

借

REPORT ON PORTS AND HARBOURS
IN
SOUTHERN THAILAND

December 1968



OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

JICA LIBRARY



1050204[5]

国際協力事業団	
受入 月日 '84. 3. 28	122
登録No. 02172	72.8
	EX

PREFACE

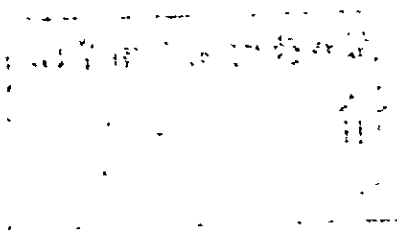
The Government of Thailand as a part of 2nd Five-year Economic Development Plan starting October 1967, placed a high priority to improve the ports and harbours, particularly those on the coast of west and southern Thailand, to cope with the rapid increase of commercial transactions and towards which the Japanese technical cooperation was asked for. In response to the request, Overseas Technical Cooperation Agency sent a survey team headed by Mr. H. Ohtao from 29th March, 1968 to 1st May, 1968.

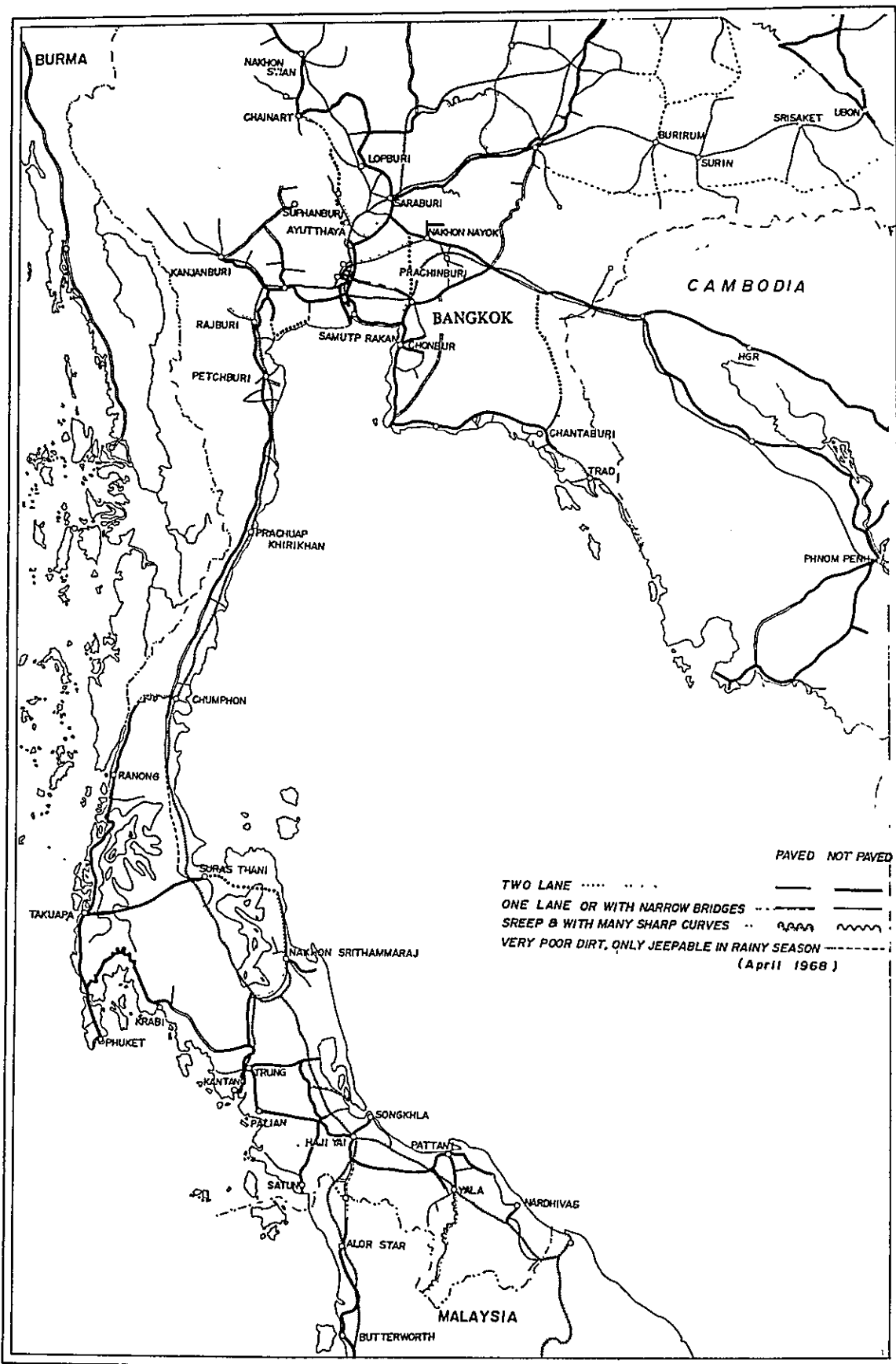
The survey team conducted spot investigations and studied the existing improvement and expansion programmes of the ports and harbours from the engineering and economic point of view.

This is the report prepared by the survey team and we hope that this report will contribute to the development of ports and harbours in Thailand.

We wish to take this opportunity to express our gratitude for the cooperation extended to the survey team the authorities concerned in Thailand.

Overseas Technical Cooperation Agency





BURMA

NAKHON SIAM

CHAINART

LOPBURI

BURIRUM

SIRSAKET LEON

SURIN

SUPHANBURI

SARABURI

AYUTTHAYA

NAKHON NAYOK

CAMBODIA

BANGKOK

KANJANBURI

PRACHINBURI

RAJBURI

SAMUTP RAKAN

PHONBU

HGR

PETCHBURI

CHANTABURI

TRAD

PHNOM PENH

PRACHUAP KHIRIKHAN

CHUMPHON

FRANONG

SURAS THANI

TAKUAPA

NAKHON SRITHAMMARAJ

PHUKET

KRABI

KANTAN

TRUNG

SONGKHLA

PALIAN

HAI YAI

PATTANI

SATURU

NYLA

NARDHIVAS

ALOR STAR

MALAYSIA

BUTTERWORTH

Report on Ports and Harbours in Southern Thailand

Index

I.	Forward	1
	1) Introduction	1
	2) Members of Investigation Team	3
	3) Schedule of Survey Tour	3
	4) Comments on Investigation	4
II.	Observation and Survey	7
	1) General Outline and Recent Trend of Transportation Facilities	7
	2) Study on the Transportation System in Southern Thailand	11
III.	Ports on the West Coast	13
	1) Takuapa	15
	2) Krabi	16
	3) Kantang	18
	4) Palian	21
	5) Satun	21
	6) Phuket	23
IV	Approach to Development of Ports on the West Coast	29
	1) River Ports	29
	2) Port of Phuket	30
V	Ports on the East Coast	34
	1) Suras Thani (Bandon)	35
	2) Pattani	37
	3) Songkhla	40
VI	Conclusion	49
	1) Negotiations on Outline of Investigation	49
	2) Outline of Report Presented in Thailand	50

I. FOREWORD

1. Introduction

In Japan, large and small ports and harbours are found at an average of every 4km along the coastline which extends over 27,000km. In 1967, there were 23 ports handling more than 10,000,000 tons of incoming and outgoing cargo per year, while over 70 ports attracted more than 1,000,000 tons of marine cargo.

Ports facing the Pacific Ocean are attacked by typhoons with wind velocities of over 30m/s accompanied by heavy rains in summer, while ports on the Japan Sea coasts are subject to the frequent surging of high waves caused by violent winds in winter.

The topography of the country presents difficult problems in constructing ports and harbours in certain locations, as there are many rivers with rapid currents, and the discharged sand and silt accumulate as drift sand, obstructing the utilization of the seacoast and creating weak grounds.

In the past 100 years, river ports for wooden vessels have been deprived of their prosperity by ports at river mouths for small steel vessels. Small ports along the coasts with favorable natural conditions which need no dredger have not been able to meet the demand of vessels of larger dimensions, and have handed over the leading roles in marine transportation to artificial sea ports enclosed by breakwaters.

With the expansion of foreign trade and the growth of various industries, ports and harbours constructed around large cities by modern methods of engineering, dredging shallow waters neglected so far, and reclaiming land for harbour facilities, are destined to play important roles in marine transportation.

Furthermore, following World War II, as the promotion of manufacturing industries and foreign trade has been the fundamental policy of Japan, ports and harbours have been developed as prerequisite facilities for industrial plants from the economic point of view. In locations with favorable conditions for industrial development, ports and harbours have been constructed, breaking through devastated areas of land along seacoasts with accumulated drift sand. We may count several examples of such ports which have grown into first-class ports in the past few decades, handling several million tons of cargo per year.

Earthquakes make the designing of structures a complicated affair, and

the sudden change in meteorological and tide phenomena of the sea call for the swift construction; though the same phenomena act to cost expensive. Overcoming these various difficulties, great progress has been achieved in the field of construction engineering.

The recent trend to build tankers and vessels of larger dimensions at a rapid pace has brought a complete change in the course of construction, particularly dredging plants, construction machinery, materials, and method of construction.

When we, harbour engineers with experience in ports and harbours under such circumstances, explored the ports on the west coast of southern Thailand for the first time and observed the untouched state of the ports, it may be easily understood that we were strongly moved to plan the construction of an effective up-to-date port, anticipating bright prospects for future development.

Looking back upon the valuable experience gained from the confusing course of port and harbour development witnessed during the past hundred years in Japan, studying the change of times, and trying to save any waste in time and money, we hope that Thailand will not go through the bitter experience which we have experienced in ports and harbours in Japan. We believe that it is the most natural feeling of Japanese engineers as neighbours of the people of Thailand, living in the same Asian continent and working for mutual prosperity, that we wish to extend our cooperation for an effective development of southern Thailand in the shortest period of time.

I wish to present this report reflecting the opinions of the members of our survey team, and I hope that the report will serve as reference material for the authorities concerned.

2. Members of Survey Team

Leader Hiroji Ohtao (Ex Vice President,
Transportation Technical Research Institute,
Ministry of Transport)
Kozo Harashima (Expert on economic problems of Thailand)
Mototsugu Takahasi (Chief, Investigation and Designing Office,
Third District Harbour Construction Bureau,
Ministry of Transport)
Hisashi Aono (Chief, Planning Section, Port and Harbour
Research Institute, Ministry of Transport)

3. Itinerary of Survey Tour

March 29, 1968	Left Tokyo, Arrived Bangkok
March 30 - April 4	Called on authorities concerned of the Govern- ment of Thailand and the Japanese Embassy to report on arrival and make necessary arrange- ments.
April 5 - April 13	Left Bangkok Arrived Phuket Survey of Ports of Phuket, Takuapa, Krabi, and Suras Thani. Collection of data.
April 14 - April 17	Left Phuket Arrived Bangkok Collection of data
April 18 - April 21	Left Bangkok Arrived Songkhla Survey of Ports of Satun, Songkhla, Pattani and Kantang
April 24	Left Songkhla Arrived Bangkok
April 24 - May 1	Arranged data in order. Called on authorities concerned of the Government of Thailand and the Japanese Embassy to report on results of investigation and departure for Japan.
May 2	Returned Tokyo

4. Brief Comments on Investigation

Within the limited days and areas of survey by our team, under the present circumstances, Phuket on the west coast of Thailand and Songkhla on the east coast were found to be the only locations with favorable natural topography for the construction of an up-to-date port. We wish to say strongly that it is extremely important to study and provide for the utilization of space on land along with the construction of the wharf. Today, in a rapidly changing society, we have to recognize the importance of carrying on investigations for a harbour development program with special idea of transportation and particular consideration for problems in various the other fields. We must also understand that the investment of large funds will be entirely in vain, unless the construction of facilities is carried out after detailed investigation of natural features.

In ports at river, an investigation of the natural features of the river itself must be carried on in the beginning. With the progress of improvement works on the river, after confirming effective measures to be taken along the seacoast around the river mouth, we may begin the construction of the port. Otherwise, it will be extremely dangerous to invest a large sum, and we have seen many cases in which the ports can no longer bear the burden of maintenance cost.

The marine fleet of the world is on the trend of a rapid increase in the type and number of vessels. The rapid increase of marine transport cargo is promoting the construction of up-to-date ports and the expansion and improvement of ports and harbours. River ports are thought to be destined to fall out from the competition eventually.

As Thailand is in a position to play an important role in Asia with abundant natural resources and vast tracts of undeveloped land, the training of port and harbour engineers specializing in various fields is a matter of extreme urgency, and from the actual survey in the country, we feel the need to provide for appropriate measures immediately.

Summarizing various points to be considered, the construction of the port of Songkhla should be started immediately, according to our proposed plan but we cannot approve the program which is under way at present. The reasons are as follows it is entirely impossible to solve the problem of drift sand by a single jetty, and it is extremely doubtful whether the direction of the proposed channel will be satisfactory even for the operation of coastal small vessels. The new

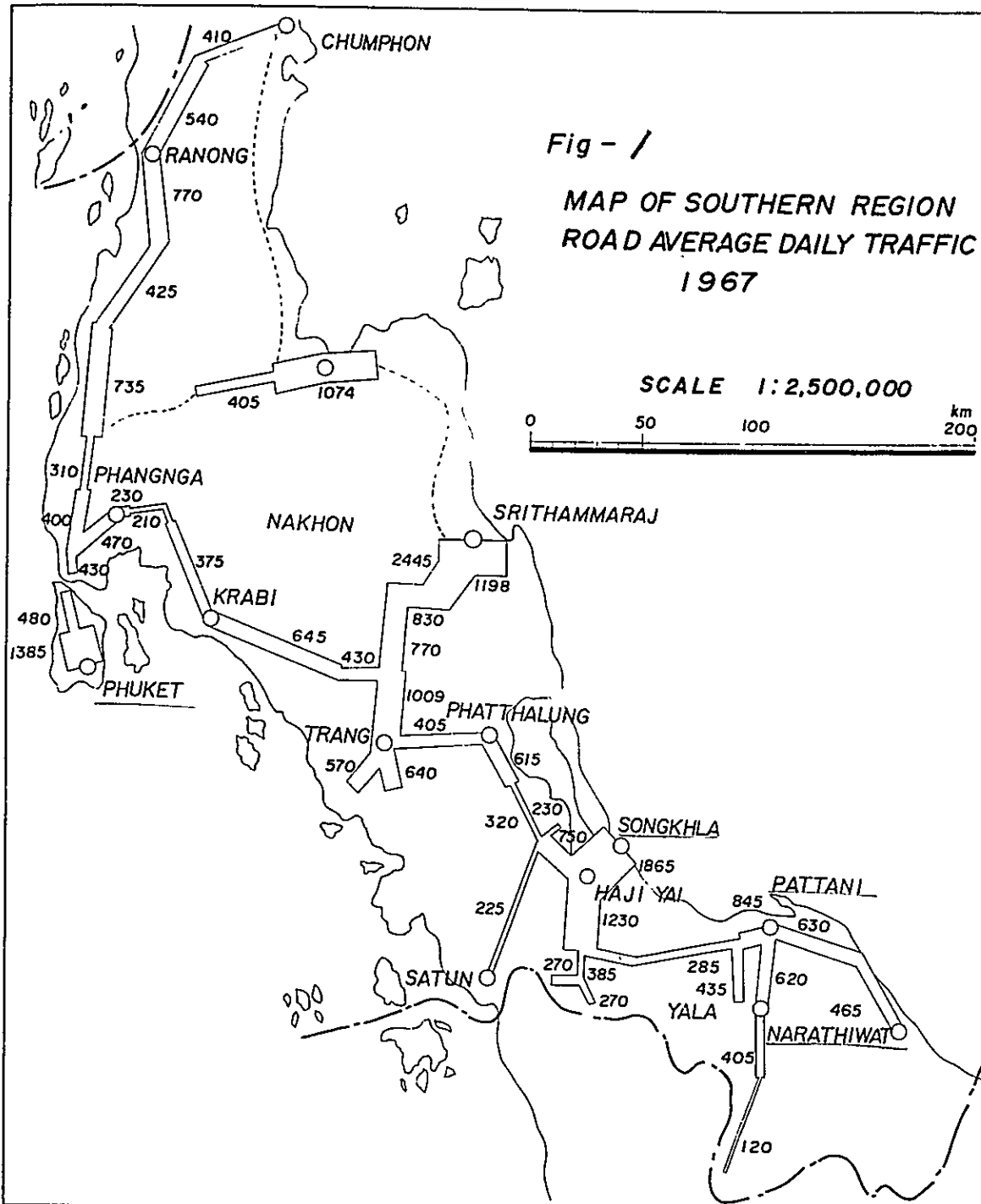
channel will cross the inner channel at almost a perpendicular angle, and the current at this location becomes extremely complicated and variable at times. Vessels will have difficulty in steering, bottom depth is unstable and accidents are apt to occur at the site. The land space will be occupied by undesirable structures for the function of the new expected quay. If the condition of today should last long, the adequate spot where key structures of new port are to be arranged will be spoiled to nothing. I am afraid a wound received in the early stage will turn out to be a deep scar at a mature stage.

