

KINGDOM OF THAILAND
MINISTRY OF TRANSPORT AND COMMUNICATIONS
DEPARTMENT OF HIGHWAYS

**ROAD DEVELOPMENT STUDY
IN THE SOUTHERN REGION**

FINAL REPORT

VOLUME 5

**FEASIBILITY STUDY ON
THE KRABI-KHANOM HIGHWAY**

SEPTEMBER 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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Volume 5 : THE KRABI - KHANOM HIGHWAY

I. MAIN TEXT	1
II. ENGINEERING STUDY	E-1
III. APPENDIX	A-1

I MAIN TEXT

VOLUME 5: FEASIBILITY STUDY ON THE KRABI - KHANOM HIGHWAY

Table of Contents

	Page				
1.	Introduction	1 - 1	5.	Assumed Development Scenario of the Highway Link	5 - 1
1.1	Objectives of the Study	1 - 1	5.1	Traffic Demand on the Highway Link	5 - 1
1.2	The Master Plan Study of the SSDP	1 - 1	5.2	Development Scheme of the Highway Link	5 - 2
1.3	This Study as an Input to the Master Plan Study ..	1 - 1	6.	Engineering Study on the Highway Link	6 - 1
2.	The Southern Seaboard Development Program (SSDP)	2 - 1	6.1	Conditions for Design	6 - 1
2.1	Outline of the SSDP	2 - 1	6.2	Design Standard	6 - 1
2.2	Study Team's Understanding on the SSDP	2 - 2	6.3	Alignment Alternatives	6 - 3
3.	Planning Framework of the Southern Region and the SSDP	3 - 1	6.4	Major Design Components	6 - 3
3.1	Planning Framework of the Southern Region	3 - 1	6.5	Project Cost	6 - 9
3.2	Assumed Planning Framework of the SSDP	3 - 4	6.6	Project Implementation Schedule	6 - 9
4.	"Trans-Thai Landbridge" as an Alternative Route for International Cargo Flow	4 - 1	6.7	Pipeline and Railway	6 - 9
4.1	Vessel Traffic through the Strait of Malacca	4 - 1	7.	Project Evaluation	7 - 1
4.2	Container Ship Operations by Shipping Companies .	4 - 2	7.1	Specific Characteristics of the Project	7 - 1
4.3	Transport Hours over the Land Bridge (Case Study)	4 - 2	7.2	Economic Viability Test	7 - 1
4.4	Probability of Vessel Traffic Diversion	4 - 3	7.3	Land Acquisition Requirements	7 - 2
4.5	Traffic Demand of International Containers over the Krabi - Khanom Highway Link (Case Study)	4 - 4			

ROAD DEVELOPMENT STUDY IN THE SOUTHERN REGION

Phase 2 Study: The Krabi - Khanom Highway Link

1. Introduction

1.1 Objectives of the Study

The scope of work for "Road Development Study in the Southern Region" was concluded on October 12, 1989. The study continues for seventeen (17) months from February 1990 to June 1991, including the following three phases:

Phase 1 Study: February - November 1990

To establish a highway development master plan of the Southern Region by taking account of the future development trend by the year 2006, and to carry out preliminary feasibility studies on the candidate highway projects to be developed or improved by the year 1996 and to identify the priority projects for further feasibility study.

Phase 2 Study: June - November 1990

To carry out a feasibility study on the Krabi - Khanom Highway Link which the DOH requested JICA as an urgent project.

Phase 3 Study: December 1990 - June 1991

To carry out feasibility studies on the priority projects identified in the Phase 1 Study. The total length of highways for the Phase 3 Study is targeted at about 300 kilometers.

This report discusses the results of the feasibility study on the Krabi - Khanom Highway Link in the Phase 2 Study.

Major objectives of this study are:

- 1) to propose an appropriate geometric alignment of the Krabi - Khanom Highway Link between Krabi and Khanom deep sea ports as a part of the "Trans-Thai Landbridge";
- 2) to design the Highway Link and estimate the project cost; and
- 3) to evaluate the project from a view point of the national economy based on the planning framework of the Southern Seaboard Development Program (SSDP) and the estimated project cost.

1.2 The Master Plan Study of the SSDP

The Office of the Southern Seaboard (OSSB) was established in November 1989 to promote the SSDP. The OSSB published a paper titled "Thailand New Strategic Thinking towards the Year 2000 and Beyond" in May 1990 to outline the basic concept of the SSDP.

The master plan study on the SSDP which prepares a development framework of the SSDP is scheduled to be commenced in the middle of November 1990 under the administration of the Office of the Southern Seaboard (OSSB).

The master plan will include:

- 1) feasibility studies on such various investment programs as the land bridge, crude oil pipeline, regional oil refinery, off shore pipeline, industrial zones, and urban centers;
- 2) related surveys required for the above feasibility studies; and
- 3) environmental impact assessments and management plans.

1.3 This Study as in Input to the Master Plan Study

It would be a natural procedure that the Master Plan Study goes ahead of this study to provide a planning framework on which the Krabi - Khanom Highway Link relies. Due to the urgency of land acquisition planning for the Land Bridge, however, this study preceded the master plan study.

In consequence, this study relies on various assumptions which would likely be reviewed and revised during the course of the master plan study. This is particularly true of the planning framework of the SSDP including international container flow over the Land Bridge.

The Study Team, however, has made an effort to leave ample room for further deliberation through the SSDP master plan study, especially on: (1) highway route selection; (2) increment of traffic lanes; and (3) coexistence with pipeline and railway in the same right-of-way.

2. The Southern Seaboard Development Program (SSDP)

2.1 Outline of the SSDP

Fig. 2.1.1 illustrates the location and major components of the SSDP.

2.1.1 Main Objectives of the SSDP

- 1) to provide a more efficient and shorter international shipping route via an intermodal transport system of sea - road/rail/pipeline - sea across the South of Thailand;
- 2) to create competitive industrial locations, trade and business together with new towns so as to provide and create job opportunities at the terminals of the Land Bridge; and
- 3) to ensure sustainable growth that is not in conflict with other development objectives such as tourism, fisheries and compatible with the environment and ecological system.

2.1.2 Basic Components of the SSDP

A Land Bridge connecting the Andaman Sea at Krabi and the Gulf of Thailand at Khanom will act as the catalyst for the establishment of new economic zones at the end terminals of the Land Bridge.

The basic components of the program consist of:

- 1) Krabi Terminal : Offshore Loading & Unloading Crude Terminal / Deep Sea Port / Industrial Estate / New Town
- 2) Khanom Terminal: Offshore Loading & Unloading Crude Terminal / Deep Sea Port / Industrial Estate / New Town
- 3) Land Bridge : High Speed Road / Rail / Liquid (Crude/Natural Gas/ Petrochemical/ Water) Pipeline

Krabi Industrial Estate will have a focus on tank farm and agro industries while Khanom Industrial Estate will have a focus on oil refinery, gas separation, petrochemical, gas related industries, oil related industries, tank farm, and agro industries.

Fig. 2.1.2 depicts the outline of Krabi and Khanom terminal development.

