

NEARSHORE CIRCULATION IN THE SEA OFF VELSÃO, GOA

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ABSTRACT

Results of the studies on circulation in Velsao bay and adjoining areas are presented. In the near shore regions of the head of the bay, strong tidal influence was observed and the tidal variations in currents decreased with increasing distance from the shore. At 2 km and further offshore, the onshore component of the current was mostly absent and the circulation pattern showed some seasonal variations in the coastal current system. The implications of these findings in relations to the dispersal of any pollutants discharged in the area, are discussed.

INTRODUCTION

Velsao (Lat. 15°22'N, Long 73°53'E) is a small village located south of the Mormugao harbour. It is situated at the head of a small bay caused by a rock promontory south of the Mormugao harbour. This paper presents the results of investigations on circulation carried out in the Velsao bay. The Velsao bay (also known as the Cola bay) is approximately triangular in shape and extends to about 2.5 km into the land. It is an open bay with a mouth which is about 3.5 km wide. The bay has an area of about 2.3 km² and is shallow having an small bay caused by a rock promontory average depth of about 7 m. The northern shore of the bay is mostly rocky and the eastern side is bordered by a long sandy beach.

The Zuari Agrochemicals, the fertiliser factory of Goa is located near Velsao. This factory discharges its industrial effluents into the Velsao bay. The studies on currents in the area were undertaken to ascertain the dispersal characteristics of any effluents discharged into the sea in this area.

The importance of circulation in problems relating to discharge of pollutants is obvious. In the coastal embayments, the presence of tidal currents make the bay circulation distinctly different from the prevailing seasonal coastal current pattern. (Srivastava, *et al*, 1972). Along the central west coast of India, observations on currents in the inshore waters have been limited to spot measurements (Rao, *et al* 1974; Che-

rian, *et al*, 1975; Varma, *et al*, 1975). Fixed station observations on the tidal variations of currents have been carried out by Nair and Bhattathiri (1968) in the Angria bank region.

MATERIAL AND METHODS

Four observation stations were fixed along the axis of the Velsao bay at distances of approximately 0.5 km, 1.0 km, 2.0 km and 4.0 km from the head of the bay. The locations of stations I — IV are shown in Fig. 1. The bay circulation was studied by observing the direction and speed of the currents at the surface, mid-depth and nearbottom levels (1.0 m above the bottom) at these stations using a Direct Reading Current Meter from an anchored boat. Observations were also carried out by tracking the movements of surface and subsurface vane floats using two theodolites fixed on the shore. Six surveys were carried out during the period November, 1973 to September, 1974. Two of these surveys were carried out over complete tidal cycles, two during the mid-flood stage of the tide and two during the mid-ebb stage of the tide.

RESULTS AND DISCUSSION

At Station I and II oscillatory tidal currents were encountered. Station I exhibited pronounced variations in the speed and direction of the currents with the tide. At this station, the direction of flow is approximately southwesterly during the rising tide and north easterly during the falling tide. The tidal conditions on the two days

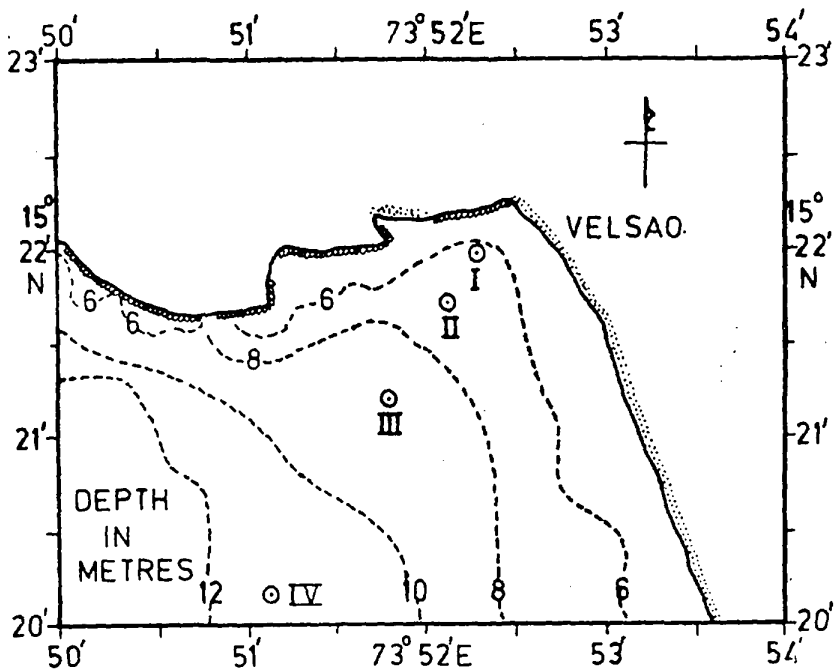


Fig. 1 : Map showing location of stations.

(29.3.74 and 10.5.74) on which observations were made over complete tidal cycle were identical. Correspondingly, the variations in the direction of the currents were also identical on both days. However, the currents were faster during May than during March. At Station I, during May, the speed varied between 7.5 cm/sec and 24 cm/sec at the surface, 7 cm/sec and 36 cm/sec at mid-depth and 9 cm/sec and 46 cm/sec at near-bottom levels over a tidal cycle. During March, the tidal variations in current speed at this station were between 3.5 cm/sec and 13 cm/sec at the surface, 0 cm/sec and 23 cm/sec at mid-depth and 0 cm/sec and 25 cm/sec at the bottom (1m above the bottom). At the surface, the direction of flow changed from southwest to northeast over a tidal cycle. At mid-depth and near the bottom, the direction varied over wider angles than at the surface.

