

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 2

TRANSPORTATION

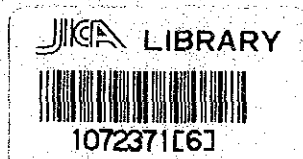
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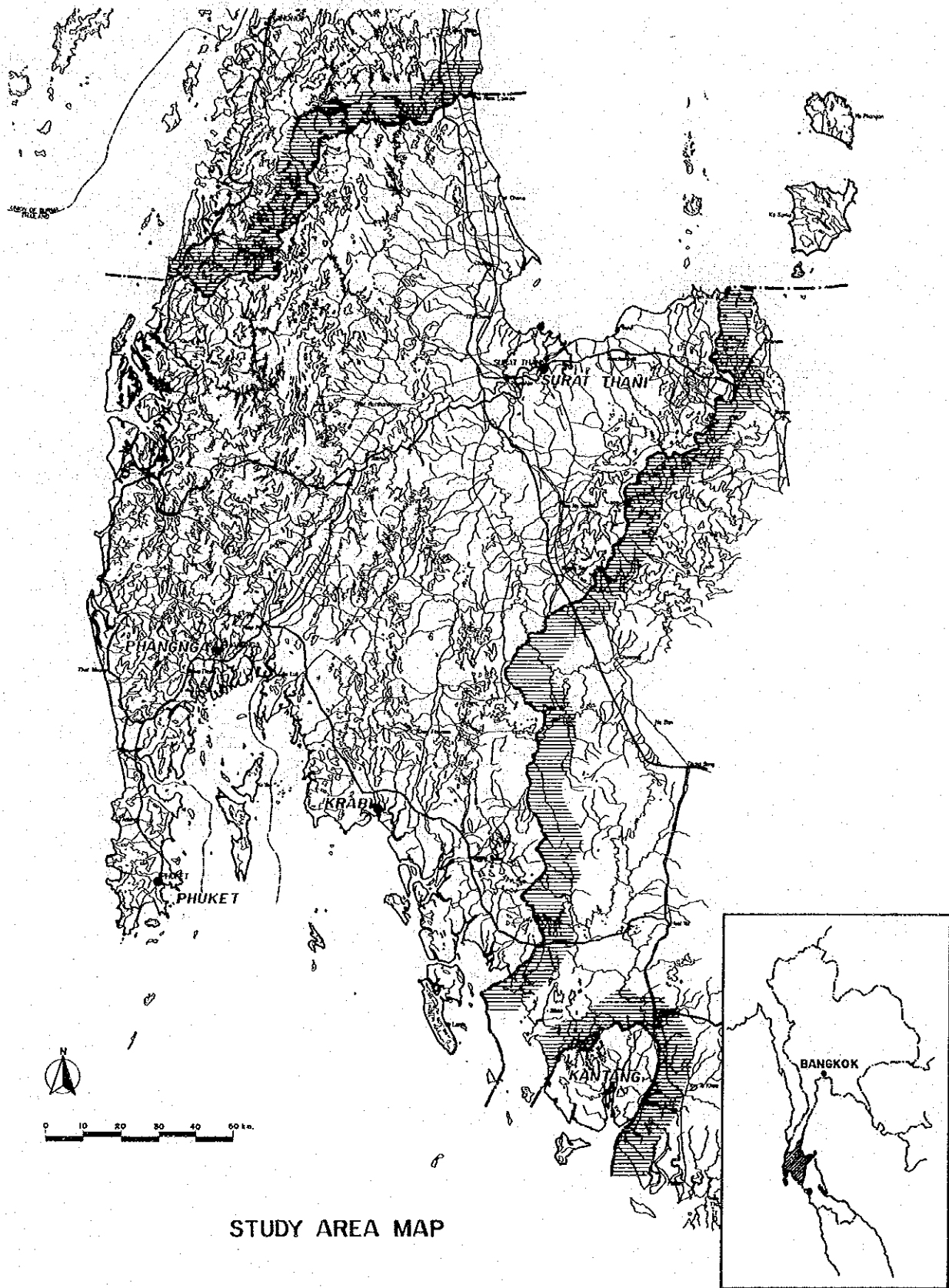
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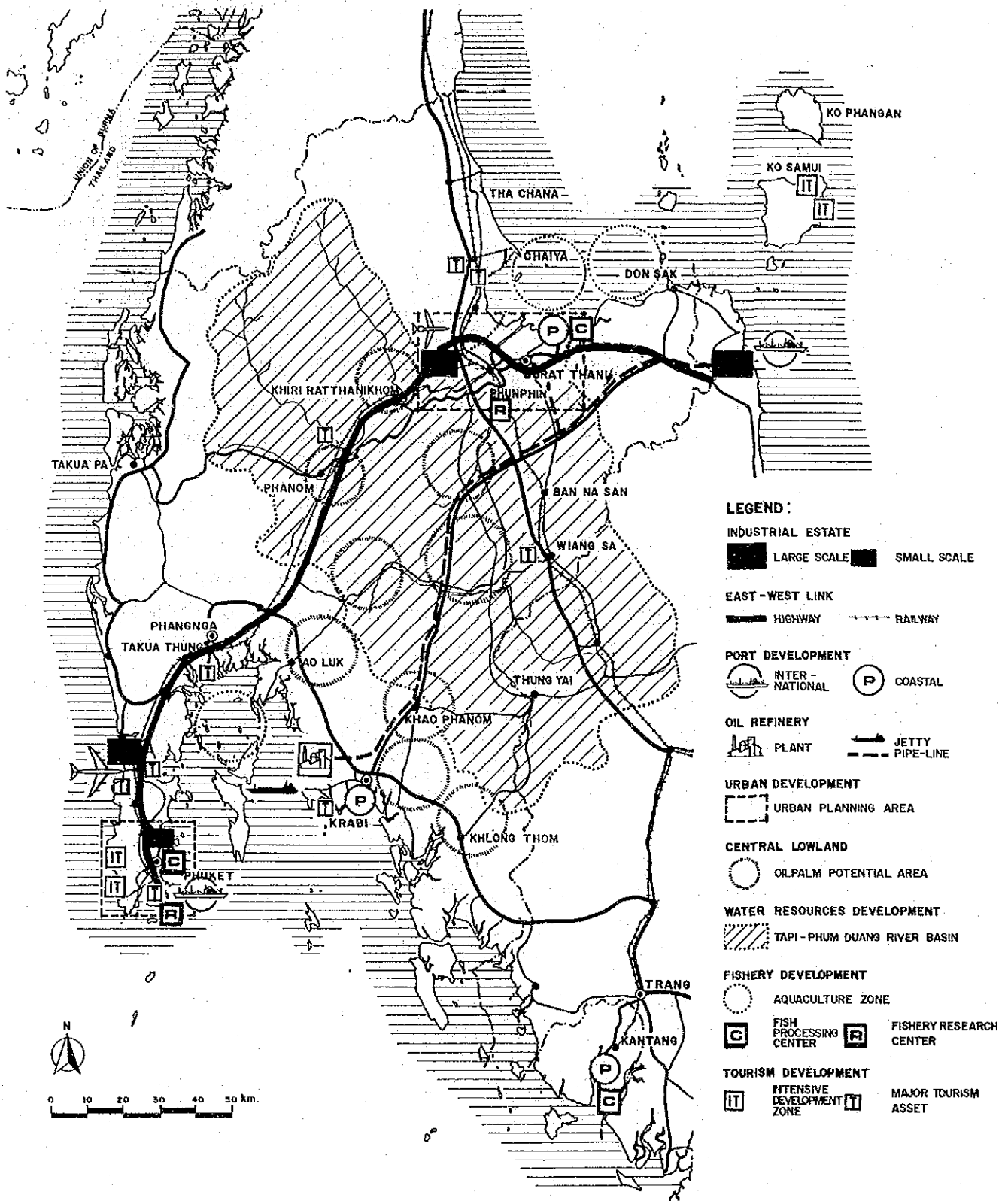
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STUDY AREA MAP



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:

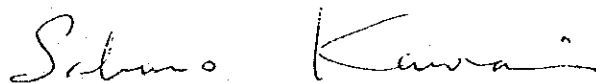
We have honor to submit to you our final report on the Subregional Study of the Upper Southern Part of Thailand. It is our great pleasure to note that this assignment has been completed through the close cooperation between two governments of Japan and Thailand.

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

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1. SUMMARY

Transportation system of the South has been developed in the order of sea transport, railway, road and air transport. Sea transport was the only available transportation means to connect the South with Bangkok and outside world until 1922 when the Southern Railway Line was connected with the Federal Malay State Railway System. The Southern Line had development influence on such inland cities as Phun Phin, Thung Song, Phatthalung and Hat Yai. Railway monopolized inland transportation until the mid 1960s when highway development started to be accelerated. Through the road development during the past two decades, the areas which used to be inaccessible were turned into farm land, and human settlements were developed along the road. Road development was very useful to promote the regional development by enlarging the area for economic activities as well as providing flexible transportation means to carry products to market.

In the course of transportation development in the past intermodal relationship of the South was drastically changed; roles and functions which were previously performed by sea and rail transport were gradually taken over by road transport. At present, 70 percent of cargo transportation from the South to Bangkok depends on road transport, 25 percent on railway and five percent on sea transport, while, for the opposite direction, 50 percent on road, 30 percent on railway and 20 percent on sea transport. Broadly speaking, sea transport is used only for carrying oil and fuel from Bangkok to the South. Taking account of the distance of 600 to 1,000 kilometers between the South and Bangkok, transportation development should be well-coordinated among available transportation means in such a way to make best use of their respective advantages; road transport has great advantages in rather short distance transportation mainly due to flexible transportation in terms of lot size and timing, while railway and sea transport have superiority in long haul and bulk transportation particularly in terms of cost saving.

The Upper South is proposed to be developed in conjunction with the country's development strategies toward internationalization, seaboard industrial development and decentralization of Bangkok, based on the locational as well as resource advantages of the subregion. Transportation development at the earliest possible stage will greatly contribute to achieving these goals while expanded economic bases will produce grounds for further transportation development. Transportation demand of the Upper South in 2000 is estimated at 3.4 times as much as that in 1980 for cargo transportation and 2.4 times for passenger transportation; annual cargo transportation demand will increase from 4.7 million tons in 1980 to 16.2 million tons in 2000,

and annual passenger transportation demand from 37.8 million trips in 1980 to 92.1 million trips in 2000. Accelerated transportation development will tend to increase the future demand through inducement effect, and decelerated transportation development vice versa.

Transportation development of the Upper South is proposed to be promoted based on the following strategies, in view of the overall development strategy of the Upper South, inter-modal coordination and expected future transportation demand.

- (1) To make best use of Phuket Deep Seaport toward internationalization by promoting international trade between the country and the western situated countries. Good inland access to the port is essential conditions for this purpose, not only from immediate hinterland within the South but also from Bangkok.
- (2) To establish East-West Link connecting Phuket with Surat Thani for linking the Phuket and Andaman coastal economy more closely with the mainstay of the national economy being in Bangkok, and unifying economies of the Upper South at western and eastern sides. Development of East-West Link will accord with the strategy mentioned in (1) above. On top of highway development, railway extension to Phuket could be an alternative development, particularly from the viewpoint of linking Phuket with Bangkok.
- (3) To develop an international port in South Khanom toward internationalization and industrialization. Khanom Deep Seaport is expected to support the economic development of the Upper South through the retrenchment of inland transportation cost for exporting natural resources and related products, and through providing an excellent site for seaboard industrial development along the Gulf of Thailand coast.
- (4) To develop a highway link between Krabi and Surat Thani for vitalizing Krabi economy and supporting the agricultural development of the Central Lowland inbetween.
- (5) To develop a ferry link between Phuket and Krabi for lessening the locational constraints of the Phuket Island and for promoting socio-economic relationship between Phuket and Krabi/the Lower South. Krabi will become an important transportation node on the west coast.
- (6) To develop coastal shipping network between Phuket Deep Seaport and Krabi/Kantang Ports for ensuring easy access to international market from Krabi and Kantang.

Channel dredging to Krabi and Kantang Ports becomes necessary to accommodate vessels of 600 to 1,000 dead weight tons (DWT).

- (7) To improve Phuket International Airport for promoting tourism and supporting Phuket Airport Industrial Estate which is proposed to be located at the north boundary of the airport.

Of the above-mentioned strategies, East-West Link and Khanom Deep Seaport are considered most strategic to the development of the Upper South in terms of development effects and investment amount required.

East-West Link

Roles and functions required for the development of East-West Link can be articulated as follows:

- (1) To improve and develop the transportation network in the hinterland of Phuket Deep Seaport, especially from the viewpoint of heavy vehicle traffic, so as to retrench the inland transportation cost to the port.
- (2) To provide better and efficient transportation network between Surat Thani and Phuket for attaining interactive economic development of the two growth poles and the area inbetween.
- (3) To facilitate cargo transportation from Bangkok and other regions to Phuket Deep Seaport which is an alternate gateway to the western situated countries to Bangkok/Laem Chabang Ports.
- (4) To provide energy saving transportation means between Bangkok and provinces on the Andaman Sea Coast to cope with the increasing transportation demand of both cargo and passenger.
- (5) To provide additional capacity to the existing and programmed transportation network between Surat Thani and Phuket to cope with the future increase of traffic demand.

In view of the comparative advantages of road and railway transport, road transport has its advantages in (1), (2) and (5) above, while railway does in (3) and (4) above.

Traffic demand on East-West Link is estimated at 7,000 vehicles per day in 2000 in terms of passenger car unit and expected to be 9,400 vehicles in 2005, when traffic flow will be greatly disturbed by the capacity constraint of two lane highway. Taking account of the future traffic increase as well as the comparative advantages of road and railway transport, two alternative cases are established for the development of East-West Link; railway with improved two lane highway, and four lane highway.

East-West Road Link is designed based on the standard of primary national highway, by paying attention to make use of the existing and programmed highway network to a maximum extent. Total length of the link amounts to 224 kilometers, of which new construction section accounts for 88 kilometers and improvement section for 136 kilometers. Major sections for new construction are composed of Surat Thani-Route 41 (18 kilometers), Route 41 - Phanom (47 kilometers) along Khiri Ratthanikhom Railway Spur Line, and Phuket New Bridge (15 kilometers). Construction cost of the two lane highway is estimated at 1,382 million baht and that of the four lane highway at 3,007 million baht.

East-West Rail Link is designed based on the standard applied to Chachoengsao-Sattahip Rail Link. The existing Khiri Ratthanikhom Spur Line is planned to be extended to Phuket Deep Seaport mostly in parallel with the road link. Total length of the link amounts to 201 kilometers from Ban Thung Pho Junction to Phuket Deep Seaport and the length of new extension amounts to 170 kilometers. Annual transportation demand on the link is estimated at 1.4 million tons and 1.2 million passengers in 2000. Construction cost will amount to 1,442 million baht and purchasing cost of rolling stocks to 1,291 million baht by the year 2000.

Preliminary economic evaluation was performed from the viewpoint of the expected economic benefit produced by East-West Link. Economic benefit is confined to the saving on operating cost of transportation means to carry cargoes and passengers. Internal rates of return are calculated at 18.4 percent for Alternative 1 (railway with two lane highway) and 11.1 percent for Alternative 2 (four lane highway) on the premises that construction works would be completed by 1994, and that the project life would be 25 years, starting from 1995. Economic benefit produced by Alternative 1 consists mostly of the energy saving through the diversion from highway to railway of the transportation demand between the Upper South and Bangkok, while economic benefit produced by Alternative 2 consists of the energy saving through the smooth traffic flow on East-West Road Link. The internal rate of return of Alternative 2 will be improved if a phasing program to add two lanes afterwards to the original two lane highway is applied in accordance with future increase of traffic

demand.

As to Alternative 1, it is recommended that the development of road link should precede the development of rail link. Road link can accommodate a variety of transportation demand from short to long distance trips. Rail link will play an important role when long haul and bulk transportation demand reaches a substantial volume. Railway system of the Southern Line needs further improvement to support East-West Link.

Khanom Deep Seaport

The functions required for Khanom Deep Seaport are enumerated as follows :

- (1) To retrench relay transportation cost of primary products of the subregion to Bangkok (650 kilometers) and Songkhla (300 kilometers) for realizing more competitive prices in the international market.
- (2) To facilitate the export of manufactured products from inland industrial estates without recourse to transshipment to Bangkok/Songkhla, thus enhancing the possibility of relocating and attracting secondary industries from Bangkok to the Upper South.
- (3) To prepare the space for integrated development of port facilities and industrial sites for large scale industrial growth in the long run.

On the east coast, Songkhla Deep Seaport is scheduled to be completed by the end of the Fifth Five-Year Plan period. This port is expected to further promote the regional development of Hat Yai/Songkhla as well as to retrench inland transportation cost of primary exporting products. Though Songkhla Deep Seaport will contribute to saving inland transportation cost of primary exporting products of Surat Thani to some extent, the port will have little effect on regional development of Surat Thani. For the development of the subregion, it is necessary to construct an international port. An average distance of 300 kilometers observed between major ports on the Malay Peninsula can provide an important rationale for establishing another international port.

Necessary conditions for the international port are enumerated as follows :

- (1) To be able to accommodate ocean going vessels of at least 15,000 DWT, taking account of the vessel size operated between Singapore and Bangkok.

- (2) To keep the necessary deviation from international shipping route to the minimum and to ensure the easy maneuverability of ocean going vessels.
- (3) To keep easy the construction and maintenance work including water channel from the viewpoint of investment cost and construction technology.
- (4) To have enough space adjacent to the port area for the integral development of port and industry in the long run.
- (5) To minimize the environmental destruction which is expected to be caused by port construction, channel dredging and vessel operations.

South Khanom is the best location in view of the above conditions.

Cargo handling volume of Khanom Deep Seaport is estimated at 823,00 tons in the year 2000. Major cargoes expected to be handled are 379,000 tons of rubber, 200,000 tons of gypsum and 244,000 tons of manufactured and miscellaneous products. In case some large scale industries are located at the area adjacent to deep seaport area in the long run, handling volume of materials and products will reach a more substantial volume.

Major port facilities required for the year 2000 will be four berths with minus 10 meter depth and 180 meter length each for accommodating ocean-going vessels, one berth with minus six meter depth and 80 meter length for possible coastal shipping with Eastern Seaboard and Songkhla, water channel with minus 10 meter depth, 2.4 kilometer length and 120 meter width, and turning basin with a diameter of 360 meters. Construction cost including floating crafts and cargo handling equipment is estimated at 1,020 million baht. The components of the first stage construction are one berth for ocean-going vessels, one berth for the coastal shipping, water channel and turning basin.