As for the Port of Phuket, from the present scale of port activities and natural topography, the time is not ripe yet to begin the construction of the port, unless a large amount of cargo is forced to be secured for the port to be developed on a large scale. But, as it is in a key location, we recognize the need to advance further investigation and study of various problems.

Dredging works should be limited to the minimum amount to meet urgent needs until a development program has been adopted. The selection of suitable dredgers, and the disposal of dredged sand should be determined upon further careful study.

The training of investigation staff and field engineers is a matter of great urgency at present, and we believe that the best solution would be to establish an organ near the actual site such as a laboratory equipped with experimental facilities for the study of hydraulics, soil and surveying.

We also believe that favorable results may be obtained by accepting a larger number of engineers and experts to the port and harbour seminar sponsored every year in Japan. And if requested, we may send a team of port and harbour experts to the Port Department, on a long-term basis, to give appropriate advice, upon learning the actual situation of the country, and cooperate in the smooth operation and development of various facilities in ports and harbours.



II. OBSERVATION and SURVEY

1. General Consideration and Recent Trend of Transportation Facilities

For a long time, the development of a wide region of land has been strongly advanced through adequate connection of railways and water transport and countries which may be called advanced nations possess an efficient system of land and sea transport of these kinds.

Following World War II, air transport has been added to the old transport system, and the motor-car with various advantages has become the main force in transportation on land. Closely linked with marine transport, motor-car transport is gaining popularity in the new age.

The recent revolutionary progress in the field of engineering has demanded a rapid change in the industrial structure, with far-reaching effects in social and economic circles. As colonial territories gained independence in various parts of the world, drastic changes of transport between countries also will continue to take place until a new social order has been established on the earth.

As Thailand is advancing the modernization of the nation with great success in a rapidly changing society, various economical disturbing phenomena arising from new demands, dissatisfaction, and disagreement may be presenting problems as particularly strong obstacles or conflicts in different quarters. A rapid movement of people and goods in large quantity over a wide area are inevitable conditions in the course of modernization of a nation, presenting serious problems for the transportation system.

On the other hand, advanced nations, possessing various permanent facilities through heavy investments over long years in the past, and experienced labor distributed in the respective areas, seem to be experiencing tremendous difficulties in adjusting the situation to meet the demand of the new age. The transportation system is no exception, and reconstruction of the system is carried on to the verge of creating considerable confusion.

Various new trends may be observed in marine transportation, Tankers of mammoth dimensions are constructed as well as special vessels for particular type of cargo, and the introduction of the container system has called for special cargo vessels and changes in the facilities of wharves. Hydrofoil boats and hovercrafts are beginning to serve as short-distance, high-speed passenger boats, and

nuclear powered vessels will be launched in the near future. These above mentioned trends add a new phase to the incessant progress of the increase in size of vessels and the number of vessels in operation.

In land transport, highways have been constructed to replace railways in their connection with vessels, and trucks of large capacity and cargo handling machinery are more widely used than ever. At the same time, waters around ports and harbours are utilized by various industries and tankers to the full extent, threatened with the occurrence of disaster and accidents.

Ports and harbours and adjoining areas on land come to play important roles as roll-on and roll-off system will become in common soon, and from the point of cutting in transportation cost, various industries desire to construct their plants near the waterfront. The population is rapidly centering around towns and cities with ports and harbours, so that unless the planning of ports and harbours and the towns and cities are carried on at the same time, both the cities and the ports will not be able to function efficiently to achieve their respective purpose.

In locations where a combined line of petroleum industries, knock down factories, timber manufacturing and steel industries came to establish their plants, we may show examples of harbours handling merely several tens of thousand tons of cargo developing into large port cities handling several million tons of sea borne cargo per year in the past several decades really in Japan.

In the touch of original coastline like a southern Thailand to the full advantage meeting world trend of today and particularly the selection of appropriate sites for new modern artificial ports and harbours various factors, not only natural conditions but also mentioned above must be taken into consideration in conducting investigations and planning owing to avoid any errors in a longrange program of the development of a region with promising prospects for the future.

Short sight investigation and planning with attention only on one particular region or instant demand and advantage of one extremely limited district will liable to not only sow seeds of obstruction future development, but will also prove the lack of sufficient study on the appropriate investment of valuable funds.

Last year we submitted a report on the development program of the Port of Songkhla. As the present preliminary investigation of southern Thailand is closely related to the program, we wish to state here that we have tried to avoid and repetition of the previous report.

Several factors may have delayed the development of ports and harbours in Southern Thailand. Both the kind and quantity of cargo in this region have been lacking to attract the call of ocean-going vessels. Domestic industries requiring the service of sea transport have not yet been promoted along the coast. According to these reasons small wooden boats were able to meet the needs of coastal navigation, and the natural water depth was quite sufficient. As existing villages are scattered near the banks of the rivers in small scale, the economic condition of the area has not reached the stage to make a strong demand for the construction of public wharves.

Circumstances has completely changed today as neighbouring nations of Thailand gained independence from European powers, they have started to promote their own industries and raise the standard of living. They might want themselves to trade with each other or with other countries where industries were developed by their own will. The expansion of sea transport will inevitably become an essential condition in the course, and durable steel vessels of larger dimensions, capable of withstanding winds and waves shall be gradually replacing wooden boats, giving rise recently to the problem of water depths in ports.

Viewing the transportation system of today built up from the geographical figure of the entire country of Thailand in regard to sea-borne cargo from the Port of Bangkok, the west coast, will merely be the hinterland of ports on the east coast in distance which are capable of competing with overland transport, as in a location looks similar to an isolated island because of going round Singapore so far. Therefore, it may be concluded that priority should be given to the development of ports on the east coast so long as domestic maritime view concerned.

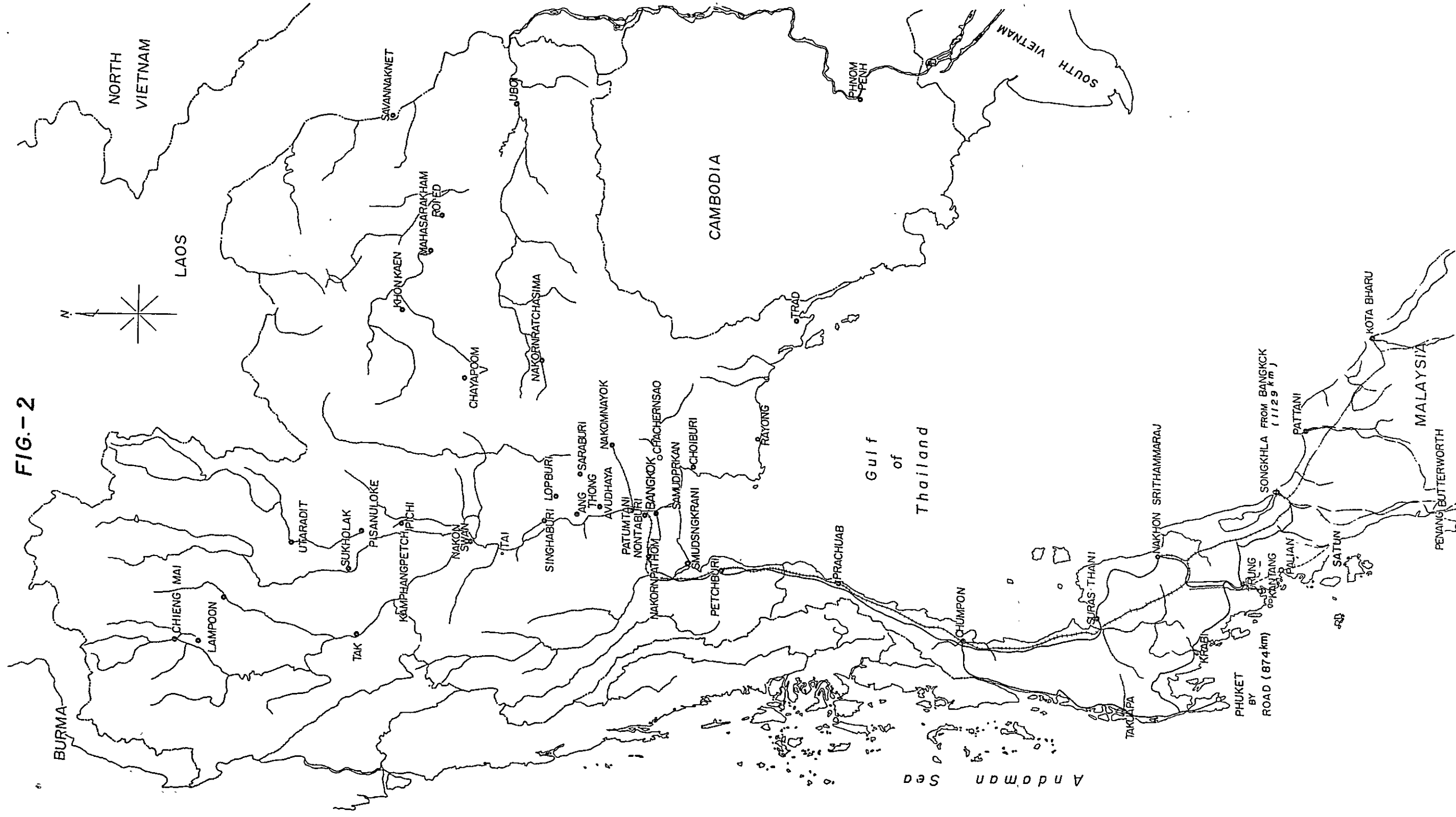
However, from a viewpoint of foreign trade is another with undeveloped regions depending on sea transport in the neighbouring countries including west coast, if the trade between primary products and secondary manufactured products in demand in these regions could be started around the ports, it will be necessary to equip the ports of west coast with adequate facilities is possible as earlier coming days.

The construction of ports may be considered in correlation with the establishment of various factories in line with motor-cars and transportation facilities machinery plants related to construction works, petroleum industries, and factories of manufacturing daily commodities, food plants, etc. on a large scale on the west coast.

In respect to trade with advanced nations, if regions on the west coast should compete with neighbouring nations under similar favorable conditions and succeed in cultivating rubber, as in Malaysia, sugar, tobacco, vegetable oil, spices, and animal feed which advanced countries might be wanted foreign vessels will be willing to call at the ports.

In this case, it will not be in vain to make investments in advance in ports which has adequate topography to build the port and located in the vicinity of favorable sites for future industrial development. However, it will be a rather bold decision to judge that industrial plants will definitely be established around the present port towns.

FIG.-2



2) Study on the Transportation System in Southern Thailand.

Southern Thailand is the southwest part of the country, a narrow stretch extending southward down the Malaya Peninsula. The western coastline of Thailand which connects the coasts of Burma and Malaysia extends for approximately 700 km, and the northern end of the Island of Sumatra is situated in the southwest direction from the central part of the coastline. To reach the east coast of the country from the west coast near the border of Malaysia, vessels must sail around Singapore over a distance of more than 1,500 km taking the shortest route, whereas the east coast may be reached from the west coast by overland routes of 50 - 100 km. The mountain range running along the west coast is approximately 500 m above sea level, and only few sections rise over 100 m. The construction of a highway connecting the east and west coasts will not involve great difficulty.

The majority of the towns along the coast have grown around river banks, but only several towns possess a population of over 5000. A heavy amount of sand is washed down the rivers, with winding curves in the lower stretches, breaking off into small branches with islands scattered around the river mouths. With shelving bottoms along the coast, vessels find considerable difficulty in navigation.

The Port of Penang of Malaysia serves as the transit port for sea-borne cargo for the district. Tin and rubber, the main products and important convertible resources of southern Thailand is transported to Penang by small boats of less than 200 tons from various ports once or twice a month, and manufactured goods and daily commodities from Europe and India are loaded as cargo on the return trip. The waters along the coast are favorable fishing grounds, and small fishing boats carry the catch of fisheries to the towns along the coast, supplying food for the tables of the inhabitants, together with the abundant agricultural products of the area. Southern Thailand is composed of a number of districts, each confined in its own small isolated economic sphere. However, as highways under construction are completed, the transportation of cargo will obviously extend to distant areas.

The present distribution of population may be expected to undergo a drastic change depending on the future transportation policy. The prosperity of towns and villages which have developed around stations along the railway may also be subject to considerable change.

The railroad runs along the east side of the peninsula reaching Singapore on the southern end of the Malaya Peninsula, but on the west coast, there is only one branch line extending to the port of Kantang via Trang.

Recently, a reinforced concrete bridge 660 m long with a width of 8 m has been constructed across the straits between the Island of Phuket and the main peninsula, and an up-to date paved highway to Bangkok has been completed. A regular daily motor-car service connects the towns of Phuket and Bangkok in 15 hours, and along with air line transport, a direct transportation system connecting the west coast and the central district of Thailand has been established.

Cargo transportation seems to have been carried on between Suratthani on the east coast and Krabi on the west coast making full use of river navigation. Transfer of cargo in the course of transport involves large expenses, often causing damages, loss and delay. The advantage of direct transport by trucks from loading to unloading accounts for its growing popularity and larger sphere of activity in land transport in spite of the restriction in capacity and weight. If natural features of the area should allow the construction of a canal to connect the rivers on the east and west coasts, the ports on the west coast will be connected directly with various districts along the river course extending over 3,700 km in the central part of Thailand as well as the ports on the east coast by advantage of short river navigation routes. The construction of a canal is a problem worth serious consideration and study.

Ports in Southern Thailand (in order of the amount of cargo handled)	Incoming and Outgoing Marine Cargo Average for 1964-1967 (thousand tons)
1. Songkhla	311
2. Pattani	131
3. Phuket	117
4. Bandon	105
5. Kantang	84
6. Naradhivas	40
7. Satun	25
8. Takuapa	15
9. Krabi	15

III. Ports on the West Coast

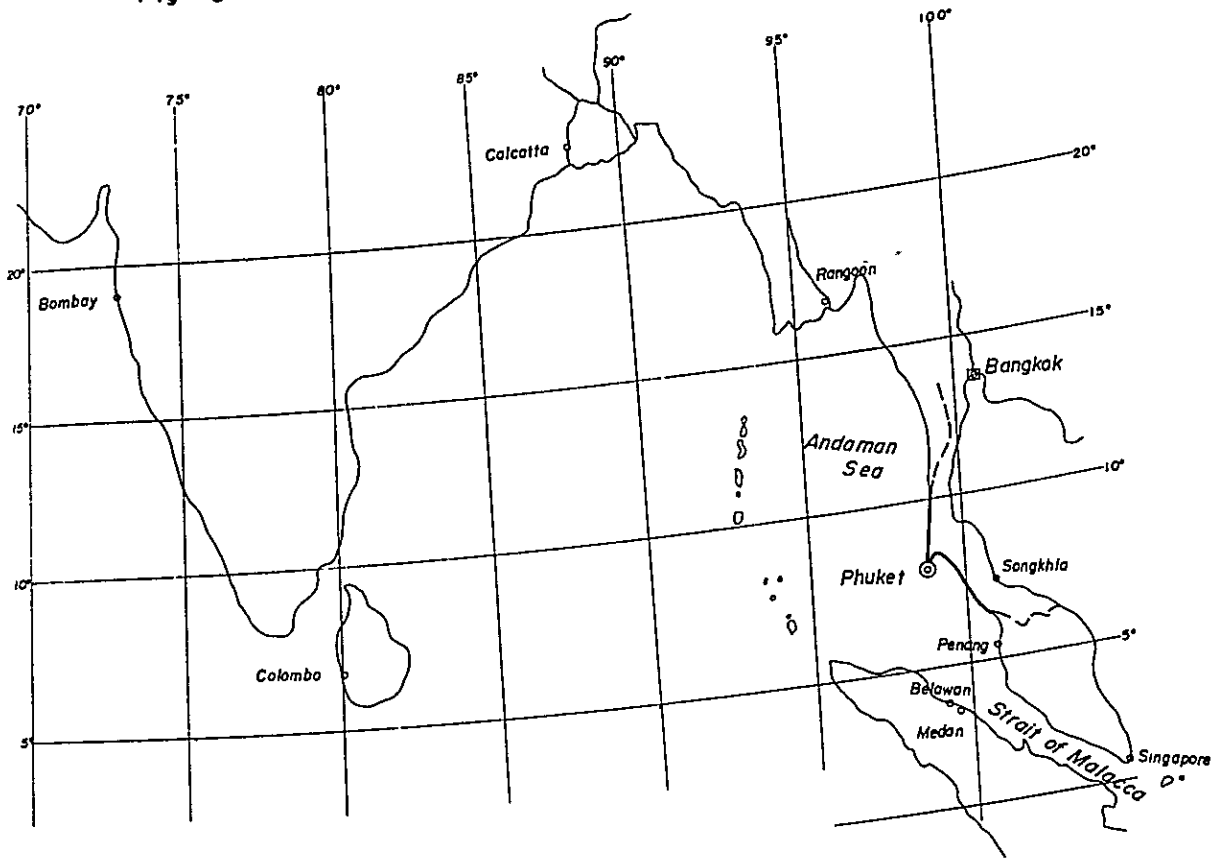
The ports on the east coast of southern Thailand are capable of carrying on marine transport activities through direct connection with the port of Bangkok and regions along the river banks. However, the ports on the west coast may be characterized by their dependence on connections with land transport for the smooth operation of domestic trade. Along the west coastline facing the Straits of Malacca, the Island of Sumatra serves to maintain a relatively calm sea throughout the seasons. The northern half of the peninsula faces the Andaman Sea, and is strongly affected by winds in the wet season. The southern half of the peninsula is along the international navigation route, while the northern half is slightly off the course.

