COASTAL HYDROGRAPHY OF THE SOUTHERN ANDAMAN SEA OF THAILAND, TRANG TO SATUN PROVINCE

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ABSTRACT

The southern Andaman Sea coast of Thailand, Trang to Satun provinces, is a high potential fishing area. This study will provide basic information for fishery, aquaculture, and coastal management in the future since water circulation may control biological processes in the marine environment. During the northeast monsoon season in 1986, the water currents in shallow water had high variations both in speeds and directions but speeds were lower when compared to the west coast of Phuket. The high variations were caused by obstruction from islands, an island mass affect. The shallow area was strongly influenced by tidal currents. The water currents on the west side of the island chain along the shoreline had higher speed and tended to flow northward as a surface current in the open sea. It might therefore flow southward during the southwest monsoon season and follow the surface current in the open sea.

INTRODUCTION

The southern Andaman Sea coast of Thailand, from Phuket to Satun province, has a coastal line of about 340 km. On an average the continental shelf width is about 130 km which is wider than the northern part in Phuket to Ranong province. The coastal line is composed of mangrove forest which is quite abundant, many tributaries, rivers, and small islands in a chain are located along the shore-line. The mangal area ranges from 26,500-31,500 hectares (Supapipat 1988). There are also large seagrass beds located at Haad-chaomai to Muk Island and Talibong Island of Trang province and Lanta Bay of Krabi province.

This area is dominated by two monsoons. The southwest monsoon prevails during May to October and is characterized by storms and heavy rainfall (about 2000 mm rainfall) and a stirred up sea. The northeast monsoon prevails during November to April and is characterized by being a calm and dry season with about 200 mm rainfall.

Water characteristics of the southern part, Phuket to Satun province, were summarized by Limpsaihol et al. (1987). Sea water was influenced mainly by runoff resulting in relatively high salinities which ranged from 32.6-32.8 ppt. The dissolved oxygen, pH and temperature values ranged from 5.5-6.4 mg l⁻¹, 8.06-8.15 and 27.6°-29.3°C respectively and were relatively uniform along the coast. However, there was relatively good mixing resulting in the total suspended solid values of 9.9-14.8 mg l⁻¹. The nutrient values of nitrate and phosphate ranged from 0.120-3.402 and 0.082-0.872 μg-atom l⁻¹ respectively. However, the surface water was fertilized mainly by mangal runoff (Limpsaihol et al. 1987) resulting in a high primary production of 180-880 g C m⁻² year⁻¹ (Janekarn and Hylleberg 1987).

Chatananthaweji and Bussarawit (1987) suggested that the sea bottom sediments of the Andaman Sea coast of Thailand were affected by wind and current between the two monsoons. Their study also indicated that the sea bottom of the southern part was dominated by mud and very fine sand which was discharged by rivers.
Figures 1a-b. The median particle diameter in phi (φ) units during two cruises as shown in the figure (adopted form Chatananthaweji & Bussarawit 1987).

Table 1. Abundance and biomass in the coastal region north of Phuket Island and to the south (from Chatananthaweji and Bussarawit 1987).

<table>
<thead>
<tr>
<th></th>
<th>Northern Part</th>
<th>Southern Part</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average abundance in 1982</td>
<td>664±260 ind.m⁻²</td>
<td>1117±377 ind.m⁻²</td>
</tr>
<tr>
<td>Average abundance in 1983</td>
<td>737±349 ind.m⁻²</td>
<td>1129±520 ind.m⁻²</td>
</tr>
<tr>
<td>Average biomass in 1982</td>
<td>7.576±5.300 g.m⁻²</td>
<td>30.810±51.650 g.m⁻²</td>
</tr>
<tr>
<td>Average biomass in 1983</td>
<td>13.011±9.721 g.m⁻²</td>
<td>35.710±55.821 g.m⁻²</td>
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</table>

(3.00-4.00 phi) and the sediments were poorly sorted (Figure 1a-b). They also found that this area had more abundant benthic macrofauna both in terms of individuals and biomass per square meter than the northern part (see Table 1).

From the results of all studies above, it could be concluded that the southern part of the Andaman Sea coast of Thailand is a high potential area for fisheries. Promanon (1987) showed that there was mariculture activity along the coastal line, such as cockle farms, and fish cultures, etc. Shrimp farms have become more popular in this area during the past few years. The economy of local people in the region is therefore based on fishery, wood cutting and
aquaculture. The tourism has become important, accordingly.

