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Coastal Currents near Waltair by double theodolite method

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ABSTRACT. Letting a system of 'drag and float' in the coastal waters by the aid of a catamaran boat and following it from the coast by means of double theodolite, the sea water currents are computed. The instrumental details and the results of observations made at the Palmbeach, Waltair are presented.

1. Introduction

The manifestation of coastal currents is much valuable for the fishing boats. It aids both for the security of the boat and for a better catch.

Letting a system of drag and float in the coastal waters and following it from the coast by means of a double theodolite (the two theodolites being kept apart by a known and reasonable distance along the coast), the (horizontal) currents have been computed from the trajectories of the drag-float. The instrumental details and the results of observations made at the Palmbeach of Waltair are presented in the subsequent paragraphs.

2. Instrumental details

Two square planks of wood (each side 60 cm) crossed at their vertical axes form into the drag. A cylinder of thin sheet (1/16 inch thick) of iron closed at both ends forms into the float. The diameter and the length of the cylinder are 30 cm each. The drag and the float are linked together. A suitable weight (13 kg) of iron is attached to the free end of the drag. The weight is so enough to allow the float to be just below the sea surface when the system is let into the sea. A light-weight aluminium tube of length three metres is fixed vertically to the top of the float. This three-metre mast carries a small red flag for identity. The drag, when let into the sea, is carried away by the currents and the float with its mast just follows the former. The wind stress is not felt at the float as it is submerged in the water without being exposed to the wind. The drag and float system is shown in Fig. 1.

Two theodolites are situated along the coast and are separated by a distance of 518 metres (1700 ft). A boatman takes the system of drag and float on a catamaran boat, then lets it off in the sea at a suitable distance from the coast. The boatman watches the float-mast without disturbing its surroundings. Two observers, one at each of the two theodolites, follow the float-mast through their respective theodolites after synchronising their stop-watches. Thus the two observers record simultaneously the angle subtended by the float at their respective theodolites at regular intervals of time. From these data, the positions of the drag at various instances can be obtained by triangulation method. It means the trajectory of the drag can thus be achieved. The currents in a particular region can be computed from the corresponding trajectory.

This method of obtaining currents is subjected to certain limitations. It is not possible to cover the breakwater zone by the use of an ordinary catamaran boat as it is not easy to control the boat in the breaker zone. Unless the distance between the two theodolites is reasonably large enough, much error would involve in the current values which are determined by the triangulation method. The coastline along which the two

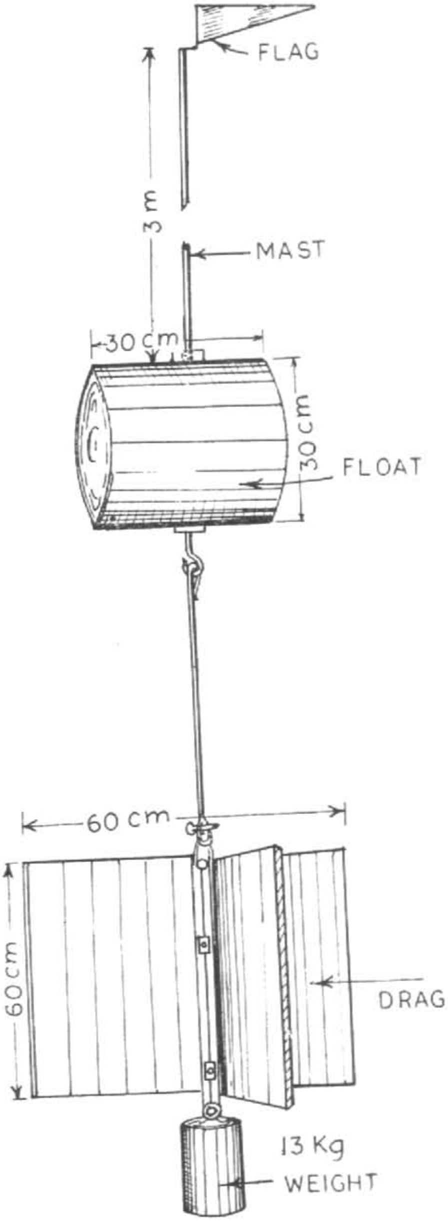

Fig. 1. The drag meter

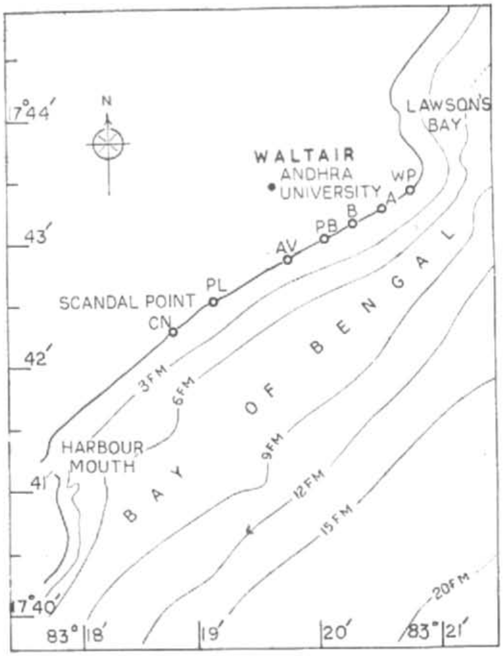

Fig. 2. Location of stations

A and B—The stations of the two theodolites. WP, PB, AV, PL and CN—The stations of wave refraction studies

theodolites are installed should be straight for easy and direct communications between the two observers at the theodolites. Above all, the resolving power of the theodolite puts its own limitation on the distance of observation of the float-mast. With all these limitations, this method of obtaining currents seems to be a useful one.

