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Study of Longshore Current Equations for Currents in Visakhapatnam Beach

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Longshore currents were measured along the Visakhapatnam beach at weekly intervals from March 1978 to March 1979. Visual observations on breaker characteristics were also made during this period. Using modified Longuet-Higgins equation and Galvin equation, the longshore currents were computed and compared with measured longshore currents.

Visakhapatnam beach is about 7.5 km long and has great recreational value. Earlier studies[1] on this beach are mostly confined to the evaluation of beach profiles and description of the accretion and erosion processes. A thorough understanding of the longshore current pattern including rip currents is essential to evaluate the recreational value of the beach and the nearshore waters. This paper presents data on longshore currents along the Visakhapatnam beach and visual observations on breaker characteristics.

Materials and Methods

Study area—Coastal processes at Visakhapatnam beach are influenced by the rocky promontories existing near Lions Club Park, Red Light House, Waltair Point and Kailasa Range hill and the outer harbour breakwaters (Fig. 1). The beach lying between the fishing harbour and Palm beach is about 90 m wide while further north up to the Kailasa Range hill it is about 150 m wide. Northern side in between Waltair point and Kailasa Range hill, there is a shallow bight (Lawson's Bay). The shoreline in this particular area is almost straight with depth contours nearly parallel to the shoreline. Major part of the beach undergoes erosion during southwest monsoon and deposition during northeast monsoon and calm weather period[1].

Nine stations were established from north of fishing habour to Kailasa Range hill (Fig. 1). Longshore currents were measured at every 50 m distance along the coast at weekly intervals during March 1978 to March 1979. Most of the observations were made during 0600 and 0900 hrs irrespective of the tidal phase. The average magnitude and direction of longshore currents were measured by releasing neutrally buoyant rubber balloons in the surf zone and noting the distance travelled by them in 2 min. Simultaneously at each station, the breaker heights were noted visually. The approximate breaker angle was also recorded. Wave periods were measured by noting the average time elapsed between 10 consecutive waves beyond the breaker zone. The longshore current velocity was computed[3] using the following formulae:

$$V = 20.7\, m\, (g\, H_b)^{\frac{1}{2}} \sin 2\, \alpha_b$$

(modified Longuet-Higgins equation)

$$V = K\, g\, m\, T_b \sin 2\, \alpha_b$$

(Galvins equation)

where, V is longshore current velocity;

g acceleration due to gravity; m beach slope; k parameter of breaker form[3]; H_b breaker height; T_b breaker period; and α_b breaker angle.

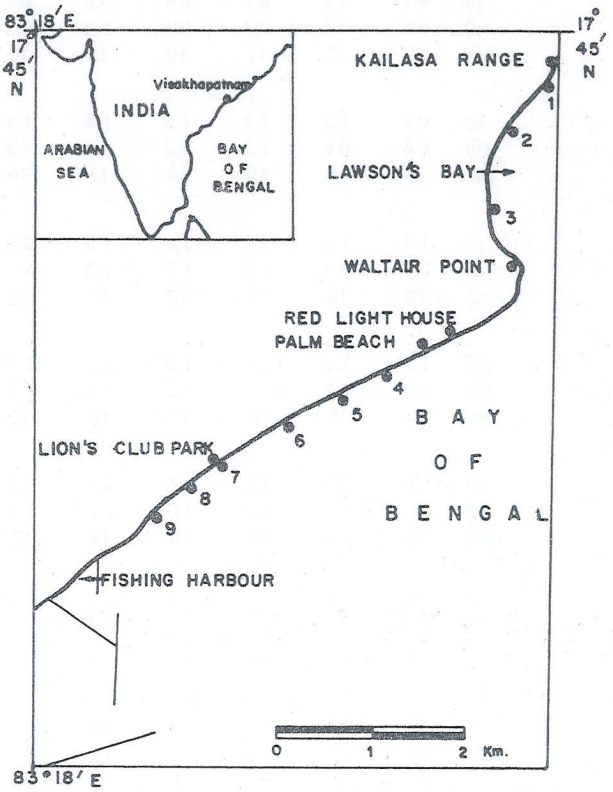

Fig. 1—Location map

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The average foreshore slope during the mid tide level was measured and it was taken as 1 in 30. The parameter of the breaker form was taken as 1.