The effects of port development appear interdependently in many forms including reduction in transportation cost, increases in employment opportunities, regional industrialization and so on. Preliminary economic evaluation was performed based solely on the effect of inland transportation cost reduction. Internal rate of return of the project is estimated at 11.3 percent, net present value at minus 29 million baht at a discount rate of 12 percent and benefit cost ratio at 0.95 at the same discount rate. Judging from these indicators, this project is considered to yield appropriate benefit of reductions in inland transportation cost to the extent that the investment will pro-

duce the return almost equivalent to an opportunity interest rate.

It will very necessary to coordinate the development schedule of Khanom Deep Seaport with that of Songkhla Deep Seaport. From the viewpoint of subregional development diffusion, it will be better to start the first stage construction of this port than to proceed to the consecutive expansion of Songkhla Deep Seaport, after its completion of the first stage construction.

2. TRANSPORTATIONAL SITUATIONS OF SOUTH

2.1 HISTORICAL DEVELOPMENT OF SOUTH

2.1.1 Location of South

The South is situated on the upper part of the Malay Peninsula extending from Chumphon (about 10.5°N) to Sungai Kolok (about 6.0°N). The length covered by the region amounts to 592 kilometers and the width to 232 kilometers. The total area is about 70,200 square kilometers. The South faces to the Gulf of Thailand on the east and to the Andaman Sea on the west.

The South is situated at a strategic point from the aspect of international navigation. Most of the ocean going vessels which make voyages between Southeast Asia and the western situated countries approach to the peninsula so as to pass through the Strait of Malacca.

The South is located very closely to Malaysia, Singapore and Indonesia. Songkhla is located at a distance of 170 kilometers from Penang, 410 kilometers from Kuala Lumpur, 420 kilometers from Medan and 690 kilometers from Singapore while it is located at a distance of 700 kilometers from Bangkok in terms of direct distance. Surat Thani, at a distance of 520 kilometers from Bangkok, is located at 390 kilometers from Penang, 590 kilometers from Medan, 640 kilometers from Kuala Lumpur and 920 kilometers from Singapore. Location of the South is illustrated in Fig. 2.1.

2.1.2 Historical Development of Transportation

The oldest means of transport connecting the South with Bangkok and the outside world was coastal and overseas navigation. The east coast ports such as Songkhla and Nakhon Si Thammarat directed their interest towards Bangkok, Singapore and the Far East countries, whereas the west coast ports such as Phuket and Kantang kept in close contact with Penang and Singapore, particularly after it became one of the most important transshipment points of the area.

The coastal ports were developed under private initiative to serve the local fishing industry and the domestic trade between isolated settlements at a time when land transport was not established. Most of the coastal ports in the South are riverine ports with severe draft restrictions at the entrance of the channel. Frequent maintenance dredging is required to combat siltation from river borne and littoral source. Further-

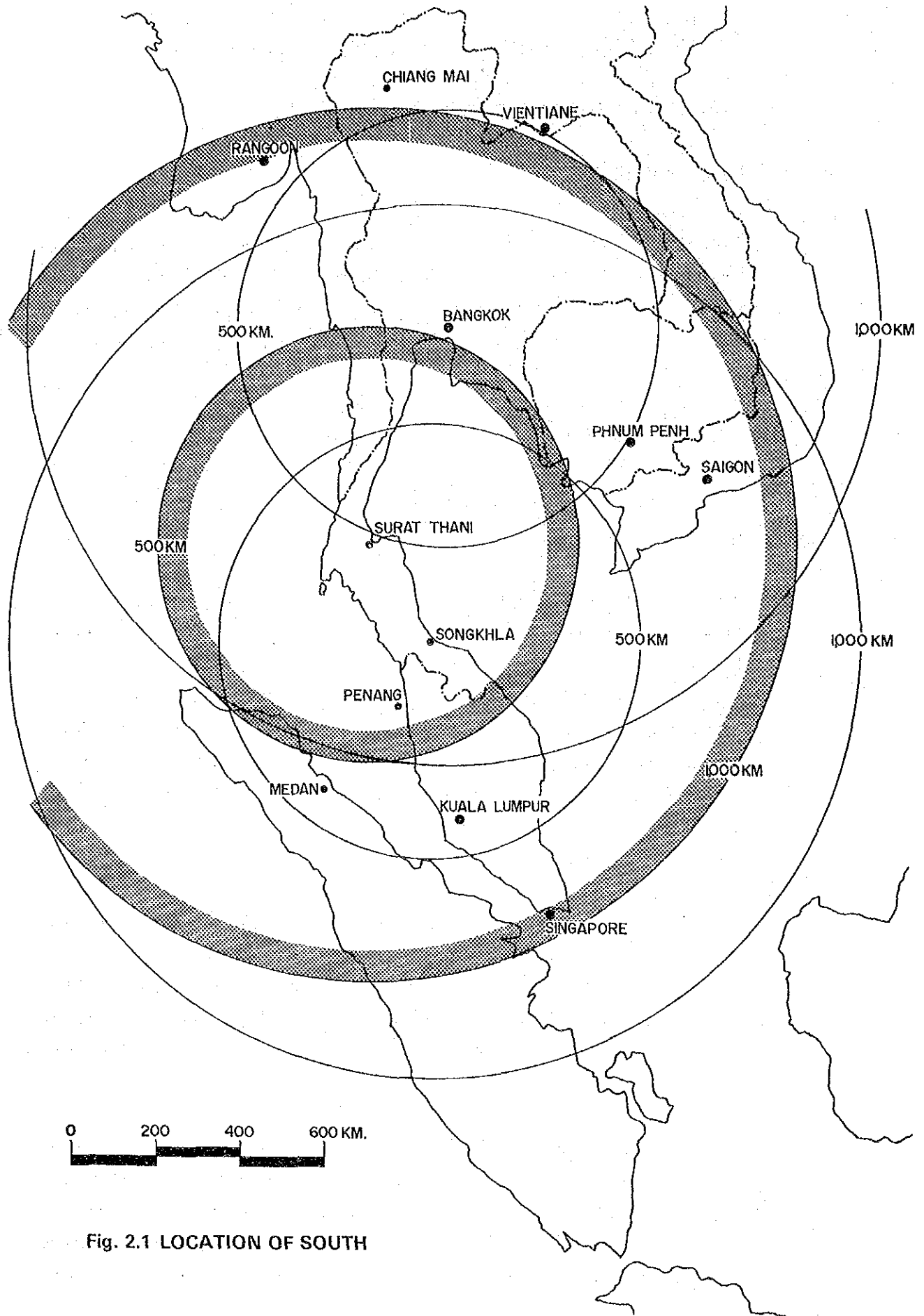


Fig. 2.1 LOCATION OF SOUTH

more, the more exposed ports on the east coast are usually closed to navigation at the height of the north-east monsoon season. These features present serious constraints to further development of the ports and make it very costly to construct ports capable of allowing larger size of vessels to work alongside berths. At this time, these isolated settlements functioned as a base for collecting and despatching natural products/resources of the area without particular relationship among the neighbouring settlements.

The modern breakthrough in land transportation was brought in the South in 1903, when a new railway line was opened between Bangkok and Phetchaburi over a distance of 152 kilometers. The Southern Line was connected with the Federal Malay State Railway System in 1922, when the total length of the Southern Line including four branch lines amounted to 1,346 kilometers with meter-gauge single line. The alignment of the trunk railway makes use of the coastal plain down to Surat Thani and then follows the intermountain plain further south to Thung Song. Here, the line to Trang and the port of Kantang branches off while the trunk line crosses the Nakhon Range towards the east to reach the coastal plain again. Then, the Nakhon Si Thammarat branch makes its way north and main line continues to Hat Yai. The railway served as an up-to-date means of transport for the South which, for a considerable number of decades, kept its monopoly in land transport.

The South was connected to Bangkok through the railway, and inland settlements such as Phun Phin, Thung Song and Hat Yai were developed along the corridor.

Road construction became parts of government's policy only after 1936, but on the peninsula, the local administrators have already started to construct roads to serve tin mining and, later, rubber planting areas. These roads, mainly of low standard, formed first a feeder network for the newly built railway. These roads were steadily improved and extended to form the main north-south highway, Route 4, which followed the east coast of the peninsula just in parallel with the Southern Railway Line from Bangkok to Chumphon. At Chumphon it crosses the peninsula to the west and extends along the Burmese border and west coast as far as up to Trang where it crosses to Phatthalung, extends along the eastern side of the isthmus and branches south at Hat Yai to the Malaysian border. Through the development of Route 4, settlements on the west coast were connected to Bangkok as well as to the neighbouring settlements on the west coast.

During recent 20 years, new highways were vigorously constructed and steadily improved to higher levels of standard. An east-west link between Surat Thani and Takua

Pa was completed with asphaltic surface in 1968, followed by completion of a north-south link between Surat Thani and Nakhon Si Thammarat along the east coast in 1977 and another north-south link in the central area between Lang Suang and Phatthalung in 1978. It can be said that, Route 41 penetrating the central part of the peninsula formed an all weather highway network to connect every southern province with Bangkok as well as with each other, without long distant detouring.

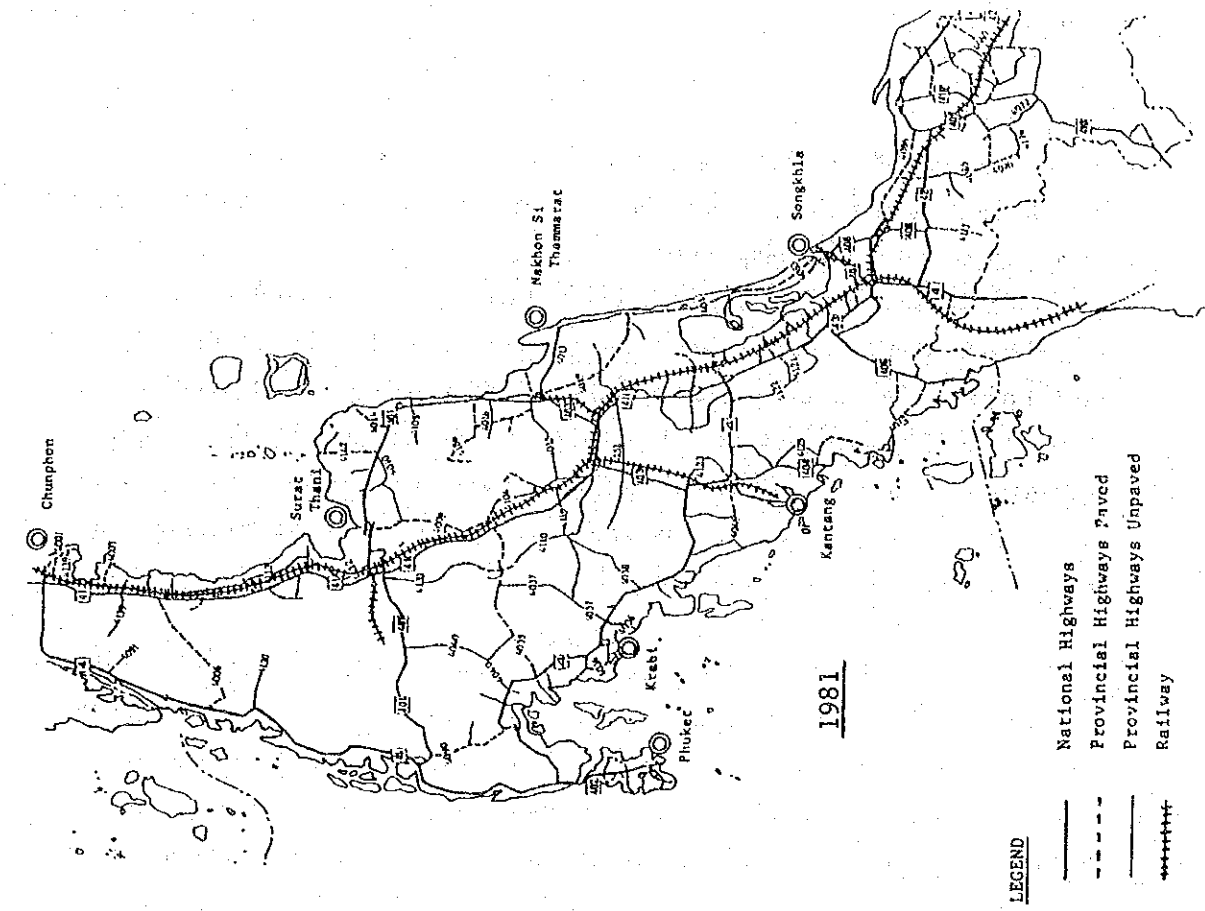
Development of highway network in the South stimulated the establishment of inland settlements at major junctions and expanded the accessible land for new cultivation. Development of transportation network in the South is schematically shown in Fig. 2.2.

In accordance with the improvement of transportation system, the economy of the South has been diversified and activated and the sphere of the people's activity has also been expanded. Through these changes, transportation demand of industry and people has been varied in terms of quantity and quality. Transportation means are evaluated by users from the viewpoint of transportation cost, travelling time, punctuality, comfortableness and so forth. Concentrated investment on highways has attained the superiority of road transport to railway and ship transport, which are enforced to be left behind of the recent requirement of the transportation demand.

In 1971, the domestic airline, namely, Thai Airways provided air transport services from Bangkok to Phuket, Trang, Songkhla and Pattani. Songkhla Airport, however, was closed in 1972 when the new international airport at Hat Yai was opened to traffic. Two airports, Narathiwat and Surat Thani were added to the air transport network afterwards. During the period from 1972 to 1982, total number of air passengers of the South increased from 45,000 persons in 1972 to 447,000 in 1982, the growth rate being 25.8 percent per annum.

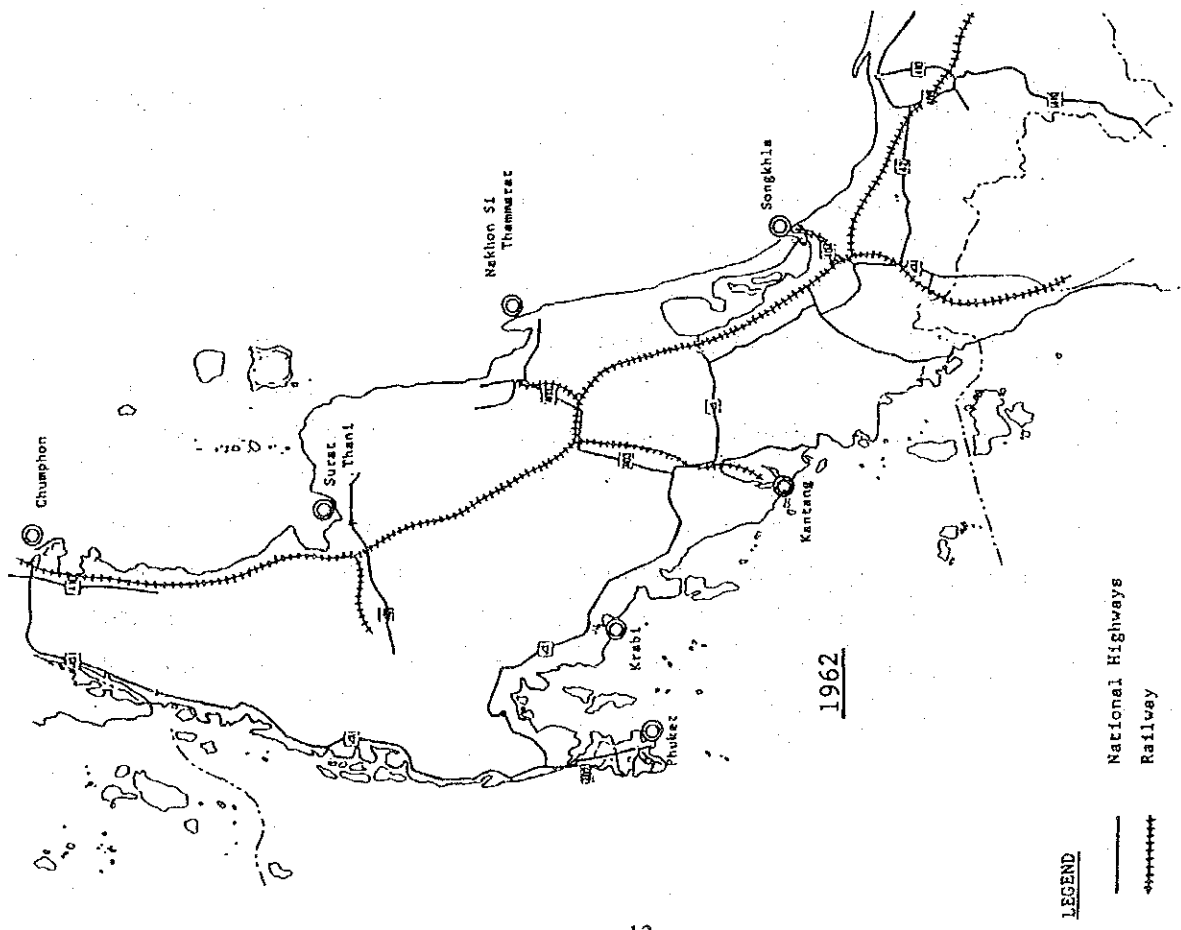
2.2 CARGO FLOW OF SOUTH

The South has been set apart from the rest of the country mainly due to the long distance from the capital, the lack of land transportation during a long period of history, the economically different structure in proximity to the Malaysian economy and so forth. Rubber plantations, coconut growing and tin mining prevail in the South and these resources have been exported to foreign countries through local ports.



LEGEND

- National Highways
- - - - - Provincial Highways Paved
- Provincial Highways Unpaved
- + + + + + Railway



LEGEND

- National Highways
- + + + + + Railway

Fig. 2.2 TRANSPORTATION NETWORK

With the advent of land transportation, especially highway, the picture of the South has considerably been changed from the former times; though the export of resources to foreign countries has great importance to the economy of the South until now, economic relationship with Bangkok has been strengthened. Cargo flow of the South to and from other regions including Bangkok amounted to 3.8 million tons while export and import of the South are estimated at 1.5 million tons in 1981. This estimation is based on "The Comprehensive Development Study of Coastal Shipping in the Kingdom of Thailand" by JICA in 1984. Export of rubber and tin as well as import of oil are added to the estimation. This cargo flow shows the increased economic relationship between the South and Bangkok.

Cargo flow of the South with Bangkok and other regions in 1981 is compiled for the purpose of outlining the broad image of the South based on three data sources with reclassification of commodity grouping and time adjustment. Data sources are as shown in Table 2.1. Cargo flow from the South to Bangkok and other regions is estimated at 1.5 million tons while cargo flow on the opposite direction is estimated at 2.3 million tons in 1981. The South is estimated to have the excessive import of 0.8 million tons. The main commodities transported from the South to Bangkok and other regions are composed of agricultural and forestry products and those transported to the South from Bangkok and other regions consist of manufactured products, petroleum products and agricultural products.

