Chapter 4 Natural Conditions in Study Area

4. Natural Conditions in Study Area

This chapter presents an outline of the natural conditions in the Study area which is located in the east coast of the southern region on the Gulf of Thailand.

4.1 General Conditions

4.1.1 Geography, Topography and Geology

The study area is located between Latitude 6 ° 15 ′ N – 9 ° 20 ′ N and Longitude 99 ° 50 ′ E – 102 ° 05 ′ E along the east coast of the north part of the Peninsula between the Andaman Sea on the western side and the Gulf of Thailand on the eastern side (see Figure 4.1.1-1).

In this area, there are several linear uplands lie in a north-south direction. The long ridge of western mountains about 10 to 20 km wide and approximately 300 km long extends from Ko Samui to Satun forming Khao Luang in altitude of 1,835 m, the highest mountain in the Peninsula, in Nakhon Si Thammarat province and consists of granite, granodiorite and diorite during Triassic to Cretaceous period of Mesozoic era. This mountain separates this part into two regions: the east coast and the west coast of the southern Thailand.

Other uplands extend generally southward from Ban Pak Bang Sakom of Songkhla province, Ban Khae Khae of Pattani province and Narathiwat (Thaksin Ratchaniwet Royal Palace) of Narathiwat province.

Among these topographical uplands, lowlands are formed and alluvial plains of Quaternary period are widespread in Pak Phanang, Songkhla and Pattani areas.

The Study area includes four Provinces (Changwat) of Nakhon Si Thammarat, Songkhla, Pattani and Narathiwat from the north and each province is composed of several Districts (Amphoe).

The total length of the coastal line attains approximately 550 km and the length in each province is as follows:

Nakhon Si Thammarat Province :	225.0 km
Songkhla Province :	154.6 km
Pattani Province :	116.4 km
Narathiwat Province :	59.0 km

(Source : Statistical Yearbook Thailand)

4.1.2 Oceanography

The Peninsula is surrounded by Sunda shelf sea and the maximum water depth of the Gulf of Thailand facing the study area is less than 80 m.

The current in the coastal zone of the study area is along the shoreline and the general direction of currents is northwestward on flood tide and southeastward on ebb tide. However, the current pattern in this area is strongly effected by the seasonal change of winds, especially the northeast monsoon waves driven by strong east winds during November to mid-March.

In the study area, the shoreline is composed of sands except Pak Phanang Bay, Songkhla Lake Entrance and Pattani Bay and the predominant direction of littoral transport caused by longshore currents is northwestward. The sources of littoral drift are said to be primarily from the Kelantan River near the border of Thailand and Malaysia.

4.1.3 Coastal Area

The coastal areas of the study area will be largely divided into three regions (north, middle and south regions) based on the topography. They are the northern part of Nakhon Si Thammarat province from Khanom to Pak Phanang, Laem Talumphuk of Nakhon Si Thammarat province to Pattani, and Laem Ta Chi of Pattani province to Tak Bai of the southern extreme end of the Study area.

Figure 4.1.1-1 Map of Study Area

1) North Region

The coastal areas of the north region will be subdivided into three areas: the northern area of Sichon, Sichon to Pak Phun area and Pak Phanang bay.

The coast of the northern area of Sichon is characterized by rocky capes and small beaches among the capes. Khanom channel using the river-mouth of Khlong Ban Tha Chan is situated between capes and Sichon channel is in the north of Laem Khao Kho Kwang.

The coast of Sichon to Pak Phun area is characterized by a long sand beach with a length of about 45 km. In this area, there are channels for small fishing boats at Khlong Tung Ca (Thepha), Tha Mak, Pak Duat and Bang San using river-mouths of small rivers, and Tha Sala channel.

Pak Phanang Bay is characterized by mangrove in the coastal zone and mud of seabed materials. Pak Nakhon and Pak Phanang channels for fishing boats in this area are located at river-mouths of Khlong Pak Nakhon and Mae Nam Pak Phahang, respectively.

2) Middle Region

The coastal areas of the middle region will be subdivided into five areas: Laem Talumphuk to Songkhla area, Songkhla port area, Songkhla to Khao Khieo/Khao Lon area, Khao Khieo/Khao Lon to Pattani area and Pattani Bay.

The coast of Laem Talumphuk to Songkhla area is characterized by a long sand beach with a length of about 160 kilometers in the direction of NNW – SSE.

Songkhla port area is a changing point of the curvilinear coastline. Songkhla Lake is open to the sea at this point, and Ko Maeo and Ko Nu are near the entrance of the port.

The coast of Songkhla to Khao Khieo/Khao Lon area is a sandy beach with a length of about 43 km in the direction of NW – SE. Bang Na Thap and Sakom channels in this area are located at river-mouths of Khlong Na Thap and Khlong Thepha, respectively.

Khao Khieo/Khao Lon to Pattani area is also composed of sandy beach and partly swamp. The shore line of this area runs in a direction of east to west.

The seabed materials in Pattani Bay is mud and Pattani channel is located at a river-mouth of Mae Nam Pattani. Mangrove grows along the shore of the interior part of the bay.

3) South Region

The coastal areas of the south region from Laem Ta Chi to Tak Bai will be subdivided into three areas: Laem Ta Chi to Khae Khae area, Khae Khae to Khao Tanyong area and Khao Tanyong to Tak Bai area.

The coast of Laem Ta Chi to Khae Khae area is also a sandy beach in a direction of WNW – ESE. Newly constructed Panare and Bang Maruat channels are located at the eastern part of this area.

The coast of Khae Khae to Khao Tanyong area is characterized by sandy beach with a distance of about 60 km in a direction of NNW – SSE. Sai Buri and Narathiwat channels in this area are located at river-mouths of Mae Nam Sai Buri and Mae Nam Bang Nara, respectively.

Khao Tanyong to Tak Bai area is also composed of sandy beach. The shore line of this area runs in a direction of NW to SE.

4.2 Meteorological Conditions

4.2.1 General Climate

The climate of Thailand is under influence of seasonal monsoon winds. The climate may be divided into three seasons: southwest monsoon season from mid-May to mid-October, northeast monsoon season from mid-October to mid-February and pre-monsoon season from mid-February to mid-May.

The southwest monsoon from the Indian Ocean prevails over Thailand and abundant rain occurs over nearly the whole country. The exception is found in the east coast of Southern Thailand where abundant rain remains until the end of the year which is the beginning period of the northeast monsoon.

The northeast monsoon is the mild period of the year with quite cold in December and January in upper Thailand, but there is a great amount of rainfall in the east coast of Southern Thailand.