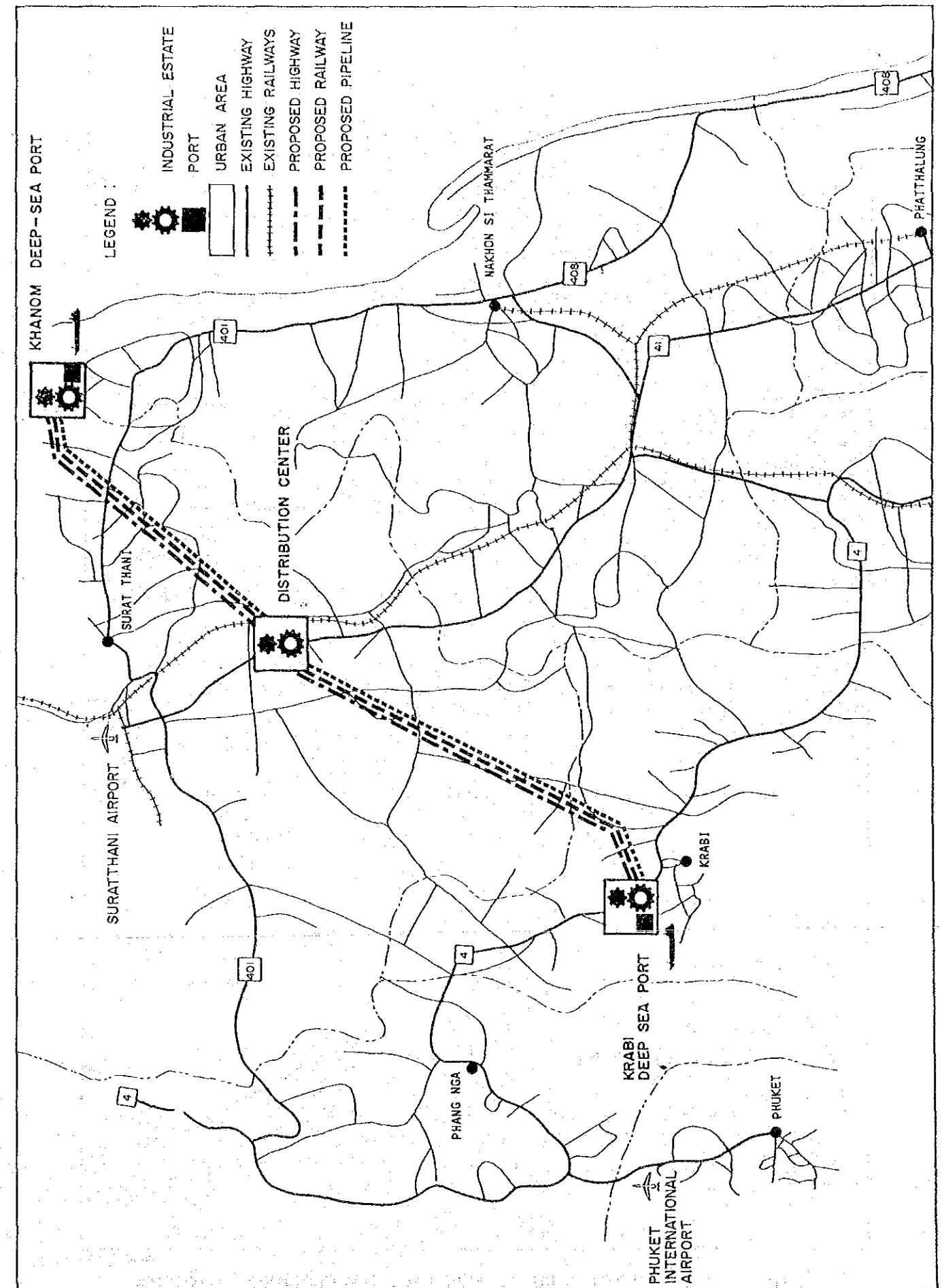
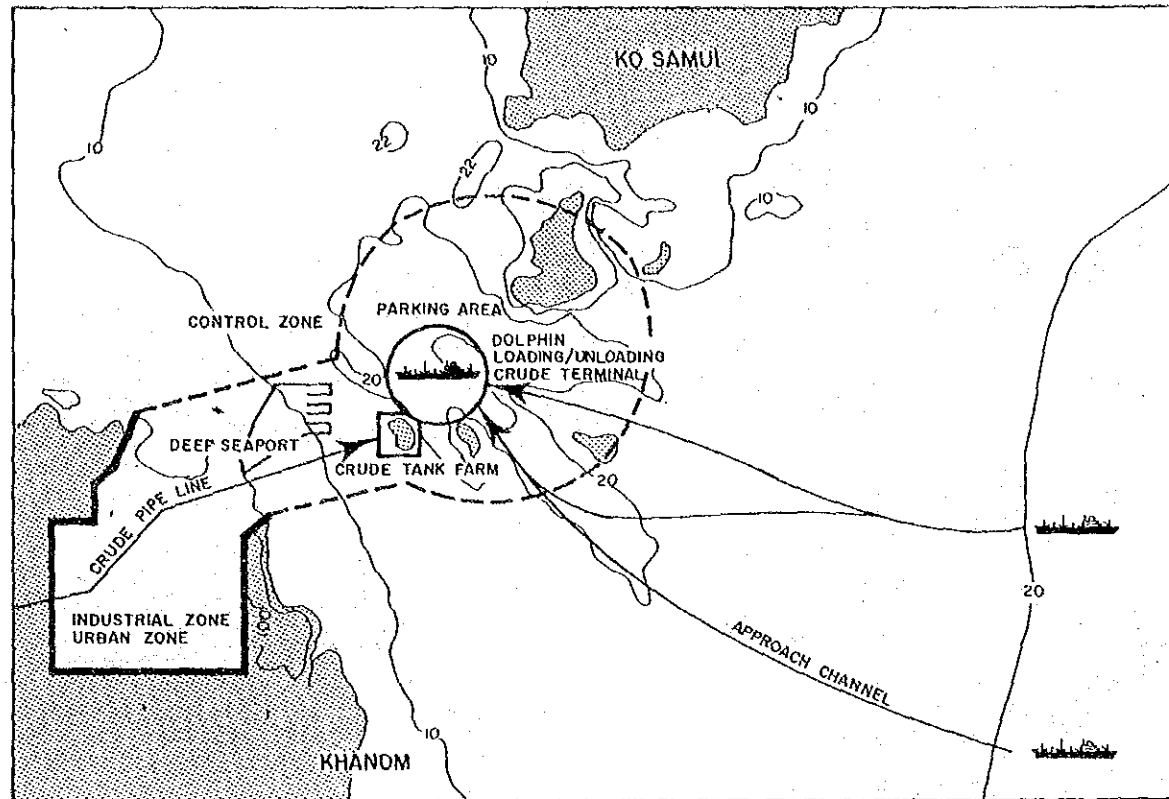
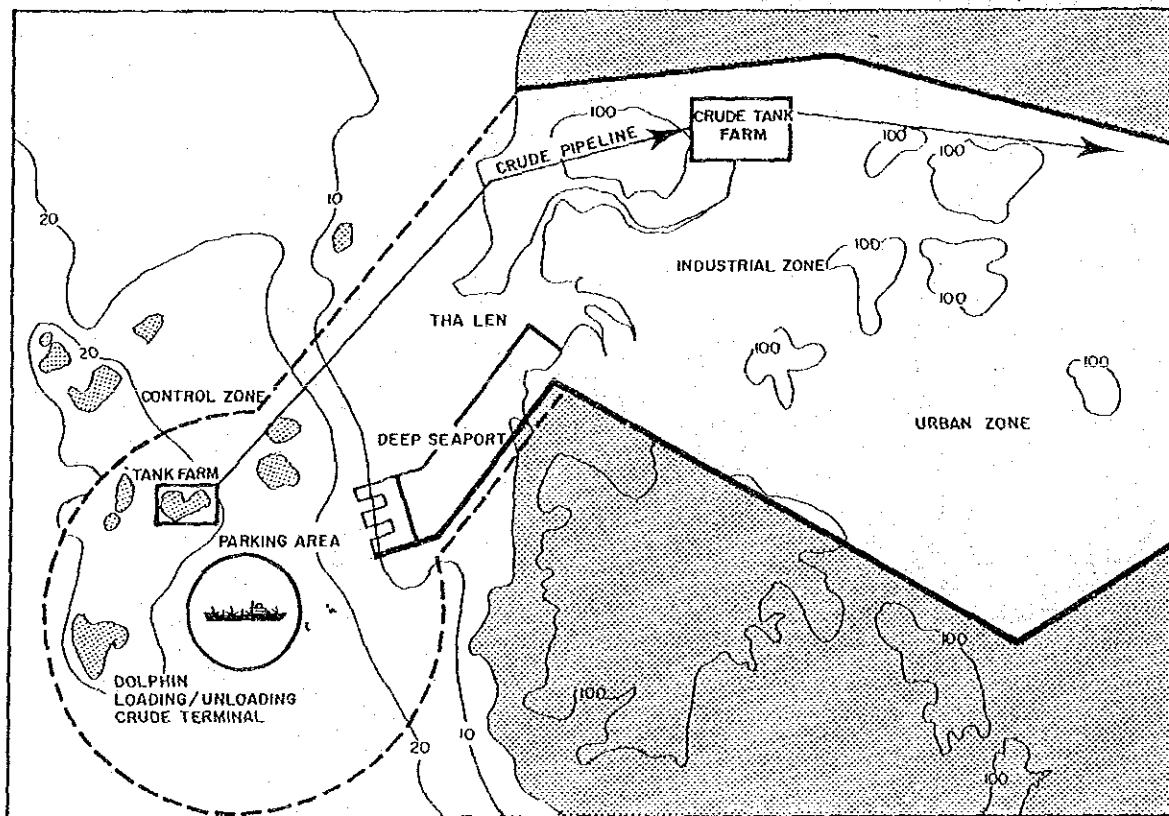