Environmental parameters are important factors which can affect marine organisms, especially planktonic larvae. It is known that many marine invertebrates can delay their settlement and metamorphosis depending upon the environment in their habitats (Mianmanus 1988 and Mitton et al. 1989). The current is a very important environmental parameter, as it does not only have effect on marine organisms directly but also affects the variation of other environmental parameters, such as the mixing processes of water masses, the distribution of salinity, temperature, and dispersion of other substances introduced into the coastal waters, etc. Scheltema (1986) suggested that larvae of invertebrates could be dispersed and the likelihood of survival of settlement is related to: a) the length of its planktonic life, b) the rate and direction of current transportation. Scheltema and Williams (1983) also found that some fossil species of molluscs having a long planktonic larval duration, had a greater geographic range than species with a shorter duration in the plankton.

Since the southern part is a fisheries potential region especially in the area of Trang to Satun province, circulation of the coastal water is a very important factor. The goal of this study is therefore to describe the water circulation of this area which will be useful as basic information for fishery, aquaculture, coastal management and future planing. It is also useful to aspects of the TMMP marine biological studies.

**MATERIALS AND METHODS**

**Current Data collection**

The current data were collected during the northeast monsoon, January-April 1986. The measurements were made during spring tide. We could not obtain measurements during the southwest monsoon as the sea was too rough and strong winds prevailed. This area is influenced by semi-diurnal tide and the tidal cycles are not significantly different. The current speed and direction was therefore collected hourly throughout one tidal circle (12 hrs) from 15 stations along the shore line (Figure 2), using Braystoke Digital Current Meter. The measurements were done at three depths, viz. surface level: 1 m below the surface; mid level: the middle of total depth which depends on the depth of each station, and bottom level: 1 m above the sea bottom. The data were analyzed for residual current by the vector analysis method.

**Meteorological data**

Meteorological data from 1985 were obtained from the Department of Meteorology, Thailand, at Lanta Island. The data consist of rainfall and 3-hourly wind speed and direction measurements.

![Figure 2. The Andaman Sea coast of Thailand, Trang-Satun provinces, and fifteen of the current measurement stations along the shoreline.](image-url)
Table 2. The current speeds (knots) and directions (degrees) of each station along the Andaman Sea coast of Trang to Satun province, Thailand.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Water Depth</th>
<th>1 m V</th>
<th>1 m Θ</th>
<th>5 m V</th>
<th>5 m Θ</th>
<th>Bottom V</th>
<th>Bottom Θ</th>
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<tr>
<td>1</td>
<td>4.8</td>
<td>0.12</td>
<td>278</td>
<td>0.08</td>
<td>280</td>
<td>0.02</td>
<td>145</td>
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<tr>
<td>2</td>
<td>4.5</td>
<td>0.04</td>
<td>223</td>
<td>0.27</td>
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<tr>
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<tr>
<td>4</td>
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<td>5</td>
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<tr>
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<td>7</td>
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<td>0.54</td>
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<tr>
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<tr>
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<td>0.10</td>
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<td>0.10</td>
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<td>0.23</td>
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<tr>
<td>15</td>
<td>11.0</td>
<td>0.09</td>
<td>213</td>
<td>0.11</td>
<td>263</td>
<td>0.12</td>
<td>257</td>
</tr>
</tbody>
</table>

RESULTS

The Current Speeds and Directions

The resultant current speeds and directions are shown in Table 2 and the patterns are shown in Fig. 3 to 5. The surface currents in shallow water (the area between mainland and island chain) directs seawards at all stations with speed ranging from 0.01-0.32 knot. However, the currents beyond the island chain flow northwards, and are parallel to the coastal line with a speed range of 0.14-0.64 knot, except southwest of Talibong Island, where the direction is turned landwards.

The subsurface currents in shallow water below 5 m to bottom can be characterized as follows:

a) Between the mainland and south of Tarutao Island, the current flowed southwestwards to Malaysian water with a speed range of 0.02-0.27 knot.
b) Between the mainland and north of Tarutao Island, the current flowed northwards to Trang province with a speed range of 0.06-0.51 knot.

c) Among Bulo-Le Island, Kradan Island and mainland, the current flowed landwards with a speed range of 0.02-0.20 knot.

d) North of Kradan Island, Lanta Island and mainland, the area was semi-enclosed with run-off from tributaries and rivers. The direction of flows were constantly southwards over the water column with a speed range of 0.06-0.12 knot.