The pre-monsoon season is the transitional period from the northeast to southwest monsoons. The weather becomes warmer, especially in upper Thailand and April is the hottest month in a year.

4.2.2 Climate in Normal Year

Figure 4.2.2-1 shows the location of existing meteorological stations in the southern Thailand. Among these stations, the following six stations were chosen as representative ones in the Study area.

1. Ko Samui (Station No. 48550) : 09 ° 28 ′ N, 100 ° 03 ′ E
2. Nakhon Si Thammarat (Station No. 48552) : 08 ° 28 ′ N, 99 ° 58 ′ E
3. Songkhla (Station No. 48568) : 07 ° 12 ′ N, 100 ° 36 ′ E
4. Pattani Airport (Station No. 48580): 06 ° 47 ′ N, 101 ° 09 ′ E
5. Narathiwat (Station No. 48583) : 06 ° 25 ′ N, 101 ° 49 ′ E
6. UNOCAL : 09 ° 17 ′ N, 101 ° 25 ′ E

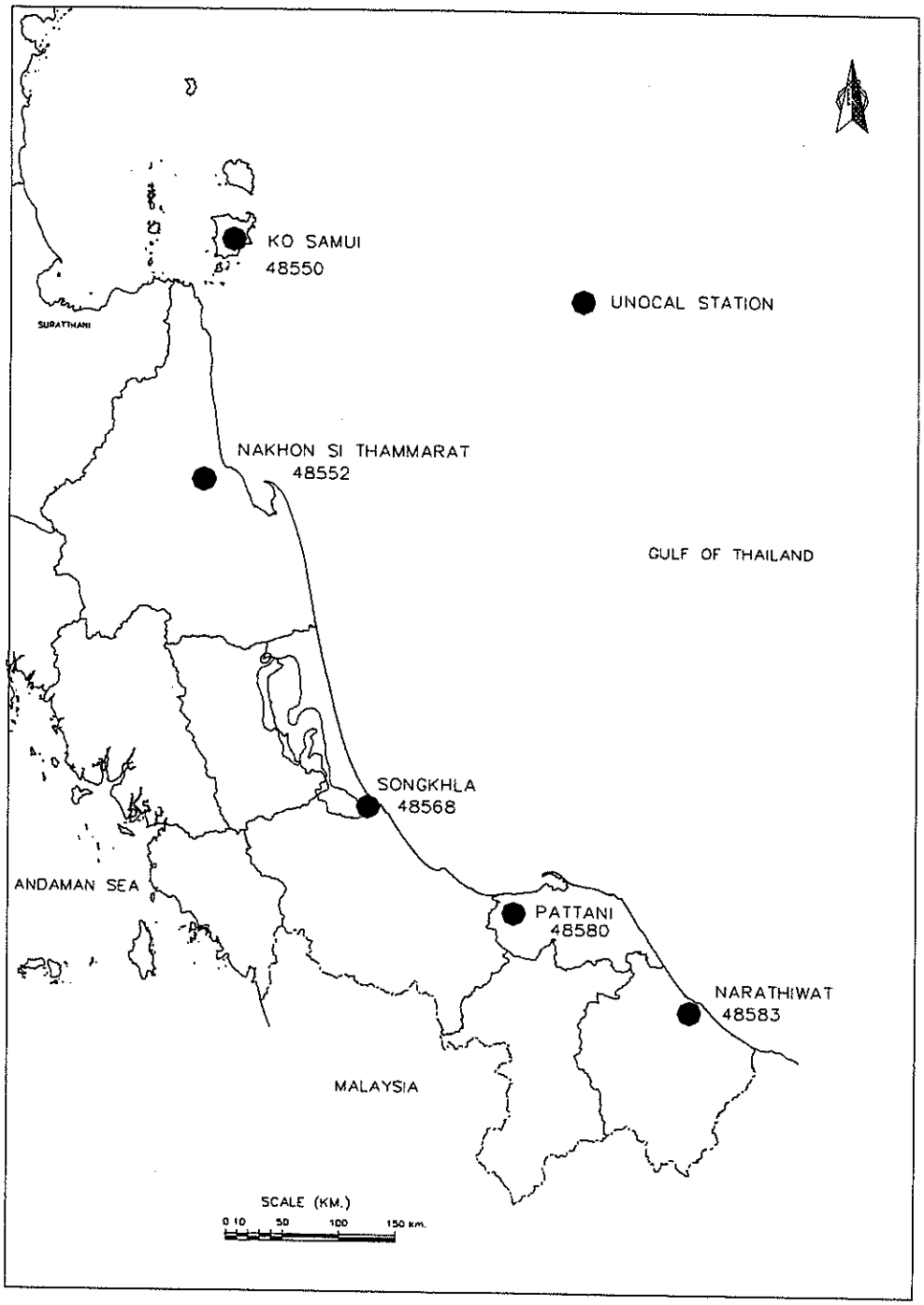


Figure 4.2.2-1 Location Map of Meteorological Stations

1) Temperature

The temperature in the southern part of Thailand is generally mild throughout the year because of the maritime characteristic of this region. The diurnal and seasonal variations of temperature are significantly less than those in other regions of Thailand.

In this region, March to June is the hottest period of the year and the maximum temperature usually reaches near 40℃ (see Figure 4.2.2-2).

2) Relative Humidity

The relative humidity in this region is relatively higher in most periods of the year because of the maritime characteristics (see Figure 4.2.2-2).

