THE ROYAL THAI GOVERNMENT

NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT BOARD

THE SUB-REGIONAL DEVELOPMENT STUDY OF THE UPPER-SOUTHERN PART OF THAILAND

FINAL REPORT
March 1985
VOLUME 6

surat thani-phuket zone

PRIMARY RESOURCES

JAPAN INTERNATIONAL COOPERATION AGENCY

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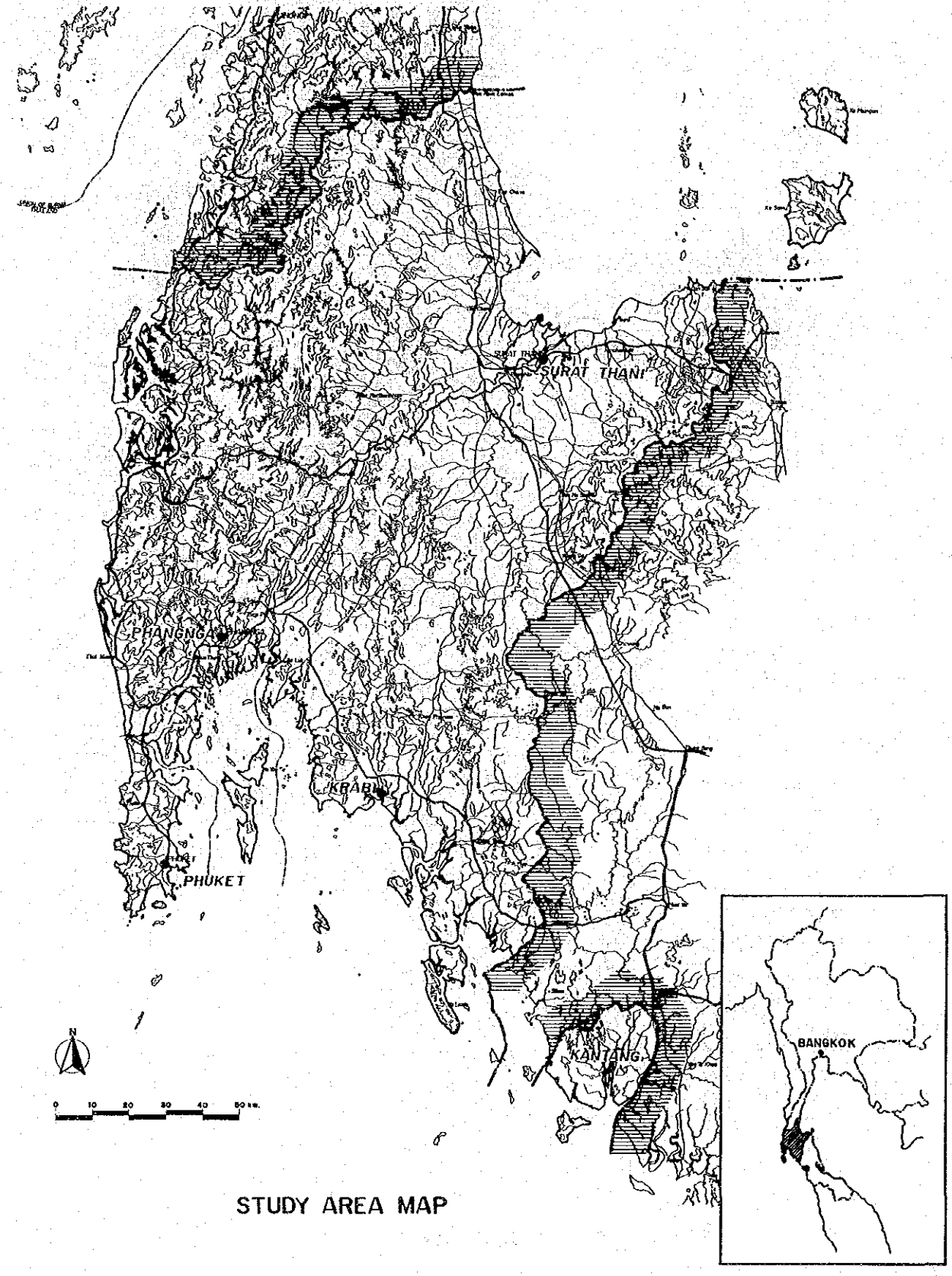
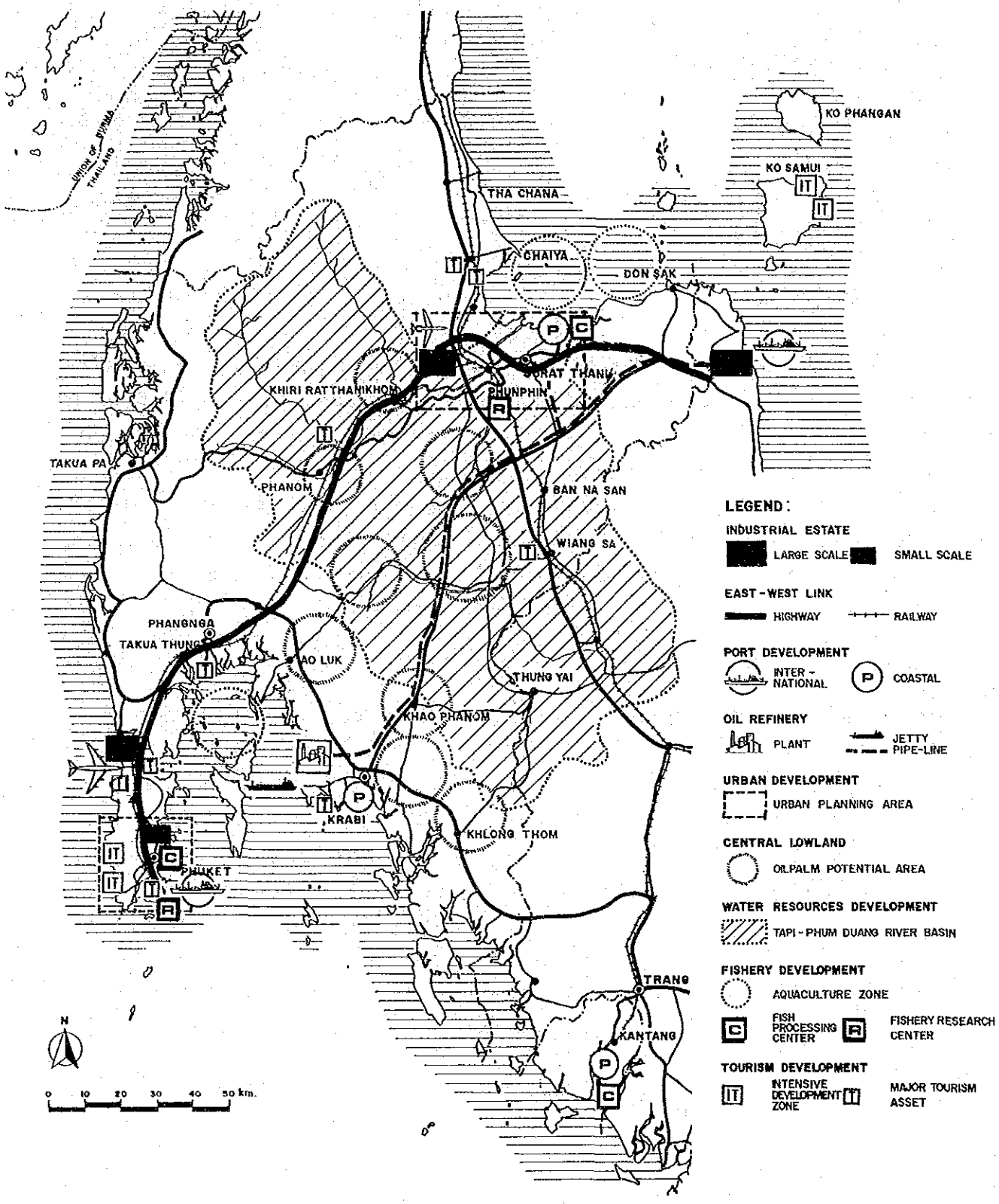


STUDY AREA MAP



PROJECT LOCATION MAP FOR PRE-FEASIBILITY STUDY

LETTER OF TRANSMITTAL

March 20, 1985

His Excellency Mr. Keisuke Arita
President
The Japan International Cooperation Agency
Shinjuku Mitsui Building
Nishi Shinjuku 2-1
Shinjuku-ku, Tokyo
Japan

Dear Mr. President:

We have honor to submit to you our final report on the Subregional Study of the Upper Southern Part of Thailand. It is our great pleasure to note that this assignment has been completed through the close cooperation between two governments of Japan and Thailand.

The report was prepared during the past two years by the study team organized by the consortium of the International Development Center of Japan and the Pacific Consultants International Co. Ltd., and headed by Dr. Masahiko Honjo, the Team Leader. It comprises seven volumes, i.e. Vol.1 Master Plan; Vol.2 Transportation; Vol.3 Urban Development; Vol.4 Industry; Vol.5 Energy; Vol.6 Primary Resources ; and Vol.7 Tourism.

In preparing this report, our team benefited a great deal from cooperation extended by officials and experts of JICA and other authorities concerned of the government of Japan. Equally important, our team was supported by the staff from NESDB and other ministries of the Royal Thai Government throughout the stay of our team in Thailand for nearly 17 months. We also wish to put on record our sincere gratitude to the wide ranging discussions over the proposals contained in the draft final report at the National Seminar of the Upper South Development Policies and Programs held in Thailand on January 25 and 26, 1985.

We wish to add that we sincerely hope this report will provide an important basis for planning and implementing the development of the Upper Southern Part of Thailand.

Yours truly,

Saburo Kawai
President
International Development Center of Japan

CONTENTS

Page

TABLES

FIGURES

1. SUMMARY

Basic resource advantages of the Upper South are land and water. While rapid deforestation has created a vast underutilized land of 6,300 square kilometers, this land has high potential of agriculture together with abundant rainfall. In addition, the Upper South has Tapi-Phum Duang Rivers with a total annual run-off of 10 billion cubic meters which is by far larger than in any other river in the South. Coexistence of vast underutilized land, abundant rainfall and large rivers can hardly be found elsewhere in Thailand. On this ground, the Upper South produces a variety of tropical crops, including rubber, oil palm, coconut, coffee, cashew nuts, sataw, rambutan, lancet, etc. The Upper South is endowed with mineral resources also, including tin, lignite, gypsum, tantalite and other rare metal resources. Unlike Eastern Seaboard which has limited elements to generate substantial benefits during a gestation period of heavy new investments, the Upper South must make use of its resources to bridge present underdevelopment and the new industrial/international-based development. In fact, the Upper South is estimated to have been contributing more or less 10 percent of the national currency earnings through its export of tin, rubber and fish alone.

We propose strategies in four major sectors of (1) landuse and land development, (2) water resource development, (3) agricultural development and (4) fishery development. For the landuse and land development, we have worked out a landuse guideline based on the analysis of a land use-capability matrix. Broadly speaking, 40 percent of the land needs to be conserved, reforestated or rehabilitated, while the remaining 60 percent can be used for promoting tree crop plantation, irrigation and crop intensification as well as for reserving space to be used in future. Under this guideline, two actions are proposed specifically; Takua Pa Tin Mining Area Rehabilitation being a crucial land rehabilitation project and Central Lowland Development being a massive oil palm development program.

For the water resource development, different strategies are necessary for two distinct areas; Tapi-Phum Duang River Basin and the remaining part of the Upper South. In the Tapi-Phum Duang River Basin, river water demand, of which about 90 percent will be consumed by proposed irrigation projects, is no more than 30 percent of the total usable water in the year 2000, but water demand will then reach about 60 percent of the total usable water without irrigation in the rest of the Upper South. Thus, in the Tapi-Phum Duang River Basin, the important strategy is to promote multiple-use and control of the rivers particularly with the Chiew Larn and Kaeng Krung Dams which have been ongoing or planned for power generation purpose. In the rest of the

basin, the important strategy is to ensure water supply especially to Phuket which is now in pressing need of water and to rural settlements in the Central Lowland. In addition, water management of Takua Pa River Basin is proposed in coordination with Takua Pa Tin Mining Rehabilitation Project.

For the agricultural development, it is stressed to change the current pattern of resource exploiting production into a pattern which is more ecologically balanced and stable. Important strategies include:

1) Acceleration in the rubber production through yield increase and the oil palm production through both planned expansion of land and yield increase;

2) Diversification of crop and multiple use of farm lands, rubber and coconut planted lands in particular, for maintaining soil in good condition and stabilizing income of small farmers;

3) Achievement of rice self-sufficiency by expanding the irrigation capable of dry season cultivation;

4) Development and accumulation of tropical agricultural technologies and resources, seeds in particular. Surat Thani Horticulure Research Center is recommended to be reinforced and expanded, in this regard; and

5) Establishment of a network for agro-products distribution and processing with agro-products centers in selected intermediate urban centers.

For the fishery development, two strategies are recommended:

1) To maintain and increase marine fish resources of the adjacent sea by designating it only for the use of the small-scale fishing and fish culture, in which the Upper South is endowed with a few potential sea at both sides of the Gulf of Thailand and the Andaman Sea;

2) To contribute to maintaining the domestic fish supply capacity by promoting deepsea fishing and improving the local system of fish preservation and processing.

Under these strategies, the following actions are of particular importance:

1) Designation of aquaculture zones in Ban Don Bay, Phangnga Bay and Kantang Bay,

improvement and diffusion of aquaculture technologies and expansion of hatcheries for seed production;

2) Study, experiment and development of artificial reef with a research center in Phuket; and

3) Fish port and processing base development at Tha Thong, Kantang and Phuket.

In view of these strategies, we have undertaken prefeasibility studies on three major programs/projects of Central Lowland Development, Tapi-Phum Duang River Basin Management and Phuket Water Supply. The Central Lowland Development Project is aimed at fully utilizing the vast land under low intensive use in the Central Lowland, mobilizing small farmers for oil palm development and improving productivity and market competitiveness of Thai oil palm. Target production of fresh fruit bunch is about 2.6 million tons in the year 2000. The program comprises two components of small holder development and large-scale estate development. Major government actions proposed include provision/upgrading of right for cultivation or land title and credit for oil palm cultivators in the small holder development, and financial assistance and resettlement scheme for evicted farmers and provision of privileges by Board of Investments and the subsidy for social infrastructure development in the large-scale estate development. For both components, R&D and extension is crucial to increase market competitiveness of Thai oil palm. During the period 1985 to 2000, the program will require about 7.4 billion baht of investment, of which about 35 percent is expected to be shared by government. As an immediate action, it is desired to conduct a study to assess the performance of rubber replanting program and a resettlement scheme financed by Bank for Agriculture and Agricultural Cooperatives from the viewpoint of applying their experiences in small-holder-based plantation development on the Central Lowland Development.

Tapi-Phum Duang River Basin Management Project contains (1) the completion of Chiew Larn and Kaeng Krung Dams to generate electric power of about 720 GWh per year, (2) the irrigation projects to cover 55,000 hectares of existing and potential paddy area by making use of these dams, (3) the flood mitigation partly by reducing flood peak of Phum Duang River with these dams and partly by developing a bypass waterway around the crossing of Phum Duang and Tapi Rivers and (4) the expansion of urban/industrial water supply system to meet an expected consumption demand of about 65,000 cubic meters per day in Surat Thani. These four components will cost about four billion baht in total. It is presumed safe to say that the economic benefit from the Kaeng Krung Power Generation and Irrigation is large enough to cover this

total cost. As an immediate action, it is desirable to update the comprehensive basin study prepared by Royal Irrigation Department (RID) in 1973 with a focus on optional utilization and operation of the Chiew Larn Dam and Kaeng Krung Dam, watershed management and environmental protection of the delta and estuary area. Feasibility studies on the newly proposed flood mitigation, irrigation and urban/industrial water supply are desired to be carried out also in a timely manner.

Phuket Water Supply Project is aimed at ensuring urban/tourism/industrial water supply for Phuket Island to meet an expected demand of 54,000 cubic meters per day in the year 2000. Two alternatives of supplying water (1) by the resource on the island alone and (2) by the resource in Phangnga to be transported through pipeline are compared and the former alternative is found less costly than the latter by about 46 percent. We, therefore, recommend to develop a series of reservoirs to be connected with different demand centers in a systematic manner. For this, it is particularly necessary to work out clear division of works among Provincial Waterworks Authority, RID, Industrial Estate Authority of Thailand, Municipality and Changwat Administrative Organization in cost and revenue sharing. Also, a subsidy of five baht per cubic meters for domestic water and 1.5 to two baht for industrial water would be needed, if the government is to keep the current low domestic water charge and provide the water attractive enough for industrial investors. As an immediate action, a terminal plant and a transmission system should be constructed in order to utilize the Ban Wat Dam at the soonest possible time. In addition studies are desired to be undertaken to examine the availability of water sources and their amount of water based on more detailed information and the utilization of existing mining ponds for economical water supply and flood mitigation.

2. RESOURCE ADVANTAGE OF UPPER SOUTH

2.1 LAND

In sum, landuse in the Upper South can be characterized by (1) current deforestation and expansion of low intensity landuse and (2) high potentiality of deforested and low intensity areas with proper management and investments.

During the period from 1973 to 1977, 21.5 percent of the evergreen rainfall forest was cut in the Upper South and it accounts for more than 50 percent of deforested area in the South. According to Royal Forest Department (RFD), the forest area decreased from 8,910 to 6,143 square kilometers during the period 1973 to 1982.

At the same time, "low intensity landuse area", which consists mainly of shifting cultivation, recently abandoned land, scrub land and regenerating secondary forest, grassland including savanna-mixed crop settlement, increased by 30 percent during the period 1973 to 1977. In the rest of the South, however, the low intensity landuse area has been decreasing only slightly and even turned to be used intensively again.

Potentiality of land development in the Upper South is observed to be very high compared with the other part of the South. Possible farm land expansion is estimated to reach more than 6,800 square kilometers, which is even larger than the existing farm land area, though most of the rest of the South have already expanded their farm land to maximum limit, and the farm and other developed lands encroached into the area unsuitable for development or to be conserved. The land potential of the Upper South can be thus fully utilized through both expansion of existing farm lands and more intensive use of "low intensity landuse area".

Based on the Land Capability prepared by the Department of Land Development (DLD) and Landuse Map 1977, landuse potentiality was estimated as shown on Table 2.1. In the Upper South, the potentiality of land development is very high especially for tree crops and cultivated crops except rice. Landuse pattern versus land capability has not been in the state of disorder compared with the rest of the Upper South, although comparatively small area of paddy field has been encroaching into the less suitable lands. Intensification of landuse, control of the land development pattern and conservation of national forest are the most essential in the Upper South to make fullest use of its high land potentiality in terms of both expansion and intensification.