Results and Discussion

Maximum and average breaker heights, average wave periods and observed breaker angles in different months are given in Table 1. From May to October the average breaker heights were more compared to rest of the period. The average wave periods varied mostly between 8 and 12s. Waves approach from south and break at an angle of about 5° to the shoreline during southwest monsoon period (March to Sept.). A reversal of direction of wave approach is observed during northeast monsoon period (Oct. - Feb.) and the waves break at an angle of about 10° to the shorline. The general direction of the longshore currents was towards NE from April to Aug. and towards SW from Oct. to Feb. The longshore current direction was transitional and variable in March and Sept. Ince and Jamieson[2] have reported that the longshore currents at Visakhapatnam are in a northerly direction during

Table 1—Maximum and Average Breaker Heights, Average Wave Periods and Observed Breaker Angles

	1978										1979		
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March
						St 1							
(i)	0.6	1.2	1.4	1.5	1.0	1.4	1.4	1.4	1.1	0.7	0.8	0.6	0.8
(ii)	0.4	0.7	1.0	1.2	0.7	1.2	1.2	1.2	0.7	0.6	0.6	0.5	0.5
(iii)	10	10	10	12	10	12	12	11	12	13	11	9	8
						St 2							
(i)	0.8	1.2	1.7	1.5	1.0	1.5	1.3	1.4	0.9	0.7	0.8	0.6	0.8
(ii)	0.6	0.7	1.0	1.2	0.7	1.2	1.1	1.2	0.5	0.6	0.5	0.5	0.5
(iii)	12	12	10	12	10	11	13	11	15	10	11	9	10
						St 3							
(i)	0.7	0.6	0.7	0.9	0.6	0.7	0.6	0.6	0.5	0.5	0.4	0.5	0.5
(ii)	0.5	0.4	0.4	0.6	0.4	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3
(iii)	12	12	11	10	15	12	12	12	15	11	11	12	12
						St 4							
(i)	0.9	1.2	2.3	1.6	1.8	1.9	1.2	2.0	1.3	0.7	1.0	0.7	0.8
(ii)	0.6	0.9	1.5	1.2	1.3	1.2	1.0	1.2	0.7	0.6	0.6	0.4	0.6
(iii)	10	10	10	10	13	10	14	11	15	10	15	11	13
						St 5							
(i)	1.4	1.2	2.3	1.6	1.5	2.0	1.2	2.4	1.3	0.7	1.0	0.7	0.8
(ii)	0.7	0.9	1.5	1.2	1.2	1.3	0.9	1.2	0.7	0.6	0.6	0.6	0.6
(iii)	10	10	9	10	13	12	10	11	15	10	15	11	10
						St 6							
(i)	1.3	1.2	2.3	1.6	1.2	2.0	1.1	2.0	1.3	0.7	1.0	0.8	0.9
(ii)	1.0	0.9	1.7	1.2	1.0	1.3	0.8	1.2	0.7	0.6	0.6	0.6	0.7
(iii)	10	10	10	10	10	12	10	11	15	10	14	11	12
						St 7							
(i)	1.0	0.9	2.1	1.6	1.4	1.8	1.2	1.4	0.9	0.7	0.8	0.7	0.6
(ii)	0.6	0.6	1.2	1.0	1.2	1.2	0.8	0.7	0.6	0.4	0.5	0.5	0.4
(iii)	10	10	10	10	10	12	10	10	14	12	14	10	10
						St 8							
(i)	1.0	0.9	1.8	1.6	0.7	1.2	1.2	1.1	0.7	0.6	0.5	0.7	0.7
(ii)	0.6	0.6	1.2	1.0	0.6	1.0	0.6	0.7	0.5	0.3	0.3	0.5	0.4
(iii)	10	10	9	10	10	12	10	10	12	8	13	14	11
						St 9							
(i)	0.7	0.9	1.8	0.7	0.6	1.2	0.6	1.1	0.7	0.6	0.5	0.6	0.6
(ii)	0.5	0.6	1.2	0.6	0.5	1.0	0.5	0.7	0.5	0.4	0.3	0.5	0.4
(iii)	10	10	9	12	12	12	10	10	12	10	13	14	12
Breaker angle*	2	3	3-5	3-5	5	2	5	178	170	175	174	179	4