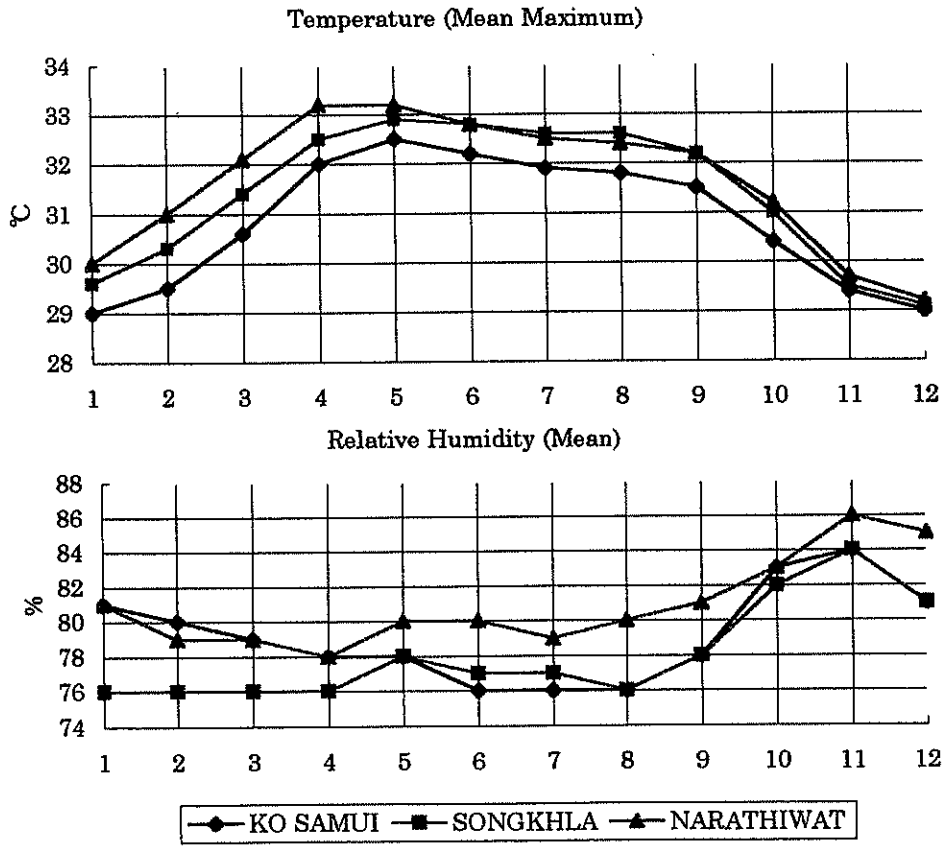


Figure 4.2.2-2 Monthly Variation of Temperature and Relative Humidity

Source: Climatology Division, Meteorological Department

3) Rainfall

The rainy season in this region (the east coast of the Gulf of Thailand) is September to January by the northeast monsoon. The peak of rainfall is in November and reaches more than 600 mm (see Figure 4.2.2-3).

According to a general annual rainfall pattern, this region receives 1,700 – 2,500 mm a year and the amount of rainfall becomes gradually larger to the south.

4) Wind

The pattern of surface wind directions is characterized by the monsoon system. During the northeast monsoon season, wind direction over the southern Thailand is northeast to east. On the other hand, the prevailing wind direction is southwest to west during the southwest monsoon season (see Figure 4.2.2-4).

Wind speed of the northeast monsoon season in this region is stronger than that of the southwest monsoon season.

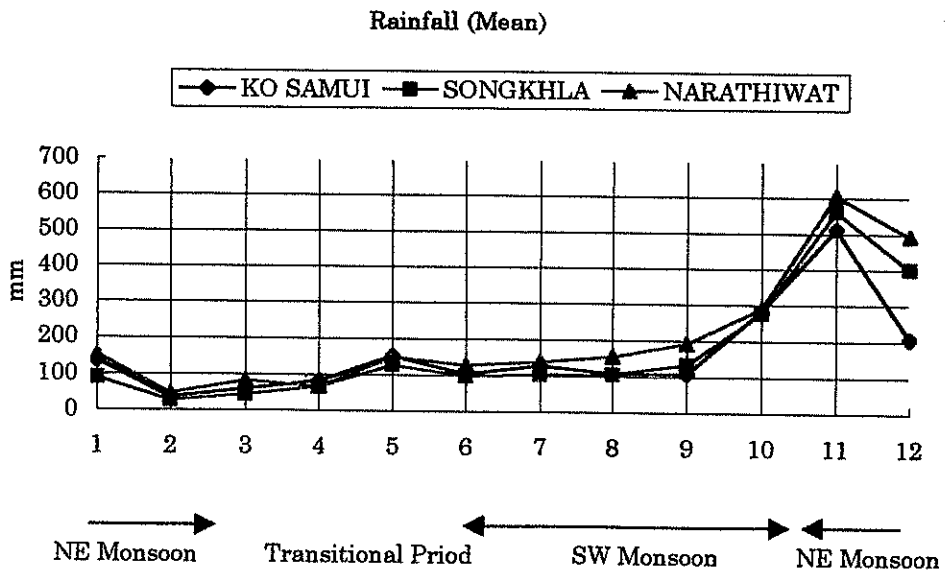
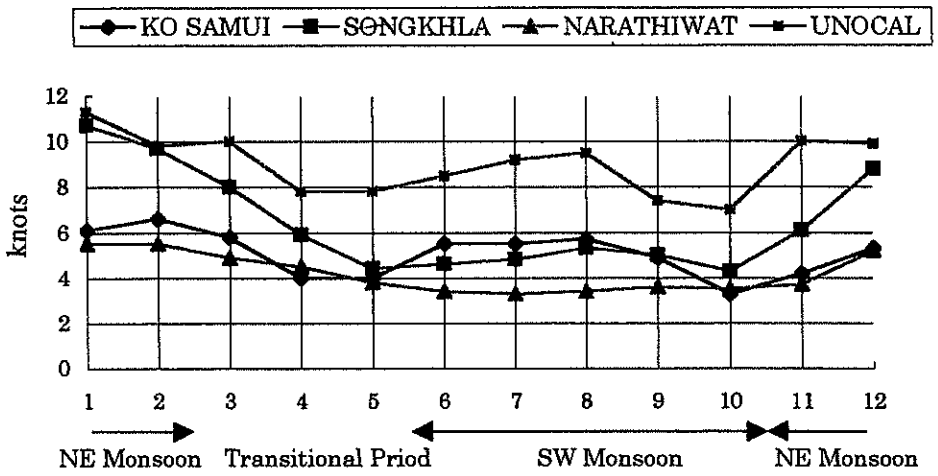


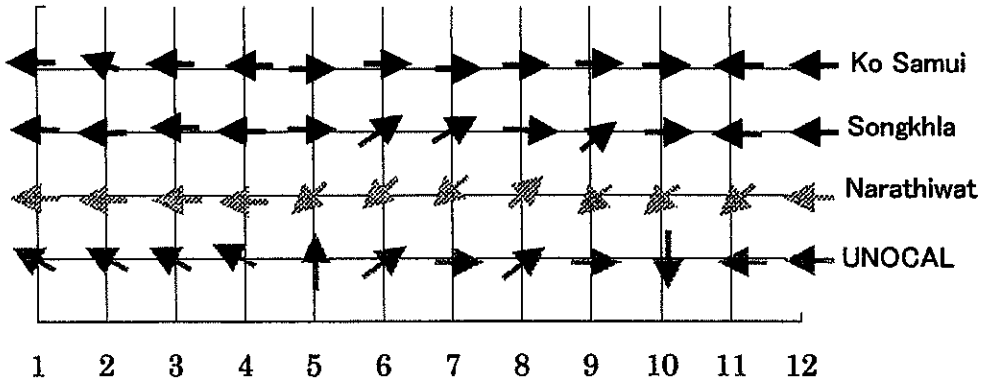
Figure 4.2.2-3 Monthly Variation of Precipitation

Source: Climatology Division, Meteorological Department

Wind Speed (Mean Wind Speed)



Prevailing Wind Direction



(Note)

: East Wind
: North Wind
: West Wind
: South Wind

Figure 4.2.2-4 Monthly Variation of Wind Speed and Wind Direction

Source: Climatology Division, Meteorological Department

4.2.3 Climate in Recent Years

Songkhla station was chosen as a representative for this region.