However, the northern half of the peninsula lies in a favorable position for trade with Burma, India, and the west coast of Sumatra, while the southern half is situated close to the west coast of Malaysia and the east coast of Sumatra, occupying a position of greater advantage in marine trade in calm seas. In the northern section, the mountain range runs closely along the coastline, and not many rivers are available for inland navigation. Tracts of fertile land are scattered across the southern half, and the rivers may be utilized when necessary improvements have been carried out in the future. The natural features of the district indicate the possibility of development of industries and the growth of large towns with suitable slopes as sites for the construction of up-to-date dwellings. '

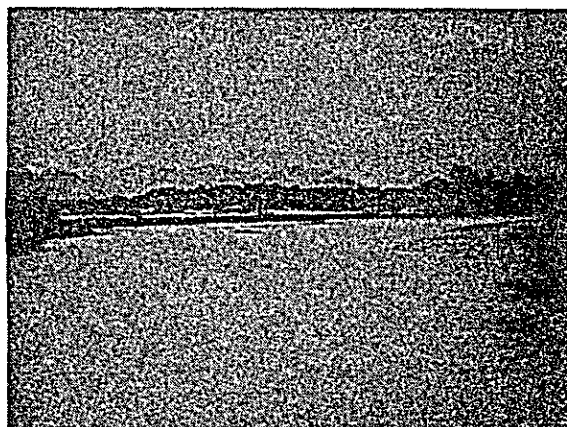
So far, we have given an account of our observation of the various ports with information obtained in advance, and now we will give a brief account of the actual state of ports in the locations of actual survey.

So far, we have given an account of our observation of the various ports with information obtained in advance, and now we will give a brief account of the actual state of ports in the locations of actual survey.

Fig - 3



(1) Port of Takuapa

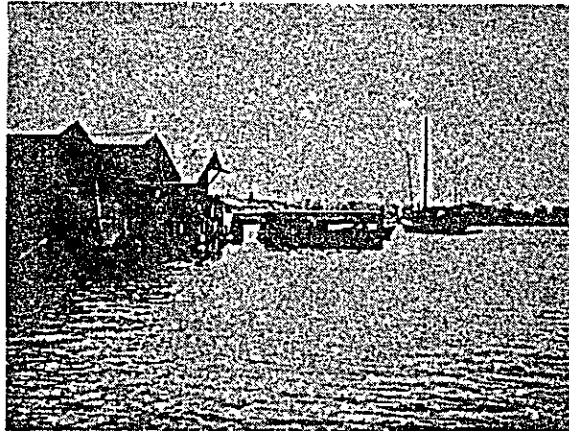


The pier of the port is located far inland from the coast of a shelving bottom on a narrow and shallow branch of a river which can easily be crossed on foot at ebb tide, and only a small amount of cargo is handled in the port. Situated on the highway linking Bangkok and Songkhla, today the town seems to be included in the economic sphere of road transport from Phuket. If the port of Phuket should be developed, the need for a port in this district will gradually disappear.

Cargo handled in the Port of Takuapa

	Exports	Imports	Total	Domestic Trade		Total	Total (thousand tons)
				Incoming	Out- going		
1964	8	2	10	1	0	1	11
1965	5	1	6	2	1	3	9
1966	4	0	4	2	0	2	6
1967	13	22	35	0	0	0	35

(2) Port of Krabi



The Port of Krabi is situated on the west coast of southern Thailand across the Island of Phuket, about 5 km upstream from the mouth of the River Krabi.

The average amount of cargo handled in the port from 1964-1967 is 15,000 tons per year, ranking as the fifth port on the west coast in the amount of cargo handled.

A 50,000 kw steam power station, the largest in southern Thailand is located in Krabi, with a generating capacity of 10 MW, using lignite and peat produced in Krabi as fuel. At present the service area includes Krabi, Pangnga, Phuket, Nakormsrithamaraj, Trang, Phatthalung, and Songkhla. Shortly, a diesel-power plant with a generating capacity of 10 MW to be erected in Krabi will also be supplying power to the area.

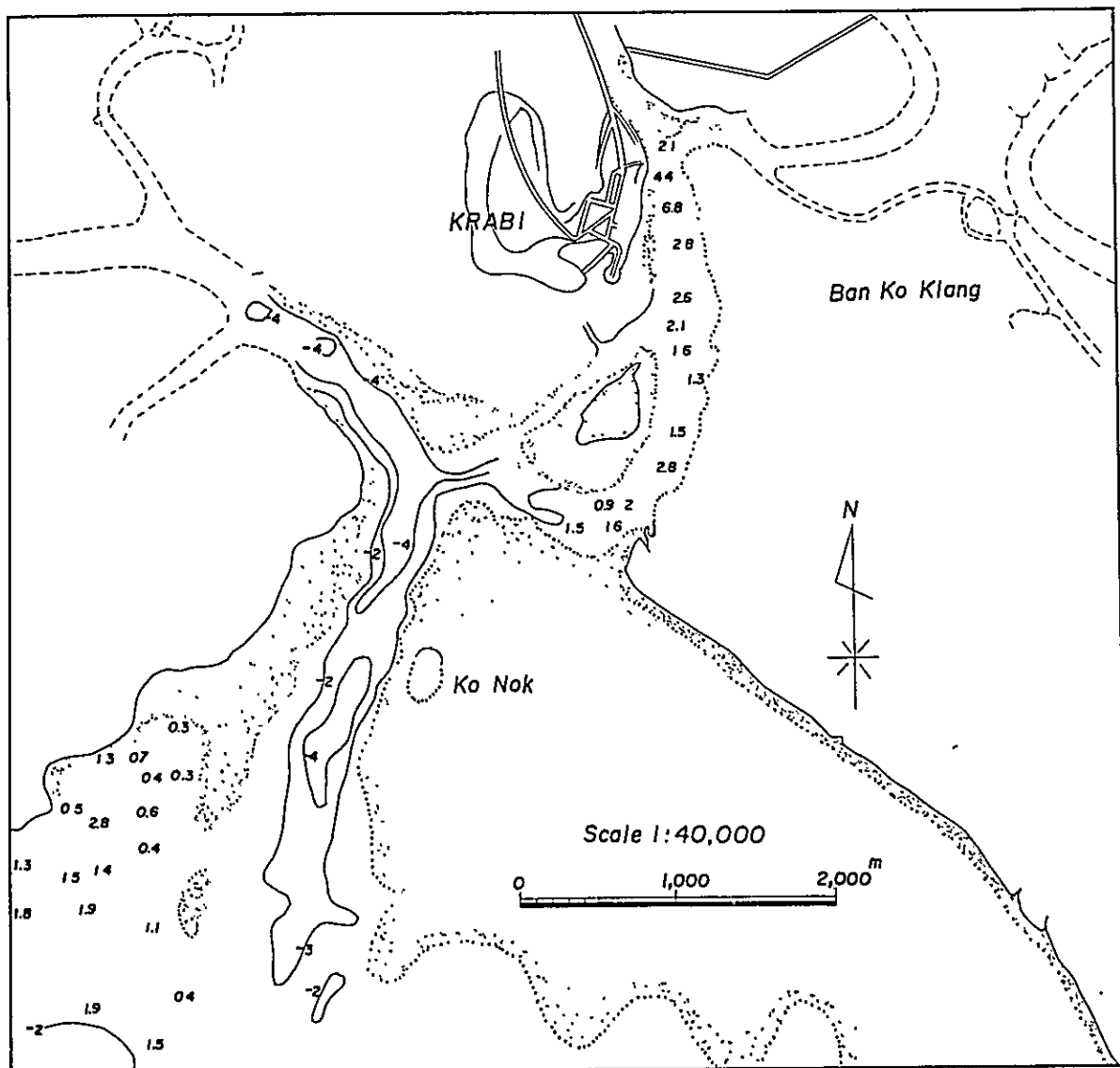
The depth of the River Krabi is 1.0m - 2.0m, and the contour line of - 5.0 m lies 5 km offshore from the river mouth. From the condition of sand bars and shoals around the river mouth, it will be extremely difficult to maintain the necessary water depth in accordance with the program to increase the water depth.

A fine paved highway has been constructed along the coast from Phuket to Krabi, and the distance may be covered in approximately three hours to serve as a convenient overland transport route. If the Port of Phuket is to be developed, we cannot find any need to improve the Port of Krabi immediately in view of the high cost of maintenance. The improvement program may be studied in the future when signs of development of the region may be observed with the advancement of industrial plants.

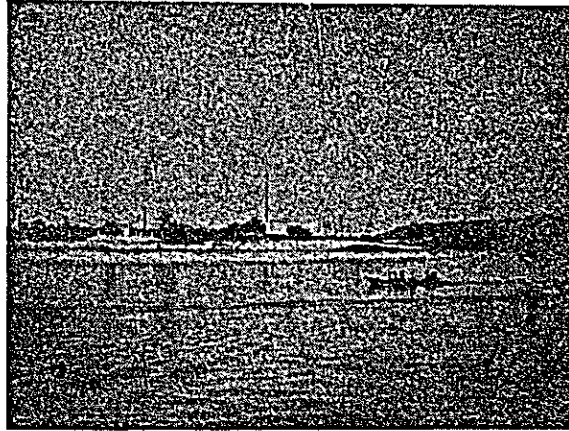
Cargo handled in the Port of Krabi

	Imports	Exports	Total	Domestic Trade		Total	Total (thousand tons)
				Incoming	Outgoing		
1964	1	17	18	0	0	0	18
1965	4	12	16	0	0	0	16
1966	2	10	12	0	0	0	12
1967	2	7	9	0	0	0	9

Fig 4 KRABI HARBOUR



(3) Port of Kantang



The Port of Kantang is situated on the west coast slightly south of the central part of southern Thailand, and is linked with the port of Phuket by a regular 63 passenger boat. The port is located about 22 km upstream from the river mouth, with the city of Trang (with a population of 18,621 persons) in the rear, which is linked by a double lane highway and a single-track railway. There is also an air base in Trang, though it is used for military purposes, and economic activities seem to be quite brisk in comparison to the population of the town. The average amount of cargo handled from 1964 - 1967 is 84,000 tons per year, consisting mainly of manufactured goods.

The tidal range is 3.5 m, the current is 1 - 2 knots at the river mouth, and the height of offshore waves does not seem to exceed 2.5 m.

The width of the river in front of the pier is more than 300 m, 100 m at the narrowest section, and over 1 km at the river mouth. The Harbour Department of Thailand has dredged a channel 60 m wide at the bottom for a distance of 27 km from a point 5 km offshore from the river mouth at a cost of 30,000,000 baht (¥540,000,000) over a period of 3 years to enable coastal navigation vessels of 300 tons to enter port. Today the dredging of the channel has been completed except for the anchorage in front of the pier, but the NEDB (National Economic Development Board) is said to have ordered the dredging to be stopped. Therefore, vessels wait for favorable tides for loading and unloading cargo which greatly decreases the efficiency in cargo handling.

Outside the channel, the water depth is 0 - 1.0 m, and from our observation, the channel will be easily buried by the attack of a single flood. According to the investigation of the Port Department, the depth of the channel can be maintained by dredging 400,000 m³ of sand, but the figure is quite questionable. In the river, there are numerous sand bars covered with large trees like an island, a proof of the large amount of sand and silt carried down the river.

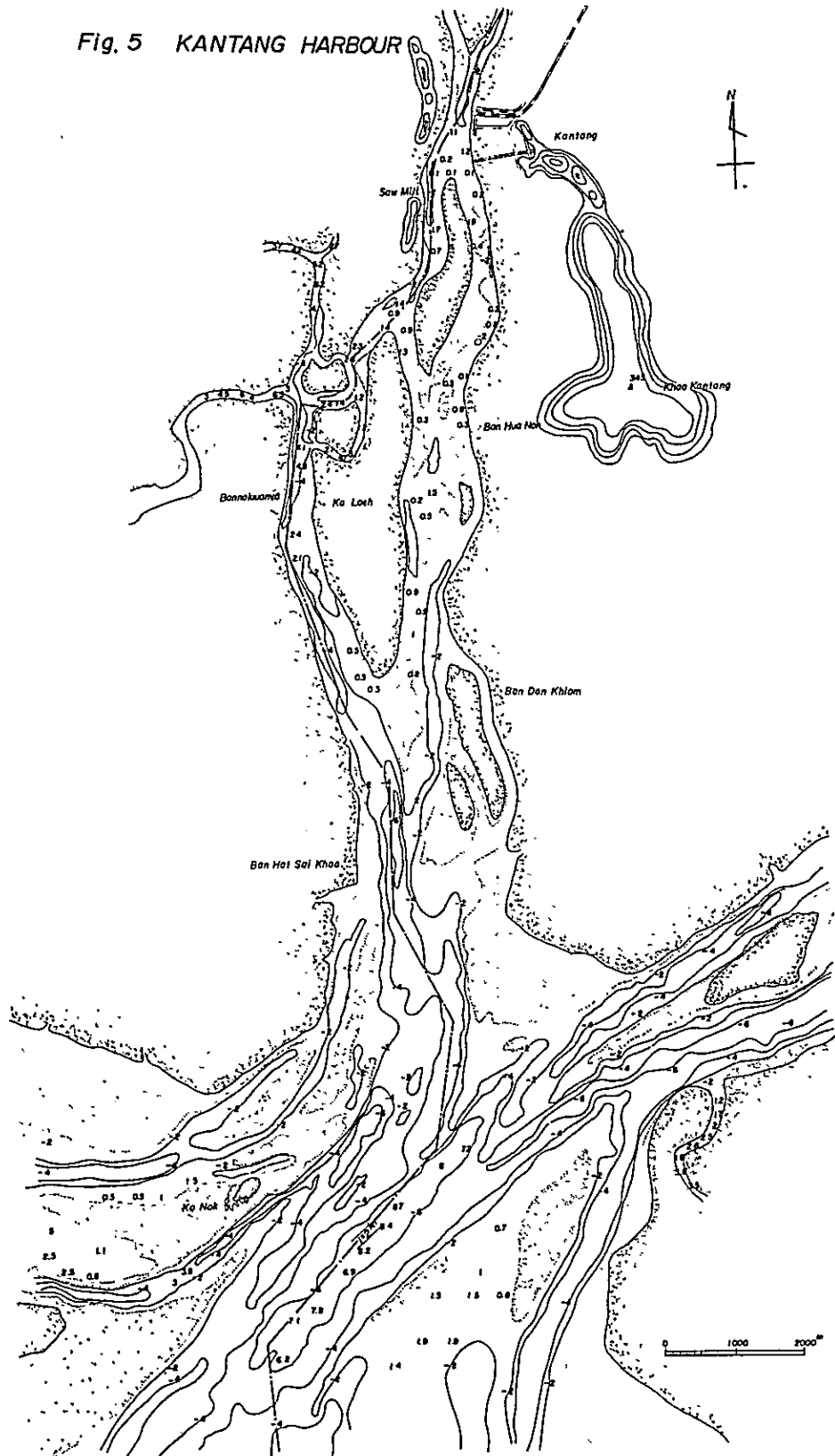
We believe that it is almost impossible to find a complete solution for the situation as long as the port is situated in the present location. However, in view of the tremendous amount of money invested, we believe that it will be necessary to carry on the minimum amount of dredging in the anchorage so that past investments will not be in vain. (It seems that the dredging has been stopped as the improvement of a highway linking the region with the east coast has rapidly decreased the need for a port)

The present port facilities include one berth of 50 m, at the pier for the exclusive use of vessels of 300 tons from Malaysia, one berth 50 m long with a water depth of -40 m at the wooden pier in front of the Port Office, and several wooden piers belonging to private fishery companies. The Port Department is planning to construct a pier of 240 m at a cost of 29,000,000 baht.

