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DRAFT ENVIRONMENTAL REPORT
ON
THAILAND

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DRAFT ENVIRONMENTAL PROFILE OF THAILAND

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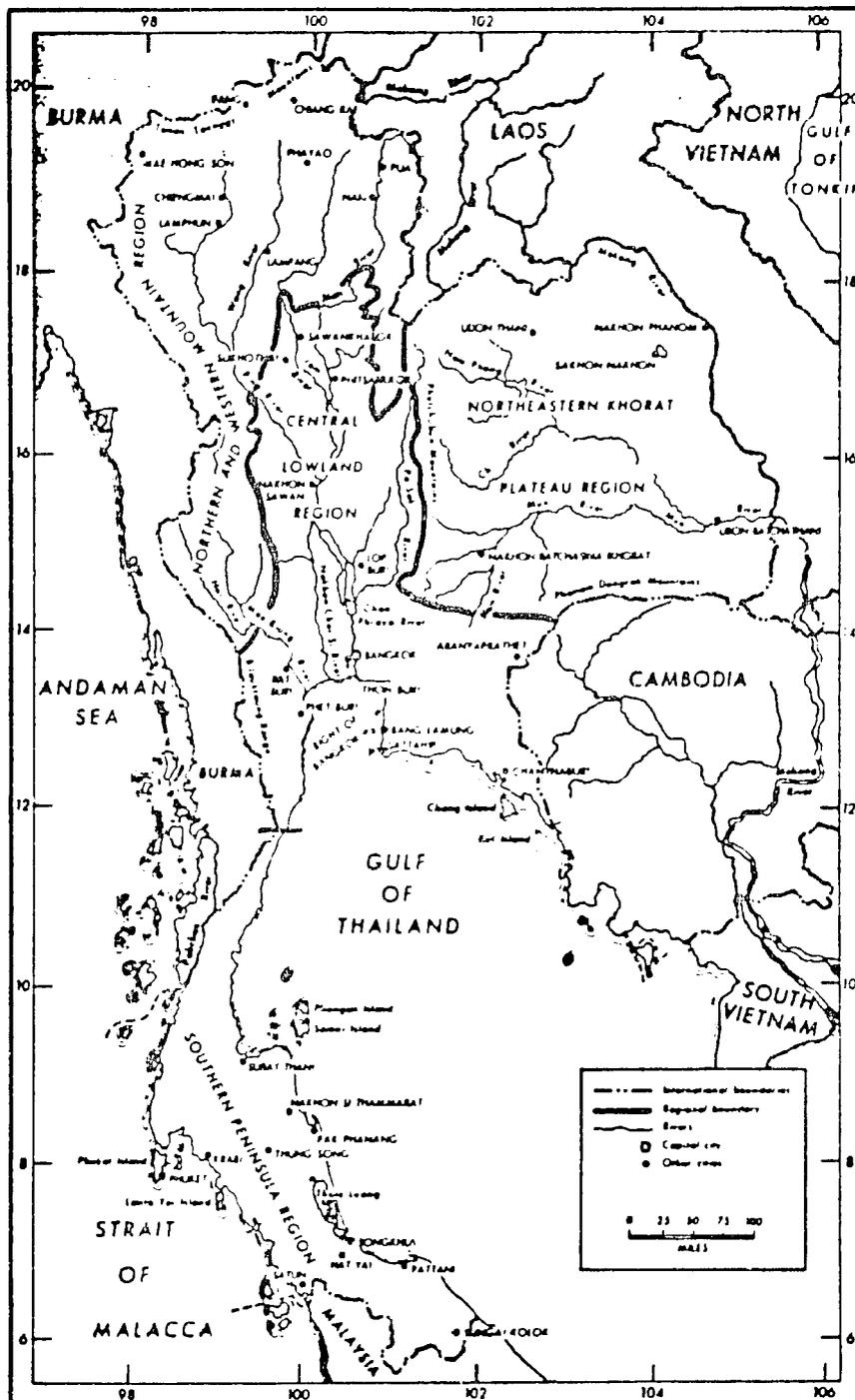


Figure 1. General map of Thailand

INTRODUCTION AND SUMMARY

Location, Size, and Population

The Kingdom of Thailand is an independent constitutional monarchy with a unique history for it has never been a colony. Bordered by Burma, Laos, Kampuchea, and Malaysia, Thailand is located in the heart of mainland southeast Asia and covers a total area of 514,000 square km (319,399 square mi). Thailand extends approximately 1,660 km (1,031 mi) from north to south, and at its widest part over 800 km (497 mi) from east to west. Its 2,100 km (1,304 mi) coastline encloses most of the Gulf of Thailand on the South China Sea and borders the Andaman Sea and Strait of Malacca on the western side of the southern peninsula.

With an estimated population of 46.2 million, Thailand is one of the 20 most populous nations in the world. Population growth has fallen significantly during the 1970's to an estimated rate of 2.3 to 2.5 percent, in part as a result of the Government's family planning program. Due to this relatively short period of demographic transition, the proportion of the total population under 15 is now very high. Thailand has a population density of 90 persons per square km. The spatial distribution of the population, on both a regional and urban/rural basis, is important because of the great variations in social, economic, and demographic characteristics between different areas. The 1970 census identified 86.8% of the population as rural, with the majority involved in agriculture. Urbanization in Thailand has increased, but from a very small base and at a more gradual rate than in most developing countries. Urban development has been concentrated in Bangkok, which is a truly preeminent city with 63% of the urban population in 1976. Internal migration in Thailand is relatively low, though increasing. Between 1965 and 1970 only 6% of the population over four moved across changwat boundaries, and in all regions except the Center net migration comprised less than 1% of the population. Life expectancy at birth is now about 61 years. The welfare of the population as measured by income, health, education, or social services differs substantially between urban and rural populations and among the rural populations of the various regions; with the Northeast ranking the lowest and Bangkok and/or the Central region the highest.

Physical Characteristics

Thailand divides naturally into four main biogeographical regions: the Northern and Western mountain region, the Northeastern Khorat Plateau, the Central Plain, and the Southern Peninsula.

The Northern and Western mountain region is made up of a series of parallel north-south mountain ranges that are sharply dissected by deep, narrow alluvial valleys providing tropic, subtropic, and sometimes near temperate climatic zones. The mountains of the North do not attain very high elevations and only a few peaks rise over 2,000 meters. The mountains are well-watered and the source of many rivers, including the four major tributaries of the Chao Phraya. The rolling hills between the major rivers are usually deeply cut by streams.

Apart from higher ground along the borders and in the upper part of the region, most of the Northeast is a gently undulating plain that is commonly referred to

as the Khorat Plateau. Although called a plateau, the area is actually a large basin less than 1,000 feet above sea level whose rolling surface is occasionally marked by a few flattop hills. The basin comprises about one-third of the country's total land area. It is bounded on the north and east by the Mekong river, on the west by the Phetchabun mountains that form the western scarp of the Plain, and to the south by the Phanom Dongrak mountains along the border with Kampuchea.

The Central region is dominated by the Central Plain, a triangle-shaped delta stretching down to the Gulf of Thailand which forms the basin of Thailand's most important river, the Chao Phraya. Known as the "rice bowl" of Thailand, the Central Plain is largely composed of lowland and swamps. The rolling plain in the north is heavily dissected by the rivers that merge to form the Chao Phraya and its delta. To the east and west are the mountains of the North and Northeast regions. In the southeast is the Bang Pakong river and surrounding lowland. Further south is the Chanthaburi mountains and, between the mountains and the Gulf, the Chanthaburi plain.

The southern region, or peninsular Thailand, consists of a narrow isthmus connecting Burma and Central Thailand to the Malaysian Peninsula. The topography of the region is rolling to mountainous and contains little flatland. There are no large rivers, but numerous small streams that flow precipitously down narrow valleys, creating a serious flood hazard.

Thailand has a tropical monsoon climate characterized by distinct wet and dry seasons. Although none of the country can be described as arid, the long dry season and poor water-holding capacity of the soils, especially in the Northeast, means that inadequate moisture can limit cropping possibilities. The monsoon pattern is modified by local thunderstorms originating in the Gulf and cyclonic storms formed by pressure areas moving in from the Pacific and the South China Sea. Annual temperature ranges are small throughout the country, with somewhat wider ranges in the Northern region, especially at higher altitudes.

Resources and Environmental Problems

Water - Water resources are generally considered to be abundant in Thailand. However, except in the South where the dry season is very brief, the availability of water is highly variable according to the time of year. Thailand's surface water resources are becoming increasingly polluted from municipal and industrial wastes, particularly in the Bangkok region. Industrial pollution is primarily organic wastes of a natural (rather than synthetic) origin. The mining sector is adding to the water pollution problem through the discharge of tailings into rivers. Waterways are also suffering from increased sedimentation due to the clearing of forests upstream. No information was available on adverse ecological effects associated with dam construction, though Thailand is accelerating its hydroelectric development program. Critical watersheds, particularly in the Northern region, are being disturbed by the loss of vegetative cover due to shifting cultivation.

Soils - The soils and land forms of Thailand can be broadly divided into three groups: recent alluvial plains; older alluvial terraces; and sedentary soils. There are relatively minor areas (less than 2%) of coastal sand, peat, and

swamp soils. Major environmental problems include leaching, and the loss of topsoil and erosion due to the practice of shifting cultivation and both open pit and strip mining.

Minerals - Thailand exploits a wide variety of minerals, with tin and tungsten the country's most important mineral resources. Wastes from the mining industry are disturbing water, soil, and the coastal zone.

Forests - Tropical forest is the natural climax vegetation throughout most of Thailand. The forests are composed almost exclusively of broadleaf species and can be divided into two main groups: evergreen species comprising about 35% of forested area; and deciduous species which cover roughly 65% of forested area. The forests of Thailand are being depleted at an increasingly rapid rate. Shifting cultivation is practiced widely throughout the lowlands, foothills, and mountains of Thailand, by the local population as well as by the semi-nomadic hill tribes. Its effects have been most severe in the Northern highlands and the Northeast region. The loss of forests through the spread of cultivation to upland areas and the highlands, where important watersheds are located, is disrupting the vital ecological functions that the forest carries out.

Coastal Zone - Thailand has an extensive coastal zone. Coastal zone development in Thailand has proceeded in the absence of any rational system of management. There are presently no integrated programs of coastal resource management within the administrative framework of Thailand. As a result, the coastal ecosystem is deteriorating, particularly in the Gulf. Mangrove forests are suffering from indiscriminate logging for charcoal production; encroachment by shrimp farming, mining, and other industrial development; and from water pollution and increased sedimentation due to upland forest clearing. Coral reefs are deteriorating due to lack of control of human activities, in particular the illegal use of dynamite by fishermen.

Wildlife - Thailand has a wide variety of wildlife, with many endemic species. Wildlife is decreasing both in quantity and number of species. The major threats to wildlife are illegal hunting and trapping, and habitat destruction through forest clearing.

Fisheries - Fisheries are an important resource in Thailand since fish is the principal source of animal food and the only significant source of protein in the national diet. Freshwater fisheries are suffering from over-exploitation and deterioration of their habitat. The situation with respect to marine fisheries is especially serious, primarily because of over-exploitation.

Institutional Responses to Environmental Problems

With the passage of the Enhancement and Conservation of National Environmental Quality Act in 1975 and the subsequent establishment of the National Environment Board, Thailand has taken significant steps toward addressing its environmental problems. However, this effort is hampered by the lack of coordination among the wide range of government agencies responsible for various aspects of resource management. Thailand also suffers from the absence of any systematic

regulatory scheme for pollution control. Finally, there is a need for applied research and ecological data on specific ecosystems and how to modify them.

In addition to the Act mentioned above, Thailand has a substantial body of environmentally related legislation. This includes legislation for water, minerals, forests, wildlife, and fisheries. Although gaps remain and improvement is needed in the legislation, the development of an effective enforcement effort now seems to be of primary importance in reversing Thailand's worsening environmental problems.

1.0 POPULATION CHARACTERISTICS

With an estimated population of 46.2 million, Thailand is one of the 20 most populous nations in the world. Between 1950 and 1970, Thailand's population grew at a rate of over 3 percent a year. This high rate of growth was largely the result of a sharp decline in mortality brought about by the Government's successful malaria eradication program begun in 1949. However, population growth has fallen significantly during the 1970's to an estimated 2.3 to 2.5 percent, in part as a result of the Government's family planning program. Due to this relatively short period of demographic transition, the proportion of the total population under 15 is now very high (see Figure 2).

1.1 General population statistics (Population Reference Bureau, 1979)

Total population: 46,200,000 (mid-1979 estimate)

Average annual growth rate: 2.3%
2.5% (World Bank, 1978)

Average population density: 90 per sq km
194 per sq km of agricultural land
(World Bank, 1978)

Birth rate: 32 per 1,000

Death rate: 9 per 1,000

No. of years to double population: 30

Estimated population in year 2000: 75,900,000

Population under 15: 43%

Population over 64: 3%

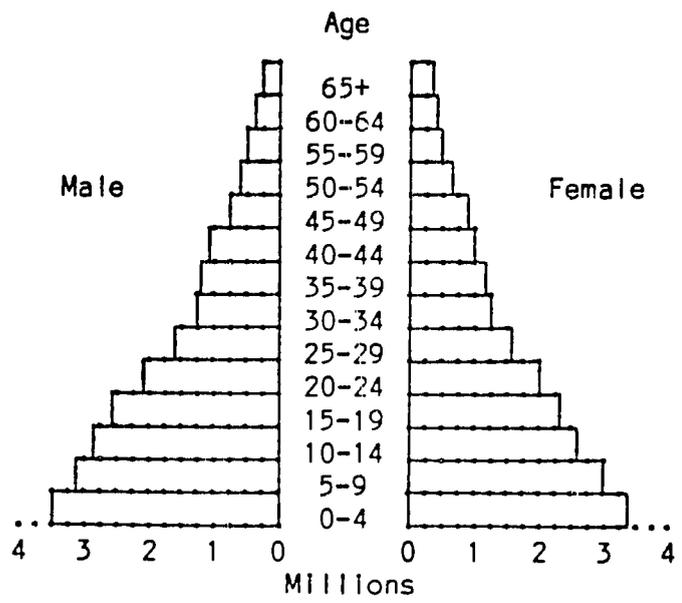


Figure 2. Age/Sex Pyramid for 1976 based on 1970 census of population as adjusted by the U.S. Bureau of the Census.

1.2 Spatial distribution

Thailand divides naturally into four geographical regions (these do not have any significance administratively) - North, Northeast, Central and South (see Figure 1, p. 1). Within these four regions the country is divided into 72 provinces, or changwats, which are further subdivided into municipalities, sanitary districts, districts, tambons and villages. The spatial distribution of Thailand's population, on both a regional and urban/rural basis, is important because of the great variations in social, economic and demographic characteristics between different areas (see Tables 1 and 2 below, and Figure 3).

Table 1. Distribution of Population by Region (in 000's)

	1970	%	1976	%	Annual growth (%) 1970-76
<u>Total</u>	<u>36,370</u>	<u>100.0</u>	<u>42,957</u>	<u>100.0</u>	<u>2.8</u>
Bangkok	3,253	8.9	4,343	10.1	4.9
Center	7,966	21.9	8,948	20.8	2.0
North	7,919	21.8	9,174	21.3	2.5
Northeast	12,715	35.0	15,169	35.4	3.0
South	4,517	12.4	5,323	12.4	2.8

Table 2. Incidence of Poverty 1/

	Population with income below poverty line as % of total population			Population as % of total in the country
	1962/63	1968/69	1975/76	1976
<u>Rural</u>				
North	75	60	38	33
Northeast	60	31	28	19
Central	35	13	12	20
South	41	31	26	11
<u>Thailand</u>				
Rural	57	37	28	83
Urban	28	11	11	17
<u>Total</u>	<u>52</u>	<u>34</u>	<u>25</u>	<u>100</u>

1. Poverty line is defined to be B 150/month/person in rural areas and B 200/month/person in urban areas, in 1975/76 prices.

Source: Cochrane, 1979 and World Bank, 1978.

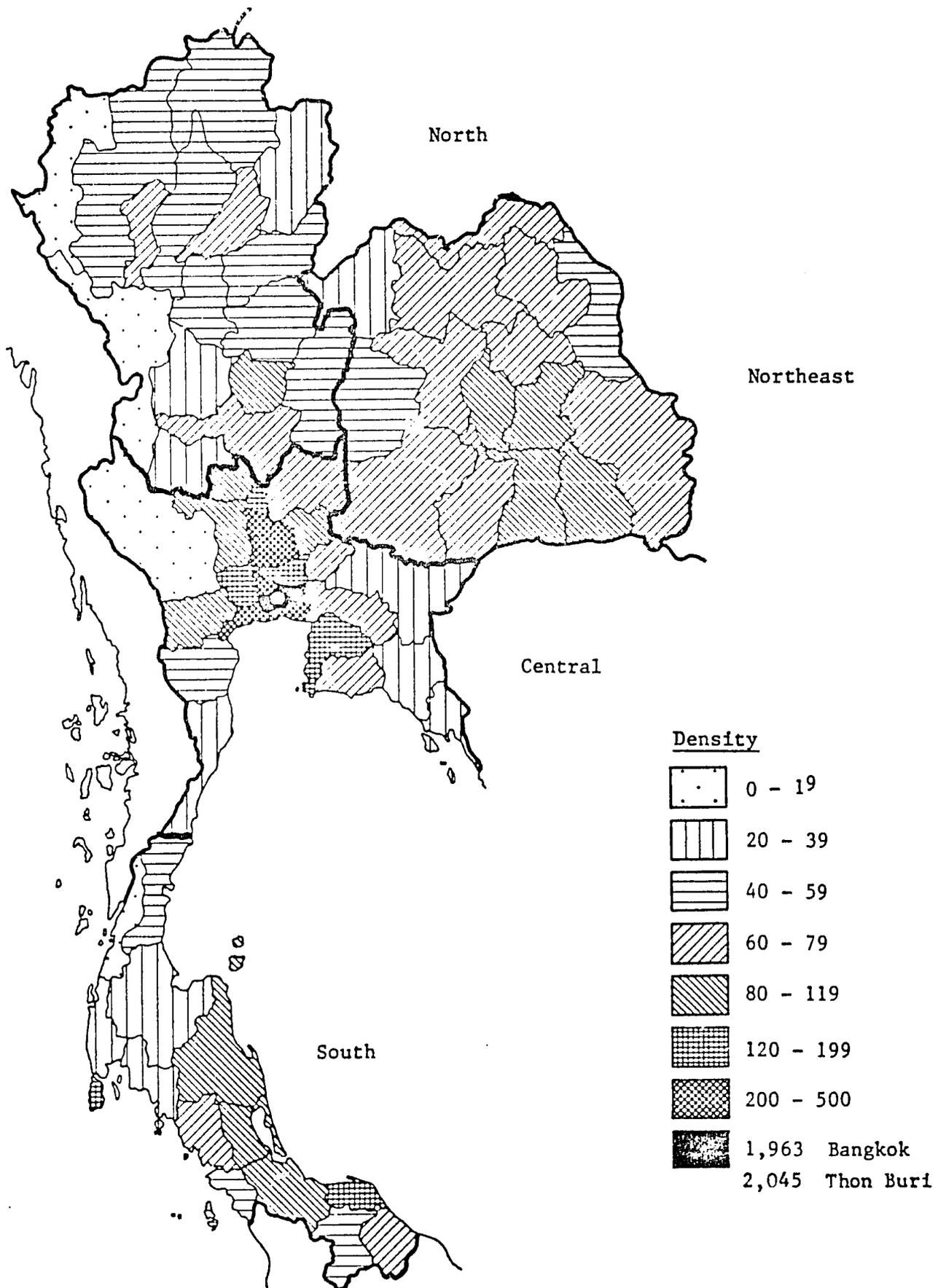


Figure 3. Population density by changwat, 1970

The 1970 census identified 86.8% of the population as rural, with the majority involved in agriculture. Table 3 outlines the distribution of urban and rural population and their respective growth rates. Urbanization in Thailand has increased, but from a very small base and at a more gradual rate than in most developing countries (see Figure 4 for location of urban growth centers). Urban development has been concentrated in Bangkok, which is a truly preeminent city with 63% of the urban population in 1976. Bangkok has a population of about 4 million, while the next largest city, Chiang Mai in the North, has a population of only 100,000. Bangkok's primacy has been growing rather than declining in recent years, with a population growth rate of nearly 5% per year. In recognition of the social and environmental costs of increasing urban concentration in Bangkok, Thailand's Fourth Development Plan proposes the development of nine provincial cities as growth poles to decentralize urban and regional growth (see World Bank, 1979 for a critique of this proposal).

Table 3. Urban and Rural Distribution of Population and Growth Rates, 1950-76

Year	Urban population*			Rural population*		
	Number ('000)	% Urban	Average annual growth rate (% per annum)	Number ('000)	% Rural	Average annual growth rate (% per annum)
1950	2,061	10.3	4.9	17,949	89.7	2.3
1955	2,618	11.5	5.2	20,144	88.5	2.9
1960	3,378	12.7	4.9	23,222	87.3	2.9
1965	4,284	13.8	5.0	26,758	86.2	2.9
1970	5,457	15.0	4.6	30,920	85.0	2.5
1975	6,825	16.3	4.9 (70-76)	35,044	83.7	2.5 (70-76)
1976	7,291	16.8		35,922	83.2	

* Urban residence is defined as persons living in municipalities; all others are considered rural.

Source: World Bank, 1978 - Background Working Paper No. 7.

