Table 9.1.2-5 Total Freight Volumes by Road and Rail Transport from the Study Related Provinces in 1999 (Origin)

Unit: tones

Commodity Group	Chumphon		Surat Thani		Nakhon Sri Thammarat		Phattalung		Songkhla		Pattani		Narathiwat		Total	
	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail
Animal Folder	812				25,583		5,251		258,280	350	49,365				339,291	350
Cassava															0	0
Cement	28		4,646	25	1,044,353	81,648	7,748		173,136	13,918				518	1,229,911	96,109
Chemical									16,273	10					16,273	10
Equipment, Oth. Manufact	4,158	298		309	6,006		8,084		285,380	4,231	42,746	29	14,037	192	360,411	5,059
Fertilizer	2,154		1,795	15	1,436				41,277	2,243				195	46,662	2,453
Live Animal	11,426		24,900		101,031		13,798		441,857		167,483		952		761,447	0
Maize															0	0
Metal Products	74,442			20	22,333		6,617		180,708	9	9,099	4		29	293,199	62
Miscellaneous Articles, Container	46,436	1,674	13,855	15,100	22,792		27,955		550,545	1,389	12,686	7	9,240	143	683,509	18,313
Ores & Metal Wastes	71,087		4,567,784	67,180	3,196,956				43,886	250					7,879,713	67,430
Other Agricultual Products	199,803	3,246	245,718	426	73,527		2,792		102,635	41	174,617	117	55,217		854,309	3,830
Other foodstuffs	588		6,812		2,803		6,065		273,925	724	24,823	30	6,035		321,051	754
Other Minerals & Building		155	35,508	30,545	234,554		77,855		221,978	912	2,464				572,359	31,612
Petroleum Products	280,108		589,339				64,870		636,488			101	83,387	406	1,654,192	507
Rice		818		78	295,911		218,235		183,499	52				30	697,645	978
Rubber	15,002		373,360		314,243		125,106		650,302	135	88,199	20	196,739		1,762,951	155
Sand, Gravel, Clay & Slag				1,457	52,801		13,200		1,561,491	192	2,676				1,630,168	1,649
Solid Mineral Fuels			92,091		8,194								23,513		123,798	0
Sugar Cane															0	0
Sugars										60					0	60
Wood, Timber	110,244	26	156,464	15,923	154,931		164,827		715,403	14	237,355		530,526	11,848	2,069,750	27,811
Total	816,288	6,217	6,112,272	131,078	5,557,454	81,648	742,403	0	6,337,063	24,530	811,513	308	919,646	13,361	21,296,639	257,142

Source: MOTC

Table 9.1.2-6 Total Freight Volumes by Road and Rail Transport to the Study Related Provinces in 1999 (Destination)

Unit: tones

Commodity Group	Chumphon		Surat Thani		Nakhon Sri Thammarat		Phattalung		Songkhla		Pattani		Narathiwat		Total	
	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail
Animal Folder	38,614		24,013		107,056	180	27,577		204,768	69	99,712	110	9,076		510,816	359
Cassava			9,938						11,263		25,839		7,288	12	54,328	12
Cement	193,082	255	221,469	72,475	693,662	30	172,681		539,632	107,179	155,241		163,973	13,876	2,139,740	193,815
Chemical	18,597			9		5,232			47,849	3,678	2,468				68,914	8,919
Equipment, Oth. Manufact	42,409	887	21,656	1,171	65,127	998	47,618		371,880	10,671	25,407	201	30,981	308	605,078	14,236
Fertilizer	23,691		76,815	419	118,453	125	32,305		95,120	583	59,943	26	23,511		429,838	1,153
Live Animal	16,019		23,790		88,976		4,282		471,991		13,323		4,757		623,138	0
Maize									3,374	2,097	962		267	7	4,603	2,104
Metal Products	173,699		351,534	2	180,316		34,325		826,701		45,493		95,121		1,707,189	2
Miscellaneous Articles, Container	118,486	229	152,029	6,988	189,392	294	127,543		1,194,995	3,057	251,382	54	137,654	12	2,171,481	10,634
Ores & Metal Wastes			4,567,784	60	3,196,956				43,886	67,379					7,808,626	67,439
Other Agricultual Products	20,473		30,075	15	44,954	243	4,331		341,487	10,034	38,615		78,145	1,034	558,080	11,326
Other foodstuffs	60,314	15	54,256		56,976	65	16,293		321,218	50,822	31,030	4	43,475	4,243	583,562	55,149
Other Minerals & Building	152,264	220	224,701	67	78,842	747	17,492		728,537	31,834	53,491	60	85,335	72	1,340,662	33,000
Petroleum Products	218,407		264,114	102	63,384		74,636		1,612,233	5	33,731		68,773		2,335,278	107
Rice	142,370	12,200	167,816	26,225	100,986	31,015			523,460	91	476,889	2,019	130,404	8,728	1,541,925	80,278
Rubber	844		22,788		32,156		32,283		1,208,191		9,706	9	21,100	135	1,327,068	144
Sand, Gravel, Clay & Slag		76		75	1,089		8,668		1,620,650		7,999		1,538		1,639,944	151
Solid Mineral Fuels									139,828						139,828	0
Sugar Cane															0	0
Sugars	79		1,042				4,410		31,146	8,820	7,085		1,544		45,306	8,820
Wood, Timber	3,807	63	14,846	424	14,465	529	33,117		340,877	486	19,033	14	1,163	68	427,308	1,584
Total	1,223,155	13,945	6,228,666	108,032	5,032,790	39,458	637,561	0	10,679,086	296,805	1,357,349	2,497	904,105	28,495	26,062,712	489,232

Source: MOTC

Table 9.1.2-7 Total freight volumes moved by truck from the Study area in 1999 (tons)

Road	Changwat of Origin 1999							
Commodity Group	Chumphon	Surat Thani	Nakhon Si Thammarat	Phatthalung	Songkhla	Pattani	Narathiwat	Total
Animal Fodder			14,861	1,080	112,380	32,317		160,638
Cement	28		131,835		8,857			140,720
Chemical					8,524			8,524
Equipment, Oth. Manufact					135,191	42,746	14,037	191,974
Fertilizer	2,154	1,795			6,281			10,230
Live Animal	10,157	20,460	77,557	11,420	196,349	116,256	634	432,833
Metal Products	74,442		17,370		63,687	4,963		160,463
Miscellaneous Articles, Con	46,436		2,121		250,997	6,991	8,733	315,278
Ores & Metal Wastes	71,087							71,087
Other Agricultral Products	199,803	244,872	69,722	678	35,422	170,716	49,373	770,586
Other foodstuffs		346	1,039		102,417	23,212	6,035	133,050
Other Minerals & Building		15,218	35,479	986	32,522	2,464		86,669
Petroleum Products					137,311			137,311
Rice				209,505	61,354			270,860
Rubber	14,057	189,844	125,251	16,665	241,809	51,063	165,510	804,200
Sand,Gravel, Clay & slag					1,391	2,676		4,067
Wood, Timber	110,244	144,663	140,846	134,756	504,903	234,690	501,786	1,771,889
Total	528,409	617,198	616,082	375,090	1,899,396	688,094	746,109	5,470,378

Source: MOTC

Table 9.1.2-8 Total freight volumes moved by truck to the Study area in 1999 (tons)

Road	Changwat of Destination 1999							
Commodity Group	Chumphon	Surat Thani	Nakhon Si Thammarat	Phatthalung	Songkhla	Pattani	Narathiwat	Total
Animal Fodder	35,630	17,252	65,182	13,789	105,431	82,820	9,076	329,180
Cassava		9,938			11,263	25,839	7,288	54,329
Cement	184,216	219,860	321,012	18,219	132,126	61,490	104,760	1,041,683
Chemical	18,597				40,100	2,468		61,165
Equipment, Oth. Manufact	37,945	10,828	57,615	34,921	246,469	21,814	22,585	432,176
Fertilizer	23,691	74,302	118,453	23,691	77,174	59,943	16,153	393,406
Live Animal	14,433	1,269	72,958	317	194,287	5,393	4,282	292,938
Maize					3,374	962	267	4,603
Metal Products	173,699	347,398	160,465	24,814	731,598	41,357	95,121	1,574,452
Miscellaneous Articles, Con	102,599	141,960	155,165	113,607	924,467	225,795	123,769	1,787,362
Other Agricultral Products	20,473	25,294	44,591		273,000	32,855	78,145	474,358
Other foodstuffs	52,447	25,450	48,798	714	200,439	16,372	43,475	387,695
Other Minerals & Building	152,264	224,701	72,436	14,783	305,513	36,984	48,291	854,972
Petroleum Products	215,176	254,422	45,937		248,176	15,637	35,817	815,166
Rice	142,370	167,816	100,986		152,195	421,370	130,404	1,115,141
Rubber			16,331		351,142			367,473
Sand,Gravel, Clay & slag			1,089		3,832	7,383	1,538	13,843
Solid Mineral Fuels					16,031			16,031
Sugars	79	1,042		4,410	31,146	7,085	1,544	45,306
Wood, Timber	3,807		1,142	22,840	88,314	13,323	21	129,447
Grand Total	1,177,425	1,521,534	1,282,160	272,105	4,136,078	1,078,889	712,177	10,190,727

Source: MOTC

"External" means the traffic is moved either from or to outside the Study area. Out of 21.3 million tons of road freight originated from the Study area, only about 5.5 million tons or 26% are shipments moved to outside the Study area. Concerning the road freight attracted to the Study area, only about 10.2 million tons or 39% of total 26.1 million tons were shipped from outside the Study area.

(2) Future Cargo Movement by Truck

This section describes the methods used in predicting future freight traffic to be moved by truck into and out of the Study area. At this stage of the study, the prediction represents the normal growth of traffic, without consideration given to special measures being implemented to attract truck traffic to coastal shipping. These estimates will form the basis for subsequent determination of potential traffic to be diverted from trucks to coastal shipping.

It is generally accepted that freight traffic is directly influenced by economic development in two ways. Firstly, larger amount of raw materials will be needed and transported to sustain greater production activities. Secondly, more finished goods will be delivered to satisfy the growth in consumption, made possible by consumers' higher purchasing power. The analysis of future cargo movement began with the establishment of the relation between freight traffic and economic development using historical time-series data. The established relation was then utilized in predicting future cargo movement.

The determination of the relation between road freight traffic and economic development was carried out at the national level due to the lack of detailed reliable data. At the national level, the historical data on total road freight traffic were retrieved from the transport statistics reported by the Ministry of Transport and Communications. The past data on GDP, which has been the common measure of national economic development, were obtained from the National Economic and Social Development Board (NESDB). The required data were readily available for the period of 1992-1998 as shown in the following Table 9.1.2-9.