Intermodal share of transportation means is estimated at 69 percent for road, 26 percent for railway and five percent for ship in the cargo flow from the South to Bangkok and other regions while the share is estimated at 51 percent for road, 28 percent for railway and 21 percent for ship on the opposite direction. Intermodal relationship is rather different for both directions. Ship is practically used only for transporting oil and petroleum products from Bangkok to the South though it used to play an important role for transporting various kind of dry cargoes for both directions. Railway shares about one fourth of transportation demand for both directions, the volume transported by railway from Bangkok and other regions to the South being as much as twice of the volume for the opposite direction. Major commodities transported by railway are rice from other regions to the South and manufactured products from Bangkok to the South. In contrast to other regions, it is a conspicuous characteristic that oil and petroleum products are not transported by railway but by ship.

Table 2.1 GOODS TRANSPORTATION OF SOUTH IN 1981

Unit: 1,000 tons/year

Commodity	Mode	From SOUTH			To SOUTH		
		Bangkok	Others	Total	Bangkok	Others	Total
Agriculture	Road	396.7	31.4	428.1	77.7	100.0	177.7
	Rail	44.1	23.8	67.9	74.4	290.3	364.7
	Ship	2.0	0.0	2.0	12.9	0.0	12.9
	Total	442.8	55.2	498.0	165.0	390.3	555.3
Rubber	Road	8.4	0.3	8.7	0.1	0.0	0.1
	Rail	54.0	6.9	60.9	4.3	2.3	6.6
	Ship	0.0	0.0	0.0	0.0	0.0	0.0
	Total	62.4	7.2	69.6	4.4	2.3	6.7
Forest	Road	318.9	36.6	355.5	2.9	1.4	4.3
	Rail	43.7	22.9	66.6	0.3	0.7	1.0
	Ship	0.4	0.0	0.4	0.0	0.0	0.0
	Total	363.0	59.5	422.5	3.2	2.1	5.3
Petroleum	Road	1.1	0.9	2.0	35.6	26.7	62.3
	Rail	1.0	0.0	1.0	24.0	0.0	24.0
	Ship	1.8	0.9	2.7	618.0	5.6	623.6
	Total	3.9	1.8	5.7	677.6	32.3	709.9
Minerals	Road	9.3	4.4	13.7	2.2	3.3	5.5
	Rail	9.7	3.7	13.4	3.4	24.5	27.9
	Ship	0.0	0.5	0.5	0.0	0.0	0.0
	Total	19.0	8.6	27.6	5.6	27.8	33.4
Construction	Road	2.2	0.7	2.9	32.2	5.7	37.9
	Rail	28.8	90.3	119.1	7.6	19.0	26.6
	Ship	0.7	0.0	0.7	7.1	0.0	7.1
	Total	31.7	91.0	122.7	46.9	24.7	71.6
Manufacture	Road	196.3	15.2	211.5	569.3	21.2	590.5
	Rail	21.8	26.0	49.8	207.6	18.7	226.3
	Ship	45.7	20.8	66.5	7.0	63.0	70.0
	Total	263.8	62.0	325.8	783.9	102.9	886.8
Others	Road	1.0	0.6	1.6	65.8	5.8	71.6
	Rail	2.4	0.0	2.4	1.0	11.7	12.7
	Ship	0.0	0.0	0.0	0.0	0.0	0.0
	Total	3.4	0.6	4.0	66.8	17.5	84.3
Total	Road	933.9	90.1	1,024.0	785.8	164.1	949.9
	Rail	205.5	173.6	379.1	322.6	367.2	689.8
	Ship	50.6	22.2	72.8	645.0	68.6	713.6
Total		1,190.0	285.9	1,475.9	1,753.4	599.9	2,353.3

Source:

- 1) Road "Annual Transport Statistics", March 1983 by Transport and Communications Economic Division, Ministry of Communications

(Note)

Original data of 1978 was extrapolated to 1981 by applying the growth rate of registered number of trucks of the country from 1975 to 1979.

- 2) Railway "Annual Transport Statistics", March 1983
- 3) Ship "Yearly Report for Outwards/Inwards Cargo Ship File, 1981" by Harbour Department

(Note)

- Commodity classification was adjusted to make correspond with the classification adopted in "Annual Transport Statistics".
- There is a discrepancy between outwards and inwards volume of the intra regional transportation.

In recent three years from 1979 to 1981, cargo handling volume of coastal shipping excluding oil and petroleum products showed a stagnant growth, and the volume transported by railway showed a decreasing trend between the South and Bangkok. This fact indicates that some cargoes which were previously transported by ship/railway have been diverted to road transport in accordance with the strenuous development and improvement of highway network. Door to door delivery with higher speed and greater punctuality has become one of the primary concerns for choosing transportation means, especially in market oriented transactions. Road transport can meet this requirement more effectively than other means of transportation.

However, it is also an important issue to attain cost reduction of goods transportation from the viewpoint of price competitiveness in the market and national energy saving. Each transportation means has respective advantages ; road transport has the advantage of door to door delivery in any lot and any time, and railway/ship transport has the advantage of low transportation cost in long haul. Taking account of the distance between Bangkok and the South, 650 kilometers for Bangkok-Surat Thani and 950 kilometers for Bangkok-Hat Yai, there will be much room for railway/ship transport to participate in this long haul transportation. It will however, be a natural tendency that road transport will increase its share for the future, if special efforts are not made to modernize railway/ship transport system which includes several times of cargo handling for main line transportation, transshipment and feeder transportation by road transport.

2.3

TRANSPORTATION INFRASTRUCTURE OF SOUTH

The total length of nationwide road network in 1981 amounted to 140,000 kilometers which consisted of 44,000 kilometers of national and provincial highways under the jurisdiction of Department of Highways (DOH) and 96,000 kilometers of such roads as rural roads, municipal roads and concession highways under the jurisdiction of other agencies. The length of national and provincial highways of the South amounted to 8,048 kilometers, which accounted for 18.3 percent of the total length, holding a subordinate position to the Northeast with 29.0 percent, the North with 28.1 percent and the Central with 24.6 percent. In terms of highway density, however, the South was ranked at the top with 0.114 kilometers per square kilometer, followed by the Central with 0.104, the Northeast with 0.075 and the North with 0.073. Average daily traffic on national highways ranged from 500 to 1,500 vehicles on inter city sections. Those roads other than national and provincial highways are usually candidate roads to be upgraded to provincial highways, depending on traffic monitor-

ing and economic evaluation.

The total length of nationwide railway network in 1981 amounted to 3,735 kilometers which was equivalent to 8.5 percent of the total length of national and provincial highways. The length of the Southern main line amounted to 1,159 kilometers to Sungai Kolok while those of the Northern, Northeastern and Eastern main lines amounted to 751 kilometers to Chiang Mai, 624 kilometers to Nong Khai and 255 kilometers to Aranyaprathet, respectively. The total of operating revenues in the fiscal year 1981 was 3,058.3 million baht, of which 1,816.1 million baht or 59.4 percent came from passenger service, 1,047.3 million baht or 34.2 percent from freight service and 195.1 million baht or 6.4 percent from other miscellaneous operations. The share of the Southern Line accounted for 39 percent of the total revenue, followed by the Northern Line with 38 percent, the Northeastern Line with 17 percent and the Eastern Line with six percent. The Southern Line had a share of 33 percent of the total passengers, 40 percent of the total passenger-kilometers, 22 percent of the total freight tons and 25 percent of the total ton-kilometers.

The inland transportation infrastructure of the South can be said to be better developed and maintained than other regions as a whole, and it is a distinguished characteristic of the South that there are several ports on both sides of the region for international and coastal shipping. Although the South has the comparative advantages from the viewpoint of transportation infrastructure, however, there are several issues for attaining further economic growth of the region and effective utilization of the transportation infrastructures.

The first issue is to improve/develop east-west links connecting both sides of the peninsula. Through the development of such north-south links as the Southern Railway Line, Highway Route 4 and Route 41, economic interrelationship among provinces on each coast of the peninsula was strengthened than before, and the areal development made a steady advance in the corridors along these links. The economies of east and west coasts, however, still remains rather independent with each other partly due to the lack of well-developed east-west links. The existing east-west links, so to speak, are Chumphon-Kra Buri, Surat Thani-Takua Pa, Nakhon Si Thammarat-Trang, Trang-Phatthalung and Satun-Songkhla. Because of the mountain ranges extending in north-south direction, some part of these links contains mountainous/hilly terrain inbetween.

The second issue is to improve intermodal connections between railway and road and between port and road. Port and railway were developed before the development of

road network, thereby resulting in inconvenient access to them and insufficient cargo handling space in railway and port areas. Some of the main railway stations are enclosed by long established urban facilities and have difficulties to enlarge the railway area to equip more space. On the other hand, small stations have limited access to the station, giving very limited service to the adjacent area.

The third issue is to improve railway and shipping service to be more competitive with truck service, especially for long haul transport. Improvement of coastal shipping service has been studied by "The Comprehensive Development Study of Coastal Shipping in the Kingdom of Thailand" which recommends a shuttle service between Bangkok and Songkhla by vessels of 700 dead weight tons (DWT).

Although there are many factors affecting the modal choice of freight and passengers, the most influential factor is travelling speed and cost. The present speed of express train on the Southern Line is approximately 53 kilometers per hour and that of freight train is 29 kilometers per hour. The former is slower than bus by about 10 kilometers per hour and the latter is about one half of truck speed. Train operation with higher speed can be achieved not only by improvement of hardware system but also by improvement of such software as train operation diagram with less stops and marshaling.

3. PRESENT TRANSPORTATIONAL SITUATIONS OF UPPER SOUTH

3.1 ROAD

Primary national highways in the Upper South are consisted of Route 4 and Route 41 ; Route 4 passes through Phangnga and Krabi on the west coast of the Upper South, connecting the subregion with Bangkok to the north and Hat Yai to the South, and Route 41, which was opened to traffic in 1978, passes through Surat Thani in the center of the Upper South, connecting the subregion with Chumphon to the North and Thung Song to the South. Though many towns and villages have been established in the corridor area along Route 4 and large part of the wayside area has been made use of for tree crop plantation and other agricultural productions, the corridor area along Route 41 is just under way to be developed.

Secondary national highways which are linked with primary national highways are consisted of Route 401 (Takua Pa on the west coast - Surat Thani - Tha Sala on the east coast), Route 402 (Khok Kloi on Route 4 - Phuket) and Route 411 (Route 4 - Krabi). Provincial highways have gradually been developed by connecting spurs extended from highways to unused land, finally making connection to the other highways.

Total length of national and provincial highways in the Upper South amounts to 1,810 kilometers and highway density is calculated at 0.082 kilometers per square kilometer as shown in Table 3.1.

Compared with the highway density of 0.114 of the South, that of the Upper South is considerably low, mainly due to the vast mountainous area in Surat Thani and Phangnga. Phuket has the highest highway density of 0.280 in the Upper South, followed by Krabi with 0.084, Phangnga with 0.080 and Surat Thani 0.074. In spite of the above, highway network of the Upper South is said to be well established as a whole, providing all-weather access to every province and district.

Conditions of the highways are also well maintained through routine, periodic and special maintenance works by highway districts of Surat Thani, Phuket and Krabi under the jurisdiction of Nakhon Si Thammarat Highway Division, DOH.

Traffic volume on major highway sections has been monitored by DOH. According to the data, the Average Daily Traffics (ADT) on primary national highways in 1981 are within the range of 1,000 - 2,000 ADT. Some sections on secondary national

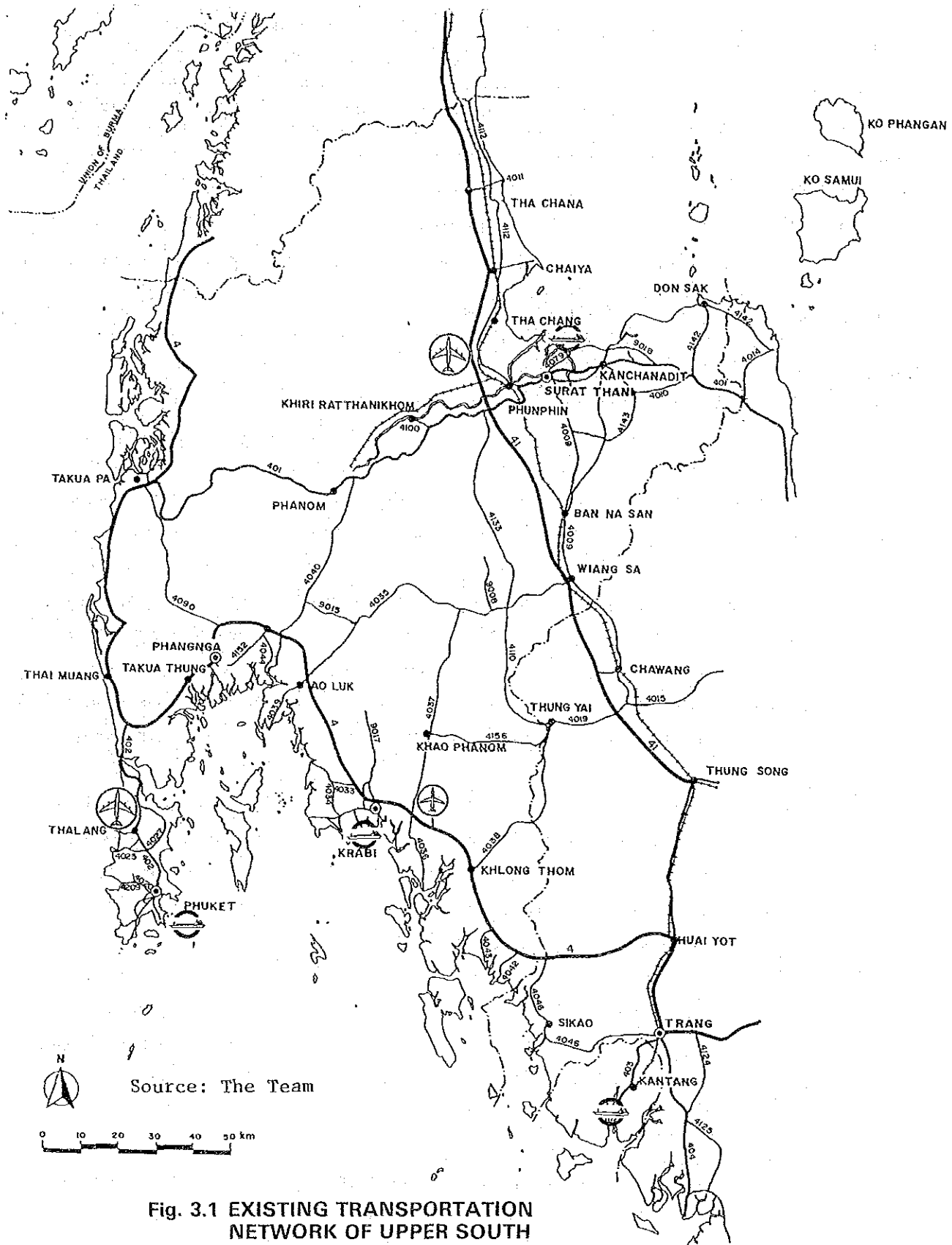


Fig. 3.1 EXISTING TRANSPORTATION NETWORK OF UPPER SOUTH

Table 3.1 HIGHWAY LENGTH IN UPPER SOUTH

	Surat Thani	Phangnga	Phuket	Krabi	Total
National Highway (km)	337.8	169.5	42.5	125.0	674.8
Provincial Highway (km)	613.3	151.1	108.3	262.6	1,135.3
Total (km)	951.1	320.6	150.8	387.6	1,810.1
Area (km ²)	12,811	4,009	538	4,624	21,982
Highway Density (km/km ²)	0.074	0.080	0.280	0.084	0.082

Source of highway length: Road Inventory Profile in 1981 by DOH

highways show large traffic volume, for instance, 5,400 ADT on Phum Phin-Surat Thani Section and 4,500 ADT on Sarasin Bridge - Phuket Section. Traffic volumes on provincial highways are considerably smaller than those on national highways, being less than 700 ADT. The section of Surat Thani - Ban Na San is only one exception, with traffic volume amounting to 2,300 ADT. It can be said that most of the highways are free from capacity constraints at present, except for some adjacent sections to big cities. Average composition ratio of vehicles for cargoes and passengers is estimated at 56 percent for cargoes and 44 percent for passengers on national highways. Average composition ratio of heavy vehicles is estimated at 12 percent.

The number of vehicles registered in the Upper South in 1981 is estimated based on "Statistical Yearbook, Thailand". Total number of vehicles amounted to 66,000 including motorcycles of 49,300. The number of vehicles per thousand population is calculated at 58 for all vehicles and 15 for vehicles excluding motorcycles. Phuket showed the highest number of vehicles per thousand population of 217 for all vehicles and 49 for vehicles excluding motorcycles, followed by Phangnga of 40 and 15, Surat Thani of 37 and nine and Krabi of 29 and 10, for all vehicles and for vehicles excluding motorcycle, respectively. The number of vehicles registered in the Upper South increased by 3.1 times for all vehicles and 3.5 times for vehicles excluding motorcycles.

Bus is the main transportation means for catering passenger transportation by highways. Three kinds of bus service are offered to the Upper South, catering for inter regional, inter provincial and intra provincial passenger transportation. Bus service is available between the four provinces in the Upper South and Bangkok, and among provinces in the South as shown in Table 3.2. Bus terminals are located in the center

of municipalities of each province and inter regional and provincial buses are linked with intra provincial buses.

The followings are the major on-going highway development projects under the Fifth Five Year Plan:

- New Construction of Phuket Bypass

This bypass is planned to relieve the increasing traffic concentration on Route 402 in the Phuket Municipal Area. The length of this bypass amounts to eight kilometers with S1 Standard (seven meter width). It is scheduled to be open to traffic in 1985. By the completion of this bypass, through traffic to and from the southern part of the island is expected to be diverted from the existing Route 402 to this bypass, including the traffics to and from Phuket Deep Seaport.

Table 3.2 BUS SERVICE RELATED TO UPPER SOUTH

	Distance (km)	Time	Speed (km/H)
Inter Region (Grade 2)			
Bangkok – Surat Thani	669	10:38	62.9
– Phangnga	881	14:45	59.7
– Phuket	891	16:59	52.5
– Ranong	586	11:40	50.2
– Krabi	867	12:40	68.5
– Chumphon	465	8:13	56.6
– Nakhon Si Thammarat	805	12:35	64.0
– Hat Yai	1,013	15:56	63.4
– Trang	938	15:05	62.2
Inter Province (Grade 3)			
Surat Thani – Phuket	296	6:46	43.7
– Krabi	192	4:13	45.5
– Chumphon	214	5:07	41.8
– Nakhon Si Thammarat	138	3:26	40.2
Phuket – Phangnga	94	2:18	40.9
– Takua Pa	133	3:03	43.6
– Trang	320	6:15	51.2
– Nakhon Si Thammarat	381	8:41	43.9
– Hat Yai	480	8:34	56.0
Krabi – Trang	136	2:51	47.7
– Thung Song	151	2:43	55.6

Source: "Survey and Analysis of the Demand for Bus Services Grade 2 & 3", by Department of Land Transport in 1982.