Internal migration in Thailand is relatively low, though increasing. Between 1965 and 1970 only 6% of the population over four moved across changwat boundaries, and in all regions except the Center net migration comprised less than 1% of the population. Figure 5 illustrates the pattern of migration in the various changwats between 1965-70, and Figure 6 the major destination of migrants for the same period. As the figures show, net immigration to Bangkok increased, while the Northeast, Center and South experienced greater net emigration and the North lower net immigration. Areas particularly affected by emigration are the dry, central areas of the Northeast and those parts of the

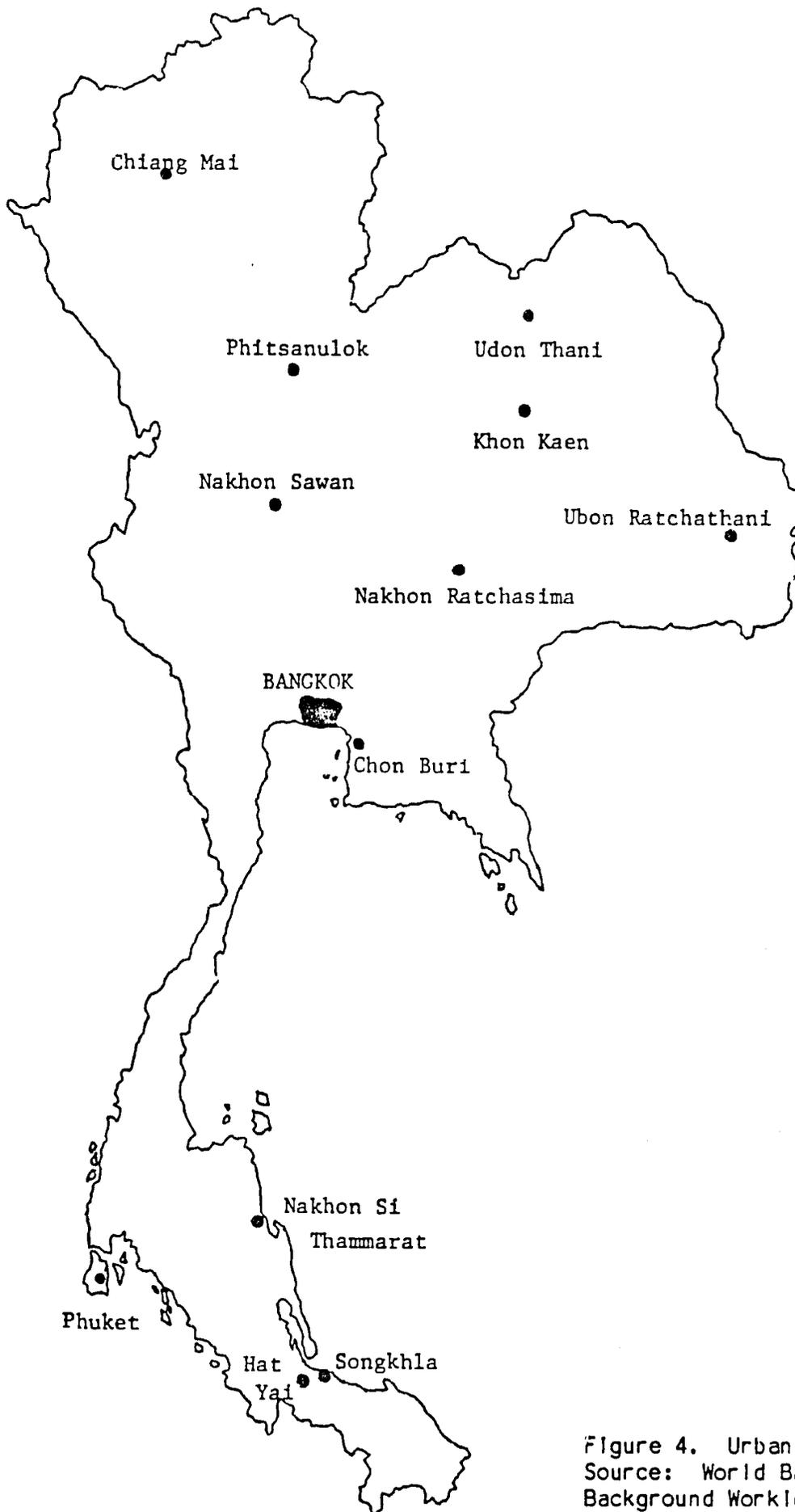


Figure 4. Urban growth centers
Source: World Bank, 1979 -
Background Working Paper No. 7

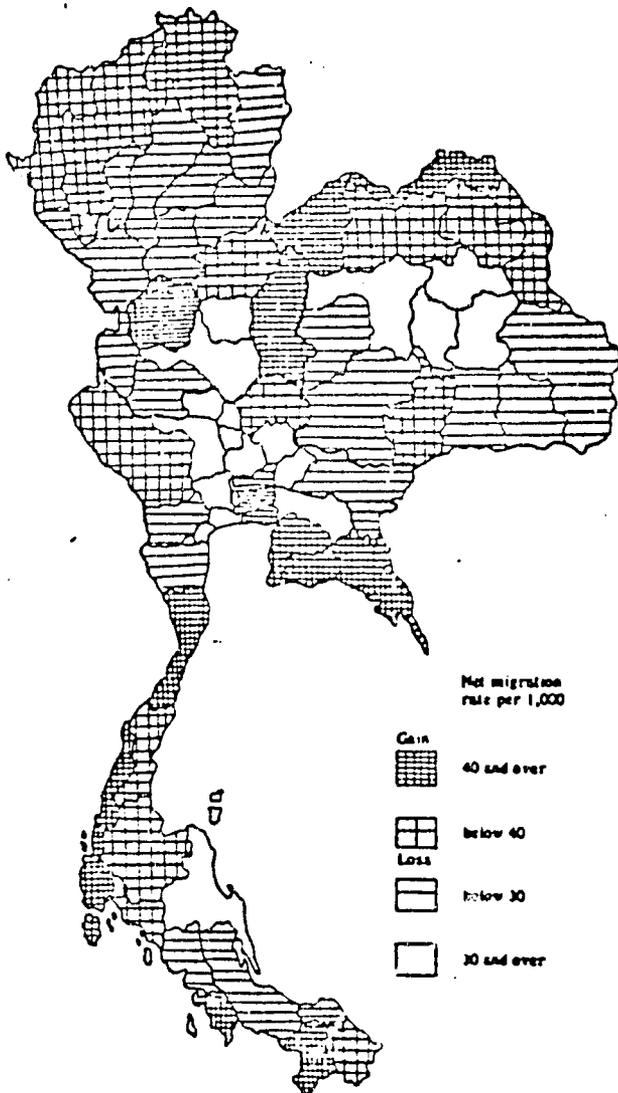


Figure 5. Net migration by changwat 1965-70
Source: Cochrane, 1979



Figure 6. Major destination of migrants, 1965-70
Source: Cochrane, 1979

Central Plain Immediately adjoining Bangkok (Cochrane, 1979).

1.3 Ethnicity and religion

The Thai people originally lived in Southern China, and first migrated south into Thailand during the thirteenth century. Thailand as a whole has an unusual degree of ethnic and cultural homogeneity. The 1970 census listed only 1% of the population as foreigners, the majority of which are Chinese (located mainly in Bangkok) and ethnic Malays (located in the South). Other minorities include Khmer (Cambodians), Indians, Pakistanis and Vietnamese refugees. The dialect of Thai spoken in Central Thailand is the official national language and is spoken by over 90% of the population. Other principal languages are Chinese and Malay. English is the country's second language and is taught in

all government schools after the fourth grade.

Thai culture is based on the predominant religion, Theravada Buddhism, professed by about 94% of the population in 1970. In the rural areas, where the bulk of the population lives, social life revolves around the wat (the Buddhist temple complex). Buddhist principles incorporated into Thai culture strongly influence the role of government and community in individual life. The basic precept is one of individual responsibility for spiritual growth. The Buddhist faith accepts the present as an outgrowth of the past but views the future as dependent on the present in a "becoming" orientation. This is very important in that Thais may not readily accept the Western notion of putting off immediate reward in the present for the value of future returns (Woolley, 1974).

1.4 Education

Adult literacy rate: 1960 - 68%

1975 - 82%

Numbers enrolled in primary school
as percentage of age group, 1976: Total - 63%

Male - 86%

Female - 79%

Numbers enrolled in secondary school
as percentage of age group, 1976: 26%

Numbers enrolled in higher education as
percentage of population aged 20-24, 1975: 4%

Source: World Bank, 1979

Number of school-age children (5-19) per teacher, 1975: 64

Source: Population Reference Bureau, 1979

With an adult literacy rate of 82% in 1975, Thailand has achieved significant progress in education. Four years of elementary education are compulsory for all school-age children, and several provinces have introduced a seven year requirement. The Government has set a goal of implementing a compulsory seven year school system on a national basis by 1990. Instruction in Buddhist morals is compulsory in all schools except those in Muslim areas. Control over education is highly centralized, with the great majority of schools under the authority of the central Government. As of 1974, the education system consisted of 394 kindergarten schools, 28,700 elementary and upper elementary schools, 1,822 secondary schools, 7 technical schools and 34 teacher training schools. There were nine universities with a total enrollment of more than 43,000 students, and an additional 45,000 students at Ramkhamhang University. In fiscal year 1978, 20% of total Government expenditure was devoted to education.

1.5 Health

Life expectancy at birth: (1960) 51
(1977) 61

Crude birth rate per 1,000 (1977): 37

Crude death rate per 1,000 (1977): 9

Infant mortality rate per 1,000 live births (1977): 56

Child death rate aged 1-4 (1977): 6

Population per physician (1977): 8,383

Population per nursing person (1976): 1,970

Population per hospital bed (1977): 800

Percentage of population with access to safe water (1975): 22

Percentage of households with access to piped water (1970): Urban - 61
Rural - 3

Daily per capita calorie supply (1974): 2,382

As percentage of daily requirement: 107

Per capita protein intake in grams (1971): 56

Source: World Bank, 1978 and World Bank, 1979.

1.5.1 Major health problems

Due to uncertainties with data on cause of death in Thailand, it is difficult to pinpoint the major health problems of the population. However, the health problems of Thailand clearly stem from the interaction of four major factors (Woolley, 1974):

Population growth - Thailand's rapid population growth has several negative consequences for health common to most developing countries. Rapid growth has led to a high dependency ratio, a declining land/farmer ratio, and increasing demand for services as well as pressure on existing services.

Sanitation and communicable disease - Mass control of communicable disease has greatly altered the patterns of death and illness. Malaria was until recently the greatest single cause of sickness and death in Thailand. Sanitation-related diseases such as dysentery, typhoid fever, enteritis, diarrheal diseases, and intestinal parasitism have emerged as Thailand's greatest health problem. These diseases, all preventable, stem from a combination of poor sanitary habits (determined to a great extent by the physical environment, such as the availability of water) and a lack of sanitation facilities. In the rural areas most of the water for drinking and other uses comes from unprotected wells, a stream, or pond.

Nutrition - Thailand is presently not faced with a serious nutrition problem, but could be faced with one in the future unless measures are taken to offset the effects of population growth. The caloric intake of the average Thai is adequate, though vitamin and protein deficiencies in the diet are common. One reason for this is the poor nutritional habits of the population due to lack of education. Young children and pregnant and lactating women are most susceptible to malnutrition. With the high proportion of people under the age of 15 in Thailand, the problem of malnutrition becomes all the more significant. The severity of many of the infectious diseases is due to the contributing factor of poor nutrition.

Health care services - In fiscal year 1978, 4% of Thailand's budget was allocated to the health care system. Health services in Thailand reach only a very small percentage of the population. This situation is aggravated considerably by the maldistribution of health services between urban and rural areas. In addition to the problem of urban/rural imbalances, there is an overall shortage of health workers, an over-emphasis on specialization, and a significant "brain-drain" of professionals. The population per-physician figure of 8,383 is misleading due to the concentration of physicians in urban areas. In 1972, there was a ratio of about one physician per 180,000 people in rural areas (Woolley, 1974).

The health care system is composed of a network of regionalized health centers distributed in rural districts of 50,000 population each. Each district is to have one primary health center, four secondary health centers, and eight to ten midwifery centers. The major distinction between first and second class health centers is the presence of a physician in the former.

In addition to these four major areas, there are several factors outside the control of the health sector that contribute to the country's health problems, such as religious beliefs, traditional behavior and attitudes, the physical environment, and economic constraints. In 1970 the ten major causes of death in descending order of frequency were: diseases of early infancy; diarrhea and enteritis; preliminary tuberculosis; pneumonia; diseases of the heart; dysentery; malaria; complication of pregnancy, childbirth and post childbirth; diseases of the stomach and duodenum; and typhoid fever.

1.6 Birth control and population policy

Although the Government had a pilot family planning project as early as 1964 and the Ministry of Public Health began providing family planning in 1968, the Government did not formally announce support of family planning until 1970. Since the introduction of a national family planning program at that time, Thailand's annual population growth rate has fallen from a pre-1970 level of 3% to the present level of between 2.3% and 2.5% (though other factors have influenced this decline). Family planning activities are carried out through existing health care facilities. The use of contraceptives differs substantially by region. The World Fertility Survey estimates that 44% of the non-pregnant married women in the North and 45% in the Central Region were using contraceptives in 1975, whereas figures for the Northeast and South were only 30% and 18% respectively. Both demand factors (literacy, per capita income, farmland per capita, urbanization and proportion Moslem) and health service factors (number of first and second class health centers per capita, physicians

per capita, and health expenditures) influence the use of contraceptives, though the supply of health facilities and personnel is more important (Cochrane, 1979). The Government's national family planning program has set a goal of further reducing the rate of population growth to 2.1% by 1981, and below 2% by the late 1980's. To expand family planning services to the rural areas, an Accelerated Development of Maternal and Child Health and Family Planning Services is under way with assistance from the U.N. Fund for Population Activities.

2.0 THE ECONOMY OF THAILAND

2.1 General economic statistics

GNP at market prices, 1977 : \$18,085 million

GNP per capita, 1977 (US\$): 420

Average annual rate of growth, 1970-77 (constant prices): 6.8%

Average annual growth rates by sector, 1970-77:

Agriculture	-	4.4%
Industry	-	10.3%
Manufacturing	-	11.2%
Services	-	6.8%

Average annual rate of inflation, 1970-77: 9.3%

Income distribution, 1976 estimate:

% of income, lowest quintile: 7.6
highest quintile: 42.2

External debt as of December 31, 1977 (US\$ millions):

Public debt, incl. guaranteed private:	1,052
Non-guaranteed private debt:	88 ⁰
Total outstanding and disbursed:	<u>1,932</u>

Currency equivalents: US\$1.00 = Baht20
Baht1.00 = US\$0.05

Fiscal year: October 1 to September 30

Weights and measures:

The metric system is officially used and is compulsory in the import trade. For local dealings, traditional units are used (with some regional variations), notably the following:

1 picul (or hap) = 60 kg	1 wa = 2 meters
1 catty = 0.6 kg	1 sok = 50 cm
1 tical or baht = 15.24 grams	1 khup = 2.5 cm
1 kwian = 2,000 litres	
1 ban = 757 litres	
1 thang = 20 litres	
1 sat = 16.6 litres	
1 rai = 0.16 hectares	
1 ngan = 400 sq meters	
1 sen = 40 meters	

Source: World Bank, 1978 and Kurian, 1978

Table 4. Distribution and Growth of GDP By Sector

Sector	Distribution (%) (current prices)			Growth (%) (constant 1962 prices)		
	1970	1976	1977 1/	1970	1976	1977 1/
Agriculture	28.3	30.8	28.5	2.6	3.1	-0.9
Crops	19.7	22.5	20.1	2.7	3.2	-2.8
Livestock	3.6	3.7	3.7	0.8	1.6	7.9
Fisheries	3.0	3.0	2.9	8.2	2.2	0
Forestry	2.0	1.7	1.7	-3.9	-	3.5
Mining, quarrying	2.0	1.4	1.9	-1.0	-5.3	22.2
Manufacturing	16.0	18.2	19.2	6.8	7.6	14.0
Construction	6.1	5.4	5.9	-0.4	9.4	11.4
Electricity, water supply	1.2	1.2	1.1	19.9	11.8	10.5
T. ansportation, communications	6.3	6.0	6.0	9.2	8.3	4.2
Trade	19.1	17.4	17.2	11.2	4.3	4.5
Banking, Insurance						
real estate	4.1	5.4	5.0	16.5	14.1	5.6
Ownership of dwellings	2.2	1.5	1.5	5.4	3.6	3.5
Public administration, defense	4.5	4.1	4.2	9.7	7.1	12.0
Other services	10.2	9.3	9.5	7.4	8.6	7.9
Total GDP	100.0	100.0	100.0	100.0	100.0	100.0

1/ Estimate.

Source: World Bank, 1978.

Table 5. Principle Merchandise Exports ('000 tons)

	1970	1973	1976	1977 1/
Rice	1,064	849	1,974	2,967
Rubber	276	391	372	399
Malze	1,448	1,386	2,419	1,542
Tin	22	23	20	21
Tapioca products	1,327	1,836	3,717	3,966
Kenaf and jute	258	264	138	81
Sugar	56	275	1,124	1,653
Shrimp	6.4	14.9	15.5	13.7
Teak 2/	29	52	72	39.5
Tobacco leaves	11	16	22	28

1/ Preliminary.

2/ '000 cubic meters.

Source: World Bank, 1978.

Table 6. Estimated Land Use in 1975 ('000 ha)

	Forest 1/	Idle and scrub	Agricultural holdings	Other uses 2/	Total
North	10,028	2,028	5,282	755	18,093
Northeast	4,705	540	9,357	1,328	15,930
Center	3,901	926	4,698	833	10,358
South	2,434	1,323	2,683	579	7,019
Thailand	21,068 (41%)	4,817 (9%)	22,020 (43%)	3,495 (7%)	51,400 (100%)

1/ Figures vary on the extent of forested area, see §3.5 on Forests.

2/ Urban, waterways, highways, etc.

Source: World Bank, 1978 - Background Working Paper No. 4.

2.2 Economic growth and structure

Over the past two decades Thailand has experienced rapid economic growth in all sectors of its economy (see Table 3 above). Between 1960 and 1977 GDP grew at a rate of 7.6% a year, despite fluctuations in key international commodity markets. This period was marked by a sustained growth in agriculture and the emergence of a significant industrial sector. This period of expansion has lifted a large number of people out of poverty (see Table 2, p. 2), though with significant differences among regions and different population groups. More than 11 million people remain below the poverty line, the large majority (over 75%) being farmers living in the rural North and Northeast growing rice under rainfed conditions (World Bank, 1978).

According to the World Bank's analysis of emerging and long-term economic trends, Thailand may in coming years face increasingly difficult problems of development. These problems are related to constraints (economic, environmental) on the continuation of past patterns of economic growth, and the extent to which different segments of the population are likely to participate in and benefit from development in the future (see World Bank, 1978 for a detailed analysis of development prospects in Thailand).

2.2.1 Agricultural sector

Thailand's agricultural sector, one of the most dynamic in Asia, continues to be the foundation of Thailand's economy. Agriculture contributes 30% of GDP and, between 1960 and 1975, agricultural GDP grew at an annual rate of 5%. Agriculture continues to provide the largest part of the country's export earnings. The crop sector accounts for 70% of agricultural production and grew at an annual rate of 4.6% between 1960 and 1975. Table 7 outlines the major crops for each region and the country as a whole, and Table 8 the livestock production.

Table 7. Proportion of Planted Area of Major Crops (%), 1975

Crop	North	Northeast	Center	South 1/	Thailand
Rice	56.7	76.3	59.3	62.2	63.66
Rubber				28.7	10.06
Maize	22.2	7.8	13.5		9.39
Sorghum					1.40
Kenaf		7.2			2.33
Cassava		6.1	10.7	3.1	4.25
Sugarcane	1.9	1.1	10.2		2.80
Tobacco					0.34
Coconut					2.34
Oil seeds	13.6		3.3		
Cotton	0.8	0.2	0.2		0.22
Groundnut		1.0			0.84
Soy beans					0.85
Mung beans					1.17
Castor beans					0.17
Sesame beans					0.18
Other	4.8	0.3	2.8	6.0	
	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.00</u>

1/ Figures are for 1973.

Source: World Bank, 1978 - Background Working Paper No. 4.

Fig. 5. Livestock ('000 head)

	1973	1974	1975	1976
Buffalo	5,942	5,947	5,442	5,679
Cattle	4,335	4,432	4,311	4,547
Swine	4,460	3,516	3,211	3,109
Chickens	61,815	47,805	53,860	49,889
Ducks	11,078	12,697	10,946	11,683

Source: World Bank, 1978 - Background Working Paper No. 4.

Future crop potential varies according to the soil conditions and climate of each region. The Central region with the Chao Phraya basin is the main rice producing area. The climatic and soil conditions of the region restrict cropping mainly to rice, with upland crops grown on the higher fringe of the region. The Northeast has a limited production potential due to poor soils with low moisture-holding capacity, unevenly distributed rainfall and an undulating topography. The Northern region has deep, narrow alluvial valleys with moderate fertility and climates ranging from tropical and subtropical to almost temperate. The region thus has potential for some temperate crops, especially vegetables and fruit trees. The Southern region is mountainous with narrow valleys cut by turbulent streams; soils are mostly sandy and often shallow. Rainfall is well distributed throughout the year - generally with a dry period around February - presenting ideal conditions for rubber, coconuts and other tropical tree crops.

The level and pattern of agricultural growth sustained over the past two decades is unlikely to continue in the future. This growth has been based on the application of low-productivity technology to an expanding land area. Over this period of time, area under cultivation increased at a rate of 4% a year. This process of expansion is already reaching its limits in some areas. Farmers have begun cultivating land that is unsuitable for permanent agriculture because of steep slopes, erosion and other problems that will lead to rapid degradation of the soil and watersheds. It is estimated that only about 2.6 million ha of forest land are suitable for agricultural use. In addition to this forest area, there are approximately 4.8 million hectares of idle and scrub land available for cultivation; this is land abandoned after logging operations, or overgrown by weeds after a period under shifting cultivation. However, only about half of the available forest and idle or scrub land could likely be brought under cultivation (see Table 9), which would increase the existing area under holdings by 16% (World Bank, 1978).

A further problem facing the agriculture sector is productivity. The expansion of area under cultivation throughout the 1960's and early 1970's was not accompanied by increases in productivity. In fact, rice yields and the yields of most major crops virtually stagnated during this period. In the Central region

Table 9. Land Outside Holdings Available for Cultivation

	Area under holdings 1975 ('000 ha)	Available forest ('000 ha)	Available scrub and idle land ('000 ha)	Forest and scrub land available for cultivation (as % of holdings)
North	5,282	138	885	19
Northeast	9,357	638	240	9
Center	4,698	100	396	11
South	2,683	536	555	41
Thailand	22,020	1,412	2,076	16

Source: World Bank, 1978.

yields have increased, and will most likely continue to do so, as a result of an expansion in dry season cropping through improved irrigation and the use of new varieties. The South may also experience some increase due to the development of irrigation. Yields have actually begun to decline in the North and Northeast due to the expansion of rice growing into upland areas (where average yields are lower than for rainfed rice grown in lower areas), and a decline in the fertility of paddy soils, especially in the Northeast (World Bank, 1978 - Background Working Paper No. 4).

2.2.2 Industrial sector

Thailand's industrial sector, comprising manufacturing, mining, and construction, has been slow to develop because of the relatively abundant supply of land and the capacity to generate agricultural exports. However, between 1970 and 1976, industry grew rapidly and its contribution to GDP increased to 25.5%. Manufacturing is the dominant subsector in industry, and in 1976 constituted 20.5% of GDP, up from 16.8% in 1970. Manufacturing grew at an average annual rate of 10.2% in real terms between 1970 and 1976, versus 6.5% for the economy as a whole. Industrialization in Thailand has centered primarily on import substitution industries. In the early 1970's, the structure of industrial production became more diversified among several groups of manufacturing industries consisting primarily of processed food, intermediate products and nondurable consumer goods. The manufacturing sector has also grown increasingly important as a source of employment and export earnings. At the end of 1976, manufactured exports constituted 36.5% of Thailand's total merchandise exports (see Table 10). However, most resource-based industries, with the exception of rubber and rubber products, have not performed well (World Bank, 1978 - Background Working Paper No. 5).

Government involvement in industry has focused primarily on the development of supporting infrastructure and services. Thailand's industrial sector is highly concentrated in the greater Bangkok area and the Central region (see Table 11). The Central region is both more industrialized and growing more rapidly industrialized than the rest of the country. The Central region contributed nearly 83% of manufacturing output in 1976. Between 1972 and 1976, 82% of the 13,130 new factories registered with the Ministry of Industry were located in Bangkok and the Central region.