Fig. 2.1.1 SOUTHERN SEABOARD DEVELOPMENT PROGRAM (SSDP)



SOURCE: OSSB



SOURCE: OSSB

Fig. 2.1.2 KRABI-KHANOM TERMINAL DEVELOPMENT CONCEPT

2.1.3 Environmental Control/Mitigation Measures

Environmental management plan will address:

- 1) Coastal Resources Management;
- 2) Watershed, Forests and Wildlife Management;
- 3) Water Quality Management;
- 4) Air Quality and Noise Management; and
- 5) Risk Management including Oil Spill Control.

2.2 Study Team's Understanding on the SSDP

The Eastern Seaboard Development Program (ESDP) is the largest industrialization program of the country. The program has a main focus on import substitution to comply with domestic consumption demand. Most of materials is domestically procured and the products are supplied to domestic market. Infrastructure development has been a major concern of the government to realize the program goal. A time sliced planning framework was prepared to facilitate the infrastructure development.

With the progress of infrastructure development, private investment has been poured to the extent that almost all the industrial plots have been occupied. The ESDP is now in an advanced stage of implementation as envisaged by the ESDP master plan.

The Southern Seaboard Development Program (SSDP) has a completely different scope with that of the ESDP. The SSDP is planned to be developed largely in an international context with an emphasis on foreign investment, imported materials, and overseas market. This program is like a business strategy in a sense that an entrepreneur tries to open a new market through introduction of a new product concept.

It is very likely that the planning framework of the SSDP will be prepared on a revolving basis, reflecting the varying willingness of international players to participate in the program. In the meantime, however, a set of infrastructure needs to be developed to turn the Krabi - Khanom Corridor into an attractive industrial location in an international context.

Difficulty in terms of attaining higher investment efficiency would lie in the way how to gear the infrastructure development with the willingness of the participants. Although infrastructure should be developed in a flexible manner, it should ultimately be an effective component of the total SSDP system.

The Study Team's understanding on major components of the SSDP is as described below:

1) "Trans-Thai Land Bridge"

The most important role of the Land Bridge would be to turn the Krabi - Khanom Corridor into an attractive industrial location with direct access to both the Pacific and the Indian Ocean sides. Without the Land Bridge, Krabi and Khanom areas remain as an independent seaboard just facing to one side of the Peninsula, calling for a detour to the Strait of Malacca as in the past. Foreign investors cannot be easily attracted to these areas because there are so many competing industrial estates in the Southeast Asian Region.

Accumulation of industrial locations and subsequent accumulation of trading functions will in due course invite direct call of international container ships to Krabi and Khanom deep sea ports. Then, there will be a good possibility of inducing diversion of container shipment from the Strait of Malacca to the Land Bridge.

2) Oil and Gas Related Industries

Oil refinery is said to be one of the most promising industry in the Krabi - Khanom Corridor to supplement future supply shortage of oil products in the East Asia and the west coast of the United States.

The present idea is to invite oil refinery investment to Khanom area. Crude oil will be imported from the Middle East to Krabi to send to Khanom and oil products produced in Khanom are exported to the eastern situated countries.

Pipeline as a component of the Land Bridge will engage in sending crude oil from Krabi off shore oil berth to oil refinery in Khanom. Pipeline will need to be constructed in the initial stage of the SSDP.

3) Export Oriented Industrialization

The Land Bridge Corridor can be turned into an industrial zone where high value added products will be produced based on imported materials and the products will be exported to overseas countries.

Highway as a component of the Land Bridge would be a prerequisite for ensuring efficient container delivery from ports to factories and vice versa. Highway with high design speed needs to be constructed in the initial stage of the SSDP.

4) Decentralization from Bangkok

The Landbridge connecting the east and the west coasts will greatly enhance the locational advantage of the Corridor area. The improved accessibility to

international market will encourage foreign investors to establish their production centers in this area. Accumulation of production activities in due course will induce overseas as well as Bangkok situated trading businesses move into the Land Bridge Corridor.

Decentralization from Bangkok will gradually be materialized keeping step with the progress of industrial locations and production activities in the SSDP.

5) Time Framework of the SSDP

The Eastern Seaboard Development Program (ESDB) took about 10 years to grow into an advanced stage of implementation. Compared with the ESDB, the SSDP likely takes longer gestation period because of huge volume of infrastructure development, particularly the Land Bridge including two deep sea ports.

It will take about two years to draw up a comprehensive master plan for the SSDP and five to six years to develop the Land Bridge for the initial stage. It will mean that the SSDP will become ready to accept private investment by 1998 or by the end of this century.

It is likely that private investment and production activities by the year 2001 will be still not so large just at its beginning stage. It is expected that production and international trading activities will become brisk towards the year 2006.

For the long future, the SSDP will contribute greatly to expand its economic scale to raise the income level of the whole Southern Region.

3. Planning Framework of the Southern Region and the SSDP

Planning framework for this study was prepared in three steps:

- 1) The first step is to prepare a planning framework of the Southern Region based on the assumed future economic growth trend of the Southern Region without the Southern Seaboard Development Program (SSDP);
- 2) The second step is to assume a planning framework of the SSDP which has no official planning framework at present; and
- 3) The last step is to prepare a planning framework of the Southern Region including the SSDP based on the two kind of planning framework prepared in 1) and 2) above.

The planning framework of the Southern Region without the SSDP was prepared as a basis to estimate future traffic demand all over the Southern Region. The planning framework of the SSDP was prepared as a basis to estimate future traffic demand directly related to the economic activities of the SSDP. A possible diversion of international container transport to the Land Bridge from the Strait of Malacca was assumed separately with the SSDP framework. The combined planning framework of the Southern Region and the SSDP was prepared to assess the possible traffic impact of the SSDP on the existing highway network in the Southern Region, particularly in the Krabi - Khanom Land Bridge Corridor.

Table 3.1.1 and Fig. 3.1.1 show the assumed planning framework for this study.

