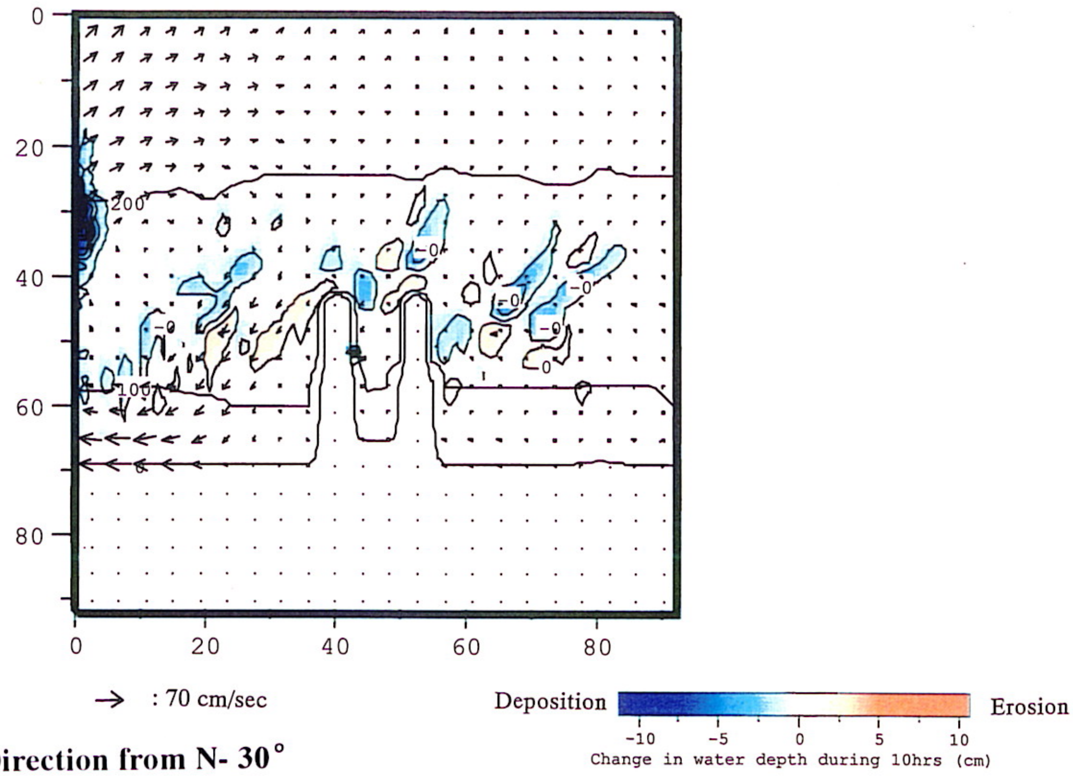
a) Wind Direction from N+ 30°



b) Wind Direction from N- 30°

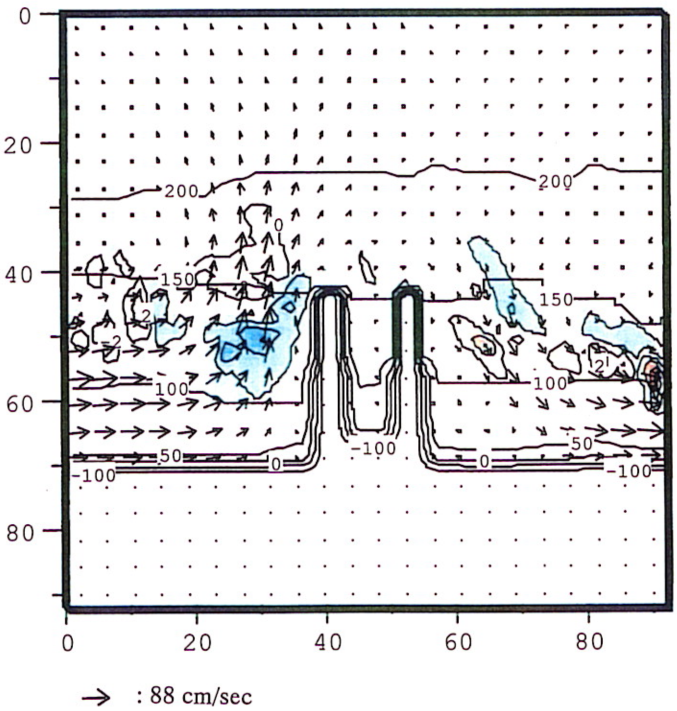


Figure 8.2.3-8 Current Pattern and Topographic Change in Bang Ra Pha Area (Future Case)

(7) Effects of Additional Jetty/Breakwater

The calculated volume of sediments within the navigational channels of Songkhla, Sichon and Bang Ra Pha using a simulation model is summarized in Table 8.2.3-2 for the present case and future case from the topographic change by comparing the topography before and after one storm. In this calculation, we assumed that the storm continued for ten hours from the same direction.