3. Analysis and Results

Currents have been computed from the observations made at the Palmbeach of Waltair during the months of January, February and March in the year 1959. The locations (A and B) of the two theodolites is indicated in Fig. 2. The observations were conducted on ten different days during this season. The average picture of the currents for this season is presented in Fig. 3.

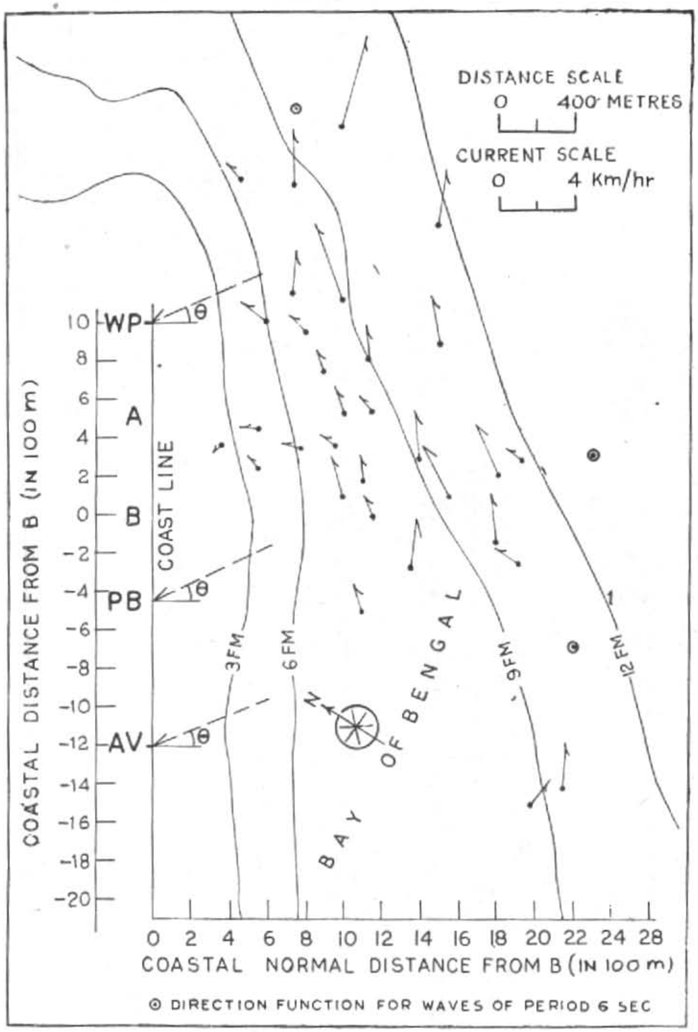

Fig. 3. Currents

The arrows represent current velocities (at their roots)
The circles indicate zero velocity

The depth contours are drawn following the survey chart No. 3002 published in 1960 by the Naval Hydrographic Office, Dehra Dun.

It can be found from Fig. 3 that the general flow of water is towards the eastnortheast with an average strength of about 1·5 km per hour (0·5 m/sec.). Its strength rarely exceeds 3 km per hour. This flow may be in continuation of the general circulation during this season in the Bay of Bengal. These results are comparable with those presented by Ganapathi and Murty (1954).

The observations rarely extended towards the coast from the three-fathom line. This being the breaker zone, it was difficult to

TABLE 1

Direction Functions

Station	Direction Function θ for waves of period	
	6 sec	8 sec
WP	23°	19°
PB	24°	20°
AV	22°	17°
PL	20°	19°
CN	23°	18°

the boatman to manage the boat in this zone. The observations below the three-fathom line indicate a zero current region. Using the data on the wave characteristics off the breaker zone, collected by the Visakhapatnam Harbour authorities, wave refraction diagrams have been constructed (for waves of periods of 6 and 8 seconds) for the stations WP, PB, AV, PL and CN along the coast. The method of Arthur, Munk and Isaacs (1952) has been adopted for constructing the wave refraction diagrams. The direction functions of the wave refraction diagrams have been presented in Table 1 and they are also indicated in dotted lines at the corresponding stations in Fig. 3. The direction function, θ, at a station gives the angle subtended by the wave ray to the normal drawn to the coast line at that station. The direction function provides information regarding longshore current or littoral current. The direction functions at all the stations indicate that the wave rays approach the coast from the north of the coast-normal drawn at each station. The analysis of the wave refraction diagrams following the method adopted by Putnam, Munk and Traylor (1949) indicates the southward direction of the longshore current and the same confines itself to the breaker zone, should be southward, unlike the direction of the general circulation in the offshore waters. Therefore, null regions could be expected at the common boundary of the littoral currents and the general circulation, wherever these two currents are equal in strength.

It is interesting to notice a 'calm' region in the offshore waters at the vicinity of the 12-fathom line. It could be expected that the tidal flow would be more rapid when the tide level passes its mean level from 'low' to 'high'. It has been verified that the observations which contribute to the zero velocity of current at the far off (at about the 12-fathom line) correspond to such time of tidal cycle. Moreover, the tidal current at such a time would be into the harbour channel which is about 6 km southwest of the station B. Under such conditions, the flow due to the tides would oppose the general circulation. Wherever both of them are equal in strength, the effective current would be zero.

Extending the area of observations towards the south of the harbour and to somewhat far off the coast and simultaneous observations on the wave characteristics and more frequent observations are necessary for making more rigorous analysis and for obtaining more useful results.

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