Amount Cargo handled in the Port

	Imports	Exports	Total	Domestic Trade		Total	Total (thousand tons)
				Incoming	Outgoing		
1964	5	44	49	12	19	31	80
1965	5	53	58	17	26	43	101
1966	5	47	52	12	22	34	86
1967	5	41	46	14	10	24	70

Fig. 5 KANTANG HARBOUR



(4) Port of Palian

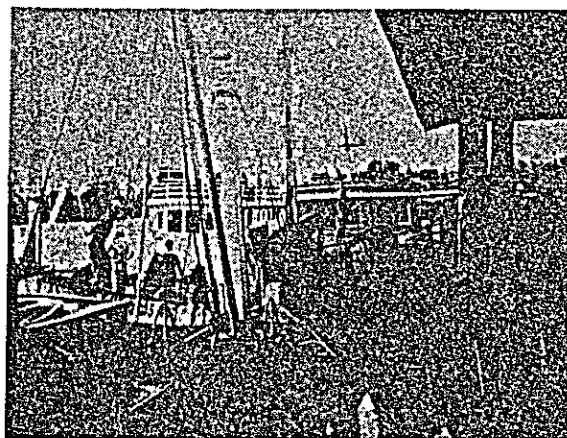


The present port is part of a small village developed on the river bank of a small channel 40 km south of Trang. A temporary bridge erected across the channel to the opposite bank, and a new road leads to the river mouth. The features show signs of a shelving bottom, but off shore cargo handling begins from a point in front of the Customs Office.

From its geographical position, while the port of Kantang is merely the outer port of Trang, Palian is situated along the highway which leads to Songkhla via Hajiyai in less than 150 km, and a paved road is near completion from Trang.

The construction of a road to Hajiyai will encounter difficulty in crossing the high mountains. However, if plans for a needed summer resort in the mountains could be studied along with the development of the port, we believe it would be worthwhile to commence fundamental investigations around the river mouth.

(5) Port of Satun



Satun is situated near the territorial border of Malaysia and Thailand. A paved road of approximately 100 km has been completed from the town of Hajiyai, opening way to truck transport from the Port of Songkhla. The present facilities are separated in two locations, and at Ko Nok (Bird Island) which we visited, a fishery wharf of 50 m has been constructed with a road running on a banking in mar shland, and the area was excitedly active with about 11 trucks. Various type of fish of different size were packed in ice and loaded on trucks to be transported to Hajiyai. The charge for a 2.5 ton capacity truck is 400 - 500 baht. The customs and marine police have their offices in the port, and the amount of cargo handled in recent years are given in the following table.

Amount of Cargo handled in the Port of Satun

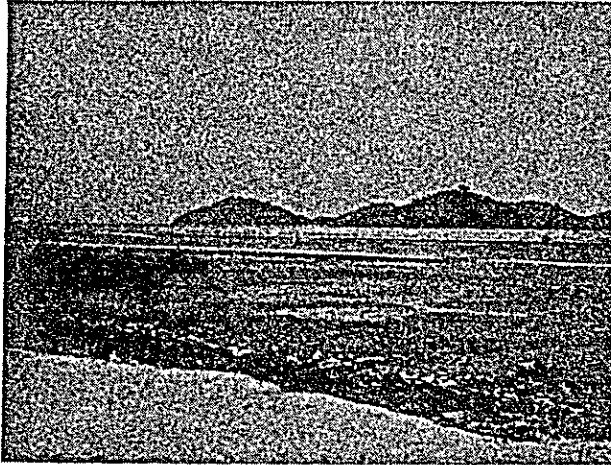
	Imports	Exports	Total	Domestic Trade		Total	Total (thousand tons)
				Incoming	Outgoing		
1964	-	13	13	2	2	4	17
1965	-	14	14	1	2	3	17
1966	16	11	27	1	2	3	30
1967	23	9	32	0	0	0	32

The present navigating channel is a natural water route taking advantage of one of the channels running between the numerous small islands at the river mouth. The width of the river is 50 m, with a water depth of about 1 m, and winding curves along the course down to the sea delay the navigation of vessels as in the case of other ports. The construction of a port must begin from the preliminary stage of drawing maps and charts, and the collection of data of fundamental survey of hydraulics and soil.

As a fishery port in the tropics, an ice factory and storage and food manufacturing factories will be indispensable facilities, as well as a shipyard to build and repair boats, and oil tanks. With promising fishing grounds in the neighbouring seas, Satun is situated at the shortest distance on the coast of Thailand from Penang, the only commercial port on the Malaya Peninsula.

With a road leading directly to the port of Songkhla, and situated in a location with bright prospects for the future, the investment of funds should be confined to the improvement of present facilities. We believe that the time has arrived to seek a new site near the river mouth for the construction of wharves to serve both commercial and fishing needs, and eventually move various facilities to the new port, under a program for a concentrated efficient investment of funds.

(6) Port of Phuket

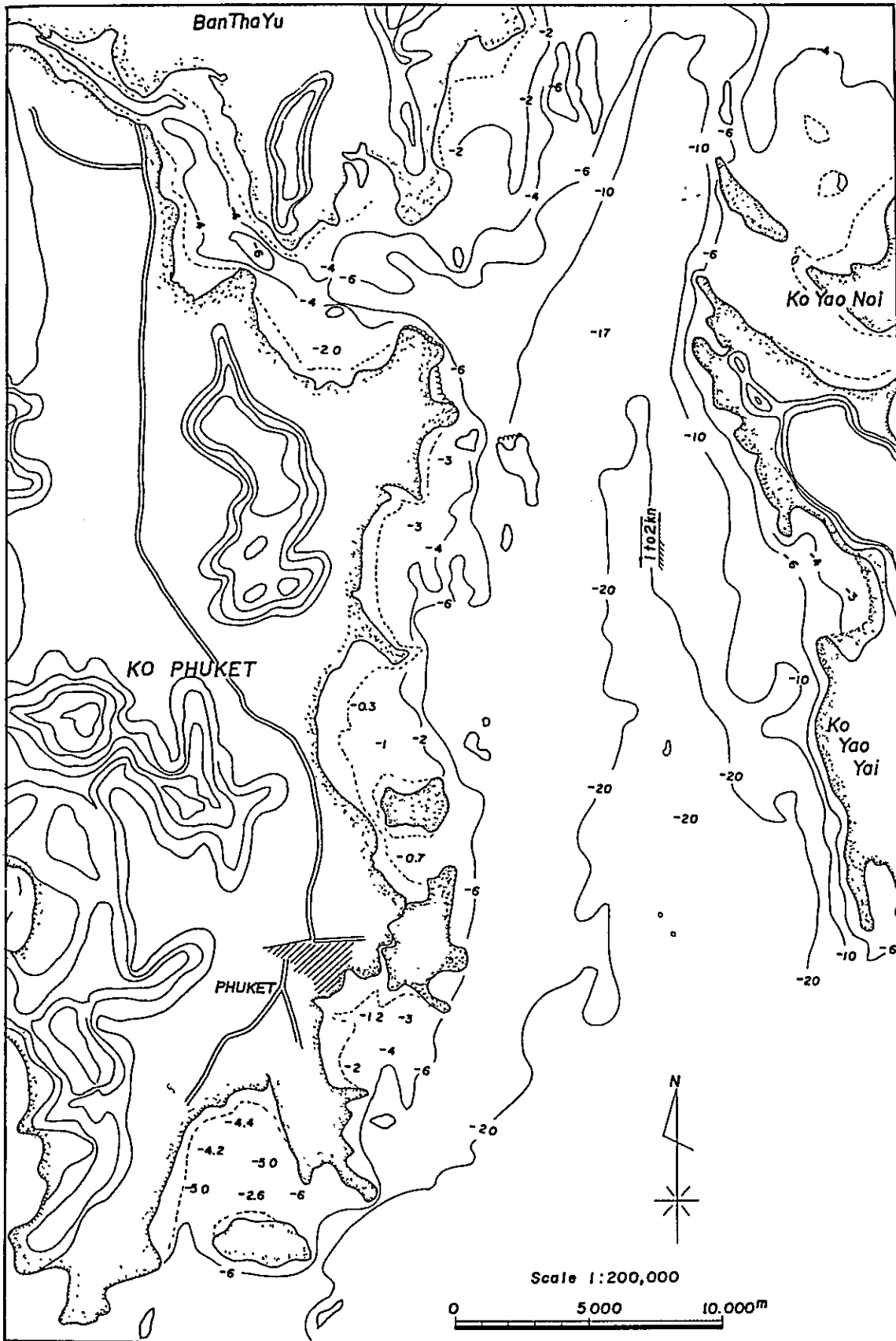


The Island of Phuket is situated about the middle of the west coast of Thailand at the end of a tract of land stretching out from the Malaya Peninsula, with an area of 522 km² and a population of 93,400. A DC 38 plane of the Thai Airlines flies daily to Phuket from Bangkok in approximately 1 hour and 45 minutes. The town of Phuket which stretches out on the southeast end of the island (7° 53' latitude and 98°23' longitude) with a population of 20,000, is the largest town on the west coast, boasting beautiful scenery as a port town.

The Port of Phuket is located near the southern end of the island and is known as the loading port of tin from olden times. The island is the center of the production of tin in southern Thailand. The port handles the largest amount of cargo among the ports on the west coast and the average amount of foreign and domestic trade cargo handled from 1964-1967 is 117,000 tons per year. The cargo consists mainly of rubber, tin, machinery, petroleum products, and domestic cargo accounts for merely 20% of the total amount handled.

Port facilities include a pier (depth -7m, length 140 m) of the tin refinery plant, a pier of the petroleum company with a depth of -8m, a length of 61 m and a width of 12 m, private wooden piers in the fishery port (depth -3.0 m, length 80 m, and width 5m) and a private pier with a depth of -1.5m and an area of 2x30m.

Fig - 6 PHUKET HARBOUR



Cargo handling is carried on by hand and public cranes are not installed. The pier has a 5-ton crane, and the tin refinery is using a 3-ton fork lift and a mobile crane.

There are 5 - 6 barges including 100 ton barges, but there are no tugboats. There are two mooring buoys installed at an interval of 230 m in Ao Tangkhen.

Vessels over 100 tons entering port are all in connection with the tin refinery. According to statistics of the South Thailand Shipping Services Company Ltd, which operates the vessels, 2 - 6 vessels of 7,000 D W T. enter port in one month loading 300 - 500 tons of tin per vessel. The destination is mainly America and countries in Europe. (Period of anchorage is 7 - 24 hours)

In southern Thailand from November to March when the northeast monsoon prevails, and at times when the east wind prevails, vessels take shelter by an island 1 sea mile offshore the Yao Yai Island. From April to October when the southwest monsoon prevails, and at times when the west wind is strong, vessels anchor in the shade of the Island of Phuket 1/2 sea mile from Cape Mai Phai.

The tidal level and current are as follows

L. L. W.	0.00 M
M. L. W.	1.11
M. T. L.	2.03
M. H. W.	2.87
H. H. W.	4.01

The tidal current does not exceed 2 knots.

The climate is mild compared to other parts of the country.

Taking the average of the past 13 years,

highest temperature of the year	31°C
average temperature of the year	27.6°C
lowest temperature of the year	24.0°C

Taking the monthly average, highest temperature 35°C

Taking the monthly average, lowest temperature 21°C

Yearly amount of rainfall	2,388 m/m
Relative humidity	78.0%
No. of days of rain	163 days per year

The Island of Phuket is one province, and according to the annals of the province, the relative humidity is 78%, the number of days of rain is 163 days/year, and the density of population on the island is 161 persons/km². The amount of tin

produced is 25% of the total amount produced in Thailand, raw rubber is 4.7% and coconuts 1.3%.

The ratio of labor population is as follows:

Agriculture	55%
Industries	19%
Trade	10%
Mining	10%
Others	6%

The main products produced in 1967 are as follows:

Tin	110,809 piculs	288,105,870 baht
Fisheries	8,235 tons	18,933,408 "
Lumber	620 m ³	
Coconuts	16,000	12,000,000 "
Rubber	6,400,000 kg	12,000,000 "
Fruits		1,500,000 "
Farm Products		4,936,400 "
Livestock		14,304,200 "
Eggs		4,785,715 "

Various Factories and Shops

Turnery	14
Automobile repair shops	16
Ice manufactory	3
Food manufacturing factory	8
Cement and tile factory	3
Tinware factory	7
Printing shops	5
Mineral refinery	1

Industries in the region include the mining of tin ore, and the refining of tin assembled from mines throughout the country by the Thailand Smelting and Re-Refining Co., with an yearly output of 15,000 tons. Approximately 6,400 tons of rubber is produced, and the fishery catch amounts to 8,200 tons which is packed in ice and conveyed to Bangkok by truck.

A paved national highway from the Island of Phuket crosses the New Bridge (width 8 m and length 160 m) and runs to the Krabi and Trang district, and the

Takuapa and Ranong district. The width of the road bed is 30 m with a banking in the banking in the center for a 2 lane asphalt paved road. (Refer to investigation data for details)

There is a branch railway line from Ban Thung Pho Station to Khirirat Nikhon Station, and the extension to the town of Phuket is included in the 10 year program.

The Port of Phuket was originally a fine port located in the southern end of the town at the lower stream of the River Phuket, but has been buried by siltation from the tin mines, and it is difficult to find the original port today. The Customs office stands quite far away from the present port. The port has been moved to the lower stream of the Tachin River since 25 years ago.

Amount of Cargo handled in the Port of Phuket

	Imports	Exports	Total	Domestic Trade		Total	Total (thousand tons)
				Incoming	Outgoing		
1964	46	22	68	19	3	22	90
1965	62	21	83	25	4	29	112
1966	79	29	108	27	1	28	136
1967	77	37	114	14	0	14	128

The fishery catch is comparatively small at present, but as a promising fishing ground in the future, the Government is establishing a Fishery Office. Of the 7, 200 tons of fisheries, 7,100 tons are transported outside the province. Approximately 80 fishing boats registered in the province and 65 vessels from other provinces are operating in the waters. There is a fish-drying factory producing 700 - 1,000 kg of dried fish, the price of which is 2.8 baht/kg, and six salt fish factories producing 1,000 kg of salt fish at 4.0 baht/kg. There are also three ice manufactories.

From 1948, the Government studied the possibility of improving the port under a large-scale development program, but the project was abandoned in 1952, as consultants opposed the program on grounds that there is not enough cargo to be handled, and if Thanoon (north of Phuket) and Surasthani should be linked by road or railway, the majority of the cargo handled in Phuket will shift to Songkhla or ports on the west coast with more convenience. 1956, the Government commenced studies on a new plan to improve the port and the feasibility of dredging the port from the economic point of view. As a result of these studies, it was decided to dredge the channel to a depth of -2.5 m, and the anchorage to a depth of -3.0 m, and construct

a pier of 60 m in length. The majority of large vessels and coastal navigation vessels will benefit from the project. The total cost will be 706,000 dollars, of which 625,000 dollars will be spent on dredging works. The project has been confirmed by the Government with the approval of the World Bank.

IV Approach to Development of Ports on the West Coast

1. River Ports

The ports on the west coast with the exception of Phuket are river ports, and the shores and river mouths are of shelving bottoms with sand and silt washed down from the rivers and drift sand. We could not find a site with promising features for a port, where a water depth of merely 5 m could be maintained.