- New Construction of Phangnga - Thap Put Project

This project is planned to offer an easier and safer route to detour the existing National Highway Route 4 which winds a way through Nang Hong Mountain with steep gradient. The total length of the project amounts to 22 kilometers with F3 Standard (six meter width). It is scheduled to be open to traffic in 1986.

- Improvement of Access Highway to Phuket Deep Seaport

This project is planned to accommodate heavy trucks to and from Phuket Deep Seaport. Provincial Highway Route 4023 is improved from F4 Standard (five meter width) to F1 Standard (seven meter width). This project was completed in 1984. The intermediate section of two kilometer length which connects this access highway with Phuket Bypass is now under study.

- Upgrading of Route 402

The section between Phuket International Airport and the boundary of Phuket Municipality is now being upgraded from S4 Standard (5.5 meter width) to S1 Standard (seven meter width), the length amounting to 28 kilometers. The upgrading is scheduled to be completed in 1984, after which the section between Phuket International Airport and Sarasin Bridge is planned to be upgraded to the same standard.

- Widening of Route 401 of the section between Phun Phin and Surat Thani

This section was originally planned to be widened from the existing two lane highway to four lane. Due to the land acquisition problem, however, possibility of new highway construction to connect Surat Thani with Route 41 is now under study. As described before, traffic volume on this section amounted to 5,400 ADT in 1981 and has been increasing afterwards due to the notable development of the wayside area. It is highly needed to construct a new link in this area.

- Surfacing of Provincial Highways

Unpaved provincial highways are planned to be surfaced, for instance, Phanom-Thap Put Section of Route 4040 and Phra Saeng-Khao Phanom-Route 4 of Route 4037. The former section is expected to reduce the travelling time distance between Surat Thani and Phangnga/Phuket and the latter to reduce the travelling time distance between Surat Thani and Krabi.

3.2 RAILWAY

The Southern Line passes through Surat Thani Province, the route kilometers there amounting to 170 kilometers including Khiri Ratthanikhom Spur Line of 31 kilometers. There are 22 stations in Surat Thani including eight stations on the Spur Line.

The daily number of trains operated on the Southern Line, particularly in relation to Phum Phin Station, amounts to eight passenger trains, two mixed trains and six freight trains for each direction. Two express trains connect Surat Thani with Bangkok and Hat Yai with the travelling time of 12 hours and 15 minutes to Bangkok and five hours and 20 minutes to Hat Yai. The average operating speed of express trains is calculated at 53 kilometers per hour for Bangkok and 55 kilometers per hour for Hat Yai. The number of boarding passengers from Phun Phin Station slightly increased from 695,000 passengers in 1972 to 738,000 passengers in 1982, the growth rate being 0.6 percent per annum.

The daily number of trains operated on Khiri Ratthanikhom Spur Line amounts to three mixed trains for each direction. The average train operating speed is calculated at 26 kilometers per hour. Passengers carried by the Spur Line amounted to 100,300 passengers in 1982.

Both the Southern Line and Khiri Ratthanikhom Spur Line are well maintained. However, due to the highway development in recent years, railway has been deprived of its past superiority in land transport. This is because of the fact that railway has just kept almost same facilities and operations as those of two decades ago without any improvement to cope with the changing transportation demand.

3.3 SEA TRANSPORT

There are four major ports in the Upper South:

- Inner Ban Don Port and Outer Ban Don Port (Tha Thong)
- Khlong Tachin Port
- Krabi Port
- Kantang Port

Inner Ban Don Port is located on the bank of the Tapi River facing to Surat Thani City. This port has many small jetties. The major port facilities are a pier for vessels operated between Surat Thani and Ko Samui, piers for Fish Marketing Organization

and those for oil handling. Tha Thong Port is located at the confluence of the Tapi and the Tha Thong Rivers. This port was constructed in 1982 with a pier of 287 meter length and minus four meter depth, a shed of 2,000 square meters and an open space of 500 square meters. This port has not been operated since then because a channel of 27 kilometer length traversing the Ban Don Bay is not dredged yet.

Khlong Tachin Port is located three kilometers east of Phuket City. This port has jetties for fishery boats on the both banks of the Khlong Tachin River and a pier of 50 meter length for container berges. Containers staffed with rubber are transported by berge equipped with gear for loading on a feeder container vessel offing. The feeder vessel carries the containers to Penang or Singapore for transshipment. A jetty exclusively used by Thaisarco is located at Ao Makkham seven kilometers south of Phuket City. A new deep seaport is planned to be constructed neighboring to the jetty.

Krabi Port is located at a point of 13 kilometers upstream of the Chirat River. A new port was constructed two kilometers west of Krabi City in 1984 with a concrete pier of 196 meter length and minus 5.5 meter depth, a shed of 2,000 square meters and an open space of 2,400 square meters. This port is not operated yet because of some institutional problems on port management and incompleteness of channel dredging.

Kantang Port is located at a point of 27 kilometers upstream of the Trang River. This port has a concrete pier with 144 meter length, 15.5 meter width and minus four meter depth. Such cargoes as rubber, cement and minerals are exported by berge to a vessel anchored offing because the channel has only minus 2.5 meter depth in a bending section. Most of the vessels to and from this port are forced to negotiate the channel by gearing to the tidal fluctuations.

Cargo handling volume of these ports in 1981 is as shown in Table 3.3. Inner Ban Don Port which is specialized in coastal shipping handled 408,000 tons including oil/fuel and 195,000 tons excluding them. Major commodities handled in this port are landing of oil/fuel, fish catches and miscellaneous goods. Khlong Tachin Port which would be identified as an international port handled 261,000 tons including oil/fuel and 128,000 tons excluding them. Major commodities handled in this port are import and landing of oil/fuel and landing of fish catches. Tin and rubber are typical exporting commodities of this port. Krabi Port which can be characterized as fishery port handled 24,000 tons including oil/fuel and 15,000 tons excluding them. Kantang Port handled 247,000 tons including oil/fuel and 174,000 tons excluding them. Major commodities handled in this port are landing of fish catches, import of oil/fuel and export

Table 3.3 CARGO HANDLING VOLUME IN 1981

Unit: t

	Surat Thani				Phuket				Grand Total
	Domestic		Foreign		Domestic		Foreign		
	Out	In	Export	Import	Out	In	Export	Import	
Agricultural Products	3,841	5,767	24	188	-	-	-	-	142
Fishery Products	-	81,863	-	-	-	47,734	-	-	47,734
Wooden Products	19,626	4,254	-	-	-	-	-	-	-
Rubber	-	27	24,197	-	-	-	-	-	24,197
Tin	19	6,836	28,188	-	-	-	-	-	28,188
Cement	142	-	-	-	-	-	-	-	-
Construction Materials	-	7,130	-	-	-	-	-	-	-
Mechanical and Chemical Equipment	110	436	14	265	-	-	-	-	306
Miscellaneous	32,923	32,424	19	27,801	-	-	-	-	27,820
Oil and Fuel	2,792	209,645	-	97,162	-	-	-	-	97,162
Total	59,453	348,382	407,835	125,346	-	83,163	-	83,163	260,978
(Excluding Oil)	(56,661)	(138,737)	(195,398)	(52,469)	-	(47,734)	-	(47,734)	(128,387)

to be continued

Table 3.3 CARGO HANDLING VOLUME IN 1981

Unit: t

	Krabai			Kantang			Grand Total			
	Domestic			Foreign						
	Out	In	Total	Export	Import	Total		Out	In	Total
Agricultural Products	1	-	1	3,614	859	4,473	-	-	-	4,473
Fishery Products	-	15,269	15,269	-	-	-	-	123,565	123,565	123,565
Wooden Products	-	-	-	-	169	169	-	-	-	169
Rubber	-	-	-	33,121	-	33,121	-	-	-	33,121
Tin	-	-	-	-	-	-	-	-	-	-
Cement	-	-	-	2,500	-	2,500	-	-	-	2,500
Construction Material	-	-	-	-	-	-	20	-	-	20
Mechanical and Chemical Equipment	-	-	-	10,168	396	10,564	-	-	-	10,564
Miscellaneous	-	-	-	-	-	-	-	-	-	-
Oil and Fuel	Export 8,252 416	-	8,668	2,027	67,272	69,299	-	3,602	3,602	72,901
Total	8,669	15,269	23,938	51,430	68,696	120,126	20	127,167	127,187	247,313
(Excluding Oil)	-	(15,269)	(15,269)	(49,403)	(1,424)	(50,827)	(20)	(123,565)	(135,585)	(174,412)

Source: Statistics of Custom Office
 Volume of fishery product indicates catch volume of marine fish in each province shown in the statistics published by Department of Fisheries in 1983.

of rubber. Export of cement, which was once a major commodity of this port, has drastically been decreased due to the increase of domestic demand.

New deep seaports are planned at Songkhla and Phuket under the Fifth Five Year Plan for the purpose of exporting natural resource based products such as tin, rubber and palm oil without lighterage and transshipment in the near future, with the expectation of exporting and importing general cargoes in long term.

Construction of Phuket Deep Seaport will be commenced in 1985. The first phase construction plan is composed of two berths with 360 meter length and minus 10 meter depth, channel dredging with 120 meter width and minus nine meter depth and a turning basin with a diameter of 360 meters.

3.4 AIR TRANSPORT

There are six airports in the South. Three airports of Hat Yai, Phuket and Surat Thani have runways enabling to accept B737, and the remaining airports of Narathiwat, Pattani and Trang have runways enabling to accept SD330. The length and width of each airport is as follows:

<u>Airport</u>	<u>Runway</u>	<u>as of</u>
Hat Yai	3,050m x 45m	December, 1979
Phuket	2,500 x 45	August, 1980
Surat Thani	2,500 x 45	April, 1981
Narathiwat	1,500 x 30	– ditto –
Pattani	1,400 x 40	– ditto –
Trang	1,500 x 30	– ditto –

Phuket is connected with Bangkok by 12 domestic flights and five international flights a week for each direction, with Hat Yai by 14 domestic flights and four international flight, with Malaysian airports by five international flights and with Singapore by two international flights. Phuket is also connected with Surat Thani and Trang by four and seven flights a week for each direction, respectively. Surat Thani is connected with Bangkok, Hat Yai and Phuket by seven, three and four flights a week for each direction, respectively. Direct flight hours from Phuket to Bangkok, Hat Yai, Surat Thani and Trang are one hour and 10 minutes, 30 minutes, 25 minutes and 40 minutes, respectively. Direct flight hours from Surat Thani to Bangkok and Hat Yai are one hour, and 40 minutes, respectively.

The number of air passengers are as shown in Table 3.4. Phuket has the fourth largest number of passengers, following Bangkok, Chiang Mai and Hat Yai. Total of arriving and departing passengers amounted to 181,000 persons and 28,000 persons in 1982 for Phuket and Surat Thani, respectively.

Cargo handling volume including mail amounted only to 250 tons for Phuket and 30 tons for Surat Thani in 1982.

Phuket International Airport is planned to be improved during the Fifth Five-Year Plan period; extension of the runway from the existing 2,500 meters to 3,000 meters for accepting B-747, strengthening the runway and improvement of passenger terminal and apron. The improvement plan of Surat Thani Airport includes the construction of a two-storey building with separate arrival and departure terminals. A temporary airport was completed at Nua Clong Village in Krabi Municipality in March, 1984. It has a 950 meter long runway with compacted gravel surface.

Table 3.4 NUMBER OF AIR PASSENGERS

Unit: 1,000 persons/year

	Phuket			Surat Thani		
	Arrival	Departure	Total	Arrival	Departure	Total
1972	9.7	9.6	19.3	—	—	—
1980	68.4	74.6	143.0	—	—	—
1982	88.5	92.0	180.5	13.6	14.1	27.7
1982/1972 (%pa)	—	—	25	—	—	—
1982/1980 (%pa)	—	—	12	—	—	—

Source: "Aviation Statistics" by the Aviation Department.

3.5 PROBLEMS OF EXISTING TRANSPORTATION SYSTEM

The total length of national and provincial highways was increased at a considerable high growth rate of 6.2 percent per annum for the period 1967-1979. During the period the number of registered vehicles attained a growth rate twice as high as the growth rate of highway construction.

In contrast to highways, the total length of railway line had no increase during the period. The total number of locomotives, passenger cars and freight cars remained almost the same with that of 12 years ago, too. The number of passengers and the tonnage of freight showed a slight increase, while only passenger-kilometers showed a considerably high growth rate of 5.7 percent per annum.

Though foreign trade ship showed a considerable high growth rate, coastal trade by ship stagnated during the period. Owing to the gradual increase of vessel size, number of vessels entered and cleared customs decreased at a rate of over seven percent. Tonnage of cargo entered showed an increasing growth rate of 4.8 percent whereas that of cargo cleared decreased slightly during the period 1967-1979.

On the other hand, passenger transportation by air increased rapidly at a rate of 12 percent being even higher than that of number of registered vehicles, though the tonnage of air freight showed a slight decline in the period.

Based on the above trend, it can be said that road and air transport expanded their roles in the inter modal relationship for passengers, and that railway and sea transport gradually lost their previous shares in goods transportation while highways were rapidly extended to every part of the country. In spite of the continuous maintenance and improvement of railway and ports, considerable part of goods transportation diverted from railway and sea transport to road.

Though the above described phenomena are for the whole country, they are applicable to the Upper South in a general sense. Considering the present situations of transportation of the Upper South and these phenomena in the past, the problems contained in each transportation means can be enumerated as follows:

Railway

- Low speed of train operation caused by lack of enough siding, wooden bridges of inadequate supporting force, inefficient signalling and telecommunication system, etc.
- Unreliability of train schedule due to frequent delay
- Inefficiency of loading/unloading of freight due to insufficient cargo handling space and facilities

- Lack of security for entrusted cargoes due to unlimited entrance to railway station yard

Sea Transport

- Low speed and inefficient transportation by old and small vessels
- Difficulties in accepting larger vessels owing to channel problems, severe drift restrictions at the entrance of channel and siltation problems
- Inefficiency of loading/unloading of cargo due to lack of appropriate facilities

Air Transport

- Capacity problem on main route
- No facilities for loading/unloading cargo and storage

Highways

- Damages caused by overloaded heavy trucks
- Sharp gradient and curve in mountainous areas
- Unavailability of road in the night time in some sensitive areas
- Increasing traffic congestions in some part of urban areas owing to mixture of through and local traffics, roadside parking and mixture of every kind of vehicles.
- Inefficient truck operation caused by empty return

4. TRANSPORTATION DEMAND FORECAST

4.1 PRESENT TRANSPORTATION DEMAND

Although the transportation flow of cargoes and passengers between the South and other regions can roughly be estimated based on the existing transportation statistics, there is no such data to show the transportation flow with reference to the Upper South. Department of Highways (DOH) occasionally carried out origin and destination surveys for the purpose of obtaining the information necessary for constructing new bypasses. The areal coverage of the surveys is rather limited, accordingly. In order to picture the transportation flow with reference to the Upper South in more broad terms, we carried out several kind of surveys; roadside Origin-Destination (OD) survey, railway station survey, airport survey, home interview survey and so on.

4.1.1 Cargo Transportation

Cargo flow related to the Upper South was firstly estimated based on roadside OD survey we carried out and the data compiled by the State Railway of Thailand (SRT) and the Harbour Department. Then, production/consumption analysis was performed for 10 major commodities so as to verify the above established cargo flow and supplement intra provincial flow of commodities which was not included in the above estimation. The major commodities selected are rice, rubber, palm oil, coconut, fish, forestry products, tin, petroleum products, cement and manufactured products. Cargo flow among provinces in the Upper South estimated by production/ consumption analysis proved to be almost similar to the flow estimated by the survey results and other data. The excessive inflow and outflow of the former estimation to the latter was interpreted as general commodities supplied to the Upper South from outside and miscellaneous commodities other than the major commodities supplied from the Upper South to outside, respectively. The estimated cargo flow is as shown in Table 4.1 and Fig. 4.1.

Total volume of cargo flow in 1980 was estimated at 4.7 million tons per year in the Upper South including intra provincial flow and 3.8 million tons excluding intra provincial flow. The volume of inter provincial flow in the Upper South was estimated at 0.8 million tons, the cargo flow between the Upper South and Bangkok including other regions at 1.5 million tons and the cargo flow between the Upper South and the Lower South at one million tons. The Upper South has close economic relationship with Bangkok rather than with the Lower South.

Surat Thani

Cargo flow of Surat Thani was estimated at 1.3 million tons excluding intra provincial flow. Cargo flow to and from the Lower South and Bangkok amounted to 490,000 tons respectively while cargo flow between other provinces in the Upper South amounted only to 170,000 tons. Surat Thani has rather close economic relationship with Nakhon Si Thammarat, but has only a limited relationship with Phuket at the moment.

Phangnga

Cargo flow of Phangnga was estimated at 1.1 million tons excluding intra provincial flow. Cargo flow to and from Phuket was the biggest amounting to 420,000 tons, followed by Bangkok with 380,000 tons and the Lower South with 90,000 tons. Phangnga has close economic relationship with Phuket and Bangkok, but has only a limited relationship with such neighboring provinces as Krabi, Surat Thani and Ranong.

Phuket

Cargo flow of Phuket was estimated at 1.3 million tons excluding intra provincial flow. Cargo flow to and from Phangnga and Bangkok amounted to 420,000 tons respectively and cargo flow to and from the Lower South amounted to 140,000 tons. Though Phuket has close economic relationship with Phangnga and Bangkok, it has only a limited relationship with Krabi and especially Surat Thani.

