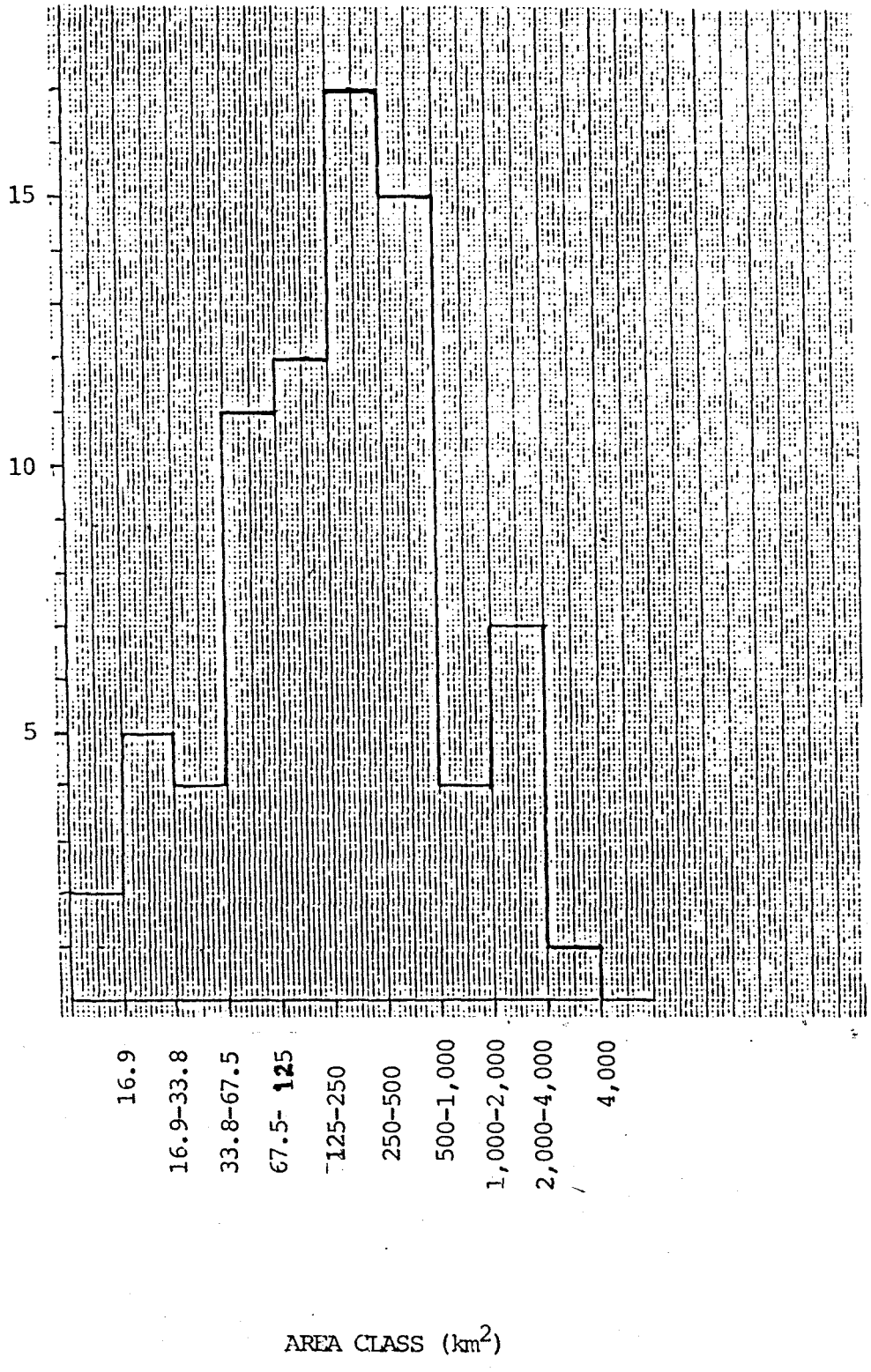
same species-area relationship. To maintain the diversity of vertebrate species in forest areas or islands less than continental size will require easy colonization of locally extinct species from other areas or careful human management, including, for some, captive breeding and reintroduction. This is especially true of areas less than 1,000 square kilometers (Sullivan and Shaffer, 1975).

Consideration of individual population dynamics and genetics also supports the argument that large wildlife sanctuaries are necessary for conservation purposes, because large game species may have to migrate large distances seasonally to find food and water. Also, small populations of 100 individuals or less have an unacceptably high probability of going extinct by chance, and contain too little genetic variation for long term survival. Populations smaller than this may require careful management to prevent their extinction. Most populations of sea turtles, crocodiles, tigers, elephants, gaur, large hornbills, cranes, storks and eagles, in Thailand are probably less than 100 breeding adults.

The size distribution of wildlife sanctuaries is thus of major concern to species conservation. The size distribution of protected areas is shown in Figure 5.4 Units known to be contiguous and allow wildlife passage between them have been lumped together. It can be seen that 12 units exceed 1,000 square kilometers and 8 exceed 2,000 square kilometers. The largest unit are the Thung Yai Naresuan - Huai Kha Khaeng Wildlife Sanctuaries, with a respectable 4,831 square kilometers. There is still forest contiguous with these sanctuaries that could be included. This area is the best hope in Thailand for preserving large mammal species, providing that poaching can be controlled.

Wildlife species of particular concern are wild cattle which may have to migrate in seasonal habitats in search of forage and water, elephants which migrate over large areas (Olivier, 1978; Storer, 1981), and large predators such as tigers which require large hunting territories of many square kilometers.

Figure 5.4 Frequency Distribution of Sizes of Protected Areas (Excluding Non-hunting Areas, Most of Which are Wetlands)



A number of relatively small parks and sanctuaries have large animal species such as elephant, gaur, banteng and tigers which will almost certainly disappear in time without reintroductions. These include Khao Chamao (84 square kilometers) and Khao Ang Ru Nai (108 square kilometers) in the Southeast; Phu Rue (121 square kilometers), Phu Kradeung (348 square kilometers) and Phu Wua (186 square kilometers) in the Northeast; Ton Nga Chang (182 square kilometers) and Thale Ban (102 square kilometers) in the South; and Tham Tarn Rod (59 square kilometers) and Lan Sang (104 square kilometers) in the West. Only the relatively large (>1,000 square kilometers) protected areas offer much hope of saving large animals in the long term (hundreds of years), and then only with careful protection and management.

Manpower and Budget

The 28 wildlife sanctuaries and 38 non-hunting areas are protected by a total of 404 permanent guards, and a larger but indefinite number of workers. This represents approximately one guard per 58 square kilometers of area. The budget of the WCD was relatively low prior to 1980, but has increased fairly rapidly since. The WCD has fewer visitor facilities to construct and maintain, so its budget requirement is less than that of NPD. Nevertheless, the personnel and guard force are still inadequate to protect the large area within the sanctuaries.

Law Enforcement in Protected Areas

Patrolling of protected areas, arrest of poachers and prosecution are labor intensive and time consuming missions, and tax the capabilities of both divisions. In sanctuaries and non-hunting areas, 319 infractions involving 368 violators were prosecuted in the first five months of 1986.

In spite of these enforcement attempts there is ample evidence that the amount of poaching in protected areas is far higher than these figures suggest, and the proportion of poachers actually caught or seen by guards is very low --- perhaps no higher than 5-10 percent. Information on poaching comes occasionally from some parks and sanctuaries when naturalists, biologists or hikers who hike deep into the areas (Brockelman, 1986; Brockelman and Sophasan, 1981; Brockelman and Srikosamatara, 1978; Dobias, 1985 Hill et al., 1986; Srikosamatara, 1980; Storer, 1981).

In Khao Yai Park, for example, poachers' camps are found along every stream in remote areas and poachers, mostly teams of persons collecting fragrant wood ("mai hom") from the tree Aquilaria crassna, as well as animal hunters, are frequently encountered. Increased attempts to reduce poaching in Khao Yai alone have resulted in 258 violators being caught in the first four months of 1986. Poaching must be halted by active enforcement activities. There are several reasons why the problem is so serious and is probably increasing:

Insufficient Patrolling

In most parks and sanctuaries guards and armed workers rarely go deep into the forest on patrol. There are usually no regular patrol schedules and in many areas there are said to be not enough guards to patrol. The existence of border guard posts alone has no effect on poachers who can cross the boundaries anywhere on foot. There are no regular budgets for equipment and supplies for patrolling.

Poor Relation with Local Residents

Patrolling in some areas has resulted in armed clashes with local villagers and an estimated 40 guards and officials having been killed on duty by local residents during the last 20 years in parks and

sanctuaries. Relations between protected area personnel and local residents are usually very poor as residents often believe that they have been unjustly deprived of land for farming or natural hunting rights in forested areas, without receiving any benefits in compensation. There is the very real belief that parks and sanctuaries are being preserved for the pleasures of outsiders or officials themselves while depriving local residents of their economic and subsistence needs.

How much patrolling is actually carried out, and the quality of relations with locals, depend very much on the attitude and leadership of the chief official of the protected area and varies greatly from one area to another.

In a few places local residents have received some material benefits from protected areas. In some sanctuaries (ie., Huai Kha Khaeng) some of the employees are recruited from local villages. In the Thale Noi non-hunting area, local fishermen are hired to carry visitors about the lake in their boats to observe birds. At Phu Kradeung National Park, several hundred local people earn wages carrying visitors' packs up the mountain. These persons even report park violations to officials, a sure sign that they see the park as an asset.

Resistances of local people will have to be overcome to reverse what is probably a worsening enforcement problem as rural populations increase around protected areas and farmland becomes less available. Forestry authorities tend to consider the problem only in terms of public relations, education and greater enforcement effort, but alternative solutions will have to be found. The most serious wildlife management problem is the management of people. For too long local people have been left out of management planning, even though they are very much a part of the systems being managed.

Hill tribes

The existence of hill tribes in protected areas of the north and northwest has created special problems to which satisfactory solutions have not always been found. At least four national parks (and one proposed one) and 11 wildlife sanctuaries in the region have had resident hill tribes (mostly Hmong and Karen), numbering several thousands in all. The policy of the RFD is that these persons are illegal squatters who must be removed to other settlement areas. Only the regional armies have the power and authority to move the tribes, however, and their collaboration to do so must be sought. Hill tribes have been moved from some areas, including Mae Ping and Khlong Lan National Parks and Huai Kha Khaeng Wildlife Sanctuaries, but remain a serious problem in other areas such as Thung Yai Naresuan, Lum Nam Pai, Doi Pha Chang Wildlife Sanctuaries and Doi Inthanon National Park, where their shifting cultivation methods cause destruction of primary forest. However, no analyses have been made of the rate of destruction of primary forest by hill tribes in any protected area. In contrast to some countries, the Thai RFD has no policies or budget for incorporating tribal people into the management of parks and wildlife sanctuaries, or creating reserves (such as "biosphere reserves") where tribes may continue their traditional life styles. Such policies are being tested, however in some special watershed management project areas.

Value and Functions of Protected Areas

Both national parks and wildlife sanctuaries have recognized value in protecting wildlife and habitat, and watersheds, but parks are used for promotion of recreation, whereas wildlife conservation activities emphasize management of wild animals and also public education. There is, therefore some overlap in function. Many parks are in fact very important wildlife refuge

Box 5.1 Cable Car On Doi Suthep: Lessons in Public Perception

The city of Chiang Mai lies at the foot of a mountain called Doi Suthep. Part way up the mountain, partly hidden by the green forest which blankets the mountain, is a temple, Wat Phrathat, whose beautiful northern style central chedi houses a relic of the Buddha. Since 1981 the mountain has been included in Doi Suthep - Doi Pui National Park. Its flora of orchids and other plants, and its bird community, are known to be extremely diverse.

In 1980, the Tourism Authority of Thailand hired a consulting firm to help prepare a master plan for tourism in Chiang Mai. The company conducted feasibility studies to construct an electric cable car from Chiang Mai city up to the foot of the temple on the mountain. The cable car, it was argued, would relieve the severe traffic congestion on the highway up the mountain on holidays, promote tourism in the city and on the mountain, and make it easier for visitors to reach the temple. The architect-manager of the company had done his homework and prepared economic justifications for the project, and carried out a preliminary environmental assessment.

The project made its way successfully through the maze of Government bureaucracy: the Tourism Authority, Chiang Mai Provincial Administration, Phra That Doi Suthep Authorities, Royal Forest Department, Zoological Organization, National Environment Board, National Park Committee, and the Office of the Royal Household (there is a Royal Summer Palace on the mountain). It passed many committees set up to study it. The project manager was persuasive and passed all the major hurdles. Except one - the general public.

In 1986, articles and letters opposing the project began appearing in the Bangkok Post, Matichon, and local newspapers in Chiang Mai. The objections raised were numerous: the cable car would destroy forest and wildlife species, disfigure the mountain, scare the animals in the Chiang Mai Zoo, intrude on the tranquility and sanctity of the mountain, promote forest fires, contribute to litter and refuse, promote inappropriate development near a holy shrine and in a national park, reduce the merit of pilgrimages to the temple, be plagued by power shortages, and stand virtually idle most of the time except for holidays and some weekends.

The project manager waged a courageous public relations campaign against these claims, but to little avail. An ad hoc organization was formed in Chiang Mai, based on the university campus, to fight the project. While the majority of Chiang Mai residents appeared to support the project or had no serious objection to it, a rather large percentage (40 percent according to one opinion poll) opposed it. The Center for Promotion of Arts and Culture at Chiang Mai University opposed the location of the cable car on Doi Suthep. All senior priests in Chiang Mai (except the abbot at Wat Phra That) opposed it.

In April of 1986, 750 people of Chiang Mai, including many monks, signed a letter to the prime minister opposing the project. The governor of Chiang Mai, who had earlier expressed surprise over the speed with which the Forest Department's National Park Division had approved the project, decided to recommend against the project. Interestingly, Forest Department and National Environment Board officials have not been drawn into the dispute.

and many sanctuaries have considerable potential to attract tourists.

The value and functions of sanctuaries and parks vary from one to the other, and ideally the functions of each should be stated in a management plan (Thorsell, 1984). In 1984 the World Wildlife Fund funded a project (WWF/IUCN 3001 - Thailand) for Khao Yai National Park which included preparation of a detailed management plan by a team of NPD officials and outside local experts. This is the first detailed management plan for a conservation area in Thailand.

The Khao Yai management plan was innovative in being specifically concerned with the well-being of local communities, a pilot project to initiate appropriate tourism with the aim of benefitting local villagers was funded in the WWF project.

Both the NPD and WCD have recently established planning sections with the intention of preparing management plans for other protected areas. It is hoped that such plans will result in increased support from the Government and outside agencies to more fully realize the potential benefit of parks and sanctuaries.

The area included within national parks, wildlife sanctuaries and nonhunting areas constitutes 9.1 percent of the area of the kingdom and the rate of increase has exceeded the ability of the NDP and WCD to bring the areas under complete protection and manage them effectively.

The system of parks and sanctuaries now serve functions not originally prescribed in law, mainly protection of valuable watersheds and other ecological services described earlier, and conservation of both fauna and flora from continued destruction. These important functions are served somewhat by default because of the failure of the forest reserve system (set up by the National Forest Reserve Act, 1964), to effectively preserve forest cover and enforce sustained yield of forest resources. Present policy (Royal Thai Forest Department, 1985) will result in conversion of most reserve forest area to tree plantation of fast growing species for wood, fuelwood, rubber, etc. which will result in nearly complete loss of native flora from reserve forests.

Conflict Between Conservation and Development

Apparent conflicts between development interests and conservation have occurred in Thailand as in every other country with active conservation programs. Such conflicts will undoubtedly increase in the future as land areas become more intensively used and the number of competing demands for any given area increases. Most conflicts are not merely political debates but involve real issues

On June 28 nearly 1,000 people staged a protest against the project at a holy place in Chiang Mai. The provincial authorities finally decided to hold the project in abeyance for the time being

This episode is a very interesting case for several reasons. First, it illustrates the importance of "intangible" environmental factors, which are difficult if not impossible for technical experts to quantify or evaluate. In this case, the environmental values in question are mostly cultural and aesthetic, and the protest involved educated cultural leaders more than ecologists or traditional conservationists. Environmental impact assessments and benefit/cost analyses must somehow come to grips with these values. They exist in the minds of people and not in technical reference manuals or architects' plans.

which must be discussed publicly to the best interests of all people. The purpose of this brief discussion is but to review some of the basic issues which require closer attention by policy makers and more research by concerned experts.

Logging vs. Protection

At the time of creation of the system of reserve forests, parks and wildlife sanctuaries, there was relatively little conflict between "preservation" and exploitation interests, as there was sufficient forest to satisfy loggers (both legal and illegal), slash-and-burn farmers and conservationists. Encroachment in reserve forests was sometimes referred to by agricultural experts as an important "safety valve" for the poor landless, ensuring that they would not all migrate to urban areas or create civil disturbance. While the public and the government became increasingly disturbed by the irrefutable evidence from Landsat images of massive encroachment and conversion of natural forests in the 1970's, enforcement measures were not strong enough to halt the trend. With undisturbed forest cover now below 30 percent of the land area, the disposition of the remaining tracts will become the subject of increasing contention. The forest area targets of the Forest Department approved in 1985 probably signal the beginning of a serious policy debate. Will conversion of the remaining reserved forests to plantations of reduced stature and biomass provide adequate watershed and soil protection? Is 15 percent of the country's area in protected forests adequate to cover all important watersheds? Should this include watershed protection areas containing largely degraded forest, or should totally protected forest area in parks and sanctuaries be allowed to increase further? What economic or non-monetary values do parks and sanctuaries have for the kingdom? How can the Forest Department or other decision makers evaluate these?

Development Projects in Protected Areas

Hydroelectric projects produce many of the most intense conflicts between technological development and nature conservation, and Thailand has had its fair share of them. Six large dams constructed between 1964 and 1985 have inundated approximately 2,052 square kilometers, and waters rising behind the Chiu Larn Dam in the South are flooding lowland areas of Khlong Sang Wildlife Sanctuary and Khao Sok National Park. The Ubonratana Dam in the Northeast, completed in 1966, illustrates how devastating a poorly planned hydroelectric project can be to forests and wildlife, as poor farmers immigrating into the reservoir region have destroyed most forests in the watershed.

Some projects have been shelved because of opposition from the RFD and nongovernmental organizations. For example, three projects that would have flooded parts of Khao Yai Park: on the Klong Tha Dan, Sai Yai, and Lam Phayathan Rivers. The Sai Yai project would have involved construction of two shallow reservoirs in the center of the park that would have eliminated many square kilometers of optimal elephant, gaur and endangered pileated gibbon habitat.

Present controversy surrounds the plans to construct the large Nam Choan on the Upper Kwae Yai River, which would create a reservoir 223 square kilometers in area lying mostly in Thung Yai Naresuan Wildlife Sanctuary (see Box 5.2).

Developments to enhance access to and human activity in national parks have also recently come under some discussion and debate. Appropriate development in parks is desirable to enhance their ability to fulfill their objectives, but should be confined to areas zoned for that purpose.

Debate in the public press has questioned the desirability of the highway recently completed through the southern portion of Khao Yai Park, and

more recently the appropriateness of a cable car in Doi Suthep - Doi Pui National Park in Chiang Mai. (see Box 5.1)

Development vs. conservation conflicts raise a number of important basic policy issues which concern policy makers. Attention to these issues will not eliminate conflicts but may permit more rational resolution of conflicts. There are signs that concern with these issues has been increasing in Thailand.

Thailand is noted for its relatively free and healthy press, and the press has played an important role in defending conservation and bringing important environmental issues before the public. This role is indispensable in any democratic society.

Government line agencies, however, as in most countries, often restrict information regarding their projects and activities on the grounds that the public is not sufficiently well informed to make judgment. This policy sometimes leads to increased controversy and less informed public debate when the information about the projects finally and inevitably leaks out.

If all protected areas had detailed management plans, which should include a statement of each area's objectives, its values and benefits to the public and a zoning plan, analysis of environmental effects would be made easier. Development agencies and even consulting experts are often ignorant of the values of conservation areas. The wildlife and park agencies of the RFD are now, in fact, establishing planning units for the purpose of preparing management plans for all protected areas. This will automatically enhance their role in the overall decision making process.

Box 5.2 The Nam Choan Dam Controversy

The planned Nam Choan hydroelectric dam on the Upper Khwae Yai River, in Kanchanaburi Province, has stirred fierce opposition by conservationists. This dam would back up a 75 kilometer long reservoir, which could completely divide Thung Yai Naresuan Wildlife Sanctuary, the largest in Thailand and probably the most important wildlife refuge in Southeast Asia, into three pieces. This has caused delays in final approval of the project, and several re-evaluations of its environmental effects. Yet, This further work has not really brought pro- and anti-dam people any closer together, nor has it improved the agreed basis on which a decision might be reached, one way or another. It has demonstrated, however, that the evaluation of benefits and costs still rests on people's personal values and preconceptions.

This is not the way environmental assessment should be in a perfect rational world, but in some senses there are different forms of rationality at work here.

The Nam Choan Dam, when completed, would produce 576 MW in dependable peak capacity, and 1,100 GWh per year in average energy output. The dam would help sustain growth in energy consumption of about nine percent per year, but the value of its contribution would depend heavily on economic factors such as the price of imported oil, the availability of natural gas, and the general rate of industrial and economic growth which is not necessarily limited by energy availability or cost.

The Japan International Cooperation Agency performed a reconnaissance study of the Upper Khwae Yai hydroelectric project for the Thai Government, completing a feasibility study in 1980. The National Environment Board requested the Electricity Generating Authority of Thailand (EGAT), which has responsibility for the project, to carry out an environmental impact assessment, which was completed by a consulting firm in 1980. It focused

on geology, minerals, fisheries, forestry, wildlife, archaeology, public health, and socioeconomic effects.

Opposition to the dam became very vocal around 1982, when many conservation groups and individuals, both in Thailand and abroad, wrote letters to government officials and to the press decrying the dam's irreversible effects. Emotional statements, however, lend little credibility to the conservation movement.

Since the major non-monetary cost of the Nam Choan Dam will be damage to the wildlife sanctuary, one would assume that the probable damage to wildlife would have received the most thorough survey and evaluation. Not so.

This lack of adequate assessment of the likely forests and wildlife impacts was due mainly to lack of appropriate funding, shortages of manpower, a lack of time in which to survey, and in the case of this project, to the insecurity of the area, preventing survey teams from penetrating very far into the sanctuary. Despite the fact that it is now safe to travel through the sanctuary, the surveys have never been finished.

The damage done by the reservoir to the sanctuary will be far greater than implied by the amount of land inundated. First of all, the reservoir will eliminate virtually all habitats at elevations of less than 380 meters above sea level. Forests at low elevations are now rare in Thailand and poorly represented in the protected area system. Riverine habitats are becoming especially rare, and are particularly rich in wildlife and recreational value. With an annual drawdown of 39 meters of elevation, the long shore of the Nam Choan reservoir will become a broad treeless expanse of rocks and mud, useless for both recreation and wildlife during most of the year.

The most serious effect of the reservoir, which has been pointed out by some biologists but ignored in environmental assessments, is the division of the large contiguous Thung Yai - Huai Kha Khaeng Sanctuaries into three smaller areas. Zoogeographers in recent years have accumulated much evidence that the number of species that survive over the long term (hundreds and thousands of years) is related to size of the area, because smaller areas contain smaller populations that more frequently become extinct by chance. Thus, as the regions outside the boundaries become less habitable for wildlife, extinction of species within the sanctuaries becomes a certainty. Large wildlife refuges are the only guarantee of the survival of species such as elephants, wild cattle, tigers, peafowl, primates and other large species. The new reservoir would make survival of these species more uncertain.

Hydropower is known to be one of the cheapest sources of energy supplying reliable base load to the ever increasing demand for electricity. No one is claiming that new energy development is not important; that is not what is really at stake. The question is whether energy produced (which is quite replaceable) minus the direct costs, be worth all the nonmonetary costs, which include forests and wildlife (which are not replaceable)? Again, it looks as if politics and influence may again decide the issue.

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6 Mineral Resources

Status and Trends

Despite the depressed state of the world commodity market, the value of Thailand's mineral output grew significantly between 1983 and 1985, from nearly 9,700 million baht to nearly 11,200 million baht. Tin accounted for 66 percent of the 1983 value and for 47 percent of the 1985 value. Those are still high proportions, but are dramatically down from the 1980 situation, when tin accounted for some 82 percent of the value of the country's mineral output. Although the international tin market featured high prices and brisk demand in 1980, with unrestricted exports until April 1982, oversupply subsequently led to the imposition of production controls on members of the International Tin Council (ITC) and, ultimately, to the collapse of the London Tin Market in October 1985.

The economic impact of the tin industry on Thailand's economy will be referred to constantly through this Chapter, because of the metal's dominant economic role, but it is worth noting that more than 20 minerals are currently being produced commercially in Thailand (Table 6.1). Aside from tin other key minerals include, in decreasing order of 1985 value, zinc, fluorite, gypsum, lead, barite, tungsten, columbite-tantalite, and antimony. Fuel minerals, including lignite, oil and gas, also make a significant contribution to the country's energy budget and GDP (Tables 6.2 and 6.3). The production of lignite, in particular, is likely to grow considerably.

Contribution to the National Economy

Thailand's mineral industries make a very considerable contribution to the country's economy. Record foreign exchange earning of 15,000 million baht was achieved in 1980, with 33,455 tons of tin exported that year bringing in about three-quarters of the total figure. At that time, minerals were second only tc rice in terms of foreign exchange earnings. By 1985, however, the value of (not including exports of condensate) mineral exports had dropped to just under 7,800 million baht, roughly half the 198(figure, with 17,359 tons of tir contributing 70 percent of the 198! figure (Table 6.4). This drop placec minerals in sixth place in the table of foreign exchange earnings, after textiles, rice, tapioca products, rubber and integrated circuits.

This decrease in the value of minera exports was attributable both to reduce international demand and falling price for key minerals such as tin, tantalu and tungsten. Zinc metal was exported fo the first time in 1985, following th opening of a zinc smelting plant late i 1984. 21,407 tons of zinc were exported worth some 470 million baht in foreig exchange.

Exports of condensate, the natura gasoline obtained when natural gas i depressurized at wellheads and separatio plants, have brought in additiona earnings since 1984. Condensate export in 1985 amounted to 63 percent of tota

Table 6.1 Mineral Production 1980, 1984 and 1985
(production: tons, value: million baht)

Mineral	1980		1984		1985	
	Production	Value	Production	Value	Production	Value
Tin concentrates	45,986	11,545.6	29,979	6,396.9	23,022	5,290.0
Tungsten:						
- Wolfram	2,661	519.4	1,144	162.7	856	112.4
- Scheelite	473	91.9	295	42.3	281	37.4
Fluorite:						
- metallurgical	172,784	200.3	230,228	326.6	263,059	449.3
- acid	60,108	105.1	57,151	114.0	35,840	73.3
Zinc ore	-	-	147,993	377.4	276,909	706.1
Lead concentrate	24,847	228.6	39,204	180.8	46,245	220.1
Columbite-Tantalite	356	303.4	477	230.0	268	143.2
Lignite	1,426,566	171.3	2,337,226	661.4	5,146,150	2,552.0
Gypsum	411,977	113.5	1,110,660	401.0	1,273,459	432.9
Barite	305,057	208.1	174,918	153.8	230,970	207.4
Antimony	6,862	134.8	4,636	97.8	2,917	64.7
Limestone (for cement)	3,957,929	98.9	9,223,406	203.6	9,844,610	428.1
Feldspar:						
- Sodium	-	-	-	-	92,620	114.1
- Potassium	24,158	12.1	74,404	107.9	11,966	19.3
Kaolin	19,931	14.0	58,616	41.0	106,704	74.7
Manganese:						
- battery grade	2,716	7.2	6,110	16.1	3,930	15.9
- metallurgical	51,538	46.4	2,577	2.6	455	0.5
Silica sand	171,000	20.5	166,787	20.0	152,133	52.4
Rock salt	16,744	4.5	9,850	2.6	12,786	3.4
Marble	5,649	2.5	37,927	16.9	21,478	41.9
Total value		13,937.8		9,676.3		11,176.1

Source: Department of Mineral Resources' Mineral Statistics, 1980-1985

production, worth over 5,000 million baht in foreign exchange.

Thailand's mineral exports will continue to make substantial contributions to the country's balance of payments, not least because of its close proximity to key consuming nations, including Japan, South Korea, Taiwan and the ASEAN countries.

Minerals also make a significant contribution to the government's revenues, by way of royalties and, to a lesser extent, business and municipal taxes. Indeed, mineral royalties represent a vital source of government income, as Table 6.5 confirms. In 1980, a total of 4,027 million baht was obtained from mineral royalties, with tin contributing 85 percent, or 3,437 million baht, of that figure. The amount collected dropped to 1,522 million baht in 1985, of which nearly 79 percent came from tin. The business and municipal tax income collected dropped from 482.6 million baht in 1980 to 240.6 million baht in 1985.

To alleviate the financial burden imposed upon tin miners, the government decided in November 1985 to reduce the business and municipal tax rate imposed on tin exports by half, from 4.4 percent

to 2.2 percent, with the possibility of a further reduction to 1.1 percent. A special fee, collected at a rate of five percent of the tin royalty, had already been dropped to help the mining industry. The money thereby derived had been used to suppress tin smuggling and to mitigate the adverse impact from the mining industry in the areas where it operates. Continuing sources of income from the industry include income tax and the fees payable for various licenses and permits.

The mineral industry is also a significant employer, although its workforce dropped from 90,813 in 1980 to 61,306 in 1984, with a further drop to 40,196 in 1985 - less than half the 1980 figure (Table 6.6). The industry also produces wider benefits, particularly where it operates in remote areas, often bringing in roads, electricity and water. Communities like Phuket, around which tin-mining has long taken place, and Mae

Table 6.2 Natural Gas Production, Sales, Value and Royalties, 1983-85
(production and sales: MMscf, value and royalty: million baht)

Gas Field	1983	1984	1985
Offshore Production			
Erawan	54,097.30	68,179.50	67,574.70
Ban-Pot	1,033.00	11,139.90	8,080.80
Satun	-	-	24,969.60
Pla-tong	-	-	21,995.60
Onshore Production			
Sirikit	1,890.16	6,186.45	10,044.62
Total Production	57,020.46	85,505.85	132,625.32
- Sales	55,169.12	82,463.23	125,859.71
- Value	3,344.38	4,940.76	8,021.63
- Royalties	422.40	617.72	1,002.69

Note: MMscf = Million standard cubic feet.
Source: Department of Mineral Resources' Petroleum Statistics, 1983-1985.

Table 6.3 Condensate and Crude Oil Production, Sales, Value and Royalties, 1983-85
(production and sales: million barrels, value and royalties: million baht)

Field	1983	1984	1985
Offshore Condensate			
Erawan	2.20	2.40	2.60
Ban-Pot	0.07	0.61	0.35
Satun	-	-	1.05
Pla-tong	-	-	1.21
Crude Oil			
Sirikit	2.22	5.10	7.59
Total Production	4.49	8.11	12.80
- Sales	4.31	8.26	12.68
- Value	2,722.11	5,283.33	8,988.92
- Royalties	340.26	660.44	1,123.60

Source: Department of Mineral Resources' Petroleum Statistics, 1983-1985

Table 6.4 Mineral Exports 1980, 1984 and 1985
(exports: tons, value: million baht)

Mineral	1980		1984		1985	
	Exports	Value	Exports	Value	Exports	Value
Tin:						
- tin metal	33,445	11,168.7	18,332	5,267.5	17,359	5,462.1
- tin-lead alloys	45	12.1	1,140	164.0	1,758	325.4
- present slag	3,306	1,520.6	1,516	178.1	330	27.5
Old tin slag	9,423	558.4			20	0.5
Zinc metal	-	-			21,407	470.7
Tungsten:						
- wolfram	3,272	576.5	1,378	158.5	766	85.1
- scheelite	322	61.8	354	46.2	379	48.1
Fluorite:						
- metallurgical grade	154,432	185.6	170,133	245.5	168,835	276.2
- acid grade	59,824	114.2	54,530	109.6	35,375	85.5
Gypsum	144,536	47.5	737,954	229.7	869,887	265.1
Barite:						
- lump	327,000	222.7	163,449	138.5	202,942	185.2
- ground	34,732	54.8	18,549	37.5	12,730	28.1
Lead concentrate	34,732	54.8	42,004	175.6	46,375	189.9
Antimony:						
- ore	4,952	93.1	5,601	105.8	5,284	117.3
- metal	68	3.7	-	-	-	-
Columbite-Tantalite	197	69.3	106	41.6	-	-
Xenotime	17	0.4	130	16.7	163	30.2
Monazite	-	-	1,852	19.3	1,277	13.7
Feldspar - sodium	924	1.4	12,400	11.1	33,902	27.1
Total value		14,934.6		7,030.3		7,779.2

Source: Department of Mineral Resources' Mineral Statistics, 1980-1985

Table 6.5 Minerals Royalties, 1980 and 1985
(million baht)

Mineral	1980	1984	1985
Tin concentrate	3,437.5	1,017.2	1,200.3
Tin slag	388.7	63.7	23.5
Tungsten concentrate	125.2	40.1	32.3
Lead concentrate	15.3	10.0	11.2
Fluorite	11.3	20.5	21.6
Lignite	5.3	25.6	104.0
Gypsum	3.0	16.4	17.3
Limestone	2.1	8.9	15.7
Barite	n.d	10.4	13.7
Antimony	8.8	n.d	n.d
Zinc metal	-	-	29.3
Total	4,026.8	1,257.7	1,521.7

Note: n.d = not determined
Source: Department of Mineral Resources' Mineral Statistics, 1980-1985.

Table 6.6 Number of Mineral Industry Employees 1980,1984 and 1985[a]

	1980	1984	1985
Mining	90,813	61,306	40,196
Mineral beneficiation	1,605	2,364	2,391
Metallurgical operations (DMR licensing)		-	3,268

Note:
a. Marked decrease was noted for tin mining; other decreases were reported for tungsten and lead operations.
Source: Department of Mineral Resources' Statistics, 1980-1985

Moh, which is in the lignite-mining area, can be transformed into major settlements. The number of active mineral mines is indicated in Table 6.7.

The positive multiplier effects of such activity are also significant, although Thailand still has some way to go in developing the necessary "downstream" industries. In this respect, however, it is encouraging to note that growing quantities of such mineral commodities as limestone, shale, gypsum, kaolin, feldspar, silica sand and marble are being used by local manufacturing industries, including the cement, ceramics, rubber, paint and building industries. Thailand's consumption of such minerals is shown in Table 6.8.

A number of tin-smelting and processing plants are already producing tin metal or alloys, prior to shipment abroad. A rebate of 50 percent of royalties is given to domestic users of tin, while domestic consumers of other minerals can claim a 25 percent refund on royalties. Zinc ore is being converted to metal at the Tak plant, both for export and domestic consumption.

BOX 6.1 The Tin Economy

Although a total of around 90 minerals are known to occur in various parts of Thailand, with perhaps 40 currently in commercial production, tin has long dominated the country's minerals industry. Chinese traders are thought to have been the first to exploit this metal in Thailand, but it also soon attracted European interest, with the first trade agreement in 1685 giving the French a tin trading monopoly. More recently, Thailand has become the second largest free-world producer of tin, after Malaysia.

Tin minning technology has evolved steadily, with a major breakthrough coming in 1906, with the introduction of tin dredging to the Phuket area, permitting offshore tin resources to be exploited on an increasingly large scale. Thailand's first- and largest - tin smelter was established in 1965. Inevitably, the scale of tin-related development has led to concern about the environmental implications. Around Phuket, for example, there have been allegations that local beaches and coral reefs were being damaged. Elsewhere, there has been growing interest in the need to rehabilitate exhausted tin mines.

But the industry has faced a much more serious threat to its viability in recent years: the lack of stability in the international tin market. Although the amount of tin consumed by Thai industry is growing, the metal is predominantly exported, and earns Thailand considerable foreign exchange. It also contributes to the government's revenues through royalty payments and business taxes. These contributions have been heavily undermined in recent years, however.

The worldwide recession has cut demand for tin and, despite the best efforts of the International Tin Council to ensure that supply was kept in line with demand, the instabilities were such that the London Tin Market collapsed late in 1985 and the tin price was cut in half. There were many reasons for this: the high price of tin had encouraged some consumers to use the metal more efficiently, or to look for substitutes, but the main causes related to tin supply itself. Tin smuggling from ITC-member countries and exports from non-member countries resulted in an international surplus of around 26,000 tonnes by the end of 1985.

The impact of the collapse on the Thai economy has been substantial. Foreign exchange earnings from mineral exports, with tin accounting for the overwhelming share, were cut in half between 1980 and 1985; the tin royalties collectable by the government were cut by two-thirds; and the number of workers directly employed in the industry was also cut by more than half.

It is estimated that it will take well over a year to clear the accumulated international stocks of tin, but the Association of Tin Producing Countries has forecasted that shrinking tin production will lead to higher prices, possibly as early as 1987, certainly by 1988. Much will depend, however, on the health of the international economy over the next few years.

Tin is a non-renewable resource, which is one reason why the government charges a royalty on its production. But even if tin demand grows substantially, Thailand still has considerable reserves of the metal, which should support production into the foreseeable future. As the grade of ore falls, however, the volume of spoil and effluent likely to be produced in metal mining and

processing must inevitably rise. As a result, there is concern that the industry should be managed in such a way that it does not unnecessarily degrade Thailand's renewable natural resources. Tin miners now have to submit environmental impact assessments to the National Environment Board before commencing new operations, which is a welcome step forward. But if rapid economic growth were to resume, the industry's environmental performance would need careful monitoring.

Table 6.7 Number of Active Mines, by Mineral 1980, 1984 and 1985 Mineral

Mineral	No. of mines		
	1980	1984	1985
Tin[a]	737	725	614
Tungsten[b]	27	20	NA
Fluorite	58	61	55
Lignite	9	14	15
Gypsum	9	20	15
Barite	38	56	44
Antimony	36	40	41
Limestone	8	23	24
Kaolin	15	38	37
Feldspar	15	25	25
Silica sand	11	20	18
Marble	4	36	39
Total	1,044	1,207	1,068

Notes:
a. including tin-tungsten mines.
b. including wolfram and scheelite mines.

Source: Department of Mineral Resources' Mineral Statistics, 1980-1985

As far as fuel minerals are concerned, lignite production has been a star performer, with better than three-fold growth between 1980 and 1985. In 1985, almost 90 percent of total production was consumed by EGAT's thermal power plants at Mae Moh and Krabi. As EGAT installs additional generating units at Mae Moh, further increases in lignite production are likely, with one forecast suggesting that by 1990 the total requirement may have reached some 9.5 million tons. Other lignite users include local cement plants and tobacco-curing factories.

Oil and gas production, meanwhile, has declined somewhat, so that by mid-1986 Thailand was daily producing some 329 million cubic feet of natural gas, 16,000 barrels of condensate and 20,000 barrels of crude oil. Domestic oil and gas production now accounts for almost 40 percent of domestic petroleum consumption, with a number of downstream activities planned.

Technology Trends

Given that more than 80 percent of the value of Thailand's mineral output comes from small and medium-scale mines, it is perhaps not surprising that there is an emphasis on "appropriate" technology in the minerals industry. Hand-sorting of ores by local people is often used when producing concentrates of fluorite, barite, feldspar and manganese ore, and is one of the reasons why Thai minerals are competitive in international markets.

Instead of making major investments in new plant or equipment, these mines tend to progressively upgrade technology, like gravel-pumping technology, which has been around for many decades. The latest refinement of this technology involves the use of multi-lane sluice boxes (known as "palongs") and jigs for the primary concentration of tin ore. A high degree of personal skill and experience is brought to bear on the mining and dressing of minerals at such plants.

Table 6.8 Thailand's Mineral Consumption 1980, 1984 and 1985
(consumption: tons, value: million baht)

Mineral	1980		1984		1985	
	Consumption	Value	Consumption	Value	Consumption	Value
Tin metal	734	243.5	870	250.2	640	199.9
Dolomite	7,980	0.9	4,017	3.2	16,928	14.2
Feldspar-Sodium	14,032	7.0	41,628	60.4	144,329	52.5
-potash					12,075	19.6
Glass sand	140,511	16.0	150,565	18.1	157,571	54.2
Gypsum	256,431	69.9	305,886	110.4	340,488	116.5
Kaolin	17,681	12.4	56,456	39.5	103,127	72.2
Lignite	1,513,390	178.2	2,276,416	644.2	5,180,004	2,568.1
Limestone (for cement)	3,230,159	80.8	9,168,527	229.2	8,700,382	372.6
Manganese -battery grade	6,028	15.9	9,734	25.7	4,204	17.1
Marble	5,651	2.5	16,250	7.2	7,739	15.1
Pyrophyllite	10,110	2.0	9,055	5.8	16,029	7.7
Rock salt	11,000	2.9	9,075	2.4	4,850	1.3
Zinc metal	-	-	-	-	25,482	626.0
Total value		723.6		1,436.6		4,187.2

Source: Department of Mineral Resources' Mineral Statistics, 1980-1985

BOX 6.2 The High Technology Metals

Tin may dominate the Thai minerals industry, but a number of other metals are also produced and exported, including antimony, lead, tantalum, tungsten and zinc. The uses for some of these metals, including lead and zinc, are well-established, while others like tantalum and tungsten, belong rather to the high technology sector - and their longer-term prospects, particularly in the case of tantalum, are consequently brighter.

Lead has suffered a slow price slide since reaching its peak in 1979. The metal is predominantly (60 percent) used in lead acid batteries, a market which is considered fairly strong, but the outlook for higher lead prices is considered bleak. Thailand only accounts for 0.26 percent of the world's lead production, Turning to zinc. The country's refining capacity is 60,000 tonnes. About half of the zinc produced is used in automobile coatings and in the construction industry, and the indications are that the metal's price could continue to strengthen.

Despite the fact that world consumption of tungsten has exceeded world production since 1983, the metal's price has been on a downward trend since early 1982. One reason for this paradox is that the non-mine supply of tungsten has been strong, in the form of recycled metal and the release of strategic stock piles. China's policy of allowing her provinces to export tungsten freely has also helped depress the market. But, at the same time, there are other economic and technological factors at work. In particular, technical advances and substitution have eaten into tungsten's market share, while the slowing pace of petroleum exploration has badly hit demand for tungsten carbide, used in drilling equipment.

The brightest prospect is probably for tantalum, a metal which is used in the manufacture of super-hard tools, electrolytic rectifiers and microelectronic equipment. Thailand is thought to have around 30 percent of world tantalum reserves (Rossi, 1986, and accounted for nearly half (46 percent) of world production in 1983. Malaysia was the next largest producer, at 13 percent. Around 60 percent of worldwide tantalum consumption is accounted for by the electronics industry, with a further 20 percent being used in metalworking machinery, and 10 percent each in the manufacture of chemical processing equipment and super-alloys.

World consumption of tantalum fell from 1,500 tonnes in 1980 (when a record price of $112 per tonne of tantalite was reached) to 560 tonnes in 1984, but rapid growth is predicted for the microelectronic industry in Japan, the United States and Europe. Japan's tantalum requirements alone are forecasted to grow by 50 percent a year.

Because advanced technology has to be brought in from abroad, there is a disincentive to its use, although many of the larger mining operations invest heavily in such technology. It is difficult to specify what represents an "advanced" technology, although a tin dredge can be so defined because the whole system must be designed and constructed in a highly technical fashion before it can be commissioned. Other examples of advanced technology plant would include the new zinc smelter at Tak, and the ill fated tantalum processing plant at Phuket. Perhaps most strikingly, the petroleum industry requires advanced technology throughout the entire spectrum of its operations.

Mineral Reserves and Potential

According to the International Monetary Fund, world commodity prices hit a seven-year low in 1986. Nonetheless, in longer term, the prospect is that the market will recover. So it is worth considering how long Thailand's reserves of particular minerals are likely to last in such circumstances.

Determining how large a country's reserves of a mineral, and how long they are likely to last, is rarely an easy task. Generally, the estimate must be made on the basis of past production records and present knowledge (DMR, 1981). A total of 1.4 million tons of tin concentrates were produced in Thailand between 1907 and 1985, and if the price rises significantly a production of 25,000 tons a year of tin-in-concentrate could be achieved for an extended period.

The proportion of Thai tin produced from offshore fields has fallen in recent years, partly because of falling prices, but also because of the depletion of high-grade offshore tin grounds. Longer term, however, there is considerable potential for exploiting lower-grade tin deposits, both offshore and onshore, in the south of the country and along the Thai-Burmese border.

As far as tantalum is concerned, this valuable mineral is found in close association with tin ore, so that increased tin output will automatically mean more tantalum. Tungsten, meanwhile, should also be available for some time to come, particularly given the geology of the western part of Thailand, which looks especially favorable in this respect. The total output of tungsten in Thailand totaled some 123,000 tons between 1934 and 1985. There are also favorable indications on the future availability of antimony ores, with Thailand having produced a total of over 106,000 tons by 1985. Current production takes place in Kanchanaburi and Chonburi.

Although no reliable figures are available on the likely reserves of fluorite, over 5.4 million tons of metallurgical and acid grade fluorite concentrates were produced between 1964 and 1985, and the existing reserves should be able to support present production levels into the foreseeable future. Declining demand and prices for this mineral have led to a slump in production, from a peak of some 427,000 tons in 1971 to around 200,000 tons a year since 1980.

Estimated reserves of a number of other industrial minerals are shown in Table 6.9 (Sampattavanija, 1984), illustrating the economic potential of some of these materials. The reserves of other minerals used to support domestic production in such industries as cement, ceramic and glass manufacture are considered sufficient for an extended time-scale.

The fuel mineral reserves, largely because of the more systematic approach which has been used in prospecting are better understood. Subject to later revision, these are now thought to be as follows: total proven natural gas, 7.5 trillion cubic feet; total possible natural gas, 12.9 trillion cubic feet; total oil and condensate, 99 million barrels; total possible oil and

condensate, 180 million barrels; total proven lignite, 670 million tons; and total possible lignite, 2,000 million tons (Suvarnapradip, 1983; Changkasiri, 1986; DMR, 1986).

A comprehensive mineral resource inventory assessment program has been in progress since June 1984. It includes an airborne geophysical survey project, largely funded by Asian Development Bank loans, together with some financial assistance from the Canadian International Development Agency (CIDA). The project is scheduled to be completed by the end of 1987. The entire country is being covered by aerial survey, to help in the preparation of aeromagnetic, radiometric and electromagnetic maps. Based on the resulting information, further exploration will be undertaken for petroleum resources, and for metallic minerals such as iron, copper, lead, zinc, antimony and radioactive materials. An integrated database will then be available for both the private and public sectors.

Table 6.9 Estimated Reserves of some Industrial Minerals

Mineral	Tons	Average Grade	Remarks
Barite	18×10^6	Sp. Gr. 4.2	
Diatomite	50×10^6	70% SiO_2	
Dolomite	100×10^6	18% MgO	
Gypsum	40×10^6	90% $CaSO_4.2H_2O$	
Kaolin	45×10^6	Mixed grade	
Limestone	very large	Cement and Lime grade	
Marble and building stone	$25 \times 10^6 m^3$	Mixed	
Potash	270×10^9	5% K_2O	Mainly Carnallite
Rock salt	18×10^{12}	90% NaCl	
Silica sand	10×10^6	99% SiO_2	
	100×10^6	95% SiO_2	

Source: Sampattavanija, 1984

Future Trends

The future development of Thailand's mineral industries will be profoundly influenced by the future state of the world economy. Substitution may cut into the markets for some of these materials but, at the same time, Thailand's own industries are beginning to consume increasing volumes of raw material, whether they are producing for domestic consumption or for export. The value of domestic consumption of minerals grew by 12 percent between 1983 and 1984, and by an astonishing 104 percent between 1984 and 1985. Most of these materials were used in the ceramic, glass, rubber, paint and paper products industries.

The prospects for tin have been well covered, but it is worth exploring the future potential of a number of other minerals. Tungsten, for example, may well be threatened in the long term by substitution by new ceramic materials (PTA, 1984). Tantalum, by contrast, should benefit from the growth of the high technology sector in countries such as Japan, the United States, West Germany and the United Kingdom. The metal is used by the microelectronic industry in capacitors, and rapid growth in demand seems likely.

Reduced demand for lead resulted in growing stocks and falling prices. At least one major Thai lead producer has been forced to cut production by a quarter, from 40,000 tons to 30,000 tons, and to dismiss several hundred workers. uncertainties about likely demand in acid battery manufacture and in the petrol additives sector inevitably raise a question mark over future demand for lead. Zinc, by contrast, is in steadier demand, both in export markets and, increasingly, in Thailand.

As far as fluorite is concerned, the overwhelming bulk of Thailand's production is exported, mainly to Japan, the Soviet union, South Korea, Taiwan, India and Australia. Total exports of fluorite from Thailand slipped from 214,256 tons in 1980 to 204,210 tons in 1984, and the prospects for boosting exports in 1986 have not been all that encouraging, with increased exports from South Africa and Mexico, and potentially from Kenya, having a significant impact on the international market. Demand for fluorite is likely to be limited by consumption rates in the aluminum and steel industries, which are unlikely to consume as much per unit of production in the future, due to improved smelting practices and to the recycling of fluorine for environmental reasons. The most likely area for growth is in the chemicals industry, with one particular area of note being the 10 percent annual growth expected in the construction industry's use of fluoropolymers.

Two other significant exports from Thailand are barite and gypsum. Some 85-90 percent of the total output of barite is used as a ballast material in drilling fluids by the petroleum exploration industry. In spite of the downturn in drilling activity, world barite production rose from 5.86 million tons in 1984 to 6.0 million tons in 1985 - although this output was still far short of the 8.31 figure achieved in 1981. There seems likely to be significant pressure in barite prices for some time.

The gypsum situation is marginally healthier. Of the total Thai output of nearly 1.3 million tons in 1985, some 68 percent was exported, representing an 18 percent increase in shipments from 1984. But here, too, the price has been falling, from 387.5 baht per ton in 1983 to 266 baht in early 1986. There must come a point where, as competing producers try to maintain market share, it is no longer a viable proposition for the weaker producers to stay in the game. Ultimately, the prospects for gypsum will depend on the health of the construction sector, which is the dominant user.

On the energy front, lignite is likely to be the main growth point, with two more 300MW thermal power plants due on stream in 1987. Other applications of

lignite are not expected to change very much. The petroleum prospect is less attractive, with the low price of oil a considerable disincentive for drilling activity and, indeed, for some production activity. But when the energy market recovers, Thailand will be fairly well placed with its reserves of lignite, petroleum, oil shale and geothermal power.

ISSUES

Prospecting in Reserved Areas

As the more easily accessible mineral deposits are exhausted, mineral minning will have to be carried out in increasingly inaccessible areas, and in areas reserved for other purposes. It is probable that, as a result of the airborne geophysical survey conducted since 1984, a number of areas will be discovered with considerable potential for the economic extraction of such minerals as antimony, fluorite, lead, tin, tungsten and zinc. Some of them may well prove to be in such reserved areas as national parks or wildlife reserves.

Wherever they are found, the discovery of mineral deposits can lead to potential conflicts with other important land uses, including agriculture, forestry, water resource development, fisheries, landscape protection or tourism. With different government agencies pursuing separate objectives, some degree of friction is almost guaranteed, and the issue of whether minerals should be exploited in reserved areas -- and, if so, how -- is likely to become more pressing.

Rather than risk being taken by surprise by such issues, these government agencies should take action now. If there is general agreement that such minerals will never be worked inside reserved areas, no matter how significant the deposits, then there is no problem. If, as seems more likely, some mineral deposits will need to be worked in such areas, for strategic or other reasons, then the legal and institutional framework within which such issues will be resolved should be reviewed and, where necessary, overhauled.

A government review panel, with a proportion of independent members, should be established to carry out the review and, in particular cases, decide on the respective merits of the cases put forward by those who propose mineral working within a reserved area, and those who oppose the proposition. If a decision is taken to allow the developer to proceed, then the panel would also be in a position to define suitably rigorous conditions to ensure that the environment is properly protected.

The Full Force of the Law

If the imposition of such conditions is to mean anything at all, they must be rigorously enforced. Unfortunately, however, the evidence suggests that the government agencies responsible for enforcement have been less than totally effective.

Consider the illegal mining which has taken place around the country. Whether one thinks of the mining of offshore tin in Phangnga, of wolfram ore at Khao Soon (in Nakkon Si Thammarat) or Doi Ngom (in Phrae), of scheelite ore at Doi Mok (in Chiang Mai), or of antimony ore at Chonburi, all have been affected by illegal mining. These "mob miners" encroach upon the rights of those who have legitimate rights over the minerals in the area. This illegal activity can lead to a number of highly undesirable results.

First, the legitimate owner or concessionaire is deprived of his rights. Second, valuable minerals are exploited in a wasteful manner, such that the eventual yield of a particular deposit may be significantly reduced. Third, the increased output from such illegal mining can result in the imposition of tighter quotas on legitimate miners. The tin or

tungsten ore produced illegally usually finds its way out of the country by illegal means, avoiding the payment of royalties to the government. And, once out of the country, these illegal exports help flood the international market, depressing prices.

Clearly, these pressures adversely affect the economic health of important sectors of industry. And it is worth pointing out that, from an environmental point of view, they also make it much harder for legitimate mining ventures to invest money in sensible environmental protection measures. Effective enforcement of the appropriate standards and conditions is clearly going to be essential if the country's nonrenewable and renewable natural resources are to be managed in an economically and environmentally sustainable manner.

Environmental Rehabilitation

There is no denying the fact that Thailand's mineral industries have damaged the environment, nor that such impacts will continue to some extent. Although further action is clearly needed to ensure that industry's environmental performance is up to standard however, there may a temptation to legislate too fast (Morris, 1983). What is needed, in fact, is steady pressure on an industry, coupled with technical and even financial assistance, where necessary.

The DMR, for example, awarded a seven million baht contract to the Asian Institute of Technology to develop pollution control technology for the offshore tin mining industry around Phuket. The results indicate that a suitable and effective technology can be provided to ensure that slimes discharged from tin dredges are more adequately treated, protecting local beaches and reefs. Funding for this project was derived from special fees collected from tin miners.

The rehabilitation of mined-out land is another DMR responsibility. The law requires operators to restore land to conditions as near as possible to the site's original state. A total of 10 rehabilitation projects have been approved, with combined funding of 47.6 million baht, by the committee set up by the Ministry of Industry to oversee the spending of the special fee fund. Unfortunately, the fees, levied at the rate of five percent of the tin ore royalty, were abandoned by the Council of Ministers in November 1985, to help the hard-pressed tin miners.

To ensure further progress in the environmental area, the standards set should be achievable, and then be progressively tightened as the industry recovers. Precise guidelines should be drafted by the National Environment Board (NEB) to ensure that environmental impact assessments (EIAs) prepared in advance of mining projects cover all the relevant issues and concerns. And the EIAs themselves should increasingly draw on a common environmental database, as is now beginning to happen in such mining areas as Kanchanaburi and Som Pan, in Ranong.

Adding Value Locally

The current economic malaise of the minerals industry reflects the fact that many of its products are, in effect, commodities. With the international economy depressed and commodity markets exerting considerable pressure on primary producers to keep their costs down, the prospect for increasing the mineral industry's investment in more environmentally acceptable technology is not bright. For this reason, environmentalists should support the trend toward value-added businesses in Thailand, with new industries growing up to refine and process a growing share of the country's mineral resources.

Given that mineral exports will need to continue into the foreseeable future, however, there is also an urgent need to consider ways in which Thailand might be

able to increase the return on those exports. By increasingly trading such minerals on world markets themselves, Thailand's larger mineral mining companies could win a larger proportion of the value added.

To support such initiatives, the government should ensure that it keeps constantly up to date with market developments, in terms of any changes in global patterns of supply and demand, the consumption trends in consuming countries, and other factors likely to affect the volume and value of Thailand's mineral exports. Private industry organizations, like the Mining Industry Council, should be equipped with sufficient information and personnel to respond quickly and effectively to industry's needs for market intelligence and other forms of marketing support. A government organization should be given overall responsibility for mineral marketing and trade, an approach which would enable the government to handle the sale of certain commodities on its own behalf, as in government-to-government trade. And, to further advance progress in this field, more attention also needs to be given to training Thais in the art of mineral marketing and trading.

Simultaneously, the domestic smelting of ores and their processing into semi-finished or finished products should be encouraged, wherever feasible. The smelting of tin and zinc ores is already helping the economy, and the potential should be investigated in other sectors. It is unfortunate that the proposed tantalum plant ran into such problems, since this is exactly the sort of project, subject to environmental considerations, which Thailand should be trying to encourage. Tungsten ore processing should also be initiated by an appropriate entity, since the price of tungsten ore is very low at present, while semi-finished and finished products continue to command a reasonable price. It would therefore be worth evaluating the possible production of such products in Thailand, possibly on a small scale, mainly for domestic use and perhaps using imported technology.

The primary objective in promoting the increased domestic utilization of ores is to increase the value of Thailand's exports and to achieve import substitution in areas where the country currently imports products made from the minerals that it can produce domestically. The economic multiplier and employment generation effects of such economic activity can be considerable, promoting a virtuous cycle of growth, diversification and further investment.

The government should issue policy guidelines stressing the need for the rapid development of domestic utilization of Thailand's mineral resources. The DMR should be responsible for providing the necessary information on mineral reserves, mineral quality and the current productive capacity of key industries. The private sector should be encouraged to take the lead in the commercial sphere, with technology contributed from the public sector, where appropriate.

The value of tax and other financial incentives should not be underestimated. The DMR already gives a rebate of 50 percent of royalty payments on tin (and 25 percent on other mineral royalties) to local industrial consumers. The royalty system is still probably the best system for Thailand, particularly given the small size of most mining ventures.

The Need for a National Minerals Policy

All in all, a more systematic approach is needed to the development of Thailand's mineral wealth. The minerals industry is too often unsystematic when carrying out exploration and production activities, because its structure places a considerable premium on producing profits as fast as possible. Given a more systematic approach, it is likely that mining operations would be more efficient, while any environmental impacts could be identified at an early

stage and properly managed.

In recognition of the vital role played by minerals development in Thailand, the government should formulate a National Minerals Policy, addressing all of the issues identified above. It should be developed on the basis of an improved understanding of the available mineral reserves, and aim to maximise the ultimate national benefits to be had from the exploitation of the country's valuable, nonrenewable mineral resources.

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7 Mangrove Resources

7.1 STATUS AND TRENDS

Mangrove area

In 1961 the total mangrove forest area of the country was approximately 2,299,375 rai. Due to the conversion of mangrove areas for other purposes, such as aquaculture, mining, resettlement sites or salt ponds, the mangroves had decreased to about 1,679,335 rai by 1986. This indicates an annual conversion of mangrove forest rate of 24,802 rai, or 1-2 percent from 1961-1986 (Table 7.1). Details of the conversion of mangrove forests for other purposes will be discussed later in this Chapter.

Presently, the existing mangrove forest is about 1,679,355 rai, but it is believed that the area will increase in the future. There are at least three main important reasons for this prediction. First, the Royal Forest Department has established 34 Mangrove Management Units to control forest exploitation and to prevent illegal cutting of mangrove forests. Second, the legal conversion of mangrove forests to other purposes will be limited and the utilization of mangrove areas for such purposes will be permitted only in the areas allocated by mangrove land use zoning, which will be discussed later in the text. And third, the Royal Forest Department is planning to promote the establishment of a large scale mangrove plantation program. The total potential area to be planted will be approximately 300,000 rai. Most of the area to be planted is currently denuded and unproductive (yield below three cubic meters/rai). Some suitable mudflats will also be planted. The project will run for five years and is scheduled to start in 1988. The annual planting target will be 60,000 rai. This indicates that the denuded area and unproductive forest of existing 327,119 rai could be fully planted during the life of this project.

Up to now, the Royal Forest Department has replanted about 39,160 rai of mangrove. There are also the private mangrove plantations, comprising about 205,975 rai. Most of the plantations consist of the species Rhizophora apiculata, which is used for charcoal production.

In 1992, therefore, it is estimated that the total mangrove area will be 1,679,335 rai. Even though the area is the same as in 1986, these should be more productive forests. In conclusion, the total area of 1,679,335 rai of mangroves in 1992 will be composed of 1,104,081 rai of managed forest area, 342,160 rai of government plantations, 205,975 rai of private plantations and only a small area (27,119 rai) of unproductive forest. Details of projected mangrove areas are presented in Table 7.2.

Silvicultural (cutting) systems

The Silvicultural (cutting) System has been revised from time to time in order to suit auction licensing, to promote effective regeneration and to protect against illegal cutting. Before 1961, the sole objective was charcoal production. The management of mangrove

Table 7.1 Degradation of Mangrove Forests in Thailand, 1961-1986

Year	Mangrove forest	Degraded area		Degradation rate	
	(rai)	(rai)	%	(rai/yr)	%
1961[1]	2,229,375				
1975[1]	1,954,575	344,800	15.0	24,629	1.1
1979[1]	1,795,675	158,900	8.1	39,725	2.0
1986	1,679,335	116,340	6.5	16,620	0.9
1961-1986	-	620,040	27.0	24,802	1.1

Sources:
1. Klankamsorn and Charuppat, 1982.

Table 7.2 Projected Mangrove Forest in Thailand (1986-1992)
(rai)

Year	Mangrove area				Total mangrove area
	Managed by RFD				
	Natural forest		Plantation	Private[4] plantation	
	Under[1] Concession	Unproductive[2] area	Planted[3] area		
1986	1,104,081	330,119	39,160	205,975	1,679,335
1987	1,104,081	327,119	42,160	205,975	1,679,335
1988	1,104,081	267,119	102,160	205,975	1,679,335
1989	1,104,081	207,119	162,160	205,975	1,679,335
1990	1,104,081	147,119	222,160	205,975	1,679,335
1991	1,104,081	87,119	282,160	205,975	1,679,335
1992	1,104,081	27,119	322,160	205,975	1,679,335

Sources:
1. Kongsangchai, 1984.
2. Estimated.
3. Kongsangchai, 1985.
4. FAO, 1986.

Box 7.1 The Miraculous Mangrove

If today's plant biotechnologists, operating at the leading edge of high technology, were asked to genetically engineer a tree able to flourish on soils which are regularly inundated with seawater, so that they are both salty and waterlogged, they might despair. But such a tree already exists and flourishes around the coasts of Thailand. The mangrove is at once an extraordinary living system and an increasingly vital economic resource.

The mangrove forest is also a highly symbolic resource, straddling the interface between the terrestrial and marine environments. Thailand is still fairly well endowed with mangroves. LANDSAT data suggests that some 1.7 million rai of assorted mangrove forest can be found around the country, although about three-quarters (73 percent) of this resource is found on the west and east coasts on the southern peninsula. The rest occurs in various places around the eastern and upper coastlines of the Gulf of Thailand.

Traditionally, mangrove forests have been seen as an inexhaustible source of firewood, charcoal, poles and other construction materials, in addition to providing raw materials for fishing gear and some medicines. Now research is beginning to provide incontrovertible evidence that they also play a key role in coastal and marine ecosystems, underpinning the productivity of inshore and offshore fisheries.

But in many areas these vulnerable forests are being exploited faster than they can regenerate. If any one resource best illustrates the growing need to adopt the multiple-use management approach to Thailand's coastal resources generally, it is the mangrove. Now is the time to develop a strategy designed to ensure the conservation and sustainable development of this resource, before the pressures become uncontainable.

One interesting idea involves combining mangrove plantations with aquaculture operations, in what is sometimes called the "silvo-fishery system". This approach could help slow the clearance of mangrove land for aquaculture ponds, ensuring that aquafarmers (see Box 8.2) maximize the potential of their land holdings in a way which does not undermine their longer term future.

forests by that time was operating only in some provinces because only a few concessionaires were interested. The management plan was rather sketchy. The silvicultural system was a shelterwood system, with the cutting rotation varying from 10 to 20 years. The forest area was divided into 10 to 20 annual coupes of approximately equal area. Each year, one annual coupe was granted for wood extraction under a short-term (one-year) permit. Under this cutting system, trees of 30 cm girth at breast height could be cut, but 30-40 big trees had to be left standing for each rai (0.16 ha), for regeneration purposes.

In 1961, the Royal Forest Department revised the mangrove operating plans throughout the country. The shelterwood system with minimum girth limit was retained, but a number of additional prescriptions were added, such as number of trees to be left in the cutting areas then to be varied according to the condition of the mangroves and the sizes of trees in each area. The cutting rotation was revised to 15 years, with 15 annual coupes. The areas were to be auctioned every three years.

During the implementation of the shelterwood system with minimum girth limit (1961-1969), it was found that this cutting system was difficult to supervise and control in the field. In many areas the stock was depleted and the site deteriorated. Some areas were left with only noncommercial species of trees. Another drawback was the impossibility to harvest the sheltered trees without damaging the area's regeneration potential. To solve this problem, in 1969, the Royal Forest Department again revised the mangrove management plans. The silvicultural system applied was "clear felling in alternate strips". Rotation was set at 30 years with a felling cycle of 15 years. This is practised by dividing the area into 15 coupes, each of which is further divided into 40 meter wide strips, forming an angle of 45° to the tide. Alternate strips are cut every 15 years, thus giving a rotation of 30 years. This silvicultural system shows promising results and is still used at the present time. The exploitation of mangrove forests is operated under concessions. The period of a concession is fixed by the issue of a long-term permit, lasting 15 years. This cutting system gives a higher yield. The regeneration within a clear-felled area has also improved because once the trees within the allotted strips are cut, the areas have to be promptly replanted. Under this silvicultural system, the mangrove forest can be managed on the basis of sustainable yield. The total managed mangrove forest is about 1,104,081 rai.

The cutting system for the management of plantations is clear felling, with a 10 year rotation. The area cut each year is the same and, after cutting, the area will be promptly planted.

Wood and charcoal production

Estimates of wood and charcoal production from mangrove forests in Thailand are presented in Table 7.9. From 1965 to 1969, the total wood production from mangrove forest was a small amount, only about 123,574 cubic meters per year due mainly to the small size of concessioned areas. The silvicultural system applied, "shelterwood with minimum girth", also limited the number of trees to be cut each year. The intensive management of mangrove forests has been carried out since 1970 and the cutting system applied has been clear felling with alternative strips, as already mentioned. This cutting system gave high yields, because all trees within the strips were cut. During 1970-1986, the average wood production from consessioned areas was about 725,782 cubic meters per year, with 54,000 cubic meters per year from private plantations. Therefore, the total annual wood production in this period was about 779,782 cubic meters per year. This amount of wood produces about 389,891 cubic meters of charcoal (if 50 percent of wood is lost) (Kongsangchai, 1983) or 265,125.9 tons of charcoal at 680 kg/cubic meters (Phuritat, 1975).

Assuming that the past production and cutting areas of concessioned areas (36,803 rai/yr) and private plantations (20,597 rai/yr) remain unchanged, with the same cutting systems, future annual wood production can then be estimated Table 7.3.

In 1987, the Royal Forest Department will begin to harvest the government plantations of 3,400 rai on a 10 year rotation. This area will produce about 10,200 cubic meters per year. This indicates that, from 1987, the annual wood production will be approximately 789,982 cubic meters per year - or 394,991 cubic meters per year of charcoal.

Wood production will increase in 1997 when the government plantations covering another 3,000 rai have to be cut. This will produce about 38,400 cubic meters (based on production of 12.8 cubic meters/rai) (Aksornkoae, 1975). So the total wood production in 1997 will be about 828,382 cubic meters.

Table 7.3 Estimates of Present and Future Wood and Charcoal Production from Mangrove Forest in Thailand, 1965-2002

Year	Consessioned[1] mangrove area	Wood production, (m^3/yr) RFD[2] plantation	Private[3] plantation	Potential[4] plantation	Total	Charcoal production (m^3/yr)[5]	(t/yr)[6]
1965-1969	123,574	-	-	-	123,574	61,787	42,015
1970-1986	725,782	-	54,000	-	779,782	389,891	265,125
1987	725,782	10,200	54,000	-	789,982	394,991	268,593
1988	725,782	10,200	54,000	-	789,982	394,991	268,593
1989	725,782	10,200	54,000	-	789,982	394,991	268,593
1990	725,782	10,200	54,000	-	789,982	394,991	268,593
1991	725,782	10,200	54,000	-	789,982	394,991	268,593
1992	725,782	10,200	54,000	-	789,982	394,991	268,593
1993	725,782	10,200	54,000	-	789,982	394,991	268,593
1994	725,782	10,200	54,000	-	789,982	394,991	268,593
1995	725,782	10,200	54,000	-	789,982	394,991	268,593
1996	725,782	10,200	54,000	-	789,982	394,991	268,593
1997	725,782	10,200	54,000	38,400	828,382	394,991	268,593
1998	725,782	10,200	54,000	768,000	1,557,982	414,191	281,649
1999	725,782	10,200	54,000	768,000	1,557,982	778,991	529,713
2000	725,782	10,200	54,000	768,000	1,557,982	778,991	529,713
2001	725,782	10,200	54,000	768,000	1,557,982	778,991	529,713
2002	725,782	10,200	54,000	768,000	1,557,982	778,991	529,713

Sources:
1. Based on wood production, Royal Forest Department, 1985.
2. Based on mangrove plantation working plan, Royal Forest Department, 1986.
3. FAO, 1986.
4. Based on plantation productivity, Aksornkoae, 1975.
5. Based on 50% of wood production, Kongsangchai, 1983.
6. Based on 680 kg/m^3 of charcoal, Phuritat, 1975.

Beginning in 1998, wood production will begin to increase at a considerable rate due to the production derived from the plantation of about 60,000 rai each year under the ADB project. The annual wood production from this area of plantation is estimated to be 768,000 cubic meters per year. The total wood production, therefore, from 1998 will be about 1,557,982 cubic meters per year. This amount of wood can potentially produce approximately 414,191 cubic meters or 281,649.9 tons of charcoal each year (Table 7.3). It is believed that the increasing wood and charcoal production from mangroves will contribute significantly to total wood fuel consumption (about 85 million cubic meters) in Thailand by 2000 (FAO, 1972).

Fisheries Production Related to Mangrove Forest

Capture fisheries

The importance of mangrove forests for artisanal fisheries is widely recognized. People who live inside or close to mangrove forests have long known the value of mangroves for fishing. So far, no definitive data have been recorded on the total fish catch around the mangrove or estuarine areas. However, as mentioned earlier, mangrove forests serve as nursery and feeding grounds for many marine species of commercially importance.

Even though there are no conclusive data, it has been noticed that the total fish catch in many mangrove and estuarine areas is decreasing. Aksornkoae et al., (1984) reported that mangrove dwellers in Kor Lao and Had Sai Khao villages gave four main reasons for the decreasing marine species Estuary. Firstly, the mangrove forests have been severely cut for many years. Secondly, the number of immigrants have increased throughout the years. Thirdly, more efficient fishing gear is used, such as trawls and scissor or push nets. Lastly, the water in this estuary is being heavily polluted by tin mining activities nearby.

Culture fisheries

At present, due to the loss of access to some 6,000 square kilometers of high seas fishery areas by the declaration of Exclusive Economic Zones by neighboring countries, and the declining production of offshore fisheries, the Department of Fisheries is attempting to develop coastal aquaculture to offset the loss of marine fisheries. The culture of shrimp, fish and molluscs being promoted. (see more details in Chapter 8)

Shrimp culture, mainly of Penaeus merguensis and P. monodon, has been practised in Thailand for many years. However, most of the shrimp culture area still uses traditional method, depending on the natural seed stock. But culture methods are evolving from traditional extensive to semi-intensive and intensive systems, utilizing modern facilities, equipment and management techniques. These aim to produce significantly higher yields per unit area. In 1982, there were 192,453 rai of culture area and production was about 10,090 tons. It is estimated that additional potential areas of about 144,750 rai of coastal area including mangrove forests can be utilized for shrimp culture (Table 7.4). Although there are quite large potential areas for shrimp culture, the Department of Fisheries aims to intensify existing pond culture rather than to replace mangroves with more ponds. The current traditional (non-intensive) methods will be changed to more semi-intensive and intensive culture. Today the shrimp hatcheries show promising results, but the shrimp seed is not yet enough to supply the increasing demand from shrimp farmers. These two methods will increase the present low average yield of shrimp up to 50 kg/rai/yr (semi-intensive) and 400 kg/rai/yr (intensive) (Varikul, 1985) which is much more than 40 kg/rai/yr produced by the present traditional (non-intensive) methods (Saraya, 1986).

The Department of Fisheries will also promote floating cage culture for fish, which has already proven viable. There are three main species for cage culture: Lates calcarifer, Lutianus argentimaculatus and Epinephelus salmoides. The suitable area for cage culture must have sufficient water depth to float the cage at low tide. It is estimated that the potential area for fish cage culture is above 100,000 rai in the Southern provinces (Brohmanonda, 1985). The production of Lates calcarifer or Lutianus argentimaculatus from a cage with a dimension of 200 cubic meters (10x10x2) is about 800 kg/yr, while the production of Epinephelus salmoides may reach 700 kg/yr.

Molluscs represent another economically important target for culture in Thailand. Four species are currently cultured: horse mussel, green mussel, blood cockle and oyster. In 1982, there were about 16,118 rai of culture area and 32,706 tons of production. The farming areas are scattered along the coastlines. In the future, the Department of Fisheries has a plan to extend the cultivated area of molluscs. It is estimated that an additional 217,358 rai of coastal areas could be utilized for mollusc culture (Table 7.4).

Table 7.4 Potential Areas for Aquaculture in Thailand, by Province (rai)

Province	Shrimp	Green mussel	Horse mussel	Blood cockle	Oyster
Samut Prakan	1,000	-	-	-	-
Samut Sakhon	-	2,000	600	2,000	-
Samut Songkhram	3,000	4,000	-	3,300	-
Chachoengsao	3,000	5,000	3,000	1,200	-
Chonburi	2,000	2,000	2,000	500	1,000
Rayong	1,100	4,000	1,000	500	1,500
Chanthaburi	3,000	3,600	-	-	3,000
Trat	20,000	-	-	-	-
Phetchaburi	4,000	2,000	-	3,325	1,000
Prachuap Khiri Khan	8,000	4,000	500	1,000	2,000
Chumphon	10,000	3,800	1,000	1,250	940
Surat Thani	20,000	4,000	1,250	18,000	1,562
Nakhon Si Thammarat	30,000	6,250	1,875	14,200	1,875
Songkhla	1,500	1,000	-	-	550
Pattani	16,000	2,000	-	2,000	2,500
Narathiwat	1,150	-	-	-	3,125
Ranong	3,600	3,000	3,125	12,500	3,125
Phangnga	4,500	6,000	12,500	12,500	6,250
Krabi	2,200	3,000	1,000	4,700	1,256
Trang	6,500	2,500	-	6,600	3,125
Stun	4,000	3,000	1,000	6,250	3,125
Phuket	200	1,000	-	600	-
Total	144,750	62,150	28,850	90,425	35,933

Source: Brackish Water Fisheries Division, Department of Fisheries, 1983.

Conversion of mangrove for other purposes

Approximately 620,040 rai, or 30 percent, of Thailand's mangrove forests have already been destroyed by conversion to other uses during the past 25 years.

The main conversions of mangrove forest have been to aquaculture, mining, salt pond construction and other activities, including agriculture, urbanization, industrial sites and harbors. Until 1986, the total aquacultural land in mangrove areas was about 237,459 rai, or 38.3 percent of the total conversion area, while mining, salt ponds and other uses covered a total area of about 34,066, 66,000 and 282,515 rai or 3.5 percent, 10.6 percent, and 45.6 percent, respectively (Table 7.5).

It is believed that in the future, the rate of conversion of mangrove areas for other uses, will decrease. One reason is that the government, through the Royal Forest Department and in cooperation with the National Research Council and the National Environment Board, is planning to establish mangrove land-use zones for development. The mangrove forest will be divided into three zones: preservation, conservation and development. Based on this land-use classification, only the development zone could be used for other activities. Details of mangrove land-use zoning will be discussed later in this Chapter.

7.2 KEY ISSUES

Solution to Conflicting Mangrove Land Uses

The most effective step towards resolving the conflicts of mangrove land use is the classification of mangrove land use zones.

For management purposes, mangroves may be divided into three zones: the preservation zone, the conservation zone and the development zone. The preservation zone mainly covers areas of undisturbed mangrove forest, especially along the banks of rivers, estuaries, coastlines and around islands. This area is important in terms of ecology,

Table 7.5 Conversion of Mangrove Areas for Other Land Uses

Land-use type	Area, (rai)			Percent of mangrove area
	Before 1980[1]	Between 1980-1986[2]	Total	
Aquaculture	162,725	74,734	237,459	38.3
Mining	5,787	28,279	34,066	3.5
Salt ponds	66,000	-	66,000	10.6
Others	269,180	13,327	282,515	45.6
- Agriculture	-	4,386	-	-
- Urbanization	-	4,592	-	-
- Industrial sites	-	1,135	-	-
- Harbours	-	3,214	-	-
Total	503,700	116,340	620,040	100.0

Sources:
1. Klankamsorn and Charuppat, 1982.
2. National Forest Land Management Division, RFD, 1980 and Chantadisai and Apinan, 1985.

supporting and maintaining the life of both plants and marine animals. The area will be used as a "green belt" to protect shorelines as well as prevent soil erosion. The preservation zone also includes an area which can be used for scientific research, education, wildlife and national parks. The conservationzone covers an area of managed mangrove forest and plantations. This area will be utilized for sustained yields; by means of the careful management of forest production. The development zone mainly covers denuded and unproductive areas. This area would provide for the development of other uses, such as aquaculture, agriculture, salt pans and urbanization.

This zoning approach is now gradually being introduced by the National Environment Board.

Multiple-Use Management System

The use of mangrove areas should emphasize multiple sustainable use, rather than conversion for a single, exclusive use.

Figure 7.1 illustrates the guidelines for multiple-use management of coastal areas for forestry, fisheries and others. In this system the subtidal zone will be used for mollusc culture and pen culture, the lowest intertidal zone for mollusc culture, and the remaining intertidal zone for mangrove.

It is possible, indeed desirable, to combine mangrove plantations with aquaculture (fish or shrimp farms). This system, so-called "Tlumpang Sari" or "silvo-fishery system", has been adopted in Indonesia for many years and the system shows promising results. The silvo-fishery system should be applied to avoid the clearing of mangrove forest solely for aquaculture purposes. The system specifies that the fish or shrimp ponds will be constructed surrounding mangrove areas by digging a small canal about five meters in width and 1.5 meters in depth. The ditch area for raising fish or shrimp is approximately 20 percent of the total area. The optional size for such joint operations is 20 rai. The coexistence between mangrove and shrimp farm can thus be materialized.

Creating Awareness

Promotion of Research, Training and education

Scientific understanding of the mangrove ecosystem and its interaction with terrestrial and marine environment is essential for the development of national policies for conservation and optimum use of mangrove resources. More relevant research, both basic and applied, is needed. The government should allocate more funds for research projects on mangroves. National and international research collaboration should be stressed.

The government should be alerted to the need for increased numbers of ecological scientists with skills and experiences appropriate to mangrove management. Efforts should be made at the national level to inform policy makers, planners, mangrove managers, mangrove resource users, and the local population living in the mangrove areas or dependent upon mangrove resources, about the widespread economic and ecological functions of mangroves and the negative results of mismanagement. Courses at the university and pre-university levels on the ecological and economic value of mangrove ecosystems should be encouraged.

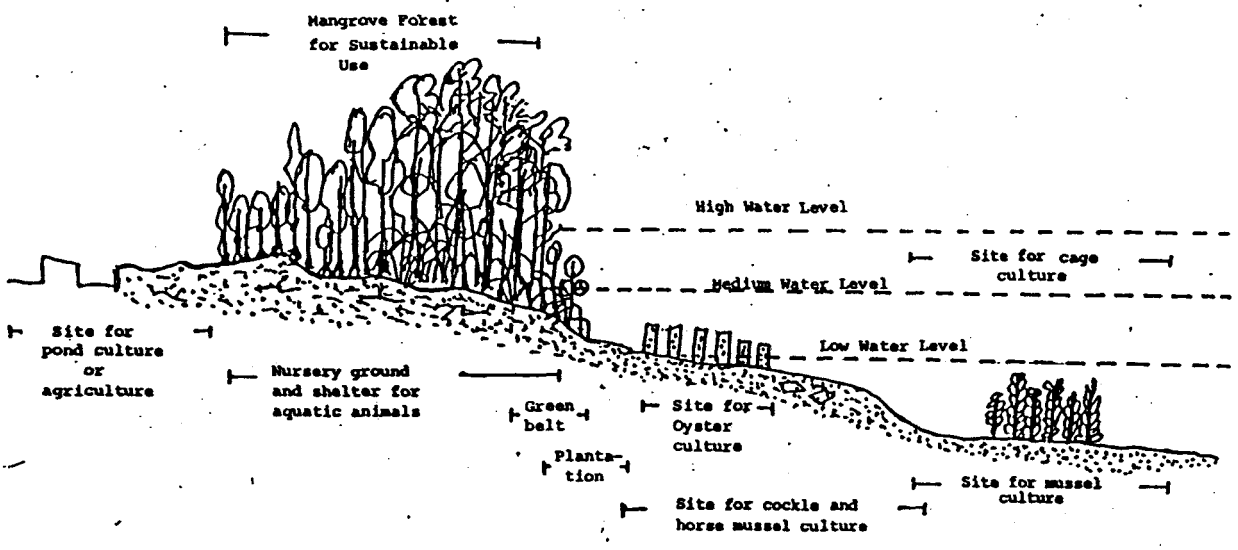

Figure 7.1 Multiple-use management of coastal area

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8 Fishery Resources

STATUS AND TRENDS

Rice and fish are the main components of the Thai diet. Fisheries have played a vital role in the national economy of the country. Fish provides highly nutritious, and relatively cheap, animal protein for the multitude of Thai people, the so-called "poor majority". During the past two decades fishery development has gained momentum with the introduction of efficient fishing gear such as purse seine, gill and trawl nets. The trawl net fishery, commencing around 1962, is now highly developed, with a distant water trawl fleet operating off the coasts of Kampuchea, Vietnam, Malaysia, Indonesia, Burma, Bangladesh and India. The past two decades have seen a spectacular increase in marine fishery production (90 percent or more of the total landing catch), mainly contributed by trawl net fishery.

The phenomenon is illustrated in Table 8.1, which shows that prior to 1960 the total production remained at about 200,000 tons annually, with approximately 50,000 tons of inland production. From 1960 onwards there has been a spectacular increase in production to about 1.7 MMT in 1973. However, total production dropped to around 1.5 MMT in 1974 due to the fuel oil crisis. Nevertheless, it rose again in 1976 to 1.7 MMT and has since fluctuated in the range of 1.8 - 2.2 MMT. For the inland fisheries, the average production over the past few years has been approximately 150,000 tons (including freshwater aquaculture).

The average consumption of fish by Thai people is said to be 22.5 kg/man/year. However, if we include the amount of fish used in the production of feeds for various types of animals, such as poultry and pigs, in addition to highly priced fish cultured in fish farms, the actual total amount consumed would be about 39 kg/man/year.

Table 8.2 shows how the annual marine catch is used. Most is consumed fresh, while the rest is preserved in various forms; frozen; canned; cured (which includes dried and salted, steamed or smoked); made into shrimp paste; or processed into fishmeal. From 1966 to 1981, marine fish have been increasingly used in the fishmeal industry and as animal feed. Approximately 40 percent of total marine landings are 'trash' fish, which are used in these lower value markets.