Table 2.1 LANDUSE POTENTIALITY

Land capability : Unit: km^2

Description of land	Upper south	Outside upper south	South total
Paddy and urban land	1,062	9,438	10,500
Tree crops & cultivation	12,223	11,835	24,058
Limited suitability	2,560	10,263	12,823
Conservation	6,470	16,864	23,334
Total	22,315	48,400	70,715

Landuse :

Paddy and urban area	1,231	8,401	9,632
Tree crops & cultivation	5,228	16,348	21,576
Low intensity landuse	8,858	12,140	20,998
Primary forest	6,998	11,511	18,509
Total	22,315	48,400	70,715

Landuse potentiality : 1/
(Spacial development potential)

Paddy and urban area	- 169	+ 1,037	+ 868
Tree crops & cultivation	+ 6,995	- 4,513	+ 2,482
Areal expansion Total	+ 6,826	- 3,476	+ 3,350

(Land availability potential)

Low intensity landuse area	+ 6,298	+ 1,877	+ 8,175
Primary forest	+ 528	- 5,353	- 4,825
Areal supply potential	+ 6,826	- 3,476	+ 3,350

SOURCE : - Landuse Potential Map and Landuse Map 1977, Department of Land Development.
- Forest Area Survey Data, Royal Forest Department.
- South Thailand Regional Planning Study.

NOTE : 1/ Landuse potentiality is calculated based on each category of landuse and land capability. Special note should be made that this preliminary study highlights only the total amount, resulting in the negligence of the mixture of actual disorderly landuse.

2.2 WATER

While the inland area of the Kingdom experiences twofold rainfall, often modified through mountain ranges, the southern peninsular is exposed fully and without hindrance to both currents. However, since there are mountain chains along the peninsular, both the west and the east coasts experience the summer and the winter monsoon differently. Figure 2.1 shows annual rainfall in the Upper South. Except in the middle of the subregion, rainfall is more than adequate to cultivate tropical tree crops such as rubber and oil palm.

The Upper South consists of Phum Duang River Basin, Tapi River Basin and about 50 other small basins accounting for 41, 37 and 22 percent of the whole area, respectively. Annual runoff of Tapi-Phum Duang Rivers reaches more than 10 billion tons accounting for 60 percent of the total runoff identified in the South.

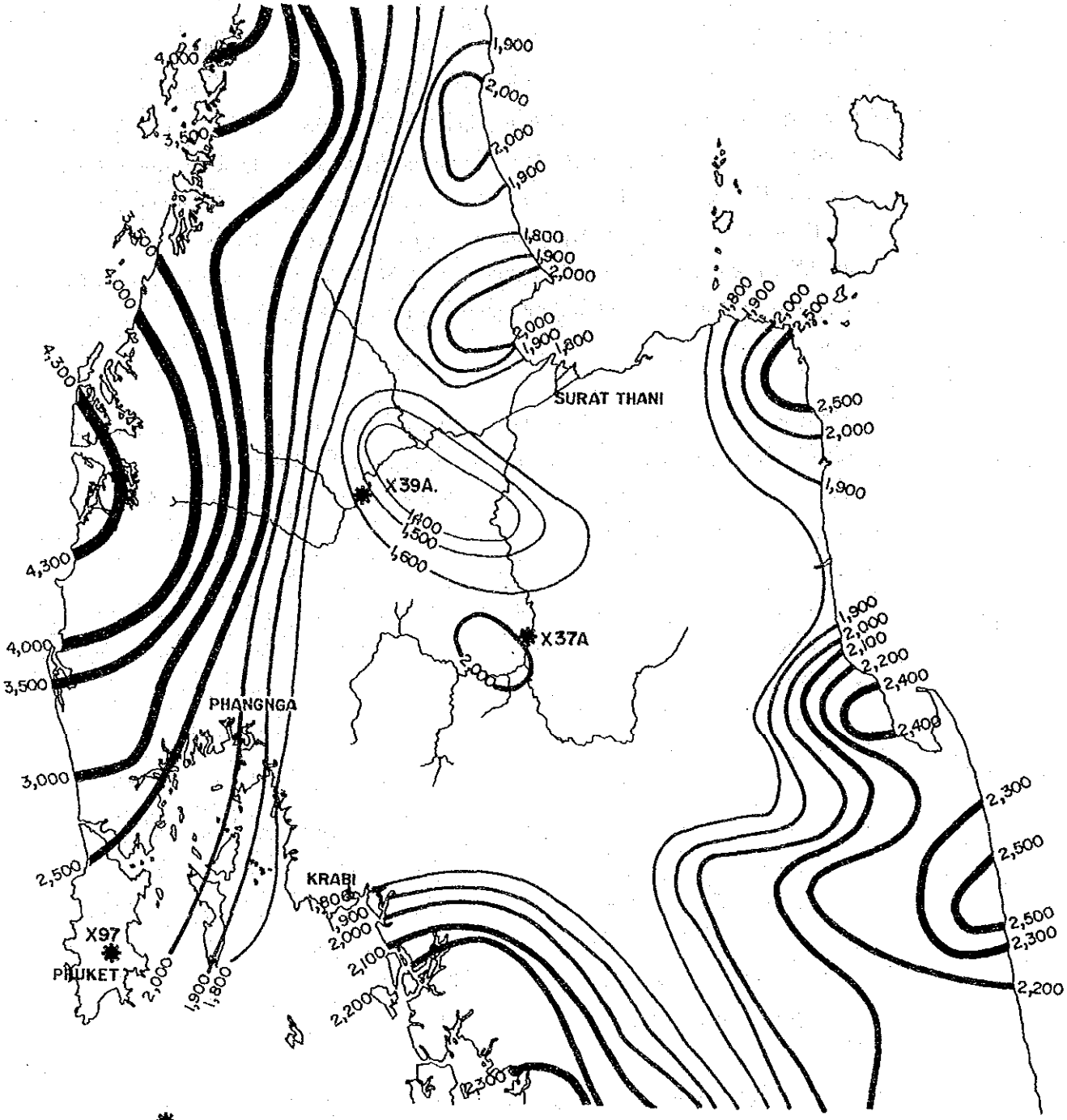
There are many vast unused cultivable lands in other regions of Thailand, but these combination of heavy rainfall, large rivers and vast unused cultivable lands is little found elsewhere.

2.3 RESOURCE PRODUCTS

The Upper South contributes substantial share to the national production in a variety of resource product items (see Table 2.2). In the crop production, it produces more than 10 percent of the national production in oil palm, cashew nuts, sataw, rubber, rambutan, coffee, lancet and coconut. Forestry production in the Upper South also exceeds more than 10 percent of the national total. Marine fish catch reaches 10 percent of the national total as well although the catch started to decline recently.

As for mineral products, the Upper South produces not only tin but many other minerals including rare metals of tantalite, zircon, columbium tantalum, monazite, xenotime, antimong and columbite as well as nonmetallic minerals of lignite, gypsum, barite and fluorite.

Tin mining has been a largest income and foreign exchange earner of the Upper South. There are both negative and positive prospects in future tin production. Available projections such as those by an American research institute, World Bank and US Bureau of Mines suggest that the growth rate of tin production will be less than one percent per annum toward the year 2000 while International Tin Council projects a higher rate of growth of 1.7 percent toward 1985. World tin consumption



* River Gating Site, Number indicate RID Gate No.

Source: RID

No.	Name of River	Catchment Area (km^3)	Discharge (m^3/sec) Mean	Min	Max	Ratio Max/ Min	Annual Runoff (mil. m^3)
X38A	Khlong Phum Duang	2,706	179.60	5.70	1686.60	296	5,679.3
X37A	Mae Nam Ta Pi	5,200	131.92	16.50	421.60	26	4,171.5
X97	Khlong Ao Yan	2	0.02	0.00	1.64	-	0.5

Fig. 2.1 ANNUAL RAINFALL AND HYDROLOGICAL CHARACTERISTICS OF SELECTED RIVERS

Table 2.2 UPPER SOUTH RESOURCES/PRODUCTS ACCOUNTING FOR MORE THAN FIVE PERCENT OF NATIONAL TOTAL

Items	Percentage in Naitonal Total Resources/Products
Crops 1/	
Oilpalm	50.3
Cashewnuts	46.5
Sataw	37.5
Rubber	21.1
Rambutan	20.4
Coffee	18.9
Lancet	17.5
Coconut	13.8
Durian	9.5
Jack Fruit	6.2
Tangerin	6.0
Forestry Products 2/	
Firewood	28.9
Charcoal	23.7
Non-teak trees	10.5
Marine Fish Catch 3/	9.5
Mineral Products 4/	
Tantalite	81.5
Zircon	72.7
Tin Concentrates	64.5
Columbium Tantalum	53.9
Monazite	46.7
Xenotime	46.3
Lignite	36.6
Gypsum	28.5
Antimong Metal	22.6
Antimong Ore	11.8
Columbite	10.2
Barite	8.7
Fluorite	7.9
Tourists 5/	
Domestic	6.8
Foreign	8.1

1/ Number of trees except rubber, which is shown in production(t) term. Source : 1978 Agricultural Census for crops other than rubber and Office of Southern Agriculture & Cooperatives (1981) for rubber

2/ In cubic meter volume. Source : Annual Report of Royal Forestry Department

3/ In tonnage. Source : Fishery Record of Thailand (1980)

4/ In tonnage. Source : Mineral Statistics of Thailand(1976-80)

5/ Except tourists to Bangkok. Source : TAT, a study on the Potential of Tourism Development in Thailand (1982)

will increase only at a very limited rate due to accelerated substitution of tin by other materials such as tin free steel, aluminum, plastics, chemical adhesives and welding, and relative price of tin maintained at a high level by International Tin Council. On the other hand, tin mining of Thailand has comparative advantage over other major producers in term of both cost competitiveness and resource potentials Thai tin production is dependent largely on offshore mining which has stronger cost competitiveness over onshore mining. Production-reserve ratio is estimated at about 50 years for Thailand while it is 13 years for Malaysia, 89 years for Indonesia, 32 years for Bolivia and 17 years of Australia, according to the estimates made by Sainsbury & Road (1973) and US Bureau of Mines (1978), on the basis of economically recoverable reserve. Total tin resources of Thailand are estimated at 4.6 times as large as the economically recoverable reserve. Tin mining of the Upper South, therefore, is expected to expand at a moderate rate although it will diminish its relative magnitude as a leading sector in favor of more stable and diversified economic activities to be encouraged through industrialization.

A number of these agricultural and mineral resources are exported. A simple estimation suggests that the Upper South contributes more or less 10 percent of the national total foreign currency earnings even through its selected export commodities of tin, rubber and fish only are taken into account.

Comparative resource advantages of the Upper South has an important implication to its development especially when it is contrasted with the Eastern Seaboard Development. Whereas Eastern Seaboard has limited elements to generate substantial benefits during a gestation period of heavy new investments, the Upper South must make use of its resources to bridge present underdevelopment and the new industrial/international-based development. Resource utilization will (1) let the Upper South to earn in part the financial resources to return new investments, (2) diversify industrial base through the growth of resource processing industries, (3) encourage urbanization and distribution activities necessary for the expected industrialization in this remote area, (4) enable gradual improvement of infrastructures to be partly supported by the demand from expansion of existing activities and partly prepared for newly induced activities.

3. RESOURCE POTENTIALS AND STRATEGIES

3.1 LANDUSE AND LAND DEVELOPMENT STRATEGY

3.1.1 Existing Landuse and Land Capability

1) Existing Landuse in 1982

In order to examine the latest change of landuse in the Upper South, a landuse map in scale 1:250,000 was prepared based on the image of Landsat-2 as of January 1982. It is most useful to know the stretch of low intensity landuse area typical to the Upper South, which is shown in Fig. 3.1. Table 3.1 shows the existing landuse of the four changwat in the Upper South in 1982. Low intensity landuse area accounts for approximately 41 percent, comprising 17 percent of secondary forest, seven percent of secondary forest mixed with crops, 15 percent of idle land and two percent of mining & others. Low intensity landuse area in the Upper South accounts for 70 percent of its cultivable land.

The existing conditions of the low intensity landuse area are briefly explained as follows:

Secondary Forest: This area is usually uneasily accessible. Most of the area became secondary forest after cutting or shifting cultivation;

Secondary Forest mixed with Crops: This area is characterized by its extensive landuse of low productivity though legal as well as illegal small holders cultivate rubber trees on scattered cutovers;

Idle Land: This area, generally, belongs to the land suitable for agricultural cultivation. However, due to scarecity of labor and capital, this area seems to have been abandoned or forced to stop farming; and

Mining and Others: This area covers exhausted/operating mining sites and urban landuse area.

2) Land Capability

Fig. 3.2 shows the land capability map which is prepared by DLD andTable 3.2 shows general description of soils, recommended landuse and major input required for max-

Table 3.1 EXISTING LANDUSE IN 1982

Unit: km^2

Changwat / Landuse	Surat Thani Area	(%)	Phangnga Area	(%)	Phuket Area	(%)	Krabi Area	(%)	Total Area	(%)
Primary Forest	4,178	(32.4)	2,083	(49.9)	71	(13.1)	732	(15.6)	7,064	(31.7)
Mangrove Forest	65	(0.5)	411	(9.9)	27	(5.0)	378	(8.0)	881	(3.9)
Low Intensity Landuse	5,861	(45.5)	853	(20.5)	225	(41.4)	2,274	(48.3)	9,213	(41.3)
Secondary Forest	2,732		223		211		728		3,894	
Ditto with Crops	947		177		–		454		1,578	
Idle Land	2,157 1/		166		–		1,089 2/		3,412	
Mining & Others	25		287		14		3		329	
Tree Crops	2,183	(16.9)	719	(17.2)	194	(35.7)	1,146	(24.3)	4,242	(19.0)
Paddy Land	605	(4.7)	105	(2.5)	26	(4.8)	179	(3.8)	915	(4.1)
TOTAL	12,892	(100.0)	4,171	(100.0)	543	(100.0)	4,709	(100.0)	22,315	(100.0)

Note 1/: Includes some paddy area.

2/: Rubber and oil palm plantation area scattering would be included.

Source: 1) Prepared by the Team in cooperation with National Research Council using LANDSTAT-2 images of January 1982.

2) Landuse 1977, Department of Land Development.

imizing land productivity in accordance with mapping unit.

Land capability of the Upper South is shown in Table 3.3 and characteristics of each changwat of subregion are briefly summarized as below:

Surat Thani

Surat Thani has the highest land capability in the Upper South. 58 percent of the cultivable land, 97 percent of the land suitable for paddy and 55 percent of the land suitable for tree crops belong to Surat Thani. Surat Thani is the only changwat that has a large capability of large-scale paddy and irrigation development.

The information of this map was interpreted from LANDSAT-2
imagery by enlarging from diazochrome 1 : 1,000,000
to 1 : 250,000 scale PATH ... ROW ...
JAN 23 1982
PREPARED BY REMOTE SENSING DIVISION
NATIONAL RESEARCH COUNCIL THAILAND

KO SAMUI

CHAIYA

SURAT THANI

TAKUA PA

PHANGNGA

KR

PHUKET

KANTANG

LEGEND

- PRIMARY FOREST
- SECONDARY FOREST (LOW INTENSIVE)
- MANGROVE
- OIL PALM
- RUBBER
- COCONUT
- FIELD CROPS
- ORCHARD
- PADDY
- MIX WITH CROPS (LOW INTENSIVE)
- IDLE LAND
- MINING AND OTHERS