Table 4.1 CARGO OD TABLE IN 1980

Unit: 1,000 tons/year

	1	2	3	4	5	6	7	8	9	Total
1. Surat Thani	400.5	60.4	3.7	46.4	154.3	75.4	228.8	37.2	1.2	1007.9
2. Phangnga	34.5	102.4	253.3	46.0	3.3	3.3	162.3	0.0	0.0	605.1
3. Phuket	2.4	167.5	177.4	74.1	13.5	2.2	247.9	15.4	54.5	754.9
4. Krabi	27.2	20.8	43.1	247.1	68.8	39.1	126.0	0.0	0.0	572.1
5. Other South	336.1	91.5	126.6	232.9	0.0	0.0	0.0	0.0	0.0	787.1
6. Chum/Ranong	41.4	55.6	22.6	0.1	0.0	0.0	0.0	0.0	0.0	119.7
7. Others	260.0	221.2	172.3	82.2	0.0	0.0	0.0	0.0	0.0	735.7
8. East Countries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9. West Countries	0.0	0.0	113.6	0.0	0.0	0.0	0.0	0.0	0.0	113.6
Total	1102.1	719.4	912.6	728.8	239.9	120.0	765.0	52.6	55.7	4696.1

Source: The Team

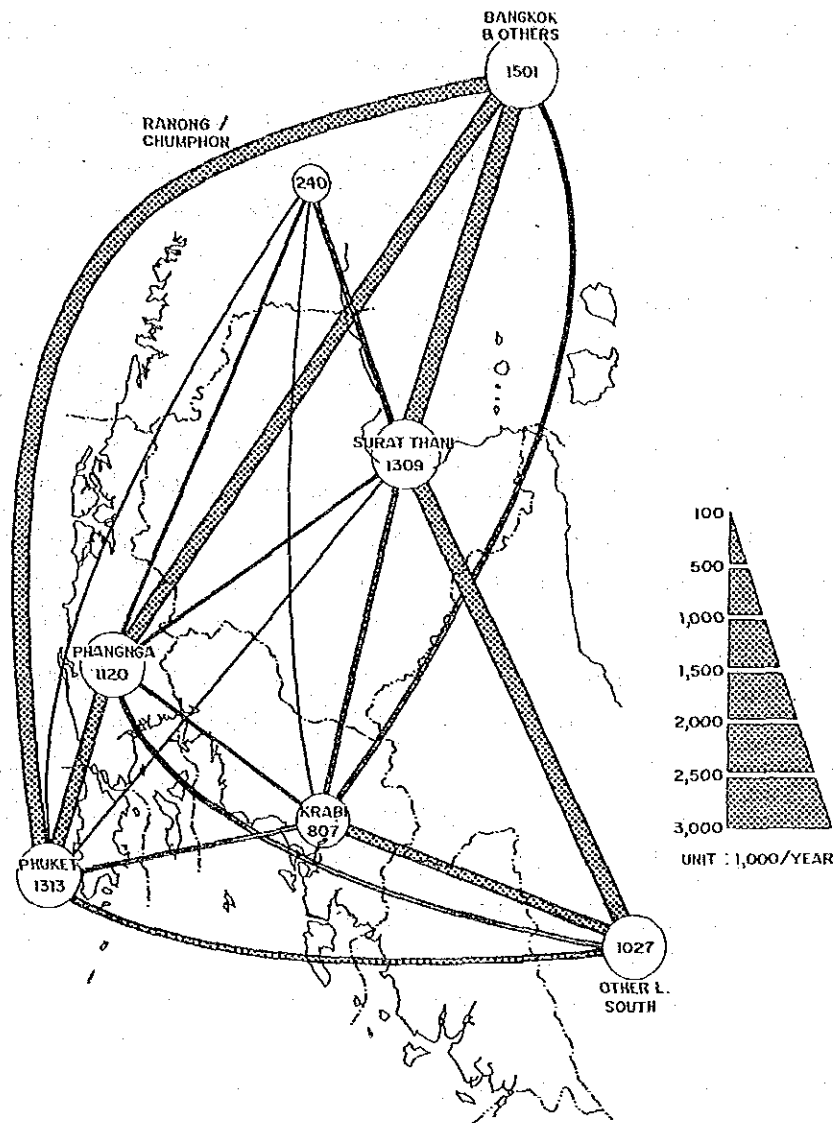


Fig. 4.1 CARGO FLOW IN 1980 - ALL COMMODITIES, ALL MODES -

Krabi

Cargo flow of Krabi was estimated at 0.8 million tons excluding intra provincial flow. Cargo flow to and from the Lower South amounted to 300,000 tons, followed by Bangkok with 210,000 tons and Phuket with 120,000 tons. Krabi has close economic relationship with the Lower South, especially with Trang but only a limited relationship with the provinces in the Upper South.

Judging from the above estimation, it can be said that the economies on the east and west coasts of the peninsula have been developed separately and still have little inter-relationship between them. Surat Thani has been connected with Bangkok and the Lower South, Phangnga and Phuket have been connected with Bangkok though they

have strong interrelationship with each other, and Krabi has been connected with the Lower South. Development of East-West Link to connect the economies on both coasts, development of efficient transportation means between the Upper South and Bangkok, and development of Phuket-Krabi Link to integrate the economies on the west coast are considered to be major issues for the Upper South development.

4.1.2 Passenger Transportation

Passenger flow related to the Upper South was firstly estimated based on roadside OD survey, railway station survey and airport survey we carried out and the data compiled by the State Railway of Thailand and the Department of Aviation. Then, person trip analysis was performed for residents of the Upper South based on the home interview survey carried out by us and for visitors to the Upper South based on the origin and destination survey compiled by Tourism Authority of Thailand. The latter estimation was proved to be 61 percent of the former estimation in terms of inter provincial trips. Major difference came from inter provincial trips in the Upper South. Reasons for this difference can be attributable to the following factors:

- Inter provincial trip ratio obtained from the survey was too low because the home interview survey was carried out mainly in municipal area where most people can usually satisfy their daily needs without making inter provincial trips. People who live near provincial border area often make more inter provincial trips.
- Visitors to the Upper South often make excursion trips. For the lack of such data, however, possible excursion trips were not included in the estimation.

In this study, the latter estimation was adopted to decide the total number of person trips while the former estimation was applied to assume the trip distribution pattern of residents in the Upper South.

Total number of person trips in 1980 was estimated at 104,000 trips per day in the Upper South including intra provincial flow and 31,000 trips excluding intra provincial trips as shown in Table 4.2 and Fig. 4.2. The number of inter provincial trips in the Upper South was estimated at 6,800 trips, the number of trips between the Upper South and the Lower South at 13,800 trips and the number of trips between the Upper South and Bangkok including other regions at 7,300 trips. The Upper South has closer relationship with the Lower South rather than with Bangkok in terms of person trip flow.

Surat Thani

Person trip flow of Surat Thani was estimated at 22,500 trips per day excluding intra provincial flow. Person trip flow to and from the Lower South excluding Songkhla amounted to 9,500 trips, followed by Bangkok with 4,400 trips. Surat Thani has close relationship with Nakhon Si Thammarat, but has only a limited relationship with Phuket at present.

Phangnga

Person trip flow of Phangnga was estimated at 4,600 trips per day excluding intra provincial flow. Person trip flow to and from Bangkok amounted to 600 trips, followed by Ranong/Chumphon with 400 trips. In the Upper South, Phangnga has the closest relationship with Phuket, followed by Surat Thani.

Phuket

Person trip flow of Phuket was estimated at 4,500 trips per day excluding intra provincial flow. Person trip flow to and from Bangkok amounted to 1,300 trips, followed by the Lower South with 1,100 trips. Phuket has the closest relationship with Phangnga, followed by Surat Thani in the Upper South.

Table 4.2 CARGO OD TABLE IN 1980

Unit: Person trip/day

	1	2	3	4	5	6	7	8	9	Total
1. Surat Thani	39032	585	133	1677	495	4745	1356	2178	102	50303
2. Phangnga	585	11399	912	57	82	126	182	315	17	13675
3. Phuket	133	912	8246	31	217	321	3	629	20	10512
4. Krabi	1677	57	31	13910	49	856	4	368	2	16954
5. Songkhla	495	82	217	49	0	0	0	0	0	843
6. Other L. South	4745	126	321	856	0	0	0	0	0	6048
7. Ranon/Chumphon	1356	182	3	4	0	0	0	0	0	1545
8. Bangkok	2178	315	629	368	0	0	0	0	0	3490
9. Others	102	17	20	2	0	0	0	0	0	141
Total	50303	13675	10512	16954	843	6048	1545	3490	141	103511

Source: The Team

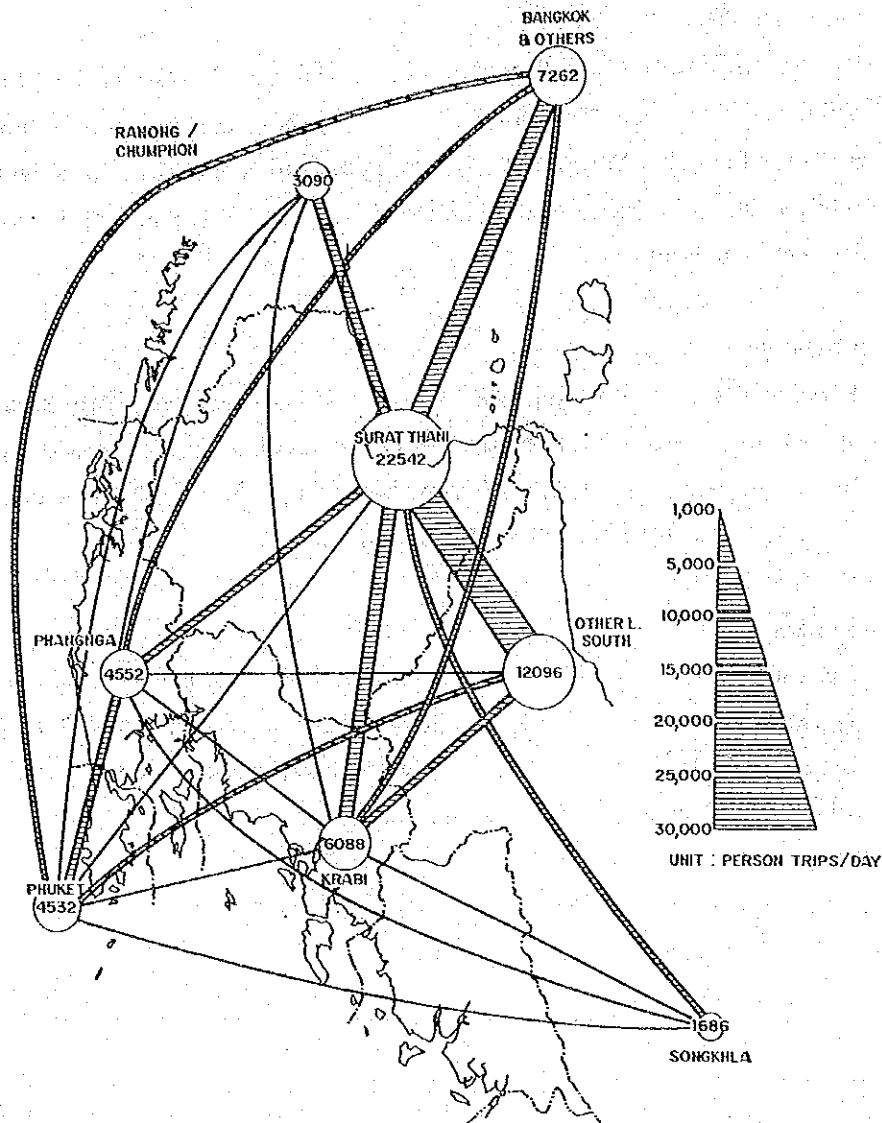


Fig. 4.2. PASSENGER FLOW IN 1980 - ALL MODES -

Krabi

Person trip flow of Krabi was estimated at 6,100 trips per day excluding intra provincial flow. Person trip flow to and from the Lower South excluding Songkhla amounted to 1,700 trips, followed by Bangkok with 700 trips. Krabi has the closest relationship with Surat Thani in the Upper South and with Trang outside the Upper South.

Although there are some differences of distribution pattern between person trip flow and cargo flow in detail, the general situations resemble each other. Interrelationship between Surat Thani and provinces on the west coast, especially Phangnga and Phuket is still very limited and interrelationship between the Upper South and the Lower South is not strong, except for Surat Thani-Nakhon Si Thammarat. For promoting the integrated development of the Upper South, development of East-West Link, Phuket-Krabi Link and efficient transportation means between the Upper South and Bangkok will be major issues in terms of person trip flow as well.

4.2 FUTURE TRANSPORTATION DEMAND

4.2.1 Cargo Transportation

Future cargo flow related to the Upper South was estimated based on production/consumption analysis. The future economic framework established was incorporated into the estimation of production volume. Market for each commodity was assumed based on the present market information and interview survey to the expert of respective fields.

Rice

Rice production in the Upper South will be increased from 104,100 tons in 1980 to 257,500 tons in 2000 in terms of white rice. Rice consumption will, at the same time, be increased owing to the population increase, resulting in the same level of white rice deficit as at present. Surat Thani will proceed from rice deficit to rice surplus province due to the expansion of irrigated field. Inter provincial rice transport in future will remain almost the same as at present, while intra provincial rice transport will be 2.5 times larger than the present volume.

Rubber

Rubber production will be increased from 98,000 tons in 1980 to 349,000 tons in 2000 by means of productivity increase. Phuket and Kantang Ports are outlets of rubber export on the Andaman Sea Coast but rubber produced on the coast of the Gulf of Thailand is destined to Bangkok or Hat Yai for transshipment at present. It is expected that the present pattern of rubber export will be considerably changed when an international port is developed in Surat Thani for direct export to eastern countries and an East-West Link connects two major ports of Phuket and Surat Thani in more accessible way. Rubber transportation pattern will be reformed from north-southbound to east-westbound movement, so to speak.

Palm Oil

Oil palm production is at the dawn of boom in Upper South as this area is blessed with suitable land for oil palm production and domestic market is promising for vegetable oils. Palm oil production in 2000 is estimated at 472,000 tons, approximately six times as much as the present quantity. The most prospective area lies in the Central Lowland situated at South Surat Thani and North Krabi. The primary transportation flow of palm oil is estimated to be northbound from the Central Lowland to Bangkok for aiming at domestic market. The secondary flow will be westbound to Phuket for exporting to the western situated countries. Fresh fruit bunch of oil palm in 2000 is estimated at 1,900,000 tons, which will necessitate feeder road network centering on extraction plant.

Coconut

Coconut production has been declining for these years due to unattractive market price. However, it is recommended that the production should be promoted from a viewpoint of its versatile utilization. Coupled with such measures as inter cropping, cattle breeding and so on, coconut production is estimated to increase from 75,000 tons in 1980 to 183,000 tons in 2000. Surat Thani will be the biggest coconut producing province in the Upper South. Fresh fruit of coconut and processed coconut oil will be sent to Bangkok.

Fish

The quantity of fish landed in 2000 is assumed to remain at the same quantity of 162,000 tons as at present due to the deterioration of fishery resources. This will entail that export reserve will gradually be reduced as domestic demand for fishery products will steadily increase. Considering that fish markets in Bangkok area will remain predominant in future, the present pattern of fish transportation will not seriously be changed for the future. Intensive development of fish farming in the Ban Don Bay, the Phangnga Bay and Kantang Area will have a possibility to increase the quantity of fish transportation.

Forestry Products

Owing to the deterioration of forestry resources in recent years, it is estimated that the production of forestry products in future will only maintain the present level of production. However, it is anticipated that rubber replantation in a regular cycle will produce additional wood supply. The quantity of forestry products will be increased from 470,000 cubic meters in 1980 to 654,000 cubic meters in 2000 taking account of the old rubber trees cut down. Main market for forestry products of the Upper South is considered to be Bangkok and the area itself. It is estimated that 294,000 cubic

meters will be forwarded to Bangkok while 360,000 cubic meters will be locally consumed.

Tin

The quantity of tin metal export through Phuket is estimated at 35,100 tons in 2000, increment from 1980 being 4,700 tons. This estimation is based on the projected world demand of 247,000 tons, Thailand's share of 15.8 percent and the exporting share of Phuket in Thailand of 90 percent. Though the estimated quantity itself would not have significant impact on transportation infrastructure, tin as well as rubber induce liner ships to call Phuket Port.

Petroleum Products

Consumption of petroleum products of the Upper South in 1980 was estimated to be 335,600 kiloliters. The demand of Surat Thani was met by supply through ship from Bangkok Area while the demand of Phuket was by ship mostly from Singapore. Phangnga was supplied from Phuket and Surat Thani, and Krabi was supplied from Surat Thani and Kantang. It is estimated that the demand for petroleum products of the Upper South in 2000 would amount to 1,470,000 kiloliters. It is considered that railway link between Surat Thani and Phuket will greatly contribute to the transportation of petroleum products required in Phangnga. This picture, however, will be greatly changed if a local refinery is established in Krabi Province.

Cement

Siam Cement located at Thung Song solely supplies the cement demand in the South Region. The cement demand of the Upper South in 2000 is estimated at 1,075,000 tons while the demand in 1980 was estimated at 204,000 tons. With inexhaustible reserve of limestone, the Thung Song Factory is deemed to have enough capacity to meet the increasing demand by means of necessary expansion of its plant. Railway is the most preferable transportation means for cement transportation owing to the low cost bearing ability of the commodity. East-West Railway Link will help transport cement from Thung Song to Phangnga and Phuket. From a viewpoint of proper stock management, reliability of train operation schedule is considered to be a requisite condition.

Manufactured Products

Manufactured products of the Upper South is estimated to increase from 353 thousand tons in 1980 to 4,029 thousand tons in 2000. Market for these products are supposedly composed of 30 percent for the producing province, 33 percent for the South Region, 28 percent for other domestic market and nine percent for overseas market in

terms of tonnage. Value of manufactured products per unit quantity is generally higher than that of the other commodities, requiring rapid delivery in a small lot. It is estimated that transportation of manufactured products will depend largely on trucks, which necessitate improvement/development of road network for attaining higher travelling speed.

General Commodity

In addition to the above mentioned major commodities, the Upper South will be supplied with various kind of commodities produced outside the subregion. The import quantity of this kind of commodity will depend on the level of economic activity and per capita consumption. Per capita GPP was applied for estimating a growth rate of general commodity. It was estimated that general commodity would increase from 995,000 tons in 1980 to 2,573,000 tons in 2000. The preference of transportation means of general commodity will be similar to that of manufactured products.

Miscellaneous

In keeping pace with regional development of the Upper South, it is expected that miscellaneous commodities other than the major commodities will be produced and distributed to market. They will be composed mostly of such agricultural products as livestock and various kind of fruits. It was estimated that the miscellaneous cargo would increase from 849,000 tons in 1980 to 2,820,000 tons in 2000.

The quantity of cargo generated from the Upper South is estimated to increase from 2.9 million tons in 1980 to 10.7 million tons per year in 2000 with a growth rate of 6.7 percent per annum and the quantity of cargo attracted to the Upper South is estimated to increase from 3.5 million tons in 1980 to 11.2 million tons in 2000 with a growth rate of six percent per annum. In case of excluding intra provincial cargo transportation of the four provinces, the generated quantity from the Upper South will amount to 7.6 million tons in 2000 with an annual growth rate of 6.9 percent from two million tons in 1980, and the attracted quantity to the Upper South will amount to 8.1 million tons in 2000 with an annual growth rate of six percent from 2.5 million tons in 1980. The growth rates of inter provincial cargo transportation are estimated at 8.7, 4.3, 5.1 and 6.1 percent per annum for Surat Thani, Phangnga, Phuket and Krabi, respectively in terms of total quantity of generation and attraction. In keeping pace with the development of economic activities of the Upper South, cargo movement among the four changwat will be increased at an annual growth rate of 6.2 percent. The annual growth rates of cargo movement between the Upper South and Bangkok, and between the Upper South and the Lower South are estimated at 6.2 percent and 6.3 percent, respectively.