It should be noted that the main changes in the utilization of marine fish have been the increase in frozen seafoods and canned seafoods. Frozen seafoods increased from just over 10,000 tons in 1968 to 152,779 tons in 1983. Canned seafoods also increased from 6,276 tons in 1977 to 110,378 tons in 1983. Frozen products and canned products are mostly exported to the world market.

Fisheries create job opportunities not only in the fishing industry and aquaculture, but also in other related industries, such as post-harvest technology, net-making, cold storage and ship building (Table 8.3)

Table 8.1 Fishery Production of Thailand 1952-1983

Year	Quantity (ton)			Value (million baht)		
	Total	Marine	Inland	Total	Marine	Inland
1952	191,500	138,500	53,000	752	428	324
1953	204,500	148,200	56,300	820	507	313
1954	229,800	166,400	63,400	928	581	347
1955	212,970	151,400	61,570	976	604	372
1956	217,960	152,240	65,720	1,146	684	462
1957	234,570	170,900	63,670	1,190	735	455
1958	196,300	145,000	51,300	1,153	725	428
1959	234,570	170,900	63,670	1,233	754	479
1960	219,045	146,471	72,574	1,412	832	580
1961	305,605	233,275	72,330	1,571	1,029	542
1962	339,788	269,709	70,079	1,634	1,106	537
1963	418,685	323,374	95,311	1,935	1,167	768
1964	576,986	493,196	82,790	2,490	1,835	655
1965	619,120	529,483	85,637	2,470	1,798	672
1966	720,282	635,165	85,117	2,578	1,903	675
1967	847,443	762,188	85,256	3,047	2,309	738
1968	1,089,303	1,004,058	85,245	4,037	3,251	786
1969	1,270,034	1,179,595	90,439	4,798	4,011	787
1970	1,448,404	1,335,690	112,714	5,876	5,043	833
1971	1,587,077	1,470,289	116,788	6,375	5,145	1,230
1972	1,679,540	1,548,157	131,383	7,213	5,728	1,485
1973	1,673,901	1,538,016	140,885	8,209	6,562	1,647
1974	1,510,466	1,351,590	158,876	5,984	4,094	1,890
1975	1,555,300	1,394,608	160,692	7,194	5,102	2,092
1976	1,699,086	1,551,792	147,294	7,532	5,379	2,153
1977	2,189,907	2,067,533	122,374	10,660	8,622	2,035
1978	2,099,281	1,957,785	141,496	13,828	11,459	2,369
1979	1,946,334	1,813,158	133,176	14,004	11,318	2,686
1980	1,792,948	1,647,953	144,995	14,067	10,507	3,560
1981	1,989,025	1,824,444	164,581	17,134	13,213	3,921
1982	2,120,133	1,986,571	133,562	18,931	14,246	4,685
1983	2,255,433	2,099,986	155,447	19,238	15,236	4,002

Source: Department of Fisheries.

Table 8.2 Composition of Annual Utilization of Marine Catch 1963-1983

Year	Percentage					
	Total Catch	Market Fresh	Frozen	Curing	Processed into Fishmeal	Others
1963	100.0	47.8	-	24.8	-	27.4
1964	100.0	40.4	-	16.4	-	43.2
1965	100.0	45.3	-	19.7	30.6	4.4
1966	100.0	47.0	-	19.8	28.5	4.7
1967	100.0	55.9	1.2	12.3	17.8	12.8
1968	100.0	48.2	3.5	11.4	16.2	20.7
1969	100.0	42.4	0.4	10.1	24.1	22.0
1970	100.0	38.8	1.6	15.1	24.5	20.0
1971	100.0	39.3	2.4	7.8	21.5	29.0
1972	100.0	34.0	1.8	8.9	23.6	31.7
1973	100.0	36.6	4.3	8.5	37.9	15.7
1974	100.0	33.7	0.8	10.3	41.7	13.5
1975	100.0	35.7	1.7	11.3	41.7	9.6
1976	100.0	42.0	2.0	11.4	35.4	9.2
1977	100.0	33.8	4.7	14.5	29.9	17.1
1978	100.0	28.5	7.7	14.2	47.0	2.6
1979	100.0	31.6	6.1	12.8	45.1	4.4
1980	100.0	26.0	7.5	12.0	49.1	5.4
1981	100.0	27.7	6.7	14.6	42.8	8.2
1982	100.0	23.2	8.6	24.2	38.5	5.5
1983	100.0	22.9	7.4	28.5	38.9	2.3

Source: Department of Fisheries.

Fisheries contribute to the country's foreign exchange earnings. The amount of export rose from 88,221 tons valued at 1,549 million baht in 1974 to 344,899 tons valued at 12,677 million baht in 1983. This represents almost a 10-fold increase during the 10 year period (Table 8.4). The trade balance of fishery products was + 11,584 million baht in 1983. The major export products that contributed to the substantial increase in the export value were canned seafood, frozen shrimps, frozen squid and cuttlefish, and fish meal.

Capture Fisheries

Prior to the Second World War, the fisheries of Thailand were confined to the utilization of fresh water aquatic organisms in inland waters and to marine fish and invertebrates in the in-shore waters along the coast. Fishing boats employed in in-shore fisheries prior to the Second World War were mainly non-powered sail boats. In the 1930s, purse seines made of cotton twine, introduced from China and therefore still known as Chinese purse seine, were used to catch schools of pelagic fish, such as short bodied mackerel, in in-shore waters.

During 1945-1960, besides traditional fishing gear such as hand and troll lines, lift nets, cast nets and push nets which were of minor importance, new types of fishing gear contributed substantially to the approximately 150,000 tons marine catch. These include purse seine, bamboo

fish corrals (stake traps) and nylon gill nets.

Two different types of purse seines can be distinguished. The Chinese purse seine mentioned above has a length of 200-300 meters, a depth of 50-60 meters and stretched mesh size of approximately 3.5 centimeters. The gear is operated during dark moonless nights by two row boats. The Aun-Dam purse seine or Aun Cha Lom (so called Thai purse seine) has a length of 250 meters and a depth of 40-50 meters. The gear is operated by a fishing boat, with no row boat.

Bamboo fish corrals (stake traps) locally known as "Poh" used to be very common in the in-shore fishery of the country, with a total number of about 1,500 during 1945-1962. However, the number of this type of fishing gear has decreased drastically during the past two decades because it cannot compete with more efficient mobile gear, such as purse seines or trawl nets. Gill nets employed by Thai fishermen are set nets, drift nets and encircling nets. After the Second World War, increased numbers of motorized boats using monofilament nylon and gill nets of various sizes were introduced into Thailand through the technical assistance of the US Government. These nets have gained popularity among Thai fishermen up to the present day. The main fisheries of the country during 1945-1960 were carried out by about 1,400 motorized vessels and about 1,440 non-motorized vessels (less than 14 meters long), while the number of fishermen during the period was estimated by the DOF to be 32,000. However, if small scale fishermen had been included, the number would have been higher (Tiews, 1962).

Table 8.3 Post Harvest Industries in Thailand 1982-1983

Industry	Number	
	1982	1983
Freezing and cold storage	41	47
Fishmeal plants	94	98
Canning	24	26
Fish paste	2,337	2,603
Salted fish	696	759
Dried shrimps	301	276
Dried squids	826	854
Dried mussels	1,262	1,494
Steamed fish	147	142
Smoked fish	170	184
Fish-shrimp cracker	8	72
Fish-ball	52	72
Fish sauce	35	37

Source: Fishery Statistical Bulletin for South China Sea Area 1982, 1983, SEAFDEC.

The past two decades have seen a distinct and remarkable change in the structure of the marine fisheries sector. With the successful introduction of trawl net fishing into Thailand in 1962, there has been a spectacular increase in marine catch during 1963-1983. This has resulted in overfishing of demersal fish stocks both in the Gulf of Thailand and in the Andaman Sea.

Table 8.5 shows the breakdown of the country's fishery production during 1973-1983 into three major components, i.e. marine (capture only), inland (capture only) and aquaculture. At the beginning of this period (1974-1976), the marine catch declined to about 1.3 MMT because of the fuel oil crisis, but rose again to 1.9 MMT in 1977. Then the catch steadily declined again because of the new sea regime, before starting to recover in 1981. The catch reached a recorded high, at 2.25 MMT, in 1983. During the same time span, production from inland waters remained relatively in the range of 100,000-130,000 tons.

There are many factors which have influenced the rapid expansion of marine fisheries during the past decades besides the progressive development of trawl fisheries. These factors include: (1) Increased efficiency of fishing gear employed and the greater capacity of fishing boats. In recent years not only did trawlers became larger and more

Table 8.4 Balance of Imports and Exports of Fish and Fish Products 1957-1983

Year	Import		Exports		Balance of Trade ('000 Baht)
	Quantity (MT)	value ('000 Baht)	Quantity (MT)	Value ('000 Baht)	
1957	2,938	27,405	19,371	64,041	- 41,636
1958	5,324	52,698	12,359	35,674	- 16,934
1959	8,933	95,151	8,869	29,553	- 65,598
1960	9,287	70,189	8,959	34,259	- 35,930
1961	10,229	63,058	10,640	42,492	- 20,556
1962	7,865	55,738	9,078	41,235	- 14,503
1963	6,578	48,645	9,049	72,723	+ 24,078
1964	8,346	55,211	10,911	95,755	+ 40,544
1965	11,876	69,099	17,251	149,951	+ 80,852
1966	10,132	63,839	18,639	234,971	+ 171,082
1967	10,026	65,256	17,390	286,553	+ 221,297
1968	9,337	64,134	16,186	309,000	+ 244,866
1969	12,196	88,480	21,758	324,105	+ 235,625
1970	14,229	85,607	44,956	369,818	+ 284,211
1971	15,934	82,325	55,111	497,558	+ 415,233
1972	15,139	83,692	82,381	807,165	+ 723,473
1973	19,542	92,551	104,133	1,649,930	+ 1,557,379
1974	19,965	93,545	88,221	1,548,977	+ 1,455,432
1975	19,682	125,192	97,994	2,106,088	+ 1,980,896
1976	24,931	149,819	133,454	3,097,741	+ 2,947,922
1977	18,634	138,616	180,331	3,590,903	+ 3,452,287
1978	28,703	176,307	235,386	5,086,125	+ 4,909,818
1979	79,967	432,021	277,896	7,326,244	+ 6,894,223
1980	43,569	483,250	262,568	7,250,810	+ 6,767,560
1981	47,174	549,959	300,036	8,775,742	+ 8,225,783
1982	46,215	725,532	295,500	10,852,617	+ 10,127,085
1983	58,942	1,093,081	344,899	12,677,173	+ 11,584,092

Source: Department of Fisheries.

Table 8.5 Annual Fishery Production of Thailand by Major Types of Fisheries

(ton)

Year	Total Production	Marine	Inland	Aquaculture[a]
1973	1,673,901	1,474,742	110,885	93,274
1974	1,510,466	1,297,174	127,931	85,361
1975	1,555,300	1,284,810	130,717	139,773
1976	1,699,086	1,388,239	113,263	197,584
1977	2,189,907	1,915,999	82,564	191,344
1978	2,099,281	1,837,807	102,129	159,345
1979	1,945,830	1,690,380	108,211	152,239
1980	1,792,948	1,544,434	110,361	138,153
1981	1,989,025	1,756,939	116,468	115,618
1982	2,120,133	1,949,681	87,733	82,719
1983	2,255,433	2,055,225	108,481	91,727

Note: a. The sum of freshwater culture, brackishwater culture, and mariculture.
Source: SEAFDEC (1978, 1983 and 1985), Fishery Statistical Bulletin for the South China Sea Area 1976, 1981 and 1983. Southeast Asian Fisheries Development Center, Bangkok.

efficient in fishing but purse seines were rapidly modernized. (2) Discoveries of new fishing grounds, such as round scad (Decapterus spp.) grounds in the middle of the Gulf of Thailand. (3) Improved infrastructure of Thailand, and (4) increased demand for fish food, due to Thailand's quickly expanding population.

Structure of Fishing Industry

Prior to 1960, the fishing industry of Thailand consisted virtually of small-scale fishing households. While more than 80 per cent of inland fishermen were actually farmers, probably 50 per cent of coastal fishing households had more than one main source of income. Typically, they operated within their family unit and rarely hired outside help. They used small, uncomplicated gear which produced relatively low yields.

Since 1962, when otter board trawling methods were introduced, the marine fishery of Thailand experienced rapid growth with a considerable change in the structure of the fishing population. The marine fishery at present is commercial rather than small-scale or artisan-oriented. As indicated in Table 8.6, fishery employees' household increased from 8,329 households in 1976 to 26,875 households in 1985. A change is also reflected in the increase in the number of in-board motorized vessels from 10,435 in 1976 to 16,905 in 1985.

Another trend in the changing fishery employment structure is that brought about by the size of fishing vessels employed by the industry. It should be noted that the proportion of motorized boats in 1985 is much larger than that reported in 1976.

Finally, the rise in the number of high cost gear such as trawl nets, and the decline in the number of traditionally non-mobile gear, for instance, traps and set bag nets, are clear indicators that during the past twenty years the pattern of fisheries has shifted from primarily subsistence to enterprise or commercial fisheries.

At present it can be assumed that large and medium fishery enterprises are the

Table 8.6 Marine Fishing Industry Employment

	1976	1985
Fishery Households[a]		
Marine fisheries	31,869	51,678
Employee	8,329	26,875
Total fishery households	40,198	78,553
Fishermen		
Extent of employment	69,927	89,777[b]
Solely	51,198	65,569
Mainly	13,754	17,486
Partly	4,975	6,722
No. of Fishing boats		
Non-motorized boats	5,367	8,302
Motorized - out-board	10,333	28,233
- in-board	10,435	16,905
Total	26,135	53,440

Notes:
a. This refers to a household in which one or more members were engaged in marine fishery for the past year. A registered company which engaged in marine fishery is also included herein.
b. Use the data of 1983

Sources:
1. Department of Fisheries (1978), Statistics on the Population of Marine Fishermen.
2. SEAFDEC (1985), Fishery Statistical Bulettin for the South China Sea Area 1983.
3. National Statistical Office (1985), Preliminary Report 1985: Census of Marine Fishery.

Box 8.1 Keeping Pla Tu on the Plate

"Pla tu", or the Indo-Pacific mackerel, is a very important staple food in Thailand. In the old days, those who lived in coastal provinces ate pla tu almost every day. Nowadays, because of a limited supply and a greater demand, the price of this fish has risen considerably. Nevertheless, pla tu still makes a significant contribution to the Thai diet. Its dietary importance can be compared to that of the milkfish in the Philippines and Indonesia.

The scientific name of pla tu is Rastrelliger brachysoma. Pla tu is widely distributed in the Tropical Western Pacific and has been studied extensively. In the gulf of Thailand pla tu occurs inshore, where the salinity is less than 28 parts per thousand. The size at first maturity for pla tu in the Gulf has been reported as 17.5 centimeters in length. fish attaining this length are about one year old. The spawning season of pla tu is long, with pelagic eggs of this fish found throughout the year. However, two peaks of spawning have been observed, the first between February and March, and the second from June to August.

Pla tu spawn in the waters along the west coasts of the Gulf. The highest density of larvae was located in water 20-60 kilometers off Prachub Khiri Khan and Chumphon Provinces. Ready-to spawn fish stay near the bottom at a 18-25 meter depth and the trawl fishery catches a large quantity of mature fish there.

The fecundity of pla tu was estimated to be about 200,000. This number includes immature eggs of less than 0.01 millimeters in diameter. during a spawning season, a female releases eggs in batches of

approximately 20,000. The eggs hatch within a period of 23-28 hours, depending on the ambient water temperature.

Pla tu feed mainly on phytoplankton. Growth of the fish is very rapid, attaining a length of 15 centimeters five months after hatching. After one year of age, growth becomes slower; it is rare to find fish that are two years old, since most of them are caught during the first year.

The life cycle of pla tu involves a short migration. After hatching during April and May, mackerel larvae are transported by currents into inshore water to feed. During June and July the fish start moving northward along the west coast into the inner Gulf, where they feed extensively and are exposed to the purse seine fishery of the Inner Gulf. The fish stay in the Inner Gulf until October-November. Then they gradually move southward to spawn in the waters off Prachuab Khiri Khan and Chumphon Provinces, where they are fished extensively by purse-seiners during November-January.

It is believed that there are at least two stocks of pla tu, one on the Gulf's west coast and the other on the east coast. The east coast stock is subjected to the fisheries of Vietnam, Kampuchea, and Thailand, while the west coast stock is fished entirely by the Thai fishing fleet.

The maximum sustainable yield of pla tu in the Gulf is estimated to be 66,500 tons. during 1971-1982, the average catch per year of this fish was 61,472 tons. In 1983 the catch was 79,803 tons, valued at 856 million baht. Hence, it can be said that pla tu is fully utilized and should be maintained at this level; otherwise overfishing may adversely affect the stocks.

backbone of the marine fishing industry of Thailand. The development of the marine fishing industry of Thailand had reached its peak in employment, boat building and production. Hence, at present this industry must look forward to expanding its activity in the high seas with a view to reaping benefits and to obtaining investment returns as soon as possible.

As regards the marketing part of the fishing industry, it can be seen that most fish landings are channelled through the private sector. However, there are two semi-government agencies, The Fish Marketing Organization (FMO) and the Cold Storage Organization (CSO), involved in marketing activities.

Major Fisheries

Several types of fisheries are being operated in Thai waters and adjacent areas. Nevertheless, the major ones are trawl fisheries and purse seine fisheries.

Trawl Fisheries

With the rapid development of trawl fisheries since 1960, inshore gear such as push nets, set bag nets and bamboo stake traps account, for a negligible proportion of the total catch of demersal species.

Three types of trawls are presently employed in demersal or trawl fisheries. These are otter board trawls, pair trawls and beam trawls. The major portion of the demersal species (over 75 per cent) is caught by otter board trawls. Beam trawls fish mainly for shrimps in the inshore waters along the coast. Their catches are quite low as compared to those of the otter board and pair trawls. The majority of the trawlers in operation are otter trawlers of less than 14 meters in length. Only 147 trawlers are 25 meters in length or longer. Hence, it is assumed that intense fishing took place

in the waters not far from the coast, i.e. within a depth of 50 meters. The dimensions of the trawl gears depend on the size of the vessels and on whether they are using the 2-sheet German trawl or the 4-sheet Japanese trawl.

Among the multitude (over 200 species) of demersal fish caught, less than 15 species are predominant in the demersal catch. These include threadfin bream (Nemipterus spp.), goat fish (mullidae), lizard fish (Synodontidae), big-eye (Priacanthidae), sea catfish (Taehysaridae), sharks and rays, travelly (Carangidae), bass (Lutjanidae), baracudas and wolf herring (Chirocentridae).

Trawl gears catch not only demersal fish but some pelagic fish and invertebrates such as molluscs, crustaceans, spanish mackerel and Indo-Pacific mackerel. In recent years, shrimps (Penaeus and Metapenaeus spp.), squid and cuttlefish, caught by trawl net fishing have contributed substantially to the income of trawlers in general.

The rapid expansion of trawl fisheries has resulted in several developments in Thai marine fisheries, which include : (1) The keen fishing competition in the fishing grounds in the Gulf of Thailand and in the Andaman Sea (off the Thai coast). (2) The development of medium and large-sized trawlers (18 meters or longer) and the formation of a distant water fishing fleet of trawlers operating off the coast of Kampuchea, Vietnam, Malaysia, Indonesia and recently in the Bay of Bengal and India. (3) An increase in the export of some fishery products, notably frozen shrimps and squid, as well as fish fillets. (4) An increase in the amount of trash fish, which is used for fish meal, and by the duck farming and fish culture industries.

Purse Seine Fisheries

Prior to the Second World War, pelagic species were mainly caught in the inshore waters of the Gulf using stationary gear such as bamboo stake traps and set bag nets. The Chinese purse seine was introduced to Thailand around 1925, employing a sail boat with two small row boats for setting the net.

Since the end of the Second World War, nylon gill nets have been used widely and the Chinese purse seine fishing method has been modified. Instead of using two row boats to set the net, the main boat, which is now motorized, sets the net by itself. This method is called Thai purse seining. The Thai purse seine fishing method is now widely practised in Thailand for capturing pelagic fish and can be considered as an enterprise fishery. Since the purse seiners have recently become larger in scale, the gear employed is also larger on the average than that used two decades ago. Large-sized purse seiners are now equipped with labour saving devices such as the purse line winch, thus enabling a boat to reduce its crew nearly by half, from 22 to only 12. In addition, more medium and large-sized purse seiners are now equipped with radar, fish finders, wireless equipment and refrigeration units (Yamazaki, 1978).

However, in contrast to trawl fishery with some large-sized trawlers now fishing in distant waters, pelagic fishery is still practised in the waters of Thailand. Several other types of gear employed by small-scale fishermen, such as gill nets, traps and small seines, also contribute substantially to the pelagic catch.

Since 1973, with the introduction of luring techniques using palm leaves by day and lamps by night, the production of pelagic catches, mainly sardines and scads, has increased sharply, and the number of luring purse seine vessels rose from 100 in 1973 to 410 in 1983. In recent years the catch of scads declined but the catch of small tunas rose significantly. In 1983, there were 691 registered purse seine vessels and the catches by weight of mackerel, sardines,

small tunas, and scads were 30 percent, 27 percent, 18 percent and 7 percent of the total pelagic fish catch, respectively (Department of Fisheries, 1985).

Status of Fisheries and Future Development

There are various assessments of the potential yield of the pelagic and demersal resources of the Gulf of Thailand and the west coast of the Thai peninsula. Gulland (1968) concluded that the Gulf of Thailand waters had above-average productivity. It should be noted that the estimated figures on potential yield kept on rising with better data. The latest estimations on the maximum sustainable yield of the Gulf and the west coast are compiled in Table 8.7.

The Table indicates that the exploitation of demersal fishery resources, particularly those in the 0-50 meters depth in the Gulf of thailand and off the west coast of peninsular Thailand, have been very intense, and overfishing is evident in both areas, e.g. the significant reduction in the catch per unit of effort. For the demersal resource below 50 meters depth in the Gulf (i.e. in the middle part of the Gulf), it is anticipated that there are still some demersal resources available for future development. However, the ground in the middle part of the Gulf is generally very irregular, consisting mainly of soft mud, and is thus not suitable for conventional trawling. Hence, other suitable gears should be developed for these resources, e.g. bottom hand line or the use of better trawling techniques.

As for the pelagic fishery resources, the exploitation level in the Gulf has exceeded the estimated maximum sustainable yield. On the west coast, meanwhile, the exploitation rate is approaching the estimated mazimum sustainable yield.

The extreme over-exploitation of both demersal and pelagic resources raise suspicion that a substantial catch might have been taken from elsewhere, outside Thai territorial waters. Suraswadi et al. (in press) estimated that in 1983 about 134,900 metric tons of fish were taken from areas outside Thai territorial waters. Of this amount, about 102,696 tons were taken from the Gulf areas beyond Thailand's EEZ. This estimate, if

Table 8.7 Level of Exploitation and Maximum Sustainable Yield (MSY) of Marine Fishery Resources in The Gulf of Thailand and The West Coast of Peninsular Thailand (tons)

Fishing Ground	Resources	Exploitation level		Estimated MSY	
		1982[a]	1983[a]		
The Gulf	Pelagic	466,480	616,800	400,000	Phasuk, (1982)
The Gulf	Demersal	1,170,946	1,136,434	750,080	Boonyubol & Pramokchutima, (1982)
West coast	Pelagic	101,122	93,954	100,000	Menasveta, (1977)
West coast	Demersal	211,133	208,037	200,000	Menasveta, (1980)
Total		1,949,681	2,055,225	1,450,080	

Note: a. Data extracted form SEAFDEC (1984 & 1985).

correct, shows that only a small percentage of the total catch was taken from other waters.

Future Trends

There is no potential for future development of trawl fisheries which exploit mainly demersal fishery resources, since the production at present is higher than the estimated maximum sustainable yield from the Gulf. In the Andaman Sea, increasing the fishing effort may not significantly increase the total demersal catch.

The exploitation of small and medium-sized Gulf pelagic resources such as sardines, scad, and mackerel has exceeded maximum sustainable level and a further increase in the fishing intensity may not result in an increase in the total catch. In the Andaman Sea, pelagic resources utilization should be maintained at the present level.

In Thai waters, particularly in the Andaman Sea, there are small-sized tunas, bonitos and skipjacks, and fishing for bonitos and skipjecks could be expanded in the future. There are several other resources which could be utilized in the future, including seaweed, sea cucumbers and jellyfish. An economically important species of seaweed is Gracilaria confervoides (L). The production of seaweed in Thailand in 1983 was 670 tons and there is a potential for seaweed culture to supplement the production from natural stocks, provided that the waters are free from pollution.

The exploitation of the jellyfish resource began during the early 1970s. In 1983, Thailand harvested approximately 180,281 tons of jellyfish, but the problems of jellyfish production appear to be in processing. With improved processing techniques, it is expected that the quality of the production will be enhanced, thus enabling Thailand to command a better export price. The potential of the jellyfish resource in the Gulf and in the Andaman Sea is unknown since this resource is exploited mainly by small-scale fishermen.

Additional resources include sea urchins and sea cucumbers. Among the sea urchins, Diadema setosum Leske is the most important and the gonads can be exported to Japan for a high price. The Department of Fisheries has listed eight species of sea cucumbers known to occur in the Gulf. The economically most important species in Stichopus spp., which can be exported. It is believed that 1,000 tons of sea cucumber could be harvested annually, since this animal is distributed widely over the coastal areas of Thailand.

Means of increasing the value of the present catch are required. Improved handling methods at sea and during transportation, together with the development of higher value products, are needed. Beside fisheries in our waters, Thailand should increase its joint venture efforts with neighboring countries and also investigate the potential of high-sea fisheries.

History and Status of Aquaculture

Aquaculture has developed considerably since the beginning of the century. Freshwater aquaculture was developed a long time ago, but coastal aquaculture is much more recent. Prior to the use of synthetic insecticides, substantial amounts of fish could be produced as a by-product of rice cultivation. Aquaculture production during the past decade is shown in Table 8.8.

Aquaculture contributed about 5-10 percent of the total fishery production of the country in recent years. According to Table 8.8, aquaculture production increased sharply from 1973 and reached a peak of 197,584 tons in 1976. Since then, production gradually declined to 91,727 tons in 1983. This was due to the variation of mariculture production. In considering the data in Table 8.8, we could observe that

Box 8.2 The Aquaculture Industry

Thais eat enough seafood each year to place them among the top in the world fish-eating stakes. Fish is eaten frozen, canned, salted, dried, steamed, smoked or as fish paste. The country has always made extensive use of its rich inland, brackish water and marine fisheries, exporting a significant propotion of the total catch. A huge diversity of species is harvested, from seaweed to sponges, from cephalopods to corals. Some fishermen use push nets, set bag nets or bamboo stake traps, while others have large, seagoing trawlers which operate off the coasts of Kampuchea, Vietnam, Malaysia, Indonesia and India.

But a number of the open-sea fisheries have been exploited well beyond their maximum sustainable yield, with the result that the harvest per unit of fishing effort is falling. Other fisheries could well follow. At the same time, too, the declaration of national Exclusive Economic Zones has led to Thai fishing vessels being excluded from some of their traditional fishing waters.

Aquaculture, the farming of inland, brackish or marine water, now makes a considerable contribution to the Thai diet, accounting for some 5-10 percent of the total tonnage produced by all the country's fisheries. However, Thailand still lags way behind such countries as the Phillippines and Taiwan as far as aquacultural production is concerned. Yet the potential for this industry is clearly very considerable, if a number of important constraints can be effectively tackled.

The freshwater and brackish water aquaculture industries have been growing rapidly in many areas. Freshwater aquafarmers use cages, ditches, ponds or paddies to raise such species as carp, catfish, gouramys, marble goby and Nile tilapia. In brackish water areas, typically in or around estuaries and mangroves, the focus is on such species as prawns, shrimp or sea bass. In 1983, there were over 4,000 shrimp farming operations in Thailand, whose total output was over 13,600 tons. Traditional methods are giving way in many areas to improved techniques: whereas the shrimp farmer traditionally flooded his pond with brackish water already containing the eggs and larvae of wild shrimp (plus many other species, including shrimp predators), he maly now buy his shrimp fry at a hatchery.

Mariculture, which involves farming the saltwater environment, has proved somewhat more problelmatic. Preferred species here have included bloody cockles, green mussels and oysters. But production has slumped from a peak in 1979 of nearly 112,000 tons to just under 30,000 tons in 1983. The suspicion is that a key factor responsible for this slump is the deteriorating quality of water off the mounths of some of Thailand's major rivers.

Aquafarmers are putting increasing effort into improving their brood-stock, using techniques such as selective breeding and hybridization to achieve better growth rates, improved resistance to disease (with ulcerative dermal necrosis a particular concern at the moment), or enhanced tolerance to degraded water conditions. but, however successful these efforts may be, the evidence suggests that water pollution (see Chapter 10) and the destruction of the country's mangroves (Chapter 7) could emerge as real constraints on the long-term success of this important agricultural industry.

Table 8.8 Aquaculture Production in Thailand
(ton)

Year	Aquaculture (Total Production)	Freshwater Culture	Brackishwater Culture	Mariculture
1973	93,274	N.A.	N.A.	N.A.
1974	85,361	N.A.	N.A.	N.A.
1975	139,773	N.A.	N.A.	N.A.
1976	197,584	N.A.	N.A.	N.A.
1977	191,344	32,641	10,334	148,369
1978	159,345	39,367	10,049	109,929
1979	152,239	29,465	10,838	111,936
1980	138,153	34,634	11,901	91,618
1981	115,618	48,113	13,759	53,746
1982	82,719	45,829	12,988	23,902
1983	91,727	46,966	14,920	29,841

Note: N.A. = not available.
Source: Fishery Statistical Bulletin for South China Sea Area 1977-1983 SEAFDEC.

freshwater and brackish water cultures had a tendency to increase constantly while mariculture production fell sharply. Since mariculture accounted for a major portion of total production, the decline in this category would certainly be reflected in the decline of the total production. It is generally believed that the declining production of mariculture is due to water quality degradation of farming areas particularly in the coastal area of the Upper Gulf of Thailand. The area is subjected to run-off from the four main rivers of the central plain.

The technical level of aquaculture in Thailand is fairly advanced, particularly in the seed production system, applying the induced spawning technique which has become popular in this country. At present, seed of all cultivated species could be produced from hatcheries (Table 8.9). Nevertheless, the seed production of certain species like tiger prawn (Penaeus monodon) is still lower than the demand.

In comparing aquaculture production of the countries in South China Sea region (Table 8.10), it is found that Thailand ranks at a moderate level. Taiwan takes the lead in aquaculture production, despite her limited land area and the shortest length of coastline. This means that there is still room for Thailand to accelerate and intensify the aquaculture development program.

Types of Aquaculture Venture

Aquaculture, although it contributes a relatively small portion, about 5-10 percent in tonnage, to total fishery production has long term potential for increasing fishery production for either local consumption or export earning from high value shrimps and fish species. Aquaculture activities in Thailand can be divided into three categories, i.e. freshwater culture, brackish water culture, and mariculture. The numbers of aquaculture farms, and rearing areas, and total production in 1983 are given in Table 8.11. The present cultured species of the three categories are listed in Table 8.12.

Freshwater Culture

As mentioned elsewhere, freshwater fish culture has long been established and practiced in Thailand, and more than 15 species of fish and invertebrates are presently cultured. Freshwater culture consists of four main practices:

a. Pond culture. There were 69,213 rai (11,074 ha) of freshwater culture ponds in 1983, distributed among 28,942 farms with 39,174 ponds. On average, a farm had 1.5 ponds with a net production area of 1.84 rai (0.3 ha). Total production from pond culture in 1983 was 26,071 tons. The major production species were nile tilapia, gouramys, catfishes, carp-like fishes, and snakeheads.

b. Paddy field culture. Fish production from paddy fields totalled 19,697 tons in 1983. The area under production was recorded at 185,450 rai (29,672 ha). The species being cultured in this type of venture are carp-like fishes, especially tawes, nile tilapia, and gouramys.

c. Ditch culture. A variety of fish species are cultured in ditches throughout the country. Culture practices vary and are generally not a well developed subsector. Total production in 1983 was 872 tons, from a total area of 2,038 rai (326 ha).

d. Cage culture. About 600 cage culture farmers produced 326 tons of fish from 963 cages in 1983. The total production area was about 63 rai (10 ha). This corresponds to average production of 3.2 kg/m^2. The fishes being cultured by this type of venture are marble goby and river catfish.

Brackish Water Culture

Table 8.9 Fish and Shrimp Seed Production in 1983

No.	Common Name	Scientific Name	Seed Production (MT)
1	Common Carp	Cyprinus carpio	9,982,961
2	Nile Tilapia	Tilapia nilotica	15,745,209
3	Tawes	Puntius gonionotus	41,908,296
4	Rohu	Labeo rohita	21,928,609
5	River Catfish	Pangasius sutchi	2,855,520
6	Chinese Carps		
	Silver Carp	Hypopthalmichthys molitrix	
	Grass Carp	Ctenopharyngodon idellus	436,250
	Bighead Carp	Aristichthys nobilis	
7	Sea Bass	Lates calcarifer	4,725,610
8	Giant Prawn	Macrobrachium rosenbergii	18,575,555
9	Marine Prawn		
	Banana Prawn	Penaeus merguiensis	9,765,441
	Tiger Prawn	P. monodon	
10	Others		6,542,795
		Total	131,466,746

Source: DOF, 1985.

Table 8.10 Comparison of Aquaculture Production Among Countries in South China Sea Area

Country	Total Land Area (km^2)	Length of Coastline (km)	Aquaculture production (MT)			
			Fresh-water	Brackish-water	Marine	Total
Thailand	513,115	2,614	46,966	14,920	29,841	91,727
Malaysia	332,435	4,405	13,850	960	38,530	53,340
Philippine	299,404	17,460	99,280	183,770	162,020[a]	445,070
Taiwan	36,000	1,566	140,585	61,020	39,182	240,793

Note: a. Mostly sea weed.
Source: Extracted from Fishery Statistical Bulettin for South China Sea Area 1983. SEAFDEC.

Table 8.11 Number of Aquaculture Farms, Rearing Area, and Production in 1983

Category	Number of Farms	Area (rai)	Production (ton)
Freshwater (Total)	47,480	256,764	46,966
Pond culture	39,174	69,213	26,071
Paddy field culture	6,495	185,450	19,697
Ditch culture	848	2,038	872
Cage culture	963	63	326
Brackishwater (Total)	5,235	228,688	14,920
Gulf of Thailand			
Pond culture	4,307	221,606	13,678
Cage culture	639	6,569	879
West coast			
Pond culture	20	500	7
Cage culture	269	13	356
Mariculture (Total)	2,999	15,374	29,841
Gulf of Thailand			
Oyster culture	1,889	5,681	3,453
Sea mussels culture	559	2,719	19,285
Blood cockle culture	81	4,037	6,545
West coast			
Oyster culture	6	37	8
Blood cockle culture	464	2,900	550
Total	55,714	500,826	91,727

Source: DOF, 1985.

Brackish water culture is a type of aquaculture which is operated in the coastal area, especially the exploited mangrove forest area. It is the area where there is an interface between freshwater and seawater. Therefore, salinity in this area usually ranges from 5 to 25 ppt. Brackish water culture concentrates on penacid prawn culture, but is still generally primitive with low productivity. The cage culture of sea bass in the coastal area is also becoming popular.

a) Shrimp Culture

In 1983, the number of shrimp farms was 4,327 (4,307 farms in the Gulf of Thailand and 20 farms on the west coast), with a total area of 222,106 rai (35,537 ha), see also Table 6.13. Total production from the farms in 1983 was 13,685 tons which was broken down into 10,399 tons of penaeid prawns, 1,187 tons of shrimps and the rest is made up of miscellaneous fish and invertebrates. The shrimp farms are mainly concentrated in the provinces of Samut Prakarn, Samut Sakhon, and Samut Songkhram. During the past decade, shrimp culture development in terms of production and area cultivated increased significantly (Table 8.13).

The farms are constructed along the main or branch canals. Some are located

Table 8.12 List of Cultured Species and Production in 1983

Groups and Common Name	Scientific Name	Production (ton)
Mariculture		
Oysters	Crassostrea spp.	3,461
Mussels	Mytilus spp.	19,285
Blood cockles	Anadara granosa	7,095
Brackishwater culture		
Sea bass[a]	Lates culcarifer	1,084
Mullets	Mugil spp.	223
Other finfish including grouper	-	2,027
White banana prawn[b]	Penaeus merguiensis	
banana prawn[b]	Penaeus indicus	10,399
Jumbo tiger prawn[b]	Penaeus monodon	
Shrimp[b]	Metapenaeus spp.	1,187
Freshwater culture		
Tawes	Puntius gonionotus	
Rohu	Labio rohita	
Grass carp	Ctenopharyngodo idellus	7,823
Bighead carp	Aristichthys nobilis	
Silver carp	Hypopthalmichthys molitrix	
Nile tilapia[a]	Tilapia nilotica	12,125
Marble goby[b]	Oxyeleotris marnoratus	200
River catfish[a]	Pangasius sutchi	
Catfish[a]	Clarias batrachus	9,924
Catfish[a]	Clairas macrocephalus	
Eel	Anguilla spp.	70
Gouramys[a]	Trichogaster pectoralis	10,260
Snakehead[a]	Ophicephalus striatus	4,787
Milkfish	Chanos chanos	2
Others finfishes	-	616
Giant prawn[a]	Macrobrachium rosenbergii	1,153
Frogs	-	1
Reptiles	-	5
		91,727

Notes:
a. Some are exported.
b. mainly exported.
Source: DOF, 1985.

Table 8.13 Brackishwater Shrimp Culture Development During 1974-1983

Year	Number of Shrimp Farms	Acreage (rai)	Production (ton)
1974	1,518	75,578	1,775
1975	1,568	80,422	2,537
1976	1,544	76,850	2,523
1977	1,437	77,617	1,590
1978	3,045	135,815	6,395
1979	3,378	154,222	7,064
1980	3,572	162,727	8,063
1981	3,657	171,619	10,728
1982	3,943	192,453	10,091
1983	4,327	222,106	11,586

Source: Department of Fisheries, 1985a.

at about five kilometers or more from the seashore. Farms located further in land cannot introduce enough volume of sea water to the pond by only utilizing the tidal elevation, and must use pumps.

The major shrimp culture farms still use an extensive method, the traditional method. This method, initiated from the use of rice or salt fields, involves raising the dikes around the field and constructing a sluice gate. At the beginning of the culture season, the water is introduced through the sluice gate into the pond by pumping it up from nearby canals or ditches. The pump used was introduced about four years ago and is called a push pump. This is assembled with a second-hand car engine (mostly more than 100 horsepower), a long shaft and a propeller.

The water is pushed into a pond by the strong motive force of the propeller's revolution. In this water shrimp fry, crabs and various species of fish are included. By this pumping method, shrimp fry as well as others are introduced into a pond without suffering appreciable damage.

During the rearing period there is no feeding, and after the water has been in a pond for 45-60 days, the farmers catch shrimps for sale. The other aquatic organisms are also caught and then the pond is drained for subsequent culture activities. This type of shrimp farming is usually undertaken from May to September and from November to March. Thus, the culturing method is very simple, and the production per hectare averages 300 kg/year, depending on the fundamental productivity of each pond and the number of predators and competitors. Unit production is rather low when compared to that of other countries, with figures as high as 625 kg/ha/year reported in some parts of the Philippines.

Recently some progressive farmers have practiced an improved method. A pond is dry to keep the water about one meter in depth without any shallow part and the water pumped into the pond through a nylon screen to prevent organisms from entering the pond. Then, the shrimp fries which are transported from a hatchery or collected from the wild are stocked in the pond. Supplementary or intensive feeding is carried out. Trash fish, squid and rice bran are mainly used as feed. In this way the number of predators and competitors for food is reduced substantially and the unit production is increased to 500 kg/ha/year or more.

The size of traditional shrimp ponds ranges from 1.6 to 16 hectares but most are 3.5 to 15.8 ha. Ponds employing improved methods range from 0.5 to 1.6 ha. The cultured species are mainly Penaeus merguiensis and Metapenaeus spp.

The size of cultured shrimp (Penaeus merguiensis) is usually smaller than 10 grams in weight, making it suitable for export to foreign countries.

The pond culture of Peneaus monodon by the improved method is very seldom practiced, due to the shortage of the fry resulting from scarcity of the gravid female.

b) Sea bass culture

In Samut Sakhon, and Samut Songkhram, Lates calcarifers, commonly called sea bass, is raised in ponds and in small scale cages in Songkhla Lake. In 1983, 1,710 households engaged in sea bass culture in Thailand. The total production was 1,084 tons. The size of farms used for rearing sea bass ranges from 3.2 to 16 ha, with an average of 7 ha. In Songkhla Lake, there are about 200 cage farms, mainly distributed on the east coast.

The net-cage commonly used is 3 x 5 x 2 meters and the mesh size can be increased gradually as the fish grows. The culture period from fingerlings (approximately 1 centimeter in total length) to marketable size (0.7 kg in body weight) is around six months. The stocking density at harvesting is 300-500 fish/cage.

Mariculture

The molluscs which consist mainly of bivalves are cultivated in inshore and coastal areas of Thailand. In 1983 Thailand produced a total of 29,841 tons from cultivation, which was 26 percent of the total shellfish production in the country and made up as follows: approximately 6,545 tons of bloody cockles, 19,285 tons of green mussels, and 3,453 tons of oyster (Table 8.13).

The Department of Fisheries statistics on bivalve culture indicate that in 1983 there were 3,033 farms with 19,290 rai (3,086 ha) engaged in shell fish farming in Thailand (Department of Fisheries, 1985a). The production for various species expressed as per ha per year was estimated as 20.2 tons for bloody cockles, 48.9 tons for green mussels and 20.6 tons for oysters.

a) Bloody cockle culture

This species requires harder bottoms with a good mixture of sand for its habitat and is raised on the bottom in shallow waters. The culture site can be air-exposed during low tide, but preferably not exceeding four hours exposure. Small cockles used as seeds are generally collected from natural cockle grounds or imported from Malaysia. About 3.5 to 4 million seeds are used in a hectare of cockle farm. Scattered seeds grow to marketable size within 1 to 1.5 years. Manual bottom dredges are used for harvesting, and the full-sized cockles are selected while undersized ones returned to the growing beds. Poaching has been a local problem. Although bloody cockles are presently produced in two provinces, Petchburi and Satun, potential areas for this species are located in Chanthaburi, Rayong, Pangnga, Samut Songkhram, Chachoengsao, Chumporn and Trang.

Great demand for this species exists in domestic markets. The production, however, cannot satisfy the whole domestic demand and a certain amount of cockles is imported from Malaysia.

b) Mussel culture

Green mussels grow in water of about two to eight meters in depth. The culture method used in Thailand is exclusively the stake method. Palm stakes made from the trunk of the mangrove date palm (locally called "mai ping") and bamboo stakes are commonly used. At present, the use of the palm stakes is more widely practiced among farmers, because they are inexpensive and more durable (three years' operation) than bamboo (1-1.5 years). The only difference is that the farmer can get longer bamboo stakes (up to 10 meters) which can be used in deeper waters, while the palm stakes are generally from 3 to 6 meters in length. About 5,000 stakes at 0.25 meter interval are set in every hectare of farm. The culture period is about eight months and the mussels grow up to 7-8 centermeters in shell length.

Recently, the hanging method of green mussel culture has been developec experimentally for the purpose of

establishing economical culture methods (Chaithanavisut and Menasveta, 1985). This technique should be extended to the mussel farmers. The major areas where green mussels are widely cultured are in Chachoengsao, Chonburi, Samut Sakhon, Samut Songkhram, Samut Prakarn and Petchaburi. Potential grounds for the culture method are extensive in the Gulf of Thailand, including Nakhon Si Thammarat and Surat Thani.

c) Oyster culture

The oyster culture method practiced in Thailand is unusual. Natural rocks, artificial concrete blocks and wooden materials are used as a substratum for the attachment and growth of the oyster. These substratums are settled in the estuary area with a 500 centimeters interval between substratums which enables people to walk across for routine management. Once built, the farm lasts a long time with minor maintenance.

Spats of oyster occur in two seasons during the year, one in May-July and the other in October-November. Harvest is usully made from October to April, depending on the size of the meat. Small and medium sized oysters are processed as a shell-less meat, and large sized ones, mainly produced in the Surat Thani bay area, are served as half shell oyster at restaurants and hotels.

Oyster farms are generally small-scale, about 0.6 ha on average. Although oyster farmers cultivate only small areas or a fraction of a hectare, they can get quite a profit as the price of oysters is comparatively high. Presently oysters are cultured in the province of Trat, Chonburi, Rayong, Surat Thani, Chumphon, Pattani, Prachuap Khiri Khan and Songkha. Potential areas are still available in the above-mentioned provinces and are newly found in Chanthaburi, Rayong, Phangnga, Narathiwat, Trang, Satun, Nakhon Si Thammarat, Krabi, and Phetchaburi.

Future Trends in Aquaculture

Freshwater aquaculture is planned for fishes which are a staple food for Thai people. These fishes include pla salid (gouramy), pla nil (nile tilapia), pla dook (catfish), and snakehead fish (pla chon). Nile tilapia has a particularly good potential for future development, on the account of the availability of technological know-how and market acceptability. Nile tilapia has long been researched around the world. It is generally recognized as a fast growing and easily-propagated species, if properly managed. Nevertheless, a major set-back for freshwater aquaculture has been the fish disease problem of the past four years. Unless this problem is solved, aquaculture production from freshwater will be significantly constrained.

The brackish water culture, especially of shrimp, has a high potential and bright propects. Aquaculture production of shrimp in Thailand is expected to increase even more as present farms convert from low yield, extensive culture techniques to semi-intensive and/or intensive culture; more ponds are brought into production; seed stock availability increases; and pond management practices improve.

Total mangrove area in Thailand is about 1,945,000 rai (312,640 ha). In 1983, the total areas devoted for various types of brackish water shrimp farming was 222,106 rai, which yielded 13,685 tons valued at 963 million baht. A more detailed survey conducted by the Brackish water Fishery Division indicated that at least 140,000 rai scattered in 22 provinces along the coastline are suitable for brackish water shrimp farming. Beside this, another 200,000 rai behind mangrove areas can be utilized for this purpose. This will make up to a total of 562,106 rai (both being utilized and potential areas). If half of this area is converted to semi-intensive culture practice, a total yield per year would be approximately 73,150 tons at a

value of 80,000 million baht (1986). On the basis of the present pace of technology development and investment opportunity, we can expect shrimp production from brackish water culture to reach this level within the next ten years.

As for mariculture, future activities will be focused on the promotion and expansion of mollusc culture to other productive areas. As mentioned elsewhere, water pollution problem have caused a major set-back of mollusc culture in the inner Gulf. The problem will be persistent and will not be solved unless wastewater treatment systems are set up in big cities, towns, and industrial plants situated above the inner Gulf. This is likely to be a large, expensive, and time-consuming project. So mollusc culture should be promoted in other potential areas. It can be anticipated that the production from mariculture could easily achieve the same level recorded in 1977 (148,369 tons) within a short period, because the technology is already available.

8.2 ISSUES

The Exclusive Economic Zone (EEZ) and the Thai-fisheries

During the 1950s and 1960s, challenges to the principle of the freedom of the seas governing the use of the oceans, which had been practised for several hundred years, emerged, not only with respect to the exploitation of living marine resources but to other activities such as the exploitation of oil and minerals. As a result, a Committee on the Peaceful Uses of the Sea Bed and Ocean Floor Beyond the Limits of National Jurisdiction was established by the United Nations in 1967. The membership of the Committee rose rapidly as Member States became concerned about the implications which might arise from the deliberations of this Committee. There were several issues relevant to the uses of the oceans to be considered, and the first Session of the United Nations Conference on the Law of the Sea was held in December 1973.

During the period 1973-1980, nine sessions of this Conference were held. The discussions during these sessions had far-reaching effects on fisheries. The principle of an exclusive economic zone (EEZ), one of the major outcomes of the Conference, has become universally accepted. Under the new regime of the sea, 100 coastal states have unilatterally declared Exclusive Economic Zones which extend national jurisdiction over fisheries out to 200 miles seaward of the baselines of territorial seas. Now 99 percent of the world's marine fish catch is taken in these zones of national jurisdiction. Hence, the principle of freedom of the seas for fishing has now been abolished, except for those fisheries beyond 200 miles.

Thailand, along with neighbouring countries, has proclaimed an EEZ. The proclamation of EEZ made by Thailand looked as if it had increased the sea under her jurisdiction by about 50 percent (Figure 8.1). But Thailand, the leader in marine fishing in the region, has lost about 300,000 square miles of the sea that once were utilized by Thai fishermen.

The decreasing fishing grounds resulted from the proclamation of EEZs by neighbouring countries has created frequent fishing conflicts. Each year many Thai fishing vessels and fishermen are arrested for alleged violation of neighbouring waters. During 1977-1985, 469 Thai fishing vessels were seized. Of these, 198 and 107 vessels were seized by Vietnam and Burma, respectively. The rest by Malaysia, Kampuchea, India, Indonesia, and Bangladesh (Suraswadi et al, in press). These records are only those that were reported to the Thai authority. It is believed that there would be more that were not reported.

The damages to the Thai fishing vessels seized so far by the neighbouring

countries have been estimated to be about 2,000 million baht. Moreover, the government has to pay large sum of money for fines, transportation, and miscellaneous expenses to repatriate the fishermen (Suraswadi et al., in press).

As a solution, the government is promoting joint fishing ventures with other coastal states. So far bilateral negotiations have produced some fruitful results. Countries that have joint-venture fishing arrangements, directly or indirectly, with Thai fishing companies include: Oman, Saudi Arabia, Somalia, Indonesia, India, Bangladesh, and Australia (Suraswadi et al., in press).

Another approach adopted to compensate for the loss of marine fishery production caused by the new sea regime is aquaculture. Increased efforts on aquaculture development are called for in the Sixth National Economic and Social Development Plan (1987-1991). Aquaculture is looked upon as the savier substituting any production loss from marine capture fisheries.

The Over-fishing Issue

From available figures as reported earlier the Gulf of Thailand is overfished and only the pelagic resources of the Andaman Sea offer room for expansion. Overfishing is a result of various factors including excessive use of fishing vessels and gears. Increasing fishing costs, particularly fuel prices, have put pressure on the fishermen which has resulted in the illegal use of smaller meshes in order to catch more. On top of this, the development of fish meal and animal food industries induces the harvesting of trash fish. In addition, near shore push-netting is another practice that damages the resources because of the high percentage of juvenile shrimp and fish species netted.

Better management of marine capture fisheries in Thailand's EEZ is a prerequisite to any improvement in the existing situation. Emphasis should be given to the use of economic incentives to self-regulate the trawling practices in consonance with the maximum sustainable yields. On this issue, a better understanding of imminent changes due to the introduction of new marine capture fishery technologies and the expansion of the marine product industry is needed. The ultimate objective is to arrest overfishing in Thailand's waters which is now the case.

Constraints of Aquaculture Development

To fulfill its potential, the present obstacles which may impede aquaculture development must be overcome. Major constraints are:-

Seed Production

At present, most aquaculturists still have to rely on nature for the supply of natural seeds. Artificial breeding has been successfully conducted for marine shrimp (Penaeus spp.) (Kungvankij, 1982), giant prawn (Macrobrachium rosenbergii) (Menasveta, 1980: Menasveta, 1982). Other species such as the jumbo tiger prawn (Penaens monadon) still requires further research and experiment.

Hatchery production of marine shrimp seed requires a reliable source of spawners (gravid females) which will spawn fertile eggs for the hatchery. These eggs will eventually grow and develop into postlarvae. Postlarvae and latter stage juveniles are the primary seed used to stock shrimp culture ponds. In gereral, gravid females can be obtained from three sources : (1) caught from the wild in a gravid condition; (2) taken from culture ponds in a gravid condition; and (3) obtained either from the wild or ponds in a non-gravid condition, and then induced to maturity in the hatchery.

Most marine shrimp culture today relies

on the natural production of gravid females. However, this source is unreliable for many of the most important species. Only the third alternative can serve the increasing demands of the future. However the technique of induced maturity has yet to be perfected and require more field experiment. The present unreliable and unpredictable nature of seed production continues to be the instability factor in shrimp culture industry.

Aquaculture Feed Production

Most fish and shrimp farmers presently use conventional diets. These diets include rice bran mixed with water, trash fish, and chicken wastes. Due to this uncontrolled nature of the feed, its nutritional value can not be guaranteed.

Although aquaculture development in Thailand is still in its early stage, its potential is well recognized. Both local and international conglomerates in agribusiness are expanding their investment in this viable sector. It is forecasted that Thailand can become one of the world's leading exporters of aquaculture products. If this is the case, demand for high quality formulation feeds will rise in direct proportion.

Nutrition in aquaculture plays the same dominant role as in any other field of animal husbandry. Sound nutrition ensures growth, maturation and reproduction. As present, there is insufficient knowledge on nutritional requirements of the culture species in Thailand. More research is also needed in the use of feed ingredients of plant origin as substitutes for trash fish and fish meat in aquaculture diets, alternative feed processing methods which consume less energy, and cost-effectiveness of various formulations.

Genetic Improvements

Seed of various cultivated species are presently produced both by governmental agencies and the private sector. Selling of seed is often very profitable. This is due to the fact that the producers only handle the eggs or hatchlings for a short period of time. Those that may suffer are the farmers who raise the offspring to market size. This is because the offspring produced without genetic manipulation may be genetically inferior. It was reported that farmers in Suphanburi province usually lost approximately 60-70 percent of their initial stock in raising catfish. They also noted that the growth rate of fish seemed to be lower than it used to be.

Genetic manipulation can be developed by the methods of selective breeding and hybridization. Hybridization can be both inter-racial and inter-specific. The objectives of a broodstock improvement program may vary from place to place and with different species. Nevertheless, the general objectives are : (1) better growth rate; (2) disease resistance; and (3) the ability to withstand degraded water quality. A good example of the successful genetic improvement is the work that has been carried out at the University of Washington, Seattle. After 36 years of rainbow trout selective breeding, the culture breed stock can produce an offspring that has the growth rate 120 times faster than the wild rainbow trout.

Disease Problems

During 1982-1985, Thailand faced a series of serious fish disease epidemics, causing widespread death of fish in 52 provinces in the country. Loss in 1983 was estimated at one hundred and sixty million baht. The epidemic occurred both in natural waterways and in fish ponds. Many species of freshwater fish, especially those which are very popular with local consumers, such as snakehead fish (Ophicephalus striatus), eel (Fluta alba), and snake-skin gouramy (Trichogaster pectoralis), were affected. The dead fish were found to have large ulcers on the head, lips, and cheeks, as well as on the body and tail (Menasveta,

1985).

The first serious fish epidemic took place in the south of Thailand, during early 1982. The second outbreak occurred between late 1982 and early 1983. The Government took immediate action to combat the disaster and identify the cause. The third and fourth outbreaks occurred between late 1983 and early 1984, and between late 1984 and early 1985, respectively. Thus the outbreaks are usually associated with the cooler months in Thailand (i.e. November - February).

This fish epidemic is not just a problem for Thailand, but can be considered regional in scope. Similar epidemic first occurred in northern Australia about 8 - 9 years ago. When it spreaded to Java in late 1980, severe losses were experienced by fish farmers. In 1981 it spreaded to Malaysia and entered the southern part of Thailand in the following year. The central part of Thailand was badly hit in 1982 - 1984 as has been mentioned. Now the epidemic has moved to the northern part of Burma as well as to Laos. The epidemiology of this disease is similar to the ulcerative dermal necrosis (UDN) which was a problem in northern Europe during 1974 - 1976.

During the past three years experts were divided in their opinions on the underlying causes of the epidemic. Some believe that pesticides and herbicides were the main cause whereas others refuted such hyppothesis. Until now, a number of research studies have come up with different explanations.

The causes of the fish epidemic can be divided into two parts, i.e., predisposing causes and the cause of death. The predisposing causes appear to be a combination of abnormally low temperature, and changes in the acidity of the water brought about by heavy rain. These environmental changes cause stresses in the fish as they try to, adapt themselves to changing water conditions. Such environmental stress may weaken the fish and make them susceptible to virus and bacterial infections, in particular from Aeromonas hydrophila. Other organisms such as fungi, protozoa, and ectoparasites may play a lesser prominent role in causing infection. The present levels of insecticides and herbicides in natural water probably had little to do with this fish disease epidemic (Menasveta, 1985). This has been the most conclusive finding up-to-date.

Water Pollution

Aside from fish diseases, aquatic pollution can become a limiting factor to aquaculture development. The damage to the clam culture at the Mae Klong estuary due to pollution from sugar mill effluents in the early 1970s can still serve as a good reminder. With the projected growth in both domestic and industrial wastes along the banks of major rivers namely Chao Phraya, Tha Chin and Mae Klong, the generated wastes will eventually find their ways to the estuaries and to the Gulf. The impact to the coastal aquaculture in the Upper Gulf hence should be taken seriously.

To rectify the situation, there is a need to coordinate the monitoring program of various governmental agencies so that more meaningful collection and interpretation of data can be achieved. At the same time, long term projection of the waste loads and their impact to water quality should be attempted on a regular basis. The objective is to alert the parners in advance on potential pollution. (more treatment of this subject in Chapter 10)

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Part III Environmental Quality Management

9 Air and Noise Quality Management

9.1 STATUS AND TRENDS

Present Status of Air Quality

National ambient air quality standards were promulgated in 1981 to protect human health. Six pollutants were specified: carbon monoxide, ozone, sulfur dioxide, suspended particulates, nitrogen dioxide and lead (Table 9.1). Their sources and effects are well known, and are used as bases for standard setting although few studies on local conditions have been carried out locally.

Most of the ambient air quality monitoring work in Thailand has been conducted in Bangkok. However, work has started in other cities and industrial regions such as Chiang Mai, Hat Yai and the Eastern Seaboard.

In Bangkok, there are two separate networks of permanent air monitoring stations. The first network, under the joint operation of the Ministry of Public Health and the Faculty of Engineering, Chulalongkorn University (MPH/CU), was started in 1978. It consists of three monitoring stations, located selectively in residential, commercial and industrial areas of Bangkok. As it is a part of the WHO/UNEP global air monitoring system, the data have been analyzed and published by WHO periodically. The second network, under the Office of the National Environmental Board (ONEB), was started in 1983 and consists of eight stations. The air quality situation and trends observed are described in the following sub-sections:

Suspended Particulate Matter

Data on suspended particulate matter from all stations in 1983 and 1984 are shown in Table 9.2. In 1983 seven 24-hr samples exceeded 0.33 mg/m^3, which is the national ambient air quality standard. Comparatively, in 1984, none exceeded the standard. The range is between 0.02 and 0.50 mg/m^3.

For the Ministry of Health/Chulalongkorn University network a large number of daily particulate concentrations exceeded the standard (0.33 mg/m^3). Annual geometric mean of particulate concentration also exceeded the long term standard (0.10 mg/m^3).

From 1979 to 1984, it was observed that annual particulate concentrations, as well as maximum daily concentrations, was increasing (Figure 9.1) At Chulalongkorn University, the annual particulate concentration has increased from around 0.099 mg/m^3 to 0.184 mg/m^3 between year 1980 and 1984. Air pollution in terms of particulates at the other two sites (Lardprao and Samray) was even more severe, with annual concentrations of 0.197 mg/m^3 and 0.234 mg/m^3 in 1984.

Particulates are believed to originate from fugitive dust. Higher particulate concentrations are usually observed near roadways. An ONEB survey along major

Table 9.1 NEB Air Quality Standards.

Pollutant	NEB Standards	Characteristics	Principal sources	Principal effects
Carbon monoxide (CO)	8 hour: 20 mg/m^3 1 hour: 50 mg/m^3	A colorless, odorless gas with a strong chemical affinity for hemoglobin in blood	Incomplete combustion of fuels and other carbon-containing substances, such as in motor vehicle exhaust; natural events such as forest fires or decomposition of organic matter	Health: Some reduced tolerance for exercise, impairment of mental function, impairment of fetal development, death at high levels.
Photochemical oxidants (O_3)	1 hour: 0.2 mg/m^3	Colorless, gaseous compounds which can generate photochemical smog.	Atmospheric reaction of chemicals under the influence of sunlight	Health: Aggravation of respiratory and cardiovascular illnesses, irritation of eyes and respiratory tract, impairment of cardiopulmonary function. Other: deterioration of rubber, textiles, and paints; impairment of visibility; leaf damage and reduced growth of premature plants.
Sulfur dioxide (SO_2)	Annual (geometric mean): 0.1 mg/m^3 24 hour:0.3 mg/m^3	A colorless gas with a pungent odor; SO_2 can oxidize to form sulfur trioxide, which forms sulfuric acid with water	Combustion of sulfur-containing fossil fuels, smelting of sulfur-bearing metal ores, industrial processes, volcanic eruptions	Health: Aggravation of respiratory diseases, including asthma, chronic bronchitis, emphysema; reduced lung function; irritation of eyes, respiratory tract; increased mortality. Other: Corrosion of metals; deterioration of electrical contacts, paper, textiles, leather, finishes and coatings, building stone; formation of acid rain; leaf damage, reduced growth in plants; impairment of visibility

Table 9.1 (contd.)

Pollutant	NEB Standards	Characteristics	Principal sources	Principal effects
Total suspended particulates (TSP)	Annual (geometric mean): 0.1 mg/m^3 24 hour: 0.33mg/m^3	Any solid or liquid particles (diameter ranging from 0.3 to 100 microns) dispersed in the atmosphere, such as dust, pollen, ash, soot, metals, various chemicals	Stationary combustion, especially of solid fuels; construction activities; industrial processes; atmospheric chemical reactions; smoking tobacco; forest fires, wind erosion, volcanic eruptions	Health: Directly toxic effects or aggravation of the effects of gaseous pollutants; aggravation of asthma or other respiratory or cardiorespiratory symptoms; coughing, chest discomfort; increased mortality Other: soiling deterioration of building materials, other surfaces; impairment of visibility; cloud formation; interference with plant photosynthesis
Nitrogen dioxide (NO_2)	1 hour: 0.32mg/m^3	At high concentrations, a brownish-red gas with a pungent odor, often formed from oxidation of nitric oxide	Motor vehicle exhaust, high-temperature stationary combustion, atmospheric reactions	Health: Aggravation of respiratory illnesses. Other: fading of paints, dyes; impairment of visibility; reduced growth, premature leaf drop in plants; formation of acid rain
Lead	24 hour:0.01mg/m^3	A nonferrous heavy metal occuring in air as vapor, aerosol, or dust	Available in nature; lead mining, smelting, processing; motor vehicle emissions; manufacture of lead products (e.g. batteries)	Health: Accumulation in body organs; anemia; kidney damage; central nervous system damage.

Table 9.2 Bangkok Air Quality Data for Suspended Particulate Matter (SPM), 24-hour concentration

Site	Type of Area	Year	SPM (mg/m^3) Min	Mean	Max
ONEB Network					
1. ONEB	residential	1983	0.030	0.107	0.240
		1984	0.050	0.102	0.160
2. Ladprao Chankasem	residential	1983	0.030	0.121	0.410
		1984	0.030	0.117	0.300
3. Bansomdej	mixed	1983	0.040	0.136	0.500
		1984	0.010	0.118	0.270
4. Ratburana	industrial	1983	0.030	0.103	0.420
		1984	0.040	0.126	0.260
5. Saovapa	commercial	1983	0.040	0.094	0.420
		1984	0.050	0.098	0.240
6. Sukhumvit	residential	1983	0.040	0.114	0.280
		1984	0.040	0.096	0.200
7. Bangna	industrial	1983	0.040	0.115	0.390
		1984	0.040	0.143	0.250
8. Ladkrabang	rural	1983	-	-	-
		1984	0.020	0.062	0.130
MPH/CU Network					
1 Samrong	industrial	1979	0.063	0.156	0.364
		1980	0.019	0.158	0.413
		1981	0.068	0.253	0.706
		1982	0.096	0.243	0.897
		1983	0.074	0.215	0.999
		1984	0.057	0.197	0.767
2 Chulalongkorn University	residential	1978	0.072	0.152	0.293
		1979	0.084	0.150	0.350
		1980	0.022	0.099	0.386
		1981	0.043	0.112	0.288
		1982	0.054	0.136	0.403
		1983	0.072	0.155	0.394
		1984	0.076	0.184	0.458
3 Ladprao	residential	1979	0.090	0.184	0.409
		1982	0.039	0.159	0.305
		1983	0.043	0.163	0.405
		1984	0.063	0.234	0.622

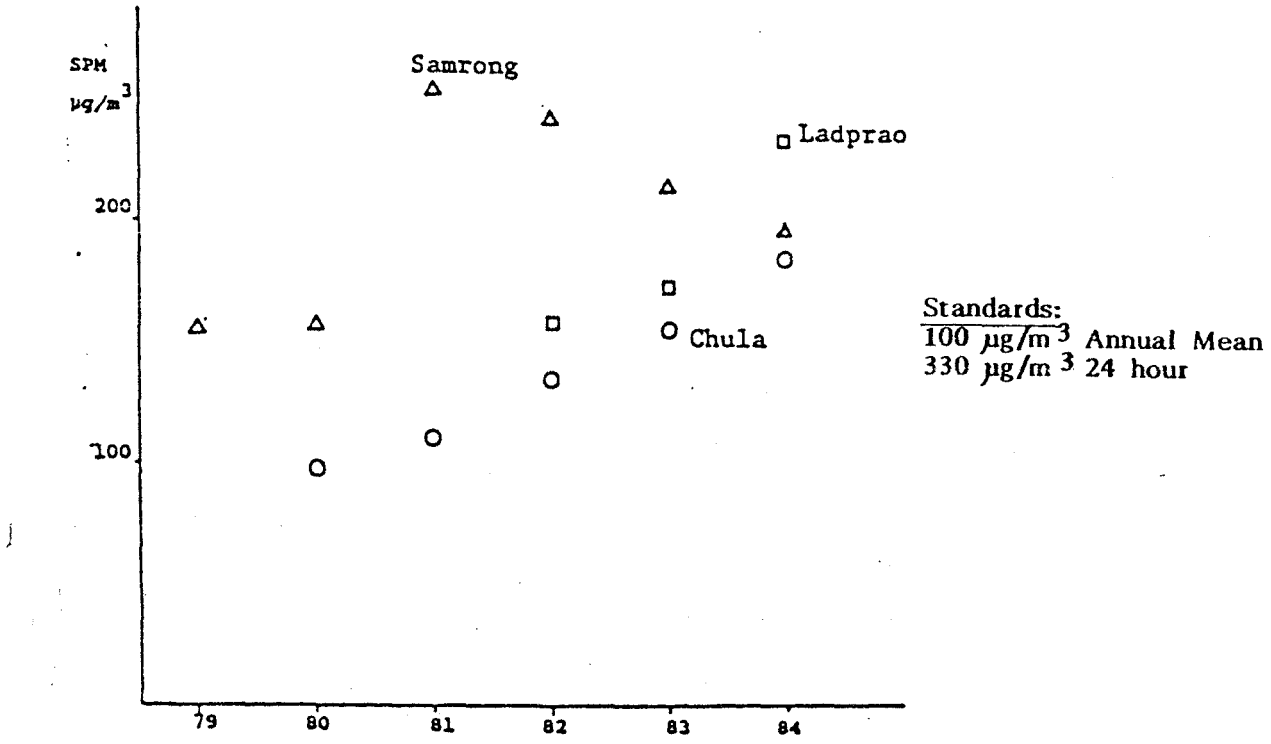


Figure 9.1 Particulates: Annual Average Concentration (MPH /CU stations)

streets in Bangkok in 1984 found that all ten sites exceeded the short term particulate standard (0.33 mg/m³) (ONEB, 1985e). The situation is similar in other cities, such as Chiang Mai and Hat Yai, where curbside particulate levels always exceed the national standard (Table 9.3).

Table 9.3 Particulate Concentrations near Major Streets in Cities in 1983, 24-Hour Average

Site	Maximum Values (mg/m^3)
Bangkok	0.23 - 1.05
Chiangmai	0.41 - 0.47
Hat Yai	0.42 - 0.45

Due to its relatively larger size, fugitive dust does not pose as a serious health hazard since it can not penetrate deep into the respiratory system. However, particulates do cause irritation and allergy. The sheer unpleasantness in breathing in particulates and black smoke is so evident that it warrents rectifying measures.

Lead

Lead analysis by ONEB showed that the daily concentration of lead in Bangkok ranged from 0.01 to 1.96 µg/m³ in 1983, and from 0.07 to 3.60 µg/m³ in 1984 (Table 9.4). For MPH/CU stations, daily lead concentrations between 1979 and 1984 ranged from 0 to 1.5 µg/m³, well below

Table 9.4 Lead Concentration in Bangkok.

Site	Area	Lead ($\mu g/m^3$) Year	Min	Mean	Max
ONEB Network					
1. ONEB	residential	1983	0.13	0.40	1.12
		1984	0.12	0.28	0.64
2. Ladprao Chankasem	residential	1983	0.08	0.36	0.75
		1984	0.08	0.31	0.85
3. Bansomdej	mixed	1983	0.01	0.30	1.96
		1984	0.07	0.29	0.85
4. Ratburana	industrial	1983	0.02	0.32	1.33
		1984	0.08	0.27	0.94
5. Saovapa	commercial	1983	0.21	0.74	1.70
		1984	0.10	0.37	1.90
6. Sukhumvit	residential	1983	0.04	0.42	1.40
		1984	0.12	0.40	1.70
7. Bangna	industrial	1983	0.02	0.33	1.20
		1984	0.07	0.67	3.60
8. Ladkrabang	rural	1983	-	-	-
		1984	0.07	0.24	1.01
MPH/CU Network					
1 Samrong	industrial	1979	0.432	0.914	0.516
		1980	0.009	0.289	1.146
		1981	0.011	0.258	1.233
		1982	0.050	0.201	0.986
		1983	0.000	0.171	0.699
		1984	0.006	0.072	0.375
2 Ladprao	residential	1982	0.018	0.156	0.715
		1983	0.000	0.120	0.363
		1984	0.000	0.092	0.417

the standard of 10 μg/m³ (Figure 9.2).

A downward trend in lead concentration was apparent at both MPH/CU Stations, as shown in Figure 9.2. At Samrong, an industrial area, annual lead concentration decreased from 0.914 μg/m³ to 0.072 μg/m³ between 1979 and 1984, while the maximum daily lead concentration also decreased, from 1.516 μg/m³ to 0.375 μg/m³.

Lower lead emissions have been brought about indirectly by greater consumption of LPG and diesel oil, which are cheaper than leaded gasoline. Direct lead emission control was initiated by the Ministry of Commerce in 1984, with the reduction of the lead limit for gasoline from 0.84 to 0.45 grams per liter. This caused a further drop in ambient lead concentrations in 1984.

High lead concentrations are found at curbside near traffic. A survey by ONEB in 1984 at 10 locations in Bangkok center found 24-hour lead concentrations in the range of 1-5 μg/m³. It could be concluded that lead concentrations decrease rapidly with distance from roadways. A recent survey for the Expressway and Rapid Transit Authority (Thorani Tech, 1986) at 10 locations, with samples taken at a distance between 5 to 20 meters from curbside, shows lead concentrations (24-hour) between 0.1 and 0.5 μg/m³.

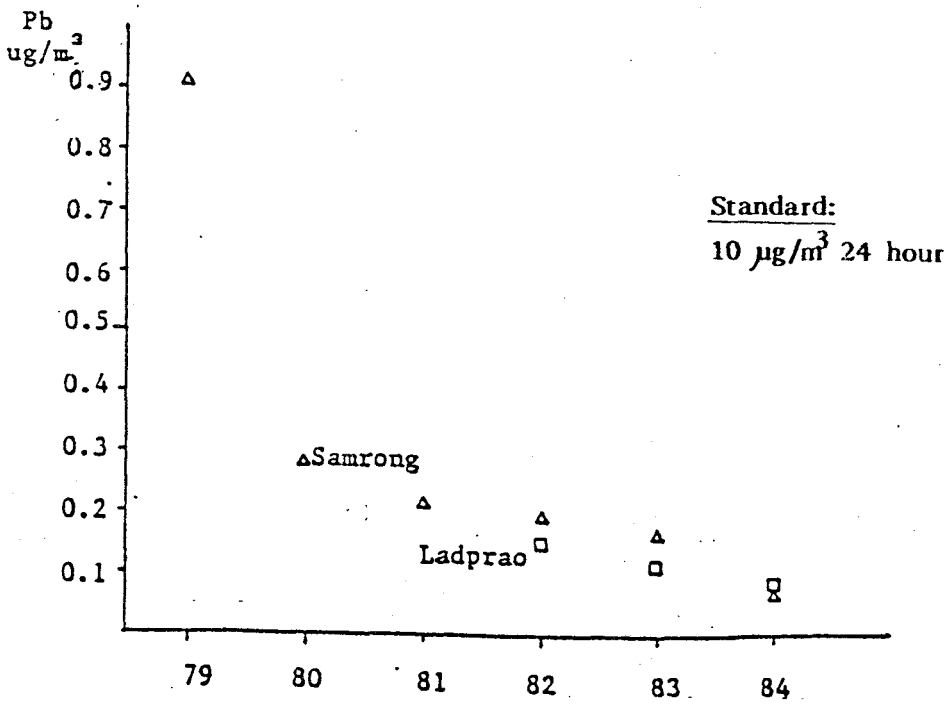


Figure 9.2 Lead: Annual Average Concentration (MPH /CU stations)

It can be concluded that the level of lead in ambient air is within the safe limit, presenting no immediate danger to general public health.

Carbon Monoxide

Motor vehicle emissions are the major source of carbon monoxide. Along narrow congested streets, CO can build up to a harmful level and cause headaches, angina attack, and theoretically, at very high concentrations, death. CO, however, disperses very rapidly within 10 metres from the traffic and the effects of CO from streets rarely extend much further.

The 8-hour average carbon monoxide concentrations recorded at all ONEB monitoring stations were less than six mg/m^3 in 1983 and less than 10 mg/m^3 in 1984. These stations are all located a fair distance from the traffic. Curbside CO concentration is of greater concern. In 1984, the CO standard (20 mg/m^3 for 8-hr average) was exceeded at Pratunam Intersection, Soi Asoke and Nanatai Intersection. ONEB also found other major cities, such as Chiang Mai and Haadyai, experiencing high CO concentrations along major streets (Table 9.5).

Table 9.5 Carbon Monoxide Concentration near Major Streets of selected Cities in 1983, 8-Hour Average

Location	Maximum Values (mg/m^3)
Bangkok	27-37
Chiang Mai	16-18
Hat Yai	6-27

Source: ONEB, 1985e.

When meteorological conditions allow good dispersion of air pollutants, as on open roads, CO concentration remains low. Factors leading to high CO build up are excessive vehicle emissions and physical obstruction to wind movement, such as tall buildings on narrow streets. The exhaust emission standard for CO was set at six percent by volume when measured at idle. However, CO emissions are believed to be falling, due to better engine design of new automobile models, for lower fuel consumption and better emission control.

A vehicle emission survey by ONEB (1985) found that about 28 percent of all cars on the street exceeded the six percent emission standard while only six percent of new cars exceeded the standard (Table 9.6). In a 1980 survey by ONEB, as many as 54% of used cars exceeded the six percent CO limit. This encouraging trend, as mentioned earlier, can be attributed to the improvement in the engine design of new car models.

Another contributing factor to the reduction of CO is the changing pattern of energy use in the transportation sector. Under Thailand's energy price differential policy, cheaper fuels, diesel oil and LPG, are gaining in popularity with the consumers. Diesel and LPG-fueled internal combustion engines emit much less CO than gasoline engines.

Table 9.6 CO Emission Survey

CO	New Car		Used Car	
%	No.	%	No.	%
< 1	20	21	75	17
1-2	15	15	54	12
2-3	21	22	49	11
3-4	14	14	46	11
4-5	13	14	33	8
5-6	8	8	55	13
> 6	6	6	123	28
Total	97	100	435	100

Source: ONEB, Survey of Air Pollution Problem due to Highway Traffic in Bangkok, 1985.

ONEB (1985a) found that about 85% of LPG-fueled motor tricycles emitted less than one percent CO.

Sulfur Dioxide

Sulfur dioxide combines with particulates may cause respiratory illness, and in extreme cases, death. While levels of particulates are high in Bangkok, ambient sulfur dioxide is usually very low due to the widespread use of low sulfur fuels in energy consuming sectors. Potential risks are in areas near power plants and industrial boilers.

ONEB stations showed very low sulfur dioxide concentrations, never exceeded 0.03 mg/m^3 for a 24-hr average. MPH/CU station at Chulalongkorn University observed a maximum daily concentration of 0.07 mg/m^3 over four years of monitoring, between 1981 and 1984, which is well below the short term standard of 0.3 mg/m^3. The annual mean SO_2 concentrations are around 0.009 - 0.0015 mg/m^3 as compared to the long term standard of 0.1 mg/m^3 (Table 9.7). Therefore sulfur dioxide pollution is not a major threat to health.

Table 9.7 Sulfur Dioxide 24-Hour Concentration, Bangkok

Site		SO_2 (mg/m^3)		
	Year	Min	Mean	Max
Chula-longkorn University	1981	0.002	0.009	0.070
	1982	0.002	0.013	0.048
	1983	0.004	0.015	0.061
	1984	0.004	0.015	0.048

Note: MPH/CU network.

Ozone

Ozone is a product of photochemical reactions among hydrocarbons, nitrogen oxides and other gases, under conditions of intense sunlight. The reaction takes about two hours to formulate, during which time the wind may transport the product away from the sources. ONEB stations did not detect ozone levels greater than the detectable limit of 0.02 mg/m^3 in 1983 and observed a peak concentration of 0.1 mg/m^3 at noon in 1984. The levels of ozone detected were always below the one hour standard of 0.2 mg/m^3.

Due to its mobility, there is a need for further study on the local ozone formation and its transportation before any conclusion can be made. At present, however, there does not appear to be cause for alarm.

Community Noise Situation and Trends

Noise Criteria

Noise can be defined as any sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing, or is otherwise annoying. The human ear does not respond linearly to increases in sound pressure; the response is essentially logarithmic. Therefore, noise measurements are expressed by the term "sound pressure level" (SPL), which is the logarithmic ratio of the sound pressure to a reference pressure, and is expressed in terms of decibel (dB). The reference level is in 0.0002 milibar, the threshold of human hearing. The logarithmic decibel scale is also useful to describe a very wide range of audible sound in terms of small numbers. Table 9.8 provides a summary of various sound pressures and the corresponding decibel level with examples of noise sources (Canter, 1977).

In most noise research, the A-weighted sound level [dB(A)] is used. The dBA, in which greater emphasis is given to medium and high frequencies, to which the human ear is most sensitive, correlates well

Box 9.1

HOW POLLUTION CONTROL COSTS STACK UP FOR EGAT

Lignite, or brown coal, is increasingly used in electricity generation in Thailand, with significant implications for air quality in lignite-burning areas. Lignite consumption looks set to continue growing, given that it accounts for well over half (57 percent) of the country's proven and possible energy resources. The overwhelming bulk (87 percent) of these reserves are found in the Mae Moh basin, where lignite-fuelled power generation is now concentrated.

With 825MW of installed power generation capacity, accounting for about 5.7 million tons of lignite annually (up from just 433,000 tonnes in 1975), the Electricity Generating Authority of Thailand (EGAT) is the biggest lignite user. And when a further 900MW of generation capacity comes on stream in 1990, EGAT's annual power consumption is expected to increase to about 12.5 million tonnes.

Work by the Office of the National Environment Board (ONEB) has found significant environmental impacts both in the production and use of lignite. As far as air pollution is concerned, the main problem during lignite production is suspended dust, once the lignite is burned the problems are dust, sulfur dioxide (SO_2) and nitrogen oxides (NO_x). It is estimated that the total flue gas emissions from a 150MW lignite-fired power station total 240.5 kilograms per second.

The pollution control strategy adopted by the electricity generation industry has involved the use of "tall stacks", very tall chimneys which help disperse air pollutants over a much larger area. The first three EGAT lignite-burning units, each rated at 75MW, were fitted with 80-meter stacks, costing 20 million baht each. The other four existing units, of 150MW apiece, are fitted with 100-meter stacks, each costing 35-40 million baht. The next units, each of 300MW capacity, will be fitted with 150-meter stacks, which will cost at least 35 million baht apiece.

The dispersal of pollutants like SO_2, however, is only a stop-gap solution. While there are no signs of "acid rain" problems emerging in Thailand, the "tall stack" policy has led to widespread environmental acidification in Europe, Scandinavia and North America. Even dust can cause problems unless further control measures are introduced. EGAT, in fact, already uses electrostatic precipitators, which can remove up to 99.5 percent of the particulates in flue gas emissions, in its seven operational units. For the first three units, the precipitators cost 60 million apiece, while the price went up to 80 million baht each for the precipitators installed in the next four units. A figure of 118 million baht has been given for the precipitation equipment for EGAT's first 300MW plant.

To ensure compliance with air quality standards, EGAT has two mobile laboratories which monitor air quality in the Mae Moh area. The capital cost involved in setting up these laboratories was 11 million baht, and EGAT estimates that it has invested another 10 million baht in environmental monitoring and testing equipment. Increasingly, too, EGAT carries out Environmental Impact Assessments (EIAs) for major new power generation projects. In 1985, for example, it completed an eight million baht EIA covering the entire spectrum

of environmental impacts from power generation at Mae Moh.

If there is growing pressure to control SO_2 emissions, EGAT has a number of options. First, it can switch to low-sulfur (two percent sulfur, or lower, rather than three percent) lignite, which is available in the Mae Moh basin. Another, potentially complementary, approach would be to remove some of the sulfur from the lignite before it is burnt, although this would cut SO_2 emissions by only 30 percent. A more effective, and more expensive approach, would be to use flue gas desufurization. This involves scrubbing the sulfur out of flue gas emissions with wet limestone or lime spray drying.

According to ONEB, the costs of electrostatic precipitation work out at around 0.042 baht per KWh of electricity generation. Flue gas desulfurization, which might remove 90 percent of the SO_2 emissions, would be much more expensive, at 0.22 baht/KWh.

Overall, then, the control of SO2 would be the most expensive air pollution control challenge for EGAT. If SO_2 controls were to be required, the weighted average cost of electricity would rise to 1.3815 baht/kWh, representing a 0.033 baht/kWh increase. EGAT's prices already include 0.0063 baht/kWh for the cost of dust control. Just for comparison, SO_2 controls would raise electricity prices by around 2.6 percent, which represents a fairly small increase when compared with the 47.75 percent increase in 1981 and 5.64 percent increase in 1982.

The total costs of SO_2 control are potentially high, but it is worth noting that they would represent a relatively small proportion of EGAT's revenues (less than three percent), in the unlikely event that EGAT had to bear all the costs involved. It is also worth noting, however, that they would represent a considerably larger share of EGAT's net profits (21.2 percent of 1985 net profits, for example). There is currently no evidence that EGAT'S SO_2 emissions are exceeding the natural absorptive capacity of the atmosphere, but the growing use of lignite suggests that a close eye should be kept on the emission implications. If action has to be taken, the evidence suggests that it need not cripple the economy.

with the subjective impression of loudness. A 10 decibel increase in the sound level doubles its subjective intensity (that is its loudness or noisiness), whereas a doubling of the acoustic energy results in an increased of three decibels only.

