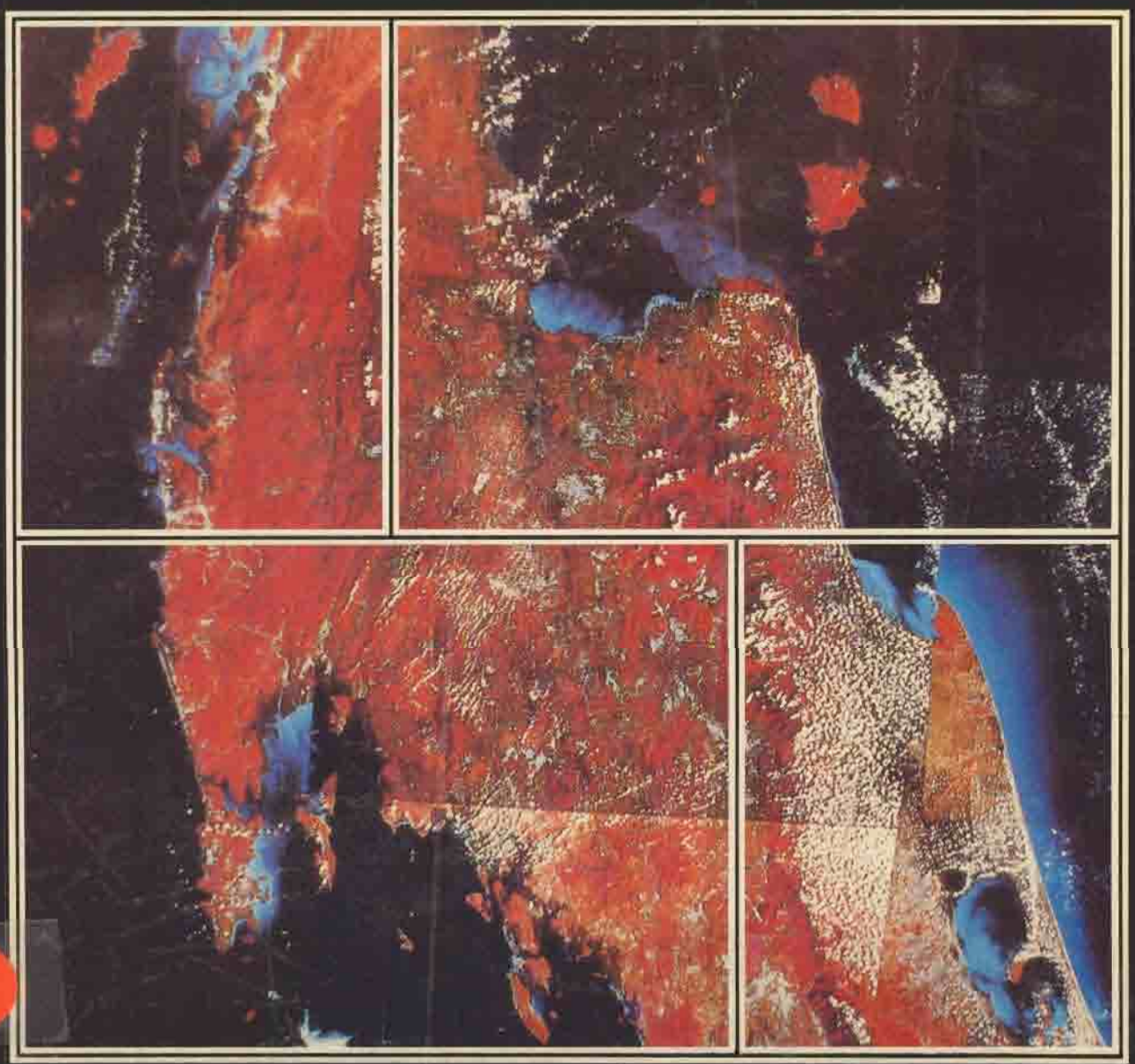
The Coastal Environmental Profile of Ban Don Bay and Phangnga Bay, Thailand

Edited by
James N. Paw, Sirikul Bunpapong,
Alan T. White and Marie Sol M. Sadorra



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ICLARM

Association of Southeast Asian Nations/
United States Coastal Resources Management Project
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Cover: False color composite landsat images of Ban Don Bay and Phangnga Bay linked together to show the whole Upper South, Thailand.

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Contents

List of Tables

List of Figures

List of Acronyms and Abbreviations

A.	Amphoe (meaning second-order administrative district)
ASEAN	Association of Southeast Asian Nations
BAAC	Bank of Agriculture and Agricultural Cooperatives
BOD	Biological oxygen demand
COD	Chemical oxygen demand
CPUE	Catch per unit effort
CRM	Coastal resources management
CRMP	Coastal Resources Management Project
DO	Dissolved oxygen
DOF	Department of Fisheries
DOL	Department of Labor
DOLD	Department of Land Development
DOMR	Department of Mineral Resources
DOPW	Department of Public Works
DOTCP	Department of Town and Country Planning
EEZ	Exclusive Economic Zone
EGAT	Electricity Generating Authority of Thailand
EIA	Environmental Impact Assessment
EQSD	Environmental Quality Standard Division
GPP	Gross Provincial Product
ICLARM	International Center for Living Aquatic Resources Management
IWD/MOI	Industrial Works Department/Ministry of Industry
JICA	Japan International Cooperation Agency
K.	Khlong (meaning river)
MPN	Most Probable Numbers
NP	National Park
NTTWA	Navigation in Thai Territorial Waters Act
ONEB	Office of the National Environment Board
PAT	Petroleum Authority of Thailand
PMBC	Phuket Marine Biological Center
PMFS	Phuket Marine Fisheries Station
PMP	Phuket Master Plan
REDECON	Resources and Development Consultant Limited
RFD	Royal Forestry Department
RTG	Royal Thai Government
TAT	Tourism Authority of Thailand
TISTR	Thailand Institute of Scientific and Technological Research
UNESCO	United Nations Educational, Scientific and Cultural Organization
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WS	Wildlife Sanctuary

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- Department of Public Works (DOPW)
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Forewords

The coastal zone of Thailand with a 2,600-km coastline is very rich in natural resources which include fisheries, coral reefs, mangrove forests, beaches and mineral deposits. Over the past decade, rapid increases in population and human activities along the coastal areas have resulted in degradation of these valuable natural resources. Many areas have already experienced the effects of water pollution, depletion of mangroves, overgrowth of urban communities and other negative consequences.

As indicated by the results of a recent Upper South Regional Planning Study by the Japan International Cooperation Agency (JICA), the development potentials of the area are great and that many of the activities rely on the use of coastal resources. This gives rise to the need for a plan to guide the management of coastal resources utilization that will allow sustainable development.

Thailand is a participant to the Association of Southeast Asian Nations (ASEAN)-United States (US) Coastal Resources Management Project (CRMP). The project, which was initiated in June 1986, is being carried out in Ban Don and Phangnga Bays. A project team was formed, consisting of local experts who conducted preliminary field investigations in the pilot site in July 1986. The field findings and other data from secondary sources were collated and analyzed. *The coastal environmental profile of Ban Don Bay and Phangnga Bay, Thailand* is the synthesized result of the study.

This publication is the first step towards rational management of the Upper South coastal zone. Recommendations for developing plans to sustain coastal resources use are presented. A Workshop on Project Environmental Profile and Proposal Refinement held in Pattaya, Thailand, in October 1986 and subsequent discussions with government agencies initially helped in finalizing the draft of this profile.

It gives me great satisfaction to present this book to coastal resources scientists, experts, managers, policymakers and other interested individuals and groups in the ASEAN and other countries. I hope that this publication will be useful in the formulation of a viable management plan and as a reliable database.

I wish to thank the project and other experts for their valuable contributions in bringing this profile to a successful completion. Gratitude is expressed to Mr. James W. Evans for preparing the first draft of the profile, and to Dr. Suthirak Sujarittanon for helping review it. I wish to extend my sincere appreciation to the technical and support staff of the International Center for Living Aquatic Resources Management (ICLARM) and the Office of the National Environment Board (ONEB) for reviewing and editing the profile.

Gratitude is due the United States Agency for International Development (USAID) and the Royal Government of Thailand, without whose sponsorships, the study would never have been possible.

Arthorn Suphapodok
Thailand Project Director
ASEAN-US Coastal Resources
Management Project

The coastal waters of Southeast Asian countries have some of the world's richest ecosystems characterized by extensive coral reefs and dense mangrove forests. Endowed with warm tropical climate and high rainfall, these waters are further enriched with nutrients from land which enable them to support a wide diversity of marine life. Because economic benefits could be derived from them, the coastal zone in these countries are heavily populated. Over 70% of the population in the region live in coastal areas which have been recently characterized by high-level resource exploitation. This situation became apparent during the last two decades when population pressure and associated economic activities have increased considerably. Large-scale destruction of the region's valuable resources has caused serious degradation of the environment, thus affecting the economic life of the coastal inhabitants. This lamentable situation is mainly the result of ineffective or poor management of the coastal resources.

It is essential to consider coastal resources as valuable assets that should be utilized on a sustainable basis. Unisectoral overuse of some resources has caused grave problems. Indiscriminate logging and mining in upland areas might have brought large economic benefits to companies undertaking these activities and, to a certain extent, increased government revenues, but could prove detrimental to lowland activities such as fisheries, aquaculture and coastal tourism dependent industries. Similarly, unregulated fishing efforts and the use of destructive fishing methods, such as mechanized push-nets and dynamiting, have caused serious destruction of fish habitats and reduction of fish stocks. Indiscriminate cutting of mangroves for aquaculture, fuel wood, timber and the like have brought temporary gains in fish production, fuel wood and timber supply but losses in nursery areas of commercially important fish and shrimp, coastal erosion and land accretion.

The coastal zone of most nations in ASEAN are subjected to increasing population and economic pressures manifested by a variety of coastal activities, notably, fishing, coastal aquaculture, waste disposal, salt-making, tin mining, oil drilling, tanker traffic, rural construction and industrialization. This situation is aggravated by the expanding economic activities attempting to uplift the standard of living of coastal people, the majority of which live below the official poverty line.

Some ASEAN nations have formulated regulatory measures for their coastal resources management (CRM) such as the issuance of permits to fishing, logging, mangrove harvesting, etc. However, most of these measures have not proven effective due partly to enforcement failure and largely to lack of support for the communities concerned.

Experiences in CRM in developed nations suggest the need for an integrated, interdisciplinary and multisectoral approach in developing management plans providing a course of action usable for daily management of the coastal areas.

The ASEAN-US CRMP arose from the existing CRM problems. Its goal is to increase existing capabilities within ASEAN nations for developing and implementing CRM strategies. The project, which is funded by USAID and executed by ICLARM, attempts to attain its goals through these activities:

- Analyzing, documenting and disseminating information on trends in coastal resources development;
- Increasing awareness of the importance of CRM policies and identifying, and where possible, strengthening existing management capabilities;

- Providing technical solutions to coastal resources use conflicts; and
- Promoting institutional arrangements that bring multisectoral planning to coastal resources development.

In addition to implementing training and information dissemination programs, CRMP also attempts to develop site-specific CRM plans to formulate integrated strategies that could be implemented in the prevailing conditions in each nation.

Thailand has taken a major step in the conservation and protection of its valuable coastal resources by participating in the development of its CRM for the Upper South Region. The region, covering an area of about 52,600 km^2, is situated at the upper part of the Malay Peninsula and comprises the provinces of Surat Thani, Phuket, Phangnga and a portion of Krabi. But the main foci of activities are Ban Don Bay area in the Gulf of Thailand and Phangnga Bay area in the Andaman Sea side.

A reliable database from secondary sources, crucial to the formulation of a viable management plan, was made available to the project of which this profile is a product. This database was strengthened through a number of collective field surveys by an interdisciplinary team of scientists from Kasetsart University; Chulalongkorn University; Department of Fisheries (DOF); Phuket Marine Biological Center (PMBC); Department of Land Development (DOLD); Mahidol University; and ONEB of Thailand and with the assistance of the professional staff of ICLARM. These research efforts will ultimately lead to a practical CRM plan for the Upper South.

Chua Thia-Eng
Project Coordinator
ASEAN-US Coastal Resources
Management Project

Introduction

TEERAYUT POOPETCH AND JAMES W. EVANS

A development planning study was carried out for the Upper South Region under JICA (JICA 1985) which has been designated by the Royal Thai Government (RTG) as one of the target regions for development. The government's initial Master Plan identified several potential areas for development, including coastal resources, but no consideration for CRM was made.

ONEB, recognizing the need for integrated development and management of coastal resources, prepared a proposal for a CRM plan for the Upper South. The proposal, which identified Ban Don Bay and Phangnga Bay as the two key planning areas, was approved for inclusion in the ASEAN-US CRMP.

This book presents a profile of literature and a collation of available data for the preparation of CRM plans for Ban Don Bay and Phangnga Bay. Contained are information on their physical setting, natural and human resources, economic conditions and institutional framework. Existing constraints (e.g., lack of institutional coordination, adequate plans and strategies) to effective management are also evaluated, and issues of special concern are identified. The preparation of these plans is the primary objective of the project. The plans are expected to serve as a practical guide in pursuing RTG activities related to the two areas' optimal "economic-cum-environmental" development.

Recent trends of exploitation and importance of marine resources in Thailand show that the fisheries resources of the Gulf of Thailand have already passed maximum sustainable production. "Trash fish" now represent more than 40% of the total marine landings from Thai waters with up to 50% of the "trash fish" being juveniles of valuable fish and shrimp. In coastal areas, land use patterns are changing. In the Eastern Seaboard, emphasis is on heavy industries, whereas in the Upper South, tourism and tin mining are of economic importance to Phuket and Phangnga. Aquaculture, particularly for shrimp, is being expanded in Ban Don and is encroaching into the adjacent mangrove areas (TDRI 1987).

The Thai fishing sector supplies about 23 kg of fish/person/year to a population of 52 million. Marine capture fisheries account for over 90% of total fish production but many problems threaten the sustainability of the industry and the catch. Poverty and overfishing of inshore fisheries resources have exacerbated the conflicts between small-scale fishermen and large trawlers. Further, the declaration of the Exclusive Economic Zones (EEZ) by neighboring countries has reduced Thai fishing grounds. Thus, there is a need in Thailand for management of all coastal resources such as estuaries, mangroves and coral reefs.

It is important to formulate a CRM plan for Ban Don Bay before development goes too far. This area is rich in natural resources which have vast development potential. The coastal resources appear to be in relatively good condition at present, but this is expected to change because of population pressures and land-based development. This bay receives runoff from one of the largest catchments in the Upper South so that water resource development may alter

the bay's hydrological and water quality conditions in the future. Surat Thani, for instance, is one of the largest urban zones. Continued development here will increase change in land use patterns, pollution loads and coastal resources exploitation pressures.

Although on the west of Phangnga Bay are ecological characteristics similar to most other areas in the Upper South, it harbors the largest intact mangrove forest in the country. Wildlife is an important component in Phangnga National Park which also protects part of this mangrove area. Important coastal resources abound with fertile fishing grounds and aquaculture areas. Also, tourism is an important sector that could be sustained and enhanced.

Although population density is high, the bay's population has a traditional life-style and shares similar cultural and life values with the other areas. The economic status and structure of the populace are higher than those of the general Thai levels where resources are typically based on agriculture, fisheries, mining and industry.

The CRM plan will provide the necessary background information for the preparation of a macrolevel plan for the Upper South coastal zone management. Data on the interaction/ relationship of coastal resources and the various uses by people will assist in the formulation of CRM guidelines applicable in the Upper South and to a degree, throughout the ASEAN region.

Chapter 1
The Upper South: Physical Setting and Land Use

SIRIKUL BUNPAPONG AND JAMES N. PAW

Location, Topography and Geology

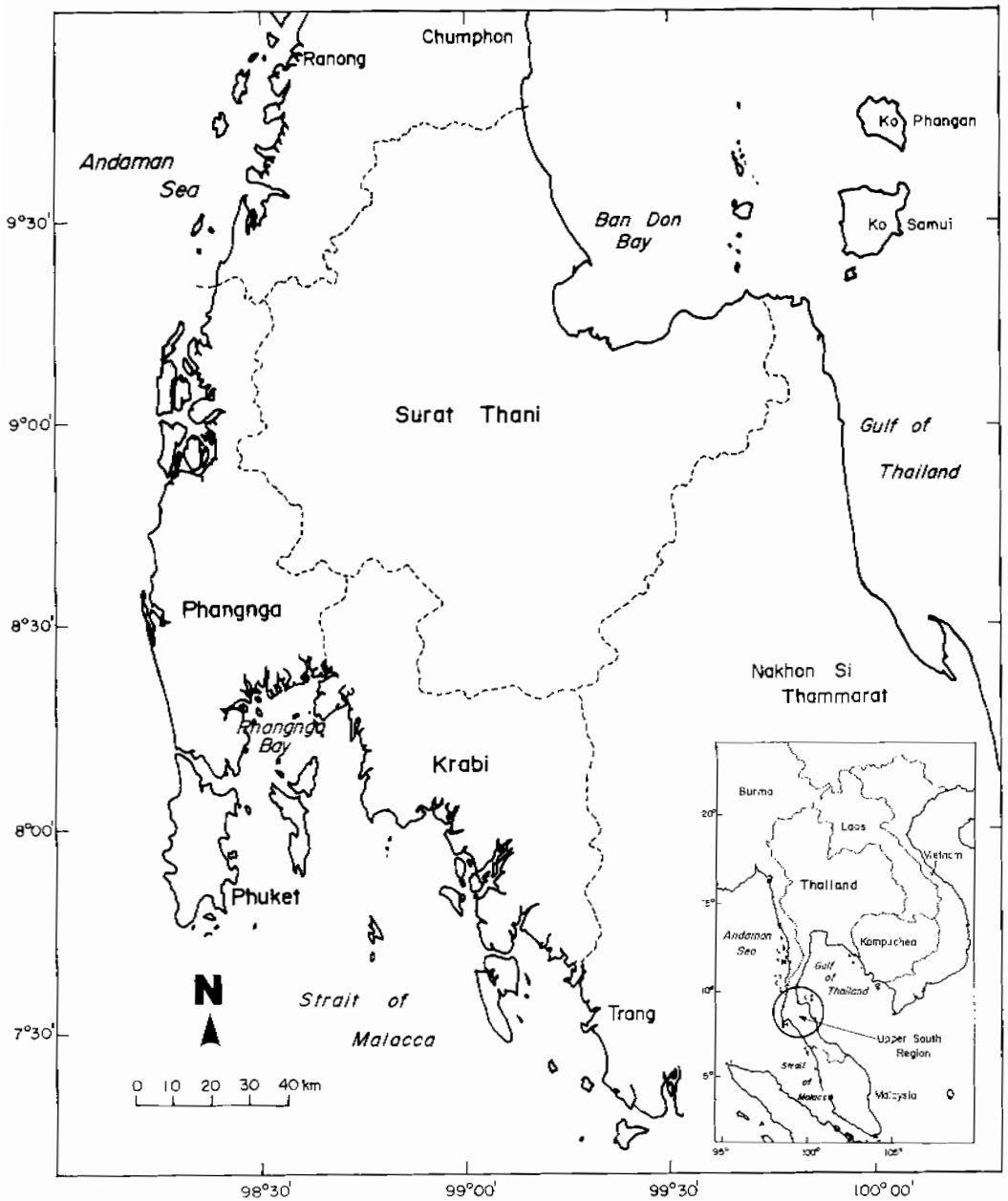
The Upper South Region has a total area of about 52,600 km^2 and is situated on the upper part of the Malay Peninsula. The region faces the Gulf of Thailand on the east and the Andaman Sea on the west. The area of study covers the coastal areas between Surat Thani in the northeast and Phangnga/Phuket in the southwest. The project site comprises the provinces of Surat Thani, Phangnga and a portion of Krabi but the main foci of activities are Ban Don Bay area in the Gulf of Thailand and Phangnga Bay area in the Andaman Sea side (Fig. 1.1).

Two parallel ranges are situated on the Upper South Region (Fig. 1.2). The Phuket Range runs southward along the peninsula from Khlong (K. from here, and which means "river") Khura Buri, close to the west coast and south to Phuket Island descending into the Andaman Sea. The range is roughly 400 km long and 25-75 km wide. The mountains reach heights of 600 to 900 m.

Located about 100 km from Phuket Range to the east is Nakhon Range. The latter stretches from the southwesternmost of Satun to the north where the mountain chains lie under the Gulf of Thailand marked by a few islands such as Samui and Phangan. The mountains between Surat Thani and Nakhon Si Thammarat reach heights of 1,300-1,400 m and the range between Thung Song and Trang reaches 500-800 m only. The Central Lowland, a flat land forming the watershed of the Tapi River System, is situated between the two ranges (JICA 1985). The topography and cross-sectional profiles of the study area are schematically shown in Fig. 1.3-1.6 and the typical geology is in Table 1.1.

The Upper South Region lies in a rich tin-bearing granite belt which intrudes folded sedimentary rocks along the length of the upper Malay Peninsula. This granite belt extends from Indonesia to the north in Thailand where sinistral displacement occurs southwest along K. Marui Fault. There are two major faults occurring in the north-south and northeast-southwest directions which strongly influence the topography of the region. Sedimentary rocks, particularly remnants of Permian limestones, form steep-sided hills and ridges which are extensive in the west coast.

Along Phangnga Bay, some of these large limestone ridges display a well-marked karst topography. Lowlands, particularly along the coast and the central basin, are composed generally of alluvial deposits. Detrital materials along beaches contain economically important minerals such as tin, rare-earth minerals and quartz. Most of these minerals are derived from erosion of coastal mineral-bearing granitic formations. Marine sediments, on the other hand, are



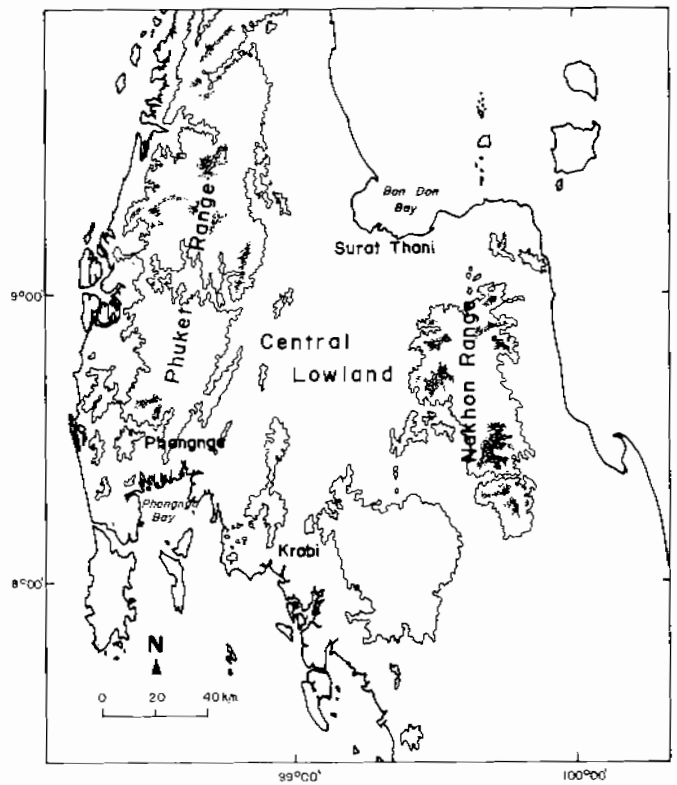


Fig. 1.1. *(Left)* The Upper South Region of Thailand located on the upper part of the Malay Peninsula.

Fig. 1.2. *(Above)* Mountain ranges in the Upper South, Thailand (JICA 1985).

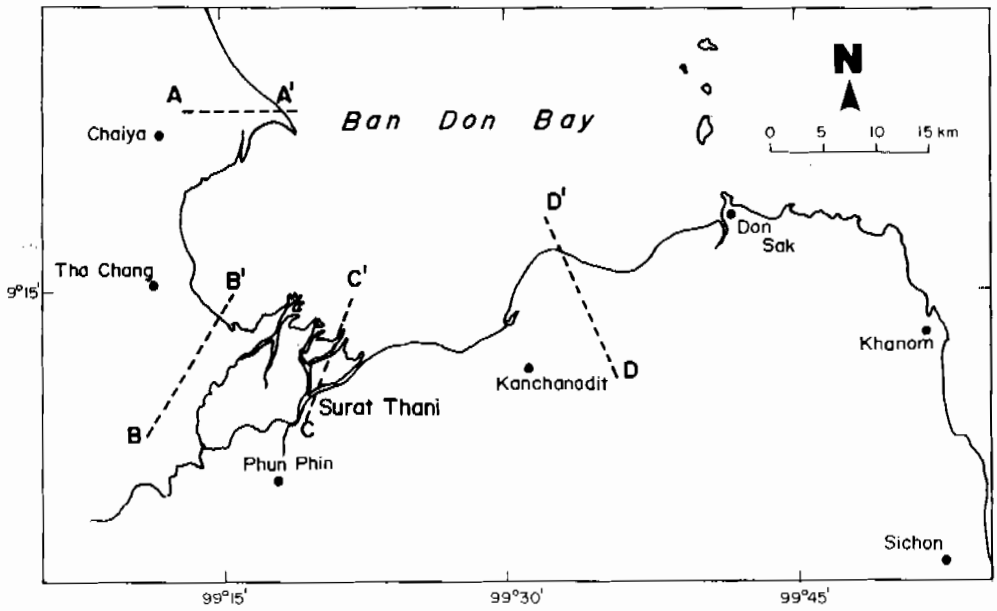


Fig. 1.3. Study site in Ban Don Bay with the cross-sectional areas marked.

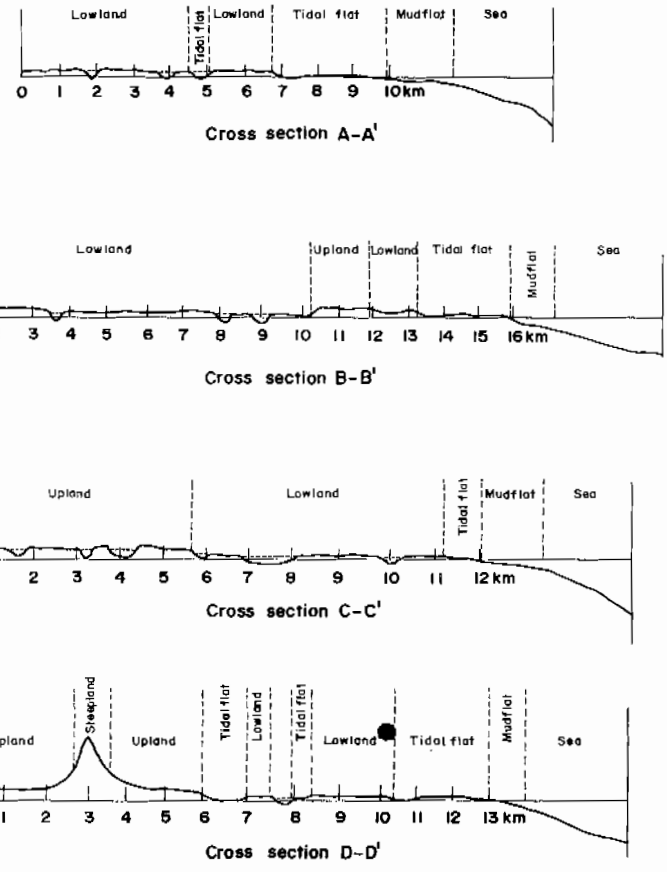


Fig. 1.4. Cross-sectional profiles of the coasts along Ban Don Bay.

Table 1.1. Geology of the Upper South Region, Thailand (modified after JICA 1985).