Fig. 3.1 EXISTING LANDUSE IN UPPER SOUTH IN 1982

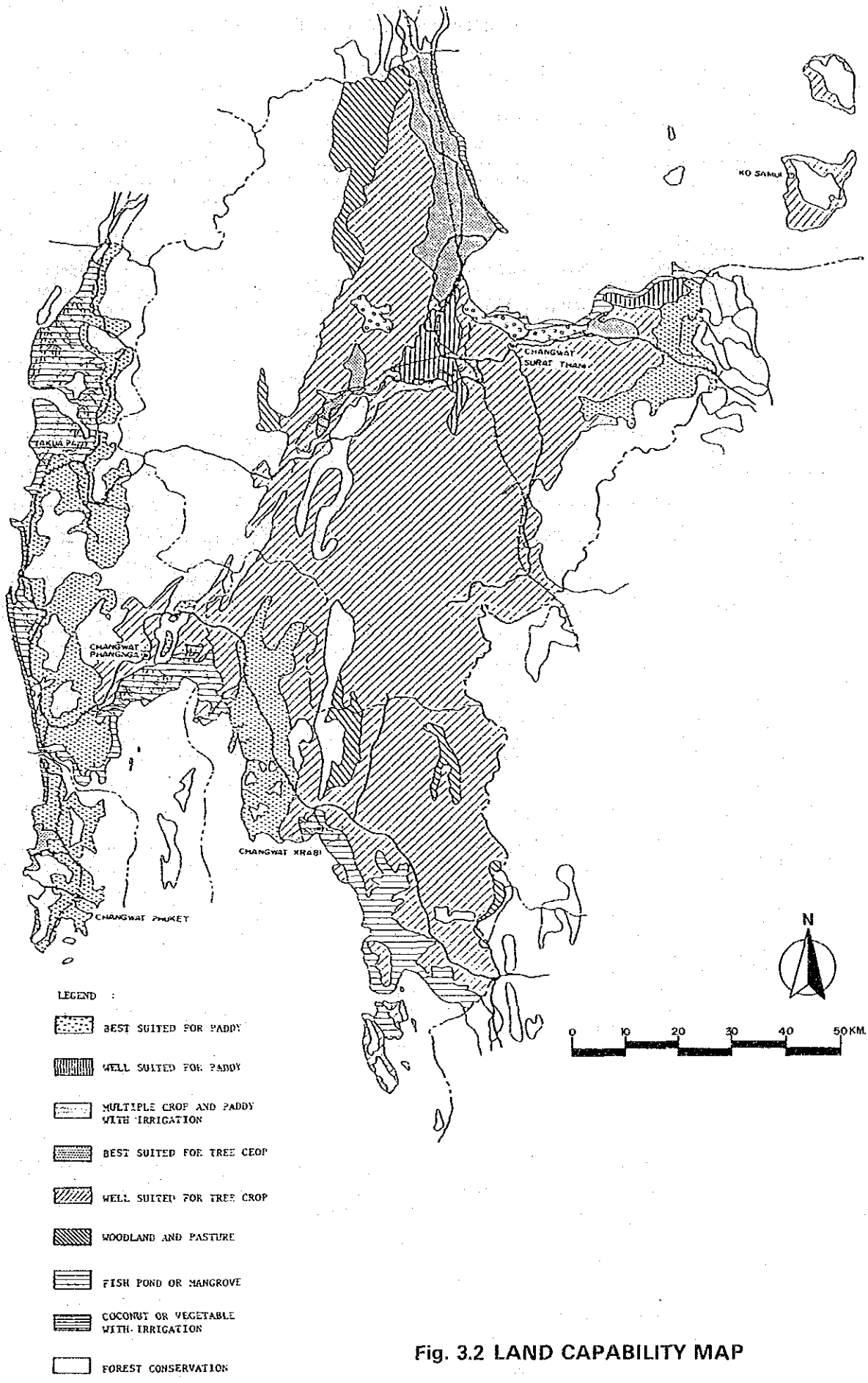


Fig. 3.2 LAND CAPABILITY MAP

Source: DLD

Table 3.2 CHARACTERISTICS OF MAPPING UNIT

Mapping Unit	General Description of Soils	Recommended Land Use	Major Inputs Required
	AREAS WITH SOILS SUITED FOR PADDY (WET LAND) RICE		
6	Deep, level, poorly drained, clayey soils with moderate to high fertility.	Best suited for wetland rice in the rainy reason; with irrigation multiple crops of rice vegetables or other upland crops can be grown.	Ordinary fertilizer application and irrigation to maintain productivity; irrigation; suitable variety of rice.
7	Deep, level, poorly drained, clayey soils with low to moderately low fertility.	Well suited for wetland rice in the rainy season; with irrigation multiple crops of rice, vegetables or other upland crops can be grown.	Proper fertilizer application, irrigation, improved variety of rice.
10	Deep, level to nearly level, poorly drained, medium textured or loamly soil with low to moderately fertility.	Well suited for wetland rice in the rainy season; with irrigation multiple crops of rice, vegetables or other upland crops can be grown.	Suitable fertilizer application; irrigation; improved variety of rice; (drought may occur during period of little rainfall in the rainfed area)
	AREAS WITH SOILS SUITED FOR TREE CROPS IN HIGH RAINFALL ZONE		
12	Deep, gently sloping to strongly sloping moderately well to well drained, fine textured or clayey soils.	Best suited for various kinds of fruit trees (durian, rambutan, orange, mangosteen, etc.) beverage crops (coffee), industrial oil crops (oil palm, coconut) and rubber.	Ordinary fertilizer application to maintain soil fertility; use of some erosion control measures on sloping soils such as cover crops, terracing, contour cropping, etc.
13	Deep to moderately deep, gently loping to strongly sloping, moderately well to well drained soils with low fertility and of humid zone.	Well suited for many kinds of fruit trees, beverage crops, industrial oil crops and rubber.	Proper fertilizer application; use of erosion control practices such as cover crops, terracing, contour cropping, etc.
	AREAS WITH SOILS GENERALLY UNSUITED FOR CULTIVATED CROPS		
15	Shallow, gently sloping to steep, moderately well to well drained gravely soils of the humid zone including areas with bedrock, laterite or stone near the surface.	Generally suited for rubber but best suited for woodland and pasture.	Proper fertilizer application, well prepared growing pit; use of erosion control practives such as cover crops, terracing, contour cropping, etc.
16	Muddy soils on tidal flat, prolonged deep flooding, regular flooding by sea water.	Not suited for any commercial crops, better maintained for woodland (mangrove) production or construction of shrimp and fish ponds in local areas.	Extensive improvement if being converted into cultivated land.
18	Deep, gently sloping, excessively drained sandy soils on beach or sandy terrace.	Not suited for cultivated crops except for pastures; but where water supply is adequate, water melon and other vegetable can be procuded on beach area. Coconut is well adapted.	Proper fertilizer application; irrigation or water conservation.
20	Shallow to deep, well to excessive drained, rolling to very steep soils of the hills and mountains.	Not suited for any commercial crops. Suited for woodland or establishment of watershed protective vegetation.	Not recommended to convert into cultivated land because it required very high input which will impair the environment.

Source : General Potential Landuse Map of South Thailand
Department of Land Development, Ministry of Agriculture and Cooperatives.

Table 3.3 LAND CAPABILITY OF UPPER SOUTH

Unit: km^2

	LAND CAPABILITY \ CHANGWAT	SURAT THANI	PHANGNGA	PHUKET	KRABI	TOTAL
CONSERVATION & LIMITED SUITABILITY	FOREST CONSERVATION (20)	4,522	1,614	133	363	6,632
	FISH POND OR MANGROVE (16)	99	897	27	551	1,574
	WOOD LAND AND PASTURE (15)	545	0	0	231	776
	COCONUTS OR VEGETABLE WITH IRRIGATION (18)	37	75	0	0	112
TREE CROPS	WELL SUITED FOR TREE CROPS (13)	6,301	350	0	2,886	9,537
	BEST SUITED FOR TREE CROPS (12)	359	1,235	383	645	2,622
PADDY LAND	MULTIPLE CROPS & PADDY WITH IRRIGATION (10)	533	0	0	33	566
	WELL SUITED FOR PADDY (7)	446	0	0	0	446
	BEST SUITED FOR PADDY (6)	50	0	0	0	50
	TOTAL	12,892	4,171	543	4,709	22,315

In ( ) indicate DLD Mapping Unit.

Source: - General Potential Landuse Map of South Thailand by Department of Land Development.

- Areas are measured by the Team..

Phangnga

Phangnga has the least cultivable land in the Upper South, accounting only for 38 percent of the changwat area. However, 47 percent of the area best suited for tree crops (Mapping Unit No. 12) belongs to Phangnga. Phangnga has considerable size of the land suitable for mangrove forest (Mapping Unit No. 16) which is endowed with large capability of fish culture.

Phuket

The area size of Phuket is only 538 square kilometers, but 75 percent of the island is classified as the area best suited for tree crops.

Krabi

The area of cultivable land accounts for 76 percent of the changwat, of which 99 percent belongs to the land suitable for tree crops. The capability for developing tree crops is estimated to be very high, associated with plentiful rainfall.

3.1.2 Landuse Guideline and Issues

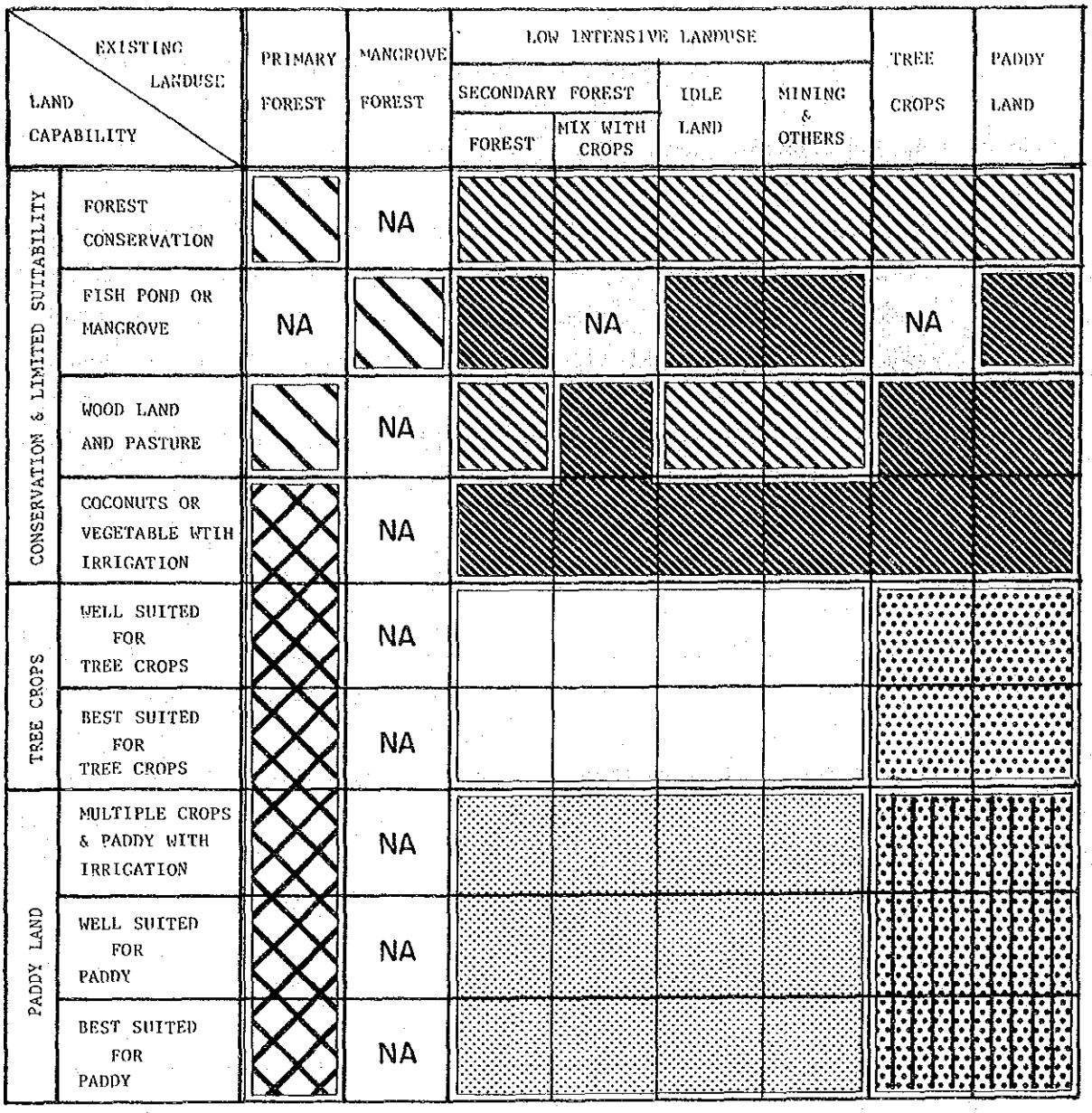
An evaluation chart was prepared by integrating the maps of existing landuse and land capability and potentiality of land development, as shown in Figure 3.3. The chart indicates eight categories of landuse for the future, which are briefly explained below:

1) Conservation

If an area belongs to the area requiring "erosion control and watershed protection" and its existing landuse is "primary forest", the area is defined as conservation area. "Mangrove area" is tentatively defined as conservation area, in consideration of its scarcity and the environmental protection.

2) Reforestation Area

In case a "conservation area" should be used for the other purposes, the area is defined as reforestation area for attaining erosion control and restoring watershed conservation function. If an area is used for secondary forest, idle land and the other low intensity land in spite of its suitability for wood land and pasture, the area is defined as



LEGEND :

: CONSERVATION

: REFORESTATION

: LAND REHABILITATION

: RESERVED FOREST

: TREE CROPS

: PADDY & IRRIGATION

: PRODUCT INTENSIFICATION (TREE CROPS)

: PRODUCT INTENSIFICATION (PADDY)

Fig. 3.3 EVALUATION OF LAND DEVELOPMENT

reforestation area, too. Forestry resource should be cumulated in this area.

3) Land Rehabilitation Area

This is the area of "poor potentiality" of landuse development. Production activities in this area should be carefully managed. Cropping on inclined plane, for instance, should be performed with erosion control/protection measures and due attention needs to be paid to the density of development. Irrigation and drainage system should be designed carefully to cope with salination problem for the agriculture on coastal plain. Maintenance system should be established not to cause erosion and environmental destruction along the coastal line.

4) Reserved Forest Area

If the existing landuse of an area is "primary forest" and its landuse capability belongs to "the area suitable for tree crops and paddy", the area is classified into this category. This area should be reserved for development in future as adjustable buffer zone with forestry. In recent years, extensive landuse area has been markedly invading into the area of this category, resulting in remarkable decrease of primary forest in the Upper South. Undisturbed forest of high potentiality is invaluable resource under these circumstances.

5) Tree Crops Development Area

This area is composed of "low intensity landuse area" in the categories of existing landuse and "the land suitable for tree crops" in the categories of land capability and thus it is "good or excellent" in potentiality of land development. In this area, farmland should be extended and productivity should be raised by promoting tree crop plantation.

6) Paddy and Irrigation Development Area

This area is categorized as the area that the existing "low intensity landuse" as idle land or secondary forest can be converted into "paddy land" through irrigation or farmland improvement in response to its land capability. Paddy land should be expanded and productivity should be raised by introducing semi annual cropping system in this area.

7) Product Intensification Area (Tree Crops/Paddy)

In this category, existing landuse of an area just corresponds with its land capability. Farming system and settlement have been established to some extent. Productivity should be raised by introducing irrigation and farmland improvement in paddy land. Productivity should also be raised by introducing high yielding varieties, fertilizers and farm management in tree crop land.

Based on the evaluation chart and the maps shown earlier, an evaluation map of land development has been worked out as shown in Fig. 3.4. Area/size of each category was measured on the map by changwat. The results are as shown in Table 3.4. The table indicates that 96 percent of "paddy and irrigation development area" and 68 percent of "paddy and intensification area" are centered on Surat Thani. 92 percent of "tree crops development area" and 78 percent of "intensification of tree crops area" are concentrated on both Surat Thani and Krabi. These facts suggest that the Central Lowland has very high potentiality of plantation development.

To develop the Upper South in line with the land use guideline, the following issues are very important especially from the viewpoint of development and conservation.

1) Primary Forest and Mangrove Forest

- A system should be established to control and manage illegal cutting and cultivation in the conservation area.

- The area suitable for forestry should be selected and designated in reserved forest and reforestation areas. At the same time, management system should be formulated for everlasting forestry.

- The area to be conserved in the mangrove forest should be specified and the realistic criteria for and against development should be established.

2) Secondary Forest

A proportionate green tract of land should be preserved in case of urban and rural development. The area of secondary forest should be delineated for its better utilization. In rural area, the secondary forest is an important source of firewood and charcoal, and in plantation area, it will help mitigate ecological inbalances caused by spread of monoculture such as oil palm. In reality, however, plantation area can

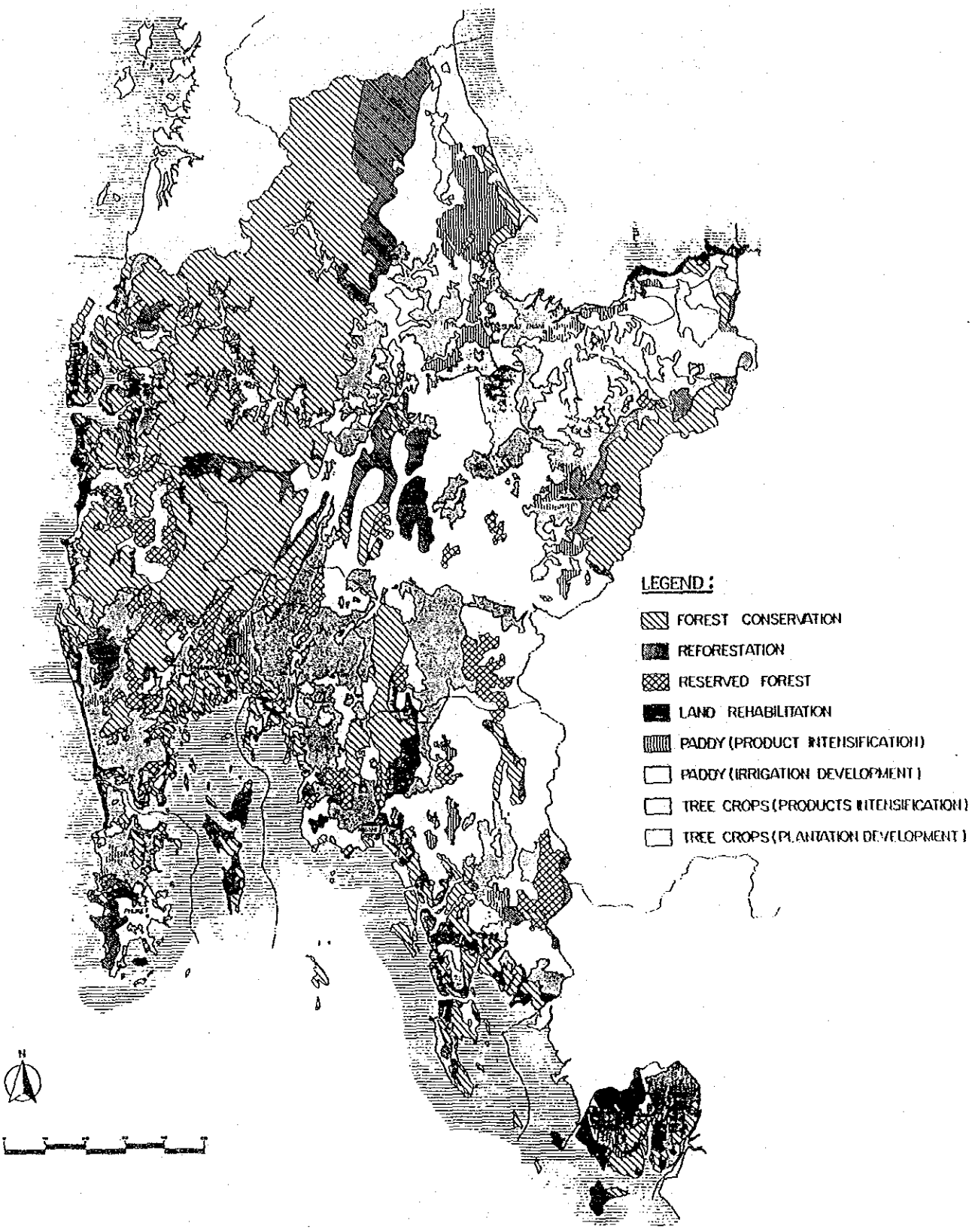


Fig. 3.4 EVALUATION MAP OF LAND DEVELOPMENT

Table 3.4 EVALUATION OF LAND DEVELOPMENT

Unit: km^2

TYPE OF DEVELOPMENT	SURAT THANI	PHANGNGA	PHUKET	KRABI	TOTAL
CONSERVATION	4,127 1/	2,120	75	721	7,043
REFORESTATION	1,159	224	75	116	1,574
LAND REHABILITATION	77	242	10	308	637
RESERVED FOREST	276	374	23	389	1,062
TREE CROPS PLANTATION DEVELOPMENT	3,929	397	135	1,846	6,307
PADDY & IRRIGATION DEVELOPMENT	546	0 2/	5	20	571
PRODUCT INTENSIFICATION (Tree Crops)	2,183	719	194	1,145	4,241
(Paddy)	595	95	26	164	880
TOTAL	12,892	4,171	543	4,709	22,315

Source: The Team

Note: 1/ Including 160 Sq. Km. of Flood Retarding Area of Tapi River.

2/ Excluding small scale irrigation development.

utilize 75 to 85 percent of the land for its specific purpose. The remaining portion will be used for attached facilities such as living space, infrastructure and green tract of land. An appropriate method of managing and utilizing the secondary forest should be elaborated in each case of development.

3) Plantation Development Area

The size of area and accessibility should carefully be studied for developing tree crop plantation area:

Large-Scale Plantation Area

The location of large-scale plantation depends on land availability and accessibility. The land which has a possibility of large-scale development is characterized by low population density and inferior accessibility. Providing access to such isolated, under developed areas will merely lead to unplanned scattered settlements, thus resulting in the increased difficulty in securing areas for large-scale plantations. The development process of rubber plantation area gives examples in this regard. Planning of access road should be integrated into development plan of large-scale plantation area.

Small-Scale Plantation Area

On the other hand, rural road development is a prerequisite for attaining product intensification and rural development in comparatively developed areas. Low intensity landuse areas such as the secondary forest mixed with crops and the idle land can be converted to intensive landuse area through the development of communication network, which will facilitate the diffusion of improved techniques to such areas and the transportation of product to market.