Impacts of noise on health are cumulative and the energy-equivalent noise level (Leq) refers to the equivalent steady noise level that, in a stated period of time, would contain the same noise energy as the time-varying noise during the same time period. If the measuring time is 24 hours, the index would be referred as Leq(24). ONEB has not yet established a community noise standard. In this report, noise assessment will be referenced to the community noise standard Leq(24), equal to 70 dB(A), adopted by the USEPA.

Community Noise Impacts

Surveys and opinion polls in many countries have found that the disturbance most frequently cited by respondents is noise in the home (OECD, 1985). The prime offending source of noise in terms of the number of people disturbed is road traffic, followed by neighborhood and aircraft noise.

Table 9.8 Sound Pressure and Sound Pressure Level (SPL) Recognized for different Sources of Noise

Sound pressure (μbar)	SPL (dBA)	Example
0.0002	0	Threshold of hearing
0.0063	30	Studio for speech broadcasting
0.02	40	Very quiet room
0.063	50	Residence
0.2	60	Conventional speech
0.63	70	Street traffic at 100 ft
1.0	74	Passing automobile at 20 ft
2.0	80	Light truck at 20 ft
6.3	90	Subway at 20 ft
20	100	Loom in textile mill
63	110	Loud motorcycle at 20 ft
200	120	Peak level from rock and roll band
2000	140	Jet plane on the ground at 20 ft

Source: Canter, 1977.

As stated earlier, a large proportion of Thai vehicles violate the noise source standards, and motorcycles are the worst offenders. These sources of noise are increasing at a considerable rate. The total number of vehicles in this country increased from 1.5 million to 2.7 million between year 1978 and 1983. The estimated number of vehicles in 1986 is around 3.2 million, of which nearly 70 percent are motorcycles (Figure 9.3). In Bangkok alone, the estimated number of motorcycles is around 560,000 units, or nearly half the total number of 1.2 million motor vehicles reported in 1986.

While there is a dearth of information on community noise levels, there are several surveys on curbside noise level in Bangkok. ONEB carried out a curbside noise survey at four locations on busy streets in 1985 and found that noise levels at all four sites exceeded the Leq(24) standard of 70 dBA. Two of these sites, Wang Burapa and Wongwien Yai, also had average noise level greater than 85 dB(A), which is the noise source standard (Table 9.9).

Table 9.9 Curbside Noise Levels in Bangkok

Location	Leq(24) dBA
1. Wang Burapa	87.6
2. Odeon	77.9
3. Wongwien Yai	89.3
4. Krung Thon Bridge	77.1

Source: ONEB (1985)

Information on community noise level from the study by Chulalongkorn (1983) and Thorani Tech (1986), as summarized in Table 9.10 and 9.11, showed that most sites along main streets had Leq between 60-70 dB, while some houses located close to streets or busy intersections had noise levels exceeding of 70 dB.

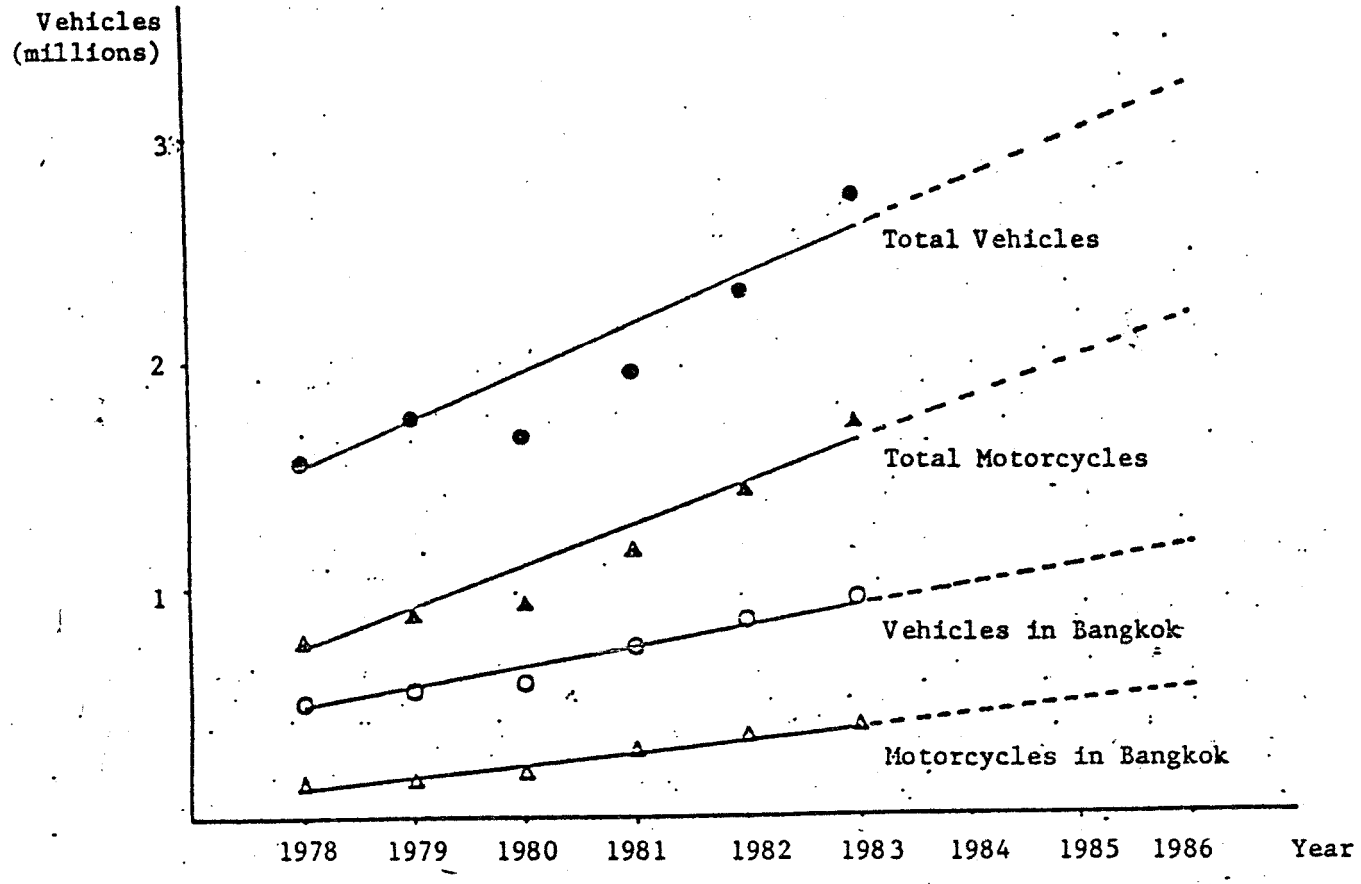
Away from the sources, noise level decreased with distance from busy streets. ONEB (1981) surveyed 41 sois (lanes) and found that as distance from the street increased from 100 meters to 800 meters, the average noise level went down from 68 dBA to 54 dBA (Figure 9.4).

Waterway transportation is an essential part of the Thai life style, and noise nuisance from commuter boats inevitably has am impact on those living along canals and rivers. A survey by Chulalongkorn University (1983) found that the average noise level Leq(24) equaled 72.8 ± 5.2 dB(A), with louder noise experienced along small canals than on the Chao Phraya River.

Noise Nuisance and Hearing Loss

ONEB has received numerous complaints on noise nuisance from traffic, construction

Figure 9.5 Number of Vehicles in Thailand and Bangkok



Source: Registration Division , Police Department.

and industry. Affected areas are residential houses, schools, hotels. Examples are : Wat Thepsirin School class room noise level at the range of 76-95 dB(A); and a house in Soi Ruamrudi, close to the expressway, recorded Leq(24) noise levels of 77.9 dB(A). These noise levels are unacceptable and cause nuisance to classroom activities, and to working and living conditions alike.

Examination of 85 motor-boat operators by Chulalongkorn University (1983) found that 70 persons or 82% had hearing loss. The damage was found to correspond with the number of years spent driving the boats. All operators working more than 15 years had hearing loss. However, in the beginning the hearing loss occurred outside normal conversation frequency and it was generally too late when these boat operators found that they had problems in hearing.

Noise Trends

As urbanization proceeds and noise sources multiply, more people will be exposed to louder noise for longer periods. If the vehicle growth rate continues at the present rate, the number of vehicles in the whole kingdom will be around 6.5 million, with 2.5 million vehicles in Bangkok alone by the year 2000. While there are no data on number of people exposed to loud noise, the percentage will increase as the quiet lanes are turned into busy streets.

Table 9.10 Noise Levels along Port-Dindaeng Expressway

No.	Site	dBA 24 hours				
		L_{eq}	L_{dn}	L_{10}	L_{50}	L_{90}
1.	Din-Daeng Flat	78.4	70.9	81.0	75.3	68.0
2.	Kamolsuksa School (Din-Daeng)	74.0	63.9	77.0	69.0	61.2
3.	Nitiprinya School (Din-Daeng)	59.3	63.4	62.5	56.8	52.5
4.	Opposite to Makkasan railway station	60.8	65.2	63.7	58.1	51.5
5.	Petchaburi Road Interchange (South West side)	67.3	72.0	70.0	64.6	58.0
6.	Petchaburi Road Interchange (South East side)	68.0	73.6	70.6	65.4	60.0
7.	Imperial Hotel	63.0	66.9	66.2	55.7	48.1
8.	International Red Cross (Soi Ruamrudee)	66.3	69.8	68.8	58.5	47.1
9.	Rama IV Road Interchange (North side)	68.9	73.9	71.2	66.8	61.3
10.	Rama IV Road Interchange (South side)	72.5	76.6	74.9	67.5	57.3
11.	Close to Chong-Nonsee railway (Port Interchange)	61.0	61.4	64.6	52.6	42.0
12.	Klong Toei Nivet (Port Interchange)	57.1	61.0	59.9	54.6	48.4
13.	Pra Harutai Convent	58.2	61.0	59.7	54.5	49.4

Notes : L_{eq} = equivalent noise level
L_{dn} =
L_{10} = 10 % of the time the stated level is exceed
L_{50} = 50 % of the time the stated level is exceed
L_{90} = 90 % of the time the stated level is exceed

Source: Chulalongkorn University, 1983

Development of housing communities near Bangkok Airport will locate people closer to the noise source. Since the airport will remain there for the foresee future, it seems inevitable that more complaints on aircraft noise will come from the growing population in the area.

9.2 ISSUES

Acid Rain

"Acid rain" is the term commonly used to describe the deposition of acidic or acid-forming compounds in either their dry or wet forms. These compounds are derived primarily from natural and man-made emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and hydrocarbons (OECD, 1985).

Every year, large quantities of SO_2 and NO_x are discharged into the atmosphere from the combustion of fossil fuels such as coal, lignite and oil. In Thailand about 48 percent of the SO_2 is emitted by electricity-generating power plants and another 34 percent from other industrial sources. Industrial and utility boilers emit about 44 percent of the NO_x, and transportation vehicles generate another 23 percent (Table 9.5). Since large numbers of industrial plants and transportation vehicles are found in Bangkok, large proportions of the country's overall SO_2 and NO_x emissions are from Bangkok (one third of SO_2 and a quarter of NO_x emissions).

Usually, much of the sulfur and nitrogen emitted is deposited within a short distance. Effects on local areas include material corrosion and crop damage.

A portion of SO_2 and NO_x emissions may

Table 9.11 Noise Levels along the Present and Proposed Expressway Routes

Location	Distance from the near curb of the expressway (m)	Noise Levels (dB) for 24 hours				
		L_{eq}	L_{dn}	L_{10}	L_{50}	L_{90}
Sacred Heart Convent School	33	68.5	74.3	70.5	66.0	59.5
Soi Ruam Rudi	10	66.0	71.3	69.5	62.0	53.0
Sukumvit Soi 66	10	72.5	76.0	76.0	70.0	58.0
Seri Housing Estate	20	51.7	55.1	53.2	46.4	40.3
Siam Cement Housing	2	59.7	64.1	62.2	57.2	50.6
Chavnit School	60	54.4	58.0	55.2	48.8	45.6
Nipat Vittaya School	16	59.0	62.2	62.7	54.9	44.8
Urupong Apartment	40	61.8	66.0	64.4	60.1	53.5
Ngamwongwarn Road	15	67.2	72.2	70.3	64.9	56.0
Changwattana Road	57	61.8	66.1	62.6	56.0	48.0
Mahidol University	10	68.6	75.1	71.4	65.2	53.9

Source: Thorani Tech, 1986.

BOX 9.2

TURNING A DEAF EAR TO NOISE

One of the first things a newcomer to Bangkok notices is the high noise level in the city streets. Buses, trucks and motorbikes all seem to complete to break the sound barrier. And visitors are not the only ones who find the constant blare of the traffic unacceptable: most of the complaints made to the authorities about air and noise pollution focus on road traffic. The increasing prssures are indicated by the fact that the number of road vehicles has been increasing at a rate of about 10 percent a year in Thailand. The number of vehicles nearly doubled in six years, growing from 1.5 million in 1978 to 2.7 million in 1983.

If you ask the average person in Bangkok to pinpoint the worst offenders, he or she will almost certainly mention motorcycles. Of the estimated 1.2 millon vehicles in Bangkok in 1986, around 560,000, or nearly half, were motorcycles. And their number has been increasing by over 25 percent a year.

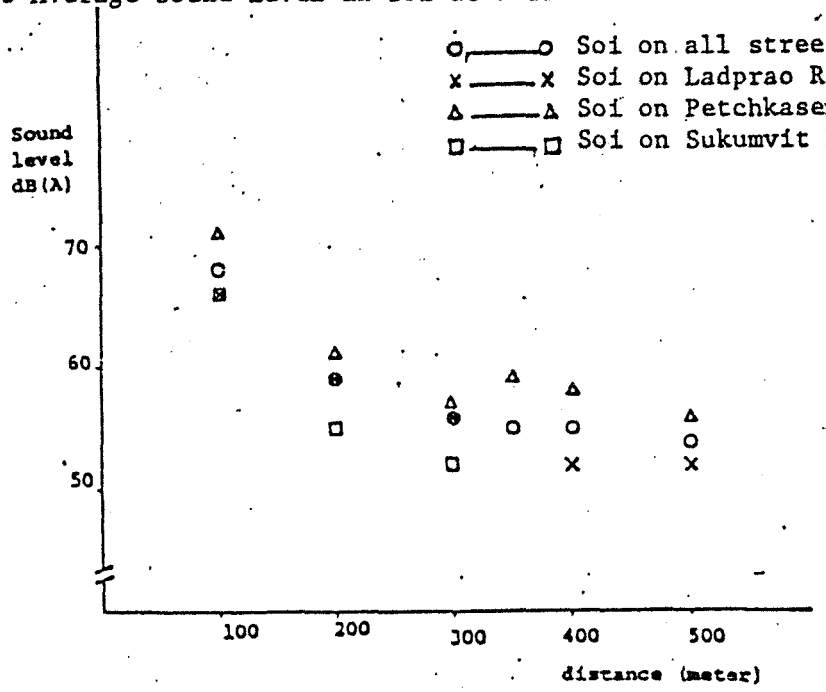
For all types of vehicles, research has shown that they generally meet the relevant noise standards when they first leave the assembly line. But follow-up surveys have shown that some 20 percent of the vehicles on the road exceed the noise standards, either because they have been poorly maintained or because,in the case of many motorcycles, their exhausts have been tampered with-specifically to increase their noise output. An ONEB survey in 1977 found that 16 percent of motorcycle exhausts studied had been tampered with.

Trucks and buses, meanwhile, tend to be more signficant in terms of vibration, althouth they also make an important contribution to teh dark smoke and other air pollutants which blight city streets. The Police Department is responsible for on-street enforcement of the appropriate standards, but its resources are simply not up to the task.

Given that the traffic forecasts suggest that Thailand will have around 6.5 millon vehicles in the year 2000, with 2.5 million of those in Bangkok, it is clear that steps will have to be taken to contain the problem. The real human health impact is perhaps best illustrated by the "drivers" of Bangkok's motorized (and very soisy) "long-tailed" boats. A study of 85 boat-owners found that 82 percent had hearing loss, with the extent of hearing loss reflecting the number of years they had been in the business. All those who had been in it for 15 years or more were suffering from hearing loss. But because the hearing frequencies used in everyday conversation are among the last to go, the victims generally fail to realize what is happening until it is too late.

Clearly, the problem is an enormous one. But immediate steps could be taken to cut down on gratuitous noise pollution. Tougher enforcement of noise laws against motorcycles, for example, could be coupled with efforts to encourage manufacturers to make their exhaust systems tamper-proof. Bangkok and Thailand's other major cities would not become silent overnight, but even the longest journeys start with a first step.

Figure 9.6 Average Sound Level in Soi at Various Distances from Main Streets



Source: ONEB, Survey of Sound Levels in Soi , 1981.

be transported several hundred kilometres by prevailing winds. After being chemically transformed into sulfates and nitrates, the acidic compounds may be deposited as dry or wet particles. This has become an international issue in Northern America and Europe.

It is important to note that normal rainfall is slightly acidic, with a pH sometimes as low as 5.0. However, low pH in rainfall does not automatically mean that the water in lakes and streams will become acidic. Many watersheds have a natural ability to buffer acidity. As the acid rainfall moves through the watershed, alkaline soils can neutralize the acidity. However, some watersheds, particularly those at high attitudes and with thin soils, have less ability to buffer deposited acids.

There is very little information on the background pH values of rainfall or water resources to indicate the present situation regarding acid rain in Thailand. The potential for acid rain however, is small since the amount of SO_2 and NO_x emission is relatively small. The acidic compounds are mostly deposited within a short distance due to the fact they only a few tall stactes are in operation in the country.

Lead in Gasoline

There is a trend towards the reduction of lead in gasoline worldwide. While lead-free gasoline is used in U.S.A., the amount of lead allowed in gasoline varies from country to country. In Thailand, the Ministry of Commerce lowered the limit of lead in gasoline from 0.84 mg/l to 0.45 mg/l in 1984.

After combustion, about 75 percent of the lead additives in gasoline are emitted in the car's exhaust. Most of the lead is emitted as particulates, mainly in the size range of 1 to 5 um. Particulate lead tends to deposit near the emission source; only about 20 percent of the lead emitted will remain in the air for a longer period (WHO, 1977). Data from Thailand confirm that the major portion of lead emitted from motor vehicles deposited close to

roadways. Concentrations of lead in ambient air range from 1 - 5 $\mu g/m^3$ at the curbside to around 0.1 to 0.5 $\mu g/m^3$ further from the traffic. The level of lead is within the standard limit of 10 $\mu g/m^3$ for 24-hour average values.

Annual lead concentrations found at Samrong (MPH/CU Network) fell from 0.914 $\mu g/m^3$ to 0.072 $\mu g/m^3$ between year 1979 and 1984, due to the partial substitution of leaded gasoline by the increasing demand on LPG and diesel oil. The reduction of lead in gasoline also caused a significant drop in lead-in-air concentration, in 1984. The concentrations of lead in Bangkok were found to be well within the safety limit. The contribution of lead in gasoline to the transportation sector's overall health impact should be minimal in comparison to other pollutants and other sources.

Air and Noise Pollution from Transportation

Transportation is the leading cause of complaints about air and noise pollution in Bangkok and other major cities. With rapid modernization and expanding urbanization, the number of vehicles has increased at 10 percent annually. These emission sources have encroached on people both at work and at home.

High levels of CO concentration, often exceeding the relevant standard, were found in major cities (Table 9.5). While congested traffic and wind dispersion are also important factors, a large percentage of cars were found to violate the emission standards (Table 9.6). However, it was found that new cars produced less emissions, due to better engine design. Replacement of the stock of motor vehicles should progressively reduce the average CO emission from cars.

Noise of motorcycles from assembly lines is within set standards. Noise violation by motorcycles in actual use is due to tampering with exhaust pipes. Although an industrial standard for exhaust pipes (TIS 340-2528) has been set, a careful examination is needed on the problem of after-use practice. The major causes of noise problems arising from vehicles can be summarized as three-fold: (1) tampering with exhaust pipes or mufflers, to deliberately increase the noise emission level; (2) lack of attention in maintaining worn-out exhaust systems; and (3) inadequate enforcement, either through on-street checks or annual inspection during registration renewal.

If noise abatement is the objective, then drastic and strict measures will have to be undertaken to ensure a quieter environment. The measures will have to be directed against the three major causes mentioned above. Judging from past performance in the enforcement of standards, it is not expected that enforcement will get any better in the near future, although an action plan has been proposed by ONEB(1985) to strengthen the manpower and resources needed to enforce the emission regulation. As to the problems of tampering and maintenance, the solution will lie in the design of tamper-proof and maintenance-free exhaust systems, such as the use of stainless-steel and permanently welded inner tubes. This is especially the case for motocycles and public transport, where the vehicles are normally poorly maintained.

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10 Water Quality Management

10.1 STATUS AND TRENDS

The following section briefly reviews the water quality data for the urban khlongs, three out of Thailand's four major rivers (the Bang Pakong is considered relatively clean), groundwater, estuaries and coastal waters, the Gulf of Thailand and the Andaman Sea. The number of quality parameters which could be reviewed is very considerable. The Office of the National Environment Board, for example, has river quality monitoring stations which regularly check water temperatures, pH, conductivity, salinity, chloride, dissolved oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), coliform bacteria, total phosphorus, nitrate nitrogen, ammonia nitrogen, total Kjeldahl nitrogen (TKN), phenol, cyanide, heavy metals and pesticides. For the purposes of the present discussion, however, three key indicators will be covered the levels of dissolved oxygen (DO), heavy metals and pesticides.

The City Khlongs

In the lower reach of the Chao Phraya where Bangkok is located, there are many khlongs, or canals, some of which are natural. Most, however, are man-made. Most of these khlongs are used for drainage, irrigation and navigation, as well as for fire fighting purposes. In the central area of Bangkok, the khlongs receive all surface runoff, as well as sullage, garbage, industrial wastes, and the effluent from septic tanks and cesspools, ultimately conveying all of these inputs to the Chao Phraya.

Not surprisingly, many of the khlongs in the central area of Bangkok have become heavily polluted. In 1980, the BMA Bureau of Drainage and Sewerage conducted a survey of different khlongs, concluding that for most of the time the dissolved oxygen content was zero, while the BOD_5 values were equivalent to sewage, rather than to those for normal water (JICA, 1981). The khlongs ir other cities, such as Samut Prakan, Chiang Mai or Khon Kaen, have also been used as sewers. In the dry season, these khlongs become septic and produce an offensive smell.

The Chao Phraya River

The Chao Phraya drains an area of about 177,000 square kilometers, including the most heavily populated and industrialized areas of Thailand. As a consequence, it is heavily polluted (see Box 10.1). The river is the country's largest: its minimum width when running through Bangkok is 180 meters, with depths of 20 meters and more, while 10 kilometers from the Gulf it broadens to 500 meters - and to 1,000 meters near the mouth. The river's minimum discharge rate is less than 50 cubic meters per second, in the low water period which runs from April to June. From August to December, by contrast, the flow normally exceeds 1,000 m^3/sec, while the maximum flow rate is in excess of 4,000 m^3/sec.

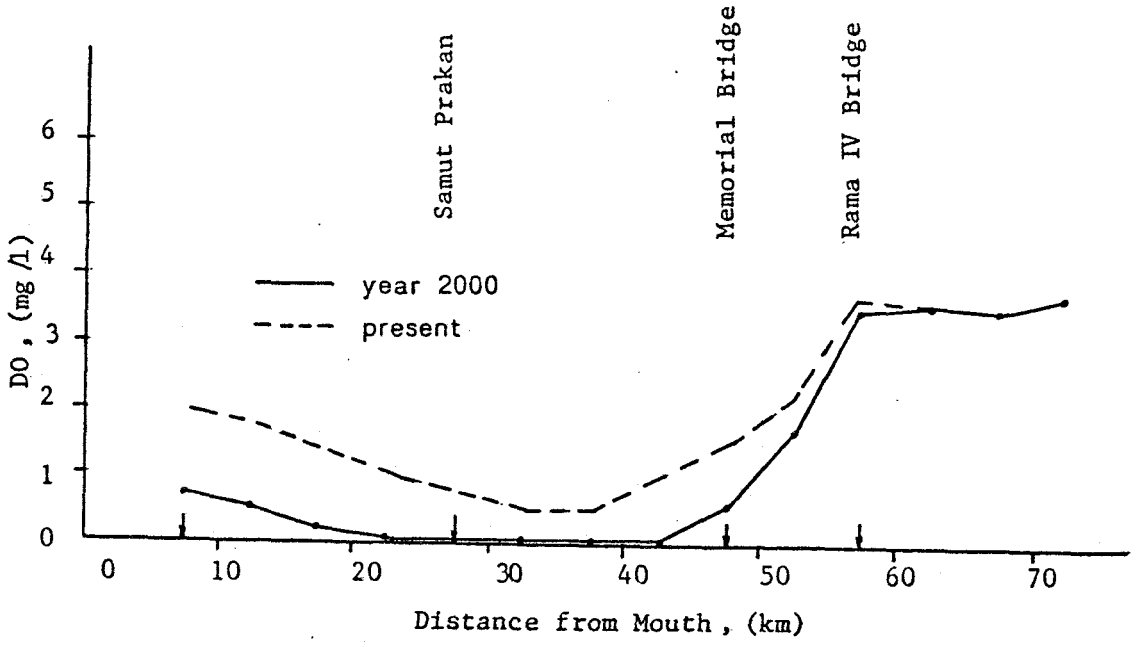
Given the quantities of sewage and industrial effluent being discharged intc the Chao Phraya, dissolved oxygen (DO)

levels are probably the best single indicator of the state of the river's health. The recorded DO levels have shown depressed sag curves for nearly 20 years, with the area affected showing a tendency to spread. Despite the somewhat higher DO curves recorded for 1979 and 1980, the evidence suggests that DO levels will remain depressed during low flow conditions for the foreseeable future. During high flow conditions, the area of depressed DO levels is shifted downstream (Figure 10.1).

Since the 1960s, there has been concern that these low DO levels would finally result in the formation of anaerobic conditions in extended lengths of the river. In fact, it is likely that anaerobic conditions already result in the river when the first major rainfall occurs following the dry season, flushing organic deposits into the river from the khlongs and drains. But the DO record suggests that there may have been a number of competing trends at work. Since the river has not yet turned anaerobic for significant periods of time, it may well be that the increasing treatment of high-BOD industrial effluents has to some extent compensated for the growing volumes of untreated sewage discharged by Bangkok's rapidly growing population.

Nonetheless, the latest report on Bangkok's sewerage needs (JICA, 1981), forecasts that much of the river between the Rama VI Bridge (58 kilometers from the river's mouth) and Samut Prakan could become anaerobic in low flow conditions

Figure 10.4 Forcast Dissolved Oxygen Level in the Chao Phraya in the Year 2000



Source: JICA, 1981

Box 10.1 When Will the Chao Phraya Die?

Like England's Thames or the Rhine running through the heart of Europe, the Chao Phraya River can be seen as a litmus test of the environmental standards of those living and working within its enormous watershed area. The results are far from reassuring.

The Rhine, which flows through many countries on its way to the sea, still has a long way to go before it can be restored to health, particularly now with the severe damage caused by the Sandoz spill. But the Thames has been resurrected. In the 1940s, it was technically dead; now even salmon swim in it. Unfortunately, the evidence suggests that by the year 2000 the lower reaches of the Chao Phraya, Thailand's most famous river, will be in an even worse state than the Thames was at its lowest point. Taking into account the sewerage systems installed in the nineteenth century, it took nearly 100 years to clean up the Thames, so what are the prospects for the Chao Phraya?

To get an idea of what the Chao Phraya might look like in 20 years, consider the khlongs, or canals, of Bangkok. With less than two percent of the city's population currently linked to the sewers, many of the khlongs have effectively become open sewers. Measurements taken of the water in Khlong Rajabopit, for example, showed that its properties were almost identical to domestic sewage. The Chao Phraya is a large river, draining an area of 177,000 square kilometers, but its ability to assimilate the discharges from the septic khlongs and sewers, and the effluents from industrial areas like Samut Prakan, is already at breaking point in some areas.

These problems are considerably aggravated during the low water flow conditions experienced in the dry season. Indeed, the prospect is that an anaerobic, or completely deoxygenated, area will develop. During low water periods, this anaerobic zone could eventually stretch from above the Memorial Bridge to Phra Pradaeng. If there is no oxygen in the water, most of the microorganisms which normally break down the pollution load will be unable to operate. And if the fate of the Thames was anything to go by, the water will become black and foul-smelling.

A mathematical model developed by the Japan International Cooperation Agency (JICA) confirms that if effective wastewater control measures are not soon adopted in the Bangkok Metropolis, anaerobic conditions will become commonplace in the lower Chao Phraya in low water conditions. JICA has recommended that Bangkok should install a new sewerage system and sewage treatment plants, estimating the cost at nearly 37,000 million baht (roughly US$ 1,400 million), a huge sum by anyone's standards.

It seems highly unlikely that Thailand will be able to raise this level of funding in the foreseeable future. Other, more limited, schemes designed to treat domestic or industrial waste will probably stand a better chance of being implemented. One option would be to install smaller treatment plants for high-rise buildings, university campuses, big hotels, schools and other institutions, given that treatment is generally much cheaper than installing complete sewerage systems. Meanwhile, the Chao Phraya will continue to die.

Table 10.1 Sources of High BOD Loadings in Three Areas of the Chao Phraya River Basin, 1984-1985

Region and Purpose of Survey	No. of factories Surveyed	Total Waste flow Rate (m^3/day)	Total Influent BOD_5 loading (kg/day)	Total Effluent BOD_5 loading (kg/day)	Total BOD_5 removal by waste treatment (kg/day)	Treatment Efficiency (%)	Estimated Domestic Sewage Loading (kg/day)
1. Northern Region, 14 Provinces in Ping, Wang, Yom, Nan Pasak, Mae Kok river basins. (Kamphang Phet, Tak, Lampang, Lamphun, Chiang Mai, Chiang Rai, Phayao, Nan, Phrae, Uttaradit, Sukhothai, Phitsanulok, Phichit, Phetchabun)	76	766,945	99,119	18,087	81,032	82	485,203
2. Upper Chao Phraya River, 8 Provinces in Lopburi and Pasak River basins (Nakhon Sawan, Singhburi, Ang Thong, Ayutthaya Lopburi, Saraburi, Phetchabun Chainat)	84	97,739	78,217	11,004.8	67,213	86	197,281
3. Lower Chao Phraya River, Pathum Thani, Nonthaburi, Bangkok, Thonburi, Samut Prakan)							
3.1 Nonthaburi-Pathum Thani including Samlae Water Intake	48	42,858	93,094.17	4,269.35	88,814.82	95.4	44,791
3.2 BMA area at Khlong Phasi Charoen	76	31,097	14,430.19	2,763.68	11,666.5	80.8	276,007
3.3 Left hand side of Samut-Prakan at Khlong Samrong	73	81,500	20,574.7	1,869	18,705.7	90.9	23,257
3.4 Right hand side of Samut-Prakan at Khlong Bang Phueng	70	5,465	8,781.25	972.17	7,809.08	88.9	11,035
Total	267	87,902	136,880.3	9,874.2	126,996.1	Avg.92.8	355,090

Source: DIW, 1985.

by the year 2000 (Figure 10.1). BOD_5 concentrations fluctuate from 1-4 mg/l, with an average value of 2.0 mg/l in the lower reaches (below kilometer 50). It has been estimated that 364,900 kg/day of BOD loading is discharged into the river, including 355,000 kg/day in the form of untreated domestic sewage and 9,900 kg/day of treated industrial wastes (Table 10.1).

Table 10.2 Some Heavy Metals in the water and sediment of Chao Phraya River, September 1984

Metals	River Water (µg/l)		Sediment (mg/kg)	
	Average	Range	Average	Range
Cu	16.0	4.81-66.9	22.2	10.4-41.7
Ni	18.6	2.75-137	21.8	13.8-32.9
Pb	2.07	ND-4.05	22.6	8.9-92.0
Cd	2.52	ND-4.29	0.4	ND-0.92
Total Hg	<0.2	ND-0.43	.00116	ND-.00218

ND = Not Detectable
Source: Onodera, 1985, p.78 and 83

As far as heavy metal contamination of the Chao Phraya is concerned, Table 10.2 shows some recorded levels in water and sediment. Copper concentrations fluctuated between 4.8 and 66.9 µg/l (or parts per billion) in water and between 10.4 and 41.7 µg/kg in sediment, but were within the 100 µg/l standard for good quality water. Nickel concentrations ranged from 2.72 to 137.5 µg/l, implying some breaches of the 100 µg/l standard for good quality water, although the average value of 18.6 µg/l was acceptable. The reported levels of lead, cadmium and mercury were all within acceptable limits, as were chromium, manganese and zinc concentrations. Heavy metal contamination in water reflected the areas of peak discharges (Figure 10.2), while sediment contamination seems to be most pronounced in the lower stretches of the river (Figure 10.3).

Organochlorine pesticides such as Aldrin, BHC, DDD, DDE, DDT, Dieldrin,

Table 10.3 Concentrations of Organochlorine Pesticides in the Chao Phraya River in April and October 1984[a]
(µg/l)

Organochlorine pesticides	April			October			ONEB Standard
	Freq.[b]	Max.	Med.	Freq.[b]	Max.	Med.	
∝BHC	95	0.056	0.002	100	0.035	0.007	0.02
β BHC	5	0.024	-	0	-	-	
γ BHC (Lindane)	27	0.021	-	72	0.032	0.003	
Heptachlor	41	0.015		27	0.166	-	0.2
Heptachlor epoxide	32	Trace	-	18	Trace		0.2
Chlordane	0	-	-	0	-	-	
Aldrin	100	0.284	0.126	100	0.028	0.008	0.1
Dieldrin	100	0.289	0.080	88	0.442	0.029	0.1
Endrin	0	-	-	0	-	-	0
p,p'-DDE	36	0.031		18	0.030	-	
o,p'-DDT	0	-	-	0	-	-	1.0
p,p'-DDD	9	0.025	-	18	0.03	-	
p,p'-DDT	13	0.015	-	9	0.271	-	1.0

- = Non detectable
Notes:
a. The survey extended from the river mouth to 340 km.
b. Frequency of occurrence in %
Source: Onodera, 1985, p.65

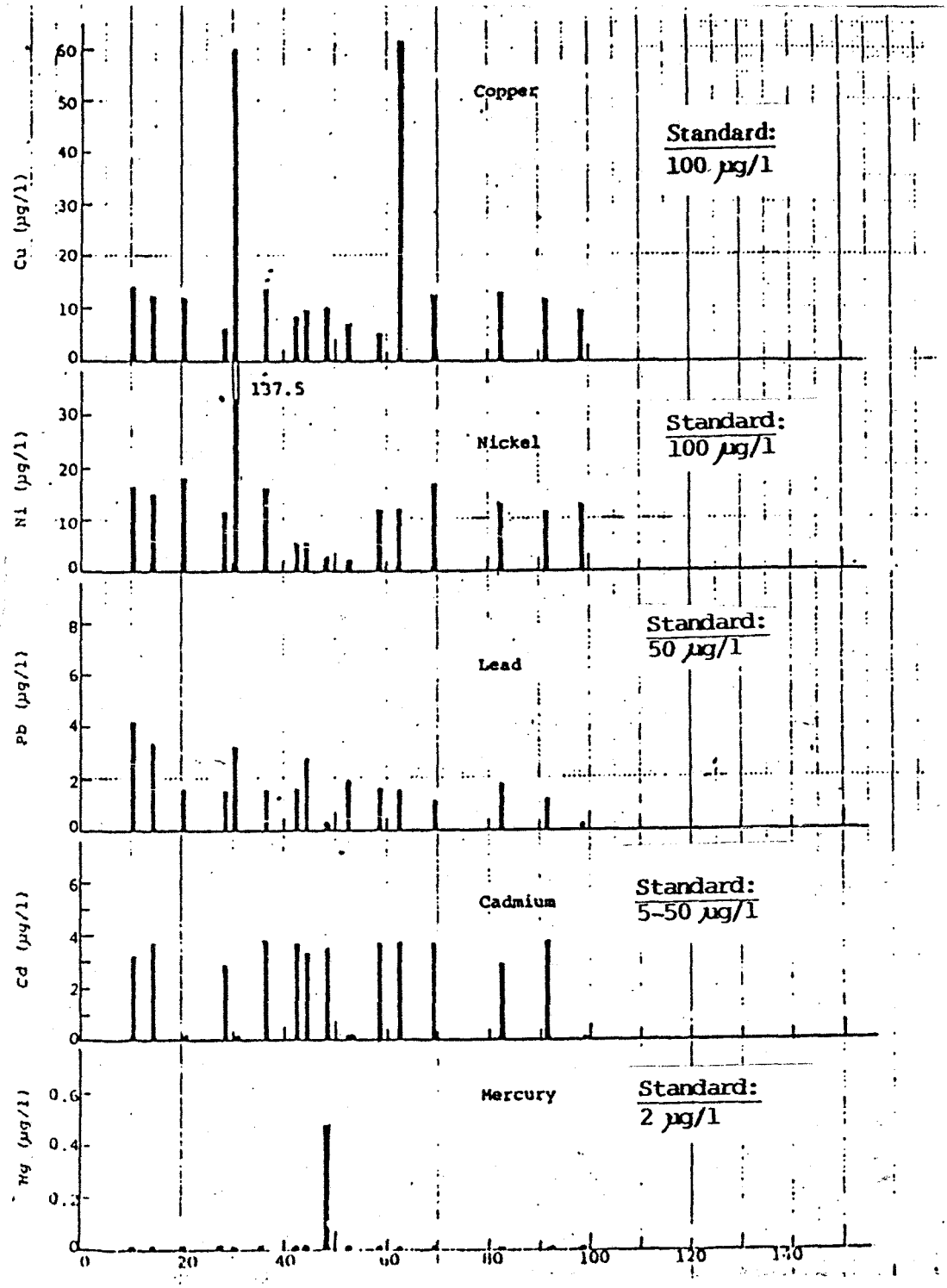


Figure 10.2 Distribution of Heavy Metals in the Water of the Chao Phraya River, September 1984.

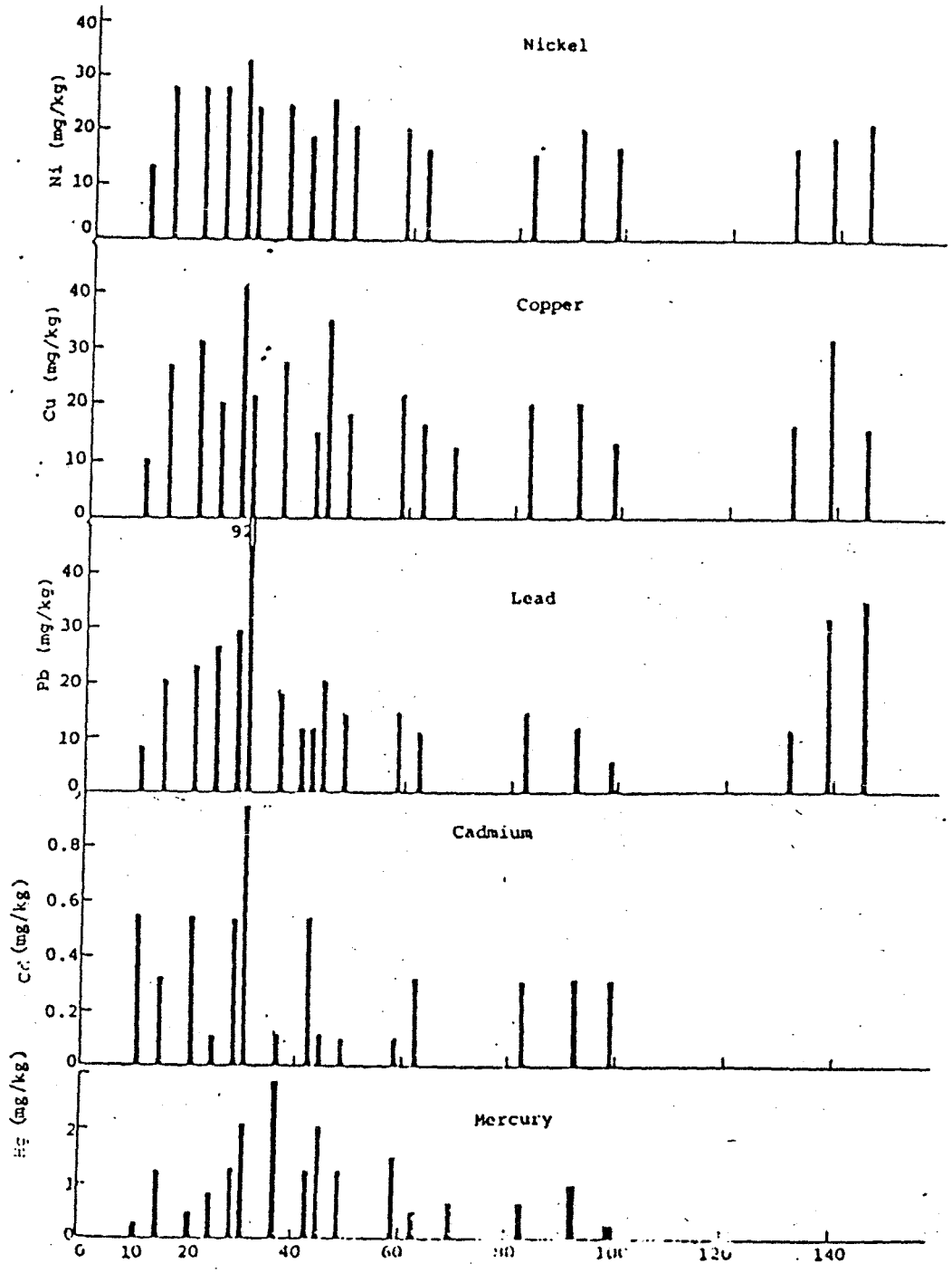


Figure 10.3 Distribution of Heavy Metals in the Sediments of the Chao Phraya River, September, 1984

Source: Onodera, 1985

Heptachlor and Lindane were all found in the city khlongs and the Chao Phraya. Levels of Aldrin, BHC and Dieldrin in water collected in April of 1984 were 0.126, 0.022 and 0.080 µg/l (Table 10.3), respectively. These concentrations were between three and ten times greater than those measured in October, during the rainy season (Figure 10.4). The peaks in organochlorine pesticide contamination were found at three different locations, 300, 170 and 60 kilometers from the river's mouth, indicating the discharge of pesticides in significant quantities at three different points along the river. Concentrations of these pesticides were found to be 10-100 times greater in sediments than in water (Figure 10.5), indicating that there is long-term accumulation in sediments.

Overall, the available data show that there is a heavy pollution load in the lower reaches of the Chao Phraya, with DO levels dropping to near zero in places. The levels of such toxic substances as heavy metals and pesticides have not yet reached critical levels, although monitoring should continue as the urbanization and industrialization of the Chao Phraya watershed proceeds.

The Thachin River

The Thachin River also receives a considerable BOD loading from sewage and industrial effluents. The flow of the Thachin fluctuates between 28 m^3/sec in the dry season (January-July) and about 200 m^3/sec in the wet season (August-December), at the Phophaya Gate.

Around the river's 12,000 square kilometers water catchment area, it is estimated that about 20 communities with a population of nearly 200,000 discharge about 3,700 kg BOD_5/day to the lower reaches of the river. Moreover, 160 industrial concerns, mainly involved in food and textile manufacture, discharge about 5,600 kg BOD_5/day to the upper reaches, 120 kg BOD_5/day to the middle reach and 4,800 kg BOD_5/day to the lower

Table 10.4 Loadings from Different Agricultural Wastes Discharged in the Thachin River Basin

Type of Agriculture	Total Estimated Loadings to Thachin River Basin (kg/day)		
	BOD	Pesticides	Hg
1) Paddy Field	4,858	0.1424	-
2) Crop Plantation Land	9,804	0.6086	-
3) Pig Farm	28,869	0.00119	0.0052
4) Striped Snake Head Fish Farm	9,644	0.0254	
5) Shrimp Farm			
6) Non protein feeding fish farm	-	-	-
7) Chao Phraya River Inflow	24,036	2.424	
Total	77,211	3.2	0.0052

Source: TISTR, 1982.

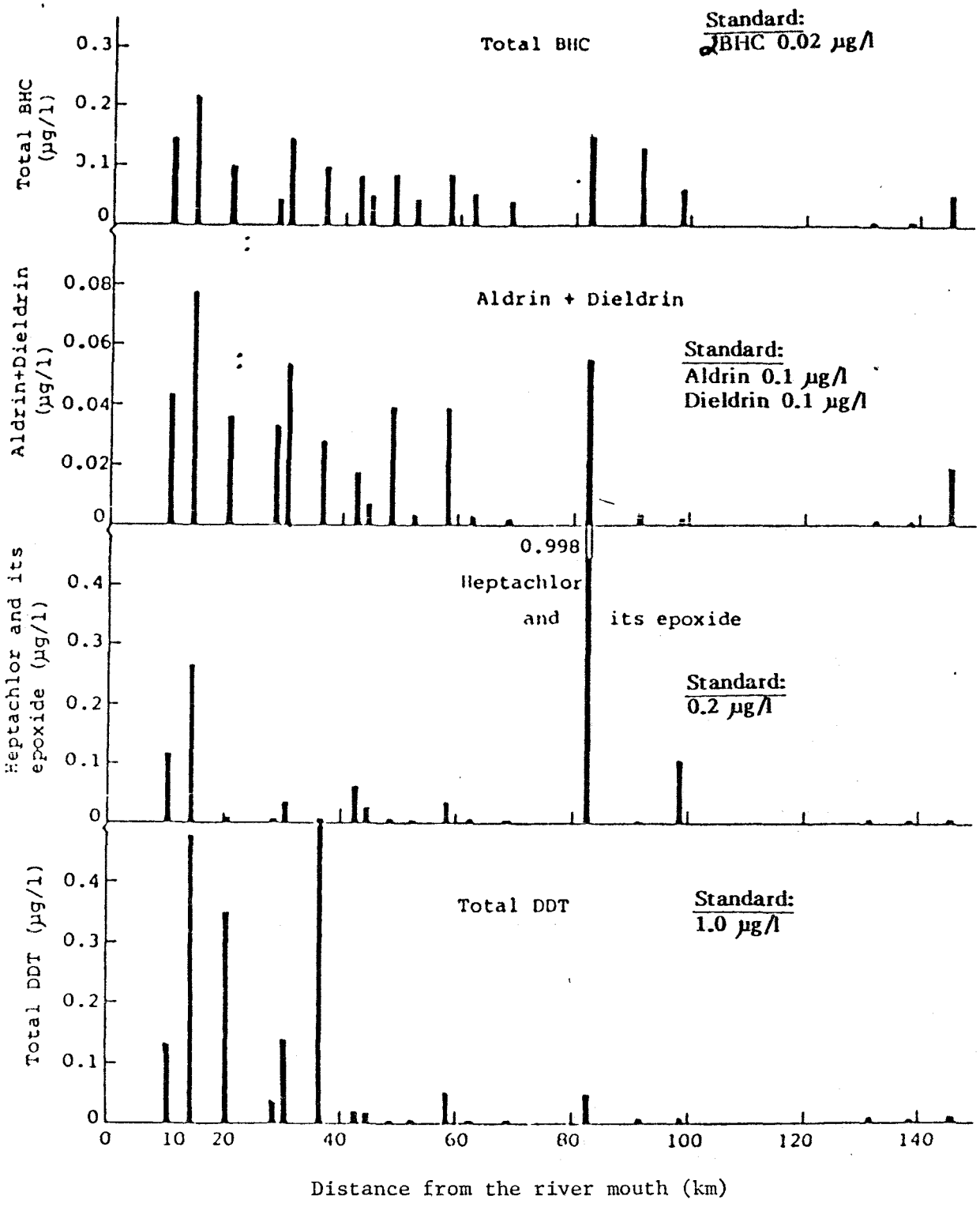


Figure 10.4 Distribution of Organochlorine Pesticides in the Water of the Chao Phraya River, September, 1984

Source: Onodera, 1985

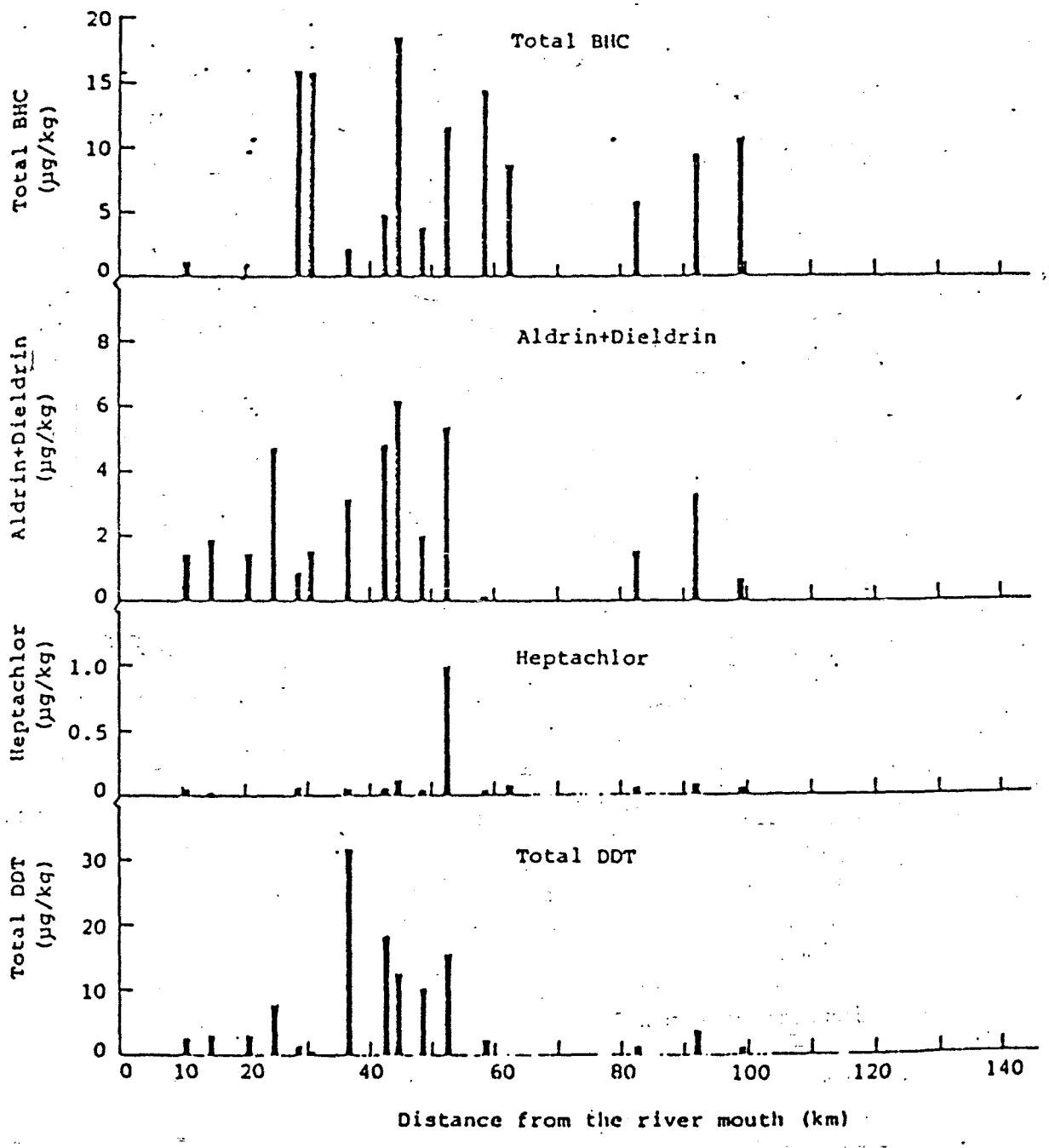


Figure 10.5 Distribution of Organochlorine Pesticides in the Sediments of the Chao Phraya River, September 1984

Source : Onodera ,S, 1985

Table 10.5 BOD_5 Loadings from Various Industries Dischaged to the Maeklong

Areas	Total BOD_5 generated		Treated by Ponds		Agri. Use		BOD_5 Dischaged into Maeklong		Treated by Treatment Plants	
	(kg/day)	%	(kg/day)	%	(kg/day)	%	(kg/day)	%	(kg/day)	%
Kanchanaburi										
Tha Muang	56,545	100	13,942	24.6	4,640	8.2	19,803	35.0	18,160	32.2
Tha Maka	36,249	100	12,797	35.3	1,622	4.5	186	0.5	21,644	59.7
Muang	53	100	41	77.4	-	-	12	22.6	-	-
Subtotal	92,847	100	26,780	28.8	6,262	6.7	20,001	21.5	39,804	43.0
Ratchaburi										
Ban Pong	53,640	100	26,622	49.6	2,240	4.2	1,154	2.2	23,624	44.0
Photharam	404	100	402	99.5	-	-	2	0.5	-	-
Muang	9,184	100	113	1.2	-	-	9	0.1	9,042	98.7
Damnoen Saduak	3	100	3	100	-	-	-	-	-	-
Subtotal	63,211	100	27,140	42.9	2,240	3.5	1,165	1.8	32,666	51.8
Samut Songkhram										
Muang	128	100	1	0.8	-	-	122	95.3	5	3.9
Grand Total	156,186	100	53,921	34.6	8,502	5.4	21,288	13.6	72,475	46.4

Source: NEB, 1986, p.34

reaches. Agricultural inputs include drainage water from paddy fields (about 15,000 kg BOD_5/day), pig farm wastes (16,500 kg BOD_5/day), fish and prawn farms (9,600 kg BOD_5/day), and pesticides (about 0.15 kg BOD_5/day). Moreover, the upper reaches of the river receive a diversion flow from the Chao Phraya which includes a BOD load of about 27,000 kg/day and mercury contamination in the order of 2.26 kg/day (Table 10.4).

Heavy metals do not exceed the standards for good quality water. Mercury and lead concentrations are 0.62 µg/l, compared with the allowable limit of 2 µg/l, while average lead concentrations are also less than the good water quality standard of 5 µg/l. There was one sample, near kilometer 240, at Samchook, Suphanburi, where the mercury level was relatively high, however, at 14.6 µg/l.

As far as pesticides are concerned, the average Heptachlor concentration is relatively higher, at 0.08 µg/l, than those for Aldrin (0.06 µg/l), BHC (0.013 µg/l), DDT (0.004 µg/l) and Dieldrin (0.063 µg/l). Pesticide concentrations increase somewhat towards the mouth of the river, but the reported concentrations are well within the permissible limits.

The Maeklong River

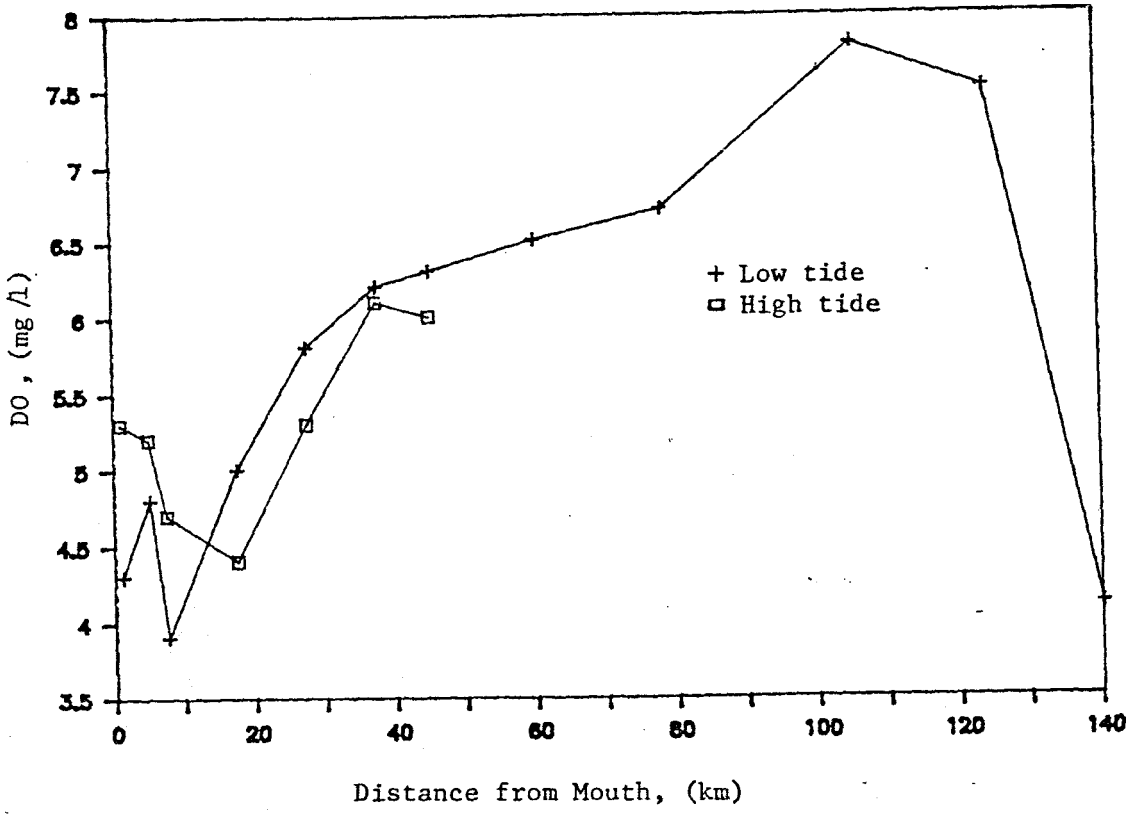
The Maeklong is one of the most important rivers of western Thailand. Along its 140 kilometer course, it drains an area inhabited by several hundred thousand people and, more importantly, supporting the largest concentration of sugar cane plantations in the country. By the 1970s, there were 17 sugar mills in the area, which together accounted for over 60 percent of Thailand's total sugar

processing capacity. In 1976, the total estimated BOD discharges into the river during the dry season was estimated at 110,320 kg/day. As a result, there was widespread pollution in the lower part of the Maeklong and in the estuary. Cockle farms in particular, were hard hit by the deteriorating river quality.

In July 1974, therefore, the Ministry of Industry launched a project designed to solve the problem. Wastewaters from the sugar mills were to be pumped to a central treatment plant, consisting of a series of equalization ponds and anaerobic lagoons, followed by oxidation ponds. The water from sugar mill condensers continued to be discharged into the river, however. Where such waters were recirculated through a sugar mill, their BOD content (caused by a rising sugar content) was considerably enhanced. Whereas the acceptable level of BOD was about 40 mg/l, the recirculated condenser water picked up about 30-60 mg/l with each pass through the system.

The treatment facilities are reported to have costed about 32 million baht ($US1.6 million, @ 20 baht to the US$ in 1979-80). The cost of the land occupied by the facilities was about eight million baht, bringing the total initial capital cost to 40 million baht (US$2.0 million). The operating costs were reported to be around 3.2 million baht (US$160,000) per year in the early 1980s, excluding power costs.

Figure 10.6 Dissolved Oxygen Levels in the Maeklong River, April 1986



Source: NEB, 1986, p.64.

Table 10.6 Heavy Metals in Groundwater, 1982-1985[a]
(mg/l)

Year	1982	1983	1984	1985	Drinking Water Standard[b]	
					(1)	(2)
Copper	ND-0.13 (0.007)	ND-0.25 (0.0033)	ND-0.12 (0.0026)	ND-0.03 (0.0021)	1.0	1.5
Zinc	ND-19 (0.333)	ND-8.4 (0.380)	ND-3.1 (0.263)	ND-8.8 (0.284)	5.0	15.0
Manganese	ND-22 (0.389)	ND-7.4 (0.376)	ND-6.1 (0.276)	ND-6.7 (0.297)	0.3	0.5
Number of samples	248	384	437	284		

ND = non-detectable level; figures in parenthesis are average values.
Notes:
a. in the Land-subsidence control zone, namely Bangkok, Samut Prakan, Samut Sakhon, Nontaburi, Pathum Thani and Ayutthaya.
b. Groundwater Division, MOI Notification No. 4 (B.E. 2521).
(1) Highest desirable level (mg/l)
(2) Maximum permissible level (mg/l)
Source: Groundwater Division, 1986.

The environmental quality of the Mae Klong river has now greatly improved, thanks to the treatment system installed by the industries unloading their effluents to the river. Table 10.5 shows that only 13.6 per cent of the BOD_5 load is now directly discharged to the river. Mae Klong could, in fact, serve as a successful example of how concerted effect between government, industry and the effected communities can restore the health of a sick river (Figure 10.6).

Groundwater

Groundwater is increasingly important as a source of drinking water, as Chapter 3 explains. The data are fairly sparse on groundwater contamination in Thailand. The most immediate problems revolve around saltwater encroachment into aquifers beneath the Bangkok region. In areas where groundwater pumping has been particularly heavy, saltwater encroachment in the 150 meters aquifer has been taking place at the rate of around 500 meters a year. The encroachment is slower, at around 100 m/year, where there is a lower rate of groundwater extraction.

In the extraction wells which have been most seriously affected, chloride concentrations have risen from 10 mg/l to more than 600 mg/l over the past nine years. In the case of one well, in Thonburi, the chloride content increased steadily from 40 mg/l in 1963 to more than 1,000 mg/l in 1969. As a result of this process a number of public supply wells are known to have been abandoned.

Table 10.6 gives some indicative figures for heavy metal contamination of groundwater in the land-subsidence control zone of Bangkok, during 1982-1985. Despite some relatively high

samples, the average concentrations for all these compounds were within the drinking water standards. The manganese level, however, was relatively high in 1982. No testing was carried out for other heavy metals, such as lead, nickel and mercury, or for pesticides. Given the levels at which such materials are used in Thailand, and the increasing importance of the groundwater resource, more effort should be devoted to groundwater quality monitoring. This will be particularly important, as Chapter 11 notes, where solid waste or hazardous waste disposal facilities are in operation or planned.

The Estuaries, Coasts and Seas

Following concern about deteriorating conditions in Thailand's estuaries and coastal waters, the Subcommittee for Research on the Quality of Water and Living Resources within the Natural Resource Council was formed in 1973, and the resulting research program was essentially completed by 1984. The purpose of the exercise was to gather data which would serve as a baseline for future environmental management. The study area included estuarine areas near the mouths of major rivers, the upper and lower areas of the Gulf of Thailand, and the Andaman Sea.

The results, as the previous discussion would lead one to expect, show that the estuaries of the Chao Phraya and Thachin rivers are characterized by relatively low DO levels. Other estuaries,

Table 10.7 Heavy Metals in Estuaries in the Gulf of Thailand
(µg/l)

Estuaries		Pb	Zn	Cu	Cd	Hg
Thachin	Avg	10.72	3.44	17.11	1.91	0.24
	Min	6.50	0.11	2.70	0.90	0.10
	Max	22.00	14.50	94.00	2.45	0.50
Maeklong	Avg	9.65	6.76	22.96	2.01	0.38
	Min	4.00	0.10	3.10	1.10	0.08
	Max	24.00	25.00	150.00	2.55	1.25
Phetchaburi	Avg	11.97	3.13	14.61	2.01	0.27
	Min	3.50	0.08	3.20	1.15	0.08
	Max	28.00	12.50	94.00	2.55	0.88
Bang Pakong	Avg	11.78	2.20	27.14	1.88	0.30
	Min	4.00	0.07	2.00	1.20	0.10
	Max	26.00	10.57	124.00	2.35	1.24
Pranburi	Avg	11.00	4.29	19.52	1.94	0.28
	Min	6.00	0.17	1.00	0.75	0.08
	Max	24.00	28.00	160.00	2.50	0.12
NEB River Standard		50.00	1,000.00	100.00	5.00 to 50.00	2.00

Source: Fishery Dept. 1979-1980

including those of the Phetchaburi Chanthaburi, Tapi, Lang Suan, Pak Phanang and Chumphon, also show evidence of some pollution , but at a much lower level than either the Chao Phraya or the Thachin. Generally, the DO levels were high, with an average value of 7.15 mg/l along the East Coast of the Gulf of Thailand, and a minimum value of 2.3 mg/l. These results suggest that the current organic load discharged by the major rivers is being assimilated quickly into the marine environment.

Heavy metals are a different matter, since they do not break down like BOD. Some results for heavy metals are given in Table 10.7, all of them within the National Environment Board's standards for river water. The concentrations were generally considerably higher in river sediments, however. Lead, for example, was 1,000-2,000 times more concentrated in the sediments of the Bank Pakong, Mae Klong, Phetchaburi, Pranburi and Thachin rivers than in their waters, while zinc was 6,000-20,000 times as concentrated in the sediment. The differences were lower for some other heavy metals, such as copper (300-600 times), cadmium (60-130 times) and mercury (20-80 times). In general, heavy metal concentrations are still within the safety limits, although occasional local "hot spots" of mercury have been found, probably because of dumping activities.

The mercury concentrations found in marine animals are generally below the safety limit (0.5 mg/kg) set by the US Food and Drug Administration (FDA). Of 221 specimens collected, only two showed the highest mercury value of 0.227 mg/kg, and only 3.6 percent of the samples showed mercury levels higher than 0.1 mg/kg.

As far as pesticide concentrations in the Gulf of Thailand are concerned, the results from the river mouths were generally very low. However, one value for DDT was observed which was 1,400 times the safety limit. Again, it is thought that this may result from illegal industrial dumping. DDT was detected in 12 samples, out of 100 at the level of 0.002-0.003 µg/l, exceeding the standard of 0.001 µg/l.

The situation could easily have been worse than the present data show it to be. But there is no room for complacency. One phenomenon which has been of particular concern in coastal areas, has been the "red tide" condition, thought to result from the excessive nutrients and inorganic pollutants which wash down into the estuaries and coastal areas. Red tides have been a major problem for the mariculture industry, which is described in Chapter 8, and are considered to be the major cause of the mass mortalities affecting green mussel farms.

As far as the Andaman Sea is concerned, there is even less in the way of concrete information about the prevailing pollution levels. In part, however, this reflects the fact that the pollution problems here are essentially very localized, including sediments and slimes from the tin mining industry in the Phuket region and a certain amount of sewage and oil pollution.

10.2 ISSUES

Management of Domestic Wastewater in Urban Areas

Almost universally, urban domestic wastewater disposal is dealt with by means of on-plot, squat-plate, pour-flush cesspools or septic tanks for human excreta, and by means of street drains for kitchen and laundry waste (or sullage). It is estimated that the present use of cesspools and septic tanks for excreta reduces the overall BOD of sewage (excreta plus sullage) to about 50 percent. So the remaining 50 percent of BOD goes to sewers, drains, khlongs and rivers. The proportion of Bangkok's population currently connected to mains sewers is very small indeed, at around two percent.

The total BOD_5 imposed by discharges of domestic sewage and industrial waste to Bangkok's sewers, drains, and waterways is estimated at 365,000 kg BOD/day, with 355,000 kg/day coming from domestic sources and 10,000 kg/day from industrial sources. Such high BOD loadings have already created insanitary or obnoxious conditions in all the city's khlongs, and also result in the low dissolved oxygen content of the Chao Phraya during dry weather flow conditions. Eventually, as Box 10.1 describes, the result will be to turn long stretches of the river anaerobic.

To reduce the overall pollution load and avoid such anaerobic conditions, Bangkok needs a new sewerage system and sewage treatment plants, as proposed in the report prepared by the Japan International Cooperation Agency (JICA, 1981). But this must be a long term measure, partly because such systems take a long time to build, but also because Thailand will find it difficult to raise the necessary funds for such a large investment program. Although the total program cost is high, at 36.7 billion baht, it is worth noting that this approach represents 1,270-4,933 baht per capita, of providing appropriate disposal.

As far as shorter-term measures are concerned, an immediate priority should be to use existing treatment plants to the full. Existing sewage treatment and industrial waste treatment facilities, both in Bangkok and elsewhere, should be evaluated, with a view to transferring additional loads of domestic or industrial wastes to those facilities found to have excess capacity.

High-Rise Buildings

Large-scale developments, such as high-rise buildings, university campuses, big hotels, government institutions, schools, housing villages, or large department stores should be provided with sewage treatment plants. There may be problems, due to the limited space available, unless such requirements are designed into the project from the earliest stages.

Sewage Pumping Stations

The Bangkok Metropolitan Administration (BMA) has received complaints from people living downstream of Krung Kasem and Chong Nonsri, where its two sewage pumping stations continue to pump raw sewage into the Chao Phraya during low flow periods and at low tide. Measures should be taken to ensure that sewage discharge only takes place at high tide, which will afford much greater dilution and reduce the prospect of septic or anaerobic conditions forming in the river.

Monitoring of Waterborne Disease

There should be a monitoring station a few kilometers downstream from the Rama IV sewage pumping station at Chong Nonsri to study the role of sewage discharges in the transmission of key waterborne diseases, such as acute dysentery, cholera and typhoid.

Operator Training

It is essential that those treatment plants actually installed should operate as efficiently as possible. Plant operators should have sufficient technical knowledge to monitor the effluent and seek appropriate help from sanitary experts and the responsible authorities. The present operator training period of 3-5 days seems much too short. A longer period of 3-6 months would be more suitable.

Analysis and Research

The effluents to be treated, including sullage or "grey water", should be analysed, to ensure that cesspools, septic tanks and other treatment facilities are operating at a reasonable

efficiency. Further research is needed to identify the most appropriate alternatives to conventional sewerage and sewage treatment.

Industrial Waste Management

Although industrial effluents and wastes are less of a problem than domestic sewage discharges, a great deal more must be done to ensure that industrial water pollution is identified and effectively controlled. Most large industrial concerns already have their own wastewater treatment systems, many of them relatively sophisticated activated sludge treatment plants. However, many of these plants are reported to have sludge bulking problems, such that the effluent quality is sometimes worse than the quality of the incoming materials.

Activated sludge systems are complicated and need professional handling, particularly where there are constant changes in the nature and volume of the incoming waste streams. What is needed is a willingness on industry's part to explore ways of improving its current environmental performance, coupled with the use by industry of suitably qualified and trained personnel.

It will still be difficult for medium and smaller-sized factories to invest in treatment facilities, which suggests that one of three options might be adopted in such cases: (1) wastes can be tankered to nearby treatment plants, provided that they are organic and can be treated biologically; (2) if the waste is inorganic, chemical and/or toxic, it may be possible to transport it to a central treatment plant, such as those currently planned for Bang Khun Tien, and elsewhere. The private sector should be encouraged to invest in such facilities, in part by ensuring that the relevant pollution control regulations are fully enforced; and (3) if the Bangkok sewerage system is finally built, industrial effluents can be discharged to sewer for treatment at a central works, on payment of the relevant charges or effluent taxes.

Appropriate Waste Treatment Technologies

In rural areas, where land is not at a premium, appropriate low cost waste treatment technologies may include stabilization ponds and lagoons. Waste utilization should also be encouraged, wherever feasible. The aim should be to use by-products, such as biogas or organic fertilizers, to offset some of the costs of waste treatment. Since most Thai industry is agroindustrial in nature, the potential for such an approach should be fairly good. In some cases, too, it may make sense to encourage the location of industries producing organic effluents in areas of the country where the natural cleansing abilities of the local rivers has not been exploited.

Cleaner Technologies

Cleaner, or low-waste, technologies are designed to generate less pollution and waste than conventional technologies, rather than simply treating pollutants at the end of the process. Clean or cleaner technologies may include recycling, process and product reformulation, substitution of less hazardous feedstocks, and/or the installation of more efficient equipment.

Industrial Inventory

A nationwide survey of industrial activity would provide extremely useful information for those involved in planning, regulation and enforcement activities. The sort of information which needs to be collected includes locational details, type of industry, scale of operations, production rate, number of employees, raw materials used, and waste flow and characteristics. This inventory approach has already been pioneered by the Department of Industrial Works (DIW),

but this work should be extended.

Protection of Drinking Water Intakes

Drinking water for Bangkok is abstracted from the Chao Phraya at Sam Lae, Pathum Thani, some 90 kilometers from the river's mouth. Water quality in the area is deteriorating, with increasing bacterial contamination and BOD values, in part because of the new industries moving into the area. One consequence is that increasing volumes of chemicals have to be used to treat water intended for drinking purposes. The National Environment Board (NEB) has suggested three guidelines designed to protect the quality of water in the region of these intakes.

First, the NEB suggests that industries producing heavy metals, pesticides, polychlorinated biphenyls or other such toxic products or wastes should not be permitted to locate in sensitive areas of the water catchment. Second, factories producing more than 50 cubic meters per day of wastewater, not including cooling water, should not be permitted. Although, third, this second type of operation may be permitted by the responsible authorities in particular cases.

Control of Waste Disposal Sites

The open dumping sites at Soi On Nuj, Nong Khaem and Ram Intra have generated significant quantities of leachate during heavy rainfall. This leachate is now a major source of water pollution unless it is properly controlled. It should be treated prior to being discharged into canals or rivers.

Agricultural Waste Treatment

A survey of the geographical distribution of pesticide and fertilizer applications would help in identifying actual or potential pesticide pollution problems in major river basins. Wherever possible, animal wastes should be treated anaerobically, to recover biogas and organic fertilizer, and to cut the BOD potential of such materials. Farmers should be given appropriate instruction to ensure that they do not over-apply or otherwise misuse agrochemicals, resulting in run-off into local water courses.

Integrated Estuarial and Coastal Zone Management

The pollution monitoring programs already under way in major estuaries, coastal areas and the Gulf of Thailand should be continued, in order to detect any emerging trends. Given their critical role in underpinning major commercial fisheries, the estuaries and coastal seas should be properly protected. Illegal dumping of industrial and other wastes in the sea should be totally prohibited by the Harbor Department and other responsible agencies.

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11 Solidwaste, Toxic and Hazardous Substances Management

11.1 SOLIDWASTE MANAGEMENT

In any community, the characteristics and quantity of solid waste do not stay unchanged. The plastic portion tends to increase as living standards rise, for example. The percentage of paper may dwindle in some cities as plastic starts to replace it.

The Composition of Urban Waste

Data on the changing composition of wastes in provinces other than Bangkok are not currently available. As far as Bangkok's wastes are concerned, between 1980 and 1985, paper dwindled from 21.9. to 18.4 percent, while the plastic and rubber portions increased from 8.9 to 14.5 percent. Wooden material decreased from 23.2 to 8.9 percent, probably due to the increasing scarcity and price of such materials.

The garbage or vegetable/putrescible fraction increased by about 25 percent, from 29.9 to 39.9 percent while incombustible materials such as glass, bottles and metal fell from 10.1 to 6.0 percent.

The moisture and ash content dropped by about one and 30 percent respectively over a five year period. By contrast, volatile or combustible solids increased from 27.2 to 31.9 percent. This trend, however, does not make the wastes suitable for incineration, due to the still high energy requirement. The decrease of calorific value from 1,130 to 1,120 kcal/kg of wet wastes confirms this conclusion.

Different agencies have different forecasts of Bangkok's future population, partly depending on whether the nonregistered population and migration were taken into account. The data supplied by the Population Policy and Planning of NESDB are used here, Based on the projected population, the waste production of 0.85 kg/c/d, the population to be serviced of 80 percent and the collection efficiency of 95 percent, the overall collection can be expected to grow from 3,860 in 1987 to 4,220 tons/day in 1991 (Table 11.1). Considering a scavenged volume of 110 and 100 tons/day, as suggested by BMA Division of Policy and Planning, the corresponding disposal volumes then turn out to be 3,750 and 4,120 tons/day respectively.

The uncollected volume is mostly dumped onto vacant areas nearby, while some is directly dumped into canals and/or rivers, or discharged into drainage systems. One way or another, there will be an ultimate impact on the quality of the receiving water resources. The collected and scavenged volumes also need to be disposed of. This can create water pollution problems, as described later in this Chapter.

Cost Accounting

Solid waste management can be seen as a "thankless task", with no end nor fixed, lasting accomplishments. And yet it consumes large portions of community revenues, costing anywhere from 200 to

500 baht/ton o ste material handled, or from t 47 to 137 baht/resident/ye

In general, at 10 percent of the costs of solid e management are covered by the ct user charges collected. One hous d with six people produces about 0.7 /year and yet it used to pay only abou baht/year (only 70 baht/ton). Market e particularly problematic. One ate market in Chonburi generates least 3,300 tons/year of waste, h ays a fee of only 36,000 baht/yea to cover all municipal services pro ed (less than 11 baht/ton). Simila hotels often generate large amount f waste. One large hotel in Pattaya duces about 350 tons/year, yet pays a id waste fee of only about 1,100 bah ar (less than four baht/ton).

For the service to be formed well, it needs a reliable, adeq budget: one which could be more assur if special revenues earmarked for solid waste service were being collected. Fees, until this year, were stipulated by law at only 4 baht/household/month (for less than 20 l/day). A new (1985) Ministry of Public Health Notification now enables all communities to raise their fees to 40 baht/household/month with increasing fees allowed for quantities per house or building equal or less than 20 l/day.

With these raised fees, solid waste collection may become profitable for the first time and many private companies are interested in the potential. At present, BMA is experimenting on a project allowing private enterprises to collect solid wastes from selected residential areas for a mutually-agreed fee. If this proves successful, it is highly likely that more contracts will be granted to private companies in the future.

ISSUES

Solid wastes from hospitals and medical clinics, as well as from industry, are collected together with other community wastes. It appears that none of the establishments separate potentially pathogenic wastes (e.g. spent bandages,

Table 11.1 Forecast of Bangkok Solid Wastes Production, 1987-1991.

Year	Total Population[1] (million)	Estimated volume of solid wastes (ton/day)				
		Produced[a]	Collected[b]	Uncollected	Scavenged[2]	To be disposed[c]
1987	5.972	5,076	3,860	1,216	110	3,750
1988	6.115	5,198	3,950	1,248	110	3,840
1989	6.256	5,318	4,040	1,278	100	3,940
1990	6.396	5,437	4,130	1,307	100	4,030
1991	6.527	5,548	4,220	1,328	100	4,120

Notes:
a. based on 0.85 kg/c/d.
b. based on 80% of population to be serviced and 95% collection efficiency.
c. to be disposed = collected - scavenged
Sources:
1. Subcommittee on Population Policy and Planning, NESDB 1985 (including non-registered population).
2. Policy and Planning Division I, BMA, 1986.

laboratory cultures, or surgical wastes) or toxic substances (e.g. mercury or lead) from the normal wastes. This leads to contamination of the domestic solid wastes and may result in complications in waste handling and management.

Most Thai communities rely on open dumping and occasional open-air burning as their disposal technique. Only Bangkok, thanks to its better financial status, can use composting processes and small incinerators for solid waste disposal. Table 11.2 summarizes the current overall capacity of Bangkok's solid waste disposal facilities. Overall disposal capacity amounts to 1,480 tons/day.

However, only approximately 600 tons/day of wastes are presently processed by the above-mentioned facilities (ONEB 1985a). This is due to an unusually high downtime at some of the facilities. Regardless of the downtime of the disposal facilities, the present capacity cannot cope with the volume of already collected wastes. This necessitates additional disposal capacity. At present, four dump sites are in use, namely at On-Nuj, Nongkhaem, Ram Intra and Ratburana.

Partly due to the high investment cost involved, and partly due to the high energy requirement because of the moisture content of the wastes, incineration processes have not been effectively used in Thailand. Sanitary landfill practice, in which the solid wastes are discharged into pits and subsequently covered with soil, is also practically non-existent. Open dumps are widely employed by Thai municipalities, resulting in public health hazards such as disease transmission, vector breeding, foul odors, and surface and groundwater contamination.

Where burning is used, the waste is typically burned on-site during the dry season to control vectors and reduce volumes. During the rainy season, insecticides are sprayed on-site to control vectors. Certain communities own machines (with bulldozers and loader attachments) for spreading and covering refuse at the disposal site, while other communities intermittently rent equipment. Overall, however most communities are simply concerned to get solid wastes "out of town" as fast as possible. Little thought is given to suitable treatment or disposal processes. At present, the most promising potential approach would seem to be sanitary landfill, especially in upcountry provinces. This technique offers both relatively low investment costs and a useful potential for land reclamation projects.

Water Pollution

The wastes generated from all sources are collected and disposed of together by the relevant authorities. Toxic chemical and

Table 11.2 Overall Capacity of Bangkok Solid Wastes Disposal Facilities, 1985. (tons/day)

Facilities	Site				Total
	On-Nuj 1	On-Nuj 2	Nong Khaem	Ram Intra	
1. Composting	320	320	160	320	1,120
2. Small incinerators	100	100	60	100	360
Total	420	420	220	420	1,480

Source: Suttapreeyasri, 1985.

Table 11.3 Characteristics of Solid Waste Leachate (stored in dump-site ponds) (mg/l except pH)

Description	Dump Site			Typical[3] Sewage
	Nong Khaem[1]	On-Nuj[1]	On-Nuj[2]	
pH	8.2-9.0	7.6-9.1	7.9-8.6	-
Alkalinity[a] as $CaCO_3$	6,126	3,225	1,000-8,900	100
BOD[b]	590	312	150-1,230	150-200
COD[c]	14,260	3,300	1,930-8,820	-
TKN[d]	570	222	575-1,700	50
Phosphate	21.5	7.8	22.5	-
Suspend solids	146	109	110-2,410	300
Colour(Pt-Co)	-	-	3,500-22,500	-
PCB	-	-	0.6-0.7	-
Chromium VI	-	-	1	-
Mercury	-	-	3.8-4.5	-

Notes:

a. Alkalinity is the capability to buffer changes of pH.

b. BOD (Biochemical Oxygen Demand) denotes the organic content readily digestable by organisms.

c. COD (Chemical Oxygen Demand) is the equivalence of oxygen used for the chemical oxidation process. It represents both biologically and chemically digestable parts of organic matters present in a sample.

d. TKN (Total Kjeldahl Nitrogen) is the sum of organic and ammonia nitrogen content. It is also used for organic matter measurement, especially that of protein type.

Sources:

1. Panswad 1982, Annual average of 1979-1980.
2. Pattamapirat 1986a.
3. McGauhy 1986. 'Engineering Management of Water Quality'.

pathogenic wastes can therefore contaminate domestic solid wastes. These wastes, when dumped, stored in open areas and rained upon, can cause water pollution due to their high organic-content leachate. The leachate is usually stored in ponds in the disposal area. Its typical characteristics are shown in Table 11.3.

The data show the high water pollution potential of such leachate (Table 11.4). If discharged into waterways, it can cause problems such as low dissolved oxygen (DO) levels, septic conditions, and algal blooms. Such high alkalinity values (of 1,000 to 8,900 mg/l as $CaCO_3$) make the water unsuitable for various industrial processes, while the high content of organic matter (COD of 1,930 to 14,260 mg/l and BOD of 150-1,230 mg/l) makes such leachate much more polluting per unit volume than domestic wastewater (COD of about 600 mg/l and BOD of 150-200 mg/l).

According to the relevant World Health Organization (WHO) standards for drinking water, the color on the platinum-cobalt scale should not be over 15 units. Looking into the concentration of color (3,500 to 22,500 units) present in the leachate, it is possible to roughly estimate the degree of the problem arising from leachate discharges. At present, there is a continuous outcry from people living along canals which receive the discharge of leachate from both the On-Nuj and Nong Khaem dump-sites. The BMA has begun to realize the seriousness of the problem and has currently conducting a treatability test of the offending leachate.