1) Rainfall

Figure 4.2.3-1 shows the annual variation of precipitation over these 10 years at Songkhla. The maximum precipitation reached 2,969 mm in 1999 and the maximum monthly rainfall was recorded in November to December.

Days of rainfall reached more than 20 days a month in the northeast monsoon season and was the least in February or March in this region.

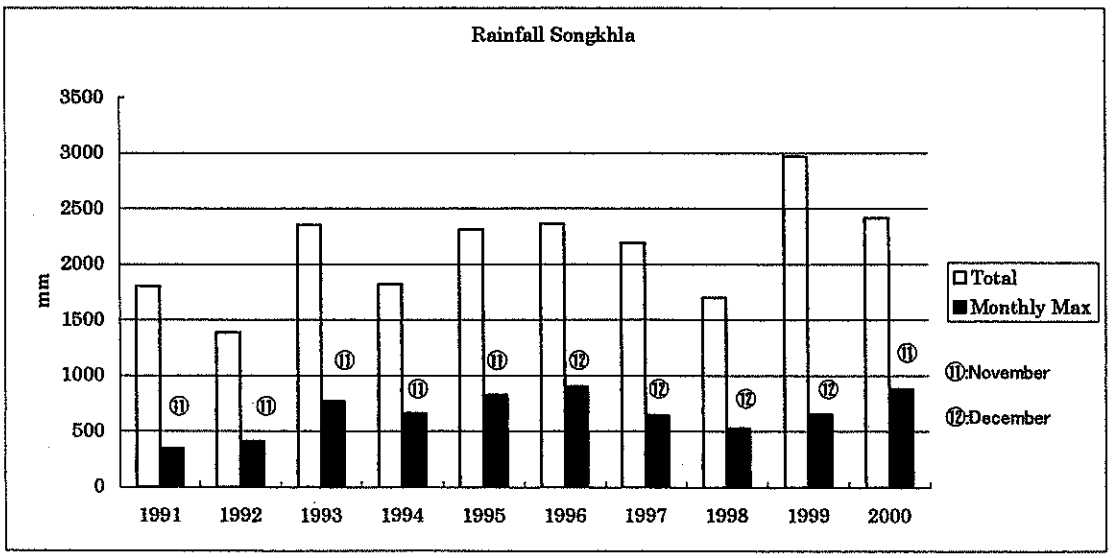


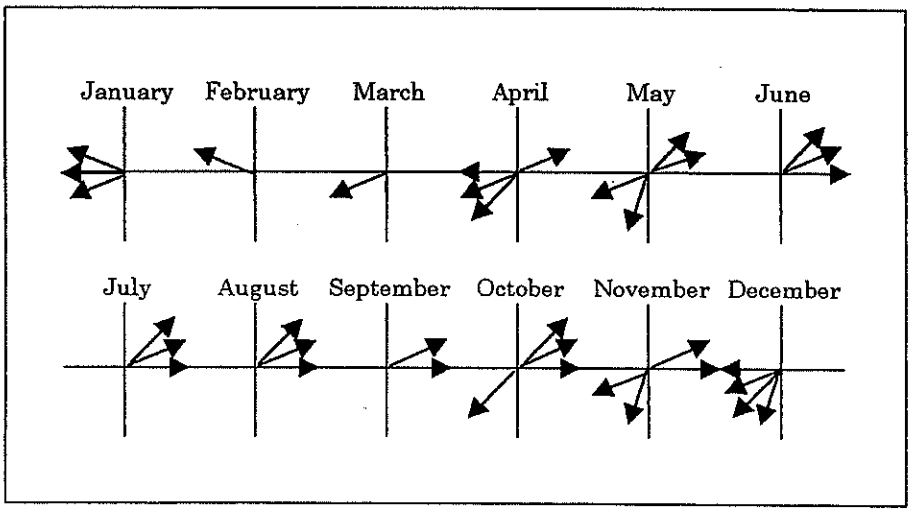
Figure 4.2.3-1 Annual Variation of Precipitation at Songkhla

Source: Climatology Division, Meteorological Department

2) Wind

Figure 4.2.3-2 shows prevailing wind directions in each month during these 10 years at Songkhla.

This figure clearly shows that wind directions in December to March are predominant from the eastern direction and those in June to September are predominant from the western direction. Two seasons of April to May and October to November are transitional seasons.



(Note)

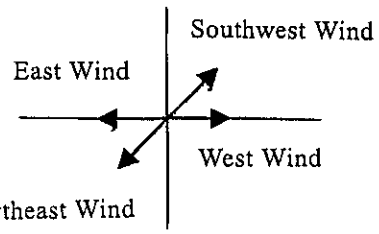


Figure 4.2.3-2 Annual Variation of Wind Direction at Songkhla

Source: Climatology Division, Meteorological Department

4.2.4 Meteorological Conditions during Site Survey

Figure 4.2.4-1 shows wind rose during the site survey at Songkhla from February to April 2001.

These wind roses show that prevailing wind directions during site survey were northeast to east. The maximum wind speed was recorded 14 knots at 18:50 on 14th February.