It would be advisable to concentrate on the development of the Port of Phuket and merely maintain the present facilities in the other ports until port activities increase and call for further improvement. In the meantime, available data may be collected to study the characteristics of the rivers, and fundamental investigations carried on to collect information necessary to draft plans for the improvement of facilities in various ports. It would not be too late to determine the order in which the ports should be developed, watching closely the progress of the development of southern Thailand with the construction of highways.

Ports at river mouths are subject to various damages from floods and draught, and the water depths along the channel vary constantly. Visibility in navigation is obstructed by winding curves of the channel, and the radius of the curve is too small in sections for the safe navigation of vessels. With the increase in the dimensions and number of vessels, frequent occurrence of accidents cannot be avoided and the ports can no longer function in their capacity as a traffic terminal.

In the existing ports, it seemed advisable to select a new site near the river mouth or beyond, and construct adequate anchorage and wharves, reclaiming land with sand and silt obtained from dredging the channel from the sea. Roads may be constructed to neighbouring towns and villages for the transportation of cargo to and from the new ports, and the time will come when the towns will gradually expand toward the ports.

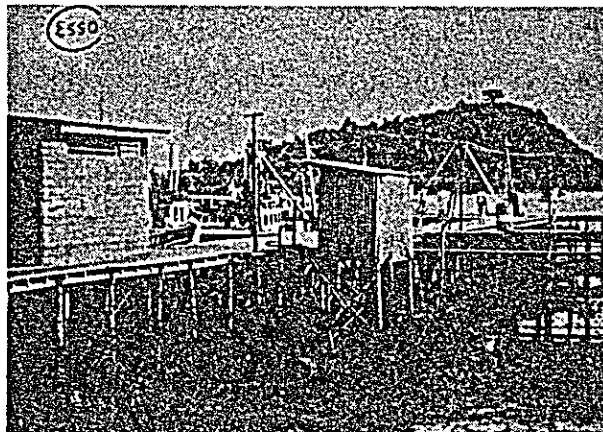
We believe that a change in policy should be taken to check as far as possible further investment of funds to increase the depth of the channel in long rivers and for maintenance dredging, particularly in districts with prospects for future development.

Even in ports where a considerable amount has already been invested as in the case of Kantang, we believe that it would be wise to stop any plans for further development of the port, and merely carry on certain additional works necessary to supplement the present functions of the port so that funds invested so far

will not be wasted. It would be advisable to absolutely refrain from investing new funds of a large sum to maintain the facilities in the improved state. The district in the rear of the Port of Kantang will probably become a promising center of economic activities in southern Thailand. As mentioned above, it would be the best policy to conduct investigations in search of a favorable site such as Palian, from the point of location and distribution of ports, and gradually shift the operation of marine transport to the new site.

Analyzing the progress of the economic development of southern Thailand, the utilization of rivers and necessary investments should be considered under an over-all development program. We believe that the time has not come to conduct engineering works on a large scale to make drastic change in the natural channel around the river mouths in an attempt to preserve the present ports at the river mouths.

2. Port of Phuket



The shores of the Port of Phuket is buried with sand and silt which has probably been pushed out from the coast. A small amount of marine cargo comes from the mining of tin ores and rubber plantations. However, from its geographical position, favorable topography, and natural surroundings. Phuket shows promising signs for future development into a fine port city. But even if port facilities should be improved to enable large vessels to enter port and berth along the newly constructed wharf for loading and unloading of cargo, we cannot expect the large number of ocean-going vessels sailing the sea in front of Phuket every day to change their course and call at the port.

Various conditions must be satisfied in order to persuade vessels unloading European products at Penang to be transferred to ports on the west coast of Thailand to call at Phuket to unload these goods. There must always be a sufficient supply of cargo to be loaded from the port to pay for the extra expense of calling, and the facilities and services in the port must be attractive enough for trading firm and various distribution systems to change the flow of goods. Trade with neighbouring countries along the coast cannot be expected to increase as cargo to be exchanged will be of similar products of the region.

Unless Phuket can be developed into a manufacturing center to produce various goods at a low cost to supply the inhabitants of the neighbouring ports with daily necessities, coastal navigation vessels will not be attracted to the port.

We have tried to find a solution by securing a large amount of cargo for the Port of Phuket immediately. Thailand imports 3,000,000 - 4,000,000 tons of petroleum oil per year. This marine cargo will increase with the modernization of the country, and this also applies to neighbouring countries on the west coast. Bangkok is a river port, and it is extremely difficult and a heavy burden to continue to increase the width and depth of the long channel to meet the demand of large tankers, the dimensions of which are on an ever increasing trend. A larger number of tankers entering the port will no doubt increase the danger of accidents in the port of Bangkok.

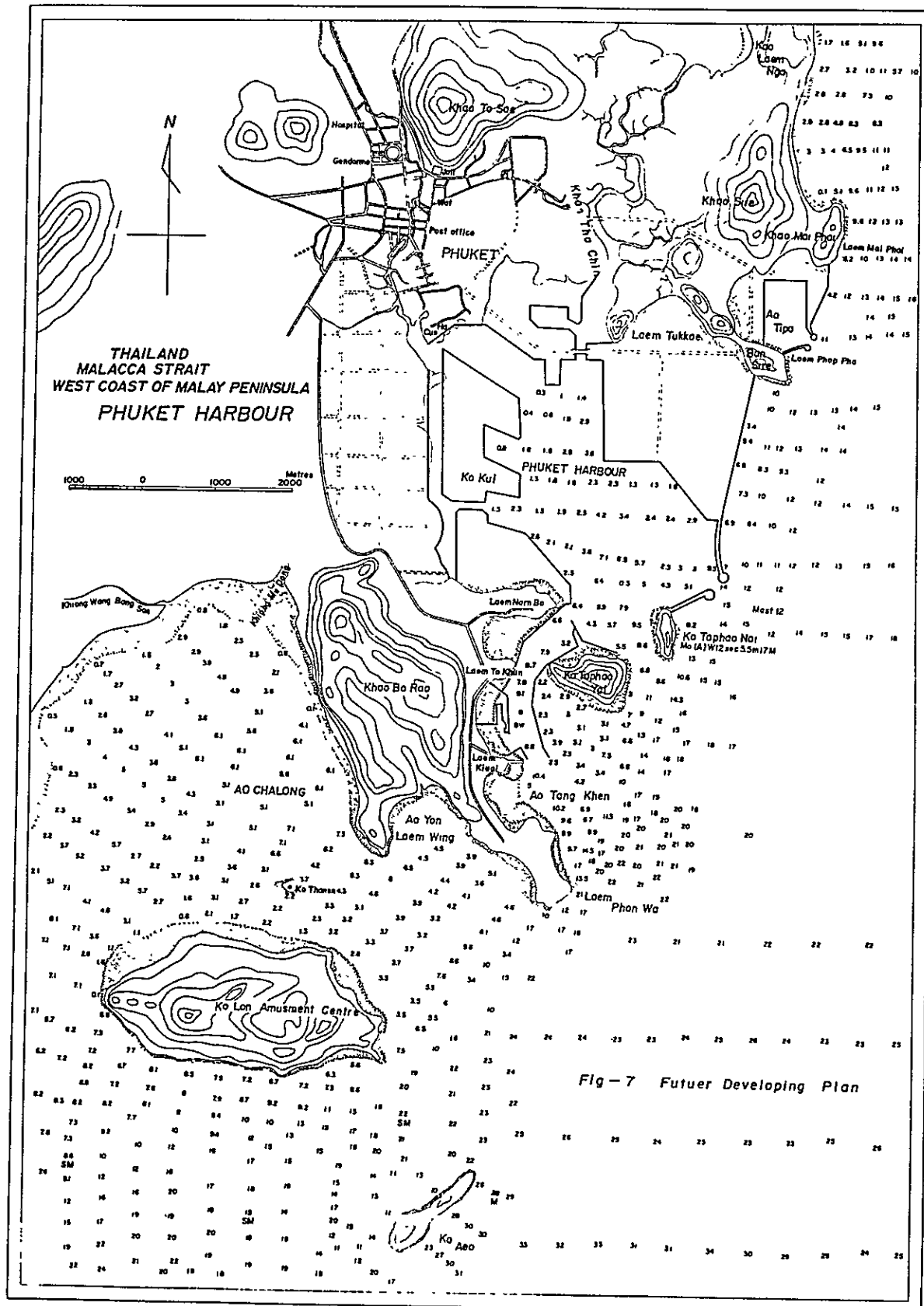
If the petroleum imported from the Persian Gulf and the Suez district could be unloaded and stored in Phuket, and if an oil refinery could be built to refine a portion of the crude oil, it would certainly be in compliance with the important national policy of developing the southern region. If the oil could be sent to the ports on the east coast by pipelines in the future, and transferring facilities at intersections with roads and railways can be supplied, similar ports to be constructed on the east coast may be of a smaller scale, sufficient to meet the needs of coastal vessels for some time.

The unloading of a large amount of crude oil from tankers will serve as the main purpose to begin the construction of a large port for ocean-going vessels at Phuket. A large volume of exports to Europe including teakwood is conveyed by railways to Bangkok. Calculating the cost of transportation to Bangkok and the cost of transportation to Phuket in event a railroad is built, we may find the possibility of attracting the cargo to Phuket. Gradually promoting various industries and establishing tourism facilities, we may look forward to the development of an

up-to-date international port and harbour city in the future.

We feel that it is of the utmost importance at the present moment to carry on an over-all investigation of economic problems and natural features to draft an adequate program for this purpose.

We believe that Phuket is situated in a location where works for development of the port should be gradually carried on according to a grand master plan, as a separate case from the development of other ports on the west coast. We have presented a draft of the plan in diagram, but the scale of the plan, the shape of the port, and other details should be determined after careful study from various quarters in the future.



V. Ports on the East Coast

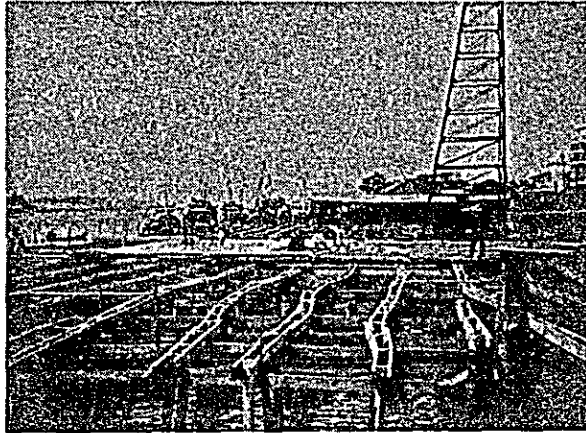
Proposed sites for the construction of ports on the east coast were not included in the present investigation program, but as we explored two or three sites in connection with the survey of ports on the west coast, we will give a brief account of the ports.

In southern Thailand, the population is gathered on the east coast, and the ports on the east coast can be connected directly with Bangkok and inland river navigation routes extending over a distance of 3,500 km. The ports are in a position to play a bigger role in the development of the district than their counterparts on the west coast.

The transport of marine cargo in recent years in the ports on the east coast which we explored are given in the following table.

	Year	Imports	Exports	Total	Domestic Trade			Total
					Incoming	Outgoing	Total	
Port of Bandon	1964	-	1	1	49	68	117	118
	1965	-	1	1	44	56	100	101
	1966	-	-	-	44	47	91	91
	1967	4	-	4	52	52	104	108
Port of Songkhla	1964	8	164	172	72	39	111	283
	1965	5	160	165	82	45	127	292
	1966	2	179	181	91	45	136	317
	1967	2	218	220	76	54	130	350
Port of Pattani	1964	3	40	43	54	6	60	114
	1965	-	31	31	61	6	67	128
	1966	11	31	42	75	7	82	157
	1967	-	39	39	55	15	70	125
Port of Naradhiva	1964	-	15	15	9	6	15	30
	1965	-	20	20	14	8	22	42
	1966	9	23	31	11	5	16	47
	1967	-	23	23	11	8	19	42

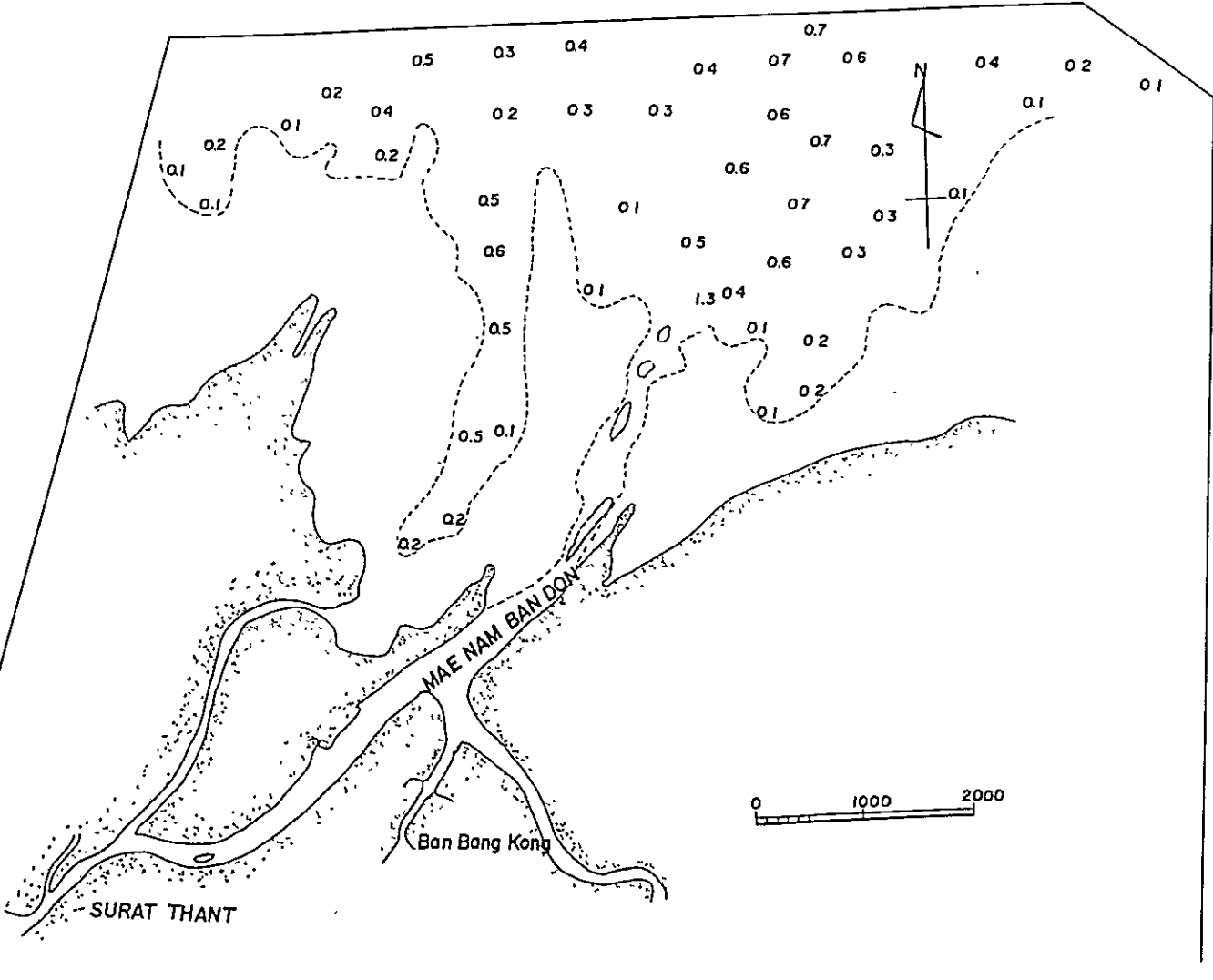
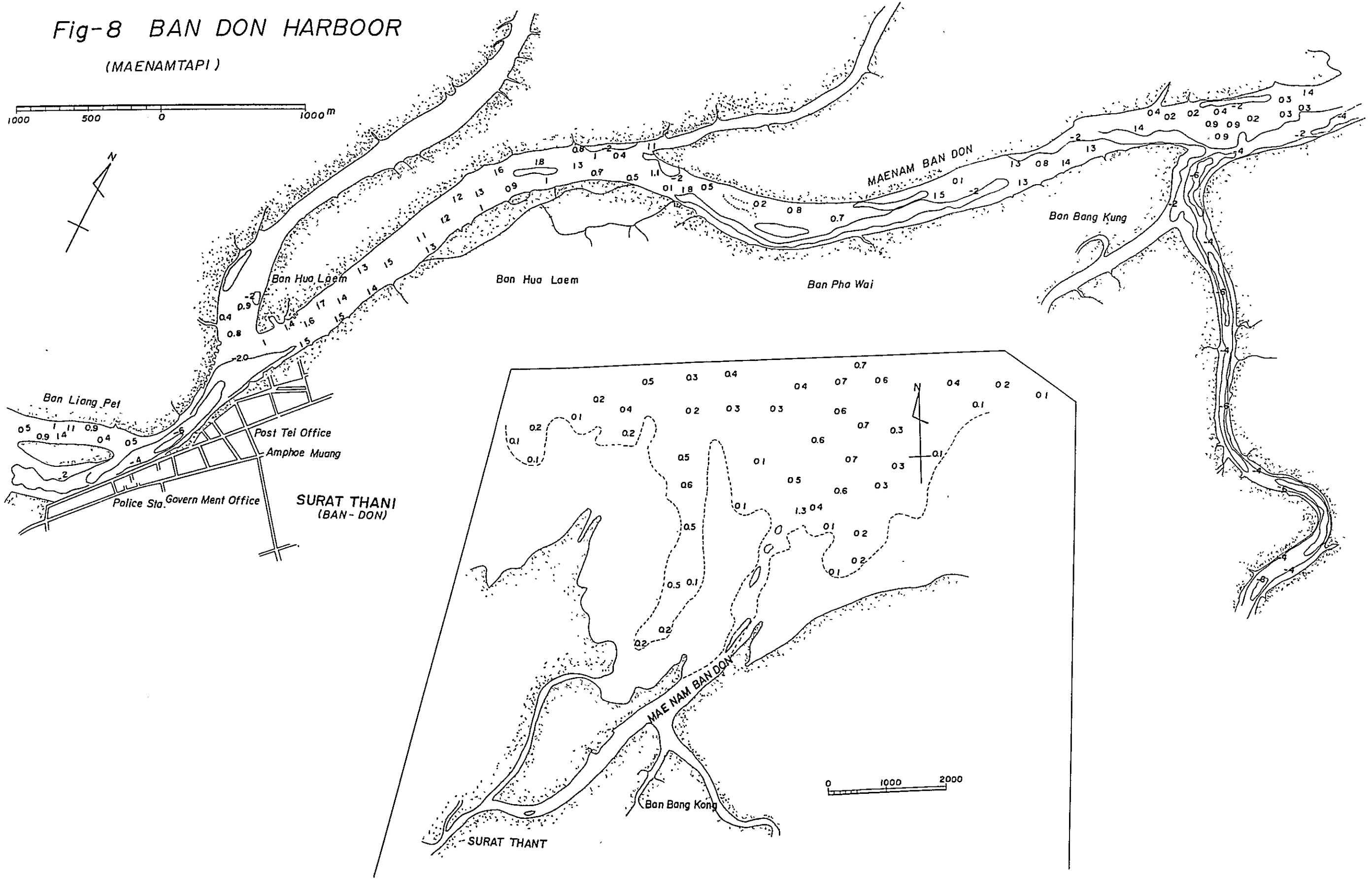
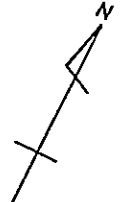
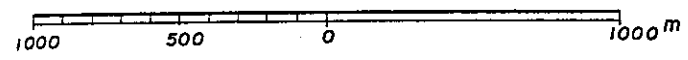
(1) Port of Bandon (Suras Thani)