(i) $H_B max$ = maximum breaker height (m); (ii) $H_B av$ = average breaker height (m); (iii) T = average wave period (s).
*Measured in degrees clockwise with respect to coast.

southwest monsoon and in a southerly direction during northeast monsoon as indicated by measurements and observations of beach changes due to littoral drift. Speed and direction of longshore currents along the Visakhapatnam beach during different months are shown in Figs 2 and 3.

At sts 1 and 2, the longshore current speed was <0.3 m.s^{-1} during April to Aug. and for about 20% of the time it was >0.3 m.s^{-1}. The longshore current direction was consistently towards NE. It is interesting to note that only very weak currents were found to occur near st 3 (<0.1 m.s^{-1}). The currents between sts 3 and 4 were influenced by the protruding rocky outcrops. The current speed at these stations was in general <0.3 m.s^{-1}. From sts 4 to 7, the beach is exposed to comparatively high wave energy and the observed longshore currents show considerable variation in speed. Currents >0.3 m.s^{-1} were observed for more than 30% of time. Currents exceeded 0.7 m.s^{-1} for 5% of the time. Longshore currents in reverse direction (towards SW) were noticed for 10% of the time. At near sts 8 and 9, the currents were moderate ranging from 0.1 to 0.5 m.s^{-1}. At these places, the waves diffracted by the breakwaters have also influenced the longshore current pattern.