Surat Thani

Cargo flow of Surat Thani in 2000 is estimated at 6.9 million tons excluding intra provincial flow, which is 5.3 times as large as that in 1980. Inter provincial cargo flow between Surat Thani and other provinces in the Upper South amounts to 1.4 million tons, which is 7.8 times as large as that in 1980. Although Bangkok will still remain to be the most important economic counterpart to Surat Thani, economic relationship among four provinces will be promoted at higher pace. Cargo flow between Surat Thani and Phuket will amount to as much as 0.5 million tons which is equal to the cargo flow between Surat Thani and Bangkok in 1980.

Phangnga

Cargo flow of Phangnga in 2000 is estimated at 2.6 million tons excluding intra provincial flow, which is 2.3 times as large as that in 1980. Although cargo flow to and from Phuket and Bangkok remains predominant, cargo flow to and from Surat Thani and Krabi is estimated to increase at higher growth rate, amounting to 460,000 tons for the former and 250,000 tons for the latter.

Phuket

Cargo flow of Phuket in 2000 is estimated at 3.5 million tons excluding intra provincial flow, which is 2.7 times as large as that in 1980. Although cargo flow to and from Phangnga and Bangkok is expected to increase at moderate growth rates, cargo flow to and from Surat Thani is estimated to increase at a rapid growth rate, amounting to 490,000 tons.

Krabi

Cargo flow of Krabi in 2000 is estimated at 2.6 million tons excluding intra provincial flow, which is 3.3 times as large as that in 1980. Although cargo flow to and from the Lower South was larger than to and from the other provinces in the Upper South in 1980, this situation will be reversed in 2000, the former amounting to 680,000 tons while the latter 920,000 tons.

In keeping pace with economic development of the Upper South, inter provincial cargo flow in the Upper South will be greatly stimulated. Surat Thani will be a development center in the subregion from the aspect of agriculture and manufacturing industry. Surat Thani is expected to be a product supplying center to the provinces in the Upper South as well as to Bangkok. Inter provincial cargo flow in the Upper South will be 3.4 times from 780,000 tons in 1980 to 2,610,000 tons in 2000. So as to cope with the estimated cargo flow, improvement/development of transportation infrastructure becomes one of the vital issues to be tackled, especially the development

Table 4.3 CARGO OD TABLE IN 2000

Unit: 1,000 ton/year

	1	2	3	4	5	6	7	8	9	Total
1. Surat Thani	1738.6	393.9	444.7	351.8	654.6	317.1	1509.7	196.5	133.0	5739.9
2. Phangnga	61.4	474.5	363.7	122.7	132.5	38.5	408.3	9.7	19.3	1630.6
3. Phuket	50.2	381.8	398.5	56.0	79.5	21.8	348.6	77.6	131.8	1545.8
4. Krabi	56.9	130.1	201.7	483.9	164.1	34.6	527.0	86.5	114.4	1799.2
5. Other South	1072.2	362.4	477.9	518.7	0.0	0.0	0.0	0.0	0.0	2431.2
6. Chum/Ranong	163.1	38.6	48.2	55.3	0.0	0.0	0.0	0.0	0.0	305.2
7. Others	1515.6	146.1	349.9	209.6	0.0	0.0	0.0	0.0	0.0	2221.2
8. East Countries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9. West Countries	0.0	0.0	493.7	0.0	0.0	0.0	0.0	0.0	0.0	493.7
Total	4658.0	1927.4	2778.3	1798.0	1030.7	412.0	2793.6	370.3	398.5	16166.8

Source: The Team

of East-West Link connecting east and west coasts of the peninsula. On top of this, cargo flow between the Upper South and Bangkok will be increased, coinciding with the subregional development of the the Upper South. The volume will amount to 5,010,000 tons in 2000 from 1,500,000 tons in 1980. To meet this requirement, improvement and development of transportation system connecting the Upper South with Bangkok become another important issue. Taking account of the distance of more than 600 kilometers between the Upper South and Bangkok, development of transportation system should be planned from the viewpoint of making best use of comparative advantages of road, railway and ship transportation.

4.2.2 Passenger Transportation

Passenger transportation was estimated with reference to residents in the Upper South and visitors to the area from outside. These two were then integrated into an origin and destination table of passengers.

Person Trip by Residents

The number of trips per person-day in the Upper South was estimated at 2.01 including every kind of trips based on the home interview survey which we carried out. Of the person trip rate of 2.01, the ratio of person trips destined outside the district revealed to be 3.8 percent and the ratio destined outside the province revealed to be one percent. These results were utilized for estimating the number of person trips of

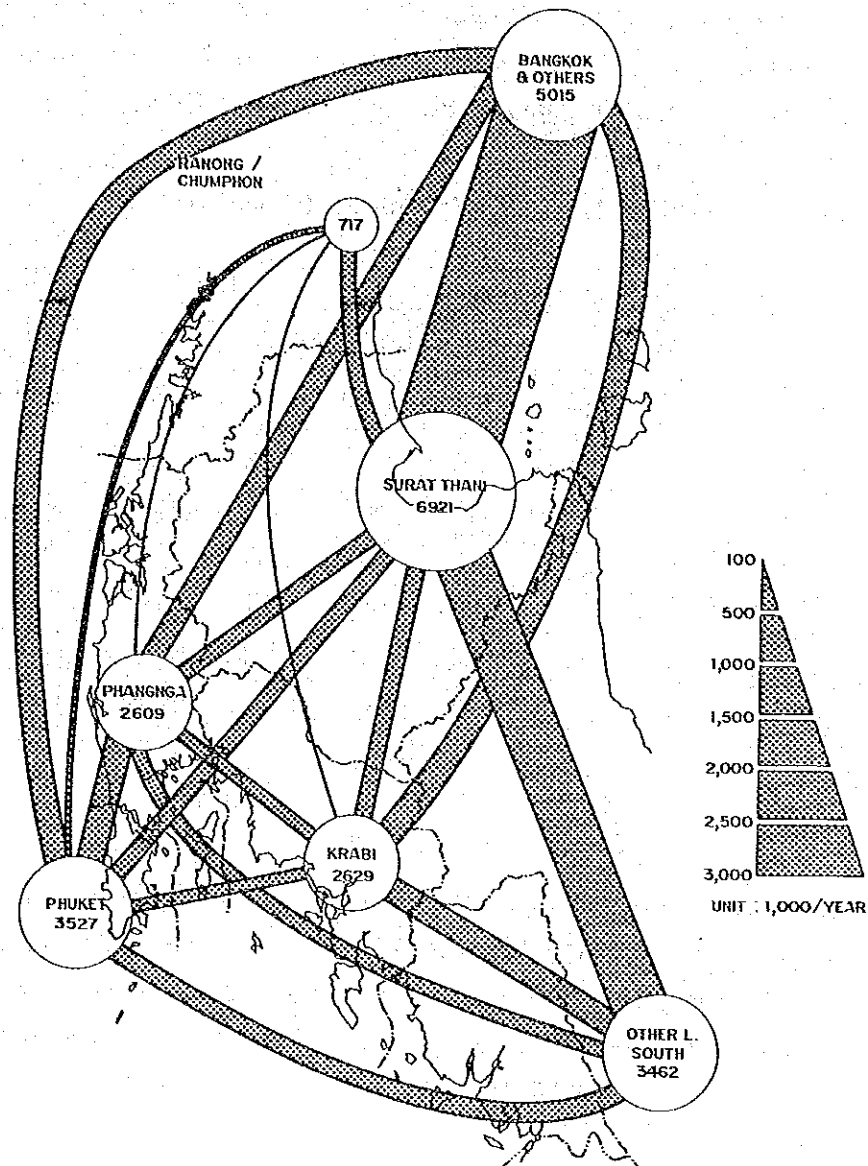


Fig. 4.3 CARGO FLOW IN 2000 - ALL COMMODITIES, ALL MODES -

the residents in the Upper South, coupled with population data. However, due to the lack of this kind of data for rural area, it was assumed that the ratios of person trips destined outside district/province from rural area would be 50 percent higher than those from urban area because the residents in rural area are forced to make trips of longer distance to urban centers, social facilities and so on to satisfy their daily needs.

It is expected that person trip of residents will be activated in the future owing to the development of economic activities in the area and their income increase. Person trip rate per person-day in 2000 was assumed to be 2.4 taking account of other transportation studies, and the ratios of person trips destined outside district/province were assumed to increase at the rate same as that of person trip.

The estimated generation and attraction of person trips were then distributed to each origin/destination pair based on the distribution pattern obtained from the roadside interview survey. The results are summarized as shown in Table 4.4.

Table 4.4 PERSON TRIP BY RESIDENTS (GENERATION)

Unit: 1,000 person trips/day

	Intra Zonal			Inter Zonal			Total		
	1980	2000	%pa	1980	2000	%pa	1980	2000	%pa
Surat Thani	39.0	98.4	4.7	7.0	17.6	4.8	46.0	116.0	4.7
Phangnga	11.4	23.8	3.7	2.0	4.3	3.7	13.4	28.1	3.7
Phuket	8.2	24.1	5.5	1.5	4.3	5.6	9.7	28.4	5.5
Krabi	13.9	34.4	4.6	2.5	6.2	4.6	16.4	40.6	4.6
Others	—	—	—	6.2	15.4	4.7	6.2	15.4	4.7
Total	72.5	180.4	4.7	19.2	47.8	4.7	91.7	228.5	4.7

Source: The Team

The total number of person trip generation of residents in the Upper South was estimated to increase from 91,700 in 1980 to 228,500 in 2000 with an annual growth rate of 4.7 percent. Phuket is estimated to attain the highest annual growth rate of 5.5 percent, followed by Surat Thani of 4.7 percent, Krabi of 4.6 percent and Phangnga of 3.7 percent.

Person Trip by Non Residents

The number of visitors to the four changwat coupled with their origins are available from the statistics compiled by Tourism Authority of Thailand. The number of visitors to the Upper South is estimated in Tourism Sector Study. Based on these information, future person trip by non residents was estimated on the premises that future distribution pattern of visitors' origin was similar to the present pattern and that the visitors to a province from the other provinces in the Upper South were taken into account by person trip by residents of the area. Table 4.5 summarizes the estimated future person trip by non residents. It should be noted that person trips by foreigners are not included in this OD table because their distribution pattern would be changed to a great extent by opening new international flight routes to the area.

Table 4.5 PERSON TRIP BY NON RESIDENTS (GENERATION)

	1980	2000	Unit: Person trips/day %pa
Surat Thani	4311	9553	4.1
Phangnga	239	406	2.4
Phuket	794	1184	2.0
Krabi	557	793	1.9
Others	5901	11936	3.6
Total	11802	23872	3.6

Source: The Team

The number of person trip generation per day by non residents was estimated to increase from 11,800 trips in 1980 to 23,900 trips in 2000 with an annual growth rate of 3.6 percent.

Person Trip by both Residents and Non Residents

The OD tables thus estimated were then integrated into an origin and destination table representing the total flow of person trips. Table 4.6 and Fig. 4.4 show the result of this estimation.

Total number of person trip related to the Upper South was estimated at 252,400 trips per day including intra provincial trips and 71,700 trips excluding intra provincial trips. The growth rates of person trips were calculated at 4.6 percent per annum including intra provincial trips and 4.3 percent per annum excluding intra provincial trips. The number of inter provincial trips in the Upper South was estimated at 16,900 trips, the number of trips between the Upper South and the Lower South at 31,400 trips and the trips between the Upper South and Bangkok including other regions at 16,200 trips.

Surat Thani

Person trip flow of Surat Thani was estimated at 54,300 trips per day excluding intra provincial flow. The growth rate from 1980 was calculated at 4.5 percent per annum. Person trips to and from the Lower South excluding Songkhla amounted to 22,700 trips at an annual growth rate of 4.5 percent and those to and from Bangkok amounted to 10,200 trips at an annual growth rate of 4.3 percent. Though the growth rate of person trips between Surat Thani and Phuket was estimated to be high, the

Table 4.6 PASSENGER OD TABLE IN 2000

Unit: Person trip/day

	1	2	3	4	5	6	7	8	9	Total
1. Surat Thani	98355	1081	525	4354	1200	11365	3263	5120	261	125524
2. Phangnga	1081	23775	2303	93	140	203	316	513	33	28457
3. Phuket	525	2303	24126	110	464	642	15	1351	74	29610
4. Krabi	4354	93	110	34432	91	1597	13	719	9	41418
5. Songkhla	1200	140	464	91	0	0	0	0	0	1895
6. Other L. South	11365	203	642	1597	0	0	0	0	0	13807
7. Ranon/Chumphon	3263	316	15	13	0	0	0	0	0	3607
8. Bangkok	5120	513	1351	719	0	0	0	0	0	7703
9. Others	261	33	74	9	0	0	0	0	0	377
Total	125524	28457	29610	41418	1895	13807	3607	7703	377	252398

Source: The Team

number of trips still remains rather low compared with other OD pairs of Surat Thani.

Phangnga

Person trip flow of Phangnga was estimated at 9,400 trips per day excluding intra provincial flow. The growth rate from 1980 was calculated at 3.6 percent per annum. Phangnga will keep the closest relationship with Phuket, followed by Surat Thani.

Phuket

Person trip flow of Phuket was estimated at 11,000 trips per day excluding intra provincial flow. The growth rate from 1980 was calculated at 4.5 percent per annum. Phuket has the largest number of person trips to and from Phangnga of 4,600 trips, followed by those to and from Bangkok of 2,700 trips. It is very likely that person trip flow to and from Phangnga will be larger than this estimation owing to the increasing excursion trips of tourist in this corridor.

Krabi

Person trip flow of Krabi was estimated at 14,000 trips per day excluding intra provincial flow. The growth rate from 1980 was calculated at 4.2 percent per annum. It is estimated that the relationship between Krabi and Surat Thani will be further strengthened while that between Krabi and the Lower South will relatively be stagnated.

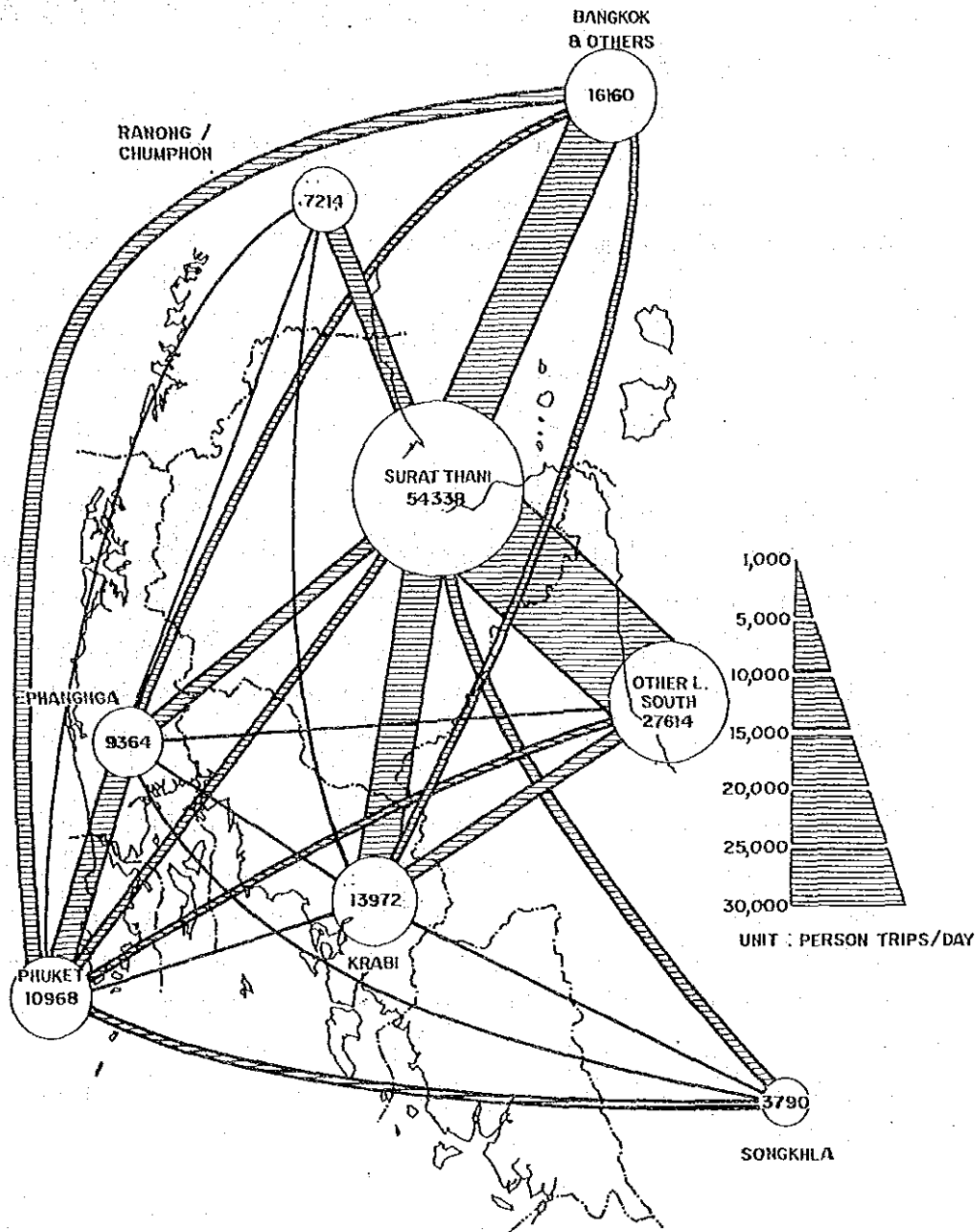


Fig. 4.4 PASSENGER FLOW IN 2000 - ALL MODES -

In the aspect of person trip flow, improvement/development of Krabi-Surat Thani Link will be an important issue for the integrated development of the Upper South. It is also an important issue to improve/develop the transportation system between the Upper South and Bangkok, taking account of the substantive transportation demand expected in this corridor.

5. STRATEGIES AND MAJOR PROJECTS FOR TRANSPORTATION DEVELOPMENT

5.1 TRANSPORTATION DEVELOPMENT STRATEGIES

5.1.1 Considerations on Transportation Demand and Supply

Transportation demand related to the Upper South could be categorized into four groups in terms of trip length; provincial, subregional, national and international levels.

Provincial transportation demand is met mostly by road transport which has access and traffic functions. Access function of road transport is considered more important than traffic function so as to expand the area for utilization; access from arterial highways to such production sites as agriculture, forestry and mining, access to such centers as district and village, access to tourism spots, access to such transportation nodes as railway, port and airport, and access to every part in urban centers.

