Pertanika J. Sci. & Technol. 4(1): 141-148 (1996)
ISSN:0128-7680

COMMUNICATION
Surface Circulation off Kuala Terengganu in the Transitional Period between the Northeast and Southwest Monsoons

Mohd. Nasir Saadon and Meged Mahmoud Marghany

Pusat Perikanan dan Sains Samudra
Universiti Pertanian Malaysia
Mengabang Telipot, 21030 Kuala Terengganu, Malaysia

Received 17 October 1994

ABSTRAK

Tujuan penyelidikan ini ialah untuk memahami corak peredaran arus permukaan di perairan Kuala Terengganu. Drog hanyut telah digunakan, pada bulan April 1993, untuk mengukur arus permukaan. Bulan April adalah musim peralihan di antara monsun timur laut dan barat daya. Keputusan kami menunjukkan drog hanyut yang digunakan bergerak dalam satu bulatan. Pergerakan sebegini biasanya menunjukkan kewujudan pusar. Walau bagaimana pun, kami berpendapat kajian yang lebih mendalam perlu dilakukan untuk mengesahkan kewujudan pusar di perairan Kuala Terengganu dalam musim peralihan.

ABSTRACT

The aim of this investigation is to understand the surface current circulation pattern off Kuala Terengganu. A drifting drogue was used to measure surface current during April 1993, the transitional period between the northeast and southwest monsoon seasons. Our results show that the drifting drogue moves in an almost circular motion, suggesting the presence of an eddy. However, further studies are needed to confirm the existence of an eddy off Kuala Terengganu during the transitional period.

Keywords: surface current circulation, coastal erosion, drogue, eddy, knot, nautical miles

INTRODUCTION

Due to coastal erosion along the Kuala Terengganu coastline, current circulation has been of interest to many researchers. A million dollar project to prevent further erosion has been initiated. Although many studies have been done, the understanding of surface current circulation patterns in this area remains unclear.

Kawamura (1986) used satellite data to show that circulation in the Gulf of Thailand headed southwards, along the east coast of Peninsular

Malaysia, to Kuala Terengganu. In another report, Liew *et al.* (1987) found that even at 85 km from the coastline, tides have some influence on both the speed and direction of surface currents. Saadon and Rosnan (1991), using a drifting drogue, found that tide is the dominating factor shaping the surface current circulation. A study on the sub-surface current in the same area also indicated that tide plays a major role in current circulation in Kuala Terengganu waters (Saadon and Baharim 1992).

Previous studies were mainly conducted during the southwest and northeast monsoon seasons. Therefore, current circulation studies during the transitional period are still lacking. The aim of this study was to gain some understanding of the surface current circulation off Kuala Terengganu during the transitional period when the wind is generally weaker and more variable than during the monsoon seasons (Chua 1984).

There are many ways of measuring surface currents in shallow waters. One is by the use of drogues, which are inexpensive and easy to handle. Even with the presence of modern current meters, there are situations where drogues are more useful. Our results show that the path taken by the drogue was circular. Because this was the first attempt to study surface circulation during the transition period, the authors feel that further studies are needed to confirm the existence of an eddy.

MATERIALS AND METHODS

The drogue used in this study had two intersecting sails of 2.5 m length and 0.6 m width (*Fig. 1*). A weight below it ensured that it sank until its tether rope was taut and essentially vertical. The tether rope was polyethylene, 3 m in length and 5 mm in diameter. The surface float was a styrofoam board of size 50 × 50 × 4 cm . The flag mast was made from PVC tubing 2 m in length and 2 cm diameter. A small weight at the lower portion of the flag mast stabilized the mast, which carried a marker flag of 30 × 20 cm above the water surface. It also carried a beacon for night-time observation.