Irrigation Development Area

The same measures as just described in the above should be applied to this area, too. In addition, development of water distribution system is very important in irrigation. In the existing system, though primary and secondary canals are constructed and operated by public, tertiary canals are left to farmers in all respects. Farmers cannot afford to bear the expenses incurred by the development of tertiary canals and, eventually, the irrigation system as a whole remains unoperationable. If this way of development remains unchanged, measure to finance the farmers needs to be envisaged in combination with other measures such as organizing farmers cooperative

associations, improving financial system for small farmers, setting guideline on rice price and improving production method.

3.1.3 Projects

Better development and maximum utilization of land always go together with land preservation. It should be noted that the ecological balance in tropical rain forest is very sensitive and difficult to restore the original ecosystem. Bearing this in mind, two actions are proposed specifically, within the framework of the landuse guideline. One is Takua Pa Tin Mining Area Rehabilitation being a crucial land rehabilitation project and another is Central Low Land Development being a massive tree crop development program.

1) Takua Pa Tin Mining Area Rehabilitation

Land rehabilitation is very important especially in Takua Pa Area. The rehabilitation would turn the waste land into the productive land. There is an appriciable case study which aims to indicate a "Development Guideline for Abandoned Mineland" focusing on Amphoe Takua Pa. Prepared by Oratai Aunskul, Department of Urban Planning, Chulalongkorn University, 1982. According to this study, the abandoned lands are divided into two categories; the tailing areas covered with high mound of earth sand and gravels, and the other is mining ponds. For the tailing areas, the Guideline recommends the following development approach/measures :

(1) Reforestation area: Environmentally critical areas such as mangrove forests and hilly terrains of watershed should be reserved and restored their original conditions as much as possible.

(2) Area suitable for agriculture: Alluvial plains which are more fertile than other areas should be developed for agriculture.

(3) Area suitable for grazing: The upland which is free from floods should be developed to be grazing area.

(4) Area suited for community expansion: The areas connected with Takuapa Municipality in which infrastructures are available should be developed for settlement area.

For the mining ponds, the Guideline recommends as follows:

(1) Fresh water fishery should be developed in the mining ponds which are not affected by the sea water.

(2) Saline water fishery could be developed in the mining ponds with the sea water access.

(3) The mining ponds in community expansion area can be reserved as water resources for fire fighting or pipe water purposes, in case that their water quality is sufficient enough.

These guidelines are mapped out as shown in Figure 3.5.

We appreciate the above measures for land rehabilitation policies and recommends to carry them out. The report, furthermore, said that the necessity of government coordination and help will entail establishing a budgeting system of the "Special Maintenance Fund", which could be collected from the mining concessionaires for implementation of land rehabilitation. We fully agree with this idea. Implementation of land rehabilitation in accordance with this Development Guidelines is expected to improve the errosion problems especially in the hilly watershed area. As it will reduce the siltation at the river mouth of Takua Pa, flood problems in the town area of Takua Pa will be alleviated simultaneously.

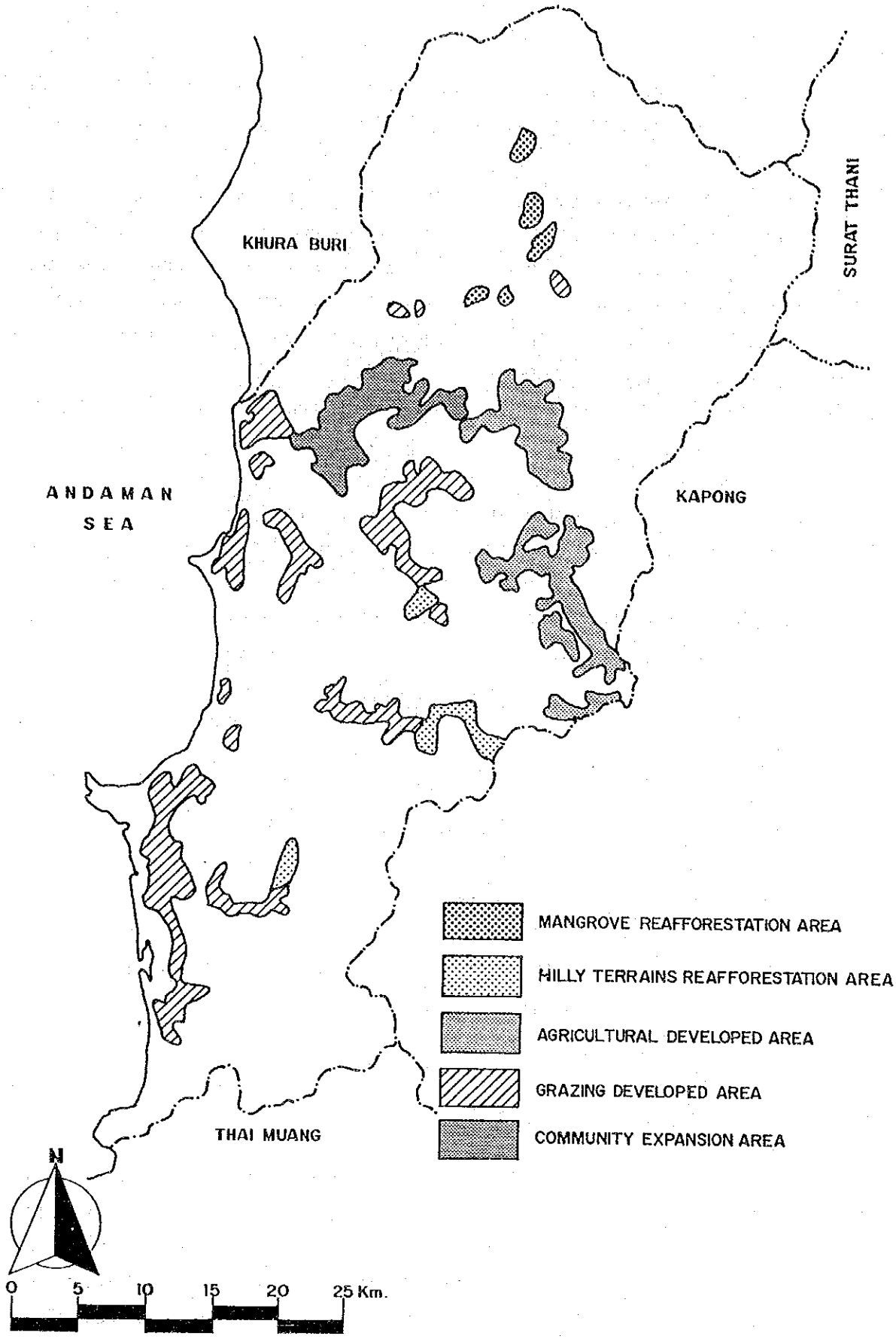
2) Central Low Land Development

(1) Oil Palm as Suitable Crop

As mentioned in the preceding section, there is a vast area suitable for tree crops development and its density of population is still low. Especially, a lot of areas with high potential for tree crops plantation are found to be in low intensity use in the so called "Central Low Land". In the Central Low Land, oil palm can be an advantageous crop from the land development point of view for the following reasons :

- The climatic and geological conditions, rainfall in particular are suitable for oil palm plantation.

- The areas with a certain coverage necessary for oil palm plantation exist only in the Central Low Land. The harvested oil palm needs to be extracted at factory within 24 hours and maintained in high quality. While the stable supply of raw material should



SOURCE: DEVELOPMENT GUIDELINE FOR ABANDONED MINE LAND
CASE STUDY : AMPHOE TAKUAPA, CHANGWAT PHANGNGA 1982. (by Miss Oratai Aunskul)

Fig. 3.5 DEVELOPMENT GUIDELINE FOR ABANDONED MINE LAND IN AMPHOE TAKUA PA

be assured for the factory, a feasible size of the factory is determined by the volume of harvests. Therefore, oil palm development calls for large-scale plantation.

In terms of implementation, there can be different types such as estate development and a contract system with farmers without entrepreneurship. In this study, the estate development is focused on in order to examine the reality of development from the land development point of view. Needless to say, some socio-economic issues should be carefully taken into account for the justfication of estate development.

Seven potential sites shown in Figure 3.6 have been identified based on the following criteria :

- Possibility of land preparation at a proper scale :
  As already mentioned, oil extracting factory needs to be located simultaneously. It is generally said that an area of 20,000 to 30,000 rai is necessary to make one factory feasible and that 12 to 15 kilometers is a maximum desirable distance between plantation areas and the factory.

- Possibility of good accessibility : The location of the oil extracting factory needs convenience of transport and good accessibility to service center.

- Appropriate distance between one and another sites.

(2) Two Types of Large Scale Estate Development

The existing oil palm estates are roughly classified into the following two types :

- Concentrated Type, and

- Scattered Type

In the concentrated type, an extracting plant is located together with the plantation estate of about 20,000 rai, while in the scattered type, the fresh fruit bunch (FFB) is gathered from scattered farms with the total area of several thousands to 10,000 rai into the extracting plant factory because of the lack of a unified large land. Needless to say, the former is easier to manage and more efficient than the latter, but the difficulty of land acquisition exists. Evaluating the sites from this viewpoint, the following can be identified :

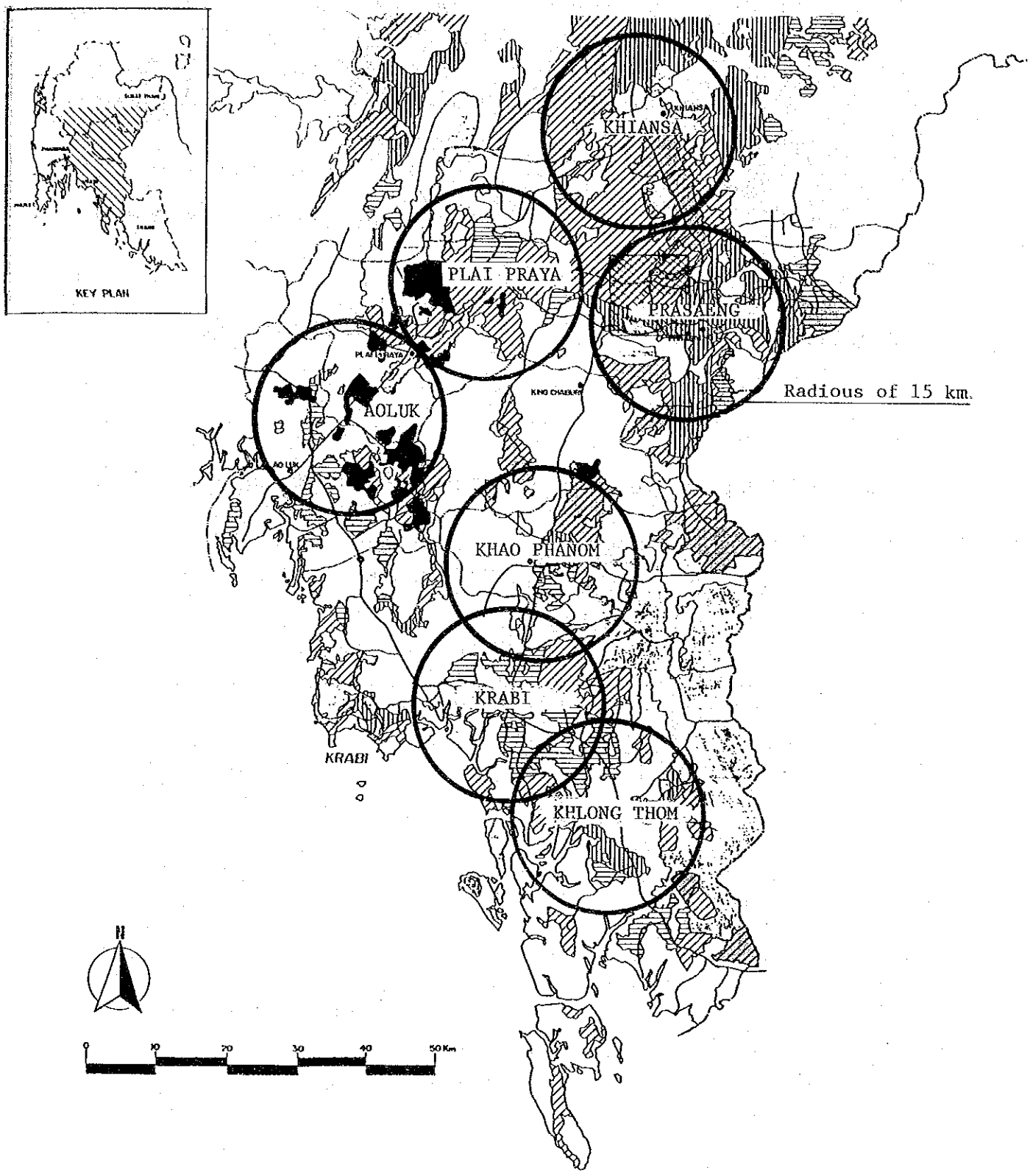
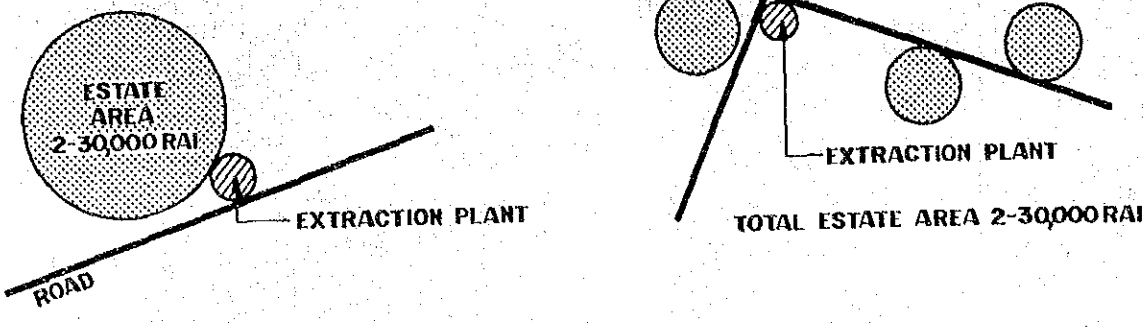


Fig. 3.6 PROPOSED SITE OF OIL PALM ESTATE



CONCENTRATION TYPE

SCATTERED TYPE

Table 3.5 POSSIBLE DEVELOPMENT TYPE OF OIL PALM ESTATE 1/

	Oil Palm Estate Development Potential	Possible No. of Nuclear Estate Development		Characteristics
		Concentrated Type	Scattered Type	
KHIANSA	Very High (355/565)	2	3-3	Largest available land
PLAI PRAYA	Very High (330/470)	2	2-3	Including existing estates
PRASAENG	Very High (330/510)	2	2-3	High potentiality and possibility of expansion in surrounding area
AOLUK	High (210/250)	1-2	1-2	More than half of area are already developed.
KHAO PHANOM	Low (50/270)	0	1	Possibly developed after year 2000, rubber plantation has more advantage.
KRABI	High (310/340)	1-2	2-3	High potentiality with good infrastructural advantage.
KHLONG THOM	High (205/335)	-	2-3	Potentially high but limited to develop scattered type.

Source : TUSP

Notes : 1/ In parenthesis numbers indicate (Area of rank I + II/Totals of Potential Area in square kilometers) Rank I and II means high potential of development. (Refer to Technical Paper.)

- In the sites of Khian Sa, Plai Praya and Prasaeng at least two estates of "Concentrated Type" will be able to be located;

- In the site of Krabi, one estate of concentrated type can be located, and if land acquisition is carried out smoothly, the development of two estates will be possible; and

- In the site of Kholong Thom, the possible development is subject to "Scattered Type".

The outcome from the above considerations is summarized in Table 3.5.

3.2 WATER RESOURCE DEVELOPMENT POTENTIAL AND STRATEGY

3.2.1 Water Resource Potential

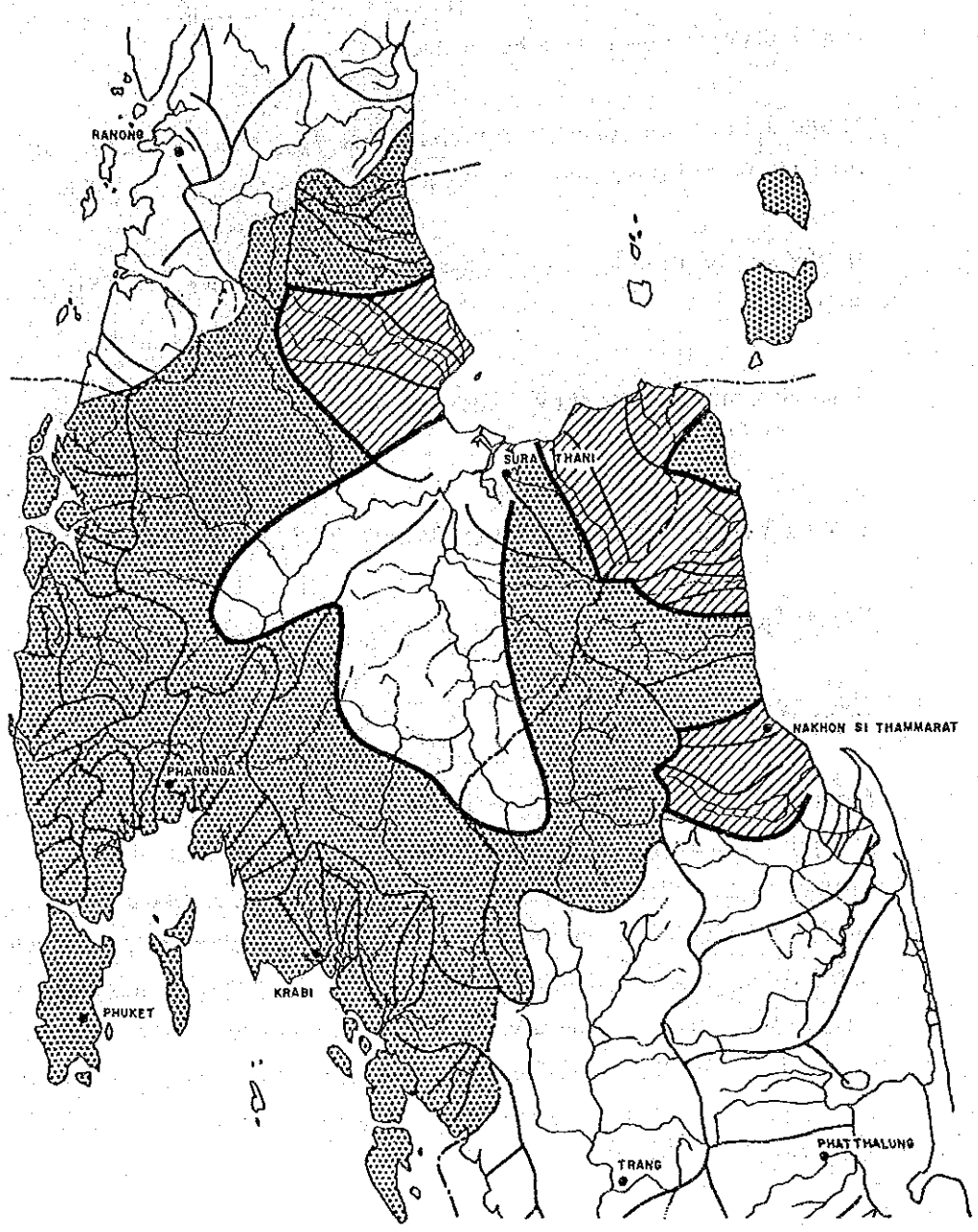
1) River Water

Figure 3.7 shows the potentially available volume of river water by river basin compiled from such materials as annual rainfall map, the water demand of both existing and future irrigation sites and the maintenance flow of river downstream. The Tapi-Phum Duang River Basin has water sufficiently available for additional utilization as the present level of utilization remains very low despite that the basin has ample volume of flowing water. On the contrary, the river basins situated in the north and the east Surat Thani have little available water for additional utilization as the water demand for existing irrigations far exceeds the possible supply. The other river basins fall between these two extremes.