Table 9.1.2-9 GDP and Road Freight Movement

Years	GDP 1988 price Million Baht	Road Freight '000 Tons
1992	2,282,569	285,720
1993	2,473,936	316,720
1994	2,695,418	344,098
1995	2,935,351	383,275
1996	3,109,332	408,430
1997	3,057,023	406,288
1998	2,746,136	384,421

In our Study, the relation between road freight traffic and the economic development assumed the well-known Cobb-Douglas function as shown in (1).

$$V = a X^{b} \qquad (1)$$

V denotes road freight traffic and X represents the GDP. The attractive feature of the Cobb-Douglas formula is that the elasticity of dependent variable with respect to a change in the

independent variable becomes constant irrespective of the values of the dependent and independent variables. To be more specific, equation (1) indicates that every 1% change in the GDP would generate a b % change in road freight traffic volume.

Taking natural logarithms on (1), one would obtain a linear function as follows:

$$ln(V) = ln(a) + b\ ln(X) \qquad (2)$$

Classical regression analysis was undertaken to calibrate the parameters in equation (2) against the time-series. The statistical analysis finally revealed a value of b of 1.168, meaning that a 1% increase (decrease) in GDP would lead to a 1.168% increase (decrease) in cargo movement by truck. This particular result appeared reasonable and indicated that the road freight traffic has been relatively elastic with respect to the GDP; truck traffic has changed at a slightly faster rate than the GDP.

Given the estimated elasticity of truck traffic demand, the truck traffic growth is determined directly from the forecasts of future changes in economic development. Ideally, one would prefer predicting traffic growth by cargo type. However, this would require the corresponding forecasts of economic growth by development sector. For example, to separately estimate the growth of agriculture cargo movement would certainly make use of the estimates of future changes in the economic value of the agriculture sector. Unfortunately, the forecasts of economic growth by development sector are not generally available and the forecasts have been usually provided in the aggregate term covering the entire economy instead.

In the recent Transport Master Plan completed for the MOTC in January 1999, the Thailand Development Research Institute (TDRI) provided estimates of the future development in the economy by geographical regions. The annual changes in the gross regional product (GRP) of the lower Southern region embracing the Study area were predicted as follows:

	1996-2001	2001-2006	2006-2011
GRP of Lower Southern Region	-0.32%	3.85%	4.01%

Based on the above GRP growth, the corresponding annual growth in road traffic associated with the study area was subsequently estimated as follows:

	1996-2001	2001-2006	2006-2011
Road Freight Traffic Growth	-0.374%	4.500%	4.68%

Applying the above growth rates across-the-board to all cargo types, the cargo movements by truck between the study area and the rest of the country in the year 2006 and the year 2011 are estimated and presented in the following tables:

Table 9.1.2-10 Forecast Freight Volumes Moved by Truck from the Study Area to the Rest of the Country in 2006 (tons)

Road	Changwat of Origin 2006							
Commodity Group	Chumphon	Surat Thani	Nakhon Si Thammarat	Phatthalung	Songkhla	Pattani	Narathiwat	Total
Animal Fodder	-	-	18,381	1,336	139,000	39,972	-	198,690
Cement	35	-	163,064	-	10,954	-	-	174,054
Chemical	-	-	-	-	10,543	-	-	10,543
Equipment, Oth. Manufact	-	-	-	-	167,214	52,871	17,362	237,448
Fertilizer	2,664	2,220	-	-	7,769	-	-	12,653
Live Animal	12,563	25,306	95,929	14,125	242,860	143,795	785	535,362
Metal Products	92,076	-	21,484	-	78,774	6,138	-	198,473
Miscellaneous Articles, Con	57,436	-	2,623	-	310,453	8,647	10,801	389,960
Ores & Metal Wastes	87,926	-	-	-	-	-	-	87,926
Other Agricultral Products	247,132	302,877	86,238	839	43,813	211,155	61,068	953,121
Other foodstuffs	-	428	1,285	-	126,678	28,711	7,464	164,566
Other Minerals & Building	-	18,822	43,883	1,219	40,226	3,047	-	107,198
Petroleum Products	-	-	-	-	169,837	-	-	169,837
Rice	-	-	-	259,133	75,888	-	-	335,021
Rubber	17,387	234,814	154,920	20,613	299,088	63,158	204,716	994,697
Sand,Gravel, Clay & slag	-	-	-	-	1,721	3,310	-	5,031
Wood, Timber	136,358	178,931	174,210	166,676	624,503	290,283	620,649	2,191,611
Total	653,577	763,398	762,018	463,940	2,349,321	851,088	922,845	6,766,189

Table 9.1.2-11 Forecast Freight Volumes Moved by Truck from the Study Area to the Rest of the Country in 2011 (tons)

Road	Changwat of Origin 2011							
Commodity Group	Chumphon	Surat Thani	Nakhon Si Thammarat	Phatthalung	Songkhla	Pattani	Narathiwat	Total
Animal Fodder	-	-	23,104	1,680	174,716	50,243	-	249,744
Cement	44	-	204,964	-	13,769	-	-	218,777
Chemical	-	-	-	-	13,252	-	-	13,252
Equipment, Oth. Manufact	-	-	-	-	210,180	66,457	21,824	298,461
Fertilizer	3,348	2,790	-	-	9,765	-	-	15,904
Live Animal	15,791	31,808	120,578	17,754	305,263	180,743	986	672,924
Metal Products	115,735	-	27,005	-	99,015	7,716	-	249,471
Miscellaneous Articles, Con	72,195	-	3,297	-	390,224	10,868	13,577	490,161
Ores & Metal Wastes	110,519	-	-	-	-	-	-	110,519
Other Agricultral Products	310,632	380,702	108,397	1,055	55,070	265,411	76,759	1,198,027
Other foodstuffs	-	539	1,616	-	159,228	36,088	9,382	206,852
Other Minerals & Building	-	23,659	55,159	1,532	50,563	3,830	-	134,743
Petroleum Products	-	-	-	-	213,477	-	-	213,477
Rice	-	-	-	325,717	95,387	-	-	421,105
Rubber	21,855	295,149	194,727	25,909	375,940	79,387	257,318	1,250,286
Sand,Gravel, Clay & slag	-	-	-	-	2,163	4,161	-	6,324
Wood, Timber	171,396	224,908	218,973	209,504	784,970	364,872	780,125	2,754,748
Total	821,515	959,555	957,820	583,151	2,952,983	1,069,777	1,159,972	8,504,773

Table 9.1.2-12 Forecast Freight Volumes Moved by Truck from the Rest of the Country to the Study Area in 2006 (tons)

Road	Changwat of Destination 2006							
Commodity Group	Chumphon	Surat Thani	Nakhon Si Thammarat	Phatthalung	Songkhla	Pattani	Narathiwat	Total
Animal Fodder	44,070	21,339	80,622	17,055	130,405	102,439	11,225	407,155
Cassava	-	12,292	-	-	13,931	31,960	9,014	67,198
Cement	227,853	271,940	397,052	22,535	163,423	76,055	129,576	1,288,434
Chemical	23,003	-	-	-	49,599	3,052	-	75,654
Equipment, Oth. Manufact	46,933	13,393	71,263	43,193	304,852	26,981	27,935	534,549
Fertilizer	29,302	91,903	146,512	29,302	95,455	74,143	19,979	486,596
Live Animal	17,851	1,569	90,240	392	240,309	6,670	5,296	362,329
Maize	-	-	-	-	4,173	1,189	330	5,693
Metal Products	214,845	429,689	198,475	30,692	904,898	51,153	117,653	1,947,405
Miscellaneous Articles, Con	126,903	175,588	191,920	140,518	1,143,452	279,281	153,087	2,210,749
Other Agricultral Products	25,322	31,286	55,154	-	337,668	40,637	96,656	586,723
Other foodstuffs	64,870	31,478	60,357	883	247,918	20,250	53,774	479,531
Other Minerals & Building	188,332	277,927	89,595	18,285	377,882	45,745	59,730	1,057,496
Petroleum Products	266,147	314,689	56,818	-	306,964	19,341	44,302	1,008,260
Rice	176,094	207,568	124,907	-	188,247	521,183	161,294	1,379,294
Rubber	-	-	20,199	-	434,320	-	-	454,520
Sand,Gravel, Clay & slag	-	-	1,347	-	4,740	9,132	1,902	17,122
Solid Mineral Fuels	-	-	-	-	19,829	-	-	19,829
Sugars	97	1,289	-	5,455	38,524	8,763	1,910	56,038
Wood, Timber	4,708	-	1,413	28,250	109,234	16,479	26	160,110
Grand Total	1,456,331	1,881,951	1,585,875	336,561	5,115,824	1,334,454	893,689	12,604,685

Table 9.1.2-13 Forecast Freight Volumes Moved by Truck from the Rest of the Country to the Study Area in 2011 (tons)

Road	Changwat of Destination 2011							
Commodity Group	Chumphon	Surat Thani	Nakhon Si Thammarat	Phatthalung	Songkhla	Pattani	Narathiwat	Total
Animal Fodder	55,394	26,822	101,339	21,437	163,913	128,761	14,110	511,775
Cassava	-	15,451	-	-	17,511	40,172	11,331	84,465
Cement	286,400	341,816	499,076	28,325	205,415	95,598	162,870	1,619,500
Chemical	28,913	-	-	-	62,344	3,836	-	95,094
Equipment, Oth. Manufact	58,992	16,834	89,574	54,292	383,184	33,914	35,112	671,902
Fertilizer	36,832	115,517	184,158	36,832	119,982	93,194	25,112	611,627
Live Animal	22,438	1,973	113,428	493	302,057	8,384	6,657	455,430
Maize	-	-	-	-	5,246	1,495	415	7,156
Metal Products	270,049	540,098	249,474	38,578	1,137,413	64,297	147,884	2,447,794
Miscellaneous Articles, Con	159,511	220,705	241,234	176,624	1,437,264	351,043	192,423	2,778,805
Other Agricultral Products	31,829	39,325	69,326	-	424,432	51,079	121,492	737,483
Other foodstuffs	81,539	39,567	75,865	1,110	311,622	25,454	67,591	602,747
Other Minerals & Building	236,724	349,341	112,616	22,983	474,979	57,499	75,078	1,329,221
Petroleum Products	334,534	395,548	71,418	-	385,839	24,311	55,685	1,267,335
Rice	221,342	260,903	157,002	-	236,617	655,102	202,739	1,733,705
Rubber	-	-	25,390	-	545,920	-	-	571,309
Sand,Gravel, Clay & slag	-	-	1,693	-	5,958	11,479	2,391	21,521
Solid Mineral Fuels	-	-	-	-	24,924	-	-	24,924
Sugars	122	1,621	-	6,857	48,423	11,014	2,401	70,438
Wood, Timber	5,918	-	1,775	35,509	137,302	20,714	32	201,251
Grand Total	1,830,538	2,365,522	1,993,369	423,041	6,430,343	1,677,344	1,123,324	15,843,480

(3) The Modal Shift from Land Transport to Ro/ Ro Shipping in the Study Area

Cargo movement by land transport reveals that Songkhla province in the Southern region has the most significant volume of cargoes available for modal shift to coastal shipping.