The drogue was deployed and its movement observed twice in the study area. The first deployment was at Lat. 5° 21.0' N and Long. 103° 14.0' E (about 5 nautical miles from the coastline) on 4 April 1993, at 1200 h. The drogue was allowed to drift for 53 hours and was recovered on 6 April 1993, at 1700 h. The next deployment started at 0800 h on 7 April 1993, at Lat. 5° 21.0'N and Long. 103° 18.0'E (about 8 nautical miles from the coastline). It was recovered 49 h later on 9 April 1993, at 0900 h.

The position of the drogue was taken hourly by bringing the research boat (UNIPERTAMA III) close to the drogue during each deployment. The exact position of the drogue was determined with the use of a global positioning system (GPS) installed in the research boat. All positions were then plotted on navigational chart No. 771.

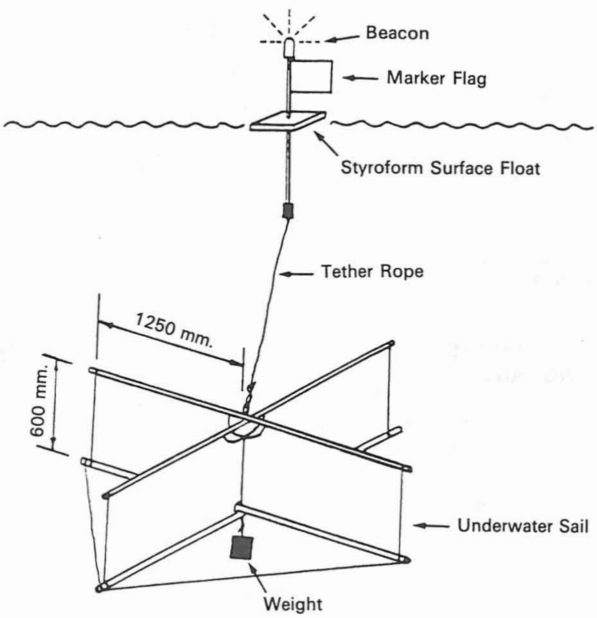

Fig. 1. The drogue used in this study

RESULTS

In the first deployment (*Fig. 2*) the drogue moved northward very fast immediately after release with a speed of approximately 1.5 knot (0.77 m/s). One hour later its speed slowed, but the net direction of movement was northward. During this period the tide was flooding. This northward movement continued for 7 hours. At 1900 h on 4 April 1993, it started to take a southerly direction, coinciding with ebb tide. This southerly direction lasted for 5 h before the drogue moved north again and then northeast till 1100 h on 5 April 1993. During this period the tide was low at 0148 h, high at 0700 h and low again at 1246 h.

After 1100 h on 5 April 1993, and with tide flooding, the drogue moved southward until 2000 h. It then moved west for 4 h, north for 1 h, and east for 2 h. The tide was ebbing. Then it moved south and westward. At 0800 h on 6 April it moved north until it was recovered. During this last portion of its journey the tide was flooding. Throughout the whole 53-hour period, the drogue travelled a distance of about 21 nautical miles with an average speed of about 0.4 knot (0.2 m/s).

In the second deployment (*Fig. 3*) the drogue moved towards north in a zigzag manner for 10 h. At the time of release the tide was ebbing. Then it moved south, also in a zigzag manner, for 14 h, during which time the effect