Comparatively rough sea during the site survey took place on the following days;

February : 1st to 10th, 14th to 20th, 26th to 28th
March : 6th to 15th, 20th to 25th, 29th to 30th
April : 1st to 4th

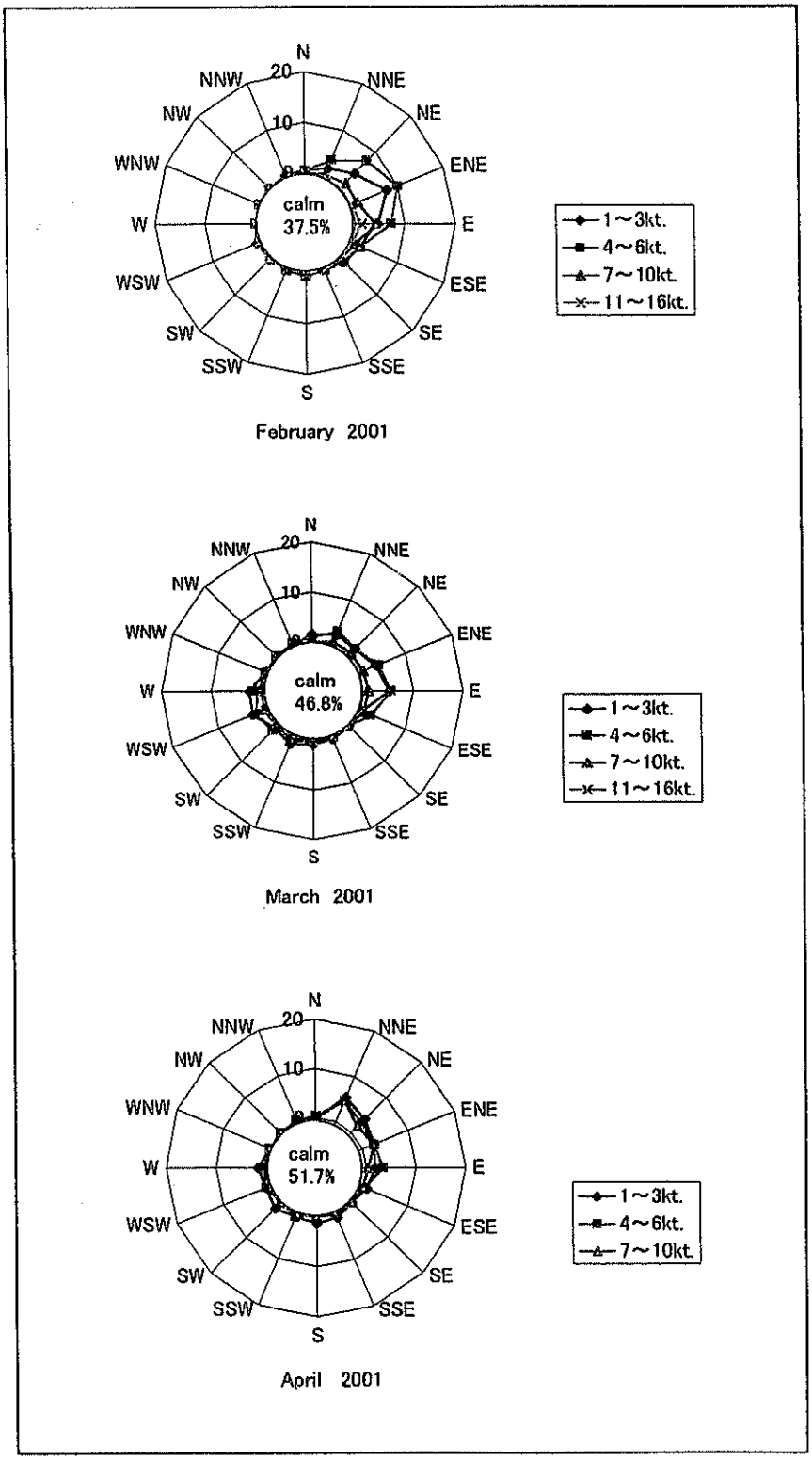


Figure 4.2.4-1 Wind Rose at Songkhla from February to April 2001

4.3 Hydrological Conditions

4.3.1 Hydrological Stations

Figure 4.3.1-1 shows the location of existing hydrological observation stations in the southern Thailand. The following five river basins are located in the study area:

1. Peninsula East Coast 2 (Basin No. 21)
2. Thale Sap Songkhla (Basin No. 23) : 7,568 km^2
3. Peninsula East Coast 3 (Basin No. 21)
4. Mae Nam Pattani (Basin No. 24) : 3,964 km^2
5. Peninsula East Coast 4 (Basin No. 21)

(Note) Area of Basin No.21 (Peninsula East Coast 1 – 4) : 27,358 km^2

4.3.2 Monthly Amount of River-Flow

Main hydrological stations are shown in Table 4.3.2-1.

The monthly average amount of river-flow in typical rivers big to small in the study area is shown in Table 4.3.2-2.

The amount of river-flow at Station No. X.40A, having 3,302 km^2 in basin area, of Mae Nam Pattani chosen as a big river reaches 4,617.9 x 10^6 m^3, 2,753.2 x 10^6 m^3 and 1,128.2 x 10^6 m^3 in maximum, mean and minimum amounts, respectively.

In the case of small rivers, the amount of river-flow at Station No. X.168, having 315 km^2 in basin area, of Khlong Thepha reaches 303.55 x 10^6 m^3, 183.55 x 10^6 m^3 and 57.61 x 10^6 m^3 in maximum, mean and minimum amounts, respectively.

With regard to monthly variation, the amount is larger during October to January, especially in November and December at every station, reflecting the seasonal change of rainfall.