The Polychlorinated biphenyl (PCB) content of 0.6-0.7 mg/l found in the leachate is relatively high. A high dilution ratio is essential once the leachate is discharged into rivers if safety limits are to be safeguarded. The high insecticide content may be attributed to the pesticide sprays used

Table 11.4 Potential Water Pollution Load from Solid Wastes

Year	Total Population (million)	Uncollected portion		Dumped portion		% Population equivalence
		(ton/day)	P.E. (million)	(ton/day)	P.E. (million)	
(1)	(2)	(3)[1]	(4)[a]	(5)[1]	(6)[b]	(7)[c]
1987	5.972	1,216	0.834	3,750	1.837	44.7
1988	6.115	1,248	0.856	3,840	1.882	44.8
1989	6.256	1,278	0.876	3,940	1.931	44.9
1990	6.396	1,307	0.896	4,030	1.975	44.9
1991	6.527	1,328	0.911	4,120	2.019	44.9

P.E. = population equivalence

Notes:

a. (4) = (3) x 0.06 x 0.4/35
based on 0.06 g BOD per gm garbage (Panswad 1982), 40% of wastes being 'garbage' type, population equivalence (P.E.) of 35 gm BOD_5/c/d

b. (6) = (5) x 0.049/100
based on 0.049 gm COD per gm solid wastes (Panswad 1982), population equivalence of 100 gm COD/c/d

c. (7) = ((4) + (6)) x 100/(2)

Source:

1. from Table 11.1.

on the waste piles to control vectors in the rainy season. This high content of insecticides can be a bacterial inhibiting factor, which could be significant if a biological process were to be selected to treat the leachate.

PCBs are now proving to be a more severe environmental problem than initially envisaged. When compared with similar compounds such as DDT, the residence time of PCBs in the environment is much longer. The estimated inputs of PCBs are currently many times those of DDT. There are no technical or economic reasons why the use of PCBs in transformers, large and small capacitors, and heat-transmitting fluids should not be prohibited in new equipment. The use of PCBs as a chemical feedstock or as intermediates in synthesis processes should be prohibited (Lack T.J. 1984). The US Food and Drug Administration (FDA) has issued an interim safety standard of 5.0 ppm PCB in any food. The Environmental Protection Agency (EPA) has imposed limits on PCB discharges, deciding that environmental levels should remain below 0.01 ppm at all times (Waite T.D. 1984).

Of equal concern is the total concentration of heavy metals, namely chromium VI (1 mg/l) and mercury (3.8 to 4.5 mg/l). The Ministry of Industry requires that the discharged effluent contents of insecticide, chromium and mercury should be nil, 0.5 and 0.005 mg/l, respectively. The high content of these two heavy metals may be from the leachate effect of certain discarded items, such as fluorescent lamps and dry cell batteries.

Due to their non-biodegradability, one way to bring these metals down to acceptable standards is dilution. However, the dilution ratio to achieve this would be very high for the mercury case (1:800), rendering the method next to impossible in practice. A chemical coagulation or precipitation approach followed by sedimentation is therefore also likely to be required to treat the waste leachate.

Composting

In Bangkok, up to 17.5 percent of the solid wastes collected are sent to four composting plants, at different locations, while the rest is piled in open dump areas. It takes about six months for the composting process to yield a soil conditioner with a fertilizer value (expressed as %N : %P : %K available) of 1.5:1.3:1.5 and pH of eight (Suttapreeyasri, 1985). This product, if mixed with dried nightsoil, will produce another type of soil conditioner with an N:P:K ratio of 1.8:2.5:1.0 and the same pH value.

People are misled if they try to rate these products based on only the N:P:K ratio, which incidentally is rather low in both cases. Their soil conditioning capability is virtually ignored by local farmers. So, coupled with the fact that additional synthetic fertilizer is still needed when the composted product is applied on the field. The composted solid wastes tend to be noncompetitive in price terms and are not at all popular among users.

Clearly, the picture is somewhat discouraging. A new conceptual approach is needed in this important area. The responsible organizations should look at the situation from another angle. Besides providing more publicity on the soil conditioning value of the products to the public, the assigned staff should bear in mind that it is their duty to treat the wastes (or to turn them into valuable products, no matter how low the value is), not to produce a fertilizer product as their main aim. Whatever comes out of the process should be regarded as a by-product, not as a product, and be priced accordingly.

Management Considerations

For solid waste disposal to be performed

efficiently, the costs need to be carefully monitored. With little or no cost accounting performed, it is difficult for community officials to feel justified in charging a specific fee -- even though a recently amended fee structure enables them to cover all, or at least most, of their costs. Authority expenditures range, from only 194 to 504 baht/ton of wastes. This is too little. In developed countries, up to 10 times this expenditure is needed (and used) for solid waste disposal programs. The poor level of collection and disposal of waste in Thailand may be attributed to this single fact.

In a community where residents and visitors are considerate in placing their wastes in litter bins and well-designed household bins, sweeping would be a minor part of the solid waste management service. However, within the urban communities served, the sweeping cost surprisingly comprises a significant 35-55 percent of total solid waste management costs. Because public cooperation is so conspicuously lacking, assignments to sweepers are for only 200 to 500 meters of street length. This short length is cleaned and re-cleaned continuously throughout the day. (Thongkaimook, 1986). Public cooperation and a good publicity program are clearly essential.

Due to the lack of good record keeping, it is difficult to disaggregate the data by activity and thereby evaluate its meaning in terms of the efficiency and effectiveness of solid waste collection and disposal. New procedures for record keeping, monitoring and cost accounting are strongly recommended.

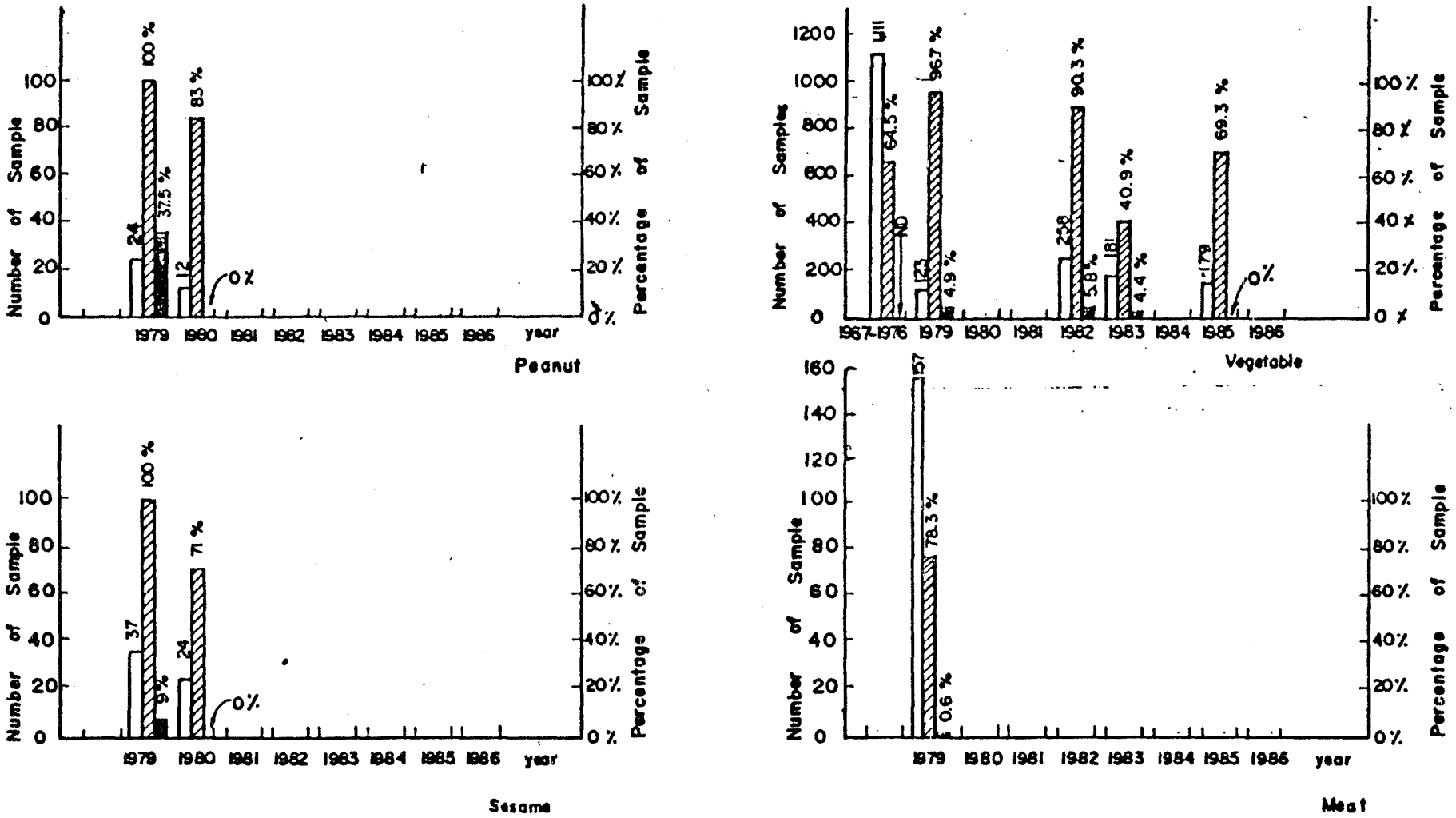
Typically, local communities have no technical data (e.g. loaded weights, densities), costing data (e.g. maintenance, repair and operating costs), productivity data (e.g. weight lifted/work shift, available loading time/shift), nor trained staff and qualified personnel to do the necessary planning. It is again recommended that engineering and economics-oriented training and technical assistance be made available.

11.2 TOXIC AND HAZADOUS SUBSTANCE MANAGEMENT

A number of trends can be discerned in Thailand's use of toxic substances and production of hazardous wastes. First, the volumes of toxic substances being imported do not suggest that there is any need for drastic action. Localized problems have emerged and the mismanagement of pesticides, particularly in the agricultural sector, underlines the need for improved controls, more vigorous enforcement of the legislation, and better education of pesticide users on the hazards involved in using these materials.

The total amount of pesticide consumed is clearly on a growth trend. If there is a drive to improve the efficiency of Thai agriculture in future years, because the total area of land available for conversion to farming is constantly shrinking (see Chapters 1 and 4), then the use of crop protection chemicals is likely to grow. The most buoyant demand has been for the relatively safe pyrethroid group of insecticides, although to date the total quantities involved are much smaller than for the organochlorine, organophosphate or carbamate groups. So far, at least, demand for the more problematic compounds (e.g. the organochlorines) has been contained. DDT has been detected in a small number of environmental samples, but at extremely low levels, considerably less than one part per billion. The Ministry of Health is the only current user of DDT.

Although the levels of pesticide found in rivers are not yet particularly pronounced, concern has been expressed about the level of pesticides found in food in Thailand. Figures 11.1 and 11.2 show the pesticide levels reported as remaining in such important foods as

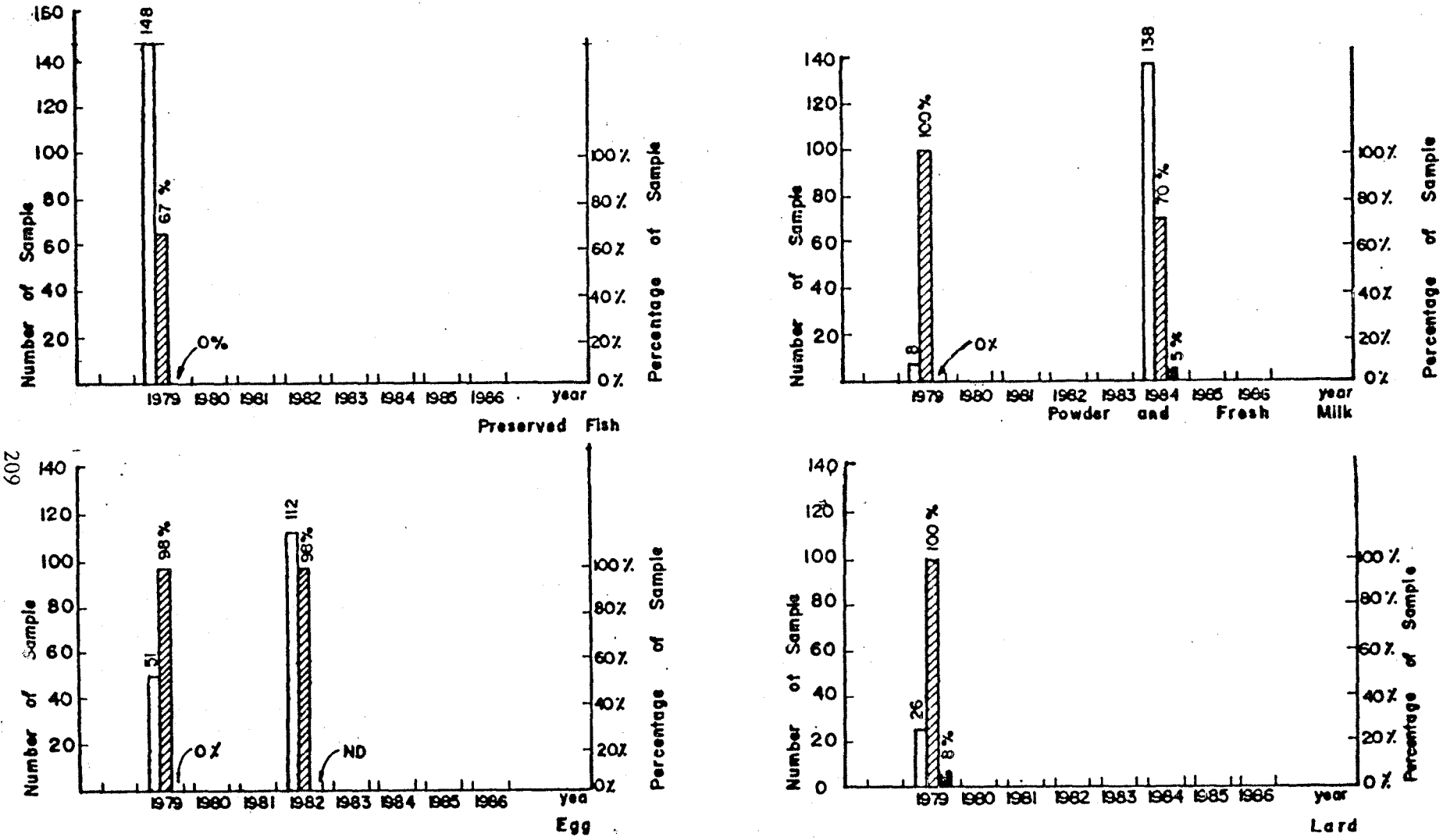


Remarks : Number of sample, Percentage of detected sample

Percentage of Over-Maximum Residue Limit , ND = No Data

Sources : Deema (1980). DOA 1980(a) , DOA 1982(a),(c).DOA 1983(a),(b),(c),(d),(e),(f),(g),(h) DOA 1935 (a),(b)

Figure 11.1) Pesticide Residues in Vegetable ,Peanut,Sesame and Meat



Remarks : Number of sample, Percentage of detected sample

Percentage of Over-Maximam Residue Limit , ND = No Data

Sources : Deema(1980),DOA 1932(b),DOA 1984(a)

Figure 11.2 Pesticide Residues in Preserved Fish,Powdered and Freash Milk, Egg and Lard.

vegetables, peanuts, fish, meat, eggs and milk. The diagrams show the number of samples taken, the percentage found to contain pesticide, and the percentage of the samples found to contain pesticide levels in excess of the maximum residues limit.

The total number of samples involved was very small indeed (around 45 vegetable samples, for example, in a year, of which three were over the maximum residue limit), so it is impossible to draw any overall conclusions. But, while it is also worth noting that residue limits are typically set to ensure a considerable margin of safety, it is at least suggestive that a small percentage of the samples of vegetables, peanuts, sesame seed, fresh milk and lard were found to be over the limit.

Herbicides are gaining growing acceptance among farmers, as shown in Table 11.5. Although herbicides are certainly toxic, they tend to be very much less toxic than most insecticides and are also much less likely to cause long-term environmental pollution problems. But like all agricultural chemicals, their formulation, distribution and use may lead to problems and should be closely monitored. The human health and ecological problems alleged to have been associated with dioxin contamination of the herbicide 2,4,5-T underline the need for careful quality control in the production of such materials.

As far as major hazard industrial plants are concerned, Figure 11.3 shows that there was almost a sevenfold growth in the number of industrial plants using and disposing of toxic chemicals registered with the Ministry of Industry's Industrial Control Division during the 1970s, although the number of new registrations has tapered off during the worldwide recession. As Section 11.4 argues, one of the key issues in this field is that there is a worrying lack of the sort of survey data on which a

Table 11.5 Estimated Local Formulation and Production of Pesticides (ton/year and percent)

Pesticides	Formulation Volume				
	1981	1982	1983	1984	1985
Insecticides	12,797	8,302	6,307	9,583	10,689
	(90.3%)	(91.4%)	(79.2%)	(52.2%)	(54.8%)
Fungicides	294	144	-	20	18
	(2.1%)	(1.6%)	(-)	(0.1%)	(0.1%)
Herbicides	729	355	1,392	8,378	8,487
	(5.1%)	(3.9%)	(17.5%)	(45.6%)	(43.5)
Miticides	349	286	268	394	313
	(2.5%)	(3.1%)	(3.3%)	(2.1%)	(1.6%)
Sub-Total	14,164	9,087	7,967	18,375	19,507
	(100%)	(100%)	(100%)	(100%)	(100%)
Local production of herbicide	-	4,500	4,500	4,500	4,500
Total	14,164	13,587	12,467	22,875	24,007

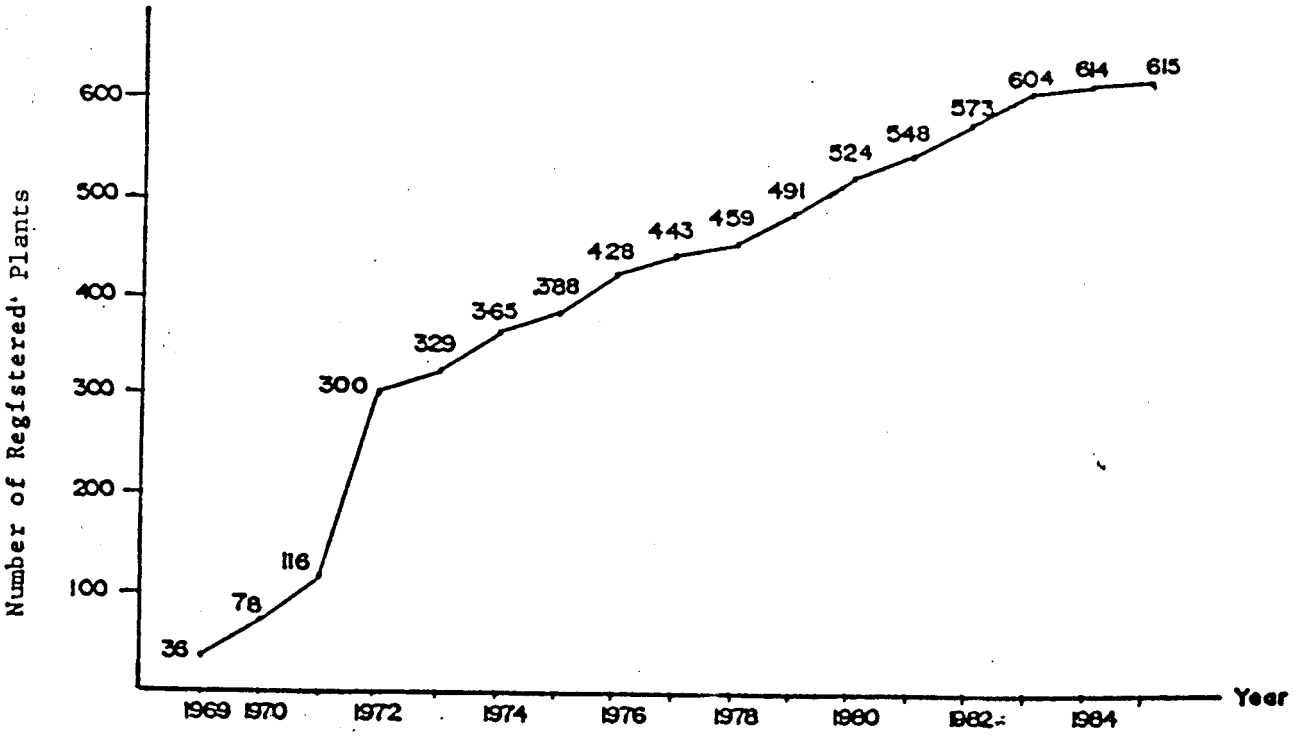
Source: Adapted from Chuapanich (1986) & BOI (1986).

comprehensive picture of the major hazards situation might be built up, both for particular localities and for Thailand as a whole.

ISSUES

Three major issues have emerged. First, there is the question of what can be done to ensure that Thailand's growing consumption of pesticides does not buy increased agricultural productivity at the expense of human health and environmental quality (Box 11.1). Second, there is the question whether sufficient is known about the country's growing number of major hazard industrial plants. And, third, what can be done to ensure that all hazardous wastes are identified and properly treated, where necessary, and disposed of in a safe fashion. An example of one possible solution to some of these problems is described in Box 11.2.

Figure 11.3 Number of Registered Plants Using and Disposing of Toxic Chemicals



Source: Industrial Control Division , MOI

BOX 11.1 The Pesticides Picture

Used carefully, pesticides can play an important role in boosting agricultural productivity. Used carelessly, they have the potential for causing more damage to people and their environment than almost any other single class of chemicals. Even when properly managed, their long residence time in human tissues and in the open environment makes it essential that their levels are monitored wherever they may end up. Like most other developing countries, Thailand has benefited from the availability of the growing spectrum, of pest control chemicals (some 2,000 brands are sold in the country), and has also produced its share of pesticide poisonings and wider environmental contamination.

The statistics for pesticide poisonings and deaths among farm workers are reported in Chapter 12. Broadly, they show that the annual rate of reported pesticide poisonings more than tripled between 1974 and 1983, from 725 to 2,353. Reported pesticide-related deaths fell from 34 in 1974 to 17 in 1983, albeit by way of a peak figure of 53 in 1976. On the basis of these figures, it has been calculated that the average annual pesticide poisoning rate between 1974 and 1983 was 9.2 cases per 100,000 agricultural workers, with an average annual death rate of 0.17 per 100,000 workers. However, these figures probably represent a severe underestimate of the scale of the problem.

A survey of 10 villages in Rayong Province, described in Chapter 12, found well over 8,000 cases of pesticide poisoning per 100,000 agricultural workers. Of these cases, only about two percent actually went to a hospital for treatment, suggesting that the official figures are likely to be overly optimistic. A random sample of workers was tested for pesticide exposure, and 37 percent proved to have been exposed, with 0.8 percent of the sample showing early warning signs of pesticide poisoning. It was also concluded that the death rate was likely more like 1-2 per 100,000.

One of the best ways of determining whether someone has been exposed to pesticides is to test the levels of the enzyme cholinesterase in their blood. The greater the pesticide exposure, the lower the cholinesterase level. The available evidence, some of which is reviewed in this Chapter, tends to suggest that workers in pesticide factories are less exposed than they were, that a proportion of those working in pesticide retail outlets are affected, and that the number of farmers with depressed cholinesterase levels is on a rising trend. This last fact points to continuing ignorance among pesticide users of the potential risk they are running.

Meanwhile, testing of pesticide residues in food has shown, in the very small number of vegetable samples tested, that anywhere between 40 and 90 percent contained detectable levels of pesticide. Although a small proportion of the samples tested were over the limit, the danger to consumers was thought to be marginal. At the same time, research on the pesticide contamination of rivers and of the Gulf of Thailand has found such contamination in places, but no conclusive evidence of major pollution problems.

One reason for this state of affairs may be that action has already been taken to control some of the most persistent pesticides, particularly

the organochlorines. The volume of organochlorine pesticides imported into Thailand has dropped sharply, from 2,592 tons in 1978 to 323 tons in 1978.

Meanwhile, there has been a significant shift in the structure of the Thai pesticides industry. There are three main options in this area: (1) import pesticides as final product; (2) import only the active ingredients, and formulate the product locally; or (3) manufacture pesticides locally. Option (1) accounted for just over half (53 percent) of Thailand's total pesticide consumption of around 30,000 tons in 1980, with option (2) making up the balance. By 1984, however, imports had slipped to around 37 percent (of an admittedly larger total consumption figure of over 38,000 tons). Local formulation had grown significantly in volume, accounting for 51 percent, and the balance was made up by two new Thai factories which have a manufacturing capacity of some 4,500 tons per year of the herbicide paraquat.

The overall picture, then, is one of growing pesticide manufacture in Thailand, with local formulation and production jointly totaling nearly 13,600 tons in 1982 and just over 24,000 tons in 1985. The cost advantage of local formulation over imports has fuelled the growth of the local formulation industry, with the 10 plants operating in 1982 having more than doubled to 26 by 1985. Given the toxicity of these products, a careful eye must be kept on their production, distribution and use. It is also essential that pesticide research and monitoring continue, to provide a picture of where these products and their breakdown products finally end up (e.g. in workers, the public or the open environment), and of what impacts they have along the way.

Pesticides

The evidence reviewed in earlier sections suggests that, while the number of pesticide poisonings is falling in pesticide plants, the local production of these compounds is increasing and new factories are coming into the business. Pressure must be maintained, and in some cases increased, on such operations, to ensure that they achieve acceptable standards.

At the same time, while there is considerable variance in the estimates of pesticide poisonings and deaths reported by different researchers who have studied the agricultural sector, the trend here is certainly an adverse one. More must be done to ensure that those pesticides that are used are used safely and that the containers in which they are shipped are disposed of in an acceptable manner. Pesticide users at the farm level clearly need more education on the health and environmental impacts associated with such materials.

New pesticide formulation and production plants should generally require EIAs before they are given the go-ahead. Meanwhile, however, the Bhopal disaster underscores the necessity of using zoning and other town planning controls to ensure that such plants are not constructed in unduly sensitive places. One company recently got BOI approval to build a pesticide factory in Pathum Thani, a small town north of Bangkok. The company plans to produce 300,000 liters/year of glyphosate and 600 tons/year of carbofuran. In the event of a major accident, the plant could possibly discharge either of these products, or intermediates like dimethyl sulfur, into the Chao Phraya river -

upstream of the main water intake for Bangkok's Metropolitan Water Works Authority.

Toxic Substances and Hazardous Wastes

The number of registered factories using toxic or otherwise hazardous materials is growing. The volume of potentially hazardous materials used in the Thai economy as a whole is also growing. Yet there is a severe shortage of reliable information on who is using what, where, and what is being done with such materials once their working life is finished.

If experience elsewhere is anything to go by, pressures will continue to build on this front because of three mutually reinforcing factors: (1) growing quantities of pesticides and other synthetic organic chemicals are being produced, transported, used and disposed of; (2) many are hazardous and some are long-lived, whether in human tissues or in the open environment; and (3) the analytical techniques used to detect concentrations of such substances are constantly evolving, and their sensitivity is increasing dramatically.

It is worth pointing out, too, that even normal garbage can produce toxic leachates which may percolate down into groundwater used for drinking water purposes. The garbage which Thais throw out each day tends to end up in waste dumps which have not been designed with groundwater protection in mind. Yet these materials include such everyday - and potentially hazardous substances - as nail polish remover, bleach, domestic pesticides and PCBs from old television sets and other equipment. What is needed is a review of the current situation in the waste disposal sector, together with the formulation of a strategy designed to ensure that Thailand's future needs for hazardous waste disposal are met.

The quality of groundwater resources will need careful monitoring, to ensure that Thailand does not repeat the problems experienced even in such technologically sophisticated countries as the United States.

Another urgent priority is the updating of the list of substances prepared under the Poisonous Substances Act. Currently, only substances that have been specifically named in ministerial regulations under the Act are subject to control. Since the process of listing such substances is extremely slow in Thailand, the result is that a considerable number of potentially dangerous substances are being used without any control. The updating of the list should be complemented by the introduction of new procedures designed to ensure that new toxic threats can be identified and controlled in a much shorter time-scale.

Another line of development would be to ensure that the issues related to the management of toxic substance and hazardous waste are properly addressed in the EIAs prepared for the National Environment Board. Ultimately, too, the list of project types for which EIAs are required should be extended. The controversy over the proposed tantalum plant at Phuket (see Box 12.2) illustrates what can happen if the public believes that it has not been properly informed about the impacts likely to be associated with a proposed development. Public education and awareness programs, together with measures designed to ensure real public participation in major planning decisions, are both essential in a democracy which aims to pursue a vigorous program of industrial modernization.

BOX 11.2 Suitable Cases for Central Treatment?

Hazardous waste disposal is a subject of considerable concern in Thailand, despite the fact that some industries have spent millions of baht on the installation of treatment facilities for their liquid wastes. The treated effluent may or may not meet the standards imposed by the Department of Industrial Works (DIW), but the chemical precipitation techniques generally used result in chemical sludges or solids which themselves require disposal. Often they are passed on to private contractors, who may dump them in sites unknown either to the industrial waste producer or to the authorities.

At the same time, many smaller companies do not have the know-how to treat or adequately dispose of the wastes they produce. The DIW has therefore decided to initiate a joint treatment program for handling toxic liquids, sludges and solid wastes from all industries situated in and around Bangkok (Lohwongwatana, 1986).

A prefeasibility study was conducted in 1984 and revealed that as many as 682 factories were regarded as definite generators of toxic wastes, out of 862 possible producers in the study area. The annual volume of hazardous wastes produced in 1984 by the factories in the study area was estimated at 22,100 tons of solids and slurries, in addition to 84,000 cubic meters of wastewater. These volumes are expected to double by the year 2000.

Three treatment centers are planned by the DIW, to be located in the western, northern and eastern suburbs, where some of the major generators of hazardous wastes are located. The aim is to minimize the cost of collecting and transporting the waste. The toxic, inorganic wastes will be converted into an environmentally inert substance using a solidification process which encapsulates the waste in a cement-like agent. The original idea was that the resulting material might be sold as a filler for use in road-making, although the disposal of the fixed wastes in a landfill site is another option.

The first treatment complex will be situated on a large plot of land in the western suburbs of Bangkok, at Samea Sam, Bangkhuntian District. There will be a 200 cubic meters per day chemical treatment plant for treating electroplating wastewater, an 800 cubic meters per day chemical treatment plant and polishing lagoons for treating textile dye wastewater, and chemical detoxification and cement mixing facilities for handling sludges and solid wastes. The center is expected to begin operations early in 1988.

A program of public hearings is under consideration by the government and, if the scheme is accepted by local people, about 160 hectares of land will be secured. In order to reduce the administrative burden on the government, the operation of the center, including the transportation of treated sludge, will be handled by a private contractor. Besides providing some 30 million baht to cover the initial investment cost, the DIW will also play a supervisory role. It hopes to recover some of its costs by sharing the profits generated in the process.

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12 Accident Prevention and Occupational Safety and Health

12.1 STATUS AND TRENDS

Historical Development

Industrial accidents first began to occur in large numbers in Europe during the 18th century as the industrial revolution made possible the use of large-scale mechanised production. In Thailand, it is not clear when the problems of accident prevention and occupational safety and health really began. But the problem was probably not a new one. During the reign of King Rama IV (1851-1868), when Khlong Dumnernsaduak was being built, His Majesty the King, when seeing workers become ill during work, had ordered a Salaya (Medical Center) built to treat the workers who were ill or injured. A Salasop (Corpse Center) was also constructed by order of His Majesty to hold funeral services for those who were less fortunate. To this day the place where the Medical Center was is still named Salaya District.

In modern times, occupational safety and health management can be said to have begun in 1928, when an Act to control businesses that are of nuisance or dangerous to the public was enacted by King Rama VII. The first Public Health Act of the country was enacted by the Parliament in 1934, two years after the change-over from absolute monarchy system to the parliamentary system as we know it today. This Act was soon repealed and replaced by the Public Health Act 1941, and is still in force today. The Public Health Act is concerned with the control and management of primary public health, such as garbage disposal, and other sanitary matters.

The first piece of labour legislation was introduced in 1956. This legislation contained provisions for the compensation of workers who became ill or were injured during work. The responsibility was primarily of the employer. In 1964, when 41 workers in a dry-cell manufacturing plant were overcome by manganese intoxication, the occupational health problem had received much public attention. Consequently in 1972, the Department of Health (DOH), which was the main government agency responsible for the general health of the public at that time, established the Division of Occupation Health within its Department. Subsequent efforts to upgrade this Division into an Institution of Occupational Health failed. In the same year when the Division of Occupational Health was established, the Revolutionary Council Decree No. 103 was announced. This decree is a comprehensive labour code, launching labour management in Thailand into a new era. The Decree covers many aspects of labour management, including labour welfare, wages, child labor and occupational health. The Workmen's Compensation Fund (WCF) was also established by this Decree.

Many ministerial regulations regarding occupational health have since been announced under Decree 103. In 1981, the National Institute for the improvement of working Conditions and Environment (NICE) was established, with assistance from

UNDP/ILO. The objective of NICE is to improve the protection of workers from occupational accidents and diseases through research, training, proposing of standards, dissemination of information and other related activities.

From another direction, the occupational health of factory workers is also the concern of the Ministry of Industry. King Rama IV was the first Thai Monarch openly receptive to western influences and ideas. During this period we saw the introduction of steam engines into rice mills and lumber mills, which brought Thai industry into the age of modern mechanization. Large factories began to appear after World War I, during the reign of King Rama VI (1910-1925). During this period, cement, cigarette, soft drinks, soap and other factories were set up. Originally the Division of Industry was established in the Department of Commerce in 1930 for the control of factories. Later, in 1941, this Division was upgraded into a Department. In 1942, during World War II, the Ministry of Industry was established to deal with war-time conditions. The first Factory Act was promulgated in 1939. This Act contained provisions for the welfare and safety of workers. Later revisions of this Act in 1969, 1975, and 1979 retain these provisions.

In 1983, the National Safety Council of Thailand (NSCT) was established, mainly due to the concern about the increasing number of traffic accidents. NSCT is a policy and advisory agency attached to the Prime Minister's Office. It is responsible for proposing national policies to the Council of Ministers and for coordinating the many agencies dealing with accidents. The present function of NSCT includes all types of accidents, however.

Accident prevention from major hazard installations is a relatively new area. Although major accidents, such as the explosion of the Bangsue Arms Depot in November 1980, have occurred in Thailand, Bhopal tragedy in India has proved an unparalleled spur. In 1986, TDRI, in cooperation with NICE/ILO, conducted an investigation and prepared some initial groundwork for establishing a major hazard control system. The several recent international industrial accidents such as the explosion of an LPG facility in Mexico City, the leakage of methyl isocyanate (MIC) from a pesticide manufacturing plant in Bhopal, and the recent accident at the Chernobyl nuclear power plant in USSR, all have made the Thai public increasing weary of major hazard installations.

Future Trends

Although we have seen the occupational injury rate rising in the last ten years, there is as yet no explanation being put forward to explain this trend. In part this is due to the lack of adequate studies or research in these problem areas. The only reliable source of injury statistics available is the WCF. But the statistics collected by the WCF are inadequate, because firstly the data are collected primarily to satisfy the legal requirements for granting of compensation claims, and secondly the Fund only covers about 40 percent of industrial workers. Therefore whether the rising trend will continue in the future is difficult to foretell, because we do not know the underlying mechanism for the trend.

Consider the rates of various types of injuries as classified by the severity of injury. If we separate the various types of injuries plot them as shown in Figures 12.1 and 12.2 it can be seen that severe injury rates (those resulting in death, permanent disability or partial disability) have all shown decreasing trends. Only injury rate from the temporary disability category has been rising.

Therefore, the increasing trend in the past could have been in part due to the expansion of WCF itself. As more

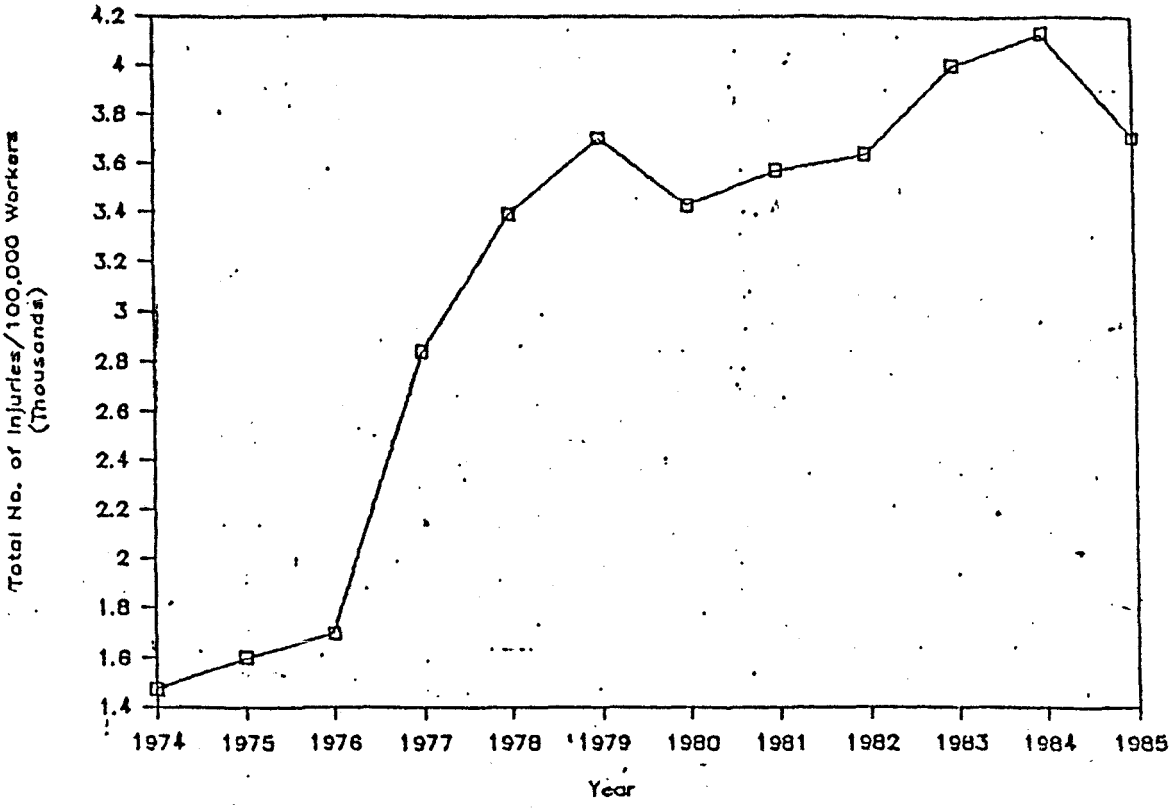


Figure 12.1: Total Number of Injured Workers, 1974-85

Source: DOL, 1984b, p. 83

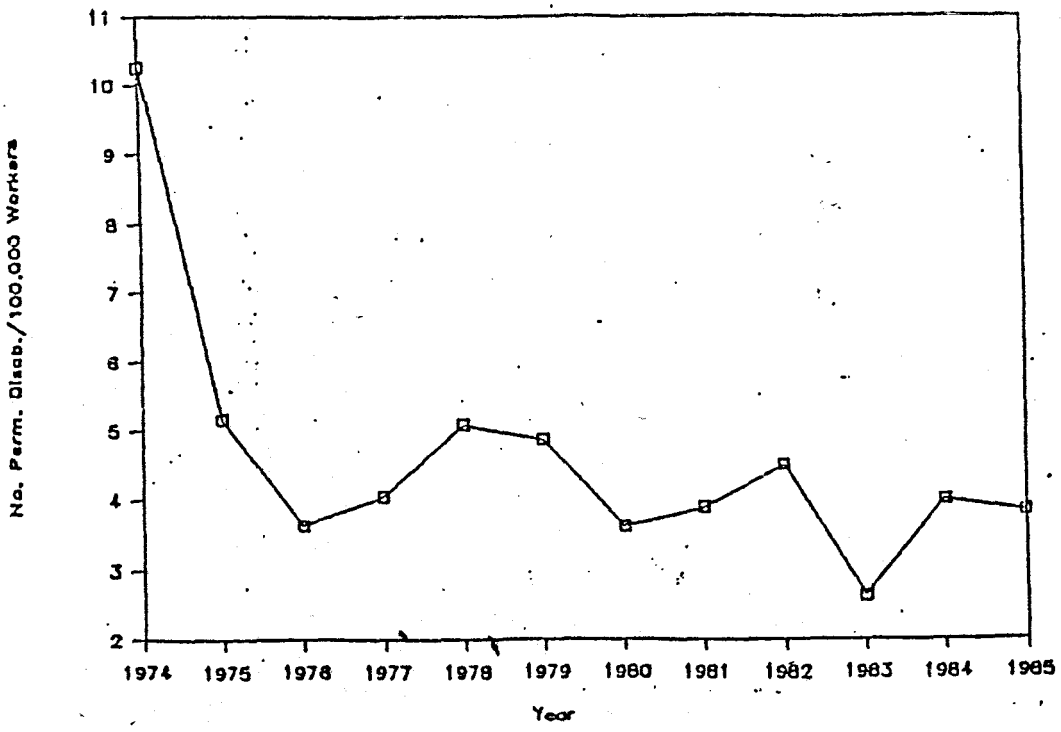


Figure 12.2: Number of Fatalities/100,000 Workers, 1974-85

employees are covered by the Fund and as more employees become aware of the Fund, more workers begin to file for claims. Again from Figure 12.1, we can see that the rate of increase was most rapid during the initial five years after the establishment of the Fund. The rate then levels off in the last five years.

Although the fatality rate has shown decreasing trends in the past, this does not necessary indicate that the situation is satisfactory. If we compare the fatality rate of Thailand to those in the Nordic countries (Findland, Norway, Denmark, Sweden), the fatality rate here is still more than an order of magnitude higher (DOL, no date, page 8).

As far as the trend in pesticide poisonings is concerned, we have seen that one of the most effective ways of detecting potential problems is to measure the cholinesterase levels in human blood. The Department of Agriculture internally specifies a minimum level of 54 Ch-E per unit, whereas the Department of Health's

BOX 12.1

WHERE ARE THE MAJOR HAZARD PLANTS?

In the wake of the disasters in Bhopal and Mexico City, there has been growing interest in finding out how many "major hazard" plants there are in Thailand, where they are, what they are doing, and what potential risks are being imposed on their workers, the communities in which they are located, and the environment.

The total number of factories registered with the Ministry of Industry's Industrial Control Division as generators of toxic waste grew from 78 in 1970, through 524 in 1980 to 615 in 1985. The continuing economic depression has helped slow the rate of new factory development, with this trend expected to continue for some years. Furthermore, those coming forward with new factory projects are likely to be asked to prepare Environmental Impact Assessments before they are allowed to proceed, which should help ensure not only that they are designed from the start with safety in mind, but also that a national database can be assembled on major hazards in the industrial sector.

Currently, the records on major hazards and toxic waste generation are patchy. Some toxic waste producing plants do not register with the Department of Industrial Works (DIW), while financial and personnel constraints slow the process by which the responsible agencies visit major hazard plants, advise their management on how to tackle particular problems, and enforce the relevant standards. At the same time, however, some of the factories wrapped into that global figure of 615 in 1985 may well be producing at a low level, or not be producing at all, simply keeping their registration on the books pending some sort of economic recovery.

But where are these factories located? The answer seems to be that the overwhelming majority are to be found in and around Bangkok, including nearby Samut Prakan and Samut Sakhon provinces. Five out of seven of Thailand's lead smelters are found in the area, together with over 80 percent of the country's fluorescent lamp manufacturers, and over 90 percent of its chemical, dry cell battery, paint, pharmaceutical and textile manufacturers. So, while problems undoubtedly exist elsewhere in the country, the immediate need is for a thorough review of the situation in and around the nation's capital.

minimum value is 74 Ch-E per unit. From the data presented in Figures 12.3 and 12.4, it would appear that while the proportion of pesticide factory workers with unacceptably low cholinesterase levels has declined significantly, from a peak figure of 47 percent of the 1982 sample to just one percent in 1985, the number of farmers with depressed cholinesterase levels has shown a tendency to increase slowly in recent years.

As far as heavy metals are concerned, the results are somewhat contradictory in places. For example, manganese concentrations in factories have shown a slight rising trend from zero percent in the 1982 samples to eight percent in 1985 (Figure 12.5). Yet, while manganese levels in the blood of workers in these factories have fluctuated between peaks of 11 percent in 1981 and 1984 and a low of zero percent in 1985 (Figure 12.6), manganese concentrations in the urine samples leapt from 31 percent in 1983 to 95 percent in 1985 (Figure 12.7). It is thought that the manganese may be transferred in drinking water. The pattern for manganese miners was somewhat similar (Figures 12.8-12.10)

With lead, a higher proportion of samples exceeded the relevant safety limit (0.20 mg/m^3 of working area air volume for a continuous eight hour shift) than was the case for manganese, with a peak proportion of 22 percent of over-the-limit samples in 1984 falling to 19 percent in 1985 (Figures 12.11-12.13). Yet the percentage of blood and urine lead levels exceeding the relevant safety standard was lower than for either the manganese factory workers or manganese miners.

Given the fact that mammals tend to excrete heavy metals through the urine, the high metal-in-urine levels for these three cases should not be surprising. What should cause concern, however, is the considerable proportion of workers apparently carrying unacceptably high heavy metal burdens in their bodies. An improved toxic substances management program is clearly needed in all these cases.

On the positive side, many forces are being exerted to ameliorate the situation, including the actions of NICE. In 1985, DOL required that all undertakings having 100 or more employees should appoint a safety officer. NICE is the agency responsible for the training of these officers. NSCT has also been actively promoting occupational safety through the mass media.

Mahidol University has been advocating the setting up of provincial occupational health centers. All these actions will help to improve future conditions. But judging from past performance, it is fair to say that the statistics of occupational injury will probably continue to increase during the Sixth Plan, mainly because of the expansion of the coverage of WCF.

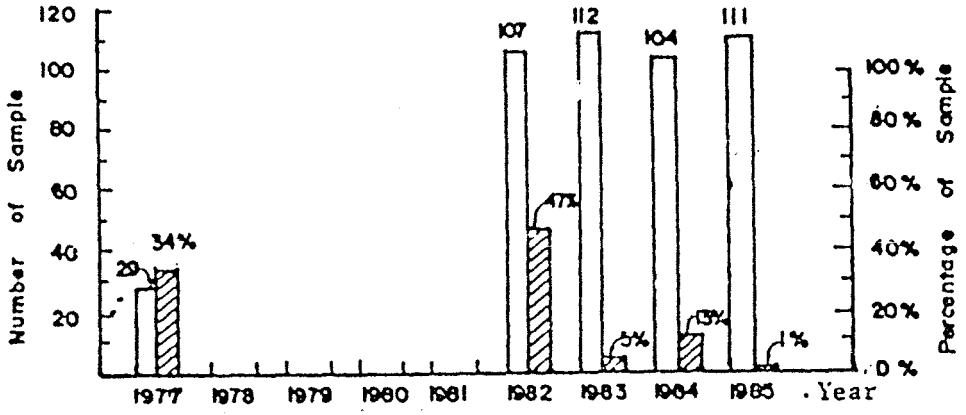
12.2 ISSUES

Poor Working Conditions

Poor working conditions have often been reported as a major factor causing occupational accidents (e.g. Thosuwonchinda, 1985, p. 109). Except in a few modern factories, working conditions in most factories are still not entirely satisfactory.

This situation exists because about two-thirds of the factories in this country are small family enterprises, the management of which may be ignorant about safety and health hazards in the workplace. The problem is compounded by the generally low educational levels of the workers. They are often unaware of the dangers or the risks involved with certain chemicals or processes.

In a recent survey of 107 enterprises in Bangkok by DOL (Hasle et. al. 1986, p. 30), it was found that although most

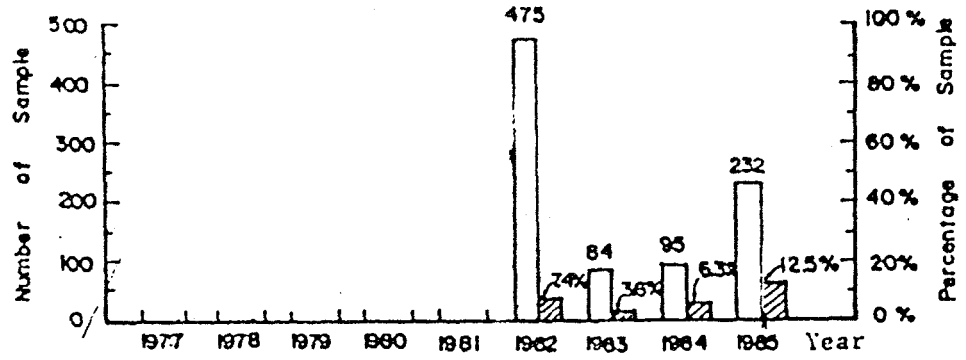


Remarks ☐ number of samples.

▨ percentage of samples with cholinesterase less than standard level.

Sources : Division of Occupational Health (1977-79B), 1982 1983, 1984 (D), 1985 (C).

Figure 12.3 Cholinesterase Level in Blood of Workers in Pesticide Factories.

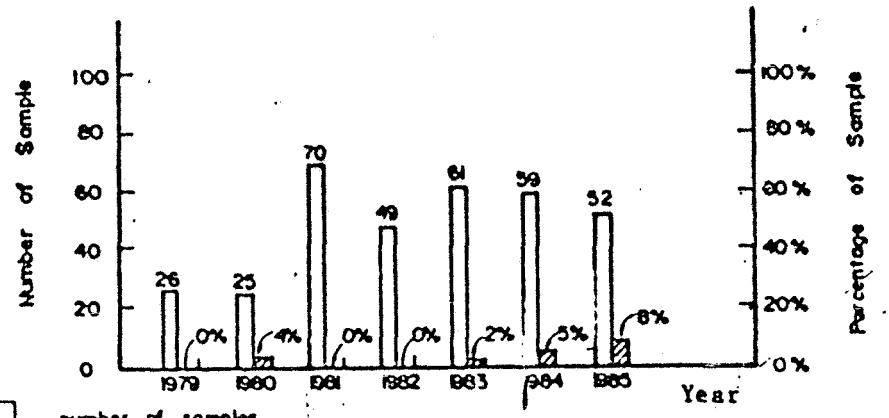


Remarks ☐ number of samples.

▨ percentage of samples with low cholinesterase level.

Sources : DOA 1982 ,1983 ,1984 ,1985(c).

Figure 12.4 Cholinesterase Level in Farmers' Blood.

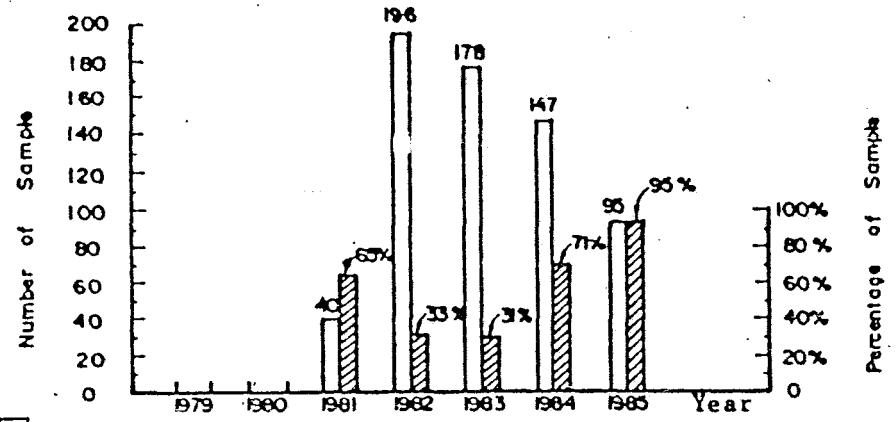


Remarks : number of samples.

percentage of samples with manganese exceeding standard level.

Sources : Division of Occupational Health 1982, ,1983,1984(A), 1984(D),1985(B),1985(D).

Figure 12.5 Manganese Concentration in Air of Factories

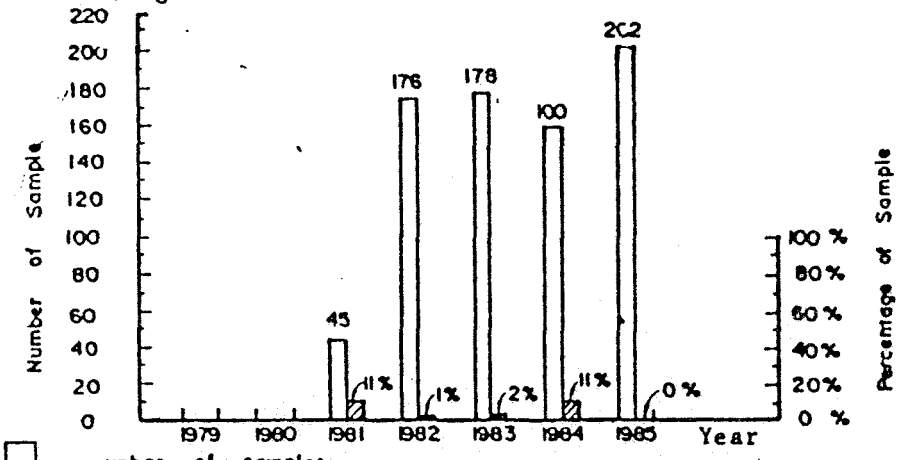


Remarks : number of samples.

percentage of samples with manganese exceeding recommended level.

Sources : Division of Occupational Health 1982 ,1983, 1984(A) 1984(D) ,1985(B) ,1985(D).

Figure 12.6 Manganese Concentration in Urine of Workers

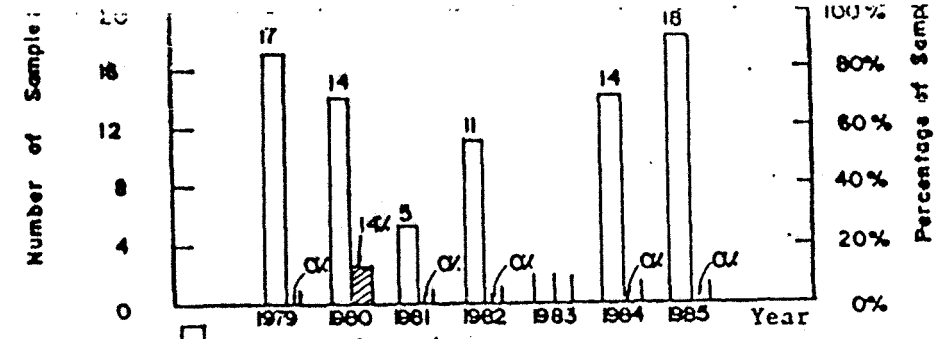


Remarks : number of samples.

percentage of samples with manganese exceeding recommended level

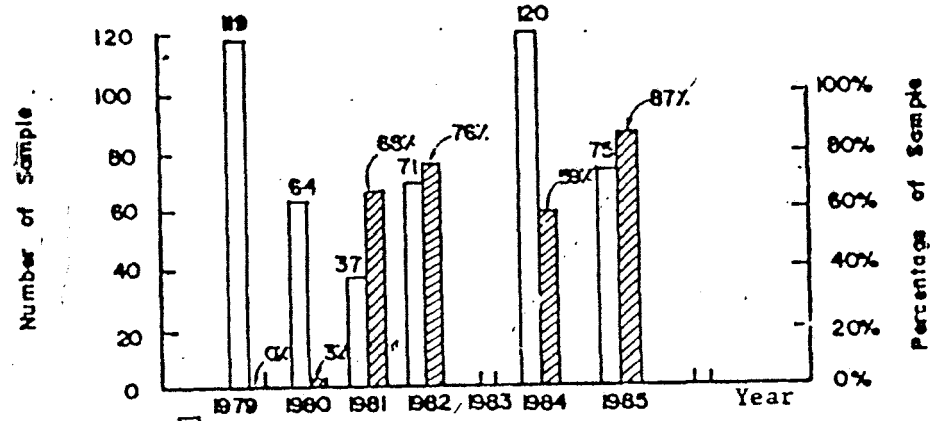
Sources : Division of Occupational Health 1982 ,1983, 1984(A) ,1984(D) 1985(B) , 1985(D).

Figure 12.7 Manganese Concentration in Blood of Workers



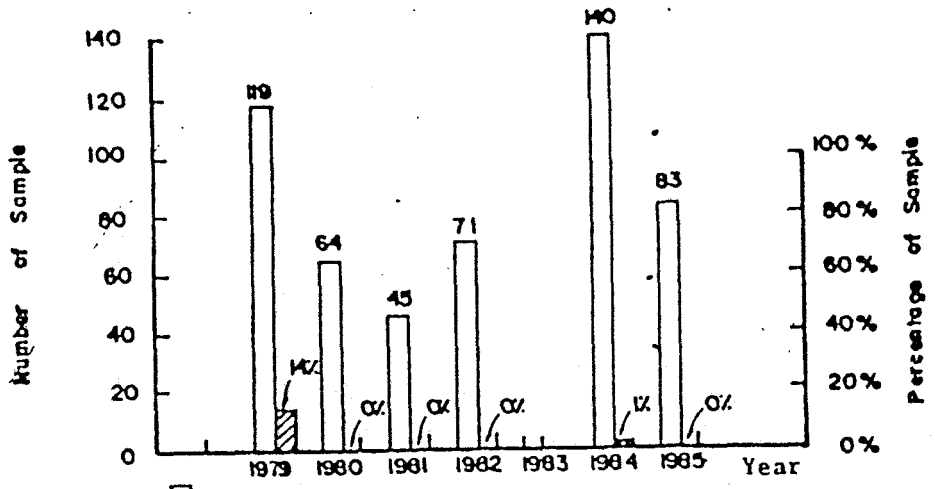
Sources : Division of Occupational Health 1984(A),1985(D).

Figure 12.8 . Manganese Concentration in Air of Mines.



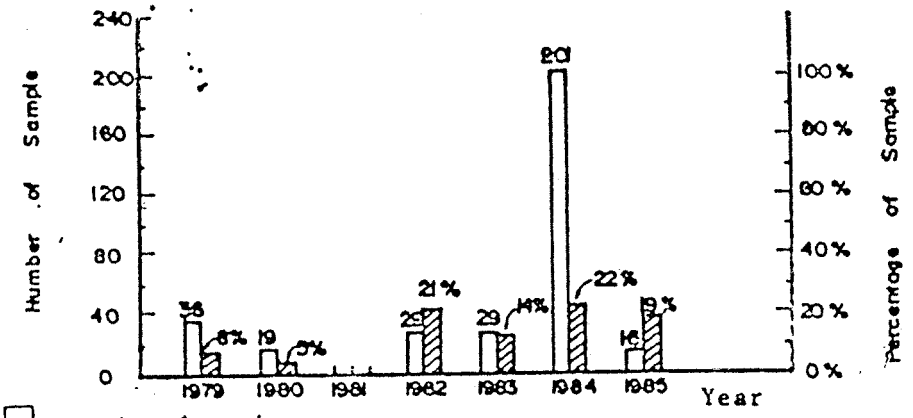
Sources: Division of Occupational Health 1984(A),1985(D)

Figure 12.9 . Manganese Concentration in Urine of Miners



Sources : Division of Occupational Health 1984(A),1985(D)

Figure 12.10 - Manganese Concentration in Blood of Miners

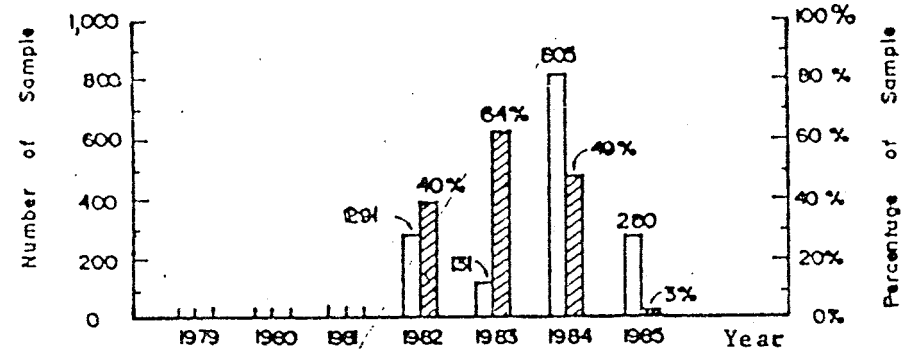


Remarks : □ number of samples.

▨ percentage of samples with lead exceeding ave.concentration during normal working period

Sources : Division of Occupational Health (1977-79A), 1980, 1982, 1983, 1984(B), 1984(C), 1984(D).

Figure 12.11 Lead Concentration in Air of Factories and Mines

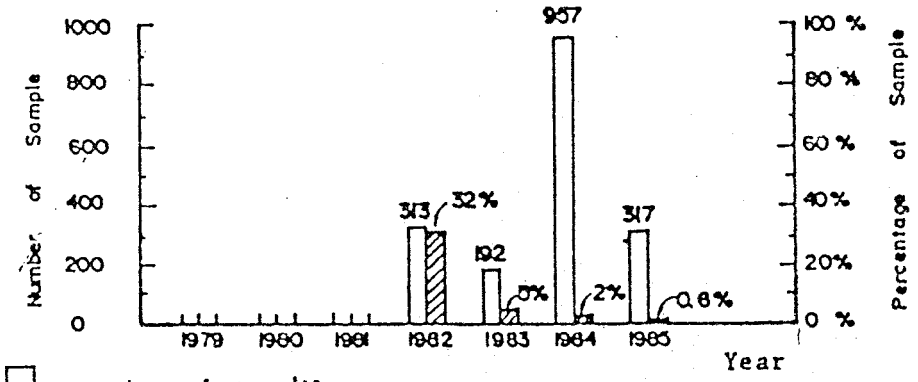


Remarks : □ number of samples.

▨ percentage of samples with lead concentration in urine exceeding recommended level

Sources : Division of Occupational Health 1982, 1983, 1984(C), 1984(D).

Figure 12.12 Lead Concentration in Urine of Workers and Miners



Remarks : □ number of samples.

▨ percentage of samples with lead concentration in blood exceeding recommended level

Sources : Division of Occupational Health 1982, 1983, 1984(C), 1984(D).

Figure 12.13 Lead Concentration in Blood of Workers and Miners

enterprises provide basic welfare facilities like toilets, washing facilities and drinking water, many of them are of low standard. Problems related to ergonomics and accident hazards were found in nearly all enterprises. Personal protective equipments was only occasionally provided and used.

For agicultural workers, there is a general agreement that pesticides are being overused and misused. Pesticide poisoning of farmers is a matter of great concern, although the extent of poisoning incidents have not yet been adequately explored. Agricultural workers in general still have the wrong perception of the danger of pesticides. These misconceptions have resulted in widespread carelessness in the use of pesticides. Many farmers do not wear any protective devices while spraying pesticides.

Inadequate Data Collection, Research and Monitoring

Present statistics of occupational accidents are obtained mainly from the WCF. The statistics are inadequate because the WCF only covers 40 percent of the total industrial workforce. Secondly, the data compiled by the WCF are primarily gathered for the purpose of determining the eligibility of compensation claims. They are not collected for accident analysis in the interest of accident prevention. An accident is reported as a simple phenomenon arising from a single and direct cause. The working conditions conducive or leading to accidents are general not reported.

Other agencies often collect information for their own internal use, and tend not to publish or share such information. Information on occupational accidents should be compiled into one or more data banks that are accessible by all agencies concerned.

In the area of occupational safety research, there is little current activity. One of the main obstacles in developing realistic programmes and policies in accident prevention is the lack of adequate baseline data concerning existing working conditions. There has never been a comprehensive baseline survey of the health and safety aspects of the working environment, especially in the agricultural sector.

Insufficient Number of Government Inspectors

In order to enforce safety regulations, it is important that the government conduct frequent inspection of the factories and other undertakings. It is commonly acknowledged that inspection of factories is inadequate. For example in 1985, DOL conducted safety inspections in 2,638 undertakings. (DOL, 1985b, p. 20), whereas the total number of factories is about 90,000. The shortage of experienced inspectors has been described as severe (Chalvalitnitikul, 1985, p. 47). It has been suggested that, as far as possible, every establishment should be inspected once a year, and that unsatisfactory or unhealthy establishments should be inspected much more frequently (ILO, 1976, p. 142). It is evident that safety regulations will be ineffective unless it can be rigourously enforced through inspection.

Inadequate Training Activities

Accidents often occur because workers are not aware of the risks involved, or do not know how to prevent them. Training in safety is therefore vital to promote awareness and to help eliminate accidents.

Although some training activities are being carried out by various public and

private organizations, the present level of safety training activities has been judged inadequate (Joungtrakul, 1985, p. 185). The DOL Labour Training Division conducts many training courses, but most of them are emphasized in labour relations area. NICE has conducted some training courses, especially the training of labour inspectors and of safety officers.

In 1985, DOL required that undertakings having 100 or more employees appoint a safety officer. A six-week training programme series was conducted in 1985 to train approximately 1,500 safety officers and should have a major influence on working conditions in medium and large sized undertakings in the future.

Other organizations, such as the Occupational Health Division of DOH, Employers' Confederation of Thailand and some workers organizations also give training courses, but very few of these courses are in occupational safety and health.

Training is a long-term solution to the problem of improving working condition, and merits more support.

Lack of a Major Hazard Control System

The increasing use of hazardous chemicals in industry has created situations where the safety of a large number of the general public can be endangered. The recent international tragedies in Mexico, India and the Soviet union clearly indicate that the establishment of a major hazard control system is necessary. (see Box 12.1)

Accidents involving hazardous substances can happen at an intallation or during transportation by truck or rail. Adequate hazard assessments will be needed to insure the safety of the public. There is also the need to develop contingency plans in case an accident involving hazardous substance occurs.

BOX 12.2

THE TANTALUM RIOT: SOME LESSONS LEARNED

It would have been one of only four tantalum processing plants in the world, and the only one in Asia. Designed to produce 600,000 pounds of tantalum pentoxide (Ta_2O_5) a year, or approximately a quarter of current world demand of 2.5 million pounds, it would also have produced an equivalent quantity of niobium pentoxide. The entire production of tantalum would have been exported, earning an estimated 500 million baht a year. Claimed to incorporate the latest pollution control technology, the plant was shortly to open. But then, on 23 June 1986, a mob broke in and burned the 1.2 billion baht plant virtually to the ground. What had gone wrong?

The first problem was that the authorities had badly under-estimated how far the public might go to stop a project with which it was not in sympathy. In retrospect, the planning of the project had not been sufficiently sensitive to public feelings at a time when the reverberations of the Bhopal disaster were still being felt and the Chernobyl disaster was headline news. Among their worst fears: the hydrogen fluoride used by the plant would leak, causing another Bhopal, or the sheer environmental impact of normal operations would undermine the booming local tourism industry.

The residents of Phuket first began to voice their concern in May of 1986, culminating in mass demonstrations by about 50,000 people in June. Local community leader were threatening to boycott the elections on 27 July, but the real surprise was the mass break-in on 23 June, the day that a public hearing was meant to begin, with the Minister of Industry present.

On the surface, things seemed to be going well. The Thailand Tantalum Industry Corporation (TTIC) had received considerable support from the Board of Investment, with the bulk of the project's financing coming from a US$53.5 million package arranged by the International Finance Corporation (IFC), the World Bank's investment arm. The project's original proponent, S.A. Minerals, was the largest investor, holding 45 percent of the equity, with the IFC, three Thai banks, the quasi-governmental Industrial Finance Corporation of Thailand and local tin-mining families holding the rest.

Tantalum is very much a high technology metal, exploited for its high tensile strength and heat resistance. It is used to make capacitators, special alloys, aerospace components and nuclear reactor equipment. It is normally derived either from tantalite ore or from tin slag, the major source in Thailand. The tin slags have a tantalum content varying from 2.5 percent of Ta_2O_5 in low grade ores to 12 percent in high grade ores. The original plan for the Phuket tantalum plant called for two components: an enrichment plant to produce slag with a 20-30 percent Ta_2O_5 content (later deferred because of falling tantalum prices), and an extraction plant using hydrofluoric acid, to dissolve the tantalum in the ground ore, and methyl isobutyl ketone, a common solvent, to extract the tantalum-rich material.

The wastes from the plant would have included 370 cubic meters per day of acidic wastewater, and eight tons per day of digestion residues. The plan was that the acidic wastewater and digestion residues would be

neutralized with lime, and the resulting 55 tons per day of waste would be filtered and the solids landfilled. The treated wastewater would be discharged to a canal in the rainy season, and to an abandoned mine during the dry season. Air pollutants, it had been promised, would be collected and treated.

One problem, however, was that an Environmental Impact Assessment (EIA) was only prepared late in the day, and then somewhat reluctantly, following government pressure on TTIC. The EIA was completed shortly before the plant was burnt down, and was not used as a means of promoting public participation. The TTIC plant was also approved before the World Bank issued its post-Bhopal guidelines for assessing the major hazards associated with industrial development projects in developing countries. The TTIC plant would now come within those guidelines, since they cover any plant handling more than 10 tons of hydrogen fluoride. Such assessments are not a legal requirement under Thai law, but the lack of such an assessment leaves the door open for rumour and speculation.

The plant was located on the northern outskirts of the city, just a few hundred meters from a teacher training college. The site was apparently chosen because of its proximity to the tin smelter produced the tantalum-rich ores, but the siting of such plants in residential areas is questionable at the best of times. Even if local people had read and understood the EIA commissioned by TTIC, which concluded that the plant could be run safely (if sufficient effort was devoted to making sure that it did), the lack of effective enforcement of pollution control standards in Thailand would have raised question marks over the apparently satisfactory picture painted in the EIA.

The tantalum riot, reprehensible though it may have been, underscored a number of points about the planning requirements for such projects. The local public remained grossly ignorant throughout the project of what was likely to be involved. But the facts that did percolate through, for example that tantalum is used in nuclear warheads, simply fanned the flames. The fact that TTIC had to be pushed into preparing an EIA cannot have inspired local confidence. And, with relatively weak planning controls, there was always the prospect that the TTIC plant would be the seed for much larger developments.

Given that there were probably deeper-rooted political forces at work, too, it is impossible to guarantee that a developer who prepares an EIA, basing it on a thorough assessment of the major hazard potential involved, and who does his best to ensure that the local community is involved in the decision-making process, will succeed. But TTIC's experience confirms that if he does not do these things, he will certainly increase his chances of failure.

Who then should share this burden or responsibility with the investors?

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13 Recommendations and Strategies

13.1 THE TRENDS

The Thai standard of living owes much to the country's generous endowment of natural resources. Thailand's once-tranquil pace of development accelerated considerably in the 1960s, and today's economy is both stronger and more resilient. Indeed, it has maintained an overall pattern of growth throughout the vagaries and turmoil of world affairs over the last 25 years. Between 1960 and 1985, based on current prices, Thailand's GDP expanded more than 18-fold, with a buoyant 7.5 percent average annual growth rate through the period. The country's population has also grown rapidly, of course, but economic growth has so far more than kept pace.

If you look at per capita GNP, this has also grown steadily, although there are marked imbalances in the distribution of the resulting wealth between sections of society and between regions. The biggest gains, unquestionably, have been in the Central Region, and particularly in the Bangkok Metropolis. This phenomenal pace of development is now weakening somewhat, however, due to a host of internal and external events and trends. Economic growth dropped below the five percent mark in 1985.

There are now signals that changes are needed in the way that Thailand's development is directed and managed. Previous chapters of this Profile have focused on some of the key emerging trends and issues in particular sectors of the economy. This concluding section will pull together some of these threads, review the overall situation, and suggest areas in which Thailand needs to rethink and remodel its approach to development.

The evidence marshaled in Parts II and III points to one inescapable conclusion: Thailand's current development strategies need overhauling in a number of areas, because they are leading to an unsustainable pace of natural resource consumption and destruction. The fate of countries which have run up such a natural resource deficit is evident enough of the need for more sustainable styles of development, throughout the world. So, before reviewing the sort of adjustment process which Thailand now needs to embark upon, it may help to briefly review some of the trends in natural resource utilization. These trends have contributed to Thailand's current economic strength, and we need to consider how our natural resources can sustain the economic development and growth needed to provide a satisfactory standard of living not only for today's Thais, but also for tomorrow's.

Resources for Development

Minerals, fishes and forest are just some of the natural resources which have helped power the growth of Thailand's economy in recent decades. Unfortunately, there has been no reliable and regularly updated index of the contribution which these resources have made -- and continue to make -- to the economy. To fill this gap, TDRI has evaluated the contributions of four natural resource-related sectors (agriculture, forestry, fisheries, and

Table 13.1 The Contribution of Natural Resource-Related Sectors to Gross Domestic Product, in 1972 Prices

Sectors / Year	1975 million baht	1975 % of GDP	1976 million baht	1976 % of GDP	1977 million baht	1977 % of GDP	1978 million baht	1978 % of GDP	1979 million baht	1979 % of GDP
Agriculture	53,016	26.0	55,457	25.1	54,104	22.9	62,098	23.8	60,735	21.9
Forestry and Related Industries	4,861	2.4	5,115	2.3	5,121	2.3	4,898	1.8	5,540	2.0
Forestry	3,330	1.6	3,380	1.5	3,205	1.4	3,001	1.1	3,392	1.2
Wood Industry	1,212	0.6	1,282	0.6	1,319	0.6	1,165	0.4	1,306	0.5
Pulp and Paper Industry	319	0.2	453	0.2	597	0.3	732	0.3	842	0.3
Fishery and Related Industries	6,065	3.0	6,207	2.8	6,688	2.9	7,783	2.9	7,652	2.7
Fishery	5,734	2.8	5,898	2.7	6,324	2.7	7,414	2.8	7,281	2.6
Fishery Product Industry	331	0.2	309	0.1	364	0.2	369	0.1	371	0.1
Mining and Quarry	2,485	1.2	2,906	1.3	3,534	1.5	4,104	1.6	4,531	1.6
Other Sectors	126,703	62.0	140,290	63.4	155,244	65.2	169,533	65.2	185,257	67.1
Total GDP	204,056	100.0	221,297	100.0	236,500	100.0	261,097	100.0	276,907	100.0

Notes:

a. Gross Domestic Product is defined as the total market value of final goods and services produced during a given period of time with factors of production located in the country.

b. For 1985, preliminary figures as compiled by NESDB.

c. Agricultural sector comprises only crops and livestocks.

d. Forestry sector comprises all timber production, fuelwood and minor forest products but excluding sawmills and other wood processing operations.

e. Wood Industry comprises saw mills and plywood factories, wood preserving mills, manufacture of wooden doors and windows, basketry, lacquer-ware, tread plates and other products.

f. Fishery sector includes both fresh water and marine fisheries as well as aquaculture.

g. Fishery Product Industry comprises preservation of fish, seafood and fish sauce making.

h. Mining and Quarry sector comprises all mineral resources production including natural gas and crude oil.

Sources: National Account Division, NESDB.

1980		1981		1982		1983		1984		1985		1985 (current price)	
million baht	% of GDP	million baht	% of GDP	million baht	% of GDP	million baht	% of GDP	million baht	% of GDP	million baht	% of GDP	million baht	% of GDP
63,190	21.6	68,028	21.9	69,801	21.5	72,251	21.1	76,299	20.9	77,784	20.5	182,729	17.4
5,455	1.8	5,136	1.6	4,874	1.5	5,009	1.5	5,340	1.5	5,571	1.4	21,035	2.0
3,318	1.1	2,896	0.9	2,682	0.8	2,630	0.8	2,741	0.8	2,823	0.7	13,165	1.3
1,178	0.4	1,257	0.4	1,217	0.4	1,342	0.4	1,496	0.4	1,568	0.4	5,559	0.5
959	0.3	983	0.3	975	0.3	1,037	0.3	1,103	0.3	1,180	0.3	2,311	0.2
6,661	2.2	7,178	2.3	6,437	2	7,011	2.0	7,383	2.0	7,865	2.1	13,940	1.3
6,276	2.1	6,777	2.2	6,019	1.9	6,568	1.9	6,862	1.9	7,290	1.9	12,651	1.2
385	0.1	401	0.1	418	0.1	443	0.1	521	0.1	575	0.2	1,289	0.1
4,780	1.6	4,623	1.5	4,431	1.4	4,414	1.3	5,415	1.5	6,012	1.6	29,279	2.8
200,650	68.8	213,991	68.8	227,178	70.1	242,241	70.6	257,046	70.6	268,088	71	765,606	73.2
292,852	100.0	311,270	100.0	324,032	100	342,946	100.0	364,206	100.0	378,756	100.0	1,047,564	100.0

FIGURE 13.1 NATURAL RESOURCE CONTRIBUTIONS TO GDP, IN BILLION BAHT, 1975-1985 (1972 PRICE)
OF RESOURCE AND RELATED SECTORS

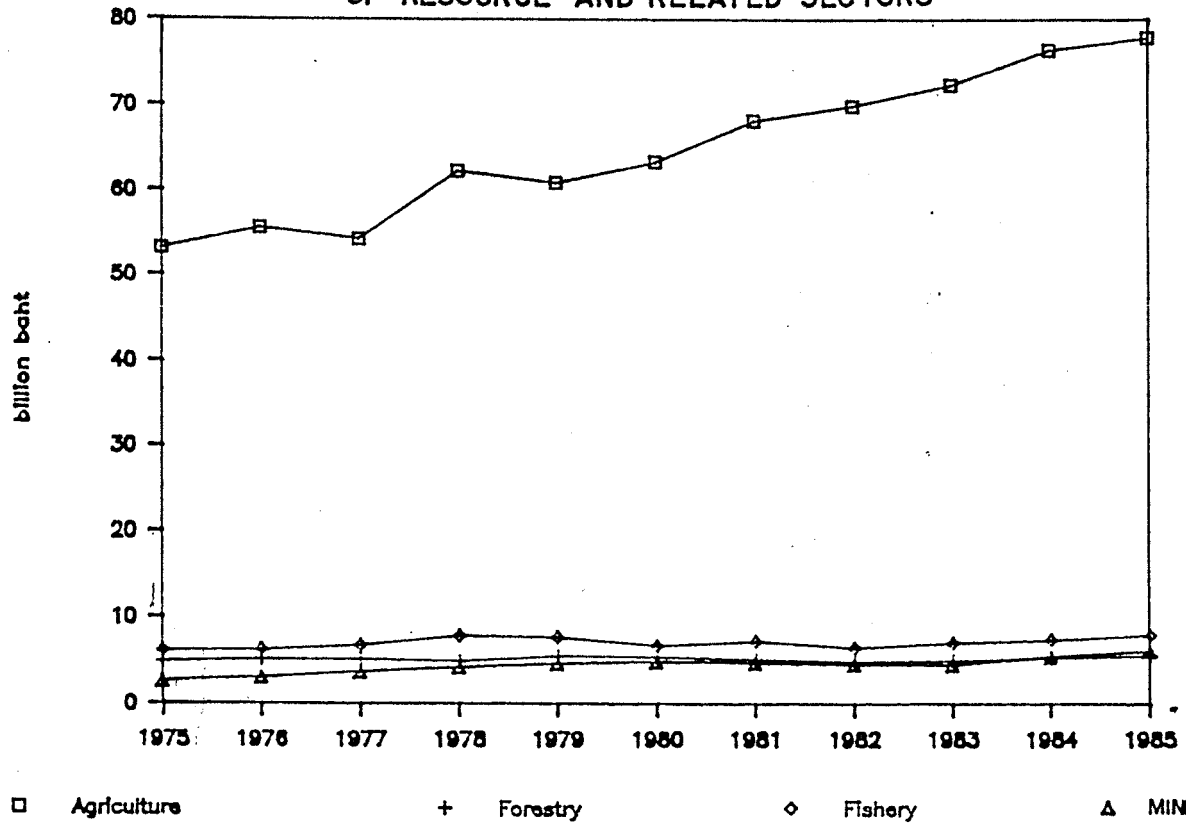


FIGURE 13.2 NATURAL RESOURCE CONTRIBUTIONS TO GDP, AS A PERCENTAGE OF GDP, 1975-1985 (1972 PRICE)
OF RESOURCE AND RELATED SECTORS

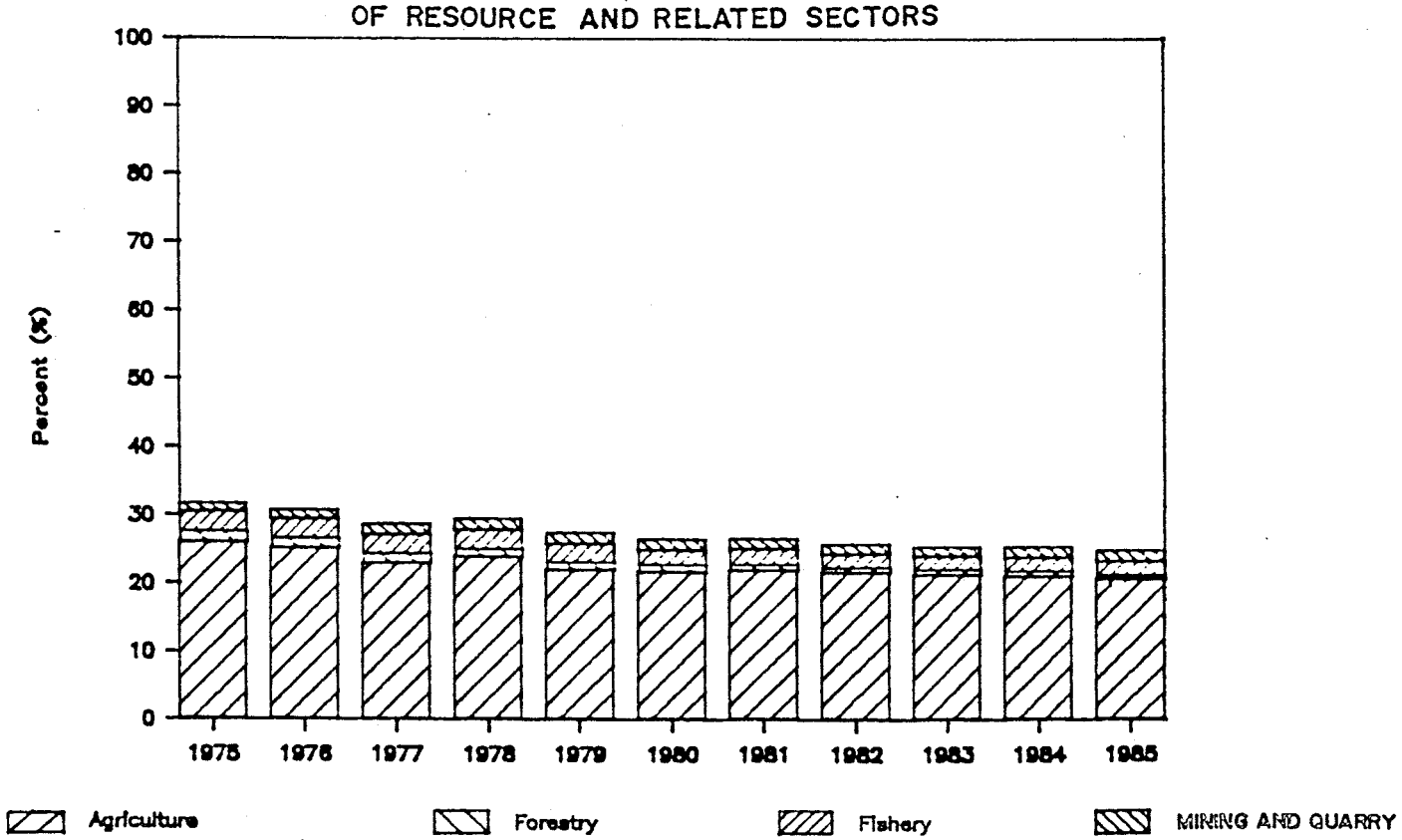
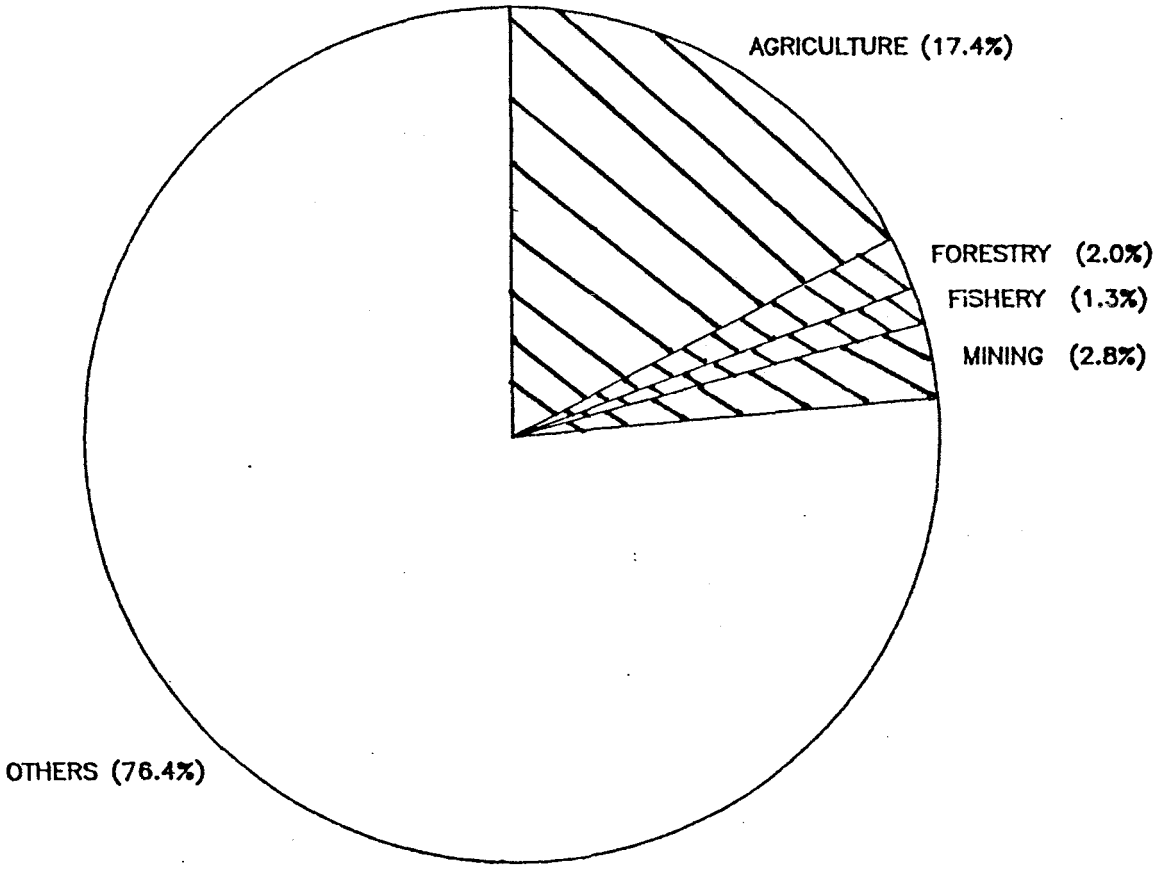


FIGURE 13.3 NATURAL RESOURCE CONTRIBUTIONS TO GDP, AS A PERCENTAGE OF GDP, 1985 (IN CURRENT PRICE) OF RESOURCE AND RELATED SECTORS



mining and quarrying) to Thailand's GDP since 1975. The results, shown in Table 13.1, and summarized in Figures 13.1 to 13.3 are very interesting indeed.