The result clearly shows that the construction of an additional jetty in Sichon and the extension of existing jetties in Bang Ra Pha are effective in the sense of protection of the navigational channel from shoaling.

Table 8.2.3-2 Volume of Sediments in Navigational Channels of Songkhla, Sichon and Bang Ra Pha

Area	Wave Condition (Wave Direction)	Volume of Sediments (m^3/storm)	Effect of Improvement (m^3/storm)
Songkhla	1. Present Case		
	1) NE+ 30°	3.0	
	2) NE- 30°	1.9	
	2. Future Case		
	1) NE+ 30°	0.4	0.4 – 3.0 = - 2.6
	2) NE- 30°	0.7	0.7 – 1.9 = - 1.2
Sichon	1. Present Case		
	1) ENE+ 30°	139.3	
	2) ENE- 30°	70.1	
	2. Future Case		
	1) ENE+ 30°	59.2	59.2 – 139 3 = - 80.1
	2) ENE- 30°	50.0	50.0 – 70.1 = - 20.1
Bang Ra Pha	1. Present Case		
	1) N+ 30°	46.7	
	2) N- 30°	11.4	
	2. Future Case		
	1) N+ 30°	5.3	5.3 – 46.7 = - 41.4
	2) N- 30°	4.0	4.0 – 11.4 = - 7.4

Note : Volume of Sediments : Songkhla Area = 550m x 230m

Sihon Area= 360m x 360m

Bang Ra Pha Area=75m x 55m

8.3 Measures for Protection of Navigational Channels

8.3.1 Measures against Shoaling of Navigational Channels

In the area where a longshore drift is predominant as the study area, the training jetty is usually used as protection for a navigational channel. In most cases, dual jetties are more effective than single jetty in order to prevent the shoaling of a navigational channel. In the study area, all the protected channels have dual jetties except Sichon that has a single jetty.

The water depth at the end of these jetties is around 2 meters below chart datum level. Therefore, when the wave breaking water depth is taken into account, the ends of jetties are outside of surf zone on usual waves. They are, however, inside of surf zone on storm waves. This means that a longshore drift is captured by the jetty at the upstream side of littoral drift on usual waves and is transported to the downstream side and the inside of jetties on extreme storm waves.

Therefore, the following methods are considered as countermeasures against shoaling of the navigational channels in the study area.

(1) Extension of existing jetties to the outside of surf zone on extreme waves.
(2) Maintenance dredging along the navigational channels without extension of existing jetties.
(3) Introduction of a sand bypassing system without extension of existing jetties.

In case of the countermeasure (1) above, serious erosion will occur in the downstream side of littoral drift. The countermeasure (2) is undertaken by CDCII and, in this case, dredging of the offshore area is impossible because of swells.

The best measure to protect the navigational channels from shoaling generated by longshore drift in the study area is the countermeasure (3). This can reduce the coastal erosion in the downstream side of littoral drift as well as keep the channels navigable.

8.3.2 Measures against Coastal Erosion near Training Jetties

In case that training jetties are constructed to protect navigational channels in the area where a longshore drift is predominant like the study area, coastal erosion arises without exception in the downstream side of littoral drift. Therefore, measures to protect the coast from erosion must collectively be considered in planning the training jetties.

There are many types of measures; erosion control works such as groins, detached breakwaters, headlands, embankments and sand bypassing system. Characteristics of these erosion control facilities are summarized in Table 8.3.2-1.

Table 8.3.2-1 Erosion Control Facilities

Littoral Drift Movement Type of Coast	Control Facilities	Functions
Longshore Drift	Groin / Group of Groins	Lowering of speed in longshore current Capturing longshore drift
	Headland	
Longshore Drift plus On-offshore Transport	Detached Breakwater / Group of Detached Breakwaters	Diffracting wave Deforming near shore current system
Sand & Gravel Coast	Embankment / Revetment / Gentle Slope-type Embankment	Lowering of wave force and speed in current
	Wave Absorbing Breakwater / Submerged Breakwater / Artificial Reef	
Exhausted Area of Sand Source	Beach Nourishment	
	Sand Bypassing	

As shown in Table 8.3.2-1, erosion control works of groins, detached breakwaters (offshore breakwaters) and headland defense works are generally used in the area where longshore drift is predominant.

Groins have a function to deposit sands by protecting movement of longshore drift. On applying groin works, care should be taken not to produce secondary disasters since the downstream side is seriously eroded by excessive deposition.

Detached breakwaters are wave absorbing structures aligned approximately parallel to the shoreline in offshore area. By the effect of wave absorption, deposition behind breakwaters (a so-called tombolo topography) is expected. In coastal areas where the foreshore was perfectly eroded and a source of littoral drift was exhausted, detached breakwaters cannot show any effect.

Headland works make a closed system of the movement in littoral drift by aligning artificially cape-shaped structures. This system is effective to coastal areas where the source of littoral drift was exhausted and a beach has a long length.