Area	Typical geology
Surat Thani	Chiang Mai loams
Central Lowland	Mountainous soils derived from igneous (granitic) and metamorphic (Khuntan sandy loams) rocks and soils from shales, conglomerates and limestone (Pak Chong loams)
Phangnga coastal strip	Recent alluvial soils and lowlands
Krabi coastal strip	Same as Central Lowland area
Phuket	Recent alluvial soils and those from granites, sandstone, schist, shale and gneiss, including limestone

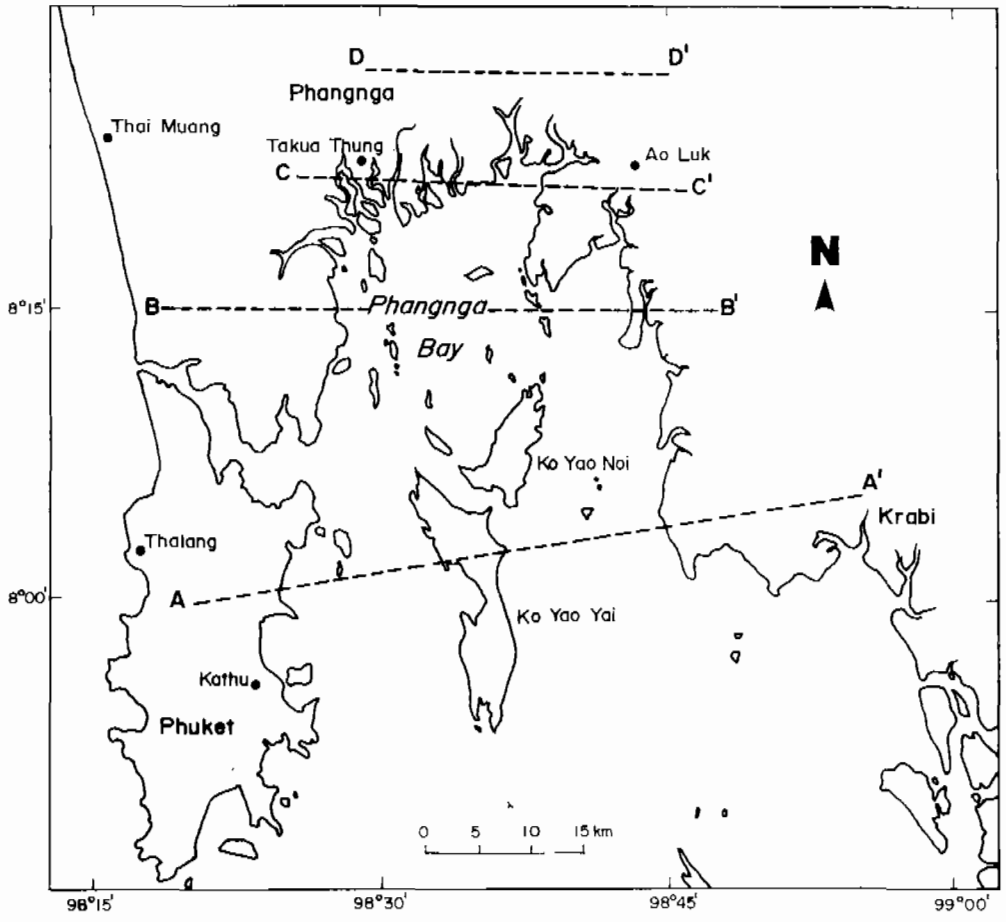


Fig. 1.5. Study site in Phangnga Bay with the cross-sectional areas marked.

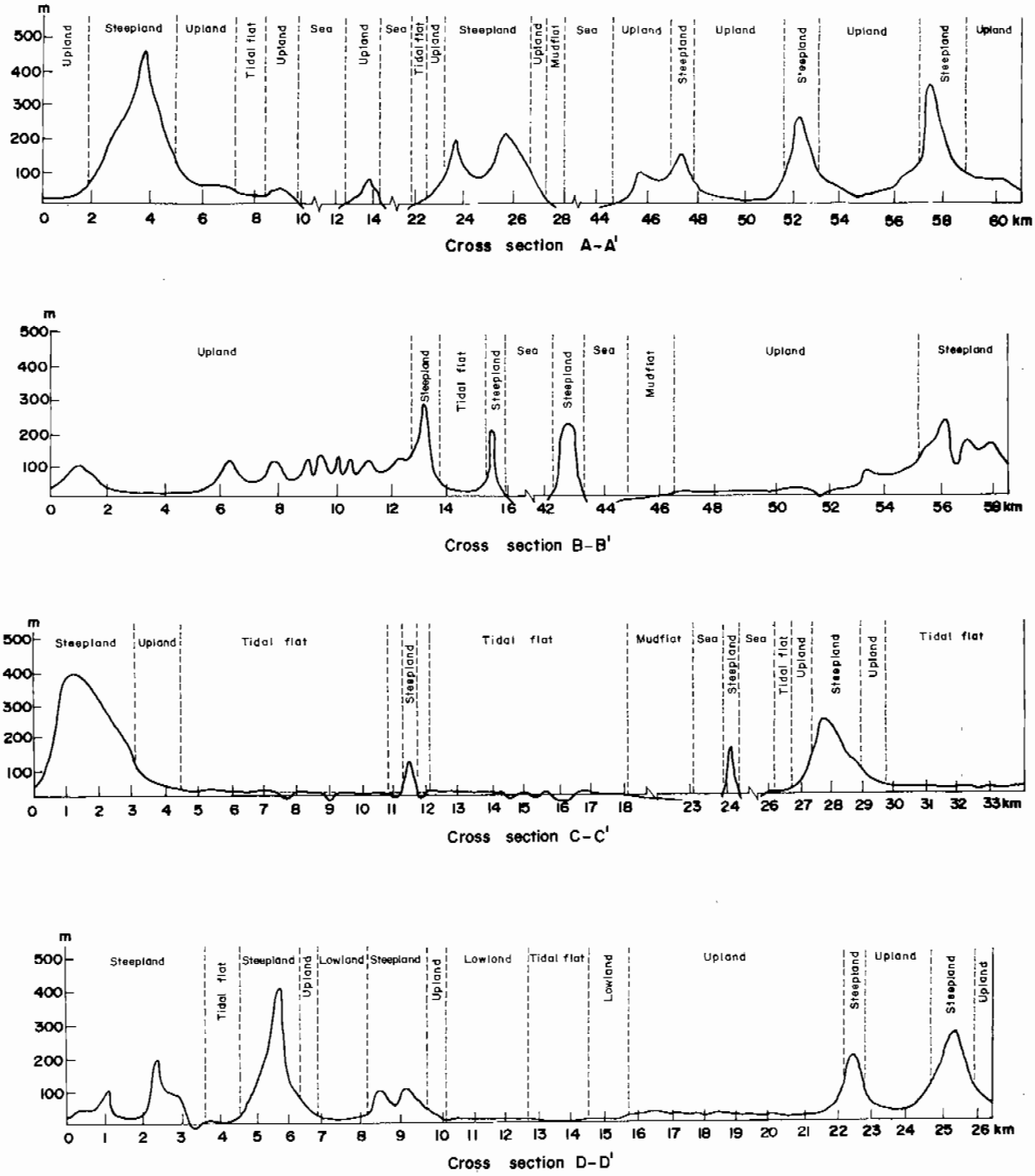


Fig. 1.6. Cross-sectional profiles of the coasts along Phangnga Bay.

mostly composed of mud, sand, silt and gravel which probably came from fluvial sediment deposits as well as from weathering and erosion of rock formations along the coast (Siripong 1987).

Climate

The climate is intermediate between equatorial and tropical monsoon types and is favored by constant high temperature without extremes of heat; high rainfall with little risk of monsoon failure; and a dry season of moderate severity.

The topography of the region with its mountain chains running along the peninsula has considerable effect on the climate especially on the rainfall distribution. Dry season is generally experienced in February and March on both the east and west coasts. In April, rainfall starts on the west coast due to the southwest monsoon and lasts from June to September. Dry season prevails until December. Rainfall on the east coasts is moderate at about 100 mm/month until the onset of the northeast monsoon in September. Precipitation intensifies up to 500 mm around November (Fig. 1.7). Although the rainfall patterns of Krabi and Phuket are of west coast type, precipitation is considerably lower than the average of Ranong and Phangnga (JICA 1985).

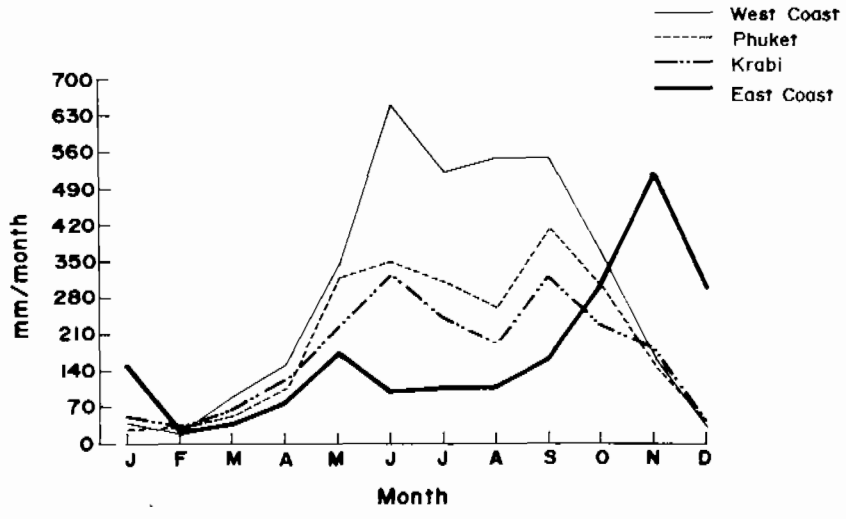


Fig. 1.7. Mean annual rainfall in the Upper South, Thailand, 1969-1978.

Mean monthly temperature ranges from 29°C (sometimes up to 39°C inland), usually in the wettest month, to 33-35°C, usually in April. Mean monthly minimum ranges from 20°C in January to 24°C in May. Inland temperature may fall to 13°C in January. Extremes at some sheltered inland sites may be outside the 12°C and 39°C range, but coastal areas have more uniform temperatures.

Catchment Area

There are a number of catchment areas between Phuket Range and Nakhon Range. The Phum Duang River Basin is the largest, covering 6,125 km^2, or 41% of the total catchment

area. This is followed by the Tapi River Basin covering about 5,460 km^2 or 37% of the total catchment area (Fig. 1.8). The headwater of K. Phum Duang is situated in the west and drains mainly on the eastern slopes of Phuket Range with several substantial tributaries such as K. Saeng, K. Sok and K. Yan. From the south is K. Tapi which drains into an extended part of the Central Lowland and the western slopes of Nakhon Range. The two main rivers join about 10 km west of Surat Thani, forming an extended delta as they discharge into the Gulf of Thailand.

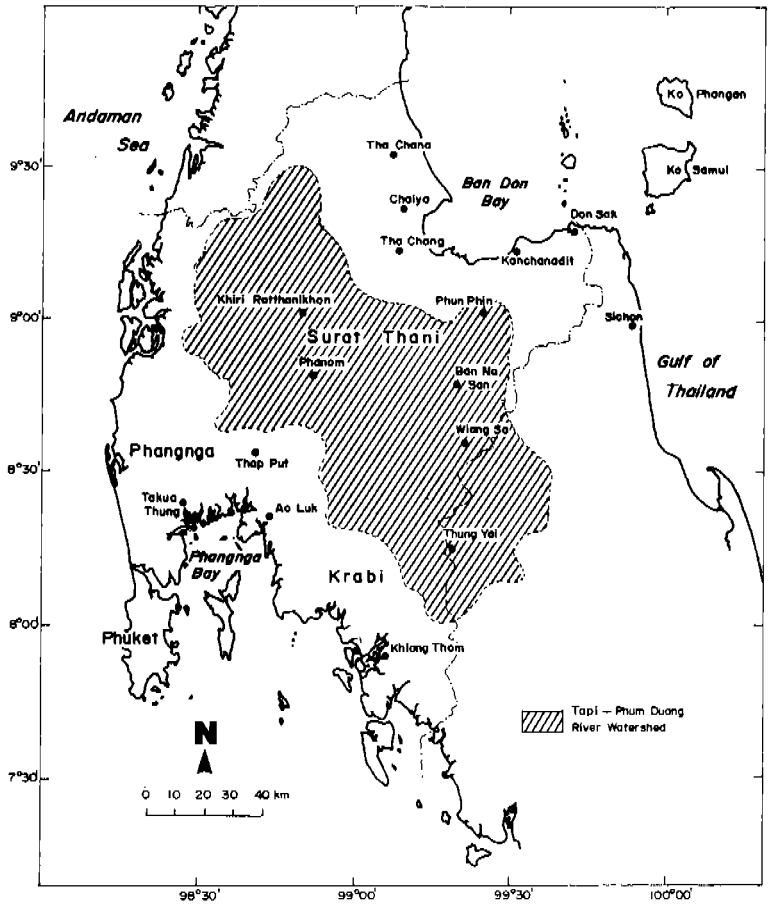


Fig. 1.8. Tapi-Phum Duang River Watershed, Upper South, Thailand.

Land Use and Agriculture

Present land use comprises cultivated areas of tree crops and paddies covering 23% of the total land area. Low intensity land use areas cover 41% and forested areas, 36%. Most of the forested areas are in the highlands and need to be reforested and/or rehabilitated for environmental protection or reserved for future use. These areas also include mangrove forests along the coastal zone. Cultivated land will most likely remain at 23% of the total area but uses will be intensified and diversified. The replacement of old rubber trees by high-yielding varieties and the introduction of irrigation in the paddy areas are likely in the near future.

The Upper South Region is endowed with a large area of unused or underused land which is estimated to cover about 6,900 km^2 or 66% of the land area suitable for agricultural

development. Water resources are available in most of the areas. The most common crops are cash crops of rubber and oil palm, which are limited to such tropical zones.

The region contributes a substantial amount to national production. Crops contribute more than 10% of the national production in oil palm, cashew nuts, long beans, rubber, rambutan, coffee and coconut. Forestry production, although declining, exceeds more than 10% of the national total (Table 1.2 and Fig. 1.9).

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Table 1.3 summarizes the results of land use studies in 1973, 1980 and 1982 as conducted by the Resources and Development Consultant Limited (REDECON 1975), DOLD (1980) and JICA (1985). Only the essential types of land use are indicated to show trends. It appears that within the agricultural sector, rubber is by far the most widespread crop in the upland areas of the four provinces. Paddy rice is the second major crop grown in the region, with the greatest concentration located in Surat Thani. Although there was some decrease in gross area for paddy rice in three provinces, the overall agricultural area for each of the provinces increased from 1973 to 1982. The figures on forest land during the same period are variable and difficult to explain. However, such variations could be due to differences in scale and lack of field information to distinguish areas with mixed features, e.g., secondary/forest mixed with tree crops (JICA 1985). Mangrove areas are being reduced markedly from year to year. Idle lands suited for agriculture showed variability but this could be due to shifting availability of labor and capital to sustain cultivation of these areas.

Table 1.2. Summary of agricultural, forestry, fisheries, mineral and tourist-based production in the Upper South, Thailand. (See footnotes on year or period covered.)

Items	Percentage value of national total resources/products
Crops[a]	
Oil palm	50.3
Cashew nuts	46.5
Sataw	37.5
Rubber	21.1
Rambutan	20.4
Coffee	18.9
Lancet	17.5
Coconut	13.8
Durian	9.5
Jackfruit	6.2
Tangerine	6.0
Forestry products[b]	
Firewood	28.9
Charcoal	23.7
Non-teak trees	10.5
Marine fish catch[c]	8.7
Mineral products[d]	
Tantalite	81.5
Zircon	72.7
Tin concentrates	64.5
Monazite	46.7
Xenotime	46.3
Lignite	36.6
Gypsum	28.5
Antimony ore	11.8
Columbite	10.2
Barite	8.7
Flourite	7.9
Tourists[e]	
Domestic	6.8
Foreign	8.1

Sources:
[a]Source: Office of Southern Agricultural Co-operatives (1981).
[b]Statistics from the Department of Royal Forestry
[c]Source: 1982 catch statistics from TDRI (1987).
[d]Statistics from JICA (1985) cover the period from 1976 to 1980.
[e]Statistics from the Tourism Authority of Thailand.

Mineral and Energy Resources

The Upper South Region is the largest tin mining area in Thailand. Tin mining provides the highest foreign exchange earning for the region, constituting 64.5% of the national tin production from 1976 to 1980 (see Table 1.2). Production has declined since then due to low price and oversupply in the world market (TDRI 1987). In 1983, 59% of the total national production of tin concentrates came from the Upper South with Phangnga and Phuket producing 15.3% of the total regional production mainly from offshore mining (TDRI 1986).

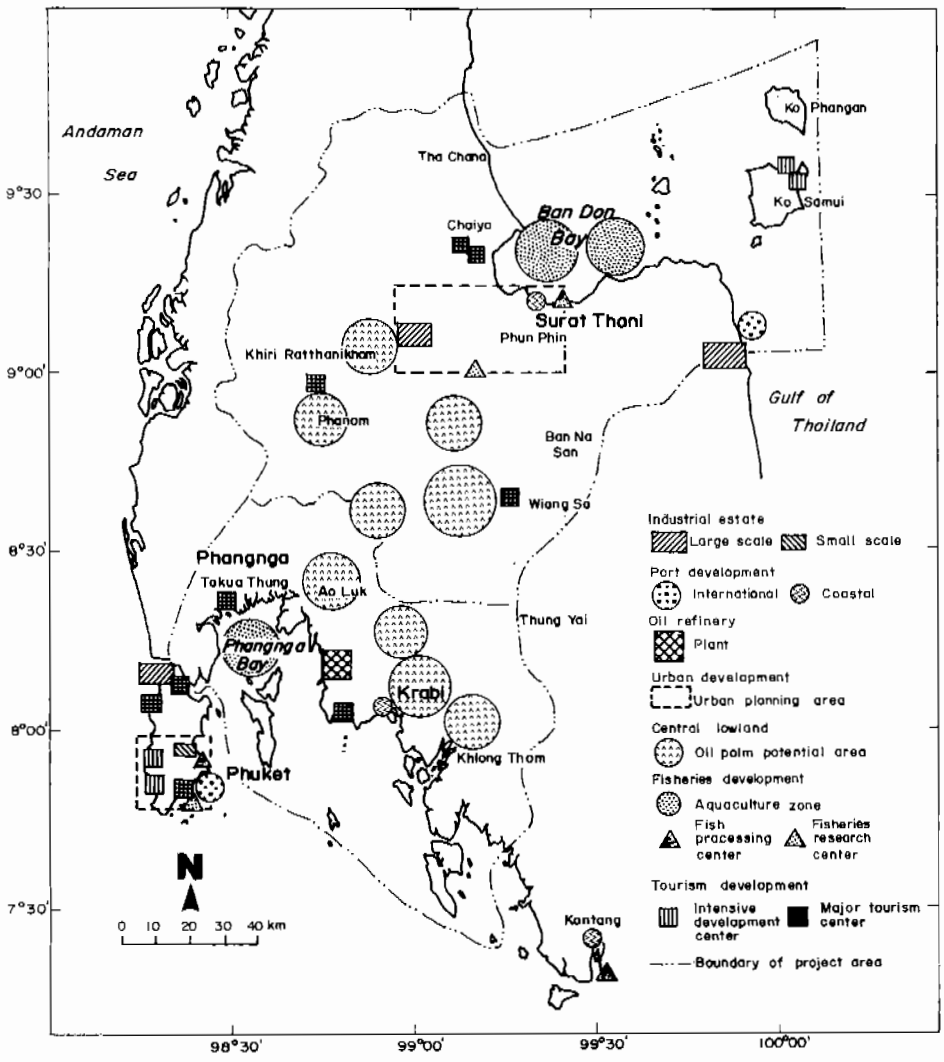


Fig. 1.9. Project boundaries and locations of significant land use.

Table 1.3. Comparison of the gross area (km^2) of major land use categories in the Upper South, Thailand, in 1973, 1980 and 1982.

Major land use	Surat Thani			% change	Phuket			% change	Phangnga			% change	Krabi			% change
	1973[a]	1980[b]	1982[c]	1973-1982	1973	1980	1982	1973-1982	1973	1980	1982	1973-1982	1973	1980	1982	1973-1982
Urban	155	24	NA[d]	–	19	22	NA	–	18	24	NA	–	18	29	NA	–
Agricultural	3,801	3,501	2,788		206	270	220		789	1,106	820		1,590	1,041	1,325	
Upland crops																
Rubber	2,648	2,038	2,183	-17.56	173	197	194[f]	–	638	944	719[f]	–	1,340	805	1,146	-14.48
Others	387	634			14	44			41	47			18	109		
Paddy rice	766	829	605	-21.02	19	29	26	+36.84	110	115	105	-4.55	232	127	179	-22.84
Forest																
Primary	6,275	6,598	4,178	-33.42	41	164	71	+73.17	1,192	2,090	2,083	+74.75	595	2,927	732	+23.03
Secondary	1,055	1,187	2,732	+158.96	146	2	211	+44.52	480	153	223	-53.54	326	88	728	+123.31
Mangrove	384	145	65	-83.07	45	41	27	-40.00	589	575	411	-30.22	454	421	378	-16.74
Low intensity																
Idle	2,962	916	2,157	-27.18	22	14	–	–	177	39	166	-6.21	1,693	49	1,089	-55.26
Mining	54	9	25[e]	–	74	28	14[e]	–	126	92	287[c]	–	19	2	3[e]	–

Hydroelectric power and lignite (low-grade coal) steam power account for 39% of the existing power generating capacity in the region. Two hydroelectric power projects were completed in 1987: the Chiew Larn Project in Surat Thani, which is in the Tapi-Phum Duang Basin and has a 240,000-kw capacity; and the Khlong Yan Project, also in Surat Thani, which has a 106,000-kw capacity.

Chapter 2
Natural Resources and Environment

Surface Water Resources

NISAKORN KOSITRATANA

Drainage system

The majority of surface freshwater discharge to the estuarine zone of Ban Don Bay is from the Tapi-Phum Duang River Watershed (Fig. 1.8 and Fig. 2.1). Several smaller coastal watersheds (Fig. 2.2 and Table 2.1) also contribute to the total freshwater runoff to the bay. The Tapi-Phum Duang River System includes several subwatersheds in the peninsular mountains of Surat Thani which form a drainage system flowing to the north and northeast and discharging into the bay in Amphoe (A. from here, and which means "second-order administrative district") Muang, Surat Thani.

The surface freshwater discharge to the Phangnga Bay planning area is from several relatively small coastal watersheds in Phangnga and Krabi Provinces. The most significant flow comes from K. Phangnga, K. Bo San and K. Marui in Phangnga Province, and K. Krabi and K. Tom in Krabi (Fig. 2.2 and Table 2.1).

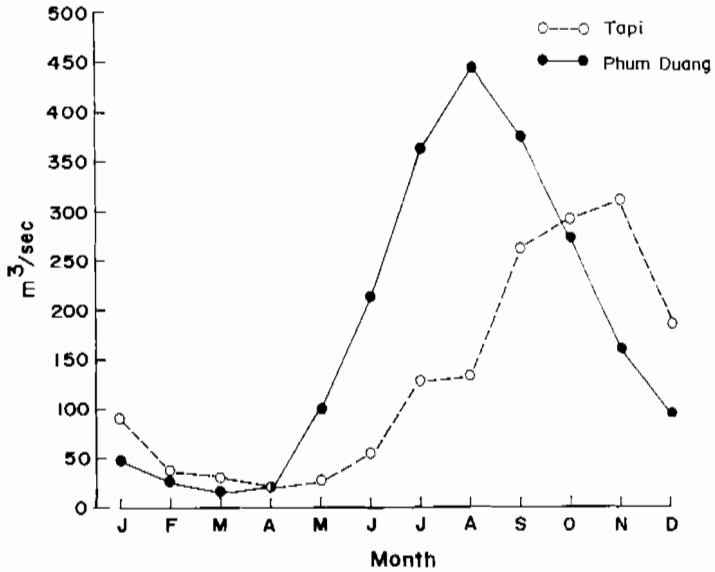
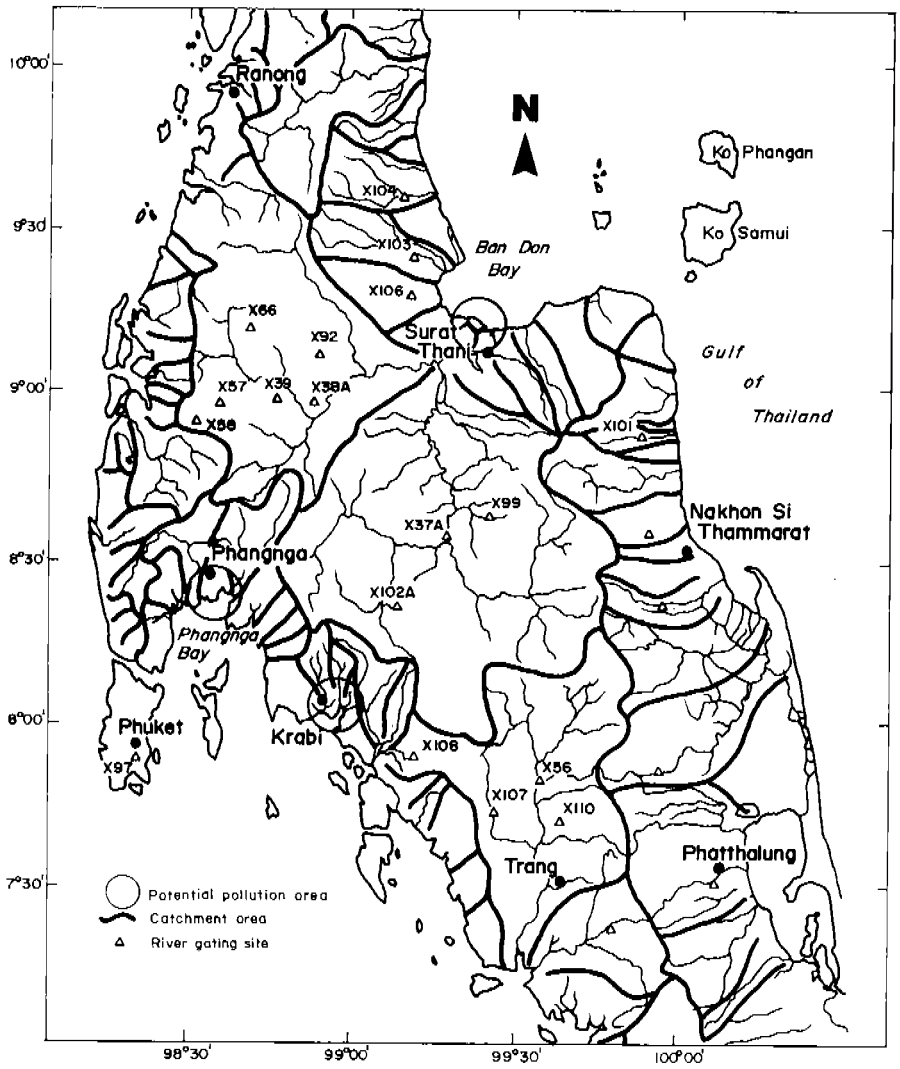


Fig. 2.1. Monthly river discharge to Ban Don Bay (JICA 1984).



Rivers (Khlong)

X104	Tha Krachai
X103	Takhian
X106	Chaiya
X38A	Phum Duang
X39	Saeng
X57	Chong Lom
X58	Sok
X66	Yan
X92	Yan
X37A	Mae Nam Ta Pi
X99	Tan
X102A	Sang
X97	Ao Yan
X101	Tha Thong
X56	Mae Nam Trang
X107	Chi
X108	Kalasi Yai
X110	Lamphu La

Fig. 2.2. Catchment areas of rivers in the Upper South, Thailand.

Table 2.1. Hydrological characteristics of selected rivers in the Upper South, Thailand, in 1984.

No.	River (*Khlong*)	Catchment area(km^2)	Discharge (m^3/s) Mean	Minimum	Maximum	Ratio Maximum/ Minimum	Annual runoff (million m^3)
X104	Tha Krachai	354	10.99	0.30	203.20	677	347.6
X103	Takhian	180	3.91	0.00	140.68	-	123.8
X106	Chaiya	309	5.03	0.00	41.42	-	159.1
X38A	Phum Duang	2,706	179.60	5.70	1,686.60	296	5,679.3
X39	Saeng	1,437	116.60	4.70	1,437.60	306	3,886.2
X57	Chong Lom	8	1.31	0.11	22.66	206	41.3
X58	Sok	312	26.36	2.00	250.05	125	833.7
X66	Yan	661	36.00	1.80	561.00	312	1,138.3
X92	Yan	1,001	44.24	5.00	473.00	95	1,399.0
X37A	Mae Nam Ta Pi	5,200	131.92	16.50	421.60	26	4,171.5
X99	Tan	105	1.78	0.28	14.08	51	56.4
X102A	Sang	152	2.76	0.04	21.88	547	87.4
X97	Ao Yan	2	0.02	0.00	1.64	-	0.5
X101	Tha Thong	95	3.49	0.41	226.90	553	110.4
X56	Mae Nam Trang	1,801	31.34	3.28	214.60	65	990.9
X107	Chi	248	4.68	0.23	48.61	211	147.9
X108	Kalasi Yai	57	0.70	0.13	5.08	39	22.0
X110	Lamphu La	229	3.82	0.13	28.83	222	120.8

Source: JICA (1985).

The hydrological characteristics of the rivers in the Upper South are summarized in Table 2.1 and Fig. 2.1 and 2.2. The ratio of the maximum and minimum discharges appear to be extremely high in most rivers which implies that monthly discharges fluctuate according to seasonal precipitations. As shown in Table 2.1, K. Tapi shows a typical eastern regime since the upper watershed is found in eastern and central parts of the region. K. Phum Duang, however, shows a western regime because the headwater is in the west.