Table 10. Exports of Manufactured Goods

	1970	1973	1976
Food processing <u>a/</u>	240	2,025	8,000 <u>b/</u>
Beverages	4	10	n.a.
Tobacco manufactures	-	9	n.a.
Textiles	149	1,757	2,364
Wearing apparel	18	689	1,511
Wood products	170 <u>c/</u>	886	600
Furniture and fixtures	-	30	n.a.
Paper and Products	7	61	n.a.
Leather and products	11	103	n.a.
Rubber and products <u>d/</u>	361	597	n.a.
Chemicals and products	42	156	246
Petroleum products	36	379	89
Nonmetallic Industries <u>e/</u>	114	373	384 <u>b/</u>
Basic metal Industries	1,673	2,139	3,243 <u>b/</u>
Metal products	18	136	n.a.
General machinery	7	n.a.	n.a.
Electrical machinery	8	78	1,127
Transport equipment	1	n.a.	n.a.
Miscellaneous	22	213	3,697
<u>Total manufactured exports</u>	<u>2,881</u>	<u>9,641</u>	<u>21,261</u>
<u>Total merchandise exports</u>	<u>14,270</u>	<u>31,253</u>	<u>58,250</u>
Percentage of total exports	20.2	30.8	36.5

a/ Does not include tapioca flour.

b/ Estimates based on information on the main constituting commodities.

c/ Estimate.

d/ Includes crepe rubber, but not smoked rubber sheets.

e/ Does not include precious stones and jewelry.

Source: World Bank, 1978 - Background Working Paper No. 5.

Table 11. Distribution of Manufacturing Production by Region, 1970 and 1976

	Regional share of manufacturing production (%)	
	1970	1976
Central region, including Bangkok	77.0	82.7
Greater Bangkok	(39.4)	(33.6)
Center, excluding Bangkok	(37.6)	(49.1)
North	7.9	5.8
Northeast	8.5	6.5
South	6.6	5.0

Source: World Bank, 1978.

3.0 RESOURCES AND ENVIRONMENTAL PROBLEMS

Thailand's Fourth National Economic and Social Development Plan places greater emphasis on intensive use of resources than past plans. Almost 7% of estimated total expenditure under the Plan is allocated to the area of "Development and Conservation of Economic and Environmental Resources." Two thirds of the proposed expenditure is to be devoted to land related programs, one fourth to forestry, and the balance to water, fuel, and power.

3.1 Topography and climate

Thailand is located in the heart of mainland southeast Asia and covers a total area of 514,000 square km (319,399 square mi). Thailand extends approximately 1,660 km (1,031 mi) from north to south, and at its widest part over 800 km (497 mi) from east to west. Its 2,100 km (1,304 mi) coastline encloses most of the Gulf of Thailand on the South China Sea, and the western side of the peninsula borders the Andaman Sea and Strait of Malacca.

Geologically, the country is made up of two parts: Northeast Thailand and the rest of the country. The Northeast Khorat Plateau region is underlain by sub-horizontally bedded arenaceous rocks (clastic sediments of sand grain size) that in many places are covered by old and recent alluvial deposits. These rocks are of the early Triassic period. Geological structure and the alluvial cover are responsible for the predominant plateau-like character of this area.

The rocks underlying the rest of the country are folded and locally metamorphosed, and include a wide variety of clastic rocks and limestones that, in many places, are intruded by igneous rocks. The dominant structural trend is approximately north-south and this has created a general topography of north-south mountain and hill ranges that are separated by intervening alluvial plains, basins and valleys. The Gulf of Thailand was created by the movement of the land during the early tertiary period.

Geographically, Thailand divides naturally into four main regions:

Northern region - The Northern and Western mountain region is made up of a series of parallel north-south mountain ranges that are sharply dissected by deep, narrow alluvial valleys providing tropic, subtropic and sometimes near temperate climatic zones. The Phi Pan Nam mountain range and the Mekong river form a natural boundary with Laos. The Phi Pan Nam ridge continues southward and merges with the Phetchabun mountains. The Thanon Thong Chai and Tanaosee ranges comprise the western frontier and extend down to the Bilauktang mountains. The mountains of the North do not attain very high elevations and only a few peaks rise over 2,000 meters, the highest being Doi Inthanon (2,595 m) southwest of Chiang Mai. Slopes are steep to very steep and generally do not exceed 20 percent.

The northern mountains are well-watered and the source of many rivers. The Mae Kok and Mae Ing rivers, rising out of the northern-most slopes of the Phi Pan Nam mountains, flow northward into the Mekong on the Laos border. The Pai, Yaum and Mae Moi rivers originate in the southern and western slopes of the Phi Pan Nam range and drain into the Salween river of Burma. Four important rivers - the Ping, Wang, Yom and Nan - flow southeastward out

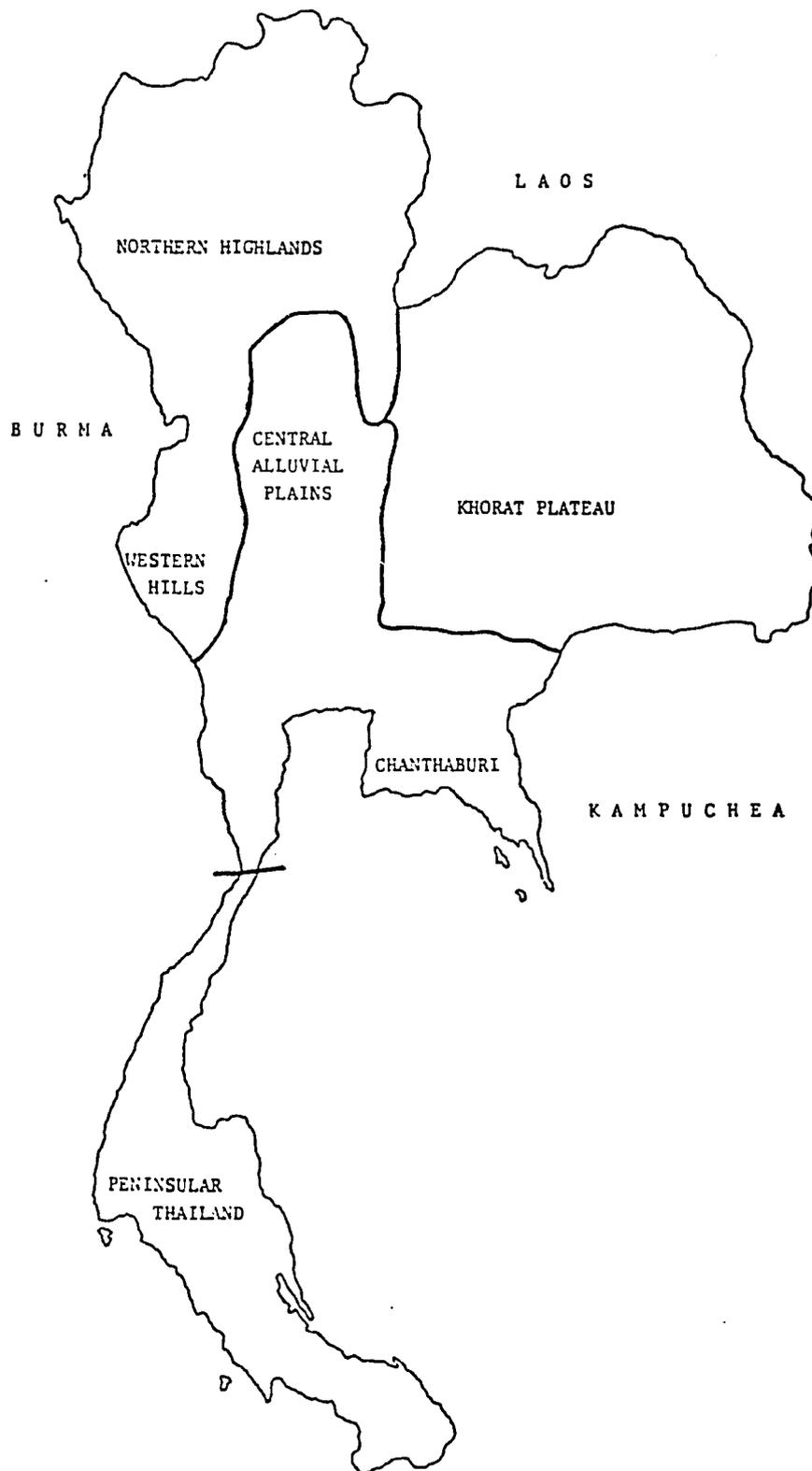


Figure 7. Biogeographical regions

of the valleys of the mountains and unite in the lowlands to form the Chao Phraya river, Thailand's most significant water resource.

The rolling hills between the major rivers are usually deeply cut by streams. Besides the major valley plains of the Ping, Wang, Yom and Nan rivers, there are several small intermontane basins, especially in the western part of the region. Eroded terrace lands are found on the margins of many of the valleys.

Northeastern region - Apart from higher ground along the borders and in the upper Northeast, most of the region is a gently undulating plain that is commonly referred to as the Khorat Plateau. Although called a plateau, the area is actually a large basin less than 1,000 feet above sea level whose rolling surface is occasionally marked by a few flattop hills. The basin comprises about one-third of the country's total land area. It is bounded on the north and east by the Mekong river, on the west by the Phetchabun mountains that form the western scarp of the plain, and to the south by the Phanom Dongrak mountains along the border with Kampuchea.

Central region - The region is dominated by the Central Plain, a triangle-shaped delta stretching down to the Gulf of Thailand which forms the basin of Thailand's most important river, the Chao Phraya. Known as the "rice bowl" of Thailand, the Central Plain is largely composed of lowland and swamps. The rolling plain in the north is heavily dissected by the rivers that merge to form the Chao Phraya and its delta. Like most deltas, that of the Chao Phraya is braided into many small channels and is joined by other rivers as it stretches across the plain southward to the Gulf. To the east and west are the mountains of the North and Northeast regions. In the southeast is the Bang Pakong river and surrounding lowland. Further south is the Chanthaburi mountains and, between the mountains and the Gulf, is the Chanthaburi plain with a rolling terrain and several short rivers all flowing in a southerly direction to the Gulf. These streams have built up small alluvial basins and deltas along the coast, while the mouths of large rivers consist of tidal flats and mangrove swamps. To the west of the Central Plain lies the watershed of the Mae Klong river and the Tanowsri mountain range which forms the border with Burma. There are also smaller ranges of hills running parallel to the mountains and near the Mae Klong river.

Southern region - The southern region, or peninsular Thailand, consists of a narrow isthmus, running north-south, and connecting Burma and Central Thailand to the Malaysian Peninsula. The topography of the region is rolling to mountainous and contains little flatland. The mountain chains that form the border between Thailand and Burma continue southward through the region on a somewhat reduced scale. Some 40% of the region is hilly or mountainous, another one third is low-lying, undulating terrain between and alongside the mountain chain, and the remaining quarter consists of coastal plains lying almost entirely along the eastern coast. The narrow southern boundary with Malaysia is the hilly range known as Kalakhiri. There are no large rivers, but numerous small streams that flow precipitously down narrow valleys, creating a serious flood hazard on the small coastal plains. Off the rugged and much indented west coast lie numerous major islands.

Thailand has a tropical monsoon climate characterized by two distinct rainfall distribution patterns. However, the climate of the Southern region differs

considerably from the rest of the country. Because of its location 6 to 10 degrees north of the equator, and with oceans to the east and west, the climate of the Southern region is intermediate between equatorial and tropical monsoon. This region and the extreme southeast of the Central region are characterized by high rainfall of 2,000 to 3,000 mm per annum. The rainfall is well distributed but generally with a brief dry period around February that is much less severe than elsewhere in Thailand. The remainder of the country is dominated by a monsoonal climate with distinct wet and dry seasons. The wet monsoon, which extends from May to October, is caused by the occurrence of the southwest monsoon, during which a low pressure area over the continent and high pressure area over the Indian Ocean bring warm, moist winds across the Bay of Bengal and into Thailand. The dry monsoon, resulting from a reversal of the pressure systems which causes dry, interior continental winds to blow from the northeast toward the lows of the Indian Ocean, occurs from November to February. There is a transition period in March and April that is usually called the hot season. Between 75% and 90% of rainfall occurs during the wet, southwest monsoon season. Average total rainfall generally ranges between 1,000 to 5,000 mm, its distribution varying according to local topographical features. Although none of the country can be described as arid, the long dry season and poor water-holding capacity of the soils, especially in the Northeast, means that inadequate moisture can limit cropping possibilities. Drier areas are in the northern valleys, the lower areas of the Central Plain, and the southwestern areas of the Northeast.

Northern region - The rainy season lasts from April to October with average annual rainfall being 1,200 mm in the upper North (but with great variations between localities depending on exposure to the southwest monsoon winds) and 1,250 mm in the lower North.

Northeastern region - The rainy season lasts from about April to October, with 1,000 mm of the average annual rainfall of 1,250 mm falling during this period. Maximum rainfall occurs in August/September and in a normal year the changwats in the upper Northeast can expect at least 30% more rain than the rest of the region.

Central region - In the Central Plain the rainy season lasts from May to October and the average annual rainfall is about 1,350 mm. In the more northerly provinces to the east of the Central Plain rainfall averages 1,370 mm per year, but further south the length of the rainy season and the quantity of rainfall is higher, ranging up to 3,670 mm. To the west the rainy season lasts from May to November, but due to its location on the shelter side of the southwest monsoon, average annual rainfall is only 1,200 mm.

Southern region - The rainy season lasts from April to January. Provinces to the east of the mountains are subject to the northeast monsoon and an average annual rainfall of 2,120 mm. Provinces to the west of the mountains are affected primarily by the southwest monsoon, but also benefit from the northeast monsoon and receive an annual rainfall of about 2,680 mm.

The monsoon pattern is modified by local thunderstorms originating in the Gulf of Thailand and cyclonic storms formed by pressure areas moving in from the Pacific and the South China Sea. Local storms may occur in March or April or later, but rarely reach far inland. Cyclonic storms follow a variable pattern. Cyclonic centers form in the Pacific during April or May and progress northward

with the sun. Early lows may bring some rain in April or May, but generally the effect of the cyclonic pressure area is felt in Northern, Northeastern and Central Thailand with heavy June rains, which cause the first sharp rise in the rivers. By about July the cyclonic path has moved northward beyond the watershed areas of Thailand, and there is a lull in the rains lasting 3 or 4 weeks, with a corresponding drop in river levels in July or August. The rains in September are often the heaviest of the year, as the cyclonic path again passes southward on a wide front over the country.

Annual temperature ranges are small throughout the country, with somewhat wider ranges in the Northern region, especially at higher altitudes. The hottest month is generally April and the coolest month January. The diurnal range is comparatively greater, especially during the winter in the North where nights are much cooler than days. Night temperatures in the higher altitudes of the North may drop during the cool northeast monsoon season to 50 degrees F., and rise during the hot season to above 100 degrees F. The most constant temperature is in the Southern region, where the daily range is rarely more than 14 degrees and the annual minimum and maximum temperatures are 68 degrees F. and 95 degrees F. respectively (Nuttonson, 1963).

3.2 Freshwater

Water resources are generally considered to be abundant in Thailand. However, except in the South where the dry season is very brief, the availability of water is highly variable according to the time of year. During the wet southwest monsoon the country is deluged with water, while rivers are nearly empty during the rest of the year. This is particularly true in the Northeast Plateau where there is hardly any water even for domestic use during the dry season.

3.2.1 Surface water

Figure 8 shows the river systems of Thailand. Among rivers in Thailand, the most important is the Chao Phraya which drains the vast Central Plain. The Chao Phraya basin occupies 177,550 square km, over one-third of the country's area. It is the largest river basin located entirely in Thailand and covers almost all of the Northern region and a large part of the Central region. Although rainfall is generally about the same throughout the basin, the northern area contributes the major share of stream runoff, since much of the precipitation in the Central Plain is retained in agricultural areas. Four major rivers that originate in the northern watersheds - the Ping and its tributary the Wang, the Yom and the Nan - drain the North and the upper part of the Central Plain and unite near Nakhon Sawan to form the Chao Phraya. The average annual flow of the Chao Phraya at Chainat (just above the Chao Phraya Dam) is about 25,000 million cubic meters (20 million acre-feet), based on a 20-year record ending in 1968. The Bang Pakong and Pa Sak rivers in the east and the Mae Klong and Phetburi rivers in the west are the other major river systems of the region. The Mekong river and its tributaries is the most important river system in the Northeast Khorat Plateau as it drains the entire area. The undulated lands of the Plateau form several small watersheds. About two sevenths of the upper Plateau drains directly into the Mekong, while the rest of the area drains into the Mekong's two major tributaries, the Mun and the Chi. Table 12 provides some data on these major river systems.

Thailand possesses four large natural lakes and a range of swamps and marshlands in several parts of the country. These areas have high biological productivity and are of considerable importance to wetland birds (many of which are migratory), and to threatened vertebrates (notably the Siamese crocodile, the gavial, and the four recorded species of otters). All of these areas are subjected to varying degrees of human disturbance, especially encroaching agriculture. With increasing intensification of agriculture it is likely that most lowland swamps and marshes will be drained and cultivated in the foreseeable future (IUCN, 1979).

Table 12. Data on Main River Systems

River	Drainage area sq km	Mean annual peak discharge cu m/sec	Average minimum flow cu m/sec	Ratio of dry season flow to mean peak discharge	mean annual runoff million cu m
Chao Phraya	110,371	3,363	32	1:105	22,880
Ping	26,396	1,675	10	1:167	5,410
Wang	10,407	445	1	1:445	1,370
Yom	12,658	1,415	1	1:1415	2,620
Nan	16,775	2,100	12	1:175	6,420
Chi	47,406	1,253	5	1:250	7,300
Mun	106,673	3,179	6	1:530	18,300
Mae Klong	27,220	2,400	48	1:50	12,860
Pasak	14,522	704	5	1:141	2,620
Petch	4,060	472	2	1:235	1,170

Source: van der Leeden, 1975.

The principal form of water development in Thailand involves the construction of dams for the production of hydroelectric power and storage of water for irrigation through canals. The utilization of surface water resources for agriculture has been carried out by Thai farmers for centuries, and agriculture remains the greatest consumer of water resources. Agriculture will continue to account for the greatest use of water in the future, though its relative share will decrease as the demand of other users increases. In addition to hydroelectric power generation, these other uses include domestic and municipal water supplies, inland navigation, and water quality control. Figure 8 shows the location of large storage dams and main diversion dams in Thailand as of the end of 1976, including the site of the future Pa Mong dam on the Mekong. Since 1950, the Royal Irrigation Department has been attempting to control the flow of the Chao Phraya river so as to modify the natural flood regime and increase and stabilize wet season rice production. As a result, it is estimated that well over 60% of the cultivated area in the Central Plain is now subject to some degree of water control.

3.2.1.1 Environmental problems

Thailand's rivers are becoming increasingly polluted from municipal and industrial wastes, the former being the more serious problem of the two. Most of the human wastes, all the drainage, and substantial amounts of solid waste such as garbage from the Bangkok region are being dumped into the Chao Phraya River and its subsidiaries. The pollution from disease-bearing microorganisms has already made water-borne diseases Thailand's top health hazard (see §1.5.1). Bangkok's existing sanitation facilities are wholly inadequate to meet the problem. An international expert in Thailand compared the direct financial costs of installing proper water and sewage facilities in Bangkok to the cost of such massive public utility projects as rapid transit systems for Boston or San Francisco.

Most of the new industries in Thailand are of the "primary processing" type, such as sugar cane processing, breweries, soft drink factories, tapioca mills, etc. Thus, the pollution produced by these factories is primarily organic wastes of a natural (rather than synthetic) origin. These organic wastes have a high BOD (biochemical oxygen demand), which means they gradually use up the dissolved oxygen in the water, in effect killing the waterway. The Factory Environmental Control Division in the Ministry of Industry estimates that well over 90% of factories in the Bangkok area and elsewhere in Thailand do not have pollution control equipment. According to the Deputy Director of the Factories Department of the Ministry of Industry, a total of 808 factories release about 3.5 million cubic feet of used water daily into the Chao Phraya River. The results of the first analytical study carried out under the four-year Lower Chao Phraya Environmental Study Program revealed that industrial wastes from liquor distilleries lacking proper waste treatment facilities are the major source of pollution in the river. The study estimated that pollutants discharged into the river would increase to 80,000 kilograms per day by the end of the year (WER, June 20, 1977). The study later discovered excessive discharges of wastes into a section of the Chao Phraya near the Klung Toey Port. According to the Board, the river water in the polluted section had zero content of dissolved oxygen and the water was noticeably black (WER, March 13, 1978). The Industrial Works Department of the Ministry of Industry was due to complete a study on the feasibility of a central industrial waste treatment facility to prevent water pollution caused by factories in the Bangkok area. The system includes running a pipeline along groups of factories, with the waste water discharged into the pipeline and passed through a water treatment system for purification.

In a study of heavy metals in the environment conducted by the Institute of Environmental Research of Chulalongkorn University in 1977, water and sediments in the vicinity of Bangkok were found to contain levels of heavy metals that exceed natural concentrations. Mercury levels were found to exceed international standards in a few instances. Another study conducted in 1979 found that water pollution from laundry soap powder was becoming a serious problem. The detergent produced in Thailand contains components which are not biodegradable, thus remaining in the waterways and slowly killing off marine life.

The mining sector is adding to the water pollution problem through the discharge of tailings into rivers. This has resulted in siltation of farm lands downstream and has adversely affected agricultural productivity and the fish catch in estuarine areas.

As a result of the above findings, Thailand has begun to tighten the laws for industrial polluters. The Ministry of Industry has been given absolute power to order the closure of factories found guilty of pollution or operating without licenses. In an effort to develop a policy on location of industry, the National Environment Board is considering stricter stream standards which emphasize the collective impact of industrial effluent. Ultimately, the aim of the National Environment Board is to link the location of industry with the assimilative capacity of local bodies of water to promote rational as well as environmentally safe use of land.

Roughly ten percent of Thailand's rural population has access to a safe, adequate water supply, posing a serious environmental health hazard (Luken, 1979). The overwhelming majority of rural households use rivers, irrigation canals, ponds, or shallow unprotected dug wells for their domestic water supply. All these common sources of water are polluted or liable to pollution, especially with insect vectors of disease.

No information was available on adverse ecological effects associated with dam construction. Thailand is accelerating its hydroelectric development program, and several major projects are either already underway or in the planning stages. Thailand is presently exploiting about 15% of the nation's hydro potential and expects to increase this figure to 50% by 1990. Included among these projects is the development of hydroelectric dams on the Mekong and Salween rivers and their tributaries. The Mekong Project, which has been in the planning stages since the 1950's, will be one of the largest such projects ever undertaken. This project and others will have far-reaching physical, biological and human effects. Environmental impact assessments have been undertaken on most large-scale hydroelectric projects initiated in Thailand within the past few years. However, a comparison of the Royal Irrigation Department's irrigation proposals for the present five-year plan with location of protected areas (see Appendices 1 and 2 for location of areas) indicates that the following conflicts could arise (IUCN/UNEP/FAO, 1979):

- The area around the Thale Noi Non-hunting Area will be irrigated.
- Khlong Saeng Dam will flood part of Khlong Saeng Wildlife Sanctuary.
- Khlong Yan Dam will flood part of Khlong Nakha Wildlife Sanctuary.
- Pha Chi Dam will flood part of Maenam Pha Chi Wildlife Sanctuary.
- Tha Khoi Dam will flood part of Maenam Pha Chi Wildlife Sanctuary.
- Khao Yai Dam will flood part of Thung Yai Wildlife Sanctuary.
- Hin Dat Dam may flood part of Khao Soi Dao Wildlife Sanctuary.