The first thing that the analysis shows is that the contribution of the agricultural sector has grown significantly, from 53 billion baht in 1975 to 77.8 billion baht by 1985, with both figures expressed in terms of 1972 prices. While the pace of growth may have been somewhat slower in some of the other sectors, it has been significant, too. The forestry sector grew from 4.9 billion baht in 1975 to 5.6 billion baht; the fisheries sector from 6.01 billion baht to 7.9 billion baht; and the mining and quarrying sector, showing a faster pace of growth, from 2.5 billion baht to 6.0 billion baht.

Judging from the latest figures (Figure 13.3), we can see that the resource and related sectors contribute as such as 23.5 percent of the total GNP. If agriculture is taken out of the picture, the other three sectors still account for 6.1 percent in 1985 (current price) or the equivalence of 64,254 million baht.

These are still major contributions, in any terms, and this index is incomplete in that it only takes into account contributions which are formally entered in the national GDP accounts. The tremendous uncosted service provided by forests in the area of watershed management are completely ignored, for example. But, even allowing for this narrow focus in the economic analysis, the contribution of these natural resource-related sectors begins to look very much healthier when you consider their contributions in terms of export values and employment.

Export-Led Growth

The contribution of Thailand's natural resources to the nation's economic state of health is nowhere clearer than in the export statistics, which are presented in Table 13.2, and summarized in Figures 13.4 and 13.5. The forestry, fisheries and minerals sectors bring in over 16.5 percent of Thailand's export earnings, and agriculture alone accounted for 49 percent of the country's exports in 1985.

Agriculture's share of Thai exports may have slipped from 55 percent in 1980 to 49 percent in 1985, but the absolute value of agricultural exports has increased significantly, from 73.3 billion baht to 94.8 billion baht, via a peak contribution of 96.5 billion baht in 1984. The forestry sector accounts for a much smaller proportion of exports. Between 1980 and 1985, the absolute value of forestry exports has grown from 1.9 billion baht to 3.4 billion baht. Even more significant has been the growth in fishery exports, which rose from 7.3 billion baht (5.4 percent of total exports) in 1980 to 18.5 billion baht (9.6 percent of total exports) in 1985. Meanwhile, mining and quarrying went in the opposite direction: a contribution of 14.9 billion baht in 1980, representing 11.2 percent of total exports, fell sharply to 9.8 billion baht by 1985, representing just five percent of total export.

While the contribution of these four natural resource-related sectors to Thailand's exports may have slipped from three-quarters (73 percent) in 1980 to two-thirds (65.5 percent) in 1985, their contribution to the country's much-needed export earnings are clearly very considerable indeed.

It three hardly needs stressing that the productivity of these sectors depends on the health of renewable natural resources and the continued, uncosted contributions made by environmental systems in terms of air quality and water quality, for instance. If greater attention can be paid to the concept of maximum sustainable yield, and to the development of value-added industries in all four sectors, their contribution to Thailand's future economic health stability could become increasingly significant.

Table 13.2 Export Values of Key Products from Natural Resource-Related Industries, 1980-1985

Sector/Product Year	1980 million baht	1980 % of total export	1981 million baht	1981 % of total export	1982 million baht	1982 % of total export	1983 million baht	1983 % of total export	1984 million baht	1984 % of total export	1985 million baht	1985 % of total export
Agriculture and related industries[b]												
Total Value	73,330	55.1	91,909	60.1	95,769	60.0	83,346	56.9	96,544	55.1	94,810	49.
- rice	19,508		26,366		22,510		20,157		25,932		22,524	
- food crops	9,773		11,566		11,840		11,452		13,464		11,889	
- cassava products	14,887		16,447		19,752		15,387		16,600		14,967	
- raw sugar and products	3,357		10,311		13,807		7,878		6,111		7,060	
- rubber and rubber products	13,025		11,470		10,060		12,406		13,892		14,807	
- fruits and fruit products	2,123		2,974		3,120		3,032		4,206		5,114	
- animal products	1,391		2,239		2,361		2,016		3,005		3,354	
- others	10,657		10,536		12,319		11,018		13,334		15,095	
Forestry and related industries												
Total Value	1,928	1.4	1,931	1.3	2,018	1.3	2,130	1.5	2,648	1.5	3,446	1.
Timber and wood products[c]	1,420		1,499		1,424		1,484		1,733		2,031	
- teak veneer	259		250		283		349		505		474	
- household utensils of wood	376		406		407		500		501		543	
- articles of wood furniture	234		183		230		215		176		267	
- others	551		660		504		420		551		747	
Minor forest products[d]	283		244		358		421		634		802	
Paper and products	225		188		236		225		281		613	
Fishery and some related industries[e]												
Total value	7,251	5.4	8,776	5.7	10,853	6.8	12,677	8.7	15,081	8.6	18,528	9.
- fish: fresh, chilled frozen	381		767		689		715		1,017		1,377	
- cuttle fish: fresh, chilled frozen	1,300		1,334		1,738		1,637		1,693		2,121	
- shrimps, prawns, lobster, fresh, chilled, frozen	1,961		2,136		2,764		3,164		2,799		3,440	
- fish canned	603		1,109		1,665		2,116		1,782		492	
- tuna in airtight containers	-		-		-		-		1,854		4,620	
- others	3,006		3,430		3,997		5,046		5,936		6,478	

Table 13.2 (contd.)

Mining and quarry[f]												
Total Value	14,935	11.2	11,856	7.8	9,743	6.1	6,669	4.6	7,404	4.2	9,782	5.1
- primary tin metal	11,169		9,653		7,986		5,225		5,268		5,462	
- tin-lead-alloy	12		34		131		202		164		325	
- zinc	-		-		-		-		-		471	
- tungsten												
wolfram	577		320		165		88		159		85	
scheelite	62		64		48		41		46		48	
- fluorite												
metallurgical grade	186		205		190		198		246		276	
acid grade	114		122		125		90		110		86	
- condensates	-		-		-		-		362		2,003	
- others	2,815		1,458		1,098		825		1,049		1,026	
Total exports of the whole country	133,200		153,000		159,728		146,471		175,238		193,365	100.0

Notes:

a. Export value reflects changes in both volume of export and prices which depend upon foreign exchange rate. Two major devaluations of baht currency in 1981 and 1984 coupled with fluctuations of some major currencies such as Yen and US dollars also significantly contribute to changes in export values.

b. consists of rice products, food crops, cassava products, raw sugar and products, oil seeds, vegetable oils, fibre crops, garden crops and products, fruits and products, other food products, rubber and products, live animals, animal feed, animal products, dairy products, fertilizer and pesticides.

c. consists of teak, yang, teak veneer, other veneer sheets, plywood, block and strips for parquet and other flooring assemblies, particle board, hardboard, soft board and other boards, blockboard, drawn wood, reconstituted wood, wooden frames, household utensils of wood, door, window of wood, articles of wood furniture, articles of personal clothing, adornent of wood, fork and spoon, other household utensils of wood, fuel wood, wood charcoal.

d. consists of bamboo stalks, bamboo in the rough, bamboo for plaiting reeds, vegetable materials in brushes or in brooms, vegetable materials used primarily for boaiting, sea weed, other vegetable products, yang oil, seedlac and sticklac, shellac, nutural gum rasins, vegetable saps and extracts, medicinal plants, other forest by-products.

e. Comprises products of fish, crabs, cuttle fish, shrimps, prawns, lobsters, jelly fish, molluscs, crustaceans, squids, octopus; also fish sauce, oyster sauce, fish meal, and seaweed.

f. comprises exports of mineral products namely tin, tungsten, antimony, barite, calcite, columbite, tantalite dickite, dolomite, feldspar, ball clay, columbium, tantalum, fluorite, gypsum, ilmenite, kaolin, lead, lignite, limestone, manganese, marble, monazite, pyrophyllite quartz, struverite, xenotime, talc, zinc and condensates.

Sources: Office of Agricultural Economics, Ministry of Agriculture and Co-operatives;
Foreign Trade Statistics of Thailand, 1980 to 1985, Department of Custom, Ministry of Finance;
Fishery Statistics Division, Department of Fisheries, Ministry of Agriculture and Co-operatives;
Mineral Statistics, 1985, Department of Mineral Reserves, Ministry of Industry.

FIGURE 13.4 VALUES OF NATURAL RESOURCE-RELATED EXPORTS, IN BILLION BAHT, 1980-1985
OF RESOURCE AND RELATED SECTORS

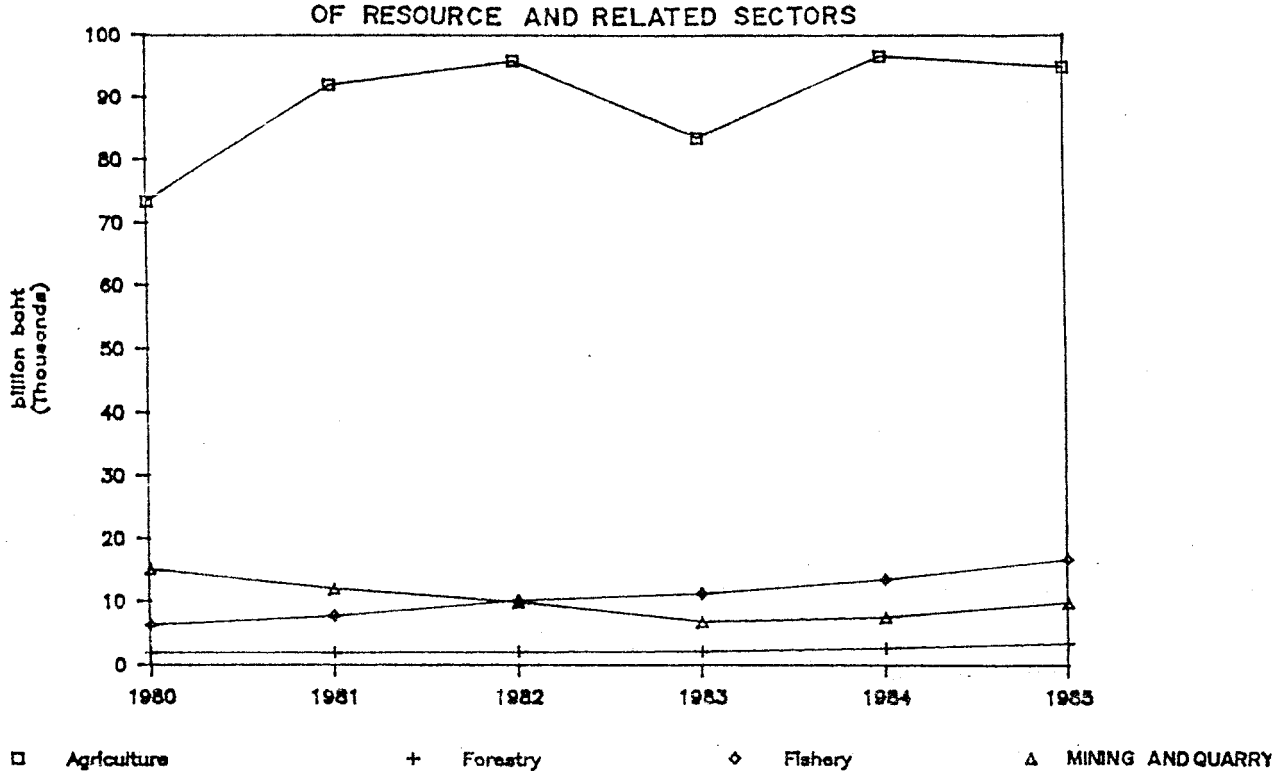
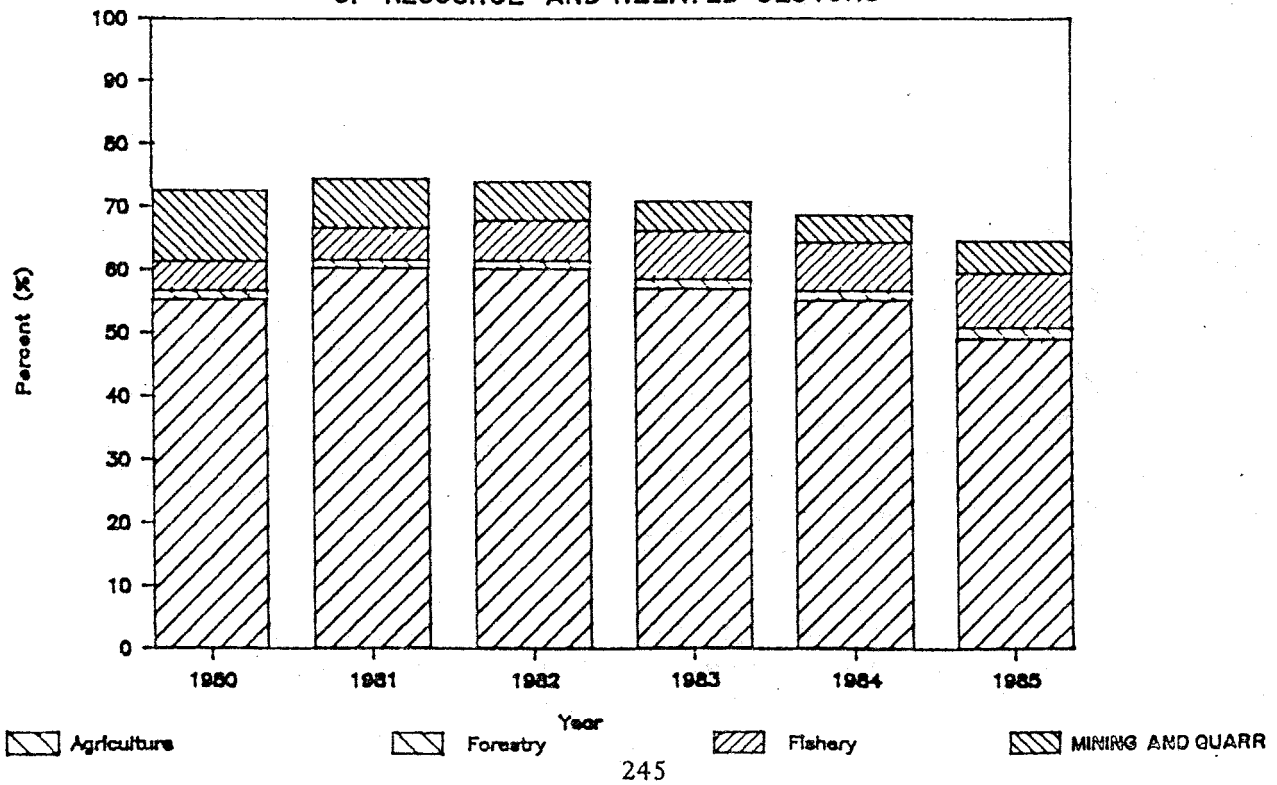


FIGURE 13.5 VALUES OF NATURAL RESOURCE-RELATED EXPORTS, AS A PERCENTAGE OF TOTAL EXPORTS, 1980-1985
OF RESOURCE AND RELATED SECTORS



Imports and the Trade Deficit

As Thailand's economy has expanded, however, so has the size of the trade deficit. The worst deficits were in the 1970s, when they reached nine percent of GDP. Since then, deficits have run in the range of 7-9 percent, roughly paralleling the economic growth rate. There was a marked drop to under five percent in 1982, but the deficit promptly rebounded to nine percent in 1983.

The OPEC "oil shocks" aggravated Thailand's trade deficits in the period following 1973, and then again after 1979. But the growing exploitation of indigenous energy supplies began to counter-balance the impact of oil prices, and the deficit shrank to seven percent of GDP in 1984 and down to 5.5 percent in 1985.

Clearly, these deficits reflected the influence of many different factors and trends. But there has been a strong pattern in the influence of the natural resource-related sectors. Prior to 1970, when the trade deficit was less of a problem, agricultural and mineral products held commanding shares of Thailand's GDP. Then, as industrial expansion took hold of the economy, it generated a growing demand for imports, producing widening trade deficits.

As shown in Table 13.3 and Figures 13.6 and 14.7, agricultural imports have grown considerably in terms of absolute value, from 19 billion baht in 1980 to 26.4 billion baht in 1985. Because of the size of the trade deficit, however, their share of the import bill grew only slightly, from 9.8 percent to 10.5 percent. Imports of forestry products have grown at a faster rate, meanwhile, from 4.5 billion baht in 1980 to 6.4 billion baht in 1985, with their share of imports remaining steady at around 2.5 percent.

The most dramatic growth of all has come in the fisheries sector, however. From a 1980 figure of just 483 million baht, imports in this sector grew eight-fold to 3.9 billion baht in 1985. Mineral imports, on the other hand, fluctuated considerably. From a figure of 41.7 billion baht in 1980, they hit a high of 48.6 billion baht in 1981, then a low of 36.4 billion baht in 1984, before rebounding to 40.2 billion baht in 1985.

Since 1983, as indicated in Table 13.4, the production of indigenous fuels, including lignite, natural gas and oil, has grown very considerably indeed. In the five years from 1981 to 1985, natural gas production increased nearly 13-fold, from 10.6 billion standard cubic feet to 132.3 billion standard cubic feet. Condensate production increased 10-fold, from 576,000 barrels to over five billion barrels. Lignite production more than tripled, from 1.4 million tons to 5.1 million tons.

Indigenous energy supplies met approximately 40 percent of Thailand's needs in 1985, and the prospect for further reductions in the country's energy deficit are good. Meanwhile, the country's natural resources make other contributions to the economy: we shall look at the revenues contributed to government funds, the generation of wealth which powers other areas of investment, and the provision of jobs.

Contributions to the Treasury

The Royal Thai Government benefits from the country's natural resource wealth in many ways. For example, it charges royalties for the award of land, forest and mineral concessions. It collects duties on exports of agricultural products, including rice and rubber. And it collects royalties on the production of energy minerals, such as natural gas and oil.

As a result, government revenues from the natural resource sector of the economy have weakened considerably. In 1980, the government earned export duty revenues of 3.4 billion baht, of which

Table 13.3 Import Values of Key Natural Resource-Related Products, 1980-1985

Sector/Product Year	1980		1981		1982		1983		1984		1985	
	million baht	% of total import	million baht	% of total import	million baht	% of total import	million baht	% of total import	million baht	% of total import	million baht	% of total import
Agriculture and some related industries[b]												
Total Value	19,048	9.8	21,479	9.8	17,552	8.9	22,739	9.6	25,204	10.3	26,361	10.5
- food crops	1,188		1,619		1,296		1,664		1,558		1,615	
- fibre crops	3,112		4,052		3,065		4,844		5,668		6,419	
- milk products	1,315		2,175		1,650		2,140		2,085		2,191	
- animal feed	1,306		1,368		1,540		1,511		2,224		1,247	
- fertilizers and pesticides	4,177		5,185		3,339		6,383		6,298		6,853	
- others	7,950		7,080		6,662		6,197		7,371		8,036	
Forestry and some Related Industries												
Total Value	4,479	2.3	5,911	2.7	5,046	2.6	6,208	2.6	5,784	2.4	6,394	2.5
Timber and wood products	1,186		1,831		1,783		2,366		2,388		2,223	
Paper and paper products[c]	2,851		3,668		2,805		3,325		2,848		3,752	
Minor forest products[d]	442		412		458		517		548		419	
Fishery and some related industries[e]												
Total Value	483	0.2	550	0.3	726	0.4	1,093	0.5	2,119	0.9	3,857	1.5
- fish, fresh, chilled, frozen	218		197		323		656		1,728		3,483	
- shrimps, prawns, lobsters, fresh, chilled, frozen	64		65		83		132		99		64	
- ark-shell, fresh, chilled, frozen	85		98		79		55		45		56	
- others	116		190		241		250		247		254	
Mining and quarry[f]												
Total Value	41,716	21.5	48,620	22.2	46,228	23.5	41,230	17.4	36,370	14.8	40,244	16.0
Metallic ore[g]	67		67		30		42		72		122	
Non-metallic ore[h]	2,345		1,312		1,145		1,213		1,263		1,596	
Crude oil	39,304		47,241		45,053		39,975		35,035		38,526	
Total Imports of the whole country	193,618		219,026		196,616		236,608		245,155		251,169	100.0

Table 13.3 (contd.)

Notes:

a. Import value reflects changes in both volume of import and prices which depend upon foreign exchange rate. Two major devaluations of baht currency in 1981 and 1984 coupled with fluctuation of some major currencies such as Yen and US dollars also significantly contribute to changes in import values.

b. consists of food crops, sugar products, cocoa and products, tea and coffee, spirits and beverages, oil seeds, vegetable oils, fibre crops, garden crops and products, fruits and products, other food products, tobacco, rubber and products, live animals, animal feeds, animal products, dairy products, fertilizers, pesticides, machineries and appliances for agricultural products.

c. consists of wood pulp, kraft paper, newsprint, printing and writing paper in rolls or sheet, corrugated cardboard, other paper and paper boards.

d. consists of hop cones and lupulin, medicinal plants, other vegetable products, lac and shellac, raw vegetable materials used primarily in dyeing or in tanning, taragacanth, arabic, agar-agar, vegetable saps and extracts.

e. consists of fish (fresh chilled frozen), fish (live), fish (live for aquarium), cuttle fish (fresh, chilled, frozen), shrimps, prawns, lobsters (fresh, chilled, frozen), fish (salted, in brine, dried), fish maws, cuttle fish in brine, dried, shark fins in brine, dried, ark-shell, fresh, chilled, frozen, other crustaceans, fish and crustaceans preparation, fish (canned), products of crustaceans, shrimp paste, liver, fish oil and oyster sauce.

f. mainly consists of iron, copper, aluminium, chromite, titanium and antimony

g. mainly consists of salt, sulphur, earths and stone, plastering materials, lime and cement

h. consists of crude petroleum and shale oil imported for petroleum products refinery, does not include refined petroleum products.

Sources: Office of Agricultural Economics, Ministry of Agriculture and Co-operatives
Foreign Trade Statistics of Thailand, 1980-1985, Department of Custom, Ministry of Finance.
Fishery Statistic Division, Department of Fisheries, Ministry of Agriculture and Co-operatives
Mineral Statistics, 1985, Department of Mineral Reserves, Ministry of Industry.

FIGURE 13.6 VALUES OF NATURAL RESOURCE-RELATED IMPORTS, IN BILLION BAHT, 1980-1985
OF RESOURCE AND RELATED SECTORS

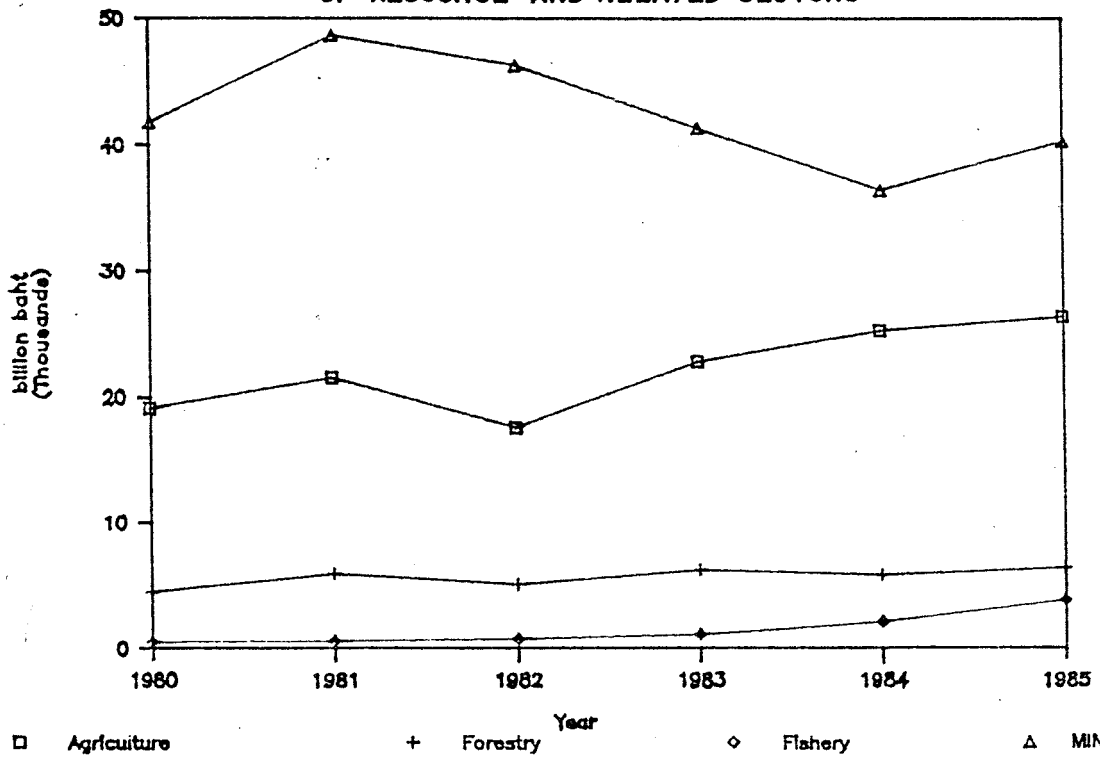
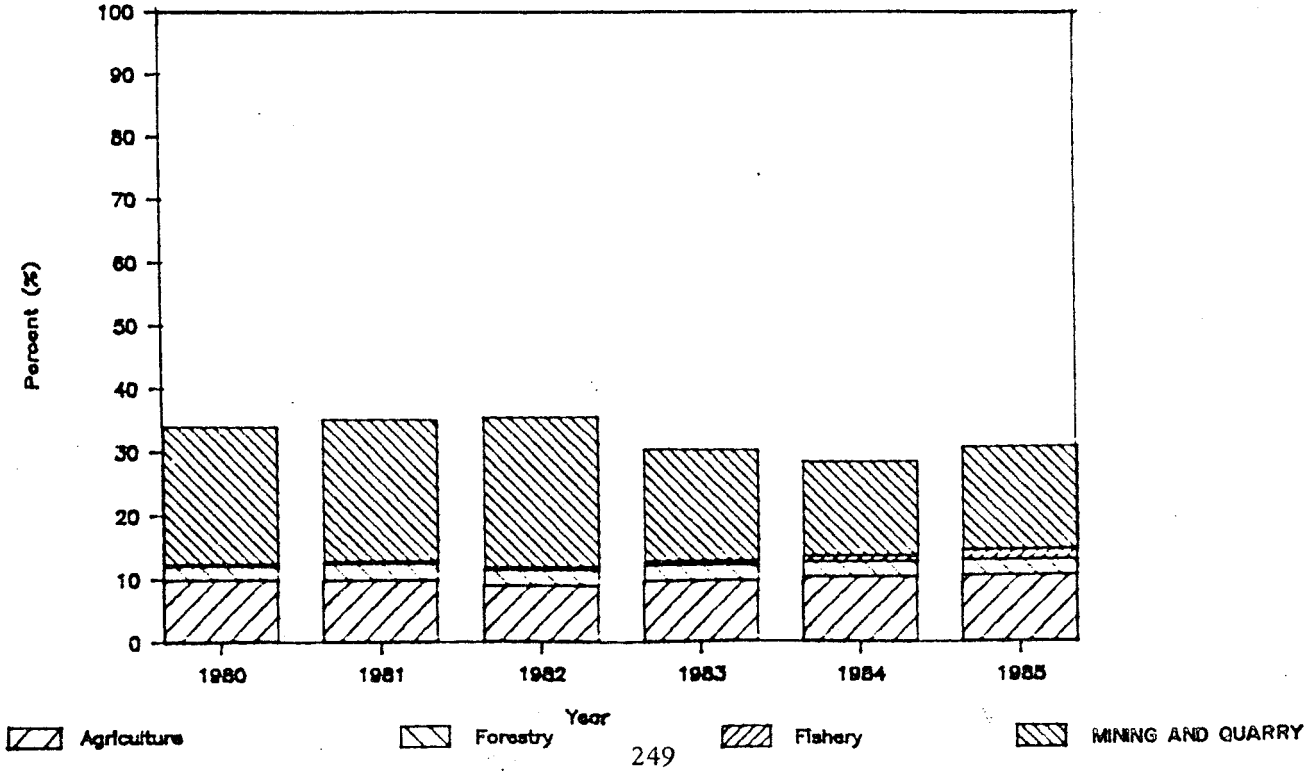


FIGURE 13.7 VALUES OF NATURAL RESOURCE-RELATED IMPORTS, AS A PERCENTAGE OF TOTAL IMPORTS, 1980-1985
OF RESOURCE AND RELATED SECTORS



2.4 billion baht (or some 70 percent) came from export duties on rubber. Its royalty income was 4.2 billion baht that year, of which 3.4 billion baht (or some 80 percent) came from tin concentrates. In 1985, by contrast, export duty revenues had dropped sharply to just one billion baht, less than a third of the 1980 figure, while the royalties received on tin concentrates had dropped to 1.2 billion baht -- again less than a third of the 1980 figure.

In the energy sector, royalties on natural gas production rose from 422 million baht in 1983 to one billion baht in 1985, while those from condensate and crude oil rose from 340 million baht to 1.1 billion baht over the same period. But the most dramatic increase was in lignite royalties, which went from five million baht in 1980 to 104 million baht in 1985.

The point that should be made about these three, healthier sectors, however, is that they are all based on the exploitation of non-renewable fossil energy resources. Efficient production may extend the life of these energy reserves, but ultimately they will be exhausted. We should be preparing for that day.

Wealth to Invest

In addition to their role in feeding, clothing and housing the population, Thailand's natural resources have also produced wealth needed to provide the capital for starting up new ventures in other sectors of the economy. Successful trading firms in the rice, teak, rubber and tin markets have often evolved into finance, banking and general trading groups.

The Siam Commercial Bank, founded in 1906, was the first modern Thai bank, and was capitalized by wealth derived from agricultural and other natural resources. Five major banks -- the Provincial Bank, Bangkok Bank of Commerce, Bangkok Bank,

Table 13.4 Volume and Value of Natural Resource-Related Primary Products, 1980-1985

Products	Year	1980 Quantity	1980 Value (million baht)
Forestry (1000 m^3)			
teak		97	191
other timbers[a]		2,447	733
firewood and charcoal		870	76
Fishery (1000 ton)			
marine fishery[b]		1,647	7,807
freshwater fishery[c]		145	1,360
Mining[d]			
tin (1000 ton)		46	2,514
lignite (1000 ton)		1,427	114
Crude Oil[e](1000 barrels)		-	-
natural gas[f](1000 MMSCF)		-	-
Condensates[f](1000 barrels)		-	-

' na = not available

Notes:

a. Mainly consists of Yang, Teng and Rung, Takien, Daeng, Pluang, Pradu, Tabek and other kinds of timber. Production value of this sector were calculated by the NESDB based upon average farm price of 1972, except for firewood and charcoal, production value were based on market prices.

b. Includes marine prawns and shrimps. Production values of this sector were calculated based upon average farm price of 1972. Figures for 1985 were estimated by the NESDB.

c. Includes freshwater aqua culture. Production values of this sector were calculated based upon average farm price of 1972. Figures for 1985 were estimated by the NESDB.

d. Production values of this sector were calculated by the NESDB. For tin and lignite, production values were based on prices announced by the Department of Mineral Resources in 1972. For crude oil, natural gas and condensate, production values were based on well-head prices.

e. 1972 price of crude oil was calculated based upon price index of arabian light imported crude oil.

f. 1972 prices of natural gas and condensate were calculated based upon the price index of liquified petroleum gas (LPG). Natural gas, production values are preliminarlyfigures from NESDB based on total production not sale volume.

1981		1982		1983		1984		1985		1985 (current price)
Quantity	Value (million baht)	Quantity	Value (million baht)	Quantity	Value (million baht)	Quantity	Value (million baht)	Quantity	Value (million baht)	Value (million baht)
73	144	58	114	58	113	48	94	39	80	272
1,725	522	1,711	521	1,762	533	1,984	581	1,844	571	2,238
900	79	1,198	105	1,064	93	1,255	110	1,055	92	470
1,824	8,646	1,987	9,418	2,100	9,954	1,973	9,352	2,042	9,679	23,672
165	1,548	134	1,257	155	1,454	162	1,520	168	1,576	5,350
43	2,349	36	1,949	27	1,488	30	1,639	23	1,259	5,290
1,686	135	1,964	157	1,866	149	2,337	187	5,146	412	2,552
-	-	-	-	2,218	94	5,100	204	7,587	321	5,225
10.6	39	47.1	189	56.2	222	85.5	329	132.3	493	8,368
576	30	2,026	108	2,268	125	3,008	158	5,202	269	3,841

Sources: National Account Division, NESDB;
Forestry Statistics of Thailand, Royal Forest Department, Ministry of Agricultural and Co-operatives;
Fishery Statistics Division, Department of Fisheries, Ministry of Agriculture and Co-operatives;
Mineral Statistics of Thailand, Department of Mineral Resource, Ministry of Industry.

Bank of Ayudhaya, and the Thai Farmer's Bank -- were founded between 1942 and 1945 by different family groups, whose fortunes were derived from trading and manufacturing activities in the agricultural and mineral sectors. In this sense, logs, rice, tin, sugar and gunny sacks were the building blocks of Thailand's modern economy. These new ventures, in turn, made possible additional large-scale ventures in agribusiness and agro-industry, as well as in the wider manufacturing and service sectors.

Clearly, the agricultural and mining industries are to be congratulated on their contributions to Thailand's economic growth, but later sections raise the question whether these achievements too often have been bought by an excessive exploitation of key natural resources. The evidence that we are seeing significant degradation of our land, forest, water and fishery resources is now overwhelming.

An Exploding Workforce

The trends in population growth, together with the changing age structure of Thailand's population, pose a number of difficult problems. For one thing, the number of people of working age has been growing much faster than the population as a whole. The number of Thais in age groups 15-59 grew from 52 percent in 1960 to 56 percent in 1980, and is projected to reach 65 percent in the year 2000. But what does this mean in terms of absolute numbers? It has meant a doubling of the working-age population from 13.6 to 26.1 million between 1960 and 1980, and it will mean that there will probably prove to have been an overall tripling between 1960 and 2000. The beginning of stabilization cannot be expected until after 2010, and the working-age population may remain at about 68 percent of the total population for some time.

So, that is the supply side of the equation: what about the demand for

Table 13.5 Estimate Seasonal Employment in Natural Resource-Related Industries, 1980-1985
(persons)

Sector/Year	1980	
	Dry Season	Harvest Season
Agriculture[b]	na	15,821,699
Forestry and Related Industries	na	378,699
- Forestry and Logging[c]	na	61,117
- Wood Industry[d]	na	282,059
- Pulp and Paper Industry[e]	na	35,523
Fishery and Related Industries	na	227,285
- Fishery[f]	na	199,023
- Fishery Product Industry[g]	na	28,262
Mining and quarry[h]	na	35,598

na = not available

Notes:

a. Employment levels presented above refer to numbers of employed persons defined in the labor force survey as follows:-
"Persons, 11 years of age and over who during the survey week
1) worked for at least one hour for any kind of payment
2) had regular job (including those who had job but were temporarily absent).
- Employment levels are seasonally compared between dry season (January to March) and harvest season (July to September).

b. Employment in the agricultural sector refers to those engaged in farm and animal husbandry including agricultural services but excluding fishery and forestry activities

c. Employment in the forestry sector refers to those engaged in forest plantation, logging operation and wildlife capture.

d. Employment in the wood industry refers to those engaged in the sawmill industry and the manufacturing of wood and wood products such as plywood, veneer and furniture

e. Employment in the pulp and paper industry refers to those engaged in the manufacturing of pulp and paper products such as kraft paper, sanitary paper, printing paper including paperboard, paper box and paper houseware.

1981		1982		1983		1984		1985	
Dry Season	Harvest Season	Dry Season	Harvest Season	Dry Season	Harvest Season	Dry Season	Harvest Season	Dry Season	Harvest Season
8,929,087	17,421,486	9,188,118	17,070,044	11,000,996	17,059,988	12,936,857	17,760,599	12,850,395	na
615,290	398,608	772,825	442,568	763,555	342,429	622,567	426,128	733,316	na
166,828	59,410	322,419	111,338	246,709	69,191	193,059	109,673	257,520	na
424,516	312,639	422,045	297,647	483,162	231,577	404,583	291,377	448,950	na
23,946	26,559	28,361	33,583	33,684	41,661	24,925	25,078	26,846	na
353,363	360,798	313,012	295,080	326,644	307,028	291,203	296,358	301,303	na
305,462	314,062	272,706	238,432	274,507	262,433	255,308	257,921	269,018	na
47,901	46,736	40,306	56,648	52,137	44,595	35,895	38,437	32,285	na
74,252	61,021	101,493	64,672	69,145	50,836	160,235	117,328	99,340	na

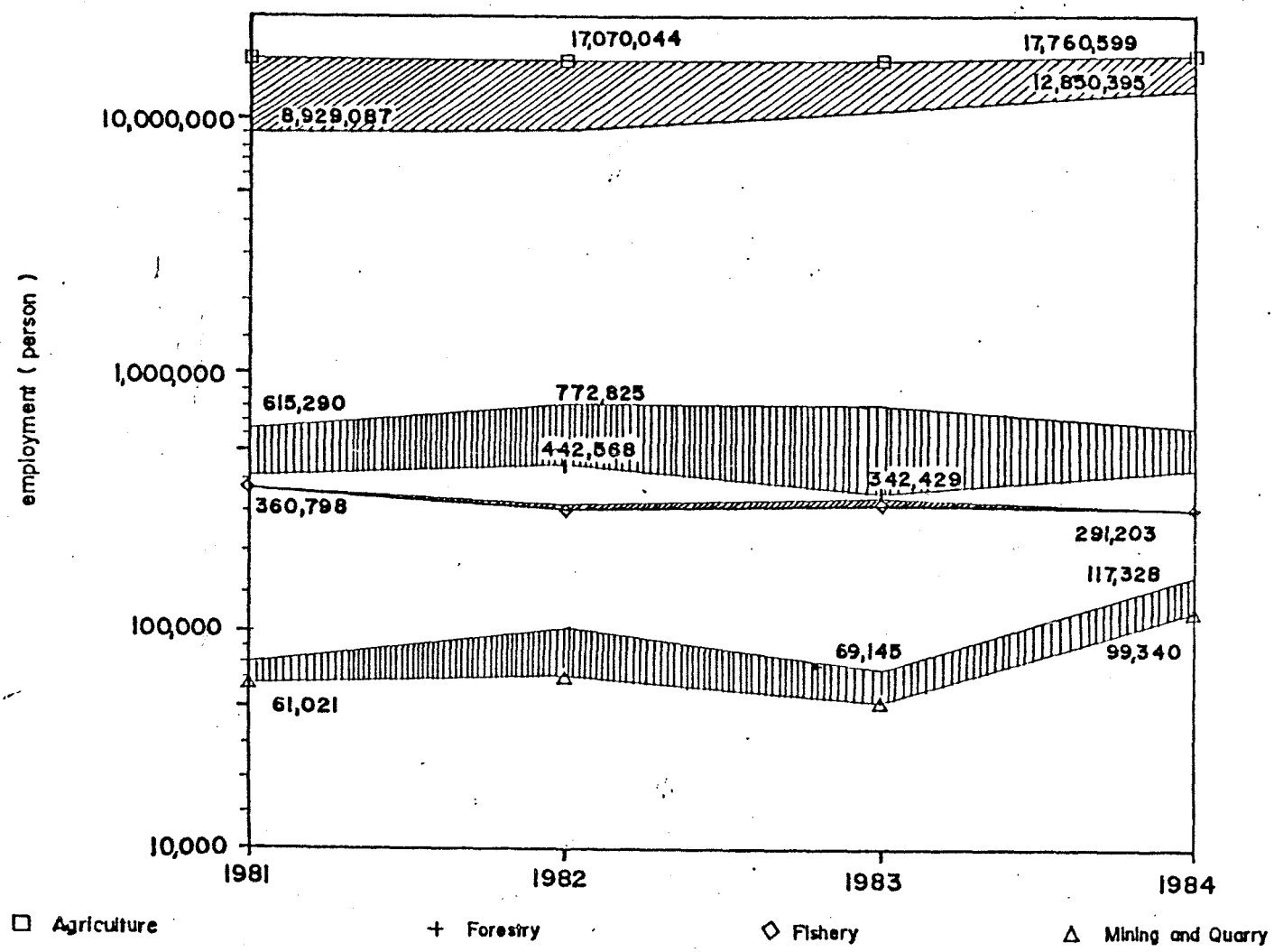
f. Employment in the fishery sector refers to those engaged in inland, marine fisheries and aquaculture

g. Employment in the fish product industry refers to those engaged in the manufacturing of fish products such as seafood canning and frozen seafood production.

h. Employment in the mining and quarry sector refers to those engaged in mining and quarry operations including oil and natural gas exploration and drilling.

Source: Unpublished TDRI data based on the Labor Force Survey statistics (1980-1985), the National Statistical Office.

FIGURE 13.8 ESTIMATED DRY AND HARVEST SEASONS EMPLOYMENT IN NATURAL— RESOURCE— RELATED INDUSTRIES, 1981 — 1985



labour? The evidence suggests that the Thai economy has done fairly well so far in absorbing and employing this doubled workforce. Employment in the urban and industrial sectors has expanded considerably, reaching an estimated 7.4 million jobs by 1985, with a projected expansion to 12 million jobs by 2000. The overwhelming bulk of the employable population, however, is employed in the agricultural sector, as indicated in Table 13.5. Figures 13.8 show dry season and harvest season employment in a number of natural resource-related industries. Not surprisingly, there is a significant shift in the structure of employment in the agricultural economy between the two seasons.

Longer term, however, it looks as though the agricultural sectors of the economy are going to be faced with the prospect of having to more than double the number of people they employ. Already, the numbers of people seeking employment in these sectors, coupled with their relatively low-value output per capita, is aggravating the per capita income gap between the agricultural and non-agricultural sectors.

The real test will clearly come when the second and third waves of new working-age Thais start to look for work. It is projected that over 7.6 million more will be looking for work between 1980 and 1990, a further eight million between 1990 and 2000, and 6.3 million more between 2000 and 2010. These extraordinary statistics sum up one of the most important challenges which Thailand will face in the waning years of the twentieth century -and beyond.

Natural Resource Mismanagement

Faced with ever-keener competition for jobs and for space to live, work and relax, Thais are beginning to confront a number of questions which hithero seemed comfortably remote. There is a feeling that many economic development projects have paid too little attention to the long-term sustainability of their natural resource base; that laws and regulations have sometimes been weighted in favor of the unscrupulous, rather than the conscientious; and that a fair distribution of the wealth derived from Thailand's natural resources is as distant a prospect as ever.

Malpractices are certainly prevalent in some areas, reducing the potential wealth to be derived from natural resources. In the mining industry, for example, the encroachment of outsiders upon the extraction rights granted to legal concession holders was discussed in Chapter 6. Instances of this problem have been reported from Phang-nga, in offshore tin mining; from Doi Ngom and Khao Soon, in wolfram ore mining; from Doi Mok, in scheelite ore mining; and from Chon Buri, in antimony ore mining. The "mob mining" seen in some of these areas does not ensure equity of wealth distribution, but short-changes the nation, in terms of lost royalties and other government revenues, and the reduced maximum ore recovery from affected concessions.

In the forestry industry, encroachment and poaching are very much the order of the day; even the national parks and wildlife refuges are not immune. In some areas, the thinking has changed from maximum systainable yield to last-ditch protection. National policy calls for the preservation of 40 percent of Thailand's surface area under forest cover, yet the latest data show that only 29 percent remains under forest - and the downward trends seem set to continue. At the current rate of progress in reforestation, as Chapter 4 pointed out, making good that missing 11 percent of forest cover, which would involve rehabilitating over 35 million rai of deforested land, will take well over 35 years, always assuming that today's deforestion can be stopped in the meantime.

In the Gulf of Thailand, too, the maximum sustainable yield (MSY) of major

fisheries is clearly being exceeded, as we saw in Chapter 8. The MSY is being exceeded by 50 percent in some demersal and pelagic fisheries. Illegal fishery practices, including fishing out-of-season, in off-limits protected areas or with destructive methods, combine with the destruction of mangrove ecosystems and increasing pollution to threaten commercially important fish stocks. Pollution in the upper Gulf has crippled important mariculture operations: the production of bivalves by upper Gulf mariculture was cut by two-thirds between 1977 and 1983.

Inevitably, the rules and regulations designed to ensure the proper management of fishery resources, however well intentioned, will fail unless they have the active support of those who do the fishing. If they cannot be persuaded that today's over-fishing undermines tomorrow's yields, the yields on which their own children will depend, then there is little hope of arresting the process of decline.

Ultimately, Thais may have to accept that highly valued foods, like fish roes and sea-turtle eggs, will have to be dropped from the menu, to ensure that future generations may harvest these species for food.

As far as our renewable land resources are concerned, as Chapter 2 explained, too many upland farmers are ignorant of - or ignore - the need for soil conservation. The loss of topsoil and the decline in soil productivity are real, growing threats to our future security. Whereas slash-and-burn agriculture was once more closely attuned with the ecosystems exploited, it now causes untold ecological damage. In part this is because hill tribe and other upland farmers believe that they are immune from prosecution under the forest laws if no trees are left standing on the land they have cleared. The result is that natural regeneration is slowed, if it happens at all.

In the process, major watersheds are being denuded, with increasing silt loads washed down into the nation's rivers, silting up dams and causing extensive downstream flooding. Meanwhile, as Chapter 3 notes, the mistaken idea that abundant, clean water is a "free" resource still persists, discouraging investment in water-efficiency technologies and practices.

The more water we use in Bangkok, where the rate of groundwater extraction is thought to exceed the safe limit by some 60 percent, the faster the nation's capital will sink. The more water we waste, the more areas have to be flooded by new dams, if suitable sites can be found (see Box 3.3). The more water we pollute, like the Chao Phraya with just one part per million of dissolved oxygen left in low water conditions, the more we have to pay for water treatment chemicals to ensure a safe drinking water supply.

And who pays for all this? Make no mistake, we do. It is not just a question of having to put up with more noise as our cities and road traffic grow, with deteriorating air and water quality, or unsafe working conditions. There is a still more fundamental question that needs to be addressed: are we undermining the natural resource base in such a way that, at the very time when there is a growing population to feed, cloth, house and employ, the natural resource base which should sustain them will be becoming less - rather than more - productive?

Short-Changing Sustainability

The revenues generated by the exploitation of Thailand's natural resources are urgently needed, of course, but who bothers to cost the revenues foregone because of the short-sighted mismanagement of key resources? Clearly, some such work is done, but in a patchy, uncoordinated fashion. In the case of mining royalties, a proportion has been put aside to ensure land rehabilitation

once the productive life of a mine is over. But no-one really knows how much such rehabilitation is going to cost, or whether sufficient funding will be available.

Take another example. Thermal power generation consumes oil, natural gas or lignite. The cost of oil and gas includes the full royalties and/or taxes paid to the Treasury, whereas the cost of lignite includes only the relevant royalties, not the full taxes, based on tonnes-of-oil-equivalent (TOE), which would ensure a fair basis for energy pricing. Hydropower generation, meanwhile, enjoys the lowest cost per kilowatt-hour, due both to heavy public sector investment and the fact that hydro resources are "free". Rather than passing those savings directly on to the electricity consumer, should we not adopt a fair pricing approach across the board, designed to ensure a careful balancing of demand with appropriate supply - and the rehabilitation of areas damaged in the process of energy production?

Again, if we consider what is happening in the agricultural sector, the evidence suggests that rice farmers are effectively subsidizing the consumer. Their nationwide, inclusive costs of production of 2,972-3,287 baht/ton of paddy, as calculated by the Office of Agricultural Economics (OAE), were generally above the farmgate paddy price. Some farmers certianly make a profit, but according to a study by Chulalongkorn University's Social Research Institute (CUSRI) the actual net gain is often less than it appears, when interest on loans is taken into account. A profit is generally expected from export sales of rice, but this is not shared by the farmer. The converse is true with the sugarcane and sugar industries, where the domestic consumer subsidizes exports by paying roughly three times the world market price for sugar. Even so, smallholders selling sugarcane to sugar factories often do so at an effective loss.

Similarly, pararubber producers operating under the small plantation system, with 20 rai or so of traditional varieties, may gross an average family income of some 1,200 baht a month, but their net income, according to CUSRI, will be about two-thirds of that, once all their costs are taken into account. The huge amount of value eventually added to rubber as it moves through the production chain does not filter down to the smallholders.

The implication throughout is that small farmers will not be able to spare the resources needed for soil and water conservation. The way in which the production and trading systems have evolved legislates against the thinking and investment needed to ensure the sustainable development of key natural resources.

A Legal Straitjacket?

While the nation's lawyers cannot single-handedly solve our problems, legislation is an essential tool in environmental protection and the drive for sustainable development. However, as earlier chapters have shown, the evolution of Thailand's legal framework is lagging behind current needs.

As far as the management of land-based resources is concerned, there are 11 laws currently in force. The oldest of them is the Forestry Act of 1941, while the most recent at the time of writing is the Land Development Act of 1983. In addition, there are a number of other legal instruments governing land administration, including Revolutionary Party orders, Cabinet resolutions and Royal decrees. A total of 24 agencies, operating under six ministries, are involved. Confusion, not surprisingly, is often the order of the day. This leads to delays and to inequities, particularly in terms of the widely different land title documents that participants in different government-backed programs receive from the respective agencies.

At the other end of the spectrum, in the water resource management field, there is no direct legislation and no master plan, either. There are five laws that touch on, or are related to, surface water management, however, the oldest being the People's Irrigation Act of 1941. None of these laws specifies the rights and duties of water users, a glaring and increasingly problematic omission. There is a single law on groundwater, the Groundwater Act of 1977. There are 31 agencies and 17 committees involved in the development of Thailand's water resources, a state of affairs which effectively precludes the development of the sound, multipurpose projects which are so badly needed.

What all this suggests is that legislation is as often serving to impede progress as to drive it forward. No-one doubts, for exxample, that reforestation, watershed management and improved forestry practices are needed, but the 1941 Forestry Act seems to be operating as a legal straitjacket. Too often, whether one thinks of programs designed to protect mangroves, fisheries or mineral deposits, innovative approaches are being stalled by antiquated legislation. This whole area is in need of urgent review.

Competing Priorities and Responsibilities

Thailand's administrative structure and procedures could scarcely be better designed to impede progress in areas which, like natural resource management, demand an integrated approach. All the agencies whose activities are described in earlier sections of this Profile set out with the best of intentions, but their efforts are ultimately overwhelmed by the sheer number of policy bodies and executing units which have to be involved. The problem is further aggravated by the fact that, while there is now a National Forest Policy, there are no coordinated central policy guidelines covering other critical areas, such as land and water resources.

Each agency operates under its own mandate and with its own legal backstops. Each develops its own mission and sets its own yardsticks for rating achievement. So a situation develops where one agency gives away land free to illegal squatters, who qualify because they committed a breach of the law in the first place, while another insists that law-abiding citizens take up their land allocations on the basis of purchase, hire-purchase or rent. Both agencies can claim that they are fulfilling their mandated missions, and both can claim success, in their own terms, at the end of the day. Overall, however, the result is less than satisfactory.

Interagency disputes waste time and other resources. Of course, a dynamic individual or group of individuals can push a project ahead, even within the current administrative structures, but the waste of effort involved is generally prodigious. The only real way forward when dealing with such interrelated problems must be the formulation of coherent, integrated policy guidelines, carried through into a series of master plans targeted on particular resources. Table 13.6 shows that seven percent of the 1986 national budget was devoted to environmental protection and natural resource development. While more money is always welcome, the evidence suggests that more could be done to ensure that the budget that has already been allocated is used efficiently and to the best effect.

13.2 THE AGENDA FOR ACTION

Previous chapters of this Profile have demonstrated that concerted action is now needed to ensure that future economic development does not unwittingly erode its own natural resource foundations. Sustainable development, which integrates economic and social objectives with a sound approach to the management of

Table 13.6 Allocation of the 1986 National Budget for Natural Resource and Environment

Sector/Program/Project	Responsible Agency	National Budget (1986) (baht)
Land Resource		
1) Program to improve efficiency in land use	LDD, ALRO, RFD, DOL, Office of the Permanent Secretary (MOAC), TISTR	1,396,849,000
2) General administration for land right protection	DOL	36,136,000
3) Land administration sub-program	DOL	610,803,900
Total 1986 national budget for land resource administration and development		**2,043,789,700**
Water Resource		
1) Water resource development for agriculture		
1.1) Administration on water resource development for agriculture program	The Secretariate of the Prime Minister, RID	2,544,350,200
1.2) Water resource for agriculture program	RID	7,049,729,000
2) Water transportation		
2.1) Administration on water transportation program	HD, MPC	81,559,900
2.2) Local water transportation development program	HD	212,659,600
2.3) Coastal transportation development program	HD	120,758,100
2.4) International sea transportation and mercantile marine promotion program	HD	136,610,600
3) Water resource for hydro-electric power generation	NEA	450,627,100
Total 1986 national budget for water administration and development		**10,596,294,500**

Table 13.6 (contd.)

Sector/Program/Project	Responsible Agency	National Budget (1986) (baht)
Forest Resource		
1) Forestry administration program	RFD	361,665,500
2) Forestry research program	RFD	86,040,100
3) Forest conservation program	RFD	922,385,900
4) Hilltribes development program	DPW, PD	118,964,100
Total 1986 national budget for forest resource administration and development		**1,489,055,600**
Fishery Resource		
1) Fishery administration program	DOF	116,772,300
2) Fishery research program	DOF	82,712,600
3) Fishery promotion program	DOF	494,048,400
4) Fishery resource conservation program	DOF	26,799,000
Total 1986 national budget for fishery resource administration and development		720,332,300
Mineral Resource		
1) Mineral resource administration program	DMR	117,858,500
2) Basic geological survey program	DMR	80,370,500
3) Detailed geological survey for mineral resource development program	DMR	40,943,900
4) Development and promotion of mineral production program	DMR	40,254,200
Total 1986 national budget for mineral resource administration and development		279,427,100

Table 13.6 (contd.)

Sector/Program/Project	Responsible Agency	National Budget (1986) (baht)
Environment		
1) Administration on environment development program	ONEB	21,760,100
2) Environmental quality control program	ONEB, DMR	25,446,100
3) Pollution control program	ONEB, DIW	26,400,300
4) Study on human settlement program	ONEB	2,358,100
5) Borrowed fund for Songkhla Lake Basin development project	ONEB	5,156,500
6) Sanitary program	DOH	185,601,100
7) Occupational health program	DOH	5,722,800
8) Conservation of national heritage sub-program	DFA	158,516,800
Total 1986 national budget for environmental administration and development		**430,961,800**
Total 1986 national budget for natural resource and environmental administration and development		**15,559,861,500**
Total 1986 national budget (for all administration and development programs)		**218,000,000,000**
1986 national budget for natural resource and environment as % of the total 1986 national budget		**7.1 %**

Notes:
a. The 1986 national budget for natural resource and environment were compiled based only upon ependiture budget as classified by programs.
Sources: Budget document no. 5: Expenditure Budget as Classified by Programs in budget year of 1986, The Bureau of Budget.

renewable and non-renewable natural resources, is the key to ensuring a better quality of life for the country's growing population.

But, if we are to come to grips with the many complex and interrelated problems and issues discussed earlier, we need to develop a strategic perspective. The process of agenda-setting, the allocation of responsibilities, the drawing up of budgets, the design of programs and projects, and the whole process of implementation must be informed and shaped by a wide-angle vision of the country's natural resource problems and opportunities which we hope that this Profile begins to provide. In the process of preparing the Profile, a number of conclusions have emerged about what needs to happen next. These are summarized below.

Natural Resource Master Plans

A more coherent, coordinated approach is clearly needed in the management of Thailand's natural resources and environment. It is probably too early to prepare a single, integrated master plan for all natural resources, but a set of master plans could be assembled, covering such critical areas as land use, water resource development, forest management, fisheries management, mineral resource development, and wildlife conservation. Each master plan should provide a proper framework for the various agencies working in the field, or in related fields.

The National Economic and Social Development Plan is already moving in this direction, and this process should be accelerated. Long-range, resource-specific master plans would feed into later versions of the Plan, but, as an insurance policy, a master plan for integrated natural resources and environmental management will be prepared concurrently.

The national plan on hydrology, currently being prepared, will throw up important lessons for other planning exercises. Reliable data are essential, and improved data collection procedures are a priority need. With numerous agencies likely to be involved in implementing such plans, most of them having limited resources, it is essential that areas of responsibility are made explicit from the outset. By encouraging long-term thinking, such plans can ensure that critical constraints do not come as a surprise. But, since surprise is almost guaranteed in this fast-moving world, such plans should also be flexible and inter-active, so that they can respond to unforeseen circumstances.

The forest resource master plan already exists in embryo, with the new national forest policy. The supporting legal framework and detailed action plan are not yet in place, but a momentum is building. Areas suitable for the 15 percent protected forest and 25 percent managed forest must be identified and focused follow-up programs designed and implemented.

Land use and soil conservation, interlinked with water and forestry isues, represent the next urgent master plan priority. The plan must address outstanding questions about land classification, land rights, land allocation, land valuation and land use planning. Here, too, the legal framework must be disentangled and updated if the master plan is to have a real chance of getting to the roots of key problems.

Administrative Streamlining

Ultimately, even the best laid plans need to be implemented. A great deal can be done by ensuring closer working relationships between existing ministries and agencies. Lip-service is paid to the notion of multi-agency, multidisciplinary approaches, but while the idea of the four- or five-ministry action team is an attractive one, the reality is that the necessary integration is rarely achieved.

Different agencies pursue their independent lines within the new context.

Therefore, the conclusion must be that key ministries and agencies will have to be restructured to ensure the necessary integration. This streamlining process will need to extend right down to the local level, which ultimately is the most important level of all. Most authorities and officials at this level are keen to achieve progress for the areas and populations within their jurisdiction. But their efforts will generally be more effective if their responsibilities are carefully defined, clear lines of communication established, and effective monitoring and accounting procedures are adopted. Pre-program budgeting can also help direct local efforts in appropriate directions, although the current system is in need of an overhaul.

Given that public participation is likely to be a critical factor determining the success or failure of such programs, a complementary approach may be to delegate more responsibility to the provincial level, with the requisite authority and funding. If all agencies investing or operating in a particular province were to coordinate their inputs in a single development package, the impact could be considerable.

An Area Focus

Past experience has shown that available resorces can be most effectively deployed when the various agencies involved adopt an integrated, area-wide approach to a particular task. This is as likely to be effective in the field of sustainable development as in any other. This approach, as a minimum, should be adopted in the management of the resources briefly highlighted below. It is perhaps worth noting, however, that flexibility is likely to be a key factor when identifying the areas to be covered in such integrated progam planning.

Coastal zone and marine resources

Many different interests share -- and compete for -- the coastal zone, including marine life spawning and nursery grounds, wood and charcoal production, brackish water aquaculture, tourism, mining, port and harbor development, road and rail networks, housing and agricultural land conversion. A collapse of the mangrove, for whatever reason, can destroy the delicate nutrient balance over wide areas, adversely affecting catches of important marine species.

While it would be inappropriate to declare a complete embargo on human activities in such areas, special management packages are undoubtedly needed to ensure that this zone can serve its multiple functions on a sustained basis. Sub-zones for development and conservation will need to be identified, an activity which will itself need careful planning and management.

Protected areas

There are many different types of protected area in Thailand, including watershed areas, national parks, protected forests and wildlife reserves. The highlands represent a critical watershed area for the whole country. Watersheds typically cover the broadest range of land types, from very steep slopes at higher elevations, where no settler is allowed, down to the flat terrain found at low elevations, where no restrictions are imposed.

The top watershed classes, Classes 1A and 1B, are in a specially protected category. Next comes Class 2, which is partly protected, but where commercial forestry is permitted. Classes 3 and 4 do not qualify for full protection, but specify the types of trees and crops which can be grown, and the conservation measures to be employed. The protected forests, whether they be parks or reserves, are defined by their legal

boundaries.

Carefully integrated planning and management programs are a priority in these specially protected areas, with effective measures needed to deal with the problems of squatters and encroachment. Special consideration will also need to be given to long-established squatters and to the reforestation of areas which have already been cleared.

Irrigated areas

The country's comparatively small total area of irrigated land holds the potential for intensive production regimes, because of the availability and controlability of water supplies. There are a number of other factors which can affect agricultural production in such areas, however, with many water supply schemes increasingly needing to serve a number of purposes simultaneously. These might include irrigation, flood control and hydropwer generation, for example. To accomodate these various uses, and their likely development over time, a comprehensive approach is needed, preferably focusing on the water basin as a whole.

Rainfed agricultural areas

Rainfed areas represent the overwhelming bulk of land currently under production and support the majority of the rural population. They share common requirements as far as their requirements for technological improvements, and land and water conservation measures, are concerned. Each region, even each sub-region, will need to meet its own specific requirements in its own way.

In these circumstances, it would clearly be advisable to tailor development plans to sub-regions having similar general features of physiography, climate and cultural background. The development package could then address all the major concerns identified by the government, including soils and water conservation, social forestry schemes, human resource development, and area-integrated agribusiness and agro-industry projects.

Economic forestry lands

The forest lands falling under this classification include the commercial forest, the community forests and land to be returned to forest. Many of these forests are in watershed areas where economic forestry activities are permitted, within guidelines laid down by the Royal Forestry Department. The commercial forest is destined for privatization, posing several knotty issues which will need to be resolved. The community forest, meanwhile, holds real promise in the reforestation of denuded watersheds.

Many of these areas, however, are coming under intense pressure from the activity of illegal squatters, illegal loggers, and shifting cultivators, Thai and non-Thai alike. To effectively address such a spectrum of pressures, broad-based management packages are, once again, urgently required.

Area-oriented integrated program planning has a great deal to offer in all the areas described above. But they should not be considered as a totally inclusive list. As our knowledge base grows, so new resource development areas will emerge as suitable candidates for this sort of approach.

Keeping the Public Informed

Public interest in environmental and natural resource management issues fluctuates considerably, although environmental awareness is much higher today than it was in the 1960s or even the 1970s. Periodically, however, an issue inflames public emotions, creating a frenzy of interest and concern. Recent

examples in Thailand include the tantalum riot in Phuket, described in Chapter 12, and the cable-car controversy at Doi Suthep, near Chiang Mai (see Chapter 5).

In both cases, the proponents of development were challenged by local conservationists and found themselves in the unfamiliar position of having to justify their plans not simply to bankers and government officials, but to the wider public as well. Experience in other countries suggests that this trend will probably strengthen. As population pressures build, the potential for environmental conflict becomes increasingly pronounced. The Nam Choam Dam project, also described in Chapter 5, shows how national and international concern about an issue, in this case the integrity of the world's tropical rain forests, can translate into local controversy.

Inevitably, however, while the public's conscience may be stirred on some issues, it is remarkably quiescent on others. One example might be the pollution of Thailand's premier river, the Chao Phraya. The canals of Bangkok (and many other cities) are now de facto open sewers, with only two percent of Bangkok's inhabitants connected to a sewerage system. Another example of an issue which has not yet had the attention it perhaps deserves is accident prevention of hazardous industrial plants, described in Chapter 12.

Without well-planned public education programs, a great deal of government money could be wasted on projects designed, for example, to clean up the Chao Phraya, slow the salinization of agricultural soils, protect major fisheries, or improve working conditions. All important objectives, of course, but in each of these areas, public support will be necessary to implement the solutions proposed in the respective master (and local action) plans.

Big-budget public awareness campaigns have their place, of course, but low-key, sustained educational programs are likely to be at least as effective. Existing community leaders are often the best channel of communication in the vast rural sector, if they can be convinced that the programs directly relate to the future health, wealth and welfare of their people. They should be provided with the information and other resources needed to ensure that the message is communicated effectively - and continuously reinforced.

Human Resource Development

People are the key to sustainable development. To ensure that their enthusiasm, commitment and ingenuity are harnessed, we need to capitalize on Thailand's healthy regionalism, ensuring that development planning is closely integrated with local priorities and resources. Sustainable development programs should be viewed not simply as a means for achieving environmentally sound economic development, but also as a means for achieving the strengthening of local communities and the upgrading of their skills-base and other human resources.

People want to improve their living standards, not undermine them. They must be shown how. Wherever possible, national programs should be brought into sharp focus, area by area. The active support of local community leaders, development workers, extension officers, teachers, nurses, housewives and youth leaders must be recruited. The effort required to mount this sort of program is clearly greater than that needed to issue a set of national guidelines, but the ultimate return on the investment of time and energy is likely to be that much greater.

Ultimately, the sustainable development of Thailand's natural resources is designed to insure that all Thais have a reasonable future to look forward to. Lowland farmers need to be assured that the destruction of watershed areas is not going to lead to extensive flood damage to their land and crops; fishing

communities must see that the destruction of the mangroves, and of the fish nurseries which they sustain, is being brought under control; and communities living in or near forest reserves must be convinced that they have a real stake in the long-term survival of the forest ecosystem. Everyone must feel that miscreants will not go unscathed, whether they are dynamiting coral reefs, clearing unsuitable highland areas for opium poppy cultivation, or dumping toxic chemicals in the nation's rivers.

A Sustainable Future

Despite its acknowledged problems, then, Thailand has a real opportunity to pioneer in the emerging field of sustainable development. Much of the groundwork has already been laid, even though the country's legal and administrative framework cannot yet exploit the full potential of the investments already made.

Previous chapters have already highlighted some of the early examples of integrated planning. The Ministry of Industry, for example, helped establish centralized effluent treatment facilities for sugar mills on the Maeklong, as described in Chapter 10, and is now seeking to establish centralized treatment facilities for industrial waste generators in several areas of the Bangkok Metropolis, as described in Chapter 11.

Investment in cleaner and more resource-efficient technology need not represent a drain on the economy. Instead, the process of innovation can lead to unexpected improvements in the producivity, efficiency and competitiveness of industrial firms. Government can play an important role in this process, using tax incentives to promote the adoption of water-efficient practices by farmers (Chapter 3), for example, or to spur investment in appropriate technologies, whether in the form of tamper-proof motorcycle exhaust systems (Chapter 9) or improved biogas plants for use in rural areas (Chapter 10).

As the pace of development becomes more intense, and the implications of getting major decisions wrong become more serious, the importance of careful planning increases. Proper planning for major hazard or highly polluting industries, for example, will help minimize the risk of a Thai version of Bhopal, and also help identify cost-saving opportunities for centralized waste treatment

A country like Thailand, while it cannot afford disasters, is also hard-pressed to find the resources to enforce the legislation already enacted. Wherever possible, then, every effort should be expended to ensure that potential future problems are identified and prevented at an early stage, rather than having to be cured later on by add-on technology, increased surveillance and politically sensitive enforcement actions. The introduction of the requirement for pre-project environmental impact assessments (EIAs) was a welcome step in this direction.

Whether it comes in the form of EIAs, natural resource profiles or computerized databanks, information will inevitably be a critical resource in the transition to more sustainable forms of development. Management proficiency will be a key factor in ensuring the success of the proposed programs and projects, and effective management depends on the ready availability of accurate, up-to-date information. Although this Profile has highlighted some of the most important links between the many areas which it has covered, it remains essentially a "snapshot" of the natural resource base of Thailand. A useful first step, certainly, but the next step must be to move towards an integrated, interactive national database on natural resources and the environment.

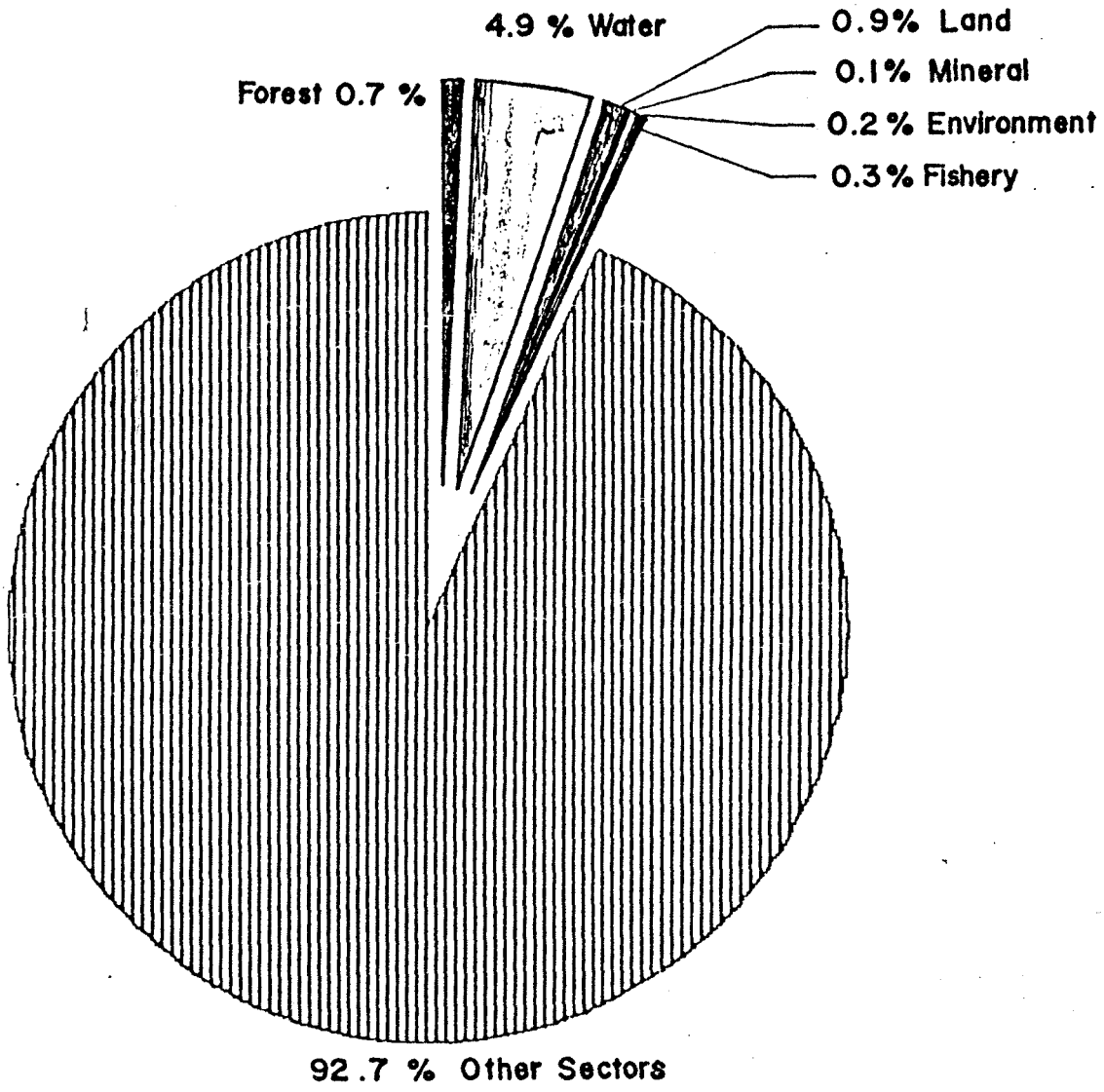
New developments in the field of

"geographic information system" permit just such an approach. Many different kinds of data - from map data through to remote sensing data from the LANDSAT or SPOT Image satellites - can be assembled onto a common grid, and computers, can begin to trace and analyze the web of interactions between, for example, forests and other natural resources, or superimpose the types of land title held in various areas on a map of the areas targeted for the "15 percent" conservation forest - or the "25 percent" productive forest.

Clearly, if such systems are to achieve their full potential, they must have access to the latest data on all the relevant areas, whether on land classification and soil types, forest coverage, surface water status, groundwater status, the yield trends for key fisheries, and mineral reserves, or on the various schemes proposed by the private and public sectors in sensitive areas.

In a world where different agencies see themselves in competition for resources and influence, information is seen as power. To begin with, it may be difficult to persuade them to share the information they have and to coordinate the data they collect in future. But, in the final analysis, the wise use of information is the only guarantee of the survival of a thriving, independent Thailand, able to meet the increasing needs of its growing population. Where there is a will to succeed in sustainable development, there will be a way. Where there is no such will, many options will be foreclosed. The choice is still ours to make.

FIGURE 13.9 ALLOCATION OF THE 1985 NATIONAL BUDGET FOR NATURAL RESOURCE AND ENVIRONMENT



Land Policy
of
Thailand

A Report prepared for the Year-end Conference,
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Contents

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Abstract

THE PROBLEM

During the past two decades, the problems of land availability, land use, land classification and development, land tenure and titling, land information, and land administration have become increasingly acute in Thailand. These problems, if left unsolved, will have serious political, economic and social consequences. A coherent national land policy is therefore urgently needed.

THE LAND POLICY

Land may be put to different uses for certain objectives. These objectives may be of economic, social and political in nature. It is not feasible to attempt to formulate a single land policy capable of achieving all types of objectives. Therefore, land policy may be divided into 4 distinct, and frequently interrelated, categories, i.e., land policies for economic, social, conservation, and national security purposes.

Land Policy for Economic Purposes

For economic purposes, the land can be divided into areas outside the forest and within the forest. For outside the forest areas, policies which are relevant include: land rights (i.e., to give title deeds to land holders), land tax (e.g., to introduce progressive land tax), agricultural zoning, farm development strategies, soil conservation and urban land use. Within the forest areas, 40% of the total land of the country must be reserved for forest, of which 25% will be commercial forest. For this type of forest, the private sector should be encouraged to participate in the development. Other policies include the degazettement of national forest reserve areas which has already become large communities and the development of coastal forest areas which should be done by means of zoning.

Land Policy for Social Purposes

No less than 2.5 million families, about 12 million people, have problems of land for their livelihood. There are 1 million families living in the forest reserve areas, 1 million tenants, and 0.5 million landless families. The distribution of land to these people has been done by a number of agencies namely the Agricultural Land Reform Office, the Public Welfare Department, the Cooperatives Promotion Department and the Royal Forestry Department. Progress on this has been rather limited and the implementation should be speeded up. There is also a need to minimize differences in the practices of these land distributing agencies, for example, with regard to land rights, infrastructure development, and farm size.

Land Policy for Conservation Purposes

According to the forestry policy, 15% of the nation's total land area must be allocated for conservation forest. This is about 48 million rai. Headwater areas must be strictly protected and reforestation should be accelerated. A master plan for development of national park areas (about 16 million rai) should be prepared.

Land Policy for National Security

Part of the land areas should be reserved for military activities and for settlements along the border which support national security.

The determination of these 4 types of land policy is based on the main objectives of each policy. This does not mean that the benefits derived will accrue only to the objective of the policy. The purpose for such a classification is to provide a clear picture of each policy, particularly of its intended or specified objective(s).

Finally, hilltribe policy is also specified separately since it cannot fall into only a single policy objective.

THE STRATEGY

Three types of strategy are proposed:

1) Land Classification Improvement
2) Establishment of a Land Information System
3) Restructuring of the Land Administration

The last strategy calls for a rather drastic restructuring of the existing land administration system in Thailand. Among the recommendations are the setting up of the Bureau of Land Reform and the Ministry of Natural Resources.

บทคัดย่อ

ปัญหาที่ดิน

ในช่วงสองทศวรรษที่ผ่านมา ปัญหาที่ดินที่สำคัญประการหนึ่งก็คือปัญหาหรือปริมาณที่ดินที่จะนำมาใช้ได้มาจากไหน การใช้ที่ดินยังไม่เหมาะสม สิ้นเปลือง และเสื่อมคุณภาพลงเรื่อยๆ การจำแนกและการวางผังที่ดินรวมทั้งการอนุรักษ์ดินและน้ำยังขาดและขาดประสิทธิผล การถือครองที่ดินมีความรุนแรงโดยเฉพาะการเช่า การโยกย้ายแรงงานและขนาดฟาร์มเล็ก รวมทั้งการขาดเอกสารกรรมสิทธิ์ที่ดิน ยอมให้ที่ดินกระจุกกระจายและขาดระบบ ทำให้เกิดความสับสนและยุ่งยากต่อการใช้และการบริหารงานที่ดิน ยังขาดประสิทธิภาพ ปัญหาเหล่านี้มีแนวโน้มทรุนแรงมากขึ้น อนาคตจะมีผลกระทบเป็นอย่างมากต่อการพัฒนาและความมั่นคงทางเศรษฐกิจ สังคม และการเมือง

นโยบายที่ดิน

เนื่องจากปัญหาด้านที่ดินค่อนข้างจะยุ่งยากสับสน และเกี่ยวพันกับหลายสิ่งหลายอย่าง การใช้ที่ดินอาจจะเป็นไปเพื่อวัตถุประสงค์อย่างหนึ่ง หรือหลายอย่างได้ วัตถุประสงค์ดังกล่าว อาจจะเป็นได้ทั้งด้านเศรษฐกิจ สังคม และการเมือง ดังนั้น การกำหนดนโยบายที่ดินอย่างหนึ่งเพื่อให้ได้มาซึ่งวัตถุประสงค์หลายอย่างนั้นย่อมไม่สามารถจะทำได้อย่างมีประสิทธิภาพ จึงน่าจะแบ่งนโยบายออกโดยอาศัยวัตถุประสงค์เป็นหลัก ซึ่งสามารถแบ่งนโยบายที่ดินของประเทศออกได้เป็น 4 ประเภท ดังนี้

1. นโยบายที่ดินเพื่อเศรษฐกิจ สำหรับนโยบายประเภทนี้ เราอาจแบ่งที่ดินออกเป็น 2 ประเภท คือ ที่ดินเอกชนหรือที่ดินนอกเขตป่าไม้ และที่ดินในเขตป่าไม้ ซึ่งเป็นที่ดินของรัฐ นโยบายเกี่ยวกับที่ดินเอกชนนั้นจะรวมถึงนโยบายเร่งรัดการออกเอกสารสิทธิ์ ให้แก่เจ้าของที่ดิน นโยบายภาษีที่ดิน (การใช้ที่ดินแบบภาวะหน้า) นโยบายการกำหนดเขตเกษตร (เพื่อให้การใช้ที่ดินเหมาะสมยิ่งขึ้น) การกำหนดกลยุทธ์การพัฒนาเกษตร ให้เป็นไปตามความเหมาะสมของพื้นที่รวมทั้งการกำหนดบทบาทของภาคเอกชนและภาครัฐบาล การอนุรักษ์ดินและน้ำ โดยใช้มาตรการที่เหมาะสมและนโยบายการใช้ที่ดินในเขตเมือง ส่วนที่ดินป่าไม้นั้น นโยบายป่าไม้แห่งชาติได้กำหนดไว้แล้วว่า จะต้องมีพื้นที่ป่าไม้ ร้อยละ 40 ของเนื้อที่ทั้งหมดของประเทศ ซึ่งจำนวนดังกล่าวจะเป็นพื้นที่ป่าไม้เศรษฐกิจถึงร้อยละ 25 ซึ่งน่าจะเป็นบทบาทของเอกชนและกำหนดให้แน่ชัดถึงเขตป่าดังกล่าว นอกจากนั้น นโยบายอื่นๆ จะรวมถึงการเพิกถอนพื้นที่ป่าสงวนแห่งชาติซึ่งได้กลายเป็นชุมชนแล้ว และนโยบายป่าชายเลนซึ่งควรจะกำหนดพื้นที่เพื่อการต่างๆ ที่ชัดเจนไว้ (เช่น เขตสงวน เขตอนุรักษ์ และเขตเศรษฐกิจ เป็นต้น)

2. นโยบายที่ดินเพื่อสังคม จากข้อมูลที่มีอยู่ว่าประชากร 2.5 ล้านครอบครัว มีปัญหาเกี่ยวกับที่ดินทำกิน ซึ่งรวมถึงผู้บุกรุกป่าสงวนแห่งชาติ (1 ล้านครอบ

ครัว) ผู้เช่าที่ดิน (1 ล้านครอบครัว) และผู้ไร้ที่ทำกิน และเกือบไร้ที่ทำกิน (0.5 ล้านครอบครัว) นโยบายการจัดที่ทำกินจึงต้องเร่งรัดแก้ปัญหาดังกล่าว เนื่องจากได้ผลยังช้า เพราะเท่าที่ดำเนินการมาโดยหลายหน่วยงาน (เช่น สำนักงานการปฏิรูปที่ดินเพื่อเกษตรกรรม กรมประชาสงเคราะห์ และกรมส่งเสริมสหกรณ์) นั้น ยังทำได้จำกัด ในการจัดที่ดินโดยหลายหน่วยงานเหล่านี้ จำเป็นที่จะต้องใช้รูปแบบหลักเกณฑ์เดียวกัน ทั้งในด้านกรรมสิทธิ์ที่ดิน และการพัฒนาด้านสาธารณูปโภคพื้นฐานต่างๆ

3. นโยบายที่ดินเพื่อการอนุรักษ์ นโยบายป่าไม้แห่งชาติกำหนดไว้ว่า ร้อยละ 15 ของพื้นที่ป่าไม้ทั้งหมด (ร้อยละ 40) นั้น จะเป็นป่าอนุรักษ์ซึ่งหมายถึงเนื้อที่ 48 ล้านไร่ การพัฒนาต้นน้ำลำธารจึงจำเป็นจะต้องดำเนินการอย่างจริงจัง โดยเฉพาะด้านการปลูกป่าซึ่งเท่าที่ผ่านมายังทำได้จำกัดมาก เพื่อการดำเนินงานที่ได้ผลยิ่งขึ้นในอนาคต สมควรที่จะจัดทำแผนแม่บทเพื่อพัฒนาพื้นที่อนุรักษ์แห่งชาติ (16 ล้านไร่) ด้วย

4. นโยบายที่ดินเพื่อความมั่นคงแห่งชาติ เนื้อที่ส่วนหนึ่งของประเทศจะต้องกันไว้เพื่อกิจกรรมต่างๆ อันเกี่ยวข้องกับความมั่นคงของชาติ เช่น เพื่อการทหาร และเพื่อการจัดตั้งนิคมในแถบชายแดน เป็นต้น

นโยบายอย่างหนึ่งซึ่งควรจะกำหนดไว้เป็นการเฉพาะก็คือ นโยบายชาวเขา ปัญหาของชาวเขาเกี่ยวพันกับหลายด้าน จึงไม่สามารถจัดไว้ในวัตถุประสงค์หนึ่งวัตถุ-ประสงค์ใดอย่างชัดเจนได้ นโยบายนี้จะต้องกำหนดขึ้นอย่างระมัดระวัง นโยบายกว้างๆ ก็คือ การแบ่งชาวเขาออกเป็น 2 ประเภท ตามลักษณะการตั้งถิ่นฐานและการทำการเกษตรกลุ่มหนึ่งซึ่งอยู่เป็นที่อย่างถาวร น่าจะจัดที่ดินและส่งเสริมในที่เดิม โดยรัฐบาลอาจจะให้มีกิจกรรมการปลูกป่าและรักษาป่าด้วย ส่วนอีกกลุ่มหนึ่งที่ทำไร่เลื่อนลอยและอยู่ไม่เป็นหลักแหล่ง ควรจะทำการเคลื่อนย้ายและจัดที่ดินทำกินให้เป็นการถาวร

กลยุทธ์

เพื่อให้การดำเนินการตามนโยบายต่างๆ ดังกล่าว เป็นไปอย่างได้ผลมีมาตรการ 3 อย่าง ซึ่งจะต้องดำ-เนินการ คือ

1. การปรับปรุงด้านการจำแนกประเภทที่ดิน
2. การจัดตั้งระบบข้อมูลที่ดิน
3. การปรับโครงสร้างระบบการบริหารที่ดิน

มาตรการที่ 3 นั้น เกี่ยวข้องกับการปรับโครงสร้างที่สำคัญ เพื่อให้ระบบบริหารงานที่ดินมีประสิทธิผลดียิ่งขึ้น ข้อเสนอที่สำคัญคือ การจัดตั้งคณะกรรมการทรัพยากรธรรมชาติแห่งชาติ การจัดตั้งหน่วยงานการปฏิรูปที่ดินและกระทรวงทรัพยากรธรรมชาติ ซึ่งน่าจะได้พิจารณาดำเนินการอย่างจริงจัง

Foreword

The project entitled "Land Policy Study", supported by the National Economic and Social Development Board (NESDB), has been carried out by the Thailand Development Research Institute (TDRI). The results of the study are intended for use in the formulation of the national land policy.