Moreover, Star Ferry Co., Ltd., a private ferry company, requested the support to Policy and Planning Office Development, to promote shifting the land transport to transport by Ro/Ro vessels. The company has the implementation plan by stages as shown below:

	Target Year	Route
Level 1	July, 2001	Bangsaphan - Laem Chabang
Level 2	2003	Bangsaphan –Bangkok
Level 3	In the future	Bangsaphan – Map Ta Phut – **Songkhla** - Bangsapan
		Bangsaphan –Laem Chabang– **Songkhla** - Bangsapan

The company also requested the right of Ro/Ro navigation to Harbour Department for the following routes:

1	Bangsaphan – Bangkok– **Songkhla**
2	Bangsaphan - Laem Chabang – **Songkhla**
3	Bangsaphan – Map Ta Phut – **Songkhla**
4	Bangsaphan – Future port

If the company's plan were implemented, Ro/Ro vessel cargo berths would be necessary at Songkhla Port. The JICA Study Team takes the request of Star Ferry Co., Ltd., into account in the master planning.

9.1.3 Summary of Cargo Forecast

Figure 9.1.3-1 shows the cargo forecast of Songkhla Port. This is obtained from simulation on the demand model described in Section 9.1.1 of this chapter. The figure suggests that, without the modal shift from "by truck" to "by coastal ships," the coastal shipping cargo will be between 433,000 and 528,000 tons in 2010 and between 658,000 and 928,000 tons in 2020.

Meanwhile, among cargoes by trucks, Songkhla Port could attract only those from/to Bangkok and Eastern Region. These cargoes are neither liquid ones nor construction materials, and would possibly be transported by RO/RO ferries. Table 9.1.3-2 shows the land transport cargo volume from/to the eastern region. The volumes each year are computed by multiplying the forecast cargoes with the average share of these two regions from 1997 to 1999. The table suggests that cargoes by trucks will be about 14,830,180 tons and 23,258,147 tons in 2,010 and 2020 respectively. For the master planning, however, the cargoes between the Southern region and Bangkok should be discarded from the modal shift for the time being. This is due to one of our study results that the coastal shipping between the southern region and Bangkok would not be

Table 9.1.3-1 Coastal Cargo Forecast and Berth Capacities Programme (Songkhla Port)

Unit: Ton

	Actual Data	Forecast			
	1999	2005	2010	2015	2020
Base Case	**276,248**	**356,901**	**474,264**	**608,287**	**771,374**
Optimistic Case	276,248	376,795	528,365	705,558	928,398
Pessimistic Case	276,248	340,749	432,945	536,089	657,930
Required Berth Capacities					
	1999	2005	2010	2015	2020
Existing Berth	350,000	350,000	350,000	350,000	350,000
Coastal Cargo Berth (Plan)			350,000	350,000	350,000
Add. Coastal Cargo Berth (Plan)					350,000
Total Capacity	350,000	350,000	700,000	700,000	1,050,000

Figure 9.1.3-1 Demand Forecast for Coastal Solid Cargo Volume (Songkhla Port)

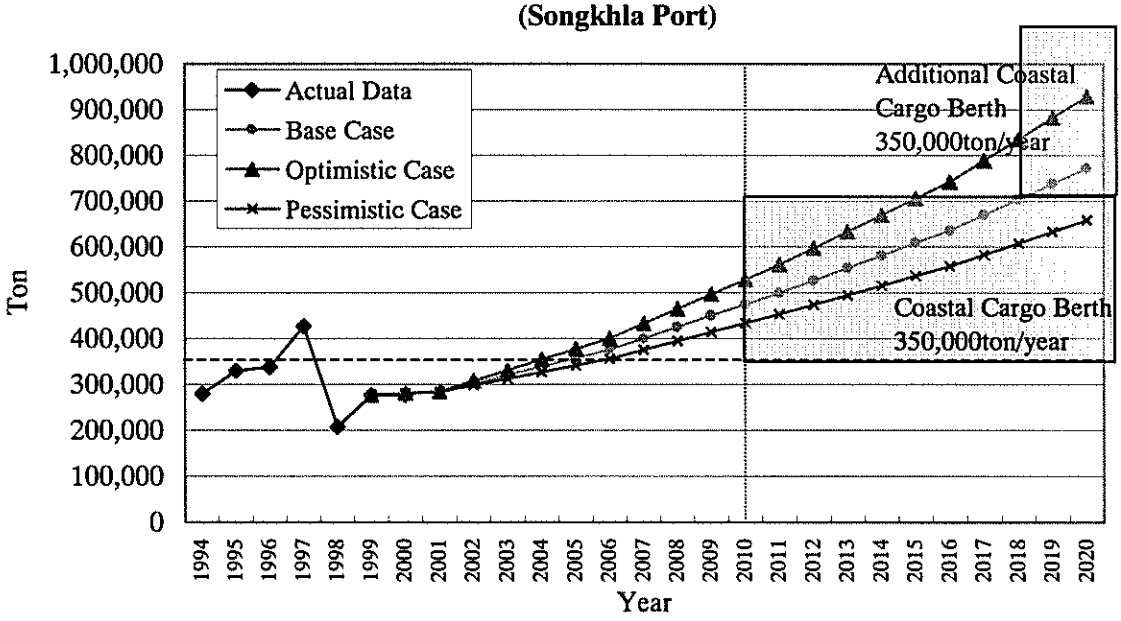


Table 9.1.3-2 Estimation of Road Transport Volume in Songkhla, Pattani and Narathiwat

Unit: tones

	1999 (Actual Data)	2005	2010	2015	2020
Total Road Transport Volume in 3 Provinces	9,240,743	11,679,056	14,830,180	18,574,481	23,258,147
3 Provinces-Eastern Region	184,815	233,581	296,604	371,490	465,163

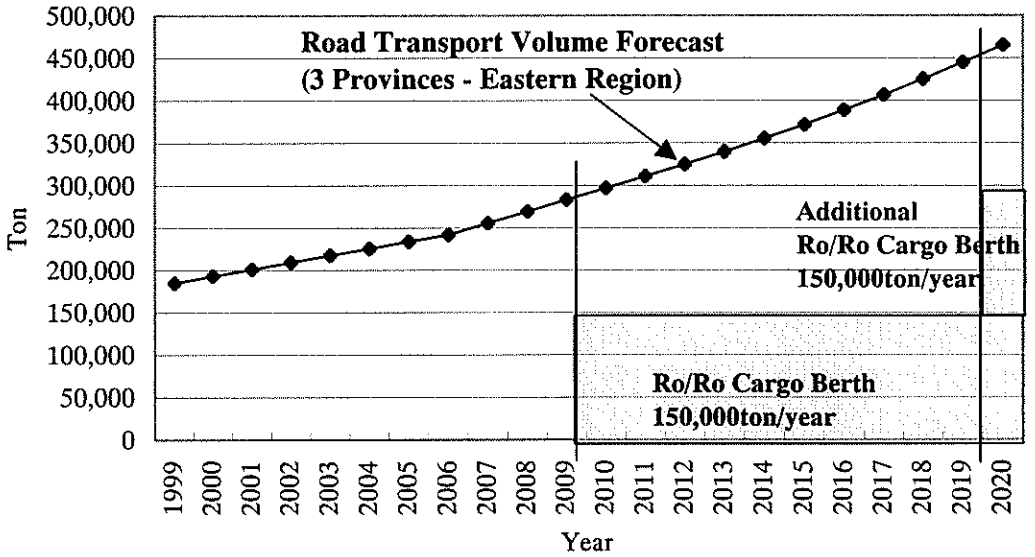


Figure 9.1.3-2 Demand Forecast for Road Transport Volume and Proposed Ro/Ro Berth Capacity (Songkhla Port ◄—► Eastern Region)

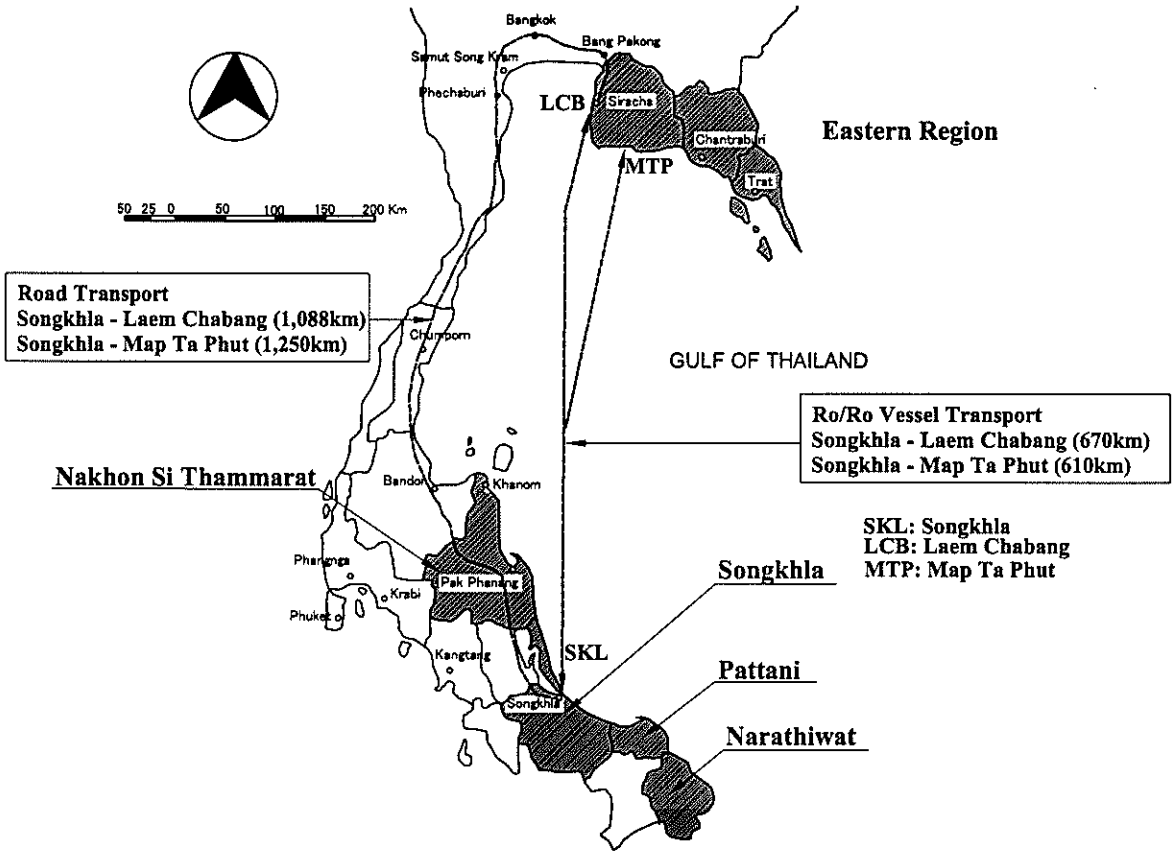


Figure 9.1.3-3 Ro/Ro Vessel Transport Routes

economically competitive until an efficient combined transport system is established. Therefore, it is assumed in the master planning that 50% of the forecast cargo volume by trucks between the Southern (Songkhla, Pattani and Naratiwat province) and Eastern regions would shift to coastal shipping.