3.2.2 Groundwater

No information was available on the quality, quantity and areal extent of Thailand's groundwater resources. However, the Government is carrying out an extensive rural water supply program and information on groundwater undoubtedly exists. A 1976 report to the U.N. Water Conference states that 200 community

groundwater supply systems have been constructed under the program. A separate report to the Conference states that 40% of total demand for all rural and urban water supply systems was provided from groundwater sources (Jaraswathana, 1976).

3.2.2.1 Environmental problems

Though no data were available, critical watersheds (particularly in the Northern region) are being disturbed by the loss of vegetative cover due to shifting cultivation. This loss of vegetative cover is reducing the amount of water that could be intercepted and penetrated into the soil. The National Conservation Plan being developed for Thailand (see Section 3.10) points out that the application of sound watershed management principles to land use has not been sufficiently developed, and recommends the concentration of all watershed management activities under one organization. The Fourth National Plan does make provision for the expansion of rehabilitation schemes in upland watersheds under the head "Watershed Conservation and Improvement of Depleted Forest Areas." In 1974 the Government, with assistance from the UN Development Programme, initiated the Mae Sa Integrated Watershed and Forest Land Use Project. The Government has proposed a new five-year integrated project involving the Watershed Management Division and other agencies together with FAO/World Bank assistance. The project aims at the integrated development of degraded forest watersheds in the Northern region, and covers approximately 1,700 square km of upper catchment sites and 53,000 hectares of lower catchment sites.

3.3 Soils

Considerable work has been carried out in surveying the soils of Thailand. Maps of the distribution of soils and climate may be found in a resources atlas prepared by the Royal Thai Survey Department in 1969. This is based on a generalized map of great soil groups published in 1967 at a scale of 1:1,250,000 (see Moorman and Rajasoonthan, "Kingdom of Thailand General Soil Map," 1967). This is being followed up by a more precise mapping effort based on detailed reconnaissance surveys at a scale of 1:100,000. As of 1978, surveys of 25 provinces had been completed.

The soils and land forms of Thailand can be broadly divided into three groups:

- (i) Recent alluvial plains
- (ii) Older alluvial terraces
- (iii) Sedentary soils

In addition there are relatively minor areas (less than 2%) of coastal sand, peat and swamp soils.

The natural fertility of the soils throughout most of Thailand is low due to leaching by heavy rainfall, which leads to the development of largely acidic soils. Variations in amount, intensity, and distribution of precipitation, length of the dry season, parent rock material as well as relief, drainage, and forest and farm practices appear to have been among the major influences responsible for regional differences in soils (Nuttonson, 1963):

Northern region - Soils are characteristically shallow and stony, occasionally interrupted by pockets of relatively fertile, recent alluvial soils

found along river valleys. The mountain soils are predominantly red-brown podzolic soils and reddish-brown lateritic soils. The Pai and Ping northern headwaters consist of steep land with some limestone crags and red-brown earth. The mountain soils of the Yuam drainage, on acid to intermediate rock, are mainly shallow red-yellow podzolic types. However, the lower-lying portions drained by the Yuam have red-yellow podzolic soil on old alluvium. These clays and loams are well drained, low in base, and low in fertility.

A variety of soil types is found in the valley plains of the Chao Phraya and Mekong tributaries. In the Ping, Nan, Kok, and Ing valleys, the soils near the rivers are alluvial, poorly drained, and clayey with high to moderate fertility. Low-humic gley soils, mostly loamy and sandy, are found commonly in the Ping, Wang, and Yom valleys. Common to all valleys are old alluvium, red-yellow podzolic soils. Undifferentiated soils of lava and volcanic rock are found in the Wang and Yom valleys. Gray podzolic soil on old alluvium is scattered in the plains of the Ping, Wang, and Yom. Red-yellow podzolic soils on residuum and colluvium, formed from acid rocks, and of low fertility are occasionally found along the foothills (Chapman et al, 1978).

Northeastern region - Soils are predominantly poor, fine, sandy loams that are high in quartz sand and silt, but contain little else. A large proportion of the soils are lateritic. Another type of soil is found in the flat plains with sparse grass that are common throughout the region. The soils of these plains consist of about ten inches of light gray to whitish silt on the surface and heavy, gray, clay subsoil. In the western part of the plateau some heavy dark clays are found, which are believed to have developed from the alluvium from limestone and other rocks in the western mountains. In sharp contrast to the infertile soils which predominate in this region are the narrow, fertile strips of alluvial soil areas along the Mekong River, where a natural levee of silt loams has been built up.

Central region - The soils of the Central Plain consist of heavy, poorly drained dark gray clays. The very low and flat nature of the plain ensures uniform flooding during the rainy season, and its permanent groundwater saturation is usually within 3 to 6 feet from the surface. The soils of this area are dominated by the heavy Bangkok clays. Alongside the rivers and streams of the plain are narrow strips and pockets of silt loams and very fine sandy loams. Along the margins of the plain where the slope of the land increases are light-grayish brown to light brown silt loams and light clay loams. The southeastern part of the Central zone, from the valley of the Bang Pakong River down to the border, is a separate soil zone. The Chantaburi Mountains that rise south of the plain are granitic. Between and around the higher mountains are lower hills and terraces, the soils of which have been formed by the weathering of sandstones and quartzites. Thus, most of the soils of this area are sandy. West of Chantaburi is a low dome-shaped area of deep-red friable clay soils which developed from dark igneous rock, referred to as Chantaburi clay.

Southern region - In the drier northernmost portion of this region there is a large area of recent alluvial soils, some of which are saline. Further south, the core of the main mountain ranges are composed of granitic batholiths and intrusions. The soils are rather complex, and are interspersed with fine sandy loams and loams. Where rain is more plentiful, high forests

are common on the local poor sandy loams and sandy clay loam soils. Rubber trees are grown on the well-drained soils and rice on most of the plains and in the lower parts of the valleys. In the southern part of the region there are many areas of steep, stony hills and mountains which often stretch close to the sea, leaving little room for alluvial soils.

A national land capability map has been prepared in which the soils were rated according to their suitability for paddy rice, upland crops and rubber. The principal criterion determining suitability classification was slope. Areas with predominant slopes of over 16-20% were considered unsuitable for cultivation (though slopes up to about 35% can be used for agricultural purposes with adequate soil conservation measures, particularly for perennial crops such as rubber). About 40% of the country is comprised of predominantly steep hills and mountains, about one-tenth of this area may be suited for agricultural use, principally in valley bottoms. However, few soil surveys have been carried out in these areas and little is generally known about them.

Almost 19% of the land area, principally the alluvial plains and low terraces, is suitable for paddy. The better of these soils, principally in the Central Plain, can be cultivated with upland crops in the dry season. On the poorer soils, mainly located in the Northeast, suitability for upland crops is more limited. About 11% of the land area can support both paddy and upland crops. The most extensive areas of this type comprise sandy and rather infertile low humic gley and red-yellow and gray podzolic soils in the Northeast. Soils suited for upland crops comprise almost 28% of land area. A small area along the eastern border of the Central Plain, derived from limestone or other basic rocks, forms the region with greatest potential for intensive upland crop farming in the country. It is this region which has been the principal area of maize production. The remaining areas suitable for upland crops, located on upper terraces and bordering hill and mountain areas, are more acid and less fertile. It is these areas that are the most frequent sites for shifting cultivation. In the South the bulk of rubber is produced on such soils (World Bank, 1978 - Background Working Paper No. 4).

3.3.1 Environmental problems

No data were available on soil degradation. Major problems include leaching, and the loss of topsoil and erosion due to the practice of shifting cultivation and both open pit and strip mining.

3.4 Minerals

Thailand exploits a wide variety of minerals (see Table 13). Tin and tungsten ore are the country's most important mineral resources. In 1970 Thailand possessed 16% of the non-Communist world's known reserves of tin and was the third largest producer in the world. The major tin deposits are located in the Southern region, particularly at Phuket Island off the northern end of the Strait of Malacca, which is the center of the country's tin industry. Lesser quantities of tin are found in the northwestern part of the country in a narrow strip along the Burmese border. The construction of a smelter on Phuket Island has made possible the domestic smelting of most of the mined tin ore. Large tungsten reserves are found in the upper west reaches of the North near Mae Hong Son, and at several places in the Bilaukaung mountains. Some tungsten is

Table 13. Major Mineral Production ('000 of metric tons)

	1970	1973	1976
Lignite	399.9	361.0	680.3
Gypsum	144.2	236.3	268.3
Fluorite ore	317.8	398.0	199.9
Manganese ore	23.9	36.3	50.2
Tin concentrates	29.7	28.6	27.9
Iron ore	22.5	36.3	25.0
Antimony	5.7	8.2	9.2
Wolfram ore (tungsten)	1.4	5.0	4.0
Lead ore	3.0	8.7	2.3

Source: World Bank, 1978.

also found on the Islands of Phangan and Samui off the eastern coast of the central Southern region. Small amounts of petroleum are produced domestically and the Government has granted concessions for offshore oil exploration in the Gulf. Table 14 below outlines the major locations of other significant minerals.

Table 14. Location of Mineral Reserves

Mineral	Location
Lignite	Lampang area, Northern region
Gypsum	Phichit, about 320 km north of Bangkok
Fluorite ore	Rat Buri, 150 km southwest of Bangkok Chiang Mai, Northern region Lamphun, Northern region
Manganese ore	Chanthaburi, Central region Malay Peninsula just north of Malaysian border Upper reaches of the Mae Klong River in the Bilaukaung range
Iron ore	Southeast of Nakhon Sawan and northeast of Kanchanaburi, Central region Loei west of Udon Thani, Northeast region Samui Island Small area just north of Bangkok
Antimony	Northern mountains southeast of Chiang Mai Surat Thani on the eastern coast of central Southern region
Lead ore	Phi Pan Nam mountains near Lampang, Northern region
Coal	Surat Thani and near Krabi, Central region Near Lampang and Chiang Mai, Northern region
Oil shale	Northwest highlands around Mae Sot
Asbestos	Uttaradit, north Central region
Barite	Uttaradit, north Central region Near Mae Sot, Northern region
Zinc	Mountains near Lampang, Northern region

Source: Henderson et al, 1971.

3.4.1 Environmental problems

See sections on Water, Soils and Coastal Zone for environmental problems associated with mining.

3.5 Forests

Tropical forest is the natural climax vegetation throughout most of Thailand. The forests are composed almost exclusively of broadleaf species (non-coniferous woods). Differences in climatic conditions, in particular rainfall and temperature, are the major determinants of the distribution of Thailand's varied forest types. The main forest types of Thailand classified according to climatic adaptation are (see Nuttonson, 1963):

- Evergreen rain forest
- True monsoon forest
- Monsoon dry forest formations
- Pine-oak mixed forest of Northern Thailand
- Grass swamp forest of the Khorat Plateau
- Coastal forest

A more common classification divides the forests into two main groups: evergreen species comprising about 35% of forested area, and deciduous species which cover roughly 65% of forested area (see Figure 9).

Evergreen forest - The evergreen forest covers much of the Northern and Western mountain regions and the low mountains fringing the Northeastern Khorat Plateau, and occurs as swamp forest on lowlands along streams (the yang forest stands). The evergreen forests can be divided into tropical evergreen (composed of evergreen rainforest, semi-evergreen and dry evergreen), hill evergreen, coniferous and mangrove forest.

The tropical evergreen forest occurs from sea level to 1,000 m in areas having an annual rainfall of at least 2,000 mm fairly evenly distributed throughout the year. It reaches its greatest development in the Southern region and southeast of the Central region. The evergreen rainforest is the tallest, densest, and most complex in composition and structure of the various forest types. The foliage of the tropical evergreen forest is composed of four major layers: a ground flora of sparse, low-growing herbs, shrubs and ferns, with grasses (typically Imperata arundinacea) occurring along streams or in areas where the forest has been cleared; a relatively open area just above the ground formed of shrubs and young trees; an almost continuous middle canopy of tree crowns at 20-25 m above the forest floor; and an upper canopy of relatively isolated emergent trees rising to 50-60 m (Dipterocarpus alatus). Vines and epiphytes are prominent. The dominant trees are Dipterocarps and the yang forest stands, consisting mainly of Dipterocarpus alatus, are the most outstanding evergreen rainforests of the country. Vast areas of the evergreen rainforest consist of other Dipterocarps, such as D. pilosus, D. costatus, D. turbitanus, and D. intricatus. Other typical tree species include Streblus zeylanica, Hydrocarpus ilicifolius, Shorea vulgaris, and Diospyros variegatus.

In a number of limited areas in the South and in the lee of the mountains to

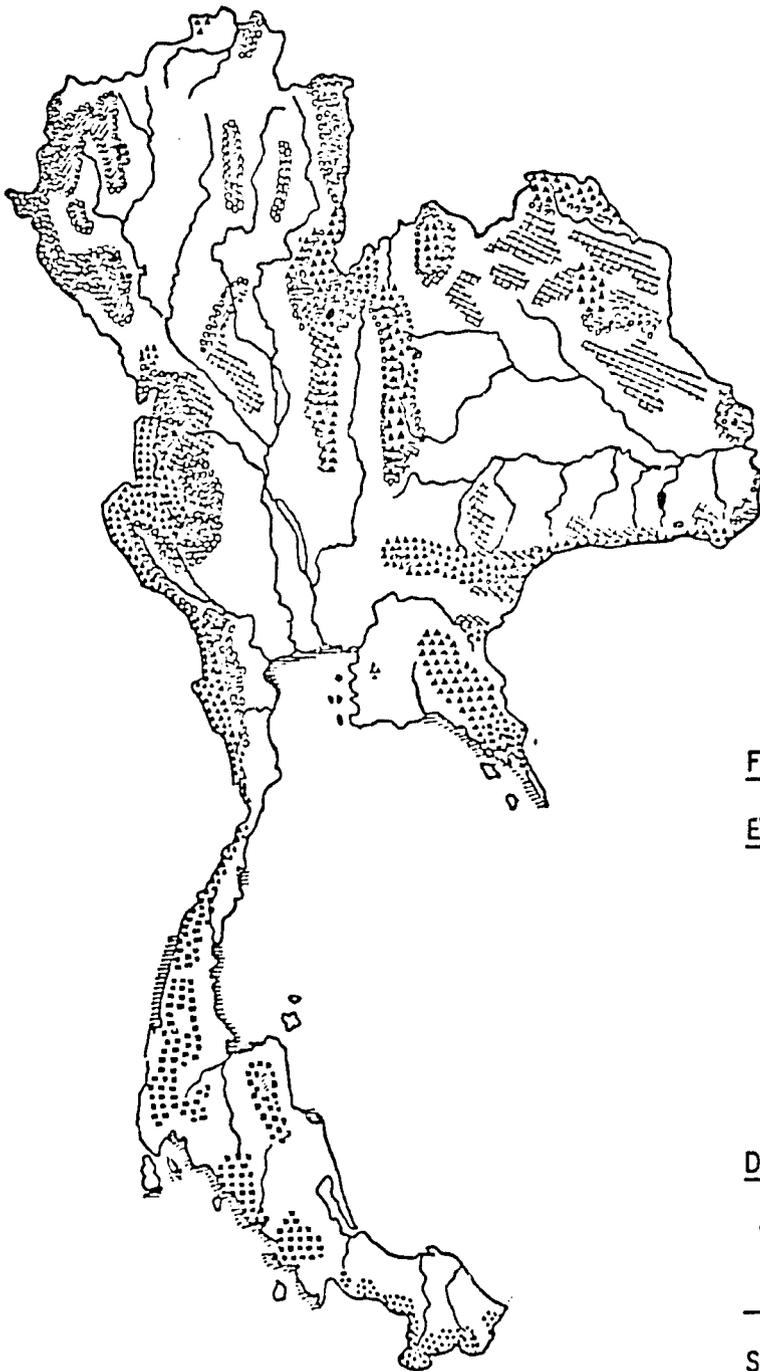


Figure 9. Forest types

Evergreen

- Tropical evergreen
 :::: Evergreen rainforest
 ■■■ Semi-evergreen
 ▲▲▲ Dry evergreen
 /// Hill evergreen
 ≡ Mangrove
 ● Coniferous

Deciduous

- Mixed deciduous
 XXX Dry dipterocarp

Source: IUCN/UNEP/FAO, 1979.

the west of Bangkok occur evergreen, sclerophyllous forests. They are usually found under the tall evergreen rainforest trees such as Dipterocarpus alatus, Hopea odorata, Hydnocarpus anthelminthica and Sandoricum indicum. The evergreen sclerophyllous woody species consist largely of the following: the thorny Balanostreblus illicifolius, Taxostrophis illicifolia, Atlantia monophylla; shrubs such as Wrightia religiosa or Ervatamia sp.; and lianas such as Calamus, Combretum and Strychnus. There is almost no ground vegetation in these forests.

The hill evergreen forests are moist, cool cloudy forests that occur in areas

above 1,000 m where the annual rainfall exceeds 2,000 mm and is fairly evenly distributed throughout the year. The canopy is lower than the tropical evergreen forest and is often composed of just two layers. The dominant trees are oaks and chestnuts - Quercus, Lithocarpus and Castanopsis. Many tree and shrubs of the families Rosaceae, Ericaceae, and Magnoliaceae are associated with these forests, as are orchids, moss, ferns, and epiphytes.

Coniferous forests occur on sandy soils at elevations from 400-1,400 m. They are relatively rare and consist mostly of pines, primarily Pinus khasya and Pinus merkusii.

The mangrove forest is found only in fairly well protected areas on mudflats between the level of the peak spring tides and the lowest neap tides. Major species are Rhizophora mucronata and R. conjugata. Other trees occurring in the inner part of the mangrove swamps are Ceriops candolleana, Bruguiera gymnorhiza, Carapa moluccensis and C. obovata.

Deciduous forest - The deciduous forests of Thailand, both of the mixed deciduous and deciduous dipterocarp types, are quite extensive and are found throughout the Northern, Central and Northeastern regions. The dominant trees are Dipterocarps. The mixed deciduous forest occurs in areas receiving 1,250-2,000 mm of annual rainfall with well-pronounced wet and dry seasons. These forests thrive on a wide variety of soil types and are found on the plains and hills up to an elevation of 1,000 m. More light reaches the forest floor than in the evergreen forest and the undergrowth is dense with many species of bamboo. Dominant trees include Dipterocarpus alatus, Shorea obtusa, Hopea odorata and Tectona grandis. When the rainfall drops below 1250 mm and the dry season lengthens to six months, the mixed deciduous forest is replaced by the dry dipterocarp forest. This type of forest is dominant in the Northeast. Typical species include Shorea obtusa, Dipterocarpus tuberculatus, D. obtusifolius, D. intricatus, and Pentacme siamensis.

Forestry products are important to the economy of Thailand, both for domestic needs and in foreign trade. Forestry provides the basis of the country's wood processing industry, and forests throughout Thailand are the major source of fuel for the rural population (see Table 15). Commercially, the most important forest types are the tropical evergreen and the mixed deciduous forests.

The tropical evergreen forests are a source of valuable non-teak timbers (in particular the Dipterocarps) and fuelwood. In addition, these forests supply most of the minor forest products of commercial importance, including:

Rattans - From Calamus spp., especially C. caesius. Splints of rattan are exported and used for cane seats and in the manufacture of cane fabric.

Dammars - From Dipterocarpaceae spp., especially Balanocarpus helmilii, Anisoptera spp., and Shorea hypocha. Dammer is used in the manufacture of varnish.

Gambodge - From Garcinia hanburyi. Gambodge is a bright yellow resin of considerable commercial value, especially as a coloring agent.

Gutta-Percha - From Palaquium obovatum. Gutta Percha is used as an insulator for heat and electricity. Its greatest single use is in the coating of ma-

Table 15. Wood Production ('000 cubic meters)

<u>Product</u>	1970	1973	1976
<u>Roundwood</u>	18,745	20,481	21,119
<u>Fuelwood and charcoal</u>	14,450F	15,174F	16,091F
<u>Industrial roundwood</u>	4,295	5,307	5,028
Sawlogs and veneer logs	2,655	3,517	3,117
Other industrial roundwood	1,640	1,790	1,911

F = FAO estimate.

All figures refer to non-coniferous woods.

Source: FAO Yearbook of Forest Products 1976.

rine cables.

Wood oil - From various spp. of Dipterocarpus, especially D. alatus, D. turbinatus, and D. pilosus. This oil is used extensively for making torches, caulking boats, varnishing, and waterproofing basketware.

Jelutong - From Dyera costulata. This is used as a base for the manufacture of chewing gum.

Bamboos - Bamboo is a versatile material used for a variety of purposes.

The mixed deciduous forests are the source of teak and other timbers important in foreign trade, as well as bamboos of domestic importance. Apart from timbers, these forests are also sources of various minor forest products such as fibers, crude drugs, and food - a few of which have been developed for export:

Tannin - From many species of trees, such as Terminalia tripteroides, T. mucronata, Anogeissus acuminata, Acacia leucophloea, and Diospyros siamensis.

Dyes - From Caesalpinia sappan, Cudrania javanensis, and Diospyros mollis.

3.5.1 Environmental problems

The forests of Thailand are being depleted at an increasingly rapid rate. Estimates of the total remaining forested area of Thailand range anywhere from 25-38% of total land area. According to comparisons of satellite photo surveys conducted in 1974 with ground surveys taken in 1961, total area under forest cover declined from 57% of total land area (29,298,000 ha) to 37% (19,018,000 ha). This represents a loss of 34.6% of existing forest (10,280,000 ha) in a space of 13 years. Luken (1978) reports that between 1966 and 1978, forest area decreased from 54% to 38%. Parham (1978) reports forested area to have been 60% of total land area in 1960, 50% in 1970, and 39% in 1973. The World Environment Report (8/16/79) reported that Thailand's forested area had de-

creased from about 51% of total land area in 1963 to just 25% at present (no citation was given). The Royal Forest Department estimates the present rate of forest depletion to be 250,000 ha a year, which means that Thailand's forests will be completely denuded in 25 years. The Department also predicts that after 1985 Thailand may even have to import timber for construction purposes. The Dean of the Faculty of Forestry of Kasetsart University believes that all legally accessible natural forests will have been exploited within the next five years. Only those areas theoretically set aside for special purposes, such as watershed, national forest and wildlife reserve areas, will survive. The bulk of forest depletion is due to illegal encroachment and destructive methods of shifting cultivation. Illegal encroachment by landless people is widespread, with logged-over areas especially vulnerable to rapid encroachment. In a survey covering 4.61 million ha, a total of 356,000 ha (7.7%) were found to have been occupied illegally. In a 1969 report to the FAO, the Royal Forestry Department estimated that the total area being cleared annually by shifting cultivation was between 30,000 and 40,000 ha. In the Northern region, which contains the country's most important watersheds, about 3 million ha (approximately 70% of the evergreen forests) had already been denuded. Shifting cultivation is practiced widely throughout the lowlands, foothills and mountains of Thailand, by the local population as well as by the semi-nomadic hill tribes. Its effects have been most severe in the Northern highlands and the Northeast region.

The loss of forests through the spread of cultivation to upland areas and the highlands where important watersheds are located is disrupting the vital ecological functions that the forest carries out; which includes intercepting rainfall, impeding runoff, moderating the release of water into streams and rivers, and returning water directly to the atmosphere through evapotranspiration. The result is loss of topsoil and soil erosion, sedimentation in streams and lakes, flash floods during the rainy season and the subsequent drying up of creeks and waterways during the dry season.