For many years, land problems have been of great concern to the Thai Government. Land problems are related to other natural resources, particularly the nation's forest. Over the past two decades, the forest areas have been declining at an alarming rate. This has been due to a number of factors, including the increasing demand for agricultural land as a result of rapid population growth. Deforestation has now reached a critical point and is of urgent concern to government and public alike. Obviously, this is a major policy issue.

The Land Policy Study covers two aspects of land issues. One involves land use, land development and conservation. The other is land tenure, especially tenancy, landlessness, and land rights which affect the livelihood of 2.5 million farm families. These problems have great impact on production, income and income distribution of the rural population. Therefore, policies relating to land resources should be carefully formulated because of the important role they will play in the final national land policy.

During the course of this study, the Study Team received assistance in terms of data and views from a great number of people and agencies. It is not possible to name them all here. Nevertheless, we would like to express our profound gratitude to many of the NESDB staff for their cooperation and sharing of many valuable insights.

Part I Introduction and Overview

1 Introduction

1.1 BACKGROUND

The central questions in economic development must deal with how well a society can produce and distribute goods and services. In countries where agriculture is still the center of economic activity, problems of efficiency and equity in this sector probably constitute the most important areas for policy making and research. This is particularly the case of Thailand where growth with equity has been the major policy objective.

In developing countries, the agricultural sector usually lags behind other economic sectors. The state of agriculture is poor because a number of factors lead to slow and unstable agricultural growth. While the interaction among these factors varies among countries, man's relation with the land, its control and use, is perhaps the most essential factor affecting the allocation of resources and the distribution of income. In developping countries, land represents the principal form of wealth and political power. In fact, land tenure systems reflect class structures and relations. In turn, these structures impinge directly on decisions about production and affect their consequences on growth and distribution.

The development of agriculture involves an improvement in productivity which, in turn, rests on the use of new technologies, e.g., fertilizer, new varieties of seed, insectisides, and irrigation. These changes in new technologies require appropriate and adequate support systems and policies, e.g., farm credit, extension services and marketing. However, the potential benefits of improvements in farm support systems can be vitiated by defective land tenure systems that the adoption of new technologies. Theoretically, land tenure systems will affect production incentive, production technique, capital formation and investment and farm productivity (Onchan, 1976). Hence, if the land tenure system is not appropriate, it must be changed so that the specified objectives of economic and social development can be attained. A number of measures may be used. One of these, which is rather radical in terms of action, is land reform, now commonly used by developing countries.

As for Thailand, it is expected that problems related to land will become increasingly acute. It is generally recognized that the nation's land frontiers are now being approached and that land resources have become increasingly scarce. Shortage of land for agriculture may pose a serious problem since the labor force in agriculture has been increasing at a rather high rate (i.e., over 2% per year).

The total land area is about 320 million rai, of this, 136 million rai are under the national forest reserve and cultivated area constitute 152 million rai. Due to the relatively high rate of population growth during the last two decades, and the investment in the 1950s and 1960s, encroachments on the national forest reserve have been

widespread, covering a total area of 43 million rai. It is also belived that most of the 30 million rai of pre-reserve area have already been over-run. It is estimated that at least one million households are settled in forest reserves without proper title to the land they occupy and cultivate.

Land ownership security outside forest reserves is also a serious problem. In 1985, only about 17 percent of the total private land had title deeds (N.S.4). This constitutes an important obstacle to farm investment and rural development.

Problems of tenancy and landlessness have been increasing in recent years and are expected to become more widespread with the intensification of agriculture. This is already quite evident in the Central Plain and the upper North.

Soil erosion and degradation have been severe and extensive due to : i) the uncontrolled expansion of agriculture into watershed areas and marginal lands, and ii) discouragements to land improvement arising from insecure ownership, the lack of land use planning and management, inadequate water control, and shifting cultivation.

Up to now, there has been no coherent land policy, but rather a proliferation of government agencies involved in land policy making. At present, there are as many as 24 government land agencies and several land committees with overlapping responsibilities. Several different laws on land must be contended with, including revolutionary orders, various cabinet resolutions, and several ministerial decrees.

These problems, if left unsolved will have serious political, economic and social consequences. A coherent national land policy is urgently needed, one which would include efficient land administration, a set of land laws, regulations, and policy guidelines for optimal land use; land rights and titles; soil and water conservation and development; and land reform. Such a national policy should be supported by an efficient information system holding an inventory of Thailand's land and soil resources. Systematic and regular monitoring of changes in land use, ownership and productivity are a necessary concomitant.

1.2 OBJECTIVES OF LAND POLICY

Land policy is an integral part of the national economic and social policy and must therefore be in accord with the objectives of the national policy. Generally, all objectives should converge toward one end-the improvement of general economic and social welfare. Two of the primary goals of any economic policy are: (1) maximizing the social product over time, and (2) optimizing income distribution among people. As for the objective of land policy of Thailand, they should include the attainment of the following:

a) Maximum efficiency in the use of land resources
b) Optimum distribution of income
c) Maximum economic and social security
d) Conservation of resources and environment

1.3 SCOPE OF LAND POLICY

Land policies are social control measures designed to improve the use of land resources and the conditions of property rights under which people work and live on the land. The main problems to which land policy is addressed, therefore, lie in the areas of :

a) Land use, conservation and development
b) Land tenure

In this study, land policy will

broadly cover these two aspects of land problems.

Land use involves demand for and supply of land. Since the aggregate supply of land is limited and fixed, expansion of land areas under use will also be limited. Hence, land must be used wisely and efficiently. Since, land can be exploited and soil degraded, conservation of soil and watershed is important for future use. Land and forest resources are closely related. Therefore, policy on forestry must also be examined.

Land tenure is a rather broad issue. In general, it is concerned with the rights over the land that man uses. One aspect of land tenure which should be of interest is the lack of land ownership security in both public and private lands. This affects farm productivity and income distribution. Problems of tenancy and landlessness are serious and tend to worsen over time. Land allocation or distribution is therefore necessary and is carried out under such programs as land reform and land settlement. These are the two aspects of land policy which are emphasized in this study. Also covered is the question of changes in land administration which are necessary if land policies are to be effectively implemented. Finally, in policy formulation and implementation, a good land information system is also required. This, too, is carefully considered here.

1.4 OBJECTIVES OF THE STUDY

This study has three main objectives:

a) To document and analyse the current land problems of Thailand.

b) To formulate and recommend national policy on land use, land development, land titling, land reform and land administration, along with a supportive information system.

c) To propose strategies for carrying out the recommended national land policy.

1.5 METHODS OF STUDY

Problems related to land resources are numerous and very complex, especially since land is closely interrelated with other natural resources, especially forests and water. It is therefore necessary to emphasize only those important land issues which are of particular policy interest, both in the short and long-run.

The whole project has been divided into 5 sub-projects as follows :

i : Land Use, Forestry, Land Classification and Conservation
ii : Land Tenure (Rights and Land Titles)
iii : Land Reform and Land Allocation
iv : Land Administration
v : Land Information System

The data comes mainly from secondary sources. Primary data has also been collected through interviews with people both in Bangkok and the provinces. Meetings and workshops held during the study period also provided useful information for the formulation of the land policy.

This report first discusses the agrarian structure and agricultural economy of Thailand. This is intended to provide an overview of the agricultural economy and an indication of some of the important problems. The results of the sub-project studies follow with one chapter for each sub-project. In the concluding, chapter, a land policy for Thailand is proposed.

It must be noted that the results presented in this report are drawn from the main report of the Land Policy Study and the supplementary reports in 9 volumes of the sub-projects. Therefore,

details on certain matters not given here can be found in those reports.

2 The Agrarian Structure and Agricultural Economy of Thailand

2.1 INTRODUCTION

Over the past two decades, economic growth in Thailand has been rather high compared with other developing countries. The average per capita income in 1985 was about 132% higher than in 1965, an average growth of 4.3% per year. The rate of economic growth has started to slow down in the 1980s and was below the target of the 5th National Economic and Social Development Plan. Though there are some indications that more rapid economic expansion may be expected, it will still be less than what was experienced during the period from the First to the 4th Plan.

During the latter period from the mid-1960s to late 1970s, the agricultural sector had a satisfactory rate of growth - 4.3% from 1971 to 1980). Since 1982, the agricultural sector has had a rather low and fluctuating growth rate. It was 1% in 1982 and 2.2% in 1986. The growth rate in livestock and fisheries has been higher than for crops during the past few years. The main factor contributing to the high growth of agriculture in earlier periods was the rapid expansion of cultivated areas. In later periods, however,expansion of area has been limited while the prices of major crops have continued to decrease. This has affected the production incentive and agricultural income as well.

There has also been a structural change in the Thai economy. Over the past decade, national income from agriculture dropped from 30% of GNP to 20%. The industrial and service sectors have increased in importance. It is expected that the share of the industrial sector will soon be greater than that of agriculture. However, at present, about two-thirds of the total population are still dependant on agriculture which, in return, implies low labor productivity and low income.

Another well-known fact about Thai agriculture is that the income of farmer is very low compared to non-farmers. In 1983, per capita income of the farmer was only one-seventh of the non-farm income, and this trend has not shown any improvement. The problems of income distribution between regions, economic sectors, and urban and rural has become more serious. During the period of planned development, poverty has declined substantially, from over 50% to about 25%. Yet poverty is still a serious problem affecting certain groups of people, for example, landless workers, tenants, and small farmers. The income gap between the urban and rural people must be overcome. If allowed to widen further, it will have an effect on economic growth and on social and political security. Rural poverty is usually related to the country's agrarian structure, which is discussed in the next section.

2.2 AGRARIAN STRUCTURE

Thailand's agricultural growth and income distribution are affected by its

agrarian structure which has never been of a form that would best facilitate optimum allocation of land resources. It is not flexible enough to adjust itself to changing technology and market environment and it has contributed to worsening distribution of income. Some of the major aspects of the Thai agrarian structure are surveyed in the following.

Distribution of Landholding

The concentration of landholding is an indication of one of the problem's the agrarian structure. The data in Table 2.1 and Figure 2.1 show that this problem is rather serious. Over time, it has gradually worsened. In 1966, there were 18% and in 1978, 15% of the smallest-sized farm households, i.e. landholdings of less than 5.9 rai of land who owned only 2.6% and 2.3% respectively of the total land area. At the same time, large farmers, i.e. those with landholdings of over 60 rai, constituted only 5.4 of the total number of farm households in 1966 and 6.3% in 1978. These large farmers owned 22.2% and 24.3%, respectively, of the total land area. This indicates that the proportion of small farm households declined both in number and area while that of large farms increased in both. The data for 1978 and 1983 also indicate a rather unequal distribution of landholding and the problem has become increasingly serious (National Statistical Office, 1978, 1983).

In the case of public land, the distribution of landholding among squatters is also very unequal. In 26 provinces, 24% of those with small holdings of less than 10 rai own only 4% of the total land area. While 3% of those with large holding of over 100 rai own, 17% of the total land area (Table 2.2 and Figure 2.2).

This data shows very clearly that the distribution of landholdings is a problem on both private and public lands. This should be of interest to those concerned with land allocation and land tenure programs.

Farm Size and Number of Farms

Since the land is limited and population growth has been rather high, farm size should be gradually declining. However, this may not be the case of Thailand. Over the past two decades, more land has been put into farm production at the expense of the forests. In fact, from the 1960s to late 1970s the growth rate of cultivated land to late 1970s, was higher than the growth rate of population. This helps explain why the nation's average farm size has not been decreasing as generally believed. From 1953 to 1983, farm size remained almost constant (Table 2.3). The regional level shows the same pattern. 1/

Another type of data which supports this fact is the land-man ratio which has been rather constant, or even higher, in recent years. For example, if the ratio is computed by using agricultural land and farm population, an increase appears in farm land per capita in 1964 and 1983 (Table 2.4).

However, the problem of farm size appears to be serious in certain areas, particularly in the Upper North. Many provinces namely Chiang Mai, Phrae, Lampang, Lamphun and Mae Hong Son have an average farm size of less than 10 rai per household. The census data from the National Statistical Office reveals that in these provinces over 50% of the farms are less than 6 rai. Moreover, there is a significant number of farms even smaller than this. The problem, deserves attention (Table 2.5).

Another interesting aspect of farm size is the problem of land

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1/ With the exception of the North in 1953, where farm size was small. This appears rather strange compared to later years. There may be some statistical error here.

Table 2.1 Distribution of Landholdings, 1966,1978.

Size of Holding	% of owners		% of Area Owned	
	1966	1978	1966	1978
Less than 5.9	18.6	15.9	2.6	2.3
6 - 14.9	29.4	27.4	13.0	11.4
15 - 29.9	27.5	29.0	26.5	25.7
30 - 44.9	13.1	11.5	21.6	16.3
45 - 59.9	6.0	9.9	14.1	20.0
Over 60	5.4	6.3	22.2	24.3
Total	100.0	100.0	100.0	100.0

Source : National Statistical Office

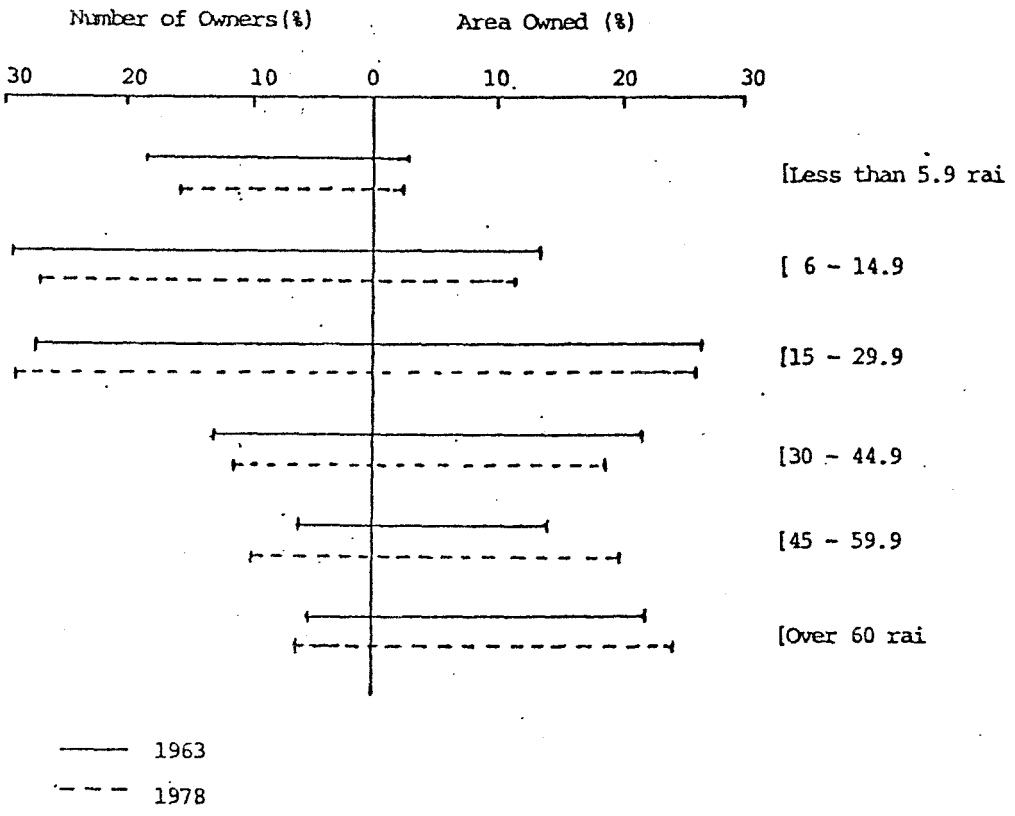

Figure 2.1 Distribution of Landholdings 1966,1978

Source : Data from Table 2.2

Table 2.2 Distribution of Landholdings in Public Lands in 26 Provinces,1977 -1979

Size of Holding (rai)	No. of Owners	%	Area owned	%
Less than 10	12,283	23.6	72,102	4.4
10 - 20	11,530	22.1	157,717	9.7
20 - 30	10,034	19.2	255,255	15.7
30 - 40	5,491	10.5	194,743	12.0
40 - 50	5,089	9.8	238,226	14.7
50 - 100	6,080	11.7	424,970	26.2
Over 100	1,641	3.1	280,310	17.3
Total	52,148	100.0	1,623,323	100.0

Source : Agricultural Land Reform Office

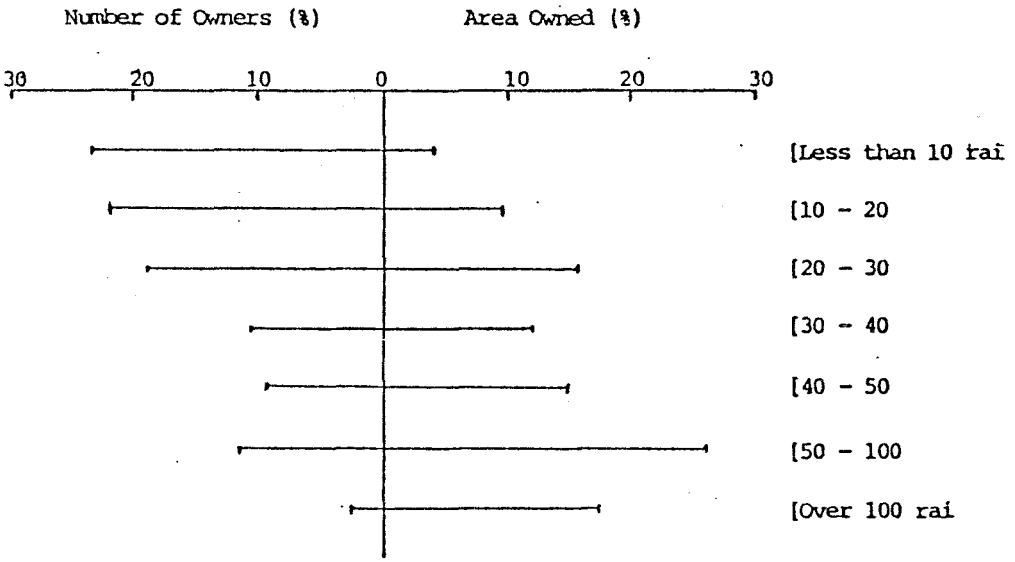

Figure 2.2 Distribution of Landholdings in Public Lands in 26 Provinces, 1977 - 1979

Source : Data from Table 2.3

Table 2.3 Farm Size in Thailand, 1953 - 1984

unit : rai

Year	Northern		North		Center		South		Whole Kingdom	
	No. of Farms	Farm Size	No. of Farms	Farm Size	No. of Farms	Farm Size	No. of Farms	Farm Size	No. of Farms	Farm Size
1953	993,504	27.4	357,605	9.6	776,124	30.7	264,368	26.1	2,397,735	25.6
1975	1,675,650	28.3	1,054,521	22.7	826,505	33.3	563,370	23.5	4,120,046	27.2
1976	1,705,145	28.6	1,064,341	21.6	843,932	33.3	573,291	23.2	4,186,709	27.0
1977	1,740,386	27.7	1,117,175	21.1	867,978	32.9	587,752	22.8	4,313,291	26.4
1978	1,754,760	28.1	1,147,130	21.3	868,463	33.7	607,260	22.2	4,377,613	26.6
1979	1,772,033	28.0	1,137,153	22.1	881,156	33.2	615,577	22.2	4,405,919	26.7
1980	1,786,465	28.0	1,162,618	22.4	891,620	32.6	626,844	22.0	4,467,547	26.6
1981	1,840,184	28.1	1,181,594	22.6	887,930	32.3	622,643	22.9	4,532,351	26.8
1982	1,945,713	27.2	1,236,449	22.3	878,827	32.8	624,466	23.0	4,685,455	26.4
1983	1,944,263	27.4	1,253,521	22.2	879,974	32.6	635,291	22.6	4,713,049	26.3
1984	1,975,599	27.4	1,256,666	22.6	876,080	32.7	632,089	22.6	4,740,434	26.6

Source : Office of Agricultural Economics, Agricultural Statistics of Thailand, 1953, 1976/77, 1984/85, and 1985/86

Table 2.4 Land-Man Ratios in Thailand 1964,1971,1978 and 1983

Region	1964			1971			1978			1983		
	A	B	C	A	B	C	A	B	C	A	B	C
North	0.69	0.79	16.59	2.29	2.81	13.52	2.61	3.39	11.36	2.77	3.61	10.51
Northeast	2.27	2.23	10.66	3.46	3.74	8.52	3.18	3.87	6.81	3.09	3.89	6.13
Center	3.60	6.70	6.75	1.87	3.78	5.40	1.98	4.35	4.39	1.79	3.78	4.05
South	3.60	4.33	12.16	2.60	3.32	9.72	2.41	3.29	7.91	2.33	3.17	7.17
Whole Kingdom	2.52	3.12	10.85	2.58	3.48	8.71	2.58	3.79	7.09	2.51	3.70	6.48

Land-Man Ratio :

$$A = \frac{\text{Agricultural Land}}{\text{Total Population}}$$

$$B = \frac{\text{Agricultural Land}}{\text{Agricultural Population}}$$

$$C = \frac{\text{Total Land Area}}{\text{Total Population}}$$

Source : Computed from data from Office of Agricultural Economics

Table 2.5 Farm Size in Upper North,1981-1984

Unit : Rai

Province	1981	1982	1983	1984
Chiang Mai	9.1	8.9	8.6	8.6
Chiang Rai	16.4	15.4	15.5	15.5
Lampang	8.4	9.3	9.6	9.9
Lamphun	8.7	8.8	8.5	8.3
Mae Hong Son	6.8	8.4	7.9	8.3
Nan	10.1	11.0	11.4	11.0
Payao	14.2	13.7	13.4	14.8
Phare	8.8	9.8	9.8	9.7

Source : Office of Agricultural Economics,1981-1984

fragmentation which, has resulted from the system of inheritance and the widespread encroachment on public lands. It appears that many farmers own more than two plots of land (Onchan, et. al., 1986), which might render misleading the data on farm size which has shown a rather constant situation. In fact, the average size of each plot is found to be very small. This has important implications in terms of farm production systems and efficiency.

The number of farms increased from 2.4 million to 407 million from 1953 to 1983 (Table 2.3). The farm population also increased considerably from 24 million to 34 million during the 1964-1983 period. However, the proportion of farm population has declined from over 80% to 65% during the past two decades (Office of Agricultural Economics, 1964-1985/6). These data indicate that the Thai economy is still greatly dependant on agriculture, and apparently will remain so in the foreseeable future.

Tenancy

The farm tenancy problem was of special interest to many people in the early '70s. It was believed that the problem was very serious. In fact, many farmer leaders staged protests on this issue and demanded that the government take serious action. It was a prominent issue during the student uprisings. Major political parties and many politicians supported land reform as a solution the tenancy problem. In 1975, the government decided to implement a land reform program, focussing first on the Central Plain where the situation was said to be relatively serious.

Nonetheless, the data on this issue indicates that, at the aggregate level, tenancy is not a serious problem. It has, in fact, not worsened over time. In 1973 and in 1983, rented area accounted for only 12% and 11%, respectively (Table 2.6). At the regional level, tenancy does appear to be rather serious. In the Central Plain rented land constituted 29% and 25% in 1973 and 1983, respectively. The North also has some problem, but it is not serious. In terms of the number of rented farms, the problem appears to be more serious. Of the total number of farms in the Central Plain in 1983, rentals accounted for 35% about 800,000 families. 1/

In summary, the available data, particularly in recent years, does not clearly show the tenancy trend of the country. Data from the micro studies in the Upper North and lower Central Plain indicate serious problems of tenancy, there, both in terms of number of tenants and contractual arrangements (e.g., rental rates) (Onchan, 1978).

Land Rights

Legal land documents are usually issued by the Department of Lands. They include : N.S.4 (Title deeds), N.S.3, and S.K.1. However, other types of land documents are also issued by government agencies implementing land allocation programs, e.g., ALRO, Public Welfare Department, and Cooperative Promotion Department. However, only N.S.4 and N.S.3 (and N.S. 3K) are acceptable to financial institutions as loan collateral.

Up to now, the Department of Lands has issued N.S.4 for only 15% of the total private lands. Therefore, a large amount of private land is not yet properly documented. This includes over 40 million rai of encroached forest reserve, or 70 million rai if pre-reserved forest is included. The lack of land ownership security (i.e. N.S.4 and N.S.3) has substantially affected agricultural development in Thailand

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1/ The data on tenancy problem is rather confusing, particularly for the mid 1970s. For example, in 1973, it was reported by the Agricultural Land Reform Office that there were over 900,000 rented farms.

Table 2.6 Landholding and Rented Area by Region,1973,1984

Unit : Million Rai

Region	1973			1984		
	Holding Area	Rented Area	% of Rented Area	Holding Area	Rented Area	% of Rented Area
Central	27.27	7.98	29.27	28.60	7.11	24.86
North	23.19	3.65	15.74	28.35	4.25	14.99
South	13.68	0.61	4.42	14.29	0.51	3.56
North-east	48.80	1.59	3.27	54.08	2.09	3.87
Whole Kingdom	112.94	13.83	12.25	125.31	13.95	11.13

Source : : Ministry of Agriculture and Cooperatives, Land Utilization in Thailand 1973,1984.

(Feder,et.al., 1986). In the rural areas, very few farmers have N.S.4. To obtain N.S.4 or N.S.3, the farmer has to cover the cost incurred as well as the fee. Though it may not be very high, the poorer farmers usually have more trouble meeting the expense than their rich counterparts. Furthermore, those farmers who manage to obtain the N.S.4 or N.S.3 will be in a better position to qualify for cheap credit from credit institutions, both public and private.

Landlessness

The problem of landlessness has been of interest to the government for over 40 years. This is evident in the land allocation program initiated long ago to solve the problem. However, there has been relatively little effort to analyze the problem, and research on the issue is rather recent and limited.

The survey on landlessness in 51 provinces by ALRO reveals that about 10% of the farmers are landless. Eleven recent own less than 5 rai and are considered near-landless. Small farmers who own 5-10 rai constitute about 12% (Table 2.7). Landlessness does appear to a be problem in agricultural development. It is relatively more serious in the Upper North where theproportion of landless and near-landless constitute an alarming 45% of all farmers.

2.3 THE AGRICULTURAL ECONOMY

Production

As mentioned earlier, the rate of agricultural growth has slowed down in recent years. One of the contributing factors to slower growth has been the decline in the prices of major farm commodities rice, sugar, cassava and corn. This problem is likely to continue in the near future.

Agriculture in Thailand has been greatly diversified since the 1950s. Field crops have become very important. However, the Thai economy seems to depend too much on too few farm coomodities. Greater agricultural diversification is being promoted. This has become a clear objective of the current Sixth Plan (1987-1991). The new commodities to be promoted are those that have good market potential and prices.

Generally, Thai agriculture is still using traditional techniques. However, new technology, particularly mechanical types have been increasingly used. The use of of new inputs such as fertilizer, insecticides and new varieties of seed has been quite limited. This is partly because rice price is relatively low compared to fertilizer price. As a result, the yield of rice of Thailand is the lowest among the major rice producing countries (World Bank, 1981). Thailand was able to greatly increase farm production during the past two decades because of the great expansion of cultivated areas, particularly of corn, cassava, and sugar cane (Table 2.8).

Agricultural productivity, is therefore generally low, and yield fluctuations are serious. From 1959 to 1977 the rates of growth in yield per rai of many crops were even negative. Although, an improvement in land productivity has been achieved in recent years (Table 2.8, 2.9), yields are still low, and improvement is urgently needed.

Marketing

Marketing activities (for both input and output) are mostly carried out by the private sector. The government is keen to assure that free trade is practiced and promoted. So far, the marketing systems for agricultural products are quite efficient, dynamic, and competitive. Even though the general complaint is that marketing is

Table 2.7 Landlessness in 51 Provinces, 1984

Type of Farmers	No. of Household	%
Landless	362,702	9.6
Less than 5 rai	424,179	11.2
5 - 10 rai	457,199	12.1
Over 10 rai	2,548,606	67.2
Total	3,792,686	100.0

Source : Agricultural Land Perform Office, 1986

Table 2.8 Rate of Growth of Planted Area, Production and Yield Per Rai of Major Crops, 1959-1984

Crops	1959-1970			1970-1977			1977-1984		
	Planted Area	Production	Yield Per Rai	Planted Area	Production	Yield Per Rai	Planted Area	Production	Yield Per Rai
Rice	2.1	2.8	0.7	2.1	-0.3	-2.4	0.6	3.5	2.9
Corn	11.8	14.3	2.5	5.6	2.6	-3.0	5.0	9.5	4.4
Cassava	9.5	8.0	-1.4	20.2	13.5	-6.7	6.6	7.0	0.4
Sugar cane	0.2	2.2	2.0	22.3	20.4	-1.9	1.8	6.0	4.2
Cotton	3.6	3.2	-0.4	2.8	6.6	3.8	0.9	4.1	3.2
Mungbean	16.7	12.8	-4.0	7.2	1.0	-6.2	3.0	5.6	2.6
Soybean	9.7	7.6	-2.2	12.7	11.5	-1.2	2.7	9.2	6.5

Source : Trend rate of growth is estimated by : $\log Y = a + bt$

Table 2.9 Yield Per Rai of Major Crops,1972-1984

Year	Rice	Corn	Cassava	Sugar cane	Mungbean	Soybean
1972	261.52	211.04	3,380.68	8,396.29	148.36	137.90
1973	276.44	326.13	2,080.00	8,201.93	131.14	135.95
1974	260.28	322.62	2,180.35	7,540.27	145.32	134.23
1975	264.67	349.15	2,318.32	8,147.91	117.97	154.30
1976	268.86	333.17	2,236.92	8,367.12	89.62	178.86
1977	230.71	222.59	2,246.36	5,348.96	76.09	100.57
1978	260.33	322.25	2,101.67	6,427.75	98.17	157.29
1979	257.54	300.45	2,281.38	4,698.00	94.52	150.36
1980	270.82	334.60	2,234.76	6,783.05	93.36	126.90
1981	279.44	352.12	2,302.36	7,829.92	93.31	165.03
1982	263.04	286.07	2,220.42	6,096.02	92.70	145.79
1983	291.54	336.62	2,276.20	6,619.25	95.43	177.62
1984	298.28	372.17	1,087.00	7,317.46	107.43	196.76

Source : Office of Agricultural Economics,1972/73-1984/85

inefficient and that farmers are exploited by middlemen, careful study has not borne this out (Department of Business Economics, 1984).

For both economic and political reasons, the Thai government has long implemented marketing and price policies. Market intervention of various forms has been practiced. The most important organizations are the Marketing Organization for Farmers (MOR) and the Public Warehouse Organization (PWO). Price support and price guarantee schemes have also been implemented, but with little success. At present, in an attempt to raise the farm gate price of rice, the government is providing cheap credit to rice millers and private marketing organizations (including agricultural cooperatives) for the purchase of paddy from farmers. The increase in the amount purchased is expected to raise the demand and hence the paddy price. However, in spite of these interventions, marketing system is still completely controlled by the private sector.

Agricultural cooperatives have been providing marketing services for over 60 years. They have been closely supervised and supported by the government, but have not been very successful. Their services are still rather limited and their impact on the structure and performance of the marketing system has been quite insignificant.

Foreign Trade

Although agricultural products constitute a major portion of Thailand's export, the share of agricultural products has declined steadily over the past two decades. From about 90% of the total export value in 1950, the figure has reached about 60% in recent years.

Agricultural export has also been greatly diversified. The value of rice and rubber exports declined from 80% to about 40% during the past 30 years. Other commodities such as sugar, corn, cassava, and pineapple,have increased their share. The share of wood product exported declined from 5% to 1%, while fishery products increased from 1% to 5%.

Imports of farm products are not very significant as Thailand can produce enough food for its own population. Imported farm items include wheat and dairy products.

One of the most controversial longstanding policies of the Thai government was the rice premium. Those who objected to the collection of the premium-a form of export tax-usually argued that it would depress farm prices, was unfair to rice farmers and made Thai rice less competitive in the world market. Those who supported it, particularly the government, argued that it contributed to price stability and food security and was an important source of revenue. Due to the decline in rice price in the world market and the need to dispose of the rice surplus in the country, the premium was abolished this year.

At present, export policy is receiving special attention from the government. It is almost the first time that Thailand is facing problems of market and prices of its major products, including corn which used to enjoy market and price stability. An export subsidy is being considered; an export credit guarantee scheme is another suggested measure. This issue of foreign trade is of great concern to the Thai government. It is very important to the development of the agricultural economy.

2.4 INCOME, INCOME DISTRIBUTION AND POVERTY

As mentioned earlier, farm income is very low when compared with non-farm

occupations. Regional income disparity is also serious, particularly in the North and Northeast, where farmers in the latter region have the lowest income in the nation. In fact, the average income of a Northeastern farmer was only 37% of one in the Central Plain, and only 57% of the national average. Therefore, income distribution within the farm sector is still rather unequal (Table 2.10).

The income gap between farm and non-farm sectors has been gradually widening. From 1980 to 1984, the income of both groups increased, from ฿ 5,445 to ฿ 5,912 for the farm population and from ฿ 32,346 to ฿ 43,284 for the non-farm people (Office of Agricultural Economics, 1985). While the increase of income of the non-farm people was rather steady, that of the farm people fluctuated in certain years. Income instability has been a problem of the farm sector.

As regards income distribution of the households in Thailand, available data indicates that it is quite unequal and, indeed, gradually worsen. In 1963 and 1972, the poorest group, the bottom 20%, received only 2.9% and 2.4% of the total income. The richest group the top 20%, got 59.5% and 64.4%. Clearly, the poor are getting poorer while the rich get richer (Krongkaew, 1980, p. 142). The Gini Coefficient was .45 in 1975/76 compared with .473 in 1981, an average increase of 4.9% per year. The disparity worsened in the rural areas (Krongkaew and Tinnakorn, 1985, p.52).

Poverty was considerably alleviated from 1975/76 to 1981, from 31.7% to 23.9% of the total population. The poor live in the rural areas. They have large families, small farms, and low education (Krongkaew and Tinnakorn, 1982, p.52).

As to the structure of rural income, it is interesting to note that off-farm income is very important, particularly in the poor regions of the Northeast and the North, and among the landless and near-landless (Onchan and Chalamwong, 1979). Furthermore, the proportion of off-farm income has gradually increased from 46% to 55% and 59% in 1971/72, 1975/76 and 1982/83, respectively (Table 2.11). As for the Northeast, the proportion increased from 48%, to 66% and 68% in the same years. This clearly shows the importance of promoting non-farm enterprises in rural areas to provide employment and income for the rural poor. It should be an important part of the process of rural development.

2.5 AGRICULTURAL AND LAND TAXES

Agricultural taxation will have an impact on agrarian structure, farm productivity and income. A brief overview is made here.

It is generally known that an indirect agricultural tax is much more important than a direct one. Export taxex are a good example of indirect tax while income and land taxes are direct ones. The latter type of tax has not been significant in Thailand. However, since land tax has a direct bearing on land policy, special attention is given to it here.

Land taxes have been a subject of interest to the government and the people concerned for many years. It is believed that such taxes would bring revenue to the government, raise efficiency in land use and improve social justice. It has been proposed that there should be a progressive land tax similar to the income tax. However, not much progress has been made in this regard.

Under the existing system, tax revenue from land and buildings is used for local activities. It is also collected by the district office of the Local Government Department, Ministry of Interior. The "medium price" of land is used in the valuation of property. For

Table 2.10 Per Capita Income of Agricultural Population by Regions,1979-1983

Unit : Baht

Year	Northeast	North	Central	South	Average
1979	2,769	4,874	7,036	6,496	4,696
1980	3,221	5,444	8,355	7,499	5,445
1981	3,068	6,207	9,528	7,104	5,773
1982	3,047	6,003	9,421	7,421	5,743
1983*	3,500	6,309	9,335	8,689	6,159
Rate of Growth	4.22	6.33	1.07	5.88	6.14

Remark : * Primary Data

Source : Office of Agricultural Economics, 1985

Table 2.11 Net Cash family Income of Farm Households by Region, Thailand, 1971/72, 1975/76, and 1982/83

Region	1971/72			1975/76			1982/83		
	Net Cash Farm Income	Net Cash Non-Farm Income	Total	Net Cash Farm Income	Net Cash Non-Farm Income	Total	Net Cash Farm Income	Net Cash Non-Farm Income	Total
Northeast	1,674.9	1,578.7	3,253.6	2,062.2	4,005.5	6,067.7	5,746.6	12,529.3	18,275.9
	(51.5)	(48.5)	(100.0)	(34.0)	(66.0)	(100.0)	(31.4)	(68.4)	(100.0)
North	2,102.8	1,631.8	3,734.6	4,717.4	4,577.2	9,294.6	10,607.2	11,450.9	22,058.1
	(56.3)	(43.7)	(100.0)	(50.7)	(49.3)	(100.0)	(48.1)	(51.9)	(100.0)
Central Plain	5,688.5	3,625.5	9,314.0	7,361.4	6,138.9	13,500.3	17,194.3	15,829.4	33,023.7
	(66.1)	(38.9)	(100.0)	(54.5)	(45.5)	(100.0)	(52.1)	(47.9)	(100.0)
South	1,621.4	2,411.9	4,033.3	5,175.5	6,386.0	11,561.5	11,403.1	20,989.3	32,392.4
	(40.2)	(59.8)	(100.0)	(44.8)	(55.2)	(100.0)	(35.2)	(64.8)	(100.0)
Average	2,268.1	1,943.1	4.211.2	4,232.2	5,261.7	9,493.9	9,821.4	13,961.9	23,783.3
	(53.9)	(46.1)	(100.0)	(44.6)	(55.4)	(100.0)	(41.3)	(58.7)	(100.0)

Remarks: Calculated from the data of the Ministry of Agriculture, Non-cash and input incomes are excluded.

Source : Office of Agricultural Economics, Agricultural Statistics of Thailand, 1979/80, 1984/85

tax purposes, prices are divided into 43 levels, from less than ฿ 200 per rai to over ฿ 50,000 per rai.

The tax rate ranges from a low of ฿ even higher when the land price is over ฿ 500,000).

In fact, land taxes are found to be regressive. The tax paid for land of ฿ 500,000 per rai is only 0.1% of the land price, but land costing ฿ 1,000-1,200 per rai pays a tax of 0.5%.

Farmers pay an insignificant amount of land taxes. In 1983/84, the average amount of land tax per family was ฿ 81. This constituted 4% of the total net farm income of the farm households (Table 2.12).

The careful design and implementation of a progressive land tax will contribute to its success, according to the specified objectives. Classification of farm size and valuation of land are very important. These can have an impact on resource allocation and income distribution. An example of tax rates which can be used are: 5%, 15%, 20%, 30%, 50%, and 100%. It is important that the small and/or average sized farms not be adversely affected by the progressive land tax rates (see details in Pipatseritham, 1974).

Finally, the issue of lands left idle for speculative purposes can be solved by means of land taxation. This type of land should be taxed at a high rates because this encourages the owners to use such land. Idle lands constitute a significant portion of the total land area in both urban and rural. Very low landtax rates have resulted in low costs for holding land for speculation. This has caused widespread land speculation, something which should be of great attention to policy makers.

Table 2.12 Land Tax Paid by Farm Households by Region

Unit : Baht/household

Region	1976/77	1978/79	1980/81	1982/83
North-east	49.95	74.04	69.25	74.38
North	50.77	67.64	66.72	68.82
Center	126.78	114.24	109.62	115.75
South	67.66	95.34	84.82	80.40
Average	67.17	83.02	78.83	81.09

Source : Office of Agricultural Economics, 1976/77 - 1984/85

Part II Land Problems and Policies of Thailand

3 Land Classification Policy

3.1 INTRODUCTION

Land is a scare resource which should be used efficiently and wisely. Land use is determined by a number of factors, physical, economic, and social. All of them are important, but the nature and characteristics of land or soil is one of the most important determinates of the type of farm which can flourish there. For example, one type of soil may be more suitable for rice than cassava. Hence, soil survey and classification is closely related to land use.

Land and soil connote different meanings to different people. In general, however, land refers to the surface of the earth including mountains, swamps, rivers, deserts, islands and beaches. Soil is a natural feature of the earths surface. It supports the growth of plants. It comprises mineral and biological materials and has many layers, all of them interrelated.

3.2 LAND CLASSIFICATION POLICY : PAST AND PRESENT

National Plans

The need for land classification has been recognized since the First Plan (1961-1966) which explicitly addressed this issue. During the second period of the First Plan (1964-1966), land classification was to be accelerated and soil survey and mapping were also to be implemented. During the Second Plan, land capability classification was implemented and was to be completed for the whole country in 1988. In the Third Plan, land classification was emphasized and was to accomplish the task of finding out the total area suitable for agriculture. A soil survey was also made in irrigated areas in the Central Plain. A land use survey was also conducted for use as a basis for agricultural development planning.

In the Fourth Plan, the Department of Land Development was to conduct surveys to collect data on economic, social and environmental situations for use in land use planning. This planning was to start in the North and Northeast. Classification was also carried out in forest areas which might be opened for use. Three departments - Lands, Land Development and Royal Forestry were responsible for the project.

In the Fifth Plan, the land use survey was to be accelerated so that the results could be used in the formulation of land use policy. The survey of encroached forest areas was included in this. If found to be suitable for agriculture, such areas would be allocated to the people under the forestry village program.

In the current Sixth Plan, emphasis is still on land development, land use and land evaluation. The objective is to attain an efficient use of land resources.

The Land Allocation Committee

The Committee recognizes the importance of soil survey, land classification and land use planning. It has stated clearly that before a land allocation program can be undertaken, the Department of Land Development must conduct a soil survey, carry out the land classification and then practise land use planning.

Land Development Act, 1983

The establishment of the Department of Land Development in 1963 resulted in the transfer to this department of land classification activity from the Department of Lands and soil survey from the Rice Department. The Land Development Act defines the duty of the Land Development Department as follows :

"The Department of Land Development is resposible for soil survey and analysis to assess its natural fertility and feasibility, land classification, land development, land census or land economic assessment. These are to be carried out under the provision of this Act".

This definition shows that the government has a clear policy on land classification by means of soil survey, land capability classification, and land use planning. This will form a basis for the continuing economic and social development of the country.

3.3 LAND CLASSIFICATION IN THAILAND

Land classification activities have been undertaken and some improvements have been made by using new and improved technology. Since 1961, land classification can be divided into 5 types. They are as follow :

Broad Land Use Classification

This type of classification was started in 1961 by the Department of Lands. Later it was transfered to the Department of Land Development. It was very broad, classifying the total land area into 2 categories. The first was forest area; the second, agricultural area. This classification was made in accordance with the policy of the First Plan. By this classification, 162.2 million rai of land was to be preserved as forest area.

Land Reclassification

The past two decades, have witnessed a tremendous change in land use. The national forest reserves and the prereserve forest areas have been widely encroached upon and used for agricultural purposes. However, the government held toits policy of preserving 50 percent of the total land area under forest. In 1982, the Cabinet approved the Land Use and Land Rights Policy proposed by the National Rural Development Committee. The policy called for land reclassification, which began in 1983 by the Ministry of Agriculture and Cooperatives and related agencies. The Department of Land Development (DLD) conducted a survey of pre-reserve forests and was able to cover about 20 million rai. The purpose was to identify areas suitable for agriculture. These areas are to be. degazetted and used for agricultural purposes. Those lands unsuitable for agriculture will be proclaimed national forest reserves. Then DLD will conduct a survey in the encroached national forest reserves. This land classification uses detailed data from the survey of soil, land use, land tenure, and socio-economic conditions.

Land Capability Classification

Land capability classification follows the soil survey. It interprets the data from the soil survey which began in 1964

and is now completed for the whole country. The classification identifies areas suitable for agriculture as well as the limitations in use of these areas. It a groups the soils which have similar characteristics. Two systems are used in the land classification :

a) Land classification for field crops. There are a total of 8 classes.
b) Land classification for rice. There are a total of 8 classes.

Land Suitability Classification for Economic Crops

This type of classification is carried out at the same time as soil survey report. It provides details on the suitability for crops of each soil series. It is more detailed than a land capability classification. The suitability classification has already been done for many crops such as rice, field crops, fruit trees, rubber, coconut, and pasture.

Land Evaluation

This is an important step which has been taken since 1983 by the Department of Land Development for use in land use planning. The system developed by FAO is used. The land evaluation includes the following types:

a) Land evaluation for rainfed agriculture
b) Land evaluation for irrigated agriculture
c) Land evaluation for forestry
d) Land evaluation for livestock

3.4 RESULTS OF LAND CLASSIFICATION

Soil Survey and Classification in Thailand

Soil survey and classification was started in 1936 by various agencies under the Ministry of Agriculture. As already mentioned, when the Department of Land Development was set up in 1963, the work was transfered to this department.

A soil map was first published in 1953 by Dr. R. L. Pendleton, an advisor to the Ministry with a scale of 1:2,500,000. The unit of soil in the map was "soil series". It was rather limited in detail for each soil series.

A second soil map was produced in 1968 by Moorman and Rojanasoonthorn with a scale of 1:1,250,000. Soil classification was based on a method developed by Dudal and Moorman which was widely used in Southeast Asian countries. The soil unit used was "great soil group".

Since 1970, the Soil Survey Division of the Department of Land Development has been using a new soil classification (i.e. U.S. Soil Taxonomy) in soil survey and classification. The new system provides a clearer definition of each soil group. The Department of Land Development published the nation's third soil map in 1979. The soil unit used for mapping is the "great soil group".

In addition, the Department of Land Development has been publishing various soil maps of larger scales, e.g. a regional soil map with 1:500,000 scale, one for the provincial level with 1:100,000, and 1:10,000 - 1:20,000 at project and farm-level.

DLD has also carried out "detailed reconnaisance" soil surveys of each province in the country and has published provincial soil maps of a scale of 1:100,000 for 58 provinces". Maps for the other 15 provinces are in the process of being published. The soil unit used for mapping was "soil series". At present, a semi-detailed survey is being carried out for accelerated projects in certain areas in the country.

The soil surveys of DLD have been

collecting data since 1963. This data has been used widely by those involved in development and planning.

In 1973, DLD undertook land use planning in many provinces using data from soil surveys and land and suitability classifications. A land use map of the scale of 1:250,000 was also produced. At present, such maps have been prepared and completed for 30 provinces.

With advances in soil science and technology, DLD has been able to improve the accuracy and the efficiency of its data interpretation. In 1983, it started using the method developed by FAO for land evaluation. This is another important step in land use planning. In 1985, DLD also introduced a computorized land evaluation system developed by Cornell University to improve the land evaluation program.

The results of the soil survey by DLD are shown in Table 3.1. It can be seen that soil has been classified into 10 series.

From the soil survey, the findings on soil suitability for agriculture are presented (Table 3.2). They include the following:

a) Area suitable for field crops is 67.7 million or 21 % of the total area.

b) Area suitable for paddy is 84.5 million rai or 26 % of the total area.

c) Area suitable for tree crops in heavy rainfall area is 16.4 million rai or 5 % of the total area.

d) Area presently unsuitable for economic crops but potentially useful with some development is 49.8 million rai or 15.5 percent of the total area.

e) Area unsuitable for agriculture is 99.8 million rai or 31 % of the total area.

The Survey and Data Collection on Land Use

Since data on land use forms a basis for the analysis of projects for agricultural development, the survey on land use is very important. At present there are a number of government agencies carrying out the survey. They include, for example, DLD, Department of Lands, Office of Agricultural Economics, City Planning Office and the Royal Forestry Department However, different survey methods are usually used by these agencies.

Survey methods and data collection in Thailand can be divided into 5 types as follow :

a) Interview : This is used by various agencies which study the socio-economic conditions of farmers under development projects, usually relating to agriculture. The accuracy depends greatly on the interviewers and the respondents.

b) A Survey Using Area Frame Sampling : This method uses maps, aerial photos, and interviews. It is used to study cultivated area, landholding and production. It is mainly used by the Office of Agricultural Economics.

c) LANDSAT Imagery Interpretation and Field Observation : This is used in classifying areas of land use for various purposes. It involves the interpretation of LANDSAT imagery and ground survey (for checking). It is widely used by DLD and the Royal Forestry Department. At present, there is still a problem of lack of detail since the scale used is rather large (1:250,000).

d) Aerial Photo Interpretation and Field Observation : This is used for land use classification. It usually provides more accurate data than the LANDSAT imagery interpretation.

Table 3.1 Soil Classification in Thailand

Series	Area	
	Rai	%
Entisols	10,537,500	3.29
Vertisols	2,597,500	0.81
Inceptisols	30,158,125	9.40
Mollisols	3,751,875	1.17
Spodosols	384,375	0.12
Alfisols	29,369,375	9.16
Ultisols	135,120,000	42.13
Oxisols	95,625	0.33
Histosols	448,750	0.14
Unclassified*	108,233,750	33.75
Total	320,696,875	100.00

* Including slope complex,water,etc.

Source : Department of Land Development

Table 3.2 Land Suitability for Agriculture

(Rai)

	North	N - East	Central	East	South	Total
Area suitability for upland crops	20,036,318	30,694,340	11,485,471	5,306,758	160,642	67,683,529
Area suitability for paddy	16,434,526	40,520,643	14,873,477	5,583,579	7,057,075	84,469,300
No limitation	16,434,526	39,054,014	9,904,130	5,111,964	7,057,075	77,561,709
Acid sulfate soil	0	0	4,732,250	471,615	0	5,203,865
Saline soil	0	1,074,778	237,097	0	0	1,311,875
Area suitable for parennial crops	0	0	702,428	960,385	14,696,933	16,359,806
Area generally unsuitable for economic crops but can be suitable for cultivating special crops if there are appropriate measures	14,724,446	21,250,255	3,355,121	5,565,186	4,933,812	49,828,820
Area unsuitable for agriculture	54,241,443	12,092,402	12,847,168	3,988,102	16,707,570	99,876,685
Water body	590,947	796,323	186,838	83,802	640,900	2,478,810
Grand Total	106,027,680	105,533,963	43,450,503	21,487,812	44,196,992	320,696,950

Source : Land Development Department

e) Registration : Registration usually takes place after the completion of the cadastral survey. For example, the registration of community land, national forest reserves, and national parks.

Of the above methods, aerial photo and LANDSAT imagery have become important in recent surveys. A brief mentioned will be made of these techniques.

Aerial photography was introduced in Thailand in 1930 for use in making maps. It has since become widely used. For example, in 1972-1979, aerial photography was used for the project on the issuance of N.S.3-K by the Department of Lands. In 1983-1985, it was used for land reclassification in forest areas. The latest use was in 1985-1986 for the accellerated land titling project of the Department of Lands.

As for LANDSAT imagery, Thailand joined the satelite resource survey of the USA. in 1971. In 1982, it installed a Satelite Relay Station. LANDSAT imagery has been used for land use and forestry surveys since 1973.

Comparing these two methods of survey, it is obvious that LANDSAT imagery has time and cost advantages over aerial photography (Table 3.3). However, in terms of accuracy, the latter method appears better. Moreover, aerial photos are particularly suitable for certain tasks such as land titling, which is being implemented by the Department of Lands.

Problems Encountered in the Survey

a) Difference in the Resuts. The 5 methods of survey give different results simply because of the very nature of the methods used. This will certainly cause a problem in using the data.

b) Out-of-Date Aerial Photo. Though aerial photo gives accurate data, the cost is very high. It usually takes a long time (2-3 years or more) to complete a project so that the data becomes old or out of date. Nor does it usually cover the whole country. Currently, there are 3 sets of the aerial photos : The first were taken in 1966-1969; the second, for N.S.3-K project, in 1972-1979, and the latest, for forest areas only, in 1983-1985.

Finally, the Land Titling Project of the Department of Lands is now using aerial photos taken since the inception of the project in 1985.

c) LANDSAT Imagery Interpretation. The main problem is a lack of equipment and qualified personnel since it is necessary to use a computer for accurate interpretation. The scale used is still too large to get the necessary details. Recently, there has been an improvement in this type of technology which should be brought for use in Thailand.

Present Land Use

As already mentioned, the data on land use have been collected by various agencies using different methods. The results are, therefore, rather different. In this study, forestry and agricultural land use maps are used along with ground checks. The data on land use in 1985 are as follow :

National Forest Reserve		136,223,169 rai
Forested Area	92,392,551	
Encroached Area	43,843,618	
Agricultural Land		152,041,555 rai
Rice	84,250,816	
Field Crops	51,411,432	
Horticulture	101,262	
Rubber	10,541,957	
Oil Palm	386,421	
Other Tree Crops	5,349,667	
Residential Land		2,736,585 rai
Water Bodies		3,059,256 rai
Other		26,623,385 rai

Table 3.3 Costs of Survey by Landsat and Aerial Photo

	Landsat	Aerial Photo
Number of Photo Used	13	3,652
Period of Field Work (day)	90	210
Manpower Used (person)	4	20
Total Expenses (baht)	52,300	322,020
Survey Expense per rai (baht)	.00049	.00304

Source : Department of Land Development, 1979 A

The latest data also indicate that the area of encroached forest land is 43.8 million rai. This indicates a substantial increase of forest depletion which was reported to be 33 million rai (Land Use and Land Rights Policy, 1982). Agricultural land increased to 152 million rai.

3.5 PROBLEM OF LAND CLASSIFICATION

Accuracy of Land Classification Map

Land classification during the early period lacked clarity in maps, particularly regarding the boundaries between forestrys and agricultural land. This has caused problems between the Departments of Royal Forestry and Lands. It is due to the use of geographical maps with 1:50,000 scale in determining boundaries which has resulted in errors. If aerial photos had been used from the beginning, the problem would have been minimized.

Aerial Photograph

There are 2 problems with regard to aerial photos. One is involved with scale and the other with the out-of-date photos used. The use of old photo with a small scale will not give enough details on the current land use.

Government Control

For many years, the government has tried to reserve land for certain purposes such as forestry. However, as already pointed out, many forest reserve areas have been destroyed. The enforcement of law and the protection of forests has been completly ineffective. Another dimension of the problem is the fact that in over 40 million rai of encroached forest land where farming has been practiced for decades, the land is actually suitable for agriculture. However, the government is unwilling to give up, or degazette the land. Hence, this type of land is still considered forest area and is under the control of the government. If the land was allocated to the farmers with appropriate land rights, it could be used more efficiently.

Land Use Planning and Practice

After land classification and land use planning have been completed, it will benefit society only if it is really put into practice. This realization has not taken place in Thailand. Moreover, certain areas which are not suitable for agriculture have been put under the land allocation program. An extreme case is the one for the hilltribes.

Clearly, problems relating to the hilltribes invlove many complex dimensions, social, political and economic, and involve national security as well. It is a wellknown fact that, due to their way oflife and the practice of shifting cultivation, they have caused tremendous damage to forest and watershed resources. Past efforts of the government to deal with the problem have been rather disappointing. As the hilltribe population increases and deforestation in the highlands expands, the problem will get worse.

The Department of Land Development is responsible for preparing plans for efficient land use. However, it does not have any power to implement these plans. This, particularly, should interest the policy makers concerned.

Time Requirements

a) Land classification is a continuous system and takes time to complete. Unfortunately, time allotted to carry out the project is usually very limited. This has led to delays in producing results and can create problems for potential users.

b) Because of the time-consuming nature of the work the output usually comes out late and the results are sometimes not very useful. By the time the results are known, changes in land use might already have occurred.

3.6 THE PROPOSED POLICY

Land classification should be carried out with accuracy and efficiency if it is to be useful for land use planning The policy on this should be as follows:

a) The governemnt will support the survey's collect of data on all aspects of land resources on a continuing basis so that the data will remain consistent with the changing situations. Data will be collected by using an appropriate system.

b) The government will support land evaluation for various activities by using acceptable and appropriate methods.

c) The government will provide the support for aerial photographing every 5 years or during every National Plan. This will be done nationwide in a shortest time possible so that it can be used effectively during every period of development.

d) The government will support the use of LANDSAT technology, including the provision of necessary equipments and a clear division of responsibility among the agencies concerned.

e) The use of land for any activity must be consistent with the land capability. Area with a slope of over 35% should be strictly preserved for forest areas.

f) The government will support land use planning at all levels so that land will be used wisely and efficiently.

g) The government will support land use planning so that it will actually be put into practice. This can be done by means of promotion, or by provision of incentives or services, except when failure to practise the designated plan will cause serious damage to the land. In that case there should be strict enforcement by means of laws or regulations.

4 Policy on Soil and Water Conservation

4.1 INTRODUCTION

Though land is considered a renewable resource, if not used properly, soil fertility may be completely lost and it may no longer be productive.

The fertility of natural soil exists only within the top layer, few centimeters thickness. This topsoil has qualities of plant nutrients and organic matter, suitable for the growth and production of crops.

In most tropical countries, including Thailand, soils are usually old, highly weathered and excessively leached by the high intensity of rainfall during the shor monsoon periods. Removal of protective forest vegetation exposes structurally unstable soil to the driving force of rains resulting in accelerated soil erosion, especially the fertile top soils. Careless land use which allows rainwater to erode and detached soil particals to the lowlands cause decreasing agricultural yields. Sediments soon fill up waterways and reservoirs.

The practice of soil and water conservation must be integrated with other kinds of natural resource management such as forestry, and especially watersheds. It is necessary to protect the mountain or highland watershed areas in order to prevent soil erosion and its negative downstream effects. Efficient watershed management results in good water yields, sufficient water supplies, high water quality, regular flow, and the control of soil quality in the watershed areas.

Although soil, water and forestry conservation have been practiced in Thailand for a long time by the Departments of Land Development and Forestry, there is no national soil and water conservation policy. Therefore, there is a lack of conceptual framework, generally accepted methodology, and, consequently, of cooperation among government agencies and farmers. Past soil and water conservation practices have been complicated and costly. Appropriate measures for specific local areas have not been found.

4.2 SOIL DEGRADATION

Soil degradation is caused by many factors, the most important being soil erosion. Soil erosion may be either geological or accelerated erosion. The latter occurs when men and animals are involved in changing land use.

Research on soil loss through water erosion has been done in Thailand for at least twenty years. Plots have been established to study the effects of soils, slopes and crops on run off and erosion. The Land Development Department, which is the responsible agency for soil and water conservation is giving more attention to research in this area, including the improvement of research technique and data analyses.

Soil loss in Thailand can be divided into 5 groups from very slight to very

severe. Table 4.1 indicates the approximate 107 million rai of moderate to very severe soil loss which has occurred, especially in the upland and highland areas.

Another study on soil loss from different types of land use in Changwats Sakon Nakhon and Kalasin by Pairin et. al., (1982) showed the following:

Soil loss (Ton/Hectare/Year)

Land Use	Sakon Nakhon	Kalasin
Shifting cultivation area	15.48	16.44
Bare soil	24.76	20.87
Forest	2.38	4.48

Without water conservation practices, soil loss in the experiment at Changwat Nan (Peugrai and Marston, 1982) on a 5% slope land used for upland crops was about 26.82 ton/rai. A study on soil loss in Ping and Wang Basins (Chomchan and Panichapong, 1986) indicated the rate of soil loss at 2-10 ton/rai/year which is double the loss in contour cultivation areas.

The high rate of deforestation in the past two decades has increased the annual rate of soil erosion and the high sedimentation rate in reservoirs.

The severe soil erosion problem requires a prompt solution. However, this problem has been largely overlooked by the agencies concerned. In fact, the present soil and water conservation program covers a very limited area and is incapable of solving the existing problems.

4.3 PAST AND PRESENT SOIL AND WATER CONSERVATION POLICY

It can be said that the government has had a general policy on soil and water conservation as well as indirect supportive policies. They are included in, for example, the National Economic and Social Development Plan, land laws, forest laws and Cabinet resolutions.

National Economic and Social Development Plan

Soil and water conservation policy has been indicated continuously since the First Plan :

First Plan : The Second Phase of the Plan (1964-1966) indicated that the government would carry out a program on natural resources development, especially on land, forest, and water resources, in order to use them more productively and economically. Some consideration was given to conservation. The plan also included a survey for land classification and soil fertility. Soil and water conservation were put under the responsibility of the Department of Land Development, which was established in 1963.

Second Plan : The plan indicated that two land development centers would be established annually in the appropriate provinces to work closely with relevant agencies on the problem of watershed management.

Third Plan : The program on natural resources conservation was to be carried out for the sake of efficient future agriculture activities.

Fourth Plan : The problem of natural resources utilization including environmental deterioration, was emphasized. The plan calls for the extension of the soil and water conservation project of the Department of Land Development and expands the project to include soil improvement. The plan also gives first priority to reforestation of the watershed areas.

Fifth Plan : This plan emphasized maximum economic return from land, water and forest resources. It called for the protection of deteriorating natural resources by means of

Table 4.1 Soil Erosion Problem by Type of Land Use,1981

Erosion Status	Estimated Soil Loss (t/rai/yr)	Area (mil.rai)	%	Land Use Type
Very low	0.01-1.00	118.7	36.00	forest and paddy field
Low	1.01-5.00	90.28	26.10	forest,orchard, rubber and paddy
Moderate	5.01-20.00	25.91	8.07	rubber,orchard, upland crop and forest
Severe	20.01-100.00	42.62	13.27	rubber,orchard upland crop forest and shifting cultivation
Very severe	100.01-966.65	39.16	12.19	upland crop, forest,shifting cultivation
Others		4.56	0.23	fish and shrimp ponds,mangrove swamp and beach

Source : Land Delopment Department,1981

conservation measures, including special-problems approach to soil improvement (e.g. saline soil in the Northeast) and fast-growing tree plantation for use as fuel wood and for preventing soil erosion.

Sixth Plan : This plan emphasizes systematic natural resources development with consideration given to conservation. The plan also gives attention to watershed classification and land reclassification.

Laws

There are many laws which indicate the intention of the government regarding land and forest conservation and natural resources. They include :

a) National Park Act BE 2504
b) National Reserve Forest Act BE 2507
d) Improvement and Conservation of National Environmental Quality Act BE 2518
e) Land Development Act BE 2526

Among these laws, the Land Development Act BE 2526 gives the clearest government policy on soil and water conservation. It assigns the preparation and establishment of soil and water conservation measures in any areas of the country to the Land Development Committee.

Cabinet Resolutions and Government Policy

There are many cabinet resolutions and government policies on soil and water conservation. They include :

a) Watershed management
b) Watershed classification
c) Guidelines for implementation of Natural resource and environmental conservation for each ministry and department
d) Forest closing for resource conservation
e) National policy and guideline on environmental development
f) Policy on land use and land rights
g) National forest policy

From the analysis of these resolutions and policies, it can be concluded that, for the past two decades, the government has recognized the problem of the deterioration of natural resources, especially of land and forests. There are also policies dealing both directly and indirectly with soil and water conservation.

Concepts and Views Gained from Seminars and Research Studies

In the past ten years, there have been many seminars and research studies on soil and water conservation. The views and recommendations from such activities provided useful concept for the soil and water conservation development program. Among the studies, the works of TURA (1980) and AIT (1983) are worth-mentioning. The results from the seminars and research works indicate that the problem of the deterioration of natural resources is very severe and requires an urgent attention. Also necessary are effective conservation measures and the formulation of the national soil and water conservation policy which specifies a clear direction and goal.

4.4 PROGRESS OF THE SOIL AND WATER CONSERVATION PROGRAM

Responsible Agencies

The principal responsible agencies for soil and water conservation are the Departments of Land Development and Forestry. The Royal Forestry Department implements its programs only on public lands especially in watershed areas. The Land Development Department implements both on public and private land. However, there are a number of supporting agencies which support

principals in implementing soil and water conservation programs. Altogether, the responsible agencies include the following :

Principal agencies

a) Land Development Department
b) Royal Forestry Department

Supporting agencies

c) Office of the Rubber Replanting Aid Fund
d) Department of Public Welfare
e) Agricultural Land Reform Office
f) Department of Agricultural Extension
g) Public Universities

Details of the soil and water conservation programs of the Land Development and Royal Forestry Departments are presented in this report.

i) Land Development Department (LDD)

According to the Land Development Act, the Land Development Department has the duty to survey and to analyse the land and soil in order to determine its fertility, land classification, and suitability for utilization and development, to prepare land censuses, and to conduct economic surveys of the land. The Soil and Water Conservation Division is responsible for the activities on soil and water conservation in the LDD. There are also 12 Regional Land Development Offices and 53 Land Development Stations taking part in the soil and water conservation program.

In the 1984 fiscal year, the Soil and Water Conservation Division comprised 146 officers. Altogether, the 12 Regional Land Development Offices had 888 officers. Hence, there was a total of 1034 officers working on the soil and water conservation program of LDD.

The operating budgets for the 1984 soil and water conservation programs of LDD were as follow:

a. Soil and Water Conservation Project 155,997,043 Baht.
b. Soil Erosion Prevention in the Northern Thailand Project 19,490,242 Baht.
c. Soil and water conservation promotion activity 7,966,874 Baht.

The operating budget of the soil and water conservation program is the highest, compared with the other programs of LDD. However, given the extent of the national problem, the budget is quite limited.

ii) Royal Forestry Department (RFD)

RFD comprises 13 divisions, 21 Regional Forest Offices, 72 Provincial Forest Offices and 670 Amphur Forest Offices.

Forest conservation is a major program of RFD. In 1984, about 60% of the annual budget or 848,762730 baht, was allocated for forest conservation program. These included the following activities or projects:

National Parks	112,030,700	baht
Wildlife Preservation and Protection	100,983,000	baht
Forest gazettment	46,189,200	baht
Reforestation	118,600,000	baht
Forest maintenance	252,852,830	baht
Forest protection	11,421,600	baht
Mae Sa project	40,489,800	baht

Work Accomplishment

i) Land Development Department (LDD)

Since 1963, LDD has carried out without interruption its soil and water conservation programs. These include research, experiments, demonstrations, and technology transfer. Most of the LDD development projects also includes soil and water conservation activities.

However, since 1963, the soil and water conservation program of LDD has covered only a very small portion of the total problem area of soil erosion about 107 million rai. In fact, by the end of 1984, only 1.9 million rai had been completely surveyed and had had a soil and water conservation system designated for it (Table 4.2). Technology transfer has been extended to about 1.9 million farm households. Public relations involved about .8 million farm households. Altogether the program covered about 2 million households, about 42% of the total farm households in the country.

It should be noted that soil and water conservation is the main task of most of the development projects of LDD, i.e. the Northern Agricultural Development Project, Mae Cham Watershed Development Project, and Hilltribe Land Development Project, for example.

ii) Royal Forestry Department (RFD)

a. Reforestation

Reforestation programs have been implemented in Thailand since 1906 when teak was planted at Phrae province. The First National Economic and Social Development Plan (1961-1966), included reforestation. The program was to be a continuous one. At the end of 1984, the total reforestation of RFD was only about 2.4 million rai. Progress on this has clearly been very limited.

Another reforestation project was done by concession following an agreement concluded with the RFD. About 700,000 rai of reforestation were reported complete under this program.

Lastly, about 186,000 rai of reforestation were carried out by the private sector, including farmers.

At the end of 1984, the total area of reforestation was about 3.2 million rai, a very small area when compared with the total need for reforestation.

b. Watershed Development

The Watershed Management Division of the RFD, is responsible for the implementation of soil and water conservation projects, especially in watershed areas. It carries out surveys, research, extension, technology transfer, and watershed development activities.

The Watershed Management Division has 304 officers, 217 employees and 246 Field Units (many of them Watershed Development Units which include 81 units). Results of the work done from 1965-1985 are as follow:

Reforestation for watershed rehabilitation	661,334	rai
Reforestation for fuel wood	34,170	rai
Watershed survey	29	areas
Hilltribe village	11	villages
Conservation farming extension	24	sites

Even after twenty years of RFD soil and water conservation programs, only a small proportion of watershed area has been developed.

In summary, the contribution to the soil and water program by the LDD and RFD has been rather limited. However, there has been some transfer of results of research works to the farmers.

4.5 PRESENT SOIL AND WATER CONSERVATION MEASURES

The measures of soil and water conservation being implemented at present can be described as :

a) Mulching : Surface soil is covered with stubble or industrial residue such as sugar cane residue from

Table 4.2 Results of Soil and Water Conservation Program, Department of Land Development, 1963 - 1984

Activity	Unit	1963 -1976	1977 -1981	1982	1983	1984	Total
1. Research on Watershed Management	Project	0.00	364.00	5.00	5.00	50.00	424.00
2. Research on Soil and Water Conservation, soil improvement		251.00	387.00	140.00	129.00	127.00	1,034.00
3. Soil and Water Conservation Demonstration	Rai	0.00	33,927.00	5,421.00	6,271.00	5,049.00	51,028.00
4. Cover crops production for soil and conservation project	Rai	0.00	18,167.00	3,487.00	3,551.40	2,276.00	27,931.40
5. Training of government officers and farmers leader	Person	0.00	0.00	0.00	0.00	15,260.00	15,260.00
6. Technology transfer to the farmers	Person	786,710.00	233,880.00	75,655.00	73,359.00	80,334.00	1,249,938.00
7. Compost production demonstration	ton	0.00	193.83	0.00	0.00	310.60	504.43
8. Soil and water conservation structures construction	Km.	1,062.90	0.00	1,251.30	1,315.70	976.08	4,606.48
9. Design soil and water conservation system	Rai	0.00	0.00	529,472.00	700,000.00	700,000.00	1,929,472.00

Source . Department of Land Development

sugar mills. Mulching is a cheap method and easily practiced. It can be applied every type of land surface with other methods.

b) Cover cropping : Cover crops, including legume and grass are easily grown at low cost.

c) Crop rotation : Two or more kinds of crops are gown in rotation within the same area. This is an easy method. It requires little investment, but the crops selected for the area should correspond to the local market demand.

d) Contour cultivation : Soil is ploughed along a contour line. This can be done by tractor or by an animal-drawn plow in area which are rather smooth and gently sloping.

e) Ridge type terrace construction : Earth banks are constructed across the slope in order to shorten and divide the length of slope into different sections. This method is applied in areas with a slope of not more than 15 percent.

f) Channel type terrace construction : A broad based bank with a channel along the side is constructed along the contour line. This can be done by digging the channel and putting the earth alongside the channel at the lower level.

g) Hillside ditch : Ditches are constructed across the slope to divide the length of the slope into different sections and to divert the runoff water into the waterway.

h) Bench terracing : Bench terraces are constructed across the slope in areas of high slope. These require high cost for construction and maintenance.

i) Waterway : Waterways are constructed to discharge the runoff water from contour banks, earth banks, bench terraces or hillside ditches into farm ponds or other prepared areas.

Studies have been made of soil and water conservation projects carried out by successive past governments or through foreign assistance. Apparently, the idea of soil and water conservation planning in the past emphasized the use of mechanical measures such as the construction of terraces, hillside ditches and waterways etc.. This has made the cost of conservation very high (Table 4.3). Agronomical measures such as appropriate cropping system to prevent soil erosion were generally overlooked. Only a few projects included agronomical measures.

The idea of technology transfer by using various methods of demonstration came up at earlier periods. It was changed in the early phase of the Fifth Plan to a method of direct approach e.g. training courses for farmer leaders, or farmer meetings. The application of agronomical measures was recommended, together with mechanical measures, in soil and water conservation schemes. The farmers were more motivated to participate in the project, for example, in the establishment of a demonstration village for soil and water conservation carried out by the Department of Land Development.

4.6 THE CAUSES OF PROBLEM FOR PROJECT IMPLEMENTATION

The cause of problems by the bureaucracy

a) Even though the government has had direct and indirect policies of soil and water conservation for a long time, these policies have clearly defined neither the area nor the way in which the project should be carried out by the agencies involved.

b) There is often a lack of coordination between the projects formulated by each agency. For example, the projects of soil and water

Table 4.3 Cost per Unit of Operation of Each Type of Activity of Soil and Water Conservation

Activity	Expense			Average
	Operations	Supplise	Wage	
Training of Official (person)	1,963	137		2,100
Training of Farmer-leader (person)	350	50		400
Meeting/Training of Farmers (person)	6.5	6.5		13
Demonstration (plot:size 30-50 rai)	10,100	11,700		21,800
Construction of Soil Erosion Protection				
- Mainly Use Machines (km.)	5,500	12,200	545.5	18,245.5
- Mainly Use Labor (km.)	3,900	1,200	8,182.5	13,282.5
Production of Seeds (rai)	100	500	2,182	2,782
Purchase of Seed from Farmers (kg.)				50
Acquision of Seeding for Soil Erosion Protection (tree)				1.5

Source : Department of Land Development

conservation for both the lower and the upper parts of the catchment should be carried out simultaneously. The project of the lower part of the catchment would not be successful if the project for the upper part was not carried out.

c) There are no soil and water conservation measures which can be easily practiced by farmers.

d) The agronomical measure recommended for farmers are not compatible with their cropping system.

e) Most soil and water conservation projects concerned with demonstrating or emphasizing the construction of earth structures require a relatively large investment.

f) There may be a lack of project continuity and financial problems for maintenance.

g) Soil and water conservation are a kind of aid for which no repayment is required of the farmers. Farmers are frequently unwilling to be responsible for the maintenance of earthen structures after the project has been finished. They assume that the project is the government's responsibility.

h) Soil and water conservation researches emphasize physical features without making economic and social studies. The technology used in research is usually too high to be appropriate for the farmers.

Problems caused by the farmers

a) Poverty : Farmers cannot afford soil and water conservation practices because such practices require more spending for labor and farming material than the usual cost of land preparation, fertilizer, seed, and cost of living. These latter are considered of more importance than soil and water conservation, which do not appear urgent.

b) Some farmers cannot visualize the future outcome of soil degradation. Their lack of a sense of innovation makes them ignore the necessity of soil and water conservation. Sooner or later this has a negative impact on their land and their society.

c) Most of the lands occupied by farmers are too small to allow extensive soil and water conservation practice. Hence, they lose some area of their cultivated land.

d) The expectation of finding new land to substitute the old unproductive one still exists.

Problems caused by Characteristics of the Project

a) Most soil and water conservation measures cause higher production costs even when the easiest methods are selected. For example, land preparation for growing crops along contour lines between contour banks requires more time and care. This is an inconvenience to the person who operates the machinery. The farmer is likely to be refused by the people whom he hired for tillage operation because that kind of plowing requires more time and increases the cost by about 5-7 percent.

b) Soil and water conservation practices do not immediately and dramaticaly increase yields. Therefore, this incentive is not present for farmers who are conservationists. Investment in chemical fertilizer and high yield varieties is much more immediately profitable.

4.7 RECOMMENDATIONS

The characteristic of future Soil and Water Conservation Projects

The projects for soil and water conservation can be divided into 3 types as follows:

Type 1 : A project carried out by government agencies on state lands.

Type 2 : Projects which will be implemented by the government with the farmers' participation, or in which the government provides a services to farmers in both state and private lands.

Type 3 : Projects which will be implemented by the private sector in private lands.

Problem Analysis for Project Formulation

There are 3 types of projects. The project formulation of types 2 and 3 require investigation and analysis of various existing problems according to the three aspects discussed below :

a) An analysis of the national policy and the National Economic and Social Development Plan. This requires studies of trends and policy for this kind of development and of existing problems. These include : financial problems; the policy of public service instead of individual service; participation of the private sector; emphasis crop change; transfer of technology to farmers allowing various choices in order to improve their land use efficiency and avoiding increasing the area of agricultural land.

b) Economic and social analyses : These include age and education of the farmers; labour and employment in farm households; land tenure; area of existing agricultural land; income and expenditures; farmer's experience on soil and water conservation and their attitudes toward such projects.

c) Analysis of the results of farmer's adoption assessment. Since there are many methods used for soil and water conservation, the farmer's adoption of a particular method is noteworthy. It is essential to know which methods are preferred by farmers.

4.9 FUTURE POLICY ON SOIL AND WATER CONSERVATION

a) The government must prevent the deterioration of national land resources by setting up a national project of soil and water conservation. It will be carbried out by the government with the partial participation of farmers. The various methods of preventing soil erosion should be characterized by low cost, ease of practice by the farmer, and compatibility with the cropping system used by the farmer.

b) The formulation of each project should cover the whole area of the catchment. This is be to carried out in accordance with the land use plan of each catchment.

4.10 POLICY FRAMEWORK OF SOIL AND WATER CONSERVATION

The policy framework of soil and water conservation consists of 4 aspects which support future national policy. These are follow :

Research

Various studies will seek practical, low-cost methods of soil and water conservation which are appropriate to the topographic, economic, and social conditions of each region. The seriousness of land degradation problems throughout the country must also be investigated. This problem is an urgent one.

Transfer of technology

The transfer of soil and water conservation technology should take place in the long and short term. These include dissemination of knowledge, public relations, formal and informal

education, training of government officers and the farmer leaders, farmer meetings, demonstrations and conferences.

Public service

In areas which are deteriorated beyond the ability of farmer or the farm groups to rehabilitate the land, the government must help by providing some of the necessary material for soil conservation practice. These would include for cover cropping, tree seedlings, and circulated funds, for example.

Enforcement of laws and regulations

The government must urge the agencies involved to carry out the project under the enforcement of laws and regulations such as the watershed classification, land use plans, national forest policy and the other laws which support the project of soil and water conservation.

5 Forest land Policy

There are both inland and mangrove forests in Thailand. The characteristics and uses of the two types of forests are rather different from each other. It is also probable that the details of policy on them will differ. This study includes both of them.

5.1 GENERAL FOREST POLICY 1/

Forest Situation in Thailand

As Thailand is located in the tropical zone, the country is covered by tropical forest of two main types, namely, deciduous and evergreen forests. The deciduous forests are identified as mixed deciduous and dry-dipterocarp forest. The evergreen forest includes moist evergren, pine, mangrove, and tropical rain forest. The Royal Forestry Department reported that 70.8 percent of the original forest coverage in Thailand was deciduous forest. The other 29.2 percent was evergreen, all these forests were economically valuable, and attractive for the reason. Timber has always been commercially harvested, and there has been an inexorable and tremendous decline in the forest area.

In 1972, FAO reported that in 1967-1970 the total forest area in Thailand was 270,200 km^2 , including growing stock of about 1,289 million m^3 with an annual increase of 27.5 million m^3 per year. It was estimated in 1985 that the growing stock had declined to only 877 million m^3 . The annual increase is only 17.46 million m^3 per year compared to a demand of 88 million m^3 per year for fuelwood, poles, lumber, plywood, pulp, paper and other items.

The depletion rate of forest area was found to be 3.9 million rai annually from 1938 to 1985. The rate was highest, 7.2 million rai per year, from 1976 to 1978. The depletion rate has tended to cecline since 1978, i.e. 2.9 million rai per year from 1978 to 1983 and 1.6 million rai from 1983 to 1985 (Table 5.1). The reasons for this decrease may be that the remaining forest area is less fertile and unsuitable for agriculture or that protection measures have been strengthened.

1/ Forest is defined in the Forest Act of 1941 as "land area on which no one has any rights under the Land Act". From an ecological point of view it is defined as "the community of living things, composed mostly of trees grown on soil with root penetration into subsoil, and it is a renewable resource". Each of the two definitions emphasizes different things. The first definition emphasizes rights to the land. If no one is able to acquire the right to it, it is defined as forest land. The second definition is based on the existance of trees on the land and their role in environmental conservation. This study will based largely on the second definition. The first definition will be adopted only in some cases.

It is currently estimated that forest area comprises 49.59 percent (52,578,750 rai) in the North, 25.56 percent (10,767,500 rai) in the Central Plain, 21.90 percent (9,678,125 rai) in the South, 21.89 percent (4,993,899 rai) in the East, 14.35 percent (15,140,000 rai) in the Northeast. Altogether it comprises and 29.05 percent (93,158,274 rai) of the whole country. Among the causes forest depletion are slash and burn activity, enlargement of cultivated areas, illegal timber harvesting, forest fires, wood craft industry, and other forms of mismanagement of forest. Although reforestation has been going on for 80 years, its overall impact has been rather small, i.e. only 3 million rai for the whole country (Table 5.1).