It is estimated that reservoir construction can provide the Central Lowland with a large quantity of available water. In Takua Pa and Phangnga Districts, reservoir construction will make it possible to supply water of as much as 50,000 cubic meters per day. In Phuket Island, more than 50,000 cubic meters of water will be made available by construction of several reservoirs.

2) Groundwater

Information on groundwater in the Upper South is very limited as detailed groundwater studies have not been performed in the subregion. The potentially available volume of groundwater in each drainage system was estimated by referring to the in-



LEGEND

- High Potential Zone
- Limited Potential Zone
- No Potential Zone

NOTE

1) Water usage of over 5,000 m3/day is considered in this map.
2) The basin where water is used by irrigation more than the mean discharge is considered to have no surplus.
3) Chiew Larn Dam will offer the available water without changing the minimum flow in downstream.
4) The minimum downstream flow in dry season is considered necessary as maintenance flow.
5) Available site is considered to be within 15 km from river.

Fig. 3.7 AVAILABLE VOLUME OF RIVER WATER

formation obtained from existing wells and by presuming that the quantity of groundwater accounts approximately for 10 percent of the river water utilized. The estimated results are shown in Figure 3.8.

3.2.2 Demand and Supply Balance of Water

Water use is roughly divided into utilization of its energy (hydro-electricity) and consumption of itself (agricultural, urban and industrial uses). The consumption of water is steadily increasing due to population growth, upgrading of standard of living, the expansion of urban, industrial and agricultural activities. Water supply must be considered in relation to the water resource based on the condition that most of water stably flowing and easily taken, is utilized for agricultural use.

The total demand of water use is summarized in Table 3.6. Supply potential and balance is shown in Table 3.7. It is evident that a large amount of excess water is usable in Tapi-Phum Duang River Basin and water shortage is serious in Phuket Island. Though Surat Thani and Phuket have high potential in urban and industrial development, they are in clear contrast in terms of water.

3.2.3 Water Resources Management Strategies and Projects

Our regional development scenarios and plans were carefully studied from the viewpoint of water resource potentials and constraints as explained in the preceding sections. Through the study, the following five issues were found to be vital to the development of the Upper South :

- Management of the Tapi-Phum Duang Basin,
- Water supply in the Phuket Island,
- Water management of the Takua Pa River Basin,
- Water supply for urban and industrial areas, and
- Water supply for rural settlements.

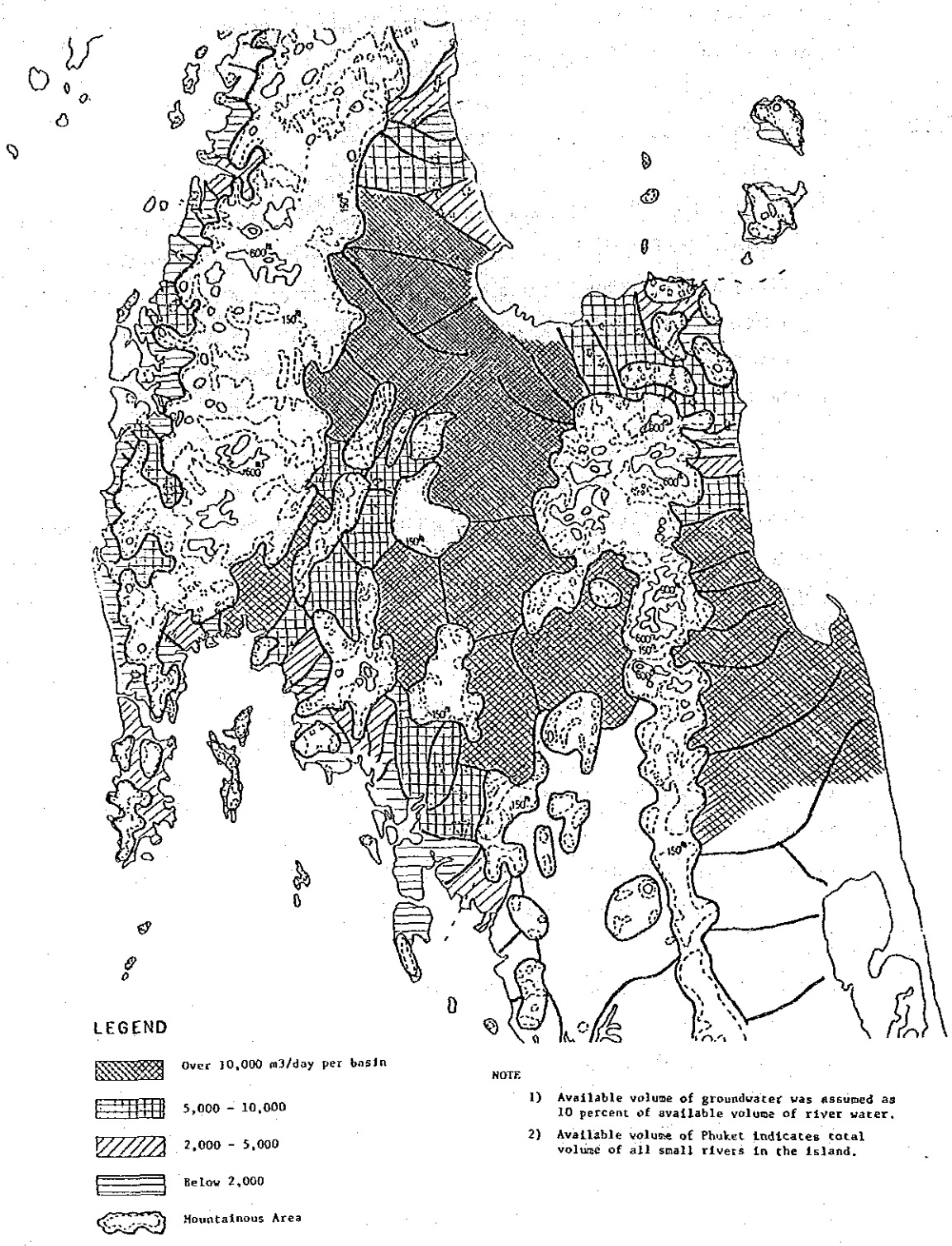


Fig. 3.8 POTENTIAL AVAILABILITY OF GROUND WATER

Table 3.6 ESTIMATION OF WATER DEMAND

Unit: m^3/day

Area	Use	Composite demand			Remarks
		to 1990	1990 – 2000	after 2000	
Surat Thani	urban		38,210	78,630	Intake from
	industry	13,250	26,500	28,000	Phum Duang and
	agriculture	250,000	850,000	1,100,000	Tapi
Sub-total		277,960	914,710	1,206,630	
Ban Na San		1,210	4,060	13,230	
Chaiya	industry	–	1,000	1,000	
	agriculture	410,000	410,000	410,000	
Sub-total		410,000	411,000	411,000	
Wiang Sa		–	1,000	1,000	
Phanom		–	1,000	1,000	
Phangnga	urban	1,210	3,180	6,720	
	industry	–	1,000	1,000	
Takua Pa	urban	1,270	3,300	7,640	
	industry	1,250	2,500	5,000	
Krabi	urban	3,900	9,240	17,680	
	industry	1,000	2,000 (7,000)	2,000	
Phuket	urban	12,250	37,590	71,810	
	industry	8,380	16,750	15,000	
Total		717,220	1,403,270	1,759,710	

Source: The Team

1) Management of the Tapi-Phum Duang Basin

The importance of developing Surat Thani has repeatedly been cited in our master plan. It is the water resource development of this basin that supports this. The phenomena mentioned below, however, constitute major obstacles to its development :

- The river side erosion is being intensified in the upstream of the river, resulting in continuous outflow of mud and silt;

Table 3.7 DEMAND AND AVAILABILITY BALANCE OF WATER

Unit: m^3/day

Area	Demand (after 2000)	Availability	Balance	Water Source
Surat Thani	1,206,630	4,000,000 *1	+	Phum Duang – Tapi River
Ban Na San	13,230	1,000,000 *2	+	Tapi River
Chaiya	411,000	84,000 *3	–	Takkian River, ground water
Wiang Sa	1,000	5,000 – 10,000 *2	+	Ground water
Phanom	1,000	10,000 *2,4	+	Ground water
Phangnga	7,720	30,000 – 50,000 *2	+	Phangnga River, ground water
Takua Pa	12,640	75,000 *2,4	+	Takuapa River
Krabi	19,680	30,000 – 50,000 *2	+	Khao Din River
Phuket	86,810	50,000 – 75,000 *2		Reservoir, supply from main land

Source: The Team

Note: *1 By average flow increasing (47 m^3/sec) of Chiew Larn Dam.
*2 Expected usable volume.
*3 Calculated by possible discharge of rainfall.
*4 Expected usable groundwater.

- The river has repeated meandering in the middle course, causing a number of scattered idle lands left alongside;

- The downstream area is exposed to frequent flooding in the rainy season and eventually a vast unused plain is remained subject to the flooding; and

- Siltation in the Ban Don Bay has continuously been progressed by the mud and silt transported through the Tapi and Phum Duang Rivers. This entails immediate siltation of shipping channels, resulting in a high cost of maintenance dredging.

To cope with these problems, the following measures are proposed to be taken for each section of the river stream :

Upstream and Middle course of stream

To promote aforestation, reforestation, terracing and cover cropping in the watershed area.

Downstream

To develop a bypass waterway and a diversion dike at the confluence of Phum Duang and Tapi Rivers for reducing floods, improving navigation in the downstream and improving salt and water balance in the delta area.

Chiew Larn Dam Project and Kaeng Krung Dam Project form important subsystem in this water resource management system.

Chiew Larn Dam Project had two major objectives at the initial planning stage, hydro power generation and irrigation of 96,000 rai at the downstream. The project, however, is now being implemented only for hydro power generation. The Phum Duang River, the biggest river in the South, has a vast catchment area. It is a very important issue in this area that water resource obtainable from the Phum Duang River should be fully utilized to attain as high yield of rice as necessary for self-sufficiency, and that water flow should be managed to allow future development of such cities located at its downstream. This project should be reassessed from every aspect and reformed into multipurposed.

Kaeng Krung Dam Project is designed for a hydro power generation, aiming its completion by 1991. This project should be designed in the same direction with the original plan, attaching more importance on irrigation.

2) Water Supply in Phuket Island

Water demand in Phuket Municipality and its outskirts is assumed to be about 54,000 cubic meters per day in 2000, according to our estimation. On the other hand, the Royal Irrigation Department foresees the 1992 water demand of about 18,000 cubic meters per day.

The most crucial factor in determining the water supply system of Phuket is to what extent water resource can be found in Phuket, considering both the water balance and the landuse efficiency of reservoir in comparison with other possible usage.

3) Water Management of the Takua Pa River Basin

The Takua Pa River Basin has the heaviest annual rainfall of 4,000 millimeters in the Upper South. At the same time, there are a number of both exhausted and operating tin mining sites, which reduced the water reserving capacity of land to a great extent. The riverbed were raised considerably owing to the continuous outflow of sand and silt from these mining sites. The area has repeatedly suffered severe flooding due to the combined effects of the phenomena mentioned above. On the other hand, the experience in tin mining for several decades helped accumulate metal working, small ship building, and other technologies in this area. Water management is a prerequisite condition for sustaining and diversifying the area's economic base.

Considering the above, it is proposed to designate Takua Pa as a "Prototype Zone of Small River Basin Management", with such measures as below:

- Restriction of development which will change the rate of effluent;
- Promotion of reforestation of the area characterized by high rate of effluent;
- Measures to restore and increase water storing and retarding functions; and
- Control and guidance of landuse development in the area of frequent flooding.

There are a number of medium and small rivers in the South. Flooding is often caused in these river basins by the heavy rain concentrated in short period. The experience of this area is recommended to be applied in these medium and small river basins.

4) Water Supply for Urban Areas and Industrial Estates

Along with the urban and industrial development strategies, a proper water supply system is crucial to be prepared. According to our estimation, the water demand for ubran and industrial use in the Upper South in 2000 is assumed to be about 123,000 cubic meters per day, of which abnout 86,000 cubic meters should be provided for residential/business use and about 37,000 cubic meters for industrial use.

For supplying the water of about 65,000 cubic meters per day required by the Surat Thani Metropolitan Area, Tapi-Phum Duang River can adequately be utilized. However, for supplying water to the urban areas of Phangnga Bay Area, several ideas are necessary such as development of small and medium reservoirs and effective

utilization of small and medium rivers and underground water under a proper control.

5) Water Supply for Rural Settlement

In most of sanitary districts of rural centers, the water supply system with supply capacity of around 300 to 500 cubic meters per day is developed under the responsibilities of Ministries of Interior, Industry and Health as well as sanitary districts themselves. However, the actual service level (percentage of households supplied by piped water) seems to be no more than 50 percent judging from our field survey.

As mentioned in the Fifth Five-Year National Health Development Plan, the purified water supply is vital to promotion of public health. It is desirable to establish the rural water supply system in all rural areas.

Furthermore, development of oil palm plantation is proposed in the Central Lowland stretching from southern part of Surat Thani to Krabi. The area of 6,000 square kilometers in the Central Lowland is estimated to be the unused cultivable land suitable for rubber and oil palm plantation, since the area of 2,300 square kilometers can be developed as oil palm plantation at the maximum. The population related to this project is estimated at approximately 30,000 who can live in the new settlements here. Water supply to these population is an essential condition to make this project viable.

3.3 AGRICULTURAL POTENTIALS AND STRATEGIES

The agriculture is the basic sector in the Upper South. It absorbs 70 percent of employment and will absorb 50 percent even in the year 2000 when the Upper South is, as proposed, more urbanized and industrialized. The Upper South is not homogeneous in production-mix, reflecting divergence in topographic and climatic conditions. Surat Thani produces mainly rubber, rice, coconut and fish. Krabi produces rubber and oil palm. Phangnga together with Phuket produces rubber, woods and fish. Low intensity agriculture prevails and thus causes the problems of disordered land use and low productivity. The rural economy has been unstable due to its dependence on limited number of crops, rubber in particular. However, the Upper South has been able to turn itself off the problem of soil deterioration associated with intensity agriculture. This contributes a lot to the great potentiality in land expansion for oil palm as well as yield increase in rubber.

3.3.1 Production and Market Potentials of Major Products

1) Rubber

Rubber production occupying 60 percent of existing farm land at present is a major potential. Market condition for the Upper South rubber will be good in long term since (1) world rubber consumption which expanded at 4.3 percent annual rate will increase further due to spreading motorization, (2) the share of national rubber has been recovering since 1979 and this trend will continue with declining price competitiveness of synthetic rubber and increased use of radial tire, (3) Malaysian natural rubber production which shares 40 percent of the world total will reach a saturation point due to land constraints and a high yield already attained and (4) domestic demand for rubber products will expand.

Production increase will be attained through yield increase rather than area expansion. Rubber yield in the Upper South is 60 kilograms per rai at present, and it is as low as one-third of the yield in estates and half of that in small-holdings in Malaysia. A yield of 300 kilograms per rai has already been attained in field stations in the South. Size of existing rubber planted area has already reached the area identified as suitable for rubber production from the viewpoint of land capability. In fact, rubber replantation has been rapid enough to realize an ambitious target set by Office of Rubber Replanting Aid Fund (ORRAF) 10 years ago.

2) Oil palm

Oil palm is another major potential crop showing a very rapid growth in the past decade. In the country, vegetable oil consumption will increase though it is not self-sufficient because of increasing but low level of per capita vegetable oil consumption which is five kilograms per year. Price competitiveness of palm oil is strong over other sources of vegetable oil such as soybean. Vegetable oil is predicted to be self-sufficient after the early 1990s. Export market is large enough since production volume of Thailand which is 77,000 tons per year in 1982 is only 0.3 percent of the world export market of palm oil in which Malaysian palm oil accounts for more than half. The world palm oil consumption is predicted to increase at about eight percent per year as in the past if not more than that. Particular attention should be paid to a large and rapidly increasing palm oil import of the Middle East and South Asian countries to which Upper South will have direct access. In 1979, India and Pakistan alone imported about 30 percent of the palm oil in the world trade market. There is a vast unused land suitable to oil palm plantation in the Central Lowland of the Upper

South. This can be a main center of oil palm plantation with government support in streamlining land development and providing financial incentives.

3) Rice

Rice is important in the Upper South as well especially for people's subsistence and employment since 61 percent of farm holdings are engaged in rice production though it occupies only 16 percent of farm land. Rice cultivation in the downstream of the Tapi-Phum Duang Rivers has high potential to increase its productivity. Most of the scattered rice fields on upland, however, have limited potentials because they are cultivated mainly by rubber planters for the purpose of their subsistence despite that their lands are not suitable for rice cultivation. Since present rice self-sufficiency is estimated only at 63 percent in the Upper South, it is desired and possible to intensify the rice cultivation particularly in the downstream of Tapi-Phum Duang River.

4) Coconut

The Upper South has 990,000 rai of the land suitable for coconut compared to the existing coconut field of 382,000 rai. However, coconut trees in the Upper South are old and coconut fields are not maintained in good condition partly due to low saling price. While yield can be increased from 214 kilograms per rai at present up to 267 kilograms per rai according to the previous South Thailand Regional Planning Study, there is a prospect in the expansion and multiuse of the land covered with coconut trees for preserving the land which are not suitable for either rubber or oil palm and for increasing the cash income opportunities of small farmers.

5) Other Tree Crops and Fruits

The Upper South is specialized in production of various tropical tree crops, including cashew nuts, sataw, rambutan, coffee, lancet durian, jack fruit and tangerine. Production of cashew nuts reaches 47 percent of the national total, sataw 38 percent and rambutan 20 percent. Urbanization of the country will increase the demand for these crops and fruits. Tourism and urban development in the Upper South will offer another market for these and other crops, including fresh vegetables.