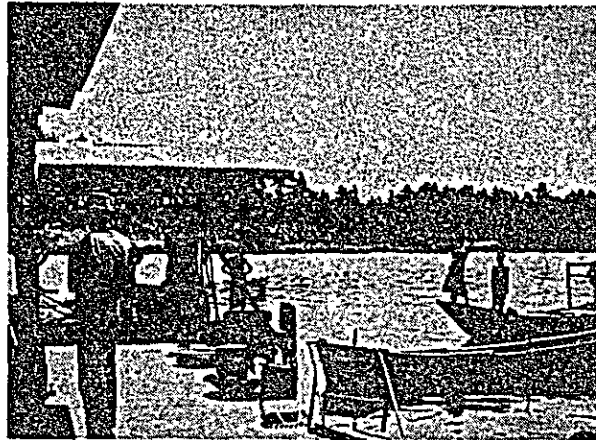
A new paved highway from Phuket via Takuapa has almost been completed. Bandon is situated about 200 km east of Takuapa at about the same latitude. The river takes a winding course for more than 20 miles from the river mouth, and 2-1/2 hours are required to reach the sea from the pier by small boats, but the port is in a state to allow the entrance of boats of less than 100 tons. Cargo handling is carried on quite briskly in the port.

An average of 105,000 tons of cargo per year were handled from 1964 - 1967, most of which are domestic cargo from Bangkok consisting of daily necessities. The water level of the river surface is 1.4 m above mean sea level, 2.2 m at high tide, and 1.8 m at ebb tide. As a water depth of 3.0 m is reached at a distance 20 km offshore from the river mouth, dredging of a channel will involve a heavy cost. Though the condition of the river at flood time is not clear, judging from the state of the coastline, we may presume that a considerable amount of sand and silt is washed down the river. Together with the disturbing effect of the northeast wind on the sea surface, the maintenance of the necessary water depth will be extremely difficult.

Fig-8 BAN DON HARBOOR
(MAENAMTAPI)



(2) Port of Pattani



The port is situated in the middle part of the coastline between Songkhla and the Malaysian border, with Yala, the new town of southern Thailand, slightly less than 40 km in the rear district, and approximately 80 km from Songkhla.

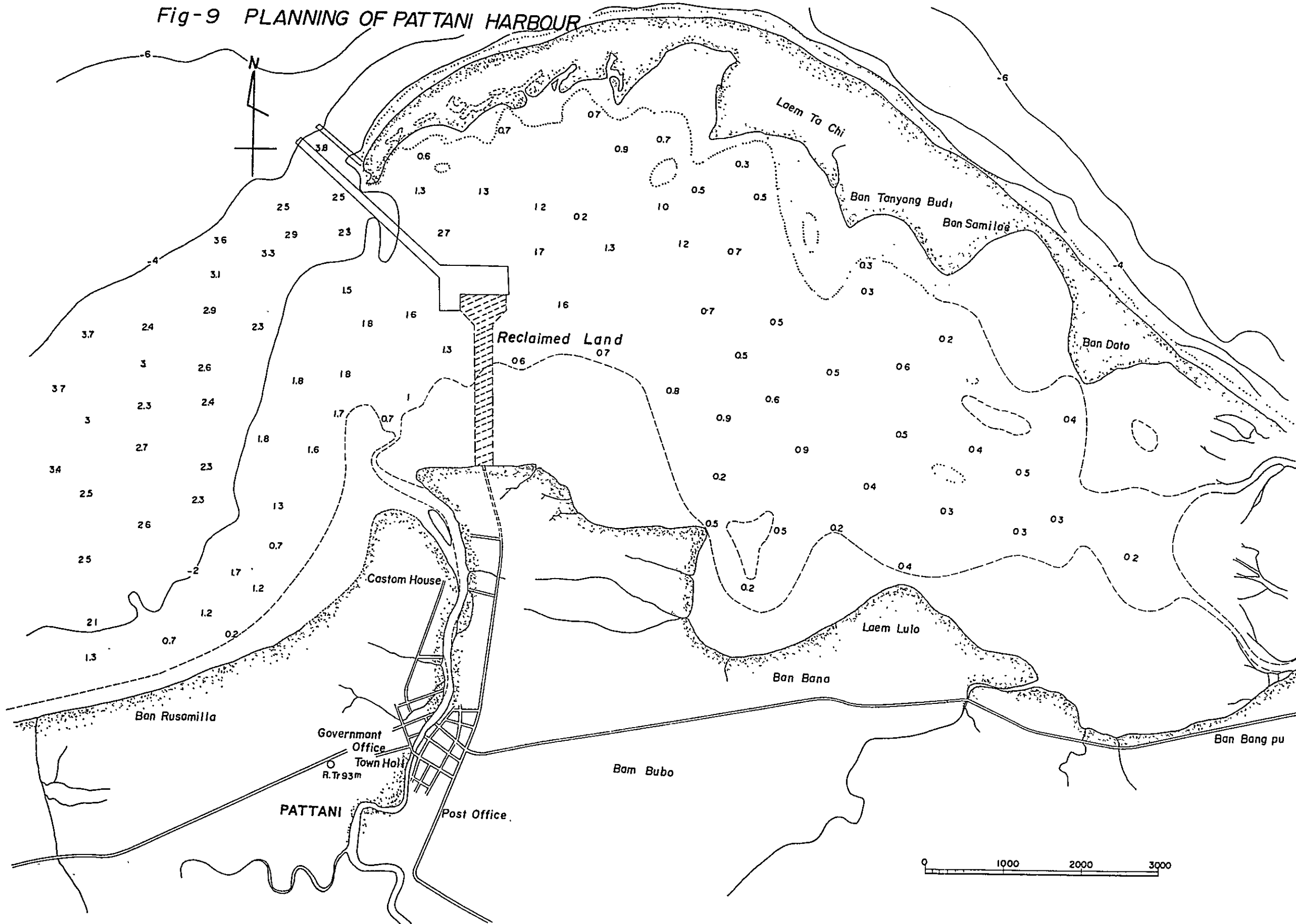
The present port is located about 5 km upstream from the river mouth, and the water depth at the river mouth is so shallow that even fishery boats find difficulty in entering and leaving port. The Port Department is planning a program for a channel of 60 m in width with a depth of -3.0 m for a distance of 4 km, dredging 960,000 m³ of sand at a cost of 3,569,300 baht to enable vessels of 300 tons to enter port.

The average amount of cargo handled per year from figures for 1964 - 1967 is 131,000 tons, ranking second to Songkhla among the ports in southern Thailand. With the development of the Port of Songkhla and the construction of a highway, the cargo to be handled will inevitably show a sharp decline. The water level is 1.6 m spiring rise, 1.44m at neap rise and the M.S.L. is 1.75m. The tidal current is 1 - 2.3 knots at the river mouth, and it may be assumed from the water depth at the river mouth that the wave height does not exceed 1.0 m.

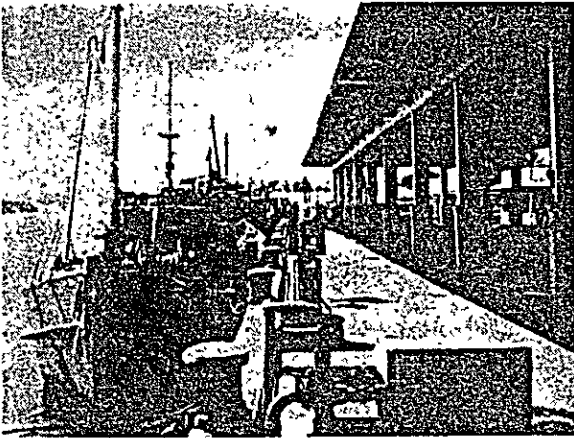
The Province of Pattani has the highest density of population in southern Thailand, and the growth of population is highest in the Province of Yala. Increasing economic activities in the provinces will call for the improvement of ports and harbours. However, judging from the sand bars and shoals at the river mouth, even if the channel is dredged to a necessary depth, it would be extremely difficult to maintain the water depth for the navigation of vessels.

It would be advisable to maintain the present condition in the port and speed up the development of the Port of Songkhla. Observing the effect of the new port on the transportation system, fundamental investigations on the Port of Pattani may be carried on, and various development programs should be compared and studied thoroughly until the time is ripe for the construction of the port. We will present a plan for the development of the port with objects to be surveyed in the investigation program.

Fig-9 PLANNING OF PATTANI HARBOUR



(3) Port of Songkhla



From its geographical position, natural surroundings and effect on the economy of the region, Songkhla is the foremost site in southern Thailand for the construction of an up-to-date port, and circumstances have reached the stage to carry out the plans immediately. We have already submitted a detailed report on these points, but we have reaffirmed the situation from our present survey of the ports on the west coast, and we have been convinced that our program for the first stage of development is a quite satisfactory plan.

The existence of a channel of adequate length and width down to the seashore with a considerable natural water depth created not by the river but from the effect of a large lake is a blessing of nature. A favorable site may be found on the shores outside the port for the construction of new facilities, and the port may also be extended into the lake. It is indeed a favorable port without any features in the topography of the area which would obstruct the future development of the port. It is one district where funds may be safely invested on a long-range program anticipating the future prosperity of the district.

The following points must be given special consideration from the engineering point of view in drafting the development program: (i) means of disposing drift sand, (ii) the navigation of incoming and outgoing vessels, (iii) the reclamation and utilization of the land in the rear of the wharf, and (iv) considerations for future expansion.

Depending on the judgement of the importance of the role to be played by Songkhla at present and in the future, two programs, one on a progressive line, and the other on a conservative line may be conceived. As we understand that two or three programs have been drafted so far, we will state how we arrived at our proposal with reference to previous plans.

Our proposal was adopted after various discussions on the original draft drawn by members of our investigation team following a survey tour of the proposed site. Our team is composed of an authority on hydraulics, an expert in planning and constructing marine structures, an expert in harbour planning, and an engineer with a long experience in supervising works in the development of ports and harbours in various parts of Japan, observing the results of the works.

(i) Construction of a Port on the Seashore

Taking advantage of the topography of the coastline and the island offshore, a long breakwater and jetty will be constructed to enclose the anchorage, inside of which a wharf will be constructed to serve mainly ocean-going vessels.

However, in view of the present state of the Port of Songkhla, the time is not ripe to invest a large sum on port facilities in the open sea from the beginning. The present facilities in the inner port will not be used in full, and as the future development of truck and container transport indicate considerable changes in the usage of wharves, it would not be feasible to fix the limits of reclaimed land and the utilization of the rear area at the present moment. The open sea should rather be reserved to meet future demands.

In the meantime, collecting data indispensable for the construction of a port, from close observation of waves, tidal currents, amount of drift sand, winds, soil, and variation of water depths, various drafts may be drawn through careful study of available data. Watching the trend of the growth of port activities to be expected from increased efficiency in port functions as the result of the completion of the first stage of construction works of our program, it would be the best policy to wait until circumstances call for further development of the port. Therefore, the previous Japanese investigation team dismissed the plan for the construction of a port in the open sea at the present stage.

Plan of Port on the Seashore (draft)

Revised Plan of 1959 (West Germany)

(Model experiments have been carried out on the original plan of 1953 at Hanover)

Fig.-10 Topographical Map of the area Araund Songkhla Port.