The cargo volumes inbound and outbound coastal shipping in 2010 and 2020 are summarized in Table 9.1.3-3:

Table 9.1.3-3 Summaries of Cargo Volumes of Coastal Shipping in 2010 and 2020

Year	2010 (tons)			2020 (tons)		
Economic Growth	Low	Medium	High	Low	Medium	High
Truck Cargoes (No Modal Shift)	432,945	474264	528,365	657,930	771,374	928,398
RO/RO cargo (Modal shift)	296,604 / 2 = 148,302			465,163 / 2 = 232,582		
Approx. Total	581,000	623,000	677,000	891,000	1,004,000	1,161,000

From the table above, the master plan of Songkhla port should be worked out to handle 1.0 million tons, of which 0.77 million tons would be conventional cargoes and 0.23 million tons RO/RO cargoes.

9.2 Priority of Coastal Channels and Ports

9.2.1 Objectives of Development of Coastal Channels and Ports

The development of the coastal channels and ports in the Master Plan is divided into three categories as follows:

(1) Development of Channels for Fishing Vessels
(2) Development of Channels for Cargo Vessels
(3) Development of Port Facilities

Each category is discussed in detail in this section.

(1) Development of Fishing Vessel Channels

Fishery is the most important industry for the inhabitants of the coastal area in the Study provinces in Thailand. According to the data of the year 2000, 9560 fishing vessels are registered in the Study coastal provinces: Nakhon Si Thammarat, Songkhla, Pattani and Naratiwat. Most of the registered fishing vessels are accommodated in the Study coastal channels.

According to the survey at 37 marine fish-landing places by Fishery Department in 1998, the total landing volume was 1,723,411 tons, of which 15.9% (or 274,548 tons) was at Muang Songkhla and 15.7% (or 270,952 ton) was at Muang Pattani. Refer to Figure 9.2.1-1.

The share of fishing industry of Gross Provincial Product (GPP) in the Study coastal provinces is 12 % of the total GPP. This percentage is much larger than 2% as the share of the whole Thailand.

In the Study coastal channels, the channels for fishing vessels are classified into three categories below:

(a) Two channels for large fishing vessels: Songkhla and Pattani channels accommodate large fishing vessels. There are various private fishing processing factories and private/public fish markets. In both areas, 11 fish canning factories are registered. There are large fish-related factories and facilities in Muang Songkhla and Pattani. Table 9.2.1-1 shows fish processing factories in the study provinces.

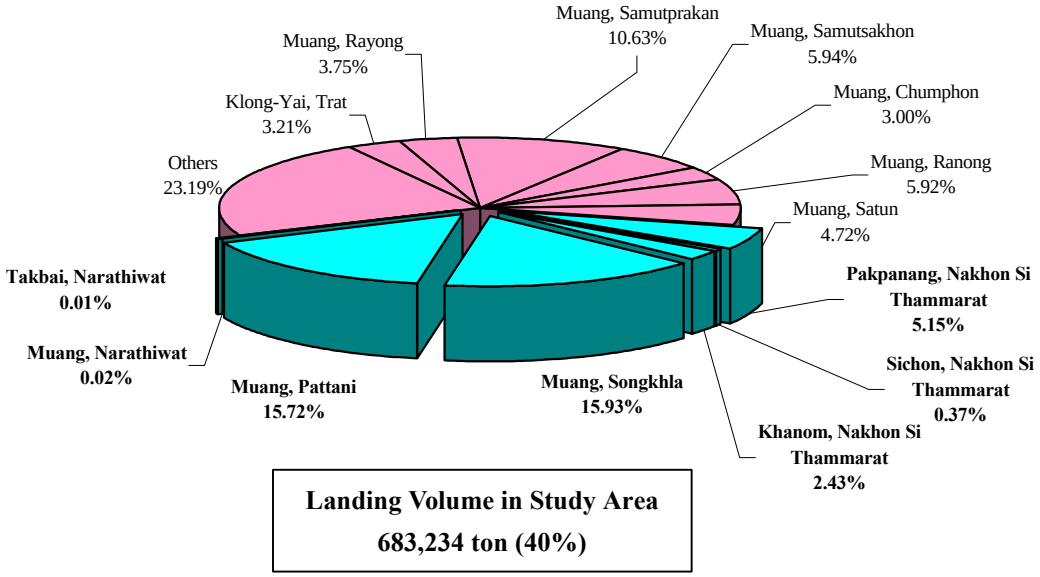
(b) Eight channels for medium fishing vessels: Pak Phanang, Khanom, Sai Buri, Sichon, Tha Sala, Pak Nakhon, Pak Paya and Narathiwat. There are private fishing facilities and markets.

Table 9.2.1-1 Number of Fish Processing Factories by Province, 1995

Province	Type of fish processing													Total
								Fermenting		Salting, Drying				
	Freezing	Canning	Reduction	Fish ball	Shrimp Cral	Steaming	Smoking	Fish sauce	Budu sauce	Salted Fish	Dried Shrin	Dried Squid	Dried Shellf	
Total	**144**	**52**	**122**	**98**	**125**	**80**	**26**	**102**	**54**	**727**	**158**	**561**	**237**	**####**
Coastal Zone 1	**7**	**3**	**13**	**13**	**-**	**1**	**-**	**33**	**-**	**43**	**8**	**61**	**-**	**182**
Trat	1	2	5	4	-	-	-	4	-	4	1	-	-	21
Chantaburi	-	-	4	2	-	-	-	3	-	9	5	1	-	24
Rayong	6	1	4	7	-	1	-	26	-	30	2	60	-	137
Coastal Zone 2	**87**	**31**	**27**	**57**	**8**	**53**	**5**	**55**	**-**	**353**	**28**	**170**	**237**	**1111**
Chon Buri	3	-	1	1	2	2	1	12	-	100	11	92	18	243
Chachoengsao	-	-	-	7	-	-	-	-	-	50	-	-	70	127
Samut Prakan	18	13	7	2	-	2	-	10	-	17	3	-	4	76
Bangkok Metropolis	11	5	-	-	-	-	-	-	-	-	-	-	-	16
Samut Sakhon	52	13	16	20	5	-	3	11	-	120	12	40	43	335
Samut Songkhram	3	-	3	5	1	44	1	20	-	41	2	17	12	149
Phetchaburi	-	-	-	22	-	5	-	2	-	25	-	21	90	165
Coastal Zone 3	**14**	**5**	**16**	**11**	**1**	**5**	**5**	**13**	**-**	**40**	**50**	**222**	**-**	**382**
Prachuap Khiri Khan	5	-	6	1	-	3	-	8	-	10	30	79	-	142
Chumphon	4	1	9	2	-	-	-	4	-	8	2	44	-	74
Surat Thani	5	4	1	8	1	2	5	1	-	22	18	99	-	166
Coastal Zone 4	**27**	**11**	**34**	**11**	**116**	**17**	**6**	**1**	**54**	**237**	**20**	**54**	**-**	**588**
Nakhon Si Thammarat	3	-	12	2	-	8	5	1	-	19	9	22	-	81
Phatthalung	-	-	-	-	-	4	-	-	-	3	3	-	-	10
Songkhla	21	6	14	5	4	5	1	-	-	23	7	-	-	86
Pattani	3	5	8	2	77	-	-	-	38	166	1	13	-	313
Narathiwat	-	-	-	2	35	-	-	-	16	26	-	19	-	98
Coastal Zone 5	**9**	**2**	**32**	**6**	**-**	**4**	**10**	**-**	**-**	**54**	**52**	**54**	**-**	**223**
Ranong	-	-	13	3	-	-	-	-	-	19	17	3	-	55
Phangnga	-	-	6	-	-	-	-	-	-	5	6	18	-	35
Phuket	2	-	3	2	-	2	1	-	-	3	-	4	-	17
Krabi	-	-	-	-	-	-	9	-	-	4	-	18	-	31
Trang	5	1	6	1	-	2	-	-	-	3	-	1	-	19
Satun	2	1	4	-	-	-	-	-	-	20	29	10	-	66

Source : Fisheries Statistics of Thailand 1995, Department of Fisheries, Ministry of Agriculture and Cooperatives

Figure 9.2.1-1 Marine Fish Landing Volume by Main Landing Place (1998)
Total Volume 1,723,411 ton



(c) 20 channels for small fishing vessels: Among the total 30 channels, other than the above mentioned 10 channels, there are 20 channels for small fishing vessels, where only small private markets or dry fish facilities exist.

Regarding the channels for large and medium fishing vessels, their maintenance significantly contributes to the fishery industries and provincial economy in the Study coastal area. However, maintenance of channels for small fishing vessels, may not contribute to the provincial economy but only to fishermen's families and their livelihood. Therefore, in this study, the master plan will discuss the channels for large and medium fishing vessels.

(2) Development of Channels for Cargo Vessels

(a) Songkhla Channel

The Songkhla channel undoubtedly much contributes to the national economy of Thailand since the channel is used by domestic and international ocean-going vessels as well as fishing vessels.

Among the international ocean-going vessels calling Songkhla International Commercial Port, 63% of the vessels recorded more than 5,000 GRT in 1999 (see Figure 9.2.1-3). Size of the cargo vessels is increasing in proportion to the cargo throughputs year by year. Besides, oil tankers from 500 to 20,000 DWT, accommodated at the oil terminal jetty, use the channel. They handled 1,142,133 ton of petroleum products in 1999.