6) Livestock and Forestry

Livestock production has been declining due to rising feeds cost and little government emphasis given to the South in favor of the Northeast. However, the South, including

the Upper South has livestock potential especially for export because the region is desease free, easily accessible to nearby importing countries and space and yield of pasture are more than adequate.

Although the Upper South has been a major forest production area, firewood in particular, it is feared that timber production will cease to exist in the coming five to 10 years since accessible forests have mostly been cut for lumber and fuel production. However, forestry industry should be maintained at least at the present level for the purpose of maintaining a base resource of wood industires and environmental balance. Reforestation is necessary in this regard particularly in the southern part of Phangnga, the area between Takua Pa and western part of Surat Thani, and the northern part of Surat Thani.

3.3.2 Strategies (see Table 3.8 also)

The agricultural sector should endure long and give support the process of regional industrialization. However, the pattern of production in the past will not be able to hold as an indication is observed in the forest production. In future, agriculture and industry will need to have closer relations such as those through supplying industrial materials and encouraging multiple and recyclic use of agricultural resources and materials by introducing industrial technologies. Bearing these in mind, the agricultural sector is required to change the current pattern of resource exploiting production into a pattern which is more ecologically balanced and stable. Important strategies include :

1) Acceleration in the rubber production through yield increase and the oil palm production through both planned expansion of land and yield increase. Towards the year 2000, we expect the yield to increase up to 180 kilograms per rai at the rate of 6.6 percent per annum which is the average increase experienced in Malaysia during the period 1955 to 1979. Horizontal expansion of rubber plantation is proposed to take place no longer since the rubber planted area of 1,943,000 rai in 1977 already exceed the area of 1,940,000 rai which is identified suitable to rubber plantation. This target entails the replantation of 65,000 rai per annum and production of 5.2 million nurseries per annum. Annual target of replanation is more or less same as the currently practiced level but current nursery production by ORRAF of about 500,000 per annum is far below the target. Although a substantial number of nurseries seem to be produced by private according to ORRAF specification, their quality is not necessarily satisfactory to the government policy to replace old trees by high yielding variety. A special emphasis needs to be given to the increased production and diffusion of

nursery stock.

2) Diversification of crop and multiple use of farm lands for maintainig soil in good condition and stabilizing income of small farmers. Rubber plantation has high potential for multipurpose and recyclic use of resources such as mushroom cultivation on waster rubber trees, diversification of intercropping, use of rubber seeds as a biomass energy source and furniture production using waster rubber trees. The multipurpose use of the land under coconut trees would include beeculture, pasture raising and production of mushroom, cacao and pepper. As coconut fields will expand, coconut production will increase to expand and diversify coconut-based industries such as production of copra, active carbon, coconut fiber and furnitures. In the rice irrigation area, it is recommended to improve soil condition by introducing bean crops as the second crop and to promote experimentation and diffusion of methods of planting, breeding, manuring and preventing insects.

3) Achievement of rice self-sufficiency by expanding the irrigation capable of dry season cultivation. Use of Chiew Larn and Kaeng Krung Dams for irrigation will make it possible to convert a part of the present single cropping area into double cropping area. The share of double cropping area will be increased from percent to 21 percent in the year 2000. Yield of rice which is 317 kilograms per rai will increase up to 613 kilograms per rai. Field stations have achieved a yield of 675 kilograms per rai in the northeast and 1,350 kiLograms per rai in the Central. With some expansion of total rice field area from 505,000 to 646,000 rai, rice production in the year 2000 will reach about 396,000 tons which is nearly sufficient to meet the rice consumption estimated at 420,000 tons even if per capita rice consumption does not change.

4) Development and accumulation of tropical agricultural technologies and resources, seeds in particular, based on diversified natural conditions in the Upper South and promotion of efficient, diversified and recyclic use of agricultural resources through positive introduction of processing technologies and biotechnologies. Horticulture research center, which is now under construction in Surat Thani, is recommended to be improved and expanded to conduct research of overall agriculture in the region such as cultivation method, introduction of crops and utilization and processing of farm products. The center should foster many local specialists and invite some from the other countries to research overall tropical agriculture toward the 21st century. Wild species of tropical crops should be collected and preserved to provide for future hereditary diversification of tropical crops. The foundation of a botanical garden can be conceived for this purpose. Also, this can be a tourist spot. A branch of the research center is recommended to be set up in all the provinces under different

Table 3.8 AGRICULTURAL DEVELOPMENT STRATEGIES BY CROP

CROP	STRATEGIES
I Rice	a) Increase of production To expand cultivation area. To improve irrigation facilities. b) Increase of yield To research on cropping pattern, breeding, method of fertilizer application and disease and insect control, etc. c) Introduction of off-season crops. To introduce legume to improve soil fertility and other crops.
II Rubber	a) Increase of Yield To research on breeding of high-yielding clone and disease and insect control, etc. To increase production and expansion of high-yielding clone. To introduce cover crops to improve farm management and soil fertility. b) Utilization of waste trees To research on utilization of waste rubber trees as timbers (furniture, etc.). To use for mashroom culture. c) Utilization of rubber seed To use as an energy resource by biomass, etc. d) Introduction of inter crop To research on breeding and cultivation method of pineapple. To introduce other crops.
III Oil Palm	a) Increase of yield To introduce cover crops. To research on breeding and cultivation technique. To introduce bee keeping (To accelerate pollination) To produce high yield nursery stock and its expansion. b) Increase of production To expand planted area. To arrange estate. c) Utilization of oil palm cake Ex. feed, organic fertilizer, biomass, etc.

CROP	STRATEGIES
VI Forestry	a) Increase of yield and production To expand planted area. To introduce high-yielding variety. b) Introduction of mixed crops Ex. beekeeping, pasture, mushroom cultivation, cacao and pepper, etc. c) Expansion and diversification of coconut-based industries. Ex. copra, active carbon, coconut fiber and furnitures, etc. Utilization of coconut cake.
V Others	a) Increase the cash income opportunities for small holder To diverse and encourage vegetable and fruit culture for self-support and local market. To encourage vegetable cultivation in Phangnga and Phuket for tourists. b) Introduction of crops to diverse crop for small holder
IV Coconut	a) Acceleration of reforestation To increase production of nursery stock.
VII Livestock	a) Encouragement of cattle production To introduce pasture under coconut tree. b) Improvement of disease control

natural conditions. Activities of the branches include demonstration, training for farmers, production of seeds and nursery stock, planning of reforestation and making manuals for diffusion of technique.

5) Establishment of network for agro-products distribution and processing. In order to promote agricultural development, it is indispensable to organize farmers into cooperatives to strengthen their credit in the agricultural market. The campaign for organization of farmers, which is proceeding positively, is desirable to be encouraged further and through this campaign, a consistent system from production to shipment is needed to be established and agro-products centers are proposed for this purpose. In order to add value to the products, this center functions as factories with capability of primary/secondary processing. This center is recommended to be located at several places to cover the hinterlands in cosnideration of convinience of transport. We propose seven sites in the Upper South, including Chaiya, Wiang Sa, Phanom, Phangnga, Ao Luk, Krabi and Phuket.

3.3.3 Production Targets

Based on the production and market potentials and the strategies described above, agricultural production targets are set as shown in Table 3.9.

3.4 FISHERIES DEVELOPMENT

3.4.1 Potentials

1) Resource Conditions

Figure 3.9 indicates trend of marine fisheries production in recent years in Thailand. At first, it has to be noted, from resource conditions point of view, that composition of so called "trash fish" is the highest (40 to 50 percent) in total catch. Although figures show some increase of production during the period 1981 to 1982, production of fish usable for human direct consumption has been continuously decreasing since 11977. The resource conditions in Siam Bay as well as the coastal water in Andaman Sea seem to be a stage of over exploitation. Maximum Sustaining Yield (MSY) in the area is estimated at around 800,000 tons, including pelagic species. Consequently, large amount of fish is supposed to currently be caught in the areas outside of Siam Bay and coastal area in Andaman Sea.

Although marine fisheries production unloaded in the Upper South accounted for

Table 3.9 AGRICULTURAL PRODUCTION TARGETS IN UPPER SOUTH

	Products	1980	2000	Annual Growth Rate: 1980-2000
Land (000 rai)	Total	3,216	4,600	1.8
	Rice	505	646	1.2
	Rubber	1,937	1,940	0.0
	Oil Palm	172	984	9.1
	Coconut	382	686	3.0
	Fruit and other crops	219	344	2.3
Production (000 ton)	Total	1,091	2,139	3.4
	Crop subtotal	436	1,440	6.2
	Rice	160	396	4.6
	Rubber	98	349	6.6
	Oil Palm (FFB)	186	2,570	14.0
	Coconut	75	183	4.6
	Fruit and other crops	26	39	2.0
	Livestock	23	38	2.7
	Fishery	162	162	0.0
	Forestry	470	499	0.3

Source: The Team

only one tenth of total production in Thailand or 175,000 tons in 1982 (see Table 3.10), the area has the following advantages in regards to marine fisheries for further development:

(1) Access to good fishing grounds around Ko Samui and other islands which are known as the best fishing grounds for shrimp and pelagic species like indo-pacific mackerel (Rastrelliger neglectus);

(2) Access to fishing grounds for pelagic species in Andaman Sea;

(3) Access to international fishing grounds for deep sea fishing in Indian Ocean.

In the meantime, the coastal areas in the Upper South, especially, Ban Don Bay, Phangnga Bay, Kantang and Krabi, have big potentials for the development of coastal aquaculture in terms of oceanographic and geographic conditions and productivities. Considering that environmental pollution is prevailing to some extent in the northern part of coastal areas along Siam Bay, the Upper South has big advantage for aquaculture development. Freshwater fish production in the Upper South (Table

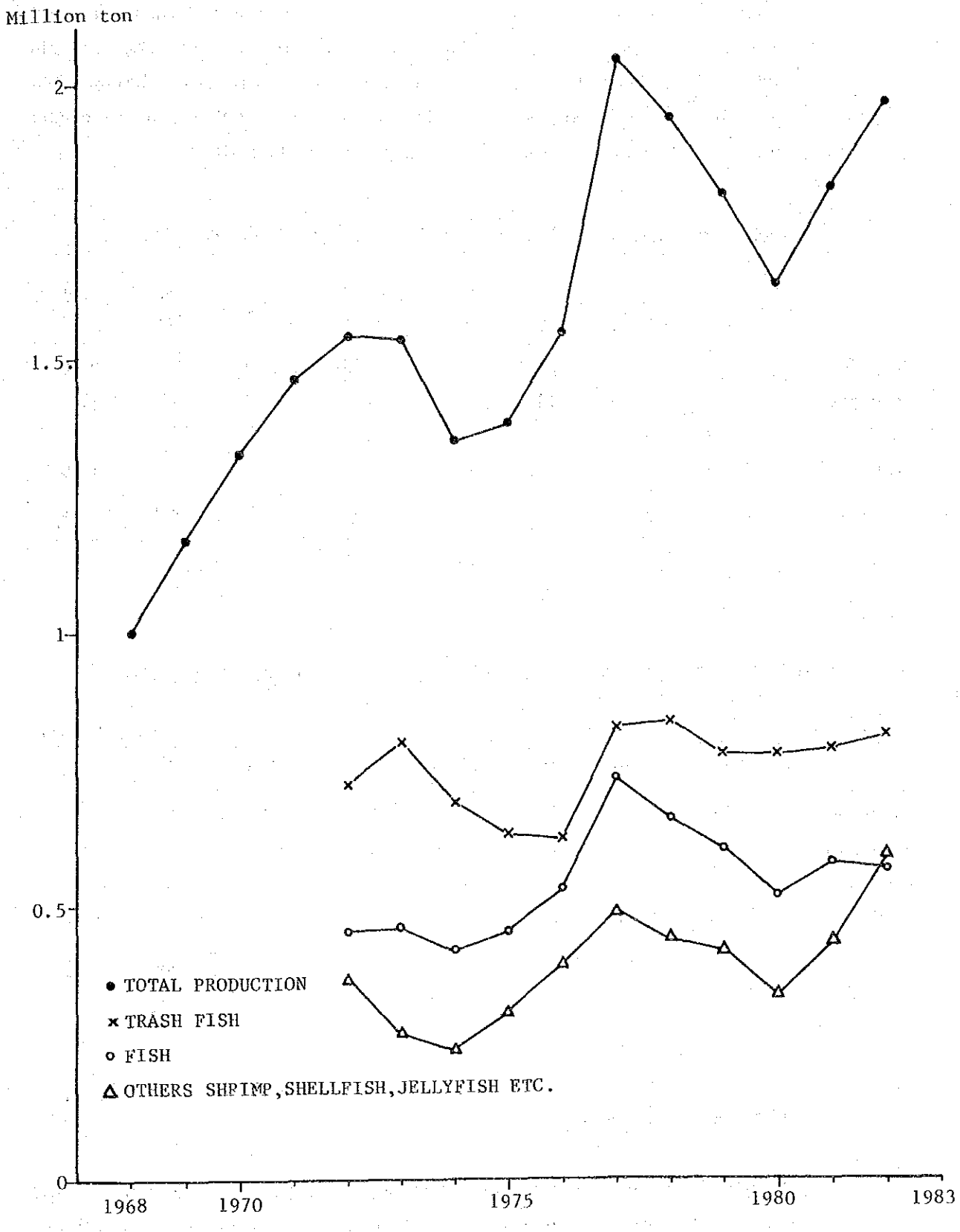


Fig. 3.9 MARINE FISHERIES PRODUCTION IN THAILAND

3.11) accounted only for three percent of total production in Thailand in 1982. Thailand produced 133,562 tons of freshwater fish according to the fisheries record in 1982. However, more than three times of volume of fish are supposed to be consumed on subsistence basis. However, there are some prospect and potential for freshwater fisheries and culture after the commissioning of Chiew Larn Dam.

Table 3.10 MARINE FISHERIES PRODUCTION IN UPPER SOUTH

Unit: 1,000 t

	1975	1976	1977	1978	1979	1980	1981	1982
Surat Thani	32.5	38.2	50.2	100.1	97.0	80.6	81.9	98.4
Phangnga	2.1	9.6	11.1	17.2	16.0	14.7	13.3	18.6
Phuket	23.2	31.3	41.8	32.2	46.0	50.5	47.7	43.8
Krabi	3.4	4.5	11.8	12.7	11.6	11.5	15.3	14.8
Total	61.2	83.6	114.9	162.2	170.6	157.3	158.2	175.6

Source: Department of Fisheries

Table 3.11 FRESH WATER FISHERIES PRODUCTION IN UPPER SOUTH

Unit: 1,000 t

	1975	1976	1977	1978	1979	1980	1981	1982
Surat Thani	1.96	2.15	1.97	2.67	2.98	4.01	4.72	2.95
Phangnga	0.07	0.07	0.19	0.16	0.43	0.77	0.25	0.57
Phuket	0.09	0.25	0.17	0.09	0.07	0.04	0.04	0.03
Krabi	0.01	0.01	0.01	0.03	0.09	0.05	0.05	0.07
Total	2.13	2.48	2.34	2.95	3.57	4.87	5.06	3.62

Source: DOF

2) Fish Demand and Supply

In spite of population growth in the Upper South at 2.5 percent per annum, it is supposed difficult to expect the increase of marine fish products keeping pace with the growing demands due to decline of marine resources as discussed previously. Figure 3.10 shows estimated diagram of fish supply and their distribution in the Upper South. Among the fish landed in the area, most of trash fish is supposed to be pro-

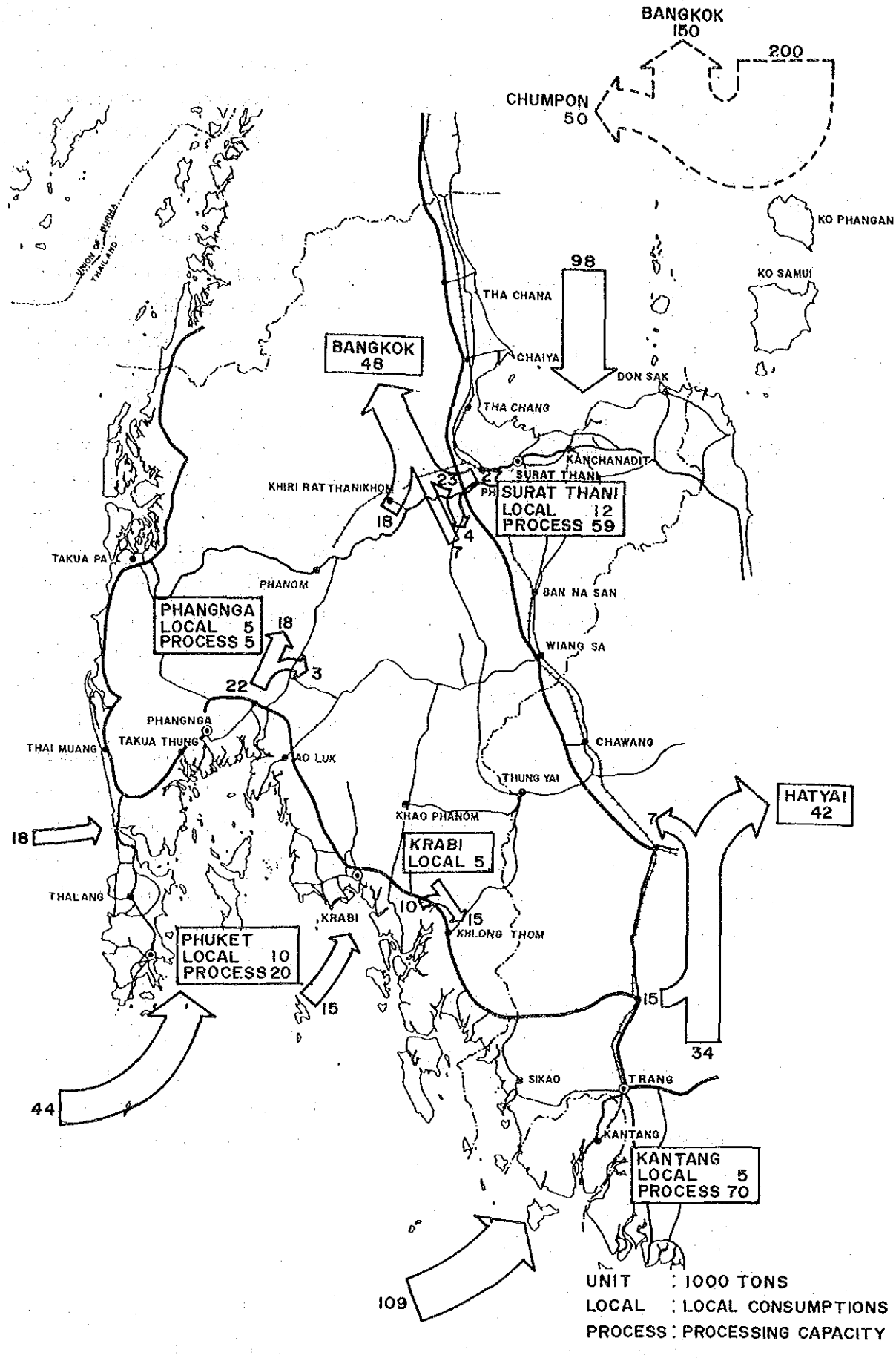


Fig. 3.10 FRESH FISH SUPPLY AND DISTRIBUTION (PRESENT)

cessed at fish meal factories located in Surat Thani, Phuket and Kantang. However, a large amount of fish, especially pelagic fish, are currently transported to Bangkok or Hat Yai because of the lack of factories to properly process fish for human consumption.