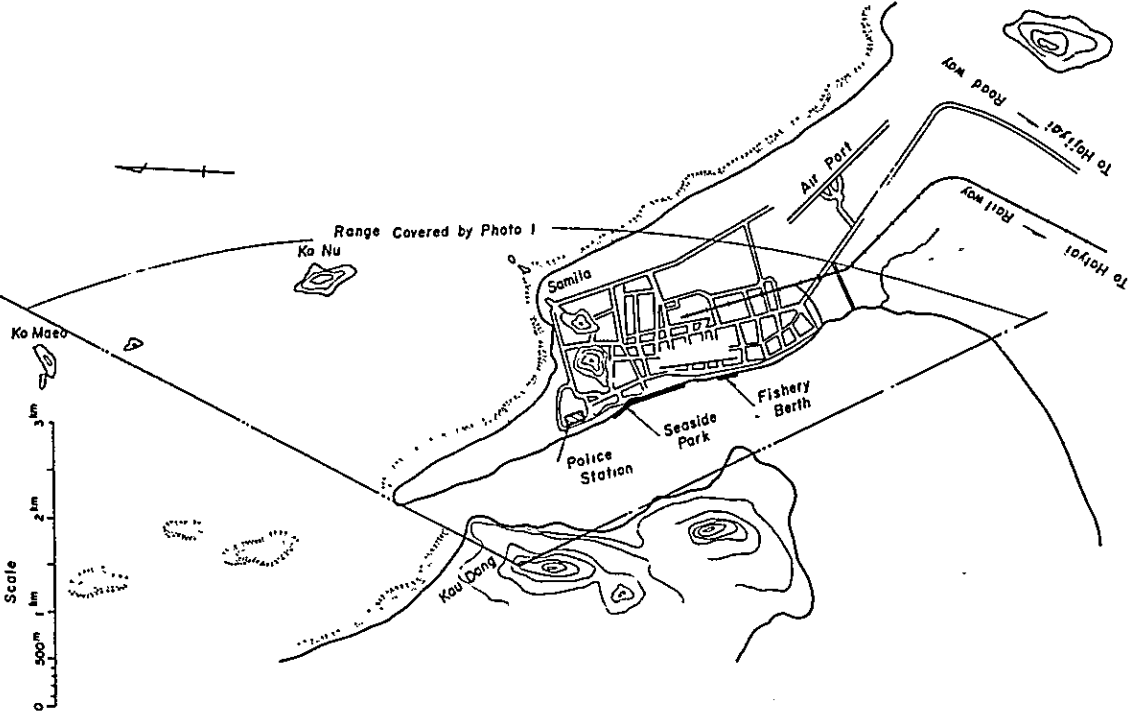


Fig -11 Port of Songkhla

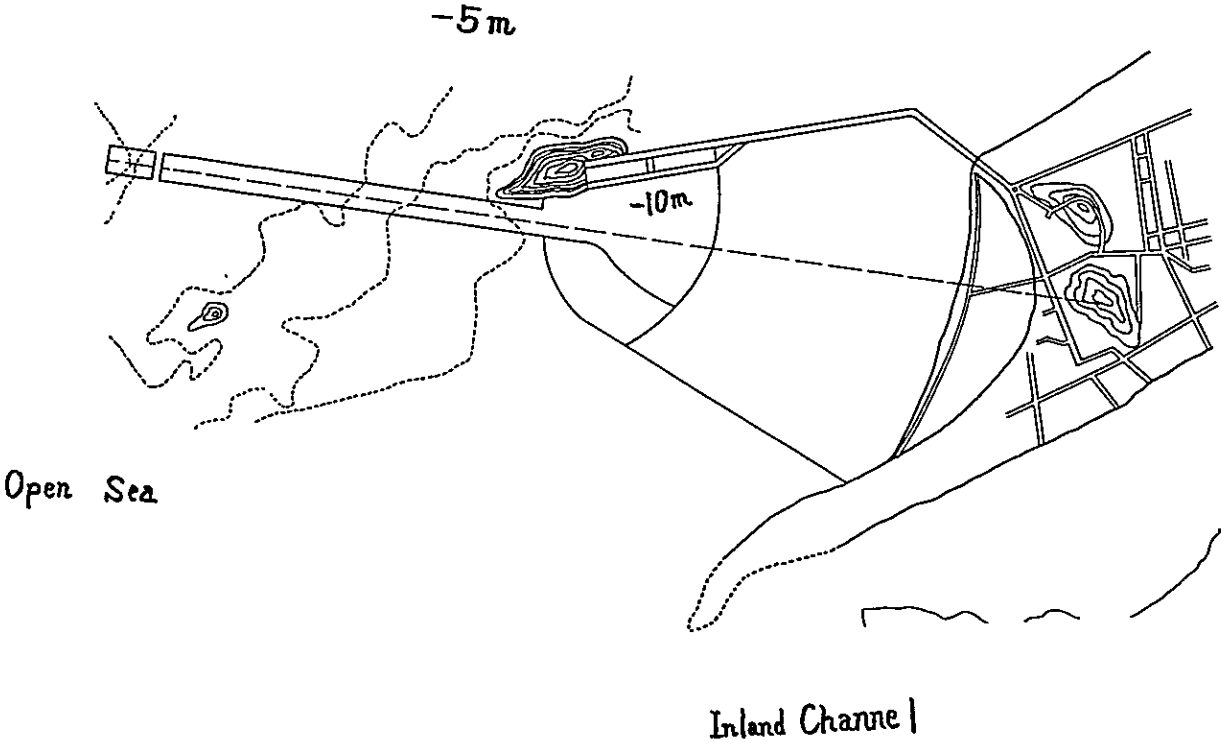


Fig.-10 Topographical Map of the area Around Songkhla Port.

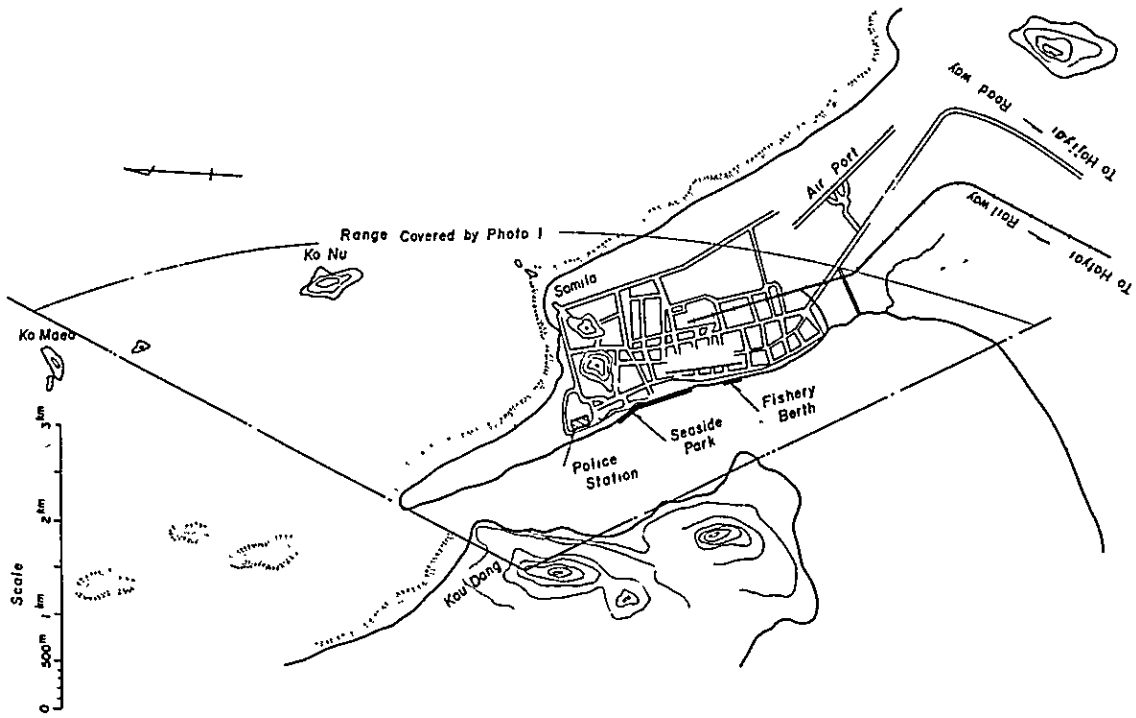


Fig -11 Port of Songkhla

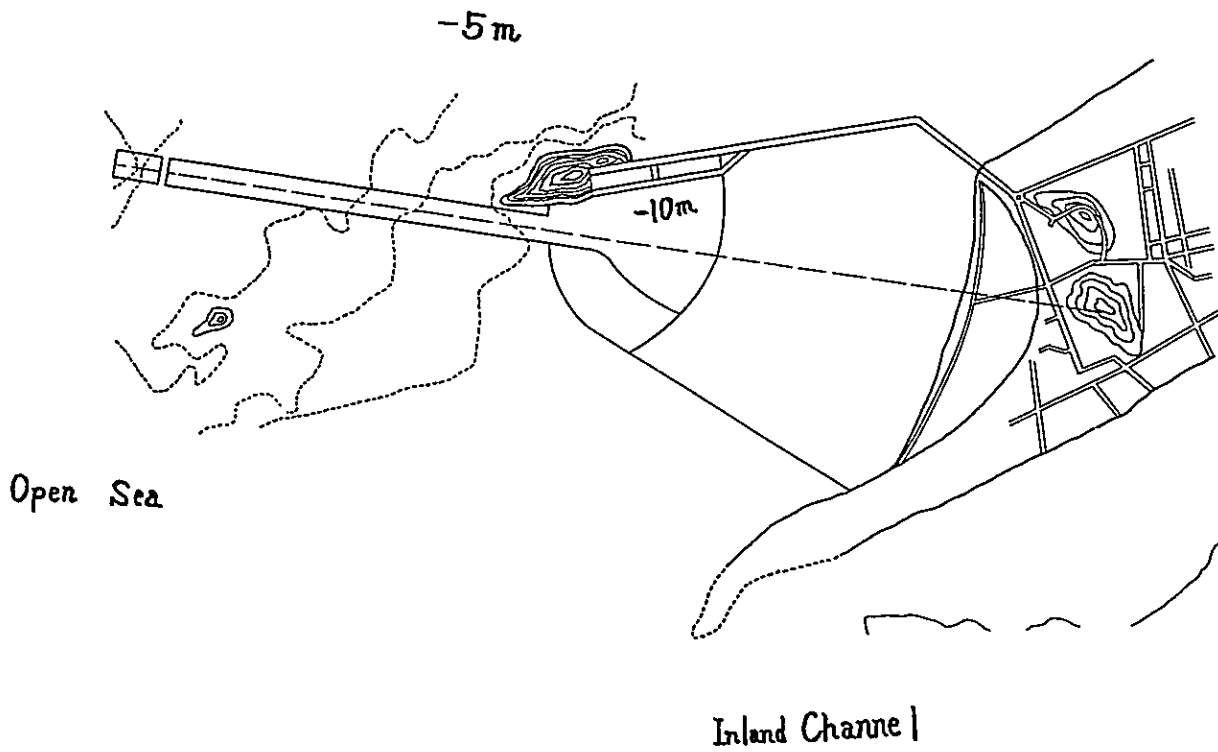


Fig - 12

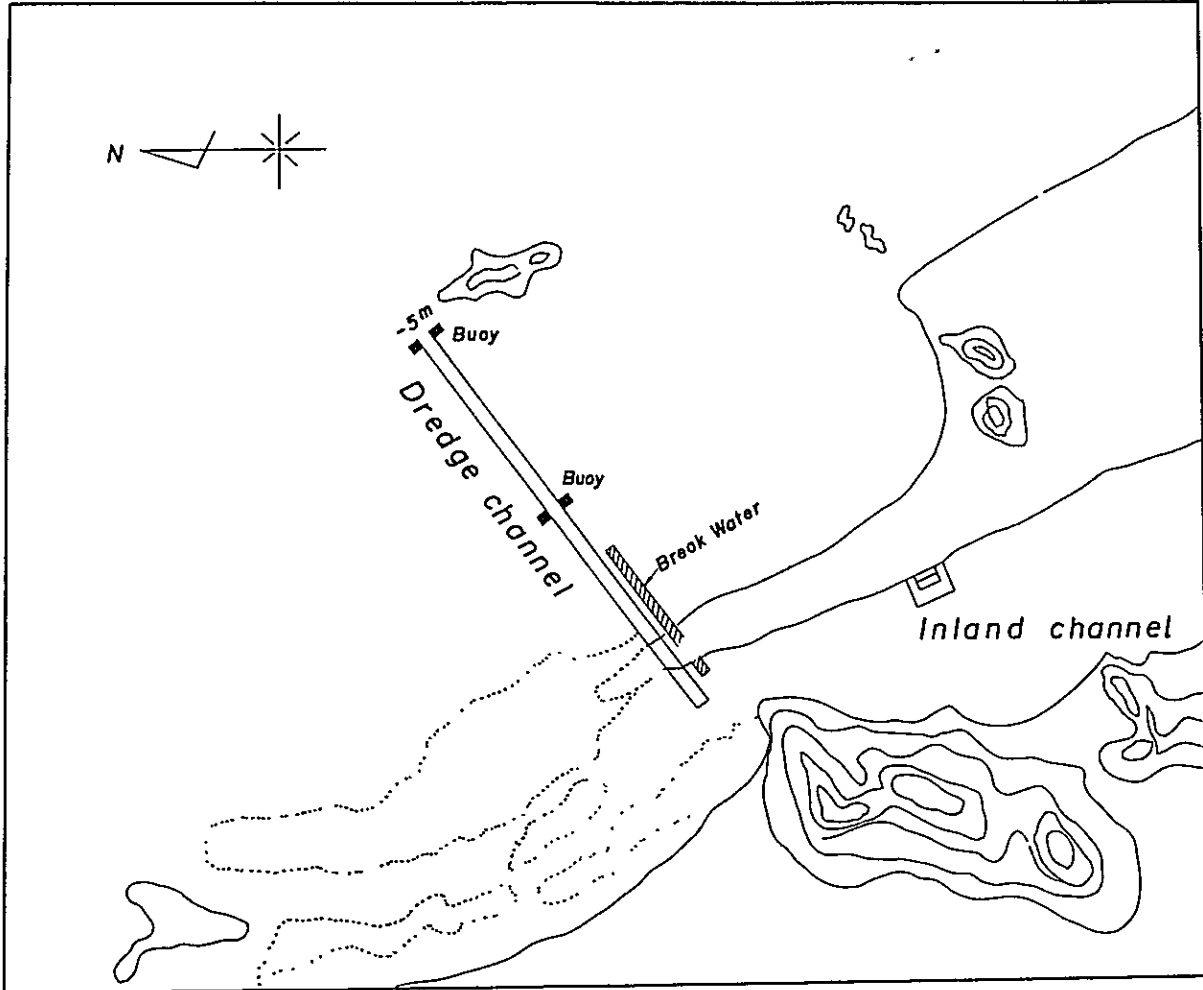
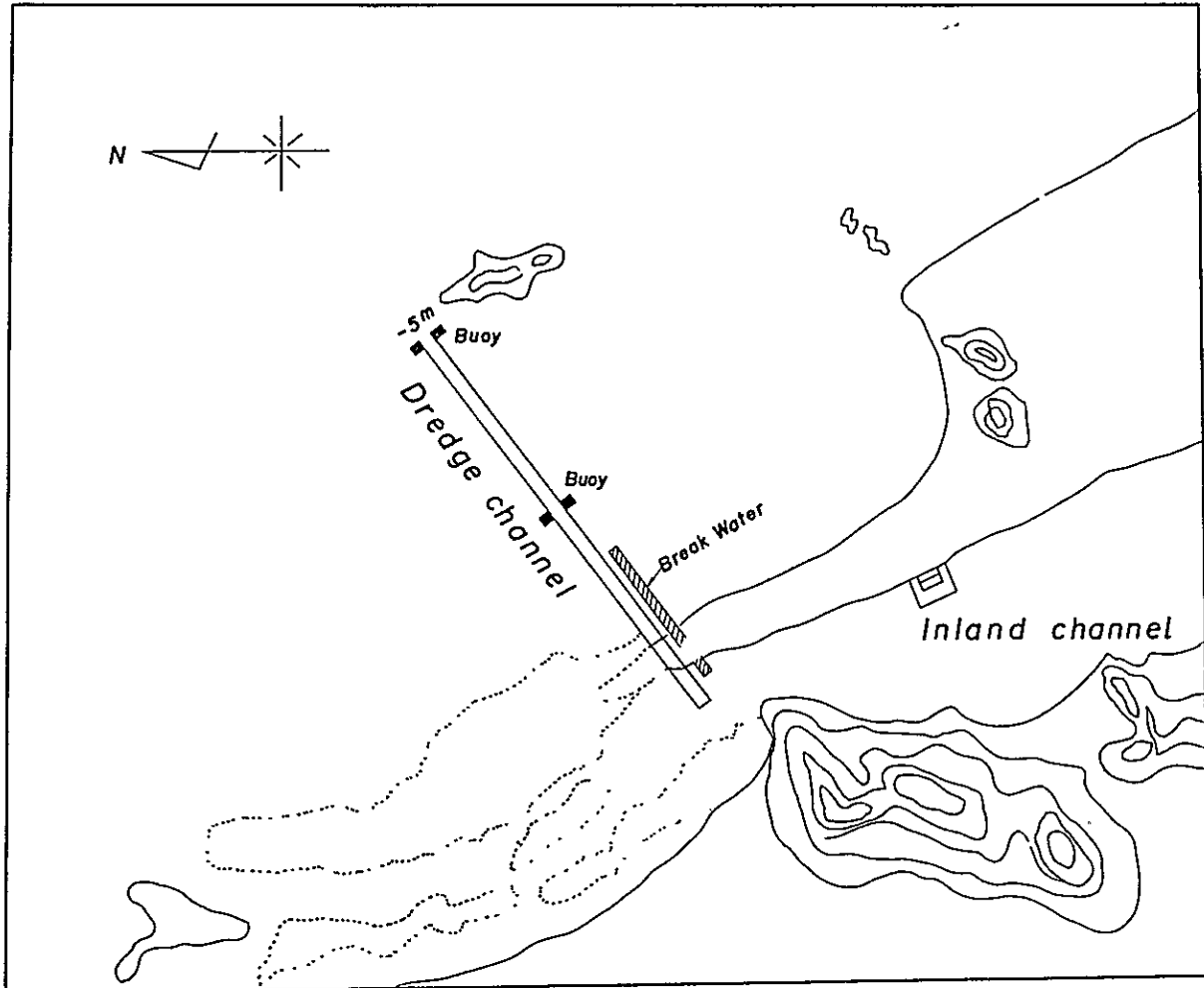


Fig - 12



(ii) Construction of a Port in the Inner Channel

The open sea and the inner channel with marine transport facilities at present will be directly joined by a dredged channel to enable large vessels to enter port and berth along the wharf for efficient loading and unloading of cargo.