Table 3.1.1 Planning Framework

Year	(in billion baht)				
	without Country	SSDP South	SSDP	with Country	SSDP South
1988	1,449	144.47	-	1,449	144.47
1996	2,480	262.63	-	2,480	262.63
2001	3,342	367.62	18.08	3,360	385.70
2006	4,504	506.70	60.95	4,565	567.65

3.1 Planning Framework of the Southern Region

3.1.1 National Framework

Gross Domestic Product (GDP) of the country was prepared based on the World Bank's long term projection by the year 2001. The GDP in 2006 was estimated by applying a growth rate during the

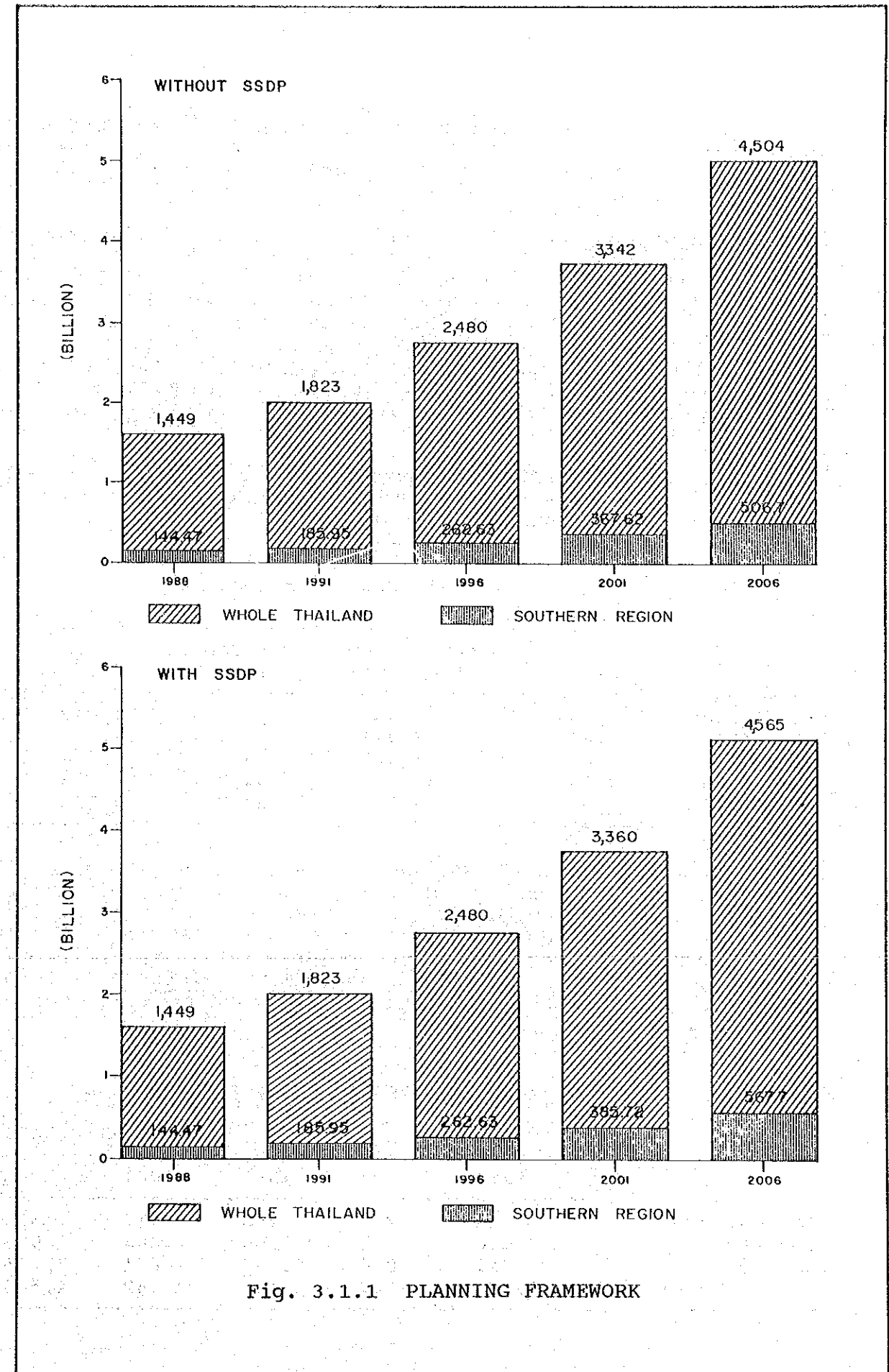


Fig. 3.1.1 PLANNING FRAMEWORK

period of 1997 - 2001. The GDP of the country is estimated to grow from 1,449 billion baht in 1988 to 2,480 billion baht in 1996, 3,342 billion baht in 2001, and 4,504 billion baht in 2006 at an average annual growth rate of 6.5 %.

Population growth rate of the country is planned to be reduced to 1.3 % by 1991. This target, however, seems to be too ambitious if compared with the actual growth rate of about 2.0 % during the period 1980 - 1988. It was assumed in this study that population growth rate will be reduced to 1.7 % in 1991 and to 1.3 % in 1996. As a result, population of the country is estimated to grow from 55.0 million persons in 1988 to 62.3 million persons in 1996, 66.5 million persons in 2001, and 70.9 million persons in 2006 at an average annual growth rate of 1.42 %.

Per capita GDP, therefore, is expected to grow from a level of US\$1,000 in 1988 to a level of US\$2,000 in 2001, and a level of US\$2,500 in 2006 as shown in Table 3.1.2.

Table 3.1.2 National Economic Framework

	GDP (billion)	Population (thousand)	Per Capita (baht)	GDP (US\$)
1988	1,449	54,961	26,364	1,042
1991	1,823	57,971	31,447	1,243
1996	2,480	62,303	39,805	1,574
2001	3,342	66,459	50,287	1,988
2006	4,504	70,893	63,532	2,512

Sectoral composition of GDP was prepared as shown in Table 3.1.3 also based on the World Bank's long term perspective by 2001 and extrapolation to 2006. Percentage share of agriculture is estimated to contracted from 15.5 % in 1988 to 7.8 % in 2001. Manufacturing industry is estimated to gain the percentage share of 7 - 8 % which agriculture sector will lose. Service sector is expected to remain constant at a percentage share of about 50 %.

Table 3.1.3 Sectoral Composition of GDP

	in billion baht				
	1988	1991	1996	2001	2006
Agriculture	225	253	288	317	351
Industry	510	666	960	1,364	1,928
Services	714	904	1,232	1,661	2,225
Total	1,449	1,823	2,480	3,342	4,504

3.1.2 Regional Economic Framework of the Southern Region

The Southern Region achieved the highest GRP share of 11.5 % of the country in 1980. The share has been declining to around 10 % in recent years. It is assumed in this study that the share will be restored to 11 % in 2001 and the past highest share of 11.5 % in 2011 through introducing various development programs such as:

- Urban and Special Area Development;
- New Economic Area Development;
- Tourism Development; and
- Development of the Southern Border Provinces.

Based on these assumptions, GRP of the Southern Region was estimated as shown in Table 3.1.4 to grow from 144.47 billion baht in 1988 to 262.63 billion baht in 1996, 367.62 billion baht in 2001, and 506.70 billion baht in 2006 at an average annual growth rate of 7.2 %, 0.7 % higher than the national average growth rate.

Table 3.1.4 GRP of the Southern Region

	GDP billion	GRP of the Southern Region share(%)	GDP billion	GRP of the Southern Region rate(%pa)
1988	1,449	9.97	144.47	
1991	1,823	10.20	185.95	8.8
1996	2,480	10.59	262.63	7.1
2001	3,342	11.00	367.62	7.0
2006	4,504	11.25	506.70	6.6
2011		11.50		
Average GRP Growth Rate				7.2%

Sectoral GRP share of the Southern Region in 1988 was 34 % for agriculture, 15 % for manufacturing industry, and 51 % for service sector. Taking account of the importance of agriculture and tourism in the Southern Region, it was assumed that the sectoral share of the region in 2006 will be 25 % for agriculture, 20 % for manufacturing industry, and 55 % for service sector as shown in Table 3.1.5. Manufacturing industry is expected to attain the highest growth rate of 8.9 % during the period 1988 - 2006.

Table 3.1.5 Sectoral GRP Composition of the Southern Region

unit: billion baht

	GRP	Agriculture %	Industry %	Services %
1988	144.47	49.73 (34.3)	21.93 (15.2)	72.81 (50.5)
1991	185.95	63.78 (34.3)	28.26 (15.2)	93.91 (50.5)
1996	262.63	81.49 (31.0)	43.97 (16.8)	137.17 (52.2)
2001	367.62	102.64 (27.9)	67.44 (18.4)	197.54 (53.7)
2006	506.70	126.67 (25.0)	101.34 (20.0)	278.69 (55.0)

Population growth rate of the Southern Region was slightly higher than the national average in the past. During the period 1980 - 1988, the region attained an average annual growth rate of 2.07 %. Population growth rate of the region will be higher than the national average for the future because of its high dependence on agriculture and less out-migration to the BMR in comparison with the other regions. It is assumed therefore that an annual growth rate of 1.7 % will be attained in 2001, ten years later than the national average. Based on these assumptions, population of the Southern Region is expected to increase from 6.9 million persons in 1988 to 8.0 million persons in 1996, 8.7 million persons in 2001, and 9.5 million persons in 2006 as shown in Table 3.1.6.