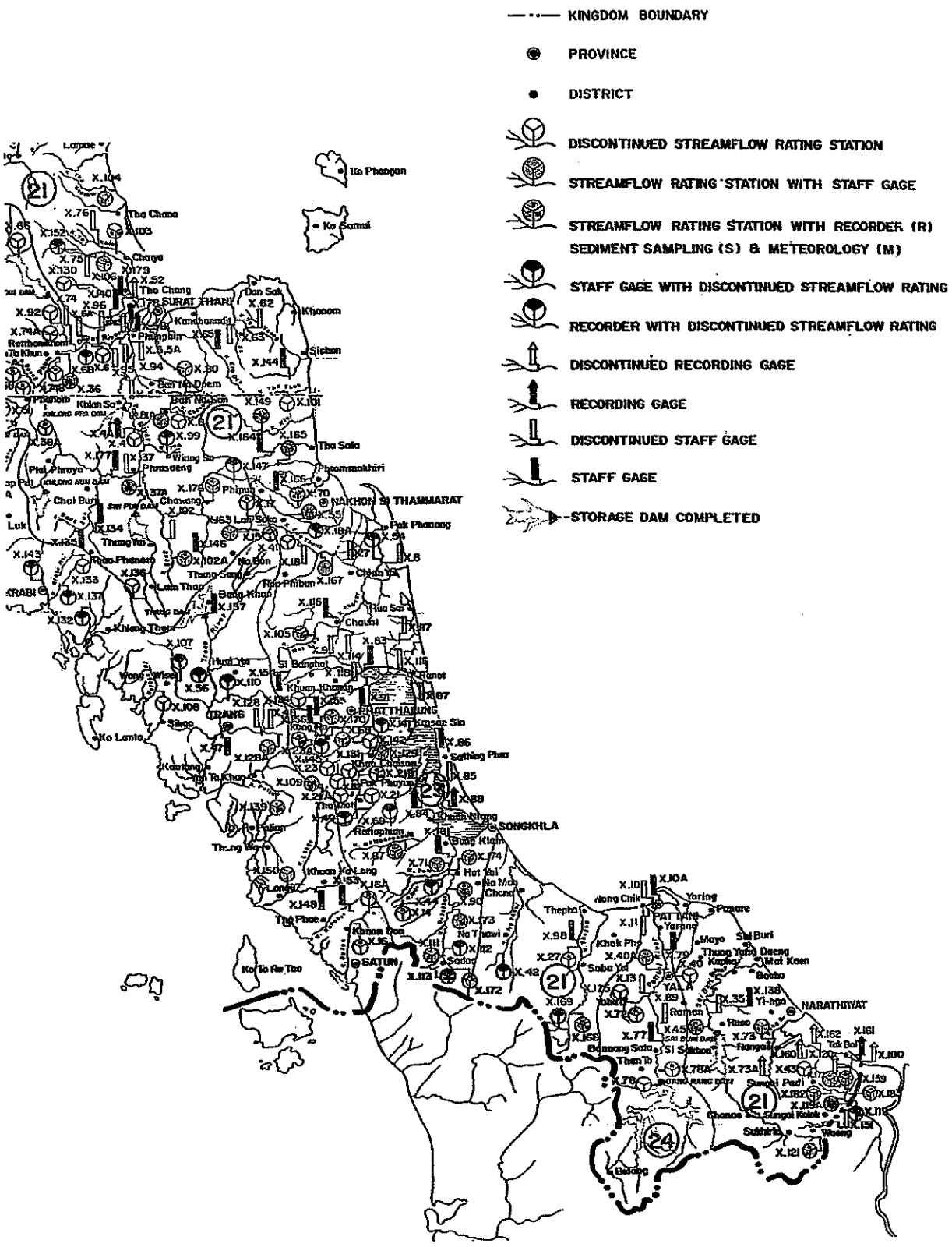


Figure 4.3.1-1 Location of Hydrological Observation Stations

Source: Hydrology Division, Royal Irrigation Department

Table 4.3.2-1 Main Hydrological Stations in the Study Area

Ref. No.	Name of River	Name of Station	(District, Province)	Basin Area (km^2)
X. 36	Khlong Phum Dung	Tha Kanon	Kiriratnikom, S.T.	3,012
X. 37A	Mae Nam Tapi	Ban Phrasaeng	Phrasaeng, S.T.	5.200
X. 55	Khlong Tha Dee	Ban Tha Yai	Lan Ssaka, N.S.T.	105
X. 70	Khlong Ban Tan	Ban Wang Kong	Muan, N.S.T.	39
X. 105	Khlong Mai Seab	Ban Mai Seab	Chauat, N.S.T.	155
X. 149	Khlong Klai	Tambon Nop Pi Tam	Nop Pi Tam, N.S.T.	69
X. 163	Khlong Jandee	Ban Jandee	Chawang, N.S.T.	97
X. 165	Khlong Nai Khew	Ban Nai Khew	Phommakhiri, N.S.T.	-
X. 167	Khlong Sao Thong	Tambon Sao Thong	Ron Phibun, N.S.T.	-
X. 109	Khlong Bang Kaew	Ban Bang Kaew	Tha Mot, Phatthalung	133
X. 42	Khlong Na Thawi	Ban Tha Padoo	Na Thawi, Songkhla	443
X. 90	Khlong U-Ta Phao	Ban Bang Sala	Hat Yai, Songkhla	1,562
X. 40A	Mae Nam Pattani	Pattani	Muan, Yala	3,302
X. 77A	Mae Nam Pattani	Ban Taling Chan	Bannang Sata, Yala	-
X. 168	Khlong Thepha	Ban Ba Hoal	Kabang, Yala	315
X. 45	Mae Nam Sai Buri	Ban Ba Kong	Ruso, Narathiwat	1,483
X. 73	Khlong Tanyong Mus	Ban Rangae	Rangae, Narathiwat	336
X. 119A	Mae Nam Kolok	Kolok	Sungai Kolok, N	1,358

(Note) Name of Province

S.T. : Surat Thani

N.S.T. : Nakhon Si Thammarat

N. : Narathiwat

Table 4.3.2-2 Monthly Variation of Water-Flow Rate

unit : million m^3

Station	Big River	Medium River		Small River			
	Pattani X.40A ($3,302km^2$)	Sai Buri X.45 ($1,483km^2$)	Kolok X.119a ($1,358km^2$)	Klai X.149 ($69km^2$)	Mai Seab X.105 ($155km^2$)	Na Thawi X.42 ($443km^2$)	Thepha X.168 ($315km^2$)
Apr.	173.5	107.5	46.20	23.38	8.21	6.44	6.87
May	220.3	148.9	59.71	23.63	4.33	10.50	10.86
June	193.7	143.0	83.28	19.44	3.45	5.97	8.87
July	179.5	128.7	106.74	20.94	4.25	6.15	9.93
Aug.	213.6	137.5	120.99	24.39	3.42	7.05	12.92
Sep.	221.9	145.1	141.56	32.49	5.43	10.48	14.41
Oct.	239.6	214.5	167.23	56.27	11.00	24.30	25.79
Nov.	339.5	463.5	355.29	132.59	34.14	47.81	33.82
Dec.	414.0	754.6	380.66	198.87	35.63	38.65	38.97
Jan.	227.7	298.9	166.48	49.69	7.61	8.49	9.11
Feb.	160.8	156.2	66.36	81.37	5.44	4.34	5.04
Mar.	169.1	146.3	58.82	51.09	3.63	3.94	6.50
Annual							
Mean	2,753.2	2,844.6	1,753.30	714.16	126.52	174.11	183.08
Max.	4,617.9	3,692.4	2,418.02	937.00	385.59	315.26	303.55
Min.	1,128.2	2,045.8	1,244.70	479.08	39.22	61.79	57.61

4.4 Oceanographic Conditions

4.4.1 Tides

Harmonic constants of tides are calculated by a long-term harmonic analysis at Pak Phanang, Pattani and Narathiwat. The principal four constituents, K_1, O_1 , M_2 and S_2 are shown in Table 4.4.1-1 together with an annual constituent Sa .