At Station II the currents were faster than at Station I and the currents showed

lesser tidal variations in both speed and direction. The direction of the surface current varied from south to northwest at the surface. The change in direction over a tidal cycle decreased towards sub-surface depths. Near the bottom, the direction of flow changed from southwest to west. During May, the speed of the current varied between 8.5 cm/sec and 22 cm/sec at the surface, 7 cm/sec and 27 cm/sec at mid-depth and 18 cm/sec and 37 cm/sec near the bottom. During March, the variations were between 7.5 cm/sec and 23 cm/sec at the surface, 9 cm/sec and 25 cm/sec at mid-depths and 7 cm/sec and 27 cm/sec near the bottom.

At Station III, over a tidal cycle, the direction of the currents changed from northwest to southwest. The speed of the surface current varied between 10 cm/sec. and 22 cm/sec. During March and between 12 cm/sec and 28.5 cm/sec during May. The speed showed slight decrease with depth.

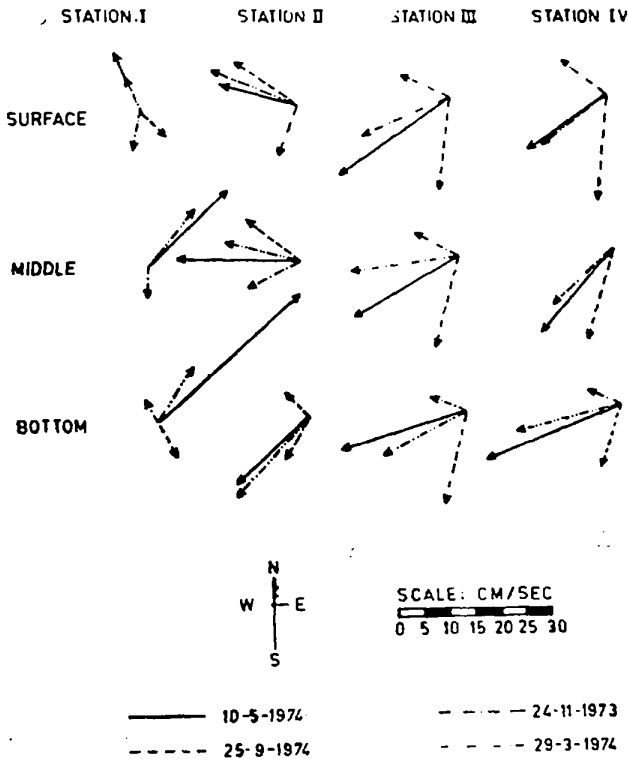


Fig. 2 : Vectors showing currents at Stations I to IV during flood tide

The currents do not show much variation in direction and speed with the tide as at Stations I and II.

Station IV showed flows directed between northwest and southwest at the surface and at subsurface levels. There is not much difference in speeds of the currents between Stations III and IV.

Figures 2 and 3 show the velocity variations of currents at the surface, mid-depth and near-bottom levels during mid-ebb and mid-flood tides on various days. A comparison of Figs. 2 and 3 shows that Stations I and II exhibit tidal variations and do not show any seasonal variations in currents whereas Stations III and IV exhibits seasonal variations and not much tidal

variations. The seasonal variations exhibited by Stations III and IV are almost identical. At these stations, the surface current gradually increases from about 10 cm/sec in November to 25 cm/sec in May. After the southwest monsoon, the current speed decreases to about 15 cm/sec in September and 10 cm/sec in November. The surface current is directed towards south in September, west-north-west in November, northwest in January and February and west-north-west in March and May. The currents are mostly directed away from the bay at stations III and IV during both the ebbing and flooding tides and also during various seasons of the year. Thus the studies indicate that at Stations I and II the currents are oscillatory while at Stations

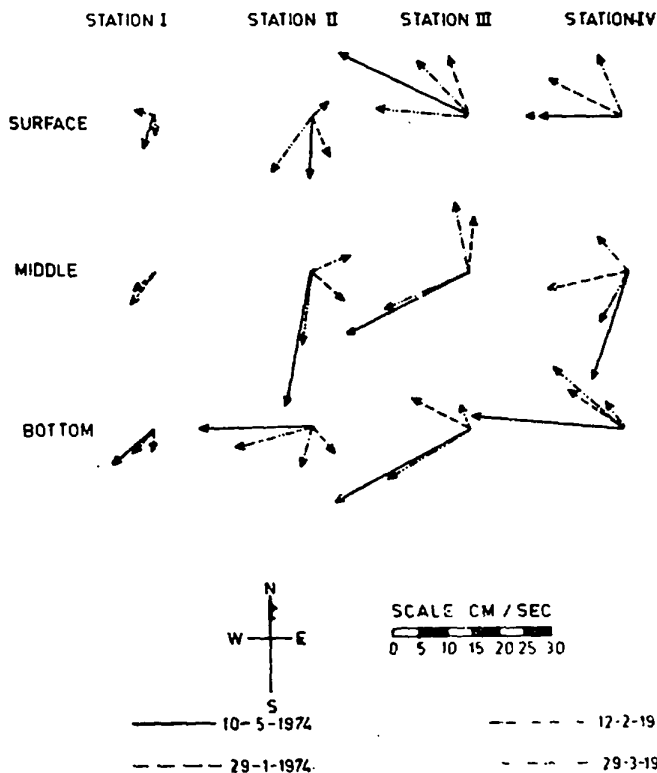


Fig. 3 : Vectors showing currents at Stations I to IV during ebb tide.

III and IV there is less onshore component of the current and a better dispersal of material due to currents.

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