Although there are processing factories in the Upper South, most of the factories are cottage industries such as those producing shrimp paste and dried shrimp (see Table 3.12). Large fish processing industries are presently concentrating in Samut Prakarn, Samut Sakon and Samut Songkhram, which are also shown in Table 3.12 for comparison.

A large number of fishing boats engaged in pelagic fisheries are stationed at fishing ports along Andaman Sea. However, a careful attention should be paid to the development of purse seining to exploit pelagic resources and to fully utilize fish unloaded. As fish catch using purse seine is fully dependent on characteristics of fish schools and fishing technologies, the volume of catch fluctuates daily and seasonally. In addition, the pelagic species are generally easy to deteriorate compared with demersal species. Therefore, the facilities to properly process the catch is needed for the full utilization of resources. It is rather difficult, however, to set appropriate capacity of factory to be located near producing area due to the fluctuation of fish supply. This is why the processing factories for these kinds of species are presently located at large-scale fishing centers such as Samut Sakon and Samut Prakarn where fish can be collected throughout the year from various producing areas. In this situation, some amount of sardine (Sardinella spp.), even though they still have good value for human consumption, are currently utilized for materials of fish meal because of the lack of suitable facilities to process them at producing area.

These fish businesses are historically handled by middlemen in the area similarly with other areas in Thailand. The middlemen have also tied up small-scale fishermen by means of the provision of credits for daily use to collect fish catch at rather lower price. Recently, the businessmen being connected with big fishing companies located in Samut Prakarn, Samut Sakon, etc. started fish transaction business in the Upper South.

3.4.2 Fisheries Development Strategies

In the Upper South fisheries development has to be divided into the following two categories in terms of extent of necessities of governmental assistance:

Table 3.12 NUMBER OF FISH PROCESSING FACTORIES, COLD STORAGES AND ICE PLANTS, 1982

	Canned Fish	Fish Souce	Fish Meal	Shrimp Paste	Salted Fish	Dried Shrimp	Dried Squid	Dried Mussel	Steamed Fish	Smoked Fish	Fish-Shrimp Cracker	Fish Ball	Budu Sauce	Cold Storage	Ice Plant
Whole Kingdom	24	96	94	2,337	676	301	826	1,262	147	170	8	52	35	41	146
Samut Prakarn	7	18	11	13	10	2	10	90	1	-	1	3	-	8	7
Samut Sakon	7	12	11	25	70	15	30	228	-	5	3	6	-	11	9
Samut Songkhram	-	15	3	150	30	3	5	504	33	3	-	-	-	1	3
Upper South															
Phangnga	-	-	-	440	-	19	-	18	-	2	-	-	-	-	2
Phuket	1	-	2	-	1	-	-	-	-	1	-	2	-	-	5
Krabi	-	-	-	544	87	52	-	-	-	146	-	-	-	-	2
Surat Thani	3	3	4	34	13	22	32	-	2	-	-	2	-	5	7
Trang (Kantang)	1	-	5	9	5	-	2	-	5	2	-	-	-	2	6
Upper South Total	5	3	11	1,027	106	93	34	18	7	151	-	4	-	7	22

Source : DOF

(1) Coastal aquaculture and fisheries development;

(2) Marine fisheries development.

1) Coastal Aquaculture and Fisheries Development

Most of fishermen in Thailand are categorized into small scale fishermen operating at coastal area. However, living standards of these fishermen have been declining due to the scarcity of marine resources. On the other hand, coastal areas in the Upper South have a large potential for aquaculture development. Coastal aquaculture requires rather heavy investment and technical cares. Small scale fishermen can not, therefore, diversify their job to coastal aquaculture without governmental assistance.

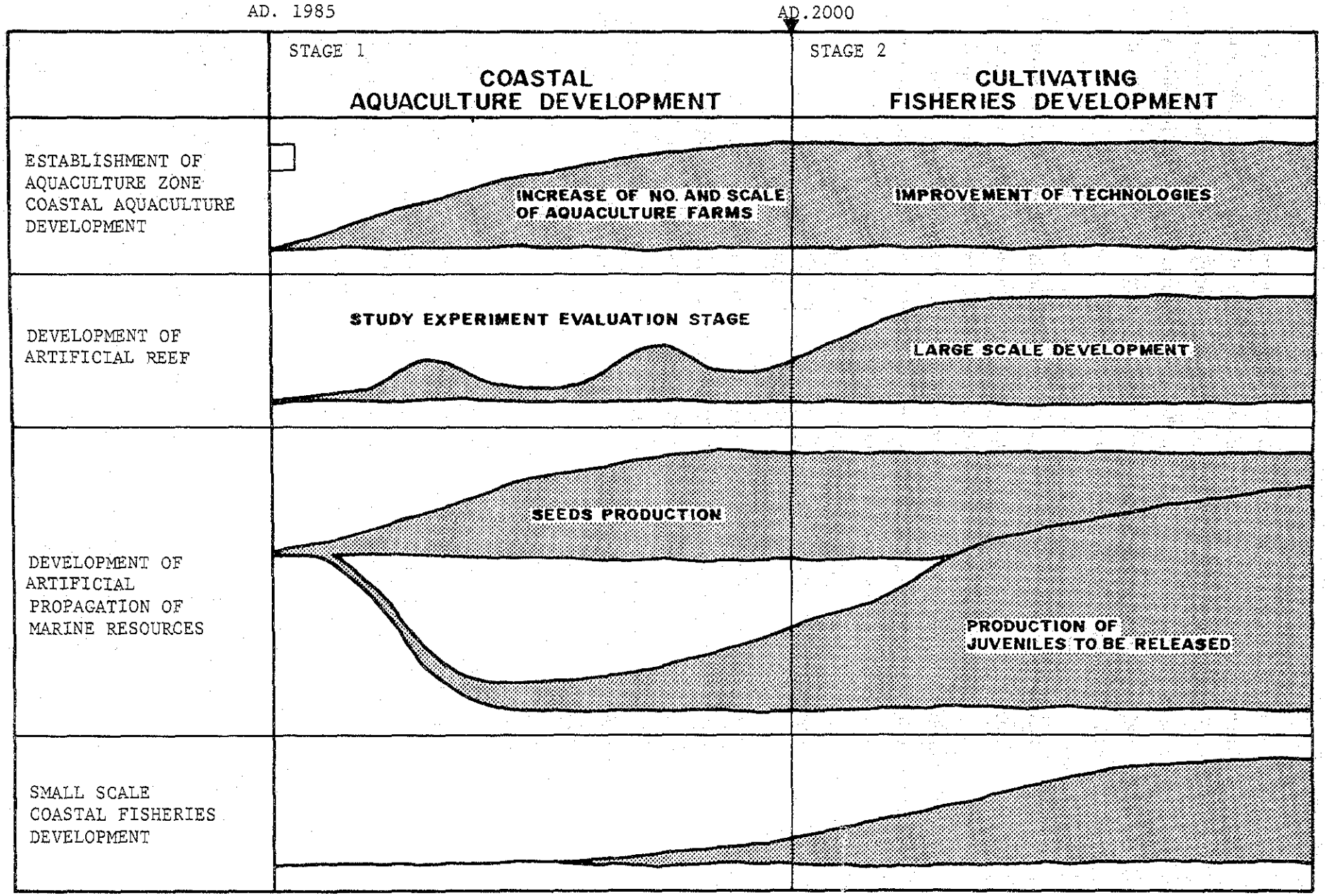
Considering that the natural marine resource in Thailand has been declining, it is now appropriate to start "cultivating fisheries" through release of the fish juveniles which are artificially propagated to semi confined natural conditions. Since the coastal area in the Upper South has proven to be an ideal ecosystem as the nursery of aquatic resources, related agency for fisheries development would have to pay particular attention to the initiation of cultivating fisheries including aquaculture development in an effort to improve resource condition of the area.

To attain the above target, systematic and integrated strategies should be elaborated. The total development would only be accomplished through close coordination of the following activities:

- Development of coastal aquaculture;
- Development of artificial reef (monstly made of concrete) aiming at fish aggregation or spawning;
- Development of artificial propagation of aquatic resources;
- Development of research work especially for environmental conditions; and
- Strengthening of legal enforcement.

Implementation of total development scheme would be planned in two stages in terms of scale of development and technical levels (Figure 3.11).

Fig. 3.11 COASTAL AQUACULTURE AND FISHERIES DEVELOPMENT



WIDTH OF FLOWS INDICATE SCALE OF EACH ACTIVITY

At the first stage, the potential areas for coastal aquaculture would be firstly selected, as "Aquaculture Zone". At this stage, artificial reef would be intensively studied from the ecological, hydrographical and structural points of view. Experimental artificial reef project would be undertaken at the stage to evaluate effects of the reef prior to large-scale development. Up to the end of the first stage, "Aquaculture Zone" would be appropriately developed as aquaculture farms.

Development of large-scale artificial reefs would substantially be started at the second stage based on the result from evaluation of experimental reefs and surveys. In this stage, the aquaculture zone change its name and is defined as "Cultivating Fisheries Area" (SAIBAI GYOGYO). To maintain the system and to technically transfer to other appropriate areas in Thailand, legal enforcement to protect the area has to be strengthened by means of the employment of appropriate surveillance boats.

2) Marine Fisheries Development

The positive development measures would not be taken to increase the fishing intensity of Siam Bay and coastal area in Andaman Sea. However, fish demands would unquestionably be increased due to growing population. If local fish production can not be expected, the following three measures have to be considered to increase fish supply for the people:

(1) Increase of Import of Fish

Presently, Thailand imports small amount of fish products in terms of both volume and value compared with total production. In addition, fishing industries have contributed a lot to the national economy through export of fish products (Table 3.13). However, if present resource conditions and fishing activities are not improved properly, the balance between fish import and export will be much affected.

(2) Encouragement of Deep Sea Fishing

Since Thai fishermen are technically competent compared with those in surrounding countries, deep sea fishing can be expanded under governmental assistance.

(3) Full Utilization of Fish Products for Human Consumption

Presently, fish products are not fully utilized for human consumption as described earlier. Therefore these conditions would have to be improved through promotion of

local industrialization.

Surat Thani would be a good location for fish processing factories because fish material can be collected from Phuket as well as from Nakhon Si Thammarat and Songkhla through good road connection. Considering the difficulty to expand capacity of existing factories in Samut Sakon and Samut Prakarn because of the lack of appropriate land, Surat Thani would be an attractive location for big fishing companies to expand their branches or factories.

It is also expected that the fish catch by means of deep sea fishing would increase in near future. Therefore, Phuket and Kantang would develop as the fish bases for deep sea fishing. However, the increased fish catch would have to properly processed in the vicinity of fishing base for full utilization of catch as mentioned earlier. Since Phuket is and will be a tourism center, environmentally sensitive industries such as fish processing are not suitable to be encouraged. Fish processing industries are desired to be encouraged, therefore, in Kantang. Figure 3.12 shows estimated fish supply and its distribution at full development growth rate of deep sea fishing is estimated at 2.5 percent per year. Middle scale bases of fish processing industries would have to be established at Surat Thani and Kantang.

Situation would lead small or middle scale trawlers and pushnetters who are not financially capable to convert their effort to pelagic fisheries or deep sea fishing. Some of the fishermen may join to aquaculture business under governmental assistance. However, most of them have to manage their fishing activities by themselves. If fish processing factories are established, local saling price of fish may be expected to increase.

Table 3.13 COMPARISON OF IMPORT AND EXPORT OF FISH PRODUCT

Unit: Quantity in 1000t and value in million baht

		1979	1980	1981	1982
Total Production	Quantity	1,813(100)	1,648(100)	1,824(100)	1,986(100)
	Value	14,004(100)	14,068(100)	17,134(100)	18,931(100)
Import	Quantity	80(4)	44(3)	47(3)	46(2)
	Value	432(3)	483(3)	549(3)	726(4)
Export	Quantiy	278(15)	263(16)	300(16)	296(15)
	Value	7,326(52)	7,251(52)	8,776(51)	10,853(57)

Source: DOF

Note: Figures in parentheses are the percentages to total production.

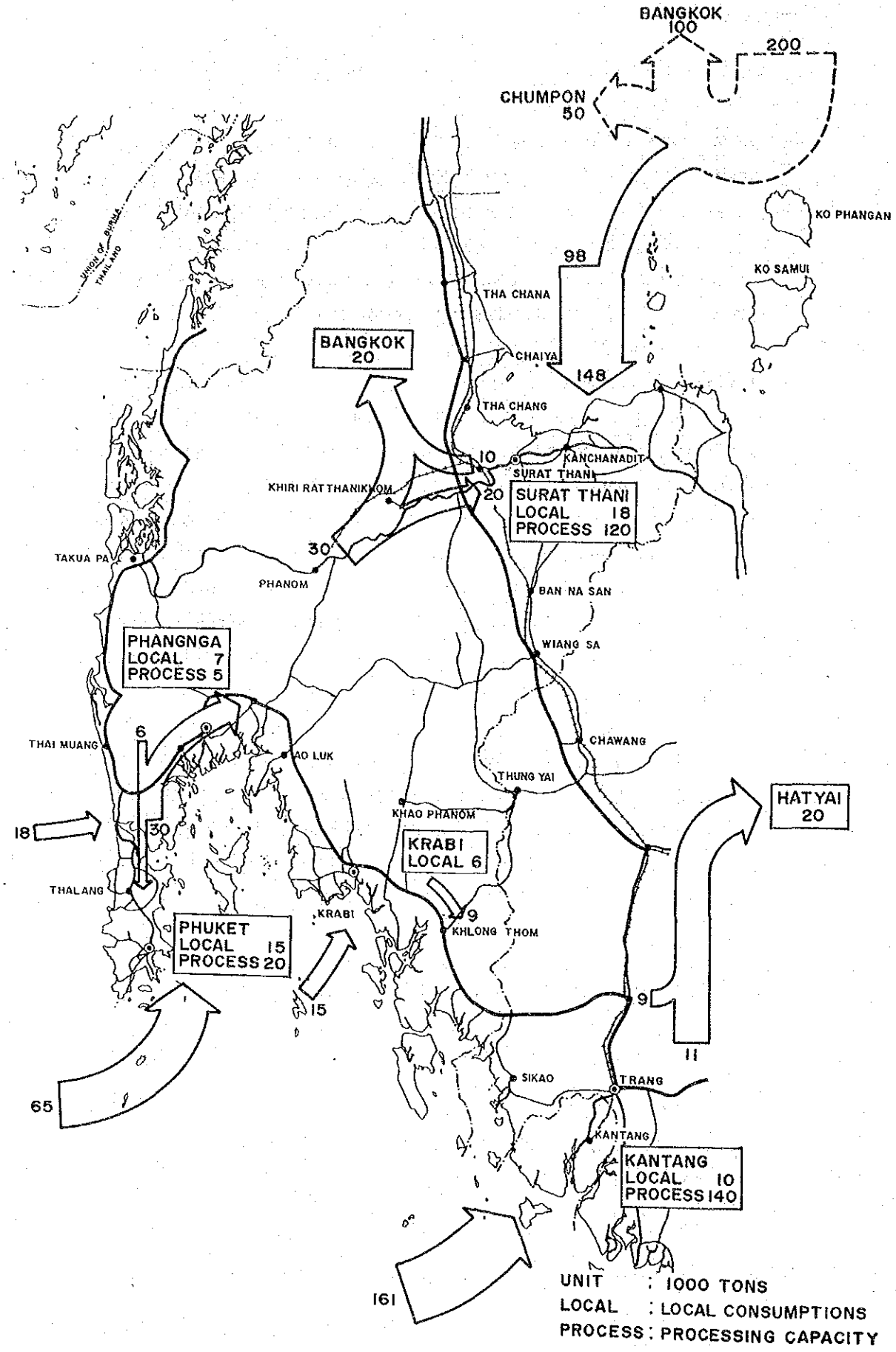


Fig. 3.12 FRESH FISH SUPPLY AND DISTRIBUTION, (A.D.2000)

3.4.3 Projects

1) Coastal Aquaculture and Fisheries Development

Whole Ban Don Bay being shallower than two meter depth and Phangnga Bay and coastal areas of Krabi shallower than three meters are tentatively designated as "Aquaculture Zone" (Figure 3.13). These areas are proposed to be exclusively used for the coastal aquaculture and small-scale fisheries.

(1) Coastal Aquaculture Development

Although about 20,000 rai of area has already been developed for coastal aquaculture in the Upper South, 100,000 rai of area still has potential for further aquaculture (see Table 3.14).

i) Shrimp Culture

In Ban Don Bay Aquaculture Zone, there are some potential areas for shrimp culture especialy in Kanchanadit and Tha Chang Area. In Phangnga and Krabi Area, shrimp culture using pen or cage would have to be developed in order to avoid the conflict with preservation scheme of mangrove area.

ii) Shell Fish Culture

Department of Fisheries (DOF) has to urgently study mechanisms of reproduction of cockle and establish seed production system prior to large development of cockle culture. Oyster culture has presently been undertaken at the intertidal area. Hanging method would also be developed at the deeper area.

iii) Cage Culture

Cage culture for sea bass and grouper would be developed mostly in Phangnga Bay, Kantang and Krabi. However, particular attention should be paid to the following points prior to large-scale development:

- Large-scale collection of wild seeds may destroy natural environment. Therefore, artificial seeds supply system would have to be established;

- Residue of feed (trash fish) may cause pollution problems.