Though a depth of 5 - 8 m is maintained in the natural waterway of the inner channel, from the seashore to the open sea, a large sand bar has been formed from the effect of waves and tidal currents, completely blocking the passage of vessels into the inner channel. Two or three different plans were proposed for the location of the artificial dredged channel leading to the inner channel from difference of opinion on measures to be taken against drift sand, operation of vessels, and the shape of the port. The judgement on the future prospects of the port of Songkhla will determine whether a plan on a progressive line or a conservative line should be adopted.

In this area, every year, rough waves caused by northeast storms bring about a complete change in the condition of the coastline and sea bottom in an extremely short period of time. The prevailing east winds and tidal currents continue to adjust the effect of the waves over a long period of time, gradually recovering the original state, comprising one phase of the natural phenomena on the seashore. The surface of the lake rises with the rainfall in the rainy season, with a one-way flow to the sea carrying the sand and silt on the banks and bottom of the inner channel down to the sea, creating a rapid change in the channel. The up and down flow of water caused in connection with the daily rise and fall of tide, and the waves on the seashore act slowly but continuously to form sand bars on the shore and restore the depth and width of the channel to the original state comprising another phase of the natural phenomena.

The force and period of elements which cause these natural phenomena vary on each occasion every year, and the combination of the elements is extremely complicated. Model tests conducted with highly reliable observation data, collected at a large expense over a long period of time, merely reveal anticipated results based on reasonable assumptions. Therefore, it is quite dangerous to depend entirely on the results of model tests carried on in the laboratory.

If it is assumed that prospects are dim for the future development of Songkhla and there is no need to hurry the construction of an efficient port, we propose a plan on the conservative line. Facilities will be constructed for the convenience of barges and coastal vessels with an experimental purpose to study the effect of drift

sand and operation of vessels in the actual water.

If it is judged that permanent facilities should be constructed at once to establish the foundation of future development as soon as possible, we propose a plan on the progressive line. To adopt a progressive plan, we must find means to simplify the complicated natural phenomena as far as possible, to study the results of hydraulic survey, rely on past experience of constructing ports in similar locations, give special consideration for the operation of vessels, and ascertain the tolerable limit of sand drift and other natural phenomena which may obstruct the functions of the port.

We have drafted a progressive plan to construct a jetty to intercept the effect of the large sand bar formed from the outlet of the channel to the seashore, and open a passage at the end of the land as a new port entrance. Taking advantage of the current running down the river during the rainy season in maintaining the water depth of the port entrance and the newly dredged channel, we have endeavored to simplify the hydraulic phenomena so that eddy flow and complicated currents arising from the change of flow due to the daily rise and fall of tide will not occur at the port entrance and in the channel particularly at the curved sections.

We judged that the natural features of the inner channel are of favorable hydraulic and topographic conditions in regard to water depth, width and length, to allow dredging in the port in order to enable vessels depending on offshore cargo handling at present to enter port as well as ocean-going vessels calling at the Port of Bangkok. Therefore, the scale of the new port entrance and channel has been determined accordingly.

With particular attention on the radius of curvature and visibility, we studied features around the curved sections so that eddy flow and tidal currents will not act to give difficulty in steering vessels. We have thoroughly examined the most satisfactory direction and width of the channel and port entrance and the design of structures so that vessels will be able to enter and leave port regardless of the wind velocity and waves.

When this program for the first stage of development for an up-to-date port has been completed in Songkhla, brisk port activities will call for the utilization of banks on both sides of the inner channel. Increased traffic in the port will demand further facilities for the safety of navigation. In this case, we must give special consideration for the second stage of port construction so that the amount of maintenance dredging will not be too large, and the action of drift sand in the channel

and port entrance will gradually be weakened.

The first stage of port construction has been planned to serve as the foundation of the second stage of port construction, and this program is obviously in a far more progressive line in comparison to the other programs.

Fig.-13 PORT OF SONGKHLA
GENERAL PLAN (Stage. I)

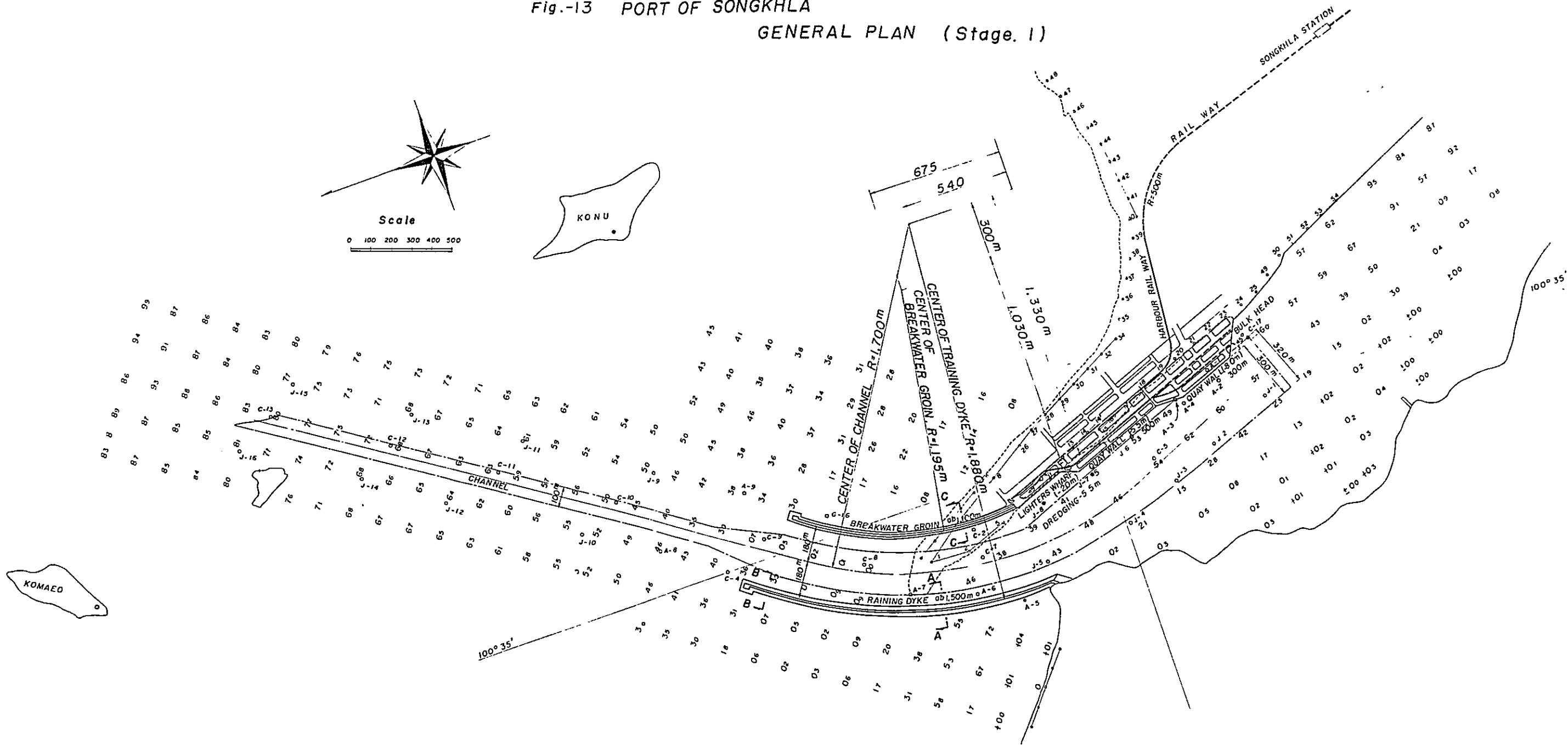
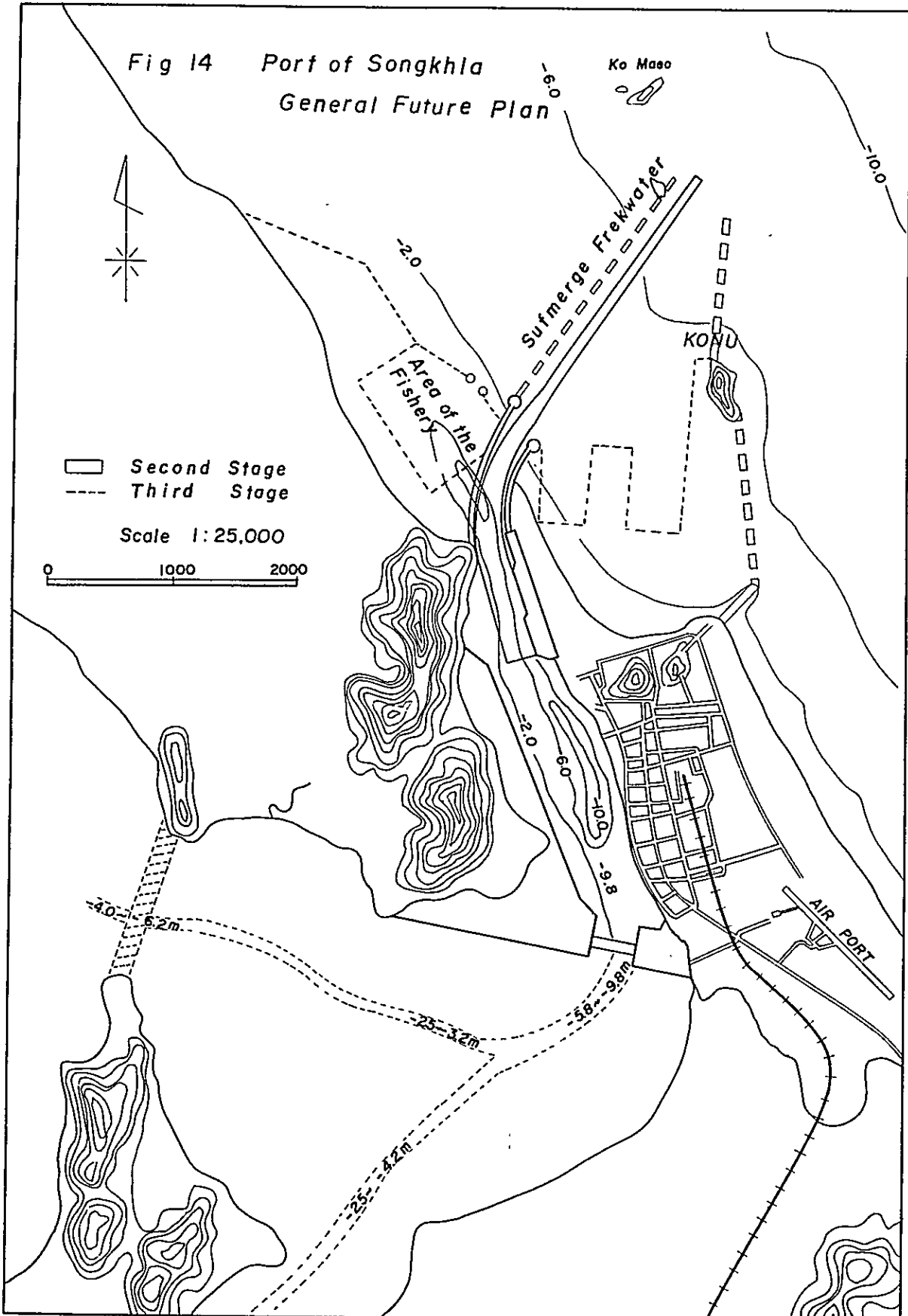


Fig 14 Port of Songkhla
General Future Plan



VI Conclusion

(1) Negotiations on Outline of Investigation

Upon consultation with the authorities concerned in Thailand, it was agreed that we inspect ports on the west coast with particular reference to Phuket, present our opinions on the investigation, give advice on necessary development works, and determine the order of the ports in regard to the importance of the role to be played by each port as far as possible. On the east coast the investigation will be limited to ports which must be investigated in relation to ports on the west coast, and ports along the northern coast of the gulf cannot be included in the tour of a limited period.

For our convenience, we have tried to determine the order in which construction works should be commenced and the priority to be given to different types of works, by establishing a standard for the classification of ports according to the purpose of construction in each port.

Class A : A port to be classified in this category is a port with favorable natural conditions, which will play an important role in the development of Thailand from the point of national, as well as regional and local prosperity. The surrounding conditions are such that the investment to develop the port into a foreign trade port with a water depth of around (-) 10 m will be in balance with the future development and services to be offered in the port. Therefore, the development program must be drafted and construction works carried out to meet various demands of a modern social economy, namely, safety, accuracy, speed, and economy.

In southern Thailand, in ports belonging to Class A, rather than to regard a port as a mere link in land and sea transport from the present situation, and draft a program of port construction to meet demands for the time being, it would be advisable to regard the construction of ports as an establishment for production, a common fundamental facility indispensable to various industries, and draft a progressive long-range program with thoroughly studied planning for permanent facilities, and accurate execution of construction works, gradually producing effective results of preceding investments, promoting future development.

Class B : Ports to be classified in this category will be those in a location to play important roles in promoting the social and economic modernization of Thailand and southern Thailand, which may easily be developed and expanded, mainly as a domestic trade port but also as a foreign trade port, depending on circum-

stances, capable of maintaining a water depth of (-) 5m. It would be desirable that the natural geographic and topographic conditions are such that the cost of improvement and maintenance of facilities will correspond to conveniences to be offered, and the transportation system to the rear district may be developed at a reasonable cost in the future.

However, at the present stage, construction of inappropriate and temporary facilities will be inevitable from political considerations for the development of a certain region.

Class C : A port to be included in this category is a port to serve local interests, and a depth of about (-) 3 m will be sufficient, but a low cost of maintenance is a necessary condition.

Class D: Ports to be included in this category are ports constructed and developed for special purposes such as fishery ports, naval ports, ports of shelter, fuel supply ports and recreational ports.

In classifying the present ports into the above category, we must consider the geographic location, interval of distribution, and relation to ports on the east coast. We conducted actual survey of the spots, attaching importance on the natural surroundings and topography, with particular consideration for the construction of ports so that the marine transport system will function effectively in comparison to land transport.

(2) Outline of Report Presented in Thailand

In our comments following the survey tour, we have already stated that, with the exception of Phuket on the west coast and Songkhla on the east coast, it is difficult to classify the present ports into each category. We could not make a decision on the propriety of improving and extending present facilities, in view of the poor economy of continuing a large investment on maintenance costs under the present financial situation.

The stability of the channel in the rivers for inland navigation is not clear, the amount of sand and silt washed down from the rivers at normal times and in times of flood has not been surveyed, and the amount of discharged sand which may be decreased by the improvement of rivers and appropriate measures on land (the mining of tin and other ores is greatly increasing the amount of discharged sand) could not be ascertained from our survey tour due to lack of investigation data.

Furthermore, there was absolutely no data to judge whether the shallow bottom of the sea is due to the sand and silt discharged from rivers or the rear lands in the rainy season, the movement of the earth's crust, or a phenomena of the sea (drift sand). And we realized that the present port activities are in a stage variable with the progress of the development program of Thailand.

Under the judgement that Phuket and Songkhla may be classified as ports in Class A, we believe that it would be advisable to conduct necessary investigation and gradually carry out the construction of facilities. However, in Songkhla, as construction works are already carried on under a short-range program contrary to the proposal of a previous investigation team, we strongly urged the study of our program immediately. Songkhla is going through an important period, and damage received when the leaves are young is apt to determine the course of the entire span of life.

If the present construction works are to be continued, from the present scale of the port, various disadvantages in the operation of vessels and the utilization of land will occur, with an unfavorable reputation reducing the standard of the port to one hardly capable of remaining as a Class B port.

Though a large sum should be invested to correct the disadvantages, it would be extremely difficult to recover favorable port functions, from the topography of the location.

We wish to report that the authorities concerned in Thailand frequently expressed a strong desire for the special cooperation of Japanese authorities, to send a team of experts to Thailand on a long-term basis and to accept a large number of experts from Thailand for extensive study of port construction in Japan.