The depletion of forests also threatens the extinction of plant and animal species (see Section 3.7.1 on Wildlife), which has serious ecological, economic, and scientific implications. The tropical forest is the habitat of a vast variety of flora and fauna. Forest depletion has caused the loss of countless plant species, especially of herbs, climbers, epiphytes, saprophytes, and parasites, and a host of other shade tolerant species. In addition, no species except a few orchids are protected outside the system of national reserves. Unlike the higher animal species, the conservation status of plant species suspected to be threatened or being exposed to severe exploitation has never been investigated. In addition to the groups named above, these will include species of Verbenaceae, Dipterocarpaceae, Rhizophoraceae, Lythraceae, Combretaceae, Palmae, Graminae (especially bamboos), Orchidaceae, Rafflesiaceae, Fagaceae (especially Trigonobalanus), Magnoliaceae, Ericaceae, Theaceae, Araceae and the limestone-confined species, many of which are found in the South (IUCN/UNEP/FAO, 1979).

Genetic improvement of agricultural crops and livestock, which is vital to Thailand's agricultural economy, is ultimately dependent on the genetic diversity of natural biotic communities. These communities serve as a genetic source for the improvement of vigour, disease resistance and other desirable properties, which are often lacking in domesticated plants and animals. In addition, the vast communities of plant and animal life in the forests contain

species of unknown value to man. There are numerous plants of potential medicinal value, and other species of plants and animals with potential for production of essential oils, protein, and other products (IUCN/UNEP/FAO, 1979).

The Government is taking steps to address the forest problems of Thailand. The policy of the Government, as expressed in the Fourth National Plan, is that 51% of the total land area (the area of the original forest reserves as identified in 1961) is to be set aside as land under the administration of the Royal Forest Department with the legal status of forest reserve. The export of timber has been banned and the Royal Forest Department has decided to reduce the present logging business by half to preserve the country's forests. No more forestry concessions will be given in the future and the current concessions will not be renewed when they expire. Recently, the Government approved a plan to reforest 300,000 acres. Half the reforestation will be implemented by the Royal Forest Department, another 45,000 acres by the Forest Industry Organization and the concessionaires, and the remaining 105,000 acres by the private sector which will be hired by the Forest Department.

In an attempt to find a satisfactory solution to the problem of shifting cultivation, and as part of its work to support the Royal Forest Department's annual reforestation program, the Forest Industry Organization initiated the "forest village system." The system is, in effect, a modification of the Burmese "taungya" method of agroforestry. Under the program, a forest village is established close to the area to be reforested, which is designated by the Royal Forest Department. Each family is provided with one rai of land on which to live, and ten rais (1.6 hectares) a year for clearing and tree planting. In between the rows of seedlings they may plant cash crops of their choice for their own benefit.

3.6 Coastal zone

The "coastal zone" is the area where land, water (fresh and marine) and air interact. It comprises that part of the land still influenced by tide and salt intrusion and that part of the sea influenced by natural and manmade processes that take place on land, such as runoff, siltation and landbased pollution. There has not been an inventory of Thailand's coastal zone and there is little data on coastal zone boundaries. The coastline can be broadly divided into four regions as follows (Adulavidhaya, 1978):

Region 1 - This region is composed of the provinces located in southeast Thailand or the eastern part of the Gulf of Thailand, which includes Chantaburi, Rayong, Choburi, Trat and Chachoengsao. The coastline is approximately 514.6 km long and includes about 479 square km of mangrove forest.

Region 2 - This region comprises the coastal area of the Central Plain that borders the Gulf, and includes Samut Prakarn, Samut Sakorn and Samut Songkhram provinces. The coastline is approximately 116 km long and includes 273 square km of mangrove forest.

Region 3 - This region covers the coast along the western side of the Gulf of Thailand and includes Phetburi, Prachuapkhirikhan, Chumphon, Suratthani, Nakhonsrithammarat, Songkhla, Pattani and Naratiwat provinces. The coastline extends about 1,247.8 km and is covered by approximately 458 square km

of mangrove forest.

Region 4 - The fourth region of Thailand's coastal zone is located on the western side of the Peninsula bordering the Andaman Sea, and includes Ranong, Phang-nga, Krabi, Trang and Satun provinces. The coastline is approximately 709 km long and mangrove forests cover about 1,917 square km.

The importance of the coastal zone to the environment and economy of Thailand is becoming increasingly recognized. The coastal zone is a source of energy, food, minerals and, to an increasing extent, tourism. However, vast amounts of land and water resources in the coastal zone remain underutilized. The following is a description of the resources of the coastal zone and their present patterns of use:

Forests - The coastal zone consists primarily of mangrove forests, though a significant proportion is in a deteriorated condition. Beach forests occur in small isolated areas. The mangrove forests are estimated to cover an area of 312,700 ha, of which 63% is on the west coast bordering the Andaman Sea. About 178,764 ha of mangrove forest is under the management of the Royal Forest Department. The mangrove forests are primarily utilized for charcoal production. Roughly 53% of the total mangrove area has been divided into 309 felling series and granted to concessionaires for charcoal production. These areas are managed according to the system of clear cutting in alternative strips, with a felling cycle of 30 years. In addition to charcoal production, shrimp farming, mining and other industrial development, and human settlements have been rapidly extended into the mangrove areas. An estimated 20% of the mangrove forest area is suitable for shrimp farming, though far less than this is in use.

Coastal aquaculture - Aquaculture accounts for the bulk of fish production along the coast. The Department of Fisheries estimates that there are about 110,000 rai devoted to aquaculture in the entire coastal area. Most of this production consists of shrimp, oyster and mussel culture, and a small amount of cockle and seabass. The most extensive aquaculture areas are located in Chonburi, Samut Prakarn, Samut Sakhon and Samut Songkhram provinces. Both production and the area devoted to aquaculture have been increasing. Most of the coastal land used for shrimp production presently is under the control of the private sector, while most of the land for shellfish production is under public control. At present, the Ministry of Agriculture and Cooperatives has prohibited the operation of mobile fishing gear within three km of the shoreline along the entire coastal zone of Thailand.

Mining - Tin is the major mineral resource within the coastal zone. Most of the coastal mining activity is located in Phuket, Phang-nga and Takua Pa. Approximately 35,442 ha have been granted for offshore mining.

Agriculture and other uses - A small fraction of the coastal land area is used for agriculture, recreation, industrial settlements, animal husbandry, and human settlements, but there is no data base on these activities. Agricultural crops include rice, nipa, coconut and horticulture crops. Approximately 10,560 ha of coastal land is used for salt farming.

Human settlements - Coastal communities can be broadly classified into five categories: fishing villages, fishing and farming villages, farming villages,

urban-industrial communities and other community communities.

3.6.1 Environmental problems

Coastal areas are especially sensitive ecological zones. Virtually all development projects in coastal areas will have profound effects on the environment. Coastal zone development in Thailand has proceeded in the absence of any rational system of management or due regard for ecological principles. There are presently no integrated programs of coastal resource management within the administrative framework of Thailand. As a result, the coastal ecosystem is deteriorating, particularly in the Gulf of Thailand. Though no data were available, the major problems include:

Mangrove forests - Mangrove forests are critical habitats of commercially important species of marine fish and shellfish, and play an important role in marine ecological processes. Indiscriminate logging of the mangrove forests for charcoal production continues to take place. In addition, most concessions have been lax in replanting exploited mangrove areas. Shrimp farming, mining and other industrial development have been rapidly extended into mangrove areas without proper planning and have thus contributed to their deterioration. Mining activities along the western coast of the Peninsula have caused significant damage to mangroves. Finally, water pollution and increased sedimentation due to upland forest clearing have disrupted the ecological system of mangrove forests.

Coral reefs - Except for those in Ko Tarutao, coral reefs are deteriorating due to lack of control of human activities, including the illegal use of dynamite by fishermen and siltation from mining activities (IUCN/UNEP/FAO, 1979).

Fisheries - Modern fishing techniques have expedited the over-exploitation of marine fisheries. Both pelagic and demersal fishing grounds in the Gulf of Thailand and the Andaman Sea are heavily over-fished (IUCN/UNEP/FAO, 1979).

Mining - Mining activities are contributing to the deterioration of the mangrove forests. Mining is also increasing the turbidity of streams and marine water, which causes deposits of mud on the seabed and on some beaches and coral reefs. The Government has now established a policy of prohibiting mining within the country's forests, so the rate of mineral resource use should soon be reduced.

Other pollution - Pollution of the coastal zone is increasing from other sources as well, both inland and in the zone itself. There is a serious problem of industrial pollution in several major estuaries. A long-term study made between 1975 and 1976 showed increased mercury pollution from industry in the Gulf of Thailand. The beaches of Pattaya are threatened by untreated sewage from hotels combined with untreated organic wastes from the tapioca starch industry. Water pollution caused by the petro-chemical industry in Chonburi is increasing.

With the increased recognition of the ecological and economic importance of the coastal zone, a more rational and comprehensive approach to coastal resource management is being developed in Thailand. Two major constraints that must be

overcome are the lack of knowledge in all aspects of the coastal zone (ecological, economic, social) relevant to its proper management, and the lack of coordination among the different government departments involved in this area. As a first step, the Coastal Land Development Office has initiated the Coastal Land Development Project to develop and manage the use of coastal resources. Under its master plan, Thailand's coastal zone will be divided into eight developmental areas for agriculture, fisheries, animal husbandry, salt farming, mangrove forest reservation, port facilities, industrial zones and recreation. As of the end of 1978, the project was still in the survey stage.

3.7 Wildlife

Wild elephants occur in the limestone hills of the North and in the woodlands of the Southern region, but have been wiped out in many other parts of the country. Elephants, along with buffalo, cattle, horses, and mules are among the more important domesticated animals for agriculture and transportation. Both the single-horned and double-horned rhinoceros existed on the Peninsula until the early part of the twentieth century, at which time the double-horned species suffered a severe decline and may now be extinct. A few single-horned rhinoceros may still be found. The tapir occurs in the forests along the Malaysian border, and wild hog and several species of deer are common in the wooded areas. Other forest dwellers include tigers, leopards, panthers and many small predators. The Himalayan black bear and the Malayan bear are found in the mountain ranges. Gibbons and several varieties of monkeys can be found throughout the country (Henderson et al, 1971).

Approximately fifty species of snakes occur in Thailand, of which about a dozen are poisonous, including cobras, coral snakes, kraits, and vipers. Sea snakes, lizards, crocodiles, and several species of turtle are present.

Thailand has a rich diversity of bird fauna with close to 1,000 species. By comparison, there are less than 500 species in Europe. The most common birds are martins, babblers, and drongos (see Cronin and Lekagul, 1974 for complete description of birds in Thailand).

3.7.1 Environmental problems

The wildlife of Thailand is decreasing both in quantity and in number of species. The major threats to wildlife are illegal hunting and trapping for local and foreign trade, and habitat destruction through forest clearing. The following species occurring in Thailand have been identified as endangered or threatened:

<u>Common Name</u>	<u>Scientific Name</u>	<u>Status</u>
<u>Mammals</u>		
Banteng	<u>Bos banteng</u>	Endangered
Deer, Eld's brow-antlered	<u>Cervus eldi</u>	Endangered
Deer, hog	<u>Axis (Hyelaphus) porcinus annamiticus</u>	Endangered
Dugong	<u>Dugong dugon</u>	Endangered
Elephant, Asian	<u>Elephas maximus</u>	Endangered

<u>Common Name</u>	<u>Scientific Name</u>	<u>Status</u>
Gibbons	<u>Hylobates</u> spp.	Endangered
Leopard	<u>Panthera pardus</u>	Endangered
Leopard, clouded	<u>Neofelis nebulosa</u>	Endangered
Rat, limestone*	<u>Rattus hinpoon</u>	Threatened
Rat, Neill's*	<u>Rattus neilli</u>	Threatened
Rhinoceros, Javan	<u>Rhinoceros sondaicus</u>	Endangered
Rhinoceros, Sumatran	<u>Didemnoceros sumatrensis</u>	Endangered
Seledang (Gaur)	<u>Bos gaurus</u>	Endangered
Siamang	<u>Symphalangus syndactylus</u>	Endangered
Tapir, Asian	<u>Tapirus indicus</u>	Endangered
Tiger	<u>Panthera tigris</u>	Endangered
<u>Birds</u>		
Duck, white-winged wood	<u>Cairina scutulata</u>	Endangered
Greenshank, Nordmann's	<u>Tringa guttifer</u>	Endangered
Hornbill, helmeted	<u>Rhinoplax vigil</u>	Endangered
Ibis, giant*	<u>Pseudibis gigantea</u>	Threatened
<u>Reptiles</u>		
Crocodile, Siamese	<u>Crocodylus siamensis</u>	Endangered
Gavial, false*	<u>Tomistoma schlegelii</u>	Threatened
Monitor, Bengal	<u>Varanus bengalensis</u>	Endangered

Loss of habitat, largely through forest destruction, is a very serious problem as described earlier in section 3.5.1. Illegal hunting and trapping continues to be the major threat to wildlife. The volume of illegal trade is estimated to be three to fifty times higher than the volume of animals caught legally. To put this into perspective, between 1966 and 1971 the following animals were reported to have been exported legally: 8,897 squirrels of Callosciurus, 897 lorises, 27,968 macaques, 1,129 otters, 1,049 civets, 35 leopards, 1,780 small cats and 245 elephants. In 1968 alone, 19 young bears were sold in Bangkok's Sunday market and 55 were exported. In 1977, 232 licences were issued permitting trade in 233,160 specimens of protected mammals. This was reduced to 187 licences in 1978, of which 21 were granted for trade in the Bangkok Sunday market. There is apparently no control of trade in unprotected species. Small quantities of tiger, leopard and clouded leopard skins are still occasionally found on sale, though trade in these products is illegal. Trade in products of the following animals is also on the increase: skins of the cobra, python, monitor lizard, and frog leather. The rhinoceros continues to be the prize animal of illegal traders; the horn and remains of a rhino are estimated to be worth between 40,000 and 80,000 baht (IUCN/UNEP/FAO, 1979).

The bird fauna is also coming under increasing pressure and many species have suffered dramatic declines in their populations. The problem stems from both

* Identified in IUCN/UNEP/FAO, 1979 - other species are from U.S. Department of the Interior, Fish and Wildlife Service. List of Endangered and Threatened Wildlife and Plants. Federal Register of Jan. 17, 1979, Part II.

loss of habitat and hunting and trapping. Pigeons, Rails and Pheasants are widely hunted and trapped for their food value. Kingfishers, Egrets, Parrots, and Blackbilled Rollers are hunted for their colorful plumages. In addition to the four birds listed above as threatened or endangered, many other species are alarmingly rare, including the Argus Pheasant, Sarus Crane, many Storks, several Pigeons, and others.

3.8 Fisheries

Fisheries are an important resource in Thailand since fish is the principal source of animal food and the only significant source of protein in the national diet. Fisheries production, both inland and marine (but especially the latter), experienced phenomenal growth between 1960 and 1971, and was easily the fastest growing economic activity in the primary production field. However, since 1971 the catch of wild species has suffered a dramatic decline and production has been maintained only through more intensive fishing and an increase in fish cultivation. Table 16 outlines the fish catch for the period 1972-1977.

3.8.1 Freshwater fisheries

Freshwater fish make up only a very small proportion of total fish production. A high proportion of Thailand's freshwater fisheries are concentrated in man-made reservoirs, fish ponds and canals, but intensive fishing continues in natural streams and rivers. Much of this catch is consumed locally.

3.8.1.1 Environmental problems

Freshwater fisheries are suffering from over-exploitation and deterioration of their habitat. Thailand does not have the manpower and resources to adequately enforce restrictions to prevent overfishing. Since the catch of wild species began to decline, production has been maintained by the use of fish hatcheries and annual restocking of ponds and reservoirs (IUCN/UNEP/FAO, 1979). As described earlier, inland waters are becoming increasingly polluted by industrial effluents, and siltation from upland erosion is further disrupting fishery habitats.

3.8.2 Marine fisheries

Thailand has extensive marine fisheries though, as described in the following section, they have not been managed properly. A notable development in marine fisheries is the expansion of fish culture. Shellfisheries (green mussel, horse mussel, cockle, and oyster), in particular, have great potential for increased production through cultivation. It is estimated that there are over 60,000 ha of suitable and available sites for shellfish culture in addition to areas presently used, which could yield a total production of over 2.5 million tons. Table 17 outlines the extent and potential of shellfish farms in Thailand.

3.8.2.1 Environmental problems

The situation with respect to marine fisheries is especially serious. The catch per unit effort declined disastrously after 1971 and, as with freshwater fisheries, the level of production has been maintained only through a substan-

Table 16. Nominal Fish Catch by Species Group (metric tons)

Species	1972	1974	1976	1977
Total	1,678,800	1,515,500	1,659,996	1,778,094
Freshwater				
Common carp	800	3,100	826	841
Asian barbs	12,100	15,500	11,029	11,232
Torpedo-shaped catfishes	34,400	34,500	19,714	20,076
Freshwater siluroids, etc	1,300	3,500	2,252	2,293
Striped snakehead	26,500	27,700	24,204	24,649
Climbing perch	9,700	12,700	9,268	9,438
Snakeskin gourami	8,900	11,000	16,075	16,370
Miscellaneous freshwater fishes	30,800	46,300	60,876	61,995
Marine fishes				
Indian halibut	-	3,300	3,238	3,419
Tonguefishes	-	4,100	6,053	6,349
Sea catfishes	11,400	8,600	5,930	6,838
Miscellaneous sea catfishes	1,200	800	1,211	1,302
Lizardfishes	15,600	12,200	10,644	11,233
Daggertooth pike-conger	-	1,800	2,306	2,442
Bigeyes	15,200	12,500	12,166	11,717
Sillago-whittings	900	1,900	1,222	1,302
False trevally	500	600	179	180
Miscellaneous snappers	6,900	4,500	6,232	6,542
Threadfin-brems	21,100	19,000	16,904	17,745
Monocle brems	5,700	4,600	3,555	3,744
Miscellaneous croakers, drums	18,800	17,900	9,786	10,256
Barracudas	3,900	3,800	3,166	3,256
Mulletts	1,600	2,100	4,582	4,884
Threadfins	2,200	3,800	1,415	1,455
Russell's scad	2,900	34,800	83,760	87,912
Hardtail scad	2,100	5,300	14,984	15,792
Miscellaneous carangids	8,900	10,600	22,284	23,443
Black pomfret	2,600	2,300	3,331	3,419
Silver pomfret	900	2,100	1,222	1,302
Miscellaneous sardinellas	11,400	58,200	66,698	110,867
Anchovies	20,300	27,600	17,296	18,071
Dorab wolf-herring	1,300	1,500	1,523	1,628
Miscellaneous king mackerals	3,300	4,900	8,849	9,280
Miscellaneous tuna-like fishes	6,600	9,900	9,719	10,256
Largehead halftail	3,400	5,500	6,316	6,675
Indian mackerel	13,900	20,400	25,885	27,188

Miscellaneous Indian mackerals	41,600	40,700	53,771	56,492
Miscellaneous skates and rays	8,500	9,100	6,731	7,000
Various sharks	5,900	4,600	4,715	4,884
Miscellaneous marine fishes	1,026,000	772,300	702,771	736,996
Crustaceans				
Freshwater prawns and shrimps	3,600	5,700	3,050	3,106
Swimming crabs	16,300	24,200	19,315	20,187
Mud crab	2,800	3,600	3,114	3,256
Miscellaneous marine crabs	-	200	3,585	3,744
Miscellaneous panulirid spiny lobsters	1,500	1,500	1,575	1,628
Banana prawn	4,800	9,100	10,201	10,745
Giant tiger prawn	200	300	94	163
Green tiger prawn	1,700	2,600	1,907	1,954
Western king prawn	600	1,200	1,241	1,302
"Metaponaeus" prawns	10,100	14,000	13,176	13,838
Sergestid shrimps	5,400	11,700	22,118	23,281
Miscellaneous prawns and shrimps	44,300	52,800	62,064	65,120
Molluscs				
Miscellaneous cupped oysters	4,200	4,400	6,963	7,326
Green mussel	71,100	13,500	73,400	76,842
Horse mussels	16,200	12,900	43,233	45,421
Ark clams	4,700	3,100	17,951	18,885
Short neck clam	14,100	13,800	23,300	24,420
Miscellaneous cuttlefishes	23,900	21,000	23,753	24,908
Common squids	44,700	42,000	36,163	38,472
Miscellaneous octopuses	4,200	1,600	4,036	4,233
Miscellaneous marine molluscs	8,900	4,400	3,715	3,907
Jellyfishes	2,700	2,400	22,738	23,932
Miscellaneous aquatic invertebrates	3,200	3,900	15	-
Miscellaneous aquatic plants	500	-	608	651

Source: FAO 1977 Yearbook of Fishery Statistics.

Table 17. Extent and Potential of Shellfish Areas in Thailand, 1976

Province	Area cultivated (ha)				Total (5)	Potential areas available for cultivation (ha)		Cockle		Total (10)	Grand total of available areas (11) (5 + 10)
	Green mussel (1)	Blue mussel (2)	Cockle (3)	Oyster (4)		Green mussel (6)	Blue mussel (7)	Cockle (8)	Cockle (9)		
<u>South China Sea Area</u>											
1. Trat	6	-	-	200	206	9 574	-	500	6 300	16 394	16 600
2. Chanthaburi	-	-	-	800	800	4 000	-	2 000	1 200	7 200	8 000
3. Rayong	-	-	-	-	-	-	-	-	1 000	1 000	1 000
4. Chelburi	500	300	-	200	1 000	100	-	100	100	1 100	1 100
5. Chachoengsao	700	-	-	-	700	100	200	200	-	500	1 200
6. Samut Prakharn	200	-	-	-	200	2 500	200	500	-	3 200	3 400
7. Bangkok	-	-	-	-	-	300	100	-	-	400	400
8. Samut Sakharn	500	-	-	-	500	1 500	800	1 000	-	3 300	3 800
9. Samut Sengkhram	500	-	-	-	500	1 500	300	300	-	2 100	2 600
10. Fatchaburi	200	-	200	-	400	2 000	-	-	100	2 100	2 500
<u>Andaman Sea Area</u>											
1. Prachuap Khirikhan	-	-	-	10	10	-	-	-	100	100	110
2. Chumphon	20	-	-	30	50	500	-	200	150	850	900
3. Surat Thani	-	-	-	50	50	3 500	200	1 000	250	4 550	5 000
4. Takhornerithbarn	-	-	-	-	-	1 000	300	500	300	2 100	2 100
5. Songkhla	-	-	-	10	10	-	-	-	70	70	100
6. Pattani	-	-	-	30	30	-	-	-	400	400	430
7. Narathiwat	-	-	-	-	-	-	-	-	500	500	500
18. Nakhon	-	-	-	100	100	3 000	500	2 000	500	6 000	6 100
19. Phangnga	-	-	-	-	-	5 000	2 000	2 000	1 000	10 000	10 000
20. Krabi	-	-	-	-	-	-	-	-	200	200	200
21. Trang	-	-	-	-	-	400	-	100	500	1 000	1 000
22. Satul	-	-	300	-	300	-	-	1 000	500	1 500	1 800
Total	2 626	300	500	1 430	4 856	34 594	4 600	11 300	13 170	63 984	68 840

1/ Based on recent field surveys by staff of the Department of Fisheries

tial increase in fishing effort and fish cultivation. Over-explicitation in both the Gulf of Thailand and the Andaman Sea has been due to a significant increase in demersal fishing in which the number of trawlers in use increased from 1,100 in 1962 to 6,300 in 1977, and in pelagic fishing in recent years. In addition, the minimum legal mesh size used in the trawls is too small - many desirable species are caught at such a small size that they are considered "trash fish", and will not have achieved their maximum production (IUCN/UNEP/FAO, 1979). The adoption of a 200 mile limit on marine jurisdiction by neighboring countries has cut off a significant source of fish, thus increasing pressure on Thai waters. In addition to over-fishing, the deterioration of marine habitats (described in § 3.6.1 on the coastal zone) has effected fisheries. In response to the decline in near-shore fisheries, the Government has prohibited fishing within three km of the shore. The Government is also in the process of concluding an agreement with Bangladesh for coordinated protection and exploitation of marine fisheries.