Per capita GRP of the Southern Region was calculated at 21,057 baht in 1988 which was equal to about 80 % of the national average. The per capita GRP gap is expected to continue to the future with gradual improvement: 82.5 % in 1996; 83.8 % in 2001; and 84.3 % in 2006.

Table 3.1.6 Per capita GRP of the Southern Region

	GRP billion	Population thousand	Per capita GRP South	Per capita GRP National	%
1988	144.47	6,861	21,057	26,364	79.9
1991	185.95	7,283	25,532	31,447	81.2
1996	262.63	7,998	32,837	39,805	82.5
2001	367.62	8,724	42,139	50,287	83.8
2006	506.70	9,456	53,585	63,532	84.3
Average Growth Rate					5.3 %pa

3.1.3 Economic Framework of the Provinces

Population of the provinces in the Southern Region was estimated through the following procedures:

- 1) estimate future population of the provinces based on the growth rates achieved during the period 1980 - 1988;
- 2) raise the population growth rates of the provinces with designated urban centers to the average population growth rate if they are lower than the average; and
- 3) control the thus calculated population of the region to the population framework established in 3.1.2.

Table 3.1.7 shows population framework of the provinces in the Southern Region.

Table 3.1.7 Population Framework of the Provinces

unit: thousand persons

	1988	1991	1996	2001	2006
1. Krabi	281	307	354	406	461
2. Chunphon	383	404	438	470	502
3. Trang	503	533	583	633	681
4. Nakhon Si.	1,396	1,444	1,520	1,588	1,645
5. Narathiwat	537	576	643	712	784
6. Pattani	518	549	600	652	702
7. Phangnga	206	218	238	259	278
8. Phatthalung	449	462	481	497	511
9. Phuket	155	164	180	195	210
10. Yala	339	366	413	462	514
11. Ranong	108	119	137	156	178
12. Songkhla	1,060	1,148	1,301	1,465	1,637
13. Satun	212	230	264	298	336
14. Surat Thani	714	763	846	931	1,017
Total	6,861	7,283	7,998	8,724	9,456

In the Southern Region, there has been a good correlation between the provincial shares of population and GPP. GPP framework of the provinces was prepared as shown in Table 3.1.8 based on this relationship and estimated population share in the future.

Table 3.1.8 GPP Framework of the Provinces

unit: million baht

	1988	1991	1996	2001	2006
1. Krabi	7,079	9,112	12,081	17,646	24,828
2. Chunphon	9,535	12,273	15,758	22,057	30,402
3. Trang	9,824	12,645	18,647	25,733	34,962
4. Nakhon Si.	19,792	25,475	36,243	51,099	70,938
5. Narathiwat	9,246	11,901	18,909	26,836	35,976
6. Pattani	7,224	9,297	16,546	22,057	30,402
7. Phangnga	7,946	10,227	11,293	15,440	21,281
8. Phatthalung	6,357	8,182	13,657	18,749	23,815
9. Phuket	6,501	8,368	12,081	17,278	24,322
10. Yala	7,223	9,297	13,394	18,749	25,842
11. Ranong	4,768	6,136	6,566	9,558	13,174
12. Songkhla	25,716	33,099	45,435	63,598	88,673
13. Satun	5,345	6,880	9,192	12,499	17,734
14. Surat Thani	17,914	23,058	32,828	46,321	64,351
Total	144,470	185,950	262,630	367,620	506,700

3.2 Assumed Planning Framework of the SSDP

The Southern Seaboard Development Program (SSDP) is the second project that the government is going to introduce after the Eastern Seaboard Development Program (ESDP). The SSDP, however, differs with the ESDP to a great extent in a sense that its formation will largely be dependent on participation of the international community.

The SSDP places an utmost focus on external orientation to transform the isthmus into a new international economic zone through introducing the "Trans-Thai Land Bridge". The isthmus should have direct economic linkage with the Middle East and the Integrated EC Market to the west and with the economic growth pole of the Pacific Rim to the east.

Once the SSDP is realized in the future, it will certainly give a great impetus to the Southern Region economy. At the present time, however, the SSDP is still in a stage of "Research & Development" to shape the so-called product concept acceptable to the international community.

Under the circumstances, it might be still too early to establish a planning framework of the SSDP. At the same time, due to the nature of the SSDP that does not depend on tangible domestic demand, a planning framework of the SSDP would undergo changes from time to time reflecting behavior of the international participants. It is likely that a planning framework of the SSDP will be prepared through the SSDP master plan study in a flexible way to accept changes in terms of investment scale and timing.

For the analytical purposes of this study, however, the Study Team prepared a planning framework of the SSDP with a main aim to assess the capacity required for the Krabi - Khanom Highway Link which is a part of the "Trans-Thai Land Bridge". The planning framework is based on an assumption that the SSDP will raise per capita GRP of the Southern Region equal to the national average in 2011. This is a target only from a view point of the national economy.

At the beginning stage of the SSDP in 2001, the SSDP is assumed to raise per capita GRP of the Southern Region by 3.7 % to 87.5 % of the national average in comparison with the planning framework of the Southern Region without the SSDP. Based on this assumption, the SSDP framework for the year 2001 is assumed at 18 billion baht which is equivalent to 1.2 % of the national GDP in 1988 or 4.9 % of the estimated GRP of the Southern Region in 2001.

In the year 2006, per capita GRP of the Southern Region is assumed to be improved by 9.2 % to 93.5% of the national average. Based on this assumption, the SSDP framework for the year 2006, as shown in Table 3.1.1 and Fig. 3.1.1, is assumed at 61 billion baht which is equivalent to 4.2 % of the national GDP in 1988 or 12.0 % of the estimated GRP of the Southern Region in 2006.

4. "Trans-Thai Landbridge" as an Alternative Route for International Cargo Flow

This chapter discusses probability of diversion of international container transport from the existing Strait of Malacca to the Land Bridge. The probability would depend largely on the following three factors:

- 1) Vessel traffic situations on the Strait of Malacca in the year around 2000;
- 2) Container ship operations by shipping companies; and
- 3) Transport services offered by the Land Bridge.

4.1 Vessel Traffic through the Strait of Malacca

Fig. 4.1.1 illustrates the traffic separation scheme of the Strait of Malacca. The traffic separation scheme has been introduced at two places: around Singapore and near Port Kelang.

Table 4.1.1 shows vessel traffic situations through the Strait of Malacca in October 1984 and in the same month of 1988. Monthly vessel traffic through the Strait of Malacca increased from 5,300 vessels in 1984 to 8,300 vessels in 1988 at an average annual growth rate of 11.6 %. During the period, container vessel traffic increased at higher growth rate of 18.0 % from 545 vessels in 1984 to 1,056 vessels in 1988. Number of vessels larger than 5,000 GRT was 2,187 vessels (41 % of the total) in 1984 and 2,951 vessels (36 %) in 1988.