Water quality

A monitoring program of the lower K. Phum Duang has been developed as a cooperative effort between ONEB and the Industrial Works Department/Ministry of Industry (IWD/MOI). The program monitoring includes chemical oxygen demand (COD), conductivity, temperature, pH and dissolved oxygen (DO) at two sampling sites. The purpose of this monitoring is to determine the effects of wastewater discharges from the new Suratip Sri Talung Distillery Plant (EQSD 1985). The distillery also initiated monitoring of the river water quality in 1986.

The results of the monitoring, which show a large range in conductivity, are summarized in Table 2.2. This indicates the influx of freshwater during the rainy season while tidal infuence is apparent during dry season which results in brackishwater condition.

A two-day nearshore water quality survey was carried out in 1984 at K. Boa Dan which discharges into Phangnga Bay. This study provides limited information on diurnal fluctuation of water quality at the mouth of the river including some nutrient concentrations.

In general, information on surface water quality is limited, but the most significant influence is that of silt from upland activities. Also, extreme fluctuations in salinity have implications for culture activities in the area.

Table 2.2. Range of water quality parameters from K. Phum Duang, 1986.

Month	pH	Temperature (°C)	Range conductivity (µmho/cm)	DO (mg/l)	COD (mg/l)
Jan	7.4-7.9	28.2-29.7	160.3-177.3	5.2-6.1	-
Feb	7.1-7.8	27.1-30.4	138.4-245.0	4.9-6.8	-
Mar	7.4-7.9	26.6-31.5	275.0-181.5	4.7-6.5	-
Apr	7.3-7.8	29.4-32.9	214.0-285.0	4.2-6.6	15.1-17.6
May	6.9-7.9	26.3-31.0	51.5-284.0	4.3-6.8	0.4-27.3
Jun	7.0-7.8	26.7-29.5	83.8-143.9	4.5-7.2	0.4-33.1

Source: Statistics from the Suratip Sri Talung Distillery Plant.

Water uses

The beneficial uses of the waters can be categorized as follows:

1. Upper watershed: village water supply; subsistence fisheries; small streamside irrigation.
2. Flood plains: domestic water supply; subsistence fisheries; irrigation.
3. Coastal zone: urban and domestic water supply; industrial water supply; commercial and artisanal fisheries and aquaculture.

A major multipurpose dam-reservoir project, Chiew Larn, will enhance water resource use by hydroelectric power generation and irrigation development. The effects of Chiew Larn

and other planned dam/reservoir projects on the salinity and hydrology of the Ban Don Bay estuarine zone are yet to be assessed.

The Upper South planning study included a sectoral report on water resources indicating that the Tapi-Phum Duang River System has potential for further water resource development. JICA (1985) recommended that this development also include measures for watershed protection, water management and fisheries development.

Land-based water pollution sources

Water pollution in Ban Don Bay is primarily due to wastewater from domestic rural and urban sources, industries, mining and ports and from natural watershed sediment and agricultural runoff. Some of the wastewater sources in Surat Thani Province are shown in Table 2.3, while Table 2.4 gives such sources in Phangnga and Krabi.

Table 2.3. List of wastewater sources in Surat Thani Province.

A. Industrial sources
   1. Fish Mill Factory Co., Ltd.
   2. Num Surat Fish Mill
   3. Ban Don Fishery Co., Ltd.
   4. Surat Thani Freezer
   5. Chao Pramong Ban Don Co., Ltd.
   6. Sea Horse Surat Thani Trading Co., Ltd.
   7. Yang Thai Pak Tai Co., Ltd.
   8. Huay Chuan Co., Ltd. (Surat Thani Branch)
   9. Taksin Palm (2521) Co., Ltd.
   10. Saha Sinka Yang Surat, Ltd.
   11. Pan Asia (1981) Co., Ltd.
   12. United Surat Rubber Co., Ltd.
   13. Surat Seafood Co., Ltd.
   14. Muang Yang Sin Thai Co., Ltd.
   15. Seng Mui Para, Ltd.
   16. Huay Chuan Co., Ltd. (Ban Na San Branch)
   17. Yang Tai Tawee, Ltd.
   18. Suratip Sri Talung Distillery Plant

B. Domestic sources: dense residential areas along:
   1. K. Tapi
   2. K. Phum Duang
   3. K. Phun Phin
   4. K. Chanak
   5. K. Kradae
   6. K. Don Sak

C. Hotel: Wang Tai Hotel

D. Ports
   1. Fisheries ports
      a. Inner Ban Don Port
      b. Ban Don Private Ports
      c. Others in A. Don Sak, A. Kanchanadit, A. Tha Chana, etc.
   2. Commercial and passenger ports
      a. Inner Ban Don Port
      b. Ferry Port
      c. Tha Thong Port
      d. Na Thorn Port
   3. Oil fuel and LPG ports
      a. Petroleum Authority of Thailand
      b. Caltex
      c. Shell
      d. Esso

Table 2.4. List of wastewater sources in Phangnga and Krabi.

Phangnga
A. Industrial sources - no data (field survey needed)
B. Domestic sources: dense residential areas along:
   1. K. Phangnga
   2. K. Bo San
   3. K. Marui
C. Land mining
D. Hotel: Phangnga Bay Resort

Krabi
A. Industrial sources
   1. Saha Palm Oil Industry Co., Ltd.
   2. Siam Palm Oil and Industry Co., Ltd.
   3. Thai Oil Industry and Suan Palm Co., Ltd.
   4. Muang Yang Sin Thai Co., Ltd.
   5. United Krabi Rubber Co., Ltd.
   6. Krabi Adin Co., Ltd.
B. Domestic sources: dense residential areas along:
   1. Mouth of K. Krabi
   2. K. Tom
C. Hotel: Wiang Thong Hotel
D. Port: Krabi Port

Marine Environment

MANUWADI HUNGSPREUGS AND PRAWIN LIMPSAICHOL

Biology

The distribution of plankton and benthic communities in the Gulf of Thailand was studied by the Marine Fisheries Laboratory and Exploratory Unit of DOF. Most of the studies on zooplankton concentrated on fish larvae and fish eggs. None were done in the nearshore zone of Ban Don Bay; the closest were done at Ang Thong Island, Surat Thani. *Vibrio* spp., coliform bacteria like *Escherichia coli* distribution in water, sediment and some marine organisms were studied in many coastal areas in the gulf (Saitanu et al. 1984a; 1984b). Total bacterial counts were 440 to 893,300 per ml of water samples and 3,000 to 58,500,000 per g of mollusk. Most Probable Numbers (MPN) of of coliform and fecal coliform bacilli were 0 to 1,600 per 100 ml of water and 0 to 100 g of mollusk. *Vibrio parahaemolyticus* was found in 85% of mollusk samples and 56% of water samples. Based on the above findings, it can be inferred that culture areas in the Upper Gulf of Thailand, oyster farms in Surat Thani, cockle farms in Nakhon Si Thammarat and some cockle farms in Phangnga were contaminated with fecal wastes.

Zooplankton community structure, abundance and distribution on the east coast of Phuket Island and Phangnga Bay (Fig. 2.3) were analyzed by Boonruang (1985) who reported

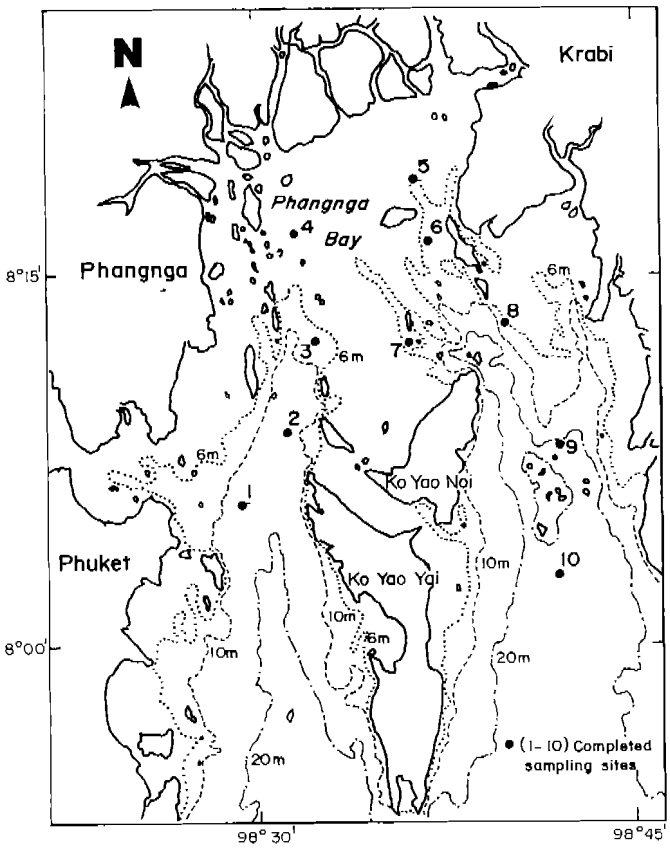


Fig. 2.3. Sampling stations and depth contours in Phangnga Bay.

the highest density during the northeast monsoon with a maximum abundance occurring in the uppermost part of Phangnga Bay. In a related study by Boonruang and Tongvichit (unpublished) on the abundance and composition of zooplankton in Phangnga Bay for the entire 1984, monthly variations were observed. Abundant zooplankton population occurred during January to March with copepods having the highest species composition (20-60%) followed by *Lucifer* spp. (1-50%). Shrimp larvae were also observed constituting 1-5% at the inner part of the bay.

A preliminary study on fish larvae abundance and composition was also undertaken from January to June 1984 by Janekarn and Nateewathana (unpublished). About 41 families were recorded with 21 of economic importance constituting 57.5% of the collected materials. Among the families were Engraulidae, Leiognathidae, Carangidae and Sciaenidae which was the most abundant. Seasonal variations were observed to be greatly affected by the monsoon periods. However, long-term observations are required to establish trends.

The primary productivity was measured in situ along the east coast of Phuket Island and Phangnga Bay in 1982 (Fig. 2.3) using carbon-14 technique. It was reported that low and high primary productivity was recorded during northeast and southwest monsoons, respectively (Sunstrom et al. 1986).

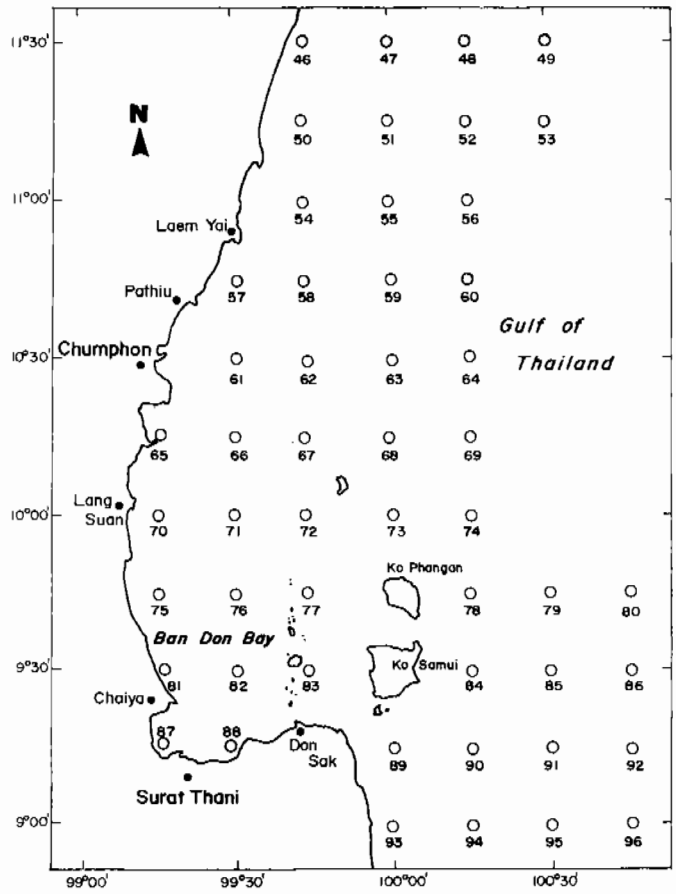


Fig. 2.4. Sampling stations for DOF near Ban Don Bay: stations 81, 82 and 83 in 1985.

Chemical and physical oceanography

Along with the DOF biological surveys, limited studies on chemical parameters such as DO, pH and nutrients were conducted. The closest sampling stations to Ban Don Bay were 81, 82 and 83 (Fig. 2.4). Stations 87 and 88 could not be sampled because they were too shallow

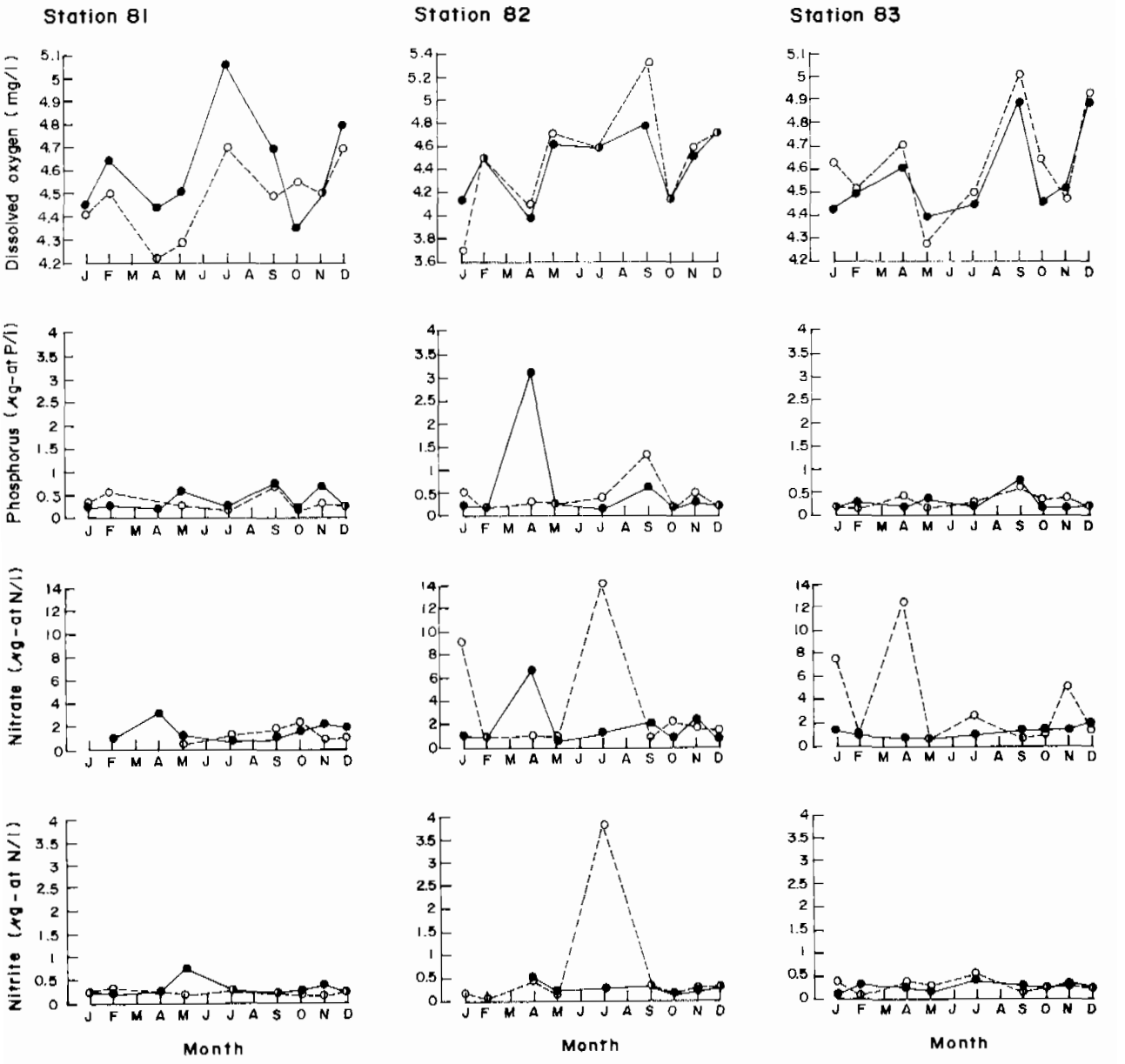


Fig. 2.5. Monthly distribution of *(top to bottom):* dissolved oxygen, phosphorous, nitrate and nitrite at stations 81, 82 and 83 in 1985.

for the DOF vessel. Monthly distribution of DO, nitrate, nitrite and phosphate in 1985 at stations 81 to 83 are shown in Fig. 2.5. At stations 82 and 83, DO at surface and bottom water samples did not show marked difference and varied from 3.7-5.3 mg/l indicating vertical water mixing.

Salinity measured throughout the water column ranged from 3.7-5.3 ppt which also indicates vertical water mixing. The higher DO in bottom layers as compared to the surface at station 81 cannot be explained. However, DO peaks in July at station 81 and in September at stations 82 and 83 may be the result of water turbulence caused by the monsoon. Nutrients at stations 81 and 83 did not show much monthly variation except for nitrate levels at the latter. Fluctuation of nutrients at station 82 may be due to the release from resuspended sediments during turbulence since the station was shallow.

The only other report available on water quality in Ban Don Bay is by Chindanonda et al. (1985). The site was a cockle farm at A. Tha Chang and A. Chaiya: DO was between 3.9-4.9 mg/l; pH, 7.76-8.7; Secchi disc visibility, 20-131 cm; nitrate nitrogen, less than 0.0138 mg/l; orthophosphate, 0.04-0.67 mg/l; ammonia nitrogen, 0-0.69 mg/l; and silica 5-42 mg/l.

In the west coast, chemical marine environmental data were collected to investigate diurnal and seasonal variations which are still being analyzed. Phangnga Provincial Fisheries Office conducted some monitoring in the cockle beds on the upper east coast of the bay, near K. Hin Rhum (Fig. 2.6). The results obtained in March to July 1986 indicated significant

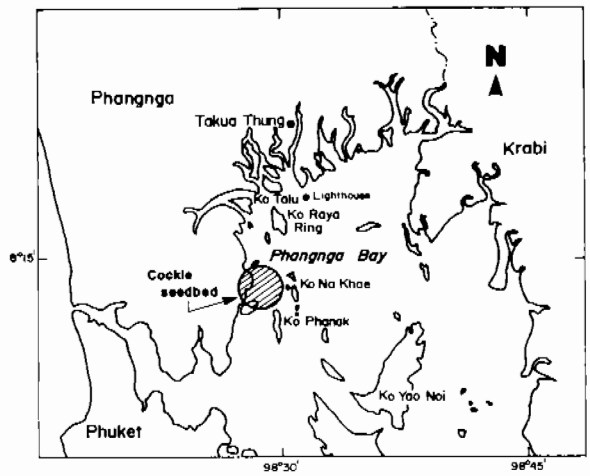


Fig. 2.6. The site of cockle seedbed survey (DOF 1986).

seasonal variations in the environmental conditions. During southwest and northeast monsoons, salinity varied from 22-30 ppt, respectively, while water transparency (Secchi disc reading) varied from 0.8 to 1.0 m, respectively. The pH varied from 7.5 to 7.9 with a relatively uniform temperature of about 29°C.

In Phuket, several field measurements were completed by PMBC. The physical data, including tidal exchange and directions, temperature and salinity, were sent to the University of South Carolina, USA, for modeling purposes.

Based on the existing data for Phangnga Bay, the primary productivity is high because of the influx of nutrients from mangrove and estuaries within the bay area. This is further enhanced by the hydrodynamic conditions prevailing in the bay, particularly tidal movements (Sunstrom et al. 1986; Parsons et al. 1977). Such high primary production has a significant impact on fisheries production and indicates good potential for shellfish farming (Petersen and Curtis 1980; Charpy-Roubaud et al. 1982). Despite such potential, however, mollusk larvae are not present in significant amounts (Kurt, pers. comm.). It is, therefore, necessary to import seeds to realize this potential.

Soils

PISOOT VIJARNSORN

DOLD classified the soils of the Upper South according to their types and agricultural uses. Soil types follow the standard set by the US Department of Agriculture (USDA) on soil taxonomy (refer to Table 2.7 and Fig. 2.7 on the units mentioned in the following paragraphs).

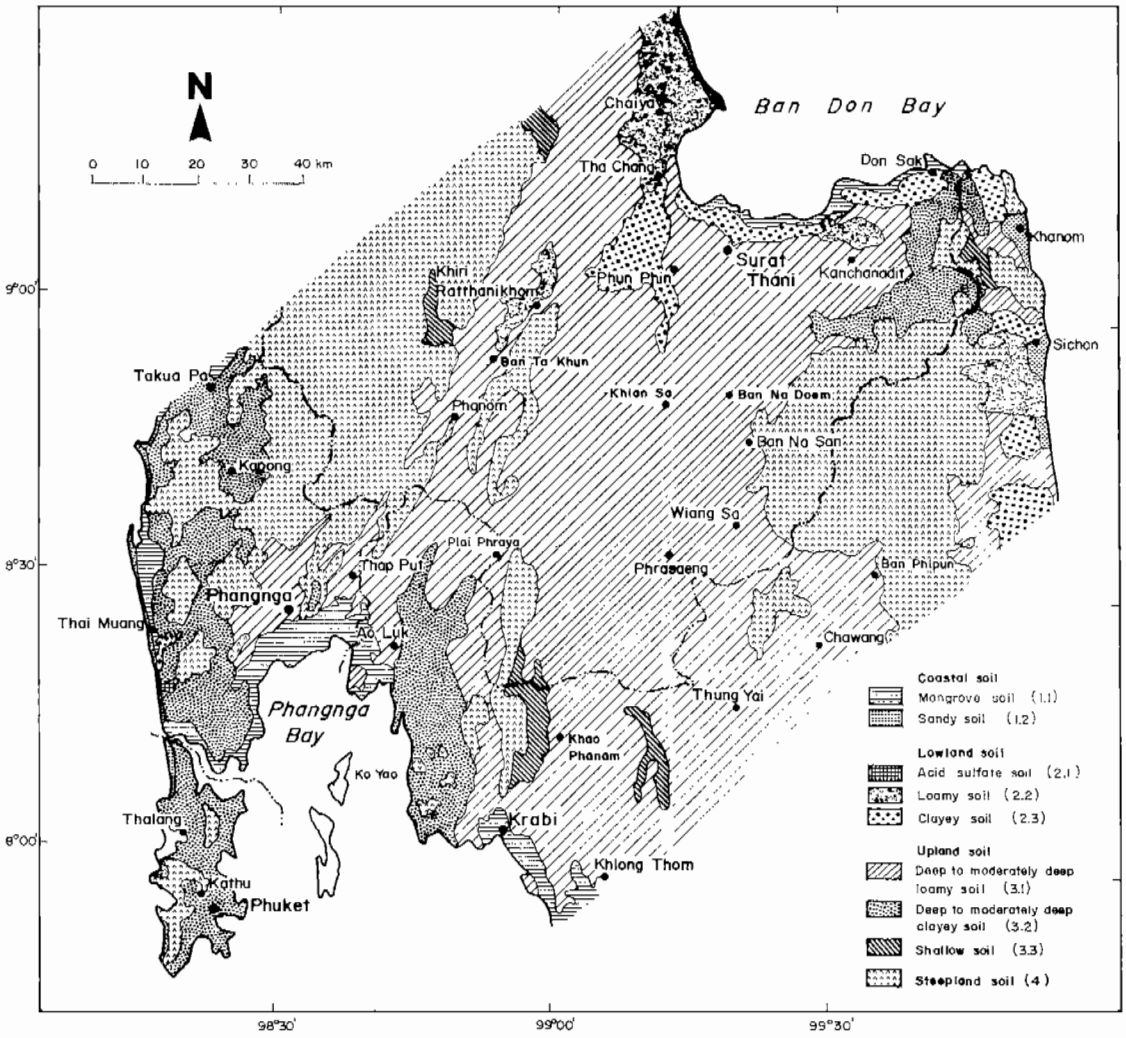


Fig. 2.7. General soil types of the Upper South, Thailand.

Coastal soils

Soils occurring on mangrove swamp (unit 1) and tidal flats or beach ridges (unit 1.1), in general, are classified as Sulfaquents or Hydraquents. These soils are permanently saturated with saline water. Sulfaquents have an appreciable amount of sulfides and are generally associated with acid sulfate soils.

In Ban Don, two main soil types can be distinguished: the muddy soils developed in the lower part of the tidal range and the acid sulfate or potentially acid sulfate soils (unit 2.1) in the upper part.

The less developed muddy soils are mostly found in submerged condition and are alkaline in reaction. They have dark gray color, clayey texture and many decayed roots in the profile. The surface layer is about 20-30 cm thick.

The acid sulfate soils have gray color and clayey texture in the surface with reddish and yellowish mottles. The soils are mildly acidic to strongly acidic in reaction.

Most soils in Phangnga Bay mangrove areas are derived from clayey and silty sediments. The soils have clayey texture throughout the profile when undisturbed by mining activities. Yellowish or brownish mottles are observed in the upper soil profile, particularly the

oxidized layers. The lower part of the profile, the C-horizon, is always saturated with water which results in bluish color or strong graying condition. The soils are alkaline (ph 7-8) in reaction and are generally moderately fertile and high in organic matter content. Mudballs are almost always observed.

Disturbed mangrove soils along Phangnga Estuary occurred as a result of tin mining. But these soils were colonized by *nipah* palm after being abandoned as mines.

Soils developed on beach ridges or dunes normally have a predominant sandy texture and form long narrow strips parallel to existing shoreline. They are classified as Tropohumods and Quartzipsamments. Most have been used for cultivation of coconuts. However, the former is less desirable due to severe limitation in root zones.

Lowland soils

Most of the lowland soils are cultivated for paddy rice. They may be developed on brackish deposits or riverine alluvium. Internal drainage is poor and commonly flooded in the rainy season.

The acid sufate soils (unit 2.1) form on brackishwater deposits with relatively high sulfur content. They are extremely acidic in reaction and are classified as Acid Tropaquepts. Rice yield commonly depends upon the degree of acidification and management level.

Most of the loamy soils (unit 2.2) occupy the lower part of alluvial terraces or transitional sites between terraces and coastal lowland. These soils are commonly classified into Plinthaquults and Paleaquults. The former have dark red mottles usually in platy, polygonal or reticulate pattern; the latter do not have these. Loamy soils are exclusively used for paddy rice. Average yield under ordinary management ranges from 1,560-2,190 kg/ha.

The clayey soils (unit 2.3) occupy the basin of large rivers or former tidal flats. They include Tropaquepts and Paleaquults and most have been cultivated for paddy rice, with yield somewhat higher than that of loamy soils.

Upland soils

These commonly occur on undulating to rolling topography with slopes ranging from 3%-35%. Their parent materials vary from old alluvium to transported material derived from various rocks. Areas where these types of soils occur are generally cleared of natural vegetation and cultivated primarily for rubber, fruit trees, oil palm and, to a lesser extent, annual upland crops such as maize, ground nuts and cassava. However, parts of the area are left idle and revert to a low secondary vegetation consisting of low shrubs, canes, bamboos and grasses, especially *Imperata cylindrica*. Upland soils are subdivided into the following units:

- The deep to moderately deep loamy soils (unit 3.1) comprise those in groups Paleudults, Tropudults and Plinthudults which are moderately to well-drained and have rapid to moderate runoff. The natural fertility is relatively low. Lateritic gravels may occur in the lower subsoils.
- The deep to moderately deep clayey soils (unit 3.2) belong only to Paleudults. Their characteristics are similar to those described in unit 3.1 except that the former have more clay content in subsoils.
- The shallow soils (unit 3.3) comprise those containing lateritic gravels or rock fragments throughout the soil profiles. Those containing lateritic gravels can be classified into Paleudults; otherwise, they can be into Tropudults or Troporthents. In general, these soils are cultivated for rubber but parts are left idle and commonly revert to a type of low shrubs and grassy undergrowth.

Steepland soils

About 32% of the total area of the Upper South are soils which occur on steepsided hills and mountains. The soil texture and the thickness of the solum are variable depending upon the nature of the parent rocks. These soils are highly susceptible to erosion even though they are cultivated with tree crops. In general, tropical evergreen forest remains dominant except on areas with commercial timbers.

Land Capability

PISOOT VIJARNSORN

Land capability classification is one of the important interpretations that can be made from the soil characteristics described above. Table 2.5 gives the land capability for upland crops and the soil suitability for paddy rice with their extent and percentage of the total area.

Table 2.5. Classification and land capability assessment of soils in the Upper South, Thailand.