The following species occurring in Thailand have been identified as endangered:

<u>Common Name</u>	<u>Scientific Name</u>
Bonytongue, Asian	Scleropages formosus
Catfish	Pangasius sanitwongsei
Catfish, giant	Pangasianodon gigas
Temolok, Ikan	Probarbus jullieni

3.9 Protected area system and biosphere reserves

Thailand has a fairly extensive protected area system that comprises between 5%

and 10% of total land area. The system includes the following categories of protected areas (IUCN/UNEP/FAO, 1979):

National parks - There are a total of 22 national parks (see Appendix 1 for their location). These areas are concentrated in forests.

Wildlife sanctuaries - There are 21 wildlife sanctuaries and an additional 12 areas proposed for inclusion (see Appendix 1 for their location). These areas are in reality strict nature reserves where exploitation is not permitted. They are thus similar in concept to national parks, though tourism is not encouraged. Wildlife sanctuaries are at present confined to areas already within the jurisdiction of the Royal Forestry Department. A system of seven education centers is being established in wildlife sanctuaries.

Non-hunting areas - There are 11 non-hunting areas (see Appendix 2 for their location). These areas are only protected against hunting and are often small in size.

Forest parks - These are small areas that serve primarily as local recreation areas.

In its survey of ecosystem management within the protected area system, the IUCN/UNEP/FAO mission identified the following problems that either diminish the system's usefulness or threaten its long-term security: lack of representativeness of biotopes (especially in coastal areas and lakes); encroachment by shifting cultivation and other forms of land use; poaching; water development projects; need for improved facilities for education and tourism; lack of management plans; and need for local involvement in protection. Many of Thailand's protected areas have suffered from some form of degradation, principally poaching and land clearance. For instance, forest clearing has caused soil erosion in Doi Inthanon National Park and a few other areas. Another problem is the spread of imperata grass and exotic species of plants (Lantana camara and Eupatorium odoratum) following fires. The protected area system does not have adequate manpower and resources to deter these disturbances.

The proposed National Conservation Plan (IUCN/UNEP/FAO, 1979) contains recommendations on the expansion of the protected area system to increase its representativeness. This includes both the expansion of existing areas and the addition of new areas. The Plan also recommends priority areas to be included in a conservation assessment of ecosystems within the protected area system (see Appendix 3 of this report).

There are three biosphere reserves in Thailand - Sakaerat Environmental Research Station, Mae Sa-Kok Reserve, and Huai Tak Teak Reserve. At present, these reserves are not subject to any comprehensive form of protection.

3.10 A National Conservation Plan

In 1977, the National Environment Board requested assistance from the International Union for the Conservation of Nature and Natural Resources (IUCN) in the development of a long-term strategy for the conservation (sustainable development) of the living natural resources of Thailand. As a result, a joint IUCN/UNEP/FAO mission, in consultation with government officials, scientists, con-

ervationists and members of the public, has developed a plan that is to form the basis of a comprehensive conservation program to be implemented in the five-year period 1980-84. The mission addressed the following issues:

- the adequacy of the existing system of protected areas;
- possible improvements to the existing system so as to protect a greater range of ecosystems and their constituent species;
- identification of the most important causes of degradation of ecosystems and the loss of their constituent species and other natural resources;
- the adequacy of existing legislation and administrative arrangements relevant to conservation;
- action to be taken to increase public awareness of the values of conservation through the school system and the extension services of government agencies to rural people.

A second draft of the plan has been completed. The plan deals primarily, though not exclusively, with natural or relatively unmodified ecosystems in forests, swamps, lakes, rivers, coastal areas and the sea. However, many of its recommendations are relevant to improved conservation of all ecosystems throughout the country. The document is presented in two volumes. Volume I comprises the plan and Volume II the appendices to the plan which provide detailed supporting data on which the recommendations are based.

4.0 ORGANIZATIONS RELEVANT TO ENVIRONMENTAL AND NATURAL RESOURCE MANAGEMENT

Following a bloodless coup led by a group of military leaders in 1977, a new constitution was recently promulgated and elections subsequently held. General Kriangsak Chomanan, who was acting Prime Minister during the intervening period after the coup, was elected to remain in office.

4.1 Political and administrative structure of Thailand 1/

Thailand has a highly centralized system of government based on a constitutional monarchy formed after the revolution of 1932. The development of Thailand's system of government is unique among Asian countries in that it is the product of a gradual process of domestic evolution uninterrupted by conquest or colonial rule. The central government is organized along conventional ministerial lines. Each ministry has between five and twelve departments which enjoy a high degree of autonomy compared with most governments of similar structure. A Council of Ministers, presided over by the Prime Minister, is the central decision-making organ and source of executive authority.

Since 1932, the bureaucracy has gradually filled the void left by the demise of the absolute power of the monarchy. During this time the central government has assumed an increasingly greater role in the management of national economic and social development. The Office of the Prime Minister occupies a particularly important and powerful position in the central government. As the activities of the government have expanded, several central agencies responsible for the formulation of policy, resource allocation, administrative coordination and research were created within the Prime Minister's Office. Three of these agencies - the National Economic and Social Development Board, the Budget Bureau and the Civil Service Commission - together with the Bank of Thailand and the Ministry of Finance are the principal institutions responsible for the allocation of human and financial resources.

The structure of local government in Thailand remains highly centralized, with the Ministry of the Interior exercising control, directly or indirectly, over all local government institutions (see Figure 10). The changwat is the largest geographic unit of local administration. Although the changwats are grouped together by region, the regions themselves have no administrative significance. Each changwat is headed by a governor who is appointed by, and reports directly to, the Department of Local Administration in the Ministry of the Interior. There are 72 changwats covering the entire country. Within each changwat is at least one municipality (of which there are currently 118), several sanitary districts or semi-urban areas, and from 3 to 19 districts or amphurs. Each amphur consists of several rural centers or tambons which are made up of groups of villages or settlements. Municipalities have a greater degree of autonomy over areas under their jurisdiction than do changwats, and are administered by an elected Municipal Assembly and a Municipal Council. Sanitary Districts are directed by District Officers, who are appointed by the Department of Local Administration and report directly to the changwat governor. Because district officers represent the lowest level of central government authority, they are the most important link between the villages and the central government. Under this highly centralized system of government, Thailand has not yet developed a

1/ This section and §4.2 are based on World Bank, 1978 - Background Working Paper No. 8.

tradition of strong local government institutions, though steps are being taken to increase participation.

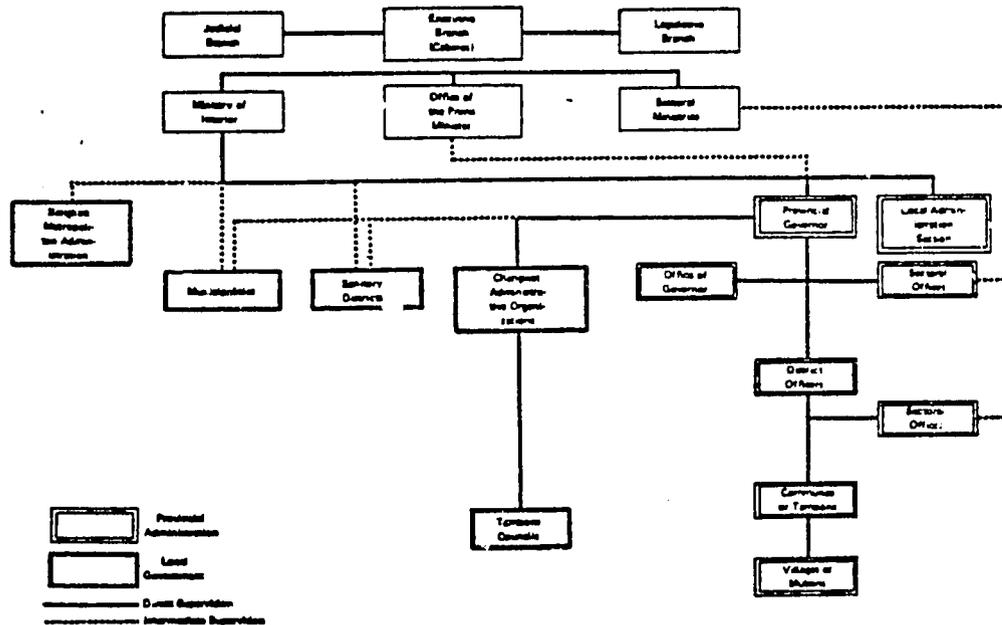


Figure 10. Provincial administration and local government

4.2 Planning processes

It has only been in the last twenty years that Thailand has taken a systematic approach to development planning. Though the quality of national planning has improved during this period and the processes of planning have become more sophisticated, planning has not become strongly established in Thailand and remains relatively ineffectual. Several kinds of planning at various levels are now being attempted in Thailand (World Bank, 1978 - Background Working Paper No. 8).

4.2.1 Comprehensive long-term planning

The National Economic and Social Development Board (NESDB) has overall responsibility for national planning and development of the Five Year National Economic Development Plan (see Figure 11 for organization chart). There have been four such plans; 1961-1966, 1967-1971, 1972-1976, and 1977-1981. Several problems exist with the national planning process. Though the plans are comprehensive in stating development objectives and policies, they do not seem to systematically guide the actions of departments, or the Council of Ministers itself, in the day-to-day conduct of governmental affairs. This has led to frequent disregard of the plans.

There are several reasons for the lack of authoritative planning on the part of the NESDB. The most important are the institutional environment within which the NESDB must operate, and the lack of a clear statutory assignment of responsibility for supervising implementation of the plan. The establishment of

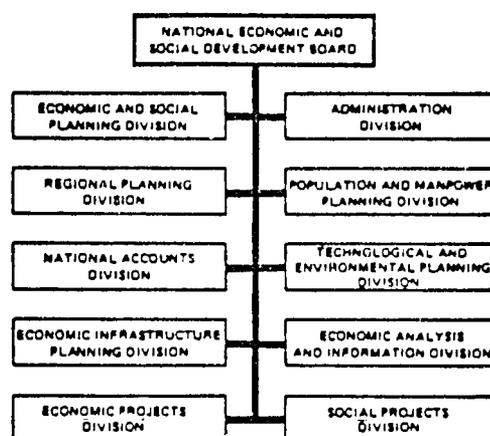


Figure 11. Organization chart of the NESDB

the NESDB and the Bureau of the Budget in the Office of the Prime Minister - two separate and potentially powerful agencies both concerned with the allocation of resources - has led to conflict and inconsistency in the direction of economic management. The responsibility of the Ministry of Finance for fiscal policy and revenue mobilization further complicates the situation (see World Bank, 1979 - Background Working Paper No. 8 for a more detailed analysis of these problems).

4.2.2 Sectoral planning

In contrast to comprehensive long-term planning, the NESDB is making slow but steady progress in the preparation of sectoral plans, which are now receiving greater attention. The executive committee of the NESDB has established a series of sectoral subcommittees to gather data, conduct research, and to formulate sectoral policies and goals. Sector plans for industry and communications have been completed.

4.2.3 Other planning processes

A major weakness in Thailand's planning system is the absence of any effective annual planning. There is thus no mechanism for reconciling annual budgeting with long-term planning perspectives. Another serious weakness in the planning process is the ineffectiveness of ministerial planning units. Departments within a Ministry often have their own planning units that prefer to bypass the ministerial unit and deal directly with the NESDB and Budget Bureau.

No sustained effort has been made at systematic regional development planning. The regional NESDB planning offices are understaffed and have not played a significant role in planning efforts. However, with the introduction of changwat planning in 1975, the regional offices have assumed an important new consultative role. They have assisted in the establishment of changwat planning units and have continued to render advice on the preparation of changwat development plans. The changwat plans cover the entire area under the provincial jurisdiction, including municipalities and sanitary districts. The first task of changwat planning units has been to collect basic information and to identify development needs. Once changwat plans are cleared and approved, government agencies may only implement those projects that are included in the changwat plans.

4.3 Government agencies

Office of the Prime Minister

National Economic and Social Development Board (NESDB)

In 1974, an Environmental Division was established within NESDB. This Division formed the nucleus of the Office of the National Environment Board upon its creation in 1975 (see below). An environmental division has been maintained within NESDB to serve as a link with the Board.

Department of Technical and Economic Cooperation (DTEC)

All grant projects, whether bilaterally or centrally funded, must be formally reviewed and approved by DTEC.

National Environment Board (NEB)

In 1975, the Government promulgated the Enhancement and Conservation of National Environmental Quality Act B.E. 2518. This act, among other things, created the National Environment Board (NEB) and its operational arm, the Office of the NEB. Figure 12 outlines the organizational structure of the NEB.

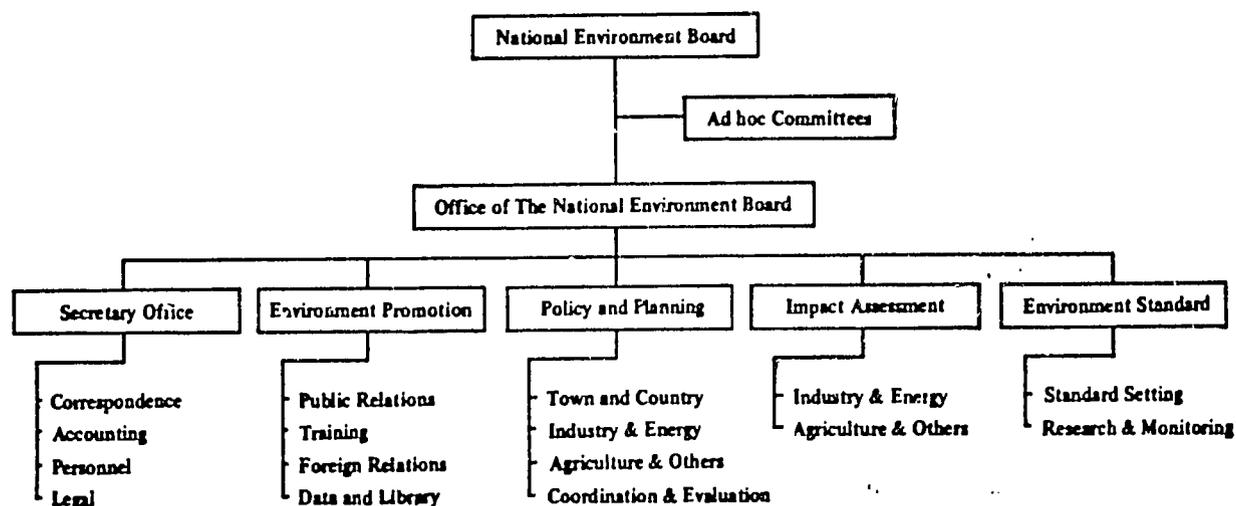


Figure 12. Organization chart of the NEB

The NEB serves as the central agency dealing with environmental issues and is responsible for developing policy to enhance and maintain environmental quality, and to advise the Council of Ministers in this regard. To assist in policy-making, the NEB has established ten Ad Hoc Committees covering relevant areas of interest. The Committees are:

- Population and Human Settlement
- Land Use
- Water

- Air and Noise Pollution
- Nature and Art Conservation
- Environmental Education and Public Relations
- Environmental Law
- Ground Water and Land Subsidence
- Evaluation of Nuclear Power Project
- Environmental Management and Development of Songkhla Lake

Both government and private sector projects are subject to environmental review by the Board. Under the National Environmental Quality Act of 1978 (see Section 5.1), which significantly strengthened the functions of the NEB, the Board is empowered to:

- request environmental impact statements;
- recommend environmental quality standards and penal action for violation of such standards to the Cabinet;
- coordinate the efforts of government agencies, state enterprises, and the private sector.

The NEB has initiated a program to develop comprehensive environmental management plans for selected ecologically sensitive areas. The objective of the program is to establish guidelines for existing and future development. The project has produced a Manual of NEB Guidelines for Preparation of Environmental Impact Evaluations and a set of Environmental Guidelines for Coastal Zone Management in Thailand.

Organizational relations between the NEB and other central organizations in the government, notably the NESDB and the Budget Bureau, are in the process of being developed. Administratively, the Secretary-General of the NESDB is an ex-officio member of the Board of the NEB, and representatives of the NESDB are normally included in almost all of the committees and working groups established by the NEB. As noted above, a small environmental staff has been retained within the NESDB to act as a link with the NEB. The NEB and NESDB act essentially as lead agencies in environmental matters. The implementing agencies of the government are responsible for incorporating environmental parameters into their programs according to policies and guidelines established by the lead agencies. For a more detailed (though dated) analysis of the NEB see Matos, 1977.

Ministry of Agriculture and Cooperatives

Agriculture Department

Agricultural Extension Department

Bank for Agriculture and Agricultural Cooperatives (s.e.) 1/

Dairy Farming Promotion Organization of Thailand (s.e.)

1/ s.e. denotes a state enterprise.

Fisheries Department

Developed a National Plan for Aquaculture Development.

Brackish Water DivisionConservation and Extension DivisionInland Fisheries DivisionMarine Fisheries Division (and Laboratory)Phuket Marine Biology CenterForest Industry Organization (s.e.)

Primarily responsible for the exploitation of the indigenous forests, the marketing of logs, the operation of a variety of forest industries largely through joint ventures with private sawmills and traders, and the direction of the forest village system (see Section 3.5.1). The FIO, in conjunction with the Royal Forest Department, is conducting a survey of the number of illegal encroachers in forest reserves and the areas of land affected.

Land Development DepartmentLand Conservation DivisionLand Classification Division

Conducting coastal surveys for land use planning.

Land Development CenterWatershed Management Division

In conjunction with a team from the Man and the Biosphere Programme in the Huai Kok Ma Biosphere Reserve, the Division is studying water discharge rates and sediment loads from degraded and protected areas.

Office of Rubber Replanting and Fund (s.e.)Royal Forest Department

The RFD is highly centralized with a central office administration and a territorial office administration operating through the offices of Provincial Governors. Management of concessions, issuance of licences, and collection of fees are the responsibility of the District and Provincial Forest Officers who report to the local District and Provincial Administration and, through Divisional Forest Officers, to the Department.

The RFD has an annual reforestation program supported by the Forest Industry Organization. In addition, the RFD operates a demonstration forest site in Suratthani tropical rain forest; the Teak Improvement Center at Lampang; and the Pine Improvement Center at Chiang Mai. Among its research activities,

the RFD is conducting plant surveys and herbarium collections, which could provide the basis for the selection of additional protected areas.

Education Center

Forest Management Division

National Forest Land Management Division

The Division is in the process of mapping the national forest reserves. Over 15 million hectares had been completed as of the beginning of 1979 out of an estimated 26 million hectares of reserves (the amount of reserves identified in a 1961 survey, comprising 51% of total land area). The Division has initiated the next stage of the project, which is determining for each forest reserve: the area remaining in forest cover; the area lost to shifting cultivation and other encroachments; and the area lost to other uses. This is being done using satellite imagery with an enlarged scale of 1:250,000.

National Parks Division

Silviculture Division

Watershed Management Division

Water Catchment Protection Division

Wildlife Conservation Division

Royal Irrigation Department

Hydrology Division

The Division is conducting water quality studies, relating water discharge to sediment loads.

Ministry of Education

The Government has introduced a new compulsory curriculum in environmental education into the primary school system. The curriculum focuses on the life sciences and follows international recommendations on environmental education by UNESCO/UNEP and IUCN. The program is to be operational in all grades by 1984.

National Commission for Unesco

Ministry of Finance

Thailand Tobacco Monopoly (s.e.)

Ministry of Industry

Industrial Works Department - cont'd.

Factory Environmental Control Division

Established in 1974, the Division is the main environmental monitoring agency in Thailand, though it does not conduct research. The Division's primary responsibility is enforcing industrial pollution control. It does this by ensuring that all new factories have pollution control equipment and by inspecting and recommending equipment for the older factories. The Division follows a policy of dealing with the most severe polluters in the most severely polluted zones first. Present priority areas are the Chao Phraya and Tha Chin rivers, and the east coast of the Gulf of Thailand. Priority industries are sugar mills, distilleries and breweries, the chemical industry, and paper and pulp factories.

Mineral Resources Department

Concerned with mine waste and groundwater development.

Mining Industry Organization (s.e.)

Offshore Mining Organization (s.e.)

Science Department

Contains the divisions of Biological Science, Chemistry, Engineering and Physics, all of which are concerned with industrial sources of pollution.

Sugar Factories (s.e.)

Ministry of Interior

Electrical Generating Authority of Thailand

Local Administration Department

Liaison between the Central Government and the provincial and local administration.

Metropolitan Water Works Authority (s.e.)

Jurisdiction includes river salinity control and saltwater intrusion in the groundwater basin.

National Housing Authority (s.e.)

Policy and Planning Office

Bureau of Public Utility and Environment

Environmental Development Section

Public Welfare Department

Public Works DepartmentPublic Parks DivisionTown and Country Planning Department

Responsible for physical planning of infrastructures, including those concerning human settlements.

Ministry of Public HealthHealth Promotion DepartmentNational Energy AdministrationTechnology Division

Contains an environmental unit.

National Forest Protection Committee

The Committee was established in 1977 and is under the chairmanship of the Deputy Prime Minister of the Interior. Its purpose is the elimination of illegal logging, encroachment, poaching and other illegal and destructive activities in forest and protected areas, and instructing the 64 provincial authorities that have forest areas within their provincial boundaries to implement these measures. It is reported that provincial committees are soon to be created to report monthly on the state of forest protection in each province.

National Research Council

The Council is located in the Office of the Prime Minister and its intended role is to supervise and coordinate all research activities in Thailand. Several new organizations concerned with environmental problems have been established in Thailand. However, because the Council in fact lacks control over most research funding, the research activities of these organizations are carried out in an unorganized and independent manner. The Council also serves as the coordinating agency for the Man and the Biosphere Programme.

Applied Scientific Research Corporation of Thailand

This is a semi-autonomous organization that receives funding from the Government and is involved in a wide range of areas.

Environmental and Ecological Research Department

EERD takes a multidisciplinary approach to environmental problems and has a wide range of technical capabilities. Major projects have included analyses of environmental resources of selected regions of Thailand, pilot plant treatment of distillery wastes, a master plan for drainage and water pollution control for Bangchan Industrial Estate, and air pollution problems in fluorescent lamp manufacturing. EERD also operates a tropical environmental data research station at Sakaerat Forest, a biosphere reserve.