Table 4.1.1 Vessel Traffic through the Strait of Malacca

	unit: vessel/month				
	October 1984		October 1988		1984-88
	vessels	%	vessels	%	% pa
Container Ships	545	10.2	1,056	12.8	18.0
Cargo Ships	1,709	32.0	1,932	23.3	3.1
Sub Total	2,254	42.2	2,988	36.1	7.3
Bulk Carriers	298	5.6	570	6.9	17.6
Tankers	1,237	23.2	1,676	20.2	7.9
Passenger Ships	10	0.2	32	0.4	33.7
Miscellaneous	1,536	28.8	3,015	36.4	18.4
Total	5,335	100.0	8,281	100.0	11.6

Source: The Malacca Strait Council

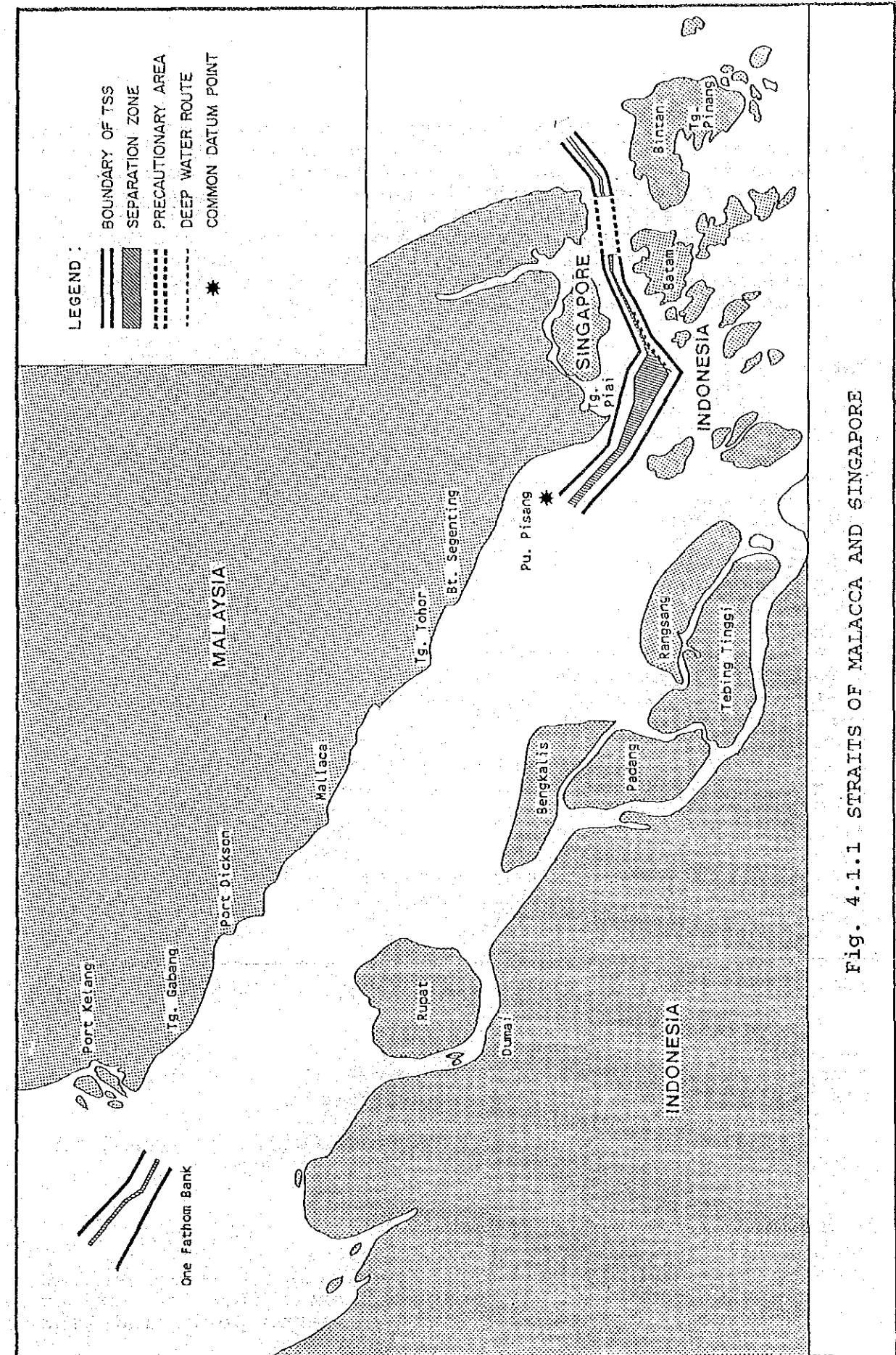


Fig. 4.1.1 STRAITS OF MALACCA AND SINGAPORE

The Malacca Strait Council envisages no particular capacity constraint until the year 2000 because the Council will continue to improve the Strait of Malacca to accommodate increasing vessel traffic for the future. It is, however, very likely that vessel traffic will suffer increasing congestions toward the year 2000. Even if the vessel traffic growth is declined to 8 % per annum, monthly traffic through the Strait of Malacca in 2001 will reach 22,500 vessels, 2.7 times as large as that of 1988, as shown in Table 4.1.2.

Table 4.1.2 Future Trend of Vessel Traffic through the Strait of Malacca

Assumed Growth Rates	1996		2001		2006	
	monthly	monthly	monthly	hourly	monthly	hourly
5 %	12,200	15,600	22	19,900	28	
8 %	15,300	22,500	31	33,100	46	
11 %	19,100	32,200	45	54,200	75	

Containerization will further progress for the future, but it is still unknown how many percentage of container ships can afford their voyage without calling Singapore Port. In terms of container shipment, Singapore Port plays an outstandingly important role in the region as an container terminal connecting international and regional container shipment. It is one of the advantages for the Land Bridge that Singapore is going to restructure its economy with a shifting emphasis from the manufacturing sector to the service sector. In this case, some part of the container transshipment function might be moved from Singapore to other ports. Krabi and Khanom ports would then be promising candidates toward the year 2006 when the SSDP would have accumulated industrial production and international trading functions.

4.2 Container Ship Operations by Shipping Companies

According to the interview to several shipping companies, they seem, at the present time, to prefer the Strait of Malacca to the Land Bridge due to cost and time factors:

- 1) Cost Increase: Double cargo handling at Krabi and Khanom ports will increase transport cost.
 - Shipping Cost between Tokyo and Rotterdam US\$2,000/TEU
 - Additional Loading and Unloading 200/TEU
 - Landbridge will, in addition to loading and unloading costs, incur such extra costs as various port charges at Krabi and Khanom ports and land transport cost over the Landbridge.

- Expected shortened distance of 850 km through the diversion from the Strait of Malacca to the Land Bridge would be equivalent to shipping cost of about US\$ 70-80 per TEU container which is less than loading or unloading cost.

- 2) Reliability of shipping schedule: Reliability of shipping schedule is the most important factor for shipping companies to attract shippers. They have already introduced weekly services of a fixed date of delivery to satisfy their customers' demand. Transshipment to the Land Bridge might invite unexpected delay due to:
 - possible occasional congestions at port;
 - possible accidents or disasters on the landbridge; and
 - possible port labor dispute.

Shipping companies which offer container transport services between the Far East and Europe regard the Siberian Railway as an emerging competitor. The Railway have been offering shorter time of transport with lower cost than the sea route through the Strait of Malacca.

4.3 Transport Hours over the Land Bridge (Case Study)

Shipping hours over the extra distance of 850 kilometers through the Strait of Malacca will be around 35 hours at an assumed vessel velocity of 15 knot per hour. Transport hour over the Land Bridge should be shorter than 35 hours if the Land Bridge is to be an alternative shipping route to the Strait of Malacca.