Major soil group	Unit[a]	Classification (based on USDA soil taxonomy)	Land capability assessment[b] Upland crops	Paddy rice	Approx. extent Km^2	Percentage
Coastal soils	1					
Mangrove soils	1.1	Hydraquents, Sulfaquents	U-V	P-V	600	2.97
Sandy soils	1.2	Quartzipsamments, Tropohumods	U-IV	P-IV	131	0.65
Lowland soils	2					
Acid sulfate soils	2.1	Sulfuric tropaquents	U-IV	P-IV	6	0.03
Loamy soils	2.2	Plinthaquults, Paleaquults	U-IV	P-III	693	3.42
Clayey soils	2.3	Tropaquepts, Paleaquults	U-IV	P-II	693	3.42
Upland soils	3					
Deep to moderately deep loamy soils	3.1	Dystropepts, Paleudults Tropudults, Plinthudults	U-III	P-V	9,203	45.48
Deep to moderately clayey soils	3.2	Paleudults	U-II	P-V	2,080	10.28
Shallow soils	3.3	Tropudults, Troporthents	U-VI	P-V	292	1.44
Steepland soils	4	-	U-VII	P-V	6,537	32.31
Total					20,235	100.00

Source: DOLD (1980).

[a] For a comprehensive discussion of the units, see section on soils in this chapter.

[b] Land capability classes:

- U-I : soils very well suited for upland crops, having no significant limitations that restrict their use.
- U-II : soils well-suited for upland crops, having slight limitations that restrict their use.
- U-III : soils moderately suited for upland crops, having moderate limitations that reduce the choice of crops and/or require special management.
- U-IV : soils poorly suited for upland crops, having severe limitations that restrict the choice of crops and/or require very careful management.
- U-V : soils having little or no erosion hazard, but having other limitations that are impractical to remove, making them not suitable for upland crops.
- U-VI : soils having severe limitations that make and limit their use to pasture, woodland, wildlife food and cover, water supply and recreation.
- U-VII : soils having very severe limitations that make them not suitable for cultivated crops and that restrict their use largely to woodland, wildlife food and cover, water supply and recreation.
- U-VIII : soils and land types having limitations that preclude their use of commercial plant production and restrict their use to recreation, wildlife food and cover and water supply.

Land suitability classes:

- P-I : soils very well suited for paddy land having no significant limitations for rice production.
- P-II : soils well-suited for paddy land having slight limitations that restrict their use for rice production.
- P-III : soils moderately suited for paddy land, having moderate limitations that restrict their use for rice production and/or require special management.
- P-IV : soils poorly suited for paddy land, having severe limitations that restrict their use for rice production and/or require very careful management.
- P-V : soils generally not suited for paddy land, having very severe limitations that preclude their use for rice production with ordinary methods.

About 56% of the total area of the Upper South is suitable for upland crops. Approximately 32% are steeplands which are not recommended for agricultural uses. Marginal lands for upland crop production comprise 9%. The others are unsuitable for upland crops due to regular flooding by seawater. The largest part of the Upper South (93%) is generally not suited for paddy land and comprises land too steep or too high to impound water.

There are limits of arable land to absorb more agriculture rapidly which is exacerbated by diminishing soil resources due to improper use. Most of the forest areas (not only on the mountains but also along the estuaries) have been cleared to some extent. In some areas, the rate of clearance is beyond control.

For protection of the land resources in the coastal areas from irreparable damage, individual land units must be evaluated in terms of their capability and compared to present uses. The use of land capability data combined with other physical and socioeconomic data will help in appropriate management and development planning of the coastal resources.

Mangrove Forests

SANIT AKSORNKOAE AND APISIT EIUMNOH

Coastal morphology

Strong wave energy inhibits the formation of extensive mangrove forests on Ban Don. Along the river mouth, muddy sediments were deposited, and mangrove forest is well-established. The tidal range is not great so coverage is along a narrow strip.

In Phangnga Bay, the tidal range is larger and a very gentle sloping or flat landform is found. Because of the flat topography and low wave energy there has been much deposition of sediments, clay, silt and organic matter. Limestone and some other rock hills also provide good shelter and wind protection.

The total mangrove areal extent of Thailand in 1986 was about 268,694 ha. The mangrove forests of Surat Thani, Phangnga, Phuket and Krabi constitute about 30% of the national total or 81,574 ha which decreased by about 3% from 1975 to 1986. Dominant species are *Rhizophora* spp., *Avicennia alba, Sonneratia alba, Xylocarpus* spp. and *Bruguiera* spp.

The primary contributing factors to the decrease are clear cutting for wood for charcoal or construction and land reclamation for urban development, aquaculture, tin mining and industry. Land use data showed that as of 1986, 38% of the total converted mangroves in the country were for aquaculture purposes. Land reclamation for agriculture, urban and industrial sites took 46% and conversion for tin mining, about 3.5%. Along the Andaman Sea, tin mining has been a major cause of mangrove degradation. About 2% of the mangrove forests were affected. Degradation is largely a result of sedimentation from tin mine tailings.

Area distribution

The mangrove forests along the coast of Ban Don Bay cover the provinces of Chumphon, Surat Thani and Nakhon Si Thammarat (Table 2.6.) and are estimated to be 25,570 ha (Klankamsorn and Charuppat 1982).

In Phangnga Bay, mangrove forests (Table 2.7) occur on the seashore, lagoon and along the rivers at levels between low and high tides. The extent of mangrove forests in

Table 2.6. Area (ha) of mangrove forests in Ban Don Bay by provinces in 1979.

Province	Area	Percentage of the total area
Chumphon		
A. Muang	3,472	
A. Sawi	2,384	
A. Pathiu	416	
A. Lang Suan	656	
Subtotal	6,928	27.1
Surat Thani		
A. Muang	448	
A. Chaiya	912	
A. Tha Chang	1,360	
A. Tha Chana	272	
A. Kanchanadit	656	
A. Don Sak	2,160	
Subtotal	5,808	22.7
Nakhon Si Thammarat		
A. Muang	4,768	
A. Phanom	592	
A. Pak Phanang	7,472	
Subtotal	12,832	50.2
Total	25,568	100

Table 2.7. Area (ha) of mangrove forests in Phangnga Bay by provinces and districts *(amphoe)* in 1979.

Province	Area	Percentage of the total area
Phangnga		
A. Muang	8,800	
A. Takua Thung	8,144	
A. Thap Put	3,164	
King A. Ko Yao	1,072	
Subtotal	21,180	38.0
Krabi		
A. Muang	10,272	
A. Ao Luk	5,056	
A. Khlong Thom	8,352	
Kor-lunta	8,080	
Subtotal	31,760	56.9
Phuket		
A. Muang	1,120	
A. Thalang	1,728	
Subtotal	2,848	5.1
Total	55,788	100

Phangnga Bay, as estimated by using satellite imagery in 1979, was about 55,790 ha (Klankamsorn and Charuppat 1982).

Species composition

Species composition of mangrove communities of Ban Don Bay was observed at A. Muang, Chumphon Province; A. Chaiya and A. Don Sak, Surat Thani Province (Miyawaki et al. 1975); and A. Khanom, Nakhon Si Thammarat Province (Aksornkoae 1985). The main species at A. Muang are composed of *S. alba, A. alba, Rhizophora mucronata, R. apiculata, Ceriops tagal, Xylocarpus granatum* and *Excoecaria agallocha.*

The important species at A. Chaiya are *R. apiculata, S. alba, A. alba, X. granatum, E. agallocha, C. decandra and Nypa fruticans.* The common species at A. Don Sak are *R. mucronata, R. apiculata, A. officinalis, X. moluccensis, E. agallocha* and *Phoenix* sp. At A. Khanom, there are more species; and the common ones are *R. apiculata, R. mucronata, X. granatum, X. moluccensis, A. alba, C. tagal, Lumnitzera* sp., *E. agallocha, Bruguiera gymnorrhiza, B. cylindrica, Heritiera littoralis, Acrostichum aureum, S. alba* and *Phoenix paludosa.*

Mangrove species at A. Muang, Phangnga Province were studied by Aksornkoae and Kongsangchai (1980). There are three habitats, each having a different species composition:

1. Near the limestone area - *R. mucronata, R. apiculata, X. granatum, X. moluccensis, B. sexangula, B. cylindrica, B. parviflora, B. gymnorrhiza, Sonneratia* sp., *C. tagal, Kandelia candel* and *A. alba.*
2. Near the shale and quartzitic formations - *R. mucronata, R. apiculata, X. granatum, B. sexangula, B. cylindrica, B. parviflora* and *C. tagal.* There are less species found in these areas compared to those in the southeastern part of the country such as in Chonburi Province (Aksornkoae 1975).
3. Near the sandstone area - *R. apiculata, S. alba, X. granatum, Lumnitzera* sp. and *Melaleuca leucadendron.*

Species zonation

Species zonation at Ban Don Bay was intensively studied only at A. Phanom (Aksornkoae 1985). Along the margin of rivers and channels running through the mangroves,

and where the soil surface is waterlogged and very muddy, pure stands of *Rhizophora* are found with roots arching into the water. *R. apiculata* and *Rhizophora* spp. are found from the river margin to about 100 m inland.

The zone of *Avicennia*, variable in width, occurs behind the zone of *Rhizophora*. Occasionally, trees of *Avicennia* may also be found in the wetter area near the forest margin. *Bruguiera* is observed behind *Avicennia*. The lands behind *Avicennia* and *Bruguiera* communities, which are more elevated and subject to less frequent tidal inundation, are occupied by *Xylocarpus*. The drier land behind this zone is colonized by *Ceriops, Lumnitzera* and *Excoecaria*. Occasionally, on the elevated and drier area at the riverbank, *Xylocarpus, Ceriops, Lumnitzera* and *Excoecaria* are observed. The fern, *A. aureum,* is found sporadically covering an area where the forest has been disturbed by cutting. The palm, *P. paludosa,* grows sparsely in mangroves and covers only the area along the river margin.

In the mangrove forests at A. Muang, Phangnga, different species tend to dominate certain zones due chiefly to species adaptation to adverse site factors such as soil condition, topographic relief and strong prevailing seashore winds.

Stand density and stem volume

Stand densities and stem volumes of all mangrove forests of both Ban Don Bay (A. Phanom) (Tables 2.8 and 2.9) and Phangnga Bay (A. Muang) (Tables 2.10-2.15) were observed

Table 2.8. Tree density (trees/ha) of mangrove forests in Ban Don Bay in A. Khanom, Nakhon Si Thammarat.

Species		Tree density						
Scientific name	Common Thai name	Distance from forest margin (riverbank) towards inland (m)					Total	Average
		0-10	30-40	60-70	90-100	120-130		
Rhizophora apiculata	*Kong-kang-bi-lek*	183	367	367	267	-	1,184	236.8
R. mucronata	*Kong-kang-bi-yai*	367	33	133	233	-	766	153.2
Xylocarpus granatum	*Taboon-khao*	517	700	1,100	733	1,200	4,250	850.0
X. moluccensis	*Taboon-dum*	-	67	200	-	-	267	53.4
Avicennia alba	*Samae-khao*	150	-	33	-	-	183	36.6
Ceriops tagal	*Prong*	183	400	167	867	700	2,317	463.4
Lumnitzera spp.	*Fard*	33	33	200	33	-	299	59.8
Excoecaria agallocha	*Ta-tum*	17	467	167	33	133	817	163.4
Bruguiera gymnorrhiza	*Pra-sak*	-	67	467	533	733	1,800	360.0
B. cylindrica	*Tua-khao*	-	-	-	-	-	33	6.6
Total		1,450	2,134	2,834	2,699	2,766	11,916	2,383.2

Table 2.9. Stem volume (m^3/ha) of mangrove forests in Ban Don Bay in A. Khanom, Nakhon Si Thammarat.

Species	Stem volume						
Scientific name	Distance from forest margin (riverbank) towards inland (m)					Total	Average
	0-10	30-40	60-70	90-100	120-130		
Rhizophora apiculata	30.52	6.29	9.72	3.50	-	50.03	10.01
R. mucronata	27.97	8.99	-	-	-	36.96	7.39
Xylocarpus granatum	18.02	11.46	34.87	18.81	5.46	88.61	17.72
X. moluccensis	-	0.93	26.51	3.00	-	30.44	6.09
Avicennia alba	38.92	-	0.47	-	-	39.38	7.88
Ceriops tagal	3.95	7.49	2.33	12.95	9.39	36.12	7.22
Lumnitzera spp.	2.50	0.60	4.46	4.53	-	12.09	2.42
Excoecaria agallocha	-	15.56	4.00	0.47	7.59	27.61	5.52
Bruguiera gymnorrhiza	-	1.76	9.02	5.66	7.23	23.68	4.74
B. cylindrica	-	-	-	0.47	-	0.47	0.09
Total	121.88	53.08	91.36	49.39	29.67	345.39	69.08

Table 2.10. Average density (trees/ha) of dominant mangrove species in limestone area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Density Distance from estuary to inland sites (m) 0-10	20-30	40-50	60-70	80-90	100-110	Total	Average
Rhizophora mucronata	1,200	325	200	125	-	-	1,850	308.3
R. apiculata	725	1,200	1,325	800	575	125	4,750	791.7
Xylocarpus granatum	150	175	225	225	500	450	1,725	287.5
X. moluccensis	-	175	50	50	-	-	275	45.8
Bruguiera sexangulata	75	50	175	50	-	-	350	58.3
B. cylindrica	-	-	-	50	175	75	300	50.0
B. parviflora[a]	-	-	-	200	50	25	275	45.8
B. gymnorrhiza	-	-	-	-	25	25	50	8.3
Ceriops sp.	50	50	325	550	475	-	1,450	241.7
Sonneratia sp.[b]	50	-	-	-	-	-	50	8.3
Kandelia candel[c]	-	50	50	50	75	50	275	45.8
Avicennia alba	100	350	225	-	-	-	675	112.5
Total	2,350	2,375	2,575	2,100	1,875	750	12,025	2,004.2

Common Thai names: [a]*Tua-dam.* [b]*Lam-pan.* [c]*Rang-ka-tae.*

Table 2.11. Average density (trees/ha) of dominant mangrove species in shale and quartzitic area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Density Distance from estuary to inland sites (m) 0-10	20-30	40-50	60-70	80-90	100-110	120-130	140-150	160-170	Total	Average
Rhizophora mucronata	400	200	-	-	-	-	-	-	-	600	66.7
R. apiculata	1,600	700	1,100	600	500	450	750	-	-	5,700	633.3
Xylocarpus granatum	100	350	250	200	300	300	650	500	550	3,200	355.6
Bruguiera sexangulata	-	250	100	250	-	-	-	-	-	600	66.7
B. cylindrica	-	-	200	150	50	50	-	-	-	450	50.0
B. parviflora	-	-	-	-	100	550	550	200	600	2,000	222.2
Ceriops sp.	-	-	100	200	200	100	150	250	400	1,400	155.6
Total	2,100	1,500	1,750	1,400	1,150	1,450	2,100	950	1,550	13,950	1,550.1

Table 2.12. Average density (trees/ha) of dominant mangrove species in sandstone area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Density Distance from estuary to inland sites (m) 0-10	10-20	20-30	30-40	40-50	50-60	Total	Average
Rhizophora apiculata	-	-	25	37.5	62.5	12.5	137.5	22.9
Sonneratia alba	75	25	-	-	-	-	100.0	16.7
Avicennia alba	50	75	100	25	50	-	300.0	50.0
Xylocarpus granatum	-	62.5	50	37.5	100	-	250.0	41.7
Melaleuca leucadendron[a]	-	-	-	-	-	37.5	37.5	6.2
Lumnitzera sp.	-	-	-	-	25	-	25.0	4.2
Total	125	162.5	175	100.0	237.5	50.0	850.0	141.7

[a]Common Thai name: *Sa-mod.*

Table 2.13. Average volume (m^3/ha) of dominant mangrove species in limestone area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Volume Distance from estuary to inland sites (m) 0-10	20-30	40-50	60-70	80 90	100-110	Total	Average
Rhizophora mucronata	29.4	13.1	7.5	2.5	-	-	52.5	8.8
R. apiculata	21.3	29.4	33.8	23.8	28.1	3.8	140.2	23.4
Xylocarpus granatum	15.0	38.1	31.2	13.1	25.0	26.9	149.3	24.9
X. moluccensis	-	17.5	11.2	6.9	-	-	35.6	5.9
Bruguiera sexangulata	1.9	5.6	5.0	2.5	-	-	15.0	2.5
B. cylindrica	-	-	-	1.2	5.0	1.9	8.1	1.4
B. gymnorrhiza	-	-	-	-	10.0	15.0	25.0	4.2
B. parviflora	-	-	-	5.6	2.5	1.2	9.3	1.6
Ceriops sp.	0.6	9.4	16.2	16.2	13.8	-	56.2	9.4
Sonneratia sp.	30.6	-	-	-	-	-	30.6	5.1
Kandelia candel	-	0.6	1.9	1.2	1.9	1.2	6.8	1.1
Avicennia alba	22.5	21.3	24.4	-	-	-	68.2	11.4
Total	121.3	135	131.2	73.0	86.3	50.0	596.8	99.7

Table 2.14. Average volume (m^3/ha) of dominant mangrove species in shale and quartzitic area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Volume Distance from estuary to inland sites (m) 0-10	20-30	40-50	60-70	80-90	100-110	120-130	140-150	160-170	Total	Average
Rhizophora mucronata	11.9	6.2	-	-	-	-	-	-	-	18.1	2.0
R. apiculata	35.0	20.6	26.2	17.5	15.0	13.1	22.5	-	-	149.9	16.6
Xylocarpus granatum	10.0	28.8	25.0	20.0	30.0	30.0	40.0	35.6	28.1	247.5	27.5
Bruguiera sexangulata	-	7.5	3.1	7.5	-	-	-	-	-	18.1	2.0
B. cylindrica	-	-	5.6	4.4	1.2	1.9	-	-	-	13.1	1.4
B. parviflora	-	-	-	-	2.5	15.0	13.1	5.0	16.2	51.8	5.8
Ceriops sp.	-	-	1.9	3.8	3.8	1.9	3.1	5.0	8.1	27.6	3.1
Total	56.9	63.1	61.8	53.2	52.5	61.9	78.7	45.6	52.4	526.1	58.4

Table 2.15. Average volume (m^3/ha) of dominant mangrove species in sandstone area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Volume Distance from estuary to inland sites (m) 0-10	10-20	20-30	30-40	40-50	50-60	Total	Average
Rhizophora apiculata	-	-	0.6	1.2	3.1	0.6	5.5	0.9
Sonneratia alba	20.0	12.5	-	-	-	-	32.5	5.4
Avicennia alba	13.1	15.0	13.8	5.0	11.2	-	58.1	9.7
Xylocarpus granatum	-	12.5	13.1	15.0	16.9	-	57.5	9.6
Melaleuca leucadendron	-	-	-	-	-	19.4	19.4	3.2
Lumnitzera sp.	-	-	-	-	0.6	-	0.6	0.1
Total	33.1	40.0	27.5	21.2	31.8	20	173.6	28.9

to be variable. Particularly in the latter, it was observed that forests near shale formation area had the highest densities and volumes while those close to the sandstone had the lowest.

Seedling distribution

Natural regeneration of mangroves around Ban Don Bay was studied at A. Phanom only (Table 2.16). There was an average density of about 9,500 seedlings/ha, which was quite impressive.

In Phangnga Bay (Tables 2.17-2.19), natural regeneration is generally abundant, especially in areas close to limestone, shale and quartzitic formations. However, regeneration in sandstone areas is rarely observed due to poor soil condition.

Information on structural characteristics of mangrove communities along Ban Don Bay and Phangnga Bay is limited. Only the communities at A. Phanom, Nakhon Si Thammarat, and at A. Muang, Phangnga Province, have been studied.

Table 2.16. Seedling distribution (per ha) of mangrove forests of Ban Don Bay in A. Khanom, Nakhon Si Thammarat.

Species Scientific name	Density Distance from forest margin (riverbank) towards inland (m) 0-10	30-40	60-70	90-100	120-130	Total	Average
Rhizophora apiculata	450	566	366	133	-	1,515	303.0
R. mucronata	833	167	-	-	-	1,000	200.0
Xylocarpus granatum	1,233	1,066	666	1,299	1,265	5,529	1,105.8
X. moluccensis	-	-	17	-	-	17	3.4
Avicennia alba	167	-	-	-	-	167	33.4
Ceriops tagal	900	7,992	9,457	3,996	9,557	31,902	6,380.4
Lumnitzera spp.	17	-	33	-	33	83	16.6
Excoecaria agallocha	-	33	-	-	33	66	13.2
Bruguiera gymnorrhiza	-	400	699	699	5,062	6,860	1,372.0
B. cylindrica	-	33	67	-	-	100	20.0
Total	3,600	10,257	11,305	6,127	15,950	47,239	9,447.8

Table 2.17. Average density of mangrove seedlings (per ha) in limestone area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Density Distance from estuary to inland sites (m) 0-10	20-30	40-50	60-70	80-90	100-110	Total	Average
Rhizophora mucronata	2,400	775	100	75	25	-	3,375	562.5
R. apiculata	1,175	1,675	1,100	1,050	1,000	625	6,625	1,104.2
Xylocarpus granatum	1,125	350	375	625	525	238	3,238	539.7
Kandelia candel	250	50	25	50	150	-	525	87.5
Ceriops sp.	-	-	725	750	925	100	2,500	416.7
Avicennia alba	1,250	625	-	-	-	-	1,875	312.5
Bruguiera spp.	75	225	25	-	-	-	325	54.2
Sonneratia sp.	225	250	-	-	-	-	475	79.2
Total	6,500	3,950	2,350	2,550	2,625	963	18,938	3,156.5

Table 2.18. Average density of mangrove seedlings (per ha) in shale and quartzitic area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Density Distance from estuary to inland sites (m) 0-10	20-30	40-50	60-70	80-90	100-110	120-130	140-150	Total	Average
Rhizophora mucronata	450	112	-	-	-	-	-	-	562	70.2
R. apiculata	2,750	3,300	2,900	1,800	700	800	600	-	12,850	1,606.2
Xylocarpus granatum	-	1,250	600	700	1,100	600	750	600	5,600	700.0
Ceriops sp.	-	-	1,000	1,050	1,100	600	525	500	4,775	596.9
Bruguiera spp.	-	2,500	2,000	3,100	2,500	2,850	1,600	-	14,600	1,825.0
Total	3,200	7,162	6,500	6,650	5,450	4,850	3,475	1,100	38,387	4,798.3

Table 2.19. Average density of mangrove seedlings (per ha) in sandstone area from estuary to inland sites of Phangnga Bay, A. Muang, Phangnga.

Species Scientific name	Density Distance from estuary to inland sites (m) 0-10	10-20	20-30	30-40	40-50	50-60	Total	Average
Rhizophora apiculata	-	-	-	-	150	150	25	
Avicennia alba	-	100	250	300	1,700	100	2,450	408.3
Sonneratia sp.	-	250	100	150	50	100	650	108.3
Xylocarpus granatum	-	50	500	50	350	100	1,050	175.0
Melaleuca leucadendron	-	-	-	-	-	100	100	16.6
Total	-	400	850	500	2,100	550	4,400	733.2

Wildlife and Protected Areas

CHOOMPOL NGAMPONGSAI

Inland

The inland habitat of upland, moist, evergreen forest in Ban Don Bay is valuable as wildlife habitat and watershed cover. Important wildlife species include *banteng*, several wild cats, elephant, gibbon, argus pheasant and helmeted hornhill, among others.

The Electricity Generating Authority of Thailand (EGAT 1980) made a study on the environmental and ecological impacts of Chiew Larn Dam Project. Inland fauna tallied in the report were 38 mammal, 69 bird, 12 amphibian and reptile species; 8 species were categorized as endangered.

In Phangnga Bay, the fauna is relatively impoverished due to the absence of large forest tracts, which have been mostly converted to rubber plantations.

Mangroves

Even though the importance of mangroves as wildlife habitats is well known, in Phangnga Bay, the mangrove forests faunal species are not well documented. In Ban Don Bay, mangrove forests are not as extensive as in Phangnga and wildlife studies are also limited.

Beaches and islands

In Ban Don Bay, coral reefs are located around the Samui-Phangan-Ang Thong group of islands. These areas are in relatively good condition and serve as tourist attractions (Fig. 2.8). In Phangnga Bay, beaches and islands are relatively impoverished but important for rare species of terns and gulls. Hat Nai Yang Beach in Phuket is one of the region's few remaining green sea turtle nesting sites.

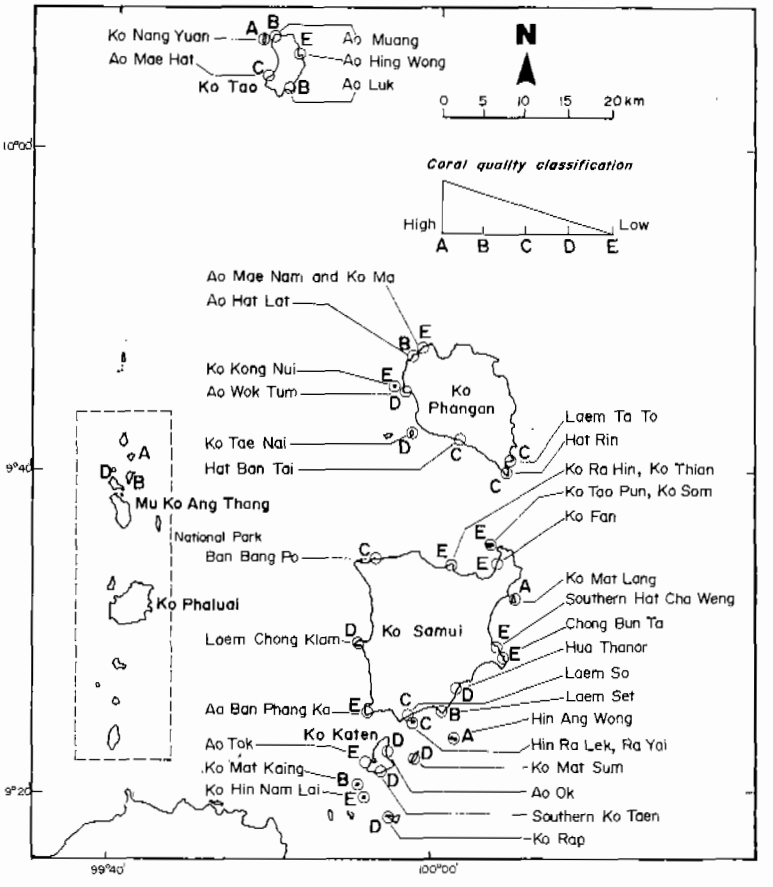


Fig. 2.8. Coral quality in the islands of Ban Don Bay.

Mudflats

Surat Thani's mudflats are significant for shorebirds, particularly migrants, and provide habitat for many crabs and some bivalves. A small area of mudflats in Phangnga is of equal importance.

Protected areas

In Ban Don Bay, there are two national parks (NP) and one wildlife sanctuary (WS). Mu Ko Ang Thong NP (84 km^2) is the only marine protected area. Khao Sok NP (645 km^2) and Khlong Saeng WS (1,155 km^2) protect upland moist evergreen forests. There are also two nonhunting areas (34 km^2) and two forest parks (24 km^2) (Table 2.20 and Fig. 2.9).

Table 2.20. Protected areas in the Upper South, Thailand.

Name	Place (province)	Type	Area(ha)	Type of forest A[a]	Type of forest B[b]	Wild-life	Coral reef
Khao Sok	Surat Thani	NP[c]	64,552	x	-	x	-
Khao Luang	Nakhon Si Thammarat	NP	57,000	x	-	x	-
Khao Phanom Benja	Krabi	NP	5,000	x	-	-	-
Ko Surin	Phangnga, Andaman Sea	NP (marine)	13,500	x	x	-	x
Mu Ko Phi Phi/ Hat Nopparatthara	Krabi	NP (marine)	38,900	-	x	-	x
Ao Phangnga	Phangnga Bay	NP (marine)	40,000	-	x	x	x
Khao Lam Pi	Phangnga	NP	7,600	-	x	x	x
Hat Thai Muang	Phangnga	NP		-	x	x	-
Hat Nai Yang	Phuket	NP (marine)	9,000	x	-	-	x
Mu Ko Ang Thong	Surat Thani, Ban Don Bay	NP (marine)	10,200	-	x	-	x
Khlong Saeng	Surat Thani	WS[d]	115,615	x	-	x	-
Khlong Phraya	Krabi	WS	9,500	x	-	x	-
Khao Phra Taeo	Phuket	NH[e]	2,228	x	-	x	-
Nong Thung Thong	Surat Thani	NH	2,956	x	-	x	-
Khao Tha Phet	Surat Thani	NH	463	x	-	x	-

[a]A - upland.
[b]B - mangrove.
[c]NP - national park.
[d]WS - wildlife sanctuary.
[e]NH - nonhunting area.

The following are the most important protected areas in terms of resource conservation:

1. Khlong Saeng WS is a large area of high regional and national significance where there is a good population of several uncommon wildlife species such as *banteng,* tiger, clouded leopard, elephant, lur gibbon, argus pheasant and helmeted hornhill. Capture operations were conducted to rescue wildlife stranded by the Chiew Larn Dam. The sanctuary's forests were destroyed when Chiew Larn Dam was constructed.
2. Khao Sok NP is contiguous with Khlong Saeng WS, and is of similar importance.
3. Mu Ko Ang Thong NP is a marine park of considerable significance as one of the few remaining areas in the gulf which contain relatively well-developed and undamaged coral reefs.
4. Other areas: The province's eastern mountains encompass some intact humid evergreen forests. Although not included in the protected areas system, these forests extend to Khao Luang NP in Nakhon Si Thammarat and are considered valuable for species conservation and watershed protection.