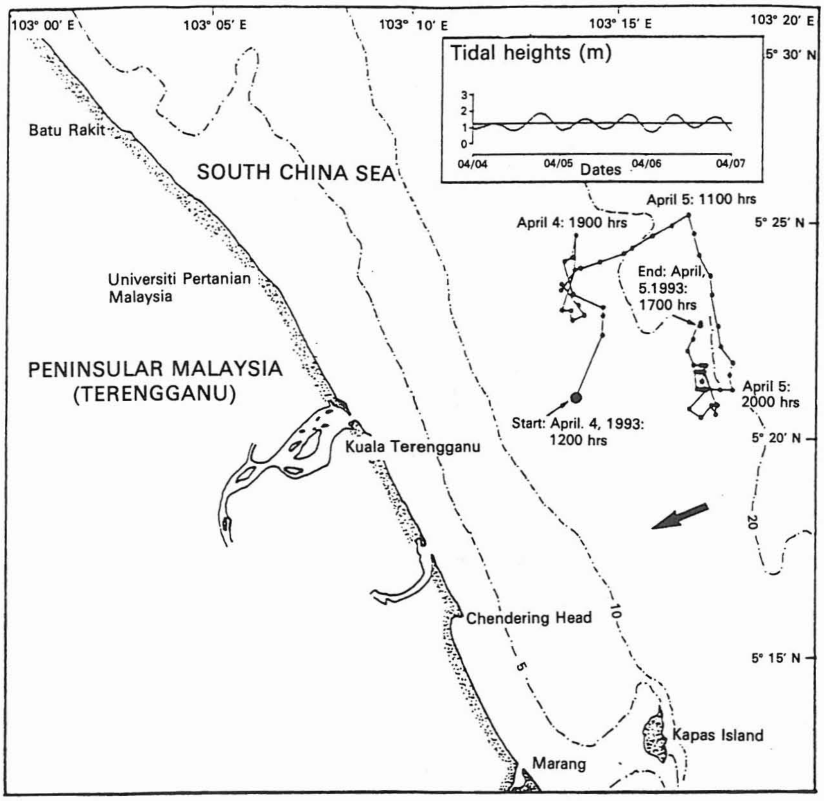

Fig. 2: The path taken by the drogue from 4 April (1200 h) to 6 April 1993 (1700 h). Each small dot represents the hourly position of the drogue. The data for the tidal curve during the first deployment are taken from Anon (1993). The arrow shows the average wind direction during the observation period. The bathymetric contours are in metres.

of tide on its movements was not very obvious. It then meandered eastward and then slightly south before it was recovered. In this period the tidal effect was also not very obvious. From 7-9 April 1993, the drogue had drifted for 49 h, covering a distance of about 13 nautical miles with an average speed of 0.27 knot (0.14 m/s).

Table 1 shows that the wind direction throughout the observation periods was northeasterly. Comparing this wind direction with the route taken by the drogue in the first deployment, there seems to be no correlation between them. Similarly, in the first half of the second deployment there is also no correlation between the direction of wind and drogue movement. However, in the second half of the second deployment, when the drogue drifted generally westward, the general direction of the drift seems to have some correlation with wind direction.