In addition, beach nourishment works (including a sand bypassing system as a non-structural measure) are used in areas where the supply of littoral drift is not expected much.

8.4 Recommended Improvements in Coastal Protection

8.4.1. Sand Bypassing System

As described in Section 8.3.1, the best measure to protect navigational channels and to reduce the coastal erosion in the downstream side of littoral drift is to implement the sand bypassing system in the study area where the longshore drift is predominant.

For the sand bypassing system, the target volume of sands becomes a matter of great concern.

Considering the coastal changes by numerical simulation models, analysis of aerial photographs and topographic survey, and the existing data in the study area, we finally estimated the target volume by a sand bypassing system at each area as shown in Table 8.4.1-1.

Table 8.4.1-1 Estimated Volume of Sand Bypassing System

Area	Estimated Volume	Priority of Implementation	Length of Jetties
Songkhla Province			
1. Songkhla	15,000 m^3/year	Medium	Long (1,000m)
2. Na Thap	10,000 m^3/year	Low	Middle (200m & 400m)
3. Sakom	10,000 m^3/year	Medium	Long (650m)
4. Thepha	15,000 m^3/year	Medium	Long (550m & 850m)
Pattani Province			
5. Bang Ra Pha	50,000 m^3/year	High	Short (250m)
6. Tanyong Pao	50,000 m^3/year	High	Short (250m)
7. Panare	50,000 m^3/year	High	Short (250m & 350m)
8. Bang Maruat	50,000 m^3/year	Low	Middle (330m & 440m)
9. Sai Buri	20,000 m^3/year	Medium	Long (250m & 800m)
Narathiwat Province			
10. Narathiwat	15,000 m^3/year	Medium	Long (350m & 700m)

8.4.2. Improvement of Existing Erosion Control Facilities

In the study area, many erosion control facilities such as detached breakwaters and groins are constructed to prevent the coastal erosion in the downstream side of littoral drift of jetties. Serious shoreline erosions, however, have taken place recently in many areas due to the construction of jetties.

These erosions come from the insufficient extent of control facilities and from the selection of unsuitable type and size for erosion control facilities.

One example of the unsuitable size is the longshore and offshore spacing of detached breakwaters as shown in Figures 8.2.2-1 and 8.2.2-2.

Another example for the unsuitable type of erosion control facility is seen in Tha Sala area and Bang Ta Wa area where I-type groins are applied as control facilities at present. The mechanism of sand transport in these areas was estimated and it was found that the sand transport is not so large and the on-offshore transport increases more than the longshore drift. In such case, T-type groins are superior to I-type groins in respect to the sedimentation of sands.

As a result of our study for the coastal erosion, some improvements of existing erosion control facilities and additional constructions of control facilities are recommended as well as a sand bypassing system (see Table 8.4.2-1).

Table 8.4.2-1 Recommended Improvement and Construction of Erosion Control Facilities

Area	Existing Facilities	Improvement of Existing Facilities	Additional Facilities
Nakhon Si Thammarat Province			
1. Sichon	Single Jetty		*Jetty** *Detached Breakwaters**
2. Tha Sala	Dual Jetties Detached Breakwaters: 4 Groins (I-type): 7	Detached Breakwaters: 4 Groins : 7 (T-type)	Groins :10 (T-type)
Songkhla Province			
3. Songkhla	Single Jetty Breakwater		*Jetty** Detached Breakwaters: 5 Groins : 6 (I-type)
4. Na Thap	Dual Jetties Groins (L-type): 4	Groins : 4 (T-type)	Detached Breakwaters: 2
5. Sakom	Dual Jetties Detached Breakwaters: 4	Detached Breakwaters: 1 Groins : 2 (T-type)	Detached Breakwaters: 5
6. Thepha	Dual Jetties Detached Breakwaters: 5	Detached Breakwaters: 2	Detached Breakwaters: 5
Pattani Province			
7. Bang Ra Pha	Dual Jetties		Detached Breakwaters: 8
8. Tanyong Pao	Dual Jetties		Detached Breakwaters: 8
9. Bang Ta Wa	Revetment Groins (I-type): 8	Groins : 8 (T-type)	Groins : 1 (T-type) Detached Breakwaters: 3
10. Panare	Dual Jetties Detached Breakwaters: 4	Detached Breakwaters: 4	Detached Breakwaters: 3
11. Bang Maruat	Dual Jetties Detached Breakwaters: 3	Detached Breakwaters: 3	Detached Breakwaters: 2
12. Sai Buri	Dual Jetties Detached Breakwaters: 3		*Detached Breakwaters**
Narathiwat Province			
13. Narathiwat	Dual Jetties Groins (T-type): 4	Groins (T-type): 3	Groins (T-type): 1

Note : Jetty and detached breakwaters in Sichon, jetty in Songkhla, and detached breakwaters in Sai Buri are additional plan of Harbour Department.

*: Facilities planned by Harbour Department