Table 9.2.1-2 Cargo Vessel Size (Draft) in Songkhla

Unit: Vessel

Draft \ Year	1991	1992	1993	1994	1995	1996	1997	1998	1999
0-3m	93	238	139	61	36	62	46	68	41
3.1-5m	48	134	229	162	205	231	255	163	185
5.1-7m	111	70	135	178	205	195	160	315	372
>7m	32	25	33	36	17	33	28	15	10
	284	467	536	437	463	521	489	561	608

Source: HD

Figure 9.2.1-2 Cargo Vessel Size (Draft) in Songkhla

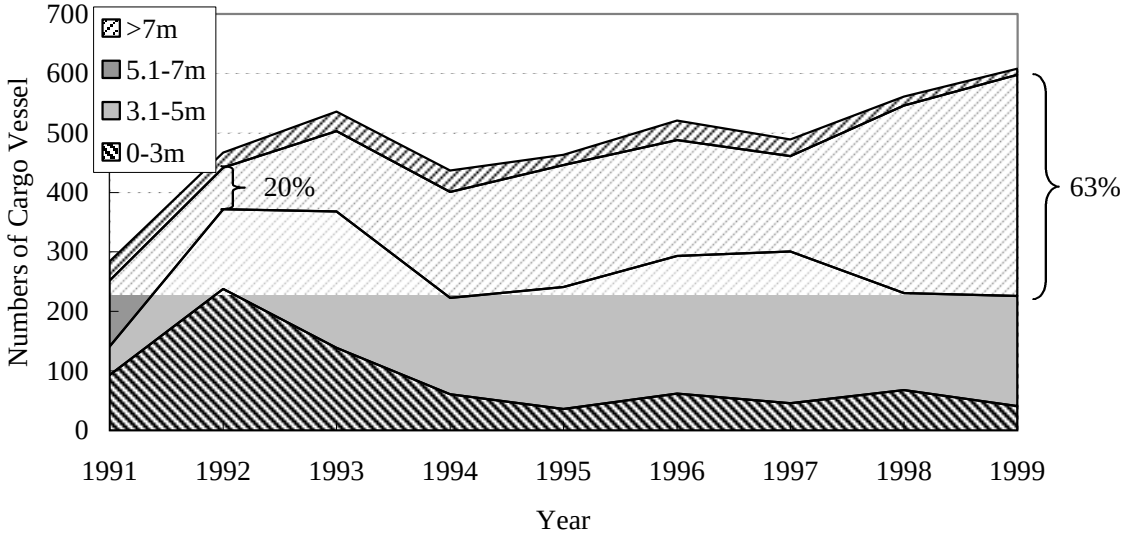


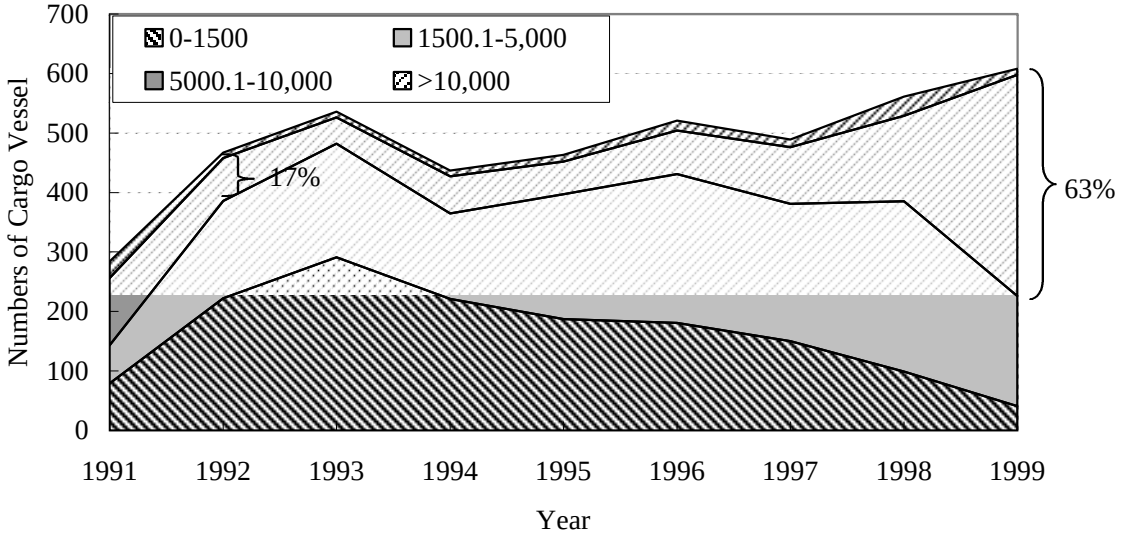
Table 9.2.1-3 Songkhla Cargo Vessel Size (GRT) in Songkhla

Unit: Vessel

GRT \ Year	1991	1992	1993	1994	1995	1996	1997	1998	1999
0-1500	79	222	291	221	187	181	150	99	41
1500.1-5,000	64	164	191	144	210	250	231	286	185
5000.1-10,000	113	72	44	62	55	73	95	144	372
>10,000	28	9	10	10	11	17	13	32	10
	284	467	536	437	463	521	489	561	608

Source: HD

Figure 9.2.1-3 Cargo Vessel Size (GRT) in Songkhla



(b) Pak Phanang Channel

Because of a PTT oil jetty built on Pak Phanang River, Oil tankers from 500 to 1,500 DWT pass through the Pak Phanang channel. The volume of petroleum products handled was 568,633 tons in 1999. The maintenance of Pak Phanang channel is important for the provincial socio-economic activities.

(3) Development of Port Facilities

In the study coastal channels, Harbour Department has an implementation plan for a 180 m berth extension of the international container terminal. According to the detailed design report for "Expansion of Songkhla Deep Sea Port," the projections of cargo and vessel traffic are described in the Table 9.2.1-4 below.

Table 9.2.1-4 Projection of Cargo and Vessels at Songkhla

	Actual	Forecast	
	2000	2005	2010
Container (TEU)	109,769	121,136	165,791
Cargo Volume (Tons)	1,185,424	1,609,841	1,944,873
Vessel traffic (number)	569	734	794

Source: Detailed Design Report for "Expansion of Songkhla Deep Sea Port" by HD

The implementation of the berth extension for the international trade, in the opinion of the Study team, will contribute to the national economy and should be included in the master plan.

Beside international trade, as domestic transportation develops, modal shift from land to coastal shipping will take place for the long distance routes. Such modal shift will contribute to the nation in the following aspects:

a) Save driving cost
b) Save petroleum of vehicles
c) Save vehicle repair
d) Reduce traffic congestion
e) Reduce traffic accidents
f) Reduce damage to perishable foods and general cargoes
g) Reduce CO_2 and NOx exhaust gas

OMPC in "Coastal Transport Development Study" selected 18 shipping routes for promoting coastal shipping. Among the 18 routes, four routes are related to Songkhla port. In the report, transport costs of these routes are compared with each other between land and sea. Consequently, based on the results of OMPC report and interviewing to the coastal shipping companies, the comparison of three routes (Songkhla - Bangkok, Songkhla-Laem Chabang, and Songkhla - Map Ta Phut) is summarized in Table 9.2.1-5. It shows that coastal shipping by general cargo

vessel will realize the lowest cost.

In view of the above discussion, the JICA Study Team will work out the layout of the port facilities at the Songkhla port to promote coastal shipping. The Team also suggests that the promotion will contribute to environmental improvement.

Table 9.2.1-5 Transport Costs of Sea and Land Transport in 3 Routes

(1) General Cargo Vessels and Truck				
	Land Distance (km)	Ship Distance (km)	General Cargo Vessel (Baht/ton)	Truck (Payload: 13 tons) (Baht/ton)
BKK-SKL	950	730	410	825
LCB-SKL	1,088	670	406	933
MTP-SKL	1,250	610	401	1,059
(2) Container Cargo Vessels and Truck				
	Land Distance (km)	Ship Distance (km)	Container Cargo Vessel (Baht/FEU)	Truck (B/Trip) (Payload: 26 tons) (Baht/ton)
BKK-SKL	950	730	21,634	21,178
LCB-SKL	1,088	670	20,627	23,938
MTP-SKL	1,250	610	19,619	27,178
(3) Ro/Ro Cargo Vessels and Trailer				
	Land Distance (km)	Ship Distance (km)	Ro/Ro Cargo Vessel (Baht/FEU)	Trailer (Baht/Trip)
BKK-SKL	950	730	24,639	21,178
LCB-SKL	1,088	670	22,793	23,938
MTP-SKL	1,250	610	20,947	27,178

Source: OMPC, Coastal Transport Development Study 2001, Coastal Shipping Companies in Thailand

Note: SKL: Songkhla, BKK: Bangkok, LCB: Laem Chabang, MTP: Map Ta Phut

9.2.2 Channel Dimensions of Master Plan

(1) Fishing Vessel Size in the Target Years

In the Study area, fishing vessels gradually decreased or leveled off between 1989-1998 (see Table 6.2-2 and Figure 6.2-1). The range of the vessel sizes showed no change from 1993 to 1998 (see Table 9.2.2-1). It seems that the fish catch from the fishing ground for the vessels at the study coastal area has reached the sustainable yield and the fish landing will not increase but remain at the same level.

Therefore, the target dimensions of the channels for the fish vessels are set at the present ones in the master plan.

(2) Cargo Vessels

Cargo vessels calling at the Songkhla port were recorded as 4,266 in 1999, while those calling at Pak Phanang were only about 550 in 1999. Even though oil tankers ranging from 500 to 1,500 GRT are calling, Pak Phanang bears no comparison with Songkhla.

Table 9.2.1 shows the dimension data of the calling vessels last 10 years at Songkhla. Based on actual range of vessel sizes, average draft and GRT of cargo vessels in future are computed by refraction method and shown in Figures 9.2.2-1 and 2.

Consequently, the depth of the Songkhla channel should be deepened to and maintained at -9.0 m below LLWL in the master plan.