The waters around Samui-Phangan-Ang Thong Islands contain undamaged coral reefs, some of which have been recommended for protected area status.

In Phangnga, there are five national parks and one wildlife sanctuary. Three of the former cover upland moist evergreen forests. Marine parks include Phangnga Bay NP (347 km^2) which has most of the region's protected mangrove areas and Hat Nai Yang NP (326 km^2, marine) in Phuket. Khlong Phraya WS (95 km^2) and Phanom Bencha WS (50 km^2) in Krabi cover upland evergreen forests and are important for watershed protection. There are one nonhunting area (22 km^2) and four forest parks (2 km^2) which primarily serve as small, domestic tourist spots.

The following are the most important protected areas in terms of resource conservation:

1. Phangnga Bay NP encompasses one of the largest areas of mangrove forest of any park or sanctuary in Thailand, though most of the bay's mangroves are located outside the park.

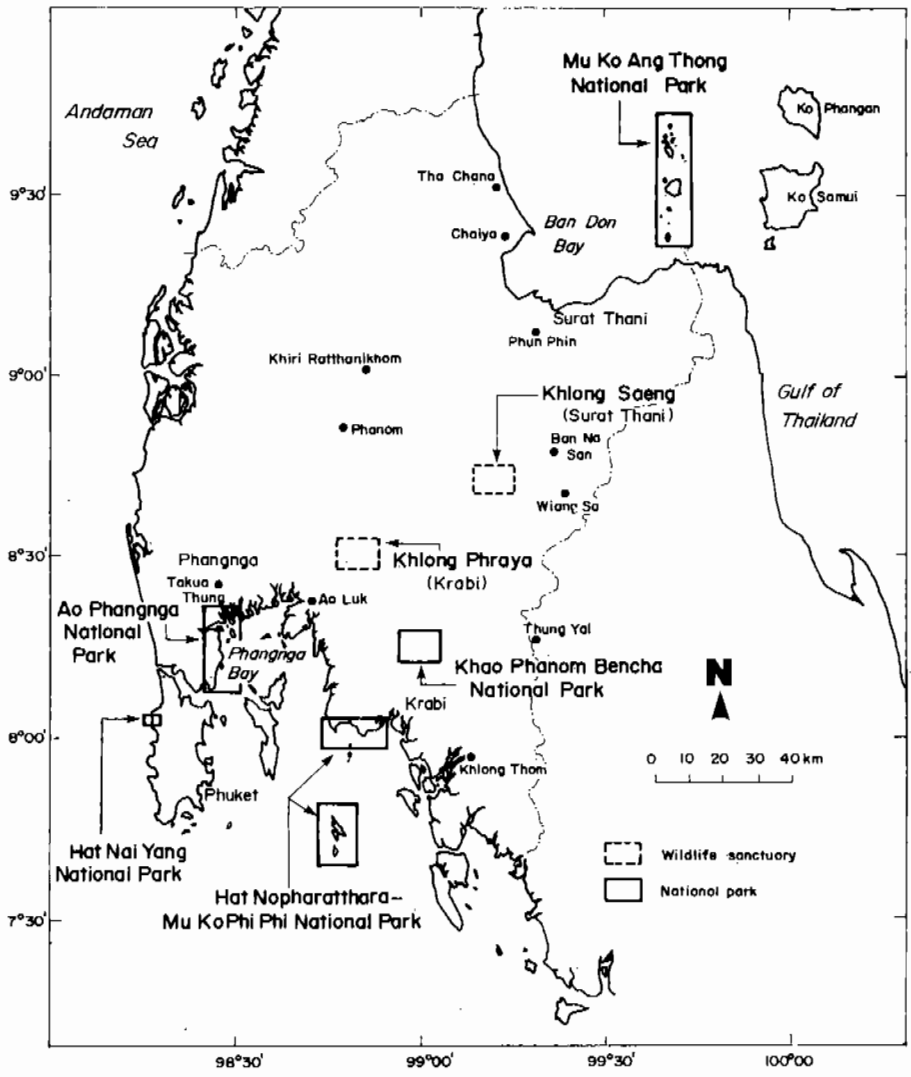


Fig. 2.9. Some protected areas in the Upper South, Thailand.

It is considered a site of high national significance for bird species dependent on mangrove habitat even though no detailed wildlife surveys were conducted there.

2. Khao Phra Taeo Nonhunting Area represents the last remaining patch of primary forest in Phuket.

3. Hat Nopharatthara-Ko Phi Phi NP is the only marine park in Phangnga Bay outside the bay's national park; marine resources such as corals are degrading rapidly here.

4. Hat Nai Yang is marginally important for turtle nesting.

Chapter 3
Fisheries and Aquaculture: Resource and Economics

Fisheries

SOMPORN LOHSAWATKUL

The Upper South marine fisheries production in 1982 was 175,600 t, constituting 8.75% of the total national output. Surat Thani contributed 98,400 t while the west coast provinces had a combined production of 77,200 t (JICA 1985).

The fishermen in Ban Don area were mostly small scale. Fishing gears included shrimp gill nets and crab gill nets; although threadfin gill nets were also used. Income was primarily from catches of shrimp and swimming crab. The dominant catch in terms of income was white shrimp *(Penaeus merguiensis)* from a total of about 60 species of marine organisms caught. The maximum catch rate was 2.1 kg/boat/day (in May). The average fishing effort using shrimp gill nets in 1981 was 240 fishing days. The total annual shrimp catch was estimated to be 150 t with a market value of about 150 million baht.* Various species of swimming crabs were recorded from crab gill nets. The maximum catch was 24.2 kg/boat/day (in October). The fishing effort of 200 fishing days in 1981 supported a catch of about 1,357 t valued at 30 million baht (DOF 1983a).

A survey of demersal fisheries was carried out around Samui, Phangan and Ang Thong Islands in 1981 to determine the demersal resources, species composition, distribution of major species and spawning periods. The average catch rate was about 40 kg/hour and comprised of squid, cuttlefish, crab, shrimp, octopus, whiting, sardine, herring, anchovies, gizzard shad and croaker.

Ban Don Bay, because of its importance as spawning and rearing grounds for anchovies, some mollusk species and club mackerel (offshore), has been declared by DOF as a conservation zone. Trawl fishing and purse seine fishing are prohibited from 1 January to 31 March and from 1 June to 31 July of every year. However, it is reported that illegal fishing (day and night) is still common, particularly by trawlers (single and twin types) on the northern side of Ang Thong Islands for club mackerel and in the area between Ang Thong and Samui-Phangan Islands. Enforcement of the fishery management regulations is not effective in part because of lack of manpower, equipment and budget at the district fisheries office at Samui (DOF 1983a).

Another field survey was carried out in the same area in 1981 on the abundance and species composition of fish larvae. Specimens from 42 families of fish larvae were collected. The most abundant families were Gobiidae (37%), Leiognathidae (14%), Clupeidae (10%), Callionymidae (6%) and Engraulidae (5%). Fish eggs and larvae were most abundant between

*US$1 = 25 baht as of June 1988.

March and May. It was concluded that the area was important as a feeding ground for fish larvae and a spawning ground for some marine fish species (DOF 1983b).

Additional study was carried out in A. Tha Chang, Surat Thani Province, in 1984 to evaluate the effect of the use of push nets on demersal fish. This net catches many small fish (usually in shallow waters), including juveniles (on the nursery/feeding grounds) of several commercially important species. The study revealed that about 43% of the catch was small-sized but of commercial value and 57% were low-value trash fish and juveniles of valuable fish. Of the trash fish, about 53% were low-quality species and 47% were juveniles of economic species (2-6 cm in length).

It was deduced that the total catch per unit effort (CPUE) is not significantly declining because by modernizing the equipment, fishermen are increasing their catch efficiency but the value of CPUE is declining, reflecting the change in catch composition. Also, the number of push net vessels is rapidly increasing, and thus the effect on economic fish yields is significant. It has been recommended that action be taken immediately to discourage the entry of new push net vessels into the area to protect the juveniles (Monton et al. 1984).

In Phangnga Bay, fisheries surveys were carried out by Phuket Marine Fisheries Station (PMFS) staff from 1967 to 1978 to: (1) compare the abundance of fisheries resources; (2) study species composition; (3) compare the catch of valuable fish and trash fish; and (4) study the species composition of valuable fish in the trash fish component. Aside from Phangnga Bay, adjacent areas at stations 14, 17 and 18 were also surveyed. The trawling survey was conducted specifically in 1967 to 1971 and 1975 to 1978.

The catch rate reached a maximum of 219 kg/hour in 1969, with the highest at 536 kg/hour at station 14, which was Phangnga Bay proper (Tables 3.1 and 3.2). The catch rate decreased to 22 kg/hour in 1976 and increased to 127 kg/hour in 1978. The trash fish catch in the area reached a maximum of 81% of the total catch in 1969 and dropped to 69% in 1978.

The major and commercially important marine resources at station 14 were squid, wolf herring, lizardfish and gizzard shad. The percentage of penaeid shrimp, the most valuable species, decreased from 10% in 1968 to less than 1% in 1978. The juveniles of many high-value fish such as snapper, grouper, goatfish, club mackerel, pomfret, lizardfish and threadfin bream comprised a large proportion in trash fish catch. This report was very important and effective for the decision on closing Phangnga Bay for trawl fisheries in 1979 by DOF.

Table 3.1. Catch rate (kg/hr) of valuable and trash fish in Phangnga Bay and the adjacent waters.

Year	No. of hauls	Valuable fish kg/hr	Valuable fish %	Trash fish kg/hr	Trash fish %	Total kg/hr
1967	23	41.82	43.70	53.88	56.30	95.70
1968	43	43.57	24.10	137.18	75.90	180.75
1969	31	41.75	19.03	177.65	80.97	219.40
1971	25	14.30	19.15	60.38	80.89	74.68
1975	10	12.98	49.39	13.30	50.61	26.38
1976	17	17.06	78.15	4.76	21.85	21.83
1977	9	39.84	39.44	61.17	60.56	101.01
1978	15	37.58	31.52	81.67	68.48	119.25

Source: DOF (1980).

Table 3.2. Catch rate (kg/hr) in the stations in Phangnga Bay and the adjacent waters.

Station/Year	1968	1969	1971	1976	1977	1978
14	257.90	535.90	166.37	22.18	99.38	126.66
17	136.39	490.99	-	26.00	94.28	100.78
18	257.61	306.57	74.25	24.25	175.50	130.32

The yearly composition of the average catch among the three stations indicated that station 14 in Phangnga Bay was more productive than the other two. The catch composition showed that about 50% of small valuable fish were taken in the catch, and all of them were added to the trash fish. It is assumed that many fish larvae drift into and feed in Phangnga Bay.

Aquaculture

NIPHOND HAEMAPRASIT AND JAMES N. PAW

Aquaculture is a traditional practice in the Upper South Region, particularly in Ban Don Bay. Under the JICA (1985) study, the coastal areas of Ban Don and Phangnga Bays are tentatively designated as "aquaculture zone". The potential for further aquaculture development in the region is great considering the biophysical, oceanographic and geographic conditions prevailing, especially in the east coast.

Phangnga Bay is a wide and irregular, indented bay bounded by Phuket, Phangnga and Krabi provinces. The inner part is shallow with extensive mudflats becoming deeper towards the eastern part along Krabi. Shrimp culture and finfish cage culture are becoming more common along the coastal waters. Mollusk culture is significant. Overall, aquaculture, except cage culture, in the west coast has declined over the years (Tables 3.3 to 3.7).

Table 3.3. Blood cockle aquaculture production in Phangnga, 1979-1984.

Year	No. of farms	Area (ha)
1979	-	-
1980	-	-
1981	101	40
1982	47	40
1983	10	253.76
1984	10	253.76

Source: DOF (1986).

Table 3.4. Production of oysters in Phangnga, 1979-1984.

Year	No. of farms	Area (ha)
1979	1	0.96
1980	1	0.96
1981	1	0.96
1982	1	0.96
1983	4	0.98
1984	6	1.05

Source: DOF (1986).

Table 3.5. Shrimp production (t) in Phangnga, 1979-1980.

Year	No. of farms	Area (ha)	Quantity (t)	Value (x 1,000 baht)	Kg/ha
1979	3	1.12	0.03	3.29	26.81
1980	3	1.12	0.67	68.62	593.75

Source: DOF (1986).

Table 3.6. Aquaculture production (t) of short-necked clam in the provinces, 1978-1984.

Province/Year	1978	1979	1980	1981	1982	1983	1984
Chumphon	-	-	-	-	2,250	368	-
Surat Thani	4,700	18,375	7,200	5,400	25,200	12,378	35,363
Nakhon Si Thammarat	-	-	-	14,850	-	2,700	-
Phangnga	-	-	-	-	1,000	2,767	-
Krabi	-	-	-	-	-	550	-

Table 3.7. Shrimp production (t) in Krabi, 1978-1983.

Year	No. of farms	Area (ha)	Quantity (t)	Value (x 1,000 baht)	Kg/ha
1978	12	2.56	0.45	22.25	175.81
1979	-	-	-	-	-
1980	28	7.52	0.86	76.86	109.81
1981	11	2.88	0.16	17.84	56.94
1982	5	10.56	1.32	184.80	125.00
1983	6	18.56	3.79	235.11	204.25

Source: DOF (1986).

Mariculture in the Upper South has also declined possibly due to water quality degradation of farming areas (TDRI 1987). Moreover, the areas are subjected to runoff from the four main rivers in the Central Plain. The Ban Don Bay area has a relatively good water quality as pollution from industrial sites and agricultural areas is minimal compared to the upper gulf area (JICA 1985).

The development of the Upper South will have an apparent impact on the aquaculture activities such as siltation resulting from coastal dredging and tin mining in the west coast as well as domestic and industrial pollution due to population increase, tourism and industrialization. Such resource use conflicts are often due to sectoral miscoordination. Thus, closer coordination among concerned government agencies and stricter enforcement of environmental protection regulations are essential. A comprehensive plan is also necessary to ensure optimal use of the coastal zone (ADB 1985).

Shrimp

Ban Don has an abundance of natural stocks of shrimp larvae, including the economically important species *Penaeus monodon* and *P. merguiensis,* and is more suitable for the development of shrimp farms than the west coast. In 1977, the total shrimp culture area was about 250 ha with 19 farms; production was about 50 t with a value of 897,000 baht. Shrimp culture developed very rapidly in the area with support from both the Asian Development Bank (ADB) and the World Bank. This led to the allocation of areas for shrimp culture to poor fishermen in 1983. The culture area was increased to more than 3,260 ha with 273 farms (Table 3.8). ADB financed the brackishwater shrimp/fish pond estate resettlement project amounting to US$14 million with the Department of Cooperatives Promotion, DOF and BAAC as executing agencies. This project involved the construction of shrimp farms in Surat Thani and Nakhon Si Thammarat. The World Bank financed a similar project in Surat Thani adjacent to the ADB project with 54 farms (ADB 1985). In the Andaman Sea side, only Krabi has extensive shrimp farms.

Table 3.8. Shrimp production (t) in Surat Thani.

Year	No. of farms	Areas (ha)	Quantity (t)	Value (x 1,000 baht)	Kg/ha
1977	19	249.6	48.39	897.01	193.88
1978	9	169.6	31.70	895.64	186.94
1979	20	241.6	45.45	1,391.20	188.13
1980	29	364.8	305.71	15,748.26	838.00
1981	31	393.6	250.80	10,920.35	637.19
1982	30	377.6	205.32	8,793.38	543.75
1983	53	545.6	211.56	20,051.71	387.75
1985	273	3,262.0	-	-	-

Source: DOF (1986).

Shrimp culture is generally extensive and relies on entry of fry through water pumping or on stocking of wild fry. DOF efforts to increase production through the use of hatchery-bred fry have been successful. However, the technology is yet to be widely disseminated. The prevailing problem is the lack of viable spawners of *P. monodon* resulting in the shifting to the culture of *P. merguiensis,* especially during summer months, partly due to high salinity of pond waters and the abundance of spawners.

The number of shrimp farms gradually increases in the Upper South every year. In 1976, there were 33 farms operating in 303 ha in Nakhon Si Thammarat. Culture area increased to 6,912 ha in 1983 representing 19% of the total shrimp farm area (35,537 ha) in Thailand. In the west coast, the development of shrimp culture is not as widespread as in the gulf area. Notable shrimp producer is Krabi. The farm areas have decreased since 1980, although production has steadily increased due to adoption of better technology and culture management (Table 3.7).

Cockle

Cockle *(Anadara granosa)* culture in Surat Thani started in 1980 with seed cockle imported from Malaysia. The culture area exceeded 392 ha with two farms and 4,800-t production. Only one farm was in operation in 1984, but the culture area remained the same. Production decreased to 776 t valued at 1,656 million baht (Table 3.9).

Table 3.9. Production (t) of blood cockle in Surat Thani, 1979-1984.

Year	No. of farms	Area (ha)	Production
1979	-	-	-
1980	2	388	4,800
1981	2	388	12,150
1982	2	388	654
1983	2	388	1,039
1984	1	388	776

In the Andaman Sea coast, cockle culture started in Phangnga in 1981 with about 100 farms covering 40 ha. From 1982-1984, the number of farms decreased to 10, but culture area increased to about 254 ha. In A. Takua Thung, the yield averaged about 2,120 kg/ha. Phuket and Krabi have only one farm each in operation, the former up to 1984 only.

Cockle seeds (weighing less than 1.0 g each) are stocked at a density on biomass basis, at 3,375-6,750 kg/ha. Initially, a portion of the cockle farm is stocked. After 3 to 6 months, young cockles are redistributed over the whole culture area using mud sled. Reaching a size of 4 cm, these cockles are harvested after 1 to 1.5 years using hand-held mud rakes. Poaching and illegal push netting within cockle farms are discouraged by fencing the farm boundaries and posting security guards. Yield of cockle is very much dependent on the natural productivity of the waters (Broom 1985; ADB 1985).

Cockles used to spawn and set naturally in some coastal areas of Thailand. This problem is probably due to overfishing of cockle broodstocks and intense illegal push netting activities along the coast which disturb the substrate and kill newly set cockle seeds. Present cockle seeds are imported from Malaysia, although against Thailand's laws. Importation, however, is not sufficient to meet local demand. In 1983, it was reported that natural set of cockles occurred down current of a cockle farm in Nakhon Si Thammarat. Such an occurrence should prompt DOF to promote natural cockle sets by encouraging farmers to leave a portion of their leased area unharvested so that some of their cultured stock can grow to broodstock size (ADB 1985).

Oysters, short-necked clam and mussel

Apart from cockle, commercially important mollusk species being cultured in the Upper South are oysters *(Saccostrea lugubris, S. commercialis* and *Crassostrea belcheri)*, green mussel *[Perna viridis (= Mytilus smaragdinus)]*, short-necked clam *(Paphia undulata)* and pearl oyster *(Pinctada* sp.*)*. The last one was cultured for sometime between 1979 and 1984 in Phuket with one farm operating a culture area of 0.53 ha.

S. lugubris is a major aquaculture product of Surat Thani. It is more expensive than *S. commercialis* and is in great demand for fresh consumption. In 1979, the culture area was 83 ha with about 100 farms and a production of 530 t. The culture area increased in 1984 to 158 ha with 214 farms; production was around 590 t valued at 11.7 million baht (Table 3.10).

Table 3.10. Production (t) of oysters in Surat Thani.

Year	No. of farms	Areas (ha)	Production
1970	101	82.83	533
1980	160	139.31	164
1981	205	158.22	499
1982	221	178.24	324
1983	234	184.96	357
1984	214	157.78	586

Oyster spats occur during May-July and October-November. Methods of culture range from traditional to semitraditional, and the most suitable for a particular area depends on the bottom condition (Saraya 1982). Date-palm and bamboo stakes are used as cultch in certain areas in Ranong and Surat Thani. Stake method is usually practiced on soft and muddy bottom. Spats settling on cultch are allowed to grow for a year before harvesting.

Ban Don Bay is a very important seedbed for short-necked clams. Clams are harvested from nature, and no culture activities are done. In 1976, total harvest was 4,700 t. Harvest in 1984 was 33,360 t valued at 61.5 million baht. For mussel, culture started in Phuket in 1984 with two farms having a total culture area of 32 ha.

Fish cage and pond culture

Cage culture is popular in the Andaman Sea side because of the several protected bays and coves. Species being cultured are grouper *(Epinephelus* spp.*)* and sea bass *(Lates calcarifer)*. Coastal waters are relatively unpolluted except near mining areas, and the wide tidal fluctuations provide ideal conditions for cage culture. In contrast, the east coast has fewer protected bays. Water pollution, especially from the Upper Gulf area, as well as the low tidal range limit the potential for cage culture (ADB 1985).

Grouper culture is popular along the coastline of Krabi, Satun and Phangnga provinces. More than 300 families own about 250 farms with 1,025 cages in about 1 ha. Phangnga Bay has more than 75% of the total number of grouper farmers. Grouper fingerlings, at an average weight of 100-300 g at 10-16 baht/piece (pc), are collected from natural waters. Trash fish are used as feed. Culture duration is 6-7 months. The selling price of reared fish differs by sizes, as follows: 0.4-0.8 kg - 85-100 baht/kg; 0.9-1 kg - 75-85 baht/kg; and >1 kg - 65-75 baht/kg. These are prices in the export wholesale market. Exporters sell to the markets in Malaysia and Singapore at 120-150 baht/kg of grouper 0.4-0.8 kg in size.

The estimated costs of grouper cage culture for the small, medium and big farms were 22,700; 41,910; and 88,960 baht, respectively. The average returns by size were 35,585; 65,270; and 117,170 baht, respectively. And the average profits by size, respectively, were 12,885; 23,360; and 28,210 baht.

Sea bass are either cultured in netcages or in ponds with the former being more widely done. In 1984, there were about 160 farms and 390 netcages with a total area of 0.9 ha in Trang, Phangnga and Ranong provinces.

The initial size of fingerlings used in rearing is 1.5-2.5 cm in length at 1.5-2.5 baht/pc. At first, farmers nurse fingerlings in the nursing pond for 3-4 months until these grow to 7.5-10 cm. Then, juveniles are transferred to cages at a stocking density of 10-30 pc/m^2. Trash fish are used as feed. Culture period is 8-10 months. The fish can grow to a marketable size of more than 500 g. The selling price is about 65-80 baht/kg.

An important factor in the expansion of cage culture of sea bass is the mass production of fry in DOF and private sector hatcheries. Most of these fry are sold to nursery operators who rear them to fingerling size and export them to Hong Kong, Taiwan and Singapore. However, some fingerlings are reared to marketable sizes for domestic consumption (ADB 1985).

A major problem in grouper culture is the availability of fry since hatchery production is still experimental. For sea bass, mortalities from cannibalism and disease result in survival rates of only 20-30%, thus the needs for further improvement in rearing techniques. The development of both grouper and sea bass cultures is also constrained by the availability of high-quality but low-priced feeds.

Chapter 4
Tourism: Resource and Economics

ROBERT DOBIAS

The major tourist areas in the Upper South--Phuket, Phangnga, Krabi and Surat Thani--are situated among three large tourism markets, namely, Bangkok, Singapore and Kuala Lumpur. This situation has allowed recent tourist increases in the four areas. In contrast to other tourist spots in the country where entertainment type of attractions are dominant, the Upper South generally offers scenic sites and desirable environment such as beaches, coral reefs and cultural/historical sites. In Phuket, an island resort, the beaches are a prime attraction. Within Phangnga Bay, the Phangnga Bay NP offers unique attractions composed of, among others, limestone islands with overhanging cliffs; the famous Phingkan Island (also sometimes called "James Bond Island"); and the Muslim sea village in Panyi Island. In Krabi, the coral reefs in the Phi Phi NP are the main coastal tourist spot.

Surat Thani Mainland

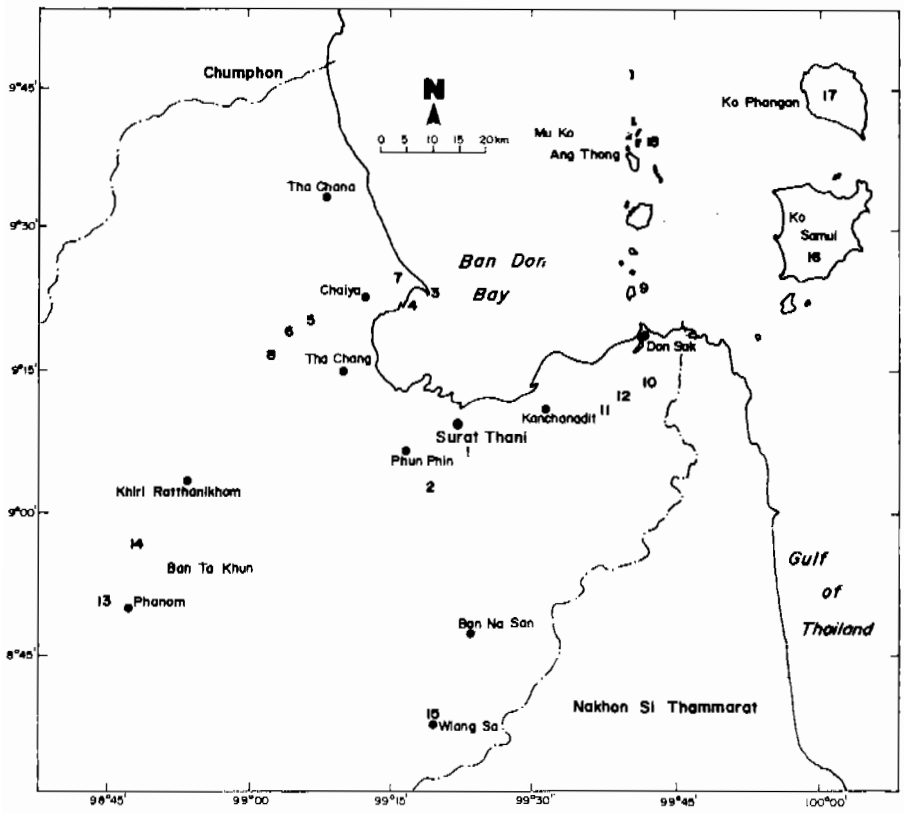
TISTR (1985) identified 42 potential and existing tourist spots in the Surat Thani Mainland and classified them into natural (27 sites); historical and religious (12), which are the prominent features; and artistic and cultural (3) attractions (Fig. 4.1).

Surat Thani Province received 256,180 tourists in 1981; 204,370 in 1982; and 218,850 in 1984, of which 15% were non-Thais. About 45% visited A. Chaiya and 27%, Surat Thani City. The province's share of national tourism in 1984 was 1.0%, but 1.4% of non-Thai tourists in the country visited the province, mainly Samui.

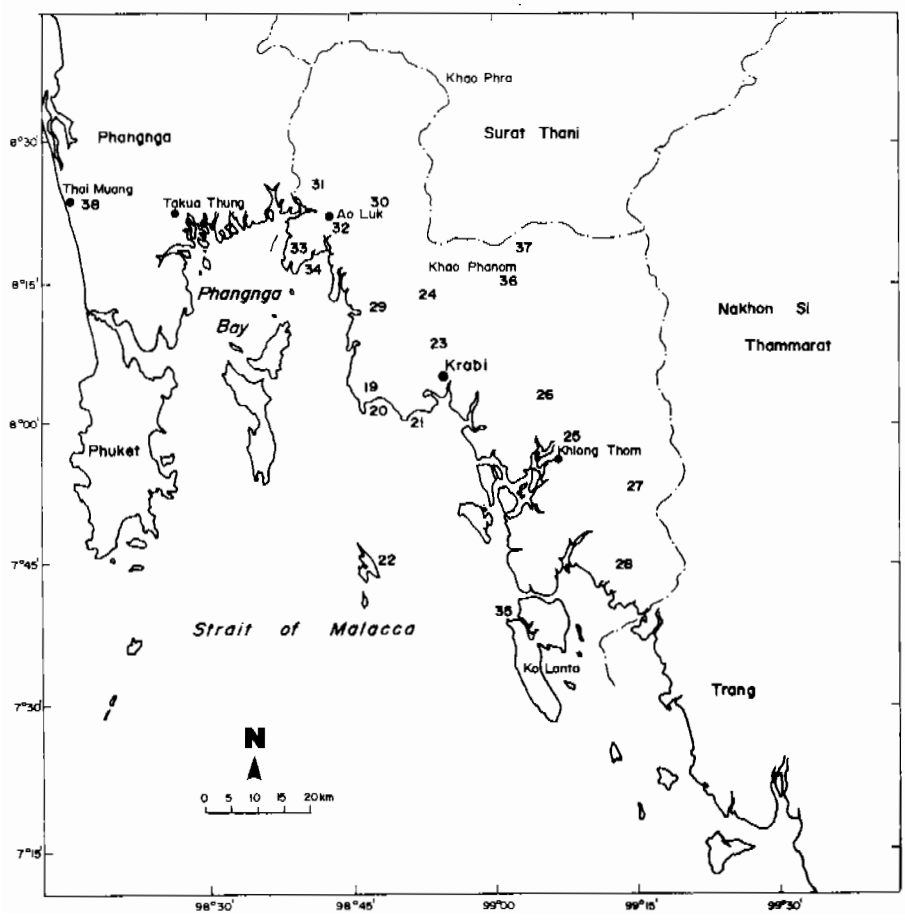
The Tourism Authority of Thailand (TAT) forecasted that tourism volume will be 246,560 in 1987; 293,575 in 1992; and 338,220 in 1997. About 40% will visit A. Chaiya and 24%, Surat Thani City. The proportion of non-Thai tourists is expected to grow from 17% in 1985 to 21% in 1987 (TAT 1986a). JICA (1985) forecasted, on the other hand, 330,000 in 1990 and 756,000 in the year 2000.