Past Policies

Policies and Implementation

Forestry activity began before 1896 with teak harvesting in Chiangmai, Lamphun, Lampang, Phrae, and Nan by the feudal chiefs who owned the forests. According to their property rights, they sold the concession to exploit the teak forests without any concern for the resulting forest deterioration. With the recommendation of Mr. S. Slade, an Englishman from India, The Royal Forestry Department (RFD) was established in 1896. Mr. Slade was appointed by the Thai Government as the first Director General of this department. The forest policies proposed by him included the following :

a) The forests must belong to the nation for the sake of everybody in the nation.

b) Establishment of an organization (Royal Forestry Department) for controling the use of forests in such a way that they will benefit every body in the nation forever.

c) Enactment of laws for controlling forest activity, protecting forests from all kinds of destruction and collecting fees.

d) Creating an enlightened forestry service by sending foresters for at least 6 months study abroad.

e) Regarding concessions, emphasis should be on forest conservation rather than forest maintenance.

f) Fees should be collected by the Royal Forestry Department rather than by local strongmen.

g) The government should by right own all forest lands.

h) Teak should not be freely used. The substitution of other kinds of wood for teak should be promoted.

i) Lumber harvests should not exceed the annual increment of growing stock.

Among these policies first proposed by Mr. S. Slade are three important ones : first, the transfer of forest rights from local strongmen to the government; second, the creation of a forestry service ; and third, enactment of forest laws and regulations.

The policies proposed by Mr. S. Slade were the first in which technical aspects come into play. On September 18, 1986 the government of Thailand with the permission of King Rama V established the Royal Forestry Department. Following this establishment, many laws were enacted.

From the first establishment of the Royal Forestry Department until 1932 the policies were mostly in the same direction as these proposed by Mr. S. Slade. A few policies, especially on timber harvesting and payments to the crown, were added.

When RFD was first established, many forest acts were aimed at the problem of excessive, unregulated teak harvesting, for example, the Forest Reserve Act of

Table 5.1 Forest Area in Thailand

Year	Forest Area		Decreasing Rate (Mill.Rai/Year)	Population (Million)
	Million Rai	% of total Country Area		
1938	230.90	72.00	-	15
1947	224.49	70.00	0.7	18
1954	192.42	60.00	4.6	20
1961	171.03	53.33	3.1	30
1973	138.57	43.21	2.7	40
1976	124.01	38.67	4.9	45
1978	109.52	34.15	7.2	48
1982	97.88	30.52	2.9	50
1985	93.16	29.05	1.6	52
Average	-	-	3.9	-

Note : (1) 1938,1947 and 1954 data were obtained from secondary sources and interview.
(2) 1961 data were derived from aerial photograph.
(3) 1973 through 1985 data were derived from LANDSAT imagery.
(4) Decreasing rate of 3.9 million rai per year was calculated from the data from 1961 to 1985.

Source : Boonchana and Tongchai, 1985 and RFD, 1985

1938 which was later replaced by the National Park Act oif 1964. These acts were generally theoretically sound but practically unrealistic.

Aside from these policies, selective harvesting was adopted soon after the RFD was established and it is still practised now. Reforestation was initiated in 1906 and was widely practiced by 1910. However, the area completed under this policy up to present has only been about 3 million rai. (Table 5.2)

In the past, although forest policies were not clear, they were included in all the National Economic and Social Development plans. They all included plans and works in either administrative matters, in protecting the forest, in timber harvesting, reforestation, or forest conservation. An analysis of forest policies in the past indicates that :

a) The government should not have completely taken over the forest areas from the local strongmen. If forest areas had remained as private property, they may have received better care and attention than they receive now.

b) The selective harvesting approach should not be employed. It gives excessive importance to ecological aspects while giving inadequate care to socio-economic aspects. Selective harvesting can be employed only in some areas. Other approaches should be tried.

c) The Private sector should be involved in reforestation in order to speed up the process.

d) The Private sector should be allowed to make use of forest land and to participate in forest protection.

Recommendations for Solving Forestry Problems

The study of past forestry policies shows some weakness of policies or implemention which contributed to today's forest problems. In order to solve or alleviate these problems, it is recommended that

a) Forest areas have to be clearly designated, based on technical, political, economic, and administrative reasons.

b) After the forest area have been clearly delineated, the government must declare which are true forest areas, which are agricultural areas, urban areas, industrial areas, etc., based on height, slope, topography, soil type, climate, and other factors.

c) In order to be able to develop and manage forest areas effectively, the government must indicate which forest areas are under government or private responsibility.

d) Not only the government and government enterprises but also the private sector should be involved in forest utilization and management.

e) The existing forest researches have not been as systematic as desirable. National forest research institute should be established.

f) Forest extension programs have not been effective and continuous. A Division of Forest Extension and Public Relations should be established. Moreover, forest management concepts should be introduced to forestry studies in schools, colleges, universities and for the public.

g) Existing forest laws are obsolete. They should be revised.

h) As situations change, organization and administration of the RFD should be improved and reorganized as well.

Aside from the above recommendations, forest policy should incorporate the following :

Table 5.2 Reforestation Area During 1906 to 1984

Year	Reforestation Area (Rai)	Purposes of Reforestation(Rai)			
		Forestry Plantation	Watershed	Rehabitation	Concession Agreement
1906 - 1960	50,984	50,984	-	-	-
1961 - 1979	1,546,467	709,185	282,300	277,645	277,337
1980	508,727	242,473	80,500	98,960	86,794
1981	328,499	94,710	73,800	90,884	70,105
1982	202,403	56,280	35,000	30,600	80,523
1983	201,587	56,095	35,000	30,100	80,392
1984	202,981	56,450	31,075	32,575	82,281
Total	3,042,048	1,266,177	537,675	560,764	677,432

Note : (1) In 1984 fiscal year, reforestation cost was 1,000 baht/rai and maintenance cost was 150 baht/rai

(2) Reforestation during 1906 - 1960 was only for the purpose of forestry plantation

i) wood export and import

ii) new technology in forest resource development

iii) urban layout policy

iv) changes in harvesting system for some types of timber and in some locations, etc.

National Forest Policy 1985

Due to the inappropriateness of previous policy and implementation, the formulation of a national forest policy is needed. The government has appointed the National Forest Policy Committee chaired by the Deputy Prime Minister (Mr. Pichai Rattakul). The National Forest Policy of 1985 was prepared and approved by the government. Major details of this policy include the following : 1/

a) The objective of long-run forest management and development measures is to produce maximum social, economic, environmental and security benefits for the nation. These measures must emphasize cooperation among forest and other natural resources.

b) The roles and responsibilities of both the government and private sectors in the management and development of forest resources must be strengthened.

c) Forest administration procedures should be improved and made adaptable to the changing quantity, quality, and situation of forest and environment.

d) Forest areas must comprise at least 40 percent of the total area of the country. This forest area is classified as:

i) Conservation forest area protected for the sake of environment, soil, water, plants, and widelife, for flood and soil erosion protection, and for study, research and recreation areas. This conservation forest area will comprise 15 percent of the total area of the country.

ii) Commercial forest areas will comprise the other 25 percent of the nation's total area. It will be the nations primary source of wood and other forest products.

e) Both government and private sectors will develop forest areas to achieve set goals in such a way that both direct and indirect benefits can be continuously derived.

f) For the purposes of forest conservation and environmental protection, city planning and layout must be improved, and forest areas clearly identificd.

g) A permanent National Forest Policy Board should be legally appointed with duties to set forest policy and control forest resource administration.

h) Reforestation in various parts of the country, either on government, local community, or private land should be promoted.

i) Forest acts require revision to permit efficient forest conservation and utilization.

j) Areas with a slope of 35 percent or more should be strictly declared as forest lands. No land rights should be given in this case.

k) Incentives for private reforestation should be given.

Recommendations on Implementation of the National Forest Policy

In order that National Forest Policy, 1985, be effectively implemented, the following are proposed :

a) Forest areas whether conserved

1/ The policy contains 20 statements or points.

commercial, must be clearly identified in order to protect forest and environment, and to promote forest development, reforestation, recreation, and timber harvest.

b) RFD has to be restructured and the relationship between RFD and other government agencies and the public sector strengthened (Figure 5.1).

c) Forest laws and measures for their implementation have to be revised.

d) A network of forest information centers should be established to collect and make use of all basic information.

e) Cutting systems have to be studied to find appropriate cropping systems for particular locations and situations.

f) Direction and timing of S.T.K. program have to be appropriately set.

5.2 MANGROVE FOREST LAND POLICY

Importance of Mangrove Forest

Mangrove forests are one of the primary natural features of coastlines and are composed of various flora and fauna. The importance of mangroves to the human population is becoming better recognized. People, particularly those living in the coastal zone, have depended on mangrove trees for many purposes, including firewood, charcoal, timber and some other minor products. The total annual wood production from mangroves is about 800,000 m or 280,000 metric tonnes of charcoal, valued 560 million baht. The significance of the mangrove forest in fishery production has also been recognized. Many commercially important fishes, crabs, prawns and various kinds of molluscs use mangroves as a nursery ground and as shelters during their juvenile stages. The potential of mangrove areas for aquaculture is gaining attention owing to the increasing demand for protein food sources and the declining yield of marine fisheries. Moreover, mangrove forests still play an important role by constituting an alluvial plain, and protecting the land against tidal bores, and cyclones as well as soil erosion.

Mangrove Forest Situation

Mangrove forests in Thailand are presently under attacked from various quarters. The increase of population at a high rate has added further problems as more land is required for habitation, agriculture, industry, and urbanization. It is estimated that in 1961 mangrove forests covered an area of 2,299,375 rai and have declined continuously to only 1,679,335 rai by 1985 (Table 5.3).

Causes of Mangrove Forest Degradation

Mangrove forest degradation has been caused by 10 factors :

a) Aquaculture. Large mangrove forest areas scattered throughout all the provinces along the coastlines have been converted to shrimp and fish farms.

b) Agriculture. Conversion of mangrove forest areas to crop producting areas due to the low crop yields which result from soil salinity.

c) Mining. Mining in mangrove forest areas have been widely practiced for a long period of time, especially in Ranong, Phangnga, and Phuket.

d) Urbanization. As a result of urbanization, mangrove forest lands are used for village settings, schools, and other similar purposes.

e) Harbour. Harbour construction in mangrove forest land has been increasingly practiced, especially in the southern region.

f) Road and electricity transmission lines. Some mangrove forest areas have

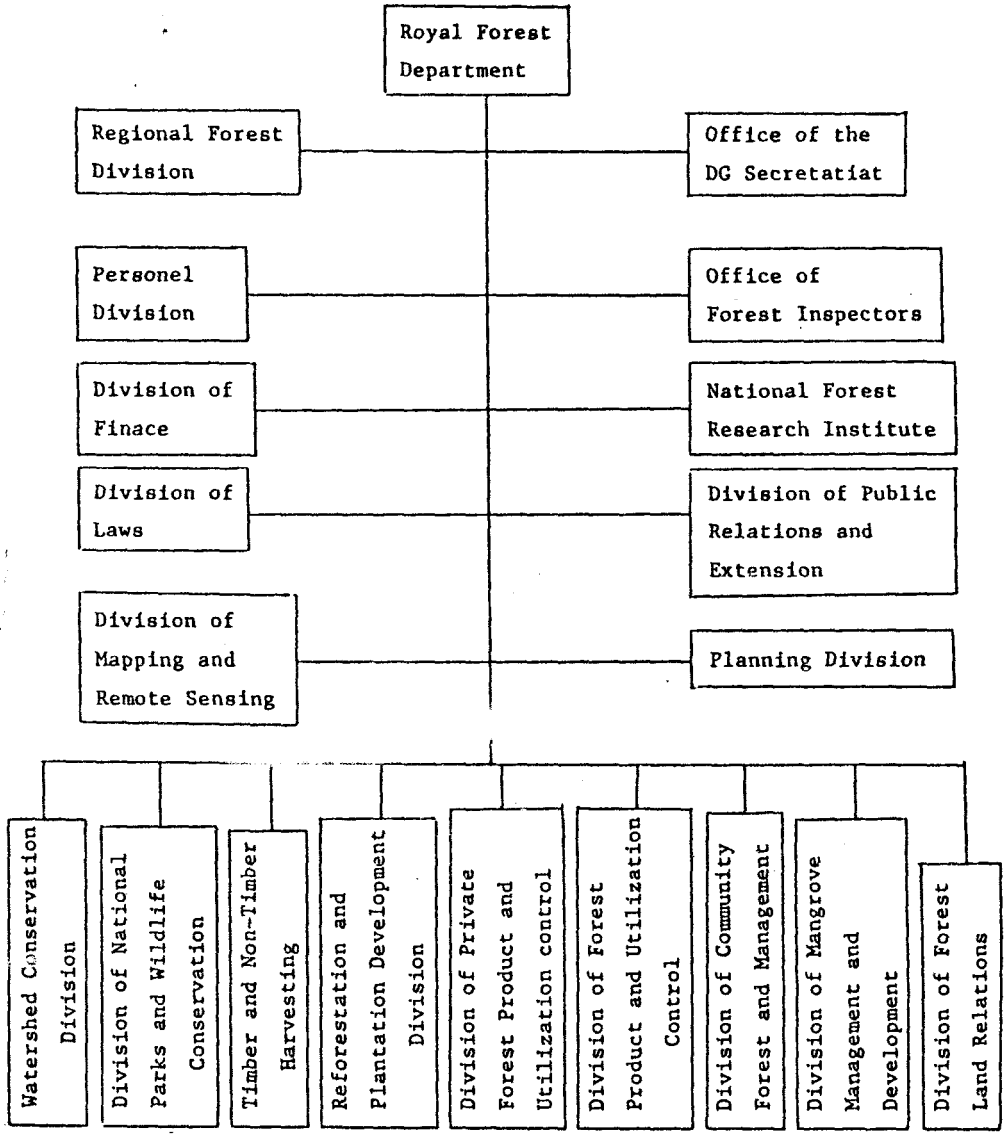

Figure 5.1 Proposed New Structure of Royal Forest Department as for National Forest Policy in 1985.

Table 5.3 Degradation of mangrove forests in Thailand during 1961 - 1985

Year	Mangrove forest	Degradation area		Degradation rate	
		Area (rai)	%	Area (rai)	%
1961	2,299,375				
		344,800	15.0	24,629	1.1
1975	1,954,575				
		158,900	8.1	39,725	2.0
1979	1,795,675				
		116,340	6.5	16,620	0.9
1985	1,679,335				
1961 -11985	-	620,040	27.0	24,802	1.1

been used for road construction and electricity transmission line installation, but this has not been significant as compared to its use for other purposes.

g) Factory and power generation house. Some mangrove forest areas in some provinces have been used as factory and power generating sites. Most of the factories located in mangrove forest areas are fishery based factories.

h) Dredging. Although dredging does not actually occur in mangrove forest areas, it creates siltation problems for the mangrove forests.

i) Salt pan. Mangrove forest areas have been widely used as salt pans, especially in Samutsakorn and Samutsongkram.

j) Over cutting. As demand for firewood and charcoal increases, more and more wood in mangrove forests is cut.

Table 5.4 shows the details of conversion of mangrove areas for other uses.

Problems and Effects of Mangrove Forest Land Use

As mentioned earlier, vast areas of mangrove forests have been destroyed by various human activities, either intentionally or as a secondary result of other activities. Each example of destruction has, as a common basis, policy decisions relating to economic development by both government and private sectors. In each case, it appears that a decision was made which either ignored the value of the mangrove resource or which placed a significantly higher value on the alternative land or resource use. In essence, short-term exploitation for immediate economic benifits has taken precedence over the long-term generation of benefits which have both economic and natural values. In the majority of cases, the full value of the mangrove resource should be taken into account so that this valuable resource can continue to produce a sustainable yield without destroying its ecosystem.

National Policy and Plan for Mangrove Land Management

As stated previously, mangroves in Thailand have been used in various ways for many years. Conflicts among mangrove area users frequently occur because there has been no definite policy on mangrove land use. The existing management policy for utilization of mangrove areas and its resources by the various institutions concerned is not clearly understood by the users. These problems have repeatedly led to severe destruction of the mangrove ecosystem. As mentioned earlier, approximately 30 % of the total mangrove forest has been destroyed or converted to other types of land uses resulting in several lamentable ecological and economic losses.

Realizing the importance of the mangrove ecosystem of avoiding conflicts among mangrove area users, and of managing mangrove resources on a sustainable basis, the national policy should be set up as follow :

a) Mangrove area management will be carried out on a sustainable basis with appropriate and effective measures in accordance with our present ecological knowledge.

b) When converting mangrove areas for other types of land use, those activities will be given priority which have a minimum impact upon the mangrove environment.

c) Use of mangrove areas will emphasize multiple sustained use, rather than conversion for a single exclusive use.

d) Rehabilitation of the deteriorated mangrove and promotion of replantation

Table 5.4 Conversion of mangrove areas for other land uses

Land- use type	Area,rai			Percentage of the total area
	Prior 1980	Between 1980 - 1986	Total	
Aquacuture	162,725	74,734	237,459	38.3
Mining	5,787	28,279	34,066	5.5
Salt pan	66,000	-	66,000	10.6
Others	269,188	13,327	282,515	45.6
- Agriculture		4,386		
- Urbanization		3,125		
- Harbour		2,684		
- Rodd and transmission line		1,467		
- Factory and power generation		1,135		
- Dredging		530		
Total	503,700	116,340	620,040	100.0

of mangrove forests by both government and private sectors should be carried out.

e) Research on the mangrove ecosystem should be promoted. Research results and conservation practices should be disseminated to all levels of people - policy makers, planners, managers, users, and concerned institutions.

To achieve these goals and objectives of the national policy and plan, the important implementation guidelines should be as follow :

Mangrove land use zoning

Prior to mangrove land use zoning, the actual map of the mangrove area should be made using remote sensing techniques with ground survey. An ecological study and an environmental impact assessment is also necessary. The mangrove areas should be outlined in 3 important zones:

a) Preservation zone : The preservation zone assures the protection of natural and relatively undisturbed plant communities. This zone will maintain species and genetic diversity and will provide areas for scientific research and education, recreation, and cultural interest. At the same time, it will provide shoreline protection, breeding grounds and shelter for fish and shellfish.

b) Conservation zone : This zone will cover the mangrove area managed for sustained yield of forestry products.

c) Development zone : This zone will cover mangrove areas which have been degraded or denuded. If reforestation cannot be accomplished, this zone can be developed for aquaculture, agriculture, urban and industrial sites, or other purposes.

Principal measures for mangrove land use

a) The use of mangrove areas for any development purposes, except wood exploitation on a sustainable yield, will be allowed only in a development zone. If any development projects are badly needed, they can be operated in a conservation zone, but they cannot in any case be allowed in a preservation zone.

b) The use of mangrove areas for any development projects requires the project implementing agency to submit a project proposal and an environmental impact assessment to the Office of the National Environment Board (ONEB) and National Mangrove Committee (NATMANCOM) for permission. If such use would have a severe adverse effects on the environment, the project will not be permitted without modifications to prevent such damage.

c) Use of mangrove forests in conservation zones for development projects requires that the strip of forest along the bank of rivers or seas be kept as a "green belt" for environmental protection. The width of the green belt from river bank or sea will vary, depending on geographical conditions, tidal regimes, and the ecological importance of each forest area.

d) Any development projects concerned with tidal regimes and fresh water discharge in the mangrove ecosystem must operate without obstructing the tidal flows. Otherwise the environment and the productivity of flora and fauna in the mangrove and in the adjoining ecosystems will be adversely affected.

e) Waste water and other wastes from any development projects must be properly treated before release into the

mangrove ecosystem. The standard of treatment set by ONEB must be adhered to.

f) The implementing agency of a project developed in a mangrove area should protect the forest nearby project sites from illegal cutting and other forest destructive activities.

g) Any project abandoned in mangrove areas still requires the implementing agency to improve the area by reforestation. If this proves impossible, reforestation should be carried out in other denuded areas to compensate for the loss of mangrove area. All expense for reforestation will be paid by the project implementing agency.

h) In case of wood exploitation, the concessionaires must operate logging systems under the laws, regulations, and obligations issued by the RFD. If not, the penalties prescribed by law will be strictly enforced.

i) The Cabinet Decisions of June 27, 1978, and August 19, 1980, must be followed by project implementing agencies for any development projects in mangrove forests.

j) The Royal Forestry Department (RFD) and the Office of the National Environment Board (ONEB) must periodically follow up all development activities carried out in mangrove areas. If any environment problems occur, they can be promptly solved.

k) Laws and regulations concerning the use of mangrove areas or resources must be strictly enforced.

Multiple use management system approach

The use of mangrove area should emphasize multiple sustainable use, rather than coversion for a single exclusive use. Figure 5.2 shows the multiple use system in coastal areas. This figure can be summarized as follow:

Oyster and horse mussel culture should be carried out in tidal regime areas with gentle slope. Under appropriate conditions, plantation of mangrove forest should also take place. In the next area nearer the sea there should be cage and mussel culture. A green belt area will be between the mangrove forest and the oyster culture area. The mangrove forest itself will serve as a nursery ground and shelter for aquatic animals. Pond culture and agricultural activities should be in inland areas only, outside the mangrove forest area.

Administration

The use of mangrove resources has been of interest to a number of institutions which has resulted in conflicts of resource use. To solve this problem, it is necessary to establish a committee for the task of preparing a national mangrove management plan. The committee will also advise on other activities in mangrove areas such as research projects, and will function as liaison and coordinator with nationally and internationally concerned institutions. This socalled "National Mangrove committee" will be composed of an expert group from different institutions concerned with mangrove resource use. The committee will be established under the National Research Council of Thailand. The organization of the committee is presented in Figure 5.3.

Other activities relating to mangrove forest landuse

For the successful implementation of mangrove forest land use policy, the following activities should be carried out.

a) Promotion of research on the mangrove forest ecosystem in order to gain basic information and provide measures for mangrove forest resource utilization.

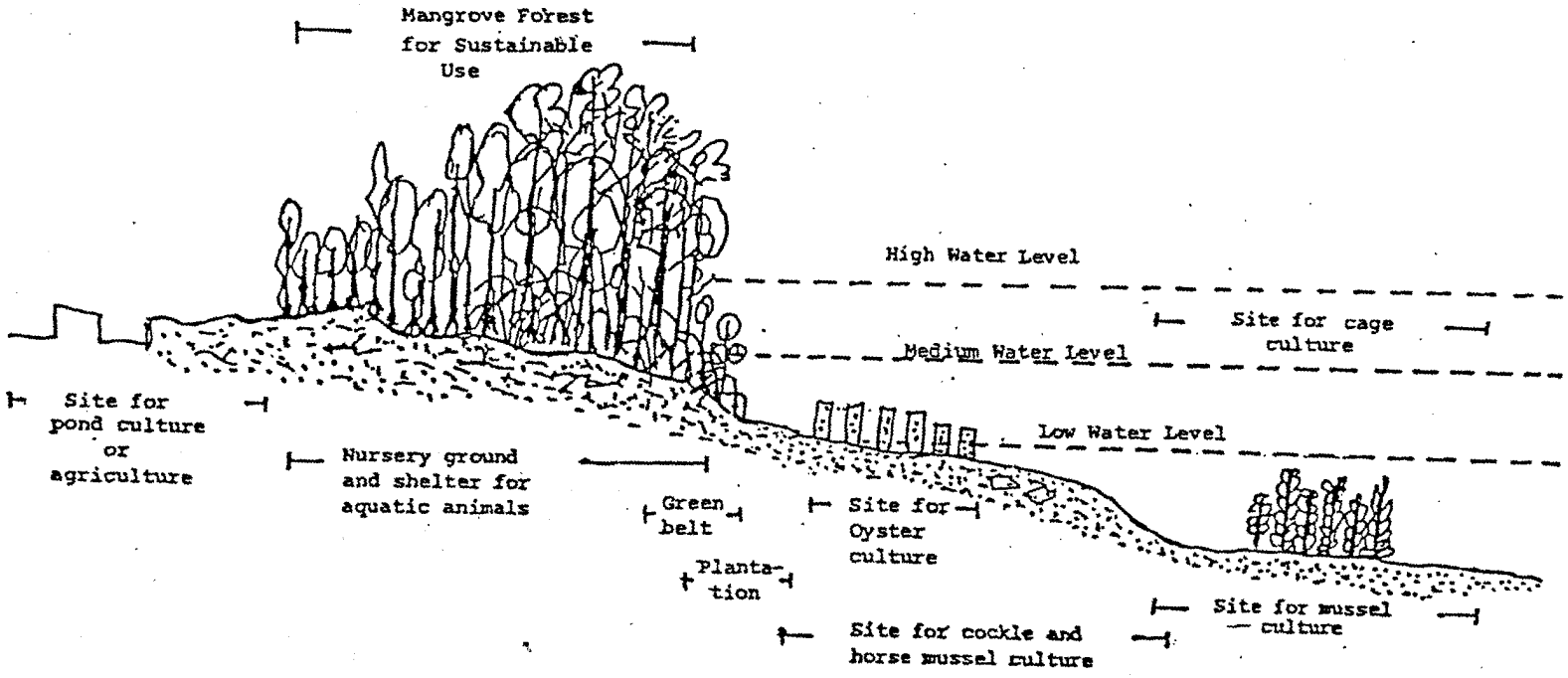

Figure 5.2 Multiple-use management of coastal area

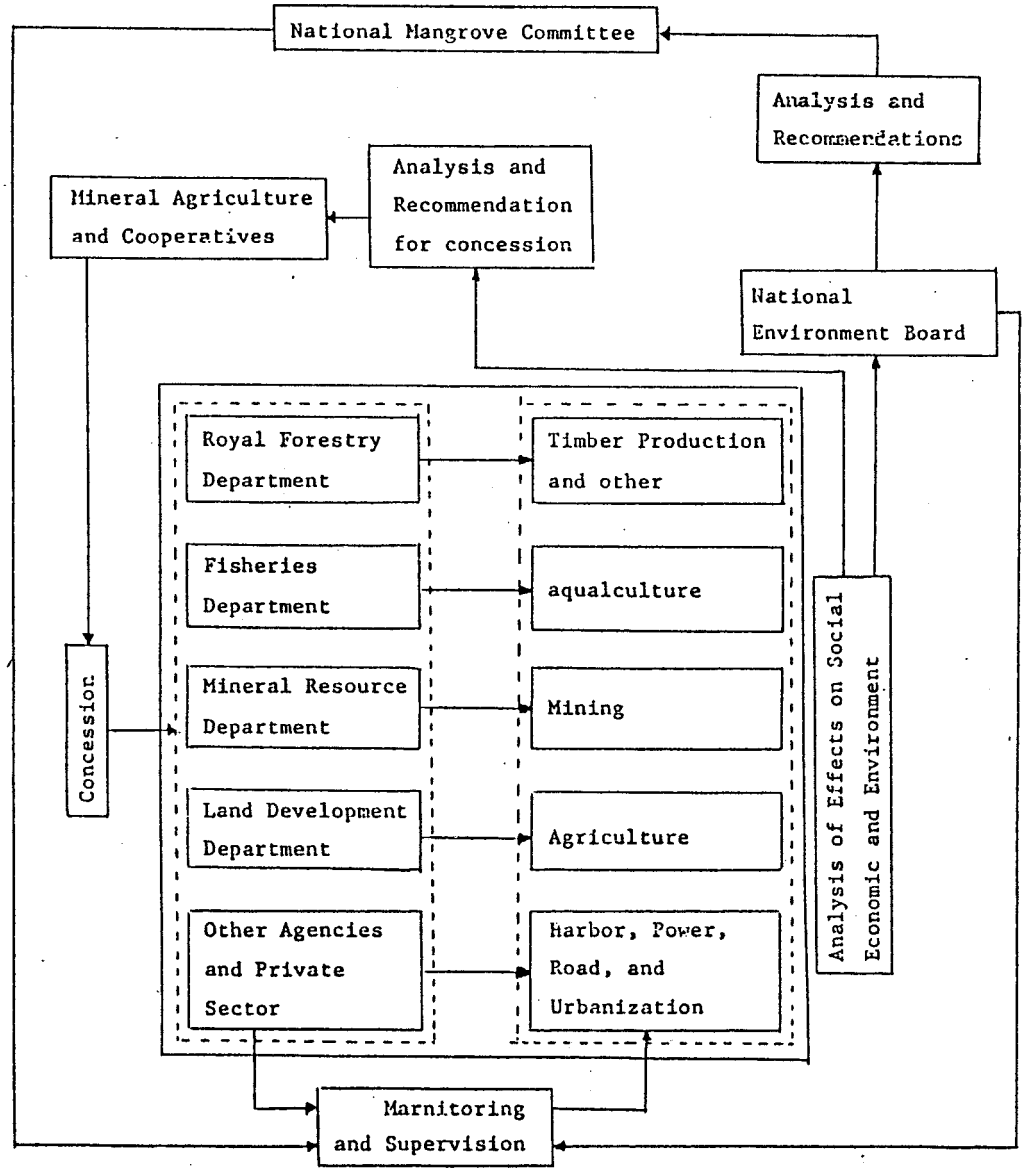

Figure 5.3 Mangrove Forest Land Use Organization

b) Provision of more manpower and instruments to a "Mangrove Forest land Management Unit" so that these mangrove forest lands will be effectively managed.

c) Extension of knowledge in conservation and utilization of mangrove forest and its importance to all levels of people including users, planners, administrators, and logislators.

d) Mangrove forest laws and regulations must be strictly enforced.

6 Land tenure Policy: Land Rights and Land Titling

6.1 INTRODUCTION

In discussing land tenure, the most fundamental question which must be analyzed in detail is land rights. The nature, extent, and underlying conditions of land rights are determined largely by the owners and holders of the land by basic and common laws, and by various rules and regulations. In Thailand, land rights are regulated by the government under a number of laws and, at times, through cabinet decisions. This has been done for reasons of convenience, but of confusion, and in order to avoid legal complications. When a certain law on land rights is to be applied in a given settlement area, all the relevant by-laws, rules and regulations must also be exercised. This can be a constraint to the implementing settlement agencies, and there are many of them in Thailand involved in the direct settlement of farmers, squatters, and displaced people in rural areas. Differences in land rights embedded in land documents or land leases result in different social and economic implications. It is the issues surrounding land rights and land titling which need to be resolved.

It must be noted that land rights are closely related to land ownership security. Economic theory postulates that when ownership is not secure, incentives for investment and improvement are diminished since the benefit from future returns on such investments is uncertain. Insecure ownership also means that farmers cannot use their land as collateral for loans, and therefore have only limited access to subsidized and cheap credit. Clearly, ownership security, having full rights over the land, will have a great impact on agricultural productivity and rural development (Feder et. al, 1986).

6.2 A REVIEW OF LAND TENURE AND LAND RIGHTS

The General Situation

We may divide land into two domains, the private and the public.

The two domains appear to be clearly delineated but, in fact, they are not. When the government distributes land to the farmers, land itself is being transferred from the public land domain to the private land domain. However, actual transfers do not so readily take place. They depend on whether the conditions under which land ownership titles are provided are statisfied by the recipients or not. Usually, upon satisfactory completion of a set of conditions, a certain type of land document is issued to the landholders. Full ownership titles will be issued only when all conditions are met. This requires time, and thus, the line between the private and public land domains becomes blurred.

The Private Land Domain

There are about 160 rai of private land which can be issued land ownership

documents. Land tenure in this type of land can be in the forms of ownership and tenancy. The tenant will have the right to use the land. He usually will have to pay rent, as agreed upon and stated in the contract (which may be in either written or oral form). His right on the land is therefore restricted. He cannot use the land as collateral for loans. As mentioned before, tenancy of farm land is concentrated in the traditional rice-growing areas of the Central Plain and North. Nationwide, tenancy is not serious, as compared with other developing Asian countries and because of the concentration of tenancy, the Agricultural Land Reform Act of 1975 requires land reform to be implemented only in selected districts (called "Land Reform Areas").

Land reform in Thailand aims at distributing farmland to tenants, and to small and landless farmers. Up to July 1986, about 300,000 rai of land have been purchased from absentee landowners. The main beneficiaries here are the former tenants. Land is being sold to them on a long-term installment basis. Upon completion of the installment plan, land ownership is transferred to the farmers. Any transfer thereafter has to meet approval from the Agricultural Land Reform Office (ALRO). The main reason is to prevent the land from being lost to non-farmers. Thus, land rights among land reform farmers fall short of full ownership rights. The majority of land reform farmers are still tenants to ALRO, because, due to low farm prices, they find it difficult to meet the annual amortization payment under the hire-purchase scheme. Land rights among the land reform tenant farmers appear to be more secure and more flexible than for ordinary tenants.

As regards land titling for private land (under the Land Code 1954) the Department of Lands has issued land documents (N.S.4, N.S.3, N.S.3-K., N.S.2) for 13 million plots covering an area of 90 million rai (Department of Lands, 1986). There are reportedly stillq about 53 million plots, about 30% of the private land, for which there are no legal documents.

Lands with N.S.4 or title deeds constitute only about 15 % of the total private land. In 1985, a total of 20.8 million rai had N.S.4, compared to 61.7 million with N.S.3 and N.S.3-K, and 7.9 million with N.S.2 (Bai Chong) (Table 6.1). Clearly land titling or and land rights is still quite a serious problem.

The N.S.4 documents are usually found in urban areas and are concentrated in the Central region. The poor region of the Northeast has a very low proportion of N.S.4 (Onchan, 1985). Furthermore, N.S.4 is almost non-existant in farm areas. For example, in Nakorn Sawan province in 1979, of more than 14,000 plots of land, (only 2 had N.S.4 covering an area of 62 rai (see Table 6.2). Another study in other areas shows similar findings (Feder et. al, 1986).

The Public Land Domain

In the public land domain which covers, at most, 202.5 million rai, mostly forest reserves, the squatter problem is the most outstanding phenomenon in recent development history. Only about 60 % of the public land remains under forest cover. The remaining 40 % (80 million rai) has at varying rates been turned into farmland. This has occurred for a variety of reasons agricultural commercialization, population presure, etc. In the early days, squatter rights were never recognized, although land transfer was common and acccepted by farmers themselves. When the problem got out of proportion, squatter rights were turned into preemptive rights and legalized. It is estimated that there are one million squatter families. Much of the squatted land is well-developed with agro-based services. Some have even changed into rural town centers. The government has adopted a number of policies and programs to solve the squatter problem, so far with limited

Table 6.1 Issuance of Land Documents by Department of Lands, 1985

Unit : Rai

Region	N.S.2	N.S.3 and N.S.3K	N.S.4 (Title Deeds)
North	1,859,690	14,362,279	3,577,466
Northeast	3,996,470	32,221,738	2,132,298
Central	1,385,618	5,438,732	14,209,350
South	692,456	9,714,771	868,467
Total	7,934,234	61,737,520	20,787,581

Source : Department of Lands

Table 6.2 Issuance of Local Document in Amphoe Nong Bua, Nakorn Sawan Province, 1979

Type of Document	Number of Plots	Area(rai)
N.S.4	2	62
N.S.3	4,253	111,240
N.S.3K	9,180	164,234
N.S.2	41	1,351
S.K.1	132	3,448
Tra Chong	23	686
Total		281,020

Source : Aricultural Land Reform Office, 1983

success.

As will be discussed in the next Chapter, many government agencies are involved in land allocation and development. However, the major land settlement agencies are the Royal Forest Department (RFD), the Agricultural Land Reform (ALRO), the Department of Public Welfare (DPW) and the Department of Cooperatives Promotion (DCP). These agencies carry out their land settlement programs based on different laws; the land rights given to farmers differ accordingly. It is precisely the differences in land rights which must be solved. For one thing, the provision of land rights to farmers and other rural dwellers has important social and economic implications to them. Transferability, inheritance rights, imposition of rental fee, terms of lease or occupancy etc. always cause confusion among all parties involved and a bureaucratic nightmare to land agencies. Individual government departments appear to have different basic concepts, ideologies and approaches to accommodating squatter farmers. These are expressed, either explicitly or implicitly, in the provision of land rights.

Some differences in land rights are shown in Table 6.3 for clarification. The RFD and ALRO issue their own version of land use or stewardship permits to farmers by using the Forest Reserves Act and the Agricultural Land Reform Act, respectively. The RFD has also sought and obtained issuance power from the cabinet, when it deemed the Forest Reserves Act inadequate. The DPW and DCP have been empowered by the Land Allocation Act to settle farmers on arable public land. Under the Land Allocation Act, full ownership of land is given to farmers, provided that they have satisfied all conditions imposed. It is linked with the Land Code which is the basic land law. The Land Code also empowers the Department of Lands (DL) to distribute land to the landless and poor, who eventually become full land owners. The amount of land allocated to farmers varies according to the laws, as indicated in Table 6.3. Transferability is usually restricted to inheritance rights only. The RFD and ALRO, at present, do not provide full ownership titles to settlers, for fear that land will sooner or later be lost to middlemen. The DL full ownership titles can be universally transferred, except in the case where land is obtained through the Land Allocation Act (5-year non-transferability) or through the Land Code (10-year non-transferability). Only full ownership titles can be used as a collateral against institutional loans.

The extent of land allocation by major departments (except the Department of Lands because of difficulty in compilation) is given in Table 6.4. Apparently, the RFD, which started the land allocation program only as recently as 1982, but has achieved quite considerable progress. However, it provides land use permits to squatters without any attempt to distribute to small and landless farmers. It does not provide basic infrastructural development facilities, unlike other departments. From Table 6.4, it is clear that land settlement so far is still inadequate to meet the needs of squatters. Under the present land reclassification project, more arable forest land is to be reclassified and distributed to farmers. Land distribution is being carried out by settlement agencies. Adjustments with regard to settlement procedure and, particularly, land rights need be made to achieve better coordination and integration.

6.3 POLICY ON LAND RIGHTS : PAST AND PRESENT

Policy on land rights is indicated or included in several land and land related policies, laws and regulations, and in the National Economic and Development Plans.

Table 6.3 Differences Among Various Land Documents

Type	Right to Transfer (Including sell)	Restriction on Transfer	Maximum Period of Legal Protection	Period of Right for Pre-emption	Acceptance as loan Collateral
Title Deeds (N.S.4)	Yes, except case of non-transferable restriction	5-10 Years	10 Years	10 Years	Yes
N.S.3	Yes, except case of non-transferable restriction	5-10 Years	1 Year	5 Years	Yes
N.K.3	No, except through inheritance or to Cooperatives	All the time	None	None	No
K.S.N.3	No, except through inheritance or to Cooperatives	All the time	None	None	No
S.T.K.1,2	No, except through inheritance	All the time	None	None	No
S.P.K.4-01	No, except through inheritance or to farmer's organization or ALRO	All the time	None	None	No

Table 6.4 Issurance of Land Documents in Public Lands by Government Agencies, 1985

Agency	Type of Document	Number	Area(rai)
Department of Public Welfare	N.K.3	128,390	-
Department of Cooperative	K.S.N.3	-	265,073
Promotions	K.S.N.5	-	52,804
Department of Royal Forestry (July, 1986)	S.T.K.1*	670,545	6,859,834
Agricultural Land Reform Office (June, 1986)	S.P.K.4-01 (Including S.P.K. 4-01 A)	17,967	361,200

* Including those to be provided S.P.K.1

Source : Data from varians agencies concerned

In 1982, the Policy on Land Use and Land Rights was approved by the Cabinet (it had been proposed by the National Rural Development Committee). In the same year, the National Land Allocation Committee formulated a National Land Policy. The National Forestry Policy was approved by the Cabinet in 1985. Tocope with the problem of massive forest encroachments, the S.T.K. program was implemented in 1982. Other programs include those land reform and land settlement schemes which entail certain provisions regarding land rights, as already mentioned. Major laws include the Land Code 1954, the Land Allocation Act 1978, and the National Forest Reserve Act, 1982.

Policy as Indicated in the National Plans

In the First Plan (1961-1966), it was stated clearly that 50 % of the country's total area would be forested. Suitable land for agriculture would be allocated to farmers, who would obtain full ownership rights. In the Third Plan (1972-1976), improvement in the land tenure system and provision of land rights to farmers were among the major policies relating to agriculture. In the Fourth Plan, forest protection received a high priority. The government would pledged to accelerate land reform and development activities. These policies continued to receive a great deal of attention during the Fifth Plan. Finally, in the Sixth Plan, which was just started last October, 1986, emphasis is placed on nation-wide land titling and the acceleration of land reform and land allocation schemes. Land development and conservation has also received much attention.

Policy on Land Use and Land Rights

This policy provides a clear picture of present land use problems, particularly those relating to forest reserves and prereserves. Of the forest reserves (123 million rai), those over 30 million rai of land 1/ which have been encroahced must be classified. If found to be suitable for agriculture, the land would be put under the S.T.K. program of the Royal Forestry Department, the programs of other agencies such as the ALRO, or both. Land classification must also be made for the pre-reserve areas of about 30 million rai. These areas which are suitable for agriculture will be allocated to farmers. They will be issued documents by the Department of Lands. Areas unsuitable for agriculture will be gazetted as national forest reserve. The general concept of the Land Use and Land Rights Policy is depicted in Figure 6.1.

Other Policies

As already mentioned, the National Land Allocation Committee also prepared a National Land Policy. However, it has not been approved by the Cabinet. Its content reflects some important current views and concepts of land tenure and land rights. In essence, it proposes that land titling be accelerated throughout the country, and that a ceiling on land holding should be enforced. Restrictions should also be put on the right to transfer land except through inheritance, or to the government or farmer organizations.

Other policies include the National Forestry Policy (1985) which will clearly identify forest areas and other types of land use. The Land Development Committee (1975) has also formulated a Land Use Policy emphasizing the issuance of land documents. Finally, in 1982, RFD started to carry outthe S.T.K. program, which gives an S.T.K. land certificate. This program will be discussed in detail in the next Chapter.

From the above discussion on various policies relating to land rights, it can be seen that over the past 30 years,

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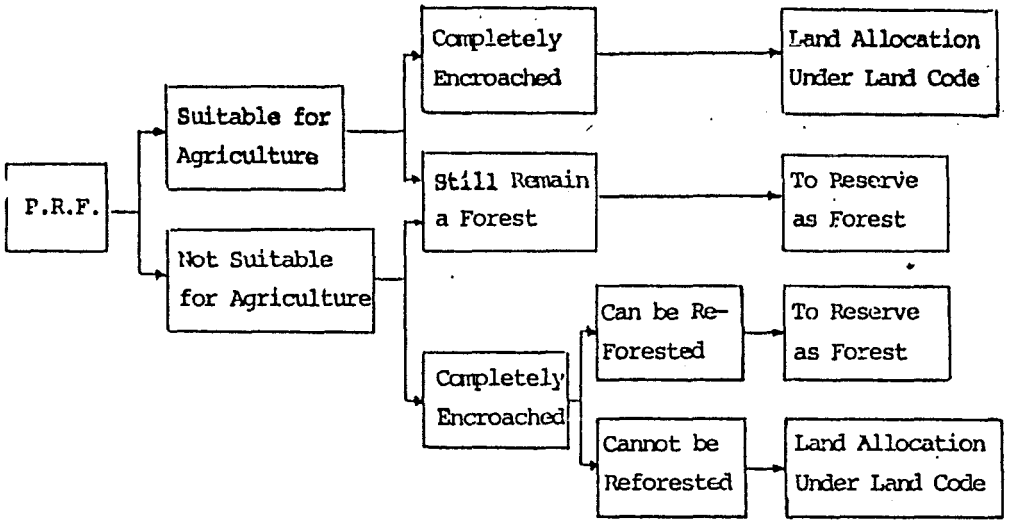
1/ It was the number at that time. It is now estimated atover 40 million rai.

A. Pre-Reserved Forest (P.R.F.)



B. National Reserved Forest (Already Encroached) (N.R.S.)

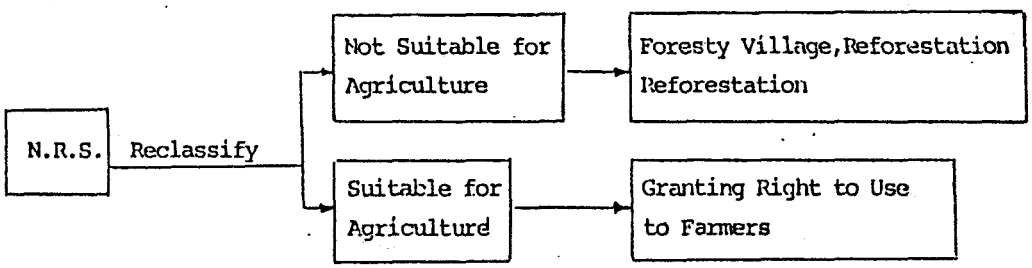


Figure 6:1 Ways to Imprement Land Rights under the Land Use and Land Rights Policy

significant changes have occurred (see Figure 6.2). Before 1957, farmers had a problem of land tenure and tenancy. Agriculture became more diversified and was increasingly commercialized. During the 1960s, land classification was carried out, and national forest reserves specified. Land allocation programs have been emphasized since the late 1970s, while land titling and land rights issues and policies have been of relatively recent interest.

6.4 POLICY ISSUES AND ANALYSIS

There are two distinct views with regard to land rights. One is that full ownership rights and the other that only partial rights should be given. The latter case it may consist in forms of rental arrangements and temporary land use permits. These conflicting views are reflected in laws and policies relating to land. The results of a systematic study on the effect of land rights jointly undertaken by Kasetsart University and World Bank (Feder et. al, 1986) clearly indicates that the provision of full legal ownership rights to residents, including squatters in forest reserve areas, will increase social welfare and agricultural development. The usufruct certificates such as S.T.K. documents will not affect farm productivity or reduce the rate of forest encroachment.

Partial land rights are usually given by land allocation agencies operating in public lands. These programs have thus been rather ineffective in reducing forest encroachment, as in the case of the S.T.K. program. In fact, the S.T.K. document differs from ALRO (or Sor Por Kor 4-01) in many ways, especially in terms of land rights and other provisions. The ALRO program emphasizes infrastructure development and support services to help raise farm productivity and income. There are no such activities under the S.T.K. program. In fact, other types of documents issued by the Public Welfare Department and the Cooperatives Promotion Department are quite similar to the Sor Por Kor 4-01. After a certain time period and the satisfaction of certain conditions, these documents can be converted to N.S.3 or N.S.4. However, it is not yet clear as to what will be the long-run policy regarding legal ownership of the S.T.K. document.

In cases where full ownership documents are present, the right to transfer is clear. The fact that it is accepted by credit institutions makes it more valuable economically. It has been argued by many, including policy makers, that if full ownership rights are given, the farmers will inevitably lose their land to capitalists or lenders. This seems very logical, but it is not supported by the available empirical evidence. Economists have been studying this issue for some time and have found no clearevidence to support the view. Evidence is given in Table 6.5 demonstrating that, in a single year (1984-1985), only 2 % of the total number of plots were sold or mortgaged. The very nature and culture of Thai farmers argues their profound and tenacious attatchment to their land. The loss of land, when it occurs is almost always caused by factors such as low income and poverty.

6.5 TOWARD BETTER INTEGRATION OF EXISTING POLICIES

On public land, particularly in the national forest reserves, the RFD aims to keep squatters at bay, and to save the remaining forests. Arguments against this contend that forest protection and the settlement of farmers are two different things. However, better and more efficient forest management is needed, and this can run counter to what a settlement agency is supposed to do in assisting the poor. It is difficult to imagine a single agency functioning efficiently with two

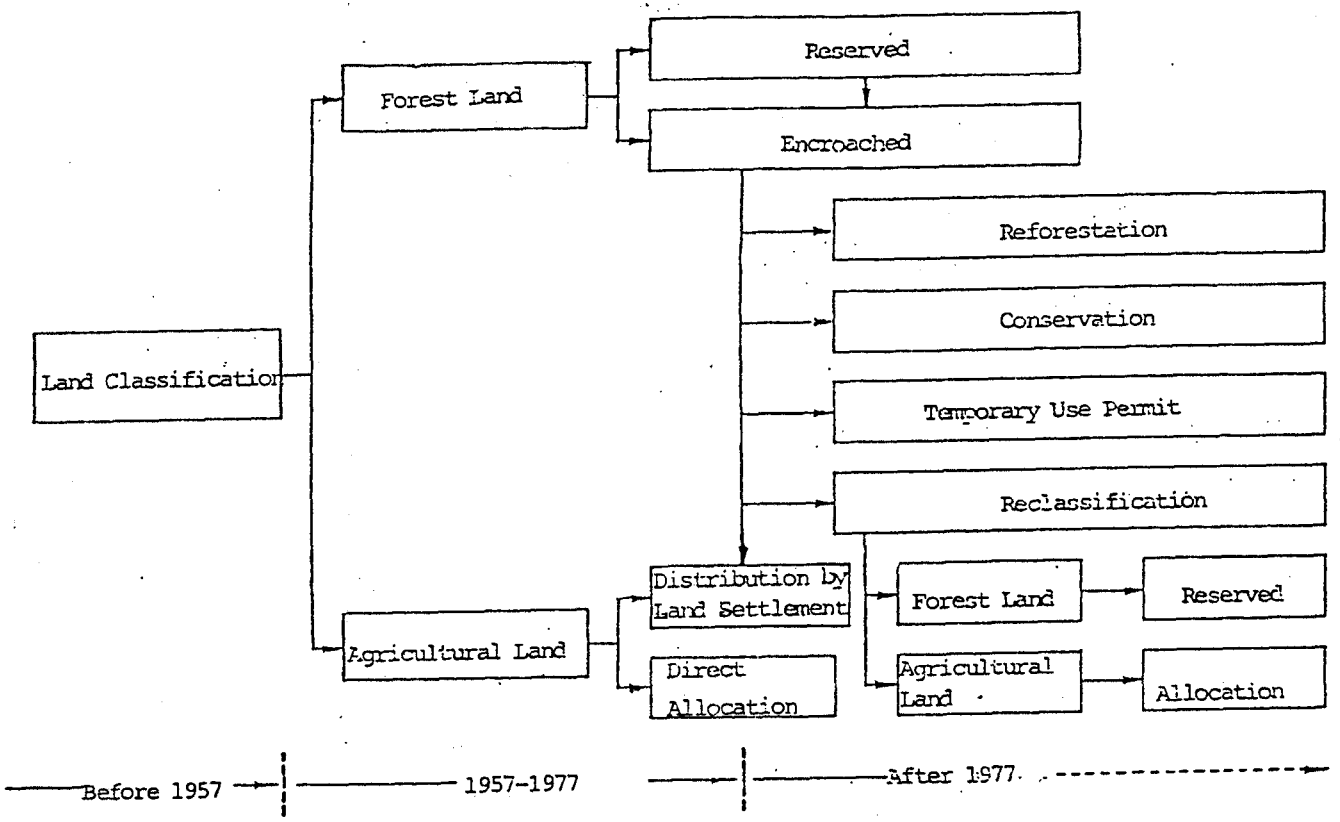


Figure 6.2 Changes in Land Use and Management During the Past 30 years

rather diverse roles to perform. The deterioration of forests has not been due only to log poachers and farmers, but also to the past failure of the RFD to protect them. It is perhaps in the best interest of all concerned that the RFD should concentrate on forest protection and allow other settlement agencies to carry out land distribution. The Land Allocation Act is restrictive and outmoded. The DPW and DCP should therefore hasten the process of land allocation and development so that all settlers can become full land owners. These departments can then release manpower and budgetary resources to new land settlement areas, exercising legal power directly under the Land Code in the same way as the DL, and not under the Land Allocation Act. The land rights granted to the farmers such as transferablility and land utilization can then be identical. The amount of land allocated should follow the same principles with greater flexibility.

The Agricultural Land Reform Act can accelerate land distribution and can be made compatible with the Land Code through inter-departmental dialogue. In this way the ALRO can continue its land distribution program as usual. Since the beneficiaries of land reforem will be entitled to use land as mere lessees,some modifications may be made to degazette Land Reform Areas and apply the Land Code. Full land ownership titles can then be issued.

As already mentioned, past research findings indicate that land ownership is superior to any other form of tenure. In the leasing system (and others, where control and supervision is partly held by the state or by non-tillers of the land), rent is extracted from the lessees, thereby reducing income generated from land. Even if rent is free as in the case of land use permit holders, government authorities find it difficult to administer hundreds of thousands of parcels of land around the country. Though transferability of land use permits is restricted, enforcement is questionable. Leased land cannot be used as collateral. Ownership of the land arguably tends to lead to greater investment in it land which, in turn, leads to higher production and income. It provides security to the owners and reduces the inequality which exists in rural areas between landowners on the one hand and tenants and the landless on the other.

However, land ownership should not be provided to farmers in the first instance. Some time should be allowed to elapse during which the government will assist them in their growing ability to rely on themselves. One serious setback is that farmers lack land ownership titles which can be used as collateral for loans. This will require further government intervention. Suitable farm programs may be undertaken to follow directions established by the government, for example, the tapioca substitution project. The farmers are still permitted to use land and are supervised by the relevant authorities. Time is also needed for the government to design and adopt new measures to prevent squatting, reforest denuded areas and, in short, reassert law and order in reserved lands. After 10-15 years, land ownership titles may be issued. Sale of public land is rare and deemed impractical. When land ownership has been transferred to the farmers, new land can be opened for settlement. In this way, settlement authorities can be mobilized to deal with the enormous problem of squatters.

6.6 PROPOSED POLICY ON LAND RIGHTS AND LAND TITLING

a) Land ownership should be provided to tillers of the land.

b) In privately-owned lands, the government should continue to reduce the tenancy problem through land reform implementation. Enforcement of agricultural land rent control should be strengthened.

c) For public lands which are distributed to farmers, the government should issue land use permits which, after 10-15 years, will be transformed into land ownership titles. Only in special cases will freehold or lease be granted for some limited but renewable time period. These include the following categories of land :

i) land reserved for potential specific government use,

ii) land which requires long-term soil and water conservation measures,

iii) land reserved for future population needs,

iv) land used as buffer against possible intrusion into restricted or reserved areas, and

v) land for commercial, industrial and residential uses.

Land rights come in the form of land use permits, except in the last category, which may be leased. Government revenues can be enormous. The proposed change in land settlement with regards to the provision of land rights and land titling is illustrated in Figure 6.2. Forests and government-used land, including state and private forest plantations, account for no more than 124 million rai. Agricultural and non-agricultural land extends to at least 78 million rai, most of which can be opened for private use. Later, transfer of land ownership should take place. Part of the land will be held back for government purposes, as indicated earlier.

A work plan may now be proposed. First, it must be noted that the major agencies involvedare the Department of Lands, the Agricultural Land Reform Office, the Royal Forestry Department, the Department of Cooperatives Promotion, and the Department of Public Welfare, all of which are concerned with land distribution and land allocation. However, the RFD will be restructured and reorganized to take responsibilities in forest management, away from the land allocation activities. The work plan spreads over a period of 25 years, as shown in Figure 6.3. Some important details and schedulings are also given. The DCP and DPW may be reorganized into a new, single entity after all existing land settlement schemes and land cooperatives are transferred to the normal administrative machinery. The topic of restructuring the existing land administrative system is discussed in Chapter 9.

At the end of 25 years, land ownership will have been transferred to the farmers, except in cases where the land is reserved for common and government uses.

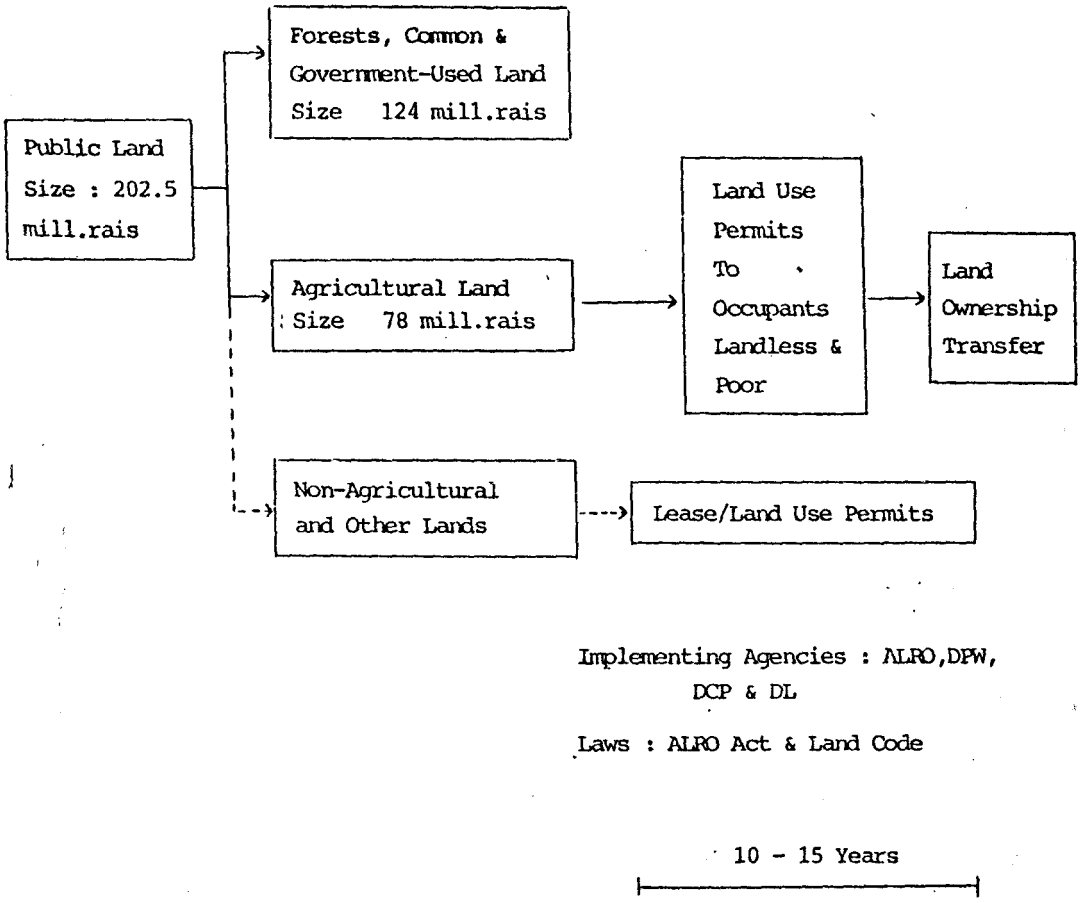


Figure 6.2 Proposed change in Land Rights Provision and Land Titling

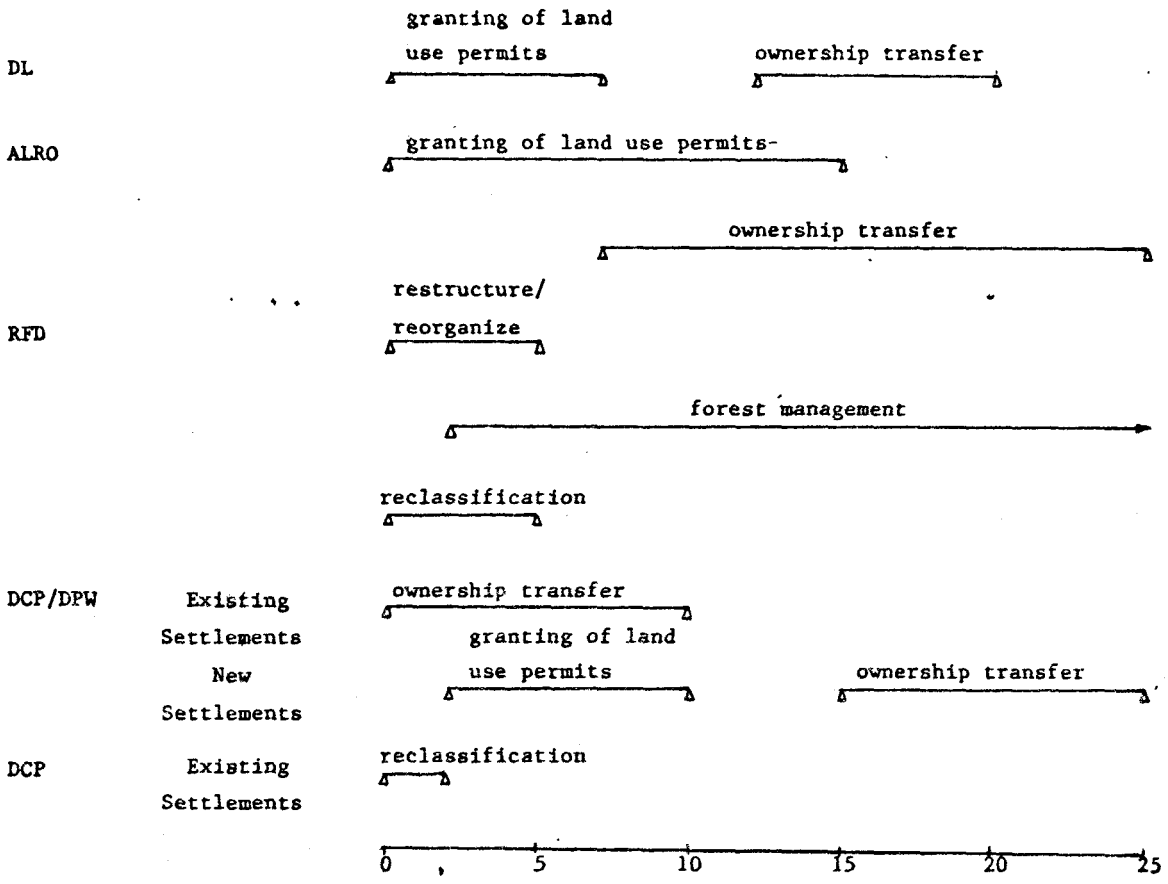


Figure 6.3 Work Plan on Land Rights and Land Titling

7 Land Reform and Land Allocation Policy

7.1 INTRODUCTION

Since, land tenure is so important to economic and social development, the land tenure system has significant impact on farm productivity and income distribution. From the theoretical point of view, the owner-operator system of land tenure would bring about an efficient allocation of resources and an optimum distribution of income. On the other hand, the landlord-tenant system usually results in lower-than-optimum resource allocation and income. Therefore, it is sometimes not simply desirable but in fact, necessary to change the landlord-tenant system to an owner-operator one. Land reform can be introduced for this change. At the same time, for the landless and for those who lack land ownership security (having no legal land documents), appropriately documented land should be provided through a land allocation program. This will facilitate the process of development.

Chapter 2 mentions the problem of the land tenure in Thailand. The tenancy problem is acute in certain areas. Farm size is also a problem. Future Trends for the future do not appear to be encouraging and may even be worse. This problem has been of interests to the government for a long time, and various land allocation programs have been carried out since in 1940's. However, the success of these programs has been rather limited. Considering the fact that there are about 2.5 million families which have land tenure problems (including about 1 million tenants and 0.5 million landless), this issue and the policy addressed to it should be carefully analyzed and articulated. Over 40 million rai of forest reserve areas have been occupied, many of them for decades. It is likely that land allocation for these people will have to be carried out, making the policy on this matter even more important in the future. The magnitude of the task is enormous compared to the existing capability of responsible agencies.

7.2 POLICY ON LAND REFORM AND LAND ALLOCATION

Even though land allocation programs have been underway for many years, the policy on land reform and land allocation only became clear in the Fourth Plan. This plan emphasized the need to solve the tenancy problem and supports land reform, particularly in agricultural land allocation programs. The policy in the Fourth Plan also call for the unified land allocation concepts and measures which should be practiced by the land reform program.

The Fifth Plan clarified national policy regarding land reform projects, ceilings on land holding, establishment of land banks, and land settlements. The Sixth Plan also emphasizes land reform, particularly in private land. Establishment of a land bank is again included in the Plan. The land tax system is to be improved. Finally, land settlement is to carried out in the land already alloted but is not to expand

into other areas.

From the above general policy, it is quite clear that the government has considered land allocation as an important policy measure for land reform. Other types of programs will have to limit their activities within their existing land areas. The Sixth Plan also states that the future concept of land allocation will be unified in accordance with the policy on land reform. As one can easily interpret, this means that the overall land allocation program must be reorganized or restructured to achieve greater efficiency in implementation.

7.3 GENERAL SITUATION OF LAND ALLOCATION IN THAILAND

Types of Land Allocation

In addressing the problem of land tenure, past governments have adopted various land allocation measures. At present, no fewer than 14 agencies are carrying out land settlement and land allocation projects.

Presently, land allocation may be divided by objective into four major categories:

a) Land allocation for the purpose of solving problems of land land rights and land ownership. Projects in this category include those under the Agricultural Land Reform Office (ALRO) and the Department of Lands.

b) Land allocation for social welfare purposes. These include self-help land settlements of the Public Welfare Department, of the Department of Cooperative Promotions, cooperative land settlements, and villages and agricultural settlements for war veterans.

c) Land allocation for development and conservation. They include: land consolidation and forestry village projects.

d) Land allocation for special objectives. These include the projects of various agencies whose primary responsibilities usually lie outside the area of for land allocation. They include, for example, land settlements for evacuees from areas flooded by the construction of dams, and model village projects.

General Problems of Land Allocation

Problems confronted in the process of land allocation may be summarized as follows :

a) Land allocation projects have been delayed and hampered by budgetary constraints, shortage of necessary personnel, and lack of cooperation from the affected people. This has resulted in a very limited success of the overall land allocation program. As indicated in Table 7.1, land allocation by the major responsible agencies (i.e., ALRO, Department of Public Welfare (DPW), Department of Cooperative Promotion (DCP)) has taken place in less than 40% of the project area (i.e. the area already allotted to these agencies). In the case of ALRO, it was only 29% of the total project area, and only about 37% for DPW and DCP. The three major agencies were able to allocate a total of only about 6 million rai to the farmers. Considering that the DPW and DCP began their programs over 40 years ago and ALRO about 11 years ago, their performance appears rather unsatisfactory.

b) Land allocation projects vary in form and substance. The STK project of the Royal Forestry Department gives the STK document which is a temporary utilization permit. It does not provide any services to farmers. The ALRO project on land reform gives an S.P.K. 4-01 land document to the farmers as well as infrastructural and

Table 7.1 Land Allocation by Major Government Agencies, 1985

Name of Agency	Project Area (Million Rai)	Allocated Area (Million Rai)	%
1. Department of Public Welfare	6.966	2.596	37.3
2. Department of Lands	12.90	10.40	80.6
3. Department of Cooperative Promotions	5.460	2.030	37.2
4. Department of Royal Forestry	0.185	0.055	29.7
5. The War Veterans Organization of Thailand	0.06	0.03	50.0
6. Agricultural Land Reform Office	6.20	1.812	29.2
7. Department of Land Department	0.201	0.179	89.0

1/ Excluding S.T.K. project

Source : Subcommitee on Land (1983), AIT (1983), ALRO (1985).

developmental services. The other two major agencies, the DPW and DCP provide similar services. The cost of these projects differ depending on the extent of the services provided.

c) Land allocation projects invariably run longer than scheduled, thereby requiring an unforeseen extension of government commitment and support. This has made it difficult for these agencies to expand their activities into other areas, and is one of the important issues which should be considered.

7.4 LAND REFORM

Meaning and Objective

Land reform in Thailand started in 1975. The Agricultural Land Reform Act specifies the meaning of land reform as the improvement in agricultural land tenure and land right and the distribution of land for farming and residence. Land is to be made available by the government or expropriation from private owners who hold land in excess of the legally prescribed amount or who are not themselves making proper use of the land. The government is to make such land available to qualified farmers or farmer organizations by way of hire-purchase, rent, or right to utilize. In addition, the state renders various forms of assistance to farmers for the improvement of their livelihood, resources, and means of production, and to improve their ability to produce, distribute and market their products.

The Agricultural Land Reform Office is responsible for the implementation of the land reform program which entails two major activities :

a) Improvement of land tenure and land right in state (public) and private land.

b) Development of agriculture in the land reform area.

The first activity involves land distribution to the landless, to small farmers, and to tenants. The second activity concerns the development of rural infrastructure, and the provision of production and marketing services.

The main objective of the land reform program is to improve the economic and social welfare of the rural population. This may be possible if farmers are provided with land and if production efficiency can be improved by providing adequate infrastructure and other services. Income distribution among farmers may also be more equal when the distribution of land and services becomes more equitable.

Implementation

There are 4 steps in implementing land reform projects for both public and private land. They are as follow :

State-owned Land	Private-owned Land
1. Preparatory work (Land acquisition, feasibility study, survey, etc.)	1. Preparatory work (Area Selection, land appraisal, etc.)
2. Settlement of farmers into the allotted land. (Plot division, selection of farmers, etc.)	2. Payment for land or expropriation of land. (Land purchase, land expropriation, payment)
3. Development of basic infrastructure. (water, road, etc.)	3. Settlement of farmers into the allotted land. (selection of farmers, plot division, etc.)
4. Coordination for development. (credit, land development, marketing)	4. Coordination for development. (credit, marketing, water, etc.)

For state or public lands, there are two types of projects. The first is funded totally from the national budget, the second totally or in part by loans or foreign assistance. There are at present only three projects in the second category.

a) Land reform of state-owned land which relies on the national budget is conducted in designated areas according to the aforementioned procedures. Work in these areas, however, is not restricted to area specific projects.

b) Land reform projects in the second category consist of :

i) A World Bank funded land reform project covering 1.2 million rai in 9 areas involving 35,000 families. The project cost total is US$ 31 million over the period from 1984 to 1988.

ii) The project for the Development of Agricultural Irrigation, Chao Phraya Water Basin, is financed by a loan from OECF. The project covers an area of 78,000 rai in the District of Lard Bua Luang. The budget for the project is Baht 396.3 million plus a loan of Baht 24.5 million. The duration of the project is from 1983 to 1987.

iii) The Land Reform Project at Pichit Province is a joint project between the Thai and Australian governments. The project covers 250,000 rais and involves 42,000 families. It is funded by a government budget allocation of Baht 106.96 million and monetary assistance of Baht 106.9 million.

This type of land reform operates in specific areas with defined stages in project planning, administration, coordination and evaluation.

Progress on Land Reform

From its inception in the year 1975, the Agricultural Land Reform Office has completed the following tasks (Table 7.2):

a) It has designated areas in 109 districts and district subdivisions in 34 provinces in the Central, North and Northeast regions as agricultural land reform areas. It has completed the mapping of 3,174,047 rai of land and completed the cadastral survey of 3,267,364 rai of state-owned land. In addition, it has completed the cadastral survey of 119,956 rai of privately owned land.

b) It has Investigated the size and nature of state land holdings. It has negotiated with residents to either increase or decrease their land holdings to maintain equitable distribution. A total of 39,401 selected farmers were allocated 740,339 rai of land.

c) Sor Por Kor 4-01 (ALRO) land utilization documents were given to 28,160 persons covering 537,309 rai of land. Permission was also granted to 53,405 households to utilize 1,283,212 rai of land. The Office has also purchased 280,277 rai of land from private owners and allotted 218,229 rai to 11,595 individuals. In addition, 84,667 rai were rented out on a permanent basis to 4,861 parties and 23,153 rai were sold by hire-purchase to 406 persons.

d) It has constructed roads and supplied, water resources for agriculture, drinking, and other uses. The Office has developed agricultural plots engaged in soil and water conservation, organized and trained cooperatives, supplied fertilizers, and engaged in reforestation and upkeep and maintenance of community forests.

e) Efforts at land reform involving private land has been minimal due to budgetary constraints. However, from 1979 to 1985, the land reform fund has received Baht 1,230.6 million from the national budget. In addition, it received Baht 100 million from the Farmers' Welfare Fund, Baht 67.9 million from interest payments, and Baht 64.8 million from other sources. Expenditures have been mostly on development activities amounting to Baht 670.3 million. Other expenditures are

Table 7.2 Summary Results of Land Reform Program, 1975 - 1985 (1)

Activity	Unit	Results		Total
		1975-1984	Oct.84-Sep.85	1975-Sep.85
1. Preparation				
1.1 Proclamation of Land Reform Area	District (2)	104	5	109
	Province (2)	34	0	34
1.2 Making of Maps	Rai	2,888,791	185,250	3,174,047
1.3 Survey of Public Lands	Rai	3,224,863	42,501	3,267,364
1.4 Survey of Private Lands	RAI	102,809	17,057	119,856
2. Land Allocation				
2.1 Purchase and Expropriation (In cash only)	Rai	263,086	17,191	280,277
	Baht	366,307,954	37,668,907	403,976,861
2.2 Negotiation on Land Distribution in Public Lands	Case	30,556	8,845	39,401
	Baht	573,877	166,462	740,339
2.3 Survey for Land Distribution	Rai	1,601,416	303,733	1,905,149
2.4 Land Distribution				
- Private Land - Permanent leasing	Family	4,313	548	4,861
	Rai	75,205	9,463	84,668
- Hired purchase	Family	551	855	1,406
	Rai	8,316	14,837	23,153
- Other purposes	Family	10,270	1,325	11,595
	Rai	190,610	27,619	218,229
- Public Land - Issuance of ALRO 401	Family	22,437	5,723	28,160
	Rai	425,497	111,811	537,308
- For Other Purpose	Family	43,686	9,719	53,405
	Rai	1,112,505	170,707	1,283,212
3. Development and Promotion				
3.1 Road Construction	Kms	893.405	170.888	1,064.183
3.2 Reserviors	Number	14	1	15
3.3 Weirs	Number	8	1	9
3.4 Ground Water	Number	9	20	29
3.5 Deep Wells	Number	55	10	65
3.6 Shallow Wells	Number	492	95	587
3.7 Irrigation Canals	Kms	82.524	30.793	113.317
3.8 Farm Plot Department	Rai	34,587	0	34,587
3.9 Tree Planting	Rai	21,927	0	21,927
3.10 Soil and Water Conservation	Rai	10,400	600	11,000
3.11 Land Clearing and Levelling	Rai	34,214	6,606	40,820
3.12 Setting Up of Cooperative	unit	88	1	89
3.13 Training of Farmers	Time	406	114	520
3.14 Sale of Fertilizer	Metric Tons	5,818.62	0	5,818.62

Note : (1) Up to September 1985
(2) Including pre Districts which has been separated from the already proclained districts
Source : Agricultural Land Reform Office

Baht 429.6 million on land purchases and expropriation and Baht 78.8 million as loans to farmers.

Accelerating Land Reform

Past progress of the land reform program has been rather limited and slow. According to this projects initial estimation, based on existing budgetary, organizational, and personnel capabilities, the completion of land reform on state-owned land would require another 16 years, and land reform on private land would take another 45 years.

As already mentioned, government policy has called for the acceleration of land reform since the Fourth Plan. It is re-emphasized in the Sixth Plan. Therefore, great effort is needed to accelerate land reform in both state and privately owned lands. The preliminary estimation for this project indicates that the total budget for such an effort would be no less than Baht 10,000 million with targeted completion in 15 years.

Land Bank

The issue of land reform financing has also been of interest to the government for some time. Policy on this matter has been stated explicitly since the Fourth National Plan. However, nothing has yet materialized.

Because accelerated land reform requires a large investment, a land bank whose primary function is to generate funds for land reform should be established. In fact, such a proposal has been recommended by a working group for the Subcommittee on Land. A similar recommendation was put forth by a research team from the Faculty of Economics, Chulalongkorn University. However, both recommendations defined the scope of activities of the land bank quite broadly to encompass more than the primary function of funding land reform. The working group proposed that the land bank be set up in the form of a fund; the Faculty of Economics recommended the form of an independent organization. However, a land bank requires a large capitalization, and the current financial status of the government may not warrant such a venture.

It is therefore proposed that, for the immediate future, existing agencies should be improved in order to speed up land reform in areas already designated for such efforts. Even so, additional budget allocations to the Sor Por Kor fund are necessary for further land purchases. Also important is the review and revision of those aspects of the Act which hamper effective implementation and operation of land reform. The formation of a land bank may be realized later, though planning for its establishment could begin now.

7.5 LAND SETTLEMENTS

Self-Help Land Settlements

Self-help land settlements first came into being in 1940 with the purpose of settling the poor, the underemployed and the unemployed in unoccupied and idle lands. The objective was to give the poor legal ownership of land so that they could subsist as farmers. This was intended to improve their livelihood and their contribution to the nation.

There are at present five types of self-help settlements differentiated by functional specifications:

a) General self-help land settlements to assist the poor and landless.

b) Self-help land settlements to assist people to achieve certain political or economic objectives.

c) Special self-help land settlements for economic development purposes and to

solve administrative problems.

d) Self-help land settlements to assist people along the border and sensitive areas.

e) Self-help land settlements for evacuees from flooded areas.

General procedures for the formulation of self-help land settlements are as follows:

a) Preparatory stage for planning, making budget proposals, etc.

b) Cadastral survey, land preparation and mapping.

c) Selection of prospective members and settlement of members.

d) Development of basic infrastructures such as the construction and repair of roads and bridges.

e) Issuance of land ownership documents.

In addition, activities related to these projects may be categorized as follows:

a) Social development related activities dealing with education and the development of health care and public health services in the settlements.

b) Political activities which enlist and encourage full participation by members in the development of their community. Emphasis is also given to the development of viable local institutions to serve farmers in a meaningful way.

c) Activities related to the betterment of livelihood such as the development of production and marketing systems, loan services, and supplementary occupation for the farmers.

At present, there are 46 of these various types of self-help settlements throughout the Kingdom. Most invariably include the original inhabitants, those who had encroached on the land, and those who lived on the land before the settlement act. All were lawfully incorporated into the settlement as members. These 47 settlements involve 109,713 families totalling 709,805 individuals on 7,103,725 rai of land, not all of which are fertile or usable. Of the 2,244,184 rai already divided and distributed to members, 2,068,341 rai have been utilized. As for the issuance of land ownership documents in these settlements, 17,397 Nor Khor 1 certificates indicating utilization of land, 2,155 Nor Sor 3 certificates of land utilization, and a total of 3,635 title deeds have been issued (Table 7.3).

The Department of Public Welfare is responsible for self-help land settlements. The department receives an average budget of Baht 250 to 350 million per year for this task, a budget inadequate to the task of effectively supporting these settlements.

In addition to budget constraints, self-help land settlements are plagued with various types of problems common to such projects, a matter which will be discussed later.

Cooperative settlements

Land settlement in the form of cooperative settlements began as early as 1938, some 48 years ago. The main objectives of this scheme were threefold:

a) to provide members with land on which to make a living;

b) to provide financing to members for the improvement and expansion of their occupations;

c) to collect members' produce for conversion and distribution at better prices.

Table 7.3 Progress of Self-Help Land Settlement, 1983

Region/number	Land (Rai)				Membership					Remarks
	Total Land	Allocable	Allocated	Already Utilized	Family	Person	N.K.1	N.K.3	N.S.3/Title Deed	
North (6)	736,498	462,739	202,935	198,087	13,803	77,802	7,689	5,121	156	
Central and East (9)	2,200,975	976,077	971,042	947,909	34,557	268,081	799	14,844	2,155*/1,493	*N.S.3K
Northeast (18)	2,177,857	774,471	624,840	495,459	36,671	235,696	6,986	9,464	1,345	
South (14)	1,988,395	759,686	445,367	426,896	21,682	128,226	1,923	2,001	641	
Total (47)	7,103,725	2,972,973	2,244,184	2,068,341	109,713	709,805	17,397	31,430	2,155*/3,635	

Source : Department of Public Welfare

Major activities of cooperative settlements can be divided into three categories:

a) Procuring land for the settlement of farmers.

b) Planning for land utilization and development.

c) Formation of cooperative settlements by way of procurement, hire-purchase, or rental

The agency responsible for cooperative settlement is the Cooperatives Promotion Department. In 1986 the 48 cooperative settlements in the kingdom covering an area of 3,196,833 rai, out of which 2,156,833 rai or 67.5 per cent has been settled. The amount of land left to be settled totals 1,040,000 rai or 32.5 per cent. According to the department's statistics seventy thousand households are presently members of the cooperative settlements. Accelerated efforts to complete the settlement projects should take another five years.

Generally, cooperative settlements came into existence from state-owned land such as forest reserves. When these areas become infertile through deforestation, they were degazetted and declared non-forest areas. The National Committee for Land Allocation granted the above-mentioned land for utilization to cooperative settlements for the poor and landless. Although the granting of right to utilize land is a major concern, the members are also required to join the cooperative of the settlement. The cooperatives are multi-purpose, providing marketing, finance, and agricultural production services to the members. In addition, basic physical infrastructures are also provided.

In the 1986 fiscal year, the Division of Cooperative Settlements, Department of Cooperatives received a budget of Baht 2091 million, a Baht 10 million increase from the previous year. Nevertheless, settlement work proceed more slowly than can be considered acceptable. Cadastral survey and division of land has not proceeded as planned. New construction proceeds slowly, partly because efforts are inadequate and often diverted to repairing existing facilities. In addition, there is a shortage of personnel needed to effectively carry out the division's work.

An analysis of the division's work performance reveals that from 1980 to 1986, an average of two new cooperative settlements emerged per year. Land allocation and land settlements run far behind. Because the older cooperative settlements are not ready to be phased out, the division's personnel and machinery cannot be made available in full force for use in newer settlements. Hence, the work at newer settlements cannot be speeded up.

If the number of new cooperative settlements is expected to increase, given the division's current capacity to process and handle projects, work performance is likely to be poor. Under such conditions, expansion into new land areas should be delayed in favour of an accelerated effort to complete the existing settlements. In the meantime, land classification can proceed and be completed so that future settlements can be implemented in concurrence with the outcome of land classification.

Other Types of Land Settlements

This section will briefly discuss 5 other types of land settlement, namely :

a) Forest communities under the direction of the Royal Forestry Department.
b) Forest communities under the Forest Industry Organization.
c) Land settlements by the Department of Lands.
d) Land settlements by the War Veterans Organization.
e) Land settlements by the Land Development Department.

The objectives of land settlement by the above organizations have changed somewhat from the traditional objectives of providing social welfare to the landless, the poor, and the needy. They now incorporate :

a) land settlement as way of mobilizing human resources for the preservation of forests;

b) land settlement as a way of to providing legal ownership of land;

c) land settlement to assist specific target groups;

The procedures, rules, regulations, and objectives for handling settlement projects vary from agency to agency. The result is that there are no standardized practices or common objectives. This individualistic and uncoordinated approach has led to overall inefficiency and ineffectiveness.

Problems of Land Settlements

Problems which land settlement projects face are multifarious. However, the key problems encountered by most agencies may be categorized into three groups: problems arising from the government sector, problems arising from the public, and problems arising from the larger environment.

a) Problems arising from the government sector

i) Slow or inflexible coordination or absence altogether of effective coordination among different agencies involved in land settlement. Lack of cooperation from other organizations.

ii) Administration and management of land settlements needs to be improved. The lack of commitment and attention to the project by some officials has resulted in the failure to understand the people's problems and needs. The administrative agency then fails to come up with relevant solutions.

iii) The top-down approach to management has led to overlooking the needs of the people and their perspectives on obstacles and problems. This results in delays and hindrances to project implementation.

iv) Priorities in budget allocation have been problematic and need to be revised. For example, the allocation of funds for cadastral survey and issuance of land ownership documents have been miniscule when compared to budget allocations for infrastructural development, even though the former are critical tasks in land settlement work.

v) Budgetary and organizational constraints have limited and delayed work progress, leading to unintended consequences. For instance, since qualified members are being settled so slowly, the land is open to encroachment by squatters and trespassers.

b) Problems arising from the people

i) Members of land settlement projects lack commitment to the project and its related activities. They are self-serving and are concerned primarily with their own immediate interests.

ii) Members lack knowledge and experience in agriculture and have not been successful in their agricultural acitivities.

iii) Members have debt problems which preclude them from receiving land ownership documents. Many harbour the mistaken perception that government loans need not be repaid and many put their loan proceeds into activities from which they cannot recover their investments.

c) Problems arising from the physical, economic and social larger

environment.

i) Soil infertility causes lower than expected productivity.

ii) Water shortage is a problem in many areas where rain water is the only source of water for agriculture. The creation of water resources has not been adequate.

iii) The absence of a stable and fair market for agricultural products has hindered the ability of the members to earn a reasonable income and pay back their debts.

iv) The tension and conflict between members of the settlement and illegal settlers has hindered the operation of the projects.