9.2.3 Priority of Coastal Channels and Ports

Following the previous discussion in this report, 30 coastal channels under the management of CDC II are given the priority according to the following criteria:

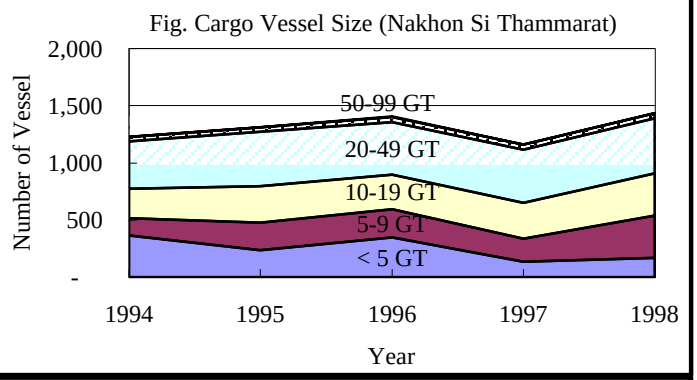
(1) Navigational channels relatively difficult to maintain (referring to the frequency of maintenance dredging recorded latest 12 years and latest three years)
(2) Large coastal changes (land erosion or sedimentation by sand drift) after construction of the training jetties
(3) Number and size of passing vessels
(4) Type of vessel (fishing or cargo vessels)
(5) Other important features if any

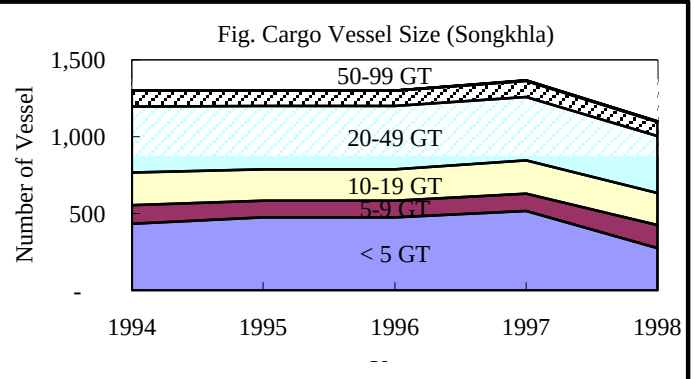
Consequently, the priority ranking of the coastal channels and ports is shown in Table 9.2.3-1.

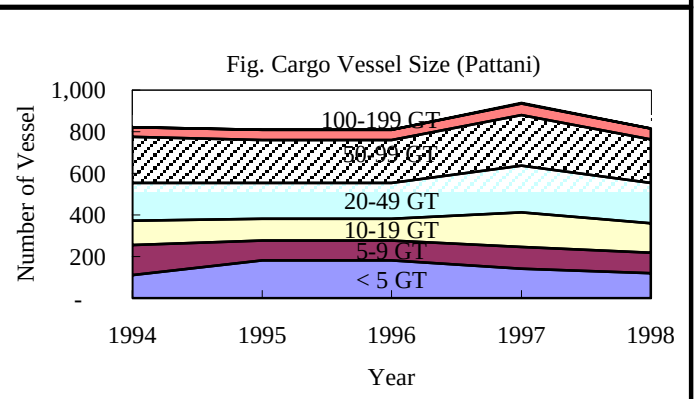
Table 9.2.2-1 Number of fishing boat registered by province 1994-1998

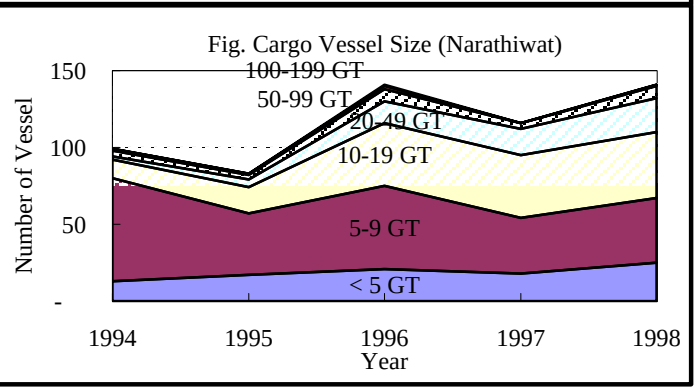
rovince yea	1994	1995	1996	1997	1998
Nakhon Si Thammarat					
< 5 GT	362	234	350	133	169
5-9 GT	151	241	242	204	368
10-19 GT	258	319	307	313	370
20-49 GT	419	480	459	467	485
50-99 GT	36	36	45	43	40
100-199 GT	-	-	1	1	1
200-499 GT	-	-	-	-	-
Total	1,226	1,310	1,404	1,161	1,433
Songkhla					
< 5 GT	432	476	476	516	277
5-9 GT	124	106	106	112	150
10-19 GT	211	207	207	217	208
20-49 GT	430	409	409	415	369
50-99 GT	102	100	100	103	93
100-199 GT	1	2	2	2	4
200-499 GT	-	1	1	1	1
Total	1,300	1,301	1,301	1,366	1,102
Pattani					
< 5 GT	111	183	183	141	121
5-9 GT	144	93	93	106	96
10-19 GT	116	107	107	164	142
20-49 GT	183	172	172	225	196
50-99 GT	220	206	206	243	209
100-199 GT	49	47	47	57	50
200-499 GT	-	-	-	1	-
> 500 GT	1	-	-	-	
Total	824	808	808	937	814
Narathiwat					
< 5 GT	13	17	21	18	25
5-9 GT	67	40	54	36	42
10-19 GT	12	17	41	41	43
20-49 GT	2	5	14	17	22
50-99 GT	4	3	8	4	8
100-199 GT	1	1	2	-	1
200-499 GT	-	-	1	-	-
Total	99	83	141	116	141

Figure : Cargo Vessel Size









Source : Thai fishing vessels statistics 1998, Department of Fisheries, Ministry of Agriculture and Cooperatives