In 1981, the mainland had 30 hotels and 1,060 rooms which increased to 40 hotels and 1,710 rooms in 1985. Surat Thani City had 19 hotels and 1,395 rooms in 1985, while Phun Phin had 14 hotels and 247 rooms. Occupancy was about 50% for the city's hotels and 40% for Phun Phin's (TAT 1986a).

The province's road network is generally quite good, but some access roads to tourist sites remain in poor condition. Air, rail and bus services to Surat Thani are relatively sufficient. Electricity supply will greatly be enhanced when Chiew Larn Dam becomes operational after



1. Khao Tha Phet
2. Bung Khun Thale
3. Laem Sui
4. Laem Pho
5. Wat Phra Borommathat Chaiya
6. Suan Mokkhaphalaram
7. Phumriang
8. Thung Sai Ngam
9. Ko Nok Pao Kikan
10. Klang Thong Waterfall
11. Wiphawadi Waterfall
12. Suan Phai Weruwan
13. Khao Sok National Park
14. Chiew Larn Dam
15. Wiang Sa Ancient Village
16. Ko Samui
17. Ko Phangan
18. Mu Ko Ang Thong National Park



19. Hat Nopharatthara Beach
20. Phra Nang Bay
21. Fossil Shells
22. Ko Phi Phi Island
23. Wat Thum Sua
24. Huai To Waterfall
25. Lignite Mine
26. Sadet Cave
27. Hin Phoeng Waterfall
28. Hat Bo Mamuang Beach
29. Sa Kaeo
30. Phet Cave
31. Phra Cave
32. Suan Rukachat Than Bok Khorani
33. Tham Lot, Tham Phi Hua To
34. Laem Sak
35. Laem Kho Kwang
36. Khlong Haeng Waterfall
37. Ton Han Waterfall
38. Hat Thai Muang Beach

Fig. 4.1. Some tourist spots in Surat Thani *(above)* and Phangnga/Krabi *(below)*.

1987. Water supply is a severe limitation in the mainland. Telecommunications are adequate and are still being expanded. Entertainment places are restricted to bars and nightclubs.

General deterioration of water quality was not yet a problem in 1985, but lack of plans for treatment in the near future may result in significant pollution. Community waste water is passed through drainage pipes or open drains. The oil palm and whisky industries are major sources of wastewater in Tapi River. The Department of Town and Country Planning (DOTCP) produced a land use plan for mainland communities in 1985, but the present situation is chaotic, in general.

Revenue from tourism in 1984 was about 242.4 million baht, with Thai tourists contributing 75% of the total. Revenue projections for 1986 and 1991 are 300.6 million baht and 467.5-773.5 million baht, respectively. Tourism has not caused much change in the mainland's socioeconomic status (TISTR 1985).

Samui and Satellite Islands

The major tourism resources are the many beaches, corals and natural attractions in Samui and Phangan Islands and Mu Ko Ang Thong NP. The majority of coral reefs have been destroyed or seriously degraded. However, some good ones still remain (Fig. 2.8).

Tourism volume in Samui has experienced a radical surge. In 1980, there were only about 14,870 visitors; this increased to 33,155 in 1981. In 1982, there were 138,785 and in 1984, there were 142,320 (65% of all tourists in Surat Thani Province). Non-Thais accounted for 18% of tourism volume in 1984 (Fig. 4.2). In 1984, Phangan tourists totaled 22,910 and Mu Ko Ang Thong NP had 54,155 (TISTR 1985).

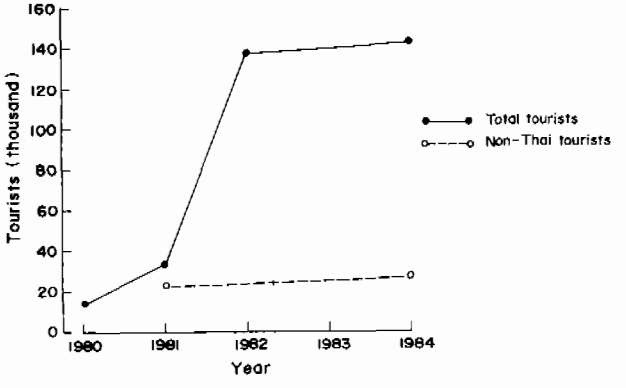


Fig. 4.2. Comparison of Non-Thai visitors with total visitors at Ko Samui, 1980-1984.

The Thailand Institute of Scientific and Technological Research (TISTR) projections for tourism growth in Samui, Phangan and Mu Ko Ang Thong NP were, respectively: 155,035; 25,260; and 58,160 in 1986; 186,810; 31,245; and 68,120 in 1991; and 216,935; 36,900; and 77,620 in 1996.

Non-Thais were expected to make up 19% of the tourism volume in 1986 and 24% in 1996 in Samui; 32% and 39%, respectively, in Phangan; and 5% and 7%, respectively, in Mu Ko Ang Thong NP. Most non-Thais will tend to be young and to be students, hired laborers or teachers. They will average 14 days in Samui, and each will spend about 186 baht/day; while Thai tourists will average 2.5 days and each will spend about 593 baht/day.

The roads in Samui are good though they still need improvement. Express boats run from the mainland to Samui twice daily, taking about three hours per way. There is a temporary airport in Samui. There is severe water shortage in Phangan and Samui.

Marine pollution in Samui and the other major islands was not a problem in 1984, according to TISTR, though some were registered off Hat Lamai. Pollution became significant in some areas around 1987. Garbage collection is a problem in Phangan and Samui. TISTR stated that the good quality of marine water in 1985 could deteriorate quickly if more buildings would be constructed near beaches and water sources. Though land uses in beach areas did not pose significant problems, land use plans and controls, however, should be formulated and enforced without delay.

Collecting corals, fishing and natural disasters have led to destruction of coral reefs in the area. About 75% of the reefs surveyed by TISTR suffered medium to severe deterioration.

Tourism revenue in Samui in 1984 was estimated to be 154.81 million baht; Thai tourists comprised 67% of the total (TISTR 1985). The majority of Thai expenditures went to transport (41%) and food (24%); while those of non-Thais went to food (49%) and accommodation (26%). Tourism, thus, has made a substantial economic impact.

Phuket

Phuket is the Upper South's major tourist attraction, with its beaches as its major assets. Phuket has no less than 10 good recreational features, including those for marine activities such as boating and diving. The development of this island and its attractions is more advanced than any other area in the Upper South. The potential for further development remains, particularly concerning improvement of utility services, parks and amenities. Most of the tourists spend not less than 7 days. Approximate tourism income was 375.5 million baht in 1981; 546.2 million baht in 1982; and 705 million baht in 1983.

Phuket attracted 6% of Thailand's total non-Thai tourist volume in 1985. The number of hotel guests increased to 137% between 1981-1985 (TAT 1986). The recorded estimated volumes were: 1981 - 145,700; 1983 - 233,670; 1984 - 239,950; and 1985 - 345,270. These figures are in marked contrast to forecasts made in the 1979 Master Plan (PCI Design 103 Ltd., 1979), which predicted 302,700 guests in 1987, and in the JICA report (1985), which forecasted 333,000 guests by 1990 (Table 4.1 and Fig. 4.3). Changes in tourism revenue for 1981-1983 are shown in Table 4.2.

Table 4.1. Forecasts on the number of hotel guests in the Upper South, Thailand, 1980-2000. Unit: 1,000 persons/yr.

		1980	1990	2000	Average growth rate (%)
Phuket	Non-Thai	52.9	120	273	
	Thai	92.8	213	491	
	Total	145.7	333	764	8.6
Surat Thani	Non-Thai	22.7	52	119	
	Thai	121.1	278	637	
	Total	143.8	330	756	8.7
Krabi	Non-Thai	0.3	1	2	
	Thai	28.3	65	151	
	Total	28.6	66	153	8.8
Phangnga	Non-Thai	5.0	11	26	
	Thai	20.2	46	104	
	Total	25.2	57	130	8.6
Upper South	Non-Thai	80.9	184	420	
	Thai	262.4	602	1,383	
	Total	343.3	786	1,803	8.7

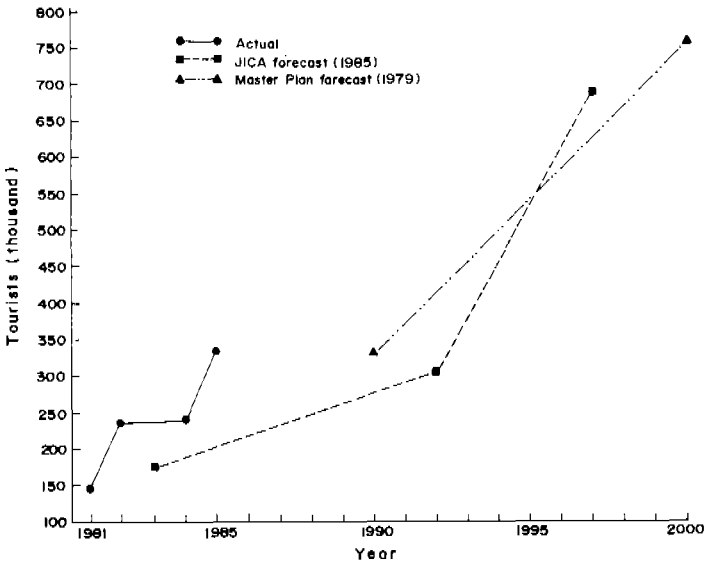


Fig. 4.3. Forecast vs. actual volume of tourists at Phuket, 1981-2000.

Table 4.2. Income from tourism for Phuket, 1981-1983.

Year	Income (baht)
1981	375,493,030
1982	546,187,500
1983	705,000,000

Tourists have begun moving from city to beach accommodations undoubtedly due to the rapid increase in the latter's facilities. The number of non-Thais in proportion to the total number of visitors rose from 24% in 1980 to 45% in 1985 (Fig. 4.4). The city-to-beach guest ratio was highest in 1983 (64:36), but in 1985, the ratio (48:52) was reversed in favor of beach accommodations.

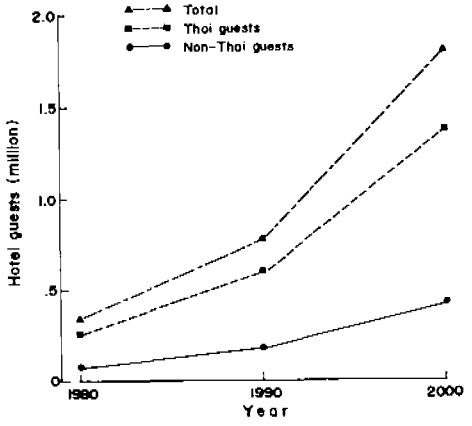


Fig. 4.4. Forecasts on the number of hotel guests in the Upper South, Thailand.

Patong Beach, of all beaches, received the most hotel guests (45,150), 38% of the total in 1985. This represented a decrease from the 1984 level (46%) due to a larger choice of beach facilities. The hotel guest volumes and relative percentages of large hotels in the city and various beaches is presented in Table 4.3.

The number of city hotels and rooms decreased slightly from 1981 to 1985 while that of beaches increased dramatically. In 1982, there were 25 hotels and 1,485 rooms in Phuket but these dropped to 21 and 1,323, respectively, in 1985. Conversely, beach accommodations rose from 52 hotels/bungalows and 1,182 rooms in 1981 to 94 and 2,650 in 1985. These represent an increase of 81% in the number of accommodations and 124% in that of rooms (Table 4.4).

Patong Beach experienced the largest increase in hotel rooms, from 365 in 1981 to 1,185 in 1985 or an increase of 226% over five years and 57% above the 1984 figure. Karon

Table 4.3. Hotel guest volumes and percentages of hotels with over 50 rooms for major Phuket beaches and Phuket City in 1985.

Place	No. of guests	% Hotels with over 50 rooms
Patong	45,153	20
Karon	16,427	0
Kata	21,471	8
Phuket City	226,883	36

Table 4.4. Comparison of increases in the number of hotel rooms in various Phuket locations.

Year	City	No. of hotel rooms Patong	Kata	Karon	Other beaches	All beaches	Total
1977	890	-	-	-	-	480	1,370
	(-)					(-)	(-)
1981	1,338	364	231	99	488	1,182	2,520
	(50%)	(-)	(-)	(-)	(-)	(146%)	(84%)
1982	1,485	457	256	99	530	1,342	2,827
	(11%)	(26%)	(11%)	(0%)	(9%)	(14%)	(12%)
1983	1,414	-	-	-	-	-	-
	(-5%)						
1984	1,325	868	414	139	599	2,020	3,345
	(-7%)	(90%)	(62%)	(40%)	(13%)	(51%)	(18%)
1985	1,323	1,185	489	272	704	2,650	3,973
	(-0.2%)	(37%)	(18%)	(96%)	(18%)	(31%)	(19%)
Increase 1981-1985	-15 (-1.1%)	821 (226%)	258 (112%)	173 (175%)	216 (44%)	1,468 (124%)	1,453 (58%)

Beach had the most rapid increase from 1984-1985; 140 to 270 rooms or an increase of 175%. In 1985, Kata, the third major beach, had 490 rooms, an 18% increase over 1984 (TAT 1986b).

The number of rooms on the island in 1985 already exceeded by 713 the Phuket Master Plan's (PMP) projections for 1987; beach rooms in 1985 were 1,240 rooms above the 1987 projection. The JICA report (1985) recommended that the total number of beach rooms should not exceed 2,780 to maintain a high-quality resort environment. However, an excess will occur with the opening in 1987 of the new Pearl Hotel near Nai Yang Beach.

The average occupancy rates in 1985 were 46% in the beaches and 49% in the city (Fig. 4.5). Rates in the beaches fluctuated from 73% in December to 26% in September; while those

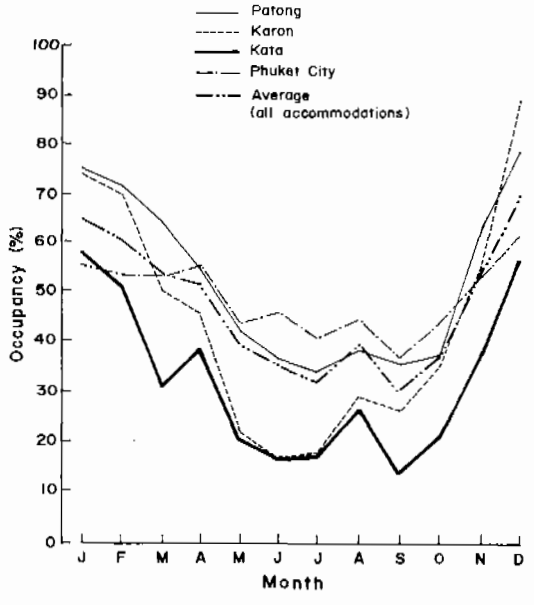


Fig. 4.5. Comparison of average hotel occupancy rates at Phuket, 1985.

in the city were 62% in December and 37% in September. Average length of stay for all visitors was 1.82 days in the city and 6.25 days in the beaches (TAT 1986a).

The opening of Phuket Airport to international flights has also helped increase access to the province, but demand still appears to be higher than available seats, at least on weekends and during the peak holiday seasons. The supply of piped water is a major service problem. The JICA (1985) report stated that some beach establishments were spending 37 baht/m^3 for potable water. Communication routes within the province are still insufficient. The same report does not comment on environmental conditions except to stress the need for addressing this issue and to recommend a ceiling on beach development.

PMP identified tin mining as a major factor in water quality deterioration, though it stated that general water quality in 1979 was excellent. The plan also recommended a ban on dynamite fishing and spearfishing as well as control of coral collection and tropical fish export.

PMP estimated that 2,200 people worked in the tourism industry in 1979, roughly half of whom were employed by hotels directly. This accounted for about 5% of the total provincial employment. The plan projected a need for 6,600 hotel employees between 1988-1997 and 30-40 additional trained guides/interpreters per year. The JICA report, on the other hand, estimated that tourism expenditure (hotel guests only) will reach 3.1 billion baht in the year 2000 for the entire Upper South; Phuket's share of this will be substantial.

Phangnga and Krabi

TAT identified 36 tourist areas in Phangnga and Krabi, 8 of which are nature-based having good potential for tourism development: Phangnga Bay NP; Khao Lam Pi Forest Park; Thai Muang Beach; Ko Phi Phi NP; Fossiliferous (Shell) Cretaceous Formation near Ao Phra Nang; Hat Nopharatthara Beach; Phra Nang Bay; and Suan Rukachat Than Bok Khorani Park (Fig. 4.1). The first 3 sites are in Phangnga and the rest, in Krabi.

The JICA report (1985) added Wat Suwannakuha (cave), Phangnga Waterfall and Khao Lak Forest Park in Phangnga; and Saet Cave and the islets of Khao Khanab Nam in Krabi. Phangnga Bay and Ko Phi Phi NP have good potential for tourism development and are expected to attract mainly Thai tourists.

Most tourists do not consider Phangnga as the primary destination in their tour despite its natural attractions. They come to Phangnga by passing through Phuket. They usually spend the day in the former and the night in the latter.

There are many problems on the development of tourism in Phangnga:

1. Environmental degradation, e.g., at waterfalls and caves;
2. Private invasion, i.e., squatters who sell items to tourists and occupy public land;
3. Community change;
4. Communication and transportation: because tourism places are mostly located out at sea, many tourists would not go by boat during the monsoon season; and
5. Poor maintenance.

Both Phangnga and Krabi Provinces depend on Phuket for tourists as the majority of them do not consider the provinces as primary destinations. However, while Phuket tourism volume has increased substantially since 1983, visits to Phangnga Bay have decreased (Fig. 4.6). Phangnga and Krabi rely mainly on domestic tourists (about 80% in the former and 98% in the latter).

In 1981, Krabi received 472,695 tourists, the majority presumably Thai day-visitors from Surat Thani, Trang and other neighboring provinces. Phangnga received 185,604 tourists in the same year, most of whom visited Phangnga Bay NP.

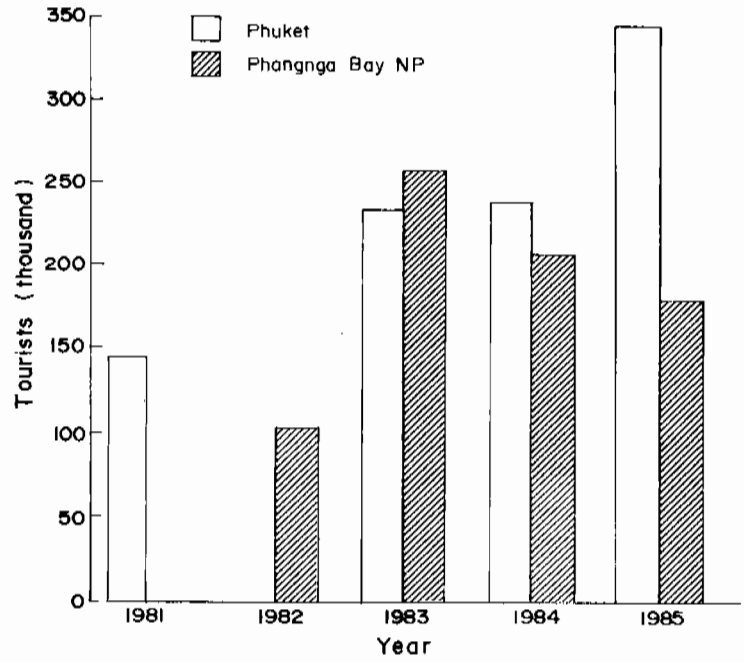


Fig. 4.6. Comparison of tourism volume of Phuket and Phangnga Bay NP, 1981-1985. Statistics for Phangnga Bay in 1981 and for Phuket in 1982 are not available. Statistics for Phangnga Bay included only 10 months in 1981 and 9 months in 1985. Total volume was estimated by adding 17% and 25%, respectively, to the recorded volume.

TAT's forecasts of hotel guests for Phangnga/Krabi were, respectively: 1986 - 85,615/35,230; 1991 - 105,783/43,915; 1996 - 125,638/50,970; and 2001 - 171,435/59,090. The proportion of Phangnga's non-Thai visitors is expected to remain at about 22% of the total until the year 2001 when it will inexplicably jump to 34%, and that for Krabi is expected to be about 2% throughout the period.

In 1985, Phangnga had 23 hotels, the same number as in 1981, and 615 rooms, an increase of 38 rooms. Krabi had 7 hotels in 1985, 1 less than in 1981, but the number of rooms increased to 316 which is 83 more than in 1981. Phangnga has one first-class hotel and Krabi, one good quality bungalow resort. It can be assumed that neither province gains substantially from tourism at present because both do not attract significant numbers of multiple-day, high-spending visitors.

Communication routes, public services and the level of utilities development are all insufficient. Nevertheless, it does not appear that special effort for provision of additional accommodation or improvement of other services is needed except as regards normal rural development operations. In the future, however, Phangnga and/or Krabi will need to strengthen tourism infrastructure in anticipation of spillover from Phuket.

The only mention of environmental conditions in the reviewed literature is on problems with offshore tin mining along Phangnga's west coast. Two other concerns that should be mentioned are mangrove cutting in Phangnga Bay and destruction of corals around Phi Phi through blast fishing.

Chapter 5
Other Economic Sectors

SUBARN PANVISAVAS, PRAGUYRUT SUKUMALACHART
AND WILASINEE WONGPRASERT

Agriculture

In 1984, the Gross Provincial Product (GPP) (at 1972 fixed price) of Surat Thani was 5,286.2 million baht or about 11% and 1% of the regional product of the South and Thailand, respectively.

Agriculture is the most important economic sector with about 57% of the total production value. However, it is now faced with fluctuation in production and marketing problems. The GPP is expanding in the wholesale and retail trade and the services sectors. The latter is especially high, affecting socioeconomic development of the region especially tourism.

Phangnga, in 1984, had a GPP value of 2,876.7 million baht at 1972 fixed price or about 6% and 0.6% of the provincial products of the South and the country, respectively (Table 5.1). With a provincial production of 43%, agriculture is also the main economic activity; followed by mining and forestry with about 18% and 10% of the GPP, respectively.

In 1984, Phuket had a GPP of 1,673.3 million baht or 3.45% and 0.4% of the regional product of the South and the country, respectively, at 1972 fixed price. Apart from agriculture, the wholesale and retail trade sector is second in importance, constituting 12% of the GPP (TISTR 1984) (Table 5.1).

Half of Phuket's area is used for agriculture, i.e., planting rubber, which was the main source of income (about 259 million baht) in 1984. The second most significant crop is coconut which earns 46 million baht, followed by orchard products at 33 million baht (TISTR 1984).

In Surat Thani, rubber comprises a total of 379,705 t; accounts for the most cultivated land in this province; and ranks sixth in Thailand. A. Ban Na San is the most productive, followed by Phun Phin and A. Wiang Sa. The agricultural income of Surat Thani depends to a large degree on rubber. Production problems are: reduction in the world price of rubber; quality of rubber; and lack of bargaining groups. Potential solutions to these are: educating farmers about improved production methods and setting government policies concerning price supports and foreign market outlets.

In Phangnga, rubber is second only to mineral extraction in GPP value. The areas for rubber cultivation are A. Takua Thung, A. Muang, A. Thai Muang and King A. Khura Buri. Most plantations are small and use family labor. Fertilizers are applied without pesticides. Raw rubber is sent out to Phuket's factories and exported to Singapore, Malaysia, England and Japan. The problems with rubber production are that the owners receive only a small income because of small landholdings; poor soil quality; and lack of water and suitable land for expansion.

Table 5.1. Comparison of gross product in 1984 at constant 1972 prices of Phangnga, Phuket and Surat Thani with the Southern Region and the country (million baht).

Production sector	Phangnga		Phuket		Surat Thani		Southern Region				Country			
	Gross product	Percentage	Gross product	Percentage	Gross product	Percentage	Gross product	Percentage Phangnga	Percentage Phuket	Percentage Surat Thani	Gross product	Percentage Phangnga	Percentage Phuket	Percentage Surat Thani
Agriculture	1,248.2	43.39	361.8	21.62	3,006.3	56.87	22,884.6	5.45	1.58	13.14	162,199.2	0.77	0.22	1.85
Fisheries	169.8	5.90	130.6	7.81	236.4	4.47	3,088.3	5.50	4.23	7.65	6,862.5	2.47	1.90	3.44
Forestry	282.6	9.82	3.2	0.19	63.1	1.19	1,963.9	14.39	0.16	3.21	2,740.9	10.31	0.12	2.30
Mining–quarrying	522.2	18.15	150.2	8.98	171.0	3.24	1,298.0	40.23	11.57	13.17	5,415.0	9.64	2.77	3.16
Manufacturing	37.2	1.29	66.5	3.97	141.6	2.68	1,466.6	2.54	4.53	9.65	77,082.7	0.05	0.09	0.18
Construction	37.5	1.31	76.5	4.57	178.4	3.37	1,796.8	2.11	4.26	1.02	17,680.2	0.21	0.43	1.01
Electricity and water supply	17.4	0.61	63.4	3.79	64.2	1.21	689.4	2.52	9.20	9.31	8,087.7	0.22	0.79	0.79
Transportation–communication	85.2	2.96	181.7	10.86	165.4	3.13	2,156.5	3.95	8.43	9.67	24,604.8	0.35	0.74	0.67
Wholesale and retail trade	227.3	7.90	203.7	12.17	594.8	11.25	6,296.9	3.61	3.23	9.45	57,430.0	0.40	0.35	1.00
Banking insurance	71.4	2.48	130.5	7.80	164.3	3.11	1,576.0	4.53	8.28	10.43	26,993.8	0.26	0.48	0.61
Ownership of dwelling	16.4	0.57	13.6	0.81	56.3	1.07	525.0	3.12	2.60	10.72	5,369.0	0.31	0.25	1.05
Public administration and defense	56.3	1.96	53.0	3.17	167.3	3.17	1,627.1	3.46	3.26	10.28	14,106.3	0.40	0.38	1.19
Services	105.2	3.66	238.6	14.26	277.1	5.24	3,127.5	3.36	7.63	8.86	41,535.7	0.25	0.57	0.67
Total	2,876.7	100.00	1,673.3	100.00	5,286.2	100.00	48,496.6	5.93	3.45	10.90	450,108.2	0.64	0.37	1.17

Source: Statistics from the National Income Account, Office of the National Economic and Social Development Board, Thailand.

Development should be geared to hybridization, adequate use of fertilizers and multicropping system, including use of grazing livestocks.

The main problems on rubber in Phuket are: difficulty in obtaining a small financial contribution from the Rubber Promotion Organization of Thailand; delays of financial assistance, which is generally released during planting time; and rubber diseases.

Rice is the second most important crop in Surat Thani and Phangnga. In the former, the largest producing areas are A. Chaiya, A. Tha Chang and A. Phun Phin. Production in the two provinces could not meet domestic demand. Hence, a substantial amount is imported from other provinces.

In Phangnga, farmers still use the traditional farming system and low-yielding rice varieties. Moreover, landholding size per family is small. There is a need to beef up production through use of modern methods, especially high-yielding hybrids.

Although the coconut is an important product for the Upper South, the steady drop in world market price has caused considerable setback to the industy. The government has been encouraging planters to raise other fruit trees and make use of high-yielding coconut hybrids.

In King A. Khura Buri, Phangnga, the cashew nut is cultivated on 3,040 ha with an annual production of about 52,600 t. The government has plans to promote and make a demonstration field for farmers. Research on the cashew nut is also being made. The long-term trend in developing King A. Khura Buri is to cultivate more suitable and profitable plants instead of coconut to match more closely existing prices and markets. For the short-term, efforts are being made to improve the yield per hectare.