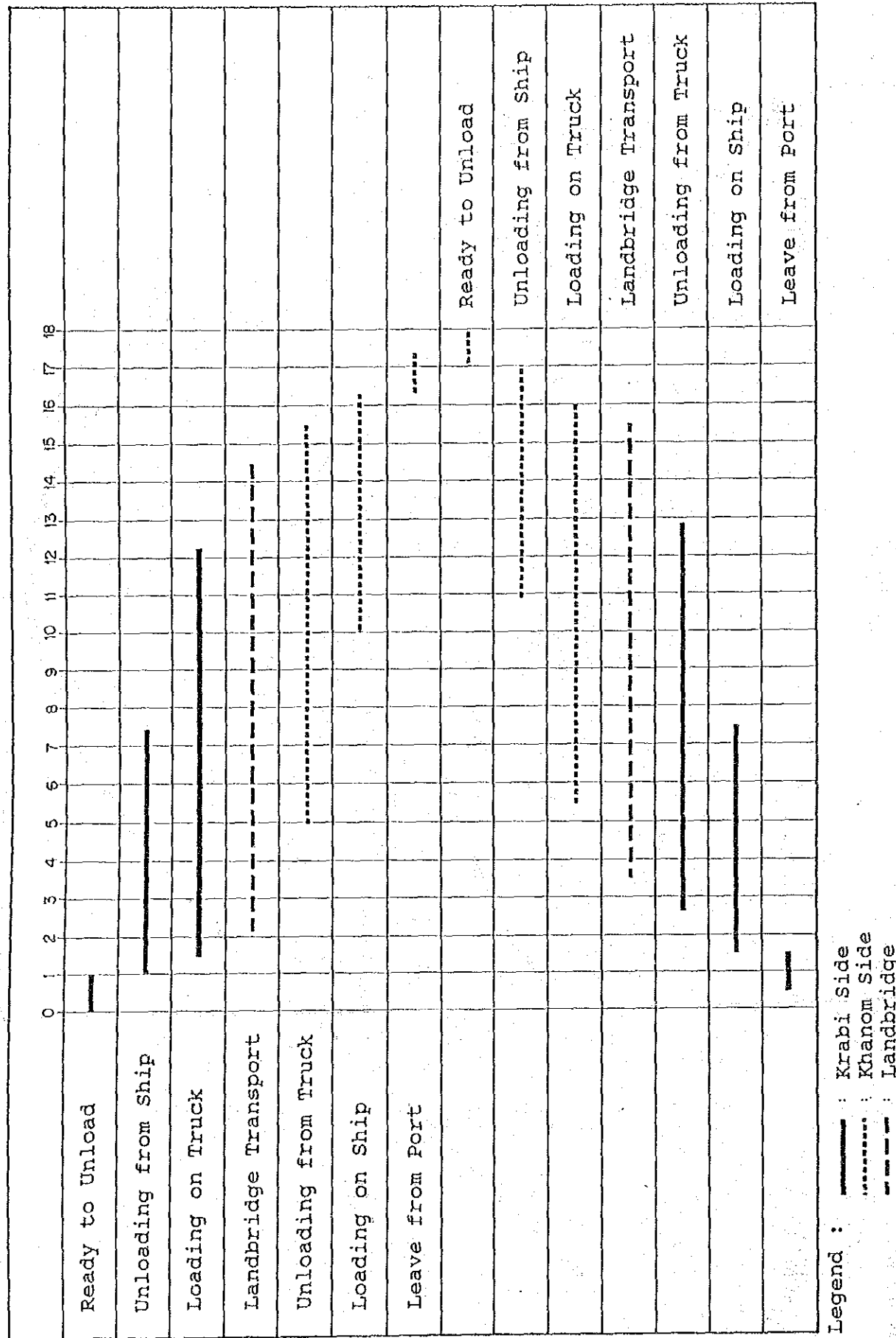
Transport hour over the Land Bridge is roughly estimated at 23 hours for a regional container ship of 1,000 TEUs and 43 hours for an international container ship of 3,600 TEUs as shown below:

- 1) Regional Container Ship of 1,000 TEU (Fig. 4.3.1)

	hours	hours cumulated
ready to unload:	1.0	
unloading time: 500/(40*2) 1/	= 6.3	2.0
loading on truck: 500/(12*4) 2/	= 10.4	12.4
Landbridge transport: 200km/(100km/h)	= 2.0	14.4
unloading from truck:	1.0	15.4
loading time:	1.0	16.4
leave from port:	1.0	17.4
Total Transport Time (17.4*1.3):	23 hours	(Guessed)

Note: 1/ 1,000/2=500 (40 feet container)
 hourly unloading efficiency=40 containers
 number of unloading machine= 2 units
 2/ hourly efficiency=12 containers
 number of machine= 4 units

Fig. 4.3.1 TRANSPORT TIME FOR 1,000 TEU CONTAINERS



2) International Container Ships of 3,600 TEU

	hours	hours cumulated
ready to unload:	2.0	
unloading time: 1,800/(40*3)	= 15.0	3.0
loading on truck: 1,800/(12*6)	= 25.0	28.0
Landbridge Transport: 200km/(100km/h)	= 2.0	30.0
unloading from truck:	1.0	31.0
loading time:	1.0	32.0
leave from port:	1.0	33.0

Total Transport Time (33.0*1.3): 43 hours (Guessed)

The above estimation, which will be affected by port designing for transshipment, suggests that:

- 1) the Land Bridge can be a competing alternative with the Strait of Malacca for a container vessel of 1,000 TEUs;
- 2) the Land Bridge cannot be a competing alternative with the Strait of Malacca for a container vessel of 3,600 TEUs; and
- 3) a most critical factor to save transport hour over the Land Bridge is the way how to tranship containers from sea to land transport instead of traveling hours between Krabi and Khanom.

Distance saving through the Land Bridge over the Sunda Strait is about 1,700 kilometers and over the Lombok Strait is about 2,800 kilometers. Transport hours required for these routes are estimated at 53 hours for the former and 88 hours for the latter. Transport hour over the Land Bridge is substantially shorter than these two.

It is likely that the Land Bridge will have a good chance to invite diversion of international container transport from the Strait of Malacca when worsening traffic congestion through the Strait of Malacca induces some container ships to divert to the Sunda and Lombok straits.

4.4 Probability of Vessel Traffic Diversion

The Land Bridge will be open to traffic by the year 1998 or the end of this century. Until then, most of the container ships will pass the Strait of Malacca due to its continuous improvement to accommodate increasing vessel traffic.

At the beginning of the next century after the completion of the Land Bridge, it is very likely that pipeline will play an important role in carrying oil and gas related products between Krabi and Khanom.

Export and import related to the SSDP will increase gradually by taking advantage of the Land Bridge. It is, however, still unknown how much international cargo flow through the strait of Malacca will divert to the Land Bridge under the prevailing system of international container shipment. In this stage, regional container ships, particularly those between Bangkok and the Middle Asia, would likely be a most promising candidate to divert from the Strait of Malacca to the Land Bridge as illustrated in Fig. 4.4.1.

It is expected, however, toward the year 2006 that container transport through the Land Bridge will increase due to (1) the expanding production activities in the SSDP, (2) further increase of international trade in relationship with the SSDP, and (3) worsening traffic situations through the Strait of Malacca. The Krabi - Khanom Highway Link will play an increasingly important role in this stage.

Due to the emergence of the SSDP as a new international economic zone in the region, international container ships will directly call Krabi and Khanom ports. Some part of international container ships through the Strait of Malacca will eventually divert to the Land Bridge. It is likely by this time that capacity constraints of the Strait of Malacca will force some part of the vessel traffic divert to alternative straits of Sunda and Lombok. The Land Bridge will then be a promising competitor to these straits.