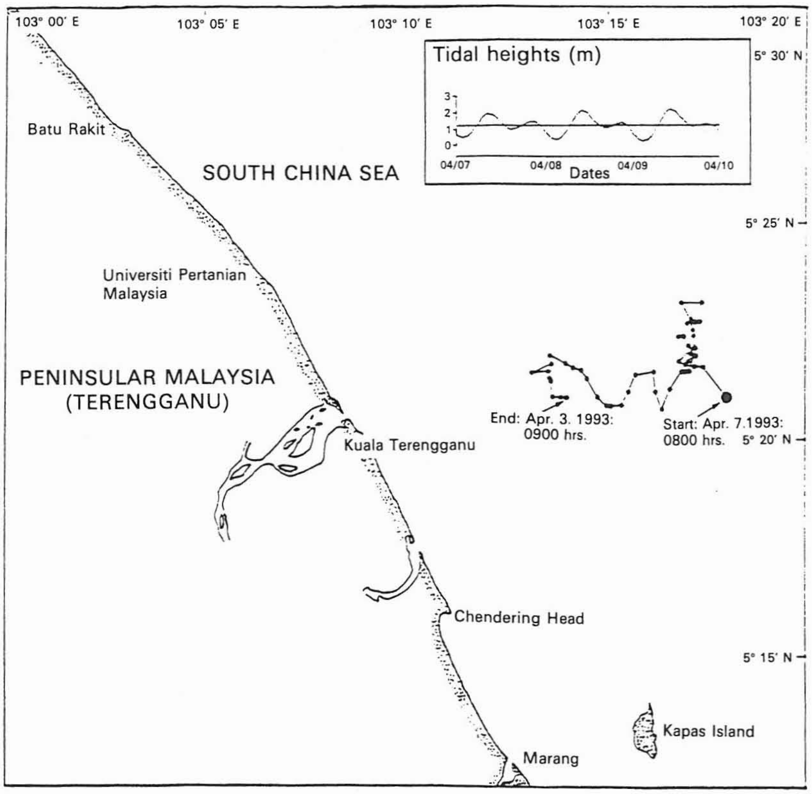

Fig. 3: The path taken by the drogue from 7 April (0800 h) to 9 April 1993 (0900 h). Each small dot represents the hourly position of the drogue. The data for the tidal curve during the second deployment are taken from Anon (1993). The arrow shows the average wind direction during the observation period. The bathymetric contours are in metres.

TABLE 1
Records of daily mean wind speed and direction in Kuala Lumpur during the observation periods

Data	Mean Speed (m/s)	Direction (Degrees)
April 4, 1993	1.4	70
April 5, 1993	1.4	50
April 6, 1993	1.2	80
April 7, 1993	1.0	80
April 8, 1993	1.8	30
April 9, 1993	1.3	90
Average	1.35	66.67

(*Source*: Malaysian Meteorological Service)

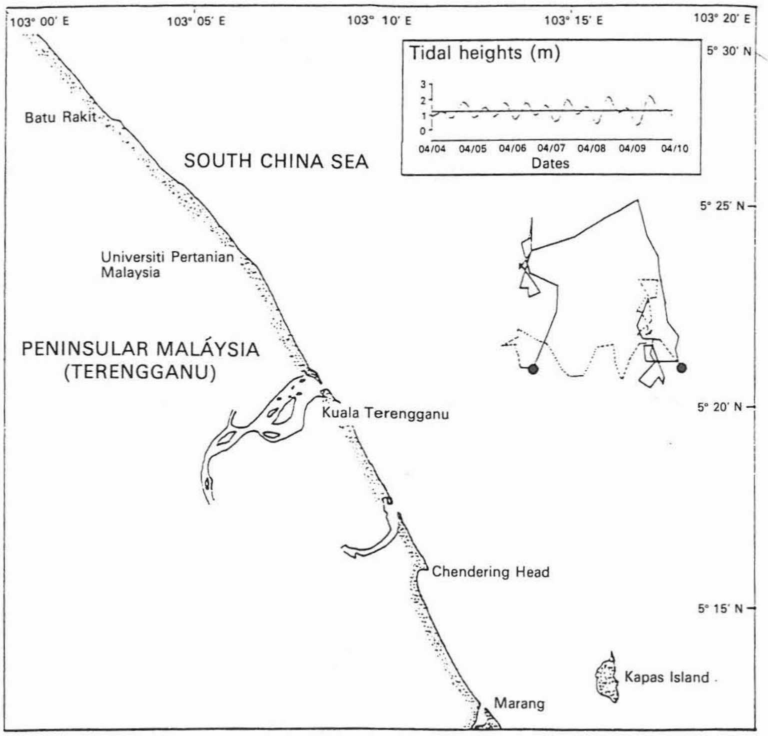

Fig. 4: The two paths taken by the drogue during the first deployment (solid line) and second deployment (broken line) are superimposed. Tidal curve during the observation period is taken from Anon (1993). The arrow shows the average wind direction during the observation period.

When the two paths of the drogue in the two deployments are superimposed (*Fig. 4*), it is found that the drogue moved in one big circle. Within this circle there are two locations (approximately Long. 103° 14'E and Long. 103° 17'E) where the drogue kept moving in a north to south direction and vice versa, which makes the paths of the drogue very confusing and difficult to analyse.

DISCUSSION

The South China Sea has a monsoon climate. To better understand the dynamics of the monsoon seasons, the reader is referred to Morgan and Valencia (1983) and Saadon and Camerlengo (1995).