In Surat Thani, oil palm is next in importance to coconut. The former's yield is about 221,310 t. It is cultivated in A. Phrasaeng, A. Khiri Ratthanikhom, A. Wiang Sa, A. Phun Phin and some parts of A. Kanchanadit. This industry is facing price reductions and thus, needs government assistance.

Livestock

Livestock also plays an important role in production in Phuket. Raised are cattle, buffalo, pigs, ducks and chickens. Cattle could not meet the demand level of the market and must be imported from Krabi, Prachuap Kirikhan and Ranong. The major problem in developing livestock production is the lack of available grazing land.

Pigs are more popular than cattle and buffalo, but the market demand is greater than supply. The problems with pig production are the high price of pig feed and conflicts with tourism promotion. Chickens are more popular than ducks, and production is enough to meet consumer needs in the province.

Industry

Food production industries like canning and rice milling; lumber milling; rubber making; construction materials; tin smelting; and transport facilities are the most common in the Upper South. In 1980, about 1,520 industrial establishments were registered in the region. In 1984, Phangnga had a total of 76 factories 23 of which were in A. Muang. There were 30 mills and 9 welding factories.

In Phuket, there are 268 factories, 256 of which are small scale. Tin, rubber and seafood factories are the large ones, and most of these are in A. Muang.

Roughly 80% of the industrial products are absorbed in the South while 11% are sent to Bangkok. Clearly, the Upper South is the center of industry of Southern Thailand.

Trading and Service

The Sixth Economic and Social Development Plan (1987-1991) which promotes Phuket as a tourist city will have positive impact on the trading and services sector. As a result of the plan, the necessary infrastructure has been built and has altered Phuket's economy. In 1984, for instance, the per capita income of Phuket (9,500 baht) was higher than that of Southern Region (5,324 baht) and of the country (7,181 baht) (Table 5.2).

Table 5.2. Average income per person in Phangnga, Phuket and Surat Thani compared with the Southern Region and the country, 1984.

Level	Gross Provincial Product (millions of baht)	Per capita income (baht)
Phangnga	2,026.8	10,288
Phuket	1,415.5	9,500
Surat Thani	3,633.3	5,358
Southern Region	34,528.2	5,324
Thailand	364,206.7	7,181

Source: Statistics from the National Income Account, Office of the National Economic and Social Development Board, Thailand.

Mining and Ports

The Upper South is the largest tin mining area in Thailand, providing the highest foreign exhange earning. In 1983, 59% of the total production of tin concentrates came from the Upper South and about 15% of these were mined from Phangnga and Phuket. Aside from tin, rare-earth minerals like tantalite, zircon, xenotime, columbite and monazite are also mined (Table 1.2). In terms of gross product for the Upper South in 1984 (at 1972 fixed price), mining and quarrying contributed 65% valued at 843.4 million baht or about 16% of the GNP.

Commercial tin mining started in Phuket. It has both offshore and inland mining as well as the first and largest tin smelter in the country. Table 5.3 shows the tin production of Phuket

Table 5.3. Value of mineral products in Phuket as compared with the Southern Region and Thailand, 1977-1980.

Level/Year	Value (millions of baht) 1977	1978	1979	1980
Phuket	172.20	148.40	159.20	239.70
Southern Region	1,559.00	1,804.00	1,802.00	1,904.00
Thailand	3,526.00	3,104.00	4,104.00	4,780.00

Source: Statistics from the National Accounts Division, Office of the National Economic and Social Development Board, Thailand.

valued at 239.7 million baht in 1980. That year could be regarded as the best time yet for the country's mining industry, being influenced by the worldwide economic boom, with tin prices attaining the highest level in history (TDRI 1987). Problems confronting the mining industry, especially tin, are the lack of water for production, lower market prices, illegal mining and conflict with other economic sectors, specifically tourism because of pollution through mine tailings.

Phuket has ports and sea transportation network mostly for fishing and industrial purposes. The ports are able to meet current needs and can accommodate ships of 80-100 gross tons (GT). A harbor to ferry tourists/domestic passengers remains to be established, however.

Chapter 6
Population

WINAI WEERAWATTANANON, GEORGE A. ATTIG
AND SHUTIMA OUNOCK

Surat Thani Province covers approximately 12,890 km^2 and has 16 districts *(amphoe),* 2 subdistricts *(sub-amphoe),* 121 *tambons* and 835 villages. In 1985, the province had a population of about 677,602: 337,414 men; 340,188 women (NSO 1984). The population is the third largest in the southern area, following Nakhon Si Thammarat and Songkhla. Statistics indicate that the population continues to increase. Infrastructure needs of Surat Thani is expected to grow leading to an increase in the number of related social services.

Phangnga, on the other hand, ranks ninth in terms of area in the Southern Region. The former is divided into 7 districts, a subdistrict and 281 villages. The population was 195,360 in 1985: 99,766 men and 95,594 women.

Phuket, having an area of 538.72 km^2, is the biggest island in Thailand. The widest part of the island is about 21.3 km and the longest, 48.7 km. It is divided into 3 districts, 17 sub-districts and 100 villages. In 1985, its population was 147,473: 73,146 men and 74,327 women.

In 1980, the combined population of Phangnga and Phuket (174,973 and 133,669, respectively) represented 5.30% and 0.65% of the total population in the Southern Region and in the country, respectively. In 1985, the population constituted 5.32% of the total population in the Southern Region, and 0.66% in the country.

Demography

Population change

Although Surat Thani's population size has continued to grow over the past 10 years, its rate of change has slowed from a peak in 1983 to its current level of 2.25% per year (Table 6.1).

Table 6.1. Population change of Surat Thani, 1979-1985.

Year	No. of population	Increase	Growth rate (%)
1979	583,137		
1980	593,095	9,958	1.71
1981	605,403	12,308	2.08
1982	615,649	10,246	1.69
1983	641,098	25,449	3.98
1984	662,653	21,555	3.36
1985	677,602	14,949	2.25

Source: Statistics from the National Statistical Office, Office of the Prime Minister, Thailand.

In 1980, Phangnga had 174,973 people, but in 1985, there were 195,360. The annual population rate increase was 2.10-2.40% or an average value of 2.22%. In Phuket, the former was between 1.54-2.37% or an average of 1.97%.

Age and sex

The largest age group is the 0-9 years old group for Surat Thani while that for the entire country is 10-19 years. The province's male: female ratio differs only slightly from the norm of 1:1, with women outnumbering men.

In Phangnga, the 0-9 years (26%) is the largest age group. In Phuket, the largest is the 10-19 years (24%) and the smallest is the above 70 years (2%) group. For Phangnga and Phuket combined, the 10-19 years (24.5%) is the largest. The age structure follows closely that for the entire country. Phangnga and Phuket both have male: female ratios of 1:1.

Migration

In Surat Thani,the most mobile group was the 5-14 years age group while the least mobile was the over 60 years age group (Table 6.2). The mobility of the former group is mainly attributed to the migration of families from various areas to Surat Thani.

Table 6.2. Percentage of migrating people to Surat Thani, 1980.

Place of origin	Total	Percentage	Age group 5-14	15-24	25-39	40-59	60+
Above 5 years	512,178	100.0	165,123	119,205	99,707	90,025	38,115
Migrating people aged above 5 years:	40,807	7.97	8,557	14,806	12,094	4,143	1,207
Within the province	19,570	3.82	4,247	6,748	5,813	2,008	754
From other provinces	19,280	3.76	3,882	7,242	5,763	1,996	397
Inside municipal limits	5,194	1.01	980	1,665	1,867	606	76
Outside municipal limits	18,316	2.40	2,313	4,928	3,539	1,270	266
Unknown	1,770	0.35	589	649	357	120	55
Central Region	1,934	0.38	318	555	859	182	20
East	449	0.09	69	176	166	38	-
West	1,685	0.33	366	591	505	193	30
Northeast	971	0.19	97	478	328	51	17
North	529	0.10	110	231	140	38	10
South	11,257	2.21	2,265	4,300	3,167	1,329	236
Unknown region	2,419	0.47	656	925	606	161	71
Abroad	17	0	-	2	8	7	-
Unknown country	1,940	0.38	428	814	510	132	56

Source: NSO (1984).

With regard to the national migration of people above 5 years of age, migration levels were the highest for the Central Region as a whole and lowest for the South. These data indicate that if development efforts are to be stressed not only in the Southern Region but also in the other regions, strategies must be formulated to change the existing national migration patterns, particularly with regard to the perceived occupational opportunities characteristic of each region. From the 1980 Population Census and Housing results, the most popular reasons for migrating to the Southern Region and within it were due to the following of relatives and the securing of a job. Other reasons included changing status, job transfer, further education and returning home.

Most migrants in Surat Thani and in Thailand, in general, were men in search of work either on a permanent or a seasonal basis (Table 6.2). Furthermore, the rate of national migration continued to increase only slightly over the ten-year period with a noticeable decline within the past three years (1983-1985).

About 44,400 in the age group of 5-14 years were immigrants to Phangnga from other provinces. In Phuket, 16,486 immigrants were between 10-14 years old. There were 10,896 who moved to Phuket within the past five years: 5,647 in the municipal limits and 5,249 outside the city. Men migrated more often than women, which was also true for the country.

Birth and death rates

In Surat Thani, the birth rate exceeded the death rate from 1980 to 1983. When population size is considered, this indicates that natural population increase has actually been reduced over this period. In 1984, the Southern Region had a birth rate equal to 135,348 and a death rate equal to 25,892. If these would be compared with the country's rates, the birth rate was equal to 926, 279 (1984) or 14.61%, which was also the birth rate in the Southern Region and in Thailand.

The birth rate in 1983 was higher than the death rate in Phangnga (24.21:4.54) and in Phuket (22.19:5.96). In 1984, the Southern Region had 1,926,279 births and 25,892 deaths. Compared with the country's rates, the birth rate was 14.61% and the death rate was 10.8%. In 1985, the birth and death rates of Thailand were 926,279 and 237,700, respectively.

Fertility

From the 1980 reports of the Population Census and National Housing Authority in Thailand, Surat Thani families, on the average, had four children. Women who lived outside the municipal limits generally had more children than those who lived inside. About 31% of young couples in Surat Thani practiced birth control which contributed to a fertility rate lower than the national average of 4.16%.

In Phangnga, it was anticipated that women would have an average of three to four children in 1986. This average was lower than those in the South and in the country.

The average age for the first married women in Phangnga was 22 years. Women who lived in municipal areas married later than those who lived outside the municipal limits. About 40% of the young couples practiced birth control, compared to 25.45% in the South and 41.16% in the country.

Density

The area with the highest population density was within the municipal limits of Surat Thani, the development center of the province (Table 6.3).

Density comparison of Surat Thani with the Southern Region and Thailand shows that the density of Surat Thani appears to be increasing. The percentages of increasing population in Surat Thani were: 0.93% in 1980 and 1.68% in 1984. In 1985, the rate decreased to 1.17%.

In Phangnga in 1980, the municipal limits of A. Takua Pa had the highest population density, 3,194.37 persons/km^2, which decreased to 3,053.64/km^2 in 1984. This was followed by the municipal limits of Amphoe (1,131.85/km^2 in 1980 and 1,302.37 in 1984) and A. Thap Put (85.15 km^2 in 1980 and 91.30 km^2 in 1984) (Table 6.4).

Table 6.3. Population density in Surat Thani, 1980-1984.

Amphoe	Area (km^2)	Density/km^2			
		1980	1982	1983	1984
Total	12,811.06	46.30	48.06	50.04	54.61
Amphoe	231.32	413.35	438.72	440.11	449.22
Inside municipal limits	6.95	5,133.53	5,750.65	5,796.83	3,848.49
Outside municipal limits	224.37	267.14	274.18	274.18	281.97
Ban Na San	835.06	74.00	75.21	75.65	76.73
Inside municipal limits	67.13	252.39	260.97	260.90	265.13
Outside municipal limits	767.93	58.41	58.97	59.46	60.26
Ban Na Doem (sub-*amphoe*)	206.00	84.42	86.17	86.38	87.64
Ban Tasuk	1,300.00	7.43	7.72	7.85	8.02
Chaiya	1,004.63	33.94	34.49	36.28	36.59
Don Sak	458.00	44.21	44.95	54.62	58.93
Kanchanadit	873.54	74.08	76.80	78.43	81.12
Khian Sa	580.00	25.49	29.91	34.09	35.44
Khiri Ratthanikhom	1,347.37	24.36	24.56	25.95	26.38
Ko Phangan	193.00	40.10	39.86	38.32	38.21
Ko Samui	227.25	136.81	133.01	131.27	133.36
Phanom	703.22	19.11	20.53	21.53	22.25
Phrasaeng	1,382.06	26.72	31.77	31.96	22.86
Khura Buri (sub-*amphoe*)			18.10	19.31	
Phun Phin	1,209.16	56.15	57.07	67.65	69.21
Tha Chana	683.09	38.82	39.13	39.37	69.21
Tha Chang	1,160.43	20.32	20.60	20.61	49.90
Wiang Sa	424.93	95.11	94.71	94.64	109.99

Source: Statistics from the National Statistical Office, Office of the Prime Minister.

Table 6.4. Population density in Phangnga, 1980-1984.

Amphoe	Area (km^2)	Density/km^2				
		1980	1981	1982	1983	1984
Total	4,099.76	42.68	43.67	44.60	45.54	46.63
Amphoe	558.15	49.63	50.52	51.23	53.10	52.37
Inside municipal limits	6.75	1,131.85	1,156.59	1,176.15	1,272.89	1,302.37
Outside municipal limits	551.40	36.40	36.98	37.46	38.17	38.88
Ko Yao (sub-*amphoe*)	137.64	67.02	68.35	70.07	71.67	72.96
Kapong	552.22	19.00	19.08	19.16	19.34	19.59
Khura Buri	932.30	15.26	15.99	16.57	16.70	17.66
Takua Pa	475.49	72.08	74.30	76.23	75.99	77.60
Inside municipal limits	3.02	3,194.37	3,168.87	3,139.12	3,037.75	3,053.64
Outside municipal limits	472.47	52.12	54.52	56.66	57.06	58.57
Takua Thung	620.33	49.74	50.61	51.56	52.29	53.16
Thai Muang	621.36	49.83	51.11	52.36	55.13	56.78
Thap Put	202.27	85.15	86.45	88.03	89.60	91.30

Source: Statistics from the National Statistical Office, Office of the Prime Minister.

Table 6.5. Population density in Phuket, 1980-1984.

Amphoe	Area (km^2)	Density/km^2 1980	1981	1982	1983	1984
Total	538.12	248.12	252.98	257.41	263.63	259.58
Phuket City	224.00	352.41	359.81	365.50	374.51	384.23
Inside limits	12.00	3,762.92	3,725.08	3,789.42	3,826.42	3,888.25
Outside limits	212.00	159.36	165.92	171.69	179.12	185.89
Khatu	62.72	204.70	212.13	219.71	224.09	225.78
Thalang	252.00	166.23	168.23	170.71	174.27	178.58

Source: Statistics from the National Statistical Office, Office of the Prime Minister.

In Phuket, the densest area in 1980-1984 was within the municipal limits of the city. In 1980, it was 3,762.92 km^2, and 3,888.25/km^2 in 1984 (Table 6.5).

Culture

Language

The Southern Thai language is spoken in both of the study areas. The Central Thai or National language is also spoken in schools, other regions and some government offices, especially at the provincial level. Local variations often by village or district and alternative languages in religious contexts, such as Pali (Buddhism) or Islamic, are also spoken.

Religion

In the Southern Region, in general, the percentages of religions practiced were: Buddhism (75%); Islam (24%); and Christianity, Hinduism or others (1%).

In Surat Thani, the population was 96% Buddhist; 2% Islamic; and 2%, of other religions (Surat Thani Statistical Report 1986).

In Phangnga and Phuket, 80% of the population was Buddhist; 19%, Islamic; and 1%, of other religions (Prateung 1976).

Family structure

The Southern Thai family structure is not unlike that of the northern and central areas of Thailand, although some differences exist. The family, on an overall basis, can be classified into stem (i.e., only one married child lives with the parents and thus, no two sons-in-law may live in the same household) or nuclear (i.e., two-generation family, parents and children).

Literacy and education

In Surat Thani, out of the population aged 10 years and over, approximately 90% was literate. Literacy rate for men (95%) was higher than for women (87%). The percentage of literate persons in the municipal area of Surat Thani was higher than that in the nonmunicipal

area. Patterns associated with urban-rural and sex differences in school attendance of the population aged 6-29 years were similar to those of literate persons aged 10 years and over. School attendance for men both in the municipal area (50%) and the nonmunicipal area (45%) was higher than for women (municipal, 46%; nonmunicipal, 42%).

The percentage of men and women who attained a level beyond elementary in the municipal area (29%) was twice more than in the nonmunicipal area (11%) of Surat Thani. Men attained a higher level of education (total of 15%) in the municipal (33%) and in the non-municipal (13%) areas compared to women (total, 11%; municipal, 25% and nonmunicipal, 9%).

To sum up, the importance of literacy, school attendance and advanced education in Surat Thani was more stressed for men than for women. Also, Surat Thani's literacy rates were higher than the Southern Region's (84%) and Thailand's (89%) (NSO 1984; 1980c; 1980d).

Phangnga's literacy rate was 91%. Of this total, the literacy rate for men was 94% and for women, 88%. Patterns of literacy, school attendance and levels of advanced education were all higher in the municipal than in the nonmunicipal areas. Furthermore, only in school attendance of the population aged 6-29 did women represent a higher percentage than men (44% and 42%, respectively).

Men had higher percentages in school attendance in the nonmunicipal area and in the attainment of a level of education beyond elementary. The percentage which obtained an advanced education in the municipal area was almost three times than that in the nonmunicipal area of Phangnga, a greater difference than that noted for Surat Thani (NSO 1980a).

Phuket's literacy rate was about 91%, with men (95%) having a higher rate than women (88%). The patterns with regard to urban-rural and sex differences along the lines of literacy, school attendance and attainment of a higher level of education matched those for Phangnga. However, in almost every category, the Phuket percentages were the highest of all three provinces, while Surat Thani's and Phangnga's were roughly equivalent on a broad basis. Only in school attendance in nonmunicipal areas did Surat Thani exhibit higher percentages, between the ages of 6-29 years old (NSO 1980b).

Phuket's literacy rates were higher than those in the Southern Region (84%) and in Thailand (89%). The same rates by sex were also higher compared to the Southern Region (men: 89%; women: 80%) and the country (92% and 85%, respectively). Phangnga, however, had the lowest percentages of school attendance in the Southern Region, while the highest percentage of higher educational level attainment was attributed to Phuket. Patterns associated with rural-urban and sex differences were comparable to those of the Southern Region and the country (NSO 1980c; 1980d).

Quality of living quarters, tenure and ownership

The standard of living in Surat Thani Province is moderate when measured by the use of permanent building materials, i.e., wood and cement: municipal area, 93%; nonmunicipal, 76%; and total, 77%. Owners occupying living quarters and associated land plots were roughly equivalent in terms of the total, 85.15% and 85.52%, respectively. Both were higher in the nonmunicipal than in the municipal areas.

Households using piped water with regard to the total households in Surat Thani, the municipal and the nonmunicipal areas (in this province) represented 13%, 63% and 8%, respectively. More municipal households (86%) also enjoyed electricity than nonmunicipal ones (19%). However, households that used either gas or charcoal for cooking were 84% in both municipal and nonmunicipal areas. In other provinces, such as Phangnga, gas substitution was possible to reduce the amount of mangrove wood for cooking. The systems of providing gas to rural customers should thus be examined in Surat Thani. Also, about 85% and 28%,

respectively, of the households in the municipal and nonmunicipal areas utilized sanitary latrine facilities.

Nonmunicipal (96%) and municipal households (88%) owned radio sets. Televisions were owned by more municipal (52%) than nonmunicipal (9%) households. Other equipment used mainly by the former households were electric fans, bicycles and motorcycles.

Compared with the other provinces in the Southern Region, the standard of living in Phuket was relatively satisfactory based on the high percentage (82%) of living quarters constructed of permanent materials. This percentage was higher, however, in the municipal (90%) than in the nonmunicipal area (76%).

The municipal households (96%) used electric lighting more than the nonmunicipal ones (55%). Gas or charcoal was used for cooking in 71% of the former and 30% in the latter. Flush toilets and molded bucket latrines as sanitary toilet facilities were used by 90% of the municipal and only 57% of the nonmunicipal households.

Regarding ownership of municipal and nonmunicipal households, respectively, of certain equipment, here were some figures: radio sets, 90% and 93%; motorcycles, 73% and 62%; electric fans and bicycles, 53% and 43%; and television sets, 54% and 15% (NSO 1980b).

In Phangnga Province, 61% of the living quarters were of permanent materials, placing this province in only a relatively moderate position than the other Southern provinces. Again, these were used more often in municipal than in nonmunicipal areas. The proportion of living quarters and of land on which the former were situated and occupied by owners were 80% in municipal and 89% in nonmunicipal areas.

Households using piped water were 7.40%, 37% and 4% of the total households in Phangnga, municipal area and nonmunicipal area, respectively. These figures represent the lowest percentages of all the three provinces in terms of water supply systems, indirectly pointing to a necessity for an expansion of the systems in the rural area. Percentages of households utilizing electricity also showed large urban-rural differences with municipal households (94%) far outreaching nonmunicipal (26%). About 86% and 40% of municipal and nonmunicipal households, respectively, used sanitary types of latrines.

Ownership percentages of household equipment in municipal and nonmunicipal areas were, respectively: radio sets, 92% and 96%; motorcycles, 60% and 44%; bicycles, 60% and 44%; and electric fans, 77% and 18%. Television sets were not in the analysis (NSO 1980a).

Employment

The South

Labor. The proportion of labor in the South (which has 3,292,361 laborers) to the country is 5.12%. The labor force in Phangnga is 53.52% of the population in this province.

In the South, there is a large number of persons with high educational attainment but are unemployed, and this number tends to increase every year. In 1974, there were 19,920 unemployed. In 1981, there were 59,300.

Agriculturists account for 57.6% of the South's labor force. Rice and rubber trees are the main crops. Labor associated with rubber production is unstable. Rice production is also tenuous due to adverse weather conditions. Labor requirements are about 150 days/year for rice and for rubber.

Labor in the South changes both within the region and the provinces. It is rare in Bangkok to find a laborer from the South. From the 1984 figures of the Department of Labor (DOL 1985), only 197 persons from the South moved to Bangkok, but 3,867 came from the

East; 1,326 from the North; and 626 from the Central Region. People in the South must have two jobs due to seasonality of agricultural activity. When they finish growing rice or rubber trees, they have to find part-time jobs to support their families.

Agriculture. The wages of persons skilled in slitting or tapping rubber trees is very high (140 baht/day). Although they do not own land, they still can support their families. Other jobs which do not require special skill pay only 40 baht/day. People who migrate to other places to harvest rice or cut sugarcane receive about 80-120 baht/day.

The population in Phangnga doing domestic work is 85.23%; in cutting rubber trees, 7.38%; and in cutting these trees for others, 7.38% (TISTR n.d.).

Minerals. Since 1979, the number of laborers in mining declined because of the low cost of minerals in the world market and the lower wages compared to other jobs (Table 6.6).

Table 6.6. Number of mineral workers in Surat Thani, Phangnga and Phuket, 1979-1982.

Province/Year	1979	1980	1981	1982
Surat Thani	1,804	1,521	1,263	1,136
Phangnga	49,543	46,445	26,424	26,015
Phuket	3,100	2,987	3,008	2,578

Fisheries. In Thailand, 23 provinces with about 40,198 families (257,254 persons) were in fisheries. In 1979, 14,584 million baht were earned, representing 2.6% of total production in the country.

Fisheries families are of three groups (DOF 1980): (1) business, which employs more than three persons; (2) family business, most workers of which are from the family and only less than three are outside employees; and (3) employed family, which works for others' and not their own business.

The population in Phuket had been increasingly involved in fisheries because the province has a large wharf. This makes Phuket a center for fishing.

In Phangnga, there were roughly 1,300 families engaged in fisheries in the two *amphoes* (Office of Changwat Phangnga 1986).

Others. Other jobs include cutting trees, burning coal, factory tasks, ship repairing and others. These jobs often occurred in provinces with an industrial city, e.g., Chumphon, Phuket, Surat Thani and Songkhla.

Surat Thani

About 63% of the population in Surat Thani in 1980 was of working age. According to statistics of the Industrial Office in Surat Thani, in 1984, this province had 514 factories which employed 5,057 persons. Most industries were located in A. Muang which had 174 industries with 1,732 employees. Next was Phun Phin which had 105 industries and 2,000 employees.

Surat Thani is now a leading industrial province in the South and can afford to hire laborers from other areas.

Phuket

In 1980, 34,618 of the population were in agriculture, 8.18% of which were unemployed. About 41,834 were in the other sectors, 3.44% of which were unemployed.

Most occupations were agricultural and entailed growing rubber trees and coconuts (40.30%). Other jobs included growing rice and working as an employee which were about 18.68% and 17.26%, respectively. Even though Phuket had much tourism, the basic occupations were still working as an agriculturist or working as an employee in trading, fishing or animal husbandry.

About 3,542 people in Phuket worked in 268 factories with an investment of 734.31 million baht. The figures were: machinery and transportation employed 982 persons or 27.7% and had 115 factories or 42.9% of all industrial groups; food and drink, 719 or 20.3%; rubber, 664 or 18.7%.

Most businessmen would invest in Phuket Amphoe because of more facility in finding labor and services here. Income was about 37,303 baht/family/year which was the third highest rate, exceeding that of farming which was only 6,126 baht/family/year (TISTR 1984).

Phangnga

In 1985, Phangnga had 192,165 working-aged persons. There were 42,624 in agriculture and 26,880 in nonagriculture. About 8,322 worked as employees in 1,035 industries.

Five years ago, about 52% of employed people were in agriculture. Percentages of people employed in mineral, trading and social services were 15.30, 11.47 and 9.45, respectively.

The main occupation near the beaches was also agriculture-related (growing rice, coconut, rubber, cashew and vegetables). Labor was 28.37%.

Chapter 7
Institutional and Legal Framework

ARTHORN SUPHAPODOK AND SIRIKUL BUNPAPONG

Introduction

The various resources and economic sectors of industry and tourism in the Upper South and in Thailand are under the jurisdiction of several government departments/agencies. There are three categories of key institutions involved in CRM, namely, policy, planning and implementation agencies. ONEB, for example, is a policy and planning agency that acts as a coordinating body on matters of environmental quality. ONEB is mandated to submit policies and measures on all aspects of environmental management to the Council of Ministers. These policies and measures, if approved, will be adopted by other agencies.

Among the planning and implementation agencies, the Royal Forestry Department (RFD) has jurisdiction over all the forest resources and the mangroves, coral reefs and islands which are designated as national parks of the country. This department grants official logging concessions to private firms and manages all national parks.

DOF, on the other hand, is responsible for formulating policies and plans for the development and management of fisheries; enforcing regulations on fishing; providing licenses to operate fishing boats; and controlling aquaculture activities, including the granting of permits to build aquaculture farms.

The development, planning and implementation of tourism is under the jurisdiction of TAT. These activities include promotions; setting up of guidelines for the improvement of infrastructure and facilities for the tourism industry; and monitoring the impacts of the industry. A master plan for integrated tourism development has been prepared by TAT, but inadequate legislation and cooperation among agencies responsible have prevented full implementation of the plan.

The Department of Mineral Resources (DOMR) is responsible for giving mining concessions to firms and managing and controlling mineral resources utilization of the country.

A number of the above agencies sometimes have overlapping and conflicting responsibilities and interests on CRM. An example is the conflict between tourism and offshore mining in the west coast of Phuket.

In an effort to formulate acceptable management policies and strategies among agencies responsible for CRM, several national committees were established. The committees set up under legislation or law include the: Committee on Land Development, Central Sub-Committee for Coastal Development and National Committee for Mangrove Resources. However, these committees have limited authority to control the utilization of coastal resources under their own jurisdiction, including plan implementation (Table 7.1).

Table 7.1. List of institutions and agencies responsible for various coastal resources in Thailand.

Ecosystem	Mangrove				Coral reef				Beach			Estuary				Mudflat				Island			Fisheries			
Major institutions and agencies	A[a]	B[b]	C[c]	D[d]	A	B	C	D	A	B	C	A	B	C	D	A	B	C	D	A	B	C	A	B	C	D
Office of the National Environment Board	X	X			X	X			X	X		X	X							X	X			X		
Land Development Department		X								X			X								X					
Department of Forestry	X	X	X				X						X	X			X	X			X	X				
Department of Fisheries					X	X	X						X	X			X	X					X	X	X	
Department of Agricultural Extension													X	X												
Department of Mineral Resources			X								X			X												
Department of Harbour											X			X								X				X
Department of Town and Country Planning										X	X															
Tourism Authority of Thailand						X				X											X					
Office of the National Economic and Social Development Board	X								X			X								X	X		X			
National Research Council				X				X							X				X							X

[a]Policy.
[b]Planning and management.
[c]Implementation.
[d]Research.