7.6 THE SOR TOR KOR PROJECT 1/

This is a project of the Royal Forestry Department on reserved forest land that has been encroached. It started in 1982 and received financial assistance from the World Bank (SAL) in 1983. The major objectives are:

a) to grant legal right to land utilization to citizens who have encroached on the land and are living off reserved forest land illegally;

b) to survey and get a clearer picture of the extent of deforestation by encroachers and the extent to which reforestation must follow.

The result thus far is the completion of a survey of 579 forests, of which 195 were surveyed with government funds and 384 with the World Bank loan. Certificates of utilization of land, Sor Tor Kor 1, have been issued to 660,379 families covering 6,750,834 rai out of approximatly 1,240 forest reserves and about a million families who had encroached forest reserves prior to January 1, 1982.

The major undertaking of the project involves aerial survey and mapping, public relations work, and survey for issuance of certificates of land utilization (Sor Tor Kor 1) which are valid for 5 years. The certificate entitles the holder to a temporary right to utilize the land. This land cannot be bought or sold. At the conclusion of the fifth year, the holder is entitled to receive a new certificate, Sor Tor Kor 2, as an extension of right to land utilization, subject to full compliance with the rules and regulations set by the Forestry Department. To date, no Sor Tor Kor certificate has been issued. A Sor Tor Kor 1 certificate holder is allowed no more than 15 rai of land, unless special permission has been granted in accordance with stipulted regulations and laws.

The Center for Forestry Research, Faculty of Forestry, Kasetsart University has studied the impact of Sor Tor Kor projects. The Office of Agricultural Economics has surveyed the socioeconomic status of farmers in the forest reserve areas. Both studies reported that most occupants of forest reserves are poor. Twenty-three percent of these farmers have an average of 5.5 rai of land per family outside the forest reserve. (Figures from the Office of Agricultural Economics) Half of these farmers had trespassed and encroached on the forest reserve within the past 10

1/ This is a rather unique and special land allocation project. In fact, it cannot really be considered a land allocation program. It has been set up to legalize the occupation of forest reserves by squatters. They occupy the land that they have used and lived on for years. Under the project, they are entitled to obtain 15 rai of the occupied land. The rest of their land, they must lease from the Royal Forestry Department. As mentioned elsewhere, the policy on this, particularly on land ownership rights, is still unclear.

years; 47 percent claimed ownership through purchase of land denuded by illegal log poaching, and 33 percent staked their claim on the land by themselves.

It is difficult to assess how effective the Sor Tor Kor project has been in deterring further encroachment on forest reserves. The reasons cited for encroachment include population increase, need for wood as fuel, and dissatisfaction with soil conditions of land previously occupied. Judging from these reasons, it is unlikely that the issuance of Sor Tor Kor certificates would be enough to deter further encroachment. While the rate of encroachment may be declining in certain areas, this may be become less land is available rather than because of the Sor Tor Kor project.

It may thus be concluded that the issuance of Sor Tor Kor certificates is not the primary deterrence to encroachment on forest reserves. On the operational side, the issuance of certificates has not been a problem, partly because of the availability of funds for support. However, there is a shortage of staff at the central office for coordination and evaluation work (there are at present ten positions for the central office), and the project has had to borrow personnel from other divisions to assist in its work. The same situation exists in the regional offices. Temporary workers are also hired. In the future, if financial and personnel assistance are not available at current levels, project implementation may run into difficulties.

Attempts should be made in the future to improve the screening of applicants to prevent possible abuse by those who do not qualify. Furthermore, development activities should be promoted concurrently with the right to use the land.

7.7 LAND REFORM AND LAND ALLOCATION POLICY

Proposed Policy

a) Land Reform

i) Short-term

(1) Speed up and complete all existing land reform projects.

(2) Accelerate the purchase and expropriation of private land for land reform purposes, in concert with current budgetary capabilities.

ii) Long-term

(1) Proceed with land reform on state-owned land and target completion within 15 years.

(2) Proceed with land reform on private land and target completion within 10 years.

b) Land Allocation

i) Short-term

(1) Speed up allocation of land and the issuance of ownership documents, particularly in self-help and cooperative settlements. Target completion to coincide with the conclusion of the Sixth National Economic and Social Development Plan.

(2) The primary principles for the allocation of state-owened land, including the Sor Tor Kor projects, must be based on the results of land classification.

ii) Long-term

(1) Proceed with the issuance of land ownership documents to those who have been allocated state-

owned land or who have been given land utilization rights, on the condition that these people adhere to the rules and regulations applying to ownership. for said purpose.

(2) Coordinate land allocation activities into a unitary system with power and authority to monitor and control the allocation and settlement of land by all organizations concerned.

(3) Development activities are to be conducted concurrently with land allocation in every instance.

Operational Strategies for Successful Implementation

a) Land Reform

i) Short-term

(1) Increase the budget to the Fund for Agricultural Land Reform to enable it to purchase and expropriate more private land.

(2) Limit the use of the Fund for the purchase and expropriation of land and for loans to farmers to pay for land compensation only. The Fund should not be used for other projects or for development activities.

(3) Revise provisions of the Royal Act on Land Reform for Agriculture, particularly with reference to the Fund and the purchasing or expropriation of land, in order to facilitate and speed up project implementation.

ii) Long-term

(1) Set up a land bank as a source of funding for land reform.

b) Land Allocation

i) Short-term

(1) Make certain that organizations dealing with land settlement allocate the bulk of their budget to land settlement and issuance of land ownership documents.

(2) Certain activities such as cadastral survey should be contracted out to the private sector.

(3) The performance of all land settlement organizations must be closely monitored and evaluated.

(4) Slow down the Sor Tor Kor project, pending the detailed results of land classification.

ii) Long-term

(1) Readjust all types of land settlement projects to achieve uniformity, then assign projects to agencies according to locality.

(2) Establish a central agency for the coordination, control, and implementation of land settlements and land allocation.

Part III Support System for Land Policy Implementation

8 Land Information System

8.1 INTRODUCTION

For over a decade the government and some other agencies have been very interested in trying to set up a national land information system. However, due to problems of politics and readiness, such a system has not materialized. In the meantime, the need for an up-to-date, accurate land information system for land-use planning has increased. In fact, several government agencies have been collecting land data for a long time, but the data have been used inefficiently. The collection of data has been mainly for each agency's own use, and little access to the information has been given to others. Systematic data collection would be far more efficient. It would eliminate the duplication of activities among agencies and would foster more rapid and accurate data collection. There has been a recent attempt to set up a national land information system (LIS). The discussions among various agencies are more frequent now, and such a system may be more feasible. Foreign consultants have also been asked for opinions and suggestions. However, a major prerequisite for a national LIS is a clearly defined national land policy.

8.2 PRESENT LAND INFORMATION SYSTEM

Land information includes information on forestry and other natural resources. Some agencies, such as the Lands Department and the Land Development Department, are responsible for the collection of land data and have been trying to develop their own land database. Some agencies are carrying out feasibility studies and pilot projects, while others already have their own databases. Soil Information System (SIS) and Geographic Information System (GIS) are examples of the existing databases. The Lands Department is now using new technology for map production and is also trying to develop a Land Ownership System. However, these attempts are facing a number of serious problems :

a) They lack appropriate technology to update existing data.

b) There are conflicts of priority. The collection of data is done primarily for specific activities rather than for general purposes.

c) Huge volumes of complex data are more difficult to process and use within

short time periods.

d) They lack of trained personnels, budget, and equipment (including computer software) to update existing data.

There is no clear national LIS policy.

8.3 MAIN PROBLEMS OF EXISTING DEPARTMENT LIS'S 1/

Existing departmental land information systems have two main problems : data and administration.

Data

The main problems of data are as follows:

a) There are many land data and maps collected by many land related departments. Each department has its own objectives and develops its own definitions and methodology. The lack of a uniform standard makes it difficult to findspecific information. Some departments try to solve the problem by using their own maps and data. Duplication of data collection is therefore frequent, and information is scattered in various places.

b) Since the data are collected by different departments without considering the needs of other outside users, land information is given by different difinitions, methodologies, and forms. The scope of use of this information within each department is very limited, obstructing the development of a national LIS.

c) Only a small number of officials now have good computer training. This means that the use of computer technology to develop a national LIS will be severely limited in the early stages.

d) The amount of existing land data is very large. In order to put it into a computerized system, the data will have to be adjusted or modified. This requires a great deal of time and effort.

e) Land problems are delicate and complex. At present, policy makers lack information to help them predict the possible social, economic, and political consequences of their decisions.

Administration

There are two main administrative problems :

a) In the absence of a clear national land policy, there is a lack of direction in specifying the administrative structure and the nature of the national LIS.

b) The specification of the administrative structure is closely related to political issues. Land information is one of the keys to understanding the country's social, economic, and political situation. Those who control this information could conceivably use it to gain both power and position. This perception leads to the difficult issue of who will be responsible for setting up the national LIS. This is one problem which will have to be solved.

8.4 CONCEPT OF NATIONAL LIS

Past efforts to understand the problems and necessity of establishing such a system reveal important concepts regarding a national LIS. They can be summarized as follow :

a) It is economically and technically

1/ A departmental LIS is a small land information system within a department.

feasible to establish a national LIS which would facilitate the use of information to analyze problems, make decisions, and specify land policies.

b) The national LIS should contain the following types of data : size, boundaries, area, use, geographical condition, soil properties, water sources, names and addresses of land holders, value and other necessary socio-economic information.

c) The national LIS should consist of many relatively small, independent sub-systems rather than a single large unit.

d) There should be the same standard and definition for each type of data in order to facilitate the use of data.

e) A coordinating organization for the national LIS should be the central unit linking all subsystems together. This will be very important to the success of the whole project. The organization should have its own personnel and should have enough authority to supervise, coordinate and regulate the work of each subsystem.

8.5 POLICY ON THE NATIONAL LIS

The state should develop the national LIS which can be used to support the nation's socio-economic planning and development. Such development should conform with the existing administrative system. The system should be able to indicate what data is available and where it can be found. It should eliminate the duplication of data, and be simple enough for each level of users and for the other agencies which contribute data.

The proposed national LIS is discussed in the following sections.

The National LIS Structure

The land data scattered throughout the various agencies has been developed primarily to serve the particular needs of each agency. Little thought has been given to providing data for other agencies. Some coordination does exist in the form of requests for data or reports from the producing agencies, but, until now, there has been no development of a single system to serve both the national administration and individual agencies. The national LIS should be accurate, complete, up to data, accessible, relevant, and easy to use.

It should consist of land information subsystems. A subsystem can be linked with other subsystems or can be cross-referenced through land parcel numbers. A subsystem is established within an agency (a department) and can communicate with others through the computer (Figure 8.1). The subsystem approach is suitable for the existing situation in Thailand. It is feasible both in terms of operation and development and is based on the specific duties and needs of each department. Coordination among these agencies can also be achieved.

A subsystem of the LIS should include:

a) Base map

b) Public utility database, e.g. tap water, electricity, and telephone, etc.

c) Land ownership database

d) Property value database

e) Soil property and national resource database

f) Land allocation database

g) Forestry database

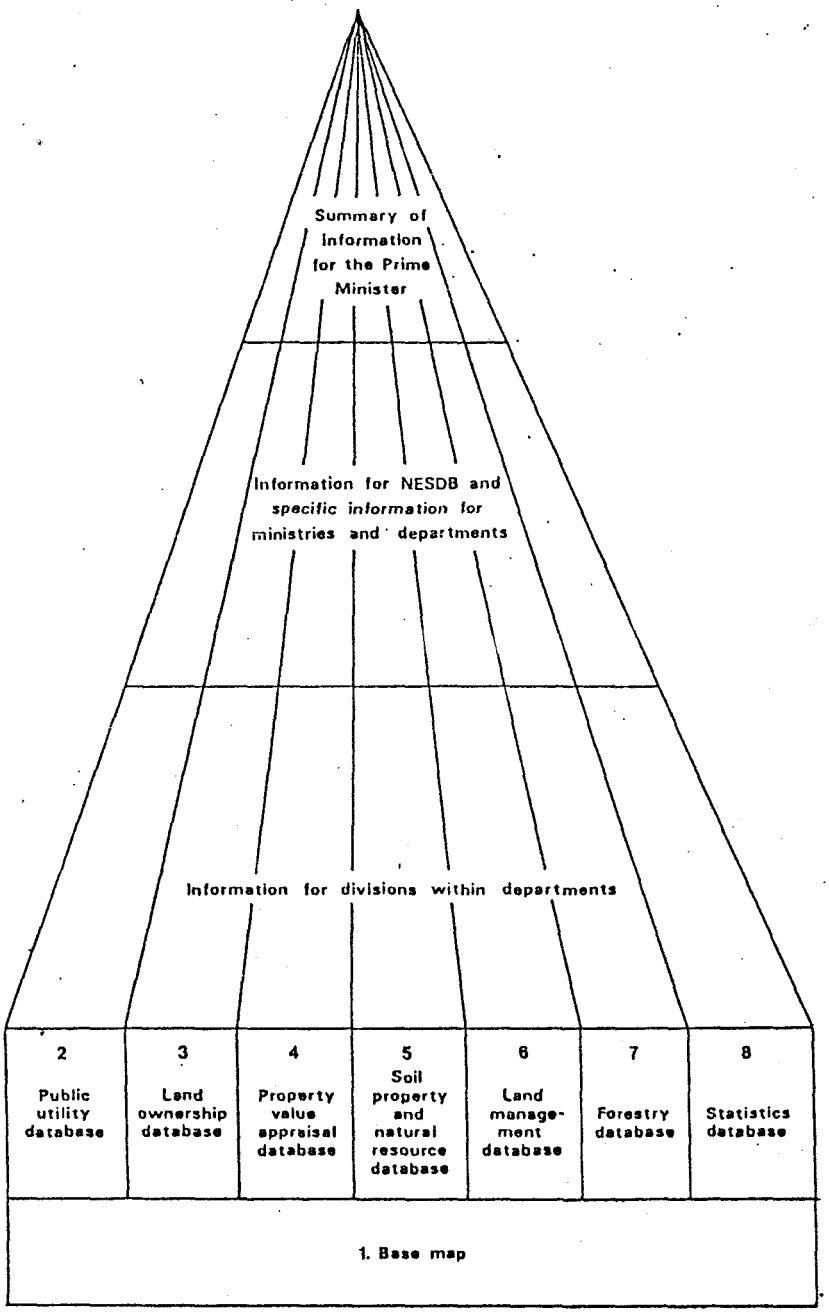


Figure 8.1 National LIS Structure

h) Statistics (socio-economic) database

There will be a summary report of each subsystem. The report should be up to date and easy to use. The summary report of each subsystem will be combined and summarized into a single report for decision makers such as Director Generals, Permanent Secretaries, Ministers, the Prime Minister, and other related committees. However, the contents of the reports for each level of decision makers and the restrictions on access to the information is left to be determined. Nor has the structure of the subsystem organization been determined. Even though national land data is divided amongseveral small groups (of data) according to its nature and agency, each small group must be connected or referable through a land parcel number. This is possible by the establishment of several databases (subsystems) scattered among related agencies which interconnect through the use of the computer (Figures 8.2)

Type of Data that are Needed to Set Up the National LIS

Any particular piece of land data can be classified into 2 main types, i.e. GRAPHIC and ALPHANUMERIC. The data which conform to the subsystems mentioned above and are needed in the construction of the national LIS are as follows :

a) Base map : Base map and aerial photographs will be made for each department (agency) according to its needs.

b) Public utility data : Indicate the number of public utilities available in any area.

c) Land ownership data : Indicate the type of land ownership of any particular piece of land.

d) Property value appriasal data : Indicate the appriasal value of any particular piece of land.

e) Soil property and natural resources data : Indicate soil properties and the availability of natural resources for land use and economic development planning.

f) Land management data : Indicate the allocation of land.

g) Forestry data : Indicate forestry conditions, forest boundaries, land use activities in forests, and the analysis of data for land allocation in forest areas.

h) Statistics data : Indicate various socio-economic statistics such as population, income, population growth, birth control, etc.

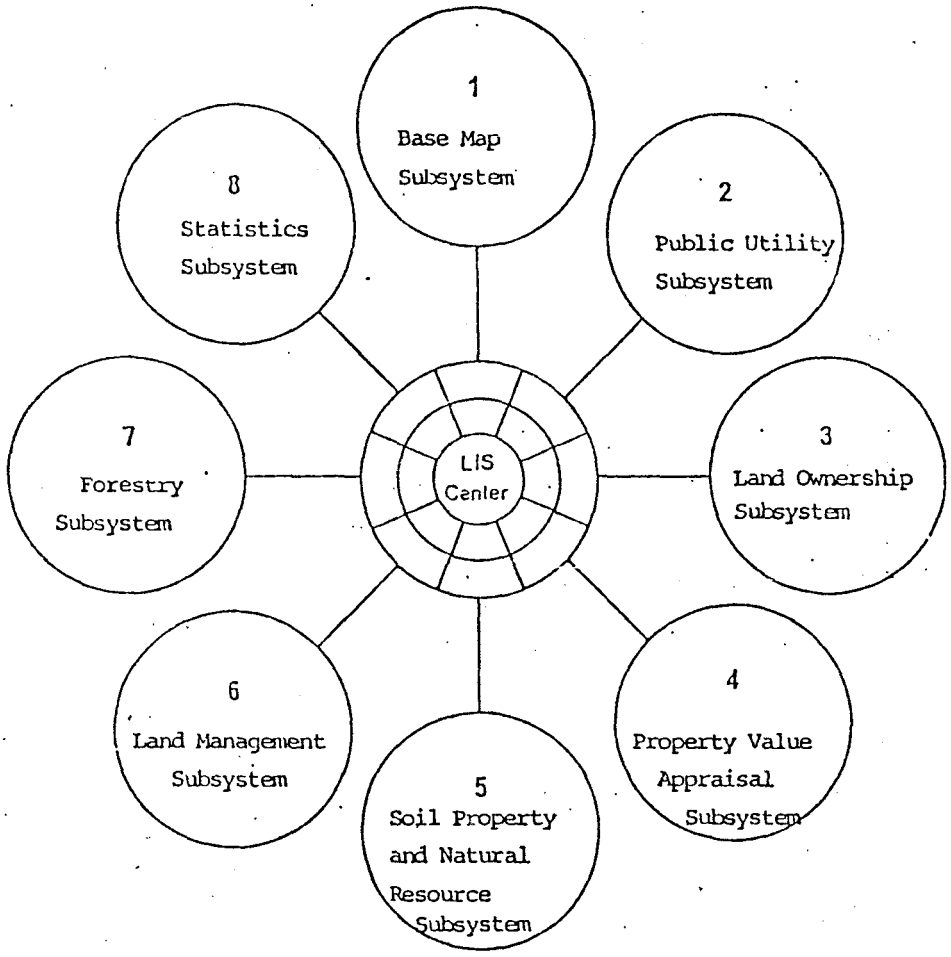


Figure 8.2 Relationships Among Land Information Subsystem

Criteria for the Use of Land Information

Land information originates in various agencies, some of which are responsible for national security. There are many levels of users - low level officials, decision makers, and those who set the nation's policies. The number of users at each level differs. Furthermore, some land information is very important for national security and cannot be revealed to the general public. Therefore, in order to facilitate the use and ensure the security of land information, the following criteria are proposed :

User level	Position	Data group 1/
5	Prime Minister	A, B, C, D, E
4	Minister	B, C, D (only ministry's data)
3	Director General	B (only with minister's approval) C, D (only with Department's data)
2	Director	C (only with Director General's approval) D (only division's data)
1	Head of Subdivision	D (only subdivision's data)

8.6 THE DEVELOPMENT OF THE NATIONAL LIS

The development of the national LIS involves the collection of data by various related agencies. In order to avoid any complication, it is necessary first to map out some clear out steps. Then the readiness of the subsystem must be considered.

1/ A = Data for national planning
B = Data for ministry planning
C = Data for department planning
D = Data for division planning
E = Base map

Development Steps

Step 1. Study land information subsystems in terms of source of data, data flow and reports.

Step 2. Consider which data are needed by decision makers. This is done by submitting sets of information to decision makers to select.

Step 3. Prepare the basic information of each subsystem to create a report for decision makers at each level. The preparation will take into account convenience and speed in finding data and using information.

The Readiness of Subsystem

At present, the development of the information system in each department or agency is at different stages. Some departments have started collecting the data they need. Some are already using computers while others are in the midst of installation or still in the planning stages. Some still have no plan or budget for this purpose at all (Table 8.1).

There are many factors to be taken into account planning to develop the national LIS. The capability of the departments responsible for the subsystems is particularly important and depends on the following :

a) Establishment of correct priorities in the development of the subsystems. Some subsystems have to be developed ahead of others. For example, the base map has to be developed before the forestry subsystem.

b) Availability of budget. The subsystem has to be one of the budgeted projects, designated for funding, either by the government or by foreign sources.

Table 8.1 Readiness in Setting Up LIS

Type of Data	Order of Priority					Budget					Personel					Technical					Total
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	
Map					✓				✓			✓					✓				13
Public Utilities				✓				✓					✓					✓			13
Land Right/Tenure					✓					✓		✓				✓					13
Land value Appraisal																					
Urban				✓				✓					✓			✓					11
Rural		✓					✓						✓			✓					9
Quality of Soil/Resources					✓					✓			✓					✓			16
Land Allocation			✓					✓					✓				✓				11
Forestry					✓			✓				✓				✓					11
Statistics	✓						✓					✓						✓			9

Note : 5 means necessary or mostly ready
4 means necessary or very ready
3 means necessary or moderately ready
2 means necessary or ready a little
1 means necessary or ready very little

c) Availability of personnel. Qualified personnel are required to oversee the subsystem.

d) Technical readiness. The department should have enough technicians and technical advisers to operate the subsystem.

The National LIS Development Plan

When the capability of the departments responsible for the subsystems has been demonstrated, a national LIS development plan can be designed, as follows :

Subsystem Development Stage

Calculation of the total points of various factors provides the indication of readiness for setting up the LIS (Table 8.2). The subsystem development can be divided into four stages, as follow :

Stage 1.

a) Base map : This map is necessary for the development of other types of data. Therefore, a base map has to be developed first.

Stage 2.

b) Soil property and natural resource data.

c) Land ownership data

d) Public utility data : At present some agencies are developing public utility data for their own use. The scope of data development should be expanded so that it can be used in planning at higher levels or at the national level.

Stage 3.

e) Property value appraisal data (urban)

f) Land management data

g) Forestry data

Stage 4.

h) Statistics data

i) Property value appraisal data (rural)

Any subsystem data in Stages 3 or 4 can be transferred to a lower stage, i.e. Stages 2 or 3, under the condition that the department is ready to develop that particular subsystem data.

The National LIS Organization

Recognizing the importance and benefits of LIS, many departments have already collected some types of subsystem data. The following are some of these important departments.

Department/Agency	Type of Data
Lands Department	Land ownership data
Forestry Department	Land statistics in forests
Property Value Appraisal Office	Home address
Bangkok Metropolitan Authority and some public utilities	Map
The Royal Thai Survey	Map
Land Development Department	Land use map, domestic information system
Department of Local Administration	Municipal and sanitary areas land tax statistics

Since many departments are involved in the collection and maintenance of subsystem data, it appears most appropriate to have a decentralized form of organization for the national LIS. Each department (organization) is responsible for the collection and the storing of certain types of data in detail. It is also necessary to have an administrative center to coordinate and manage the collection of data for national administration and for the use of data among various departments and

agencies. This multidivisional set up needs strong support from the highest administrative level of the nation, i.e. the Cabinet. The proposed national LIS organization is depicted in Figure 8.3. The recommended computer system is shown in Figure 8.4.

The LIS administrative center is responsible for detailed monitoring of the progress of the national LIS during its development. Land information needed by policy makers, technical design aspects, and specification of the form of each type of information will all require consideration. The administrative center must also make decisions on technical aspects of the computer system and on the setting up of the subsystem committees. The computer system should be able to send information to and from the administrative section and other sections.

Each subsystem committee will receive the specifications and duties for its own subsystem so that it can be linked with the national LIS. Coordination is carried out by subsystem personnels working with the administrative center.

The national LIS is divided into several subsystems. The divisions are to be consistent with the main responsibilities of the relevant departments. A subsystem can be further subdivided into small groups. This is intended to increase the efficiency of operations. For example, public utility database can be divided into electricity, telephone, and tap water groups. A small group can be further divided into sections, according to the needs of its operation. For example, the electricity group can be divided into metropolitan electricity section and rural electricity section (Figure 8.7). The small sections will work together through forms and lists of information to be sent to the national LIS. Small sections can also have their own additional lists of information.

The LIS administrative center is responsible for coordinating activities among the following :

a) LIS users at national development planning level

b) LIS users at departmental planning level

c) Subsystems

The LIS administrative center is the most important coordinator of information from the subsystems. For example, the center can combine land ownership information and forestry information. The center acts as the coordinator among decision makers who want land information combined with other information in their planning activities. Whenever decision makers have questions or want any land information, the center will analyze and try to locate the sources of information through its index or by consultation with the subsystems. Then it will prepare the information in a form that decision makers can understand and use easily.

These duties of the administrative center can be divided into 2 sections by time period. During the period of establishment, the administrative center will be responsible for the development or creation of the national LIS. After the system has been established, the center will administer the national LIS, operating it to fulfill the designated goals and targets and adjusting the system according to users' needs.

In order to achieve these objectives, however, the center must first be established with appropriate and adequate facilities.

Development Plan for the National LIS

The plan to develop the national LIS is as follows :

Stage 1. A working group consisting of representatives from the main data

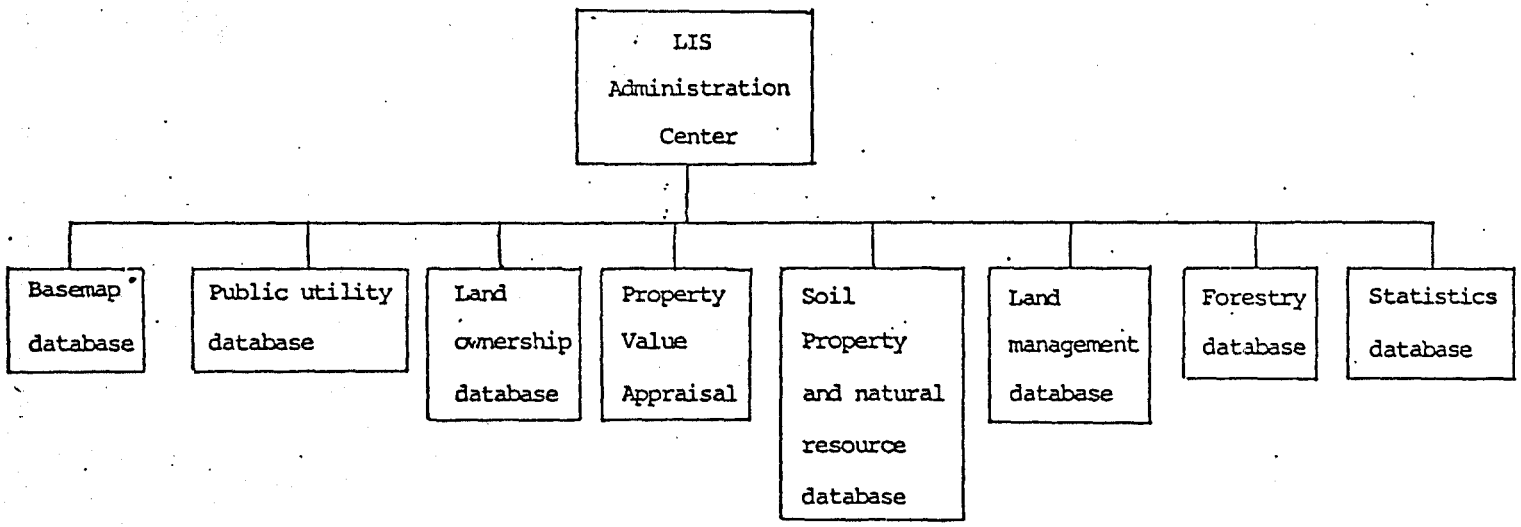


Figure 8.3 Proposed LIS Organization

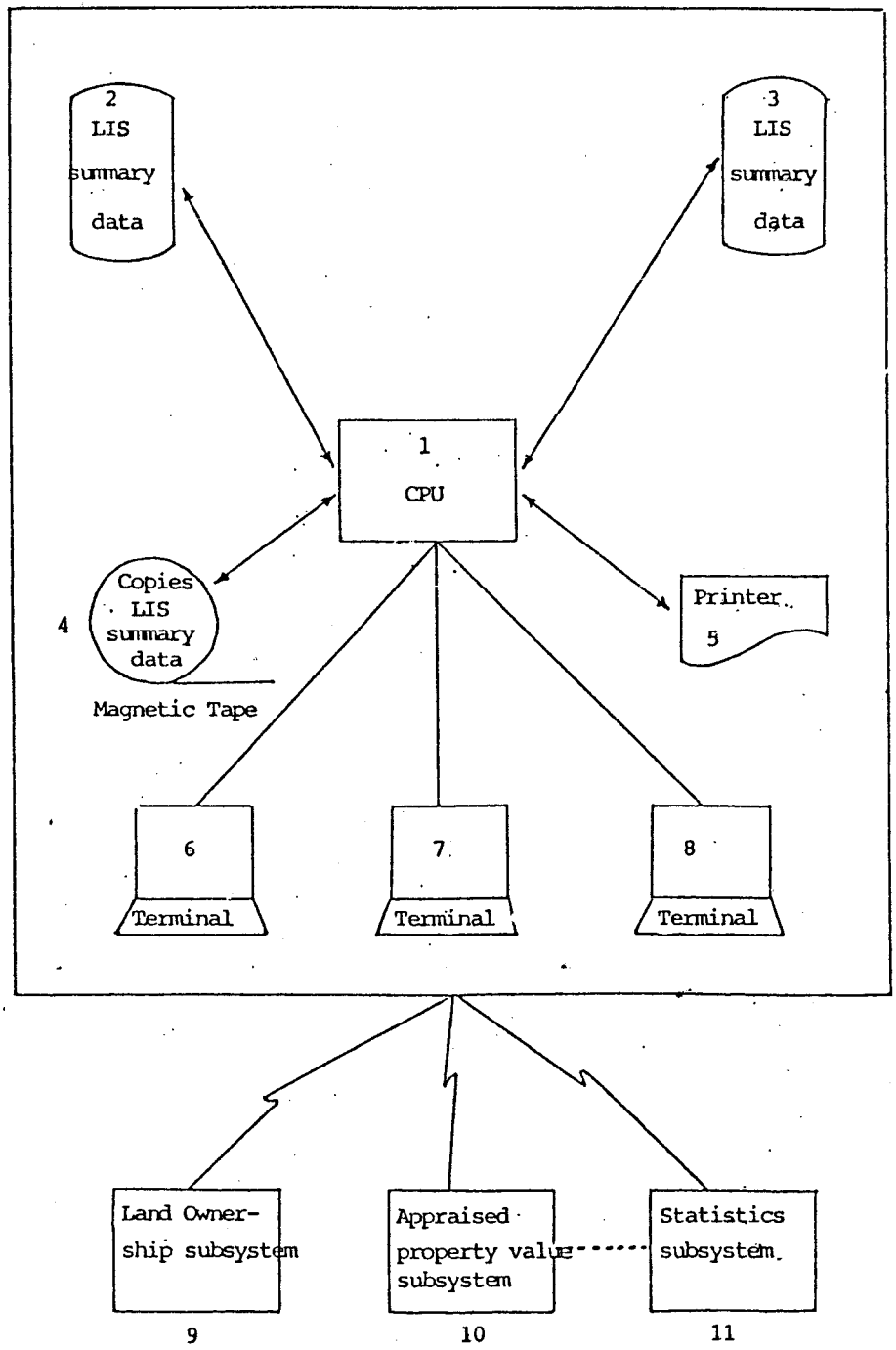


Figure 8.4 Proposed computer system within LIS Administration Center

collection departments and agencies will design methods for the collection of land data by each subsystem. This work will require between 6 and 12 months.

Stage 2. Another working group consisting of representatives from users' agencies with the consultation of land information specialists will plan for the use of land information by decision makers at various levels. Planning will take into account the amount of information which will be needed. This stage will also take from 6 to 12 months.

Stage 3. After both working groups have reported their findings and recommendations, the next stage will be to design the system. A pilot project will test the design. The form of the pilot project will depend on budget, staff, technical personnel, and the quantity of information required.

8.7 CONCLUSION

Land information is invaluable for Thailand's socio-economic planning. This information is presently scattered among various departments. LIS policy should conform to operational needs within and among the departments, and at the national level. The lack of national LIS delays planning. Plans tend to be unrealistic, cannot be implemented and obstruct the administration of the government. Since the national LIS involves many organizations and departments) its operating plan should be very clear. The system should be divided into several subsystems, according to the main duties of each department. Each subsystem will have a clear assignment to collect aportion of the data for the national LIS. In other words, each subsystem's activities and responsibilities to the national LIS should be clearly defined. In terms of administration, the national LIS needs to be a complete entity that is, there should be an LIS administrative center to collect information from subsystems and product the reports and information needed by decision makers for their planning. The center has a very important role as the link between departments which produce information and decision makers at different levels who will be the users. Therefore, the center should have a full-time, fully qualified staff. Full-time personnel should also be available to act as staff at the subsystem level. During the development stage, the type of reports and information which decision or policy makers need will be the most important factor determining the direction of the LIS development. The development of each subsystem will depend on many factors such as adequate budget, staff, and technical personnel.

9 National Land Administrative System

9.1 PRESENT LAND ADMINISTRATIVE SYSTEM

General Characteristics

In the past, land administration was performed by a number of government departments, for instance, the Royal Forestry Department who dealt with the country's forests and the Royal Irrigation Department with water resources. Only recently has the horizontal linkage approach been partially adopted where more than one department are responsible for a project, namely, in the area of town planning or coastal zone management. At present, the coexistence of these two systems represents the land administrative system in Thailand.

Land use Patterns and their Related Agencies

Land use pattern can be divided into : 1) forests, 2) water bodies, 3) minerals and energy deposits, 4) marine resources, 5) recreation, 6) agriculture, 7) industry, 8) commercial and residential areas and 9) transportation. Government agencies for these activities can be categorized into the following :

a) Government agencies with direct responsibility. These agencies are referred to those who possess power to regulate the pattern of land use in areas under their responsibilities. An outcome of these regulations could interfere with the adjacent areas in adopting the land use pattern similar to area under regulated, e.g., ALRO or the Thai Tourist Authority. These kind of agencies with direct responsibility are as many as 33 which belong to 7 ministries.

b) Agencies Responsible for Planning and Land Information. These agencies mainly involve in policy formulation affecting the land use pattern, land survey and evaluation. There are altogether 21 of these agencies from 8 ministries.

c) Land Related Agencies. These agencies act to support the work of agencies in categories 1) and 2). There are altogether 62 agencies under 9 ministries.

The above statistics indicates the fact that land use in Thailand has been administered by a large number of government agencies. The underlining difficulty with land administration is in searching for the way in which these agencies can synchronize in the fashion that maximizes the country's social benefit, and minimizes both inter-agency's conflicts and administrative cost.

9.2 PROBLEMS WITH LAND ADMINISTRATION

Conflicts in Land Utilization

Conflicts in land utilization has been widely recognized. For example, the spread of urbanization into fertile agricultural lands, deep sea mining

which deters the environment or expansion of agricultural lands into forest area. In the past, many policies have failed to minimize these conflicts, partly because of a lack of a central agency with adequate expertise to formulate land policies.

Land classification has not been seriously practiced in the past and when adopted has been unable to solve conflicts in land utilization due to a lack of cooperation between land related agencies. Such a lack of cooperation among the responsible agencies could be devoted to the disparity in interests of the land related agencies. To a degree, this problem has aggravated the existing conflicts and caused further damage to the society.

It is therefore appropriate to advocate for an establishment of a central land agency to formulate land use policies which is highly effective and well received by other agencies so that conflicts can be minimized and efficiency can be pronounced.

Lack of Clarity in the Responsibility of Agencies at the Policy Making Level

These agencies include :

a) The National Land Allocation Committee (NLAC). According to Land Act BE 2497, this committee was responsible for land classification with the Department of Lands who acted as the secretariat. In 1964, land classification was transferred to the Land Development Department and the Land Classification Committee was set up in 1972 where the responsibility of the National Land Allocation Committee was revised but the Land Classification Act was unaltered. This revision also specified the power of the NLAC in land survey and policy formulation particularly with reference to land use pattern. Despite these modifications, the Land Classification Committee still continued with its original responsibility until 1983 when extensive revision of the responsibilities took place, namely, the Land Development Department was responsible for the policy formulation regarding the land use, land classification, specification of land use areas and land development while the National Land Allocation Committee was responsible for the policy formulation regarding the land allocation, land rights planning, land conservation and land allocation to low income families. Although extensive revision has taken place, the overlaying in responsibilities between these two agencies still existed. In 1984, the Ministry of Interior proposed a draft report containing policies and measures affecting the land management, land use, and land development. The report further suggested that a Master Plan on land allocation, land use and land development be established by the National Land Allocation Committee. Such proposed was submitted to the cabinet who later requested the concerned agencies for a revision. The revised proposal contains elements which added more power to these two committees and, at the same time, suggested that these committees should work hand in hand.

Despite the effort in minimizing the difficulties related to formulation of land policy, problem of lack of clarity in the responsibility of land related agencies at the policy making level still persists and has, in turn, resulted in misunderstanding and confusion of the current land policy by the other agencies.

Other than the absence of a central land policy planning agency, there is a tendency that policies formulation by the National Land Allocation Committee and the Land Development Committee would fail to yield a socially optimal solution. While the Department of Lands consists of a large number of representatives from the Ministry of Interior, the Land Development tends to become more of agricultural oriented. In fact, the scope of land policy has to

cover a wider range of issues, namely, industrialization, town planning, energy, recreation, education, etc. To cover all these areas, an agency with a diversified expertise is demanded.

9.3 SEVERAL AGRICULTURAL LAND ALLOCATION AGENCIES

While the basic objective of agricultural land allocation is as simple as "to allocate lands to farmers for cultivation", today there are as many as 16 agencies responsible for this objective. What sets the differences in the responsibilities of these agencies is that one agency's objective serves as an input to other agencies to achieve their objective.

These sub-objectives are, namely, to maintain national security, to prevent forest encroachment, to remove families from denuded areas, etc. In fact, land allocation for cultivation follows a straight forward procedure beginning from an infrastructure planning, appropriate production planning, provision of required farm inputs and marketing. Lack of cooperation between the responsible agencies has led to an overstaff in certain areas; lack of the overall objective; differences in the size of land allocated, infrastructure and supportive services; and differences in types of land rights allocated. A movement into combining the existing resources (manpower, managerial and material) in areas of common interests would induce more efficiency and help achieve the prime objective at less cost.

9.4 CONFLICTS BETWEEN RURAL AND URBAN LAND USE

Although rural and urban land use pattern do differ distinctively, land policies for these two areas are still interdependent. One often observes that an expansion of urban areas is possible only when a portion of rural land is occupied or is simply a rural area which develops into an urban area. Thus urban and rural areas share many common characteristics, namely, residential, commercial, recreation, agricultural and industrial areas. What makes the administrative procedures differ between the two areas is simply emphasis placed on certain activities. Furthermore, economic and social relationships between rural and urban area have also been established, especially when the two areas are adjacent to one another. Therefore, it is imperative that an integrated land policy, i.e. regional planning is adopted in order to mitigate the rural-urban land use problem.

9.5 RELATIONSHIP BETWEEN TYPES OF LAND USE AND ECONOMIC AND SOCIAL DEVELOPMENT

The government's recognition of the importance of the relationship between land policy and the country's Development Plan is indicated by the establishment of the Subcommittee on Land under the National Rural Development Council. A question remains unsolved is the effectiveness of this committee in managing the country's land use. There has been a case which supported the hypothesis that the National Rural Development Committee lacks efficiency in performing their tasks. For instance, "the Policy Guidelines for Land Use and Land Rights" proposed by the Committee in 1982 advocated for a revision of the existing laws on land lease where in fact such laws have already been revised in 1981 into a Royal Decree on land lease for agricultural purposes. Furthermore, "the progress report 1984" of the Ministry of Agriculture and Cooperatives, page 1, still insisted that laws on land lease for agricultural

purposes be revised.

9.6 INFORMATION SYSTEM AND ENVIRONMENT

An essential component of any decent planning is the acquisition of an appropriate and sufficient information. With land policy planning, it was observed that land related information is well scattered in a large number of agencies, each would collect information to serve its own purposes. Information sharing system or a uniform format of information was not employed in the past. Many important land information were kept in various departments, e.g., the Department of Mineral Resources, the Department of Transportation, the National Statistical Office and the Department of Meteorology. A comprehensive land information system is therefore a prerequisite for a sound land policy planning. This issue has already been discussed in the previous chapter.

Many land related agencies have devoted much effort towards development without due regards to the environment. Land policy planning in the future needs to address the importance of environmental impact, both in the short run and long run, together with land activities.

9.7 POLICY DIRECTION FOR LAND ADMINISTRATION

It is now clear that conflicts between different land policies and duplication of work have been responsible for the delay in the work process as well as an inefficient utilization of the country's scarce resources (financial, human and natural resources). Such an inefficiency has led to a missallocation of resources, deprives the country from attaining its maximum growth, and deters the social justice and national security. Despite the past mistakes, future prospects shows a promising trend.

Government policy in this regard can be categorized into two broad frontiers:

a) The government should reassess the mandate of land related agencies in the light of minimizing the existing conflicts, promoting the harmonization between activities and clarifying the objectives. This is to ensure that land utilization coincides with the set direction as well as the national development plans.

b) The government should aim at increasing land use efficiency.

9.8 POLICY GUIDELINES AND MEASURES

Consensus Building in Land Administration

The current situation reveals the fact that each government agency responsible for land resources has been assigned with a specific task. Combining the land related agencies together would not help mitigate the existing conflicts in any way if each agency still continues to pursue its own objective. Only when consensus building is reached where all land related agencies strive towards a common objective and able to work together hand in hand that the existing problems will likely be solved. Hence, an overall plan is essential as it would reduce the required resources (manpower, central budget and materials) together with harmonizing the objectives of all agencies concerned. Three major sanctions in regulating the pattern of land use are:

a) Development. This will discourage the use of land for other purposes since the user will encounter inconveniences and will not obtain the services

provided.

b) Regulation. For example, permission for building construction in specific areas.

c) Taxation. This serves as an incentive to the land owner to follow the set land use pattern either through tax collection or exception from taxes.

Such an arrangement, although may exhibit a degree of complexity, still provides freedom to the related agencies to execute work in their own approaches. The only difficulty is how to make sure that these agencies are working along the set plan and also the national economic and social development plan.

Characteristics of the Organization Responsible for Land Use

a) Such an organization is best established in the form of committee consisting of specialists from an array of disciplines who also possess high political authority. Quality of work from such a committee should be of the highest standard and is well accepted by concerned ministries, agencies, and most importantly, the Prime Minister.

The role of the committee involves formulation of work plans and projects while will be tailored to fit the work plans of the NESDB. Work area can be divided into nine categories as already mentioned in 9.1. Such a committee should be entitled "the National Resources Committee".

b) In dealing with subjects which require a high academic skills and are dynamic in nature, the committee needs a strong secretariat who could provide the most updated information in the nine areas. However, a number of difficulties arises concerning this secretariat.

c) Staff. Well qualified staff with experience in land issues are located in various departments, i.e., the Land Development Department, the Department of Lands, Town and Country Planning Office, the Ministry of Industry and the NESDB. Much effort is required in order to extract these staff from scattered sources.

d) Information. Policy formulation and planning for land use require a large quantity of time series and updated information which is scattered in a large number of agencies. Acquisition of all these information as well as converts them into a uniform format is another task facing the secretariat. Moreover, the secretariat will have to conduct survey if any required information is not available at present stage.

e) Scope of Work. The secretariat has to deal with nine land related issues with collaboration from nine ministries and the NESDB. Having this secretariat operating under a single ministry might not be a acceptable arrangement.

With such a heavy work load of this secretary, it would be best if it is located either under the Land Development Department or the Department of Lands instead of the Ministry of Interior or Ministry of Agriculture and Cooperatives whose scope of work is already extensive. Establishing this secretariat under the Office of Prime Minister is also an appealing possibility as the Prime Minister is already the Chairman of the Natural Resources Committee. Nevertheless, this approach would mean that staff have to be drawn from other agencies and may not help reduce the friction when deals with the Royal Forestry Department, the Irrigation Department or the Department of Mineral Resources.

At this stage, a possible solution offering one of the most effective results as well as a sound administrative system is through the establishment of the newly proposed Ministry of Natural Resources where natural resources related agencies will be pulled together. Following are

justifications for the establishment of the Ministry of Natural Resources.

a) The establishment of the Ministry of Natural Resources would not create an impression that one agency is under the supervision of another but rather an atmosphere where various divisions work together side by side. Agencies which are in line for such an integration are those on water, land, forest, minerals and energy, and town planning and rural development.

b) Merging the natural resources agencies together would facilitate any required inter-agency changes in staff as they all are directed by one Minister. Tediousness in managing such a sizable team of staff can be tremendously reduced.

c) Information on all natural resources will be managed under a uniform system.

d) Efficiency in work procedure and following of commands will be achieved as all the concerned agencies are located under one Ministry.

Agencies which have been proposed to be transferred into the new ministry are

a) The Royal Forestry Department (Ministry of Agriculture and Cooperatives) who is in charge of a large land area covering agricultural lands, marine fishing zone, recreation, and forests.

b) The Irrigation Department (Ministry of Agriculture and Cooperatives) who is in charge of water resource and has a vital role in agriculture, energy, transportation, marine resource, recreation, industry and urban areas.

c) The Land Development Department (the Ministry of Agriculture and Cooperatives) who is responsible to land surveys and information analysis which will serve as a basis for policy formulation.

d) The Department of Lands (the Ministry of Interior) who deals with land related legal matters and information.

e) Office of National Energy Authority (the Ministry of Science, Technology and Energy) who deals with all the energy related issues.

f) The Department of Mineral Resource (the Ministry of Industry) who possess information on mineral and water resources as well as manages the land area under mining and energy exploration.

g) Town and Country Planning Office (the Ministry of Interior) who has a direct control over the pattern of land use particularly in the urban areas.

The scope of work of this newly proposed Ministry of Natural Resources would cover most of the land resource in the country. The inclusion of Town and Country Planning Office would facilitate much of the land use planning. This newly proposed ministry also permits a higher degree of integration and coordination between matters related to agriculture, transportation, industry, recreation, commerce, town planning. The new secretariat of the Committee on Natural Resources will be transformed into "the Natural Resources Policy and Planning Office". Staff transfer to and from the secretariat and the Ministry of Natural Resources would be pragmatic leading to a more technically sound policy planning system.

With reference to the Office of the Natural Environment Board, whose work covers all forms of land use is best to be remained at the Ministry of Science, Technology and Energy and takes an overall observation at the matter. Although a large number of agencies will be extracted from the Ministry of Agriculture and Cooperatives and the Ministry of Interior, it would not so

much affective as their work is already extensive in scope.

9.9 ADMINISTRATION BODY FOR AGRICULTURE LAND ALLOCATION

Other than the forest cover, agriculture has for long dominated the Thai economy. While its contribution to GDP has declined in recent years, agriculture still absorb as much as 70% of the total labour force. Today, there are up to 16 agencies who deals with land allocation for agriculture, they are, 1) the Department of Lands, 2) the Department of Public Welfare 3) the Department of Agriculture Extension 4) the Royal Forestry Department 5) the Agricultural Land Reform Office and 6) the Central Land Consolidate Office.

In the absence of a systematic administrative system, these agencies were established whenever necessary and without abolishing the existing ones.

Many decades ago the abundance of land in Thailand permitted the country to pursue a generous land allocation system. The Department of Lands distributed land through (1) a free to choose system (Land Code BE 2497, Section 33) and (2) allocation of land certificates to those who could provide evidence that their lands are being used for cultivation.

As unoccupied land approaches its limit and called on agricultural land allocation system, the Department of Lands commenced a land allocation project with direct bearing on allocation of large land areas (Land Code BE 2497, Section 27).

When nearby land became more scarce, agricultural land allocation was extended to include remote areas and forests. Such an expansion of work scope demanded for a new land allocation methodology--at that time land settlement was pursued on a temporary basis. In 1895 Land Settlement was legalized and presently is under the responsibility of the Department of Public Welfare and the Department of Cooperative Promotions of the Land for Livelihood Act, BE 2511.

With rising population pressure and the fact that the country is going through a transformation stage into a semi-industrialized economy the government saw appropriate to legislate a land reform act in 1975 in an attempt to consolidate the country's natural resources and rehabilitate the agricultural sector to support the future expansion of the industrial sector and the economy as a whole.

To this end, the Government began purchasing private land for distribution to the landless farmers. Given the high cost associated, the payment was stretched for a number of years and farmers, to whom land was allocated, have to pay back the amount to the Government.

As land reform turned out to be time consuming and did not eliminate problems associated with forest encroachment the Government initiated the STK project in 1979 as a means to assign property rights (right to use) to those who encroach forest reserves in the search for cultivation land. STK's property rights have been considered as an insecure land title and does not coincide with the procedure of land reform in that STK land rights was allocated at free of charge. STK has therefore served as a temporary diagnosis mechanism which contributed towards land allocation while land classification was being processed. A more systematic land allocation scheme will be pursued after land classification has been completed where forest reserved is classified according to land suitability.

Such a land allocation system which relied on the country's central budget in allocating lands to farmers on a hire purchase basis could not exis

along side the other systems which allocate lands at no charges. Hence, the past land allocation systems have been in contradiction with the present social structure and failed to achieve social justice. Furthermore, the status of land rights have also differed distinctively.

Technically, land allocation for agricultural purposes should follow the same methodology conceptually and administratively. This approach would tremendously reduce the need on the country's resources. It is therefore appropriate to propose that agencies concerned in land reform should be clustered together into one body, namely, the Land Reform Bureau. As the duty of the proposed Land Reform Bureau stretches to cover rural credit, agronomy, cooperatives and marketing, this body should be formed under the Ministry of Agriculture and Cooperatives. As for land allocation planning, should the scope of work of this body be less extensive, it may even be possible for the Office of Permanent Secretary of the Ministry of Agriculture and Cooperatives to act as the Office of Permanent Secretary of the Land Reform Bureau. This innovation would help integrate the planning of the Bureau together with other departments of the Ministry of Agriculture and Cooperatives.

9.10 STEPS INVOLVED IN THE ESTABLISHMENT OF THE NEWLY PROPOSED BODIES AND IMPROVEMENT IN THE ADMINISTRATIVE SYSTEM

a) The National Committee on Natural Resources. The establishment of this Committee would involve a careful revision of a number of existing laws and regulations as well as responsibility of a number of Committees. At present, these committees can be divided into two categories, they are :

i) Committees who possesses power to regulate the country's land use. Such power should be transferred to the Committee on Natural Resources, or else under the supervision of the Committee on Natural Resources(Figure 9.1)

ii) In terms of coordination in increasing work efficiency, the related committees should be able to cooperate among themselves. Should special issue arises, the concerned committee could act as subcommittee under the Committee on Natural Resources.

The previous plans and project either under the responsibility of the Government or committees will be followed until new plans are formulated by the Committee on Natural Resources.

b) The Ministry of Natural Resources. Due to a large number of laws and regulations which frame many agencies together in a rigid structure, it is therefore impractical, if not impossible, to combine all land related agencies into one ministry under a sound administrative system at the initial stage. A possibility opened at this initial stage is to bring together departments concerned in natural resources in such a fashion that would not interfere with the ongoing staff responsibility, budgets, plans and projects. Once this innovation is completed, staff should be recruited from various agencies in order to establish the Office of Natural Resources Policy and Planning who would serve as the secretariat for the Committee on Natural Resources (Figure 9.2).

c) The Land R eform Bureau (Figure 9.3)

Two issues arise when combining agencies concerned in land allocation for agriculture together as a body to support the country's land reform. They are :

i) Land Rights. The differences

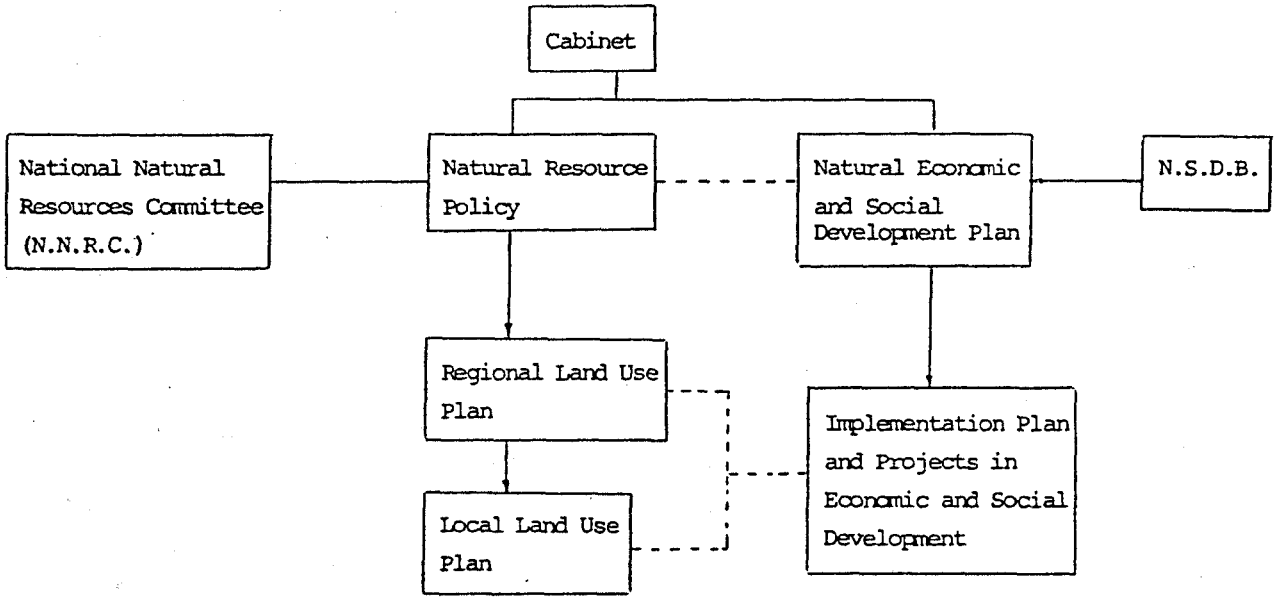


Figure 9.1 National Natural Resources Committee

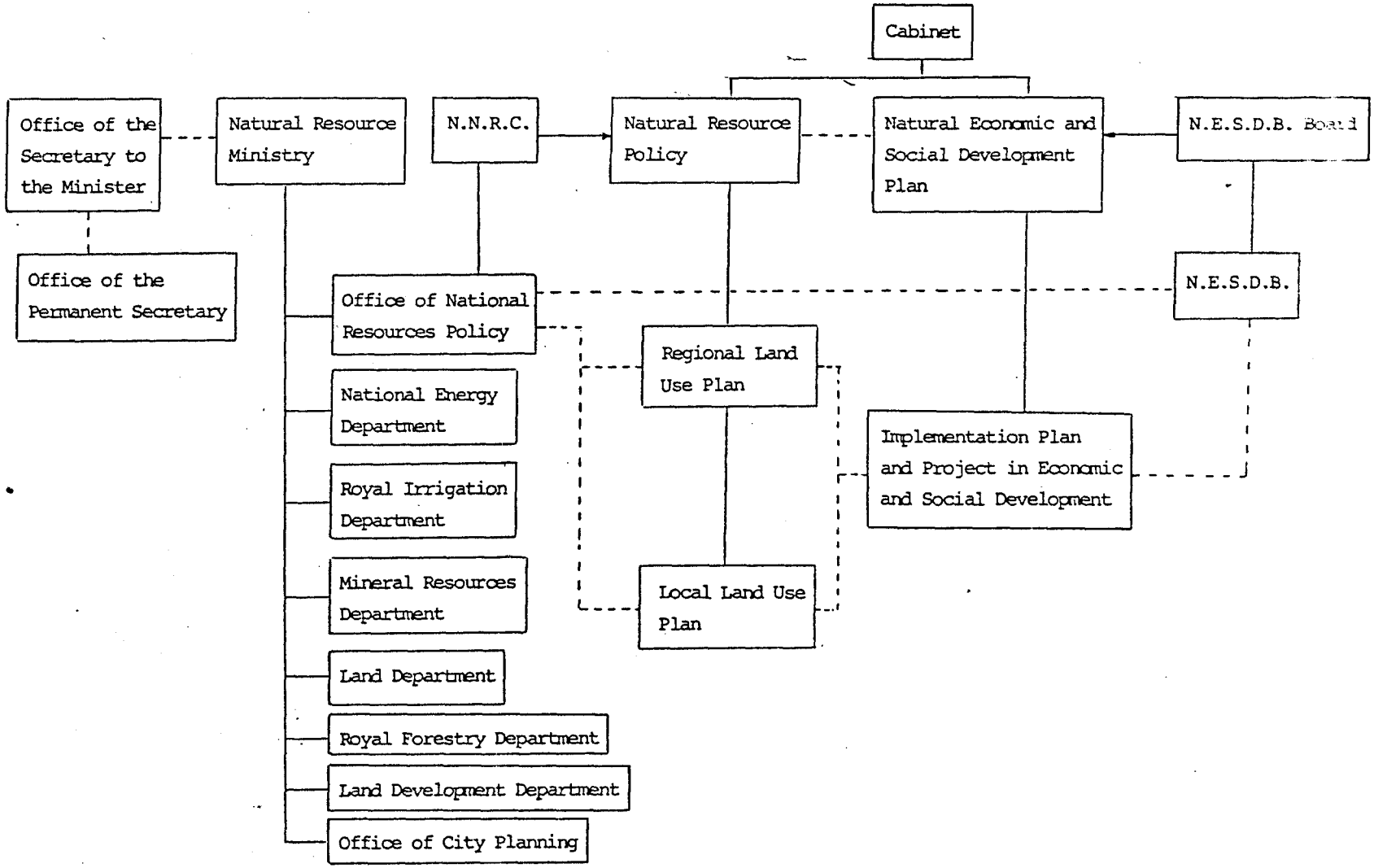


Figure 9.2 Struction of Natural Resources Ministry and Land Use and Management

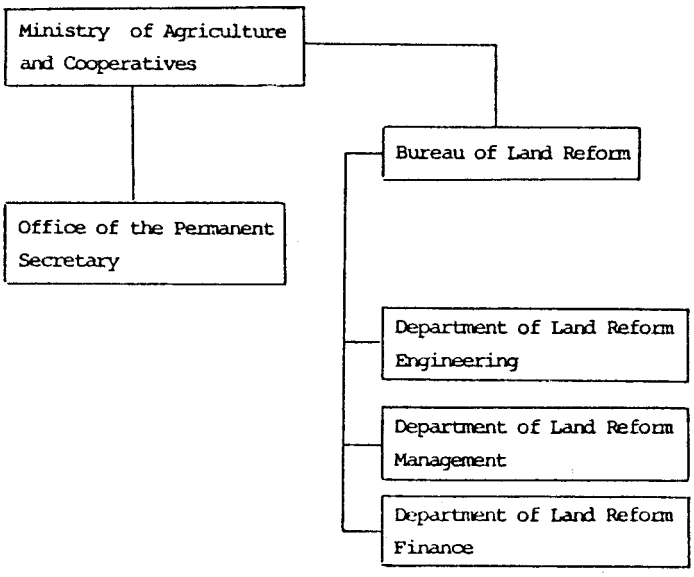


Figure 9.3 Bureau of Land Reform

in the conditions stipulated to each type of land documents (SPK, N.K. K.S.N.) call for a modification in the conditions of these certificates whether in terms of restrictions associated with land ownership certificates or payment for land which have been allocated.

ii) As there are as many as 16 agencies concerned in land allocation for agricultural purposes, the transfer would involve a reschedule of work and staff routine, and finances on a case to case basis. There may be situations where work responsibility is transferred without affecting any changes in staff or budget. The ongoing projects and plans will be executed until a new work plan in part a) is finalized and laws and regulations revised.

Finally, in establishing the Committee on Natural resources, the Ministry of Natural Resources and the Land Reform Bureau, it is essential to assign an agency the responsible to undertake a detailed and thorough study on the possible impact and the modification of work plans and responsibility, staff, and budgeting. Currently the Subcommittee on Land, initiated by the National Rural Development Committee, working in collaboration with the NESDB seems most suitable to pursue such a study as it presently involves in matters on the country's land management. In addition, the Subcommittee on Land is also in the position to tailor the required procedure to fit the direction of the National Economic and Social Development Plan. In addition, the Subcommittee on Land should also revise the existing plans and projects together with the possibility for the establishment of "the Land Reform Board" and "the Natural Resources Committee". This work should be completed within the first two years of the Sixth National Economic and Social Development Plan. Furthermore, the Subcommittee on Land should also search for solutions in establishing the Ministry of Natural Resources. This should be completed within the Six Plan period.

Part IV A Land Policy of Thailand: A Synthesis

10 Land Policy of Thailand

10.1 DIMENSIONS OF LAND POLICY

Because land can be used for a variety of purposes, there is often a conflict in how certain lands should be utilized. Whether land should be used for agriculture, forest, urban development, etc., has economic, social and political repercussions. A land policy with the intent of supporting only some factors of land use cannot meet its objectives efficiently. At the same time, a coherent land policy is obviously needed in Thailand so that the country can best utilize its land resources. Most land policy decisions are currently left to the separate government departments involved with land use. Each department, however, has its own mandate to promote particular types of land use. Not infrequently the goals of one department come into conflict with the goals of another. A clear policy is needed to help resolve these conflicts and to promote the most efficient use of the land.

Land policy should be viewed and determined from several distinct dimensions that correspond to the nation's and the society's needs. The dimensions that should be considered by the State in formulating its land policy are:

a) The economic dimension, or what is the best economic use of the land.

b) The social dimension, or what other social aspects should be considered in land use, such as land rights, land reform, etc.

c) The land conservation dimension, or how can the land best be maintained for future use.

d) The national security dimension, or how should land along the nation's borders be used to help protect national security.

Based on the results of the analysis of land problems and policies and using these dimensions as the basis for understanding land use and land tenure, it is now possible to formulate a land policy of Thailand. This will be presented in the following sections.

10.2 THE ECONOMIC DIMENSION OF LAND POLICY

Land outside forest areas

Land outside the officially designated forest areas, most of which is owned by private individuals, is set aside for agricultural, industrial and residential use. Utilization of this land should emphasize the economic benefits possible. The main points to be included in the policy in order to produce the highest economic benefits are :

Land rights

Land occupied by individuals. So far (up to July 1986) the Land Department has issued title deeds covering 23.7 million rai, N.S.3A documents covering

48.4 million rai, and N.S.3 documents covering 22.5 million rai of land. There is an urgent need to accelerate issuing of the title deeds to assume greater security of land ownership. The Land Department's land titling project being implemented at present should be supported. Accelerated efforts to enable people to acquire full rights of ownership will stimulate higher agricultural production and greater investment in land development in other activities, as it has been shown that their confidence in permanent occupancy of the land will enable them to get more credit from various financial institutions.

Land tax collection

To assure fair land utilization to prevent the acquisition of large tracts of land and to discourage land owners from allowing their lands to remain unexploited, there is a need to amend the land tax system structure as follows :

a) Re-formulation of the guidelines for assessment of the value of assets in the various types of land utilization, to conform with technical principles and facts.

b) Introduction of a progressive tax according to the area occupied, without affecting small agriculturists.

c) Levying of a high tax on occupiers of lands who do not exploit them or who hold them for the purpose of speculation.

These are supplementary measures to help solve of the problem of occupancy of large tracts of land without using the land efficiently, as well as preventing the purchase of land for speculation. Moreover, the Government will earn more revenue to maintain the various basic activities that will contribute to the most efficient land utilization in the area.

Legislation to conserve agricultural areas

The Government should initiate legislation to conserve areas that should be used for agriculture, the fertile lands most suitable for agriculture for which the State has already invested a considerable sum in developing infrastructure, the basic support activities in order to prevent the utilization of these lands for other activities. The aim is to reserve fertile agricultural lands, which are at present gradually decreasing and to prevent the encroachment into certain categories of land by non-agricultural activities that could pollute the adjacent agricultural areas. This will enable the country to obtain an adequate rate of return on its investment in the infrastructure and support activities in those areas.

Agricultural development

With regard to agricultural development projects to be established in the future, the agricultural areas should be divided into two parts.

a) For agricultural land in the irrigated zone, totalling about 21 million rai, production should be adjusted by decreasing the production of certain types of agricultural goods such as rice and sugar cane and substituting them with new crops, by reducing production costs and by creating other activities that would enhance the value of agricultural goods. In order to create a "full circuit" agricultural system including supply of inputs and marketing, the private sector should be encouraged to participate in the development of agriculture.

b) For rain fed agricultural areas, the areas should be divided into two parts. In areas with fertile soil and regular rainfall, production should be diversified by planting high-return crops such as fruit trees and various

categories of perennials in place of field crops, and there should be accelerated research in increasing the yields of crops in these areas.

The second groups of rain fed lands consists of lands not well suited for agriculture with irregular rainfall. Production of low-return crops should be stopped and substituted by other crops. The State should accelerate research to discover the crop system suitable for each location as well as the varieties of crops that should be introduced for optimal production.

Improvement of soils having special problems

For a part of the nation's lands, the soils have chemical and physical problems, such as acidic soil, saline soil, soil with a high rate of expansion and contraction, extremely sandy soil, or shallow soil, altogether totalling about 68 million rai. Part of the area is used for agriculture at present, while the rest remains unexploited. The State should accelerate research to solve the special problems of these soils. The direction of research should include :

a) Research aimed to prevent the spread of acidic soils in the North East.

b) Research aimed to improve soils already with problems in order to increase their yields.

c) Research aimed at the future exploitation of soils with problems and lands left unexploited at present, such as shallow soil, or extremely sandy soil. This would be one means of solving the problem of the shortage of lands for livelihood.

Soil and water conservation

The deterioration of soils used continuously for agriculture for a long time occurs in various forms, such as decreased fertility, altered physical conditions, and the erosion and collapsing of topsoils. Although the State has undertaken soil and water conservation for an extended period, it has not met with the success it should. The problems lie with the organization of Government activities, the lack of support from farmers, and complicated and costly soil and water conservation measures. The problems of deterioration of soil urgently requires a solution. The State is not in a position to act on agricultural areas amounting to 152 million rai. There is a need to establish projects that do not involve complicated methods, that require small investment and that can impart techniques to individual farmers, with the State's support through the provision of technical advice. Only in areas with serious problems beyond the capability of the farmers to solve them should the Government intervene to accept full operational responsibility.

Utilization of lands in urban areas

To ensure that utilization of lands as residences and communities conform to town planning principles, the government should speed up the announcement of the overall town plans, and should adhere to the plans in developing the towns and cities.

Development of the regions and principal towns should be undertaken with State participation within proper limits. The private sector should also be given a role in the development of the towns and cities, adhering to the approved plans.

Lands within the Officially Designated Forest Areas

a) Under the national forest policy, forests should comprise 25 per cent of the nation's area or about 80 million rai. For the land policy, so far as it concerns the economic use of the forest

areas, strong emphasis should be placed on participation of the private sector, both small and large operators, in the development of forests, especially in the planting of forest plantations.

b) Degazettement of national reserved forest areas that are the site of extensive existing settlements and communities. Where national reserved forest areas or national permanent forests have been settled extensively for a long time, with permanently built houses, and even with Government offices, the designation as a forest area should be cancelled and the present occupiers of the lands should be given ownership rights according to appropriate procedures depending upon local conditions.

c) Development of coastal forest areas

Coastal forests presently comprise about 1.67 million rai. They should be divided into three areas, namely reserved area, conserved area and development area. At present conflict in land use occurs due to the lack of a clear demarcation of areas. This demarcation should be accelerated and the areas developed. Coastal forest areas which are declared development areas can yield high economic returns to the nation if proper support is received from the State.

10.3 THE SOCIAL DIMENSION OF LAND POLICY

No less than 2.5 million families or about 12 million people have problems with possession of land they need for their livelihood. They are classified as squatters of national reserved forest areas, numbering about 1 million families; or they are renters of lands, numbering about another 500,000. It is incumbent on the State to meet their basic need of land so that they can earn their livelihood, above the level of poverty, and create opportunities for them and their children's future. The areas for implementation of this policy are national/forests with extensive squatter settlements, both national reserved forests and planned reserved forests, or permanent forests, as well as unexploited public lands. The main points to be formulated in the policy are:

Land Allocation Projects Currently Being Carried Out

State or public lands comprising about 30 million rai has been entrusted to State agencies since BE. 2483 for allocation to the people as land for livelihood. Up to now about 17 million rai have been allocated, leaving the rest to be implemented. Although the current operational/methods of the agencies differ, the main objectives of all the agencies are similar, i.e. to enable farmers or members of settlements to acquire adequate land to earn their own livelihood. For areas approved by the Government which have not yet been allocated to farmers, the following action is required:

a) Allocation of land by the Public Welfare Department and the Co-operatives Promotion Department. The Areas remaining to be allocated amount to 1.8 million rai (Public Welfare Department 800,000 rai, Co-operatives Promotion Department 1 million rai). The stages of operations should be streamlined and accelerated and importance be given to surveying, admission of members of settlements, and completion of issuing of title deeds within the Sixth Development Plan period, while construction of basic infrastructure should be carried out as appropriate.

b) Allocation of land by the Agriculture Land Reform Office. Land reform work on private lands should be accelerated. The Agricultural Land Reform Act, so far as it concerns capital funds or the purchase of appropriated lands, should be amended to

attain higher efficiency. As for land reform work on State lands, distribution of occupancy rights should take priority over development, and the objectives for implementation of the reform of State lands announced as land reform areas should be completed within 10 years, and of private lands within 15 years. Moreover, land reform projects in the future may be classified into two categories. In the first category, in areas suitable for agriculture where development investment is worthwhile, economic projects should be formulated for overall development. In the second category, where economic benefits are not as great, land reform should be seen and the Agriculture Land Reform Office should provide occupancy rights and develop the basic infrastructure.

c) Forest Department's STK project. While all the agencies concerned with allocation of lands for livelihood still have a large backlog of work, the allocation of lands in the national reserved forests should continue in a similar form, but the distribution of STK land utilization occupancy documents should be slowed down in the initial phase of the Sixth Development Plan period. For areas still remaining in the project in the national reserved forests the results of classification of land should be used as basis and the cartographic system adopted should be the same as that of the Land Department's. Once the results of land classification are known, the allocation of the remaining areas should be accelerated for completion within the Sixth Development Plan Period.

d) Solution of the discrepancies and problems in the present land allocation projects should be undertaken. The problems are as follows :

i) Land rights. At present documents are issued to farmers or members of settlements in the following forms :

Department/Office	Document Issued
Lands Department	N.S.3/title deed
Public Welfare Department	N.K./N.S.3/title deed
Co-operatives Promotion Department	K.S.N./N.S.3/title deed
Land Reform for Agriculture Office	S.P.K.4-01
Forest Department	S.T.K.1

ii) Differences in the form of development by the various agencies of the State.

iii) Differences in the size of lands distributed to members or farmers in the same locality.

Correction of such differences has to be done through the amendment of the various legislation, rules, resolutions, etc. as well as the streamlining of the administrative system. This should be completed within the Sixth Development Plan period.

Land Allocation in the Future

As allocation of lands is a long-term activity and cannot be amended or cancelled at will, the period of 5 years of the Sixth Development Plan should be used so that the various agencies can adjust their plans and organization and the existing legislation and rules can be changed by the initial phase of the Seventh Development Plan. The land allocation project should then be carried out as follows :

a) The forest areas heavily encroached by squatters should be set apart from those specified as conserved forests and economic forests. These areas as well as other public land with squatters and unexploited lands, should be allocated to the people, with the main consideration being given to the suitability of the lands concerned.

b) In areas where the Royal Forestry

Department has implemented the Land for Livelihood project and outside of the areas specified as forests according to the national forest policy, the work should be continued by adjusting the cartographic system in the areas already implemented under the Fifth Development Plan, so that it conforms with that of the Land Department's. Moreover, the agriculturists who live in areas unsuitable for agriculture or in the prohibited reserved areas should be moved to appropriate locations. They should be given exploitation rights for 5-10 years to enable the State to complete the basic infrastructure before the ownership rights are conferred on them, with the same policy used on other lands intended for allocation by government agencies as entrusted by a national-level committee. This committee to be set up in the future, will implement work in these areas after the Forest Department.

c) Development of infrastructure hand in hand with land allocation should be undertaken.

d) The Government should not confer land ownership rights in the initial stage, but should give exploitation rights for 5-10 years before conferring full ownership rights.

e) As allocation of lands entails other related time-consuming activities, it is not possible to entrust the work as the responsibility of any one agency and still meet the needs of the people. It is necessary to assign the main agencies concerned with land allocation at present, i.e. the Agricultural Land Reform Office, the Lands Department, the Public Welfare Department and the Co-operatives Promotion Department, who have expertise and experience in the matter, to work together. However, there is also a need to adjust the operational methods, especially in matters of land ownership so that they follow the same pattern. There may be differences in practice, size of lands allocated, level of development depending on the suitability of each location. Details on allocation of responsibilities for the areas, methods of operations, should be worked out near the close of the Sixth Development Plan, when the results of improved land classification and determination by the Royal Forestry Department of the 128 million rai of forest areas are completed.

f) Though land allocation entails rather high expenses, in the past the development cost was levied at no more than Baht 200 per rai (Article 10 of the Land Allocation for Livelihood Act BE. 2511). This amount should be raised in fairness to the rest of society which has had to divert revenues from other sources to meet the expenses. Moreover, this will create obligations to the land on the part of farmers or members of settlements who have to pay for the land instead of receiving it for free. Lastly, this will also correspond withe the agricultural land reform projects in which the Agricultural Land Reform Office has bought lands for sale by hire-purchase method to farmers.

10.4 THE LAND CONSERVATION DIMENSION

To conserve the nation's environment, there have been areas slated for conservation, fixed at 15 percent of the nation's land area or about 48 million rai, which includes the national parks, wildlife conservation areas, and headwater areas. The following policy should be adopted.

Headwater areas

To ensure regular supply of water sufficient for the nation's needs, part of the areas should be specified as headwaters for conservation from destruction or use for other activities. In the damaged headwater areas, reforestation should be accelerated including research to discover means to rehabilitate the headwater areas in

addition to accelerated reforestation.

National park areas

In the national park areas, so far comprising 16 million rai, a master plan for development should be established with the participation of the private sector so that these areas can use two categories of lands at the same time, i.e. as national parks and as tourist and recreational areas.

Consideration should be given to consolidation of the wildlife conservation areas with the national park areas so that their management will follow the same system, with the amendment of appropriate legislation and various rules to agree with one another.

10.5 THE NATIONAL SECURITY DIMENSION

Part of the nation's land should be reserved for activities supporting national security over and above any present use for military purposes. This would include setting up border settlements or projects for security in various areas, as appropriate.

In the utilization of lands according to these policy guide lines does not mean that the benefits derived will accrue to any one dimension of the policy in particular, but will of course cover dimensions of the policy as well. The determination of land policy should be based on the main objectives that will enable one to have a picture of development and administration of each dimension more clearly. Moreover, the solution of certain problems may involve formulation of specific policy with bearings on economic aspects, social factors, conservation and security, such as the hilltribes policy.

10.6 HILLTRIBES POLICY

The hilltribes problem in Thailand relates very closely to all aspects of land policy. There in an urgent need to seek a solution to the problem in order to forestall violent repercussions and damage to the whole society. The land policy so far as it concerns the hilltribes will be based on the culture and tradition of the hilltribes together with other factors. A land utilization policy can been formulated as follows :

The hilltribes should be divided into two categories, based on culture and tradition. The first category are hilltribes who can be persuaded to settle down, the second category being those who move about practising shifting cultivation and cannot be made to settle down easily.

For the first category of hilltribes, it is possible to allocate appropriate forest areas in which they can settle, by using lands in areas where they are not likely to cause damages from soil erosion or collapsing of soils.

For the second category of hilltribes, the government must move them to areas where there is a land allocation project, although great difficulty will be encountered and the Government will have to provide large budgetary support as well as close control of their movements and the blocking of new migration.

10.7 STRATEGIES

To ensure the practicability of implementing a land policy using the four dimensions, the following strategies are required:

Improvement of land classification

To know the actual condition and characteristics of lands in the national reserved forest areas and planned reserved forests (i.e. which areas are still virgin forest and which squatted areas are suitable for agriculture and which should be used for other), it is necessary to accelerate the completion of the land classification program within the Sixth Development Plan period, by utilizing the U.T.M. cartographic system, that is adopted by the Military Cartographic Department, the Land Department and the Royal Forestry Department, so that it will be the same standard for all agencies.

Improvement of land data system

a) The Government should support the development and improvement of a land data system that is acceptable to all agencies. The cartographic system used should also be one common system. The State should support introduction of remote photographic interpretation technology in surveys of land resources, as well as the training of personnel and provision of tools and equipment. In the detailed stage of work, aerial photography should be allowed, as is needed.

b) The Government should support the introduction of computers for preparation of a land data system network. There should be not only one large data centre, but many data centres in the various fields, as appropriate. Each agency should be able to develop its own data system by using small-size computers that can be linked with other agencies. The central agency will then be responsible for co-ordination of land administration and preparation of the index for various aspects of the data.

Administration

To achieve unity in land administration and to obtain actual benefits the following steps should be taken :

a) The responsibility of the Land Sub-Committee, National Rural Development Committee, which at present co-ordinates the work of the various agencies connected with land should be raised by increasing the manpower and various facilities and equipment in its secretariat, to enable it to act as a real national policy and land administration centre, to co-ordinate both the policy and the work plans connected with all the lands in Thailand. This should be done in the initial phase of the Sixth Development Plan period.

At the same time, it is necessary to improve and amend legislation concerning land resources, particularly land allocation and land rights, as well as improve the duties of the various agencies to correspond with future needs and conditions.

From the point of view of land allocation, which is practised by many agencies, every agency should complete their operations in the area for which it is at present responsible within the Sixth Development Plan period.

Allocation of the various categories of land has one principal objective, i.e. to enable the people to have lands for their livelihood, and the main differences are only in operational details. To ensure that land allocation by all agencies will be along the same lines, it behooves the Land Sub-Committee, National Rural Development Committee, to consider setting up a "Land Reform Bureau" with the first 1-2 years of the Sixth Development Plan period, by consolidating the main agencies presently responsible for land allocation, so that land allocation activities will be more efficient and fair.

b) There should be study of the feasibility of setting up a natural resources committee within the first 1-2 years of the Sixth Development Plan.

The committee, once set up, should be endowed with a capable secretariat with sufficient manpower for full-time work whose duties will be to analyse the work plans and budget and to follow up and assist the operational agencies in the solution of problems which they cannot solve by themselves.

c) The natural resources committee should then consider the means and stages of setting up a Ministry of Natural Resources to administer land resources on a long-term basis and to co-ordinate its activities with other offices concerned with other aspects of natural resources.

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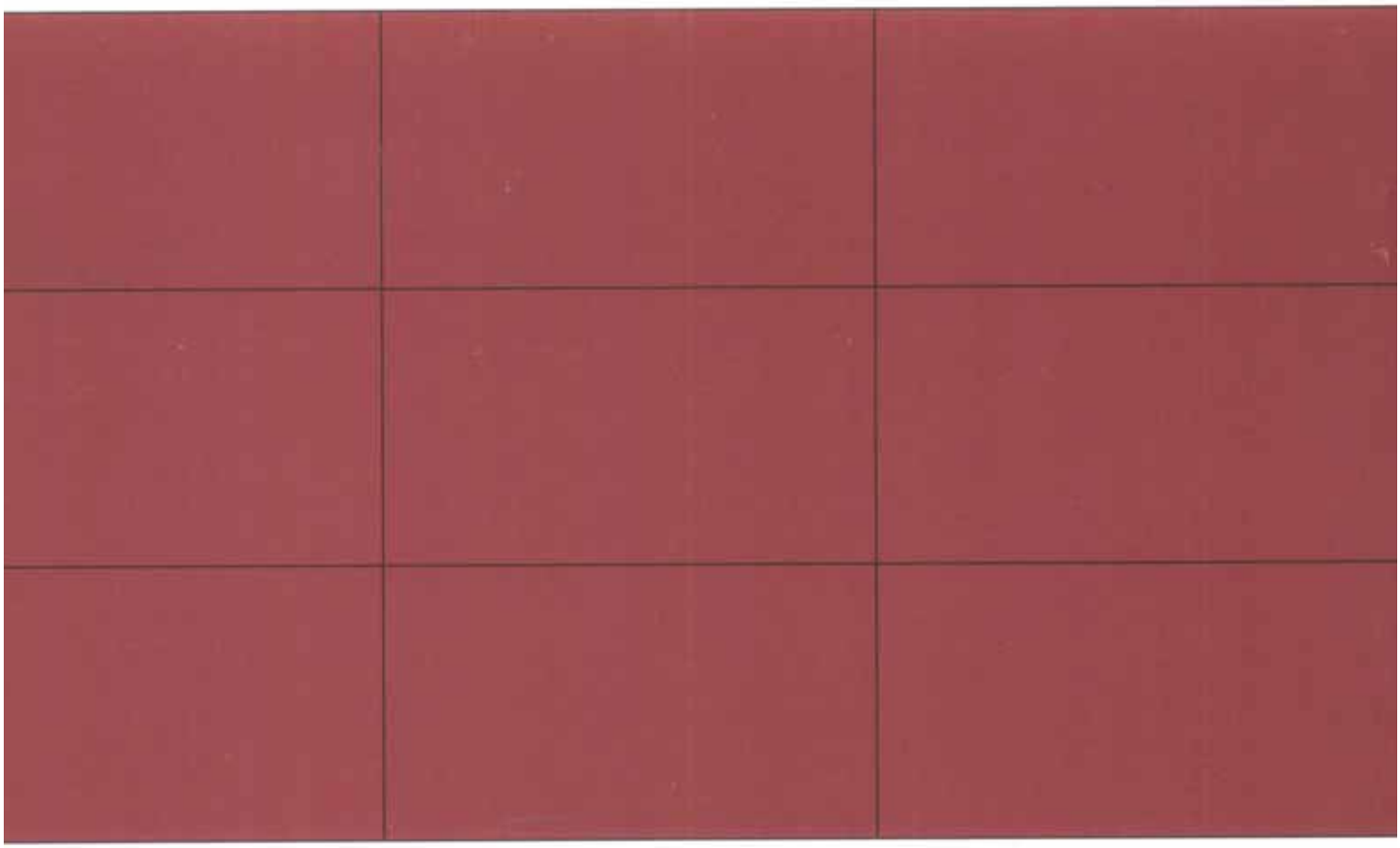

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