Figure 9.2.2-1 Rough Forecast of Average Cargo Vessel Draft in Songkhla Channel

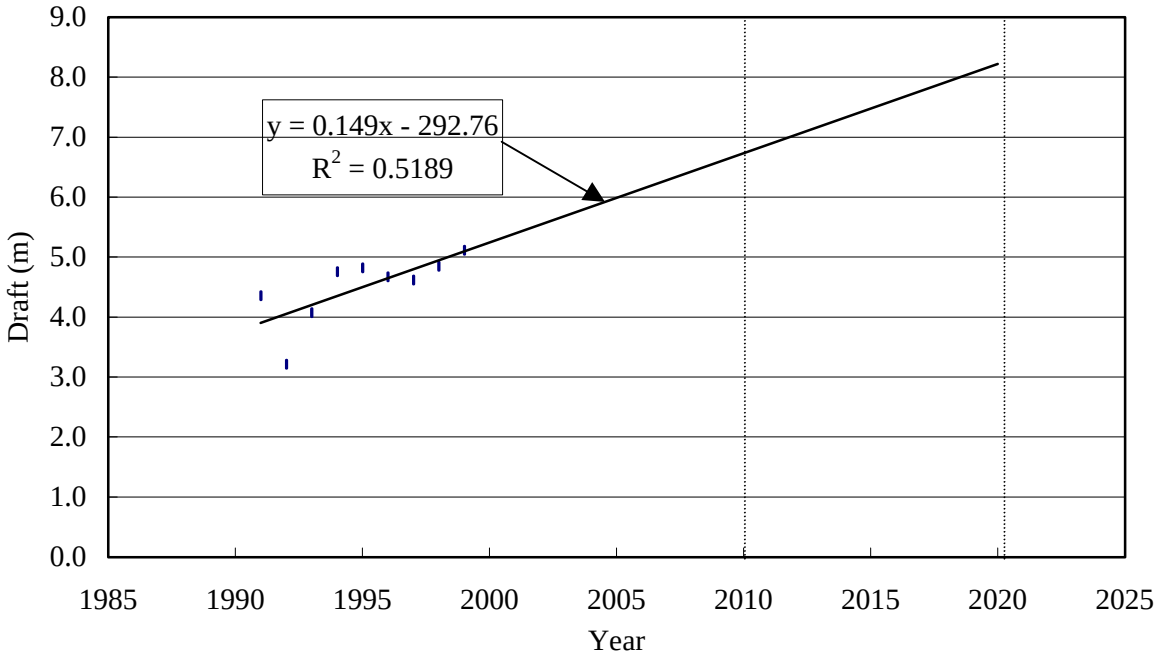


Figure 9.2.2-2 Rough Forecast of Average Cargo Vessel GRT in Songkhla Channel

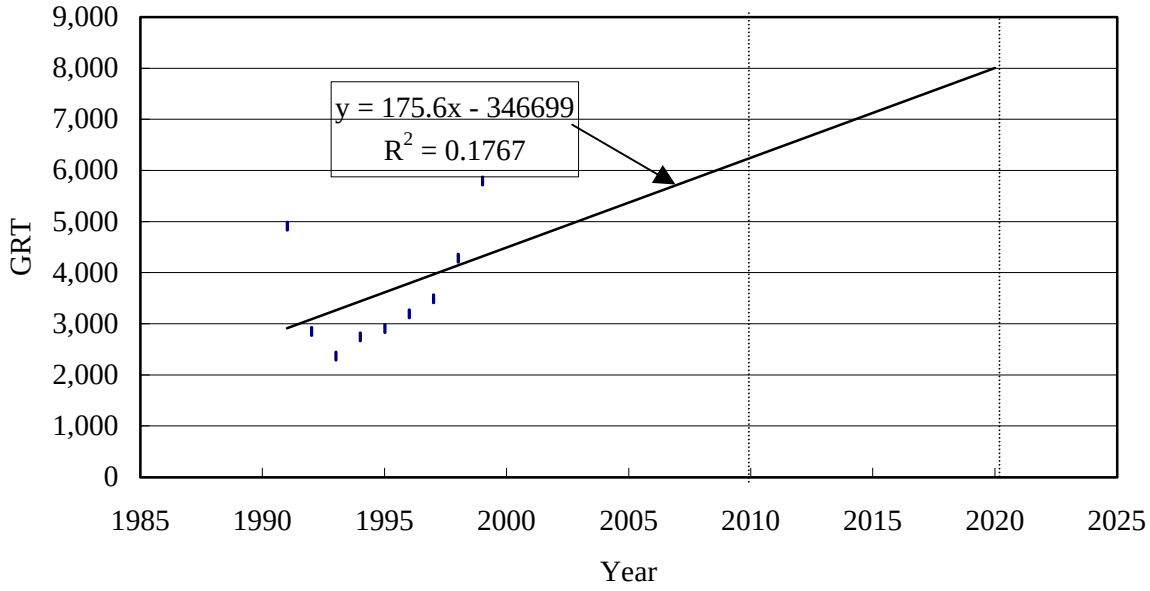


TABLE 9.2.3-1 Priority of Coastal Channels and Ports

No.	Channel	Priority Ranking	Dredging		Control Structure			Erosion around Jetties	Sand Drift Affection	No Control Structure Close River Mouth	Max. Draft of Vessel	Number of Fishing Vessel	Cargo Vessel Calling/yr	Type of Vessel and Utilization	Dredger	Dredging Depth (m)	Province
			Dredging times times/12 years	Dredging times times/3 years	F/S by HD	Completion Year of Construction	Control Structure										
1	**Songkhla (Harbour)**	A	12	3	2001(D/D)	1988	Jetty	Mid			9.0 m	1,462	4,266	Cargo Vessel, Fishing Boat	Cutter, Hopper	9	Songkhla
2	**Pak Phanang**	A	10	2							5.0 m	834	550	Fishing Boat, Cargo Vessel	Cutter, C25	4	Nakhon Si Thammarat
3	**Pattani**	B	13	3			Jetty				4.0 m	1,703	91	Fishing Boat	Cutter, Hopper	5	Pattani
4	**Khanom (Outer & Inner Channel Sector 1&2)**	B	6	2							5.0 m	215	100	Cargo Vessel (Mainly Power Station)	Cutter, Hopper	5, 4.5, 3	Nakhon Si Thammarat
5	**Sai Buri**	B	11	3	1989/2000	May 1993	Jetty	Big			4.0 m	244		Fishing Boat	Cutter, C1, Back-hoe	3	Pattani
6	**Sichon**	B	9	3	1992/2001	Feb. 1996	Jetty	Mid			3.0 m	1,327		Fishing Boat	Cutter	4	Nakhon Si Thammarat
7	**Khanom (Inner Channel Sector 3)**	B	3	2							3.0 m	215		Fishing Boat	Cutter	2	Nakhon Si Thammarat
8	**Narathiwat**	B	10	2	1992	Aug. 1996	Jetty	Mid			2.5 m	263		Fishing Boat	Cutter C37	4	Narathiwat
9	**Tha Sala**	C	11	2	1993	Mar. 1997	Jetty	Big			2.5 m	724	45	Fishing Boat, Cargo Vessel	Cutter	3	Nakhon Si Thammarat
10	**Pak Nakhon**	C	9	1							2.0 m	300		Fishing Boat	Cutter, C25	3	Nakhon Si Thammarat
11	**Na Thap**	C	8	2	1991	Jul. 1997	Jetty	Big			2.0 m	154		Fishing Boat, Shrimp Farm	Cutter, C1	2	Songkhla
12	**Sakom**	C	8	2	1994	Feb. 1998	Jetty	Big			1.5 m	155		Fishing Boat, Shrimp Farm	Cutter, C1	2	Songkhla
13	**Thepha**	C	7	1	1994	Sep. 1999	Jetty	Big			1.5 m	247		Fishing Boat, Shrimp Farm	Cutter, C1	2	Songkhla
14	**Panare**	C	8	2	1999	Jul. 2001	Jetty	Mid	Big		1.0 m	200		Fishing Boat	Cutter, C1	2	Pattani
15	**Bang Ra Pha**	C	1	0	1997		Jetty	Big	Big		1.2 m	110		Fishing Boat, Shrimp Farm	Cutter, C1	1.5	Pattani
16	**Tanyong Pao**	C	4	1	1997	Jul. 1999	Jetty	Mid	Big		1.0 m	70		Fishing Boat, Shrimp Farm	Back-hoe	1.5	Pattani
17	**Bang Ta Wa**	C	2	1				Big			1.2 m	180		Fishing Boat, Shrimp Farm	Cutter, C1	2	Pattani
18	**Bang Maruat**	C	5	2	1999	Jul. 2001	Jetty				1.0 m	230		Fishing Boat, Shrimp Farm	Cutter, Back-hoe	2	Pattani
19	**Tak Bai**	C	4	0	F/S by Irrigation Dept		Jetty				2.5 m	272		Fishing Boat	Cutter, C25	3	Narathiwat
20	**Laem Ta Chi (Pattani Outer Channel)**	C	2	0	1994	Feb. 1996	Jetty				4.0 m	700	91	Fishing Boat	Hopper	5	Pattani
21	**Pak Paya**	D	3	0							1.0 m	250		Fishing Boat	Cutter, C25	2	Nakhon Si Thammarat
22	**Pak Phun**	D	3	1							1.0 m	150		Fishing Boat	Cutter, C25	2	Nakhon Si Thammarat
23	**Pak Phaying**	D	1	0							1.0 m	150		Fishing Boat	Cutter, C25	2	Nakhon Si Thammarat
24	**Pak Duat**	D	2	0	2001					○	1.0 m	100		Fishing Boat	Back-hoe	2	Nakhon Si Thammarat
25	**Tha Mak**	D	2	0						○	0.5 m	50		Fishing Boat	Back-hoe	2	Nakhon Si Thammarat
26	**Khlong Tung Ca**	D	2	0						○	0.5 m	50		Fishing Boat	Back-hoe	2	Nakhon Si Thammarat
27	**Khlong Tu Yong**	D	0	0						○	0.5 m	50		Fishing Boat, Shrimp Farm	Back-hoe	1.5	Pattani
28	**Ban Sai Samo**	D	1	1						○	1.2 m	20		Fishing Boat, Shrimp Farm	Back-hoe	1.5	Pattani
29	**Ru Sa Mi Lae**	D	1	1						○	0.5 m	50		Fishing Boat, Irrigation	Back-hoe	1.5	Pattani
30	**Ta Lo Lae Weng**	D	3	3						○	0.5 m	50		Fishing Boat	Back-hoe	1.5	Pattani

Source: CDCII, Fishery Department in Study Coastal Provinces, HD and JICA Study Team estimate

Note: Ranking A: Important for the national and provincial socio-economic development
Ranking B: Important mainly for provincial socio-economic development
Ranking C: Important mainly for local socio-economic improvement
Ranking D: Important mainly for living standard and improvement

9.3 Master Plan of Each Port and Channel

9.3.1 Short-term Development Plan (year 2001-2010)

(1) Dredging of Channels

Songkhla

As discussed in Chapter 7, the dredging operation of Songkhla is to be carried out as follows:

Main Channel	Initial Stage	To achieve a -8 m channel depth and -9 m depth in front of the wharf. This will allow for unloading at the wharf even during low tide, and 10,000 DWT vessels can enter the channel during high tide.
	Second stage	To deepen to –9 m so that even during low tide, vessels can enter the channel.
In front of wharf	First Method	The Backhoe should be used to a depth of –8 m.
	Second Method	Then the work should be switched to Cutter since it can perform accurate depth control. It is even possible to consider using only Cutter Suction Dredge for the entire work

Pak Phanang

For the initial dredging of Pak Phanang channel, C-25 and C-37 cutter dredgers should simultaneously work a half year to deepen the channel up to –5m. Once the channel is deepened, maintenance dredging will be needed every year. Because of the slow advancing speed of the cutter suction dredgers along the channel, both C-25 and C-37 are to be simultaneously employed for the maintenance dredging for about five months every year.

(2) Channels Development

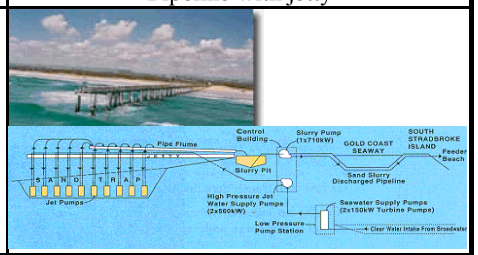
There are three alternatives to maintain the navigational channels. As shown in Table 9.3.1-2, they are dredging at the channel entrance, extension of jetties and sand bypassing. Among them, dredging at the channel entrance by a suction dredger is prohibitively difficult because of rolling and pitching by sea swells. Extension of the jetties should be discarded because it will only cause more serious coastal erosion. Thus, the sand bypass is only method technically recommendable.

Among the alternative methods of sand bypassing, work by trucks is considered more economical than by pipeline or by barges. The rough estimate is shown in Table 9.3.1-3 for reference.

Table 9.3.1-2 Comparison of for Prevention Method for Coastal Changes after Training Jetty Construction

Comparison Items \ Method		Extension of Training Jetties and Headlands	Sand Bypass (pipeline and back-hoe system)	Dredging
Visual Example				
Financial View	Construction	Construction of extension jetty Additional detached breakwater, etc.	- Back-hoe: rental or purchase - Installation of discharged pipeline	- Dredger: rental or purchase - Dredger fleet mobilization
	Total Cost	Costly	Fair	Costly
Workable Weather Conditions		-	-	No rough sea condition (Nov.-Mar. not workable)
Others		Additional jetties and detached breakwater will continuously be required.	Sand bypass system is a permanent solution to sand erosion and littoral drift problems affecting river mouths and navigation channels	Outside of training jetty area, it is difficult to dredge because of rough waves and swells.
Total Evaluation		Fair	Good	Fair

Table 9.3.1-3 Comparison of Sand Bypass System

Sand Bypass Method / Comparison Items		Barge	Dump truck	Pipeline with back-hoe	Pipeline with jetty
					
Basic System and Main Equipment		Sand excavation, transport and dumping works can be operated by grab dredger and barge.	Main equipment of system as follows. -Sand excavation: Back-hoe -Sand transport: Dump truck -Sand grading: Bulldozer	Main equipment of system as follows. -Excavation pit and installation of pump: Back-hoe -Sand transport: Sand pump and pipe line	Main facilities as follows. -Pump system: Jet pumps, High pressure jet water supply pumps, Seawater supply pumps and Slurry pump -Sand transport: Pipe flume, Sand slurry discharged pipe line -Other support facilities: Jet Pump Jetty, Slurry pit, Control building, Low pressure Pump Station
Financial View	Initial	- Grub dredger: rental or purchase - Dredger fleet mobilization	-Earthwork equipment: rental or purchase -Truck road for sand transport	- Back-hoe: rental or purchase - Installation of discharged pipe line	- Purchase above all equipment and facilities
	Construction	Dredging crew, fuel, etc.	Operator, fuel, etc.	Operator, fuel, utility etc.	Operator, fuel, utility etc.
	Maintenance	Dredger	Truck road and equipment	Equipment	Operator, fuel, equipment, etc.
	Sand Transport Unit Rate	approx. 100 Baht/m3	approx. 60 Baht/m3	approx. 65 Baht/m3	approx. 140 Baht/m3
	Total Cost	Costly	Fair	Fair	Very costly
Interruption of Navigation Channel		-	-	Pipe line installation & removal	Pipe line installation & removal
Construction Workable Weather Condition		No rough sea condition (Nov.-Mar. not workable)	-	-	-
Others		Difficult to dump to erosion area directly	-	-	-
Total Evaluation		Fair	Good	Good	Fair

As discussed in Chapter 8 of this report, detached breakwaters, groin and existing jetty improvements should be provided as shore protection works in the short-term plan. They should be built at Tha Sala, Songkhla, Na Thap, Sakom, Thepa, Bang Rapa, Tanyong Pao, Bang Ta Wa, Panare, Bang Maruat, Sai Buri and Narathiwat. As a long-term protection measure, sand should be transported to the eroded area by a sand bypassing system. (See Figure 9.3.1- 1)