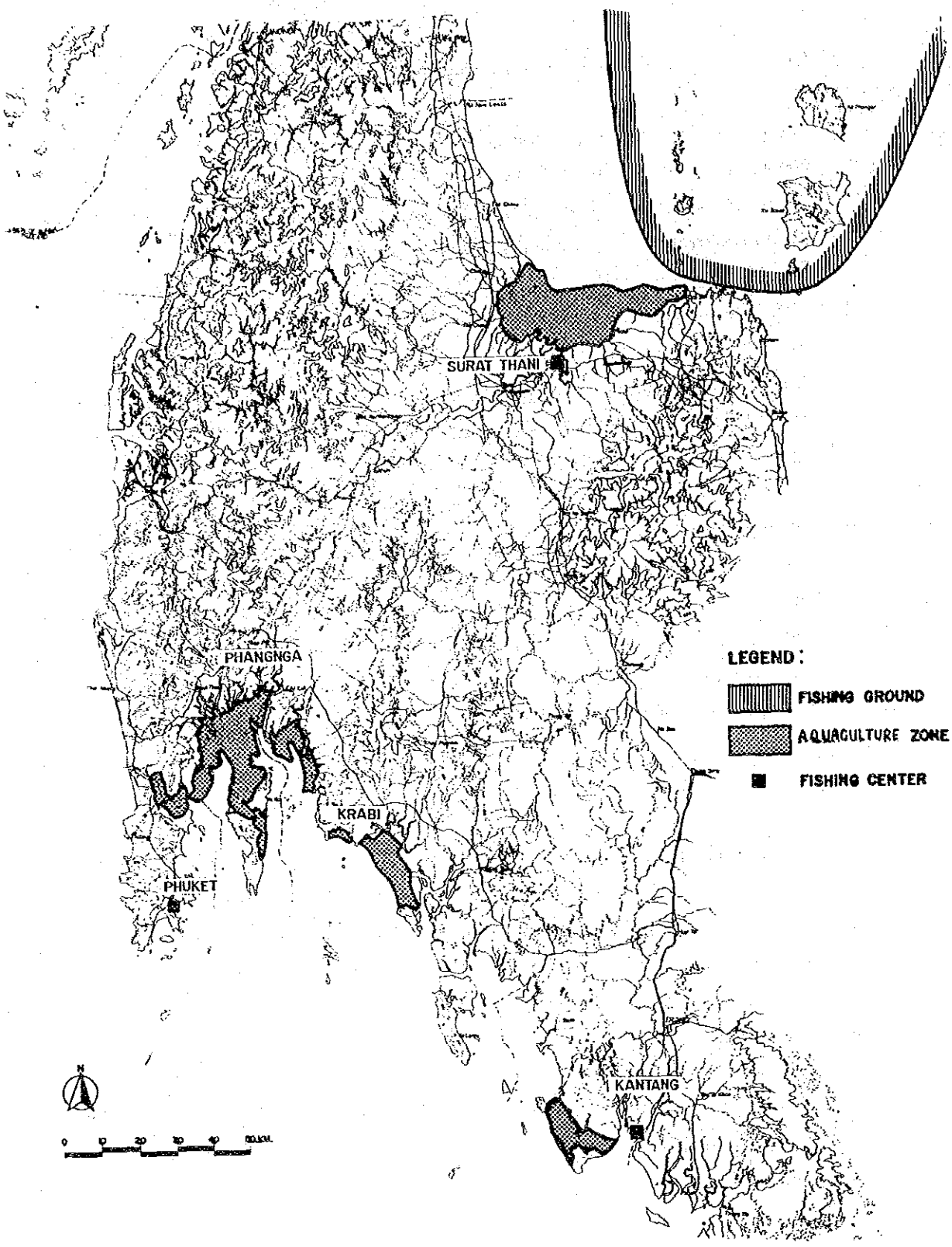


Fig.3.13 MAP FOR FISHERIES DEVELOPMENT

Table 3.14 EXISTING AQUACULTURE AREA AND FUTURE POTENTIAL

Unit : rai

	EXISTING AQUACULTURE AREA						POTENTIAL AREA					
	Cockle	Oyster	Green Mussel	Horse Mussel	Shrimp	Total	Cockle	Oyster	Mussel	Horse Mussel	Shrimp	Total
Surat Thani	3,525	494	-	-	13,456	17,475	18,000	1,562	4,000	1,250	22,500	44,812
Phangnga	1,530	1	67	-	-	1,598	12,500	6,250	6,000	12,500	4,500	41,750
Phuket	-	-	-	-	-	-	600	-	1,000	-	200	1,800
Krabi	1,000	10	-	-	-	10	4,700	1,256	3,000	1,000	2,200	12,156
Total	6,055	505	67	-	13,456	20,083	35,800	9,068	14,000	14,750	26,900	100,518

Sourse : DOF

(2) Artificial Reef Research Center

Artificial Reef Research Center (ARRC) is proposed to be established in DOF's Phuket Marine Fisheries Station. ARRC would tentatively have the following four sections to promote artificial reef project in Thailand:

- Hydrographical Research Section;
- Environmental and Ecological Research Section;
- Structure and Design Section; and
- Artificial Reef Workshop.

(3) Improvement of Capacities of Governmental Hatcheries

Existing government hatcheries would expand their capacities to produce seeds, especially for shrimp sea bass and grouper, in order to meet growing demands of seeds in accordance with development of aquaculture in Aquaculture Zone. They would finally start large-scale release program in the year 2000.

2) Marine Fisheries Development

(1) Development of Surat Thani Fishing Port

In line with the strategies described earlier, a middle scale fishing port would be constructed adjacent to Tha Thong Port. Tha Thong Port has already been constructed. However, the port is not presently utilized because of shallow navigation route up to the port. Dredging of navigation route is under construction and expected to be completed in 1985. Tentative drawing for port facilities including industrial area is shown in Figure 3.14. 150 meter length wharf and 100 rai of industrial area would be proposed.

(2) Development of Phuket Fishing Port

Some expansion of wharf facilities (100 meter length) would be proposed taking into consideration the growth of deep sea fishing in the area.

(3) Development of Kantang Fishing Port

Construction of middle scale port facilities (150 meter length), and fish processing industrial area is proposed (see Figure 3.14). Existing fish marketing system and route have to fully consider the new establishment of fish processing industries.

3) Recommendation for Fisheries Promotion

Thai Government would have to seriously consider about the marine fisheries situation. If small-scale fishermen who are not financially capable to convert or divert their job are left as they are and continue their operation under uneconomical condition due to decline of resources without appropriate countermeasures, the situation is really disastrous in terms of both socio-economic and marine resource aspects. Therefore, government should put the first priorities on these fishermen to acquire job opportunities in aquaculture and in some other fisheries business to be created under governmental project. The Government has tried to reduce the number of trawlers. These efforts will have to be strengthened under an appropriate resource management program.

The scrapped fishing boats can be used as the materials for artificial reefs. To prevent declining of resource condition, establishment of artificial reefs would be justified. Although the benefit of artificial reef can not be quantifiable at this stage, it is strongly recommended to install artificial reefs in coastal area of Thailand including the Upper South, taking into account the resource condition in Thailand to be prospective in next generation or century.

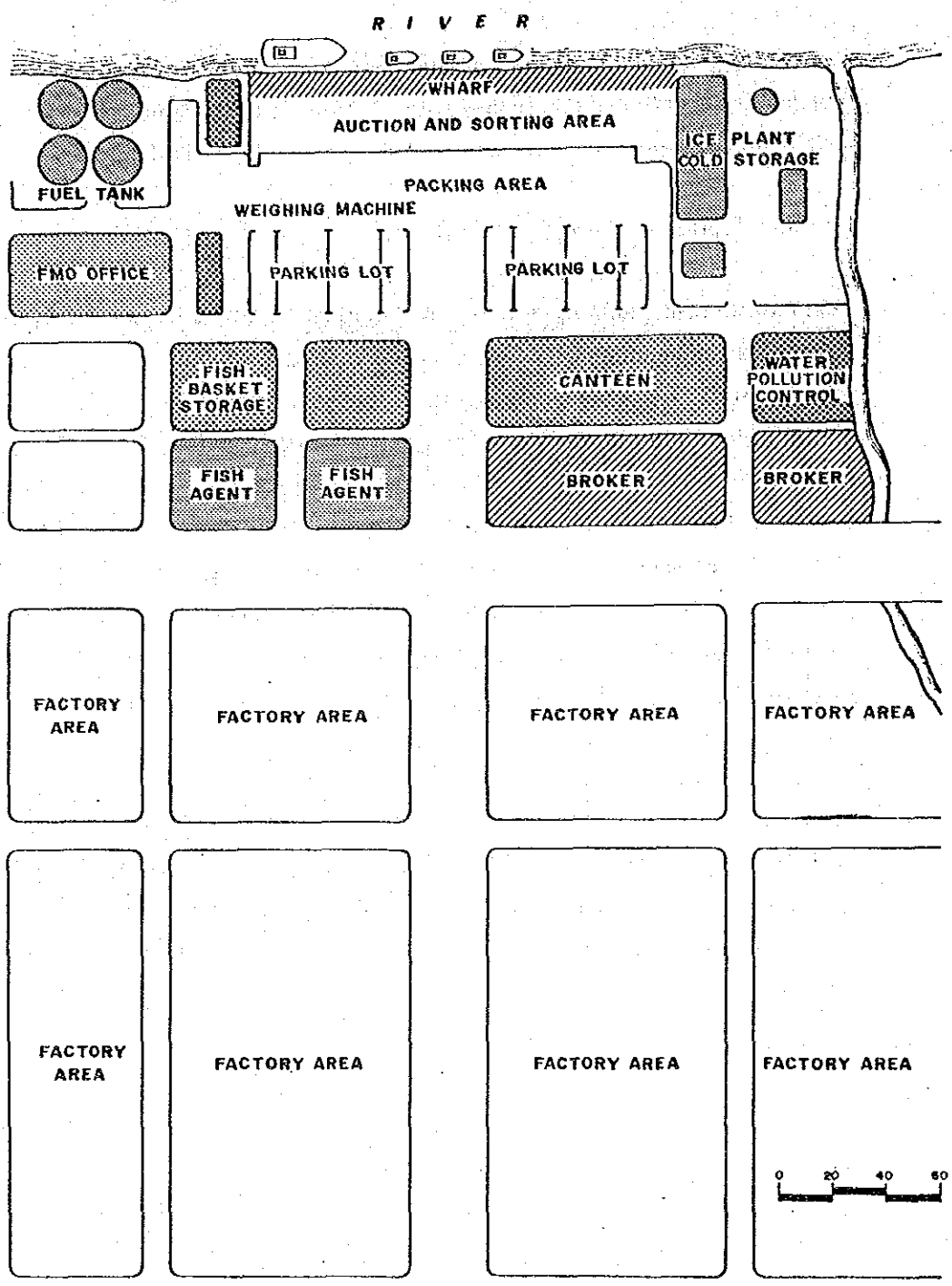


Fig. 3.14 TENTATIVE PROPOSAL OF FISHING PORT PROCESSING FACTORIES

4. CENTRAL LOWLAND DEVELOPMENT : FOCUS ON OIL PALM PLANTATION

4.1 TARGET AND CONSTRAINTS

4.1.1 Oil Palm Plantation Area Expansion

Oil palm plantation area is rapidly expanding in recent years. Average of 70,000 rai per year of new plantation area has been opened in these several years in the whole country and more than 70 percent of it is found in the Upper South. This tendency will continue in coming years, and the total area of the oil palm plantation will be half million rai in 1990 and one million rai in the year 2000. The growth rate will approximately be 15 percent up to the year 1990 and seven percent up to the year 2000.

4.1.2 Type of Plantation Development

Oil palm has been developed as an estate crop. In Thailand also, it is introduced as an estate crop and developed by large-scale estates, and extended to the small holders under the influence of the large estates. Share of large and small-scale plantations is now around fifty to fifty.

Large-scale estate development has usually been undertaken by the developers who own their extraction plants which are one of the indispensable facilities for oil palm plantation. Small holder plantations then come later and they sell the palm fruits to the extraction plants.

Agricultural production by small holders is the most common way in Thailand and agricultural development has been performed and the production increase has been achieved in the past by these small holders. In case of rubber plantation, most of the plantations have also been developed by small holders. Though quality of production is still low compared with Malaysia, production cost is highly competitive in the world market. This small holder's production system has supported the Thai economy because it has been matched with the farmers attitude and socio-economic system of Thailand.

Though oil plam plantation has critical constraint of accessbility to extruction plants, if the large-scale estate with extraction plant or the extraction plants themselves are located at strategic location, small holders could well develop the plantations.

We think that a combination of large-scale development and small holders development will be the most suitable for the oil palm plantation development in Thailand. In our proposal, an emphasis is given to the small holder's program, for large-scale development has been rapidly ongoing without substantial government assistance and small holders development is important not only from the viewpoints above discussed but from social benefit point of view.

1) Large-Scale Development

Oil palm requires large piece of land for plantation, being usually 20,000 to 30,000 rai. Land availability and land acquisition are one of the major constraints to the development, due to a large area to be developed in the short period of time. For constructing extraction plant a large capital investment is required. Large-scale estate development is executed usually by the multinational enterprises which have long experience and strong marketing and financial abilities. They have many experiences and know-hows in developing and managing plantation. A characteristic of plantation farming is that it requires a large number of labourers in one place. Labour is thus one constraint to the estate development for such enterprise.

2) Small Holders' Development

A large portion of small holders especially in the Upper South do not have secure land tenure. There are many illegal occupants in the forest reserve area of which large portion is suitable for oil palm development. To maintain the security of land for the farmers without land title, both Department of Land and Royal Forestry Department are issuing the certificate of land holding as mentioned below:

In forest Land (Publicly owned land)

- Sor Tor Kor : indicating official recognition of settlement/past cultivation.

In State Land and Private Land

- Baichong : indicating official recognition of settlement.

- Sor Kor Nung : form of squatters title.

- Nor Sor Sam : owners are allowed to sell the land.

- Title deed : permanent free hold possession.

Land title is a major constraint to the farmers when they need financial support and governmental assistance. Because of their unsecure land title and few information the small holders usually suffer from financial constraint, though oil palm plantation needs three to four year growing period before harvesting.

Oil palm plantation needs intensive care on plant and appropriate operation and management. However the small holders have difficulty in opening access to the sufficient technical and management know-how.

The place to sell the product and price of the products are the most significant factor for the farmers. However, this marketing ability is the most difficult matter for the small holders.

The small holders development can be classified into two categories based on the land title or the classification of the land which small holder occupies. One is the development in the reserved forest area. Another one is that in the private owned land or the land outside the forest reserve land. The development in the first category is a kind of combination with resettlement program and has been experienced with financial assistance from Bank for Agriculture and Agricultural Cooperatives (BAAC) in Changwat Chumphon. The development in the second category is normal agricultural cooperative type. Land tenure and financial conditions are major constraints to both categories of development.

4.1.3 Yield of Palm Oil

Yield of palm oil by type of development in Thailand and average yield in Malaysia are shown below.

Unit: t/rai

	Thailand		Malaysia
	Small Holder	Large Estate	Average Whole Country
Average Yield (FFB)[*1]	1.8	2.7	3.6

Source: Data from Hourticulture Research Institute, Department of Agriculture, 1983.

Note [*1]: The figures indicate the average yield of the plants aging four to 13 years (10 year average)

The difference in yield is caused by the following reasons:

1. Generally, Malaysia has more favourable climate for the oil palm cultivation.

2. Large commercial estate has better skill and ability in technical application and management.

3. In Malaysia, small holders are strongly supported by the government. Federal Land Development Authority is the most well known organization.

4. Small holders in Thailand have less experience of oil palm plantation and less information about the plantation management.

For setting up the target average yield in the Upper South in the future, we adopted the following assumptions:

(1) Large estates improve their productivity by introducing high yielding varieties in the future, and catch up with the average yield attained in Malaysia as of 1983.

(2) Small holders improve their productivity by application of high yielding varieties and development of their management skill, and catch up with the average yield of large estate in Thailand as of 1983.

For the improvement of the yield of palm oil, the most important issue is the research and development of high yielding varieties which are suitable to the soil and climate of the Upper South. Setting up the appropriate extension service for small holders is also an essential issue.

4.1.4 Extraction Rate

Extraction rate is another important factor to increase the production of palm oil. The rate is also lower than Malaysian average at present. In Thailand actual extraction rate from Fresh Fruit Bunch (FFB) is 16 percent in small holder and 18 percent in large estates, while the rate is around 20 percent in Malaysian estates. Target extraction rate in the year 2000 in this study is set so as to achieve 80 percent of the extraction rate that is recorded in one of the best estates in Malaysia at present. Improvement of extraction rate effects not only on the productivity of palm oil itself but also production efficiency of extraction plants.

These development targets mentioned above are summarized in Table 4.1 and consequent production output of palm oil in target years are shown in Table 4.2.

4.1.5 Number of Extraction Plants

The extraction plant is an indispensable facility for oil palm plantation. Accessibility to the plant is one major factor or constraint for the plantation development. Number of the extraction plants required is calculated based on the extent of oil palm development of both large estate and small holder's plantation. Table 4.3 indicates the number of extraction plant required. Existing extraction plants have their own estates to supply the material to the plants. Average size of the plantation of the materials supplied by large estates to their own plants will decrease in the future, as small holder development will be accelerated.

Table 4.1 BASIC TARGET FIGURES

		1985	1990	1995	2000
Area (Max.) (1000rai)	Whole Country	340	720	990	1300
	Upper South	240	500	740	1000
Yield 1/ 2/ (ton/rai)	Large Scale Estate	2.2(3.1)	2.5(3.5)	2.8(3.9)	3.2(4.6)
	Small Holder	1.5(2.3)	1.8(2.7)	2.1(2.9)	2.3(3.6)
	Average	1.85	2.1	2.4	2.6
Extraction Rate(%)	Large Scale Estate	18	20	21	22
	Small Holder	16	18	19	20
Percent of Kernel Oil (% of Palm Oil Production)		11%	11%	11%	11%
Percent Area of large Scale Estate		50	45	40	30

Phasing of Small Holder Development	Institutional Arrangement and Extension Services	Application	Improvement Achieved

Note : 1/ Average yield of all age of plants, including nonproductive ones at the age of one to three years.

2/ Figures in parentheses show the maximum average yield to be achieved.

Source: The Team

Table 4.2 OIL PALM PRODUCTION TARGET

	1985	1990	1995	2000
Whole Country				
Area(000 rai)				
Total	340	720	990	1300
Large Scale Estates	170	320	400	400
Small Holders	170	400	590	900
FFB Production(000 ton)				
Total	629 1/	1520	2359	3350
Large Scale Estates	374	800	1120	1280
Small Holders	255	720	1239	2070
Palm Oil Production (000 ton)				
Total	108	274	470	695
Large Scale Estates	67	144	235	281
Small Holders	41	130	235	414
Upper South				
Area(000 rai)				
Total	240	500	740	1000
Large Scale Estates	120	230	300	300
Small Holders	120	270	440	700
FFB Production(000 ton)				
Total	444 1/	1061	1764	2570
Large Scale Estates	264	575	840	960
Small Holders	180	486	924	1610
Palm Oil Production(000 ton)				
Total	77	202	352	533
Large Scale Estates	48	115	176	211
Small Holders	29	87	176	322

Source: The Team

Note : 1/ Actual FFB production will be 20 to 30% less than these figures due to a large percentage of immatured trees.

Table 4.3 NUMBER OF EXTRACTION PLANTS REQUIRED

	1985		1990		2000		2001-	
	Upper South	Whole Kingdom	Upper South	Whole Kingdom	Upper South	Whole Kingdom	Upper South	Whole Kingdo
Number of Extraction Plants Required	5	5	10	14	13	17	9	11 1/
Average Capacity (x1000ton/year/unit)	18	18	25	25	50	50	100	100

Source: The Team

1/ Reorganization of extraction plants will be required after the year 2000, to maintain the export competitiveness.