Table 4.4.1-1 Harmonic Constants of Principal Constituents of Tides

Station / Constituent	Pak Phanang		Pattani		Narathiwat	
	H (cm)	K (°)	H (cm)	K (°)	H (cm)	K (°)
Annual						
Sa	31.5	287.0	18.1	281.9	18.6	278.0
Diurnal						
K_1	15.0	82.6	7.2	142.6	17.0	181.8
O_1	10.2	3.6	3.3	47.2	7.0	111.4
Semi-Diurnal						
M_2	12.6	52.8	19.1	315.0	16.5	273.3
S_2	4.0	133.3	6.1	359.3	7.3	313.8
Sum of Principal Four Constituents	41.8 cm		35.7 cm		47.8 cm	

(Note) 1. Tidal station at Pak Phanang : 8 ° 21 ′ 10 ″ N, 100 ° 12 ′ 08 ″ E
2. Tidal station at Pak Pattani : 6 ° 53 ′ 34 ″ N, 101 ° 15 ′ 36 ″ E
3. Tidal station at Pak Narathiwat : 6 ° 41 ′ 36 ″ N, 101 ° 42 ′ 25 ″ E

The type of tides in the Study area is diurnal in the north part (Pak Phanang area), semi-diurnal in the middle part (Pattani area) and mixed type in the south part (Narathiwat area).

The sum of amplitudes of principal four constituents is around 40 cm. On the other hand, an annual constituent Sa is comparatively large, especially in Pak Phanang.

4.4.2 Wave and Current

National Research Council (NRC) of Thailand is conducting an oceanographic survey using buoy-type equipment from December 1991 at offshore area shown in Figure 4.4.2-1. Observation items are as follows:

1. Wind speed
2. Wind direction
3. Wave period
4. Significant wave height
5. Salinity (- 3.5 m)
6. Temperature (- 3.5 m)
7. Current speed
8. Current direction
9. Air Temperature
10. Atomospheric pressure

From view point of this study, following three stations are important:

Station No. 4 : Plathong	(09 ° 42 ′ N, 101 ° 26 ′ E)
Station No. 6 : Songkhla	(07 ° 30 ′ N, 101 ° 13 ′ E)
Station No. 9 : Nakhon Si Thammarat	(08 ° 45 ′ N, 100 ° 18 ′ E)

The effective observation data at the above three stations was obtained, although there are many holes in the data, especially at Nakhon Si Thammarat. The outline of wave and current conditions from the data is described below.

1) Wave

Table 4.4.2-1 shows the occurrence of high waves more than two meters in significant wave at Plathong, Songkhla and Nakhon Si Thammarat stations during observation period.

The highest wave height ($H_{1/3}$) is 2.8 meters at both Plathong and Songkhla stations and 2.0 meters at Nakhon Si Thammarat station. The wave period is between 5 to 8 seconds.

High waves are observed during the northeast monsoon in October to January in this area.

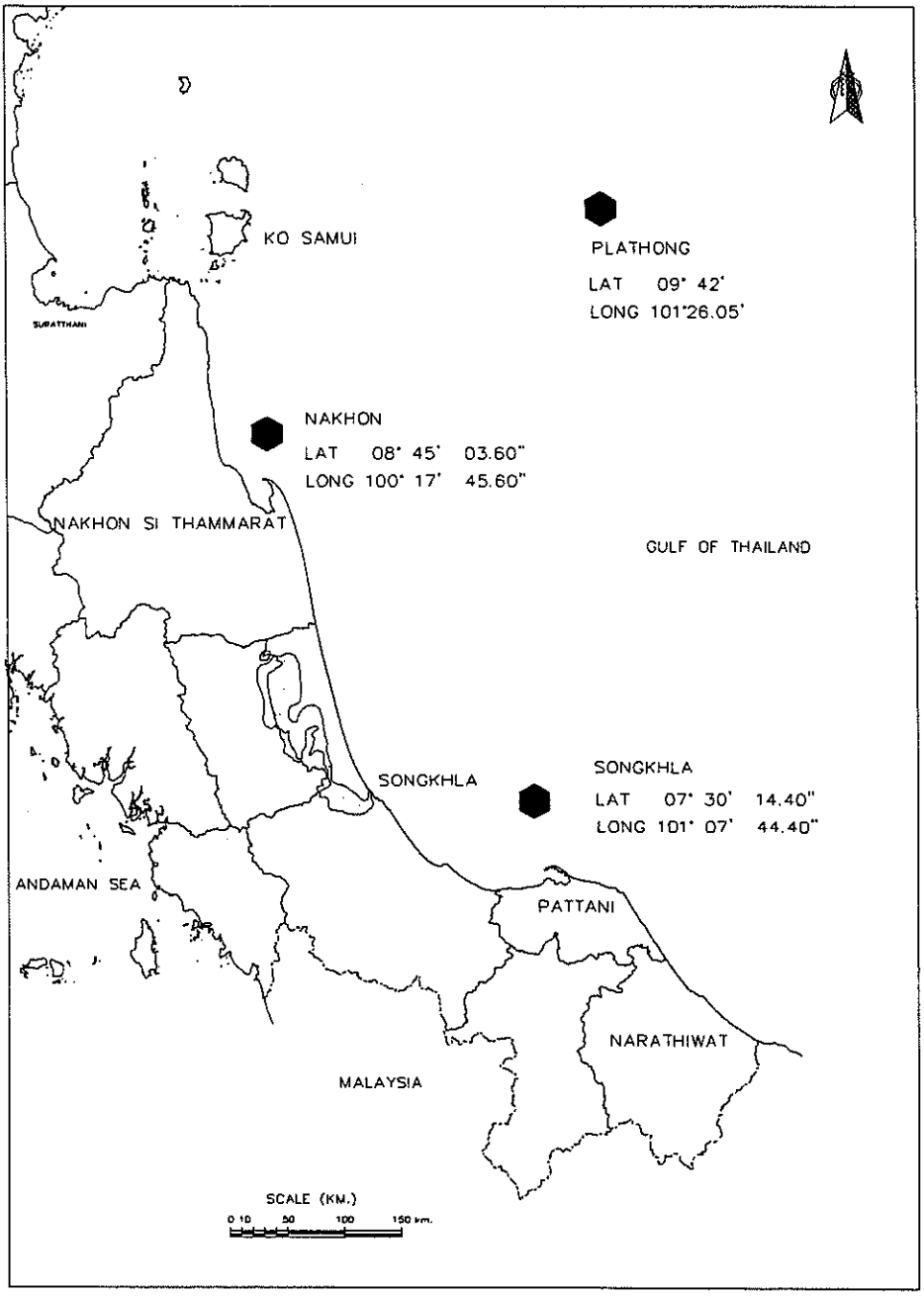


Figure 4.4.2-1 Location Map of Oceanographic Survey Stations by NRC

Table 4.4.2-1 Records of High Wave Height
(more than 2 meters)