Subregional transportation demand is met mostly by road transport, too, but traffic function of road transport is considered more important than access function as trip length increases. Railway transport could be used by passengers only between the areas of good access to and from railway station. This transportation demand is expected to increase in accordance with the progress of industrialization, population increase and a rise in per capita income of the Upper South. Transportation demand particularly between Phuket and Surat Thani will be increased at a higher growth rate as the both cities are developed into twin growth poles of the Upper South.

National transportation demand will be shared by road, railway and ship for cargo transportation, and by road, railway and air for passenger transportation. In the west coast of the Upper South, however, the available transportation means is limited at present to road for cargo transportation and to road and air for passenger transportation. Traffic function of road transport plays a major role in meeting this demand. Trucks and buses hurry on their long way to destinations. Through traffics cause conflicts with local traffics and uneasiness of residents who live in a small town along the highway. National transportation demand of the Upper South is expected to increase as well in accordance with the location of manufacturing industries to the area and growth of consumption there. Overall dependence on road transport will result in causing more conflicts and uneasiness for the future.

International transportation demand is met mostly by sea transport for cargo and air transport for passenger. However, any international outlets are not available to the east coast of the Upper South at present. This transportation demand is completed by feeder transport at both ends. Ports and airports are required to expand their capacity to cope with the future demand increase and feeder transport network should also be improved to ensure smooth flow of the generated and attracted traffics of these facilities.

Based on the above discussions, relationship between transportation demand and supply can be summarized as shown in Fig. 5.1.

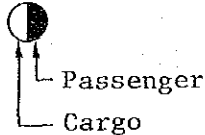
		Provincial	Sub-Regional	National	International	
East Coast	Road	◐	◐	◐	—	
	Railway	—	—	◐	—	
	Sea	—	—	◑	—	
	Air	—	—	◑	—	
West Coast	Road	◐	◐	◐	—	
	Railway	—	—	—	—	
	Sea	—	—	—	◑	
	Air	—	—	◑	◑	

Fig. 5.1 TRANSPORTATION DEMAND AND SUPPLY

Provincial and subregional transportation demand can be best served by road transport. Actually, centers of the four provinces in the Upper South are connected each other by national and provincial highways under the jurisdiction of DOH and most of the district centers are situated alongside these highways. Rural roads have been developed by other agencies to provide access to production sites of agriculture, forestry and mining. Future increase of these demands can be satisfied by improving/upgrading these highways and rural roads through the continuous monitoring of the traffic volume on major sections.

Though transportation supply for national transportation demand is well developed on the east coast of the Upper South, it is not on the west coast. Road transport is actually only transportation means for cargo because sea transport needs a long way

round the Malay Peninsula. At the stage when transportation demand remains at a rather low level due to simple and inactive economic activities, road transport will be the best transportation means in the sense that road transport can comply with every transportation demand from provincial to national level. Beyond a certain stage, however, sole dependence on road transport will create such disadvantages as considerable volume of energy consumption, damages to road structure and traffic chaos in/near town areas. To cope with future increase of national transportation demand, railway extension to the west coast can be an alternative choice.

On the east coast of the Upper South, there is no transportation infrastructure to meet the international transportation demand. This demand is fulfilled by sending export cargoes to other ports such as Bangkok for transshipment. Markup of export cargoes which is incurred by such inland transportation cost affects unfavourably to its competitiveness, resulting in stagnant development of the subregion. Development of an international gateway on the east coast of the Upper South is considered very important to vitalize the economy.

5.1.2 Strategies for Transportation Development

Strategies for transportation development of the Upper South is worked out based on the review of the existing and programmed transportation network, future transportation demand and considerations on transportation demand and supply.

The basic approach of transportation development is to make full use of the existing and programmed transportation infrastructure as much as possible. As described in the preceding sections, road network of the Upper South is well developed and maintained. Arterial highways connect provincial centers each other and rural roads which are connected with arterial highways provide access to production sites away from highways. These rural roads can be regarded as potential highways in the future. New ports were constructed at Tha Thong and Krabi, and Phuket Deep Seaport is scheduled to be constructed during the Fifth-Five Year Plan period. This deep seaport which will be a gateway to the western situated countries is expected to play a great role in developing the Upper South. Improvement of the Southern Railway Line is now in progress and two airports of Phuket and Surat Thani are planned to be improved, too. These cumulated transportation infrastructure should be fully incorporated into the future transportation development.

There will be two points of view for developing the transportation system of the Upper South. The first view is to develop the transportation system of the area so as to enhance the locational advantage of the the Upper South in both national and international sequences. The second view is to develop the transportation system so as to improve the accessibility to the potential resources and contribute to upgrading the people's living conditions in rather local sequences. In this study, however, greater emphasis will be placed on the first view because the second view can be partially taken into account during the planning process of the first view and be materialized without any big change of budgetary allocations.

In view of the overall development strategy of the Upper South and transportation study up to now, transportation system of the Upper South is proposed to be developed under the following strategies:

- 1) To make best use of Phuket Deep Seaport for developing the South and promoting international trade between the country and the western situated countries. Phuket Deep Seaport will be characterized as a commercial port due to the limited port area. Phuket City will be required to be developed for accepting port related economic activities, a considerable number of port related officials and workers, and foreign sailors to the port. Transportation network should be developed for expanding the hinterland of Phuket Deep Seaport for efficient collection/distribution of international cargoes to and from the South. Development of efficient transportation linkages between the port and Bangkok is another requirement because Phuket Deep Seaport is an alternative gateway directing to the western situated countries to Bangkok/Laem Chabang Ports. For making best use of Phuket Deep Seaport, development of supporting transportation infrastructure will be essential.
- 2) To improve/develop the East-West Link between Surat Thani and Phuket for linking the Phuket and Andaman coastal economy more closely with the mainstay of the national economy being in Bangkok, and for unifying economies of the Upper South at western and eastern sides. A prototype East-West Link is scheduled to be completed by the end of the Fifth Five Year Plan period and this link is expected to considerably reduce the travelling time between both cities. From the view point of attaining closer linkage from the east coast to the west, however, it is preferable to upgrade the whole stretch to the national highway standard. In view of the long distance from Bangkok to the Upper South, especially the Andaman Sea Coast, railway extension to Phuket will be an alternative of establishing the East-West Link.

- 3) To develop an international port in South Khanom so as to facilitate export of natural resources and related products from the vast hinterland and import of industrial materials, taking account of the potential availability of good deep seaport. Surat Thani is expected to be developed into an industrial, distribution and urban center in the emerging seaboard industrial development along the Gulf of Thailand, based on its locational and resource advantages. Development of an international port will be indispensable to attract industrial locations to the area especially in the current of internationalization. In contrast to Phuket Deep Seaport, Khanom Deep Seaport is expected to be a coastal industrial site with close relationship with Eastern Seaboard in addition to an interface between sea and land transportation. It is very important to take into consideration the development phasing of this port and Songkhla Deep Seaport.
- 4) To develop a highway link for connecting Krabi with Surat Thani to cope with the anticipated development of the Central Lowland. According to the subregional development scenario, the Central Lowland is expected to take a leading part in agricultural development, particularly oil palm cultivation. This development will generate substantial volume of oil palm transportation to extraction plants and crude oil transportation to market. Through these activities, Krabi economy will have closer relationship with Surat Thani economy, resulting in increased transportation demand between the two provinces. Though the existing highway network contributes partly to this demand, direct linkage as far as possible will promote the development of Krabi economy.
- 5) To develop a ferry link between Phuket and Krabi for lessening the locational constraints of the Phuket Island and for promoting socio-economic relationship between Phuket and Krabi/the Lower South. Phuket is expected to be a growth center on the Andaman Sea Coast with such plural important functions as international commercial port area, industrial development zone for high technological and high value added products, tourism promotion zone and major urban center in the area. Without pertinent linkage to the southern direction, locational constraints might decelerate the development of Phuket as well as development impacts would not be extended to Krabi/the Lower South. This linkage will contribute to dispersing the tourists concentrated on the west coast of the Phuket Island to the Phangnga Bay Area.
- 6) To develop coastal shipping network between Phuket Deep Seaport and Krabi/Kantang Ports for easy access to international market from Krabi and Kantang. For this purpose, both ports are required to have the port capacity and channel accommodating vessels of 600 to 1,000 DWT. Capital and maintenance dredging is

necessary to keep the depth of channel to minus four meters at the minimum.

- 7) To improve Phuket International Airport to cope with the expected increase of transportation demand of passengers and cargoes. According to the subregional development plan, an industrial estate is to be located in the area adjacent to the airport. In keeping pace with the development of the estate, cargo handling facilities for export and import should be established step by step.

On top of the above, it is necessary to improve transportation linkage between the Upper South and Bangkok/the Lower South. Bangkok is the center of every activity of the country and Songkhla/Hat Yai is the center of various activities of the South in proximity to Malaysian economy. The the Upper South, however, is only a midpoint between Bangkok and Songkhla/Hat Yai with great dependence on both centers at this moment. Improvement of transportation linkage to both centers would be a prerequisite for the Upper South development. Attention should be paid to allocate well-suited transportational functions to every transportation mode of road, railway, sea and air transport.

Transportation development strategies described above are illustrated in Fig. 5.2.

5.1.3 Phasing of Transportation Development

The overall development strategies of the Upper South are proposed to be phased into three stages in correspondence to changing roles of the subregion to meet the national challenges for internationalization, industrialization and decentralization of Bangkok Metropolis. Short-term strategies for the period of the Fifth Five-Year Plan are to encourage current resource export and tourism activities, to expand current resource processing and related economic activities and to reinforce the local base for future development of the subregion. Medium-term strategies for the period of the Sixth Five-Year Plan are to accelerate and diversity industrial development and to develop new infrastructures strategic to spatial restructuring. Long-term strategies for the period of the Seventh Five-Year Plan and beyond are to strengthen and diversity international functions of Phuket, to expand interregional industrial linkage, particularly between Surat Thani and Eastern Seaboard and to integrate Phuket and Surat Thani economies, thereby inducing the decentralization of Bangkok.

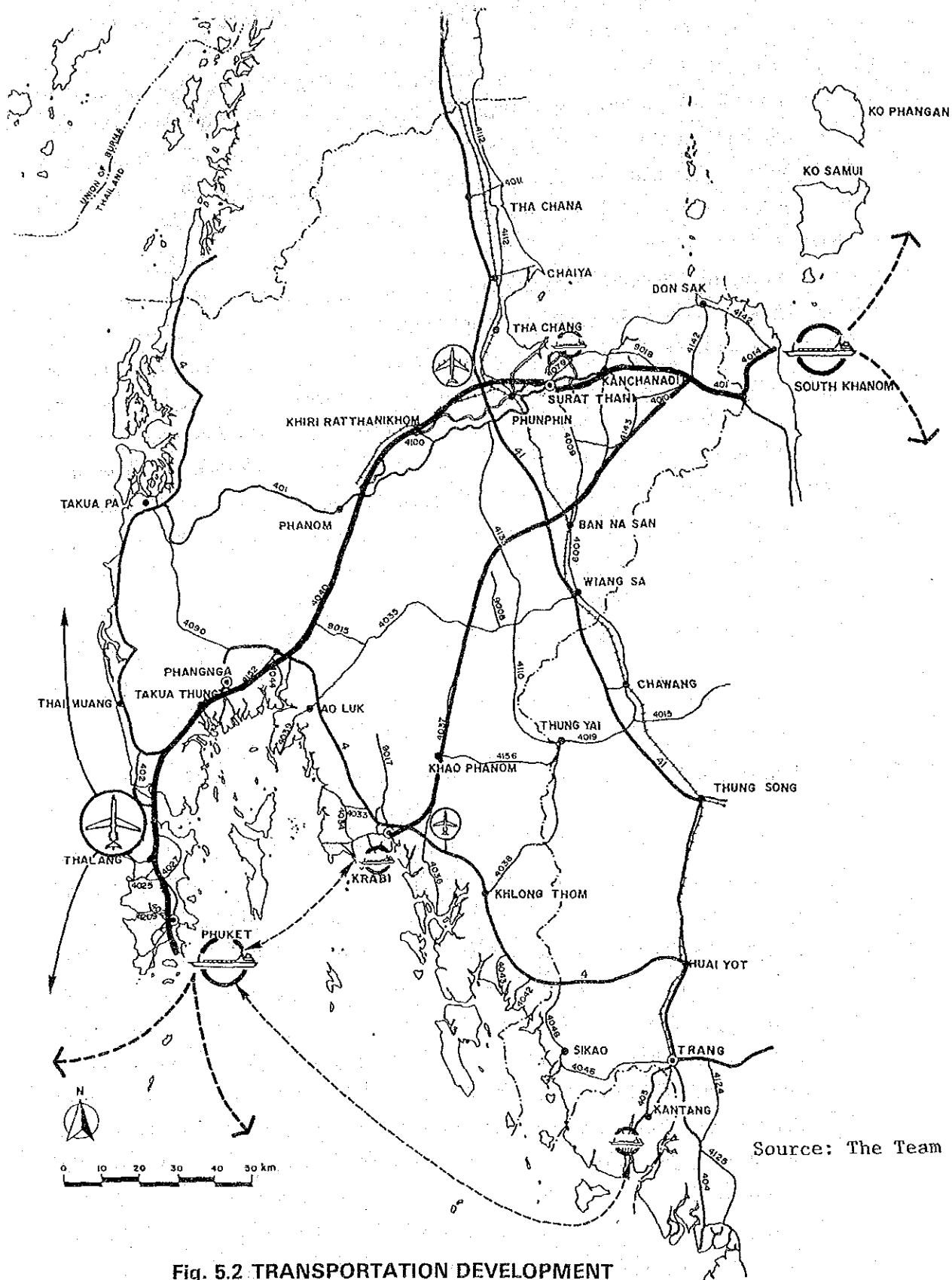


Fig. 5.2 TRANSPORTATION DEVELOPMENT STRATEGIES FOR UPPER SOUTH

Basic function of transportation development is to eliminate/ minimize the distance that separates two places. On one hand, transportation development depends on the development of other industries but, on the other hand, economic activities can neither be expanded nor diversified unless transportation development is not pursued. The history of transportation development of the South would bear witness to this statement. Transportation development plays a great role in transforming production oriented economy into market oriented economy. In view of the overall development strategies of the Upper South, transportation development needs to be accelerated some years ahead of the industrial development.

Short-term strategies for transportation development are composed of those projects identified by the Fifth Five-Year Plan; the first stage construction of Phuket Deep Seaport, improvement/development of East-West Road Link (construction of Phuket Bypass and Phangnga-Thap Put Project, upgrading of Route 402 and pavement of Route 4040 connecting Phanom with Thap Put), development of Krabi-Surat Thani Link (construction and pavement of Route 4037 connecting Krabi with Phra Saeng) and improvement of Phuket International Airport (extension of runway to 3,000 meters, expansion of passenger terminal and so on). Completion of these projects will meet immediate transportation demand and will constitute basic frame for future transportation development. Engineering studies on such major projects as East-West Link and Khanom Deep Seaport programmed for the next phase are required to be conducted during this period. Channel dredging of Kantang Port is considered necessary to be carried out in this stage, based on the prospect that this port will substitute international trading function of Phuket Deep Seaport for the time being and that the stagnant Kantang economy is expected to be revitalized by this countermeasure.

Medium-term strategies for transportation development are composed of such projects as East-West Road Link of two lanes, the first stage construction of Khanom Deep Seaport, completion of the whole stretch of Krabi-Surat Thani Link and ferry boat operation between Phuket and Krabi. Though prototype East-West Road Link is completed during the first phase, this link is required to be upgraded to primary highway standard. Major sections to be newly constructed are Surat Thani-Route 41 Section for easing traffic concentration, Route 41-Phanom Section for agricultural development and Phuket New Bridge Section for lessening travel distance. The first stage construction of Khanom Deep Seaport will include one berth for 15 thousand DWT, one berth for 3,000 DWT and several berths for small crafts. Krabi-Surat Thani Link is to be extended to Khanom Deep Seaport by the time when the first stage construction of the port is completed. This link will be constructed by making

use of the existing and programmed highways and rural roads. For ferry boat operation between Phuket and Krabi, one berth for ferry boat needs to be prepared at both ports. In this phase, cargo handling facilities should be prepared at Phuket International Airport by keeping pace with the development of Phuket Airport Industrial Estate.

Long-term strategies for transportation development are composed of such projects as East-West Rail Link of single track, expansion of Phuket Deep Seaport and Khanom Deep Seaport, and development of cargo handling facilities of Phuket International Airport. East-West Rail Link is planned to provide additional transportation means to road transport particularly for the better linkage between Bangkok and the west coast of the Upper South. The existing railway line up to Khiri Ratthanikhom is to be extended to Phuket Deep Seaport. East-West Rail Link will encourage the export to the western situated countries through Phuket Deep Seaport, not only from the immediate hinterland but also from other regions, especially from the Western Region. To cope with the expected increase of cargo handling volume, Phuket Deep Seaport will need expansion. Khanom Deep Seaport will also need additional berths for handling more cargoes as the industrialization of Surat Thani advances. During the period of this phase, production capacity of the factories located in Phuket Airport Industrial Estate will gradually increase. Cargo handling facilities of Phuket International Airport need to be developed so as to facilitate the transportation of products and materials.

Of the major projects mentioned above, East-West Link and Khanom Deep Seaport are considered most strategic to the development of the Upper South in terms of development effects and investment cost required. The following two sections explain the results of prefeasibility study on both projects.

5.2 EAST-WEST LINK

5.2.1 Traffic Demand Forecast

- 1) Cargo Transportation
- (1) Inter Regional/Provincial Transportation

Cargo transportation demand of the Upper South was estimated by commodity kind based on the production/consumption analysis. The estimated demand of each origin and destination pair was then allocated to transportation modes by applying modal

split models.

For the estimation of traffic demand on East-West Link, the following origin and destination pairs are selected from the estimated cargo OD tables:

Surat Thani	—	Phangnga
Surat Thani	—	Phuket
Surat Thani	—	Phuket Deep Seaport
Phangnga	—	Phuket
Phangnga	—	Cumphon
Phangnga	—	Bangkok and Others
Phuket	—	Chumphon
Phuket	—	Bangkok and Others
Phuket	—	Khanom Deep Seaport

Two routes are available for the pairs “Phangnga/Phuket - Chumphon/Bangkok and Others”; the one along the east coast via East-West Link and the other along the west coast. 70 percent of the volume allocated to road was assigned to the east coast route in consideration of the expected shorter travelling time through East-West Link and Route 41.