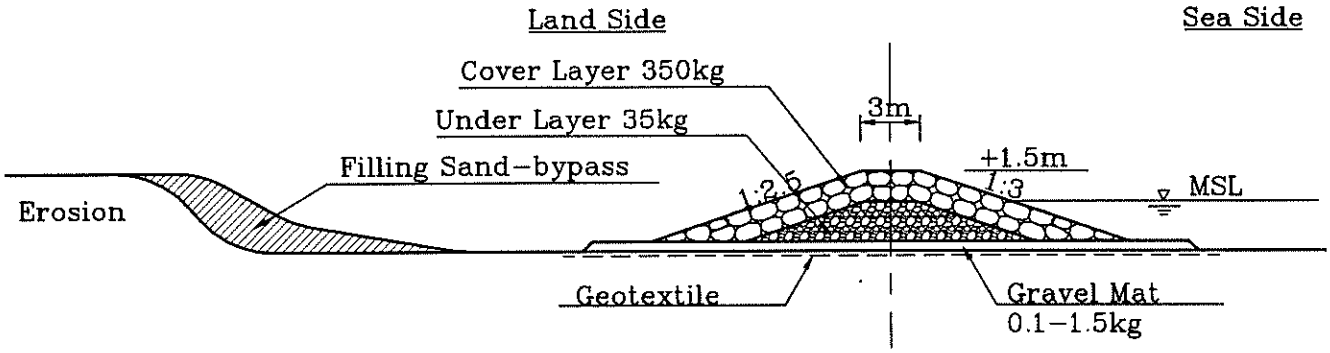


Figure 9.3.1-1 Typical Section of Detached Breakwater

As also discussed in Chapter 8, ten channels should be provided with shore protection works like detached breakwaters. At Panare, Bang Ra Pa and Tanyong Pao channels, the sand bypass system and erosion prevention structures can be applied. Their construction quantities are roughly estimated below:

Channel	Detached Breakwater	Groin(T-type)	Groin	Improvement	Sand Bypassing
①Tha Sala	-	10 Units	-	11 Units	-
②Songkhla	5 Units	-	6 Units	-	-
③Na Thap	2 Units	-	-	4 Units	-
④Sakom	5 Units	-	-	3 Units	-
⑤Thepha	5 Units	-	-	2 Units	-
⑥Bang Rapa	4 Units	-	-	-	50,000m^3/year
⑦Tanyong Pao	8 Units	-	-	-	50,000m^3/year
⑧Bang Ta Wa	3 Units	1 Units	-	8 Units	-
⑨Panare	2 Units	-	-	4 Units	50,000m^3/year
⑩Bang Maruat	2 Units	-	-	3 Units	-
⑪Sai Buri	-	-	-	-	-
⑫Narathiwat	-	1 Units	-	2 Units	-

Sichon channel with a single jetty requires one more jetty for preventing the intrusion of waves to the fishing village. In 1999, the wave intrusion damaged the village. This is considered due to the single jetty that might have rather augmented the intruding waves. Also at Sichon in 2000, fishing vessels ran aground several times. In order to prevent natural disasters and to promote safety navigation, one more jetty should be provided for the Sichon channel. At present, the feasibility study by HD is in progress.

HD is also conducting the feasibility study on Pak Duat channel. Provision of new training jetties is discussed in this Study. In view of a long-term economy, however, the construction of the training jetties should be carefully reviewed because they will cause coastal erosion and there are only small fishing vessels at Pak Duat. The navigational channel for the small fishing vessels can be easily opened and maintained by crossing the sand beach by a backhoe in an economical manner as is currently being done.

(3) Ports Development

(a) Songkhla Port (See Figure 9.3.1-2)

i) Expansion of Container Cargo Berth

According to the "Expansion of Songkhla Deep Sea Port" being prepared by HD, the first stage development of the port is targeted from 2000 to 2010. Main facilities of the project are as follows.

- Container berth (Berth Length: 180m)
- Training Jetty (Length: 450m)
- Container Yard
- CFS and Administration Office
- Substation, Canteen, Workshop
- Cargo handling equipment

ii) Expansion of Coastal and Ro/Ro Cargo Berth

Based on the cargo forecast in 2010, the required capacity of cargo handling is estimated to be 350,000 tons/year. Meanwhile, the actual cargo handling volume of Songkhla port in 2000 was recorded to be approx. 400,000 tons/berth/year. The average size of vessels was 5,000 DWT. The layout of the coastal cargo berth, therefore, is to be made with both 350,000 tons/berth/year of cargo handling volume and 5,000 DWT calling vessels into consideration.

The dimensions of the coastal cargo vessels of 5,000 DWT are as shown below:

Cargo Vessel	Overall Length	Moulded Breadth	Full Load Draft
5,000 DWT	109m	16.8m	6.5m

Source: Technical Standards Ports and Harbour Facilities in Japan

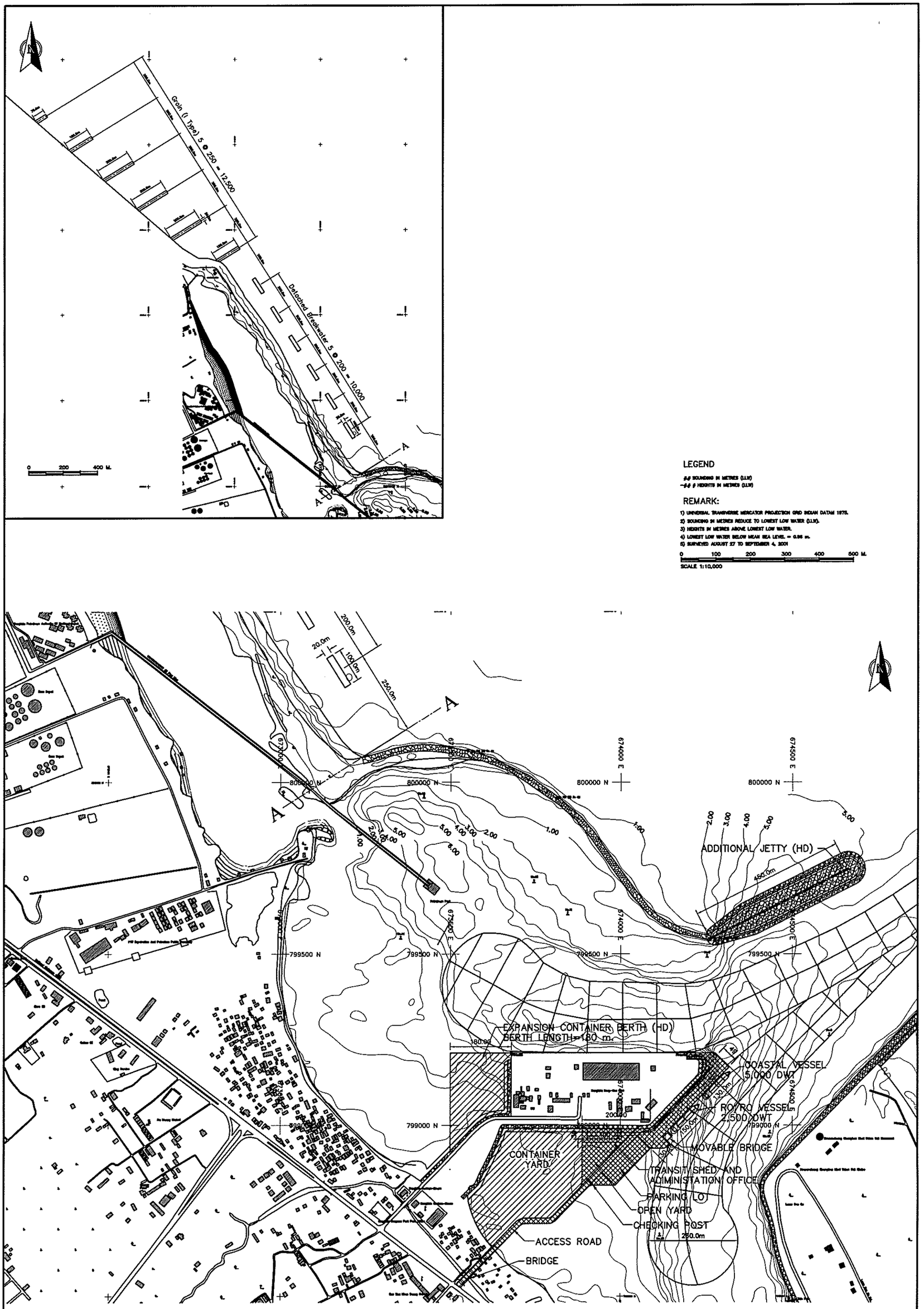


Figure 9.3.1-2 SHORT TERM DEVELOPMENT PLAN OF SONGKHLA PORT (YEAR 2010)

Consequently, the required berth dimensions for the coastal berth are as shown below:

5,000 DWT Cargo Vessel	Berth Length = 130m	Berth Depth =-7.5m

Source: Technical Standards Ports and Harbour Facilities in Japan

In the addition, subsidiary facilities of coastal cargo berth are as follows.

- Transit shed and Administration office
- Access Road and Checking Post
- Parking lot
- Cargo handling equipment
- Utility System

iii) Ro/Ro Berth

Based on the cargo forecast of year 2010, the required capacity of cargo handling is estimated to be 150,000 tons/year. In this Study, the cargo handling capacity of 150,000 ton/berth/year serviced by a 2,500 DWT standard Ro/Ro vessel is taken into account to the layout of Ro/Ro cargo berth.

The dimensions of a 2,500 DWT Ro/Ro vessel are estimated as shown below:

Ro/Ro Vessel	Overall Length	Moulded Breadth	Full Load Draft	Voyage Speed	Vehicle Numbers
2,500 DWT	115m	18.5m	5.5m	15 knot	Truck:50
Estimation (Route Songkla-Laem Chabang) 670km/1.852km/hour*15 knot=24 hour, 3 day round trip 50 trucks*10ton*80% loading *2 ships/1.5 day =533ton/day 533ton/day*300day/year=159,900ton/year					

Source: Technical Standards Ports and Harbour Facilities in Japan, Estimation by JICA Team

The required berth dimensions for a 2,500 DWT Ro/Ro vessel are as shown below:

2,500 DWT Ro/Ro Vessel	Berth Length = 150m	Berth Depth =-6.5m

Source: Technical Standards Ports and Harbour Facilities in Japan

Subsidiary facilities of the Ro/Ro berth are as follows:

- Management Office
- Access Road and Checking Post
- Parking lot
- Utility System