National Remote Sensing Center

The Center is currently being upgraded under a \$300,000 grant from U.S. AID. The Center will have the capability to reproduce color imagery (it presently only reproduces imagery in black and white). In addition, nationals are being trained in the management of a remote sensing center. Under another AID project, agricultural crop estimates are being made through the technique of area frame sampling.

Wildlife Reservation and Protection Board

4.4 Non-government organizations

Agricultural Research Institution

Asian Institute of Technology (AIT)

AIT is an autonomous postgraduate educational institution funded through grants from supporting countries. The research it undertakes is purely in support of its teaching function and therefore it does not originate any research projects. Its teaching and research programs include the control and management of water, waste water, air, and solid waste. Important projects have included a coastal pollution study of Choburi province, the use of coconut husk as a sorbent agent in oil spills, vehicle emissions and air pollution in Bangkok, and applications of slow filtration systems for surface water treatment. AIT is participating in the Chao Phraya river pollution study and a soil subsidence survey of Bangkok, and is developing a mathematical model of oilspill movement.

A regional remote sensing center for use by all ESCAP members is currently being developed within AIT under a five-year, \$6 million project sponsored by U.S. AID. The center will initially be staffed with U.S. experts who will train nationals to gradually assume responsibility for the operation and management of the center. The center will provide training at all levels and serve to develop new techniques for the application of remote sensing to natural resource problems of the ESCAP region.

Community and Regional Development Division

Environmental Engineering Division

Water Resources Engineering Division

Association for the Conservation of Wildlife

Founded by Dr. Boonsong Lekagul, a leading conservationist in Thailand, the Association is a member of IUCN.

Association for Fine Arts and Environmental Conservation

Bangkok Bird Club

Chulalongkorn UniversityInstitute of Environmental Research

Conducts teaching and basic research on environmental problems.

Faculty of ScienceMarine Science Department

Focuses on problems of aquatic resource conservation. The Department has undertaken the following projects: pollution monitoring in the Upper Gulf of Thailand; an ecological study of the coastal area of Bang Pra In Chon Buri; a pollution study in the Mae Klong estuary; and an investigation of toxic waste distribution in the environment of the Chao Phraya river.

Dusit ZooEcological Society of Thailand

c/o Mahidol University.

Friends of Khao Yai National Park AssociationKasetsart UniversityConservation DepartmentFaculty of Forestry

The Faculty of Forestry is involved in training, research and extension work.

Faculty of Fisheries

Research has dealt mostly with aquaculture and taxonomy of fishery resources. Future plans are to concentrate more effort on research in water pollution.

Khon Kaen University

Has programs in Agriculture, Soil Science, and Industrial Engineering

Mahidol University

Conducts teaching and research on environmental problems.

Biology DepartmentEnvironmental Education and Research ProjectPlanned Parenthood Association of Thailand

Prince of Songkhla UniversityFaculty of Natural ResourcesSilpakorn UniversitySchool of Architecture

Conducts work in land use issues.

Society for Conservation of National Treasures and Environment (SCONTE)

c/o Biomedical and Environmental Engineering Center, Mahidol University.

Tourist Organization of ThailandYoung Conservationists

The following are some major companies in Thailand that provide consultancy/ engineering/supply services in the environmental field:

Boonyium and Associates - Air and water pollution.Dynamic Supply Engineering - Water pollution.Kijja Consulting Engineers - Water pollution.Siam Technology (Siamteck) Co. - Water pollution.Thai Nisshin Plant Co. - Water pollution.South East Asia Technology (Seatec) Co. - Water pollution and environmental impact studies.Pollution Control Co. - Water pollution.Ebara-Infilco - Water pollution.Kurita - Water pollution.Ua Wittya - Water pollution.Thong Thaveesin - Solid waste.4.5 Membership in regional and international organizations

Thailand is a member of the United Nations and of most of its specialized agencies, including FAO and Unesco. Thailand contributes to Unesco's Man and the Biosphere Programme (MAB) and has a MAB national committee (see listing in Appendix 5). It is a member of the Governing Council of the U.N. Environment Program (UNEP) and is expected to play a significant role in the proposed ASEAN subregional environmental program (ASEP), as it already participates in the

ASEAN expert group on marine pollution established in 1973. This group has recently adopted a draft Regional Contingency Plan for marine pollution accidents. Thailand participates in UNEP's EARTHWATCH program which consists of INFOTERRA (formerly the Inter-Referral System), the Global Environmental Monitoring System, and the International Register of Potentially Toxic Chemicals. UNEP's regional office for Asia and the Pacific is headquartered in Bangkok. Thailand is a state member of IUCN, and has cooperated with and received financial aid for conservation projects from the World Wildlife Fund.

In the field of regional cooperation, Thailand is an active member of the Committee for Coordination of Investigations of the Lower Mekong Basin (an ASEAN group), the Indo-Pacific Fisheries Council and the South East Asian Fisheries Development Center. The Indo-Pacific Fisheries Council focuses on management of living marine resources. In 1966 the Council established a working party on aquaculture and the environment. The Council also coordinates the South China Sea Fisheries Development and Coordinating Programme carried out by the Food and Agriculture Organization and the U.N. Development Program. Thailand is a participant in the ESCAP/UNEP joint project on national environmental legislation in ESCAP countries.

5.0 LEGISLATION RELEVANT TO ENVIRONMENTAL AND NATURAL RESOURCE MANAGEMENT

Effective environmental management requires a comprehensive body of supporting legislation. Although gaps remain and improvement is needed, Thailand has taken significant steps toward developing such a legal foundation. The development of an effective enforcement effort now seems to be of primary importance in reversing Thailand's worsening environmental problems (Shane, 1979 and IUCN/UNEP/FAO, 1979).

5.1 General

The Constitution

The new Constitution of Thailand, passed by the Legislature this year, contains two provisions relevant to environmental quality:

Section 65 - "The State shall preserve or maintain an environmental balance and shall eliminate pollutants which endanger the health and hygiene of the population."

Section 69 - "The State should have a demographic policy appropriate for natural resources, economic and social conditions..."

Enhancement and Conservation of National Environmental Quality Act, B.E. 2518 (1975), as amended by the Enhancement and Conservation of National Environmental Quality Act (No. 2), B.E. 2521 (1978).

This first major piece of environmental legislation created the National Environment Board (NEB) together with its executive arm, the Office of the National Environment Board (ONEB). The NEB is to serve as the central agency dealing with environmental matters and is responsible for developing policy to enhance and maintain environmental quality, and to advise the Council of Ministers in this regard. Other significant parts of the legislation provide for: environmental impact statement procedures; development and application of environmental quality standards; and the handling of environmental emergencies.

Environmental impact assessment - Under Section 17, environmental impact studies are mandatory for all public and private projects specified in a list to be issued by the NEB. An "Initial Environmental Examination" (IEE), to be reviewed by the NEB, will be required in the preliminary stages of project planning. This is a preliminary examination for determining whether or not the project is likely to involve significant environmental effects. If this determination is negative, then the IEE itself will usually be the only environmental analysis needed.

If the IEE indicates that a follow-up study is needed, then a more comprehensive Environmental Impact Statement (EIS) is to be prepared by the agency or individual who proposes the project. This is to be prepared in sufficient scope and detail to enable the NEB to evaluate the overall worth of the project in terms of economic benefits versus possible impairments to environmental resources or values. Based on this evaluation, NEB can make its recommendations to the Government on whether the project should be allowed to proceed, and (a) if so, to delineate the properly applicable environmental constraints, and (b) if not,

to enumerate the reasons for this decision and, where feasible, to indicate what additional environmental protection measures need to be included in order for the project to be reconsidered (National Environment Board, 1979).

To assist in the preparation of these documents, the NEB has prepared a series of guidelines as follows:

General Guidelines for Preparation of Environmental Impact Statements - These guidelines are applicable to all types of projects.

Supplemental EIS Guidelines for Specific Project Categories - Additional guidelines, to be taken into account in preparing the EIS for a particular category of project, have been prepared for the following categories:

- Agro-industries
- Coastal zone development
- Dams and reservoirs
- Dredging and filling
- Highways
- Housing projects
- Human settlements
- Industrial estates
- Industries
- Institutions
- Mining
- Nuclear power
- Offshore mining
- Oil pipelines
- Ports and harbors
- Rapid transit
- Thermal power

Guidelines for Preparation of Initial Environmental Examination - These are applicable to all proposed projects. As noted above, the object of the IEE is to determine whether a follow-up EIS will be needed.

Guidelines for Preparation of Terms of Reference for Preparation of Environmental Impact Statements - These Terms of Reference incorporate both the General Guidelines and the appropriate Supplemental Guidelines for the category in which the project lies.

Environmental standards - Under Section 17, the NEB is authorized to promulgate basic environmental standards for the country. These standards are to serve as a guide to government agencies which currently have principal pollution control authority in specific sectors of the environment.

Environmental emergencies - Section 20 gives the Prime Minister the authority to take any action deemed necessary to respond to an "environmental emergency"; defined as "... an emergency arising from environmental pollution which, if left unremedied, will be dangerous to life, or will cause personal injury or damage to the properties of the people or the State..." Provision is made for the Prime Minister to delegate this authority to the Governor of the Changwat in which the emergency occurs.

5.2 Water

The Ministries of Health and Industry, with the aid of local governments, are primarily responsible for maintaining water quality. However, except for the industrial sector, Thailand does not have any systematic regulatory scheme for water quality control. The only administratively enforceable water quality standards are those for industrial wastewater effluent issued under the Factories Act. The Penal Code contains two provisions relevant to water quality, but these are not sufficient to serve as a regulatory mechanism for pollution control.

Penal Code, as amended, B.E. 2499 (1956)

Section 237 prohibits the introduction of any substance that is a threat to health into any public water supply.

Section 375 prohibits the disturbance of any public drain, watercourse, or sewer.

Public Health Act, B.E. 2484 (1941)

Sections 19-30 assign local governments the responsibility for controlling "nuisances" (defined in terms of danger to health or safety) within their jurisdictional boundaries. Though the Act provides local governments with the authority to establish pollution standards in cooperation with the Ministry of Health, no such regulations have been promulgated (Shane, 1979).

Factories Act, B.E. 2512 (1969), as amended by Factories Act (No. 2), B.E. 2518 (1975)

Section 36(4), as amended, authorizes the Ministry of Industry, through its factory licensing function, to order modifications and to suspend or revoke the licenses of factories creating "nuisances" or having improper drainage. The Act prescribes penalties for violation of Ministry orders, but these have not been systematically enforced. In 1970, the Ministry of Industry issued under the Factories Act water quality standards regulating industrial wastewater effluent.

Notification of the Ministry of Industry, No. 2, B.E. 2513 (1970)

Article 22 lists the following conditions that wastewater must meet to be legally discharged from factories:

- pH value is between 5 and 9;
- Permanganate value must not exceed 60 milligrams per litre;
- Dissolved solids must not exceed 2,000 milligrams per litre;
- Sulfide calculated as H₂S must not exceed 1 milligram per litre;
- Cyanide calculated as HCN must not exceed 0.2 milligram per litre;
- Zinc, chromium, arsenic, silver, copper, mercury, cadmium, barium, selenium, lead, and nickel together or separately must not exceed 1 milligram per litre;
- No content of tar;
- No content of oil and grease;
- Formaldehyde must not exceed 1 milligram per litre;

- Phenols and cresols must not exceed 1 milligram per litre;
- Free chlorine must not exceed 1 milligram per litre;
- No content of insecticide and radioactive chemicals;
- If the ratio of wastewater and water in public waterways is between 1:8 and 1:150 the mixture of chemical must not exceed 30 per 1,000,000 parts.
if the ratio of wastewater and water in public waterways is between 1:151 and 1:300 the mixture of chemical must not exceed 60 per 1,000,000 parts.
If the ratio of wastewater and water in public waterways is between 1:301 and 1:500 the mixture of chemical must not exceed 150 per 1,000,000 parts;
- Value of B.O.D. (5 days at temperature of 20 degrees C) must not exceed 20 milligrams per litre, or may differ from the prescribed limit depending on geography or nature of drainage as the officials may deem reasonable, but must not exceed 60 milligrams per litre;
- Temperature of wastewater before discharged into public waterways must not exceed 40 degrees C;
- Color or smell of wastewater when discharged into public waterways must not be objectionable.

This set of effluent standards applies to all industries regardless of the capabilities of the receiving waters for absorbing wastes without damage to water quality. There are no standards for solid wastes which can also be a major source of water pollution.

Minerals Act, B.E. 2510 (1967)

See Section 5.4 for sections of the Minerals Act relevant to water quality.

5.3 Soils

Apart from legislation protecting forests, Thailand does not have any general soil conservation regulations.

5.4 Minerals

Minerals Act, B.E. 2510 (1967)

The Act empowers the Ministry of Industry and the changwat Mineral Resources Offices to attach conditions to leases and licences for mining activities, including the purchase, sale, storage, import, and export of minerals. However, nowhere does the Act explicitly state the need for maintaining environmental quality, or lay down requirements for specific environmental problems related to mining activities (Shane, 1979).

The Act defines 'minerals' as "mineral resources being inorganic matter having stable or slightly alterable chemical composition and physical characteristics, whether or not refining or smelting is required before use and shall include coal, shale, metals derived from metallurgy and earth or sand prescribed in Ministerial Regulations as industrial earth or industrial sand in specified areas but not including water, mineral water, earth salt (gleua sintow), gra-

vel, stone, earth, or sand."

Section 43 prohibits mining without obtaining a concession or temporary mining permit.

Section 54 provides that concessions shall be issued by the Ministry and are valid for not more than 25 years.

Sections 63-64 prohibits concessionaires from in any way reducing the utility of public waterways, except as agreed to by the local Mineral Resources Officer and according to the conditions of the permit.

Sections 67-68 prohibit muddy water and silt arising from mining to flow outside the boundaries of the mine, unless the percentage of muddiness or silt in the water is below the rate prescribed in Ministerial Regulations. The concessionaire must also prevent the muddy water or silt outside the boundaries of the mine from lowering the level of public waterways or reducing their utility.

Sections 69-71 direct concessionaires to prevent the introduction of any elements of the mining process into the environment that are harmful to persons, animals, plants, or property. Should this occur, the local Mineral Resources Officer is empowered to order changes or modifications in the mining process and to halt all or part of the mining operation.

Section 72 requires that concessionaires restore the land to its original state after the termination of mining activities, unless otherwise provided in the concession.

Sections 116-119 applies the provisions of § 69-71 to mineral dressing operations.

Sections 123-126 applies the provisions of § 69-71 to metallurgy operations.

Petroleum Act, B.E. 2514 (1971), as amended by the Petroleum Act (No. 2), B.E. 2516 (1973)

This law was unavailable.

5.5 Forests

Thailand has a substantial body of forest legislation covering forest reserves and their use, logging permit procedures, replanting requirements, and penalties for violations. Despite these measures, deforestation continues, indicating that the problem is more a function of inadequate enforcement resources and a lack of interagency coordination (Shane, 1979). However, improvements in the law are needed. The IUCN/UNEP/FAO mission to Thailand charged with drafting a National Conservation Plan made the following recommendations for changes in forestry legislation (IUCN/UNEP/FAO, 1979):

- The legislation should be redrafted to more closely reflect conservation as opposed to exploitation of forest resources;
- Management guidelines are needed in the legislation to set policy and stan-

dards to be followed in forestry operations. In addition, provision should be made for the development of management plans for individual forest areas to adequately consider and conserve forest resources (including fauna and flora, soil, and water);

- the legislation should provide for improved coordination between forest policy and other developmental and conservation policies (for example, multiple-use forestry legislation).

It is reported that the Food and Agriculture Organization is sending a team of experts to assist in the revision of forestry legislation of several ESCAP nations, including Thailand.

Land for Livelihood Act, B.E. 2511 (1968)

This Act indirectly addresses the problem of deforestation by empowering the Government to establish settlements on public land for the purpose of stabilizing landless/nomadic populations.

Forest Act, B.E. 2484 (1941) as amended by:

Forest Act (No. 2), B.E. 2491 (1948)

Forest Act (No. 3), B.E. 2494 (1951)

Forest Act (No. 4), B.E. 2503 (1960)

'Forest' is defined as "land which has not yet been acquired by any person under the land law." 'Timber' is defined as "teak and timber of all other species which are trees, shrubs, and creepers, and includes bamboos, palms, rattan as well as their roots, burrs, stumps, and branches regardless of whether they have been cut, logged, sawn, split, hewn, dug out, or dealt with by any other means."

'Forest produce' is defined as "things which occur naturally in the forest", including: timber, charcoal, wood oil resins and derivatives, all plants and their derivatives, birds, nests, lac, beehives, honey, bees wax, bats' guano, rocks, minerals, and mineral oils.

Section 6 defines two classes of timber reserves:

- (1) Class A reserves comprise ordinary reserved timber the working of which requires authorization or a concession.
- (2) Class B reserves comprise rare species the working of which is only authorized by special permission of the Minister.

All teak and yang timber is classified as Class A reserved timber. The classification of other timber species is determined by Royal Decree.

Sections 11-18 cover license requirements and royalty payments for the working of reserved timber.

Sections 27-33 cover license requirements and royalty payments for the exploitation of reserved forest produce.

Sections 38-42 cover the transport of timber and forest produce, which requires

a removal pass.

Sections 47-53 cover timber conversion. It is required that any person desiring to undertake timber conversion, or have in possession converted timber over 0.20 cubic meters, must apply for permission.

Section 54 prohibits any person from clearing, razing, or in any way destroying forest unless within areas prescribed by notification in the Government Gazette or by official authorization.

Sections 69-74 cover penalties for violations of the Act.

At present only the Royal Forest Department staff (the protection units) are empowered to take action against illicit fellings and encroachments. It has been proposed that the Forest Industry Organization be empowered to undertake responsibility for protection within concession areas.

National Forest Reserves Act, B.E. 2507 (1964)

This Act regulates the management and conservation of national forest reserves, which is the responsibility of the Royal Forest Department in the Ministry of Agriculture. The Act covers the designation of national forest reserves by the Minister, their supervision and maintenance, and penalties for violation of the Act.

Sections 6-13 covers the designation of national forest reserves. The Minister is empowered to designate any forest a national forest reserve for the purpose of preserving a forest, timber, forest products, or other natural resources.

Sections 14-30 cover the supervision and maintenance of national forest reserves. Section 14 prohibits anyone within national forest reserves from holding or possessing land, clearing land, burning forest, working timber, gathering forest products, or in any way damaging the forest, except by permit or special permission.

Sections 31-35 cover penalties for violations of the Act.

5.6 Coastal zone

Thailand does not have any legislation for the management and conservation of the coastal zone. However, as mentioned earlier, the National Environment Board has developed a set of Environmental Guidelines for Coastal Zone Management in Thailand to be used in development planning.

5.7 Wildlife

Wildlife legislation in Thailand covers three broad areas: direct protection of wildlife; protection of wildlife habitat; and restrictions on the possession of, and trading in, protected animals and animal products. According to Shane (1979), although there are improvements to be made in the legislation, the real need in wildlife management is for a more credible enforcement effort. In ad-

dition, there are no provisions requiring inter-agency review of development projects likely to have an impact on wildlife habitat areas. Shane further recommends that the National Park law be strengthened by establishing strict criteria for determining the acceptability of proposed development projects in park areas in a way that leaves administrators with relatively narrow discretion. Thailand has not ratified the Treaty on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Wild Elephants Protection Act, B.E. 2456 (1913), as amended by the Wild Elephants Protection Act, B.E. 2503 (1960)

The Act requires a permit to catch elephants. One out of every five elephants captured must be given to the Government.

Game Preservation and Protection Act, B.E. 2503 (1960)

The Ministry of Agriculture (Royal Forest Department) is charged with responsibility for this Act. Protected game is divided into two categories:

Category 1 - "Those wild animals which are not usually used for food or hunted for sport or wild animals which destroy plant pests or eliminate filth, or wild animals which should be preserved for their natural beauty or to keep their numbers from being reduced, as listed in ministerial regulations."

Category 2 - "Those wild animals which are ordinarily used for food or hunted for sport as listed in ministerial regulations."

The following endangered species are listed under the law as "reserved game":

Rhinoceros sondaicus
 Didermocerus sumatrensis
 Bos sauveli
 Bubalus bubalis
 Cervus eldi
 Cervus schomburgki
 Axis porcinus
 Capricornis sumatraensis
 Naemorhedus griseus

Sections 7-13 cover the hunting and exploitation of animals. The following conditions apply to the hunting of different categories of wildlife:

Reserved species - Can only be hunted for the purpose of education or technical research or for public zoos with permission;

Category 1 - May not be hunted by any means which causes death except for the purpose of education or technical research with permission;

Category 2 - The Minister is empowered to prescribe closed seasons in which the hunting of any kind of category 2 protected wildlife shall be forbidden for any length of time. After notification of a closed season, category 2 protected wildlife can only be hunted for the purpose of education or technical research with permission.

Section 13 provides that eggs or nests of protected wildlife may not be collected, endangered or kept in possession, excepting the eggs or nests of protected animals lawfully possessed or unless kept for the purpose of education or technical research with permission.

Sections 14-18 cover trade in and possession of wildlife, with the following provisions for the three categories of wildlife:

Reserved species - It is prohibited to possess or trade reserved species, except by permission;

Category 1 - It is prohibited to possess or trade the flesh of category 1 protected wildlife;

Category 2 - It is prohibited to possess or trade the flesh of category 2 protected wildlife, except by permission.

Sections 19-26 cover the designation of wildlife preserve areas. The Government is empowered to establish wildlife reserves to preserve species. Within these preserves it is prohibited to hunt wildlife or gather nests or eggs, whether reserved or protected, except by permission. It is further prohibited to in any way disturb the environment of wildlife reserves. In addition to wildlife reserves, no one may hunt wildlife in the area of a Wat (religious temple) or place set aside for public use for religious ceremonies.

Sections 27-33 establish an Advisory Committee to advise the Minister on wildlife matters.

Should Thailand move toward ratification of CITES, the following aspects of the Game Preservation and Protection Act will have to be revised in order to comply with the Convention (IUCN/UNEP/FAO, 1979):

- The most pressing revision concerns the regulation of trade procedures as mandated by the Convention, including the use of a permit system for import, export, and re-export;
- Inclusion of flora under the ambit of the legislation;
- Additions to the lists of species covered to conform with the Convention;
- Provisions for the designation of appropriate authorities as envisaged by the Convention;
- Resolution of the problem of "bred in captivity" in regard to listed species;
- Provision for the care of live animals during transport.

National Park Act, B.E. 2504 (1961)

This Act was designed to protect Thailand's natural resources from unreasonable development and to manage such resources for the benefit of the public. The Act empowers the Government to designate national parks in the interests of education and public pleasure.

Within an area designated as a national park, no person is allowed to hold or possess land, clear or burn forests, remove any wildlife or plants, or endanger any animals or plants in any way, change the course of any waterway, allow cattle to enter the park, carry on any activity for economic gain without permission, take in any hunting gear, or fire any gun or fireworks.

Section 9 establishes a "National Park Commission" composed of the Deputy Minister of the Ministry of Agriculture as chairman, the Director General of the Forest Department, a representative of both the Ministry of Interior and the Land Department, and not more than eleven other members appointed by the Council of Ministers.