In areas with a water depth of more than 20 m, the subsurface currents flow landwards with a lower speed range of 0.02-0.18 knot, except west of Tarutao Island where the currents flowed northward to Bulon-Le Island.

Meteorological Data

Winds at Lanta Island (Figure 6) were calm only 6.5% of the time. Dominant winds were from the west and northeast, and the yearly residual wind vector was from 336° at 1.5 knots. Winds with less stress occurred during the months of November-December where winds were mainly from the north and northeast. During January-March, winds blew mainly from the northeast and east but during April-May, winds were relatively weak and blew from northwest, west, southwest, east, and northeast. The strongest winds occurred during the southwest monsoon season from June-October, with dominant wind direction from the west.

The rainfall data were obtained from 4-year records. Average monthly rainfall was highly seasonal and can be used to divide the climate into dry and wet seasons. The lowest rainfall was recorded in January (8.1 mm). The average monthly rainfall is below 100 mm during the dry northeasterly monsoon season. In the wet season, the average monthly rainfall is above 300 mm, with the peak of rainfall in July.

DISCUSSION

The surface water mass moved seaward and was replaced by the landward inflow of a
subsurface water mass, *i.e.* an upwelling phenomenon. Such circulation is a physical mechanism that keeps the sea level in balance (Pickard 1979). The surface currents therefore could distribute nutrients from nearshore areas, which are enriched from runoff and mangroves, to remote areas. While the subsurface currents bring nutrients from offshore sources to the coastal waters. So, the coastal waters of Trang-Satan is characterized by a high production potential (Prawin *et al.* 1987, Janekarn and Hyleberg 1987).

The surface currents in the area between the mainland and the island chain along the shoreline have lower lower speeds than currents on the west coast of Phuket Island (average range 0.39-0.78 knots; National Environment Board 1983) with strong influence of the tidal currents. On the west side of the island chain, the currents showed a trend to move northward along the shoreline. It indicated that the surface current of the open sea, which have direction northward during the northeast monsoon, can influence this area and it might reverse the southward during southwest monsoon following the currents in the open sea (Soegiarto and Birowo 1975).

High variations of current speed and direction were recorded. It may be due to the obstruction by many islands which affects current directions and speeds. Emery (1972) demonstrated that an island mass effect could create turbulent or lamina or eddy flow on a lee side depending upon the current speeds. The variations of currents and physical processes associated with an island mass effect could influence biological processes as well as the settlement of some invertebrate larvae and productivity in the vicinity of, and around islands (Sander 1971). This might be one of the reasons why fishermen can collect snails or bivalves abundantly around some islands.

In the area between Lanta, Ngia, Kradan Island and the mainland, currents flew seawards at all depth except in some areas where the subsurface current flew landwards to shallow water. It may be due to intensive run-off from mainland.

In the area between Talibong, Phetra, Bulon-Le Island and the mainland, the current speeds were quite low (0.02-0.20 Knot) and likely formed an eddy flow in this area. This may enhance settlement of benthic larvae and support high benthic production (Chatanantha-weji and Bussarawit 1987). This area also coincides with the fishing site of fishermen for snail and bivalves especially for *Chicoreus ramosus*.

Sutthakorn and Saranakomkul (1986) found that numerous *Rastrelliger brachysoma* which had been tagged and released in the areas a, c, and d (areas specified in the result section of the present paper) will remain in the areas except area a where some of them moved to Malaysian waters. The distribution of *Rastrelliger brachysoma* was found to correspond to water circulation. The area a in Satun province also has many cockle farms. The main problem of farming cockle is the absence of local cockle recruitment. Farmers have to buy a great number of spats from Malaysia. It seems probable that the currents dispersed cockle larvae out of this area, to Malaysian waters together with others marine organisms.

This study was conducted during the northeast monsoon season. However during the southwest monsoon season, the coastal area, between the mainland and the island chain, is much influenced from run-off, especially in the area d. The rainfall data also showed that rainfall during the southwest monsoon was higher than during the northeast monsoon. The wind stress may have less effect on circulation when compared to the northern part which was directly influenced by open sea with stronger wind stress (Khokiatiwong *et al.* 1991). As in the southern part there are numerous small islands along the coastal line, and only the west sides of islands are influenced by offshore wind driven currents.
ACKNOWLEDGEMENTS

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