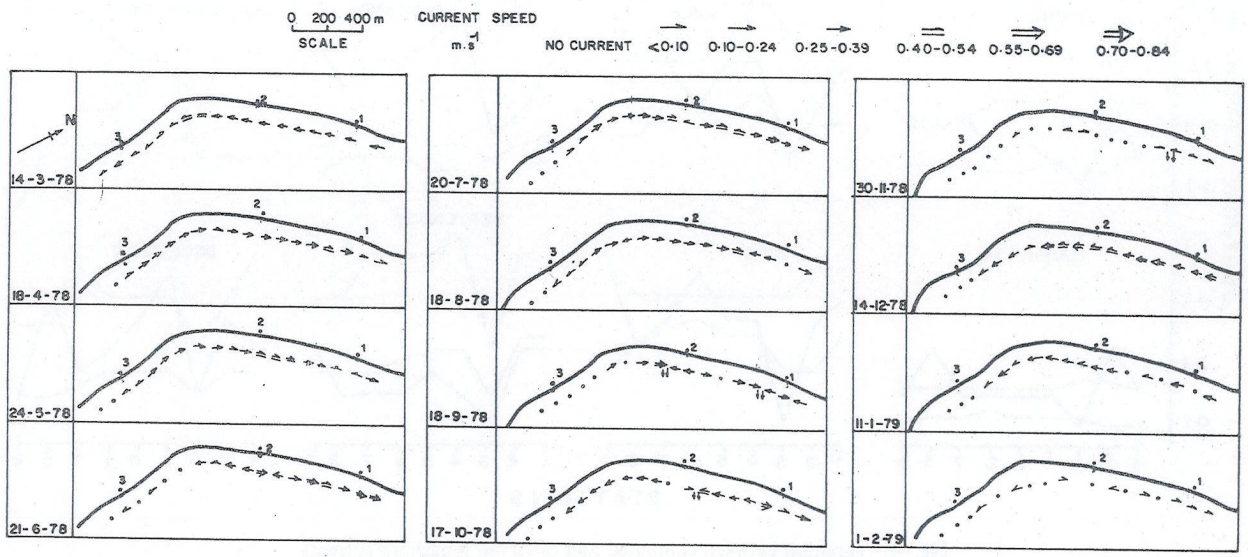

Fig. 2—Distribution of speed and direction of longshore currents from sts 1 to 3

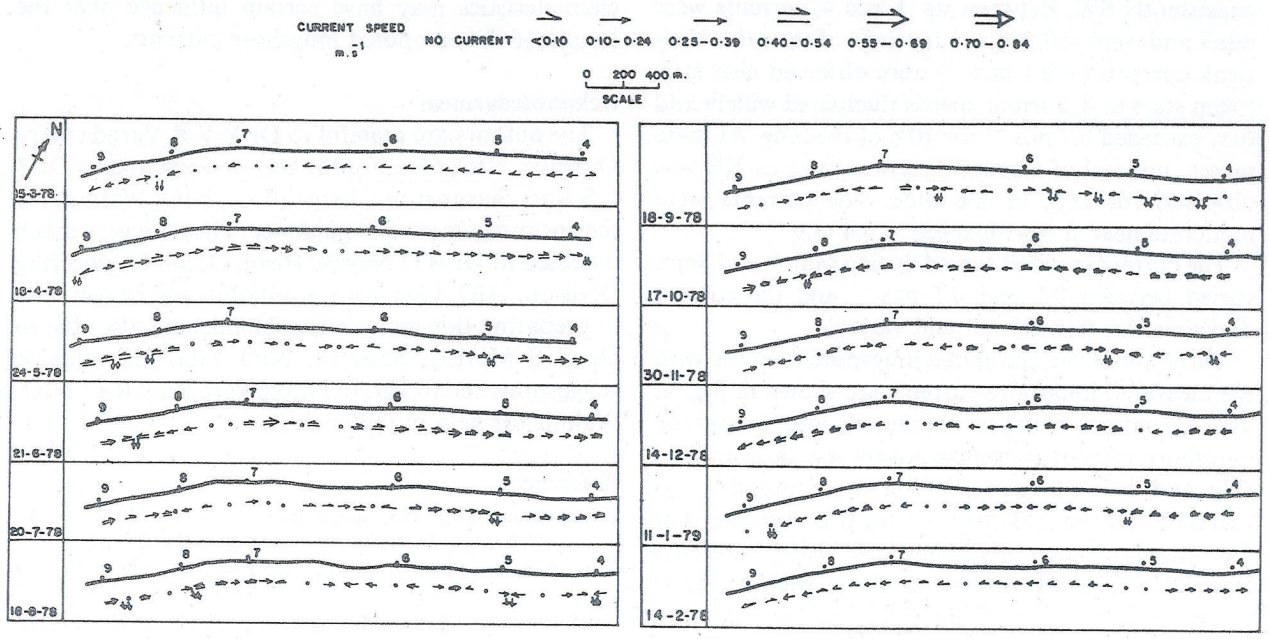

Fig. 3—Distribution of speed and direction of longshore currents from sts 4 to 9

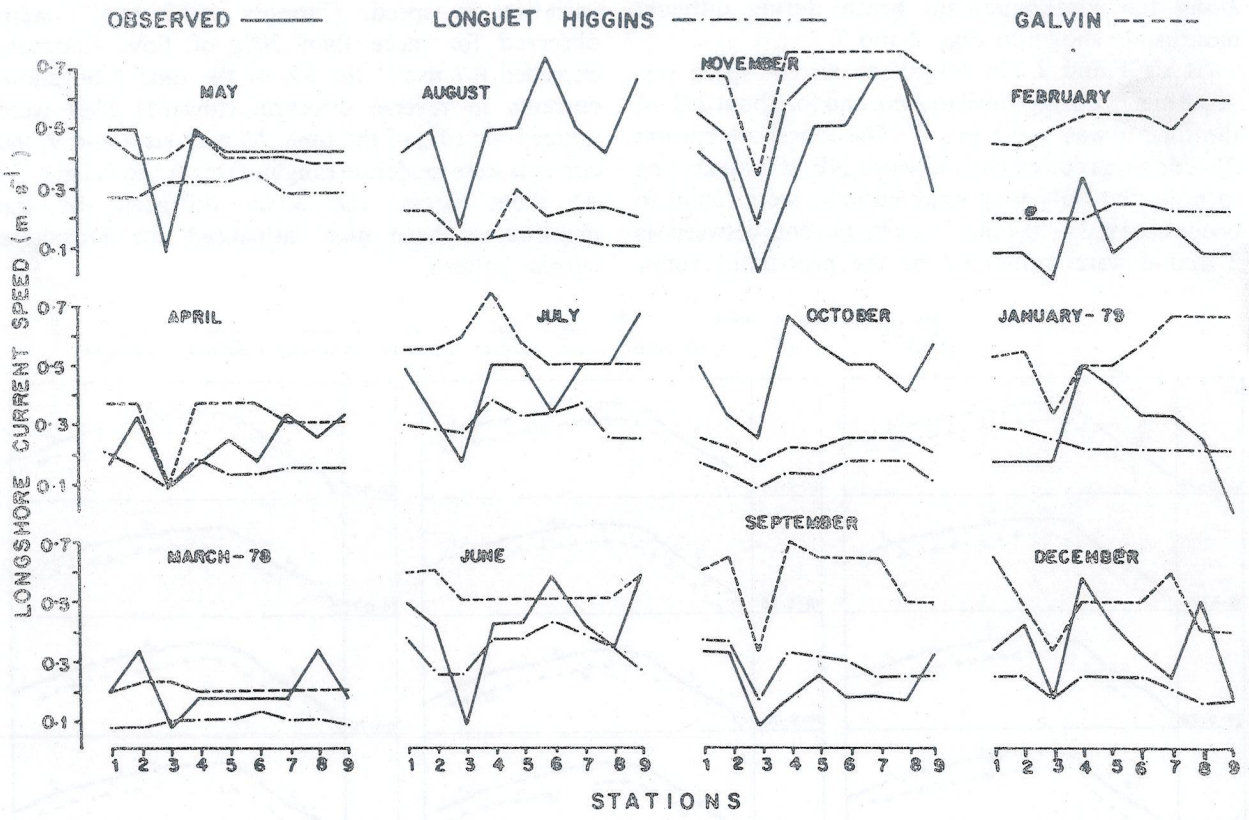

Fig. 4—Variation between computed and observed longshore currents

During Oct. to Feb. longshore current direction was consistently SW. Between sts 1 and 4, currents were weak and were <0.3 m.s^{-1} for most of the time. Very weak currents (<0.1 m.s^{-1}) were observed near st 3. From sts 4 to 8, current speeds fluctuated widely and they exceeded 0.7 m.s^{-1} for 10% of the time. At these places, reversal of current direction towards NE was observed for 20% of the time. The currents were moderate near st 9 with speed <0.4 m.s^{-1}.

The current speed observed during March and Sept. varied between 0.1 and 0.5 m.s^{-1} and the current direction was transitional and variable.

Variation of the computed longshore currents with the measured longshore currents are shown in Fig. 4. The deviation between measured and computed longshore current is comparatively less in March to July and Nov. to Jan. During other months, the variation is more and inconsistant. It is observed that the longshore currents computed using modified equation of Longuet-Higgins show slightly lesser values, whereas those computed by Galvin equation show consistently higher values than the measured currents. The visually observed data on breaker characteristics may have certain influence over the results of the computed longshore currents.

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