In its draft National Conservation Plan for Thailand, the IUCN/UNEP/FAO mission recommended the following revisions to the National Park Act:

- There should be an explicit provision in the Act for marine parks, and the law should take into account specific features which apply to marine national parks as opposed to terrestrial parks such as buffer zones, shipping lane restrictions, fishing restrictions, etc.
- National parks should not be designated purely on the basis of "education and public pleasure." Scientific criteria (outstanding ecosystems, threatened or endemic species of plants and animals) should be the prime consideration.
- The following prohibitions should be added: prohibitions against the introduction of exotic plant or animal species; pollution prohibitions beyond littering; and a general prohibition against violations of specific regulations developed in relation to the ecological conditions of each park.

5.8 Fisheries

Fishery Act, B.E. 2490 (1947), as amended by the Fishery Act (No. 2), B.E. 2496 (1953) and the Emergency Decree Amending the Fishery Act, B.E. 2513 (1970)

The Fishery Act was drafted to only cover inland fisheries, and there has been difficulty extending the Act to marine fisheries (IUCN/UNEP/FAO, 1979).

Under the Act, 'aquatic animals' are defined as "fishes, tortoises, turtles, shrimps and lobsters, crabs, horse-shoe crabs, all species of amphibians, including the eggs of any of the said aquatic animals, all species of mammal and mollusk, including shell and mother of pearl, all species of sea cucumber or sponge or marine algae, including all other animals which live in waters, and all other aquatic plants as may be enumerated by Royal Decree."

Sections 6-22 cover fishing sites. All fishing sites are classified into four categories:

- (1) Preserve site - a site which is situated within or adjacent to the precincts of a monastery or holy place, or which are suitable for the purpose of preserving aquatic animals. It is prohibited to fish or breed aquatic animals within a preserve site without authorization.

- (2) Concession site - subsistence fishing is allowed within a concession site.
- (3) Licensed site - a fishing site where fishing and breeding of aquatic animals are permitted only by license.
- (4) Public site - a fishing site where all persons have the right to fish breed aquatic animals.

Section 17 prohibits any person from constructing anything in a preserve site, concession site, or licensed site which is not private water, or in any public water. It is also prohibited to cultivate lotus, rice, jute, or other aquatic plants or trees, as specified by Royal Decree, in these areas without authorization.

Section 18 prohibits any person for the purpose of fishing to empty water into any breeding, concessioned, or licensed water which is not private water, public water, or trap pond; or to dry up or reduce water in these areas.

Section 19 prohibits the throwing of any substance harmful to aquatic animals into a fishing site.

Section 20 prohibits the use of explosives in a fishing site except for scientific purposes and with authorization.

Section 21 prohibits any person from altering a fishing site from its existing state which is not private property without authorization.

Section 23 prohibits any person from developing a culture pond on public property without authorization.

Sections 25-46 cover registration and application procedures. Section 32 empowers the Minister, or a Changwat Commissioner with the approval of the Minister, to (among other things) specify the species, site and maximum catch of fish in a licensed site, and to prohibit unconditionally the fishing of any species of aquatic animals.

Sections 52 -60 cover control of fisheries. Section 53 prohibits any person from possessing any kind of aquatic animals specified in a Royal Decree without a license. Section 54 prohibits any person from bringing into Thailand any species of aquatic animals specified by Royal Decree without authorization.

Sections 61-72 outline penalties for violations of the Act.

In its draft National Conservation Plan for Thailand, the IUCN/UNEP/FAO mission recommended the following revisions in the Fishery Act:

- The Act should be revised to more clearly expand its coverage to marine fisheries.
- A tight licensing system of fishing boats, regarding both construction and actual fishing operations, is needed to control fishing effort for proper management.

- Responsibility for aquatic mammals and reptiles should be transferred to the Wildlife Division of the Royal Forest Department.

The FAO has reportedly undertaken to assist the Government in the revision of its fishery legislation.

5.9 Air pollution

Notification of the Ministry of Industry, No. 4, B.E. 2514 (1971)

This represents the only air pollution standard so far established in Thailand. Under the standard, smoke generated by factories must be released "through a chimney having suitable height", and its blackness must not exceed "40 percent of Ringelmann Standard, except for short periods..." The regulations do not prescribe limits for the emission of invisible noxious gases.

Automobiles Act, B.E. 2473 (1930), as amended

Prohibits any vehicle from discharging "black smoke", which falls under the purview of the Police Department. There are no regulations prescribing limits to the emission of invisible components of vehicle exhaust.

As with water quality, no systematic regulatory mechanism has been established for air quality control. However, under the Enhancement and Conservation of National Environmental Quality Act (1978), the NEB is responsible for setting up ambient air and vehicle emission standards, as well as other air standards not yet the responsibility of other regulatory agencies.

5.10 Pesticides and other chemicals

Poison Act, B.E. 2510 (1967)

"Poisons" include chemicals or anything else having qualities likely to be harmful to persons, animals, plants, or other property.

Section 4 assigns responsibility for agricultural poisons to the Ministry of Agriculture, industrial poisons to the Ministry of Industry, and all other poisons to the Ministry of Public Health.

Section 5, in the interest of allaying or preventing harm to persons, animals, plants, or other property, authorizes the appropriate Minister to give notice in the Government Gazette:

- listing substances or anything else having prescribed qualities as common poisons;
- listing substances or anything else having prescribed qualities as violent poisons;
- prescribing methods of transportation, storage, manufacture, use, or destruction of poisons or handling of poison containers to be observed by licensees or users of poisons.

Other regulatory objectives of the Act include licensing (to import, export, take in transit, commercially manufacture, sell, have for sale, or contract to use common and violent poisons), proper labelling, product quality, and penalties for violations of the Act. However, the Act does not provide for the regulation of pesticides and other chemicals in terms of their environmental impact (Shane, 1979).

5.11 Multilateral conventions

Thailand is a Party to the following multilateral conventions of interest:

Agreement for the Establishment of the Indo-Pacific Fisheries Council (Baguio, 1948)

Plant Protection Agreement for the South East Asian and Pacific Region (Rome, 1956 - amended in 1967)

Convention on the Continental Shelf (Geneva, 1958)

Convention on Fishing and Conservation of the Living Resources of the High Seas (Geneva, 1958)

Convention on the Territorial Sea and the Contiguous Zone (Geneva, 1958)

Convention on the High Seas (Geneva, 1958)

Agreement Establishing the South East Asian Fisheries Development Center (Bangkok, 1967 - for which Thailand is Depositary)

Thailand has participated in the ESCAP Intergovernmental Meeting on Environmental Law (Bangkok, 1978).

There are several environmentally relevant multilateral conventions to which Thailand has not yet become a Party. The most significant include:

Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, 1973) - Thailand is taking steps to ratify CITES.

Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971)

Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 1972)

International Convention for the Prevention of the Pollution of the Sea by Oil (London, 1954 - amendments in 1962, 1969, 1971)

International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (Brussels, 1969 - Protocol for other substances, 1973)

International Convention on Civil Liability for Oil Pollution Damage (Brussels, 1969)

International Convention on the Establishment of an International Fund
for Compensation for Oil Pollution Damage (Brussels, 1971)

Convention on the Prevention of Marine Pollution by Dumping of Wastes and
other Matter (London, 1972)

Convention for the Prevention of Pollution from Ships (London, 1973)

Source: IUCN/UNEP/FAO, 1979.

Appendix 1National Parks and Wildlife Sanctuaries 1/Key to mapNational Parks

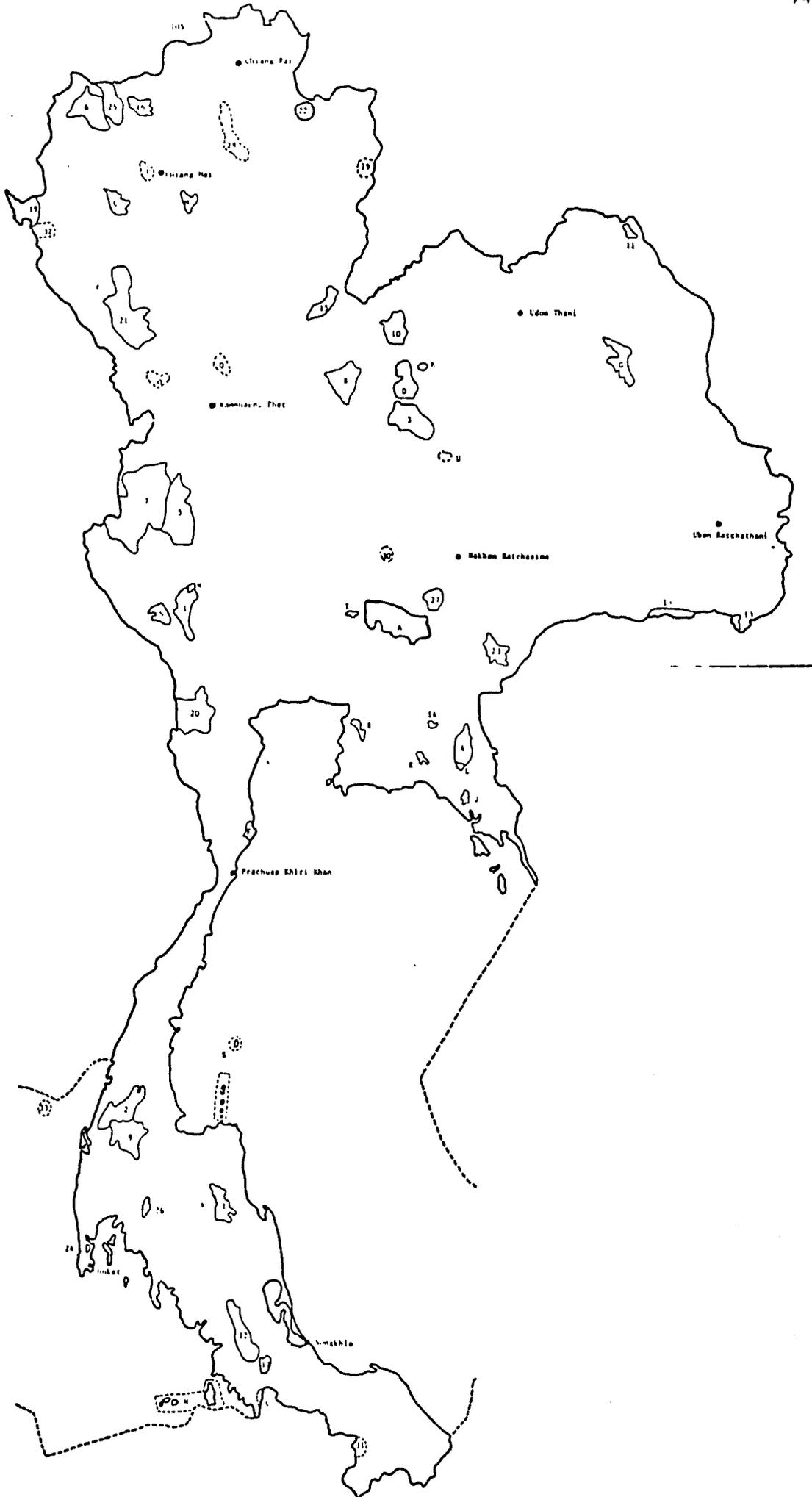
A = Khao Yai	L = Khao Kitchakut
B = Thung Salang Luang	M = Doi Khuntan
C = Doi Inthanon	N = Erawan
D = Nam Nao	O = Lan Sang
E = Phu Kradung	P = Doi Suthep-Pui
F = Khao Sam Roi Yot	Q = Ramkhamhaeng
G = Phu Phan	R = Tham Than Rot
H = Tarutao	S = Ang Thong
I = Khao Luang	T = Sam Larn
J = Khao Sabap	U = Tat Ton
K = Khao Chamao	V = Thale Ban

Wildlife Sanctuaries

1 = Salak Phra	18 = Phanom Dong Rak
2 = Khlong Nakha	19 = Salawin
3 = Phu Khieo	20 = Maenam Phachi
4 = Khao Soi Dao	21 = Mae Tun
5 = Huai Kha Khaeng	22 = Nam Kang (prop.)
6 = Lum Nam Pai	23 = Loeng Li (prop.)
7 = Thung Yai-Naresuan	24 = Khao Phra Thaeo (prop.)
8 = Khao Khieo-Khao Chomphu	25 = Nam Mae Khong (prop.)
9 = Klong Saeng	26 = Khlong Phraya (prop.)
10 = Phu Luang	27 = Sakaerat (prop.)
11 = Phu Wua	28 = Mae Taeng (prop.)
12 = Khao Banthat	29 = Mae Charim (prop.)
13 = Yot Dom	30 = Khao Chan Daeng (prop.)
14 = Khao Ang-Ru Nai	31 = Sakayo Kuwing Labu (prop.)
15 = Phu Miang-Phu Thong	32 = Khun Yuan (prop.)
16 = Doi Chiang Dao	33 = Ko Surin (prop.)
17 = Ton Nga Chang	

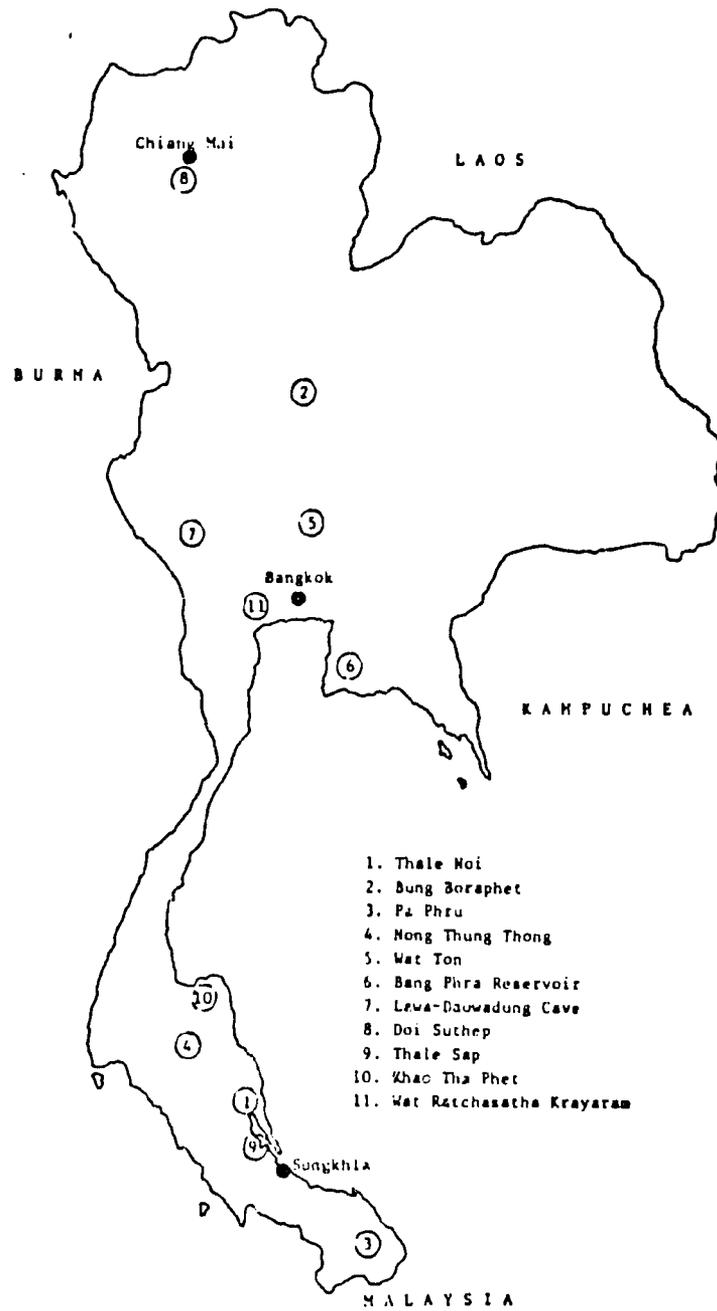
Alphabetical Index of National Parks and Wildlife Sanctuaries

- Ang Thong (IV : S)
 Doi Chiang Dao (I : 16)
 Doi Inthanon (I : C)
 Doi Khuntan (I : M)
 Doi Suthep-Pui (I : P)
 Erawan (III : N)
 Huai Kha Khaeng (III : 5)
 Khao Ang-Ru Nai (III : 14)
 Khao Banthat (IV : 12)
 Khao Chamao (III : K)
 Khao Chan Daeng (III : 30)
 Khao Khieo-Khao Chomphu (III : 8)
 Khao Kitchakut (III : L)
 Khao Luang (IV : I)
 Khao Phra Thaeo (IV : 24)
 Khao Sabap (III : J)
 Khao Sam Roi Yot (III : F)
 Khao Soi Dao (III : 4)
 Khao Yai (III : A)
 Khlong Nakha (IV : 2)
 Khlong Phraya (IV : 26)
 Khlong Saeng (IV : 9)
 Khun Yuan (I : 32)
 Ko Surin (IV : 33)
 Lan Sang (I : O)
 Loeng Li (III : 23)
 Lum Nam Pai (I : 6)
 Mae Charim (I : 29)
 Mae Taeng (I : 28)
 Mae Tun (I : 21)
 Maenam Phachi (III : 20)
 Nam Kang (I : 22)
 Nam Mae Kong (I : 25)
 Nam Nao (I : D)
 Phanom Dong Rak (II : 18)
 Phu Khieo (II : 3)
 Phu Kradung (II : E)
 Phu Luang (I : 10)
 Phu Miang-Phu Thong (I : 15)
 Phu Phan (II : G)
 Phu Wua (II : 11)
 Ramkhamhaeng (I : Q)
 Sakaerat (II : 27)
 Sakayo Kuwing Labu (IV : 31)
 Salak Phra (III : 1)
 Salawin (I : 19)
 Sam Larn (III : T)
 Tarutao (IV : H)
 Tat Ton (III : U)
 Thale Ban (IV : V)
 Tham Than Rot (III : R)
 Thung Salang Luang (I : B)
 Thung Yai-Naresuan (III : 7)
 Ton Nga Chang (IV : 17)
 Yot Dom (II : 13)



Appendix 2

Non-Hunting Areas 1/



Appendix 3

Priority Areas of a Conservation Assessment* of Ecosystems within the Protected Area System (IUCN/UNEP/FAO, 1979)

- (a) Ecological succession and habitat changes due to man.
- (b) Inventory of the fauna and flora.
- (c) Survey of the vegetation types.
- (d) Illegal forest clearing for shifting cultivation, settlement, etc.
- (e) Illegal hunting and logging.
- (f) Degradation and depletion arising from tourism.
- (g) Forest fire.
- (h) Introduction and spread of exotic species of plants and animals.
- (i) Water supply in deciduous forests relevant to animal concentration during the dry season.
- (j) Role of salt licks in herbivore ecology.
- (k) Continuation of use of satellite imagery and large-scale air photos to elucidate forest changes on a seasonal basis, and as a useful tool in tracking degradation of forest cover.

* A conservation assessment identifies conservation problems, assesses their severity and provides a basis for defining solutions.

Appendix 4

Recommended Surveys and Monitoring Projects in Ecosystems outside the Protected Area System (IUCN/UNEP/FAO, 1979)

- (a) Identification of critical freshwater and marine areas, especially those containing essential ecological processes.
- (b) Areas presently under-represented in the protected area system - for example; limestone forests, lowland dipterocarp forests (both deciduous and evergreen), marine and freshwater ecosystems (especially coral reefs, mangroves and wetlands).
- (c) Monitoring of exploitation of floristically rich forests to determine the effects of logging.
- (d) Sociological studies of forest encroachers, especially in watershed areas.
- (e) Human population migration, reasons for movement, capacity of receiving areas to absorb it and means for control.
- (f) Tourist fishing in marine areas as a possible source of re-employment for fisherman.
- (g) Distribution and dispersion rates of exotic vertebrates (for example, tilapia) and weeds (for example, water hyacinth).
- (h) Existing aquaculture in mangrove areas and identification of possible areas for expansion that would involve minimal environmental impact.

Research Projects

- (i) Integrated management plans for relatively discrete ecosystems (for example, Songkhla Lake).
- (j) Integrated rural development, especially in the vicinity of protected areas, to provide the basis for policy formulation and planning, development of agricultural productivity and agro-industries.
- (k) Ecodevelopment and alternative rural energy sources, including production of biogas and alcohol from agricultural waste products, and low energy housing design.
- (l) Impact of visitors on protected areas and adjacent land, as a basis for future management and organization of facilities; studies should concentrate on presently heavily used parks and reserves in the vicinity of Bangkok and the Southeast region.
- (m) Evaluation of the forest village system of reafforestation, with emphasis on socioeconomic and ecological objectives, and with the aim of developing guidelines for operational planning and the formulation of policy.
- (n) Reforestation techniques in Thailand and survival rates in plantations.

- (o) Natural and artificial regeneration of mangroves.
- (p) Effect of pesticides on bird populations, especially in some sample areas where intensive agriculture is being practiced.
- (q) Alternatives to timber for construction purposes.
- (r) Livestock rearing in the Northeast related to land capability, and livestock breeding improvement as a basis for a cooperative integrated industry.
- (s) Environmental education.

Appendix 5National Committee for the Man and the Biosphere Programme (as of July, 1978)

Chairman	Dr. Sanga Sabhasri Secretary General, National Research Council
Secretary	Mrs. Boonthom Dhamcharee Special Grade Scientific Officer National Research Council
Assistant Secretary	Miss Mathuros Muangnoicharoen Second Grade Scientific Officer National Research Council
Members	Dr. Saman Vardhanabhuti Director, Ecology and Environment Research Institute Applied Scientific Research Corporation of Thailand
	Dr. Tem Smitinanth Royal Forest Department
	Dr. Kasem Charnkaeo Instructor, Faculty of Forestry Kasetsart University
	Dr. Nart Tuntawiroon Project Director, Environment Education and Research Project Mahidol University
	Dr. Charoen Vajrarangsri Director, Division of Physics and Engineering Department of Science ?
	Dr. Twesukdi Piyakarnchana Director, Environmental Research Institute Chulalongkorn University
	Mr. Satcha Sookvibul Second Grade Fisheries Inland Fisheries Division Department of Fisheries

Mr. Choob Khemnark
Lecturer,
Department of Silviculture
Faculty of Forestry
Kasetsart University

Dr. Manuwadi Hungspreugs
Director,
Department of Marine Science
Faculty of Science
Chulalongkorn University

Dr. Danai Limpadanai
Lecturer,
Faculty of Natural Resources
Prince of Songkhla University

Appendix 6Expenditure on Environment in the Fourth Plan (1977-1981)

	(million baht)
<u>Total Budget</u>	252,450
<u>Forestry control and protection</u>	1,900
Increasing forest protection patrols from 220 to 336 units	
Expanding wildlife zones from 12 to 22	
Increasing national parks from 13 to 20	
<u>Management and reforestation</u>	905
Reforestation, together with replanting under the Forest Industry Organization	
<u>Watershed conservation</u>	1,500
Including improvement of depleted forest areas	
<u>Pollution control</u>	40
Surveys on industrial pollution	
Curbing of industrial pollution along river banks	
<u>Social welfare</u>	385
Hilltribe research and welfare	
<u>Recreation areas and sports</u>	85
Zoo development	
Public park development	
<u>Cultural arts</u>	390
Maintenance of historic sites	
Establishment of archives	

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