The average cargo volume to be transported on East-West Link is estimated at 746,800 and 1,894,500 tons excluding cement and petroleum products for 1980 and 2000, respectively with a growth rate of 4.8 percent per annum as shown in Table 5.1. Cement will be transported on East-West Link only if railway link is established, otherwise it will be sent to Phangnga via Route 4 and to Phuket via Kantang. The transportation of petroleum products will change drastically, depending on whether they are supplied to the Upper South from Sri Racha/Bangkok or from a local refinery proposed in this study. For this account, transportation of petroleum products is completely excluded from traffic demand forecast of East-West Link.

According to the result of the modal split, railway will take major part in transporting cargoes between Phuket/Phangnga and Bangkok/ Others. The share of railway for these origin and destination pairs is estimated at 50 percent in 2000. On the contrary, railway will not have any participation in inter provincial cargo transportation in the Upper South. These results are based on present empirical modal split data for the origin and destination pairs of Surat Thani- Songkhla, Surat Thani-Bangkok and Songkhla-Bangkok.

Table 5.1 CARGO TRANSPORTATION ON EAST-WEST LINK

Unit : 1000 ton/year

OD Pair	Year Mode Section	1980		2000					
		Road		Road		Railway		Total	
		P-P	P-S	P-P	P-S	P-P	P-S	P-P	P-S
Surat	- Phangnga	-	94.9	-	341.6	-	-	-	341.6
	- Phuket	6.1	6.1	494.9	494.9	-	-	494.9	494.9
	- Phuket Port	1.2	1.2	133.0	133.0	-	-	133.0	133.0
Phangnga	- Phuket	420.8	-	566.5	-	-	-	566.5	-
Phuket	- Khanom Port	15.4	15.4	77.6	77.6	-	-	77.6	77.6
Sub-Total		443.5	117.6	1272.0	1047.1	-	-	1272.0	1047.1
Phangnga	- Chumphon	-	41.2	-	53.3	-	1.0	-	54.3
	- BKK/Others	-	268.4	-	246.4	-	202.4	-	448.8
Phuket	- Chumphon	17.3	17.3	44.2	44.2	6.9	6.9	51.1	51.1
	- BKK/Others	294.1	294.1	201.5	201.5	230.8	230.8	432.3	432.3
Sub-Total		311.4	621.0	245.7	545.4	237.7	441.1	483.4	986.5
Grand-Total		754.9	738.6	1517.7	1592.5	237.7	441.1	1755.4	2033.6
Average		(746.8)		(1555.1)		(339.4)		(1894.5)	

Note:

- 1) P-P and P-S stand for Phuket-Phangnga Section and Phangnga-Surat Thani Section, respectively.
- 2) In case East-West Rail Link is available, cement from Thung Song to Phangnga and Phuket will be carried by railway; 186,300 tons to Phangnga and 253,600 tons to Phuket.
- 3) Fuel is excluded from the above estimation because fuel transportation will be greatly changed if oil refinery is established in Krabi.
- 4) Modal split between road and railway is estimated based on the modal split curves obtained from OD pairs of Surat Thani-Songkhla, Bangkok-Surat Thani and Bangkok-Songkhla.

Source: The Team

Improvement of railway facilities and services will become necessary to perform this expected role so as to compete with perpetual improvement of highways.

(2) Intra Provincial Transportation

Intra provincial transportation is one of the transportation demand on East-West Link. The estimated intra provincial transportation demand was apportioned to East-West Link corridor based on the population of the districts situated along the corridor. 25 percent of the apportioned demand is assumed to be the average intra provincial transportation to appear on East-West Link, considering that intra provincial transportation consists of short trip length. Intra provincial transportation demand to be appeared on East-West Link is thus estimated at 54,200 and 75,600 tons in 1980 and at 195,600 and 186,800 tons in 2000 for the sections of Surat Thani-Phangnga and Phangnga-Phuket, respectively.

(3) Export through Phuket Deep Seaport from Bangkok/Other Regions

Foreign trade of the country with western situated countries composed about one third of the total amount of foreign trade. Export to the western situated countries increased its share from 26 percent of the total export in 1975 to 35 percent in 1980, while import from the countries decreased its share from 38 percent in 1975 to 33 percent in 1980. During this period, the amount itself showed a remarkable increase, more than 30 percent per annum for export and nearly 20 percent per annum for import.

To cope with the increase of foreign trade, further investment will become necessary to facilitate the existing Klong Toey Port. However, modernizing the port is restricted by a number of factors. Access to the dock from both land and sea is difficult, hazardous and slow. On one side, the port is enveloped in the urban sprawl of Bangkok, while navigation for ships entering the port is through a shallow gulf over a shifting bar at the river mouth, and along a narrow and winding channel in a congested river. To overcome these constraints, government and industry have promoted the idea of a new port at Laem Chabang in Chon Buri Province as the natural extension of Klong Toey Port. However, success of alternative ports outside Metropolitan Bangkok is entirely dependent on communications.

Phuket Deep Seaport will possibly be another gateway to the western situated countries because of the various constraints of Klong Toey Port and the inland transportation distance of 120 kilometers from Bangkok to Laem Chabang Port. This distance

is well served by trucks, but special effort will be necessary to ease the traffic congestions on this part. However, success of Phuket Deep Seaport as a gateway to the west is also entirely dependent on communications. In consideration of the distance of 850 kilometers from Bangkok, effective railway linkage will be indispensable to make full use of the port from the national viewpoint. Otherwise, the function of the port will be restricted only to improve the external economy of the South.

Through the railway extension of 170 kilometers from Khiri Ratthanikhom to Phuket Deep Seaport, the port will be connected to Bangkok and every other part of the country. Some portion of various kind of commodities such as electronic products, clothes/footwear and other manufactured or assembled products from Bangkok Metropolis, tobacco leaf from the North, tinned pineapples from the West and so on will possibly be exported to the western situated countries through Phuket Deep Seaport. However, quantifying this possibility at this moment confronts with indistinct surroundings; future production and marketability of the products and competitiveness of Phuket Deep Seaport with Khlong Toey/Laem Chabang Ports.

It will be very plausible to consider that the Western Region at least has higher possibility to use Phuket Deep Seaport for its westbound export owing to the inland transportation distance of 110 kilometers to Khlong Toey Port and 230 kilometers to Laem Chabang Port which accompanies chronic traffic congestion in Bangkok Metropolis. The average distance from the Western Region to Phuket Deep Seaport is 750 kilometers or about three times as long as the distance to Laem Chabang Port.

Based on the above considerations, export volume through Phuket Deep Seaport from Bangkok/other regions are estimated by limiting the target regions only to the Western Region. The export through Phuket Deep Seaport from the Western Region to western situated countries are estimated at 290,000 tons under the trend type projection and 684,000 tons under the regional/national push type projection in 2000 as shown in Table 5.2. The average of the two projections amounts to 487,000 tons. This export through Phuket Deep Seaport will be materialized only if East-West Rail Link is established to the port.

- 2) Passenger Transportation
 - (1) Inter Regional/Provincial Transportation

Passenger transportation demand of the Upper South was estimated with reference to the residents of the area and visitors to the area as described in 4.2.2. The estimated

Table 5.2 EXPORT THROUGH PHUKET DEEP SEAPORT FROM THE WESTERN REGION

		1980		1990		2000	
		Mill฿	1000ton	Mill฿	1000ton	Mill฿	1000ton
Trend Type	Total Export	8,112	2,677	11,312	3,733	12,781	4,218
Projection	Westbound Export	3,488	1,511	4,864	1,605	5,496	1,814
	Potential to Phuket				535		605
	Via Phuket Port				257		290
Push Type	Total Export			20,912	6,902	30,134	9,945
Projection	Westbound Export			8,992	2,968	12,958	4,277
	Potential to Phuket				989		1,425
	Via Phuket Port				475		684

Note:

- 1) Growth rates of total export of the western region from 1980 to 1990 is based on the estimation by "Western Region Planning Study".
- 2) Growth rates of total export from 1990 to 2000 is assumed to be half of the growth rates from 1985 to 1990.
- 3) Westbound export ratio is assumed at 43 percent based on the records achieved in 1980.
- 4) "Potential to Phuket" is assumed at one third of "westbound Export", which means one third will be forwarded to Phuket for export to the western situated countries and two thirds to Klong Toey/Laem Chabang Ports.
- 5) "Via Phuket Port" shows the volume estimated to be transported to Phuket Deep Seaport by railway. The difference between "Potential to Phuket" and "Via Phuket Port" is the volume estimated to be transported by trucks to Phuket Deep Seaport. However this portion will probably be forwarded to Bangkok/Laem Chabang ports because of the shorter road distance.

Source: The Team

demand on each origin and destination pair was then allocated to road, railway and air by applying modal split models.

For the estimation of traffic demand on East-West Link, the following origin and destination pairs are selected from the estimated passenger OD table:

Surat Thani	--	Phangnga
Surat Thani	--	Phuket
Phangnga	--	Phuket
Phangnga	--	Chumphon
Phangnga	--	Bangkok/Other Regions
Phuket	--	Chumphon
Phuket	--	Bangkok/Other Regions

Two routes are available for the pairs "Phangnga/Phuket - Chumphon/Bangkok and Others"; the one along the east coast via East-West Link and the other along the west coast. 70 percent of the volume allocated to road was assigned to the east coast route in consideration of the expected shorter travelling time through East-West Link and Route 41.

The average number of trips to be transported on East-West Link is estimated at 934,800 and 2,702,200 trips for 1980 and 2000, respectively, with the annual growth rate of 5.5 percent as shown in Table 5.3. The average share of railway in 2000 on East-West Link is estimated at 36 percent for the all origin and destination pairs, eight percent for the origin and destination pairs in the Upper South and 76 percent for the pairs between Phangnga/Phuket and Chumphon/ Bangkok. Though railway link is expected to play only a limited role in inter provincial trips in the Upper South, it will have a great importance for the passenger transportation between the Upper South and Bangkok.

(2) Intra Provincial Transportation

The same method that applied to cargo transportation was applied to this transportation demand. Intra provincial demand to be appeared on East-West Link is estimated at 965,200 trips in 1980 and 2,019,400 trips in 2000 for the section of Surat Thani and Phangnga, and 641,900 trips in 1980 and 2,062,800 trips in 2000 for the section of Phangnga and Phuket.

**Table 5.3 INTER REGIONAL/PROVINCIAL PASSENGER TRANSPORTATION
ON EAST-WEST LINK (WITH RAILWAY)**

Unit: 1000 trips/year

OD Pair	Year Mode Section	1980				2000			
		Road		Road		Railway		Total	
		P-P	P-S	P-P	P-S	P-P	P-S	P-P	P-S
Surat	— Phangnga	—	427.1	—	718.3	—	70.8	—	789.1
	— Phuket	97.1	97.1	330.0	330.0	54.0	54.0	384.0	384.0
Phangnga	— Phuket	665.8	—	1597.2	—	84.0	—	1681.2	—
Sub-Total		762.9	524.2	1927.2	1048.3	138.0	124.8	2065.2	1173.1
Phangnga	— Chumphon	—	92.7	—	129.2	—	46.0	—	175.2
	— BKK/Others	—	154.0	—	68.6	—	262.1	—	330.7
Phuket	— Chumphon	1.5	1.5	5.9	5.9	2.9	2.9	8.8	8.8
	— BKK/Others	166.4	166.4	150.4	150.4	670.9	670.9	821.3	821.3
Sub-Total		167.9	414.6	156.3	354.1	673.8	981.9	830.1	1336.0
Grand-Total		930.8	938.8	2083.5	1402.4	811.8	1106.7	2895.3	2509.1
Average		(934.8)		(1743.0)		(959.3)		(2702.2)	

Note:

- 1) In case of without railway, the number of passengers on East-West Link is reduced because of induced shift of passengers to air transport.
- 2) P-P and P-S stand for Phuket-Phangnga Section and Phangnga-Surat Thani Section, respectively.
- 3) Modal split between road and railway is estimated based on the modal split curve obtained from the OD pairs of Surat Thani-Songkhla, Bangkok-Surat Thani and Bangkok-Songkhla.

Source: The Team

(3) Excursion Trips of Tourists

Yearly number of hotel guests is estimated to increase from 343,300 persons in 1980 to 1,803,00 persons in 2000, when the average period of stay is expected to be seven nights for foreign tourists and three nights for domestic tourists. Excursion trips of tourists are composed of intra provincial movement such as between city center and seashore and between city center and historical/cultural assets, and inter provincial movement in the Upper South looking for rather different tourism atmosphere. The former type of short distance movement will be greater in terms of number of trips than the latter type of middle distance movement.

The most possible excursion trips on East-West Link will be one day tour of the hotel guests between Phuket and Phangnga. It is assumed that 30 percent of estimated number of hotel guests in Phuket and Phangnga will make one day excursion trip between Phuket and Phangnga. In other words, seven percent of the total person days of the hotel guests will be allocated to this excursion trip. The number of excursion trips is estimated at 536,600 trips in 2000.

Transportation demand explained above is summarized in Table 5.4.

3) Road Traffic

The estimated cargo and passenger transportation demand on East-West Road Link was converted to number of vehicles. For the estimation of future demand, the following assumptions were adopted:

For Cargo Transportation:

	Light Truck	Medium Truck	Heavy Truck
Passenger Car Unit (pcu)	1.0	2.0	3.0
Load Factor (ton/vehicle) * ¹	0.8	2.1	7.2
Share by Vehicle Type * ³			
Intra/inter provincial	35%	35%	30%
Port Related and Others	10%	30%	60%

Table 5.4 TRANSPORTATION DEMAND ON EAST-WEST LINK

		1980	2000		
		Road	Road	Rail	Total
Cargo (1000 tons/year)	Surat Thani - Phangnga (Intra)	54.2	195.6	-	195.6
	- Phangnga (Inter)	94.9	341.6	-	341.6
	- Phuket	6.1	494.9	-	494.9
	- Phuket Port	1.2	133.0	-	133.0
	Phangnga - Phuket (Intra)	75.6	186.8	-	186.8
	- Phuket (Inter)	420.8	566.5	-	566.5
	Phuket - Khanom Port	15.4	77.6	-	77.6
	Sub-Total	668.2	1996.0	-	1996.0
	Phangnga - Chumphon	41.2	53.3	1.0	54.3
	- Bangkok/Others	268.4	246.4	202.4	448.8
	Phuket - Chumphon	17.3	44.2	6.9	51.1
	- Bangkok/Others	294.1	201.5	230.8	432.3
	Sub-Total	621.0	545.4	441.1	986.5
	Thung Song - Phangnga	26.5	-	186.3	186.3
	- Phuket	32.5	-	253.6	253.6
West Region - Phuket Port	-	-	487.2	487.2	
Sub-Total	59.0	-	927.1	927.1	
Grand-Total		1348.2	2541.4	1368.2	3909.6
Passenger (1000 trips/year)	Surat Thani - Phangnga (Intra)	965.2	2019.4	-	2019.4
	- Phangnga (Inter)	427.1	718.3	70.8	789.1
	- Phuket	97.1	330.0	54.0	384.0
	Phangnga - Phuket (Intra)	641.9	2062.8	-	2062.8
	- Phuket (Inter)	665.8	1597.2	84.0	1681.2
	- Phuket (Tourism)	102.9	536.6	-	536.6
	Sub-Total	2900.0	7264.3	208.8	7473.1
	Phangnga - Chumphon	92.7	129.2	46.0	175.2
	- Bangkok/Others	154.0	68.6	262.1	330.7
	Phuket - Chumphon	1.5	5.9	2.9	8.8
- Bangkok/Others	166.4	150.4	670.9	821.3	
Sub-Total	414.6	354.1	981.9	1336.0	
Grand-Total		3314.6	7618.4	1190.7	8809.1

Source: The Team

For Passenger Transportation:

	Passenger Car	Light Bus	Medium/Heavy Bus
Passenger Car Unit (pcu)	1.0	1.0	2.5
Load Factor (person/vehicle) * ²	2.5	6.0	33.0
Share by Vehicle Type * ³			
Intra/Inter provincial	25%	30%	45%
Others	10%	30%	60%

- Notes: *¹ The load factor was obtained through the survey carried out by the Team.
*² The existing load factor was assumed to decrease in future in accordance with the increase of income level. The existing load factor is 3.1 for passenger car, 7.7 for light bus and 37 for the average of medium/heavy bus.
*³ Share by vehicle type was assumed based on the fact that the shorter the travel distance, the higher the share of small vehicles and the longer the travel distance, the higher the share of heavy vehicles. After several trial calculation on different sets of share by vehicle type, this set revealed to represent the present composition of vehicles on road network in the Upper South.

By summing up the transportation demand for every origin and destination pair, vehicle traffic on East-West Link in 2000 is estimated as shown in Table 5.5. In the case without railway link, the average daily traffic amounts to 7,000 in terms of pcu. In the case with railway link, the average daily traffic amounts to 6,000. For both cases, the average daily traffic is still below the capacity of primary highway which is designed to accommodate 8,000 pcu. However, travelling speed will be considerably reduced from the designed speed, say at 40 to 45 kilometers per hour for the case without rail link and 45 to 50 kilometers per hour for the case with rail link.

Rail link is estimated to have limited contribution to ease the traffic concentration on East-West Link, the difference between the cases of with and without railway being estimated at 1,000 pcu. As explained in the preceding section, railway will play a major role in long distance transportation which has a tendency to depend on larger size of vehicles. The main field that rail link contributes is not to ease the traffic concentration on East-West Link but to save the energy to be consumed in long haul transportation.

Table 5.5 VEHICLE TRAFFIC ON EAST-WEST ROAD LINK IN 2000

Unit: Vehicle/day

	With Railway			Without Railway		
	P-P	P-S	Average	P-P	P-S	Average
Light Truck	1,692	1,515	1,600	1,775	1,673	1,720
Medium Truck	766	781	770	861	960	910
Heavy Truck	253	298	280	308	401	350
Passenger Car	1,258	880	1,070	1,370	1,022	1,200
Light Bus	642	469	560	753	622	690
Medium/Heavy Bus	177	132	150	216	186	200
Total Vehicle	4,788	4,075	4,430	5,283	4,864	5,070
PCU	6,300	5,700	6,000	7,000	7,000	7,000

Note: P-P and P-S stand for the sections of Phuket-Phangnga and Phangnga-Surat Thani, respectively.

Source: The Team

4) Railway Traffic

The major commodities to be transported by East-West Rail Link can be categorized into four groups;

- Primary products, mineral resources and manufactured products from Phangnga/Phuket to Bangkok/other regions.
- Consumer and industrial goods supplied to Phangnga/Phuket from Bangkok/other regions.
- Cement from Thung Song Factory to Phangnga/Phuket. Key factors for cement transportation are low transportation cost and some reliance on transportation schedule to the degree that allows to make a stock control schedule of distributing depots.
- Export through Phuket Deep Seaport to the western situated countries from Bangkok and other regions.

The estimated traffic volume in 2000 is schematically shown in Figure 5.3. Based on this traffic volume, required number of freight and passenger trains are calculated as