The monsoon winds generate the current circulation in the east coast of Peninsular Malaysia. Coastal currents generally flow parallel to the coastline. The current flows southward (northward) during the northeast (southwest) monsoon (Saadon and Camerlengo 1995). However, the current pattern during transitional periods is not clear.

Throughout the observation periods, the average wind blew mainly from the northeast. However, the drogue did not move southward, except for the second half of the second deployment (*Fig. 3*). The wind is generally weak during the transitional periods, so the current circulation is not well defined. Our results show that the surface circulation moves in a large circle (*Fig. 4*). Water moving in a circular motion usually indicates the presence of an eddy. However, eddies are usually generated by the horizontal shear of the mean flow.

Eddies extract energy from the mean flow kinetic energy. Thus, energy is supplied to the eddies by the horizontal shear of the mean flow. The study was conducted during the transitional period, when winds are light and variable. It is generally admitted that surface ocean currents are driven by winds. Therefore, it would be premature to suggest (within this transitional period) the existence of a mean current flow off Kuala Terengganu compared to the mean current flow existing during both monsoon seasons.

CONCLUSION

This was the first attempt to study the surface circulation during the transitional period. Our results show that the drogue took an almost circular motion, which usually indicates the presence of an eddy. We feel that further studies are needed to determine the possibility of an eddy off Kuala Terengganu during the transitional period.

ACKNOWLEDGEMENTS

The authors would like to thank UPM for funding this project and the crew of UNIPERTAMA III for helping in the data collection.

REFERENCES

ANON. 1993. *Jadual Ramalan Pasang Surut (Tide Tables) Malaysia 1993.* Kuala Lumpur: Jabatan Ukur dan Pemetaan Malaysia.

CHUA, T.E. 1984. Physical environments of the east coast of Peninsular Malaysia. In *Coastal Resources of East Coast Peninsular Malaysia*, ed. T.E. Chua and J.K. Charles, p. 1-10. Penang: Universiti Sains Malaysia Press.

KAWAMURA, G. 1986. A preliminary survey of the sea surface in Malaysian waters and the Gulf of Thailand with the aid of satellite data utilization system. In *Ekspedisi Matahari '85*, ed. A.K.M. Mohsin, M.I. Mohamed, M.A. Ambak, p. 45-48 Faculty of Fisheries and Marine Science Occasional Publication No. 3. Serdang: Universiti Pertanian Malaysia Press.

LIEW, H.C., KHALID SAMO and S. MASUMITSU. 1987. Subsurface currents off the south-western portion of the South China Sea. In *Ekspedisi Matahari '86*, ed. A.K.M. Mohsin, A.R. Ridzwan and M. A. Ambak, p. 17-22 Faculty of Fisheries and Marine Science Occasional Publication No. 4. Serdang: Universiti Pertanian Malaysia Press.

MORGAN, J.R. and M.J. VALENCIA. 1983. The natural environmental setting. In *Atlas for Marine Policy in Southeast Asian Seas*, ed. J.R. Morgan and M.J. Valencia, p. 4 - 17. Berkeley: Univ. of California Press.

SAADON, M.N. and M.H. BAHARIM. 1992. Current measurements in the coastal waters off Kuala Terengganu during the northeast monsoon. In *Proceedings of the Third ORI-LIPI Seminar on Southeast Asia Marine Science: Oceanography for Fisheries*, ed. T. Sugimoto, K. Romimohtarto, S. Soemodihardho and H. Nakata, p. 23-30. Tokyo: Ocean Research Institute.

SAADON, M.N. and A. CAMERLENGO. 1995. Response of the ocean mixed layer, off the east coast of Peninsula Malaysia during the northeast and southwest monsoons. *GEOACTA*. [in press].

SAADON, M.N. and Y. ROSNAN. 1991. The relationship of tide and wind to the coastal water movements of Kuala Terengganu. In *Proceedings of IEM/ICE Joint Conference 1991 - Coastal Engineering in National Development*, p. 16 - 30. Kuala Lumpur: Board of Engineers.