In 1985, a report on coastal development planning and management, which includes a review of institutional and legal aspects, was prepared by TISTR (Baker and Kaeoniam 1985) with sponsorship by the United Nations Educational, Scientific and Cultural Organization (UNESCO).

Laws and Regulations

Laws and regulations related to coastal resources and their development, as shown in Fig. 7.1, can be classified into four:

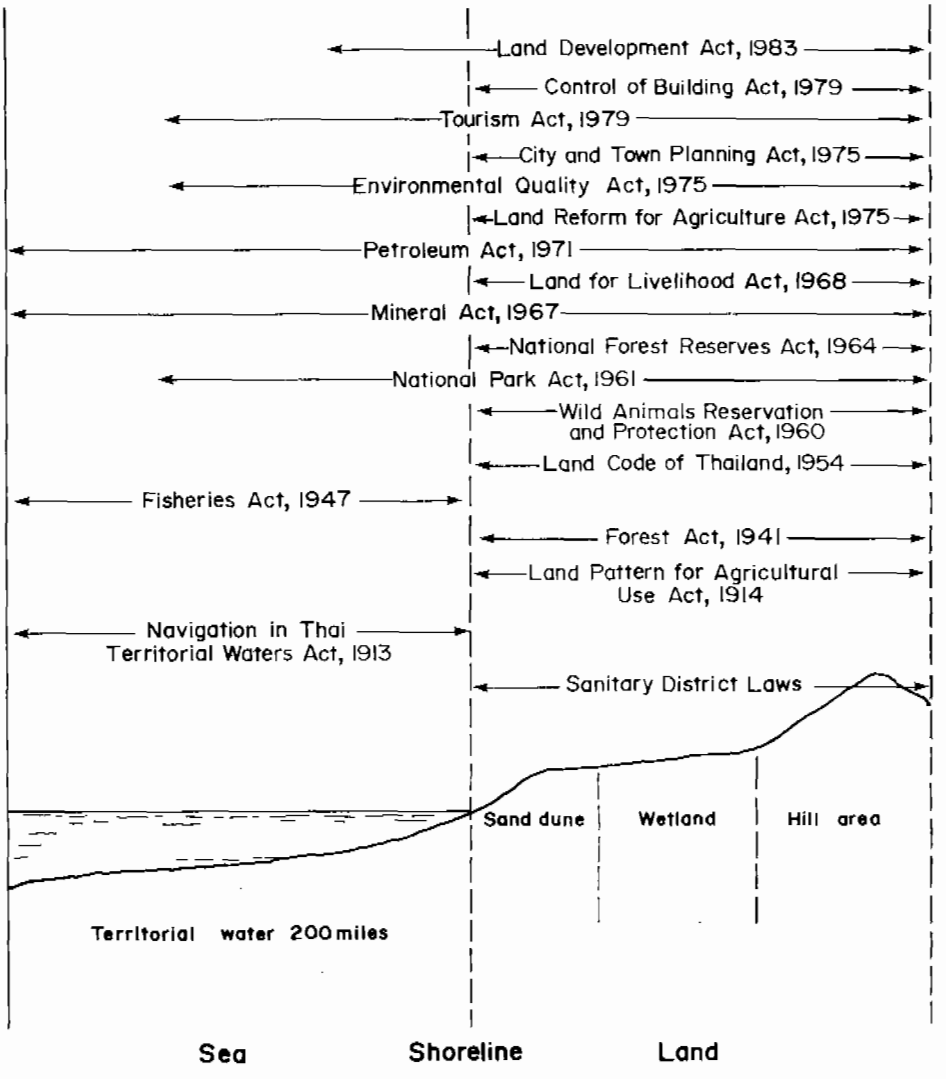


Fig. 7.1. Legislative administration of the coastal area. Source: modified after Baker and Kaeoniam 1985.

Nature conservation

This legislation consists of the Wild Animals Reservation and Protection Act of 1960, the National Park Act of 1961 and the National Forest Reserves Act of 1964. These three cover land and water zones and their interface in dedicated areas, e.g., the National Park Act which includes marine and forest parks. Implementation and enforcement of the Nature Conservation Acts are under the responsibility of RFD.

Natural resources exploitation

This group of legislation consists of the Forest Act of 1941, the Fisheries Act of 1947, the Minerals Act of 1967, the Petroleum Act of 1971 and the Tourism Act of 1979. The Forest Act of 1941 invests full authority on RFD for the protection and management of all forests in the country. The Fisheries Act of 1947, under the responsibility of DOF, is on the control and

management of fisheries resources. The Minerals Act of 1967 invests full authority on DOMR to manage and control national mineral resources utilization, including survey and permission for mining operation and sale. The Petroleum Authority of Thailand (PAT) is responsible for the Petroleum Act of 1971, which covers the exploration and production of oil and gas. The Tourism Act of 1979 invests full authority on TAT to undertake investigation, planning and investment of facilities for tourism development in the country.

Environmental protection

The Enhancement and Conservation of National Environmental Quality Act of 1975, with coordinating responsibilities by ONEB, covers the control of environmental quality and standards and the request of environmental impact assessment (EIA) of development projects.

Land and water usage

Land legislation in Thailand is very complex, covering both land tenure and land use planning. Land tenure legislation consists of the Land Code of Thailand of 1954, some provisions concerning land property rights under the Civil and Commercial Code of Thailand, the Allocation of Land for Livelihood Act of 1968 and the Land Reform for Agriculture Act of 1975. The City and Town Planning Act of 1975, the Formulation of Land Pattern for Agricultural Use Act of 1914 and the Land Development Act of 1983 constitute a legal framework for both urban and rural planning, supplemented by zoning laws embodied in a number of legislations, both old and new (such as the Control of Building Act of 1979).

With regard to water usage, the Navigation in Thai Territorial Waters Act of 1913 (NTTWA) is the key legislation governing both inland and sea navigation. As a party to the 1958 Geneva Convention on the Law of the Sea and a signatory to the 1982 United Nations Convention on the Law of the Sea, Thailand has claimed a 12-mile territorial sea plus a 24-mile contiguous zone measured from the baseline of her seacoast since 1966.

In 1969, a unilateral claim to exercise sovereign rights over the natural resources of the seabed and subsoil of the continental shelves in the offshore areas of both the Gulf of Thailand and the Andaman Sea was asserted by the Thai government. Thailand's claim to extend her EEZ seaward up to 200 miles was made by virtue of a royal proclamation dated 23 February 1981. Like the term "seacoast," no legal definition of "marine waters" or "sea" can be found in the NTTWA or elsewhere in other statutory books.

In addition to NTTWA, there are a number of other water usage laws, such as the Preservation of Waterways Act of 1903, the Public Irrigation Act of 1942, the Water Works Canal Act of 1983, etc. These laws are of little relevance to the subject of coastal zone management due to their major concern with inland waters rather than coastal marine waters.

Institutions

The great variety of resources present in the coastal area results in the participation of different implementing agencies which manage them according to the laws. Sectoral overlapping has caused management problems that need better coordination and cooperation among the agencies concerned. However, it is hoped that the difficulties will be reduced as a result of the coastal resources planning efforts.

Committees and subcommittees responsible for policy and control of operations of the various agencies in the coastal area are:

Committee for Land Development

This committee was established by the Thailand Cabinet under the chairmanship of the Minister of Agriculture and Cooperatives. The members of the committee are the Director Generals from all departments in the ministry, including the Secretary General of the Office of the National Economic and Social Development Board; the Director General of DOLD; and the Director General of DOPW. The major roles and duties of this committee are dealing with land classification and establishing measures for land development and soil improvement.

Central Subcommittee for Coastal Development

This subcommittee was established by the Committee for Land Development under the chairmanship of the Deputy Minister of Agriculture and Cooperatives. The members are the representatives from the departments concerned. The duties of this subcommittee are approving the development proposals put up by the Provincial Subcommittee for Coastal Land Development and the Provincial Subcommittee for Land Classification and Coastal Development; cooperating with these subcommittees; and performing other tasks assigned by the Committee for Land Development.

Provincial Subcommittee for Land Classification and Coastal Development

This subcommittee was established by the Committee for Land Development and is found in each of the 23 coastal provinces. The subcommittee has authority over land classification, land consolidation and reform for agricultural purposes. Its duties are screening coastal development projects, especially those subject to disputes among governmental agencies or among the government and the private sector; initiating and supporting research work related to coastal development; drafting master plans for coastal land use development of the province; and coordinating tasks among the different agencies concerned with land classification.

National Committee for Mangrove Resources

This committee, under the Office of the National Research Council, is comprised of representatives from various agencies concerned. The duties include coordinating with the National Committee for Marine Science in aspects related to mangrove resources; consulting in planning and implementing academic research projects; and considering mangrove resources problems, their development, utilization and conservation.

Committee for Coastal Resources

The committee, composed of 23 members, was established by ONEB, with the Secretary General as chairman. The responsibilities are studying and recommending CRM

policy and plans to ONEB; supervising and controlling action plans and operations of the coastal environment; initiating promotion and conservation projects under the supervision of ONEB; and solving other problems on planning and implementation.

The committee appointed two subcommittees, namely, the Phuket Action Subcommittee and the National Marine Park Subcommittee.

Committee for Coastal Environment

The committee was established by ONEB, with the Secretary General as chairman. The committee's main function is overseeing and guiding the planning and implementation of all coastal environmental activities, especially on the Upper South project under the ASEAN Cooperative Program on Marine Sciences.

Chapter 8
Coastal Resources Management Issues and Plan Formulation

ALAN T. WHITE AND ARTHORN SUPHAPODOK

An intensive workshop on the Upper South CRMP was held in Pattaya, December 1986. The consensus of the workshop participants was that:

1. The overall *goal* of a management plan for the Upper South and the resulting actions at a national level is to promote the socioeconomic development of the region.
2. The plan *objective* is to formulate sustained-use management strategies within key coastal resource sectors and to reduce existing and potential intersectoral conflicts resulting in poor management and resource/environmental degradation.
3. The general *approach* is to formulate sustained-use management strategies by careful observations of the current status of coastal resources and their management and by generating appropriate plans based on these observations in consultation with local resource users and beneficiaries.

Project Boundaries and Limits

Time and financial limitations are always present in a large project such as the ASEAN-US CRMP. It is thus necessary to set definite boundaries in both geographical and sectoral senses. It has been decided that since the Upper South Region is very large, the CRMP should then focus on the coastal and offshore resources. It is not practical to make a detailed land capability assessment and to monitor changes of the land use pattern of the whole Upper South which covers 43,270 km^2. Furthermore, broad development planning of the Southern Region has already been conducted by several government and nongovernment agencies (REDECON 1975; JICA 1985).

Figs. 1.1, 1.3 and 1.8 show the proposed CRMP area for Ban Don Bay in Surat Thani and the associated offshore islands. The distance from the shoreline (including mangrove swamps) to inland is approximately 8 to 15 km. The inland section is bounded by the interprovincial highway which is easy to recognize. The general landscape of Ban Don Bay area can be seen in the cross-sections of Figs. 1.3 and 1.4.

Figs. 1.1, 1.6 and 1.8 show the proposed project area on the Andaman Sea side of Upper South. Here, the coast of Phangnga Bay and its mangrove forest and the coral areas of Phuket and Krabi are included. The offshore fisheries and small islands in the bay are also included. The reasons for selecting this zone are:

1. This zone includes important ecosystems and coastal resources such as mangroves, beaches, mudflats, estuaries, coral reefs, coastal vegetation, islands and openwater fisheries.
2. This zone is intensely used for agriculture and for its natural resources both in- and offshore.
3. The socioeconomic factors affecting land and coastal resource use are complex and cause increasing pressure on the resources.
4. The delicate balance of the coastal ecosystems is threatened with potentially negative consequences for sustainable resource use in the area.

The information required to begin the formulation of a management plan is included. The chapters and sections of this environmental profile indicate those areas of importance. The secondary information is now complete but the more important data on the current status of the coastal resources and environment are being collected. The primary sectors are those on aquaculture; fisheries; mangroves; marine environment; land-based pollution; wildlife; land capability; socioeconomics and anthropological/cultural studies of the coastal residents, tourism development; and the legal institutional framework for plan implementation.

The focus of information collected during the various studies is on management issues and planning. It is intended that information relevant for practical planning and implementation be the outcome of field studies. Examples of appropriate data are current land use maps; the location and quantity of land-based pollution; trends and problems of aquaculture; fisheries stock assessment analysis in relation to fishing gear and intensity; primary resources and their relative importance to tourism; location and density of vulnerable wildlife; status of existing protected areas; perception of local residents on coastal resource use; and current problems of resource use from both national and local perspectives.

Coastal Resources Management Issues

Overlapping responsibilities and conflicting jurisdiction of coastal resources among key government agencies is a major CRM issue. With such conflicts, the lack of a single authority to implement management measures is one of the reasons for the rapid deterioration of coastal resources. Present laws such as the Nature Conservation Acts and the Natural Resources Exploitation Acts need to be amended to minimize sectoral overlapping as well as to enlarge their scope to include critical habitats and resources such as coral reefs. More authority should be given to existing committees to control and advise key agencies involved in CRM.

Other important issues include resource use which conflicts with development activities. An example is tin mining which affects the coastal resort area and the mangroves through excessive sedimentation from mine tailings. Domestic and industrial pollution also affects tourism and fisheries production, causing loss of critical habitat. Inappropriate land use, socioeconomic problems and lack of sufficient information base on the various resources in the region are other issues which need attention for the development of a workable management plan for the Upper South.

Some major problems resulting from the overlapping laws and responsibilities are (TISTR 1985) (Fig. 8.1 and 8.2):

RFD has authority in mangrove forest management and gives official logging concessions to private firms, with limited regard to the impact on coastal fisheries and aquaculture which are under DOF and are dependent on mangrove forest.

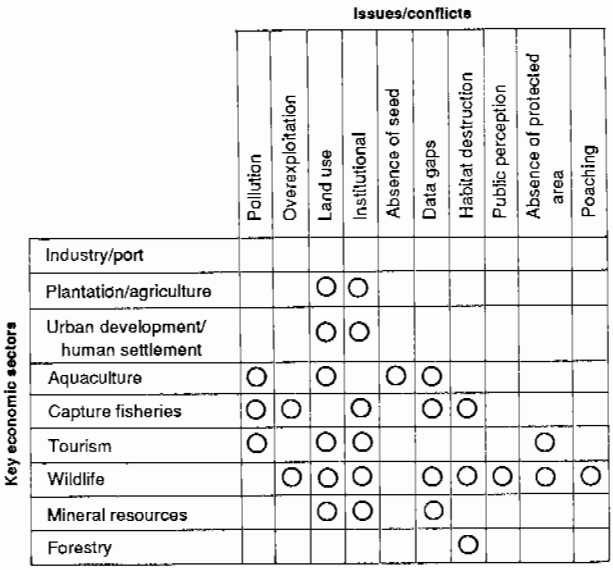


Fig. 8.1. Key sector-specific coastal resources issues/constraints in the Upper South, Thailand.

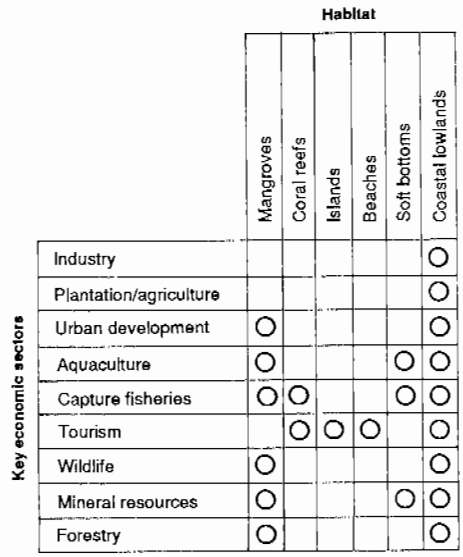


Fig. 8.2. Key intersectoral conflicts resulting in coastal degradation in the Upper South, Thailand.

DOMR grants concessions to tin mining in mangrove forest with little regard to adverse impact on mangrove forest and coastal fisheries which are under the jurisdiction of RFD and DOF, respectively. Attempts have been made to solve this problem by establishing various committees such as the Central Subcommittee for Coastal Development and the Provincial Subcommittee for Land Classification and Coastal Development. These two coordinate with the implementing agencies in the coastal area but have little authority to control their operation. Consequently, it is unlikely that they can be successful in solving the problems of coastal resource use.

The management issues summarized in Table 8.1 indicate similarities among the various sectors. A difference of perspectives among the sectors accounts for most superficial variation or whether a "cause" is an "issue" or vice-versa.

Table 8.1. Management issues and objectives.

Issues	Sub-issues	Causes	Management objectives
Degradation of forest resources	Mangrove land use conflicts Aquaculture Tin mining Resettlement Urban expansion Industry (tourism, logging)	Conflicting interests among sectors; lack definitive plans and aerial zonation	Classification of mangrove land-use zones, economic use zones, critical habitat areas, etc.
	Low mangrove productivity	Use for firewood, charcoal, timber, lumber; illegal cutting above renewable rate; low natural regeneration	Maintaining sustainable use through proper zonation and exploitation plan; increasing production
	Lack of multiple use system aquaculture and silviculture	Poor planning and economic pressure to exploit	Sustainable use with maintenance of critical habitats

Continued

Table 8.1. Continued

	Low public awareness	No education or extension; lack of participation	Involvement of local users in a management plan
	Poor institutional coordination	Lack of clear jurisdiction; poor field implementation	Better cooperation; clear programs for management
	Inland forest degradation and reduction	Encroachment; illegal logging; overexploitation; no replantation; poor law enforcement	
Wildlife	Habitat destruction	Forest clearing for aquaculture, mining, infrastructure, agriculture and urban development	Land use planning; protected areas
	Diminishing wildlife	Low public awareness of the importance of wildlife; poor management of protected areas	Education; proper management of protected areas
	Low reproduction of wildlife	High harvesting; habitat disturbances and destruction; diminishing wildlife	Sustainable use; protected areas; reintroduction of some species; improved habitat; management of specific species
	Uncontrolled hunting and trapping	Poor economic base of local people; high price paid for wildlife meat, alive or dead; increasing population	Protected areas; law enforcement; education; increasing standard of living
	Low public awareness	Poor education; lack of information; poor public cooperation	Training and education
	Poor maintenance of protected areas	Poor or no management; encroachment of people	New approaches to protected area management; more protected areas
	Institutional conflicts	Poor cooperation; lack of manpower; poor coordination at local level	Clarifying jurisdiction and role in management; revising some laws
Tourism	Coral reef degradation	Destructive fishing; collecting corals/fish; siltation; boat anchors	Increasing awareness; educating tourism operators; protected areas
	Unplanned development	Poor administration and planning	Planning and field management
	Waste disposal	Poor laws and enforcement	Improving legal framework; planning waste disposal systems; enforcing laws
	Forest degradation	Village, small-scale cutting; logging	Protected areas; watershed management
	Inequitable distribution of tourism benefits	Lack of integrated development and local participation	Training local residents; appropriate scale development
Capture fisheries	Overfishing of demersal fisheries	Excessive effort; too many vessels	Limiting access; promoting alternative livelihood
	Capture of undersized fish	Fine mesh nets; excessive trawling and extensive use of push nets	Implementing proper mesh size of 3 cm
	Presence of various types of fishing gears within a fishing area	Competition of many gear types in limited areas	Allocation of resources and areas; divisions by territories or traditional rights
	Unreliable information on catch and effort from commercial sector	Poor reporting; communication gaps	Establishing areas for monitoring catch and effort
	Inefficient use of existing catch	Poor handling and wasteful harvesting	Education; training
Aquaculture	Limits of expansion and conflict with mangrove habitat	Need to maintain mangrove habitat	Zonation scheme for aquaculture development in mangrove/estuarine areas
	Effects of wastewater on aquaculture ponds	Industrial pollution, domestic waste, operation of Chiew Larn Dam	Minimizing pollution; establishing sewerage systems

Continued

Table 8.1. Continued

	Mortality of cage culture fish from shrimp pond wastewater	Pesticides used to eliminate undesirable species in ponds; draining without dilution	Minimizing use of detrimental chemicals
	Lack of organization among pond and cage farmers	Poor cooperation; poor organizing by government agencies	Forming cooperatives; education
	Shortage of cockle seeds in Ban Don Bay	Destruction of bottom habitat for cockles by push netting	Protecting cockle spawning and nursery grounds
Land-based pollution	Surat Thani		
	Water pollution on oyster and shrimp farms at Ban Don Bay; contamination by coliform bacteria	Direct discharge of domestic wastewater; excreta, sewerage into water	Control and prevention of domestic wastewater entering oyster and shrimp farms
	Water quality in K. Phum Duang (downstream from Chiew Larn Dam) affecting aquatic life	Chiew Larn Dam discharge of low-quality water into K. Phum Duang	Control of water flow rate from dam discharging into K. Phum Duang
	High waste loading of effluents from seafood processing industries along K. Tapi	Some industries on these areas discharge directly or indirectly disqualified wastewaters (based on IWD effluent standard) into K. Tapi: direct discharging of raw wastewater in receiving water and direct discharging of low-quality treated wastewater	Control of wastewaters based on IWD effluent standard
	Domestic wastewater sewerage system directly discharged to K. Tapi	No wastewater treatment plant on municipal area	Control of domestic wastewater based on ONEB standard
		Insufficient drainage system in municipal area	Control of quality of wastewaters from specific activities in places such as market, hotel, abattoir, etc.
	High waste loading of effluents from distillery on K. Tapi	Direct discharge of treated wastewater and disposal of residuals from distillery into K. Tapi	Finding a way to reduce waste load and to treat residuals; control of treated wastewater based on IWD effluent standard
	Phangnga		
	Shallowness of K. Phangnga and K. Bang Toey	Precipitation of suspended solids discharged from mines	Reducing suspended solids loaded from mining activities
	Municipal wastewater, same as Surat Thani	Same as in Surat Thani	Same as in Surat Thani
	Krabi		
	High waste loading of effluents from industries (especially oil palm industry)	Discharging of effluents into receiving water	Same as in Surat Thani
	Municipal wastewater: same as Surat Thani	Same as in Surat Thani	Same as in Surat Thani
Socioeconomics	Ban Don Bay		
	Land ownership conflicts with oyster farms	Limited area and destruction of habitat by push nets	Area use plan to limit and zone activities
	Security	Poaching among oyster breeders	Community cooperation
	Phangnga		
	Fish for cage culture, scarce; decreasing fish catch	Overfishing and habitat disturbance; overpopulation	Fisheries management; habitat maintenance
	Lack of fishermen's knowledge to deal with resource use problems	Lack of education and alternative livelihood	Education; community organization; alternative livelihoods

Continued

Table 8.1. Continued

	Phangnga Bay		
Constraints	Large salinity variations up to 15 ppt	Heavy precipitation and dry periods during southwest monsoon (May-Oct)	Selection of species tolerable to salinity variations for mariculture; site selection more than 2 km from shore
	High concentration of suspended solids but low organic contents in inner bay region	Mining in the mangrove areas and discharge of high silt loads	If the cause is the present mining operations, the suspended solids of tailing should be concentrated and settled in a sand bar
	Low oxygen and total alkalinity in the mariculture areas at Ban Khok Khrai	Relatively insufficient water movement to remove and dilute the high accumulation of organic wastes	Increasing water movement by leaving sufficient space between cages; cleaning the nets of biofoulers so that water would pass through easily
	High coliform values	Food from improper feeding practices	Critically managing and improving the feeding procedures; mechanical resuspension of settled materials (e.g., turbulence caused by boat propellers) during strong flow of ebb tides is useful in accelerating restoration processes
	Total fish larvae in the bay are predominantly composed of species of economic value	Fish larvae seem to move from the inner bay out to the sea	Encouraging monitoring and immediate findings for space-time shift of abundance of fish larvae
	Low abundance in total fish larvae in the inner bay	Movements of larvae from the inner bay to the sea showed good correlation to the general patterns of net transport of tidal currents from the bay	Implementing temporary close seasons to particular places for trawling, push netting or other fishing methods
	High abundance in total fish larvae in outer bay, particularly on the eastern side		Encouraging and promoting effective enforcement
	Fish larvae tend to move out from the bay		Building artificial habitats (e.g., artificial reefs) to hold fish stocks and prevent bottom trawling

Clearly, there are several major issues which need to be dealt with in the course of CRM planning in the Upper South. In Ban Don Bay, the prime concerns are loss of mangrove habitat; lack of planned aquaculture development; sustaining mollusk culture production; overfishing in the bay; increasing pollution of the rivers, bay and inshore waters around the islands; inappropriate tourism development; and maintenance of coral reef areas and management of the protected areas of Ang Thong National Marine Park. In Phangnga Bay, the prime concerns are: loss of mangrove habitat; overfishing in the bay; sustaining cage culture production; water pollution, tin mining and resulting turbidity and siltation; inappropriate tourism development; maintenance of Phangnga National Park; and designation and protection of critical habitat areas such as coral reefs. For planning and implementation to be smooth in both areas, institutional jurisdiction must be clarified. Some new laws have to be created and existing laws, enforced or amended. Probably of greatest importance for implementation at the local level is the participation of concerned local government and private institutions and individuals who can play a role in CRM and/or conservation.

Conceptual Framework for Coastal Area Management Planning

The process of CRM planning involves different inputs and the participation of various agencies and individuals at the national, provincial and local levels. Relevant information on the status of coastal resources and environments is a pre-requisite to proper planning. This information is now being generated and will evolve into management plans. The overall framework for the evolution of plans is shown in Fig. 8.3. Here, the outputs (Fig, 8.4) are expressed as: (1) final goals, objectives and planning policies; (2) protected area management plans and implementation and (3) issue-oriented action plans for primary sectoral conflicts.

Process	Content and output
CRM profile Secondary information Reports Workshops	Project goals and objectives Background and scope Project boundaries (geographical and institutional/legal) Overview of the coastal resources, environment, socioeconomics, culture, population, institutions and laws CRM issues
Primary data collection by task teams	Refinement of status of the coastal resources, environment, socioeconomics, institutional participation, effectiveness of laws and boundaries of the project
Position papers Summaries of data on CRM issues to be made by task teams	Refinement of management and resource use/conflict issues Current status of environment and condition of protected areas and their management
Setting priorities and determining management actions by planning team and local participants	Final goals and objectives Planning policies Protected area management plans/implementation Issue-oriented action plans for primary sectoral conflicts

Fig. 8.3. Conceptual framework for CRM planning in the Upper South, Thailand.

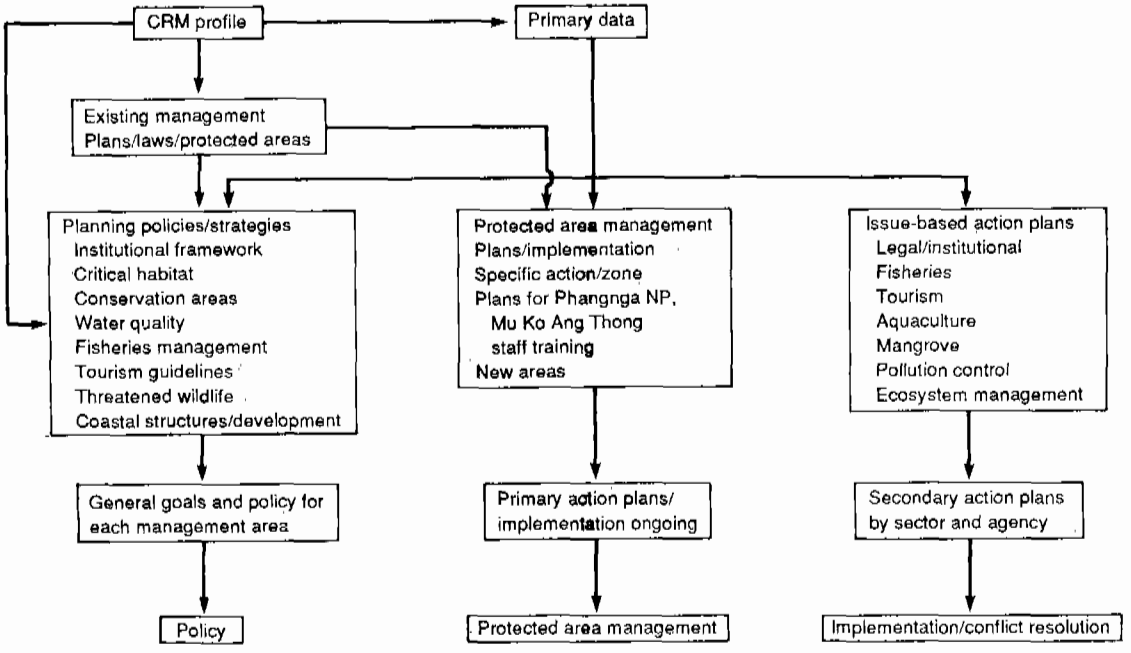


Fig. 8.4. Content of management planning in the Upper South, Thailand.

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