Year	Date	Name of Station		
		Plathong	Songkhla	Nakhon Si Thammarat
		($H_{1/3}$) (T)	($H_{1/3}$) (T)	($H_{1/3}$) (T)
1992	Oct. 27-28	2.7 m 4.8 sec		
	Nov. 10-11	2.6 m 4.8 sec		
	15	2.8 m 5.1 sec		
	Dec. 25-26	2.2 m 4.8 sec		
1993	July 17-18	2.8 m 7.8 sec		
	20	2.4 m 7.0 sec		
	Nov. 01-03		2.4 m 5.8 sec	
	28-29		2.0 m 6.0 sec	
	Dec. 06-08	2.4 m 5.8 sec	2.5 m 6.0 sec	
	16-19	2.7 m 6.0 sec	2.8 m 6.5 sec	
	22-23	2.3 m 5.8 sec	2.6 m 6.0 sec	
	25-26		2.4 m 5.8 sec	
1994	Jan. 20		2.0 m 5.5 sec	
	Feb. 03-04	2.4 m 5.8 sec	2.3 m 5.5 sec	
	Mar. 02	2.0 m 5.5 sec		
	July 07	2.2 m 5.0 sec		
	Oct. 21-22	2.3 m 5.8 sec		
	Nov. 01	2.4 m 5.5 sec		
	Dec. 19-20		2.3 m 5.5 sec	
	22	2.0 m 5.6 sec	2.3 m 5.8 sec	
1998	Jan. 30			2.0 m 5.8 sec
1999	Dec. 02-04	2.5 m 6.2 sec		
	08-10	2.2 m 6.0 sec		

Source: National Research Council of Thailand

2) Current

The current speed at Plathong station is normally 20 to 40 cm/sec and reaches 50 to 60 cm/sec when the sea is rough. The maximum speed is around 80 cm/sec. The type of current is diurnal and semi-diurnal depending on lunar age.

Current speed at Songkhla station is smaller than at Plathong station; normally less than 30 cm/sec and 40 to 60 cm/sec when rough. The type of current at Songkhla station is semi-diurnal or mixed currents.

4.5 Bottom Materials

The whole of coastal area except Pak Phanang and Pattani bays is composed of sand. In Pak Phanang and Pattani bays, bottom materials are characterized by mud.

The distribution of mud in the bays is supposedly as shown in Figure 4.5-1 from existing data and results of the site survey on the shoreline.

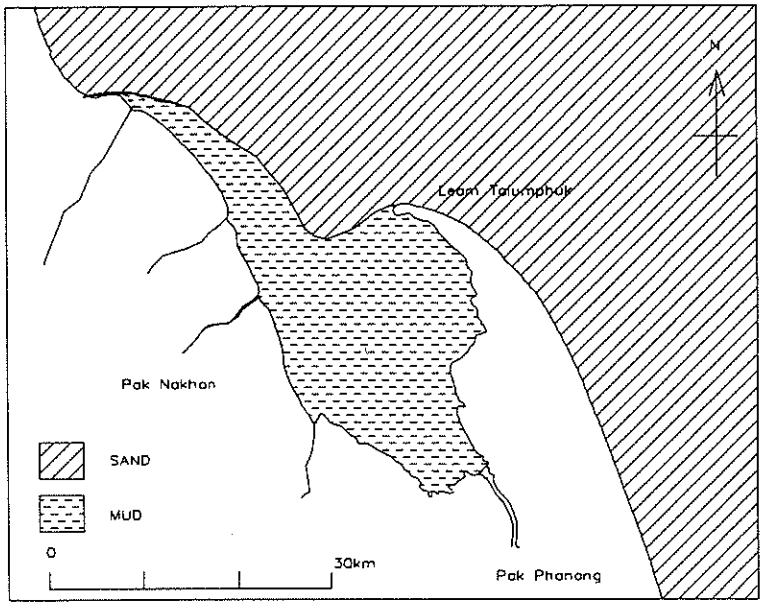
1) Pak Phanang Bay Area

a. Southern limit of sand-distribution along shoreline is at Ban Sa Bua (2) village in Tha Sala district of Nakhon Si Thammarat province.
b. Dredged materials at 17 km offshore area from Pak Phanang River mouth are sandy.

2) Pattani Bay Area

a. Eastern limit of sand-distribution along shoreline is at the most eastern groin in Bang Ta Wa near the irrigation canal of the east of Ru Sa Mi Lae in Muan Pattani district of Pattani province.
b. Dredged materials at the outer channel at Pattani are sandy.
c. Result of sampling for seabed materials at river-mouth shows muddy characteristics.

Pak Phanang Bay



Pattani Bay

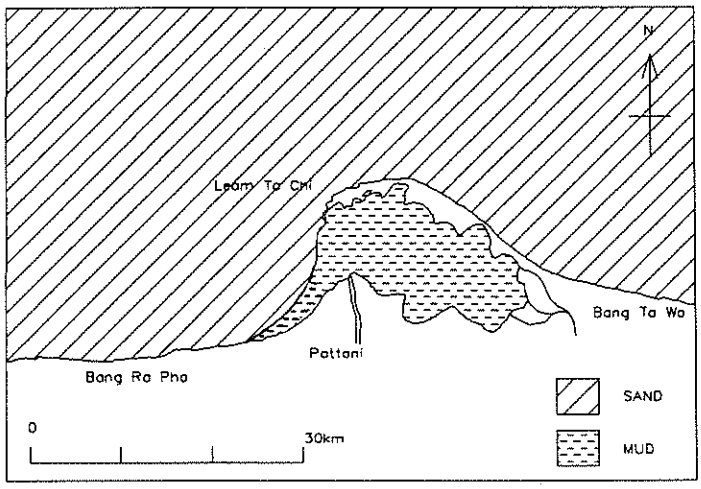


Figure 4.5-1 Distribution of Bottom Materials in Pak Phanang and Pattani Bays