4.5 Traffic Demand of International Containers over the Krabi - Khanom Highway Link (Case Study)

4.5.1 Traffic Demand in 2001

Assumption:

- 1) Diversion from the Strait of Malacca is limited only to regional container ships mainly engaging in trades between Bangkok and the Middle Asia.
- 2) One container ship of 1,000 TEUs calls Krabi and Khanom per week. Shipping schedule on the east and west coasts is well coordinated to minimize a loss time of container transport.
 - > equivalent to about 10 % of container ships through the Strait of Malacca in 1988
 - > equivalent to cargo handling volume of 1,300,000 tons a year

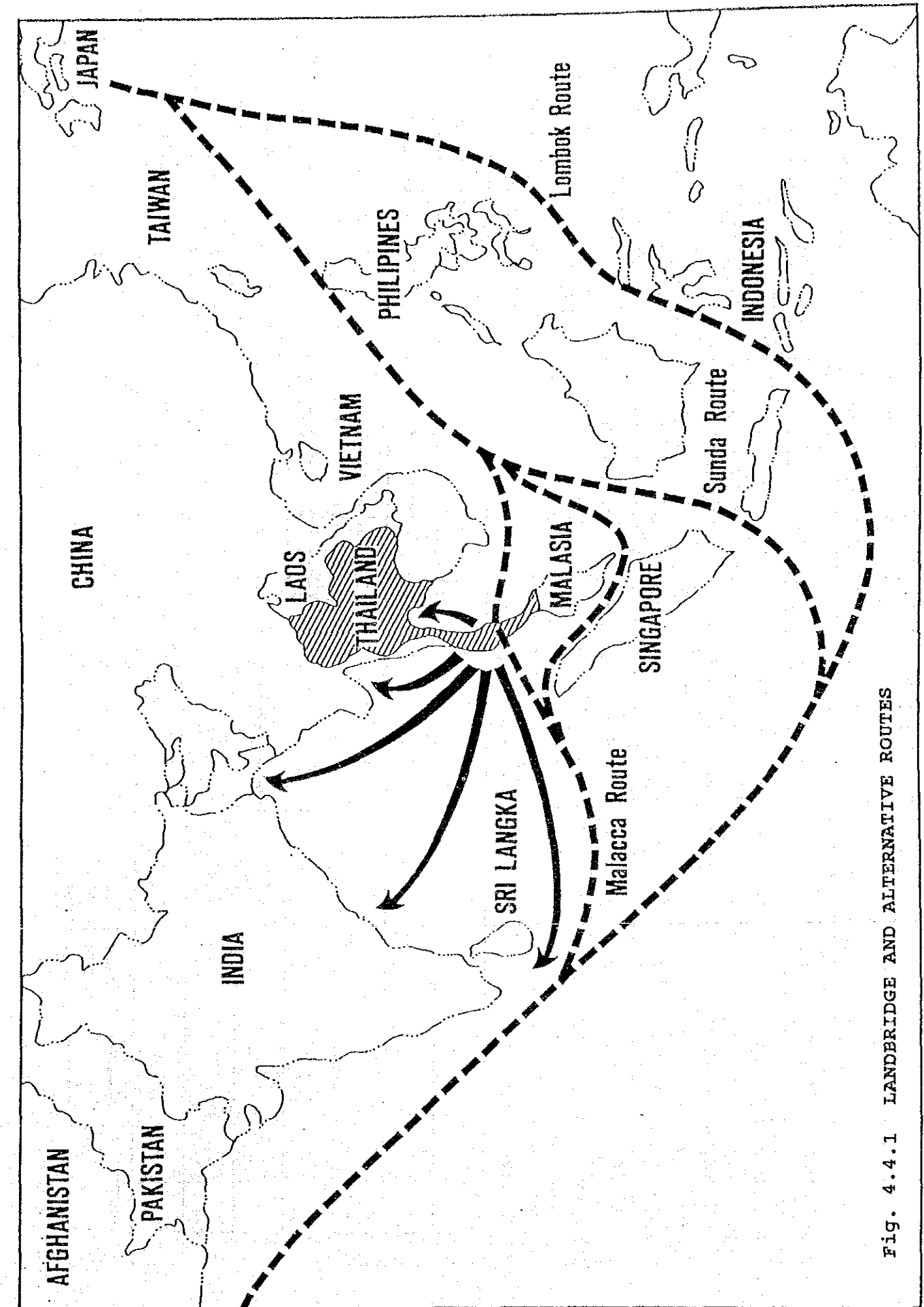


Fig. 4.4.1 LANDBRIDGE AND ALTERNATIVE ROUTES

5. Assumed Development Scenario of the Highway Link

5.1 Traffic Demand on the Highway Link

5.1.1 Type of Traffic Demand

Traffic demand on the Krabi - Khanom Highway Link comprises:

- 1) traffic demand of the Southern Region which derives from the planning framework of the Southern Region (without the SSDP);
- 2) traffic demand related to the SSDP which derives from the planning framework of the SSDP (with the SSDP); and
- 3) international container transport demand between Krabi and Khanom ports.

Traffic demand of the Southern Region (the first type) consists mainly of local traffics of passenger and cargo in the Krabi - Khanom Highway Corridor. In case of "without the Land Bridge", this type of traffic uses the existing highway network. Due to traffic congestions on some part of the existing highways, some portion of this type of traffic diverts to the Krabi - Khanom Highway Link. Trip distance seems comparatively short. This type of traffic will increase if more interchanges are set up in the future.

Traffic demand related to the SSDP (the second type) is likely to have three traffic patterns: 1) between Krabi and Khanom; 2) between Krabi and Ban Na San; and 3) between Khanom and Ban Na San. Major traffic, among others, will be import of materials from and export of products to overseas countries related to industrial estates in both Krabi and Khanom.

Traffic demand for international container transport (the third type) is the one explained in Section 4.5. There will be a large fluctuation of traffic demand from day to day depending on the arrival of container ships at both ports. If railway is constructed between the two ports, it is very likely that substantial part of this type of traffic demand will divert to the railway.

In addition to the above traffic demand, there will be various type of traffic demand related to the SSDP such as commuting trips, business trips, tourist trips, and so on. These trips are not included in this traffic demand forecast due to the uncertain details of the SSDP at the moment.

5.1.2 Traffic Volume on the Highway Link

As illustrated in Fig. 6.3.1, three alternative routes are proposed for the Krabi - Khanom highway Link, depending on how to pass the mountains in Krabi area. Over the full stretch of the Highway Link, four interchanges are proposed for the initial stage.

Table 5.1.1 shows the results of traffic assignment on the Krabi - Khanom Highway Link.

Table 5.1.1 Traffic Volume on the Krabi - Khanom highway Link unit: ADT

Section		1	2	3	4	5
Route A	2001	310	3,800	3,182	3,457	4,661
	2006	1,718	9,217	9,738	9,706	11,947
Route B	2001	312	4,209	3,265	3,158	4,654
	2006	1,721	8,924	10,106	9,429	10,671
Route C	2001	775	3,187	2,695	2,883	4,227
	2006	2,601	8,682	9,231	9,036	11,456

Note: Section 1 Krabi Port - Route 4
 Section 2 Route 4 - Route 4035
 Section 3 Route 4035 - Route 41
 Section 4 Route 41 - Route 401
 Section 5 Route 401 - Khanom Port
 ADT (Average Daily Traffic)

Traffic volume on the three alternative routes of A, B and C is estimated to be almost same each other. Traffic volume is in the range of 3,200 - 4,700 for 2001 and 8,700 - 11,900 for 2006, excluding on Section 1. Traffic volume in 2001 can be accommodated by two lane highway and that of 2006 by four lane highway.

There are, however, various factors to increase the traffic volume more than this estimation:

- 1) larger development scale of the SSDP than the assumed planning framework;
- 2) large fluctuation of traffic volume to carry international containers from one port to another;
- 3) commuting and business trips related to the SSDP; and
- 4) possible increase of local traffic through more interchanges.

Despite these factors, however, four lane highway is considered appropriate for the initial development stage of the Highway Link. It would be an economically sound to construct four lane highway for the initial stage with preparation of land for possible additional lanes for the future.

5.2 Development Scheme of the Highway Link

The SSDP master plan study is going to be commenced in November 1990 to continue for about one and a half years. Detailed engineering study and land acquisition will be undertaken after or partly in parallel with the master plan study.

Construction of the Highway Link of four lanes will be started in 1994 for about five years. It is likely that pipeline will be constructed in the same period as the basic infrastructure for developing oil refinery and petrochemical industries.

The Highway Link will be open to traffic by 1999 or 2000. Private investment will gradually become active in this stage in constructing plants, factories, distribution facilities, accommodations, etc. Some part of regional container shipment will divert to the Highway Link from the Strait of Malacca.

Although traffic volume on the Highway Link will remain small at this stage, development framework of the SSDP will become clearer than now. It would be the time to further study the appropriateness of capacity increase of the Land Bridge including introduction of railway which will largely depend on the prospect for international container diversion from the Strait of Malacca.

After 2006, construction of additional lanes and interchanges of the Highway Link will become necessary to accommodate increasing traffic beyond 2010.